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FEEDING HABITS OF THE GRAY TILEFISH, *CAULOLATILUS MICROPS* (GOODE AND BEAN, 1878) FROM NORTH CAROLINA AND SOUTH CAROLINA WATERS

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ABSTRACT

Gray tilefish, *Caulolatilus microps*, were collected from 1972 to 1977 between depths of 70 to 236 m off North Carolina and South Carolina. Gray tilefish are demersal, opportunistic predators that consume fishes and macroinvertebrates closely associated with the substrate. The principal components of their diets, in decreasing order of importance, are: crabs, shrimp, fish, echinoderms (holothurians, echinoids, stelleroids), polychaetes, ascideans, molluscs (gastropods and bivalves), stomatopods and sipunculids. As tilefish grow, they consume larger prey. Their generalized feeding is similar to other branchiostegids. This strategy is advantageous for predation on the faunal assemblages of the shelf-edge habitat where the species diversity is generally high, but the number of individuals/species is generally low.

The gray tilefish, *Caulolatilus microps* (Pisces: Branchiostegidae) is a subtropical demersal marine fish that ranges in the northwest Atlantic from Cape Charles, Virginia to Key West, Florida and in the Gulf of Mexico from Pensacola, Florida to Campeche, Mexico (Dooley, 1978). Gray tilefish occur over the outer continental shelf, shelf-edge, and upper slope at depths of 65 to 236 m (Dooley, 1978; Ross, 1978). Off North and South Carolina, gray tilefish attained a maximum size of 780 mm TL and 5.6 kg; the oldest fish captured were 15 years old (Ross, 1978). Aspects of its life history including age, growth, stock composition, and reproductive biology have been described (Ross, 1978), while the systematics of the genus *Caulolatilus* and the family Branchiostegidae has recently been elucidated (Dooley, 1978).

Since 1972, an ongoing research program by the National Marine Fisheries Service, Beaufort Laboratory, Beaufort, North Carolina, has dealt with the offshore grouper-snapper-porgy-tilefish communities of the southeastern United States to provide a biological basis for the management of an expanding recreational and commercial fishery (Huntsman, 1976; Huntsman and Manooch 1978). One aspect of the life histories of the exploited species that has been considered is their feeding habits in order to determine the community relationships and species adaptability to different environments (Dixon, 1975; Manooch, 1977; Grimes, 1979).

The feeding habits of gray tilefish and other branchiostegids are not well documented. Dooley (1978) suggested gray tilefish were epibenthic browsers that consumed sea urchins, caridean and penaeid shrimps, polychaetes, brittle stars, crabs, molluscs, ascideans, bryozoans, amphipods, eels and other fishes. The limited available data on *Branchiostegus wardi*, *B. serratus*, Atlantic gold-eyed tilefish, *C. chrysops*, ocean whitefish, *C. princeps*, and the great northern tilefish, *Lopholatilus chameleonticeps* suggest the persistence of an epibenthic predatory feeding mode within the family Branchiostegidae (Fitch and Lavenberg, 1971; Freeman and Turner, 1977; Dooley, 1978).

This paper will discuss the foods and feeding habits of gray tilefish off North Carolina and South Carolina to define their trophic relationship within the shelf-edge demersal fish community.

METHODS AND MATERIALS

From 1972 to 1977, digestive tracts of gray tilefish were obtained primarily from experimental fishing trips aboard the R/V ONSLOW BAY (NMFS, Beaufort, North Carolina). Specimens were also acquired from port sampling collections of headboat catches from Cape Hatteras, North Carolina, to Charleston, South Carolina, and during an extended exploratory fishing trip aboard the R/V EASTWARD (Duke University Marine Laboratory, Beaufort, North Carolina). All gray tilefish were captured by hook and line fishing from depths of 70 to 150 m using cut squid or fresh fish fillet (Huntsman, 1976; Ross, 1978). The entire alimentary tract was removed by severing anterior to the stomach and at the distal end of the intestines and then stored in 10% formalin.

Intestinal and stomach contents were separated to the lowest taxa possible and measured volumetrically by water displacement. Major taxonomic groupings of prey and other items found in the intestines (n = 82) and stomachs (n = 10) were quantified for relative frequency of occurrence and relative volume. Frequency of occurrence was determined by counting the number of fish containing a specific food item. Relative frequency of occurrence was then determined by the percent of fish containing that food item. The number of fish in which a specific food item was dominant was also tabulated. The dominant food item is defined as that organism which comprised the greatest total volume within an intestinal or stomach sample.

The majority of the gray tilefish (90%) regurgitated their stomach contents due to the depths and speed of ascent during capture. Consequently, most of the foods reported here came from the intestines and were often in advanced stages of digestion. This obviously imparted a bias favoring less digestible food components such as exoskeletons, shells and other hard parts of organisms and inorganic materials. The emphasis of this discussion will thus relate primarily to the qualitative or descriptive aspects of gray tilefish feeding habits. However, the variation between intestinal and stomach contents will be noted where differences were observed.

