Description of diet of pelagic fish in the southwestern Atlantic, Brazil

Guilherme Rossi Gorni[1,4], Roberto Goitein[2] & Alberto Ferreira de Amorim[3]

*[1]Departamento de Ciências Biológicas e da Saúde, Centro Universitário de Araraquara – UNIARA,
CEP 14801-340, Araraquara, SP, Brasil*
*[2]Departamento de Zoologia, Instituto de Biociências, Universidade Estadual Paulista
"Júlio de Mesquita Filho" – UNESP, CEP 13506-900, Rio Claro, SP, Brasil*
*[3]Instituto de Pesca, Agência Paulista de Tecnologia dos Agronegócios – APTA, Secretaria de Agricultura e
Abastecimento do Estado de São Paulo – SAA, CEP 11030-500, Santos, SP, Brasil*
[4]Corresponding author: Guilherme Rossi Gorni, e-mail: grgorni@gmail.com

Abstract: This study reveals the food composition of pelagic fishes living in the southwestern Atlantic Ocean. As such more common pelagic species are considered to be top predators, the study proposes to know what constitutes their main food. Fish are not commonly found within their stomach contents, but instead, cephalopods are their most common food. As can be observed, Teuthida cephalopods compose their principal diet. The stomach contents of specimens of *Xiphias gladius*, *Thunnus albacares*, *T. obesus*, *T. alalunga*, *Isurus oxyrinchus* and *Alopias superciliosus* caught during July 2007 to June 2009 by using tuna longliners were studied. Teuthida cephalopods constitute the main food item for the three tuna species, while *X. gladius* feeds mainly on Ommastrephidae cephalopods. Though the differences among the kinds of cephalopods exist, they constitute the principal resource these fish use to live at least in the southern Atlantic Ocean.
Keywords: top predators, diet composition, longline fishery, stomach content analysis.

Resumo: Este estudo descreve a composição da dieta de peixes pelágicos que vivem no Oceano Atlântico Sudoeste. Como tais espécies pelágicas são consideradas predadoras de topo, o estudo propõe conhecer o que constitui sua principal fonte de alimento. Peixes não são comumente encontrados em seus conteúdos estomacais, em vez disso, os cefalópodes são os alimentos mais comuns. Como pode ser observado, cefalópodes Teuthida compreendem sua dieta principal. O conteúdo estomacal de espécimes de *Xiphias gladius*, *Thunnus albacares*, *T. obesus*, *T. alalunga*, *Isurus oxyrinchus* e *Alopias superciliosus,* capturados durante julho de 2007 a junho de 2009 prela frota atuneira, foram estudados. Cefalópodes Teuthida constituem o principal item alimentar das três espécies de atum, enquanto *X. gladius* alimenta-se principalmente de cefalópodes Ommastrephidae. Embora as diferenças entre os tipos de cafalópodes existam, eles constituem o principal recurso que estes peixes usam para viver, pelo menos no Oceano Atlântico Sudoeste.
Palavras-chave: predadores de topo, composição alimentar, pesca de espinhel, análise de conteúdo estomacal.

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Introduction

One common problem to be faced when studying top sea predators is the fact that they are caught in small numbers by scientific expeditions. So, one should be aware that statistic significant data are hardly available. On the other hand, by comparing distinct species living in almost similar open seas, it may be seen as a possible approach to distinguish their diet composition when they are compared to other available data in the literature. So, the solely fact that studies based on results of smaller data numbers can also be useful to add them to other available ones and, so, reinforce what has been discovered until that moment. There seems to exist no other ways to study such kinds of fish, mainly in the southern hemisphere where such studies are more incipient. Such studies may permit an evaluation about the role each species may play among the other ones, competitors or not in a determined system (Schoener 1974) and may also help the understanding of their biology and population dynamics (Zavala-Camin 1982).

