FEEDING BIOLOGY OF A GUILD OF BENTHIVOROUS FISHES IN A SANDY SHORE ON SOUTH-EASTERN BRAZILIAN COAST

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ABSTRACT

The feeding biology of eight species of benthivorous fishes was studied in a sandy shore at Anchieta Island, south-eastern Brazilian coast. The fishes fed mainly on Amphipoda and Mysidacea crustaceans. The diet of the most abundant species, the drum *Umbrina coroides*, was analyzed in three standard length classes (20-55, 56-90 and 91-135 mm). This sciaenid showed an ontogenetic diet shift from Mysidacea to Amphipoda. The feeding behaviour of the sciaenid *U. coroides* and the gerreid *Eucinostomus gula* was recorded while snorkeling. During their foraging both species uncovered small organisms buried in the sand. Notwithstanding general similarities in diet, *U. coroides* and *E. gula* presented differences in feeding behaviour and morphology. Two carangid species of the genus *Trachinotus* differed in diet composition and consumed a larger array of food items than the remaining fish species. Differences in diet and feeding activity between the remaining benthivorous species were noted. These differences possibly reduce overlap in resource use and favour the coexistence of guilds of benthivorous fishes on sandy shores.

Key words: marine fishes, ontogenetic diet shift, *Umbrina coroides, Eucinostomus gula*.

RESUMO

Hábitos alimentares de uma guilda de peixes bentívoros em uma praia arenosa na costa Sudeste do Brasil

Os hábitos alimentares de oito espécies de peixes bentívoros foram estudados em uma praia arenosa na Ilha Anchieta, costa Sudeste do Brasil. Os peixes consumiram principalmente crustáceos das ordens Amphipoda e Mysidacea. A dieta da espécie mais abundante, o sciaenídeo *Umbrina coroides*, foi analisada em três classes de comprimento-padrão (20-55, 56-90 e 91-135 mm). Este sciaenídeo apresentou uma variação ontogenética na dieta, a qual variou de Mysidacea para Amphipoda. O comportamento alimentar do sciaenídeo *U. coroides* e do gerrídeo *Eucinostomus gula* foi estudado com uso de mergulho livre. Ao forragear, ambas as espécies desenterraram pequenos organismos enterrados na areia. Apesar das semelhanças gerais na dieta, *U. coroides* e *E. gula* apresentaram diferenças quanto ao comportamento alimentar e morfologia. Duas espécies de carangídeos do gênero *Trachinotus* diferiram quanto à composição da dieta e consumiram variedade maior de itens alimentares que as outras espécies de peixes estudadas. Diferenças de dieta e atividade alimentar entre as outras espécies bentívoras foram registradas. Estas diferenças possivelmente reduzem a sobreposição na utilização dos recursos alimentares, favorecendo a coexistência de guildas de peixes bentívoros em praias arenosas.

Palavras-chave: peixes marinhos, variação ontogenética na dieta, *Umbrina coroides, Eucinostomus gula*.

INTRODUCTION

Morphological and behavioral traits related to prey capture and predator avoidance regulate predator-prey interactions, thus influencing the structure of fish communities (Lowe-McConnell, 1977, 1987). Many fish species, especially when juveniles, inhabit sandy coastal areas, where they gather food and shelter from large predators (Lowe-McConnell, 1977). Benthivorous fishes present the greatest diversity of feeding modes among fishes (Gerking, 1994), external morphology related to foraging behaviour and predator avoidance, and exploit efficiently soft substrates such as sandy shores (Hobson & Chess 1986; McCormick, 1995; Platell *et al.*, 1998). These fishes usually have sensorial appendices and inferior protractile mouths (Chao & Musick, 1977; Gerking, 1994), and prey on benthic invertebrates near or on the bottom, burying the mouth into the substrate and swallowing part of the sediment (Hobson & Chess, 1986; Sazima, 1986; Soares *et al.*, 1993; Edgar & Shaw, 1995). Differences in behaviour, habitat and time of feeding, as well as kind and size of prey, may reduce dietary overlap among benthivorous fishes (Hobson & Chess, 1986; McCormick, 1995; Platell *et al.*, 1998). In spite of the value of underwater observations for an insight on fish behaviour (Longhurst, 1981; Sazima, 1986), very few underwater studies deal with marine sandy shores fishes (e.g., Hobson & Chess, 1986). In this paper we present data on feeding biology of a guild of eight species of benthivorous fishes in a Brazilian sandy shore. Also, the feeding behaviour of two of the most abundant species, the sciaenid *Umbrina coroides* (Cuvier, 1830) and the gerreid *Eucinostomus gula* (Cuvier, 1830), is described.