RESULTS

The stomachs and intestines of 92 gray tilefish (400–780 mm TL) contained representatives of seven major taxa, with arthropods, echinoderms, molluscs, annelids and fish predominant (Table 1). Thirty-four invertebrate families and eight species of fishes were observed.

Decapod crustaceans were the most prevalent organisms in the diet of gray tilefish and occurred in 78.1% of the intestines and 60% of the stomachs (Table 2). Eight families and 11 species of reptantian decapods were identified in 59.8% of the intestines and comprised 21.6% of the total volume. They exceeded all equivalent taxa in both categories. The most important crabs were the portunids (especially *Portunus spinicarpus*), callapids and porcellanids. Crabs ranged in size from several young *Anasimus latus* (carapace width and length = 5 mm) to *Ranilia muricata* (carapace width 25 mm, length 50 mm). The identifiable crabs were tropical or subtropical organisms with distributions extending from Cape Hatteras or Cape Lookout south into the Caribbean or Gulf of Mexico (Williams, 1965). As a group, they inhabit sand, coral sands, mud, coral or shell bottoms (Williams, 1965; Gosner, 1971).

Natantian decapods were the second most frequently occurring organisms in the intestines (41.5%), but were relatively unimportant volumetrically (3.4%). However, in the stomachs, the occurrence of shrimp was second only to fish and volumetrically exceeded all other taxa. This anomaly was due to the presence of large quantities (6, 67, 112, and 133 ml) of *Leptochela bermudensis* in four stomachs sampled. These small, semi-tropical shrimp (5–10 mm TL), which undergo extensive diurnal migrations (Chace, 1972), were probably engulfed from dense aggregations hovering above the bottom. The small relative volume of shrimp found in the intestines is probably the result of rapid digestion.

Echinoderms were present in 36.6% of the intestines and represented 12.4% of the total volume. Sea urchins were the most prevalent echinoderm (23.2%) and probably represented an even greater actual proportion of the volume in the diet since only small broken shell fragments were observed. Brittle stars occurred in

Table 1. List of organisms found in the digestive tracts of *Caulolatilus microps*

- Bryozoa
  - unidentified pieces
- Mollusca
  - Gastropoda
    - Turridae
    - Naticidae
      - *Polinices* sp. (*P. lacteus* or *P. uberinus*)
  - Bivalvia
    - Pholadidae
  - Cephalopoda
- Annelida
  - Polychaeta
    - Aphroditidae
    - Sigalionidae
      - *Leanira* sp.
    - Glyceridae
    - Goniadidae
      - *Goniada teres*
    - Sabellariidae
    - Oenone
      - *Oenone fulgida*
    - Eunicidae
    - Arabellidae
      - *Drilonereis* sp.
- Sipuncula
- Arthropoda
  - Crustacea
    - Cirripedia
    - Malacostraca
      - Stomatopoda
        - *Squilla* sp.
      - Decapoda
        - Penaeidae
          - *Solenocera mesopina*
          - *Solenocera* sp.
          - *Mesopenaeus tropicalis*
        - Caridea
          - Alepheidae
          - Pasiphaeidae
            - *Leptochela bermudensis*
          - Processidae
            - *Processa* sp.
        - Anomura
          - Paguridea
            - *Pagurus* sp.
        - Brachyura
          - Raninidae
            - *Ranilia muricata*
          - Calappidae
            - *Calappa angusta*
            - *Calappa* sp.
            - *Osachila* sp.
          - Majidae
            - *Anasimus latus*
          - Parthenopidae
            - *Parthenope* sp.
          - Portunidae
            - *Portunus spinicarpus*
            - *Portunus* sp.
          - Albuneidae
            - *Albunea* sp.
          - Philyrinae
            - *Iliacantha* sp.
          - Galatheidae
            - *Munida* sp.
- Echinodermata
  - Holothuroidea
    - *Pentamera pulcherrima*
    - Unidentified specimens
  - Echinoidea
  - Asteroidea
    - *Astrophyton muricatum*
    - *Astroporpa annulatus*
    - *Ophiophragmus pulcher*
- Chordata
  - Urochordata
    - Ascidiacea
  - Vertebrata
    - Osteichthyes
      - Muraenidae
        - *Gymnothorax* sp.
      - Ophidiidae
        - *Rissola marginata*
      - Synodontidae
        - *Synodus* sp.
      - Serranidae
        - *Centropristis* sp.
      - Bothidae
      - Scorpaenidae
      - Batrachoididae
        - *Porichthys porosissimus*

the intestines only as shell fragments, but one identifiable specimen, *Ophiophagamus pulcher*, represented the northern distributional record for the species (Donald Weston, pers. comm.).

