Feeding ecology of monkfish *Lophius* gastrophysus in the south-western Atlantic Ocean

M.F.M. VALENTIM^{1,2}, E.P. CARAMASCHI¹ AND M. VIANNA²

¹Universidade Federal do Rio de Janeiro, CCS/IB, Deptartamento de Ecologia, ²Deptartamento de Biologia Marinha, Avenida Pau Brasil, 211 Ilha do Fundão, Rio de Janeiro, PB 68020, PC 21941-541- RJ, Brazil

The diet of the monkfish Lophius gastrophysus is described based on the analysis of stomach contents, for the south-western Atlantic from samples landed in the fishing port of Niteroi, Rio de Janeiro state, Brazil, from April 2004 to March 2006. Feeding intensity, measured as the presence or absence of contents in stomachs, and differences in the items' composition were analysed by sex, size-class and season. High feeding intensity predominated for females >32 cm and for males <31 cm. There was no seasonal pattern in the occurrence of full or empty stomachs. The most important category in the diet was fish with 25 identified species. Dactylopterus volitans showed the highest alimentary index value, mainly because of the feeding of juvenile monkfish. The second most important category was Mollusca, represented mainly by squid. No relationships between predator- and prey-lengths and weights were observed; but there was a tendency to consume light and small prey independently of the size of the monkfish.

Keywords: Lophius, stomach content, diet, temporal variation, size-classes variation, predator-prey relationship, Brazil

Submitted 30 April 2007; accepted 5 November 2007

INTRODUCTION

The monkfish *Lophius gastrophysus* occurs in the western Atlantic Ocean from North Carolina, USA, to Argentina (Figueiredo *et al.*, 2002). It is the only species of *Lophius* off the Brazilian coast, where it is known as 'tamboril' or 'toadfish'. Recently the species became the principal target of the fishing fleet that operates in depths of more than 200 m off the south-eastern and southern Brazilian coast (Perez & Wahrlich, 2005). It is much in demand because of its increasing value in the international fish market. The species is both a target of the deepwater gillnet fishery (Wahrlich *et al.*, 2004) and a bycatch component of the shrimp-trawler fishery (Vianna & Almeida, 2005). Despite its economic importance and the increasingly intense fishing pressure (Perez *et al.*, 2005), biological data on this species are sparse and urgently needed.

The family Lophiidae is known for the presence of the illicium, the modified first ray of the dorsal fin, which has on its distal end an esca, a pendulous fleshy structure similar to a bait. This feature, together with a flat, deep body, benthic habit, large mouth, and small recurved teeth, suggest that these fish use an ambush strategy to attract and capture prey. The Lophiidae embraces four genera and 25 species (Caruso, 1983), of which *Lophius* is the most important genus because of the commercial value of its seven species. The lophiid predator habit, suggested by the anatomical lure device, has been confirmed by analysis of stomach contents (e.g. Crozier, 1985). *Lophius gastrophysus* was classified as a

Corresponding author: M.F.M. Valentim Email: frequicultura@hotmail.com piscivore and benthic feeder in studies on feeding relationships of demersal fish off south-eastern and southern Brazil (Soares *et al.*, 1993; Muto *et al.*, 2005).

The aim of the present study was to contribute to knowledge of the feeding ecology of this species, using fish obtained from commercial trawlers that operate off the coast of Rio de Janeiro. We analysed the feeding intensity, diet composition, and its variation among size-classes and during periods of three months. The prey items and the relationships between predator – prey length and weight were investigated.

MATERIALS AND METHODS

From April 2004, over a period of two years, 22 samples of *L. gastrophysus*, totalling 454 individual fish, were obtained consistently from the same commercial trawlers in the fishing port of Niteroi, Rio de Janeiro state. Total length (L_T -cm) and total weight (W_T -g) of each specimen were recorded. Each fish was dissected to identify the sex, the intestine length was measured, in cm, and the stomach was removed and fixed in 10% formalin. Prey items were identified to the lowest taxonomic level whenever possible. Whole prey items were measured and weighed; the others were only weighed. Items such as sciaenids otoliths were considered evidence of Sciaenidae prey; vertebrae and bones were considered as digested fish.

To evaluate ontogenetic variation in feeding activity, the frequency of stomachs containing some contents (%F) and empty stomachs (%E) among the length-classes for males (<31; 32-36; 37-47; >48 cm) and females (<31; 32-49; 50-67; >68 cm) were computed. Length-groups were established based on the length at first maturity of males and

females (Valentim, unpublished). Males over 37 cm (L_T) and females over 50 cm (L_T) were considered adults; when the sexes were grouped, adults had an L_T over 43 cm. To evaluate temporal variation in feeding activity, (%F) and (%E) were compared among periods of months. For both cases, the χ^2 non-parametric test (Zar, 1996) was performed at the 95% significance level ($\alpha = 0.05$). The intestinal quotient (IQ) was calculated dividing the intestine length and fish total length. Values of IQ were determined for each size-class combining both sexes (<31; 32-42; 43-49; 50-64; >65 cm) and tested using a one-way analysis of variance (F; P < 0.05).

The food items found in the mouth cavity and/or oesophagus were not considered in the diet analysis, following Crozier (1985) and Laurenson & Priede (2005). Frequency of occurrence and percentage weight as given by Hyslop (1980) were applied to characterize the diet. They were combined in the alimentary index (IAi) proposed by Kawakami & Vazzoler (1980). The IAi was modified to percentage weight (%W) instead of percentage volume (%V), according to the equation: $(IAi) = (\%FO \times \%W) / \Sigma (\%FO \times \%W) \times 100$, where %FO is the percentage frequency of occurrence of the food item, and %W is the percentage weight of the feeding item. Similarity analyses using the Bray-Curtis index were performed relating the IAi percentage of the food items to both the size-classes (for both sexes together) and to the fish capture months. The values obtained were entered in a similarity matrix for cluster analysis, using the Past Statistics Program (Hammer et al., 2003) with a 0 to 1.0 variation. Length and weight of prey related to predator were evaluated using linear regression analyses (Zar, 1996).

RESULTS

The total lengths of the individual fish ranged from 8.9 to 76.0 cm (mean \pm SD L_T = 48.2 \pm 13.2 cm). Of 454 stomachs analysed, 61.5% (279) contained some prey items ('full stomachs') and 209 were females (52.9 \pm 12.4 cm) and 70 were males (37.0 \pm 10.7 cm). The rate of full stomachs (F) differed significantly in males below 31 cm, in females over 32 cm and in the total analysed sample (Table 1). Empty stomachs (E) were recorded during the entire sampling period. The lowest rate of empty stomachs was recorded in the quarter January–February–March, 2005 (Table 2), with significant difference (χ 2 = 11.92; *P* < 0.05).

We identified 40 food items, grouped into four categories: fish, Mollusca, Crustacea and others. Fish was the principal category in the diet (IAi = 91.5%), followed by Mollusca (IAi = 7.7%), Crustacea (IAi = 0.5%) and others (IAi =

Table 2. Proportion of full stomachs (%F) and empty stomachs (%E) of *Lophius gastrophysus*, per period of three months. Numerical frequency in parentheses; χ_2 test; * indicates significant difference (P < 0.05).

Quarterly	%F	%E	χ2
Apr–May–Jun-04	68.1 (47)	31.9 (22)	9.06*
Jul-Aug-Sep-04	39.4 (37)	60.6 (57)	4.26*
Oct-Nov-Dec-04	73.0 (27)	27.0 (10)	7.81*
Jan–Feb–Mar-05	78.4 (29)	21.6 (8)	11.92*
Apr–May–Jun-05	70.0 (21)	30.0 (9)	4.80^{*}
Jul-Aug-Sep-05	55.3 (21)	44.7 (17)	0.42
Oct-Nov-Dec-05	47.5 (29)	52.5 (32)	0.15
Jan–Feb–Mar-06	77.3 (68)	22.7 (20)	26.18*
Total	61.5 (279)	38.5 (175)	23.82*

0.3%) (Table 3). In the fish category, the digested fish item predominated both in occurrence and in weight (20.4%), reaching the highest IAi value (56.3%). Among the 25 identified species distributed in 20 families, Dactylopterus volitans (flying gurnard) showed the highest IAi rate. The most important families in respect to frequency of occurrence were Dactylopteridae (11.2%), followed by Carangidae (6.2%) and Paralichthyidae (4.2%). In weight, the most important was Sciaenidae (15.1%), followed bv Dactylopteridae (10.8%) and Merluccidae (7.7%). The other fish showed IAi values down to 1.1%. In the Mollusca category, squids were present in 10.2% of the stomachs, with a high IAi value (IAi = 7.7%). The categories Crustacea and others, such as starfish, sponges, and cnidarians showed IAi values down to 0.3% (Table 3).

The diet composition in the different length-classes of *L. gastrophysus* is shown in Table 4. In the fish category, *D. volitans. Merluccius hubbsi, Raneya fluminensis, Trachurus lathami* and the digested fish were the main items and occurred in all size-classes. Paralichthyids were observed in all size-classes, despite the small percentage of occurrence and weight. *Dactylopterus volitans* showed the largest percentage in juveniles (\leq 31 and 32–42 cm). The Mollusca category was the second most important, being present in all size-classes (Table 4).

Cluster analysis of diet composition related to length (Figure 1A) indicated two main groups, associated with <31 and 32-42 cm and with 43-53 and 54-64 cm plus >65 cm. Considering that length at first maturity for both sexes combined was about 42 cm, the first two size-groups obtained in the dendrogram (<31 and 32-42 cm) corresponded to juveniles, and the larger fish, in the other size-group, to adults. The similarity was high, among juvenile and adult groups.

Table 1. Proportion of full stomachs (%F) and empty stomachs (%E) of *Lophius gastrophysus* per total length-class. Numerical frequency in parentheses;
 χ_2 test; * indicates significant difference (P < 0.05).

