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ZOOLOGY

Diet of three juvenile fish species of the coastal zone of a Southwest Atlantic beach, Brazil

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ABSTRACT. Surf zones are associated with a shelter area, nursery and feeding for several species of fish. In this study, the dietary habits of three species of fish with demersal habits (Gulf kingcroaker *Menticirrhu gracilis*, Whitesea catfish *Genidens barbus* and Barbu *Polydacytlus virginicus*), were verified in the surf zone area of an active urban beach of Baixada Santista, concerning structure in size, day and night abundances and overlapping diets. A total of 617 fish were analyzed, of which 362 were 194 were *G. barbus* and 61 were *P. virginicus*. Stomach contents, represented in Relative Importance Index diagrams, showed that the bivalve *Donax gemmula* is the most important food item for *M. gracilis*, scales of Teleostei for *G. barbus* and Euphausiacea for *P. virginicus*. In order to evaluate the similarity of the diets, the Macarthur & Levins indices and a cluster analysis with the Bray-Curtis distance were applied revealing that the diet is 44% different between *G. barbus* and *M. gracilis*, 5% between *G. barbus* and *P. virginicus* and of 84% between *M. gracilis* and *P. virginicus*. Anthropogenic waste like plastic, nylon, metal pieces, were only occasionaly observed.

Keywords: feeding; surf zone; Sciaenidae; Ariidae; Polynemidae.

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Introduction

The surf zones are characterized as a dynamic environment, being the first areas to be exploited by recreational and commercial fishing, besides shelter, nursery and feeding for many organisms mainly fishes (Ehrlich *et al*., 1994). It is considered a turbulent environment, where the animals that live in this area present diverse adaptations to survive like greater agility and different feeding strategies (Lasiak, 1986; McLachlan & Brown, 2006). According Olds et al. (2017), Brazil is the second country with the highest number of surveys in areas of surf zones considering a total of 152 surf zone studies around the world.

The identification of dietary composition of a fish population can be performed by the analysis of anatomical characteristics, direct consumption observations, stomach contents analysis and, more recently, the quantification of stable isotopes (Valiela, 1995; Koch, 2007). An ecological analysis of food should answer three basic questions: what is ingested, how much and when it is ingested (Wootton, 1990). Other issues emerge, considering biotic and abiotic factors, and diet and dietary habits of fish may vary according to ontogenetic development, with time and space (Zavala-Camin, 1996).

The three target species of this study were the Gulf kingcroaker, *Menticirrhus gracilis*; the Whitesea catfish, *Genidens barbus*; and the Barbu, *Polydactylus virginicus*. The trophic ecology of fishes from the surf zone has been reasonably well studied, at least in comparison with other potential roles of the surf zone as a fish habitat (Olds et al., 2017). Only larger specimens of *M. gracilis* (>20 cm) present commercial value, with relative importance for sport fishing, reaching up to 48.3 cm in length (Carvalho-Filho, 1999). *G. barbus* is distributed in the southeastern and southern regions of Brazil, Uruguay and Argentina (Marceniuk, 2007), reaching 120 cm in total length. Although it is common, its biology is little known, comprising with *G. machadoi*, 80% of the commercial category 'catfish' landed by the commercial fishing fleet operating in the southeastern region of Brazil (Marceniuk, 2007). *P. virginicus* is distributed in the southeastern and southern regions of Brazil (Cervigon, 1992), reaching 32 cm total length, occurring in shallow depths of soft substrates, in estuarine areas (Carvalho-Filho, 1999).

The objective of the present study was to investigate the dietary habits of three common fish species with bottom habits that occur in the Praia Grande (SP) surf zone, as a function of their size, diurnal and nocturnal occurrences, and diet overlapping. The hypothesis is that the fishes of the surf zone have different characteristics in their feeding due to body shape and ontogenetic aspects, once the high energy of this environment demands different behavior for feeding strategies.

Material and methods

The study area is located at the city of Praia Grande, central coast of State of São Paulo, Brazil (24°00'/24°05'S and 46°24'/46°35'W) (Figure 1), characterizing itself as a dissipative urban beach.