MATERIAL AND METHODS

Study site

Field work was carried out at the Palmas sandy shore, Anchieta Island, south-eastern Brazilian coast (23º 32'S, 45º 04'W). Anchieta Island is a marine park, and the Palmas shore fringes a bay of about 400 m (see Soares *et al.*, 1993 for map and general description of study area).

Underwater observations

Feeding behaviour of *U. coroides* (27 min of observation) and *E. gula* (38 min of observation) was recorded while snorkeling in shallow water (0.5-2 m depth), using "focal animal" and "all occurrences" samplings (Lehner, 1979) in a total of 30 h. Swimming slowly along the shore, we observed one individual at a time, and recorded behavioral events in a plastic slate. The number of bites on the sandy substrate per minute was recorded, and the results for the two species was compared using the t- test.

Sampling methods

Fishes were collected along the shore using a 10 x 1.5 m dragnet with 20 mm mesh size, in a depth ranging 1-1.5 m, from January through March, and July, November and December of 1997. We collected during morning and afternoon, in order to obtain information from both diurnal feeding periods (Hobson & Chess, 1986). Stomach contents were examined under stereomicroscope and food items were identified to order or class (Chao & Musick, 1977; Sazima, 1986). Voucher specimens of fishes and their gut contents are in the fish collection of the Museu de História Natural, Universidade Estadual de Campinas (ZUEC 3366-3379). For each food item we calculated occurrence (F%) and numerical (N%) frequencies (Hyslop, 1980; Marrero, 1994). We classified as main food items those where F% > 50% following Soares *et al.* (1993). The degree of stomach fullness (f) was estimated visually, considering four categories: empty, 0% < f < = 25%; moderate, 25% < f < = 50%; full, 50% < f < = 75%; and replete 75% < f < = 100 %. Stomach fullness degree of the four most abundant fish species was analyzed in two periods, morning (6:00-12:00 h) and afternoon (12:00-18:00 h). The diet of the most abundant fish species, *U. coroides*, was analyzed in three standard length classes, in order to verify possible ontogenetic changes in diet according to the species grow.

RESULTS

Feeding behaviour

Individuals of *U. coroides* and *E. gula* foraged alone over the bottom, repeatedly exploiting selected sites, approximately circular (about 40 cm in diameter). Both species searched for prey swimming in circles, apparently selecting the sites where they would forage and the substrate which they would bite. *Umbrina coroides* (7.9 ± 1.9 bites per minute) fed more frequently than *E. gula* (4 ± 1.6 bites per minute, $t_{0.05} = 3.6647$, $p < 0.01$). *Umbrina coroides* swam about 1-2 cm above the bottom, and stopped at a given site (Fig. 1a). With its body slightly prone, about 15° or 20°, the fish buried its mouth into the sand (Fig. 1b) and ejected sediment through its mouth and gill openings, producing a dense sandy cloud (Fig. 1c). *Eucinostomus gula* swam about 3-4 cm above the bottom, watching intently at the sandy substrate and stopping at a given site (Fig. 1a). Tilting its body about 45°, the fish protruded its mouth and buried it into the sand (Fig. 1b) and ejected sediment through its mouth and gill openings, producing a scattered sandy cloud of thin sediment (Fig. 1c). *Umbrina coroides* produced a round shallow hole in the sand, whereas *E. gula* produced an irregular and deeper one.