By what is known about the fish species caught in the southwestern Atlantic Ocean, the swordfish *Xiphias gladius* (Linnaeus 1758), is a cosmopolitan one, whose epi and mesopelagic habit has been frequently registered for fish occurring between 45°N and 45°S latitudes. So, its distribution comprises tropical and temperate seas, which means toleration to a wide temperatures range (Palko et al. 1981, Nakamura 1985). As it is known to be an opportunistic predator, the swordfish uses to show a broad alimentary spectrum, feeding on cephalopods, fish and crustaceans (Clarke et al. 1995, Figueiredo & Menezes 2000). Its diet composition has been studied in the Mediterranean Sea (Bello 1991); Pacific Ocean (Ibañez et al. 2004, Castillo et al. 2007, Letelier et al. 2009); at the Indic Ocean (Potier et al. 2007) and the Atlantic Ocean (Stillwell & Kohler 1985 Simões & Andrade 2000, Satoh et al. 2004, Chancollon et al. 2006). For Brazilian waters, besides the studies of Zavala-Camin (1981), Mello (1992) and Vaske-Júnior (2000), few other studies are registered.

The tuna species, which belong to the Scombridae family, are constituted by fish attaining large sizes. There are five species off the Brazilian coast. The most common ones are: *Thunnus albacares* (Bonnaterre, 1788) *Thunnus obesus* (Lowe, 1939) and *Thunnus alalunga* (Bonnaterre, 1788). These three tuna species are considered to act as opportunistic predators, whose feeding may be determined by local prey availability. Their diet is characteristically diversified, mainly composed by fish, cephalopod mollusks and crustaceans. Some studies revealed the food composition of the three species in Southern Atlantic since 1981 to 2004 (Zavala-Camin 1981, 1982, 1987, Vaske-Júnior & Castello 1998, Vaske-Júnior 2000, Vaske-Júnior et al. 2003; Sabatié et al. 2003, Satoh et al. 2004). No more studies were registered since then.

The two studied shark species, *Isurus oxyrinchus* (Rafinesque, 1810) and *Alopias superciliosus* (Lowe, 1840) are known to be epipelagic and active, which means, they wander during all the time and may dive to 500 m (Cervigón 1992, Compagno 2001). Though the economic importance played by these shark species, studies concerning their feeding habits are rare, as happens to their ecologic trophic importance in Brazilian waters, with the exception of the Zavala-Camin (1981) and Vaske-Júnior & Rincón-Filho (1998) studies.

As the last, so to say, more complete studies referring to diet compositions of such species in that region are twenty years old, this study purpose is to describe the diet composition of *X. gladius*, *T. albacares*, *T. obesus*, *T. alalunga*, *I. oxyrynchus* and *A. superciliosus* caught at the southwestern Atlantic Ocean. This should contribute to add more recent information in order to provide condition to perform ecological studies related to this pelagic environment.

Materials and Methods

Specimens of *X. gladius*, *T. albacares*, *T. obesus*, *T. alalunga*, *I. oxyrynchus* and *A. superciliosus* were collected every month from July 2007 to June 2009 by the Santos (SP) tuna longliners. These boats range their operations along the southeastern and southern Brazilian coast, in an area comprised between 17-35° S and 27-52° W., off the continental shelf (Figure 1). According to Arfelli & Amorim (2000), such boats work by using the surface longline with light attraction to the swordfish (*Xiphias gladius*), in fisheries, which may last 15 to 20 days.

1. Data collection

During the process of evisceration, which was performed immediately after fish were caught, the stomachs were individually deposited in devices with a 10% formalin solution. They were stored in a larger recipient containing formalin. The stomach contents were washed and seined. After this process, they were stored in individual labeled recipients, remaining in a 70% ethanol solution. All the items within the stomach contents were identified as to the lowest possible identification level, using taxonomic criteria based on Figueiredo & Menezes (1980, 2000), Menezes & Figueiredo (1980, 1985), Clarke (1986), Nesis (1987), and Figueiredo et al. (2002).

2. Diet analyses

The Prey Relative Importance Index expressed by percentages (%IRI) (Equation 1) (Pinkas et al. 1971, Cortés 1997) was utilized to reveal the feeding pattern exhibited by the studied specimens. This Index is calculated using the percentage number (%N), percentage in weight (%W) and by the Occurrence frequency percentage (%O) representing the identified items within each predator stomach contents (Hyslop 1980). The mass percentages were based on the humid masses of prey items found in the stomachs, instead of the reconstituted mass method.

