

Diet of four serranid species from the Senegalese coast (eastern tropical Atlantic)

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*Data on the diet of four serranid species with high commercial value, caught off the Senegalese coast, were determined by analyzing stomach contents. The studied fishes were the white grouper *Epinephelus aeneus*, the golden grouper *E. costae*, the dusky grouper *E. marginatus* and the comb grouper *Mycteroperca rubra*. The coefficient of vacuity and other dietary parameters were calculated. The four species fed mainly on teleosts but also on crustaceans and cephalopods, including the common *Octopus*.*

Key words: Osteichthyes, serranids, groupers, diet, Senegal, eastern tropical Atlantic

INTRODUCTION

Nine serranid species occur off the coast of Senegal (CADENAT, 1950; BLACHE *et al.*, 1971; FISCHER *et al.*, 1981; SÉRET & OPIC, 1991). They are economically important since they are used for local consumption and exported. Among them, four grouper species are particularly valued, *Epinephelus aeneus* (E. Geoffroy Saint-Hilaire, 1817), *E. costae* (Valenciennes, 1828), *E. marginatus* (Lowe, 1834) and *Mycteroperca rubra* (Bloch, 1793).

Fishermen usually eviscerate these fish as soon as they are landed. Consequently, biological observations of their reproductive biology and feeding habits are rarely available (CADENAT, 1954; FRANQUEVILLE & FRÉON, 1976; RABARISON-ANDRIAMIRADO & CAVERIVIERE, 1994; ECOUTIN & ALBARET, 2003).

Uneviscerated specimens were collected along the Senegalese shore. The digestive tracts were removed and the stomach contents analyzed. The results are reported in this paper and compared with similar data available from other marine areas such as the Azores Islands (BARREIROS & SANTOS, 1996) and the Mediterranean Sea (BOUAÏN *et al.*, 1983; BOUAÏN, 1984; DERBAL & KARA, 1996; HARMELIN & HARMELIN-VIVIEN, 1999; KARA & DERBAL, 1999).

MATERIAL AND METHODS

The specimens were collected in fishing sites off the coast of Senegal, especially the Cape Verde Peninsula (Fig. 1). Fish were caught by commercial gill nets, longlines and trawling.

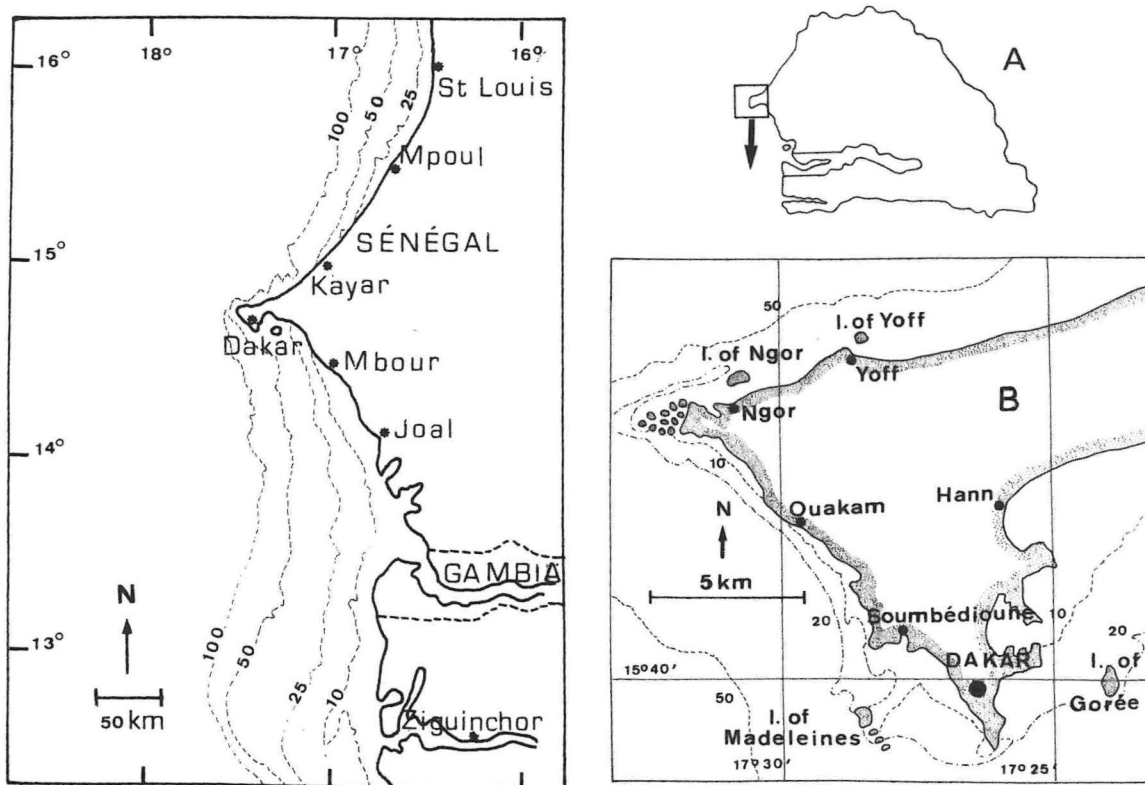


Fig. 1. A) Map of Senegal showing Cape Verde Peninsula. B) Map of western area of Cape Verde Peninsula (redrawn from Sourie, 1954) with grouper landing sites