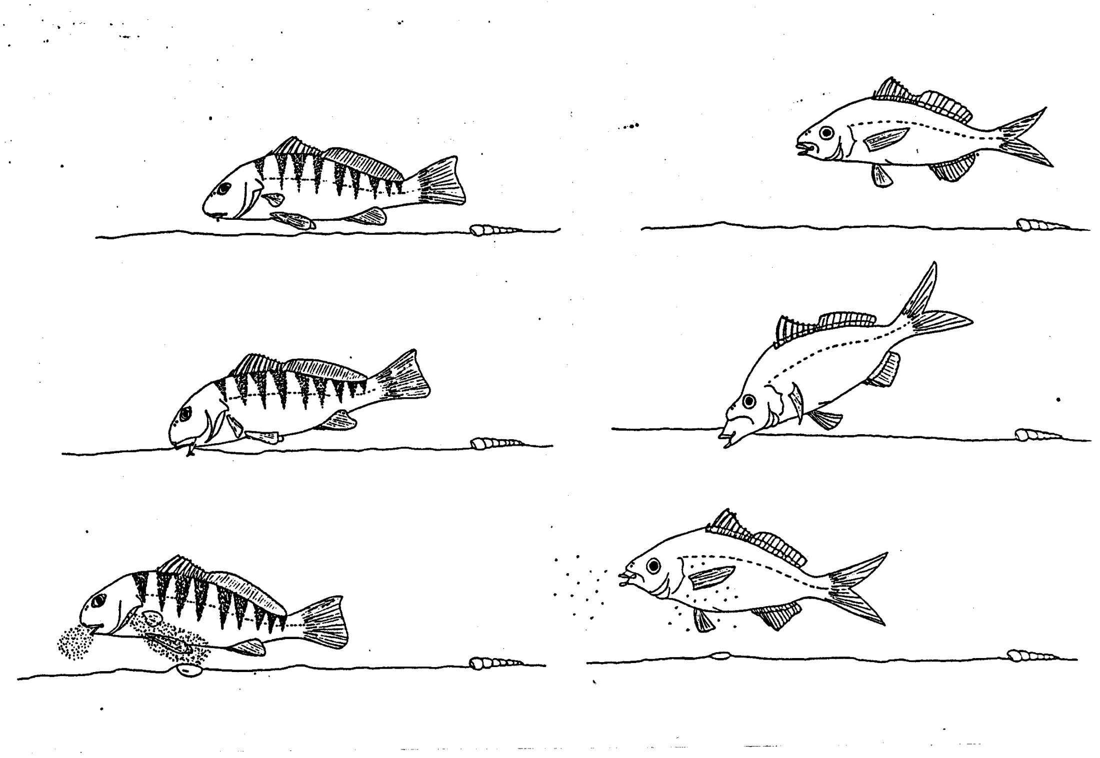


Fig. 1 — Feeding behaviour of *Umbrina coroides* (left) and *Eucinostomus gula* (right). Swimming near the bottom (a), burying mouth in the sand (b), ejecting sediment through mouth and gill openings (c).

Diet

From the eight species of benthivorous fishes (Fig. 2), the sciaenid *Umbrina coroides* was the most abundant (n = 63 individuals, 47% of fish caught). Main food items were Amphipoda and Mysidacea crustaceans. We split the former in two distinct unidentified categories, Amphipoda 1 and 2. The sciaenid *Menticirrhus littoralis* (Holbrook, 1855) (standard length, SL = 43-92 mm, n = 6) and the gerreid *Eucinostomus gula* (SL = 67-149 mm, n = 21) preyed mostly on Amphipoda 1, whereas the carangid *Trachinotus falcatus* (Linnaeus, 1758) (SL = 36-48 mm, n = 3) and the haemulid *Orthopristis ruber* (Cuvier, 1830) (SL = 47-61 mm, n = 3) consumed mostly Amphipoda 2. The sciaenid *Ophioscion punctatissimus* Meek & Hildebrand, 1925 (SL = 32-73 mm, n = 5) fed mainly on Mysidacea, whereas *U. coroides* (SL = 27-134 mm, n = 63) preyed on two main items, Amphipoda 1 and Mysidacea.

