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Diets of *Eucinostomus argenteus* (Baird & Girard, 1855) and *Diapterus rhombeus* (Cuvier, 1829) (Perciformes: Gerreidae) in Caraguatatuba Bay, southeastern Brazil

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Abstract. This study examined the feeding habits of *Eucinostomus argenteus* and *Diapterus rhombeus* in Caraguatatuba Bay, through analysis of stomach contents, collected monthly between May 2003 and October 2004 with trawls in two areas. The fish were measured and the diet was identified and quantified. For *E. argenteus*, the total length ranged from 55 to 115 mm, and for *D. rhombeus* from 75 to 197 mm; all individuals of both species were sexually immature. *E. argenteus* consumed polychaetes and crustaceans. *D. rhombeus* had a more diverse diet, mainly polychaetes, crustaceans, amphipods, and shrimp. The DTL/SL ratio calculated for *E. argenteus* was 0.80 and for *D. rhombeus*, 1.12; therefore, the former species is classified as a carnivore and the latter as an omnivore, but with a relatively high overlap between them. Large amounts of organic material and detritus in the digestive contents of both species were associated with accidental ingestion, due to their benthivorous habit. Trematodes and nematodes found in the intestine of *D. rhombeus* were considered to be parasites.

Key words: fish, feeding habits, silver mojarra, caitipa mojarra, São Paulo

Resumo. Dieta de *Eucinostomus argenteus* (Baird & Girard, 1855) e Diapterus rhombeus (Cuvier, 1829) (Perciformes: Gerreidae) da baia de Caraguatatuba, sudeste do Brasil. Este estudo teve como objetivo avaliar os hábitos alimentares de *Eucinostomus argenteus* e *Diapterus rhombeus* da baía de Caraguatatuba, através da análises de conteúdo estomacal, coletados mensalmente entre maio/03 e outubro/04, com redes de arrasto em duas áreas. Os indivíduos coletados foram medidos e os itens alimentares encontrados foram identificados e quantificados. Todos os indivíduos coletados eram sexualmente imaturos, apresentando um comprimento total variando de 55 a 115 mm e 75 a 197 mm para *E. argenteus* e *D. rhombeus*, respectivamente. A dieta de *E. argenteus* foi composta principalmente de poliquetas e crustáceos. *D. rhombeus* apresentou uma dieta mais diversificada, sendo os principais itens, poliquetas, crustáceos, anfípodes e camarões. A razão CTD/CP para *E. argenteus* foi de 0,80 e para *D. rhombeus* 1,12, sendo classificadas como carnívora e onívora, respectivamente, apresentaram uma alta sobreposição de itens alimentares. Altas concentrações de detritos foram encontrados no trato digestório das duas espécies, sendo associado a ingestão acidental devido aos seus hábitos bentívoros. Trematódeos e nemátodas foram encontrados nos intestinos de *D. rhombeus*, sendo considerados como parasitas da espécie.

Palavras chave: peixe, hábitos alimentares, carapeba, carapicu, São Paulo

Introduction

The family Gerreidae comprises small- to medium-sized, strongly compressed fish characterized by a pointed snout with highly protrusible mouth (Nelson, 2006). They occur in coastal waters of all warm seas, and some species enter brackish or fresh water. They are found predominantly over sand and mud bottoms, in seagrass beds, in fringing mangrove forests, along ocean beaches, and adjacent to reef formations where they feed on benthic invertebrates and plants (Cervigón *et al*. 1993, Carpenter 2002). The silver mojarra *Eucinostomus argenteus* and the caitipa mojarra *Diapterus rhombeus* belong to this family and are very common along the Brazilian coast (Menezes & Figueiredo 1980, Carpenter 2002, Menezes et al. 2003, Nelson 2006).

Eucinostomus argenteus reaches a maximum length of 200 mm. This species is distributed in the eastern Pacific Ocean from the United States (Anaheim Bay, California) to Peru, including the Galápagos Islands, and in the western Atlantic from the United States (New Jersey) to southern Brazil (Carpenter 2002). It is commonly found over sand or shell bottoms, occasionally in ocean inlets to estuaries; and its juveniles occur in lagoons and mangroves (Eschmeyer et al. 1983). It is omnivorous (Bussing 1995). *E. argenteus* has a modest commercial value, as it is processed for fish food or live bait in sport fishing (Randall & Vergara 1978, Carpenter 2002).

Diapterus rhombeus has a maximum length of 400 mm, although 300 mm is more common. The caitipa mojarra occurs in the western Atlantic Ocean from the United States (Florida) to southern Brazil. Abundant in mangrove-fringed lagoons, it is also found over shallow mud and sand bottoms in marine areas (Carpenter 2002). Juveniles occupy hypersaline lagoons as well as brackish waters (Cervigón et al. 1992). Its diet comprises plant material and invertebrates, especially polychaetes (Chaves & Otto 1998). This species, which is mostly marketed fresh, has little economic importance (Carpenter 2002).

The present study adds to the existing information on the biology of these species, and also provides a basis for the management of Caraguatatuba Bay, a region highly vulnerable to human impacts, where the ichthyofauna is little studied. Several industrial facilities are being constructed in the bay, including subterranean and marine gas pipelines and a gas treatment facility. In addition, the region is impacted by the São Sebastião port and oil terminal, which are soon to be expanded. Finally, state decree no. 49.215, of December 7, 2004, regarding the Economic Ecological Zone (ZEE) of São Paulo's northern coast, forbids trawling in embayments such as Caraguatatuba Bay. Since the collections made during this study ended in October 2004, the data presented here will serve in the future as a basis for evaluation of the ZEE. This study examined the feeding habits of *Eucinostomus argenteus* and *Diapterus rhombeus* in Caraguatatuba Bay, through analysis of stomach contents.