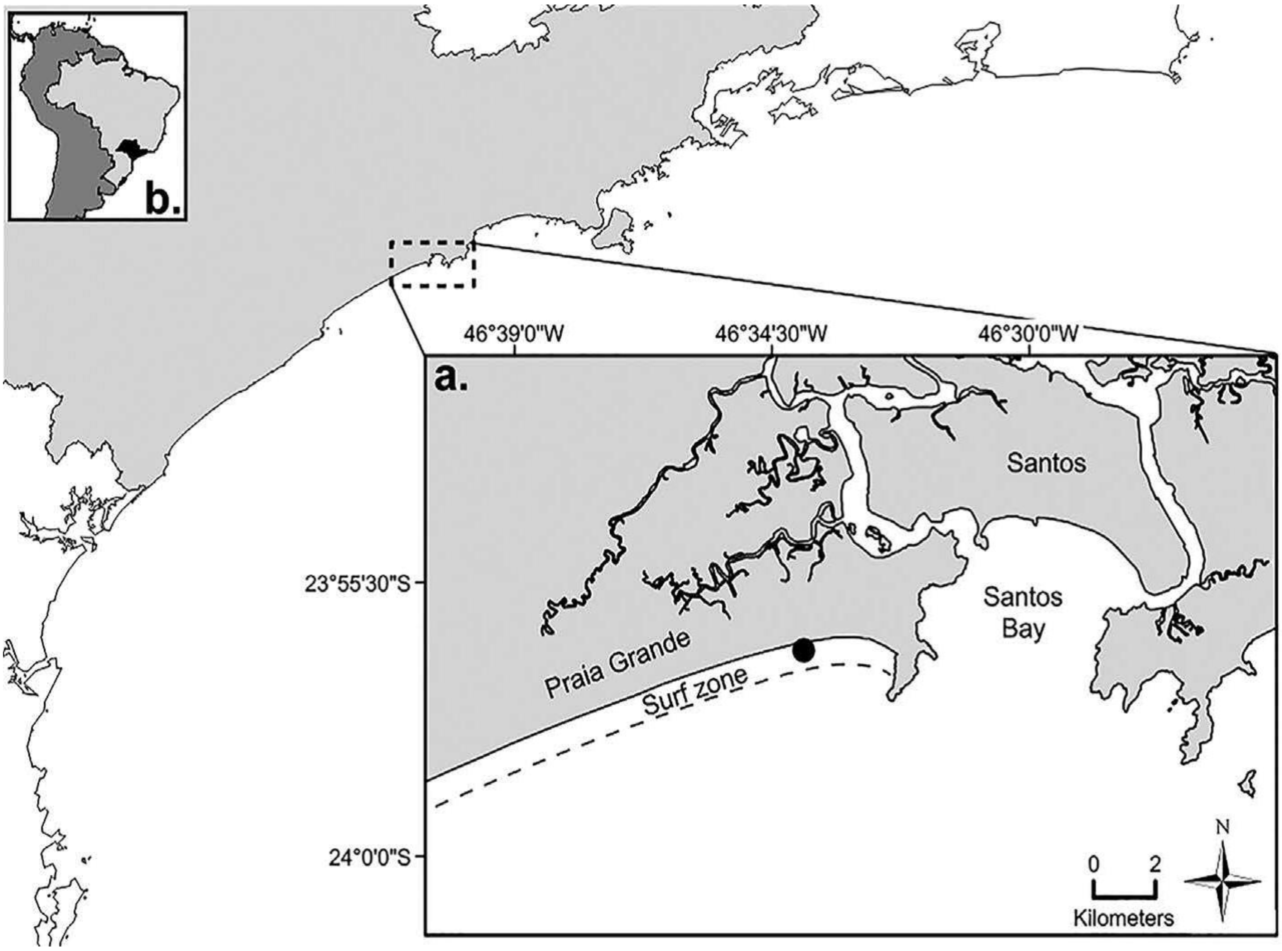

Figure 1. Sample site (●) in the central coast of the São Paulo State.

Sampling was carried out between April 2013 and April 2015 (licences ICMBio-SISBIO 36559-1, COTEC-IF: Process SMA n. 007.617/2016), bimonthly, during day and night in three points in the surf zone, separated by 150 m each other. For quantification purposes, the three points were grouped and counted as a single sample. Trawls were performed with a 10.0 x 2.0 m beach seine net, 4.0 mm mesh with a central bag 1.8 m high triangular and 2.5 mm mesh. Trawls were carried out parallel to the shoreline at 1.0 m depth along 5 minutes covering a distance of 50 m. The temperatures and salinities of the water were measured in decimal accuracy for thermometers and refractometer, respectively.

In the laboratory, the specimens were measured in total length (mm) and the digestive tracts extracted. The stomach contents were analyzed, and preys identified taxonomically and quantified using a stereoscopic microscope. The prey items were identified in major categories, and also identified to the lowest taxonomic level, when possible. The quantitative volumetric method was used, considering the volume of each food item obtained by approaching to known geometric figures (sphere, cylinder, cube, ellipse, among others) (Magnusson, Lima, Silva, & Araújo, 2003). The degree of stomach fullness of each stomach was determined according to the scale: 0 = empty, 1 = 25% full, 2 = 50% full, 3 = 75% full, and 4 = 100%full. The importance of each food item in the diet for each fish specimen was calculated according to the Relative Importance Index (Pinkas, Oliphant, & Iverson, 1971) (Equation 1):

$$IRI= \%FOi \times (\%Ni + \%Vi) \quad (1)$$

Where %FOi is the relative frequency of occurrence of each food item; %Ni is the proportion in prey number of each item in the total food; and %Vi is the proportion by volume of each item in the total food.

A rarefaction curve was applied to verify if the number of analyzed stomachs was sufficient to obtain an overview of the food spectrum of the species. Cain (1938) states that sample adequacy is achieved when a 10% increase in the total sample size corresponds to 10% or a smaller number of total collected species.

The proportions of the main groups of organisms found in the stomachs were compared among the three species to determine the similarity of diets according Pianka (1973) (Equation 2):

$$O_{jk} = \frac{\sum_i^n P_{ij} \times P_{ik}}{\sqrt{\sum_i^n {P_{ij}}^2 \times \sum_i^n {P_{ik}}^2}} \quad (2)$$

where:
- Ojk = MacArthur-Levin’s measure to the resources j and k;
- pij = Proportions resource i is of the total resources used by species j;
- pik = Proportions resource i is of the total resources used by k.

The similarity between diets was also analyzed based on a cluster analysis (UPGMA) using the Bray-Curtis coefficient. Data on circadian (day-night) and seasonal cycles (summer, fall, winter and spring) were submitted by the Shapiro-Wilk test to verify homogeneity. As they didn’t, subsequently, data were compared by non-parametric Kruskal-Wallis test (seasonal) and by Mann-Whitney (daytime) tests (corrected by Bonferroni's posteriori). The matrices were constructed with the main prey from the IRI. The large taxonomic groups were excluded to avoid interference of repetition of the data included in the subsequent groups. In order to determine the size relationship between prey and predator, a regression analysis was performed between the total length of the fish and their prey ingested through the Past program 2.17.