Males				Females	Females					
L _T -cm	%F	%E	χ2	L _T -cm	%F	%E	χ2			
<31 (J)	69.4 (25)	30.6 (11)	5.44*	<31 (J)	51.7 (15)	48.3 (14)	0.03			
32–36 (J)	42.9 (3)	57.1 (4)	0.14	32-49 (J)	66.7 (46)	33.3 (23)	7.67*			
37-47 (A)	50.0 (33)	50.0 (33)	-	50-67 (A)	67.5 (135)	32.5 (65)	24.50*			
>48 (A)	29.0 (9)	71.0 (22)	5.45*	>68 (A)	81.3 (13)	18.7 (3)	6.25*			
Total	50.0 (70)	50.0 (70)	-	Total	66.6 (209)	33.4 (105)	34.45*			

J, juveniles; A, adults

Table	3.	Frequency of	f occurrence	(%FO),	percentage	weight	(%W)	and	alimentary	index	(%IAi)	of	items	in t	the	diet	of	Lophius	gastrop	physus
						N	J, num	erical	frequency.											

Anguilliformes3.131.760.62AulopiformesSynodontidaeSaurida caribbea0.630.150.01BarachoididoneBarachoididaePorichilys poresisimus1.252.320.32GadiformesMerlucciidaeMerluccis hubbis4.177.833.65OphidilormesOphididaeRareya fluminersis3.133.031.06PerciformesCarangidaeTrachurs lathani6.255.532.47HaemulidaeOthopristis ruber0.212.080.05MullidaeMullica agentinae2.063.600.40PercophidaeDenya heterurus1.470.770.44Percophis brailensis0.630.240.260.01Precophis brailensis0.630.240.260.01Vercophis brailensis0.210.260.010.00SciaenidaeCynaccion sp.1.251.690.55PleuronectiformesParalichthyidaePargua pagrus4.123.351.56RajformesRajdaeRonginaamus1.231.0871.371ScorpaenidarDactylopteridaePargua pagrus0.210.030.00SynpathidrensMacanthidaeHippocampus erecus0.210.030.00TrigidaePargua pagrus0.210.030.000.02ScorpaenidarDactylopteridaePargua pagrus0.210.030.00SynpathidrenesSynpathidaeHippocampus erecus0.21<	Order	Family	Species	%FO	%W	%IAi
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Anguilliformes			3.13	1.76	0.62
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	-	Ophichthidae	Ophichthus sp.			
Batrachoididomes Batrachoididae Paridithys porsisimus 1.25 3.21 0.23 0.23 Gadiformes Merluccialae Merluccias hubbisi 4.17 7.83 3.65 Ophidiformes Ophidiforme Anternovidae Anternovidae 4.12 3.03 1.66 Perciformes Carangidae Trachurus lathami 6.25 3.53 2.47 Haemulidae Orthoprisits ruler 0.24 2.08 3.60 0.84 Percophidae Benbrops heterurus 1.67 0.77 0.44 Altrophis busiliensis 0.63 2.66 0.19 Pinguipedidae Pinguipes busilianus 0.21 0.36 0.00 Scaenidae Pagrus pagrus 2.92 1.75 0.77 Plauconectiformes Paralichtifys of prismanus 2.92 1.75 0.75 Plauronectiformes Paralichtifys ioscales 2.92 1.06 0.00 Scorpaenidae Pagrus pagrus 1.12 1.0.87 0.30 Scorpaenidae Dactylopterus woltans 1.12 1.0.87 0.00 Scorpaenidae Prionophysic ercuts 0.21 0.00 0.00 Scorpaenidae Hipopolycophysic ercuts 0.21 0.00	Aulopiformes	Synodontidae	Saurida caribbaea	0.63	0.15	0.01
	Batrachoidiformes	Batrachoididae	Porichthys porosissimus	1.25	2.32	0.32
			Thalassophryne montevidensis	0.42	0.23	0.01
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Gadiformes	Merlucciidae	Merluccius hubbsi	4.17	7.83	3.65
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Ophidiiformes	Ophiididae	Raneya fluminensis	3.13	3.03	1.06
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Perciformes	Carangidae	Trachurus lathami	6.25	3.53	2.47
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		Haemulidae	Orthopristis ruber	0.21	2.08	0.05
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		Mullidae	Mullus argentinae	2.08	3.60	0.84
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		Percophidae	Bembrops heterurus	1.67	0.77	0.14
$\begin{array}{c c c c c c c c c c c c c c c c c c c $			Percophis brasiliensis	0.63	2.66	0.19
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		Pinguipedidae	Pinguipes brasilianus	0.21	0.26	0.01
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		Sciaenidae		4.58	15.24	7.83
$\begin{tabular}{ c c c c c } \hline Units auriga & 2.92 & 1.75 & 0.57 \\ Sparidae & Dules auriga & 2.92 & 1.69 & 0.55 \\ Pagrus pagrus & 2.92 & 1.69 & 0.55 \\ Paralichthyidae & Harpus longimanus \\ Paralichthyis isosceles \\ Paralichthyis isosceles \\ Paralichthyis orbignyanus \\ Rajiformes & Rajidae & Rioraja agasizii & 0.21 & 0.08 & 0.00 \\ Scorpaeniformes & Dactylopteridae & Dactylopterus volitans & 11.25 & 10.87 & 13.71 \\ Scorpaenidae & Scorpaeni sibmensis & 0.21 & 0.07 & 0.00 \\ Triglidae & Prionotts muldigula & 1.46 & 0.27 & 0.04 \\ Syngnathiformes & Monacanthidae & Hippocampus erectus & 0.21 & 0.03 & 0.00 \\ Tetradontiformes & Monacanthidae & Stephanolepis hispidus & 2.08 & 3.08 & 0.72 \\ Digested fish & 2.92 & 2.70 & 0.88 \\ Total of fish category (N = 578) & Risurellidea megatrema & 0.21 & 0.21 & 0.01 & 0.00 \\ Recapada & Buccinidae & Metula anfractura & 0.21 & 0.01 & 0.00 \\ Teuthal & Lolignidae & Metula anfractura & 0.21 & 0.01 & 0.00 \\ Teuthal & Lolignidae & 9.79 & 7.74 \\ Total of Mollusca category (N = 75) & 10.2 & 7.2 & 7.7 \\ Decapoda & Hippolytidae & Metula anfractura & 0.21 & 0.79 & 0.74 \\ Hippolytidae & Metula anfractura & 0.21 & 0.01 & 0.00 \\ Penacidae & Metula anfractura & 0.21 & 0.01 & 0.00 \\ Sonatopoda & Buccinidae & Metula anfractura & 0.21 & 0.79 & 0.74 \\ Total of Mollusca category (N = 75) & 10.2 & 7.2 & 7.7 \\ Decapoda & Categorary (N = 75) & 10.2 & 7.2 & 7.7 \\ Decapoda & Astropecten cingulatus & 0.90 & 0.83 & 0.73 & 0.07 \\ Rachyura & Portunidae & Portunus spinicarpus & 2.71 & 0.79 & 0.44 \\ Total of Crustaee category (N = 31) & 6.4 & 0.51 & 0.04 & 0.00 \\ Sponge of remains & 0.04 & 0.05 & 0.01 \\ Sponge of remains & 0.04 & 0.00 \\ Sponge of $			Cynoscion sp.			
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			Úmbrina canosai			
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		Serranidae	Dules auriga	2.92	1.75	0.57
PleuronectiformesParalichthyidaeImage: Constraint of the sector o		Sparidae	Pagrus pagrus	2.92	1.69	0.55
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Pleuronectiformes	Paralichthyidae	0 1 0	4.12	3.35	1.56
$\begin{tabular}{ c c c c c c c c c c c c c c c c c c c$,	Etropus longimanus	·	0.00	
Paralichty's orbignyanusRajiformesRajidaeRioraja agassizii 0.21 0.08 0.00 ScorpaenidaeDactylopteridaeDactylopterus volitans 11.25 10.87 $13,71$ ScorpaenidaeScorpaenia isthmensis 0.21 0.07 0.00 TriglidaePrionotus nudigula 1.46 0.27 0.04 SyngnathidaeHippocampus erectus 0.21 0.03 0.00 TetraodontiformesMonacanthidaeStephanolepis hispidus 2.08 3.08 0.72 Digested fish24.38 20.06 56.27 0.01 0.02 0.00 Non-identified fish24.38 20.06 56.27 0.01 0.00 Non-identified fish 2.92 2.70 0.88 0.9 87.1 91.5 ArchaeogastropodaFissurellidae <i>Metula anfractura</i> 0.21 0.20 0.00 NogastropodaBuccinidaeMetula anfractura 0.21 0.20 0.00 NogastropodaBuccinidaeMetula anfractura 0.21 0.20 0.00 CorpaenidaeMunida filtri 9.79 7.05 7.74 Total of Mollusca category (N = 75) 10.2 7.2 7.7 DecapodaHippolytidaeExhippolysmata oplophoroides $Penaeidae$ $Metapenaeopis sp.$ $Seplarus ramosaeGalatheidaeMunida filtrit0.210.040.000.00Total of Crustacea category (N = 31)6.42.10.5$			Paralichthys isosceles			
RajiformesRajidaeRioraja agaszizii 0.21 0.08 0.00 ScorpaeniformesDactylopteridaeDactylopterus volitans 11.25 10.87 13.71 ScorpaenidaeScorpaeni sithmensis 0.21 0.07 0.00 TriglidaePrionotus nudigula 1.46 0.27 0.04 SyngnathiformesSyngnathidaeHippocampus erectus 0.21 0.03 0.00 TetradontiformesMonacanthidaeStephanolepis hispidus 2.08 3.08 0.72 Digested fish24.38 20.06 56.27 56.27 50.68 56.27 Non-identified fish2.92 2.70 0.88 56.27 50.9 87.1 91.5 ArchaeogastropodaFissurellidaeFissurellidea megatrema 0.21 0.20 0.00 NeogastropodaBuccinidaeMetula anfractura 0.21 0.01 0.00 YenthidaLoliginidae 9.79 7.05 7.74 Total of Mollusca category (N = 75) 10.2 7.2 7.7 DecapodaLexhippolysmata oplophoroides 9.99 0.51 0.07 BrachyuraPenaeidaeMetapenaeopsis sp. Scyllaridae $Scyllarus ramosae$ Galatheidae 0.83 0.73 0.07 AsteroideaAstropctinidaeAstropcten cingulatus Coral of remains 0.21 0.04 0.00 Yotal of Crustacea category (N = 31) 6.4 2.1 0.51 0.5 AsteroideaAstropctinidaeAstropcten cingulatus<			Paralichthys orbignyanus			
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Rajiformes	Rajidae	Rioraia agassizii	0.21	0.08	0.00
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Scorpaeniformes	Dactylopteridae	Dactylopterus volitans	11.25	10.87	13.71
TriglidaePriorous nudigula1.460.270.04SyngnathiformesSyngnathidaeHippocampus erectus0.210.030.00TetraodontiformesMonacanthidaeStephanolepis hispidus2.083.080.72Digested fish2.4,3820.0656.27Non-identified fish2.922.700.88Total of fish category (N = 578)80.987.191.5ArchaeogastropodaFissurellidae <i>Fissurellidea megatrema</i> 0.210.200.00NeogastropodaBuccinidaeMetula anfractura0.210.010.00TeuthidaLoliginidae9.797.057.74Total of Mollusca category (N = 75)10.27.27.7DecapodaExhippolysmata oplophoroides PenaeidaeMetapenaeopsis sp. Scyllaridae2.920.580.19StomatopodaHemisquillidaeHemisquilla braziliensis0.830.730.07BrachynaPortunidaePortunus spinicarpus2.710.790.24Total of Crustacea category (N = 31)6.42.10.50.04AsteroideaAstropctinidaeAstropecten cingulatus Coral of remains0.210.040.00Coral of remains0.040.050.010.040.04Coral of of remains0.410.050.010.040.04Coral of of remains0.210.040.040.040.04Didi of others category (N = 11)2.53.60.30.44	ocorpaciniornico	Scorpaenidae	Scorpaena isthmensis	0.21	0.07	0.00