Material and methods

Study area

Caraguatatuba Bay (23°37'S to 23°44'S and 45°24'W to 45°26'W) has a total shoreline of about 16 km, composed of several sandy beaches (Enseada, Flecheiras, Porto Novo, Romance, Palmeiras, Pan-Brasil, Indaiá, Centro and Camaroeiros). Two areas, each measuring 2 x 2 km, homogeneous but differing from each other, were selected for this study (Figure 1). The first, South area extends from Porto Novo to Palmeiras beaches and has a gentler slope, is more exposed to wave activity, and is influenced by the Juqueriquerê River, which has a small estuary. The North area, from Indaiá to Centro beaches, has a steeper slope, is relatively sheltered from wave energy, and is slightly influenced by the smaller Lagoa and Santo Antônio rivers.

Sampling method

Samples were taken monthly between May 2003 and October 2004, at three randomly selected stations in each area. Fish were caught with two otter trawls with 2.0 cm mesh, mouth opening 1.6 m high and 6.0 m wide, and bag depth of 3.5 m. At each station, a trawl 800 m long was made, from 800 to 1600 m perpendicularly outward from the mean low water mark. This stretch was equivalent to depths of 1 to 4 m. The trawling speed was 1 knot.

Specimens were immediately preserved in 10% formalin, transported to the laboratory for identification, and then transferred to 70% ethanol to preserve the gut contents. The fish were measured (total length TL and standard length - SL) and the guts were removed. The gonads were analyzed macroscopically, following the classification of Vazzoler (1996). The digestive-tube length (distance from the beginning of the esophagus to the end of the rectum; DTL) was measured to obtain the DTL/SL (digestive-tube length/standard length) ratio and to examine a possible relationship to the feeding habits of the species (Knöppel 1970, Uieda 1995). The digestive tubes were then preserved in 70% ethanol until analysis of the gut contents.

Due to differences in the degree of preservation of food items in the gut, two parts of the digestive tubes were considered separately with respect to the items ingested: the first part comprised the pharynx, esophagus, and stomach, and the second part comprised the intestine and rectum. Items consumed were identified to the lowest possible taxonomic category. The volume of each item was measured according to Bemvenute (1990), in which each food item is compressed between two plastic slides (30x30x1 mm) and the area (mm^3) measured using graph paper.

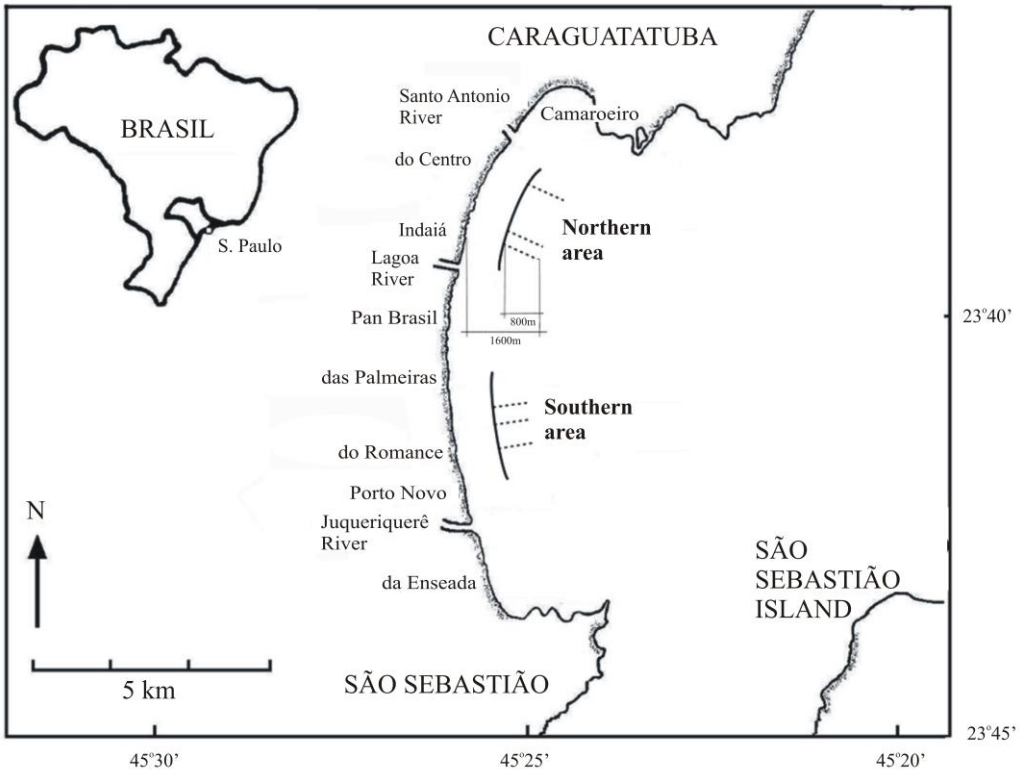

Figure 1. Caraguatatuba Bay. The study areas (South and North) are represented by the gray squares.

