STOMACH CONTENTS OF THE CARIBBEAN POMFRET *Brama caribbea* (MEAD, 1972) FROM STOMACH CONTENTS OF GREAT PELAGIC PREDATORS FROM SOUTHWESTERN EQUATORIAL ATLANTIC

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ABSTRACT

The Caribbean pomfret, *Brama caribbea*, is a common food item of pelagic predators in the Southwestern equatorial Atlantic. Stomach contents of 185 *B. caribbea*, obtained from stomach contents of great pelagic predators were analysed to know the food spectra, and determine which portion of the micronekton takes place in his feeding habits. The main food items were Euphausiacea, the hiperiids *Brachyscelus crusculum* and *Phrosina semilunata*, the fishes Myctophidae and *Acanthurus* sp., the cephalopods Enoploteuthidae, Cranchiidae and Ommastrephidae, and the heteropods. The diet composition of *B. caribbea* was 86.8% similar to the composition of the organisms found in the regional micronekton collected by midwater trawl.

Key words: Caribbean pomfret, *Brama caribbea*, feeding

CONTEÚDO ESTOMACAL DA PALOMBETA-DO-CARIBE *Brama caribbea* (MEAD, 1972), PROVENIENTE DO CONTEÚDO ESTOMACAL DE GRANDES PREDADORES PELÁGICOS DO ATLÂNTICO SUDOESTE EQUATORIAL

RESUMO

A palombeta-do-Caribe *Brama caribbea*, é um item alimentar comum de grandes predadores no Atlântico sudoeste equatorial. Conteúdos estomacais de 185 *B. caribbea* obtidos de conteúdos estomacais de grandes predadores foram analisados para se conhecer o espectro alimentar e para determinar qual porção do micronécton é parte dos seus hábitos alimentares. Os principais itens alimentares foram Euphausiacea, os hiperídeos *Brachyscelus crusculum* e *Phrosina semilunata*, os peixes Myctophidae e *Acanthurus* sp., os cefalópodes Enoploteuthidae, Cranchiidae e Ommastrephidae, e os heterópodes. A composição da dieta de *B. caribbea* foi 86,8% similar à composição de organismos encontrados no micronécton da região coletado por rede de meia água.

Palavras-chave: Palombeta-do-Caribe, *Brama caribbea*, alimentação

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INTRODUCTION

Bramids are oceanic pelagic fishes from Atlantic, Indian and Pacific oceans (NELSON, 1996). Six species (*Brama brama*, *B. dussumieri*, *B. caribbea*, *Taractichthys longipinnis*, *Pterycombus petersii* and *Pteraclis aesticola*) are reported to Southeastern and Southern Brazil (TOMÁS *et al*. 1988). These same species are also reported to occur in the Northeastern Brazil with the exception of *B. dussumieri* and *P. aesticola* (VASKE JÚNIOR, 2000). Despite the commercial importance of *B. brama* in some locations of the North Atlantic (MEAD and HAEDRICH, 1965; ERZINI and LOBO, 2001), there is no commercial fishery targeting adults of *B. brama* in Brazil, where they are caught occasionally by pelagic longline in the Southeastern and Southern regions (ZAVALA-CAMIN, 1981; TOMÁS *et al*., 1988), and deep bottom longline (HAIMOVICI *et al*., 2004). *B. brama* is also reported to Argentinian waters (CASTELLO and VERA, 1973). Among adult bramids in the Southwestern equatorial Atlantic only *T. longipinnis* are reported in longline catches. Other bramid species were recorded as larvae or juveniles in the same area (ANDRADE, 2000; BEZERRA JÚNIOR, 1999; FIGUEIREDO *et al*., 2002; LESSA *et al*., 1999; MADUREIRA *et al*., 2005; VASKE JÚNIOR *et al*., 2005a). The pomfrets, *B. brama* and *B. caribbea*, are two of the most abundant prey of pelagic predators in the Southwestern equatorial Atlantic, most of them found as juveniles in stomach contents of great pelagic predators (MATTHEWS *et al*., 1977; VASKE JÚNIOR, 2000; VASKE JÚNIOR and LESSA, 2004; VASKE JÚNIOR *et al*. 1998, 2004). Due to the importance of the bramids in the feeding habits of pelagic predators, and the lack of biological informations for these fishes, *B. caribbea* was chosen to study his feedings habits, and also to investigate the fraction of the micronekton that is used as prey by this species. For the first time, a length-weight relationship for the species was also provided