Results

In the summer the water temperature ranged from 30.0°C (day) to 28,5°C (night), with highest values in February 2015. In winter, the lowest temperatures occurred in August, with few oscilation between the two periods, 18.7 °C in the daytime and 16.7°C in the night. The salinity presented slightly variations with a minimum of 33 and maximum of 35.4, in April and October 2014, respectively.

A total of 617 fish was analyzed, 362 of *M. gracilis*, 194 of *G. barbus* and 61 of *P. virginicu*s. The distribution of the total lengths for each species are shown for day and night samples (Figure 2).

According to the literature that determines the size of the first sexual maturation (L50) of the three species, the specimens sampled were mainly juveniles. For *M. gracilis*, L50 is 19.8 cm (Braun & Fontoura, 2004), and for *G. barbus* 43.0 cm (Reis, 1986). No value of L50 is known for *P. virginicus*, although they are presumed juvenile considering the larger specimens cited in the literature.

Of the 362 stomachs of M. gracilis, 144 stomachs were 4 (39.8%), 3 (11.9%), 2 (5.5%), 1 (5.3%) and 136 with no food (37.6%). For G. barbus, 194 stomachs were analyzed, of which 106 were 4 (54.6%), 3 (30.4%), 2 (7.7%), 1 (3, 6%) and 7 stomachs with no food (3.6%). For P. virginicus, 61 stomachs were analyzed, 12 with no food and the other 49 represented by 4 (22.9%), 3 (9.8%), 2 (47.5%) and 1 (19.7%) (Figure 3).

The number of stomachs analyzed are shown for day and night periods in the Table 1.

The rarefaction curves presented stability for all species, with 13 food items for *M. gracilis*, 14 food items for *G. barbus*, and 8 food items for *P. virginicus* (Figure 4).

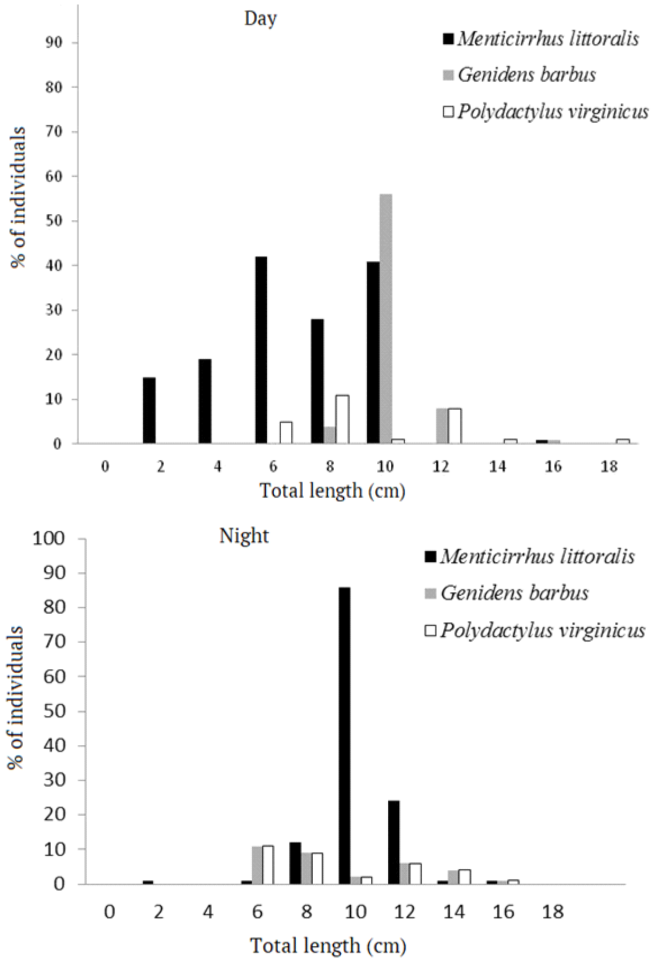

Figure 2. Length distributions for three surf zone species in the coast of São Paulo for day and night periods.

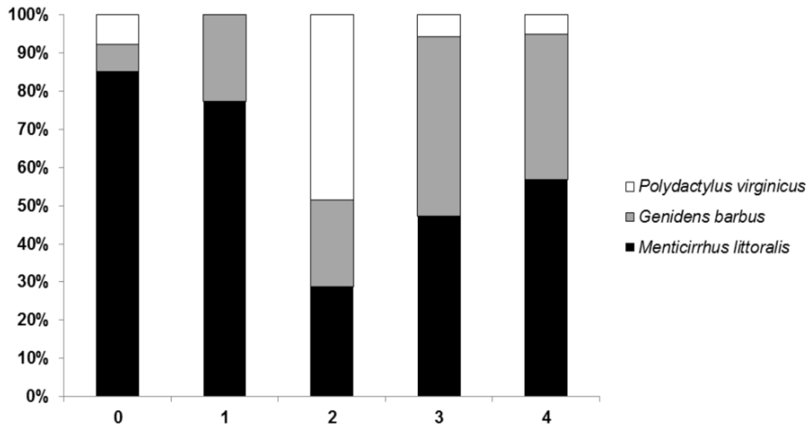

Figure 3. Degrees of stomach fullness (0 = empty, 1 = 25% full, 2 = 50% full, 3 = 75% full, and 4 = 100%full) for three fish species from the surf zone of Praia Grande, SP.

Table 1. Number of stomachs of each fish species studied in the surf zone of Praia Grande, SP. D = daytime, N = nighttime, FC = with food content, E = empty.