Data analysis

The diets of *E. argenteus* and *D. rhombeus* were analyzed for the stomach and intestine portions by the frequency of occurrence (FO%), percent composition (C%), percent volume (V%), and alimentary importance index (AIi). The FO% is the frequency of digestive tubes containing a given food item in relation to the total number of digestive tubes containing any food item; C% and V% are, respectively, the number and volume of a given food item in relation to the total food items in the diet. The index of alimentary importance (AIi) was calculated by the method of Kawakami & Vazzoler (1980), based on the frequency of occurrence (FO_i%) and the percent volume (V_i%) of each item. The similarity index (Krebs, 1989) was calculated to evaluate possible dietary overlap between *E. argenteus* and *D. rhombeus*.

A bi-dimensional scatter plot between frequency of occurrence and prey-specific abundance (P_i) was constructed in order to analyze the feeding ecology for the two species, according to the diagram of Amundsen *et al*. (1996). The prey-specific abundance (P_i) was obtained from the formula (Amundsen *et al*. 1996):

$$P_i = (\Sigma S_i / \Sigma S_{ti}) \times 100$$

where, *Si* is the stomach content (in this case, volume) comprised of prey *i*, and S_{ti}, the total stomach content in only those fish that consumed prey *i*.

No differences in diet were found between the two areas of the bay, and therefore these areas were not compared further.

Results

Between May 2003 and October 2004, only 54 individuals of *E. argenteus* were collected in the bay; 24 in June/2003, 11 in July/2003 and 19 in

May/2004. Their size range (total length) was 5.5 to 11.5 cm, with mean value ± standard error of 8.76 ± 1.39 cm; all the individuals (54) contained immature gonads and therefore could not be sexed. In the same period only 42 individuals of *D. rhombeus* were collected: 4 in June/2003, 33 in July/2003, 3 in August/2003, 1 in May/2004, and 1 in October/2004. Total lengths ranged from 7.5 to 11.5 cm, with mean ± standard error of 9.32 ± 1.85 cm; all the individuals had immature gonads, and again their sex could not be determined.

Eucinostomus argenteus consumed six food items (Table I): polychaetes, unidentified crustaceans, amphipods (identified by the presence of tubes), copepods, shrimp, and fish (identified by the presence of scales). The dominant item was polychaetes, with unidentified crustaceans second in importance. *Diapterus rhombeus* consumed seven food items (Table I): hydrozoans, polychaetes, gastropod eggs, unidentified crustaceans, amphipods (identified by tubes), shrimp, and fish (by the presence of scales). Large amounts of unidentified organic matter were present in the digestive tubes of both species (FO% = 81.8 and V% = 89.1 in the stomach and FO% = 81.6 and V% = 78.4 in the intestine of *E. argenteus*; FO% = 69.2 and V% = 89.6 in the stomach and FO% = 86.6 and V% = 75.3 in the intestine of *D. argenteus*). These results were not included in the analysis, as we considered this organic matter to be a result of advanced digestion, which would bias the estimates of the diet.

Applying the diagram of Amundsen *et al.* (1996) indicated a generalist diet for *D. rhombeus*, which eats a wide variety of rare items, of which polychaetes were the most frequent and voluminous item in both the stomach and intestine (Fig. 2). This population seems to have a wide (high WPC - within-phenotype component) niche. For *E. argenteus*, however, the stomach contents evidenced a specialized diet and a narrow niche (high BPC - between-phenotype component), while the intestine contents indicated a more generalist diet equivalent to that of *D. rhombeus*. The high prey-specific abundance observed for all items in the stomach of *E. argenteus* may be a consequence of the small number of stomachs that contained food items (13 of 54), which may have resulted in overestimating the importance of the items, since in some cases only one was found. For both species, more intestines than stomachs had contents (29 and 13, respectively for intestine and stomach for *E. argenteus*, of a total of 54 digestive tubes; and 15 and 8 for *D. rhombeus*, of a total of 40). These data may indicate a nocturnal feeding period for these fishes, explaining the relatively full intestinal portion at the time of sampling (during the day). Therefore, the intestine may better describe the feeding habits of *E. argenteus*; i.e., it is a generalist, feeding on rare items and with a wide niche.

Parasitic trematodes and nematodes were found in the intestine of *D. rhombeus*. Trematodes were present in three intestines, with six individuals found in one fish and five in each of the other two. Nematodes occurred in only one intestine, which contained four individuals. The DTL/SL ratio calculated for *E. argenteus* was 0.80 (carnivore) and for *D. rhombeus* was 1.12 (omnivore).

Because the items were examined separately for the stomachs and intestines, the frequency of occurrence of the food items in the different portions could be compared (Table I). In *E. argenteus*, all the items found in the stomach were slightly more frequent in the intestine, including polychaetes, amphipod tubes, crustaceans, and fish scales. Interestingly, two items, copepods and shrimps, were only found, with low frequency, in the intestine. In *D. rhombeus* the food items also showed, generally, slightly higher frequencies of occurrence in the intestine than in the stomach. Unidentified crustaceans and shrimp were more frequent in the stomach than in the intestine, with the opposite for amphipod tubes, polychaetes, hydrozoans, and fish scales. Gastropod eggs were found exclusively in the intestine, as were the parasitic trematodes and nematodes.