Polychaetes occurred in 31.7% of the intestines and were the dominant food item in five. The most prevalent were from the tubiculous families Eunicidae and Sabellaridae; tubes of sand, shell fragments or mud with extended setae were generally all that remained. Two species of Aphroditidae were also identified; these are typically muddy-bottom dwellers (Gosner, 1971).

Table 2. Relative frequency, relative volume and dominance of major prey organisms found in the intestines and stomachs of *Caulolatilus microps*

Food Item	Intestines (n = 82)			Stomachs (n = 10)		
	Percent Frequency	Percent Volume	Dominant Food	Percent Frequency	Percent Volume	Dominant Food
Invertebrates	96.3	78.2	53	100.0		5
Annelida						
Polychaeta	31.7	3.9	5	20.0	2.2	
Sipuncula	12.2	5.6		20.0	1.2	
Mollusca	25.6	3.9	5	10.0		
Gastropoda	12.2	1.1	2			
Bivalvia	17.1	0.6	2	10.0	<.1	
Cephalopoda	3.1	2.2	1			
Arthropoda						
Crustacea	81.7	27.4	31	60.0	64.3	5
Cirripedia						
Stomatopoda	15.9	2.4	1			
Decapoda	78.1	25.0	30	60.0		
Natantia	41.5	3.4	7	60.0	60.4	4
Brachyura	59.8	21.6	23	20.0	3.9	1
Callapidae	9.8	1.8	4			
Portunidae	17.6	6.3	10			
Porcellanidae	11.0	5.1	4			
Echinodermata	36.6	12.4	12	10.0		
Holothuroidea	13.4	3.8	4			
Echinoidea	23.2	4.5	7			
Asteroidea	17.1	2.3	1	10.0	<.1	
Urochordata						
Ascidiacea	20.7	14.2	10			
Vertebrata						
Pisces	22.0	2.6	5	80.0	32.2	5
Miscellaneous	50.0	5.0		10.0		
Shell hash	43.9			10.0	.1	
Coral rubble	22.0					
Sand	29.3					

Ascidians occurred in 20.7% of the intestines, comprised 14.2% of the volume, and were the dominant food item in 10 intestines. These were probably colonial tunicates (Charles Manooch III, pers. comm.), the remains of which were transparent gelatinous masses.

Shell hash, coral rubble and sand occurred in 50% of the intestines and comprised approximately 5% of the total volume of discernible matter. Its recurrence, together with the sessile ascidians, polychaetes, bivalves and sipunculids, was strong evidence of benthic feeding by gray tilefish.

Fish or fish parts (spines, otoliths, vertebrae) were identifiable in 22% of the intestines and accounted for 2.6% of the total volume. Whole fish were present in 80% of the stomachs and comprised 32.2% of the volume of stomach contents. The fish identifiable to family characteristically maintain a very close association with the substrate, particularly Bothidae, *Gymnothorax* sp., *Synodus* sp., and *Porichthys porosissimus*. The largest organisms consumed by gray tilefish were

a 220 mm TL *Rissola marginata* and several 135–185 mm TL moray eels and lizard fish.

Changes in food habits with increased size were considered by partitioning gray tilefish into 100 mm TL classes (Table 3). Essentially, there appeared a selection for larger prey by larger fish. The relative frequency of fish in the diet increased, although not significantly, from 17.6% in 400–500 mm TL fish to 37.5% in the 700+ mm TL specimens. Decapod crustaceans remained an important prey for all size classes. There was a significant decrease in relative importance of shrimp with a concurrent non-significant increase in larger crabs, most notably *Ranilia muricata*. Large gray tilefish persisted in consuming polychaetes, sipunculids and ascideans, while preying significantly less upon echinoderms and not significantly less on molluscs.

Discussion

The gray tilefish is an omnivorous, opportunistic predator which feeds on a heterogeneous mixture of organisms. This feeding strategy is pursued by other high order predators in both the shelf-edge community (Manooch, 1977; Freeman and Turner, 1977; Grimes, 1979) and on coral reefs (Randall, 1967; Moe, 1969; Mosley, 1966). Co-occurring red porgies, *Pagrus pagrus*, consumed an equally heterogeneous mixture of organisms with decapod crustaceans their dominant prey.

The omnivorous nature of the gray tilefish was typified by the presence of five or more phyla found together in 34.2% of the individual intestinal tracts. One 525 mm TL individual contained the remains of several portunid crabs, an unidentified crab, medium sized shrimp, barnacles, sea urchin, gastropods, several polychaetes, a sipunculid, and a colonial tunicate, together with shell hash, sand and pebbles. Their opportunistic feeding habit with respect to size and type of prey was exemplified by a 616 mm TL specimen that consumed two lizard fish (135 and 140 mm TL) and 67 ml of *Leptochela bermudensis* (<10 mm TL).