MATERIAL AND METHODS

The study area is located between 30°W and 40°W and 5°N and 20°S, where samples were carried out between October 2004 and November 2005 (Figure 1). The specimens of *B. caribbea*, in very good conditions, were obtained from frozen stomach contents of the blue marlin (*Makaira nigricans*), white marlin (*Tetrapturus albidus*), and bigeye tuna (*Thunnus obesus*) that are commonly caught by longliners in this region. The stomachs of *B. caribbea* were removed by opening the abdominal cavity and by severing them from the intestine and the esophagus, and than preserved in formalin at 5%. Food items in the stomach contents were identified to the lowest possible taxon. For each stomach data such as the number of individuals of each food item, total length for all organisms, and wet weight of each individual were recorded. Total length was registered in milimeters and weight in grams. The stomach fullness was recorded according to a five-point scale of estimated percentages of total fullness: empty, 25% full, 50 % full, 75% full, and full.

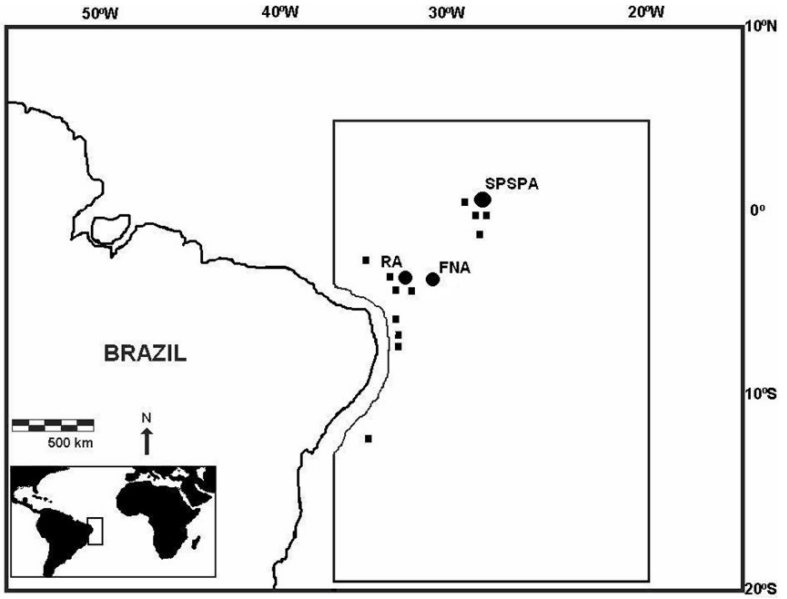

Figure 1. Sample area in the Southwestern equatorial Atlantic. RA- Rocas Atoll; FNA – Fernando de Noronha Archipelago; SPSPA – Saint Peter and Saint Paul Archipelago. Black squares are the hauls of the midwater trawl

The importance of each food item in the diet of *B. caribbea* was obtained by the Index of Relative Importance (IRI) (PINKAS *et al*. 1971), modified to weight in the pooled samples of the species:

$IRI_i = \%FO_i \times (\%N_i + \%W_i)$

where $\%FO_i$ - relative frequency of occurrence of each item; $\%N_i$ - proportion in prey number of each item in the total food; and $\%W_i$ - proportion in weight of each item in the total food content.