With respect to volume, *E. argenteus* contained proportionally fewer polychaetes and more unidentified crustaceans in the stomach than in the intestine (Table I). For *D. rhombeus* the proportions were lower for polychaetes and higher for unidentified crustaceans in the stomach than in the intestine, with shrimp only volumetrically important in the stomach.

Figure 3 illustrates the high importance of polychaetes in the diet of *E. argenteus*, especially in the intestinal content. The secondary item, unidentified crustaceans, was more important in terms of volume in the stomach and in frequency of occurrence in the intestine. For *D. rhombeus*, polychaetes were also the most important item, with a frequency identical to that of crustaceans in the stomach, though with a slightly larger volume (Figure 3). In the intestine, polychaetes were the most voluminous, although it had a similar frequency to the other items. Amphipod tubes were slightly more frequent in the stomach, and shrimp were only recorded in the stomach. Figure 2 illustrates a more specialized habit for *E. argenteus* than for *D. rhombeus*, corroborating the existence of an omnivorous habit, although only animal items

were recorded in this study for *D. rhombeus*. Despite these differences, the similarity index calculated for the diets of *E. argenteus* and *D. rhombeus* was relatively high (S = 0.75).

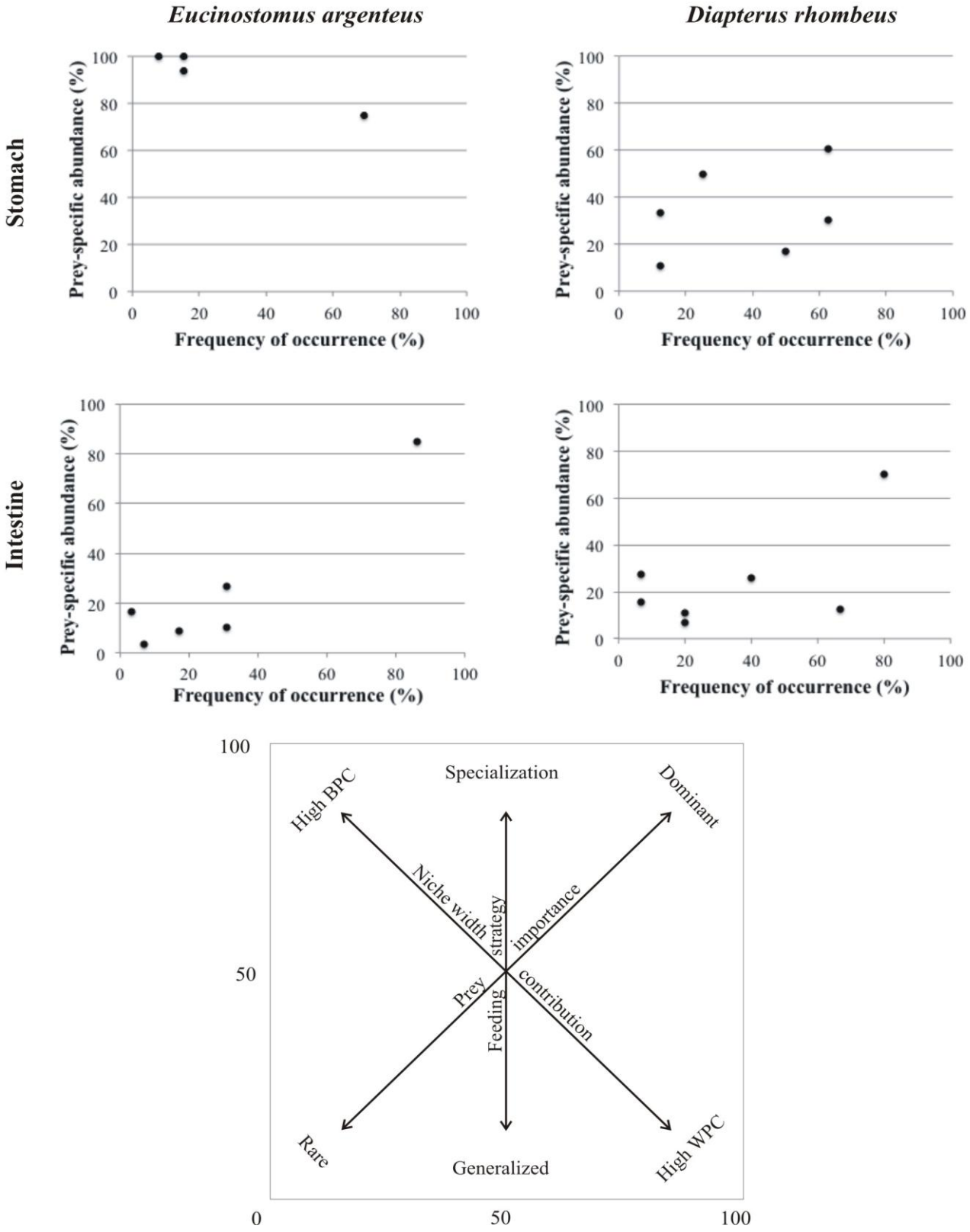

Figure 2. *Eucinostomus argenteus* and *Diapterus rhombeus*. Relationship between the frequency of occurrence and prey-specific abundance in both stomach and intestine with a comparison with Amundsen *et al*. (1996) diagram.