SyngnathiformesSyngnathidaeHippocampus erctus0.210.030.00TetaodontiformesMonacanthidaeStephanolepis hispidus2.083.080.72Digested fish2.4,3820.0656.27Non-identified fish2.922.700.88Total of fish category (N = 578)80.987.191.5ArchaeogastropodaFissurellidae <i>Fissurellidea megatrema</i> 0.210.200.00NeogastropodaBuccinidaeMetula anfractura0.210.010.00Total of Mollusca category (N = 75)10.27.27.7DecapodaLippolytidaeExhippolysmata oplophoroides Penaeidae2.920.580.19GalatheidaeMunida flinti553.60.210.04StomatopodaHernisquillidaePortunus spinicarpus2.710.790.24Total of Crustace actegory (N = 31)6.42.10.50.01AsteroideaAstropctinidaeAstropcten cingulatus Coral of remains0.210.040.00PlatyasteridaLuidiidaeLuidiia sp.0.210.040.00Coral of oremains1.040.050.010.00Sponge of remains0.832.600.240.21Otal of others category (N = 11)2.53.60.30.73		Triglidae	Prionotus nudigula	1.46	0.27	0.04
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Syngnathiformes	Syngnathidae	Hippocampus erectus	0.21	0.03	0.00
Digested fish24.3820.0656.27Non-identified fish2.922.700.88Total of fish category $(N = 578)$ 80.987.191.5ArchaeogastropodaFissurellidaeFissurellidae megatrema0.210.000.00NeogastropodaBuccinidaeMetula anfractura0.210.010.00TeuthidaLoliginidae9.797.057.74Total of Mollusca category $(N = 75)$ 10.27.27.7DecapodaExhippolysmata oplophoroides PenaeidaeMetapenaeopsis sp. Scyllarus ramosae Galatheidae0.830.730.07BrachyuraPortunidaePortunidaeHemisquilla braziliensis0.830.730.07BrachyuraPortunidaePortunus spinicarpus2.710.790.24AsteroideaAstropctinidaeAstropcten cingulatus Coral of remains0.210.040.00Coral of remains1.040.050.010.040.00Total of others category $(N = 11)$ 2.53.60.30.24	Tetraodontiformes	Monacanthidae	Stephanolepis hispidus	2.08	3.08	0.72
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Digested fish			24.38	20.06	56.27
Total of fish category $(N = 578)$ BoyByLy <td>Non-identified fish</td> <td></td> <td></td> <td>2.92</td> <td>2.70</td> <td>0.88</td>	Non-identified fish			2.92	2.70	0.88
Now of non energy (it y), y , y	Total of fish category (N =	= 578)		80.0	87.1	01.5
ArchaeogastropodaFissurellidaeFissurellidae megatrema 0.21 0.20 0.00 NeogastropodaBuccinidaeMetula anfractura 0.21 0.01 0.00 TeuthidaLoliginidae 9.79 7.05 7.74 Total of Mollusca category (N = 75) 10.2 7.2 7.7 Decapoda 2.92 0.58 0.19 HippolytidaeExhippolysmata oplophoroides Penaeidae $Metapenaeopsis sp.$ Scyllaridae 2.92 0.58 0.19 StomatopodaHemisquillidaeHemisquilla braziliensis 0.83 0.73 0.07 BrachyuraPortunidaePortunus spinicarpus 2.71 0.79 0.24 Total of Crustacea category (N = 31) 6.4 2.1 0.5 0.01 AsteroideaAstropctinidaeAstropecten cingulatus Sponge of remains 0.21 0.04 0.00 Total of others category (N = 11) 2.5 3.6 0.31	Total of hish category (11 -	- 3/0)		00.9	07.1	91.9
NeogastropodaBuccinidaeMetula anfractura 0.21 0.01 0.00 TeuthidaLoliginidae 9.79 7.05 7.74 Total of Mollusca category (N = 75) 10.2 7.2 7.7 Decapoda 2.92 0.58 0.19 HippolytidaeExhippolysmata oplophoroides $Penaeidae$ $Metapenaeopsis sp.$ 2.92 0.58 ScyllaridaeScyllarus ramosae $Galatheidae$ $Munida flinti$ 0.21 0.73 0.07 StomatopodaHemisquillidaeHemisquilla braziliensis 0.83 0.73 0.07 BrachyuraPortunidaePortunus spinicarpus 2.71 0.79 0.24 Total of Crustacea category (N = 31) 6.4 2.1 0.51 AsteroideaAstropctinidaeAstropecten cingulatus 0.21 0.04 0.00 Sponge of remains 1.04 0.05 0.01 Sponge of remains 0.83 2.60 0.24 PlatyasteridaLuidiidaeLuidia sp. 0.21 0.04 0.00 Total of others category (N = 11) 2.5 3.6 0.31	Archaeogastropoda	Fissurellidae	Fissurellidea megatrema	0.21	0.20	0.00
TeuthidaLoliginidae9.797.057.74Total of Mollusca category $(N = 75)$ 10.27.27.7Decapoda2.920.580.19HippolytidaeExhippolysmata oplophoroides2.920.580.19PenaeidaeMetapenaeopsis sp. ScyllaridaeScyllarus ramosae Galatheidae0.830.730.07StomatopodaHemisquillidaeHemisquilla braziliensis0.830.730.07BrachyuraPortunidaePortunus spinicarpus2.710.790.24Total of Crustacea category $(N = 31)$ 6.42.10.55AsteroideaAstropctinidaeAstropecten cingulatus Sponge of remains0.210.040.00Sponge of remains0.832.600.24PlatyasteridaLuidiidaeLuidia sp.0.210.040.00Total of others category $(N = 11)$ 2.53.60.3	Neogastropoda	Buccinidae	Metula anfractura	0.21	0.01	0.00
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Teuthida	Loliginidae		9.79	7.05	7.74
Decapoda2.92 0.58 0.19 HippolytidaeExhippolysmata oplophoroidesPenaeidaeMetapenaeopsis sp.ScyllaridaeScyllarus ramosaeGalatheidaeMunida flintiStomatopodaHemisquillidaeHemisquilla braziliensis 0.83 0.73 0.07 BrachyuraPortunidaePortunus spinicarpus 2.71 0.79 0.24 Total of Crustacea category (N = 31) 6.4 2.1 0.5 AsteroideaAstropctinidaeAstropecten cingulatus Sponge of remains 0.21 0.04 0.00 PlatyasteridaLuidiidaeLuidiia sp. 0.21 0.04 0.00 Total of others category (N = 11) 2.5 3.6 0.3	Total of Mollusca category	V(N = 75)		10.2	7.2	7.7
DecupodaLig20.300.19HippolytidaeExhippolysmata oplophoroidesPenaeidaeMetapenaeopsis sp.ScyllaridaeScyllarus ramosaeGalatheidaeMunida flintiStomatopodaHemisquillidaeHemisquillidaeHemisquilla braziliensis0.83Oral of Crustacea category (N = 31)0.79AsteroideaAstropctinidaeAstropecten cingulatusCoral of remains0.040.00Coral of remains0.832.60PlatyasteridaLuidiidaeLuidiia sp.Cotal of others category (N = 11)2.53.6	Decanoda			2.02	0.58	0.10
Import dateImport dateImport datePenaeidaePenaeidaeMetapenaeopsis sp. Scyllarus ramosae GalatheidaeGalatheidaeMunida flintiStomatopodaHemisquillidaeHemisquilla dePortunus spinicarpusBrachyuraPortunidaePortunidaePortunus spinicarpusCotal of Crustacea category (N = 31)6.4AsteroideaAstropctinidaeAsteroideaAstropcten cingulatusCoral of remains0.04Sponge of remains0.832.53.6Cotal of others category (N = 11)	Decapoda	Hippolytidae	Exhippolysmata oplophoroides	2.92	0.90	0.19
ScyllaridaeScyllaridaeScyllaridaeScyllaridaeGalatheidaeMunida flintiStomatopodaHemisquillidaeHemisquilla braziliensis 0.83 0.73 0.07 BrachyuraPortunidaePortunus spinicarpus 2.71 0.79 0.24 Total of Crustacea category (N = 31) 6.4 2.1 0.5 AsteroideaAstropctinidaeAstropecten cingulatus 0.21 0.04 0.00 Coral of remains 1.04 0.05 0.01 Sponge of remains 0.83 2.60 0.24 PlatyasteridaLuidiidaeLuidiia sp. 0.21 0.04 0.00 Total of others category (N = 11) 2.5 3.6 0.3		Penaeidae	Metabenaeopsis sp			
GalatheidaeMunida flintiStomatopodaHemisquillidaeHemisquillidaeHemisquilla braziliensis 0.83 0.73 0.07 BrachyuraPortunidaePortunus spinicarpus 2.71 0.79 0.24 Total of Crustacea category (N = 31) 6.4 2.1 0.5 AsteroideaAstropctinidaeAstropecten cingulatus Coral of remains 0.21 0.04 0.00 Coral of remains 1.04 0.05 0.01 Sponge of remains 0.83 2.60 0.24 PlatyasteridaLuidiidaeLuidiia sp. 0.21 0.04 0.00 Total of others category (N = 11) 2.5 3.6 0.3		Scyllaridae	Scullarus ramosae			
StomatopodaHemisquilladeHemisquilla braziliensis 0.83 0.73 0.07 BrachyuraPortunidaePortunus spinicarpus 2.71 0.79 0.24 Total of Crustacea category (N = 31) 6.4 2.1 0.5 AsteroideaAstropctinidaeAstropecten cingulatus Coral of remains 0.21 0.04 0.00 Coral of remainsPlatyasteridaLuidiidaeLuidiia sp. 0.21 0.04 0.00 Coral of remainsTotal of others category (N = 11) 2.5 3.6 0.3		Galatheidae	Munida flinti			
StoriadopodaHernisquindaceHernisquinda briziterisis 0.33 0.73 0.07 BrachyuraPortunidaePortunus spinicarpus 2.71 0.79 0.24 Total of Crustacea category (N = 31) 6.4 2.1 0.5 AsteroideaAstropctinidaeAstropecten cingulatus 0.21 0.04 0.00 Coral of remains 1.04 0.05 0.01 Sponge of remains 0.83 2.60 0.24 PlatyasteridaLuidiidaeLuidiia sp. 0.21 0.04 0.00 Total of others category (N = 11) 2.5 3.6 0.3	Stomatonoda	Hamisquillidae	Hamisavilla braziliansis	0.82	0.72	0.07
InactivitiaFortunitateFortunits spiniturpus 2.71 0.79 0.24 Total of Crustacea category (N = 31) 6.4 2.1 0.5 AsteroideaAstropctinidaeAstropecten cingulatus 0.21 0.04 0.00 Coral of remains 1.04 0.05 0.01 Sponge of remains 0.83 2.60 0.24 PlatyasteridaLuidiidaeLuidiia sp. 0.21 0.04 0.00 Total of others category (N = 11) 2.5 3.6 0.3	Brachuara	Portunidae	Portunus spinicarpus	0.03	0./3	0.0/
Total of Crustacea category $(N - 31)$ 6.4 2.1 0.5 AsteroideaAstropctinidaeAstropecten cingulatus 0.21 0.04 0.00 Coral of remains 1.04 0.05 0.01 Sponge of remains 0.83 2.60 0.24 PlatyasteridaLuidiidaeLuidia sp. 0.21 0.04 0.00 Total of others category $(N = 11)$ 2.5 3.6 0.3	Total of Crustacoa catagor	$r(N = a_1)$	Portunus spinicurpus	2./1	0./9	0.24
AsteroideaAstropctinidaeAstropecten cingulatus 0.21 0.04 0.00 Coral of remains 1.04 0.05 0.01 Sponge of remains 0.83 2.60 0.24 PlatyasteridaLuidiidaeLuidia sp. 0.21 0.04 0.00 Total of others category (N = 11) 2.5 3.6 0.3	Total of Crustacea categor	y (N = 31)		0.4	2.1	0.5
Coral of remains1.040.050.01Sponge of remains 0.83 2.60 0.24 PlatyasteridaLuidiidaeLuidia sp. 0.21 0.04 0.00 Total of others category (N = 11) 2.5 3.6 0.3	Asteroidea	Astropctinidae	Astropecten cingulatus	0.21	0.04	0.00
Sponge of remains 0.83 2.60 0.24 PlatyasteridaLuidia sp. 0.21 0.04 0.00 Total of others category $(N = 11)$ 2.5 3.6 0.3		-	Coral of remains	1.04	0.05	0.01
PlatyasteridaLuidiidaeLuidiia sp. 0.21 0.04 0.00 Total of others category $(N = 11)$ 2.5 3.6 0.3			Sponge of remains	0.83	2.60	0.24
Total of others category $(N = 11)$ 2.5 3.6 0.3	Platyasterida	Luidiidae	Luidia sp.	0.21	0.04	0.00
	Total of others category (N	N = 11)	-	2.5	3.6	0.3