The proportions in number of the main groups of organisms found in the stomachs were compared to the proportions of organisms captured by midwater trawl (VASKE JÚNIOR *et al*. 2005b; MADUREIRA *et al*. 2005) to determine the similarity of the micronekton of the epipelagial, and the food spectra of *B. caribbea.* The niche overlap was calculated by the MacArthur and Levins's measure with Pianka's simetric modification (KREBS, 1989):

$O_{jk} = \Sigma\, p_{ij}\, p_{ik} / \sqrt{(\Sigma\, p_{ij}\, \Sigma\, p_{ik})}$

Where:

O_{jk} = MacArthur-Levin's measure to the resources j and k;

p_{ij} = Proportions resource i is of the total resources used by species j (*B. caribbea*);

p_{ik} = Proportions resource i is of the total resources used by k (midwater trawl catch).

Data from the composition of the micronekton of epipelagic oceanic waters and adjacencies of the islands, were considered equivalent to the local where *B. caribbea* lives, and were obtained from midwater trawl samples from the research vessel "Atlântico Sul" during acoustic surveys in the Brazilian Northeastern Exclusive Economic Zone (MADUREIRA *et al*., 2005; VASKE JÚNIOR *et al*., 2005b). A SIMRAD EK500 echo-sounder operating at 38 kHz was used, with a SIMRAD FS 903 Sonar trawl operating inside a 268 m circumference midwater trawl (MADUREIRA *et al*., 2005). Twelve hauls were made between surface and 200 m depth in the adjacencies of islands and oceanic stations (Figure 1).

RESULTS

Fork length of 196 *B. caribbea* ranged between 10 and 320 mm (Figure 2). Most individuals were between 40 and 120 mm, and the maximum observed length of 320 mm far exceed the maximum total length of 218 mm considered by MEAD (1972).

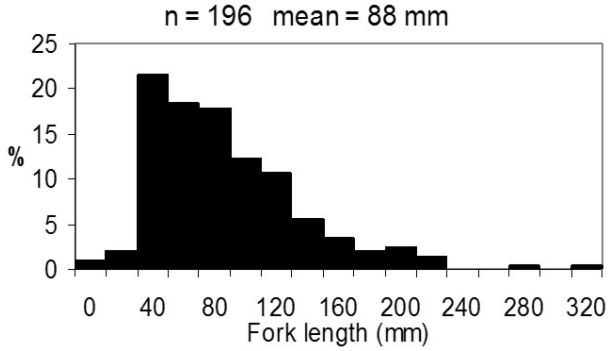

Figure 2. Length distribution of *Brama caribbea*

The stabilization of the food items richness was obtained at 42 food items and 150 stomachs approximately, which means that the number of sampled individuals was enough to obtain the feeding spectra of food items (Figure 3). A total of 185 stomachs was analyzed, where 45 items were identified, being 17 fishes, 11 cephalopods, 10 crustaceans, 2 pteropod, 1 insect, 1 heteropod, 1 polychaet, 1 ostracod, and 1 tunicate (Table 1). According to the IRI ranking, with the exception of unidentified Teleostei, the main ten items in the diet were Euphausiacea, the hiperiids *Brachyscelus crusculum* and *Phrosina semilunata*, the fishes Myctophidae and *Acanthurus* sp., the cephalopods Enoploteuthidae, Cranchiidae and Ommastrephidae, and the heteropods. All organisms were represented by larvae or juveniles, with the exception of *Phronima sedentaria*, Calanoida, *Cavolinia* sp., *Clio* sp., and *Halobates* sp. Canibalism was observed in two stomachs.

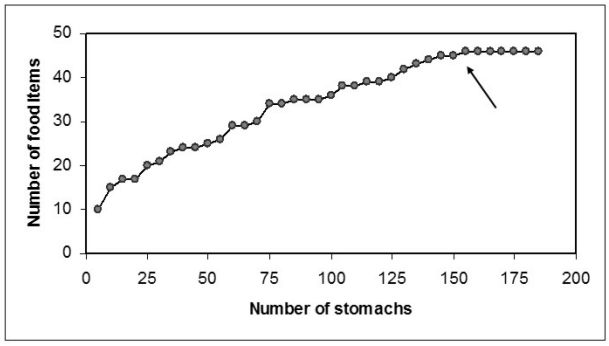

Figure 3. Food items diversity curve of *Brama caribbea* in the Southwestern equatorial Atlantic. Arrow indicates the stabilization