Table I. *Eucinostomus argenteus* and *Diapterus rhombeus.* Frequency of occurrence (FO%), percent volume (V%) and alimentary importance indices (AI_i). Total number of individuals (N=54 and N=40), individuals with empty digestive tube (Ne=3 and Ne=23), mean total length (TL = 8.76cm and 9.32cm), mean standard length (SL= 6.73cm and 6.45cm), digestive tube length and standard length ratio (DTL/SL= 0.8 and 1.12).

Eucinostomus argenteus						
	Stomach			**Intestine**		
Item	**F(%)**	**V(%)**	**AI_i(%)**	**F(%)**	**V(%)**	**AI_i(%)**
Polychaeta	69.23	67.57	90.64	86.21	78.53	91.86
Crustacea	15.38	28.34	8.45	31.03	13.89	5.85
Amphipod tubes	15.38	2.04	0.61	31.03	3.75	1.58
Copepoda	0.00	0.00	0.00	3.45	0.78	0.04
Shrimp	0.00	0.00	0.00	6.90	0.28	0.03
Fish	7.69	2.04	0.30	17.24	2.78	0.65
Diapterus rhombeus						
	Stomach			**Intestine**		
Item	**F(%)**	**V(%)**	**AI_i(%)**	**F(%)**	**V(%)**	**AI_i(%)**
Hidrozoa	12.50	2.71	0.66	20.00	1.75	0.52
Trematoda	0.00	0.00	0.00	20.00	2.29	0.68
Nematoda	0.00	0.00	0.00	6.67	0.62	0.06
Polychaeta	62.50	43.40	53.12	80.00	67.03	79.06
Gastropod eggs	0.00	0.00	0.00	6.67	1.04	0.10
Crustacea	62.50	20.25	24.79	40.00	11.87	7.00
Amphipod tubes	50.00	11.03	10.80	66.67	11.87	11.66
Shrimp	25.00	20.80	10.18	6.67	0.62	0.06
Fish scale	12.50	1.81	0.44	20.00	2.91	0.86

Discussion

Fishes of the family Gerreidae, such as E. argenteus and D. rhombeus, are usually abundant where they occur (Andreata 1987, Menezes & Figueiredo 1980, Santos & Araújo 1997, Chaves & Otto 1998 and 1999). For this reason, they have been the object of numerous studies focusing on diverse aspects of their biology (Höfling et al. 1998, Chaves & Otto 1998 and 1999, Silva 2001, Godefroid et al. 2001, Pessanha 2006). In Caraguatatuba Bay, though, these two species are present in low abundance and are restricted to certain periods of the year, mainly winter. Santos et al. (1997) summarized the relatively high abundances of Gerreidae on the coast of Rio de Janeiro State, and these fish are replaced in southern Brazil by members of Sciaenidae and Ariidae, indicating that tropical and subtropical areas are suitable for gerreids. This may explain the low abundance of gerreids in Caraguatatuba Bay, since the São Paulo coast is a transitional environment between central and southern Brazil. However, Furia (1996) found that D. rhombeus and E. argenteus are among the four most numerous species in Enseada das Palmas (Ubatuba) and among the six heaviest species. Because the Enseada das Palmas is located very close to Caraguatatuba Bay (only 0.10° to the north), the possibility of latitudinal influence on the distributions can be excluded.

The size (total length) of the individuals obtained in Caraguatatuba Bay, between 5.5 and 11.5 cm for E. argenteus and 7.5 and 19.7 cm for D. rhombeus, indicated that they were juveniles, according to Aguirre-León & Yanez-Arancíbia (1986), who considered that gerreids smaller than 12.0 cm are immature. Gonad analysis of the specimens indicated that none were sexually mature.