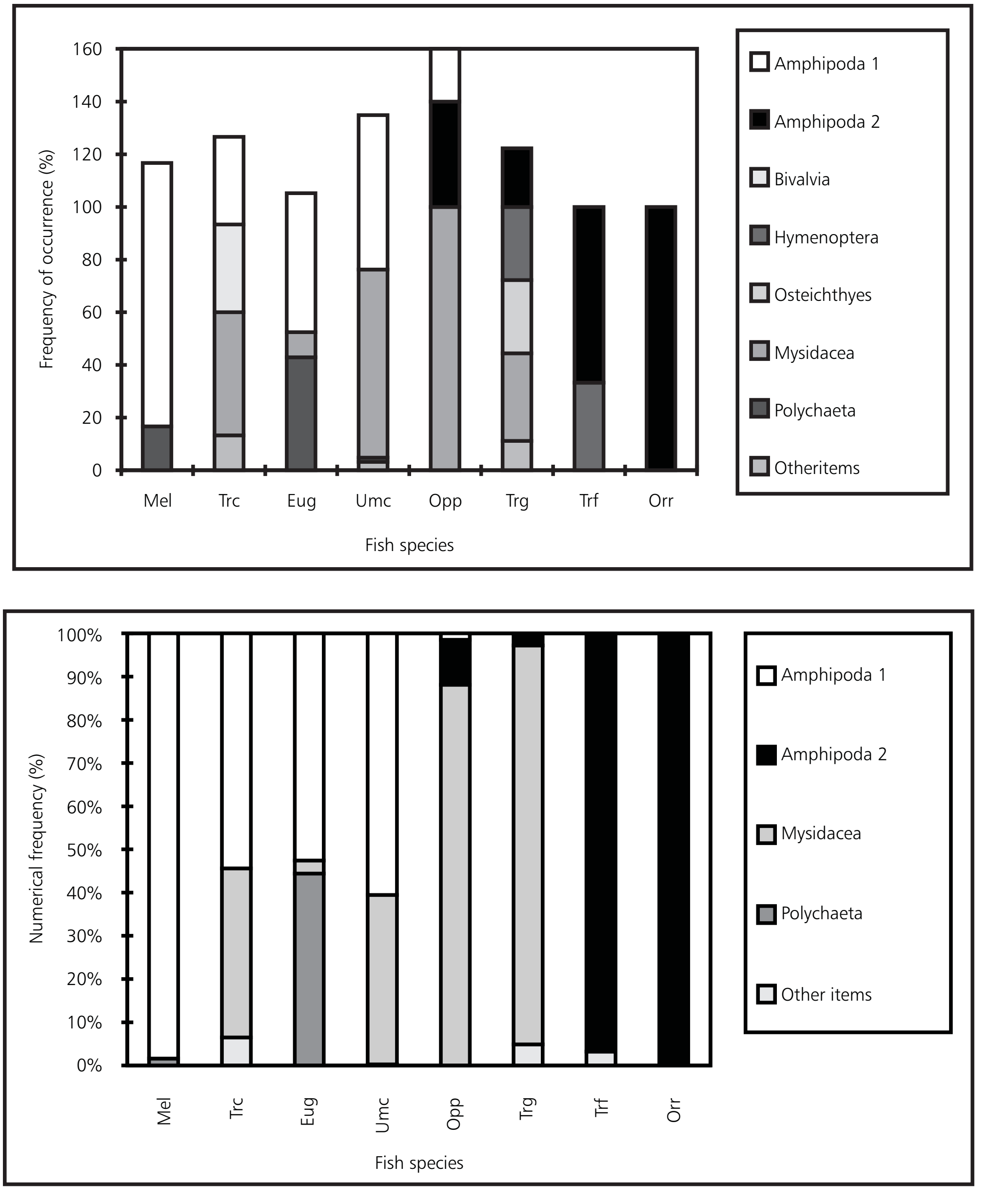
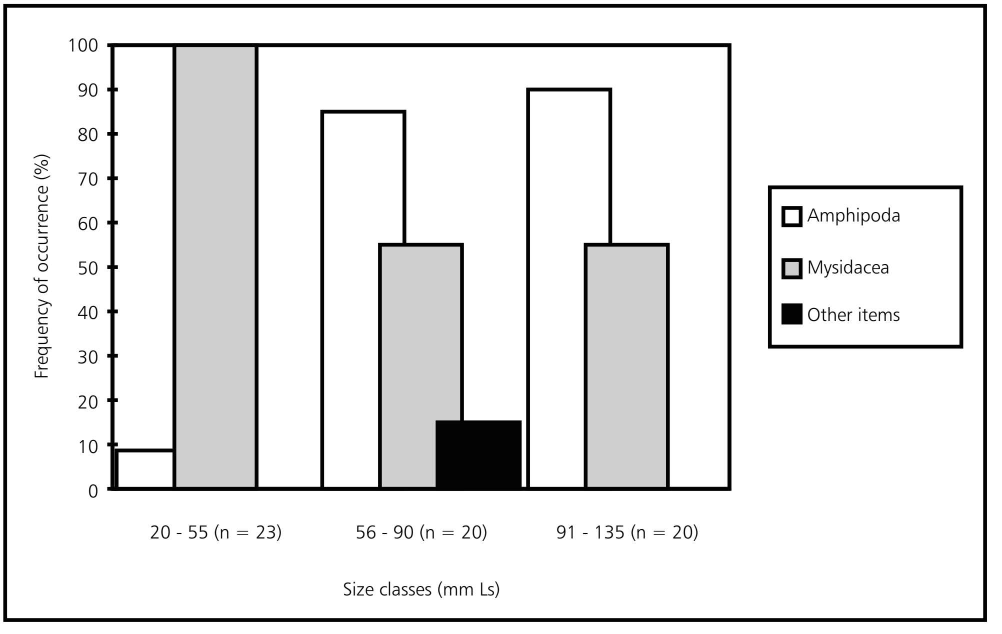


