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FOOD HABITS OF THE ROCK SEA BASS, *Centropristis philadelphica*, IN THE WESTERN GULF OF MEXICO[1]

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ABSTRACT: The rock sea bass, *Centropristis philadelphica*, is a euryphagic, benthic carnivore. Principal prey in decreasing order of importance are: natantian and reptantian decapods, mysids, fishes, stomatopods and polychaetes. As rock sea bass increase in size, crabs and fishes constitute a greater portion of their diet and mysids a smaller portion. Feeding activity is greater during daytime though diurnal dietary compositions are similar. Shrimps are the principal food in every season but are more notable during fall and winter than spring and summer; mysids and crabs are most important in spring, as are fishes in summer. Inshore (< 27 m deep) the primary foods are shrimps, mysids, larval fish and stomatopods; offshore, crabs and fishes dominate the diet. The euryphagic feeding of rock sea bass is similar to other small, co-occurring serranids, and morphologically they fit the description of a benthic forager in "convergence of body form." The ability of rock sea bass to utilize temporal-spatially abundant prey probably facilitates their broad bathymetric distribution (4-120 m) and relatively high abundance in the western Gulf of Mexico.

Rock sea bass, *Centropristis philadelphica* (Linnaeus) are small serranids which occur in the Western Atlantic from Cape Henry, Virginia, southward to the Tortugas, Florida and in the Gulf of Mexico (Gulf) to the Rio Grande and possibly into Mexican waters (Briggs, 1958; Miller, 1959; Link, 1980). In the Gulf they are found over soft mud/sand bottoms on the continental shelf between 4-120 m and seasonally inshore in bays and lagoons (Springer and Bullis, 1956; Miller, 1959; Bullis and Thompson, 1965; Hoese and Moore, 1977). *Centropristis philadelphica* are most abundant at depths of 18-47 m, particuarly during the period of peak recruitment for young-of-the-year from May through July (Ross and Chittenden). In the Gulf, they have a maximum life span of 3-4 years and reach a standard length (SL) of 225 mm, though typically they only live 1-2 years and reach 100-- 150 mm SL (Ross and Chittenden).

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The food and feeding habits of *C. philadelphica* in the Gulf have been treated briefly in the literature. Rogers (1977) described their trophic interrelationships with co-occurring species and Divita et al. (1983) characterized bathymetric variability in their diet during seasonal migrations of brown shrimp, *Penaeus aztecus*. Food habits in other portions of their range have been detailed by Link (1980) for North Carolina, and by Jordan and Evermann (1923) as generalized information on all *Centropristis* species in the Western North Atlantic.

This paper describes the foods and feeding habits of rock sea bass in the Gulf off Texas and examines ontogenetic, diurnal, seasonal and bathymetric variations in their diet.

MATERIALS AND METHODS

Collection Procedures

Rock sea bass were captured in the Gulf off Freeport, Texas (Figure 1) bi-

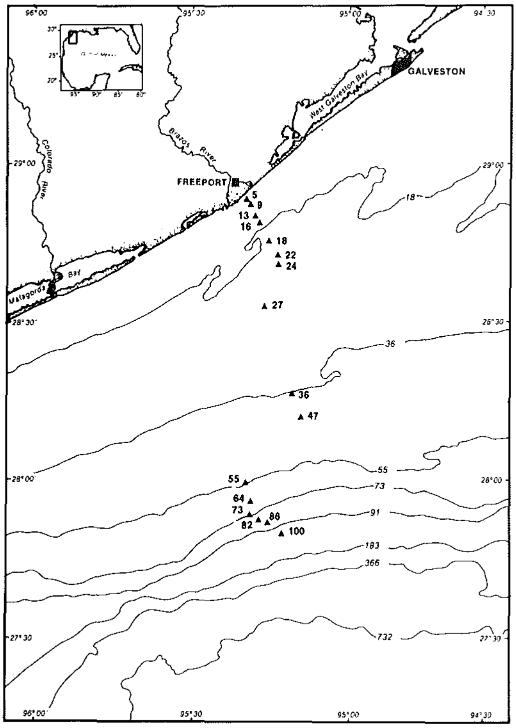

Figure 1. Location and depths of collection stations, northwestern Gulf of Mexico.

monthly between March 1980 and April 1981 from a shrimp trawler rigged with twin 10.4 m two-seam flat trawls having tickler chains and 4.4 cm stretched-mesh cod ends. Collections were made at depths of 5, 9, 13, 18, 22, 24, 27, 36, 47, 55, 64, 73, 82, 86, and 100 m. Two 10-minute (bottom time) tows were made at each depth except that eight and 24 tows were made at 13 and 22 m, respectively. Day tows were made from 1 hour after sunrise to 1 hour before sunset and night tows from 1 hour after sunset to 1 hour before sunrise.

All captured rock sea bass were measured for standard length (mm SL) and fixed in borax-buffered 10% Formalin. An anus-isthmus incision was made in each specimen to promote fixation. Specimens were then rinsed in water and preserved in either 70% ethanol or calcium carbonate-buffered 5% formalin until laboratory analysis.

Laboratory Procedures

Stomachs were removed from 100 fish each month, including 50 from each day and each night cruise if available. Specimens were selected from the total catch by stratified random sampling in which strata (<75mm; 75-149 mm, 150-224 mm) were set up to closely represent age groupings (age 0, I, II-IV respectively) (Ross and Chittenden). In addition, 20 large fish (>149 mm SL) from collections over the same grounds March 1978 to February 1980 were included for ontogenetic analyses because few large specimens (n = 27) were captured during the March 1980-April 1981 period. Stomachs were cut open in a Petri dish, and food items were sorted by taxon and counted using a binocular dissecting microscope. A stomach was considered full if it contained any undigested food items and/or partially digested but still identifiable food fragments. Food items were identified to the lowest taxonomic level possible and enumerated. Prey fragments (e.g., crustacean appendages, ophiuroid arms) were considered one animal unless it could be otherwise determined from: pairs of eyes, telsons antennal scales or chelae (crustaceans), prostomia or parapodia (polychaetes), valves (bivalves), beaks (cephalopods), disc (ophiuroids), or other parts. The volume (0.1 ml) of each individual taxon was determined by the displacement of water in a graduated cylinder.