Prey length ranged between 1 and 85 mm of body length, although most prey were situated between 1 and 20 mm (Figure 4). All prey larger than 60 mm were represented by juveniles of the mesopelagic

fish *Alepisaurus ferox* and *Gempylus serpens*. Baits were present in 17.7% of the stomachs. The degrees of stomach fullness were 6.9% empty, 17.2% of 25% full, 30.1 % of 50% full, 23.6% of 75% full, and 22.0 % of full stomachs, which means that *B. caribbea* have a constant amount of food in the stomachs, chiefly between 25% and 75%.

Table 1. Prey species composition of *Brama caribbea* in number (N), weight (W), frequency of occurrence (FO), IRI ranking, and organisms composition of midwater trawl in the Southwestern equatorial Atlantic

Organisms	*Brama caribbea*								Mid. trawl	
	N	%N	W	%W	FO	%FO	IRI	Ranking	N	%N
Acanthurus sp.	50	5,91	5,29	3,12	10	5,81	47,40	**8**	73	0,94
Alepisaurus ferox	1	0,12	0,35	0,21	1	0,58	0,18			
Aluterus monocerus									8	0,10
Antigonia combatia	1	0,12	0,09	0,05	1	0,58	0,09		1	0,01
Astronesthidae									17	0,22
Auxis sp.									6	0,08
Balistes sp.	4	0,47	0,58	0,34	4	2,33	1,73		73	0,94
Bothus sp.									477	6,13
Brama brama	3	0,35	0,73	0,10	5	0,58	0,23		25	0,32
Brama caribbea	11	1,30	4,90	2,89	2	1,16	3,61		28	0,36
Carangidae									49	0,63
Cauliodus sloani									11	0,14
Centropyge aurantonotum									23	0,30
Chiasmodontidae									12	0,15
Cubiceps sp.	1	0,12	2,50	1,48	1	0,58	0,92		183	2,35
Dactylopterus volitans	5	0,59	1,64	0,96	4	2,33	3,43			
Decapterus tabl									397	5,10
Diondontidae	1	0,12	0,04	0,02	1	0,58	0,07		1	0,01
Diretmus argenteus	1	0,12	0,20	0,12	1	0,58	0,13			
Gempylus serpens	6	0,71	2,36	1,39	5	2,91	5,81		1	0,01
Gephyroberix darwinii									1	0,01
Gonostomatidae									6	0,08
Holocentridae	3	0,35	3,00	1,78	2	1,16	2,42		12	0,15
Leptocephalus									643	8,27
Lestidiops jayakari	1	0,12	0,72	0,43	1	0,58	0,31		14	0,18
Lestidium atlanticus									6	0,08
Lestrolepsis intermedia									8	0,10
Malacanthidae									5	0,06
Monacathidae									3	0,04
Myctophidae	29	3,43	10,13	6,00	17	9,88	88,07	**6**	2107	27,09
Neolatus tripes									5	0,06
Nomeidae	3	0,35	0,90	0,53	1	0,58	0,49		5	0,06
Oxyporhamphus micropterus	3	0,35	1,40	0,83	1	0,58	0,66		10	0,13

