

## Food habits of groupers *Epinephelus marginatus* (Lowe, 1834) and *Epinephelus costae* (Steindachner, 1878) in the Mediterranean Coast of Spain

## Hábitos alimenticios de los meros, *Epinephelus marginatus* (Lowe, 1834) y *Epinephelus costae* (Steindachner, 1878) de la costa mediterránea de España

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### ABSTRACT

Stomach contents of *Epinephelus marginatus* were analyzed to determine their food habits and the relationship with the predator size. Also, the food habits of *Epinephelus costae* were studied and results obtained for both species were compared according to the ecological categories of preys found in the stomach contents, percentage number (N%) and frequency of occurrence (F%). Results revealed that fishes (33.3%), crustaceans (30.1%) and mollusks (36.6%) were the main preys consumed by *E. marginatus*. The main prey consumed by *Epinephelus costae* was fishes (97.1%) and mollusks (2.9%) were occasionally found inside their stomachs. Comparison of ecological categories of prey for both species indicated that *E. marginatus* fed on benthonic species and *E. costae* on pelagic species. The relation between diet and size of *E. marginatus* is discussed in the text.

**Key words:** Grouper, food habits, *Epinephelus marginatus*, *Epinephelus costae*.

### RESUMEN

Los contenidos estomacales de *E. marginatus* fueron estudiados para determinar sus hábitos alimentarios y la relación de los mismos con la talla de los individuos. También, los hábitos alimentarios de *E. costae* fueron estudiados y los resultados obtenidos para ambas especies fueron comparados en base a las categorías ecológicas de las presas halladas en los contenidos estomacales, al porcentaje en número N(%) y a la frecuencia de ocurrencia F(%). Los resultados revelaron que los peces (N 33.3 %), crustáceos (30.1%) y los moluscos (36.5%) fueron los grupos de presas principales consumidos por *E. marginatus*. Los peces (97.1%) fueron las presas más comunes en el contenido estomacal de *E. costae* y los moluscos se hallaron ocasionalmente (2.9%). La comparación de las categorías ecológicas entre ambas especies indicaron que *E. marginatus* consume preferentemente especies bentónicas y *E. costae* especies pelágicas. La relación entre la dieta y la talla de *E. marginatus*, es discutida en el texto

**Palabras clave:** Mero, hábitos alimenticios, *Epinephelus marginatus*, *Epinephelus costae*.

## INTRODUCTION

Like other groupers, the dusky grouper *Epinephelus marginatus* is considered in several countries a fish with excellent quality and it is highly valued. Traditional human exploitation techniques (e.g. diving and other activities) have caused a sharp decrease of grouper populations. It is a fact that the occurrence of this species along Spanish coasts is now becoming rare. In Spain, landings of this specie have decreased from 605 metric tons in 1978 to 0 metric tons in 1986 (FAO, 1991).

Groupers (*Osteichthyes*, *Serranidae*) are predatory carnivorous fishes that feed on a large variety of crustaceans, mollusks and other fishes. They inhabit flat rocky platforms and other rocky sites, coralliferous buildings, crevices, caves and sea grass beds (Heemstra & Randall, 1993). It seems that is in these habitats where they are able to locate the majority of their preys.

The available data of grouper food habits demonstrate that they are similar to other large predatory fish, which feed throughout the day (Vivien, 1973). Although, there are studies that suggest peaks of feeding activity during daylight (Randall & Brock, 1960) or during the night (Schroeder, 1964). It is reported that a higher feeding activity is observed before sunrise and after the sunset (Vivien, 1973).

Previous studies have focused on the feeding behavior and general analysis of food habits of *E. marginatus* (Cadenat, 1954; Neill, 1967; Bouain, 1984; Bruslé, 1985; Chauvet, 1991; Ghafir & Guerrab, 1992; Derbal & Kara, 1996). There are reports of daily changes on the diet of *E. marginatus*, indicating a peak of feeding activity at dusk (Abel, 1962) or daylight (Neill, 1967; Ghafir & Guerrab, 1992). Seasonal changes in food habits of *E. marginatus* demonstrate that the highest feeding activity can be observed throughout September and November (Chauvet, 1991). Studies of summer feeding habits demonstrate a diet composed primarily of fishes, crustaceans and cephalopods (Derbal & Kara, 1996).

