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Feeding habits of *Aspitrigla cuculus* (L., 1758) (red gurnard), *Lepidotrigla cavillone* (Lac., 1802) (large scale gurnard) and *Trigloporus lastoviza* (Brunn., 1768) (rock gurnard) around Cyclades and Dodecanese Islands (E. Mediterranean)

A. TERRATS¹, G. PETRAKIS¹ and C. PAPACONSTANTINO¹

¹ National Centre for Marine Research, Institute of Marine Biological Resources
Aghios Kosmas, Helliniko, 16604 Athens, Greece

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Abstract

*The feeding habits of the three most abundant gurnard species, red gurnard (*Aspitrigla cuculus*), large scale gurnard (*Lepidotrigla cavillone*) and rock gurnard (*Trigloporus lastoviza*) in the eastern Mediterranean (Dodecanese and Cyclades, Greece) are examined. The stomach contents of the gurnard specimens collected in April and September 1996 by bottom trawling were analyzed. The % frequency of occurrence, % number and % weight of prey types in the stomach contents were evaluated. By weight, Mysidacea and Decapoda dominated in the diet of the three species in both seasons, however the Index of Relative Importance, as well as the percentage frequency of occurrence varied. Rock gurnard presented the most diverse diet whereas the diet of large scale and red gurnard were more specialized. High overlap in terms of number was found between rock and large scale gurnard in May. Rock gurnard had the most diverse diet in both seasons.*

Keywords: Diet, Feeding habits, Gurnards, Greek seas.

Introduction

Stomach content analysis has been used in both fisheries and ecological researches in order to describe the diet of individuals in a population, to examine the niche overlap and the competition between consumer species (LAWROR, 1980; GRAHAM & VRIJENHOEK, 1988), to understand the life history of fish species as well as the inter and intra-specific interactions (FORNEY, 1977) and for implementing a multispecies managing approach (GULLAND, 1977 & 1983; DAAN, 1989; HISLOP *et al.*, 1991; CADDY & SHARP, 1988).

The species of the Triglidae family, (gurnards) occur over all the Greek seas and

they are significant both for the Greek trawl and small scale fishery (TERRATS, 1996; PAPACONSTANTINO, 1983) and as a constituent of the ecosystem (CARAGITSOU & PAPACONSTANTINO, 1990). Gurnards are demersal fish, which inhabit the continental and insular shelves of tropical and temperate seas to depths of 500m, found on sandy, muddy or rubble substrates (FISCHER *et al.*, 1987). They use the free pectoral rays for support and for search of food (FISCHER *et al.*, 1987; TORTONESE, 1975). The family is represented in Greek waters by 7 species, piper gurnard (*Trigla lyra*), yellow gurnard (*Trigla lucerna*), rock gurnard (*Trigloporus*

lastoviza), red gurnard (*Aspitrigla cuculus*), grey gurnard (*Eutrigla gurnardus*), large scale gurnard (*Lepidotrigla cavillone*) and spiny gurnard (*Lepidotrigla dieuzeidei*) (FISHER *et al.*, 1987; PAPAConstantinou, 1988).

There are some studies about the feeding of the gurnards along the Mediterranean coasts. COLLOCA *et al.* (1997) studied the biology of the large scale gurnard and ARDIZZONE *et al.* (1994) the trophic ecology of *Trigla lucerna*, large scale gurnard, red gurnard and *Aspitrigla obscura* in Central Mediterranean. KARTAS (1971) studied the prey species composition in large scale gurnard stomachs in the Gulf of Lion. CARAGITSOU & PAPAConstantinou (1990 & 1993) studied the diet of large scale gurnard in the Greek seas and MORENO & MAtallANAS (1983) along the Catalan coasts. REYS (1960) referring to the Gulf of Marseille studied, among other Mediterranean demersal species, the feeding habits of gurnards with the exception of the genus *Lepidotrigla*. The feeding habits of piper were studied off the Catalan coast by MACPHERSON (1977 & 1979) and MORENO-AMICH (1988) and in Greek waters by CARAGITSOU & PAPAConstantinou (1993). MORENO-AMICH (1992) studied the feeding habits of red gurnard along the Catalan coast (northwestern Mediterranean).

In this paper the feeding habits of the three most abundant gurnards species, red gurnard, large scale gurnard and rock gurnard around Cyclades and Dodecanese Islands have been studied in Spring and Autumn 1996. The aim of the study is to improve the existing knowledge on the diet of these species, to examine seasonal differences and to investigate the interspecific feeding interactions estimating the overlap on the trophic niches. There are not previous studies on the diet of the above species in the area where the present study took place. Furthermore, the overlap in the trophic niche has not been examined.