Fig. 2 — Frequency of occurrence (%) and numerical frequency (%) of food items in the diet of a guild of benthivorous fishes from Anchieta Island: *Menticirrhus littoralis* (Mei), *Trachinotus carolinus* (Trc), *Eucinostomus gula* (Eug), *Umbrina coroides* (Umc), *Ophioscion punctatissimus* (Opp), *Trachinotus goodei* (Trg), *Trachinotus falcatus* (Trf), *Orthopristis ruber* (Orr).

Two congener carangids, *Trachinotus goodei* Jordan & Evermann, 1896 (SL = 30-167 mm, n = 18) and *Trachinotus carolinus* (Linnaeus, 1766) (SL = 41-85 mm, n = 15), differed in diet composition and consumed a greater array of food items than the remaining benthivorous species. The numerical frequency follows the same general pattern described above for the frequency of occurrence (Fig. 2). A greater proportion of individuals with full and replete stomachs was recorded during the morning for *U. coroides* (30.6%) and *E. gula* (4%), and during the afternoon for *T. goodei* (34.9%) and *T. carolinus* (15.8%).

Ontogenetic changes in diet

Ontogenetic diet shift was recorded for the sciaenid *U. coroides*. Small individuals (SL = 20-55 mm) fed almost exclusively on Mysidacea, with numerical frequency of this prey dropping progressively in fishes larger than 56 mm, and being partly replaced by Amphipoda (Fig. 3).