Percentage of the Relative Importance Index:

$$\%IRI = \left(\left((\%N + \%W) \times \%O \right) / \left(\sum (\%N + \%W \times \%O) \right) \right) \times 100 \quad (1)$$

Results

For the 333 analyzed stomachs, 2328 items were registered; totalizing 43223 grams of alimentary material (see Table 1). The stomach contents revealed the occurrence of 56 prey taxa, including 23 families of fishes, 3 orders of cephalopods, crustaceans and other 4 groups, which are shown in detail at Table 1. The highest and lowest richness of alimentary taxa were respectively registered to *T. alalunga* (32 taxa) and *A. superciliosus* (7 taxa).

According to the calculation of the %IRI, the main alimentary item for *T. albacares*, *T. obesus* and *T. alalunga* was constituted by Teuthida cephalopods. In terms of numerical percentages, the most important prey for *T. albacares* were represented by Teuthida mollusks, followed in order by crustaceans and teleosts. A similar pattern was shown for *T. alalunga* to which mollusks are the most important food, but fish represent the second one in importance. *T. obesus*, in turn, feeds mainly on fish, followed by cephalopods and crustaceans (Table 1). The most important food item to *X. gladius* was also composed by cephalopods, from which the Ommastrephidae represented 63.7% of the IRI. Fish were more diversified, but the identified species did not reach more than 1% of the IRI. Crustaceans,
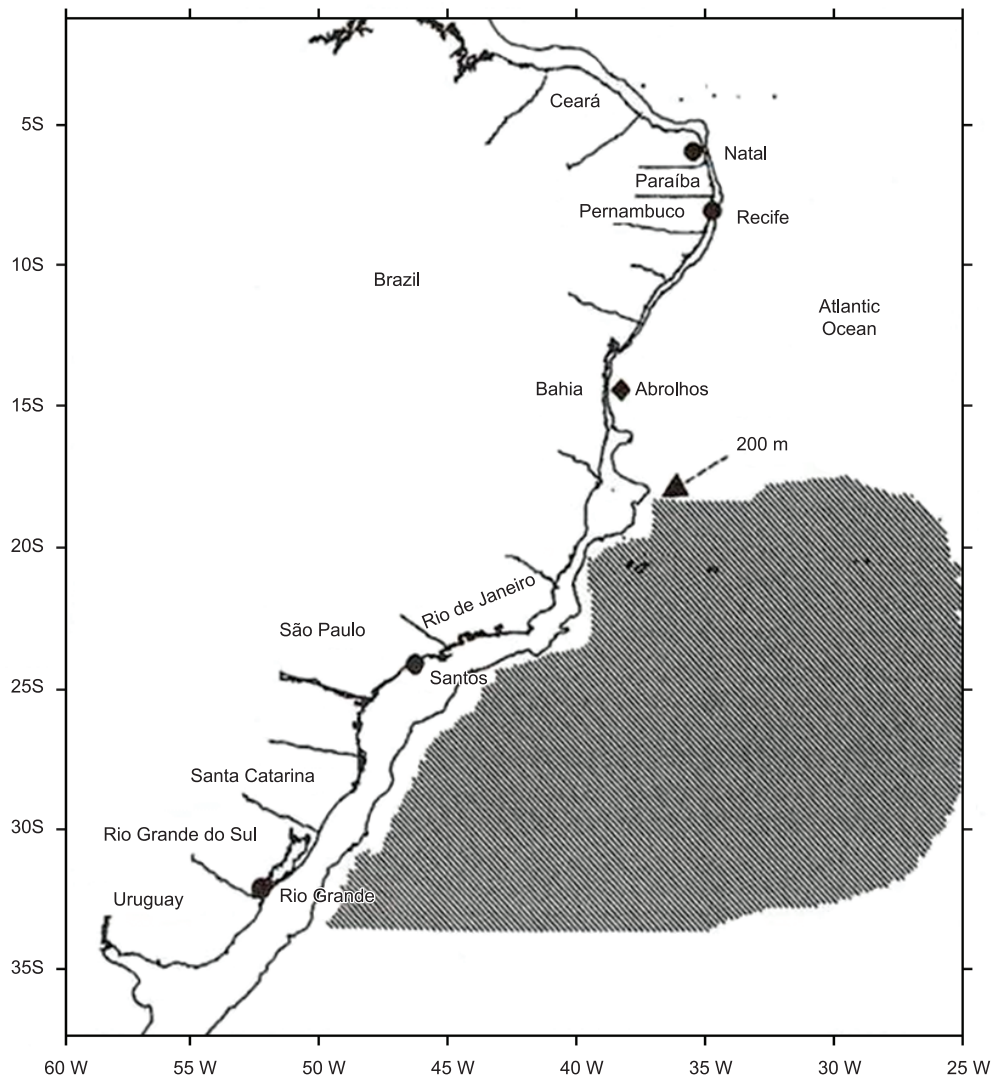
Figure 1. Santos longliners fishing area (adapted from Amorim et al. 1998).

however, were represented by decapods and performed 1.3% of the IRI.