Species	Cycle	1º Quarter		2º Quarter		3º Quarter		4° Quarter		Total
		FC	E	FC	E	FC	E	FC	E	
M. gracilis	D	41	33	10	4	17	18	49	17	189
	N	10	7	12	9	9	2	78	46	173
G. barbus	D	-	-	69	1	-	-	-	-	70
	N	-	-	92	1	26	5	-	-	124
P. virginicus	D	3	3	4	1	-	2	1	-	14
	N	7	-	19	5	-	1	15	-	47

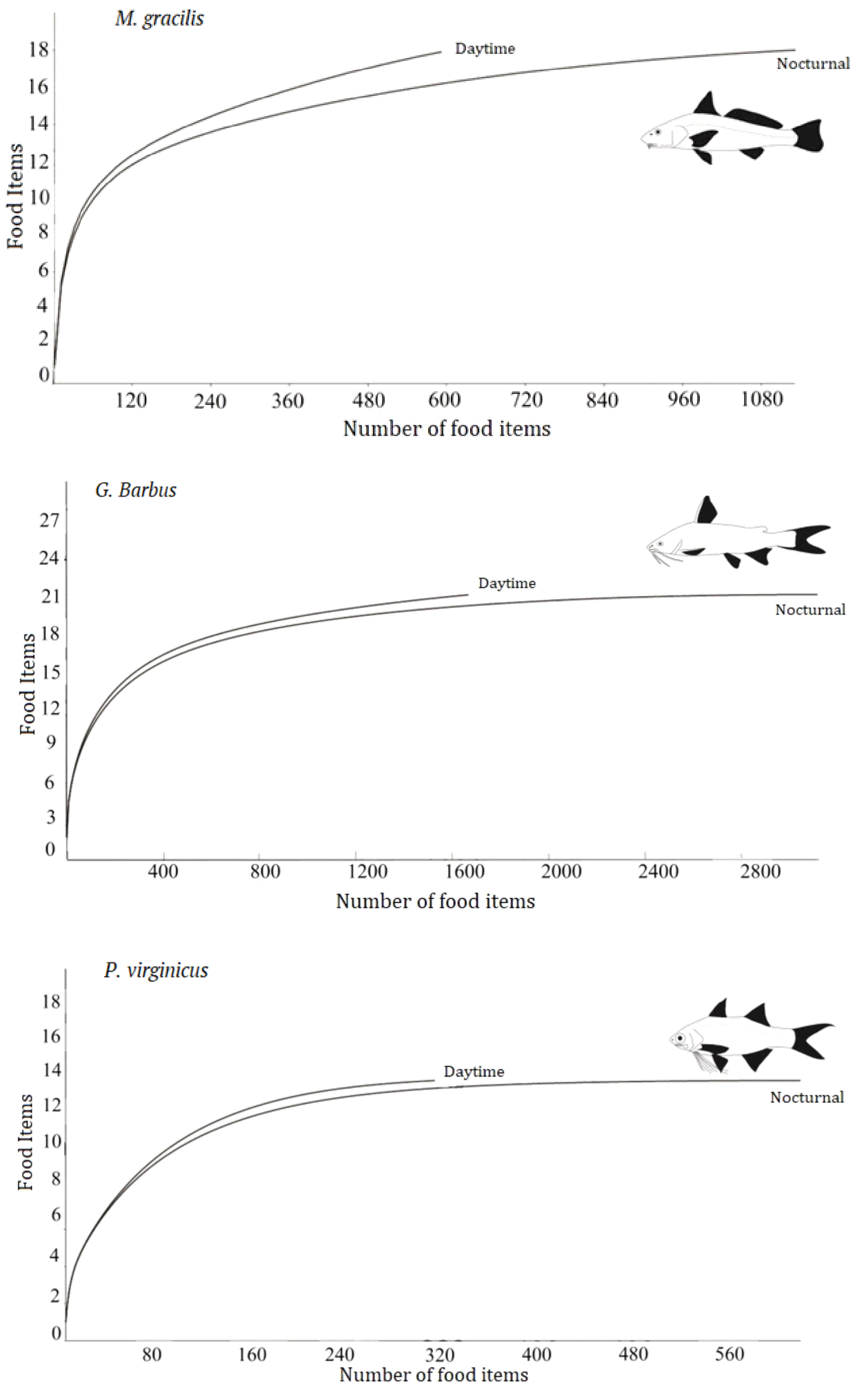

Figure 4. Rarefaction curves of food items for three fish species of the surf zone of Praia Grande, SP.

The diet of *M. gracilis* was composed mainly of bivalves and crustaceans, where the most abundant items according to IRI% were: *Donax gemmula*, Decapoda, Copepoda, *Mellita quinquisperforata*, Teleostei, and vegetal organic matter. For *G. barbus* the diet was composed mainly by Brachyuran megalopae, Teleostei, polychaete, ctenoid scales, cyloid scales, insects, and presence of seeds. The diet of *P. virginicus* was composed by fish and crustaceans, where the main food items were Brachyuran megalopae, Euphausiasea, Decapoda, *Donax gemmula*, Copepod, scales and substrate (Table 2). The presence of anthropogenic materials (plastic pieces, toothbrush bristles, bladders, aluminum foil, foam, nylon yarn and pellets) in the stomachs of the three species was occasionaly observed.

Table 2. Food items of the three fish species from the surf zone of Praia Grande, SP. IRI% (index of relative importance); FO (frequency of occurrence of each food item, V (volume of prey eaten from each food item) and N (number of ingested prey of each item fed by seasons of the year.

