Diet of elasmobranchs captured in the fishing of pink shrimp off souther of Brazil*

Dieta de elasmobrânquios capturados na pesca de camarão-rosa no sudeste e sul do Brasil*

DOI: 10.34188/bjaerv4n1-054

Recebimento dos originais: 20/11/2020
Aceitação para publicação: 20/12/2020

Júlia Ferreira dos Santos Domingos
Mestre em Aquicultura e Pesca pelo Instituto de Pesca/APTA/SAAESP
Av. Bartolomeu de Gusmão, 192 - Ponta da Praia, Santos-SP, Brasil
jufsdbiologia@gmail.com

Beatriz Paiva
Mestre em Aquicultura e Pesca pelo Instituto de Pesca/APTA/SAAESP
Av. Bartolomeu de Gusmão, 192 - Ponta da Praia, Santos-SP, Brasil
beatrizpaivabio@gmail.com

Carlos Eduardo Malavasi Bruno
Doutor em Ciências pela Universidade de São Paulo/Departamento de Anatomia dos Animais Domésticos e Silvestres da Faculdade de Medicina Veterinária e Zootecnia.
Instituto Pau Brasil de História Natural
Rua Bolívia, 545, Guararema - SP
sharkeduardo@gmail.com

Alberto Ferreira de Amorim
Doutor em Ciências Biológicas pela Universidade Estadual Paulista/Instituto de Biociências/Campus de Rio Claro
Instituto de Pesca/APTA/SAAESP
Av. Bartolomeu de Gusmão, 192 - Ponta da Praia, Santos-SP, Brasil
prof.albertoamorim@gmail.com

ABSTRACT

Some fish species compose the so-called bycatch caught by pink shrimp trawling, including elasmobranchs (sharks and rays). The objective of the study was to analyze the stomach contents of the captured and compare the items identified in the literature. The material was requested to the commercial vessels that landed in Guarujá, São Paulo, being the study area between Rio de Janeiro and Santa Catarina, from 5 to 75 meters deep. In the laboratory, total length-TL and sexing (shark and ray), fork length-FL (shark), disk width- DW (ray) in centimeters, and total weight- TW in kilograms (shark and ray). For the stomach contents, the Degree of Repletion adjusted (empty and full), the Degree of Digestion (undigested and unidentified), frequency of occurrence (%FO) and the numerical frequency (%FN). Sixty-two specimens were analyzed: 20 rays (seven *Atlantoraja castelnaui*, five *A. cyclophora*, five *Dasyatis hypostigma*, one *Myliobatis freminvillei*, one *Gymnura*

* Parte da Dissertação apresentada no Instituto de Pesca/APTA/SAAESP (bolsista CAPES)

altavela and one *Sympterygia bonapartii*); and 42 sharks (29 *Squatina guggenheim* and 13 *S. occulta*), between June 12 to September 19, 2015 and June 15 to December 29, 2016. Most of the food items had been mentioned in the literature, however others only in this study as*: Sycionia* sp. and *Dactylopterus volitans* (*D. hypostigma*); *Polydactylus* sp., *Pogonias cromis* and *Dactylopterus volitans* (*S. guggenheim*); and *Porichthys porosissimus* (*S. occulta*).

Key words: Bycatch, stomach, rays, sharks, deep-sea trawling

RESUMO

Algumas espécies de peixes compõem a chamada fauna acompanhante capturada pela pesca de arrasto de camarão-rosa, incluindo os elasmobrânquios (tubarões e raias). O objetivo do trabalho foi analisar o conteúdo estomacal dos espécimes capturados e comparar os itens identificados na literatura. O material foi solicitado as embarcações comerciais que desembarcaram no Guarujá, São Paulo, sendo a área de estudo entre o Rio de Janeiro e Santa Catarina, de 5 a 75 metros de profundidade. Em laboratório, foram obtidos diferentes comprimentos (total-CT e forquilha-CF), largura do disco-LDi e sexagem. Para o conteúdo estomacal foi aplicado o Grau de Repleção adaptado (vazio e cheio), o Grau de Digestão (não digerido e não identificado), a frequência de ocorrência (%FO) e a frequência numérica (%FN). Foram analisados 62 exemplares, sendo 20 raias (sete *Atlantoraja castelnaui*, cinco *A. cyclophora*, cinco *Dasyatis hypostigma*, uma *Myliobatis freminvillei*, uma *Gymnura altavela* e uma *Sympterygia bonapartii*); e 42 tubarões (29 *Squatina guggenheim* e 13 *S. occulta*), entre 12 de junho a 19 de setembro, 2015 e 15 de junho a 29 de dezembro, 2016. A maioria dos itens alimentares haviam sidos citados na literatura, no entanto outros somente neste trabalho como: *Sycionia sp.* e *Dactylopterus volitans* (*D. hypostigma*); *Polydactylus* sp., *Pogonias cromis* e *Dactylopterus volitans* (*S. guggenheim*); e *Porichthys porosissimus* (*S. occulta*).

Palavras-chave: Fauna acompanhante, estômago, raias, tubarões, pesca de arrasto de alto mar

1 INTRODUCTION

Sharks and rays are commonly caught in various fishing gear, such as bottom trawls, longlines and gillnets, at different depths, either intentionally or as an accompanying fauna. Many species are threatened due to their slow growth characteristics, late sexual maturation, long life, low fertility and low natural mortality (Stevens et al., 2000).

As a definition, according to Zavala-Camin (2004), the diet refers to the nature of the food preferred or used by the fish, however, some foods can be ingested just because they are available, replacing the preferred foods. Information related to feeding can explain variations in aspects such as growth, reproduction, migration and behavior related to prey capture (Vianna et al., 2000).

When it comes to individuals, it is possible to have an idea of the feeding behavior from their anatomical characteristics but grouping with others can modify their behavior and efficiency. Clusters occur to overcome interspecific competition and to improve hunting for food (Zavala-Camin, 1996).

Such studies are necessary to understand the extent of resources used across the temporal and spatial distribution of any species (Krebs, 1998), as well as the dynamics and ecology of populations and communities (Cunningham, 1989).

The objective of this study was to analyze the stomach contents of the elasmobranchs captured by the pink shrimp trawl fishing in the southeast and south of Brazil and to compare them with items identified in the literature.

2 MATERIALS AND METHODS

Review

A literature review was carried out based on national and international studies on the eating habits of the elasmobranch species obtained in the present study, and the food items were related to those cited in the literature. The location, depth, sex and stage of development were considered in the review.

Sampling

The material was obtained by requests given to the masters of the vessels that used trawls for fishing pink shrimp (*Farfantepenaeus brasiliensis* and *F. paulensis*), which unloaded at the Rio do Meio, Guarujá, São Paulo. The collection of the specimens was carried out by the master, who placed a numbered seal on the elasmobranchs captured incidentally and then froze them. The master also made a detailed record about the fishing trip containing the fishing area, day and depth related to sampling. Therefore, through the label's number, it was possible to correlate the fishing information to the individuals collected.

Through the SISBIO-IBAMA license (Numbers 46878-1), the shipment of species classified as threatened on the IUCN list (IUCN, 2017) and by the list of species of Ordinance No. 445/14 (Brasil, MMA, 2014) was permitted. During the period from March 1 to May 31, the closed season for fishing pink shrimp, no samples were collected due to the prohibition of their capture (IN nº 189/08 of IBAMA (Brasil, 2008). After the landings, the specimens were donated to the Fisheries Institute.

In the laboratory, the elasmobranchs were identified, based on Figueiredo (1977) and Compagno (1984). Based on FAO (1978), biometrics were obtained in the following ways: for rays, obtaining the total length (TL) and disk width (DWi), in centimeters; and for sharks, the total length (TL), according to Sadowski (1967), and fork length (FL) were measured in centimeters. The total weight (TW), in kilograms, and sexing were also observed.