The food composition of *I. oxyrinchus* was also dominated by cephalopod mollusks and the Teuthida order, mainly composed by Ommastrephidae, represented 30.4% of the IRI. The group formed by fish species was also more diversified, being dominated by non identified teleosts, followed by Scombridae. *Alopias superciliosus* consumed mainly Teuthida cephalopods (49.6% of the IRI), and secondarily non identified fish and then Trichiuridae (26.9% and 21.3%, respectively). Crustaceans were also present within the stomach contents, but a clear difference was observed for this item's importance to the feeding composition of these sharks (3.4% and 0.6%, respectively). Unusual items were also found within the stomach contents. Plastic bags, small box rests and even nylon treads were noticed.

Discussion

The relatively broad trophic spectrum presented by *X. gladius*, *T. albacares*, *T. obesus* and mainly *T. alalunga* may corroborate the generalist feeding habit such fishes present. Potier et al. (2007) emphasize tuna and similar fish predation to be described as an opportunistic process, as such fishes live in environments containing a relatively low organism's concentration, as are usually known the pelagic ocean regions. Besides the relative homogeneity of such environments, pelagic species may present relative ecological defined niches, which may minimize competition for resources. This may be caused by distinct vertical and seasonal distributions the fishes present (Zavala-Camin 1982).

The presence of Teuthida cephalopods within the gastric contents of *T. albacares*, *T. obesus* and *T. alalunga* has been a commonly known fact in such nature studies. Dragovich (1971), Perrin et al. (1973), Pelczarski (1988) and Potier et al. (2007) state that the squids Ommastrephidae represent the most important cephalopods present in the diet composition of *T. albacares*. Other groups, such as Octopoda are also related as food to this tuna fish, though in a relatively small amount. (Dragovich op. cit., Pelczarski op. cit.). In a similar way, Ommastrephidae squids are recognized to be the most common cephalopod food item for *T. obesus* (mainly the genera *Illex* and *Ommastrephes*) (Zavala-Camin 1981, Vaske-Júnior,

2000). Apparently, the relatively smaller size of the individuals of *T. alalunga* may impose limits to the ingestion of large squids, thus justifying the presence of smaller cephalopods, as may be the case of some octopods.

The registration of specimens, which belong to Bramidae, Monacanthidae and Trichiuridae may reinforce the idea that *T. albacares* frequently feeds near to the water column surface (Dragovich & Potthoff 1972, Bard et al. 2002). But, on the other hand, some mesopelagic families, such as Chiasmodontidae and Gempylidae are also represented as food components for such species (Figueiredo & Menezes 2000, Figueiredo et al. 2002). This may mean that *T. albacares* usually dives for incursions to search for food at deeper waters. Graham et al. (2007), looking for information about ontogenetic changes for feeding, reflecting in a broader amplitude of the food components for the species, describes a diet significant change of *T. albacares*, when the individuals` furcal lengths reach 45 centimeters or more. In addition, following these authors, when the individuals surpass this length, they use to acquire and endothermic capacity, which permits them to get prey living in colder and deeper waters.

The primarily teutophagic food composition shown by *T. obesus* may help to corroborate the results obtained by Zavala-Camin (1981), in which cephalopod mollusks comprise approximately 83% of the diet composition. So, the definition of a guild based on theutid cephalopods may be considered to be a reference to these diverse pelagic fishes. But, notwithstanding this, the data disagree from those obtained by Vaske-Júnior (2000) and Liming et al. (2005), who observe that teleost fishes are predominant to the feeding of the species. As the *T. obesus* diet may be least affected by latitudes or distances from the coast, when compared to other tuna species (Dagorn et al. 2000, Bertrand et al. 2002), one may infer that such divergences for food composition may be mainly due to local prey availabilities.