The contribution of each prey to the total diet was qualified in three ways: 1) frequency of occurrence (F), the number of stomachs in which an individual taxon occurred, expressed as a percent of the total number of full stomachs; 2) numerical abundance (N), the number of individuals of each taxon expressed as a percent of the total number of food items from all stomachs pooled; 3) volume displacement (V), the total volume displaced by each taxon expressed as a percent of the total volume of food items from all stomachs pooled.

Percent compositions were used to describe the overall diet and compare ontogenetic, diel, seasonal and bathymetric differences in feeding habits. Ontogenetic analysis compared feeding habits of fish 75 mm vs 75-149 mm vs 150-224 mm SL, size intervals which approximate age 0, age I and ages II-IV fish, respectively (Ross and Chittenden). All lengths given are SL unless specified otherwise. Seasonal analysis compared feeding habits during March-May (spring) vs. June-August (summer) vs September--November (fall) vs. December-February (winter). Bathymetric analysis compared feeding habits inshore (6-27 m) vs. offshore (36-100 m); these depths correspond with limits of the white shrimp, *Penaeus setiferus*, and brown shrimp, *P. aztecus*, communities (Chittenden and McEachran, 1976).

RESULTS

Overall Composition of the Diet

We examined 1,200 stomachs to determine overall diet; 72.1% (n = 865) contained food and 27.9% (n = 335) were empty.

Rock sea bass ate a variety of organisms representing seven classes including: Gastropoda, Bivalvia, Cephalopoda, Polychaeta, Crustacea, Ophiuroidea, and Osteichthyes (Table 1). Overall, 32 invertebrate families (at least 68 species) and 15 fish families (at least 18 species) were identified.

Decapod crustaceans were the most important forage of rock sea bass (Table 2). Present in 75.1% of the stomachs, they accounted for 59.9% of the total food items and 64.8% of the food volume. Natantians (shrimps) were the dominant decapods in the diet (N = 41.2%, V = 41.7%, F = 53.3%). Larval shrimp were the most frequent (30.2%) natantian prey, but a sergestid, *Acetes americanus*, was most abundant (17.3%) and penaeids, *Sicyonia* spp. and *Trachypenaeus* spp., were more voluminous (10.4%; 7.6%, respectively). Alpheids (*Alpheus floridanus*, *Automate* spp.) were also common (F = 7.2%) and an important part of the food volume (5.0%). Reptantian decapods (axid lobsters; galatheid, hermit and brachyuran crabs) comprised 18.7% and 23.1% of the numeric and volumetric composition respectively and occurred in 36.3% of the stomachs. Brachyuran crabs were secondary in dominance to shrimps and the principal reptantian prey. The most important crabs in the diet belonged to the families Portunidae, Xanthidae and Goneplacidae. The most common species identified were: *Portunus spinicarpus*, *P. spinimanus*, *Speocarcinus lobatus*, *Callinectes similis*, *Micropanope* spp., *Eucratopsis crassimanus*, and *Leiolambrus nitidus*.

Mysids and stomatopods were the most important non-decapod crustaceans eaten by rock sea bass (Table 2). Mysids, secondary in importance to decapods, occurred in 15.8% of the stomachs and made up 23.6% of the food items by number, but ony 1.6% by volume. Stomatopods, primarily *Squilla empusa*, were found in 7.2% of the stomachs and ranked third in volume (9.0%). Other crustaceans were of negligible importance except gammarid amphipods which occurred in 5.4% of the stomachs.

The remaining foods in the diet were of minor importance except fishes and polychaetes (Table 2). Fishes, mostly larvae, followed crustaceans in dominance and occurred in 16.1% of the stomachs and made up 6.9% and 18.2% of the respective numeric and volumetric compositions. *Bregmaceros atlanticus*, *Longchopisthus micrognathus*, *Bollman-*

Table 1. A taxonomic list of prey organisms identified from stomachs of *C. philadelphica* from the Gulf of Mexico.

ANNELIDA
Polychaeta
Arenicolidae
Phyllodocidae
Aphroditidae
Nereidae

MOLLUSCA
Gastropoda
Collumbellidae
Anchias sp.
Turridae
Terebra sp.
Bivalvia
Pectinidae
Aequipecten sp.
Cephalopoda
Lolignidae
Lolliguncula brevis
Octopodidae
Octopus vulgaris

ARTHROPODA
Crustacea
Copepoda
Harpacticoida
Malacostraca
Stomatopoda
Squillidae
Squilla empusa
Mysidacea
Mysidae
Mysidopsis bigelowi
M. furca
Amphipoda
Gammaridea
Ampeliscidae
Ampelisca sp.
Caprellidea
Decapoda
Natantia
Penaeidea
Penaeidae
Parapenaeus longirostris
Penaeus aztecus
P. duorarum
Sicyonia brevirostris
S. dorsalis
S. typica
Solenocera sp.
Trachypenaeus constrictus
T. similis
Xiphopenaeus kroyeri
Sergestidae
Acetes americanus
Caridea
Alpheidae
Alpheus floridanus
Automate rectifrons
Automate sp.
Synalpheus sp.
Hippolytidae
Hippolysmata sp.
Tozeuma serratum
Processidae
Processa sp.
Pasiphaeidae
Leptochela serratobita
Palaemonidae
Periclimenes iridescens
Periclimenaeus sp.
Reptantia
Thalassinoidea
Axiidae
Calocaris sp.
Anomura
Galatheidae
Munida irrasa
Diogenidae
Paguridae
Brachyura
Calappidae
Acanthocarpus alexandri
Calappa flammea
C. sulcata
Hepatus sp.
Portunidae
Callinectes sapidus
C. similis
Ovalipes ocellatus
O. quadulpensis
Portunus gibbsei
P. spinicarpus
P. spinimanus
Portunus sp.
Leucosidae
Parthenopidae
Leiolambrus nitidus
Parthenope pourtalessi
Pinnotheridae
Pinnixia sayana
Pinnixia sp.
Majidae
Labinia emarginata
Podochela sidneyi
Xanthidae
Micropanope nuttingi
Micropanope scultipes
Micropanope sp.
Panopeus herbstii
Panopeus sp.
Tetaxanthus sp.
Goneplacidae
Eucratopis crassimanus
Frevillea hirsuta
Speocarcinus lobatus
Graspidae
Cyclograspus integer