Variations in the predominance of consumed prey occurred. Anguilliformes, *D. volitans*, *Dules auriga*, *M. hubbsi*, Sciaenidae, *Stephanolepis hispidus* and *T. lathami* occurred in almost all samples in 2004; sciaenids reached the highest IAi value. In 2005, Paralichthyidae and *T. lathami* reached high IAi values (Table 5). The largest number of items occurred in 2004, but the feeding spectrum was more diverse in the quarter January–February–March, 2005. The second most consumed category was Mollusca; the squid item occurred in almost all the quarters of the year, mainly in summer and autumn of both years. Crustacea was not an important item in the diet, but decapods were the most consumed.

The cluster analysis of the IAi percentage of items consumed by *L. gastrophysus* in each quarterly sampling is shown in Figure 1B. The dendrogram showed two separate groups: 2005 samples and 2004 samples. Both groups had IAi values exceeding 27% for digested fish (Table 5). The highest similarity was observed between April–May–June, 2005 and July–August–September, 2005 (coefficient of about 0.7), as a consequence of high IAi values for digested

<table-container> Tend bundling of any set of a se</table-container>		-	-	•		•	-	-					-		• •	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Total length-classes (cm) Food items	<31 %FO	%W	%IAi	32-42 %FO	%W	%IAi	43-53 %FO	%W	%IAi	54-64 %FO	%W	%IAi	>65 %FO	%W	%IAi
Bendrops hereiruns4.65.4.65.4.6.46.4.9	Anguilliformes	3.5	2.6	0.6				4.8	2.7	1.4	3.1	1.8	0.7	2.5	0.9	0.2
Dack plating back plating24.63.05.41.69.994.51.71.21.71.27.88.98.32.51.40.30.0Hippe compute metha <t< td=""><td>Bembrops heterurus</td><td></td><td></td><td></td><td>4.6</td><td>5.2</td><td>2.0</td><td>0.8</td><td>0.4</td><td>0.04</td><td>2.1</td><td>0.6</td><td>0.1</td><td></td><td></td><td></td></t<>	Bembrops heterurus				4.6	5.2	2.0	0.8	0.4	0.04	2.1	0.6	0.1			
Dates arrival they compare serving3.12.00.20.20.20.20.40.	Dactylopterus volitans	24.6	33.0	50.4	16.9	29.9	43.5	10.3	11.7	12.9	7.8	8.9	8.3	2.5	1.4	0.3
Hippocangue erectus Hippocangue erectus Hippocangue erectus 0.1 0.01 Merhaccius hubbis 1.8 2.1 0.2 3.1 8.0 2.4 1.5 0.1 6.5 4.2 4.2 2.7 5.0 12.0 4.7 Mallis orgeninae 1.5 2.1 0.3 2.4 1.7 0.6 4.2 0.3 2.4 0.3 Parallechthyldhe 1.8 4.4 0.5 6.2 2.6 1.4 4.0 2.6 1.4 1.3 0.3 4.2 0.5 5.0 5.3 2.1 9.0 Parallechthyldhe 1.8 4.4 0.5 6.2 2.6 1.4 4.0 2.6 1.1 4.2 3.3 1.5 5.0 5.3 2.1 9.0 Non-identified fish 2.8 1.3 0.3 4.2 3.6 1.8 1.4 0.2 3.6 1.8 1.4 0.2 3.6 0.2 2.5 1.4 0.2 Parallechthyldhe 1.8 7.6 0.2 0.6 0.4 1.6 1.4 1	Dules auriga				3.1	2.0	0.5	2.4	2.8	0.7	4.2	1.9	0.9	2.5	0.2	0.04
Minimagentina Mullus argentina1.82.10.23.18.02.15.61.06.54.25.42.75.01.204.7Mullus argentina Untoprist suber.2.10.32.43.70.92.63.81.22.54.40.9Pagus pagus Panlachthyda 1.81.84.40.56.22.61.44.02.61.14.23.11.55.05.32.1Panlachthyda 1.81.82.62.78.62.02.21.85.452.0.82.35.752.0.02.2.23.49Non-identified fish 2.9.81.82.62.78.62.0.42.01.85.452.0.82.35.752.0.02.2.23.49Non-identified fish 2.9.81.82.62.78.62.0.42.01.83.35.72.0.02.2.23.49Non-identified fish 2.9.81.82.62.78.62.0.42.61.13.02.52.02.2.23.49Non-identified fish 2.9.81.50.20.61.41.32.92.51.42.61.61.30.23.61.51.20.21.61.31.21.50.20.61.50.21.70.31.71.71.62.91.50.10.11.50.20.61.70.62.50.40.12	Hippocampus erectus							0.8	0.1	0.01						
Mullia argentinate1.52.10.32.43.70.92.63.81.22.54.40.9Othopyists ruber7.02.51.11.51.30.23.22.10.72.54.20.54.20.5Paralkchlyida1.84.40.56.22.61.44.02.61.14.23.11.55.72.02.33.1Paralkchlyida1.84.40.56.78.61.44.00.61.14.23.11.55.02.33.1Paralkchlyida1.82.562.78.61.44.00.30.43.63.61.50.02.4Paralkchlidi1.52.51.51.50.21.61.80.31.22.51.70.2Paralkchlidigh1.51.50.20.31.61.60.31.61.50.21.70.3Prophys paralking1.51.50.20.031.50.10.22.51.70.3Prophys paralkingh1.50.20.30.60.20.30.60.30.22.50.40.3Prophys paralkingh1.50.20.60.00.20.20.50.10.11.50.40.3Prophys paralkingh1.50.20.60.40.30.20.50.40.50.40.4 <td>Merluccius hubbsi</td> <td>1.8</td> <td>2.1</td> <td>0.2</td> <td>3.1</td> <td>8.0</td> <td>2.1</td> <td>5.6</td> <td>11.0</td> <td>6.5</td> <td>4.2</td> <td>5.4</td> <td>2.7</td> <td>5.0</td> <td>12.0</td> <td>4.7</td>	Merluccius hubbsi	1.8	2.1	0.2	3.1	8.0	2.1	5.6	11.0	6.5	4.2	5.4	2.7	5.0	12.0	4.7
Orthogrids nuber -	Mullus argentinae				1.5	2.1	0.3	2.4	3.7	0.9	2.6	3.8	1.2	2.5	4.4	0.9
Pageris organs 7.0 2.5 1.1 1.5 1.3 0.2 3.2 2.1 0.7 2.6 2.0 0.6 U Paralichthyidae 1.8 4.4 0.5 6.2 2.6 1.4 4.0 2.6 1.1 4.2 3.1 1.5 5.0 5.2 3.4 Non-identified fish 29.8 27.7 8.6 20.4 2.6 1.3 2.3 2.5 1.8 7.5 2.0 2.3 3.0 Non-identified fish 29.8 27.7 8.6 20.4 2.4 1.3 2.0 1.8 7.5 4.0 2.4 Prophis brisitiens: - - - 6.8 0.1 2.6 4.3 1.3 - - - - 0.6 1.0 1.5 0.2 - - 3.1 0.0 - - - 3.1 0.2 - 3.1 0.2 2.5 1.7 0.3 3.3 3.2 0.3 1.5 0.2 2.5 1.7 0.3 3.0 3.2 0.4 0.1	Orthopristis ruber										0.5	4.2	0.3			