In order to determine the stages of maturation (juvenile or adult) the following characteristics were observed: in males the stiffness of the claspers, development of the testicles and the reproductive ducts; in females the development of uteri and nidamental or oviducal glands, follicles and the presence of eggs or embryos (Stehmann, 2002; Colonello, 2007).

The stomachs of the elasmobranchs were identified, weighed in an analytical balance (with 0.1 precision in kg), obtaining the total weight of the stomach (SW). The ends of stomach were tied with a string, so that no item was lost, and then stored in 10% formalin solution.

Stomach Content Analysis

After these procedures a longitudinal cut in the stomach was performed and the contents were withdrawn. The contents were washed with running water, sifted in a one-millimeter mesh, weighed to obtaining the weight of the contents (CW) and transferred to bottles with 70% alcohol for further identification.

All traces of food, including digested or amorphous material, were considered as stomach contents.

For the identification of food items, an initial screening was carried out, identifying the major taxonomic groups and quantifying the prey. Identifiable items such as skeletal fragments, scales, fish otoliths, and others were separated and packed in properly labeled containers for a second analysis (identification until the smallest possible taxon).

After the withdrawal and weighing of the stomachs, a degree of repletion (DR) adjusted between 0 and 4, based on Cailliet (1976), was attributed according to the amount of stomach contents found, where: Degree 0 = empty (0%); Grade 1 = slightly full (1-25%); Grade 2 = partially full (26% -50%); Grade 3 = almost full (51% -75%), Grade 4 = full (76% -100%).

After the first screening, the food items were identified to the lowest possible taxonomic level, requesting assistance from specialists and the literature: Alvarez (1968); FAO (1978); Figueiredo and Menezes (1978, 1980) and queries in FishBase (Froese and Pauly, 2017, www.fishbase.org) and WoRMS (Horton et al., 2020, www.marinespecies.org).

Data Analysis

For the data analysis, the following methods were used: Numerical Frequency (%NF) (Hynes, 1950; Hyslop, 1980) and Occurrence Frequency (%OF) (Yamaguchi et al., 2005).

Numerical Frequency (%NF)

The Number Method or Numerical Frequency (%NF) consists of counting the number of organisms of each food category in all stomachs, expressed as a percentage, establishing relative abundance and analyzing the availability of food resources in the region. This allows for estimates of selectivity or the availability of the species used as prey (Hynes, 1950; Hyslop, 1980), given by the formula: %NF = (ns / N) x 100, where: N% = numerical percentage of the sampled item; ns = number of the item being sampled; N = total number of items sampled.

Frequency of Occurrence (%OF)

The Frequency of Occurrence is the percentage of stomachs with a given item compared with all the stomachs analyzed (Yamaguchi et al., 2005). We can obtain amplitude data from the ecological niche and food item selectivity through the analysis of presence and absence of food, given by the formula: %OF = (ni / N) X 100, where: %OF = Occurrence Frequency of food item *i* in the sample; *ni* = number of stomachs of the sample containing food item *i*; *N* = total number of stomachs with contents in the sample.

Shared Resources

In this study, the R Project Bipartite Package (R Core Team 2018; Dormann et al., 2008; Dormann et al., 2009; and Dormann, 2011) was used to calculate the average links per species (a measurement that has no limit of parameters) and Niche overlap; where 0 = absence of niche overlap and 1 = total overlap.

3 RESULTS

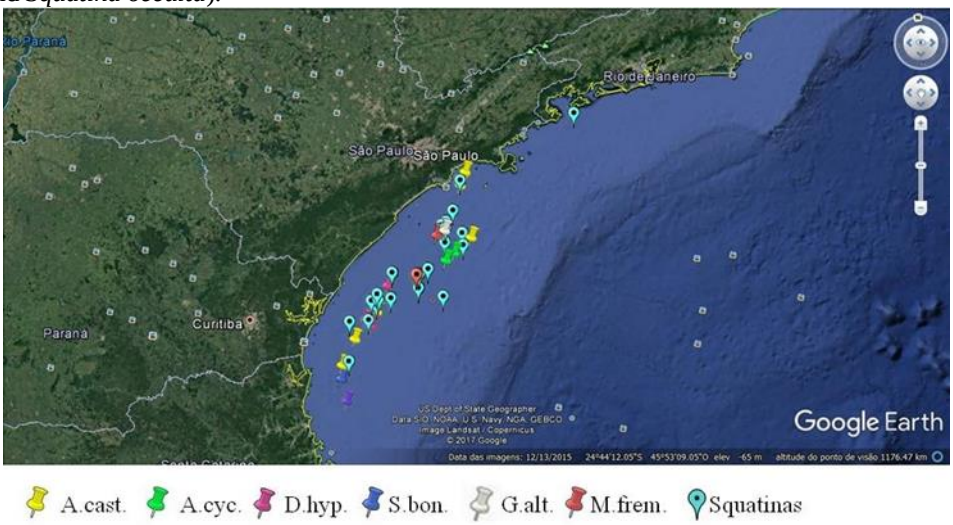
The biological fishing data emphasizing the diet of this study come from the trawl fishing directed at capturing pink shrimp by vessels that land in the Rio do Meio, Guarujá, São Paulo.

Sixty-two specimens were obtained: 20 rays (seven *Atlantoraja castelnaui*, five A. *cyclophora*, five *Dasyatis hypostigma*, one *Myliobatis freminvillei*, one *Gymnura altavela* and one *Sympterygia bonapartii*); and 42 sharks (29 *Squatina guggenheim* and 13 *S. occulta*), from June 12 to September 19, 2015 and from June 15 to December 29, 2016. The study area comprised the coastlines of the states of Rio de Janeiro to Santa Catarina (23°S to 26°S and 44°W to 48°W), at depths between 5 and 75 meters.

Figure 1 displays the capture sites of the individuals with some overlapping points. The markers on the map were used to separate between sharks (comprised of the two species of *Squatina*) with the light blue marker, and rays with different colors (each color symbolizes a species).

The Degree of Repletion was applied to 61 stomachs comprised as follow: one stomach Grade 0 (Empty) 3.3%, two stomachs Grade 1 about 27.8%, 25 stomachs Grade 2 about 24.6%, eight stomachs Grade 3 about 24.6% and 25 stomachs Grade 4 (full) 19.7%.

Figure 1. Sampling area of the pink shrimp fishing, between the coast of Rio de Janeiro and Santa Catarina (June/2015 to December/2016); A. cast. (*Atlantoraja castelnaui*), A. cyc. (*Atlantoraja cyclophora*), D. hyp. (*Dasyatis hypostigma*), S. bon. (*Sympterygia bonapartii*), G. alt. (*Gymnura altavela*), M. frem. (*Myliobatis freminvillei*), Squatinas (*Squatina guggenheim* and *Squatina occulta*).



***Atlantoraja castelnaui* (Spotback skate)**

The seven specimens of stingrays were captured between the states of São Paulo and Santa Catarina (24ºS to 26ºS and 46ºW to 48ºW) between 37 and 51 m deep. There were three females (71 to 87.9 cm TL and 2.23 to 2.6 kg TW, two juveniles and one adult) and four males (68 to 103 cm TL and 1.55 to 4.2 kg TW, all were juveniles). Concerning Degree of Repletion, one stomach was classified as Grade 0, one as Grade 2, one as Grade 3 and four as Grade 4.