On the contrary, there is a small amount of information about the biology of the goldblotch grouper, *E. costae*. These reports basically describe their reproduction cycle (Bouain and Siau, 1983) and age and growth (Bouain, 1986).

In this study we describe the food habits of groupers *E. marginatus* and *E. costae*. Their diet was compared according to the ecological categories of the preys obtained and the relationship between food habits and predator size for *E. marginatus* was described.

## MATERIAL AND METHODS

Fishes were collected along the Mediterranean Coast of Spain (North Coast of Barcelona to Tarragona and in Mallorca, Menorca and Almería Coasts) throughout one year (Figure 1). The topography of these coasts varies from rocky (flat rocky platform and other rocky sites) to large sea grass *Posidonia oceanica* (Linnaeus Delile) beds, or small rocky sites surrounded by large sand bottoms.

From 1992 to 1995 fishes were collected from sport fishing competitions. Fishes were captured by spear gun from 8:00 to 15:00 h in the afternoon, approximately, in a range of depths from 5 to 40 m. Ten fishes were collected at winter, 19 at spring, 48 at summer and 94 at autumn. Individuals of *E. marginatus* (n= 139) and *E. costae* (n= 24) had a total weight ranging from 0.325 to 20.88 Kg and 0.06 to 7.55 Kg, respectively. Captured fishes were measured for total weight (Kg), standard length (cm) and digestive tracts removed. Stomach contents were preserved entirely in 10% formalin for later analysis.

Animal preys were identified taxonomically, counted and assigned the following ecological categories: Pelagic, Benthopelagic, Suprabenthic and Epibenthic. Weight of food items present in the stomach was recorded for a few numbers of fish because it was frequent the digestion of these contents. Stomachs were considered empty when a negligible amount of unidentifiable material was present in the sample.

The relative importance of food categories was evaluated by calculating the frequency of occurrence (F%) and the percentage number (N%). Empty digestive tracts were omitted when estimating the frequency of occurrence and the percentage number (Hyslop, 1980). The mean number of ingested organism per fish (n) and a vacuity index (VI; percentage of empty guts) were also calculated. Schoener's

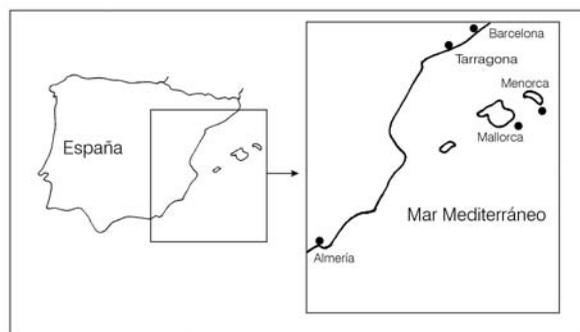


Figure 1. Map showing the Mediterranean Coast of Spain where groupers *E. marginatus* and *E. costae* were collected.

Table 1: Prey species recorded in stomachs contents of *Epinephelus marginatus*.