Menticirrhus littoralis	Summer					Autumn					Winter					Spring				
	N	V	FO	IRI	%IRI	N	V	FO	IRI	%IRI	N	V	FO	IRI	%IRI	N	V	FO	IRI	%IRI
Brachyura	20	1.9	8	175.2	10.2	9	1.9	1	10.9	8.4	14	1.9	8	127.2	29.8	18	1.9	11	218.9	54.8
Copepoda	-	-	-	-	-	10	3	5	65	50.3	7	2	3	27	6.3	3	2	2	10	2.5
Cirripedia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	0.2
Donax gemmula	52	6	21	1.218	70.7	4	3	4	28	21.7	5	3	1	8	1.9	-	-	-	-	-
Decapoda	6	3	6	54	3.1	2	2	2	8	6.2	1	2	1	3	0.7	-	-	-	-	-
Emerita brasiliensis	2	-	2	4	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ctenoid scale	8	-	8	64	3.7	1	3.9	1	4.9	3.8	1	3.9	1	4.9	-	-	-	-	-	-
Stomatopoda	-	-	-	-	-	-	-	-	-	-	1	-	1	0.23	-	-	-	-	-	-
Euphausiacea	-	-	-	-	-	6	0.4	1	6.4	4.9	2	0.4	1	2.4	0.6	-	-	-	-	-
Isopoda	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Larvae Diptera	20	2.68	8	181.4	10.5	-	-	-	-	-	2	2.7	1	4.68	1.1	-	-	-	-	-
Organic matter	-	-	-	-	-	2	-	2	4	-	3	-	3	9	2.1	1	-	1	1	0.2
Mellita quinquiesperforata	-	-	-	-	-	-	-	-	-	-	6	-	6	36	8.4	11	-	9	99	24.8
Mysidacea	-	-	-	-	-	1	-	1	1	0.8	-	-	-	-	-	-	-	-	-	-
Ostracoda	3	-	3	9	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polychaeta	2	1.9	2	7.8	0.4	-	-	-	-	-	29	3.1	4	128.4	30.1	3	3.1	3	18.3	4.6
Substrate	-	-	-	-	-	1	-	1	1	0.8	3	-	2	6	1.4	7	-	7	49	12.3
Teleostei	3	-	3	9	0.5	-	-	-	-	-	10	-	6	60	14.1	-	-	-	-	-
Vegetable	-	-	-	-	-	-	-	-	3	-	3	9	1	-	2.1	1	-	1	1	0.2
Xiphopenaeus kroyeri	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	0.2
TOTAL	-	-	-	1,722.4	100	-	-	-	129.2	100	-	-	-	426.6	100	-	-	-	399.2	100

Polydactylus virginicus	Summer					Autumn					Winter					Spring				
	N	V	FO	IRI	%IRI	N	V	FO	IRI	%IRI	N	V	FO	IRI	%IRI	N	V	FO	IRI	%IRI
Areneus cribrarius	-	-	-	-	-	1	3.9	1	4.9	3.8						-	-	-	-	-
Brachyura	31	1.9	3	98.7	26.3	-	-	-	-	-						60	1.9	2	123.8	59.8
Copepoda	-	-	-	-	-	4	3	4	28.0	21.8						-	-	-	-	-
Cirripedia	-	-	-	-	-	-	-	-	-	-						1	-	1	1	0.5
Donax gemmula	-	-	-	-	-	-	-	-	-	-						-	-	-	-	-
Decapoda	25	2	1	27.0	7.2	1	2	1	3.0	2.3						11	2	2	26	12.6
Ctenoid scale	3	3.9	2	13.8	3.4	-	-	-	-	-						-	-	-	-	-
Cycloid scale	-	-	-	-	-	1	3.9	1	4.9	3.8						1	3.9	1	4.9	2.4
Stomatopoda	-	-	-	-	-	-	-	-	-	-						-	-	-	-	-
Euphausiacea	52	0.4	4	209.6	55.9	8	0.4	3	25.2	19.7						16	0.4	3	49.2	23.8
Isopoda	-	-	-	-	-	-	-	-	-	-						1	-	1	1	0.5
Larvae Diptera	-	-	-	-	-	5	2.7	2	15.4	12.0						-	-	-	-	-
Organic matter	1	-	1	1.0	0.3	-	-	-	-	-						-	-	-	-	-
Mellita quinquiesperforata	-	-	-	-	-	-	-	-	-	-						-	-	-	-	-
Mysidacea	-	-	-	-	-	-	-	-	-	-						-	-	-	-	-
Ostracoda	-	-	-	-	-	-	-	-	-	-						-	-	-	-	-
Polychaeta	4	1.9	1	5.9	1.6	3	1.9	2	9.8	7.7						-	-	-	-	-
Substrate	1	-	1	1.0	0.3	6	-	6	36.0	28.1						-	-	-	-	-
Teleostei	-	-	-	-	-	-	-	-	-	-						1	-	1	1	0.5
Vegetable	-	-	-	-	-	-	-	-	-	-						-	-	-	-	-
Xiphopenaeus kroyeri	9	-	2	18.0	4.8	1	-	1	1	0.8						-	-	-	-	-
TOTAL	-	-	-	375.0	100	-	-	-	128.2	100						-	-	-	206.9	100