Materials and methods

Fish samples for the study of the diet were collected during two bottom trawl surveys in Cyclades and Dodecanese Islands in a framework of 57 stations (Fig. 1). The surveys were performed on a hired commercial bottom trawl fishery vessel "Ioannis Rossos". The stations were chosen in order to be representative of all biotops, depth and fishing status of the area. Sampling took place only during daylight.

After being caught, fish were preserved in 4% formalin for further analysis in the labo-



Fig. 1: Map of the area with the fishing stations.

ratory. Fish with signs of regurgitation of the stomach contents, usually with the stomach partly or totally everted, were rejected.

For each specimen, length to the nearest millimeter, total and gutted weight to the nearest gram.

Individual stomach fullness index, was estimated according to the subjective scale of Lebedev (LEBEDEV, 1946) which goes from 0 (empty stomach) to 5 (stomach extremely full with stretched walls). Subsequently, stomach contents were examined under a binocular microscope. Prey organisms were identified to the lowest possible taxon, occasionally to genera or species, but usually to family order. Once counted, the individuals of the same prey items were weighted all together (precision 0.01g) after the moisture was removed by blotting them on tissue paper. In total 203 rock gurnard stomachs (101 in May and 102 in September), 209 red gurnard stomachs (103 in May and 106 in September) and 203 large scale gurnard stomachs (103 in May and 100 in September) were examined.

The contribution of each food item to the diet was expressed as percentage numerical composition (Cn), percentage gravimetric composition (Cw) and percentage frequency of occurrence (f), (HUREAU, 1966; HISLOP, 1980). The most important food items were determined using the Index of Relative Importance (IRI) according to PINKAS *et al.* (1971), which combines the above three quantities into a single numerical index.

Food overlap among the three species was assessed with the Schoener's overlap index, C_{xy} (SCHOENER, 1970):

$$C_{xy} = 1.0 - 0.5 (\sum |P_{x,i} - P_{y,i}|),$$

where P_{x,i} and P_{y,i} are the estimated proportions by number and weight of *i*th prey item in the diets of respectively species *x* and *y*. The overlap index has a minimum of 0 (no prey overlap), and a maximum of 1 (all items in equal proportions).

Diversity of food resources used by each species was measured by the most common-

ly used diversity measure, the Shannon-Weaver index (SHANNON & WEAVER, 1963):

$$H' = - \sum p_i (\log p_i),$$

where *p_i* is the proportion of the *i*th prey item in the stomach content.

Results

Length frequency distribution of the examined fish

The length of rock gurnard caught in the sampled area ranged from 5 to 25 cm (Fig. 2). In May, one single cohort was identified, whereas in September two cohorts were noted, due to young-of-the-year recruitment. The length of the red gurnard mainly ranged from 12 to 25 cm in May and from 5 to 30 cm in September (Fig. 2). The length spectrum of large scale gurnard was the same in both seasons, ranging from 4 to 14 cm. Most individuals were measured 10 cm in May, while in September another mode was observed at 6 cm.

Depth distribution

Red gurnard was fished over a wide depth range, between 100 and 288 m in May and between 97 and 266 in September. Large scale gurnard was fished between 54-180 m in May and between 54-216 m in September. Rock gurnard showed a restricted bathymetrical distribution. It was only found over the upper depths between 32 and 191 m in May and between 32 and 106 m in September.

Feeding intensity

In May 2 out of 101 examined stomachs of rock gurnard were found empty (1.98%) whereas in September 5 out of 102 stomachs were found empty (4.9%) (Table 1).

Generally, the stomachs fullness was medium. In May the average degree of fullness was 3.23 and in September was quite lower (2.61).