Continue

Table 1. Continuation

Organisms	*Brama caribbea*								Mid. trawl	
	N	%N	W	%W	FO	%FO	IRI	Ranking	N	%N
Priacanthidae									2	0,03
Pristipomoides freemaini									1	0,01
Scombridae	6	0,71	17,00	10,07	1	0,58	6,20			
Selar crumenophtalmus									4	0,05
Stemonosudis intermedia									1	0,01
Sternoptyx pseudobscura	9	1,06	3,08	1,82	4	2,33	6,34		27	0,35
Teleostei	102	12,06	27,24	16,13	43	25,00	659,34	**1**	17	0,22
Vinciguerria nimbaria	1	0,12	0,80	0,47	1	0,58	0,33		33	0,42
FISHES	**241**	**28,49**	**82,95**	**48,76**					**4295**	**55,22**
Chiroteuthidae	2	0,24	0,12	0,07	2	1,16	0,32		22	0,28
Cranchiidae	24	2,84	3,67	2,17	17	9,88	45,30	**9**	48	0,62
Enoploteuthidae	43	5,08	20,08	11,89	30	17,44	282,72	**4**	113	1,45
Enoploteuthis anapsis									152	1,95
Enoploteuthis leptura									363	4,67
Histioteuthidae	10	1,18	0,49	0,29	7	4,07	5,27			
Illex coindetti									1	0,01
Leachia sp.									2	0,03
Liocranchia reinhardti	6	0,71	2,88	1,71	4	2,33	5,37		3	0,04
Octopodidae	1	0,12	0,30	0,18	1	0,58	0,16			
Ommastrephes bartramii	3	0,35	2,50	1,48	2	1,16	2,07		18	0,23
Ommastrephidae	28	3,31	1,09	0,65	13	7,56	26,13	**10**	84	1,08
Onychoteuthidae	3	0,35	6,20	3,67	2	1,16	4,62		1	0,01
Onykia sp.	1	0,12	1,20	0,71	1	0,58	0,47			
Ornithoteuthis antillarum	4	0,47	10,62	6,29	3	1,74	11,67		7	0,09
CEPHALOPODS	**125**	**14,78**	**49,15**	**29,11**					**814**	**10,47**
Brachyscelus crusculum	145	17,14	6,29	3,73	32	18,60	340,16	**3**		
Brachyura Megalopae	12	1,42	1,32	0,78	9	5,23	10,39		58	0,75
Calanoida	6	0,71	0,04	0,02	1	0,58	0,36			
Caridea									21	0,27
Cranocephalus sp.	7	0,83	0,54	0,32	5	2,91	2,97			
Decapoda	1	0,12	0,01	0,01	1	0,58	0,06		29	0,37
Euphausiacea	162	19,15	10,22	6,04	31	18,02	402,24	**2**	1088	13,99
Penaeidae									4	0,05
Phronima sedentaria	19	2,25	2,63	1,55	10	5,81	20,15		21	0,27
Phrosina semilunata	28	3,31	4,15	2,45	17	9,88	51,09	**7**	12	0,15
Scylariidae Phylossome									34	0,44
Platyscelidae	10	1,18	0,61	0,36	9	5,23	7,14		2	0,03
Sergestidae	16	1,89	3,89	2,29	5	2,91	11,37		799	10,27
Stenopodidea									1	0,01

Continue

Table 1. Continuation

Organisms	*Brama caribbea*								Mid. trawl	
	N	%N	W	%W	FO	%FO	IRI	Ranking	N	%N
Stomatopoda									493	6,34
CRUSTACEANS	**406**	**47,99**	**29,70**	**17,56**					**2562**	**32,94**
Clio sp.	8	0,95	0,18	0,11	1	0,58	0,53			
Cavolinia uncinata	7	0,83	0,17	0,10	5	2,91	2,34		24	0,31
Cavolinia gigas									3	0,04
PTEROPODS	**15**	**1,77**	**0,35**	**0,21**					**27**	**0,35**
Halobates sp.	17	2,01	0,85	0,49	15	8,72	19,28			
INSECTS	**17**	**2,01**	**0,85**	**0,49**						
HETEROPODS	**39**	**4,61**	**5,67**	**3,36**	**21**	**12,21**	**88,81**	**5**	**3**	**0,04**
POLYCHAETS	**1**	**0,12**	**0,01**	**0,01**	**1**	**0,58**	**0,06**			
OSTRACODS	**1**	**0,12**	**0,01**	**0,01**	**1**	**0,58**	**0,06**			
TUNICATES	**1**	**0,12**	**0,02**	**0,01**	**1**	**0,58**	**0,07**		**52**	**0,67**
SIPHONOFORES									**7**	**0,09**
TOTAL	**846**	**100,00**	**169,56**	**100,00**					**7778**	**100,00**