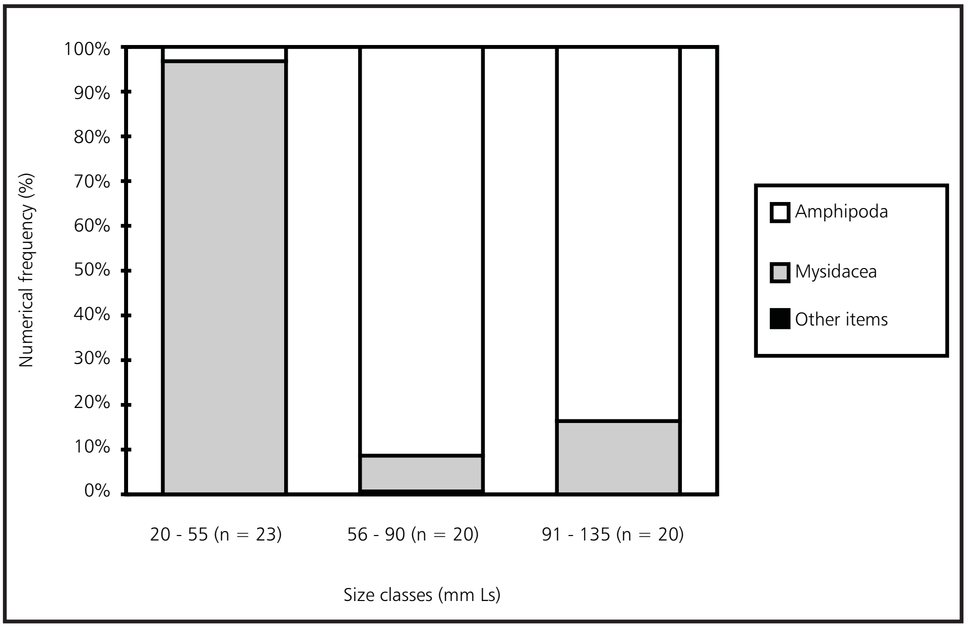


Fig. 3 — Frequency of occurrence (%) and numerical frequency (%) of food items in the diet of three size classes of *Umbrina coroides*.

DISCUSSION

The feeding behaviour repertoires of *Umbrina coroides* and *Eucinostomus gula* are directed to uncover small organisms in the sandy substrate. Both fishes may be classified as diggers of localized excavations (Sazima, 1986).

Notwithstanding general similarities in their diets, these two fishes present differences in feeding behaviour and morphology.

Eucinostomus gula has a more tubular, protractile mouth and spends more time inspecting visually the substrate, whereas *U. coroides* has a larger mouth with a barbel near the tip of the lower jaw, and bites at the substrate more frequently than *E. gula* does.

Thus, *E. gula* apparently relies more on vision, whereas *U. coroides* may use mainly tactile cues to detect prey. Similarly, among California nearshore fishes that forage in the sand, the labrid *Halichoeres semicinctus* (Ayres, 1859) intently inspects the substrate, indicating a reliance on vision to find prey, whereas the ophidiid *Chilara taylori* (Girard, 1858) apparently detects prey with its barbel-like pelvic fins (Hobson & Chess, 1986).

The sciaenid *Menticirrhus littoralis* (Holbrook, 1855) and other benthivorous fishes touch their barbels on the substrate to find prey (Moyle & Cech Jr., 1982).

In our study, foraging *U. coroides* tilted its body less than did *E. gula*, a trait which may be related to the ventral position of mouth in the former, as recorded for *Menticirrhus saxatilis* (Bloch & Schneider, 1801), whose inferior mouth allow it to dig with few changes in its swimming position (Chao & Musick, 1977). Both *U. coroides* and *E. gula* feed on benthic crustaceans, but only *E. gula* eats polychaetes. This major difference in diet may be related to *E. gula* visual inspection of substrate and its tubular mouth, which allows it to reach more deeply in the sand.

Both *U. coroides* and *E. gula* search for prey in an approximately circular area, apparently selecting sites where they forage. This foraging pattern may be related to the spatial distribution of prey, as carnivorous fishes preying on benthic organisms usually search for patches with a greater concentration of prey (Zavala-Camin, 1996), which is in accordance with the optimal foraging theory (Stephens & Krebs, 1986).