Parallichlyidae 1.8 4.4 0.5 6.2 2.6 1.4 4.0 2.6 1.1 4.2 3.1 1.5 5.0 5.3 2.1 Digested fish 29.8 1.3 2.6 27.7 8.6 20.4 27.0 18.8 54.5 20.0 23.3 57.5 20.0 22.3 349 Digested fish 29.7 2.6 27.7 8.6 20.4 27.0 18.8 54.5 20.0 23.5 57.5 20.0 22.3 349 Don-identified fish 29.7 2.6 27.7 8.0 1.1 0.2 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 2.0 0.0 2.0 2.0 0.0 2.0 </td <td>Pagrus pagrus</td> <td>7.0</td> <td>2.5</td> <td>1.1</td> <td>1.5</td> <td>1.3</td> <td>0.2</td> <td>3.2</td> <td>2.1</td> <td>0.7</td> <td>2.6</td> <td>2.0</td> <td>0.6</td> <td></td> <td></td> <td></td>	Pagrus pagrus	7.0	2.5	1.1	1.5	1.3	0.2	3.2	2.1	0.7	2.6	2.0	0.6			
Digged fish 29.8 13.8 25.6 27.7 8.6 20.4 27.0 18.8 54.5 20.8 23.3 57.5 20.0 22.2 34.9 Non identified fish - - 4.13 0.3 -42 0.3 4.2 0.6 1.8 7.5 4.0 2.2.4 34.9 Non identified fish - - 4.13 0.2 - 4.2 0.3 0.42 0.6 1.4 0.1 -	Paralichthyidae	1.8	4.4	0.5	6.2	2.6	1.4	4.0	2.6	1.1	4.2	3.1	1.5	5.0	5.3	2.1
Non-identified fish	Digested fish	29.8	13.8	25.6	27.7	8.6	20.4	27.0	18.8	54.5	20.8	23.3	57.5	20.0	22.2	34.9
Parcaphis basiliensis 1.3 2.9 Pringipes basiliensis 0.8 0.1 0.1 Porichlys poroxissimus 0.8 0.1 0.6 4.3 1.3 Prioribus mudigula 1.5 0.2 0.3 3.1 0.5 0.2 Rangya fluminensis 8.8 1.7 9.5 0.6 0.0 3.5 1.5 0.2 0.2 0.4 Storpia gassi 1.5 1.6 0.2 0.2 0.5 0.1 0.01 2.5 0.2 0.6 Scaraida aribbaea 1.5 1.2 0.2 0.6 0.3 0.1 1.01 2.5 0.4 0.4 Scaraida aribbaea 1.5 1.2 0.2 0.6 0.3 0.02 2.5 0.4 0.4 Scaraida aribbaea 1.5 1.2 0.2 1.6 1.7 0.5 0.3 0.02 2.5 0.4 0.1 Scaraida aribbaea 1.5 1.2 0.2 1.6 1.7 1.6 0.4 0.02 1.5 0.6 0.7 5.0 0.4 <	Non-identified fish							2.4	1.3	0.3	4.2	3.6	1.8	7.5	4.0	2.4
Pinguipes brasilianus 0.8 1.1 0.1 Poriohthys porsissimus 0.8 0.1 2.6 4.3 1.3 Prinotus maligula 1.5 0.2 0.02 0.5 1.1 0.5 0.2 0.3 0.02 2.5 1.7 0.3 Prinotus maligula 1.5 1.1 0.2 0.5 0.5 0.5 0.1 0.01 2.5 0.2 0.02 0.5 0.1 0.01 2.5 0.2 0.01 0.5 0.1 0.5 0.1 0.5 0.1 0.5	Percophis brasiliensis							2.4	11.3	2.9						
Poricitity poroissimus 1.5 0.2 0.63 0.1 2.6 4.3 1.3 Prionotus nudigula 1.5 0.2 0.03 1.5 0.5 0.2 2.5 1.7 0.3 Rancya fluminensis 8.8 1.3 1.5 1.1 0.2 0.5 0.5 0.1 0.01 2.5 0.7 0.3 Rancya fluminensis 8.8 1.7.3 9.5 4.6 6.0 4.0 3.5 1.5 0.2 0.0 0.5 0.1 0.01 2.5 0.2 0.04 Scarida caribbaea 2.4 8.4 0.2 0.03 0.01 0.01 2.5 0.2 0.05 0.1 0.01 0.5 0.1 0.01 0.5 0.1 0.01 0.5 0.1 0.01 0.5 0.1 0.01 0.5 0.1 0.01 0.5 0.1 0.01 0.5 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	Pinguipes brasilianus							0.8	1.1	0.1						
Prionatus inudigula 1.5 0.2 0.03 3.1 0.5 0.2 Raneya fluminensis 8.8 17.3 9.5 4.6 15.0 6.0 4.0 3.5 1.5 0.5 0.3 0.02 2.5 1.7 0.3 Rioraja aggissici 1.5 1.1 0.2 0.02 0.5 0.1 0.01 2.5 0.2 0.04 Sciaeridae 2.4 8.4 2.2 6.3 15.1 1.12 1.7.5 36.5 5.1 Scorpaen alshmensis 1.5 1.2 0.2 1.6 1.3 0.2 0.5 0.1 0.01 2.5 0.4 0.1 Scorpaen alshmensis 1.5 1.2 0.2 1.6 1.3 0.2 3.6 0.5 2.4 0.4 0.1 <td< td=""><td>Porichthys porosissimus</td><td></td><td></td><td></td><td></td><td></td><td></td><td>0.8</td><td>0.8</td><td>0.1</td><td>2.6</td><td>4.3</td><td>1.3</td><td></td><td></td><td></td></td<>	Porichthys porosissimus							0.8	0.8	0.1	2.6	4.3	1.3			
Raneya fluminensis 8.8 17.3 9.5 4.6 15.0 6.0 4.0 3.5 1.5 0.5 0.3 0.02 2.5 1.7 0.3 Rioria gagssizi 1.5 1.1 0.2 0.02 0.5 0.1 0.01 2.5 0.2 0.02 Saurida caribbaea 1.5 1.1 0.2 0.4 8.4 2.2 6.3 15.1 11.2 17.5 36.5 50.1 Scipening isthmensis 1.5 1.5 0.2 0.6 1.3 0.2 3.6 5.5 2.4 4.4 0.4 0.2 3.6 5.5 2.4 5.0 1.8 0.7 5.0 0.3 0.02 2.5 0.4 0.1 Stephanolepis hispidus 1.5 1.2 0.2 1.6 1.3 0.2 3.6 5.5 2.4 5.4 5.4 0.1 Thadasophyne montevidensis 1.5 0.2 0.2 1.6 1.3 0.2 4.6 0.1 2.5 0.4 0.1 Thadhurs lathami 1.5 0.7 7.0	Prionotus nudigula				1.5	0.2	0.03				3.1	0.5	0.2			
Rioraja agassizi 1.5 1.1 0.2 Saurida caribbaea 0.8 0.2 0.02 0.5 0.1 0.01 2.5 0.2 0.04 Sciaenidae 2.4 8.4 2.2 6.3 15.1 11.2 1.7 36.5 50.1 Scorpaena isthmensis 1.5 1.2 0.2 1.6 1.3 0.2 3.6 5.5 2.4 1.5 1.2 0.1 50.1 <	Raneya fluminensis	8.8	17.3	9.5	4.6	15.0	6.0	4.0	3.5	1.5	0.5	0.3	0.02	2.5	1.7	0.3
Saurida caribbaea 0.8 0.2 0.02 0.5 0.1 0.01 2.5 0.02 0.61 Sciencidae 2.4 8.4 2.2 6.3 15.1 11.2 17.5 36.5 50.1 Scorpaen isthmensis 1.5 1.2 0.2 1.6 1.3 0.2 6.5 0.4 11.2 17.5 36.5 50.1 Stephanolepis hispidus 1.5 1.2 0.2 1.6 1.3 0.2 6.5 0.4	Rioraja agassizi				1.5	1.1	0.2									
Sciaenidae 2.4 8.4 2.2 6.3 1.1 1.2 1.7.5 3.65 5.01 Scorpaena isthmensis 1.5 1.2 0.2 1.6 1.3 0.2 3.6 5.5 0.4 0.01 <td>Saurida caribbaea</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>0.8</td> <td>0.2</td> <td>0.02</td> <td>0.5</td> <td>0.1</td> <td>0.01</td> <td>2.5</td> <td>0.2</td> <td>0.04</td>	Saurida caribbaea							0.8	0.2	0.02	0.5	0.1	0.01	2.5	0.2	0.04