In all, 274 specimens belonging to four seranid species were examined. Their total length (TL) was measured to the nearest millimeter. The digestive tracts were removed from the specimens and examined in the laboratory. Usually, fresh stomach contents were analyzed, they were rarely immersed in formol 10%. The entire prey or remains of prey from the stomach contents were identified by zoological group or family and, when possible, by genus or species. Entire prey were measured to the nearest mm and weighed to the nearest gram. All ingested prey were recorded and a list of prey was compiled to obtain a general picture of the diet of the predator.

The coefficient of vacuity (Cv) was calculated as the number of empty stomachs divided by the total number of stomachs studied. Qualitative and quantitative methods used in the analyses follow HUREAU (1970), HYSLOP (1980) and ROSECCHI & NOUAZE (1987).

The number of individuals (N_i) for each category of prey was recorded as well as the num-

ber of stomachs with contents (N). The index of frequency (If) is expressed as a percentage, calculated as $If = N_i/N \times 100$. Prey were divided into three categories: occasional prey when $If < 0.10$, accessory prey when $0.10 < If < 0.5$ and preferential prey when $If > 0.5$.

The index of abundance (In) was calculated as the number of prey of a certain category (n_i) in all the stomachs divided by the total number of prey (n) in all the stomachs. It is expressed as: $In = n_i/n \times 100$. The prey category may be a species, a genus or a zoological group, according to the degree of identification.

A gravimetric analysis of the stomach contents was used. The wet mass of the food was determined and a mass index (MI) was calculated as $MI = im/m \times 100$, where im is the mass of each item and m is the total mass of all the prey in a predator.

The alimentary index was defined by HUREAU (1970) as $Q = In \times MI$. Three groups of prey or prey items were preferential prey when

$Q > 200$, accessory prey when $20 = Q = 200$ and occasional prey when $Q < 20$.

The feeding habits were studied in two seasons: the cold season from November to May and the warm season from June to October. During the cold season, the water temperature is less than 20°C, during the warm season, it reached over 24°C (REBERT, 1983).

RESULTS

One hundred and sixty one *E. aeneus* were examined, 66 during the cold season and 95 during the warm season. Their *TL* ranged 400-900 mm and weight 1.4-7.9 kg. Among them, 46 specimens ranged 600-750 mm and 15

ranged 800-900 mm. During the cold season, forty-seven stomachs were empty, the coefficient of vacuity (*Cv*) was 71.2%. The stomach contents contained an abundance of teleosts (Table 1). *Sardinella aurita* ($Q = 794.4$; $MI = 42\%$) was a preferential prey while *Octopus vulgaris* ($Q = 163$) was an accessory prey with an *In* of 19%. During the warm season, only 20 of the 95 examined stomachs contained food or remains of food. The *Cv* was 78.9%. Teleosts were abundantly ingested ($Q = 6945.66$). Several species could not be identified ($Q = 2779.75$). The mollusks are represented by *Sepia officinalis* as an accessory prey. The occurrence of the crustacean *Callinectes amnicola* ($Q = 12.07$) can be considered an occasional prey in the stomachs of *A. aeneus*.

Table 1. Stomach contents of *Epinephelus aeneus*

Cold season (N=19)	<i>ni</i>	<i>im</i>	<i>Ni</i>	<i>If</i>	<i>In</i>	<i>MI</i>	<i>Q</i>
MOLLUSCS							
<i>Octopus vulgaris</i>	3	33.22	2	10.52	18.75	8.68	162.75
CRUSTACEANS							
unidentified crab	1	27.5	1	5.26	6.25	7.19	44.93
TELEOSTS							
unidentified	8	122.62	7	36.8	50	32.07	1603.5
<i>Sardinella aurita</i>	3	162	3	15.78	18.75	42.37	794.43
<i>S. maderensis</i>	1	37	1	5.26	6.25	9.67	60.43
Total teleosts					75	84.11	6308.2
Warm season (N=20)	<i>ni</i>	<i>im</i>	<i>Ni</i>	<i>If</i>	<i>In</i>	<i>MI</i>	<i>Q</i>
MOLLUSCS							
<i>Sepia officinalis</i>	1	105.5	1	5	7.69	16.29	125.25
CRUSTACEANS							
<i>Callinectes amnicola</i>	1	10.2	1	5	7.69	1.57	12.07
TELEOSTS							
unidentified	7	334.3	4	20	53.84	51.63	2779.7
<i>Sardinella aurita</i>	1	20.1	1	5	7.69	3.10	23.83
<i>Chloroscombrus chrysurus</i>	1	125.1	1	5	7.69	19.33	148.64
<i>Pagellus bellottii</i>	1	35.1	1	5	7.69	2.62	20.14
Fistularidae	1	17	1	5	7.69	2.62	20.14
Total teleosts					84.6	82.1	6945.7