Crustaceans are the main food of the benthivorous fishes from Anchieta Island and are known as a major prey for benthivorous fishes from coastal southern (Haimovici *et al.*, 1989) and northern Brazil (Teixeira & Helmer, 1997), as well as in South Africa (Booth & Buxton, 1997). Crustacean availability regulates fish production at West Australia (Edgar & Shaw, 1995).

The most abundant fish species in our study, the sciaenid *U. coroides*, shows a diet shift from Mysidacea to Amphipoda as it grows. Ontogenetic dietary changes are known for *Umbrina canosai* (Berg, 1895) (Haimovici *et al.*, 1989), being usually recorded for several other fish species (Cancino & Castilla, 1988; Gerking, 1994; Booth & Buxton, 1997). Mysidacea usually swim in midwater, as opposed to the more benthic Amphipoda, associated with sand bottom (Barnes, 1980). Thus, when *U. coroides* turns to Amphipoda, it probably changes its foraging from mid-water to the bottom. Such behavioral change also occurs in a South African sparid fish, *Pterogymnus laniarius* (Valenciennes, 1830), which occupies reef areas interspersed with sand substrate, and feeds mainly on mysids in midwater as juvenile. When subadult, it turns to prey on benthonic ophiuroids and amphipods (Booth & Buxton, 1997). On the Western Australian coast, small *Upeneichthys stotti* Hutchins, 1990 and *U. lineatus* (Bloch & Schneider, 1801), Mullidae, consume Mysidacea whereas larger individuals prey on larger benthonic organisms, such as carid decapods and brachyuran crabs (Platell *et al.*, 1998). Mysids apparently are an important food item for juveniles of benthivorous marine fishes.

Umbrina coroides and *E. gula* feed mainly during the morning, whereas *T. goodei* and *T. carolinus* concentrate their feeding activity in the afternoon. Such time partitioning in feeding activity may favour species coexistence (Lowe-McConnell, 1977; Ross, 1986), as recorded for reef (Collette & Talbot, 1972), estuary (Chao & Musick, 1977) and freshwater (Winemiller, 1989) habitats.

We found that two congener carangids, *T. goodei* and *T. carolinus*, differ in their main crustacean prey items, respectively Mysidacea and Amphipoda. Differences in diet between sympatric congeners are well known for tropical and subtropical marine fishes (Schmitt & Coyer, 1982; Platell *et al.*, 1998). In a Northeast Brazilian coastal lagoon, two abundant benthivorous gerreids differ in diet composition, with *E. gula* eating polychaetes, and *E. argenteus* Baird & Girard, (1855) showing a more diversified diet, eating also crustaceans and mollusks (Teixeira & Helmer, 1997). Two embiotocid fishes of the genus *Embiotoca* prey on Amphipoda crustaceans, each fish species consuming a distinct prey size (Schmitt & Coyer, 1982). Given the general morphological similarities between congeners, differences in feeding are mainly attributed to resource sharing, thus minimizing competition and allowing multiple species coexistence (Lowe-McConnell, 1987; Gerking, 1994; Platell *et al.*, 1998).

Due to an increase in mouth size, larger fishes consume prey larger than do juveniles (Stergiou & Fourtouni, 1991; Platell *et al.*, 1998). However, this does not apply to *U. coroides* in our study, as the amphipods consumed by larger individuals are not larger than the mysids taken by smaller fishes. Considering this, the ontogenetic diet shift of *U. coroides* probably evolved as a mean to reduce competition for food both between juveniles and adults, and between juveniles of this sciaenid and the gerreid *E. gula*, another abundant benthivorous fish which also eats amphipods. Changes in feeding habits in different life stages may reduce the intraspecific and interspecific overlap in food resource use (Winemiller, 1989; Platell *et al.*, 1998). The differences in diet and feeding activity between the benthivorous species here studied may favor the coexistence of the guilds of benthivorous fishes in sandy shores, as already recorded by Hobson & Chess (1986) in California.

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