The items found in the stomach contents were identified as follows: three samples of Bothidae family fishes (two observed in a juvenile male, captured in the winter, off the coast of São Paulo, 24ºS and 46ºW and one in a juvenile male, captured in the winter, off the Santa Catarina coast , 26ºS and 48ºW); one *Porichthys porosissimus* (observed in the stomach of a juvenile male, captured in winter, off the coast of Santa Catarina, 26ºS and 48ºW); one *Mullus argentinae* (observed in a juvenile male captured in the winter, off the coast of São Paulo, 24ºS and 46ºW), one specimen of Arhynchobatidae ray, (found in the stomach of a juvenile male, captured during the winter, off the coast of São Paulo, 24ºS and 46ºW and fragments of unidentified bone fish). Two specimens of Penaeidae shrimp, one Nematoda, and small plastic fragments (probably ingested along the substrate) were also observed.

The highest numerical and occurrence frequencies occurred in the following organisms: Bothidae family (NF 21.4% and FO 33.3%); Penaeidae (NF 21.4% and FO 16.7%); and *Ctenosciaena gracillicirrhus* (NF 14.3% and FO 33.3%). The relative abundance of *A. castelnaui* was 11.7%.

***Atlantoraja cyclophora* (Eyespot skate)**

Five adult females were sampled between 56 and 62.7 cm TL and between 43.8 and 47.5 cm DWi, captured off the São Paulo coast, 25°S and 48°W, during the daytime period in the winter of 2015. In relation to Degree of Repletion, one stomach was observed with a Grade 2, two were Grade 3 and two were Grade 4.

The following crustaceans were found in the stomach contents: *Achelous spinicarpus*, Portunidae crabs (in three stomachs); one Squillidae mantis shrimp (observed in a female captured off the coast of São Paulo, 25ºS and 46ºW); appendages of a crustacean, Penaeidae shrimp; and shell fragments of the Gastropoda class.

The highest numerical and occurrence frequencies were of the following organisms: *Achelous spinicarpus* (NF 40% and FO 40%); Portunidae (NF 40% and FO 20%) and Squillidae (FN 20% and FO 20%). The relative abundance of *A. cyclophora* was 8.3%.

***Dasyatis hypostigma* (Groovebelly stingray)**

From among the *D. hypostigma*, two adult females (91.5 to 106.4 cm TL and 4.71 to 7.7 kg TW) and three males (two adults and one juvenile, 89 to 92.3 cm TL and 3.22 to 4.92 kg TW) were analyzed. In relation to Degree of Repletion three specimens were Grade 2 and two were Grade 3.

The following items were found in the stomach contents of the stingrays: Dactylopteridae fish bone, three specimens of *Dactylopterus volitans* (with Digestion Grades 2 and 3, in the stomach of an adult female, caught in the spring, off the coast of Paraná, 25ºS and 47ºW); mantis shrimp of the Squillidae family (in an juvenile male, caught in the spring off the coast of Paraná, 25ºS and 47ºW, and also in an adult male, captured in the summer off the coast of Paraná); Penaeidae shrimp, Sycionidae shrimp, *Sicyonia* sp. (in the stomach of a juvenile male, caught in the spring off the coast of Paraná, 25°S and 47°W); Portunidae larva (in the stomach of a juvenile male, caught in the spring off the coast of Paraná); a specimen of the Isopoda Order (attached to a fragment of teleost muscle); appendages of crustaceans; fragments of the Polychaeta Class; and fragments of a gastropod shell.

The highest numerical and occurrence frequencies were found with the following organisms: polychaete fragments (NF 34% and FO 60%); Penaeidae (NF 30% and FO 40%); shell fragments

(NF 16% and FO 20%) and Squillidae (NF 6% and FO 60%). The relative abundance of *D. hypostigma* was 8.3%.

***Sympterygia bonapartii* (Smallnose fanskate)**

The *S. bonapartii* specimen was captured off the coast of Santa Catarina (26°S and 48°W) during the daytime in the winter of 2016. It was a juvenile female with a TL of 50.1 cm, DWi of 29.8 cm and weighted 1.009 g (Table 1). The stomach demonstrated Grade 2 repletion.

Stomach contents observed were: Squillidae mantis shrimp; Sicyionidae shrimp; fragments of Portunidae crabs; fragments of teleosts; and a Nematoda. The relative abundance of *S. bonapartii* was 1.7%.

***Myliobatis freminvillei* (Bullnose eagle ray)**

The Bullnose eagle ray specimen was captured off the coast of São Paulo (24°S and 46°W) at night during the spring. It was a female juvenile, 77.9 cm (TL) and 40.5 cm (DWi). The stomach was with Grade 1 repletion.

In the stomach contents, six prawns of the Penaeidae shrimp and one Nematoda were found. The relative abundance of *M. freminvillei* was 1.7%.

***Gymnura altavela* (Spiny butterfly ray)**

The *G. altavela* specimen was captured off the São Paulo coast (24°S and 46°W) at night during the spring. It was an adult female, 73.2 cm (TL), 103.6 cm (DWi) and 14.8 kg (TW). Nothing was found in the stomach contents. The relative abundance of *G. altavela* was 1.7%.

***Squatina guggenheim* (Angular angel shark)**

Twenty-nine specimens of angular angelsharks were analyzed: 23 females, TL between 51 and 90.2 cm, and TW between 1.34 and 6.51 kg, nine adults and 14 juveniles, and six males between 59.4 and 80.3 cm (TL) and between 2.72 and 5.47 kg (TW), two adults and four juveniles. Twenty-eight stomachs were analyzed, and 12 were Grade 1, five were Grade 2, six were Grade 3 and five were Grade 4.

The following items were found in the stomach contents: one *Dactylopterus volitans* (displaying Grade 2 digestion in an adult female, caught in the summer off the coast of São Paulo, 25ºS and 46ºW); one *Pogonias cromis* (in a juvenile male, captured in the winter off the coast of Paraná, 25ºS and 46ºW); one *Polydactylus* sp. (in a female juvenile, caught in the winter off the coast of São Paulo, 25°S and 46°W); one ray egg (in a female's stomach, caught in the winter off

the São Paulo, 24ºS and 46ºW); a specimen of the family Penaeidae shrimp (in the stomach of a female juvenile, captured in the winter off the coast of São Paulo, 25ºS and 46ºW); one *Doryteuthis sanpaulensis* (in a female juvenile, captured in the winter off the coast of Paraná, 25ºS and 46ºW); 34 Nematoda (14 were in the stomach a female juvenile, captured off the coast of São Paulo, 24°S and 46°W) and fragments from the Polychaeta class.

The highest numerical and occurrence frequencies occurred in the following organisms: Nematoda (NF 60.7% and FO 35.7%); unidentified teleost (FN 14.3% and FO 21.4%) and fragments of polychaetes (FN 7.2% and FO 3.6%). The relative abundance of *S. guggenheim* was 46.7%.

***Squatina occulta* (Hidden angel shark)**

Thirteen specimens were verified: 9 females (between 47.8 and 124 cm (TL) and between 1.43 and 14 kg (TW), three were adults, greater than 82.8 cm and 6.88 kg, and six juveniles); and four juvenile males (between 62.6 to 87cm (TL) and 1.94 to 5.88kg (TW)). Thirteen stomachs were analyzed: four were Grade 1, four were Grade 2, three were Grade 3 and two were Grade 4.