Occurrence	F	F (%)	N	N (%)	E
<i>Epinephelus marginatus</i>					
Pisces	59	51.3	62	33.3	
Osteichthyes indet.	33	28.7	33	17.7	
Osteichthyes	57	49.6	61	32.8	
<i>Serranidae</i> indet.	1	0.9	3	1.6	
<i>Serranus</i> sp.	1	0.9	1	0.5	Sb
<i>Chromis chromis</i>	2	1.7	3	1.6	Sb
<i>Apogon imberbis</i>	1	0.9	1	0.5	Sb
<i>Sparidae</i> indet.	2	1.7	3	1.6	
<i>Diplodus</i> sp.	1	0.9	1	0.5	Bp
<i>Pagellus acarne</i>	1	0.9	1	0.5	Bp
<i>Pagellus</i> sp.	1	0.9	1	0.5	Bp
<i>Sarpa salpa</i>	3	2.6	3	1.6	Bp
<i>Conger conger</i>	2	1.7	2	1.1	Sb
<i>Sphyaena sphyraena</i>	1	0.9	1	0.5	Pe
<i>Trachurus trachurus</i>	2	1.7	3	1.6	Pe
<i>Scorpaena</i> sp.	3	2.6	4	2.2	Sb
<i>Gadidae</i>	1	0.9	1	0.5	
Condrihthyes indet.	1	0.9	1	0.5	
Mollusca	51	44.3	68	36.6	
Mollusca indet.	1	0.9	1	0.5	
Cephalopoda	47	40.9	64	34.4	
Cephalopoda indet.	1	0.9	1	0.5	
<i>Octopus vulgaris</i>	44	38.3	60	32.3	Eb
<i>Sepia officinalis</i>	3	2.6	3	1.6	Bp
Gastropoda					
<i>Casidaria</i> sp.	1	0.9	1	0.5	Eb
<i>Murex brandaris</i>	1	0.9	1	0.5	Eb
Bivalvia					
<i>Spondilus gaederopus</i>	1	0.9	1	0.5	Eb
Arthropoda					
Crustacea	41	35.7	56	30.1	
Crustacea indet.	10	8.7	10	5.4	
Braquiura	27	23.5	38	20.4	
Braquiura indet.	8	7.0	14	7.5	
<i>Liocarcinus corrugatus</i>	9	7.8	9	4.8	Eb
<i>Pisa nodipes</i>	2	1.7	2	1.1	Eb
<i>Pisa</i> sp.	1	0.9	1	0.5	Eb
<i>Pilumnus</i> sp.	4	3.5	4	2.2	Eb
<i>Eriphia</i> sp.	2	1.7	2	1.1	Eb
<i>Maia</i> sp.	2	1.7	2	1.1	Eb
<i>Maia verrucosa</i>	1	0.9	1	0.5	Eb
<i>Calappa granulatta</i>	1	0.9	1	0.5	Eb
<i>Herbstia</i> sp.	2	1.7	2	1.1	Eb
<i>Macrura reptantia</i>	7	6.1	7	3.8	
<i>Scyllarus arctus</i>	7	6.1	7	3.8	Eb
Natantia indet.	1	0.9	1	0.5	

Percentage number (N), Frequency of occurrence (F) and Ecological Category (E). Pelagic (Pe), Benthopelagic (Bp), Suprabenthic (Sb) and Epibenthic (Eb).

index was used to measure dietary overlap between groupers of different size classes (Schoener, 1970):

$$C_{xy} = 1.0 - 0.5 (\sum |P_{xi} - P_{yi}|)$$

Where,  $P_{xi}$  and  $P_{yi}$  are the estimated proportions by number of prey (i) in the diets of size classes or collection sites (x and y, respectively). It ranges from 0, which indicate no overlap, to 1 indicating a complete overlap. Based on previous studies (Zaret and Rand, 1971; Wallace, 1981), results from the Schoener's index above 0.6 were considered as a significant dietary overlap.

Because the importance of *Octopus vulgaris* (Cuvier) as prey for every weight class a regression between weight of *O. vulgaris* and predator was conducted. Total weight of this item was retro-calculated from the measurement of the beaks (Clarke, 1986).

## RESULTS

### Qualitative and quantitative analysis of digestive tract contents

#### General trends

#### *Epinephelus marginatus*

Twenty-four of the 139 dusky groupers had empty stomachs so the analyses of their contents were limited to 115 individuals. The percentage of empty guts was 16.6% and the mean number of ingested organisms was 1.56 org/fish. A total of 186 preys were recorded, 20 families were identified and 26 preys were identified to the species or genus level.

Percentage number and frequency of occurrence of main prey are summarized in Tables 1 and 3.