Scorpaena isthmensis 1.5 1.2 0.2 1.6 1.3 0.2 3.6 5.5 2.4 Thalassophryne montevidensis 5 0.3 0.02 2.5 0.4 0.1 Trachurus lathani 10.5 10.7 7.0 6.2 4.0 2.1 7.1 6.2 4.7 4.7 2.2 1.2 5.0 1.8 0.7 Fissurellidea megatrema 0.5 0.1 4.7 4.7 2.2 1.2 5.0 1.8 0.7 Loliginidae 7.0 11.1 4.9 13.8 17.6 20.9 9.5 8.7 8.8 9.9 5.6 6.6 7.5 3.1 1.8 0.7 Loliginidae 7.0 1.4 9 13.8 1.76 20.9 9.5 8.7 8.8 9.9 5.6 6.6 7.5 3.1 1.8 0.7 Loliginidae 7.0 1.8 1.76 0.9 9.5 8.7 8.8 9.9 5.6 6.3 0.3 0.1 Loidainfactura 1.8 1.1 <	Sciaenidae							2.4	8.4	2.2	6.3	15.1	11.2	17.5	36.5	50.1
Stephanolepis hispidus 1.5 1.2 0.2 1.6 1.3 0.2 3.6 5.5 2.4 Thalassophryne montevidensis 0.5 0.3 0.02 2.5 0.4 0.1 Trachurus lathani 10.5 10.7 7.0 6.2 4.0 2.1 7.1 6.2 4.7 4.7 2.2 1.2 5.0 1.8 0.7 Fissurellidea megatrema 0.5 0.4 0.02 0.5 0.4 0.02 0.5 0.4 0.02 0.5 0.4 0.02 0.5 0.4 0.02 0.5 0.4 0.02 0.5 0.4 0.02 0.5 0.4 0.02 0.5 0.4 0.02 0.5 0.4 0.02 0.5 0.4 0.02 0.5 0.4 0.02 0.5 0.4 0.02 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.5 0.4 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.	Scorpaena isthmensis										0.5	0.1	0.01			
Thalassophryne montevidensis 0.5 0.3 0.02 2.5 0.4 0.1 Trachurus lathami 10.5 10.7 7.0 6.2 4.0 2.1 7.1 6.2 4.7 4.7 2.2 1.2 5.0 1.8 0.7 Fissurellidea megatrema 0.5 7.0 11.1 4.9 13.8 17.6 20.9 9.5 8.7 8.8 9.9 5.6 6.6 7.5 3.1 1.8 Metula anfractura 1.5 0.1 0.01 0.3 3.2 0.3 0.1 3.6 0.8 0.3 0.2 0.5 0.4 0.1 0.5 0.4 0.0 0.5 0.4 0.0 0.5 0.4 0.0 0.5 0.4 0.0 0.5 0.4 0.0 0.5 0.4 0.0 0.7 0.5 0.4 0.0 0.7 0.4 0.0 0.5 0.4 0.0 0.5 0.4 0.0 0.5 0.6 0.5 0.6 0.5 0.6 0.5 0.6 0.5 0.6 0.5 0.6 0.5	Stephanolepis hispidus				1.5	1.2	0.2	1.6	1.3	0.2	3.6	5.5	2.4			
Trachuras lathami 10.5 10.7 7.0 6.2 4.0 2.1 7.1 6.2 4.7 4.7 2.2 1.2 5.0 1.8 0.7 Fissurellidea megatrema	Thalassophryne montevidensis										0.5	0.3	0.02	2.5	0.4	0.1
Fissurellidea megatrema 0.5 0.4 0.02 Loliginidae 7.0 11.1 4.9 13.8 17.6 20.9 9.5 8.7 8.8 9.9 5.6 6.6 7.5 3.1 1.8 Metula anfractura 1.5 0.1 0.01	Trachurus lathami	10.5	10.7	7.0	6.2	4.0	2.1	7.1	6.2	4.7	4.7	2.2	1.2	5.0	1.8	0.7
Loliginidae 7.0 11.1 4.9 13.8 17.6 20.9 9.5 8.7 8.8 9.9 5.6 6.6 7.5 3.1 1.8 Metula anfractura 1.5 0.1 0.01 0.01 0.1 3.6 0.8 0.3 0.1 3.6 0.8 0.3 0.1 2.5 3.2 0.6 Decapods 1.8 1.1 0.1 3.1 1.0 0.3 3.2 0.3 0.1 3.6 0.8 0.3 Hemisquilla braziliensis	Fissurellidea megatrema										0.5	0.4	0.02			
Metula anfractura 1.5 0.1 0.01 Decapods 1.8 1.1 0.1 3.1 1.0 0.3 3.2 0.3 0.1 3.6 0.8 0.3 Hemisquilla braziliensis 1.6 0.4 0.1 2.5 3.2 0.6 Portunus spinicarpus 1.8 0.7 0.1 1.6 0.3 3.6 0.9 0.4 2.5 0.4 0.1 Astropecten cingulatus 1.8 0.7 0.1 1.6 0.3 3.6 0.9 0.4 2.5 0.4 0.1 Luidia sp. 1.8 0.7 0.1 1.6 0.04 0.05 0.01 2.5 0.3 0.0 Luidia sp. 1.8 0.4 0.04 1.5 0.04 0.05 0.04 1.0 0.05 0.01 1.0 1.0 0.05 0.01 1.0	Loliginidae	7.0	11.1	4.9	13.8	17.6	20.9	9.5	8.7	8.8	9.9	5.6	6.6	7.5	3.1	1.8
Decapeds 1.8 1.1 0.1 3.1 1.0 0.3 3.2 0.3 0.1 3.6 0.8 0.3 Hemisquilla braziliensis 1.6 0.4 0.1 2.5 3.2 0.6 Portunus spinicarpus 1.8 0.7 0.1 3.2 1.0 0.3 3.6 0.9 0.4 2.5 3.2 0.6 Astropecten cingulatus 1.8 0.7 0.1 1.6 0.3 3.6 0.9 0.4 2.5 0.4 0.1 Astropecten cingulatus 1.8 0.7 0.1 1.6 0.04 0.9 0.4 2.5 0.3 0.0 Luidia sp. 1.8 0.4 0.04 1.5 0.04 0.05 0.8 0.04 1.0 0.05 0.01 1.0 1.0 0.05 0.01 1.0 1.0 1.0 1.7 0.7 Sponge of remains 1.8 0.4 0.04 1.0 0.05 0.01 1.0 1.0 5.0 1.7 0.7 Total number of preys 66(40) 87(45)	Metula anfractura				1.5	0.1	0.01									
Hemisquilla braziliensis 1.6 0.4 0.1 2.5 3.2 0.6 Portunus spinicarpus 1.8 0.7 0.1 3.2 1.0 0.3 3.6 0.9 0.4 2.5 0.4 0.1 Astropecten cingulatus 1 1.0 0.3 3.6 0.9 0.4 2.5 0.3 0.0 Luidia sp. 2.5 0.3 0.0 2.5 0.3 0.1 Coral of remains 1.8 0.4 0.04 1.5 0.04 0.05 0.04 1.0 0.05 0.01 Sponge of remains 1.8 0.4 0.04 1.0 0.05 0.01 1.7 0.7 Total number of preys 66(40) 87(45) 192(70) 300(88) 51(36) 51(36)	Decapods	1.8	1.1	0.1	3.1	1.0	0.3	3.2	0.3	0.1	3.6	0.8	0.3			
Porturus spinicarpus 1.8 0.7 0.1 3.2 1.0 0.3 3.6 0.9 0.4 2.5 0.4 0.1 Astropecten cingulatus	Hemisquilla braziliensis										1.6	0.4	0.1	2.5	3.2	0.6
Astropecten cingulatus 2.5 0.3 0.0 Luidia sp. 2.5 0.3 0.1 Coral of remains 1.8 0.4 0.04 1.0 0.05 0.01 Sponge of remains 1.0 4.7 0.6 5.0 1.7 0.7 Total number of preys 66(40) 87(45) 192(70) 300(88) 51(36)	Portunus spinicarpus	1.8	0.7	0.1				3.2	1.0	0.3	3.6	0.9	0.4	2.5	0.4	0.1
Luidia sp. 2.5 0.3 0.1 Coral of remains 1.8 0.4 0.04 1.0 0.05 0.01 Sponge of remains 1.0 4.7 0.6 5.0 1.7 0.7 Total number of preys 66(40) 87(45) 192(70) 300(88) 51(36)	Astropecten cingulatus													2.5	0.3	0.0
Coral of remains 1.8 0.4 0.04 1.5 0.04 0.005 0.8 0.04 0.004 1.0 0.05 0.01 Sponge of remains 1.0 4.7 0.6 5.0 1.7 0.7 Total number of preys 66(40) 87(45) 192(70) 300(88) 51(36)	Luidia sp.													2.5	0.3	0.1
Sponge of remains 1.0 4.7 0.6 5.0 1.7 0.7 Total number of preys 66(40) 87(45) 192(70) 300(88) 51(36)	Coral of remains	1.8	0.4	0.04	1.5	0.04	0.005	0.8	0.04	0.004	1.0	0.05	0.01			
Total number of preys 66(40) 87(45) 192(70) 300(88) 51(36)	Sponge of remains										1.0	4.7	0.6	5.0	1.7	0.7
	Total number of preys	66(40)			87(45)			192(70)			300(88)			51(36)		