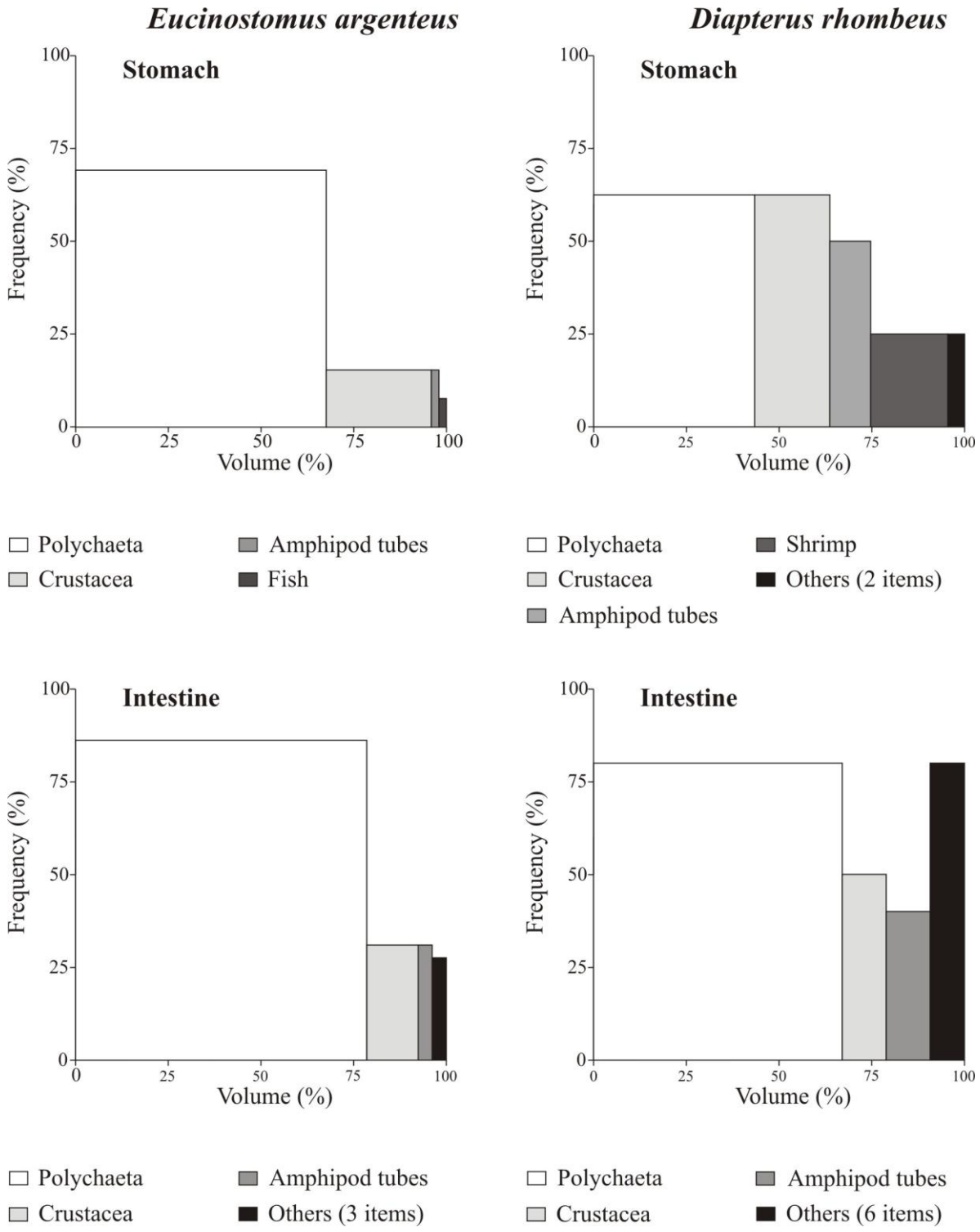

Figure 3. *Eucinostomus argenteus* and *Diapterus rhombeus.* Relationship between the frequency of occurrence and the percent volume of the items with higher feeding importance in both stomach and intestine.

The occurrence of these two species in low densities, at limited times of the year and with small sizes, corroborate the data provided by Silva (1994), who classified *D. rhombeus* as a cyclic visiting species in Combota Channel (estuarine lagoon system of Itaipú-Piratininga, Rio de Janeiro), where

large numbers of juveniles (lengths less than 6.0 cm) were collected, indicating that they probably use estuarine areas for shelter and growth. Santos *et al*. (1997) attributed the relatively high abundance of *D. rhombeus*, both off the beach and in trawls, to the fact that this species completes its life cycle in Sepetiba Bay, an estuarine area on the Rio de Janeiro coast; here, these fish initially develop in nearshore areas and shift to the middle of the bay when they reach about 7.0 cm. Similarly, Chaves & Otto (1998), studying *D. rhombeus* in Guaratuba Bay (Paraná), observed no seasonal variations in abundance, but did find variations in size, and concluded that *D. rhombeus* may spawn in the spring in the ocean and use the bay areas and estuarine-lagoon environments as temporary residence. On the other hand, Chaves & Robert (2001) concluded, based on data for spatio-temporal distribution, reproduction and diet, that *Gerreis (=Eucinostomus) melanopterus* does not spawn in the inner estuary and only returns to the estuary as adults, distributing according to salinity. Teixeira & Helmer (1997) also stated that the salinity as well as the temperature determine the distribution of gerreids. In a study of seven species of Gerreidae in the estuarine complex of Mundaú-Manguaba (Maceió, Alagoas), where *E. melanopterus* and *D. rhombeus* comprised 98% of the individuals of this group, Teixeira & Helmer (1997) observed that the salinity and temperature account for habitat sharing between juveniles of the two species. Similarly, Austin & Austin (1971) found that a population of *D. rhombeus* in Puerto Rico is associated with high salinities (> 30), and only enters brackish waters as juveniles.

The DTL/SL ratio suggests that E. argenteus was classified as a carnivore and D. rhombeus as an omnivore (Knöppel 1970). The feeding habit observed here, with the predominant consumption of polychaetes by the former species and of polychaetes and crustaceans by the latter one, has been found in some, but not all studies. For *E. argenteus*, Springer & Woodburn (1960), in Tampa Bay, Florida, reported a diet based on polychaetes, copepods, and small molluscs. Also in Florida, Odum & Heald (1972) found amphipods and larvae of small crustaceans in the stomach contents of juvenile individuals (< 20 mm), and molluscs and plants were secondary items. Kerschner *et al*. (1985) analyzed fish measuring 10 to 104 mm (SL) in Florida, and observed that the prey items varied little between morning and night, the diet consisting mainly of polychaetes, bivalves, and crustaceans. Soares *et al*. (1993) observed that, for individuals between 74-185 mm from Ubatuba (São Paulo), the main food item was polychaetes and secondarily gammarids and ophiuroids. Gasalla (1995) recorded copepods as the main food in Saco do Mamanguá (Parati, Rio de Janeiro). Höfling *et al*. (1998), in the estuarine-lagoon complex of Cananéia, found that smaller fish (50-100 mm) fed on benthic crustaceans, polychaetes, molluscs, and filamentous algae, while the larger fish (100-150 mm) fed mainly on polychaetes, benthic crustaceans, and molluscs. Pessanha (2006) observed in Sepetiba Bay, that juvenile *E. argenteus* preyed mainly on appendicularians, calanoids, tanaids and polychaetes, while subadults and adults preyed on polychaetes, harpacticoids, and *Caprella* (Table II).