ECHINODERMATA
Ophiuroidea

CHORDATA
Osteichthyes
Nettastomatidae
Hoplunnis sp.
Ophichthidae
Clupeidae
Etrumeus teres
Engraulidae
Anchoa sp.
Engraulis eurystole
Synodontidae
Sauida brasiliensis
Bregmacerotidae
Bregmaceros altanticus
Syngnathidae
Sparidae
Stenotomus caprinus
Sciaenidae
Cynoscion nothus
Cynoscion sp.
Mullidae
Upeneus parvus
Opistognathidae
Lonchopisthus micrognathus
Gobeidae
Bollmannia communis
Gobionellus hastatus
Stromateidae
Peprilus burti
Scorpaenidae
Triglidae
Prionotus stearnsi
Prinotus sp.

nia communis, *Engraulis eurystole*, *Cynoscion spp.* and *Stenotomus caprinus* were the most common species identified. Polychaetes occurred in 5.8% of the stomachs and constituted 2.2% of food items and 3.2% of food volume. Species of the family Nereidae were the most commonly consumed polycheates.

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Table 2. Overall percent numerical abundance (N), percent volume displacement (V) and frequency of occurrence (F) for prey items in the diet of *C. philadelphica* from the Gulf of Mexico. Percent compositions <.1% are indicated by an asterisk (*).

Food Item	N	V	F
MOLLUSCA			
Gastropoda	0.3	0.2	1.0
Bivalvia	0.3	0.1	1.0
Cephalopoda	0.3	1.4	0.9
Unident. Mollusca	0.2	0.1	0.7
Total Mollusca	1.2	1.7	3.7
ANNELIDA			
Polychaeta	2.2	3.2	5.8
Unident. Annelida	0.1	*	0.4
Total Annelida	2.3	3.2	6.1
ARTHROPODA			
Crustacea			
Copepoda	0.3	*	0.8
Stomatopoda	2.5	9.0	7.2
Amphipoda	2.2	0.3	5.4
Mysidacea	23.6	1.6	15.8
Unident. Crustacea	0.8	0.3	2.1
Decapoda	59.9	64.8	75.1
Natantia	41.2	41.7	53.3
Larval Natantia	12.2	9.0	30.2
Unident. Natantia	0.3	0.1	0.7
Penaeidea	24.5	25.8	19.5
Unident. Penaeidea	1.3	2.4	2.9
Penaeidae	6.0	19.4	14.6
Misc. Penaeidae	0.7	1.4	1.6
Trachypenaeus spp.	4.2	7.6	9.4
Sicyonia spp.	1.2	10.4	3.8
Sergestidae	17.3	4.0	3.7
Misc. Sergestidae	*	*	0.1
Acetes americanus	17.3	4.0	3.6
Caridea	4.2	6.8	11.1
Unident. Caridea	0.6	0.4	1.0
Misc. Caridea	0.6	0.7	2.5
Palaemonidae	0.4	0.5	1.1
Pasiphaeidae	0..1	0.2	0.2
Alpheidae	2.5	5.0	7.2
Reptantia	18.7	23.1	36.3
Thalassinoidea	0.3	0.5	1.0
Anomura	0.6	0.5	1.9
Brachyura	17.8	22.2	34.0
Larval Brachyura	0.5	0.1	1.2
Unident. Brachyura	4.6	2.5	11.9
Calappidae	0.3	0.3	0.9
Portunidae	5.0	12.3	8.9
Goneplacidae	2.9	2.4	5.4
Xanthidae	3.2	3.3	8.1
Pinnotheridae	0.3	0.1	1.0
Majidae	0.3	0.3	0.9
Parthenopidae	0.8	0.8	1.7
Total Crustacea	89.2	76.0	88.3
ECHINODERMATA			
Ophiuroidea	0.2	0.3	0.7
Unident. Echinodermata	*	*	0.1
Total Echinodermata	0.2	0.3	0.8
CHORDATA			
Osteichthes			
Ichthyolarvae	5.9	14.6	11.6
Fishes	1.0	4.2	4.5
Total Osteichthyes	6.9	18.2	16.1
UNIDENTIFIED REMAINS	0.2	0.4	0.8
Number of Stomach	1200		
Number and percent full	865		(72.1%)
Number and percent empty	335		(27.9%)

Ontogentic Variations

We examined 1,220 stomachs for ontogentic comparisons of feeding habits; 330 were from fish <75 mm SL (age 0), 843 from fish 75-149 mm SL (age I), and 47 from fish 150-224 mm SL (age groups II-IV). The percent and number of full stomachs in the respective size intervals were 73.3% (n = 242), 72.1% (n = 608) and 61.7% (n = 29).

Mysids and natantian decapods (mostly larval natantia and penaeids) were the most important food of small rock sea bass (75 mm) (Table 3). Shrimps were the most common (46.7%) and volumetrically important (46.4%) food and were second in numerical abundance (22.3%). Mysids were numerically the most abundant prey (56.9%) but were second in frequency of occurrence (41.7%) and volume (14.5%). Other important foods were crabs (N = 6.9%, V = 10.4%, F = 22.3%) and larval fish (N = 5.3%, V = 10.3%, F = 9.1%). The

Table 3. Percent numerical abundance (N), percent volume displacement (V), and frequency of occurrence (F) of prey in the diet of *C. philadelphica* from the Gulf of Mexico by size-age intervals. Percent compositions <0.1% are indicated by an asterick (*).