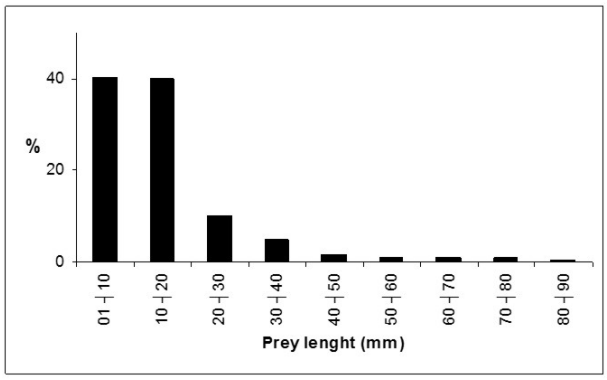

Figure 4. Lengths of all organisms found in the stomach contents of *Brama caribbea*

The proportions of the numeric micronekton composition, and the numeric food spectra of *B. caribbea* were 86.8% similar (O_{ij} = 86.8) (Table 2). For fishes, 41 taxa occurred in total, being 4 taxa only for *B. caribbea*, 22 only for midwater trawl, and 15 for both. For cephalopods, 15 taxa occurred, being 3 only for *B. caribbea*, 4 only for midwater trawl, and 8 for both. For crustaceans, 15 taxa occurred, being 3 only for *B. caribbea*, 5 only for midwater trawl, and 7 for both. Three taxa of pteropods occurred, being two only for *B. caribbea*, one only for midwater trawl, and one for both. The insect *Halobates* sp., and the taxa Polychaet and Ostracod occurred only for *B. caribbea*. One taxa of Siphonophore occurred only for midwater trawl, and one taxa of Heteropod and Tunicate occurred for both. A total of 86 taxa were recorded, where 16 taxa were preyed only by *B. caribbea*, 33 taxa occurred only in the midwater trawl, and 32 taxa occurred for both. All organisms caught in the midwater trawl were represented by young and larval stages, with the exceptions of some fishes and cephalopods.

Table 2 - Proportions of the main groups of organisms found in the stomach s of *Brama caribbea,* and proportions of main groups of organims collected by midwater trawl in the Southwestern equatorial Atlantic

Organisms	% *Brama caribbea*	% Midwater trawl
Fishes	0,2849	0,5588
Crustaceans	0,4799	0,3182
Cephalopods	0,1478	0,1114
Pteropods	0,0177	0,0036
Tunicates	0,0012	0,0067
Heteropods	0,0461	0,0004
Siphonophores		0,0009
Insects	0,0201	
Polychaets	0,0012	
Ostracods	0,0012	
TOTAL	1	1

DISCUSSION

According to ROGER and GRANDPERRIN (1976), trophic webs in the tropical Pacific are mainly composed by phytoplankton, small zooplankton, euphausids, micronekton, tunas, and tuna like fishes. Of these, the micronekton is the most important, whereas it transfers energy to cephalopods and small pelagic fishes who will take place as food supply of great pelagic predators. If we consider that *B. caribbea* is an active eater of micronekton, and is frequently preyed by great pelagic fishes in the Southwestern equatorial Atlantic (VASKE JÚNIOR, 2001; VASKE JÚNIOR, *et al*., 2003), then, we can consider that the species is an important link between the micronekton and the pelagic predators, functioning as an energy transference step. For this reason, we can consider the stomach contents of *B. caribbea* as a good sampler of the local micronekton, once *B. caribbea* is considered a species that lives in the epi and mesopelagial (MEAD and HAEDRICH, 1965; MEAD, 1972). When the bramid species were described by MEAD (1972), most of them were recorded from stomach contents of tunas, and midwater trawls, between 0 and 660 m layers in the tropical Pacific. He considered *B. caribbea* as a pseudopelagic fish, once it is also found close to land masses and islands.