A higher proportion of empty stomachs

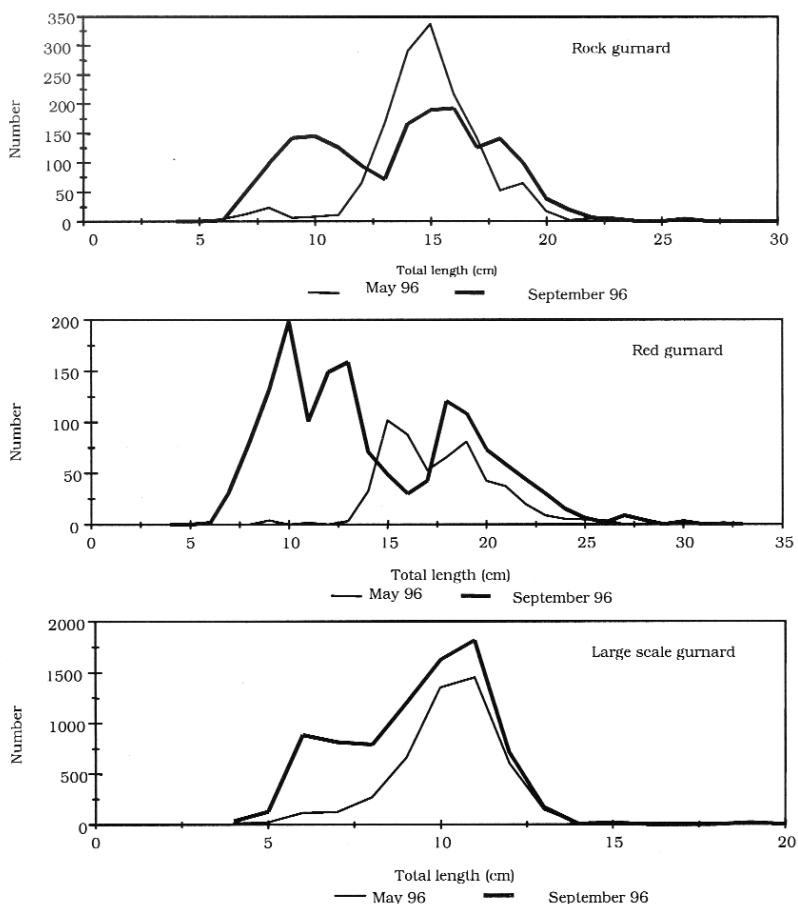


Fig. 2: Length frequency distribution of the catch of the studied species.

was observed in red gurnard than in rock gurnard in both seasons. In May 11 out of 103 (10.66%) and in September 10 out of 106 (9.63%) examined stomachs were found empty (Table 1). The average degree of fullness was almost the same in both seasons (2.71 in May and 2.52 in September).

The stomachs contained small quantity of

food in both seasons.

The proportion of empty stomachs in red gurnard was similar to the proportion of empty stomachs in large scaled gurnard. In May 10 out of 103 (9.71%) and in September 7 out of 100 (7%) examined stomachs were found empty (Table 1). The examined stomachs contained small quantity of food in

Table 1

Total number of stomachs examined, number of empty stomachs, percentage of empty stomachs and average degree of stomach fullness of the studied species.

	Species					
	Rock gurnard		Red gurnard		Large scale gurnard	
	May	September	May	September	May	September
Number of stomachs	101	102	103	106	103	100
Number of empty stomachs	2	5	11	10	10	7
% of empty stomachs	1.98	4.90	10.68	9.43	9.71	7.00
Degree of fullness	3.23	2.61	2.71	2.52	2.75	2.86

Table 2
Prey composition by number (Cn%) in the diet of the studied species per season.

Species Prey taxa Season	Rock gurnard		Red gurnard		Large scale gurnard	
	May	September	May	September	May	September
Euphausiacea	4.42	0.16	21.50	1.08	7.80	0.33
Mysidacea	43.45	12.60	14.83	17.49	40.66	34.22
<i>Lophogaster typicus</i>	2.76	1.09	40.50	12.10	20.12	32.39
<i>Paramysis hellery</i>	16.96	8.09	6.33	7.13	16.02	4.65
<i>Anchialina agilis</i>	2.44	8.71	0.83	1.51	4.31	12.29
Decapoda Natantia	0.55	0.16	1.83	0.22	2.87	
Cragonidae	2.29	1.71	0.17	1.73	0.62	0.83
<i>Aegeon sp.</i>	0.32	0.62				
<i>Pontophilus scupultus</i>		8.55		1.51		0.33
Decapoda Reptantia		0.62		0.22		0.66
Scyllaridae	0.63			0.22		
Galatheaidea	3.00		0.83		0.62	
<i>Galathea sp.</i>	3.39	12.75	1.17	7.99	0.21	1.50
<i>Munida sp.</i>	0.16		6.17	38.44	0.21	2.82
Grapsidae		1.56				
Gonoplacidae		1.56				
Pomacentridae	4.57	1.71	1.67	0.86		
Maiidae	1.03	0.62		0.22		
<i>Inachus sp.</i>	0.32	2.95	0.17			
Anisopoda		3.42				
Amphipoda	0.71	0.47		0.43	0.21	0.50
Gammaridea	4.26	11.35	1.17	0.22	5.34	2.49
<i>Lysianassa longicornis</i>	0.79		1.67		0.21	1.16
Cumacea	1.03	1.56			0.41	1.00
Isopoda	3.39	1.24	0.17	0.65	0.41	4.82
Polychaeta		2.18	0.33			
Mollusca	0.24		0.17			
Cephalopoda	1.10	1.40	0.17	0.86		
Fish	0.63					
Gobiidae		1.09		7.13		
Fish larvae	0.55		0.33			
Fish eggs	1.03	13.84				