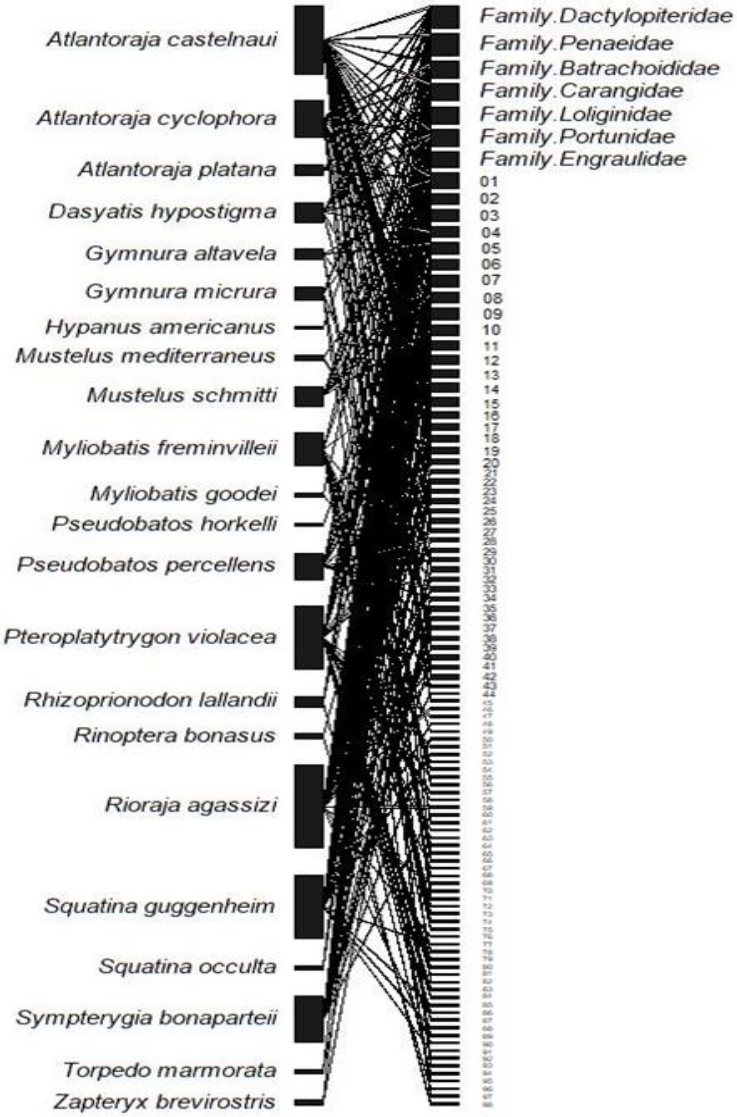
The following items were found among the stomach contents: a *Porichthys porosissimus* (in a female juvenile, captured in the winter off the coast of São Paulo, 25ºS and 46ºW); fragments of teleosts; a cephalopod spike (not identified); three shell fragments of the Bivalvia class; 20 Nematodes; a specimen of the Polychaeta Class; and 12 small plastic fragments.

The highest numerical and occurrence frequencies occurred in the following organisms: Nematoda (FN 62.5% and FO 46.2%); unidentified teleost (FN 18.8% and FO 38.5%) and fragments of bivalve shells (FN 9.4% and FO 15.4%). The relative abundance of *S. occulta* was 21.7%.

Sharing of food resources

The average number of links per species was 1.48 and Niche Overlap was 0.15. Sharing is displayed in the sharing chart (Figure 2).

Figure 2. Food resource sharing between elasmobranchs species.



The elasmobranch species is represented at the bottom of the graph, and the food items of each species with their respective links is in the upper part. The image also shows which resources were unique and which ones were shared. The items of the seven major families are listed in Table 1. Then items 1 to 96, the families are listed in Table 2.

Table 1. Major families, order or class as observed in Figure 3.

Family Dactylopiteridae	*Dactylopterus volitans*
Family Penaeidae	Specie not id.
Family Batrachoididae	*Porichthys porosissimus; Triathalassothia argentina;* Specie not id.*; Opsanus brasiliensis*
Family Carangidae	*Decapterus* sp.*; Parona signata; Trachurus* sp.*; Trachurus lathami*
Family Loliginidae	*Doryteuthis plei; Doryteuthis sanpaulensis; Loliguncula brevis; Loligo vulgaris*
Family Polynemidae	*Polydactylus* sp.
Family Engraulidae	*Anchoa marinii; Engraulis anchoita*

Table 2. Families (or order or class) of items from 1 to 96 as observed in Figure 3.

01 Family Squillidae	**Specie not id**
02 Family Gobiidae	*Gobiosoma parri*; *Gobius niger*; **Specie not id**.
03 Family Merlucciidae	*Merluccius hubbsi*; *Merluccius merluccius*
04 Family Mullidae	*Mullus argentinae*; *Mullus* sp.
05 Family Ommastrephidae	*Illex argentinus*; *Illex coidetti*
06 Family Ophidiidae	*Raneya brasiliensis*; *Genypterus blacodes*
07 Family Pandalidae	*Heterocarpus ensifer; Austropandalus grayi*
08 Family Serolidae	*Acanthoserolis polaris*; *Cristaserolis marplatensis*; *Serolis* sp.
09 Family Sycioniadae	*Sycionia* sp.
10 Class Polychaeta	*Euclymene* sp.; *Sthenelais* sp.; **Specie not id**.
11 Family Arhynchobatidae	*Atlantoraja castelnaui*; *Sympterygia bonapartii*; *Psammobatis* spp.; *Psammobatis extenta*
12 Family Crangonidae	*Aegaeon boschii*; *Crangon septemspinosa*; *Pontocaris* sp.
13 Family Sciaenidae	**Specie not id.**
14 Family Triglidae	*Prionatus punctatus*; *Prionotus nudigula*; *Prionotus* sp.
15 Family Bothidae	*Bothus* sp.;
16 Family Congridae	*Conger orbignyanus*
17 Superfamily Majoidea	*Eurypodius latreillii*; *Pelia rotunda*; *Libidoclaea granaria Libinia spinosa*; *Leurocyclus tuberculosus*
18 Family Penaeidae	*Artemesia longinaris*; *Farfantepenaeus brasiliensis; F. paulensis; Penaeus schmitti; Rimapenaeus constrictus; Rimapenaeus* sp.; *Xiphopenaeus kroyeri*; **Specie not id.**
19 Class Cephalopoda	**Specie not id.**
20 Family Alpheidae	*Alpheus heterochaelis*; *Alpheus puapeba*

21 Family Trichopeltariidae	*Peltarion spinulosum*
22 Family Belliidae	*Corystoides abbreviatus*; *Corystoides chilensis*
23 Family Branchiostomidae	*Branchiostoma platae*
24 Family Cepolidae	*Cepola macrophthalma*
25 Family Cheilodactylidae	*Nemadactylus bergi*;
26 Family Clupeidae	*Sardina pilchardus*
27 Family Cynoglossidae	*Symphurus tessellatus*
28 Family Eugraulidae	*Eugraulis japonicus*
29 Family Haemulidae	*Pomadasys corvinaeformis*; *Conodon nobilis*
30 Family Octopodidae	*Octopus tehuelchus*; *Octopus* sp.
31 Family Paguridae	*Pagurus exilis*
32 Family Percophidae	*Percophis brasiliensis*
33 Family Phrosinidae	*Phrosina semilunata*
34 Family Pinguipedidae	*Pinguipes brasilianus*
35 Family Sergestidae	*Acetes* sp.; *Peisos* sp.
36 Family Serranidae	*Diplectrum radiale*; *Serranus hepatus*; *Dules auriga*
37 Family Solenoceridae	*Mesopenaeus tropicalis*; *Pleoticus muelleri*
38 Family Triakidae	*Mustelus schmitti*
39 Family Varunidae	*Cyrtograpsus affinis*
40 Nematoda	**Specie not id.**
41 Order Mysidacea	**Specie not id.**
42 Class Bivalvia	**Specie not id.**
43 Class Gastropoda	**Specie not id.**
44 Family Achiropsettidae	*Achiropsetta tricholepis*
45 Family Blepharipodidae	*Blepharipoda doelloi*
46 Family Alciopidae	*Naiades* sp.
47 Family Aphroditidae	*Aphrodita* spp.
48 Family Arcidae	*Lunarca ovalis*
49 Family Atherinidae	*Odontesthis incisa*
50 Family Amphitretidae	*Japetella diaphana*
51 Family Bovichtidae	*Cottoperca gobio*
52 Family Buccinidae	*Busycon* sp.
53 Family Calyptraeidae	*Crepidula fornicata*
54 Family Cavoliniidae	*Cavolinia gigas*
55 Family Champsodontidae	*Champsodon* sp.
56 Family Cranchiidae	**Specie not id.**
57 Family Diodontidae	*Diodon hystrix*
58 Family Diogenidae	*Loxopagurus loxochelis*
59 Family Epialtidae	*Leucipa pentagona*
60 Family Fissurellidae	**Specie not id.**
61 Family Gadidae	*Trisopterus capelanus*
62 Family Gempylidae	*Gempylus serpens*
63 Family Thoridae	*Spirontocaris liljeborgii*
64 Family Inachoididae	*Collodes rostratus*
65 Family Leiognathidae	*Equulites klunzingeri*
66 Family Lestrigonidae	*Phronimopsis* sp.
67 Family Lutjanidae	*Lutjanus synagris*
68 Family Tetrasquillidae	*Heterosquilla platensis*
69 Family Monacanthidae	*Stephanolepis hispidus*
70 Family Munididae	*Munida* sp.