Table 4. Frequency of occurrence (%FO), percentage weight (%W) and alimentary index (%IAi) per total length-class of items in the diet of *L. gastrophysus*. (Number of the samples containing prey in parentheses.)

M.F.M. VALENTIM ET AL.

Quarterly	2004			2005		2006			
food items	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	
Anguilliformes	0.41	3.08	1.46	1.16			0.61	0.002	
Bembrops heterurus		0.10	0.09	0.11		0.09	6.34		
Dactylopterus volitans	7.76	0.15	3.60	0.05			10.80	71.45	
Dules auriga	0.03	0.13	0.70	0.99			0.12	1.58	
Hippocampus erectus								0.01	
Merluccius hubbsi	5.28	2.84	6.40	0.07	7.74	8.10		0.68	
Mullus argentinae	0.88	2.74		0.39	1.60	5.26		0.05	
Orthopristis ruber				2.36					
Pagrus pagrus	0.21	0.37		0.24		0.46		2.18	
Paralichthyidae	0.90	2.74		0.27	8.82	0.92	2.59	0.48	
Digested fish	43.24	30.54	27.21	48.0	55.82	79.06	61.23	15.99	
Non-identified fish	0.01	1.28	0.09	2.46	17.45	0.12			
Percophis brasiliensis		3.35		0.91			0.27		
Pinguipes brasilianus	0.12								
Porichthys porosissimus	0.12	10.08		0.67					
Prionotus nudigula	0.18		0.10			0.33	0.05		
Raneya fluminensis	2.74	13.41			0.31	0.22	2.30		
Rioraja agassizi								0.02	
Saurida caribbaea	0.01					0.16		0.01	
Sciaenidae	36.09	16.56	26.15	0.04		0.38		0.70	
Scorpaena isthmensis								0.02	
Stephanolepis hispidus	0.11	4.25	13.10	0.20					
Thalassophryne montevidensis			0.25		0.15				
Trachurus lathami	0.27	2.11	1.62	0.16	7.01	4.31	10.75	0.58	
Fissurellidea megatrema	,	0.37			,	10	,,,	-	
Loliginidae	1.19	0.72	17.85	37.89	0.71	0.00	1.75	6.13	
Metula anfractura	0.00	,	, ,	., ,					
Decapods	0.11	0.69		0.05	0.30		2.93		
Hemisquilla braziliensis				2.37	0		20	0.01	
Portunus spinicarpus	0.32	0.55		0.33	0.08	0.60		0.10	
Astropecten cingulatus	0			0.05					
Luidia sp.				0.05					
Coral of remains			0.08	-			0.25		
Sponge of remains		3.94	1.28	0.12			~ /		
Total number of preys	128	70	76	73	49	44	55	201	
Total number of samples			, -	, 5	12				
containing prey	47	37	27	29	21	21	29	68	

Table 5. Alimentary index (%) of items consumed by Lophius gastrophysus.

AMJ, April-May-June; JAS, July-August-September; OND, October-November-December; JFM, January-February-March

fish and *M. hubbsi*. In general, the diet of *L. gastrophysus* was quite similar among the quarterly samples, promoted by the constant presence of fish items. The feeding habit with a tendency to piscivory was evident in all length-classes and throughout the two-year sampling period, varying only in the relative importance of the different items in the diet. The IQ was significantly different among the five length-classes (F = 9.54; P < 0.05; N = 443) (Figure 2).

The linear regression analysis showed no correlation between total lengths of predator and prey items (N = 342; r = 0.13; P = 0.001), or the total weights of predator and prey items (N = 497; r = 0.22; P = 0.000001). On the other hand, the dispersion graphs in Figure 3 show that, regardless of its size, *L. gastrophysus* consumed mainly prey items of small size and low weight.

DISCUSSION

The sample size of *Lophius gastrophysus* was larger than that taken on the inner continental shelf by Soares *et al.* (1993), but

similar to the sample size reported by Muto et al. (2005) on the outer continental shelf and upper slope. These are the areas exploited by commercial trawlers based in the state of Rio de Janeiro, from which the samples analysed in the present study were obtained. The proportion of empty stomachs was similar to that recorded by Olaso et al. (1982) and Crozier (1985) for congeneric species. The high proportion of empty stomachs among individuals of *L. gastrophy*sus can be explained by their exclusively fish-based diet. According to Nikolsky (1978), the high nutritional value of this kind of diet reduces the need to ingest food continuously. On the other hand, Zavala-Camin (1996) noted that a large number of empty stomachs might result from regurgitation of stomach contents, providing misleading information about the population behaviour. We have no records of the frequency of regurgitation in L. gastrophysus taken by the commercial trawlers that constituted our sample, but some stomachs were flaccid (5%), enlarged and filled with liquid. Crozier (1985) suggested that, despite the lack of studies on the subject in Lophius piscatorius, the degree of digestion and the high rate of remains of non-identified fish indicate that the digestive



Fig. 1. Dendrogram based on the Bray-Curtis similarity index among (A) length-classes (by cm), and (B) among quarterly samples, based on the alimentary index (%) of items consumed by *Lophius gastrophysus*. JFM, January-February-March; AMJ, April-May-June; JAS, July-August-September; OND, October-November-December.

process is slow. The same may hold true for *L. gastrophysus*, although some regurgitation may occasionally occur.

The possibility of incidental digestion of prey by fish caught in trawls poses a problem for the evaluation of their diet. Laurenson & Priede (2005) observed that prey were ingested during the tow in *L. piscatorius*, in addition to the stomach contents. The same was observed during our study, and these prey items were not considered in the diet analysis.

Lophius gastrophysus is essentially piscivorous, with a wide spectrum of prey, as previously demonstrated in other studies (Soares *et al.*, 1983; Muto *et al.*, 2005). Armstrong *et al.* (1996),



Fig. 2. Intestinal quotient (IQ) values of *Lophius gastrophysus* per length-class; bars indicate standard deviation (N, sample size).



Fig. 3. Relationship between (A) total lengths of *Lophius gastrophysus* and total lengths of prey items consumed and (B) between total weights of *L. gastrophysus* and total weights of prey items consumed.

Laurenson *et al.* (2004) and Preciado *et al.* (2006) classified different species of *Lophius* as opportunists that take both benthic and pelagic prey, and even seabirds (Bigelow & Schroeder, 1953). Based on this criterion, the presence of pelagic, benthopelagic and demersal prey in the stomachs of *L. gastrophysus* allows it to be classified similarly, although demersal prey predominate.

The stomach contents might reflect the spatial and temporal availability and abundance of the prey, as fisheries were carried out in similar areas and depths in both years. Muto *et al.* (2005) reported that in L. gastrophysus from south-south-eastern Brazil, Merluccius hubbsi and squid predominated in the stomach contents. Both of these resources are abundant in that area (Haimovici et al., 2002). Squid were also the second most important resource. However, among the items of the fish category, Dactylopterus volitans was the most important. The predominance of D. volitans in the stomach contents of juveniles of L. gastrophysus probably reflects the distribution of predators in shallower areas near the shore. Figueiredo & Menezes (1978) and Soares et al. (1993) characterized D. volitans as a coastal benthic species that mainly eats crustaceans, molluscs and small benthic fish. It is recognized by commercial trawler fishermen as an indicator species of the presence of pink shrimp (Farfantepenaeus spp.). The life habit of D. volitans and the bathymetric stratification of L. gastrophysus, with smaller and immature individuals in shallower areas and larger and adult individuals in deeper areas (Perez et al., 2002), explains the importance of this prey in the diet of juveniles of L. gastrophysus. A similar bathymetric stratification was observed by Laurenson et al. (2005) for Lophius piscatorius, with juveniles occurring in coastal areas and swimming to deeper waters as they grow. In L. gastrophysus, the juveniles consumed smaller quantities and variety of prey than did the adults, in contrast to the behaviour of L. piscatorius (Laurenson & Priede, 2005) and Lophius americanus (Armstrong et al., 1996; Scharf et al., 2000). The higher prey diversity in the diet of adults, however, might be a bias caused by the different sampling size. The prey-capture strategy of Lophius involves, besides attracting the prey by wiggling the illicium, a large and quite protractile mouth combined with a strong bone structure and

a developed musculature, which forms an efficient suction mechanism (Paxton & Eschmeyer, 1998). Through the extreme expansion of the mouth and the gill cavity, the rapid opening of the mouth easily sucks in the prey (Paxton & Eschmeyer, 1998). Thus, the smaller size of the mouth of juveniles and, consequently, the amplitude of the oral cavity might explain the pattern observed. In fact, in *L. americanus*, the mouth opening increases about four times as fast as the fish grows (Scharf *et al.*, 2000). On the other hand, it is noticeable that *L. gastrophysus*, despite capturing a larger variety and quantity of prey when adult, takes mainly small prey in spite of its large mouth.