Dooley (1978) asserted that gray tilefish are epibenthic browsers. A close association with the substrate when feeding was certainly demonstrated by the consumption of sessile benthos, slow moving or obligate epibenthic organisms and benthic fishes. However, gray tilefish appear able swimmers and pursue engybenthic prey as evidenced by their preying upon *Rissola marginata*, juvenile *Centropristis* sp., *Leptochela bermudensis* and portunid crabs.

The polyphagous benthic feeding exhibited by gray tilefish appears to be the common feeding mode for branchiostegids. Eight golden-eyed tilefish, *C. chrysops* (340–545 mm TL) fed on similar but smaller organisms including shrimp, sea urchins, bivalves, polychaetes, brittle stars and holothurians (pers. observ.). *C. princeps* inhabits rocky bottoms in the northeastern Pacific; *B. wardi* and *B. serratus* are known from the outer portions of the Australian coral reefs; *L. chameleonticeps* occurs over mud bottoms of the outer continental shelf, upper slope and heads of submarine canyons in the northeast Atlantic and Gulf of Mexico. In all cases, tilefish are reported to have consumed a heterogeneous mixture of macroinvertebrates, with crustaceans predominant, and fishes (Fitch and Lavenberg, 1971; Freeman and Turner, 1977; Dooley, 1978).

Not only is there diversity in types of prey consumed by gray tilefish, but also diversity in the substrate occupied by these organisms. Identifiable reptantian decapods and polychaetes are reported to be associated with sand, coral sand, mud, coral and shell bottoms (Gosner, 1971). Bothids and synodontids usually occur over flatter sandy bottoms, while *Centropristis* sp. and *Gymnothorax* sp.

Table 3. Relative frequency of occurrence (% Freq.) and dominance of organisms (Dom. Food) found in the stomachs and intestines of *Caulolatilus microps* (n = 92) partitioned by 100 mm size classes (400–800 mm TL). Chi-square contingency test values presented for comparisons of frequency of occurrence of major prey taxa in 400–600 mm TL vs. 601–800 mm TL size classes (χ^2 = 3.84, df = 1)

Size Class N	400–500 mm 17		501–600 mm 36		601–700 mm 31		701–800 mm 8		
Food Item	% Freq.	Dom. Food	% Freq.	Dom. Food	% Freq.	Dom. Food	% Freq.	Dom. Food	Calculated χ^2
Annelida									
Polychaeta	17.6		38.9	3	32.3	2	25.0		0.03
Sipuncula	17.6		13.9		6.4		25.0		0.14
Mollusca	35.2		27.7		19.4		12.5		1.21
Gastropoda	17.6	1	16.7	2	12.9	1			
Bivalvia	23.5		11.1		6.4		12.5		
Cephalopoda	5.9				3.2				
Arthropoda									
Crustacea	82.4	11	83.3	11	83.9	17	75.0	3	0.02
Cirripedia	5.9		2.8						
Stomatopoda			11.1		19.4	1	25.0		1.45
Decapoda	76.5	7	83.3	11	67.7	17	75.0	3	
Natantia	58.8	2	58.3	4	29.0	3	12.5		8.53*
Reptantia	58.8	5	41.7	7	48.4	9	75.0	3	0.18
Callapidae	11.8	1	5.5	2	9.7	1	12.5		
Portunidae	23.5	3	19.4	4	15.1	4	12.5		
Porcellanidae			5.5		9.7	2	50.0	3	
Echinodermata	52.9	2	77.8	7	35.4	2	12.5	1	12.23*
Holothuroidea	5.9	1	16.7	3	9.7		12.5		
Echinoidea	29.4		25.0	4	12.9	2	12.5	1	
Asteroidea	23.5	1	16.7		12.9				
Urochordata									
Ascideacea	17.6	1	13.9	4	19.4				0.07
Pisces	17.6	2	27.7	2	32.3	4	37.5	3	0.48
Miscellaneous	58.8	2	38.9	4	48.3	7	37.5	3	
Shell hash	47.1		33.3		35.5		37.5		
Coral rubble	17.6		13.9		22.6		25.0		
Sand	23.5		19.4		32.3		37.5		

are generally associated with a rocky outcropping or reef type areas off the Carolinas. Gray tilefish were captured off North and South Carolina in areas of precipitous relief and rocky outcroppings and also over flatter, gently sloping areas; they are reported to inhabit mud and sand bottoms in the Gulf of Mexico (Springer and Bullis, 1956). Though restricted to a relatively narrow belt of warm Florida Current water off the southeastern United States, they appear capable of utilizing the gamut of bottom types and reliefs occurring from 65 to 236 m. In this sense, gray tilefish demonstrate greater environmental flexibility than typical reef associated fishes.

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