Table 2. Families (or order or class) of items from 1 to 96 as observed in Figure 3…continued…

71 Family Muricidae	*Nucella lapillus*
72 Family Mytilidae	*Mytilus edulis*
73 Family Nassariidae	*Tritia trivittata*
74 Family Naticidae	*Euspira heros*
75 Family Nephropidae	*Metanephrops rubellus*
76 Family Nototheniidae	*Patagonotothen longipes* ; **Specie not id.**
77 Family Ovalipidae	*Ovalipes ocellatus*
78 Family Paguridae	*Pagurus acadianus*
79 Family Pasiphaeidae	*Leptochela serratorbita*
80 Family Phronimidae	*Phronima sedentaria*
81 Family Phycidae	*Urophycis brasiliensis*
82 Family Pinnotheridae	*Austinixa patagoniensis*; *Dissodactylus criniticheli*s; *Pinnixa brevipollex*
83 Family Polybiidae	**Specie not id.**
84 Family Polybiidae	*Liocarcinus depurator*
85 Family Salpidae	**Specie not id.**
86 Family Sciaenidae	*Macrodon ancylodon*; *Micropogonias furnieri*; *Menticirrhus americanus*; *Leiostomus xanthurus*; *Ctenosciaena gracilicirrhus*; *Pogonias cromis*; *Cynoscion guatucupa*; *Paralonchurus brasiliensis*; *Umbrina canosai*; *Larimus* sp.; *Cynoscion microlepdopus*
87 Family Scombridae	*Scomber japonicus*
88 Family Sebastidae	*Helicolenus lahillei*
89 Family Sepiidae	*Sepia officinalis*
90 Family Sparidae	*Pagrus pagrus*
91 Family Squillidae	*Squilla* mantis; *Squilla* sp.
92 Family Stromateidae	*Stromateus brasiliensis*
93 Family Sycionidae	*Sicyonia typica*
94 Family Nuculanidae	*Yoldia* sp.
95 Filo Echinodermata	**Specie not id.**
96 Sub-classe Elasmobranchii	Elasmobranchii egg

4 DISCUSSION

The results of this study corroborate some of the researched literature. The animals analyzed preferentially captured prey together with the substrate (benthic), which was to be expected considering the capture technique used (bottom trawling). There was also the observation of items not described previously, contributing to the enrichment of information on the diets of these species. The order of food items cited did not follow a pattern of importance, so we chose to put them in alphabetical order.

Atlantoraja castelnaui (Spotback skate)

The presence of *A. castelnaui* occurs from southeastern Brazil to northeastern Argentina, up to 220 meters deep (Last et al., 2016), and is classified as "Endangered" (IUCN, 2017) and "At Risk" by Ordinance No. 445 (Brasil, MMA, 2014).

In the present study, *Mullus argentinae* was found in the stomach of a juvenile male, in the winter (July/2015) off the coast of São Paulo, at 60 meters deep, which corroborating with Barbini and Lucifora (2012) and Domingos et al. (2013). The item *Porichthys porosissimus* (observed in

the stomach of a juvenile male, captured in winter, off the coast of Santa Catarina) was also cited by Barbini and Lucifora (2012). Meanwhile, Domingos et al. (2013) reported that this item was ingested by a female juvenile in the winter of June/2012, off the coast of RJ at 59 meters deep, by a juvenile male in the winter of August/2012, off the coast of RJ at 41 meters deep, and by a female in the spring of October/2012, off the coast of RJ at 58 meters of depth. However, Barbini and Lucifora (2012) also found them in the summer (December/2005 to December/2007), in Uruguay and the northeast of Argentina, between 50 and 200 meters deep.

Their diet is primarily fish, but juveniles also feed on cephalopods and echinodermata (Last et al., 2016). Crustaceans also appeared in medium amounts (Casu, 2010; Barbini and Lucifora, 2012; Domingos et al., 2013, Della-Fina, 2014), as well as the mollusks (Barbini and Lucifora, 2012).

***Atlantoraja cyclophora* (Eyespot skate)**

A. cyclophora occurs from southeastern Brazil to northwestern Argentina, up to 100 meters deep and occasionally up to 320 meters, and is classified as "Endangered" (IUCN, 2017). No classification of this species was found on the list of Ordinance No. 445. The *A. cyclophora* of this study were found off the coast of São Paulo (25º03'S), occurring between 70 and 73 meters deep.

Their diet consists of benthic invertebrates and small bony fish in adult individuals (Last et al., 2016). According to Froese and Pauly (2017), the diet of *A. cyclophora* captured in Brazil consists of: Brachyura crustaceans, Caridea, Gammaridea, Penaeidae and Stomatopoda, and Teleostei fish, ingested by both juvenile and adult individuals.

In the present study, the crustacean *Achelous spinicarpus* was found in adult female rays in July 2015, off the coast of São Paulo, between 70 and 73 meters deep. This corroborates with Casu (2010) who observed individuals captured from Rio de Janeiro to Santa Catarina, between 10 and 146 meters deep, and Viana and Vianna (2014) who found *A. spinicarpus* in January 2006 and August 2007, near Ilha Grande-RJ, at 60 meters deep. In Viana and Vianna's study (2014) *A. spinicarpus* was mentioned as an important organism in the diet of the species, mainly in the summer of 2006, in which the diet was probably influenced by the environmental variations due to the approach of ACAS (South Atlantic Central Water) to the coast of Rio de Janeiro during that period, favoring benthic animals, such as crustaceans.

According to the results, corroborating with the researched literature, the diet of *A. cyclophora* consists primarily of crustaceans, followed by fish.

***Dasyatis hypostigma* (Groovebelly stingray)**

D. hypostigma occurs from southeastern Brazil to Uruguay, between 5 and 80 meters deep, but is more common between 5 and 40 meters. Its biology is little known (Last et al., 2016) and is classified as Insufficient Data (IUCN, 2017). No classification of this species was found on the list of Ordinance No. 445. In this study they were captured off the coast of São Paulo (24º46'S) and Parana (25º49'S), between 47 and 58 meters deep.

Little literature was available on the dietary habits of the species in Brazil. According to Paiva and Amorim (2014), the following fish were observed: *Mullus argentinae, Opsanus brasiliensis, Porichthys porosissimus, Prionatus punctatus* and *Trachurus lathami*. Also the shrimp species *Farfantepenaeus brasiliensis* was mentioned.