ni = number of prey in all stomachs, *mi* = mass of prey in all stomachs (expressed as percent)

Ni = number of prey in all stomachs

If = $Ni/N \times 100$, where *N* is total number of stomachs with contents

In = $ni/n \times 100$, where *n* is total number of prey in stomachs

MI = $im/m \times 100$, where *im* is the mass of a category of prey and *m* is total mass of all prey in all stomachs, $Q = In \times MI$

Table 2. Stomach contents of *Epinephelus costae*

Cold season (N=5)	<i>ni</i>	<i>im</i>	<i>Ni</i>	<i>If</i>	<i>In</i>	<i>MI</i>	<i>Q</i>
TELEOSTS							
unidentified	2	6.22	1	20	50	5.13	256.5
<i>Sardinella aurita</i>	2	115	2	40	50	94.86	4743
Warm season (N=5)	<i>ni</i>	<i>im</i>	<i>Ni</i>	<i>If</i>	<i>In</i>	<i>MI</i>	<i>Q</i>
CRUSTACEANS							
<i>Penaeus notialis</i>	1	1.4	1	20	100	100	10000

Note: see Table 1.

Thirty-eight 38 *E. costae* were observed. Their total length ranged 400-850 mm and their mass 500-7000 g. Ten specimens were between 550 and 600 mm TL. During the cold season, 18 stomachs were examined, but only 5 contained food or remains of food. The coefficient of vacuity was 72.2% and all prey were teleosts (Table 2). During the warm season, only five of 20 examined stomachs had contents, the coefficient of vacuity was 75%, and a single species, the decapod crustacean, *Penaeus notialis*, was identified.

Fourteen *E. marginatus* were observed. Their total length ranged 430-850 mm and their mass 2500-7600 g. Ten specimens were over 550 mm total length. The stomach of all seven specimens during the cold season contained

food or remains of food and they fed exclusively on teleosts (Table 3). During the warm season, three of the seven specimens had ingested prey ($Cv = 57.1\%$). All were teleosts.

Sixty-one *Mycteroperca rubra* were observed. Their total length ranged 350-7000 mm and total mass 500-7000 g. Forty-seven specimens were over 500 mm. Of 44 stomachs examined during the cold season, 18 contained food or remains of food, the coefficient of vacuity reached 59.1%. Teleosts were ingested, among them a single *S. maderensis* was identified (Table 4). During the warm season, 8 of 17 stomachs contained food or remains of food ($Cv = 52.9\%$). *M. rubra* ingested teleosts ($Q = 4341.5$) exclusively.

Table 3. Stomach contents of *Epinephelus marginatus*

Cold season (N=7)	<i>ni</i>	<i>im</i>	<i>Ni</i>	<i>If</i>	<i>In</i>	<i>MI</i>	<i>Q</i>
TELEOSTS							
unidentified	1	0.10	1	14.28	50	0.09	4.5
<i>Sardinella aurita</i>	1	110	1	14.28	50	99.90	4995
Warm season (N=3)	<i>ni</i>	<i>im</i>	<i>Ni</i>	<i>If</i>	<i>In</i>	<i>MI</i>	<i>Q</i>
TELEOSTS							
unidentified	1	5.3	1	33.3	100	100	10 000

Note: see Table 1.

Table 4. Stomach contents of *Mycteroperca rubra*

Cold season (N=18)	<i>ni</i>	<i>im</i>	<i>Ni</i>	<i>If</i>	<i>In</i>	<i>MI</i>	<i>Q</i>
TELEOSTS							
unidentified	6	216	6	33.33	75	76.73	5754.75
<i>Sardinella maderensis</i>	1	60.5	1	5.55	12.5	21.49	268.62
OTHER							
unidentified	1	5	1	5.55	12.5	1.78	22.25
Warm season (N=8)	<i>ni</i>	<i>im</i>	<i>Ni</i>	<i>If</i>	<i>In</i>	<i>MI</i>	<i>Q</i>
TELEOSTS							
unidentified	4	72.1	4	50	36.36	74.10	2694.2
<i>Sardinella maderensis</i>	7	25.5	1	12.5	63.64	25.89	1647.3

Notes: see Table 1.