enidens barbus	Summer					Autumn					Winter					Spring				
	N	V	FO	IRI	%IRI	N	V	FO	IRI	%IRI	N	V	FO	IRI	%IRI	N	V	FO	IRI	%IRI
Areneus cribrarius						2	3	1	5.0	0.00	-	-	-	-	-					
Briozoa						5	3.9	4	35.6	0.03	-	-	-	-	-					
Brachyura						11	1.9	8	103.2	0.07	10	1.9	6	71.4	0.34					
Copepoda						5	1.9	3	20.7	0.01	-	-	-	-	-					
Crystalline						45	1.9	7	328.3	0.24	2	1.9	2	7.8	0.04					
Cirripedia						5	0.4	5	27	0.02	5	0.4	5	27	0.13					
Donax gemmula						29	3	6	192	0.14	8	3	3	33	0.16					
Decapoda						5	2	4	28	0.02	5	2	4	28	0.13					
Emerita brasiliensis						-	-	-	-	-	-	-	-	-	-					
Ctenoid scale						574	3.9	58	33,55	24.2	-	-	-	-	-					
Cycloid scale						460	3.9	27	12,525	9.1	406	3.9	38	15,57	74.8					
Stomatopoda						-	-	-	-	-	298	3.9	13	3,924.7	18.9					
Euphausiacea						8	0.4	4	33.6	0.02	-	-	-	-	-					
Nylon wire						8	-	8	64	0.05	-	-	-	-	-					
Insect						492	2.7	176	87,064	62.9	5	2.7	2	15.4	0.1					
Organic matter						48	-	48	2,304	1.7	18	-	18	324	1.6					
Mellita quinquiesperforata						5	-	5	25	0.02	1	-	1	1	0.0					
Mysidacea						-	-	-	-	-	-	-	-	-	-					
Ostracoda						-	-	-	-	-	-	-	-	-	-					
Polychaeta						9	4	8	104	0.1	5	4	5	45	0.22					
Pellets						4	0.13	1	4.13	0.0	-	-	-	-	-					
Passion fruit seed						9	0.13	3	27.4	0.02	4	0.1	1	4.13	0.02					
Substrate						14	-	14	196	0.14	1	-	1	1	0.0					
Teleostei						56	-	31	1,736	1.25	30	-	23	690	3.3					
Vegetable						12	-	6	72	0.05	-	-	-	-	-					
Xiphopenaeus kroyeri						-	-	-	-	-	12	-	6	72	0.35					
TOTAL						-	-	-	138,41	100	-	-	-	20,82	100					

The overlap analysis of the diets showed that *M. gracilis* and *P. virginicus* had similarity of 84% in their diets, *G. barbus* and *M. gracilis* 44%, and *P. virginicus* and *G. barbus* only 5%. The same pattern of similarity was observed in the cluster analysis (Figure 5).

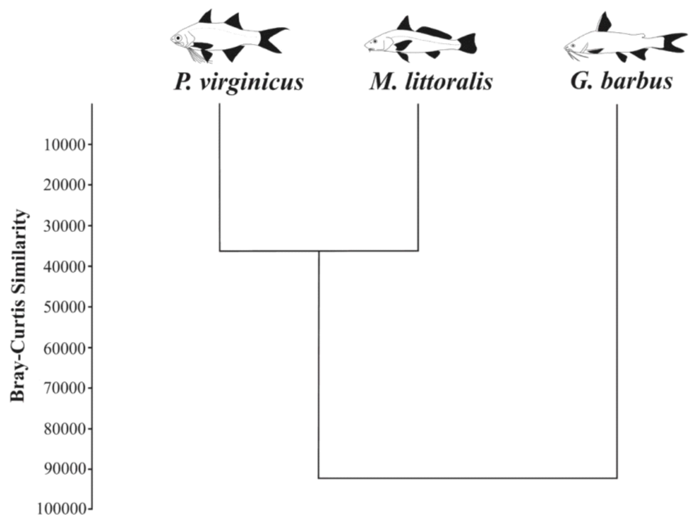

Figure 5. Similarity between the diet of three surf zone fish species of Praia Grande-SP.

The Shapiro-Wilk test showed that the data were not homogeneously distributed, which implied the need to use non-parametric tests, such as Kruskal-Wallis (K-W, for season) and Mann-Whitney (M-W, for daytime). Therefore, those tests did not evidenced significant differences in feeding in relation to circadian variations for *M. gracilis* ($p = 0.409$), *G. barbus* ($p = 0.368$), and *P. virginicus* ($p = 0.291$), and seasonal for *M. gracilis* ($p = 0.475$). However, there were significant differences for *G. barbus* and *P. virginicus* (M-W, p = 8.765-10) and to *P. virginicus* in winter (K-W, $p = 0.0051$). When evaluated only in the present stations no significant differences were verified ($p > 0.05$).

The most ten taxa of seasonal and circadian food abundance were identified and separated for each of the studied species. For *M. gracilis*, ctenoid scales (Teleostei), *D. gemmula*, fragmented Teleostei, Euphausiacea, Brachyuran megalopae, copepod, polychaete, Mellita quinquiesperforata and Diptera larvae were observed in all seasons. It was a remarkable presence of anthropogenic waste in the stomachs, such as nylon yarn, aluminum foil and mainly plastic fragments (bladders, grocery bags) as well as toothbrush bristles. Genidens barbus presented scales (ctenoids and cycloids), insects, fragment of plants, eye lenses of Teleostei, Mellita quinquiesperforata, and Diptera. Of the 194 individuals analyzed, 78 presented these seeds in their stomach contents, both in autumn and winter (seasons with lesser frequency of bathers). For *P. virginicus* the items found were cenoid scales, *D. gemmula*, Decapoda, Euphausiacea, Brachyuran megalopae, copepod, substrate and cycloid scales. Nylon yarn, aluminum foil and mainly fragments of plastic bags were also observed.