In the present study, the crustacean *Sycionia* sp. (ingested by a juvenile male ray, caught in the spring off the coast of Paraná, at a depth of 47 meters) and the fish *Dactylopterus volitans* (ingested by an adult female ray, in November/2016 off the coast of Paraná, at depth of 47 meters) were considered important results, since no records of these items were found in the researched literature, which shows the need for further studies on the diet of this species of ray.

***Sympterygia bonapartii* (Smallnose fanskate)**

S. bonapartii occurs from southeastern Brazil to Patagonia between 100 meters deep and occasionally up to 500 meters (Last et al., 2016). It is classified as "Insufficient Data" (IUCN, 2017) and as "At Risk" by Ordinance No. 445 (Brasil, MMA, 2014).

There was little literature on the dietary habits of this species in Brazil. In Argentina, according to Oro and Maranta (1996), in the diet of *S. bonapartii* captured in Mar del Plata, the following items were observed: fish (*Shymphurus* sp .; *Austroatherina incisa; Parona signata; Anchoa marinii* and *Raneya brasiliensis*); crustaceans (*Serolis* sp., *Pleoticus muelleri, Artemesia longinaris, Coenophthalmus tridentatus, Libinia spinosa, Leucippa pentagona, Leurocyclus tuberculosus, Peltarion spinulosum, Austropandalus grayi, Pontocaris* sp.*; Cyrtograpsus affinis, Austinixa patagoniensis* and *Corystoides chilensis)* and mollusks (cephalopods) *(Illex argentinus, Doryteuthis sanpaulensis* and *Octopus* sp.). According to Last et al. (2016), their diet consists of decapod crustaceans and small bone fish in adult individuals.

In the present study crustaceans of the genus *Sycionia* and *Achelous spinicarpus* were identified in a juvenile female, captured in Santa Catarina, in September of 2015, at 49 meters of depth. The item *A. spinicarpus* observed in this study was considered an important result, since it has not been mentioned in the researched literature.

***Myliobatis freminvillei* (Bullnose eagle ray)**

M. freminvillei occurs from Massachusetts to the northeast of Argentina (Last et al., 2016), from 0 to 100 meters deep and is more common from 0 to 10 meters (Froese and Pauly, 2017). It is classified as "Insufficient Data "(IUCN, 2017) and as "At Risk" by Ordinance No. 445 (Brasil, MMA, 2014). Their diet consists of bivalves, gastropods and crustaceans (Last et al., 2016).

In the present study, the Penaeidae family shrimps were found in a juvenile female, captured off the coast of São Paulo, in December 2016, at 50 meters deep.

In *M. freminvillei* caught between March and December 2009 and March and December 2010 in Delaware and Narragansett Bays, USA, Szczepanski-jr. (2013) observed the occurrence of mollusks of the classes Gastropoda and Bivalvia and crustaceans. In Gastropoda, the following organisms were observed: *Busycon* sp.; *Crepidula fornicata; Nucella lapillus; Ilyanassa trivitata* and *Euspira heros;* Bivalvia *(Anadara ovalis; Mytilus edulis; Yolda* sp., *Ensis directus* and *Tagelus divisus);* Crustaceans *(Crangon septemspinosa, Spirontocaris lilljeborg, Pagurus acadianus, Pagurus longicarpus, Pagurus pollicaris, Callinectes sapidus, Carcinus maenas* and *Ovalipes ocellatus*).

According to the results and the researched literature, the diet of *M. freminvillei* consists mostly of gastropod and bivalve mollusks, followed by crustaceans.

***Gymnura altavela* (Spiny butterfly ray)**

G. altavela occurs in the Atlantic Ocean and the Mediterranean Sea, irregularly between the Americas, up to 150 meters deep and classified as "Endangered" (IUCN, 2017) and as "Critically Endangered" by Ordinance No. 445 (Brasil, MMA, 2014).

Their diet consists of crustaceans, mollusks, bony fish and rays (Last et al., 2016). Daiber and Booth (1960) described the occurrence of *G. altavela* in Delaware Bay, USA, during the periods of July to September of 1956, July to August of 1957, July of 1958, and July to August of 1959, and also cited the occurrence of a specimen of *Leiostomaus xanthurus*. In Italy, Psomadakis et al. (2008) mentioned the occurrence of a fish specimen of the family Gobiidae (unidentified species) in the stomach of an adult male. According to Froese and Pauly (2017), in Senegal, males and females, juveniles and adults, feed on bony fish and crustaceans. Yemisken et al. (2017) observed in the diet of *G. altavela*, the fish families Champsodontidae (*Champsodon* sp.) and Leiognathidae (*Equulites klunzingeri*), and cephalopods of the Ommastrephidae family (*Illex coidetti*).

The greater presence of fish followed by crustaceans and mollusks in the diet of *G. altavela*, although not observed in the present study, was cited in the literature researched.

***Squatina guggenheim* (Angular angel shark)**

S. guggenheim occurs in the southwest Atlantic Ocean, from southeastern Brazil to Argentina between 4 and 360 meters deep, but commonly found between 4 and 266 meters (Froese and Pauly, 2017). It is also classified as "Endangered" (IUCN, 2017) and as "Critically Endangered" by Ordinance No. 445 (Brasil, MMA, 2014).

According to Vögler (2003) the diet of *S. guggenheim* consists primarily of bony fish, followed by crustaceans and mollusks. Moreover, Vögler (2003) and Colonello (2005) stated that the fish present in the diet of *S. guggenheim* between Argentina and Uruguay are: *Cynoscion guatucupa; Dules auriga; Engraulis anchoita; Macrodon ancylodon; Menticirrhus americanus; Merluccius hubbsi; Micropogonias furnieri; Paralichthys orbignyanus; Paralonchurus brasiliensis; Percophis brasiliensis; Porichthys porosissimus; Prionotus nudigula; Prionotus punctatus; Psammobatis* sp.*; Raneya brasiliensis; Shymphurus* sp.*; Trachurus lathami; Umbrina canosai* and *Urophycis brasiliensis*. Vögler (2003) also cited to the fish: *Conger orbignyanus; Cottoperca goby; Genypterus blacodes; Genypterus brasiliensis; Helicolenus lahillei; Nemadactylus bergi; Notothenia longipes; Paralichthys* sp.*; Patagonotothen ramsayi* and *Squatina guggenheim*. Colonello (2005) also observed: *Cheilodactylus bergi* and *Mustelus schmitti*. The crustaceans cited were: *Peltarion spinosulum* (Vögler, 2003), *Pleoticus muelleri* (Vögler, 2003; Colonello, 2005) and *Artemesia longinaris* (Colonello, 2005). The cephalopod *Illex argentinus* was cited by Colonello (2005); and Polychaeta of the genus *Aphrodita* by Vögler (2003).

In the present study, *Dactylopterus volitans* was found in an adult female in December 2016, off the coast of São Paulo, at a depth of 51 meters. Also, *Pogonias cromis*, in a juvenile male, captured in September of 2015 off the coast of Paraná, at 51 meters of depth. Moreover, *Polydactylus* sp. was found in a juvenile female, captured in July of 2015 off the coast of São Paulo at 70 meters of depth. The *Doryteuthis sanpaulensis* mollusk was observed in this study in a juvenile female captured in August of 2015 off the coast of Paraná, at 64 meters of depth, corroborating with Colonello (2005) who observed the occurrence of this item in juveniles, but in spring and between Uruguay and Argentina.

The items *Polydactylus* sp., *Pogonias cromis* and *Dactylopterus volitans* observed in *S. guggenheim* in this study were important results, since they were not mentioned in the researched literature.

***Squatina occulta* (Hidden angel shark)**

S. occulta occurs from southeastern Brazil to Argentina (Menni and Lucifora, 2007), up to 300 meters deep (Gomes et al., 2010) and is classified as "Endangered" (IUCN, 2017) and as

"Critically Endangered" By Ordinance No. 445 (Brasil, MMA, 2014). According to Gomes et al. (2010) it feeds preferably on small bony fish.