For other species of *Eucinostomus*, Odum & Heald (1972), in Florida, observed, in the stomach contents of *E. gula*, amphipods, copepods, small molluscs, mysids and plant remains in the dry season; and insect larvae and amphipods during the rainy season, with polychaetes infrequent. Also in Florida, Carr & Adams (1973) found that for *E. gula*, as the fish increased in size, copepods were replaced by polychaetes in a transition from planktivory to carnivory. Huerta-Craig (1986) recorded the preferential food items (copepods and polychaetes), secondary (amphipods and plant fragments) and accidentals (ostracods, isopods, and crustacean fragments) for *E. melanopterus* as well as the preferential food items (polychaetes, amphipods, and plant fragments), secondary (copepods) and accidental (molluscs and insects) for *E. gula* in São Vicente estuary (São Paulo). Cunningham & Maciel (1995), studying *E. melanopterus* in Conceição Lagoon (Santa Catarina State), found that this species behaves as a secondary consumer, with a wide-spectrum diet (16 items) based mainly on copepods, ostracods, and polychaetes. Motta *et al.* (1995) recorded polychaetes, bivalves, and cumaceans as main items in the diet of *E. gula* in Tampa Bay.

For *D. rhombeus*, Austin & Austin (1971) found copepods, ostracods, plant material, and polychaetes in the stomach contents in a population in Puerto Rico. According to Menezes & Figueiredo (1980), *D. rhombeus* feeds mainly on algae and small invertebrates. Huerta-Craig (1986), for juveniles of *Diapterus rhombeus* (121 to 201 mm) in the São Vicente estuary, based on the frequency of occurrence, distinguished three groups of items: preferential (algae, polychaetes, amphipods, and copepods), secondary (molluscs, isopods, oligochaetes, and mysids) and accidental (tanaids, ostracods and reptant decapods). Gasalla (1995) observed a diet constituted mainly of copepods in Parati. Santos & Araújo (1997) observed, in Sepetiba Bay, that the food items found in highest proportions

in the diet of *D. rhombeus* were fragments of plants and animals, and microcrustaceans (calanoid copepods, ostracods, cyclopoid copepods and amphipods), with some non-significant ontogenetic

Table II. Main items of diet *Eucinostomus argenteus* and *Diapterus rhombeus* found by different authors.

Authors (year)	Local	Specie	Main items
Springer & Woodburn (1960)	Tampa Bay (USA)	*E. argenteus*	Polychaetes, copepods and small molluscs
Odum & Heald (1972)	Florida (USA)	*E. argenteus*	Amphipods and larvae of small crustaceans
Kerschner *et al.* (1985)	Florida (USA)	*E. argenteus*	Polychaetes, bivalves and crustaceans
Soares *et al.* (1993)	Ubatuba (BR)	*E. argenteus*	Polychaete
Gasalla (1995)	Parati (BR)	*E. argenteus*	Copepods
Höfling *et al.* (1998)	Cananéia (BR)	*E. argenteus*	<100 mm: Crustaceans, polychaetes, molluscs and filamentary algae
			>100 mm: Polychaetes, benthonic crustaceans and molluscs
Pessanha (2006)	Sepetiba Bay (BR)	*E. argenteus*	Juveniles: Apendicularia, Calanoida, Tanaidacea and Polychaeta
			Adults: Polychaeta, Herpacticoida and Caprella
Present study (2012)	Caraguatatuba Bay (BR)	*E. argenteus*	Polychaetes
Austin & Austin (1971)	Puerto Rico (PR)	*D. rhombeus*	Copepods, ostracods, vegetal material and polychaetes.
Menezes & Figueiredo (1980)		*D. rhombeus*	Algae and small invertebrates.
Huerta-Craig (1986)	São Vicente (BR)	*D. rhombeus*	Algae, polychaetes, amphipods and copepods
Gasalla (1995)	Parati (BR)	*D. rhombeus*	Copepods
Santos & Araújo (1997)	Sepetiba Bay (BR)	*D. rhombeus*	Fragments of vegetables and animals and microcrustaceans
Teixeira & Helmer (1997)	Mundaú (BR)	*D. rhombeus*	Polychaetes, crustaceans, molluscs and plants
Chaves & Otto (1998)	Guaratuba Bay (BR)	*D. rhombeus*	Polychaetes
Höfling *et al.* (1998)	Cananéia (BR)	*D. rhombeus*	<100 mm: Vegetable material and crustaceans
			>100 mm: Fishes, crustaceans and algae
Pessanha (2006)	Sepetiba Bay (BR)	*D. rhombeus*	Juveniles: Tanaidacea, Apendicularia, Cyclopoida and Calanoida
			Adults: Herpacticoida
Present study (2012)	Caraguatatuba Bay (BR)	*D. rhombeus*	Polychaetes and crustaceans