DISCUSSION AND CONCLUSION

The coefficients of vacuity (C_v) for all species were high (over 50%) in both seasons. This could be a consequence of the fishing method. Most of the specimens were caught by demersal gill nets where they remained captive during a rather long period and, perhaps, the food prey were more or less completely digested by the time the fish were landed. In contrast, the C_v of *E. marginatus* reached a high value during the cold season. According to HARMELIN & HARMELIN-VIVIEN (1999), "it is impossible to infer any conclusion concerning a feeding periodicity in the dusky grouper", but our observations agree with CHAUVET (1991) who reported a peak in autumn concerning the trophic activity of the species. Moreover, reproductive activity considerably reduces trophic activity in groupers even if the former does not occur throughout the year (BOUAÏN, 1984).

Teleosts were the most commonly found food item in the examined stomachs. Other zoological groups, such as crustaceans and cephalopods, were accessory or occasional prey.

There were no seasonal differences in diet except for *E. costae* that fed on crustaceans during the cold season. According to CAVERIVIERE

(1982), feeding changes in teleosts, especially groupers, is liable to both hydrological parameters and biological environment. Groupers are rather opportunist (BOUAÏN, 1984).

According to CADENAT (1935, 1954), LONGHURST (1957, 1960), FAGADE & OLANIYAN (1973) and SEMBÈNE (1995), *E. aeneus* from the western African coast feed on teleosts, among which sparids were mostly identified. RABARISON-ANDRIAMIRADO & CAVERIVIERE (1989) reported that specimens caught in Senegalese waters are rather ichthyophagous and they rarely fed on crustaceans. Moreover, they ingest *Sepia* sp., probably *S. officinalis*. BOUAÏN *et al.* (1983) reported that teleosts constitute 83% of the prey mass in stomach contents of *E. aeneus* off the southern Tunisian coast, the dominant species being the annular seabream, *Diplodus annularis*, the striped red mullet, *Mullus barbatus*, the common pandora, *Pagellus erythrinus*, and the salema, *Salpa salpa*. The mass index was 15% for crustaceans and 1.5% for molluscs.

In the other groupers of our sample, cephalopods were not identified in stomach contents. In eastern tropical Atlantic waters, a similar pattern was reported by CADENAT (1954), LONGHURST (1960), and RABARISON-ANDRIAMIRADO & CAVERIVIERE (1989) but FISCHER *et al.*

(1981) wrote that serranids mostly ingested cephalopods. In Tunisia, serranids caught in the Gulf of Gabes fed on teleosts (BOUAÏN, 1984).

Summarizing previous papers, HARMELIN & HARMELIN-VIVIEN (1999) stated that a size-related shift occurs in food preferences of the dusky grouper. They report that fish were the dominant food of smaller individuals, followed by molluscs and crustaceans; larger individuals clearly preferred *Octopus vulgaris* to fish and crustaceans. In our sample, this phenomenon was not observed. For all species, most of the examined specimens were large, yet teleosts were mainly found in the stomach contents. KARA & DERBAL (1999) reported a similar pat-

tern for specimens from the Algerian coast. At the beginning of the eighties, demographic proliferation of the common *Octopus* was reported off Senegal and in adjacent marine waters, where it is currently the dominant species of craft and industrial fisheries (CAVERIVIÈRE, 1990). Among the opinions suggested, this phenomenon could be the consequence of abundant and uncontrolled captures of the common *Octopus* by predators such as great migrant sharks and serranids (CAVERIVIÈRE, 1997). While the former opinion is not clearly proven (DIATTA *et al.*, 2001), the latter cannot be disregarded.

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Proučavanje ishrane četiriju seranida obalnih voda Senegala (istočni dio tropskog Atlantika)

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SAŽETAK

Analizom sadržaja želudaca dobiveni su podaci o ishrani četiriju primjeraka komercijalno interesantnih vrsta seranida koji su uhvaćeni u obalnim vodama Senegala (istočni dio tropskog Atlantika), a to su: bijela kirnja, *Epinephelus aeneus*, kirnja zlatica, *E. costae*, obična kirnja, *E. marginatus*, te crvena kirnja, *Mycteroperca rubra*. Izračunat je koeficijent ispražnjavanja zajedno s ostalim prehrambenim parametrima. Četiri vrste koštunjača se pretežito hrane rakovima i glavonošcima među kojima je pronađena obična hobotnica *Octopus*.

Ključne riječi: seranidi, kirnje, ishrana, Senegal, istočni dio tropskog Atlantika