In the present study, *Porichthys porosissimus* was identified in the stomach of a female juvenile, captured in the winter (Aug./2015) off the coast of São Paulo, at 64 meters deep, corroborating with the researched literature regarding bony fish intake, and, in this case, it was possible to identify the item.

Concerning the analysis of food resource sharing, since the value observed was 0.15, it means that the species overlap very little, due to the diversity of the items and the physical space sampled.

5 CONCLUSION

The itens found for the first time as *Sycionia* sp. and *Dactylopterus volitans* (*D. hypostigma*); *Polydactylus* sp., *Pogonias cromis* and *Dactylopterus volitans* (*S. guggenheim*); and *Porichthys porosissimus* (*S. occulta*).

ACKNOWLEDGEMENTS

We would like to thank CAPES, for the scholarship received by Júlia Ferreira dos Santos Domingos; SINCROLIFT company, for allowing access to landings; the ship captains Ézio Suzate (LIZA vessel) and Orlando Laurenco "Xodó" (JAMBO vessel) for the material transferred; to the professors Dr. Hugo Bornatowski, Dr. Teodoro Vaske Junior and Dr. Evandro Severino Rodrigues for assisting with the article and the identification of the items found.

REFERENCES

ALVAREZ, R.Z. 1968. Crustáceos. Decápodos ibéricos. **Invest. Pesq.**; 32: 510. Available from: https://decapoda.nhm.org/pdfs/10992/10992.pdf Access on: 20 jul 2019.

BARBINI, S.A.; LUCIFORA, L.O. 2012. Feeding habits of a large endangered skate from the south-west Atlantic: the spotback skate, *Atlantoraja castelnaui*. **Marine and Freshwater Research**; 63(2):180-188. Available from: <https://www.researchgate.net/profile/Luis_Lucifora/publication/256840973_Feeding_habits_of_a_large_endangered_skate_from_the_southwest_Atlantic_The_spotback_skate_Atlantoraja_castelnaui/links/02e7e523df17676942000000/Feeding-habits-of-a-large-endangered-skate-from-the-south-west-Atlantic-The-spotback-skate-Atlantoraja-castelnaui.pdf.> :http://dx.doi.org/10.1071/MF11170 Access on: 20 jul 2019.

BRASIL. 2008. Instrução Normativa IBAMA nº 189, de 23 de setembro de 2008. Diário Oficial da República Federativa do Brasil, Brasília, 23 set. Available from: http://www.icmbio.gov.br/cepsul/images/stories/legislacao/Instrucao_normativa/2008/in_ibama_189_2008_defesocamaroes_revoga_in_ibama_91_2006_92_2006.pdf. Access on: 01 fev 2019.

BRASIL, Ministério do Meio Ambiente. 2014. Portaria nº 445, de 17 de dezembro de 2014. **Diário Oficial da Uniao, Secao**, v.1, n.245, p.110-130, 2014. Available from: http://pesquisa.in.gov.br/imprensa/jsp/visualiza/index.jsp?data=18/12/2014&jornal=1&pagina=129&totalArquivos=144. Access on: 28 ago 2018.

CAILLIET, G.M. 1976. Several approaches to the feeding ecology of fishes: pages 1-13 in C. A. Simenstad and S. J. Lipovsky (eds.). Fish food habits studies. First Pacific Northwest Technical Workshop; proc. WSG-W077-22.

CASU, C.A.S. 2010. Análise da dieta alimentar de Rajidae (Rajiformes, Chondrichthyes) costeira desembarcada no estado de São Paulo e sua interação na cadeia trófica. In: II ENCONTRO DE PÓS-GRADUANDOS DO INSTITUTO DE PESCA, 01, 2010. *Resumos...* Santos – SP. Available from: < https://www.pesca.sp.gov.br/2epgip/2epgip_resumos.htm> Access on: 14 fev 2020.

COLONELLO, J.H. 2005. Ecología reproductiva y hábitos alimentarios del pez ángel, *Squatina guggenheim* (Chondrichthyes: Squatinidae), en el Distrito Biogeográfico Bonaerense, entre 34º y 42ºS. 73p. (Tese de Licenciatura. Mar del Plata, Argentina: Universidade Nacional de Mar del Plata, Facultad de Ciencias Exactas y Naturales. Instituto Nacional de Investigación y Desarrollo Pesquero). Available from: http://www.oceandocs.org/bitstream/handle/1834/2596/Colonello_2005.pdf?sequence=1. Access on: 20 jul 2019

COLONELLO, J.H.; LUCIFORA, L.O. & MASSA, A.M. 2007 Reproduction of the angular angel shark Squatina Guggenheim): geographic differences, reproductive cycle, and sexual dimorphism. **ICES Journal of Marine Science** 64: 131-140.

COMPAGNO, L.J.V. 1984. FAO species catalogue, Vol.4. Sharks of the world. An annotated, and illustrated catalogue of shark species know to date. Parts 1, and 2. **FAO Fish. Synop.**; 4(125): 1-665.

CUNNINGHAM, P.T.M. 1989. Observações sobre o espectro alimentar de *Ctenosciaena gracilirrhus* (Metzellar) (Scianidae) **Rev. Bras. Biol.**; 49(2): 335-339.

DAIBER, F.C; BOOTH, R.A. 1960. Notes on the biology of the butterfly rays, *Gymnura altavela* and *Gymnura micrura*. **Copeia**; 1960(2): 137-139. Available from: <http://www.jstor.org/stable/1440209> 10.2307/1440209 Access on: 20 jul 2019.

DELLA-FINA, N. 2014. Aspectos da biologia de *Atlantoraja castelnaui*, *Squatina occulta* e *Squatina guggenheim* capturados na pesca de arrasto no sudeste e sul do Brasil. 65f. (Dissertação de Mestrado em Aquicultura e Pesca. Instituto de Pesca, APTA). Available from: <http://www.pesca.sp.gov.br/pos-graduacao/dissertacoes-defendidas/category/13-ano-2014> Access on: 27 nov 2018.

DOMINGOS, J.F.S.; DELLA-FINA, N.; ARFELLI, C.A.; RODRIGUES, E.S.; AMORIM, A.F. 2013. Alimentação de *Atlantoraja castelnaui* (Elasmobranchii, Rajiformes) capturada na pesca de arrasto do camarão-rosa no sudeste e sul do Brasil. In: seminário de Iniciação Científica do Instituto de Pesca, 8, 2013. São Paulo-SP. Available from: https://www.pesca.sp.gov.br/8Sicip2014/resumos/p003-Julia-Ferreira-dos-Santos-Domingos.pdf Access on: 20 jul 2019.

DORMANN, C.F.; FRÜND, J.; BLÜTHGEN, N. & GRUBER, B. 2009. Indices, Graphs and Null Models: Analysing Bipartite Ecological Networks. **The Open Ecology Journal**, 2, 7-24.

DORMANN, C.F., GRUBER B. & FRUEND, J. 2008. Introducing the bipartite Package: Analysing Ecological Networks. **R news** Vol 8/2, 8 - 11.

DORMANN, C.F. 2011. How to be a specialist? Quantifying specialisation in pollination networks. **Network Biology** 1, 1 - 20.

FAO. 1978. Species identification sheets for fishery purposes (Western Central Atlantic). Fish. areas: 31, vol.I, II, III, IV, V, VI Roma, 1.

FIGUEIREDO, J. L. 1977. Manual de peixes marinhos do sudeste do Brasil. Introdução. Cações, raias e quimeras. São Paulo, Museu de Zoologia da Universidade de São Paulo. 111p.

FIGUEIREDO, J. L.; MENEZES, N. A. 1978. Manual de peixes marinhos do sudoeste do Brasil. II. Teleostei (1). São Paulo: Museu de Zoologia da Universidade de São Paulo. 119p.