In a similar way, *T. alalunga* presented a feeding spectrum based on cephalopod mollusks, followed by fish and crustaceans. It was not possible, however, to establish a pattern to analyze the results by basing them on available literature, as there are not coherent data related to the food preference of this tuna species. Zavala-Camin (1981) in an analysis by examining 741 stomachs, registered a predominance for mollusks (59.9%), followed by fish and crustaceans. Sabatié et al. (2003) state that crustaceans comprised the most important contribution (43%), and then it was followed by fish and cephalopods. Satoh et al. (2004), in contrast, suggests a predominantly piscivorous diet of *T. alalunga*, as this item was found to comprise more than 65% of the components of the stomach contents for the individuals of this species. A fact to be registered may consider the existence of an opportunistic behavior of the individuals of the species, which may feed on fish or squid shoals.

A substantial contribution of items formed by crustaceans to the diets of *T. albacares* and *T. alalunga* may be related to a morphological design, which consists in a shorter distance between their gillrakers, a fact that, as observed by Magnuson & Heitz (1971) may permit an ingestion of smaller prey. According to a diagnosis made by Zavala-Camin (1978), by comparing the species mentioned above, *T. obesus* presents the lowest number of gillrakers, when compared to the other species (varying from to 25 and 30), a fact which may explain the low occurrence of crustaceans in the feeding habit of the species.

The diet of *X. gladius* was predominantly composed by cephalopod mollusks and secondarily by fish. These results are similar to those related to this species at the South Atlantic Ocean (Zavala-Camin 1981), at the northwest Atlantic (Stillwell & Kohler 1985) and to the Pacific Ocean (Ibañez et al. 2004, Castillo et al. 2007,

Letelier et al. 2009). Meanwhile, studies made for the Mediterranean Sea (Relini et al. 1995), at the northeast Atlantic (Chancollon et al. 2006) and at the Indic Ocean (Marsac & Potier 2001, Potier et al. 2007) show a precisely converse pattern, thus classifying the swordfish as a primarily ictiophagic predator. The *X. gladius* diet may vary consistently at distinct habitats and seasons, as a consequence of the variations of the distinct prey population dynamics (Letelier et al. 2009).

Pelagic mollusks of the Ommastrephidae family are commonly found as food items of *X. gladius*. Authors like Zavala-Camin (1981), Stillwell & Kohler (1985), Simões & Andrade (2000) and Vaske-Júnior (2000) have registered *Illex argentinus* and *Ommastrephes bartramii* as the most commonly identified Ommastrephidae species. In contrast, the stomach contents of *X. gladius* caught at the Pacific Ocean were mainly composed by the species *Dosidicus gigas* and *Todarodes filipovae* (Ibañez et al. 2004, Castillo et al. 2007, Letelier et al. 2009). Other cephalopods as those who belong to the Loliginidae family commonly represent a low importance as food to *X. gladius*, as only in one stomach from 168 analyzed by Stillwell & Kohler (1985) contained such kind of squid. Simões & Andrade (2000) and Potier et al. (2007) also observed a low occurrence for Octopoda individuals as items for the stomach contents of this fish, a result which agrees to these study results.

In a similar way, crustaceans are reported to constitute a less important item to the fish diet related to these species, and may also be considered as an accidental item (Letelier et al. 2009). Notwithstanding this idea, decapod crustaceans have also been reported by Zavala-Camin (1981) and Chancollon et al. (2006).

Teleost fishes have been represented as the most diverse group, and were recognized as being formed by 12 taxa. Species of the family Myctophidae, as well as individuals of the genera *Synagrops*, *Brama*, *Cubiceps* and *Gempylus* may corroborate what has been registered by Zavala-Camin (1981), Stillwell & Kohler (1985), Vaske-Júnior (2000), Chancollon et al. (2006), Potier et al. (2007) and Letelier et al. (2009). As the elevated variety of prey species indicates, previous studies concerning the food composition of *X. gladius* suggest this species to be an opportunistic and generalist feeder. Such presumptions may, however, be taken cautiously. As Cortés (1997) states, a predator may be recognized as a specialist by choosing its prey by size and even behavior, instead of by species representations, mainly as this should be the fact to influence the feeding rate.