	0-74 mm SL (age 0)			75-149 mm SL (age I)			150-224 mm SL (age II-IV)		
FOOD ITEM	N	V	F	N	V	F	N	V	F
MOLLUSCA	0.6	2.1	2.1	1.5	1.6	4.3	7.1	4.5	13.8
Gastropoda	0.1	*	0.4	0.5	0.2	1.5	1.8	0.1	3.4
Bivalvia	0.1	0.2	0.4	0.5	0.1	1.3	1.8	0.1	3.3
Cephalopoda	0.3	1.8	1.2	0.3	1.2	0.8	3.5	4.3	6.9
ANNELIDA	1.6	5.5	5.4	2.8	3.5	7.1	1.8	0.1	3.4
Polychaeta	1.6	5.5	5.4	2.6	3.5	6.6	1.8	0.1	3.4
ARTHROPODA									
Crustacea	92.6	82.1	94.6	87.5	73.5	86.0	73.7	67.1	79.3
Copepoda	0.4	0.2	1.7	0.2	*	0.5	*		
Stomatopoda	1.4	7.2	5.8	3.1	10.9	7.9	*		
Amphipoda	2.8	1.1	9.5	1.9	0.3	5.6	*		
Mysidacea	56.9	14.5	41.7	5.9	0.5	5.9	*		
Decapoda	29.7	57.8	66.5	75.9	61.6	78.3	71.9	66.9	79.3
Natantia	22.3	46.4	46.7	51.4	42.0	54.6	28.1	28.4	34.5
Larval Natantia	7.8	14.6	26.9	14.5	9.7	31.7	14.0	2.1	13.8
Penaeidea	12.1	21.5	15.3	31.3	24.6	21.1	10.5	24.3	20.7
Penaeidae	3.6	17.2	12.4	7.1	16.7	15.6	10.5	24.3	20.7
Trachypenaeus spp.	3.0	15.1	9.9	4.8	8.2	9.4	1.7	2.5	3.4
Sicyonia spp.	*			1.6	6.9	4.8	8.8	21.8	17.2
Sergestidae	8.0	3.4	2.1	22.5	4.8	4.3	*		
Acetes americanus	8.0	3.4	2.1	22.4	4.8	4.3	*		
Caridea	1.7	9.7	7.0	5.5	7.7	14.0	3.5	2.0	6.9
Palaemonidae	*			0.2	0.3	0.5	*		
Pasiphaeidae	*			0.6	0.6	1.5	*		
Alphaeidae	1.4	9.0	5.8	3.1	5.4	7.9	1.8	0.2	3.4
Reptantia	7.4	11.3	23.6	24.5	19.6	41.1	43.9	38.5	51.7
Thalassinoidea	0.4	0.9	1.7	0.3	0.6	0.8	*		
Anomura	*			1.0	0.6	2.8	1.8	0.1	3.4
Brachyura	6.9	10.4	22.3	23.3	18.4	39.0	42.1	38.4	48.3
Larval Brachyura	0.2	0.3	1.2	0.6	0.1	1.3	*		
Calappidae	*			0.4	0.6	1.3	1.8	6.2	3.4
Portunidae	1.0	1.1	1.7	6.7	6.7	10.7	22.8	29.8	34.5
Goneplacidae	1.8	3.5	5.4	4.0	4.0	9.4	*		
Xanthidae	0.3	0.7	0.8	4.3	3.1	7.4	3.5	0.6	3.4
Pinnotheridae	0.4	0.7	1.7	0.3	0.1	0.8	*		
Majidae	0.2	0.3	0.8	0.3	0.3	1.1	1.8	1.2	3.4
Parthenopidae	0.1	0.2	0.4	1.2	1.0	2.3	*		
ECHINODERMATA	*			0.3	0.4	1.1	3.5	0.1	3.4
Ophiuroidea	*			0.3	0.4	1.0	3.5	0.1	3.4
CHORDATA									
Osteichthyes	5.3	10.3	9.1	7.6	20.5	17.9	14.0	28.1	27.6
Ichthyolarvae	5.3	10.3	9.1	5.9	11.9	12.0	3.0	2.9	7.0
Fishes	*			1.7	9.6	5.9	11.0	25.2	21.4
UNIDENTIFIED REMAINS	*	*	0.3	0.3	0.5	1.0	*		
Number of stomachs	330			843			47		
Number & percent full	242		(73.3%)	608		(72.1%)	29		(61.7%)
Number & percent empty	88		(26.7%)	235		(27.9%)	18		(38.3%)

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remaining taxa were of negligible importance except amphipods, stomatopods and polychaetes, each of which occurred in greater than 5% of the stomachs.

Shrimps remained the dominant food of 75-149 mm rock sea bass (Table 3), particularly penaeids, sergestids, and carideans. Their numeric percentage more than doubled from the <75 mm class; volumetric compositions (42.0%) and frequency of occurrence (54.6%) were similar between the <75 mm and the 75-149 mm size classes. Brachyuran crabs (portunids, gonoplacids and xanthids) ranked next in importance, displaying a substantial rise over the <75 mm size class. Contained in 39.0% of the stomachs, crabs constituted 23.3% of prey items and 18.4% of their volume. Ichthyolarvae and stomatopods were the other major food of 75-149 mm fish. Ichthyolarvae occurred in 17.9% of the stomachs, while stomatopods comprised 10.9% of the volume. The most notable change in feeding habits between the small and medium size classes was the great decline in the importance of mysids; they were a major food of fish <75 mm but a minor food for fish 75-150 mm (V = 0.5%). Polychaetes and amphipods were other prey identified in at least 5% of the stomachs.