differences in the diet: microcrustaceans were more abundant in the diet of small fish (TL<120 mm), while ostracod eggs and insect fragments were more common in large fish (TL>120 mm). Teixeira & Helmer (1997), in the estuarine-lagoon complex of Mundaú-Manguaba, found that *D. rhombeus* based its diet, in order of importance, on polychaetes, crustaceans, molluscs and plants. Chaves & Otto (1998), in Guaratuba Bay, found an absolute dominance of polychaetes in its diet (50.4% of the preponderance index) and Höfling *et al.* (1998) found that small individuals of *D. rhombeus* (50-100 mm) in the estuarine-lagoon complex of Cananéia fed mainly on plant material and crustaceans, while the larger ones (100-150 mm) fed on fish, crustaceans and algae. Finally, Pessanha (2006) observed, in Sepetiba Bay, that juveniles of *D. rhombeus* consumed mainly tanaids, appendicularians, cyclopoids, and calanoids, while sub-adults and adults consumed harpacticoids (Table II).

Based on this review of the observed differences in the diets of *E. argenteus* and *D. rhombeus* and other species of the same genus, one can conclude that these species are opportunistic feeders, consuming the items available in the environment, rather than specializing in a preferential item. This observation is corroborated by application of the diagram of Amundsen *et al*. (1996) to the intestine portion of the gut contents (see results section). The values obtained for the DTL/SL for *E. argenteus* (0.80) and for *D. rhombeus* (1.12) also corroborate the above information, in which the former species is essentially a carnivore, while the latter uses proportionally more plant resources, i.e., is omnivorous; although in Caraguatatuba Bay, *D. rhombeus* fed essentially on animal resources.

The digestive tubes of *E. argenteus* and *D. rhombeus* in Caraguatatuba Bay contained large amounts of unidentified organic matter and sediment. According to Chaves & Otto (1998), this may be associated with the benthic habit of these species. Menezes & Figueiredo (1980), in their book on marine fishes of southeast Brazil, noted that a large part of the stomach content of gerreids is composed of mud. Huerta-Craig (1986) reported the presence of digested or shapeless matter and sand grains in the stomachs of *D. rhombeus*, and Chaves & Otto (1998) found large amounts of unidentified white flesh (probably fish), organic matter, and sand in the stomachs of this species. We did not include these components in the feeding analyses, because of the advanced degree of digestion of the food items. We found similar proportions of this material in both the stomach and intestine portions, which indicated that digestion was advanced in the stomach portion at the time of sampling. Thus, in contrast to the findings of Silva (2001) and Pessanha (2006), who observed diurnal feeding activity for *D. rhombeus* and *E. argenteus*, the higher proportion of intestine portions with food contents in relation to stomachs, indicates that these species feed at night and, because the samples in Caraguatatuba Bay were taken in the daytime, the food was in an advanced state of digestion.

The undigested trematode and nematode worms found in the intestinal portion of some individuals of *D. rhombeus* were considered parasites. Huerta-Craig (1986) found 74 parasitic nematodes in six individuals of *D. rhombeus*.

The diets of *E. argenteus* and *D. rhombeus* in Caraguatatuba Bay seemed to overlap extensively (S = 0.75), which does not appear to be limiting for the species, because of their low abundance in the study area. Other studies have compared the trophic relationships and the use of resources by *E. argenteus* and *D. rhombeus*. Silva (2001) observed that *D. rhombeus* and *E. argenteus* show wide trophic spectra in the lagoon system of Itaipú-Paratininga, with temporal and spatial niche overlap, and differences in the microhabitat of the prey species. *E. argenteus* fed mainly on the benthic macrofauna (Tanaidacea) and *D. rhombeus* on the meiobenthos (Harpacticoida and free-living nematodes), as well as on macrofauna and zooplankton. Silva (2001) also observed that the rates of daily consumption of *E. argenteus* were twice those of *D. rhombeus*. This difference may be related to the feeding behavior of the two predators and to the degree of mobility of the prey. Pessanha (2006) found no evidence of seasonal changes in the diets of *E. argenteus* and *D. rhombeus* in Sepetiba Bay, although they noted that differences in the abundance of these species in different seasons may indicate a pattern of resource partitioning. The migration to deeper areas during growth and the differences in proportion of the food items found in the stomach seem to be a strategy used by the three species studied by Pessanha (2006) (*E. argenteus, D. rhombeus* and *M. furnieri*) to avoid competition. Although Pessanha did not observe overlap in diets between *E. argenteus* and *D. rhombeus*, there was higher intraspecific overlap in the smaller size classes, due to the fish's morphological limitations in exploiting other prey items.

Among other species of Gerreidae, the study by Teixeira & Helmer (1997) in the estuary-lagoon system of Mundaú-Manguaba did not show an overlap in food items between *Eucinostomus melanopterus* and *D. rhombeus*. Kerschner *et al.*

(1985) analyzed the diet of four gerreids (*Eucinostomus argenteus*, *E. gula*, *E. jonesi* and *E. lefroyi*) and observed that changes in diet composition seemed to be influenced by the habitat structure. They also observed that the intraspecific variation in the diet reflected an apparent ontogenetic feeding progression. The general pattern seen for the four species was a transition from copepods and other crustaceans, to small fish, to a high percentage of polychaetes and larger fish.

The results presented above demonstrate that these two species can be considered predatory carnivores, where *E. argenteus*, showed a preference for consuming polychaetes and crustaceans, and *D. rhombeus* showed a more generalist diet, with a preference for polychaetes, crustaceans, amphipods, and shrimp.

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