The organisms identified as the food items of *X. gladius* may corroborate the assumption about the daily vertical displacement pattern presented by the individuals of this species, which has been described by Carey & Robison (1981) and Takahashi et al. (2003). Such a fact could be evaluated in this way by the reason that both mesopelagic and epipelagic (Myctophidae in general and Ommastrephidae) were commonly found within the fish stomachs, as happened to *Brama* sp*., Auxis* sp. and *Euthynnus alleteratus* (Nesis 1987, Figueiredo et al. 2002). The occurrence of species, which usually occupy both strata (epi and mesopelagic), such as *Thunnus alalunga* and *Gempylus serpens*, reinforce the idea to this kind of movement considered to happen to this fish. Another observed characteristic for this feeding strategy may be linked to the act of chasing for cephalopods or fish, which use to form shoals. This fact is thoroughly discussed by the studies of Simões & Andrade (2000), Ibañez et al. (2004) and Chancollon et al. (2006), who try to relate the fact to a lesser effort in relation to the capture success.

The importance of Teuthida cephalopods to the feeding of *I. oxyrinchus* and *A. superciliosus* has also been related in the literature. Following the data furnished by Vaske-Júnior & Rincón-Filho (1998), Polo-Silva (2007) and Preti et al. (2008), the squids *Illex*

Table 1. Registred prey items in the stomachs of *Thunnus albacares*, *Thunnus obesus*, *Thunnus alalunga*, *Xiphias gladius*, *Isurus oxyrinchus* and *Alopias superciliosus*. N: number of stomachs; Cf: furcal length variation (cm); %N: percentages in number; %W: percentages in weight; %O: percentage in occurrence; %IRI: index of relative importance in percentages.

Prey	T. albacares N = 29 Cf: 30 - 114				T. obesus N = 63 Cf: 60 - 182				T. alalunga N = 77 Cf: 74 - 122				X. gladius N = 101 *Cf: 60 - 275				I. oxyrinchus N = 47 Cf: 82 - 281				A. superciliosus N = 16 Cf: 204 - 409			
	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI
Chordata Teleostei																								
Acanthuridae																								
Acanthurus cirurgus (Bloch, 1787)									0.2	<0.1	2.5	<0.1												
Acropomatidae																								
Synagrops bellus (Goode & Bean, 1895)													0.5	0.4	1.2	<0.1								
Synagrops sp.													0.2	0.3	1.2	<0.1								
Anoplogastridae																								
Anoplogaster cornuta (Valenciennes, 1833)									0.3	<0.1	2.5	<0.1												
Bramidae									0.2	0.5	2.5	<0.1												
Brama brama (Bonnaterre, 1788)	2.1	0.8	8.0	0.2					0.8	0.9	10.0	0.2	0.2	4.3	1.2	<0.1								
Brama caribea Mead, 1972									0.2	0.5	2.5	<0.1												
Brama sp.													0.7	3.9	4.6	0.2								
Pterycombus petersii (Hilgendorf, 1878)									0.2	<0.1	2.5	<0.1												
Caproidae																								
Antigonia cepros (Lowe, 1843)									1.3	0.3	7.5	0.1												
Chiasmodontidae																								
Pseudocopelus altipinnis (Parr, 1933)	0.2	0.3	4.0	<0.1																				
Ephippididae																								
Chaetodipterus faber (Broussonet, 1782)	1.3	<0.1	4.0	<0.1					0.2	<0.1	2.5	<0.1												
Gempylidae	0.2	<0.1	4.0	<0.1	1.1	1.9	2.0	0.1																
Gempylus serpens Cuvier, 1829					2.4	6.1	14.0	1.4					2.5	1.6	6.0	0.2								
Lepidocibium flavobrunneum (Smith, 1843)																	0.7	26.8	3.0	1.9				

*In *X. gladius* was used to measure the lower jaw fork length (LJFL).

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Table 1. Continued...