Diet of *E. marginatus* was composed primarily of mollusks, fishes and crustaceans with percentages of 36.6, 33.3 and 30.1%, respectively. Fishes were ingested by 51.3% of the individuals and were composed mainly of *Sparidae* followed by *Serranidae* families. Mollusks were consumed by 44.3% of the specimens studied, being Cephalopods the most frequent (40.9%). These were mainly *Octopus vulgaris* followed by *Sepia officinalis* (Linnaeus). Crustaceans were ingested by 35.7% of the fishes and the Reptantia group the most significant category. The most frequent species found was *Liocarcinus corrugatus* (Pennant) followed by *Scyllarus arcus* (Linnaeus) and *Pilumnus* sp (Leach).

The most frequent species was *O. vulgaris*, which was ingested by 38.3% of the analyzed fish. Regression analysis between *O. vulgaris* weight and predator weight was no statistically different.

#### *Epinephelus costae*

Three individuals of this specie had empty stomachs limiting the analysis to 21 stomach contents. The percentage of empty guts was 12.5% and the mean number of ingested organisms 4.95 org/fish. A total of 104 preys were recorded, it was possible to identify 5 families and 4 preys were identified to the species or genus level. Percentage number and frequency of occurrence of prey is summarized in Tables 2 and 3.

The food items for *E. costae* were mainly fishes, being 97.1% of the total number of prey. This group was represent-

Table 2: Prey species recorded in stomachs contents of *Epinephelus costae*.

Occurrence	F	F (%)	N	N (%)	E
<i>Epinephelus costae</i>					
Pisces	17	81.0	101	97.1	
Pisces indet.	13	61.9	22	21.2	
Sparidae	4	19.0	76	73.1	
Sparidae indet.	2	9.5	2	1.9	
<i>Boops boops</i>	2	9.5	74	71.2	Pe
<i>Belone belone</i>	1	4.8	1	1.0	Pe
<i>Scorpaenidae</i> indet.	1	4.8	1	1.0	Sb
<i>Sardina pilchardus</i>	1	4.8	1	1.0	Pe
Mollusca	3	14.3	3	2.9	
Cephalopoda	3	14.3	3	2.9	
Cephalopoda indet.	2	9.5	2	1.9	
<i>Octopus vulgaris</i>	1	4.8	1	1.0	Eb

Percentage number (N), Frequency of occurrence (F) and Ecological Category (E). Pelagic (Pe), Benthopelagic (Bp), Suprabenthic (Sb) and Epibenthic (Eb).

Table 3: Percentage number (N%) and frequency of occurrence (F%) of main prey categories of *E. marginatus* and *E. costae*.

	N	CV	m	F	Crustacea			Molusca			Fish
					Nat	Rep	Ind	Octo	Deca	Gast	
<i>E. marginatus</i>	115	16.6	1.56	F	0.9	29.4	8.7	38.3	2.6	0.9	51.3
				N	0.53	24.2	5.37	32.25	1.61	1.07	33.33
<i>E. costae</i>	21	12.5	4.95	F	0.00	0.00	0.00	14.29	0.00	0.00	85.71
				N	0.00	0.00	0.00	2.88	0.00	0.00	97.12

Number of fish with stomach contents (N); Mean number of ingested organisms per fish (m); Percentage of empty guts (CV%); Natantia (Nat); Reptantia (Rep); Indeterminate (Ind); *Octopus vulgaris* (Octo); Decapoda (Deca); Gastropoda (Gast).

ed primarily by the *Sparidae* family (73.1%), and was mainly composed by *Boops boops* (Linnaeus) that represented 71.2% of the total number of prey. Mollusks of the Cephalopoda (Cuvier) class were present in a frequency of 2.9%.

**Feeding of *E. marginatus* with relation to fish size**

Fish were grouped into seven weight classes for which the percentage and frequency of the main food categories are listed in Table 4. Dietary overlap was observed in 15 of the 21 results between size classes. (Table 5).

Furthermore, the total number of mollusks and fishes increased with fish size. Our results clearly demonstrate that these preys are dominant in the diet of larger/older groupers. On the other hand, the number of crustaceans ingested decreased proportionally with fish size (Table 4).