FIGUEIREDO, J. L.; MENEZES, N. A. 1980. Manual de peixes marinhos do sudoeste do Brasil. III. Teleostei (2). São Paulo: Museu de Zoologia da Universidade de São Paulo. 90p.

FROESE, R.; PAULY, D. 2017. FishBase. World Wide Web electronic publication. Available from: <www.fishbase.org.> version (06/2017) Access on: 28 set 2017.

GOMES, U. L.; SIGNORI, C. N.; GADIG, O. B. F.; SANTOS, H. R. S. 2010. Guia para identificação de tubarões e raias do Rio de Janeiro. 1ª edição. Rio de Janeiro: Technical Books Editora. 234p.

HORTON, T., et al. 2020. World Register of Marine Species. Available from http://www.marinespecies.org at VLIZ. Access on: 14 fev 2020. doi:10.14284/170

HYNES, H. B. N. 1950. The food of fresh-water sticklebacks (*Gasterosteus aculeatus* e *Pygosteus pungitius*), with a review of methods used in studies of the food of fishes. **J. Anim. Ecol.**; 19:36–57. Available from: <https://www.jstor.org/stable/1570> 10.2307/1570. Access on: 20 jul 2019.

HYSLOP, E. J. 1980. Stomachs contents analysis – a review of methods and their application. **J. Fish. Biol.**; 17: 411- 419. https://doi.org/10.1111/j.1095-8649.1980.tb02775.x.

INTERNATIONAL UNION FOR CONSERVATION OF NATURE – IUCN. 2017. IUCN Red List of Threatened Species. Version 2017.2 [online]. Available from: www.iucnredlist.org. Access on 16 nov 2017.

KREBS, C. J. 1998. **Ecological Methodology**. 2º ed. Benjamim /Cummings. 624p.

LAST, P. R.; WHITE, W.T.; CARVALHO, M. R.; SÉRET, B.; STEHMANN, M. F. W.; NAYLOR, G. J. P. 2016. Rays of the World. Ithaca: Cornell University Press. CSIRO PUBLISHING. 832p.

MENNI, R. C.; LUCIFORA, L. O. 2007. Condrictios de la Argentina y Uruguay. ProBiota, FCNyM, UNLP, Serie Técnica-Didáctica. La Plata, Argentina: Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata; 11:1-15. Available from: <http://aquaticcommons.org/1670/1/11-_Lista_Condrictios.pdf> Access on: 20 jul 2019.

ORO, E.B.; MARANTA, A. 1996. Regimen alimentário estacional de *Sympterigia bonapartei*, Müller y Henle 1841 (Pisces; Rajidae) em Mar del Plata. **Bol. Lab. Hidrob. de São Luís**. 9:33-53. Available from: http://www.periodicoseletronicos.ufma.br/index.php/blabohidro/article/view/1997/217 Access on: 20 jul 2019.

PAIVA, B.; AMORIM, A. F. 2014. Alimentação de *Dasyatis hypostigma* (Elasmobranquii, Rajiformes) Capturada na Pesca de Arrasto de Camarão-Rosa no Sudeste e Sul do Brasil. In: CONGRESSO BRASILEIRO DE ZOOLOGIA, 30, 2014. *Resumos*... Porto Alegre - RS; 30: 837-837.

PSOMADAKIS, P. N.; DALÙ M., SCACCO, U.; VACCHI, M. 2008. A rare batoid fish *Gymnura altavela* (Chondrichthyes, Gymnuridae) captured in the Tyrrhenian Sea. **Marine Biodiversity Records**; 1, e6: 1-4. Available from: <https://www.cambridge.org/core/journals/marine-biodiversity-records/article/a-rare-batoid-fish-gymnura-altavela-chondrichthyes-gymnuridae-captured-in-the-tyrrhenian-sea/32DB0FB07E2788D19DAB40C15F79B189> 10.1017/S1755267206000662. Access on: 20 jul 2019.

R CORE TEAM. 2018. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available from: <https://www.R-project.org/ > Access on: 20 jul 2019.

SADOWSKI, V. 1967. On the measurement of the total length of sharks. **Sonderdruck aus Zoologischer Anzeiger. BD.**; 81: 198–199.

STEHMANN, M.F.W. 2002. Proposal of a maturity stages scale for oviparous and viviparous cartilaginous fishes (Pisces, Chondrichthyes). **Arch. Fish. Mar. Res.** 50(1): 23–48.

STEVENS, J.D., Bonfil, R., Dulvy, N.K.; Walker, P.A. 2000. The effects of fishing on sharks, rays and chimaeras (chondrichthyans), and the implications for marine ecossystems. **ICES Journal of Marine Science**. 57: 476-494. https://doi.org/10.1006/jmsc.2000.0724

SZCZEPANSKI-JR, J.A. 2013. Feeding Ecology of Skates and Rays in Delaware and Narragansett Bays (Tese de Doutorado em Biological Sciences/Environment and Life Sciences). Paper 27. Rhode Island, U.S.A.: University of Rhode Island. Open Access Dissertations. Available from: https://digitalcommons.uri.edu/oa_diss/27 Access on: 20 jul 2019.

VIANA, A.F.; Vianna, M. 2014. The feeding habits of the eyespot skate *Atlantoraja cyclophora* (Elasmobranchii: Rajiformes) in southeastern Brazil. **Zoologia (Curitiba)**, Abril; 31(2): 119-125. Available from: <http://www.scielo.br/pdf/zool/v31n2/03.pdf> http://dx.doi.org/10.1590/S1984-46702014000200003 Access on: 28 nov 2018.

VIANNA, M.; ARFELLI, C.A.; AMORIM, A.F. 2000. Feeding of *Mustelus canis* (Elasmobranchii, Triakidae) caught off south-southeast coast of Brazil. **Boletim do Instituto de Pesca**, 26(1): 79-84. Available from: <https://www.pesca.sp.gov.br/vianna_26_1.pdf> Access on: 20 jul 2019.

VÖGLER, R.E.S. 2003. Ecología trófica de *Squatina guggenheim* Marini, 1936 (Chondrichthyes, Squatinidae) y sus relaciones con variables ambientales en aguas uruguayas y del norte argentino. 119f. (Tese de Doutorado em Oceanografia. Concepción, Chile: Universidad de Concepción. Facultad de Ciencias Naturales y Oceanográficas. Departamento de Oceanografía). Available from: <http://repositorio.udec.cl/bitstream/handle/11594/774/Tesis_Ecologica_Trofica_de_Squatina_Guggenheim.Image.Marked.pdf?sequence=1&isAllowed=y> Access on: 20 jul 2019.

YAMAGUCHI, A.; KAWAHARA, I.; ITO, S. 2005. Occurrence, growth and food of longheaded eagle ray, *Aetobatus flagellum*, in Ariake Sound, Kyushu, Japan. **Environ. Biol. Fishes**; 74: 229–238. 10.1007/s10641-005-0217-0

YEMISKEN, E.; FORERO, M.G.; MEGALOFONOU, P.; ERYILMAZ, L.; NAVARRO, J. 2017. Feeding habits of three Batoids in the Levantine Sea (north-eastern Mediterranean Sea) based on stomach content and isotopic data. **J. Mar. Biol. Assoc.** U.K.; 1-8. Availablefrom: <http://www.ebd.csic.es/lie/PDF/Yemisken_et_al_2017.pdf> 10.1017/S002531541700073X Access on: 20 jul 2019.

ZAVALA-CAMIN, L. A. 1996. Introdução aos estudos sobre alimentação natural em peixes. Maringá: EDUEM. 129p.

ZAVALA-CAMIN, L. A. 2004. O planeta água e seus peixes. Edição do autor. 326p.