Crabs, particularly portunids, dominated the diet of 150-224 mm SL rock sea bass (Table 3). This was true for all percent compositions (N = 42.1%, V = -38.4%, F = 48.3%). Fishes also attained greatest importance in large rock sea bass, ranking third in all percent compositions (N = 11.0%, V = 25.2%, F = 21.4%). Shrimp (primarily penaeids) were secondary to crabs in abundance (28.1%), volume (28.4%) and frequency of occurrence (34.5%). *Sicyonia* spp. became important in the diet of 150--224 mm fish. Ichthyolarvae, a major prey of fish <150 mm SL, were a minor food of larger fish though found in 7.0% of stomachs. The remaining taxa were of negligible importance except cephalopods, which occurred in 6.9% of the stomachs.

Diurnal Variations

Feeding activity of rock sea bass appears to be greater during the day than at night. Only 19.7% (n = 98) of 497 stomachs from day-captured fish were empty but 33.7% (n = 237) of 703 stomachs from night-captured fish were empty, the difference being significant ($X^2 = 28.3$; $p < 0.05$). Additional evidence of a higher level of activity (or avoidance) by day was the fact that CPUE of night collections was much greater than day collections (Ross and Chittenden).

Food habits for day and night collected fish were generally similar, with crustaceans, particularly decapods, the principal prey (Table 4). Shrimp predominated both periods, although *Trachypenaeus* spp. and carideans were more important during the day and *Sicyonia* spp. were more important at night. Stomatopods and mysids were also more important during the day, but crabs, particularly *Portunus* spp., were more important at night. Fishes and polychaetes were consumed equally during both periods.

Seasonal Variations

Seasonal food habits were determined from 300 stomachs in each season. Percents and numbers of full stomachs were 72.4% (n = 217) in the spring, 76.7% (n = 230) in the summer, 68.3% (n = 205) in the fall and 71.0% (n = 213) in the winter.

Overall feeding habits did not vary significantly throughout the year although the importance of individual taxa sometimes varied with season. Shrimps were the principal food in all seasons but

Table 4. Percent numerical abundance (N), percent volume displacement (V), and frequency of occurrence (F) of prey in the diet of *C. philadelphica* from the Gulf of Mexico. Percent compositions <0.1% are indicated by an asterick (*).

	Day			Night		
FOOD ITEM	N	V	F	N	V	F
MOLLUSCA	0.4	0.2	1.5	2.1	2.3	5.6
Gastropoda	0.1	*	0.3	0.6	0.3	1.7
Bivalvia	0.2	0.1	0.8	0.5	0.2	1.3
Cephalopoda	0.1	0.1	0.5	0.5	1.7	1.3
ANNELIDA	2.0	2.5	6.5	2.8	3.7	6.4
Polychaeta	2.0	2.5	6.5	2.5	3.6	5.8
ARTHROPODA						
Crustacea	89.1	78.2	90.0	89.2	74.2	86.9
Copepoda	0.1	*	0.3	0.5	*	1.3
Stomatopoda	3.1	16.5	10.3	1.6	3.2	4.5
Amphipoda	2.3	0.4	6.3	2.1	0.2	4.7
Mysidacea	34.6	2.9	22.3	9.8	0.7	10.3
Decapoda	48.7	58.0	71.4	73.9	69.9	78.3
Natantia	32.5	43.3	56.6	52.0	40.3	50.4
Larval Natantia	0.2	*	0.3	0.4	0.1	1.1
Penaeidea	17.8	25.0	25.1	32.8	26.5	15.9
Penaeidae	7.6	19.2	20.1	3.9	19.6	9.7
Trachypenaeus spp.	6.2	11.5	15.0	1.6	4.6	4.5
Sicyonia spp.	1.0	7.1	3.8	1.6	13.1	4.3
Sergestidae	9.0	3.6	2.0	27.7	4.3	4.9
Acetes americanus	9.0	3.6	2.0	27.7	4.2	4.9
Caridea	4.7	9.0	14.0	3.5	5.0	8.4
Palaemonidae	0.4	1.0	1.5	0.1	*	0.2
Pasiphaeidae	0.2	0.3	1.0	0.5	0.6	1.1
Alpheidae	2.4	5.6	8.0	2.1	4.0	5.2
Reptantia	16.2	14.7	31.8	21.9	29.6	40.3
Thalassinoidea	0.4	0.8	1.5	0.2	0.3	0.6
Anomura	0.5	0.5	1.8	0.8	0.4	1.9
Brachyura	15.3	13.4	4.0	20.9	28.6	39.1
Larval Brachyura	0.7	0.2	2.0	0.2	*	0.4
Unident. Brachyura	4.2	2.3	10.0	5.1	2.7	13.5
Calappidae	0.2	0.5	1.0	0.3	0.2	0.9
Portunidae	4.8	3.9	8.3	5.3	18.8	9.4
Goneplacidae	3.1	3.7	5.3	4.7	3.1	9.4
Xanthidae	1.6	1.9	0.8	3.1	2.7	6.9
Pinnotheridae	0.2	0.2	1.0	0.4	0.1	1.1
Majidae	0.1	0.3	0.5	0.5	0.3	1.1
Parthenopidae	0.3	0.4	1.8	1.4	1.0	2.2
ECHINODERMATA	*	*	0.5	0.5	0.6	1.3
Ophiuroidea	*	*	0.5	0.5	0.5	1.0
CHORDATA						
Osteichthyes	8.2	18.3	17.0	5.3	19.2	14.4
Ichthyolarvae	4.3	3.6	5.1	5.3	13.9	5.9
Fishes	4.2	4.3	17.0	5.3	6.0	13.8
UNIDENTIFIED REMAINS	0.3	0.7	1.2	0.2	0.1	0.4
Number of stomachs	497			703		
Number & percent full	399	(80.3%)		466		(66.3%)
Number & percent empty	98	(19.7%)		237		(33.7%)

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Table 5. Percent numerical abundance (N), percent volume displacement (V), and frequency of occurrence (F) for prey items in the diet of *C. philadelphica* from the Gulf of Mexico by season. Percent compositions <0.1% are indicated by an asterick (*).