both seasons and the average degree of fullness was 2.75 in May and 2.86 in September.

Prey composition by number

In May, the stomach contents of rock gurnard consisted mostly of Mysidacea and Decapoda reptantia (65.8% and 13.1%, respectively) followed by Amphipoda, Euphausiacea and Decapoda natantia which contributing into a lesser extent (Table 2, Fig. 3). In September, Mysidacea, Decapoda reptantia, ichthyoplankton (fish eggs) and Amphipoda were the most important preys (30.5%, 21.8%, 13.8% and 11.8%, respectively). Most abundant Mysidacea species were *Paramysis hellery* *Anchialina*

agilis. Among the Decapoda, Galatheaidea (Decapoda reptantia) and Cragonidae (Decapoda natantia) were the most abundant in both seasons. Small number of Polychaetes were present in September (2.18%).

The diet of red gurnard in May, consisted mainly of Mysidacea and Euphausiacea (62.6%, and 21.5%, respectively) (Table 2, Fig. 3). Decapoda reptantia contributed by 10%. In September Decapoda reptantia were the dominant prey contributing by 47.9% to the diet followed by Mysidacea (38.2%) and fish (7.1%). *Lophogaster typicus* was the dominant Mysidacea prey species in both seasons. The most abundant Decapoda reptantia were *Munida sp.* in both seasons.

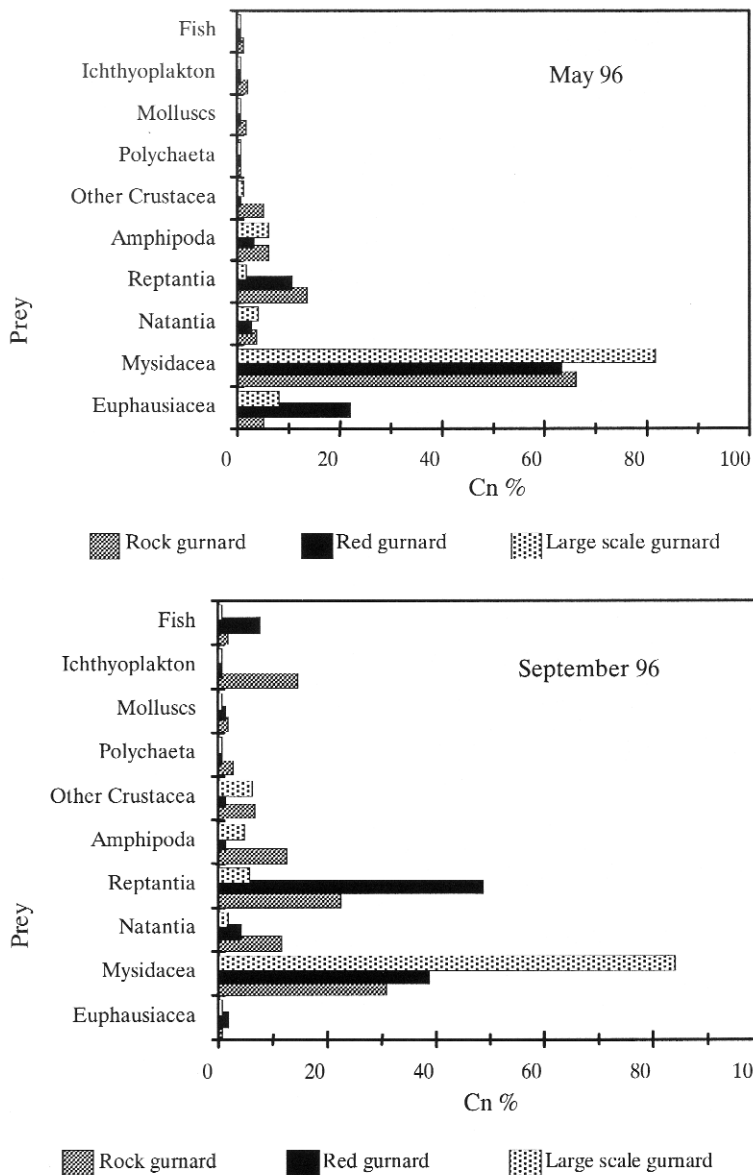


Fig. 3: Prey composition of the studied species by number (Cn%) per season.