Prey	T. albacares N = 29 Cf: 30 - 114				T. obesus N = 63 Cf: 60 - 182				T. alalunga N = 77 Cf: 74 - 122				X. gladius N = 101 *Cf: 60 - 275				I. oxyrinchus N = 47 Cf: 82 - 281				A. superciliosus N = 16 Cf: 204 - 409			
	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI
Thyrsitops lepidopoides Cuvier, 1831					6.7	0.1	2.0	0.2																
Lutjanidae	0.2	0.2	4.0	< 0.1																				
Merlucidae									9.9	0.8	2.5	0.3												
Monacanthidae																								
Stephanolepis hispidus (Linnaeus, 1766)	0.2	< 0.1	4.0	< 0.1					0.2	< 0.1	2.5	< 0.1												
Myctophidae													0.2	< 0.1	1.2	< 0.1								
Nomeidae																								
Cubiceps sp.													0.2	1.1	1.2	< 0.1								
Peristediidae																								
Peristedion altipinnis (Regan, 1903)									0.2	< 0.1	2.5	< 0.1												
Phosichthydae																								
Pollichthys sp.	0.2	< 0.1	4.0	< 0.1					0.2	< 0.1	2.5	< 0.1												
Scianidae																								
Cynoscion sp.									0.3	0.9	2.5	< 0.1												
Scombridae																	0.7	50.7	3.0	3.5				
Auxis sp.													0.4	0.3	1.2	< 0.1								
Euthynnus alleteratus (Rafinesque, 1810)													0.2	0.8	1.2	< 0.1								
Scomber colias Gmelin, 1789									0.8	13.7	10.0	1.8					1.4	1.5	6.1	0.4				
Thunnus alalunga (Bonaterre, 1788)													0.2	2.2	1.2	< 0.1								
Serranidae																								
Anthias menezesi Anderson & Heemstra, 1980									0.2	< 0.1	2.5	< 0.1												
Sparidae																								
Pagrus pagrus (Linnaeus, 1758)									0.2	< 0.1	2.5	< 0.1												
Sternoptychidae	0.4	0.1	4.0	< 0.1																				
Tetraodontidae																								

*In *X. gladius* was used to measure the lower jaw fork length (LJFL).

Table 1. Continued...

Prey	T. albacares N = 29 Cf: 30 - 114				T. obesus N = 63 Cf: 60 - 182				T. alalunga N = 77 Cf: 74 - 122				X. gladius N = 101 *Cf: 60 - 275				I. oxyrinchus N = 47 Cf: 82 - 281				A. superciliosus N = 16 Cf: 204 - 409			
	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI	%N	%W (g)	%O	%IRI
Sphoeroides tyleri Shipp, 1974	0.6	< 0.1	4.0	< 0.1																				
Trichiuridae	1.7	0.8	12.0	0.3					0.8	< 0.1	5.0	0.1					0.7	1.4	3.0	0.1	4.8	37.8	16.7	21.3
Evoxymetopon sp.	0.2	0.2	4.0	< 0.1																				
Lepidopus altifrons Parin & Collete, 1993	0.2	< 0.1	4.0	< 0.1					0.2	0.6	2.5	< 0.1												
Trichiurus lepturus Linnaeus, 1758									0.3	0.8	2.5	< 0.1	1.3	2.3	2.4	< 0.1								
Triglidae									0.6	0.8	2.5	< 0.1												
Prionotus sp.																								
Unidentified Teleost	15.3	5.2	44.0	7.9	35.4	2.4	16.0	6.9	9.2	5.5	30.0	5.6	48.4	9.7	60.7	33.5	10.4	16.2	45.5	26.9	18.7	35.0	58.3	26.9
Chordata Urochordata									1.3	0.2	5.0	0.1					6.9	< 0.1	6.1	0.9				
Mollusca																								
Cephalopoda																								
Ord. Teuthida	38.2	80.2	80.0	83.1	35.1	56.9	84.0	87.7	42.6	52.6	65.0	78.9	27.8	69.2	69.0	63.7	27.1	3.0	45.5	30.4	73.5	25.6	75.0	49.6
Loliginidae	2.9	6.0	24.0	1.9	0.8	0.8	4.0	0.1	0.3	5.0	5.0	0.3	1.1	1.7	7.1	0.2								
Ommastrephidae					0.8	29.9	4.0	1.4	1.0	12.4	12.5	2.1												
Enoploteuthidae									0.2	< 0.1	2.5	< 0.1												
Ord. Octopoda	2.5	< 0.1	12.0	0.3	5.1	< 0.1	10.0	0.6	4.7	< 0.1	22.5	1.3	2.7	< 0.1	8.3	0.2	2.1	< 0.1	9.1	0.4				
Ord. Sepiida	0.2	< 0.1	4.0	< 0.1	0.5	< 0.1	2.0	< 0.1	5.0	0.5	7.5	0.5	0.2	< 0.1	1.2	< 0.1								
Unidentified Cephalopoda					0.5	0.4	4.0	< 0.1					0.7	0.2	4.8	< 0.1	32.6	0.3	42.4	31.1				
Mollusca Gastropoda	4.4	< 0.1	16.0	0.6	0.5	< 0.1	4.0	< 0.1	0.2	< 0.1	2.5	< 0.1	0.2	< 0.1	2.5	< 0.1					0.6	< 0.1	8.3	0.3
Mollusca Bivalve					0.3	< 0.1	2.0	< 0.1													1.2	< 0.1	8.3	0.6
Arthropoda Crustacea																	12.5	< 0.1	12.1	3.4				
Ord. Decapoda	4.8	1.3	16.0	0.9	4.3	0.3	6.0	0.3					7.5	0.4	17.9	1.3								
Ord. Isopoda	0.2	< 0.1	4.0	< 0.1																				
Unidentified Crustacea	20.6	0.2	16.0	2.9	2.1	0.7	14.0	0.5	17.3	1.0	32.5	7.6	0.2	< 0.1	1.2	< 0.1								
Vegetal	0.4	< 0.1	8.0	< 0.1					0.5	< 0.1	7.5	< 0.1	0.9	< 0.1	3.6	< 0.1	2.1	< 0.1	9.1	0.4	0.6	< 0.1	8.3	0.3
Other	2.7	4.4	28.0	1.8	4.3	0.5	18.0	1.0	0.8	2.7	12.5	0.6	3.1	0.5	9.5	0.3	2.8	< 0.1	9.1	0.6	0.6	1.5	8.3	1.0