	SPRING (Mar-May)			SUMMER (June-Aug)			FALL (Sep-Nov)			WINTER (Dec-Feb)		
FOOD ITEM	N	V	F	N	V	F	N	V	F	N	V	F
MOLLUSCA	1.6	2.3	6.0	1.1	1.9	3.0	1.3	1.9	4.0	0.6	0.1	1.4
Gastropoda	0.6	0.1	2.3	*			0.6	0.4	2.0	*		
Bivalvia	0.6	0.1	1.8	0.2	0.2	0.4	0.3	0.2	1.0	0.3	0.1	0.9
Cephalopoda	0.4	2.1	1.8	0.5	1.3	1.3	0.1	1.2	0.5	*		
ANNELIDA	2.9	2.3	9.7	2.3	4.1	6.3	0.4	0.6	1.5	3.6	6.1	9.4
Polychaeta	2.7	2.2	8.8	2.3	4.1	6.2	0.4	0.6	1.5	3.5	6.0	8.9
ARTHROPODA												
Crustacea	85.3	73.7	88.0	76.1	74.4	89.6	90.8	80.5	88.8	90.7	74.3	86.9
Copepoda	0.2	*	0.9	0.5	0.1	1.3	0.3	*	0.5	0.2	*	0.5
Stomatopoda	0.4	1.6	1.8	2.1	5.5	4.9	6.6	12.8	17.6	1.2	12.3	3.8
Amphipoda	4.9	0.8	12.0	1.4	0.3	4.3	0.7	0.1	2.0	1.0	0.2	3.3
Mysidacea	32.5	2.4	19.3	32.6	6.0	29.6	2.6	0.3	5.4	9.9	0.7	7.5
Decapoda	47.2	68.9	77.0	36.6	61.3	66.1	80.5	67.2	78.1	78.1	60.8	80.3
Natantia	20.1	36.9	51.6	18.1	32.2	37.4	67.1	41.0	58.5	64.7	49.4	67.1
Larval Natantia	10.9	9.3	34.6	9.0	8.7	22.6	11.3	6.9	26.8	18.1	10.8	37.6
Penaeidea	5.4	22.4	14.8	5.5	16.1	11.7	49.6	27.9	29.8	42.3	30.2	25.4
Unident. Penaeidea	0.9	3.0	3.7	0.5	0.2	0.9	2.4	1.9	3.9	1.3	3.3	3.3
Penaeidae	4.4	19.4	12.0	5.0	15.9	11.3	5.0	20.1	14.6	9.8	20.2	20.2
Trachypenaeus spp.	2.8	5.7	6.9	3.7	12.0	8.3	2.3	2.5	6.8	8.3	12.3	15.5
Sicyonia spp.	1.2	11.3	4.6	0.6	2.5	1.3	2.4	16.7	7.8	0.9	7.0	2.8
Sergestidae	0.1	*	0.5	0.1	*	0.1	42.2	5.9	9.3	31.2	6.7	5.2
Acetes americanus	0.1	*	0.5	*			42.2	5.9	9.3	31.2	6.7	5.2
Caridea	3.4	5.0	11.5	2.7	7.1	7.4	6.2	6.2	14.2	4.4	8.5	11.3
Misc. Caridea	0.5	0.5	1.2	0.4	0.5	0.9	0.9	0.6	2.1	0.7	0.5	1.7
Palaemonidae	0.2	0.2	0.9	0.6	2.1	1.7	0.1	0.5	0.5	*		
Pasiphaeidae	0.6	0.4	1.8	*			0.3	*	1.0	0.6	1.7	1.4
Alpheidae	1.8	3.0	6.9	1.4	4.2	3.9	3.9	4.5	8.3	2.3	6.5	7.0
Reptantia	27.1	32.0	44.2	18.5	29.1	36.5	13.3	26.2	31.2	13.4	11.4	33.3
Thalassinoidea	0.4	0.5	1.8	0.3	1.0	0.9	0.3	0.5	1.0	0.2	0.5	0.5
Anomura	0.3	0.3	1.4	0.3	0.4	0.9	0.4	0.4	1.5	1.5	0.6	3.8
Brachyura	26.3	31.2	41.5	18.0	27.8	36.5	12.6	25.3	28.8	11.8	10.3	30.5
Larval Brachyura	1.1	0.3	2.8	0.3	0.1	0.9	0.1	*	0.5	0.2	*	0.5
Calappidae	0.1	0.3	0.5	*			0.4	0.4	1.5	0.6	0.5	1.9
Portunidae	8.7	16.7	17.1	4.3	14.2	5.2	4.4	19.9	9.3	1.5	1.4	4.2
Goneplacidae	6.8	7.2	12.0	1.7	1.4	3.5	2.9	2.2	9.3	2.2	2.1	6.1
Xanthidae	2.1	1.9	5.1	3.7	4.3	7.4	1.7	1.4	4.4	2.5	3.2	6.6
Pinnotheridae	0.2	0.1	0.9	0.6	0.5	1.7	*			0.4	0.2	1.4
Majidae	0.6	0.8	2.3	0.2	0.2	0.4	*			0.3	0.2	0.9
Parthenopidae	0.9	0.9	1.6	1.5	3.1	2.6	0.1	0.1	0.5	0.6	0.4	1.4
ECHINODERMATA	0.1	*	0.5	0.2	*	0.4	0.1	*	0.5	0.4	1.1	*
Ophiuroidea	0.1	*	0.5	0.2	*	0.4	0.1	*	0.5	0.4	1.0	1.4
CHORDATA												
Osteichthyes	9.8	21.1	17.9	20.4	19.5	14.3	7.3	17.1	17.6	4.4	18.4	14.3
Ichthyolarvae	8.7	17.4	11.5	17.7	15.4	11.3	4.0	11.1	11.7	3.4	12.5	12.2
Fishes	1.1	3.8	5.5	2.7	4.1	4.4	2.3	6.0	3.9	1.0	5.9	4.2
UNIDENTIFIED REMAINS	0.3	0.7	1.4	0.1	*	0.2	0.3	0.3	0.1	0.3	0.2	0.9
Number of stomachs	300			300			300			300		
Number & percent full	217	(72.4%)		230	(76.7%)		205	(68.3%)		213	(71.0%)	
Number & percent empty	83	(27.6%)		70	(23.3%)		95	(31.7%)		87	(29.0%)	

they were fed upon more frequently and in much greater numbers during fall (N = 67.1%, F = 58.5%) and winter (N = 64.7%, F = 67.1%). Crabs were most important in spring (N = 26.3%, F = 41.5%), decreased through summer (N = 18.0%, F = 36.5%) and fall (N = 12.6%, F = 28.8%) and were least important during winter (N = 11.8%, F = 30.5%). Mysids were frequently consumed during spring and summer but were less important in fall and winter.