The percentage of empty guts in the weight classes ranged from 0 to 36.3% and the mean number of ingested organisms was from 1.33 to 2 org/fish.

**Differences between species**

Percentage number (N%) and frequency of occurrence (F%) of main prey categories of *E. marginatus* and *E. costae* are presented in Table 3 and Figure 2. It seems that *E. costae* fed on fish preferably while *E. marginatus* fed on fishes, mollusks and crustaceans with similar percentages.

Epibenthic species were the main preys consumed by *E. marginatus* counting 79.7% of the total number followed by preys in the Suprabenthic category (9.3%). Pelagic and Benthopelagic preys represented 11% of the organisms consumed by this specie. The main preys for *E. costae* belong to pelagic ecological category with 97.4% of the total food consumed, followed by species related to the benthos (2.6%). The ecological categories for each prey are summarized in Tables 1 and 2.

The differences between the prey ecological categories for both species are observed in Figure 3.

**DISCUSSION**

In this study as in previous ones (Chauvet, 1991; Ghafir and Guerrab, 1992 and Derbal and Kara, 1996), fish, mollusks and crustaceans were identified as common preys for the dusky grouper, *E. marginatus*. Furthermore, similar percentages of preys (fish, mollusks and crustaceans) were found inside the stomachs. This contrasts with some studies where groups themselves like crustaceans (Derbal and Kara, 1996) or mollusks (Chauvet, 1991; Ghafir and Guerrab, 1992) or mollusks and fishes (Barreiros and Santos, 1998) were found to be the most frequent prey group. We believe that those findings are related to the small number of organisms sampled giving as a result diets composed primarily of fishes and crustaceans (Bruslé, 1985) or just fishes (Bouain, 1984).

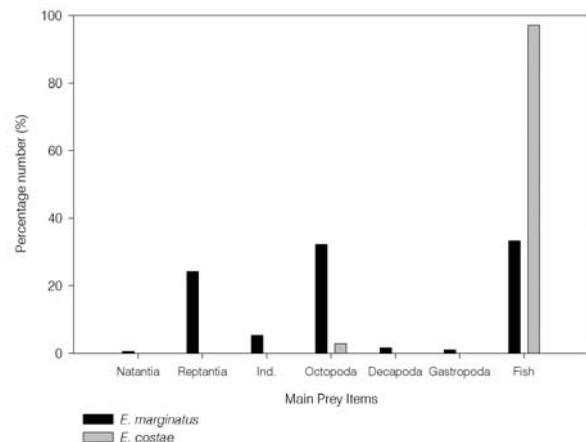


Figure 2. Main prey items and percentage number (N) found in the stomach contents of *E. marginatus* and *E. costae*.

Table 4: Percentage number (N%) and frequency of occurrence (F%) of main prey categories according to different weight of dusky grouper,

Weight (Kg)	N	CV	m	F	Crustacea			Molusca		Fish	
					Nat	Rep	Ind	Octo	Deca	Gast	
3	43	27.1	1.59	F	3.45	27.49	27.59	24.14	10.34	0.00	41.38
				N	2.17	26.09	21.74	17.39	6.52	0.00	26.09
3-6	26	10.3	1.43	F	0.00	14.29	28.57	28.57	4.76	0.00	52.38
				N	0.00	16.67	20.00	20.00	3.33	0.00	40.00
6-9	10	0	1.66	F	0.00	11.11	22.22	44.44	0.00	0.00	66.67
				N	0.00	6.67	13.33	33.33	0.00	0.00	46.67
9-12	6	25	1.33	F	0.00	0.00	16.67	83.33	16.67	0.00	16.67
				N	0.00	0.00	0.00	12.50	62.50	12.50	0.00
12-15	11	15.4	2	F	0.00	42.86	14.29	57.14	0.00	28.57	42.86
				N	0.00	21.43	7.14	35.71	0.00	14.29	21.43
15-18	9	10	1.5	F	0.00	0.00	33.33	50.00	0.00	0.00	50.00
				N	0.00	0.00	22.22	44.44	0.00	0.00	33.33
18-21	10	0	1.5	F	0.00	12.50	0.00	62.50	0.00	0.00	62.50
				N	0.00	8.33	0.00	41.67	0.00	0.00	50.00

Number of fish with stomach contents (N); Mean number of ingested organisms per fish (m); Percentage of empty guts (CV%); Natantia (Nat); Reptantia (Rep); Indeterminate (Ind); *Octopus vulgaris* (Octo); Decapoda (Deca); Gastropoda (Gast).