Most prey ranged between 1 and 40 mm, which means that this is the capacity of prey ingestion for *B. caribbea* until 320 mm FL. For this reason, larger organisms collected by midwater trawl were not present in the diet of *B. caribbea*, *e.g.* the fishes *Aluterus monocerus* (340 to 410 mm TL), *Auxis* sp. (185 to 205 mm TL), *Cubiceps* sp. (104 to 168 mm TL), Leptocephalus (50 to 295 mm TL), *Decapterus tabl* (135 to 195 mm TL), Paralepididae (*Lestidiops jayakari*, *Lestrolepsis intermedia, Stemonosudis intermedia, Lestidium atlanticum*) (20 to 200 mm TL), and *Selar crumenophtalmu*s (150 to 200 mm TL), except for rare larval fish stages. Likewise, large squids like *Enoploteuthis leptura* (40 to 120 mm TL), *Enoploteuthis anapsis* (110 to 320 TL), *Illex coindetti* (140 mm TL), and *Leachia* sp. (180 mm TL), were not preyed by *B. caribbea*.

The frequency of *B. caribbea* in the stomachs of pelagic predators in the South equatorial Atlantic is high, being the main food item of bigeye tuna (*Thunnus obesus*) representing 50.85 % of total prey in frequency of occurrence (not published data), but represented only 0.36 % in number of the total catches of the midwater trawl, probably due to the capacity to avoid the net haul. On the other side, *B. caribbea* can not avoid the efficiency of predation of the tunas and other pelagic predators.

LEGAND *et al*., (1972), also analyzed the composition of stomach contents of tunas, and the micronekton obtained by Isaacs-Kidd Midwater Trawl (IKMT) in the tropical Pacific. They concluded that stomach contents of tunas are different of the micronekton catches of IKMT due to the different migrant species, and the day-night feeding habits of predators. The bramids *Taractes* sp. and *Pteraclis* sp. were not captured in the IKMT, probably due to their capacity to avoid the net. As in the present study, euphausids and cephalopods were the main prey items of the bramids. WATANABE *et al*. (2003), also found a high diversity of prey species in the diet of *Brama japonica* in the central North Pacific, pointing out the importance of cephalopods, hiperiids, and the fishes Paralepididae in the diet of this species. In this study, it was observed a remarkable presence of the sea skater *Halobates* sp. in the stomachs of *B. caribbea*. These insects are abundant in the pleuston and epineuston of tropical oceans (ANDERSEN, 1991; CHENG, 1989), thus, they could not be expected to appear in the diet of an epimesopelagic fish like *B. caribbea*. *Halobates* sp. was not found in the stomachs of *B. japonica* in the Pacific, probably because the fishes have been captured between 37°N and 40°N, although *Halobates* sp. were also found in the stomachs of yellowfin tuna (*Thunnus albacares*) in Southern Brazil (30°S) (VASKE JÚNIOR and CASTELLO, 1998). If *B. caribbea* feeds on *Halobates* sp. with some frequency, it means that *B. caribbea* feeds very close the sea surface more frequently than expected, despite his epi and mesopelagic habit.

Some taxa that occurred in high number in the midwater trawl like *Bothus* sp. (477), Leptocephalus (643), Sergestidae (799), and Stomatopoda (493), were not present in stomachs of *B. caribbea*, probably due to the transparence of the larval stages that can avoid the predation by *B. caribbea*, but are easily caught by the midwater trawl. On the other hand, Euphausiacea (1088) and Myctophidae (2107) were the most numerous organisms captured by midwater trawl, being the second and the sixth food items in the diet of *B. caribbea*. Thus, these two taxa, Euphausiacea and Myctophidae, can be considered the most important organisms that are eaten by *B. caribbea* in the link of micronekton and pelagic predators in the food web of the Southwestern equatorial Atlantic.

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