Other prey exhibited seasonality by a conspicuous presence or absence in the diet during one season (Table 5). Amphipods (F = 12.0%) and molluscs (F = 6.0%) were prevalant during spring and stomatopods (F = 17.6%) in fall, but in other seasons these taxa were much less frequent. The opposite was true of polychaetes which occurred in at least 6% of the stomachs during every season but fall (F = 1.5%). Predation on fishes occurred throughout the year, with F values ranging from 14.3-17.9%, although their abundance was appreciably higher in summer (N = 20.4%) than in other seasons (N = 4.4-9.8%). High summer abundance of fish in the diet reflects a large increase in the number of ichthyolarvae (17.7% summer; 3.4-8% other seasons).

Bathymetric Variations

Evaluations of feeding habits with depth were based on 795 inshore fish and 405 offshore fish. The respective percent and number of specimens with full stomachs from each area were 75.0% (n = 596) and 66.4% (n = 269).

The importance of individual taxa in the diet of rock sea bass was different between inshore and offshore depths though decapods were the dominant prey in both areas (Table 6). Shrimps, the primary foods inshore, were consumed more than twice as often inshore (68.9%) as offshore (30.9%), where they were second in importance; only sicyonids were more important in diets offshore. Similarly, mysids (21.0% inshore; 4.5% offshore), ichthyolarvae (14.1%; 5.9%, respectively) and stomatopods (9.1%; 3.0%, respectively) entered the diet more frequently and were of much greater importance inshore than offshore. The consumption of crabs and fishes exhibited the opposite trend. Brachyuran crabs, particularly portunids and gonoplacids, were third in dominance inshore but were the principal food offshore where their occurrence more than doubled (24.3% inshore; 59.9% offshore). Fishes were present in 13.8% of the offshore rock sea bass but were a minor prey inshore where they were found in less than 1% of stomachs.

DISCUSSION

The rock sea bass is a euryphagic, benthic carnivore. The diversity of organisms in their diet indicates a generalized non-specific feeding behavior. Overall, they consumed organisms representing five phyla including 32 invertebrate families and 15 fish families. Individually, 57.6% of the stomachs contained two or more classes, 31.2% three or more classes, and 15.1% four or more classes of organisms.

The prey of rock sea bass typically are closely associated with the generally soft mud or sand bottom of the continental shelf in the western Gulf (Lynch, 1954). Bivalves, polychaetes, stomatopods, penaeid and caridean shrimps, axiid lobsters and portunid, calappid and parthenopid crabs often burrow into soft sediments; goneplacid and pinnotherid crabs are commensals with burrowing invertebrates. Gammarid amphipods, harpacticoid copepods and ophiuroids also commonly inhabit soft bottoms.

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Table 6. Percent numerical abundance (N), percent volume displacement (V), and frequency of occurrence (F) of prey in the diet of *C. philadelphica* from inshore and offshore waters of the Gulf of Mexico. Percent compositions <0.1% are indicated by an asterick (*).

	INSHORE (5 to 27 m)			OFFSHORE (36 to 100 m)		
FOOD ITEM	N	V	F	N	V	F
MOLLUSCA	0.5	1.1	2.0	3.6	1.8	7.4
Gastropoda	0.1	*	0.3	1.1	0.3	2.6
Bivalvia	0.2	0.1	0.7	1.0	0.2	1.9
Cephalopoda	0.3	1.0	1.0	0.7	1.1	0.7
ANNELIDA	2.2	4.8	6.4	3.1	1.1	5.6
Polychaeta	2.2	4.8	6.4	2.6	1.0	4.5
ARTHROPODA						
Crustacea	40.7	75.7	89.6	83.4	76.2	85.5
Copepoda	0.3	0.1	1.2	*		
Stomatopoda	2.8	12.3	9.1	1.3	4.6	3.0
Amphipoda	2.1	0.4	5.7	2.6	0.2	4.8
Mysidacea	29.1	2.8	21.0	2.7	0.1	4.5
Decapoda	55.7	59.9	70.6	75.7	71.2	85.1
Natantia	43.3	47.5	68.9	33.4	33.8	30.9
Larval Natantia	10.7	10.4	30.5	17.7	7.0	29.4
Penaeidea	28.1	28.4	23.3	11.0	22.4	11.2
Penaeidae	5.9	19.0	16.8	6.0	2*	9.7
Trachypenaeus spp.	4.6	12.6	12.8	2.6	1.0	3.0
Sicyonia spp.	0.8	5.2	2.8	2.4	17.4	5.6
Sergestidae	20.8	6.1	3.9	4.4	1.2	0.7
Acetes americanus	20.7	6.0	3.9	4.4	1.2	0.7
Caridea	4.1	8.6	12.8	4.4	4.3	7.4
Palaemonidae	0.1	0.4	0.5	*		
Alpheidae	2.7	6.4	8.9	1.6	3.0	3.4
Pasiphaeidae	0.2	0.2	0.7	1.1	0.8	1.9
Reptantia	12.4	12.4	25.8	42.3	37.4	59.9
Thalassinoidea	0.3	0.7	1.2	0.3	0.4	0.7
Anomura	0.2	0.2	0.7	2.3	0.8	4.5
Brachyura	12.0	11.6	24.3	39.7	36.2	56.9
Larval Brachyura	0.6	0.1	1.5	0.2	*	0.4
Calappidae	0.1	0.2	0.3	1.0	0.6	2.2
Portunidae	3.4	2.2	5.2	11.1	25.9	17.1
Goneplacidae	1.6	3.7	6.0	9.0	2.9	12.6
Xanthidae	2.4	2.6	3.9	4.7	2.1	8.9
Pinnotheridae	0.4	0.2	1.5	*		
Majidae	0.1	0.1	0.3	0.8	0.5	1.9
Parthenopidae	*	0.1	0.3	3.6	1.7	5.2
ECHINODERMATA	*	*	0.2	0.8	0.8	2.1
Ophiuroidea	*	*	0.2	0.8	1.7	1.9
CHORDATA						
Osteichthyes	6.4	18.0	14.3	8.7	19.9	20.4
Ichthyolarvae	6.0	15.6	14.1	6.1	13.9	5.9
Fishes	0.4	2.4	0.4	2.6	6.0	13.8
UNIDENTIFIED REMAINS	0.2	0.4	0.7	0.5	0.3	1.1
Number of stomachs	795			405		
Number & percent full	596	(75.0%)		269		(66.4%)
Number & percent empty	199	(25.0%)		136		(33.6%)