It was no correlation between the number of items in the sets of stomach contents and the size of the predator. This means that predators do not change preference for sizes of food items as they grow. For *G. barbus* prey ranged between 1.5 and 2.0 mm with larger ranges reaching 7.2 cm (Figure 6). For *M. gracilis*, prey ranged from 1 to 1.5 mm, with a maximum of 4.0 cm. For *P. virginicus*, in spite of the reduced number of food items measured, it can be observed a range between 1.5 and 2 mm, with an average size of 1.5 mm. The exception was 7.5 mm ctenoid scale, ingested by an individual 16 cm TL.

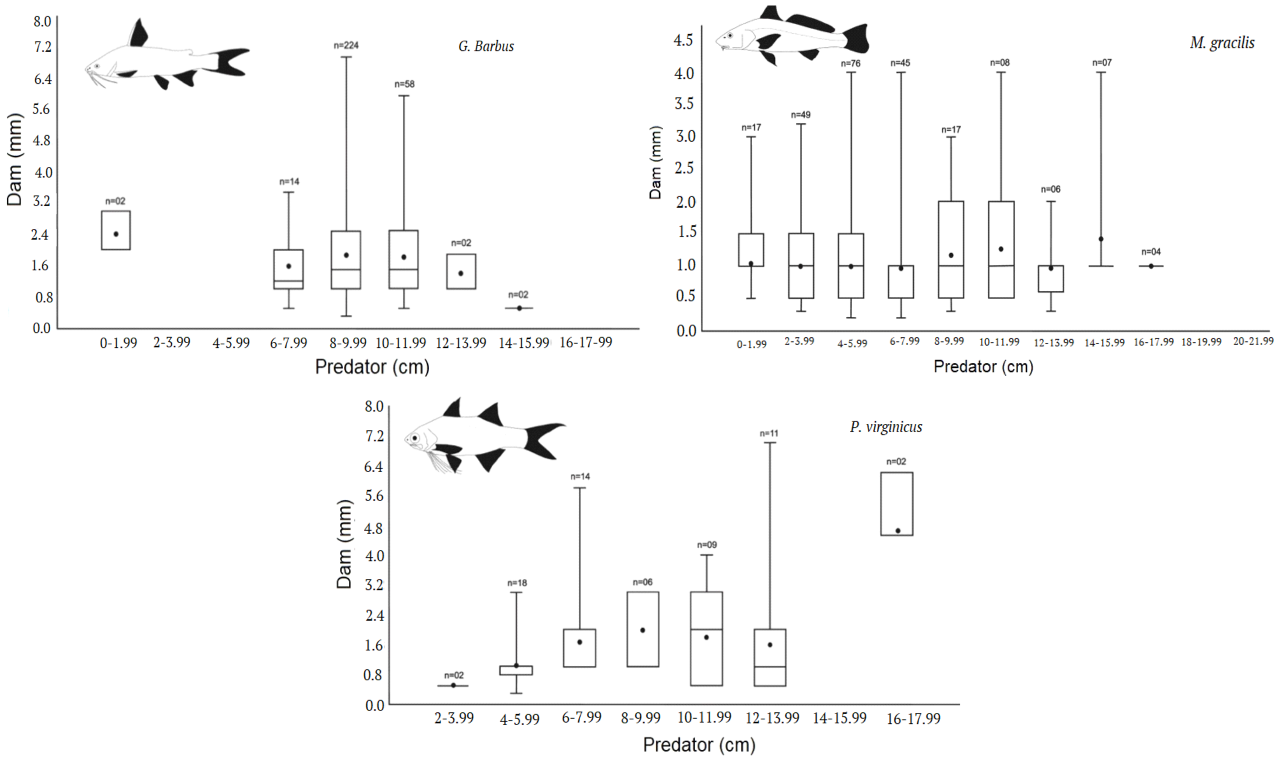

Figure 6. Prey-predator relationships for three fish species from the surf zones of Praia Grande, SP. Range of total length of prey items with maximum, minimum and median length (black dot). Number above the intervals means number of measured preys.

Discussion

The three species have demersal habits, although they present anatomical differences, mainly in relation to mouth size, number of gill ranks, and different sensorial capacities that may have been the reason for the differences found in the proportions of food items in their diets. Two factors are relevant in the selection of fish food items, the availability of prey and the predator's ability to detect and capture prey (Wootton, 1990).

The importance of the surf zone of Praia Grande-SP was evident that although they share the same environment and food resources available, they still showed differences in the proportions of the food items. For *M. gracilis* the preference for the bivalve *D. gemmula*, followed by Decapoda larvae and copepods (< 1 mm), may be associated with the small size and anatomy of the mouth, directed towards the underside for capture of bivalves in the sandy bottom, as well as organisms that are near the bottom or in the midwater like the copepods and Decapoda larvae. The preference for bivalve and polychaete items was also recorded in other studies of sciaenids (Amaral & Migotto, 1980; Chaves & Vendel, 1998; Camargo & Issac, 2004). According to Palmeira, and Monteiro-Neto (2010), the diet of *M. gracilis* was based on amphipods, unidentified crustaceans and mysids where the most abundant item was Emerita spp. In addition to crustaceans, fishes and polychaetes were also important for *M. gracilis* (Castillo, 1986; Lunardon, 1990; Chaves & Umbria, 2003; Rondineli, Braga, Tutui, & Bastos, 2007). According to Amaral and Migotto (1980), polychaetes represented a great importance only for small sized individuals (<12.1 cm), explained by the ease of digestion of this type of prey (Almeida, Fonsêca-Genevois, & Vasconcelos-Filho, 1997).