The results of this study are similar to those reported by Derbal and Kara (1996) for *E. marginatus* where they could identify some of the prey species reported in this study. They report the presence of *Chromis chromis* (Linnaeus), *Maja sp.*, *Scyllarus arctus* and *Octopus vulgaris*. Also, there are other studies where *O. vulgaris* has been found to be a common component of the diet of *E. marginatus* (Cadenat, 1954; Chauvet, 1991; Derbal and Kara, 1996 and Barreiros and Santos, 1998).

The majority of the preys found in the stomach contents identified were benthic species, with the exception of some pelagic species such as *Sardina pilchardus* (Walbaum) and *Trachurus trachurus* (Linnaeus). Personal observations and comments suggest that *E. marginatus* should be considered a benthic predator that feeds from species located at rocky sites and sea grass beds. Since previous research indicates that these are their natural habitats (Heemstra and Randall, 1993), we can conclude that the dusky grouper, *E. marginatus* avoids large movements to catch their preys.

Different preys were observed for the goldblotch grouper, *E. costae*, where the main ecological category of preys was found to be pelagic. Based on direct observations of the great swimming capacity and a more elongated shape

when compared with the dusky grouper, we can conclude that *E. costae* finds its preys mainly throughout the water column and prefers to feed from small size fish schools.

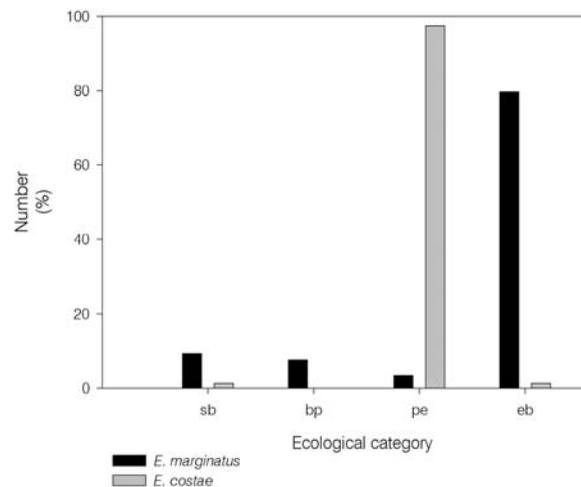


Figure 3. Prey ecological categories inside stomach contents of *E. marginatus* and *E. costae*. Pelagic (Pe); Benthopelagic (Bp); Suprabenthic (Sb); Epibenthic (Eb).

Table 5: Dietary overlap of stomach contents of dusky grouper, *E. marginatus* between size classes.

Size class Weight (Kg)		0-3	3-6	6-9	9-12	12-15	15-18	18-21
0-3	N	-	0.835	0.635	0.489	0.674	0.652	0.518
3-6	N	-	-	0.800	0.483	0.652	0.733	0.683
6-9	N	-	-	-	0.583	0.686	0.800	0.867
9-12	N	-	-	-	-	0.554	0.694	0.542
12-15	N	-	-	-	-	-	0.643	0.655
15-18	N	-	-	-	-	-	-	0.750x

Brulé and Rodríguez-Canché (1993), indicated that a high percentage of empty stomachs could be observed when specimens were caught by hook and line. They report a vacuity index of 63.4% for juveniles of *E. morio* (Valenciennes in Cuvier and Valenciennes) compared with our result of 25.2%. Also, the time of capture could influence the vacuity index as demonstrated by Derbal and Kara (1996) for *E. marginatus* captured with spear guns throughout the day. They obtained a vacuity index of 46.3%. In addition to this, net capture methods could also affect this index because often fish remain trapped long enough to allow regurgitation, partial or total digestion of the food contained inside the stomach.