However, some organisms, including *Sicyonia* spp., xanthid crabs, octopods, and *Synalpheus* sp. are often associated with mixed (shell hash, rock and/or coral rubble) bottoms (Davis, 1955; Williams, 1965; Barnes, 1968; Gosner, 1971; Fedler, 1973; Wicksten[4]).

[4]M. Wicksten, Dept. Biology, Texas A &M Univ., pers. commun.

A small component of the prey has less affinity for the bottom, suggesting rock sea bass may sometimes venture into the water column for food. *Acetes americanus* and mysids are hypoplanktonic (Davis, 1955; Barnes, 1968). Most fishes identified are typically engybenthic though ichthyolarvae and a few families (Clupeidae, Engraulidae, Stromateidae) as well as squids are characteristically pelagic (Breder and Rosen, 1966; Hoese and More, 1977; Hardy, 1978).

Our findings on diet and feeding habits generally agree with other studies on rock sea bass in the Gulf. We found shrimps, crabs, fishes and stomatopods to be major components of the diet as have Rogers (1977) and Divita *et al.* (1983). Minor differences in feeding habits were our finding mysids, and Rogers' finding squids, to be major prey. Feeding habits of rock sea bass in the Gulf differ somewhat from fish captured over North Carolina scallop grounds where fish, scallops, crabs, shrimps and ophiuroids were dominant prey (Link, 1980). However, much of this difference in diet probably reflects collections made over different bottom types. Many fish in the North Carolina study were captured from offshore scallop beds (mixed shell hash/rock bottom) while our fish were caught almost exclusively from shrimp grounds on soft mud/sand bottoms.

Morphologically, rock sea bass fit the benthic forager "convergence of body form" discussed by Davis and Birdsong (1973). They have a relatively large head and mouth, their body is not fusiform, and their tail is truncated. Thus, rock sea bass are adapted for discontinuous swimming while maintaining close association with the substrate.

The euryphagous, benthic feeding habits of rock sea bass appear to typify other small co-occurring serranids. *Serranus* spp. (Robins and Stark, 1961; Hastings and Bortone, 1980), *Serraniculus pumilio* (Hastings, 1975) and *Diplectrum* sp.. (Bortone, 1971, 1977; Bortone *et al.*, 1981) forage on heterogenous assemblages of benthic organisms including shrimps, crabs, fishes, gammarid and caprellid amphipods, mysids, ophiuroids, isopods, gastropods and polychaetes.

The changes in feeding habits that rock sea bass exhibit with increasing size and water depth reflect their gradual offshore movement with increasing age or size. Juveniles (<75 mm, 2-5 mos. old) are most abundant in 13-47 m during late spring and summer. A gradual offshore movement begins in fall and proceeds throughout their life so that fish age II and older (>150 mm) usually occur in 47-100 m depths (Ross and Chittenden). The differences in diets of small and large fish correspond with inshore-offshore differences. Small individuals captured inshore consumed smaller prey, predominately mysids, postlarval penaeids (*Penaeus* spp., *Trachypenaeus* spp.), stomatopods, and polychaetes. Offshore, large fish ate larger prey, primarily portunid crabs, *Sicyonia* spp., and fish as well as ophiuroids and molluscs. Diet for these large fish was similar to that of large rock sea bass captured on scallop beds off North Carolina (Link, 1980). Rogers (1977) and Divita *et al.* (1983) also noted for *C. philadelphica* and co-occurring *Diplectrum bivittatum* and *Serranus atrobranchus*, that small decapods and macrocrustacean epi/infauna were the most important prey in shallow waters, while macromobile organisms including larger crustaceans and fishes became more important in deep water.

Rock sea bass fed by day and night and freshly ingested prey were found in fish collected during both periods. Although more stomachs were empty at night, nocturnal food volume was greater and reflects increased predation on large organisms like crabs. Rogers (1977) reported similar temporal periodicity in rock sea bass feeding but noted it peaked during crepuscular periods.

The comparison of results of this study with other food habits studies indicate rock sea bass have an adaptable feeding mode which enables the utilization of locally abundant prey (*e.g.*, mysids, shrimps) and is not selective for any particular taxa. Omnivorous feeding was described for co-occurring serranids, bothids, triglids, sciaenids, and halieutichthids (Rogers, 1977; Divita *et al.*, 1983). The apparent incidence of relatively broad diet overlap with co-occurring species implies these fishes can take advantage of a variety of locally abundant prey. Such a feeding strategy may explain the abundance and broad bathymetric distribution (4-120 m) of rock sea bass in the western Gulf.

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