For *G. barbus* it was also observed the presence of benthic organisms and zooplankton in the diet, with a remarkable and constant presence of ctenoid and cycloid scales, related to the sensitive location by the catfish barbels and the large size of the mouth. The presence of scales is also an indication that in the sandy bottom of the surf zone, scales of several fish of species with cyloid scales (Clupeidae) and ctenoid (Sciaenidae, Haemulidae, Polynemidae, among others) should be detached frequently from the bodies, due to the great dynamics of the waves in this environment. The dynamics of the beach where the sampling took place, an open sea beach, hinders the concentration of scales or fish carcasses in its surfzone. Unlike typically lepidophagous fish species, those that recorded the ingestion of scales in this study took advantage of their availability in the environment. Denadai et al. (2012) emphasized the lepidophagic habit of the catfishes, due to the high amount of scales found in their stomachs. Ingestion of scales is common mainly in freshwater fish (Sazima & Uieda, 1980). Sazima and Machado (1983) emphasizes that the scales of Teleostei do not offer the necessary nutrients to supply all the energetic needs of the fish. The scales present a mucus, when is ingested is an important source of energy for lepidophagous species, being rich in proteins (Wessler & Werner, 1957) and lipids (Lewis, 1970). Mishima, and Tanji (1982) observed in their studies in a southward estuary that adult individuals of *G. barbus* feed basically upon decapods.

Denadai (2012) stated that the diet of adults of *G. barbus* in the Patos Lagoon, southern Brazil, was composed by crustaceans of the families Capellidae, Callianassidae and Callapidae, polychaetes of the family Magellonidae and fish. Araujo (1984) also recorded, for *G. barbus* in Patos Lagoon, polychaetes, Mysodopsis tortonese (Mysidacea) and eggs of Micropogonias furnieri, and even soybean grains from the activities of the Port of Rio Grande (southern Brazil).

Chaves and Vendel (1996) reported that some items in the diet of adult *G. genidens* were not part of the diet at all seasons, such as polychaetes (absent in the fall) and molluscs (winter and spring), with no predominance of polychaetes in any of these seasons. In the present study it was also verified the absence of polychaetes in the spring and summer. The uncommon presence of insects is probably related to the abundance of vegetation and human waste near the sample points. Junior, Viliod, and Knoeller (2018) observed in the juvenile diet of Trachinotus carolinus and *T. goodei* a remarkable preference for insects mainly from the family Formicidae, considered the main prey items in the same studied area. The presence of insects in the stomach contents, particularly Diptera larvae, also observed for Atherinella blackburni (Gonzalez & Junior, 2017) in the same region, emphasizes that the large vegetation field with rainwater streams and constant presence of urban rubbish, are attractive for several species of insects. It is also be noted the high frequency of fruit seeds consumed by these fish, justified by the constant tourists visits throughout the year, being the seeds discarding on the beach, and so, washed by rain and tides. Polydactylus virginicus, which had the lowest prey diversity, despite significant similarity with the diet of *M. gracilis*, have more nocturnal feeding habits. The average prey sizes were around 1.5 mm, with preference for planktonic organisms such as megalopae, euphausiids and copepods.

The zooplankton community of the surf zone of Praia Grande was studied by Moreno (2017), who found a rich and dynamic community with 116 taxa, with predominace of holoplankton, especially in the nocturnal period. The main representatives were copepods, cladocerans, misids and young stages of decapods, bivalves, polychaetes and echinoderms. As a consequence, juvenile fishes find in this environment the abundant and diverse food resources for their development, although wave regime can affect fish feeding due to modification of the sediment structure (Bennett, 1989 apud Niang, Pessanha, & Araujo, 2010). Stomachs with constant presence of food indicated intense feeding activity during day and night periods, once of 194 individuals, only seven presented empty stomachs. The seeds found are from passion fruit (*Passiflora edulis*) probably coming from the tourists who consume it in some type of drink on the beach and discard them at the sand and so washed to the sea. The observed results of the dietary spectrum showed that the three species presented a great diversity of prey, and the importance of the items in the diets may be related to the increase of their availability throughout the year.

In the same location, it was observed that, as exception of *A. blackburni* and Hemiramphus brasiliensis, 35 other Teleostei species are juveniles of species of economic importance at larger sizes (Gonzalez & Junior, 2017), which means that the local is an important area of growth, shelter and feeding for juvenile fish of Carangidae, Mugilidae, Sciaenidae, Engraulidae and Ariidae, among others. The Sciaenidae, here represented by *M. gracilis*, was considered the most important in studies previously carried out in other regions in the southeast (Rocha & Rossi-Wongtschowski, 1998; Araujo, Cruz-Filho, Azevedo, & Santos, 1998) and south Brazil (Muto, Soares, & Rossi-Wongtschowski, 2000; Godefroid, Spach, Schwarz Jr., & Queiroz, 2003). Several studies have classified the juveniles of *M. gracilis* as abundant in surf zones (Vasconcellos, Santos, Silva, & Araujo, 2007; Monteiro-Neto et al., 2008; Favero & Dias, 2015). Mazzoni and Costa (2007) stated that, for most fish species, the larger the size of the predator, the greater the size of the consumed prey. Otherwise, this study did not present a good correlation once it was restrict to juveniles.

The three studied species are caught by the commercial trawl and gill fisheries fleets at larger sizes along the whole Brazilian coast. Therefore, the knowledge of the distinct stages of their life cycles is fundamental for the characterization and management of future fisheries management, including the fisheries that occur in the adjacent sea or the poorly known juveniles, as in the present study.

Conclusion

The present study did not show changes in eating habits between the size classes of organisms. According to Haluch (2009), a change in preferred prey was observed between the smaller (4.2 to 8.1 cm) and larger (28.2 to 32.1 cm) size classes for *M. americanus*. Finally, studies on the biology of juvenile organisms are essential for future proposals for the preservation and knowledge of the Surf Zone.

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