The similarity among size-classes indicated gradual changes in diet composition during the growth of *L. gastrophysus.* Crozier (1985) recorded the same pattern for *L. piscatorius*, and the importance of a crustacean (*Nephrops*) for the latter fish led him to suggest that lophiids may be the principal predator of this commercial fishing resource of Northern Ireland. However, the presence of *D. volitans* in stomachs of juveniles of *L. gastrophysus* and their capture by commercial trawlers indicates that this shrimp fishery may be having an impact on *L. gastrophysus* juveniles.

In fish, the dietary composition may vary seasonally because of alterations in food availability caused by changes in habitats available for forage, changes due to biological patterns of organisms and changes caused by feeding activity of the fish themselves (Wooton, 1990). The diet of *L. gastrophysus* showed some seasonal changes, as evidenced by the clustering of the same periods in both sampling years. Squid, for example, were more intensively consumed during summer. Some climatic differences occurred in the Equatorial Pacific Ocean during the two years of the study (www.cptec.inpe. br), which may have been reflected in fish communities of the Atlantic (Sánchez *et al.*, 2000).

In the relationship between feeding habit and digestive tract morphology of fish, carnivores tend to have shorter intestines compared to herbivores (Zavala-Camin, 1996). The low values of the IQ of *L. gastrophysus* confirm its carnivorous habit with a tendency to piscivory. Zavala-Camin (1996) noted that fish which keep the same diet show a decrease in IQ as they grow, because daily consumption is relatively smaller in largersized individuals. In *L. gastrophysus* the length of the intestine did not follow the growth of the fish, despite the fact that both juveniles and adults are fish eaters.

In general, the size of the prey has a direct relationship with the size of the predator (Gerking, 1994); however, for *L. gastrophysus*, the linear regression between the predator length and the lengths of the prey items indicated only a slight correlation. Small, light prey tended to be consumed independently of the size of the predator, suggesting that *L. gastrophysus* shows low selectivity for prey. Thus, it consumes any prey of handling size and/or weight that it can attract, as observed by Crozier (1985) for *L. piscatorius*. Therefore, considering that *L. piscatorius* juveniles and adults feed in the same area, intra-specific competition may occur. However, competition among different sized individuals in *L. gastrophysus* would be minimized by the dietary segregation observed between juveniles and adults.

ACKNOWLEDGEMENTS

This research was financially supported by a UFRJ-UNIVALI cooperative agreement (Contract UNIVALI-SEAP/PR/001/2003), and is part of Maria de Fátima M. Valentim's

doctoral thesis at PPGE/UFRJ. We are grateful to CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) for Maria de Fátima M. Valentim's doctoral scholarship, and to CNPq (Conselho Nacional de Desenvolvimento Técnico e Científico) for Érica P. Caramaschi's research scholarship. We thank Mestre Sebastião da Silva for obtaining the samples analysed in this study; biologists Luis C.S. Junior and Amanda C. Andrade for their aid in identifying stomach contents, Dr Maria C. Ostrowski and biologist Tereza C.G.S. Ferreira for identification of crustaceans, and Dr Miriam P. Albrecht for suggestions on the manuscript. Dr Janet W. Reid revised the English text.

REFERENCES

- Armstrong M.P., Musick J.A. and Colvocoresses J.A. (1996) Food and ontogenetic shifts in feeding of the goosefish, *Lophius americanus*. *Journal of Northwest Atlantic Fishery Science* 18, 99–103.
- **Bigelow H.B. and Schroeder W.C.** (1953) Fishes of the Gulf of Maine. *Fish and Wildlife Service, United States Department of the Interior, Fishery Bulletin* 53, 1–577.
- **Caruso J.H.** (1983) The systematics and distribution of the lophiid anglerfishes: II. *Revisions of the genera* Lophiomus *and Lophius. Copeia* 1, 11–30.
- **Crozier W.W.** (1985) Observations on the food and feeding of the anglerfish *Lophius piscatorius* L., in the northen Irish Sea. *Journal of Fish Biology* 27, 655–665.
- Figueiredo J.L. and Menezes N.A. (1978) *Manual dos peixes marinhos do Sudeste do Brasil. II.* Teleostei (1). Museu de Zoologia, USP, São Paulo, 110 pp.
- Figueiredo J.L., Santos A.P., Yamaguti N., Bernardes R.A. and Rossi-Wongtschowski C.L.D.B. (2002) Peixes da zona econômica exclusiva da região sudeste-sul do Brasil: Levantamento com rede de meia-água. Ed. EDUSP: Imprensa de São Paulo.
- Gerking S.D. (1994) Feeding ecology of fish. San Diego: Academic Press.
- Haimovici M., Wongtschowski C., Bernardes R.A., Santos R.A. and Fischer L.G. (2002) *Relatório preliminar sobre Lophius gastrophysus*. Prospecção de arrasto de fundo. Programa REVIZEE-Score-Sul. 8 p.
- Hammer Ø., Harper D.A.T. and Ryan P.D. (2003) Past Palaentological Statistics, Version 1.28. Disponível em: wwww.folk.uio.no/ohammer/ past. Accessed July 2006.
- Hyslop E.J. (1980) Stomach content analysis: a review of methods and their application. *Journal of Fish Biology* 17, 411-429.
- Kawakami E. and Vazzoler G. (1980) Método gráfico de índice alimentar aplicado no estudo de alimentação de peixes. *Boletim do Instituto Oceanográfico* 29, 205–207.
- Laurenson C.H. and Priede I.G. (2005) The diet and trophic ecology of anglerfish Lophius piscatorius at the Shetland Islands. Journal of the Marine Biological Association of the United Kingdom 85, 419–424.
- Laurenson C.H., Hudson I.R., Jones D.O.B. and Priede I.G. (2004) Deep water observations of anglerfish (*Lophius piscatorius* L.) in the north-eastern Atlantic ocean by means of remotely operated vehicle. *Journal of Fish Biology* 65, 947–960.
- Laurenson C.H., Johnson A. and Priede I.G. (2005) Movements and growth of monkfish *Lophius piscatorius* tagged at the Shetland Islands, Northeastern Atlantic. *Fisheries Research* 71, 85-195.
- Muto E.Y., Silva M.H.C., Vera G.R., Leite S.S.M., Navarro D.G. and Rossi-Wongtschowski C.L.D.B. (2005) Alimentação e relações tróficas

de peixes demersais da plataforma externa e talude superior da região sudeste-sul do Brasil. Série Documentos REVIZEE-Score Sul. 64 pp.

- Nikolsky G.V. (1978) *The ecology of fishes*. Neptune City: T.F.H. Publications.
- Olaso I., Pereda P. and González R. (1982) The feeding of young angler fishes (Lophius budegassa Spinola and L. piscatorius L.) in divisions VIIIc and IXa of ICES. ICESCM 1982/G:38 p.
- Paxton J.R. and Eschmeyer W.N. (1998) *Encyclopedia of fishes*. 2nd edn. Boston: Academic Press.
- Perez J.A.A. and Wahrlich R. (2005) A bycatch assessment of the gillnet monkfish *Lophius gastrophysus* fishery off southern Brazil. *Fisheries Research* 72, 81–95.
- **Perez J.A.A., Pezzuto P.R. and Andrade H.A.** (2005) Biomass assessment of the monkfish *Lophius gastrophysus* stock exploited by a new deep-water fishery in southern Brazil. *Fisheries Research* 72, 149–162.
- Perez J.A.A., Pezzuto P.R., Andrade H.A., Schwingel P.R., Rodrigues-Ribeiro M. and Wahrlich R. (2002) O ordenamento de uma nova pescaria direcionada ao peixe-sapo (*Lophius gastrophysus*) no sudeste e sul do Brasil. *Notas Técnicas da FACIMAR* 6, 65–83.
- Preciado I., Velasco F., Olaso I. and Landa J. (2006) Feeding ecology of black anglerfish *Lophius budegassa*: seasonal, bathymetric and ontogenetic shifts. *Journal of the Marine Biological Association of the United Kingdom* 86, 877–884.
- Sánchez G., Calienes R. and Zuta S. (2000) El Niño 1997–98 in the Peruvian ecosystem. *CalCOFI Report* 41, 62–86.
- Scharf F.S., Juanes F. and Rountree R.A. (2000) Predator size-prey size relationships of marine fish predators: interspecific variation and effects of ontogeny and body size on trophic-niche breadth. *Marine Ecology Progress Series* 208, 229–248.

- Soares L.S.H., Gasalla M.A., Rios M.A.T., Arrasa M.V. and Rossi-Wongtschowski C.L.D.B. (1993) Grupos tróficos de onze espécies dominantes de peixes demersais da plataforma continental interna de Ubatuba, Brasil. Publicação Especial do Instituto Oceanográfico 10, 189–198.
- Vianna M. and Almeida T. (2005) Bony fish bycatch in the southern Brazil pink shrimp (*Farfantepenaeus brasiliensis* and *F. paulensis*) fishery. *Brazilian Archives of Biology and Technology* 48, 611-623.
- Wahrlich R., Perez J.A.A. and Lopes F.R.A. (2004) Aspectos tecnológicos da pesca do peixe-sapo (*Lophius gastrophysus*) com rede de emalhar no sudeste e sul do Brasil. *Boletim do Instituto Pesca* 30, 87–98.

Wootton R.J. (1990) Ecology of teleost fishes. London: Chapman and Hall.

Zavala-Camin L.A. (1996) Introdução aos estudos sobre alimentação natural em peixes. Maringá: Eduem. Nupelia. 129 pp.

and

Zar J.H. (1996) *Biostatistical analysis.* 3rd edn. Englewood Cliffs, NJ: Prentice-Hall.

Correspondence should be addressed to:

Maria de Fátima Moraes Valentim Universidade Federal do Rio de Janeiro Centro de Ciências da Saúde, Instituto de Biologia Departamento de Ecologia Laboratório de Ecologia de Peixes Avenida Pau Brasil, 211 Ilha do Fundão Rio de Janiero Brazil 21941-541 email: frequicultura@hotmail.com