Smith (1961) and Derbal and Kara (1996), concluded that food habits of groupers change with size. These results are consistent with this study were the amount of mollusks and fishes found in stomachs was more elevated with predator size, while the amount of crustaceans decreased. There are similar reports like the ones made by Brulé and Rodríguez-Canché (1993), they find that crustaceans were the primary preys in small size *E. morio*. Parrish (1987) reviewed several studies where they indicate that fish and decapod crustaceans are the dominant food preys for groupers. We found similar results for small size fish, but mollusks and fishes were predominant diet of large fish.

Derbal and Kara (1996) did not report the presence of mollusks species inside the stomachs of small size *E. marginatus*, which differs with our findings. We found these types of preys inside the stomachs of 650 g individuals, being *Cephalopods* the most predominant mollusks prey. Regression analysis between *O. vulgaris* weight and predator weight was statistically insignificant. However, we observed that the size of *O. vulgaris* generally increases with predator size although occasionally small *O. vulgaris* can also be found in large grouper stomachs.

In this study *E. marginatus* individuals were collected throughout the year, although the vacuity index fluctuated seasonally this could indicate that this specie feeds year

round. Results demonstrated a lower feeding activity in winter (CV=80%). This is probably a result of the cold waters in the Mediterranean Sea. The highest feeding activity was observed in spring (CV= 0%) followed by summer and autumn (CV=20%). These findings are different to that observed by Chauvet (1991) where higher feeding activity is observed between September and November. These differences can be attributed to variances in the methodologies followed in both studies.

There are several studies (Neill, 1967; Ghafir and Guerrab, 1992) that coincide with our findings about grouper daylight feeding activity. Brulé *et al.* (1994) in studies with *E. morio* captured during daylight conclude that it was more common to find preys inside the stomach throughout the day, but that feeding habits of groupers are not entirely diurnal as stomach contents taken from specimens captured at night were at times fresh enough to indicate recent ingestion.

Results of present and previous studies indicate that *E. marginatus* is a predator fish that feeds on a large number of different species of fishes, mollusks and crustaceans. In conclusion, crustaceans are the smallest prey in relation to fish size and they are the most common prey of the small dusky grouper. As groupers reach increase in size they consume higher amounts of larger preys such as fishes and cephalopods.