The dominant prey in the diet of large scale gurnard in both seasons was Mysidacea (81.1% in May and 83.5% in September) (Table 2, Fig.3). In May small number of Euphausiacea and Amphipoda were found. The dominant Mysidacea species in May were *Lophogaster typicus* and *Paramysis hellery*, whereas in September were *Lophogaster typicus* and *Anchialina gilis*.

Prey composition by weight

The most important preys in the diet of rock gurnard in terms of weight in May were Decapoda reptantia (28.9%) Mysidacea (24.2%), Cephalopoda (23.3%) and Decapoda natantia (18.6%) and in September Decapoda (reptantia 44.4% and natantia 26%) (Table 3, Fig. 4). The propo-

Table 3
Prey composition by weight (Cw%) in the diet of the studied species per season.

Species Prey taxa Season	Rock gurnard		Red gurnard		Large scale gurnard	
	May	September	May	September	May	September
Euphausiacea	0.24		1.22	0.41	7.93	0.24
Mysidacea	6.39	0.77	0.32	2.19	8.49	6.55
<i>Lophogaster typicus</i>	8.26	2.22	50.26	12.47	71.71	79.27
<i>Paramysis hellery</i>	9.21	1.82	3.91	5.89	2.10	3.62
<i>Anchialina agilis</i>	0.35	2.45	0.29	0.22	1.71	1.79
Decapoda Natantia	0.61	2.09	3.35	0.30	4.37	
Crangonidae	11.86	4.39		2.76	0.89	0.70
<i>Aegeon sp.</i>	6.18	9.59				
<i>Pontophilus scupultus</i>		9.89		0.80		0.81
Decapoda Reptantia		1.98		1.21		3.21
Scyllaridae	2.01			0.43		
Galatheidea	4.79		0.32			
<i>Galathea sp.</i>	2.89	5.70	2.07	0.74		0.24
<i>Munida sp.</i>	0.31		25.64	23.09	1.96	0.86
Grapsidae		5.91				
Gonoplacidae		7.36				
Pomacentridae	13.58	13.31	5.39	2.38		
Maiidae	3.47	2.57		0.63		
<i>Inachus sp.</i>	1.86	7.58	2.86			
Anisopoda		0.38				
Amphipoda		7.92		0.31		
Gammaridea	0.92	2.79			0.58	
<i>Lysianassa longicornis</i>	0.31					0.12
Cumacea					0.14	
Isopoda	3.43	0.48		0.06	0.12	2.58
Polychaeta		1.94				
Mollusca						
Cephalopoda	23.34	5.06	3.91	7.91		
Fish			0.45	10.06		
Gobiidae		2.57		28.15		
Fish larvae						
Fish eggs		1.23				

rtion of Mysidacea and Cephalopoda in September, was much lower than in May (7.3 % and 5.1%, respectively). Among the identified Mysidacea in May, *Paramysis hellery* and *Lophogaster typicus* were the most abundant species. Crangonidae and Pomacentridae were the most abundant Decapoda preys.

In the stomach of red gurnard in terms of weight in May, Mysidacea and Decapoda reptantia contributed by 91% (54.8% and 36.3%, respectively) (Table 3, Fig. 4). In September fish was the most important prey contributing 38.2%, followed by Decapoda reptantia (28.5%) and Mysidacea (20.8%). In May the majority of the Mysidacea were *Lophogaster typicus* (50.3%) and among the

Decapoda reptantia the most important ones were *Munida sp.* (25.6%). In September fish of the Gobiidae family were most abundant (28.1%).

The most important preys in the diet of large scale gurnard in terms of weight in May and September were Mysidacea (84% and 91.2%) (Table 3, Fig. 4.). *Lophogaster typicus* was the most abundant Mysidacea species (71.7% in May and 79.2% in September).