*In *X. gladius* was used to measure the lower jaw fork length (LJFL).

argentinus (Ommastrephidae), *Dosidicus gigas* (Ommastrephidae), *Histioteuthis* sp. (Histioteuthidae), *Loligo* sp.(Loliginidae) and *Gonatus* sp. (Gonatidae) are the species most commonly eaten by these sharks.

Specimens of Scombridae and *Lepidocybium flavobrunneum* (Gempylidae) appear to be important items (mainly in weight measurements) to the diet of *I. oxyrinchus*. *Lepidocybium flavobrunneum* is a fish species whose individuals may grow to large sizes, as are some specimens caught by fishery equipments. According to Vaske-Júnior & Rincón-Filho (1998) some specimens, when caught by the fishery activities are frequently marked by bite marks caused by sharks. This may happen during the process of fishing and to the opportunistic behavior of these sharks. The absence of elasmobranchs in the diet of *I. oxyrinchus* helps to corroborate results obtained by Maia et al. (2006). As Pikitch et al. (2005) state, this absence may be credited to the low densities such sharks and other ones present in the oceanic environment, when compared to more complex habitats. Other large predators, such as *X. gladius*, should also be considered as potential prey for *I. oxyrinchus* (Stillwell & Kohler 1982, Maia et al. 2006), but this fact was not observed in this study.

According to Polo-Silva (2007) and Preti et al. (2008), *Alopias superciliosus* is also a fish feeder and the specimens representing the Paralepididae, Merluccidae and Sciaenidae are known to be the most representative to this shark`s diet. This information however is in disagreement to these present studies. It may be detached that such disagreements relating the literature and the present study can be due to the reason that many teleost fishes were found in a profound digestion state, which may be a common situation when the study reveals facts happening within the stomach contents of sharks.

The low incidence of crustaceans for the food composition of *I. oxyrinchus* may reveal a probable incidental ingestion of such organisms. Following Maia et al. (2006), a regular ingestion of crustaceans may be more related to young individuals of this elasmobranch. As seen by the IRI 0.6%, this item may be even less important to individuals of *A. superciliosus,* in a way to corroborate data obtained by Preti et al. (2008), who found such prey in only one stomach. As a common observation of objects originated by human activities and even so, found within the stomach contents of sharks, this one may also be an accidental fact such as this one shown by the crustaceans (Hazin et al. 1994, Vaske-Júnior & Rincón-Filho 1998).

The ecological feeding details of top predators, such as these studied species, are important components for modeling trophic relationships and their implications to the pelagic stratum dynamics of the Southwest Atlantic Ocean. So, it may be seen as a necessary step for more studies involving great predators who live in this region, in order to get information to build more multi-specific models, which are important to conservation and better use purposes.

Acknowledgments

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