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## REFERENCES

- ABEL, E. F. 1962. Freiwasserbeobachtungen an fischen im Golf von Neapel als Beiträge zur Kenntnis ihrer Ökologie und ihres Verhaltens. *Internationale Revue der Gesamten Hydrobiologie* 47(2) : 219-290.
- BARREIROS, J.P. & R.S. SANTOS. 1998. Notes on the food habits and predatory behavior of the dusky grouper, *Epinephelus marginatus* (Lowe, 1834) (Pisces: Serranidae) in the Azores. *Arquipélago. Life and Marine Sciences* 16A : 29-35.
- BOUAIN, A. 1984. Moronidés et Serranidés (Poissons Téléostéens) du Golfe de Gabès. Ecobiologie et Halieutique. Thèse Doctorat Etat, 393 p. Univ. Tunis.
- BOUAIN, A. 1986. Croissance lineaire des merous du Golfe de Gabes (Tunisie). *Cybius* 10(3) : 215-229.
- BOUAIN A. & Y. SIAU. 1983. Observations on the female reproductive cycle and fecundity of three species of groupers (*Epinephelus*) from the Southeast Tunisian seashores. *Marine Biology* 73 : 211-220.
- BRULÉ, T. & L. G. RODRÍGUEZ CANCHÉ. 1993. Food habits of juvenile red groupers, *Epinephelus morio* (Valenciennes, 1828), from Campeche bank, Yucatan, Mexico. *Bulletin of Marine Science* 52(2) : 772-779.
- BRULÉ, T., D. ORDAZ AVILA, M. SÁNCHEZ CRESPO & C. DÉNIEL. 1994. Seasonal and diel changes in diet composition of juvenile red grouper (*Epinephelus morio*) from Campeche bank. *Bulletin of Marine Science* 55(1) : 255-262
- BRUSLÉ, J. 1985. Exposé synoptique des données biologiques sur les mérour *Epinephelus aeneus* (Geoffroy Saint Hilaire, 1809) et *Epinephelus guaza* (Linnaeus, 1758) de l'océan Atlantique et de la Méditerranée. *FAO Synopsis sur les pêches* N° 129.
- CADENAT, J. 1954. Notes d'Ichthyologie ouest-africaine. 7. Biologie-Régime alimentaire. *Buletin de l'Institut Fondamental de l'Afrique Noire. Serie A. Sciences Naturelles* 16: 564-584.
- CLARKE, M. R. 1986. *A handbook for the identification of cephalopod beak*. Clarendon Press, Oxford, U.K. 273 pp.
- CHAUVET, C. 1991. Statut d'*Epinephelus guaza* (Linnaeus, 1758) et éléments de dynamique des populations Méditerranéenne et Atlantique, pp. 255-275. In: Les Espèces marines à protéger en Méditerranée (Boudouresque C. F., Avon M. And V. Gravez, eds.) GIS Posidonie publication, Marseille.
- DERBAL, F. & M. H. KARA. 1996. Alimentation estivale du merou, *Epinephelus marginatus* (Serranidae), des cotes est Algeriennes. *Cybius* 20(3) : 295-301.
- FAO, 1991. *Bulletin of Fisheries Statistics*. N° 31. 210 p.
- GHAFIR, S. M. & K. GUERRAB. 1992. Le mérour, *Epinephelus guaza* (L. 1758) des côtes de l'ouest Algérien: éléments d'écologie et de biologie. *Memoire de fin d'études, I.S.M.A.L.* (Alger), Spécialité Halieutique: 108 p.
- HEEMSTRA, P.C. & J. E. RANDALL. 1993. FAO Species Catalogue Volume 16 *Groupers of the World (Family Serranidae, Subfamily Epinephelinae)*. Food and Agriculture Organization of the United Nations, Rome, pp. 382.
- HYSLOP, E. J. 1980. Stomach contents analysis- a review of methods and their application. *Journal of Fish Biology* 17: 411-429.
- NEILL, J.R. 1967. Observations on the behavior of the grouper species *Epinephelus guaza* and *Epinephelus alexandrinus* (Serranidae). *Underwater Association Report, (1966-1967)* : 101-110.
- PARRISH, J. D. 1987. The trophic biology of snappers and groupers. Pages 405-463 In: J. J. Polovina and S. Ralston, eds. *Tropical snappers and groupers: biology and fisheries management*. Westview Press, Boulder, Colorado.
- RANDALL, J. E. & V.E. BROCK. 1960. Observations on the ecology of Epinepheline and Lutjanid fishes of the Society Islands, with emphasis in food habits. *Transactions of American Fisheries Society* 89 : 9-16.
- SCHOENER, T. W. 1970. Nonsynchronous spatial overlap of lizards in patchy habitats. *Ecology* 51 : 408-418.
- SCHROEDER, R. 1964. Photographing the night creatures of alligator reef. *National Geographic* 125 : 128-154.
- SMITH, C.L. 1961. A revision of the American groupers: *Epinephelus* and allied genera. *Bulletin of the American Museum of Natural History* 146: 67-242.
- VIVIEN, M. L. 1973. Contribution à la connaissance de l'éthologie alimentaire de l'ichtyofaune du platier interne des récifs coralliens de Tuléar (Madagascar) *Tethys Supplément* 5: 221-308.
- WALLACE, R. K. 1981. An assessment of diet overlap indexes. *Transactions of American Fisheries Society* 110 : 72-76.
- ZARET, T. & A. S. RAND. 1971. Competition in tropical stream fishes: support for the competitive exclusion principle. *Ecology* 52 : 336-342.

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