Frequency of occurrence

In May the most frequent prey items found in rock gurnard diet were, unidentified Mysidacea (54%), *Paramysis hellery*

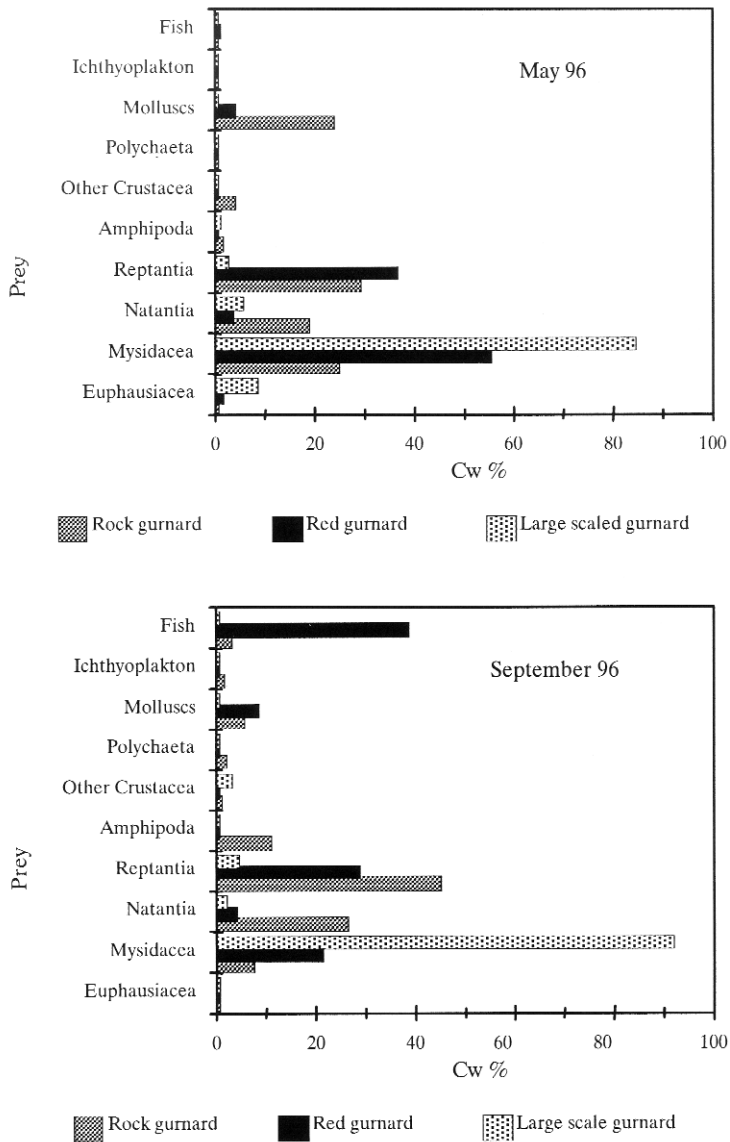


Fig. 4: Prey composition of the studied species by weight (Cw%) per season.

(41%), Pomacentridae (31%) and unidentified Gammaridae (27%) (Table 4). In September unidentified Gammaridae (38.14%), Fish eggs (25.8%), unidentified Decapoda reptantia (24.7%), unidentified Mysidacea (22.68%) and *Galathea* sp. (22.7%), were the species most frequently found.

In May, the most frequently species found in red gurnard diet *Lophogaster typicus* (58.24%), Euphausiacea (20.9%) and un-

identified Mysidacea (20.9%) (Table 4). In September, the most frequently prey species were, *Lophogaster typicus* (27.1%) Unidentified Mysidacea (24%) and Gobiidae (22.9%).

In May the most frequently species found in large scale gurnard diet were unidentified Mysidacea (51.1%), *Lophogaster typicus* (38%), *Lysiana longicornis* (13%) and Euphausiacea (13%) (Table 4). In September,

Table 4
Frequency of occurrence (F%) of the preys in the diet of the studied species per season.

Species Prey taxa Season	Rock gurnard		Red gurnard		Large scale gurnard	
	May	September	May	September	May	September
Euphausiacea	10.00	1.03	20.88	4.17	13.04	1.08
Mysidacea	54.00	22.68	15.38	23.96	51.09	44.09
<i>Lophogaster typicus</i>	24.00	6.19	58.24	27.08	38.04	45.16
<i>Paramysis hellery</i>	41.00	17.53	17.58	13.54	28.26	20.43
<i>Anchialina agilis</i>	7.00	16.49	3.30	4.17	8.70	22.58
Decapoda Natantia	5.00	1.03	9.89	1.04	5.43	
Crangonidae		4.12		1.04		4.30
<i>Aegeon sp.</i>	24.00	9.28	1.10	8.33	3.26	3.23
<i>Pontophilus scupultus</i>	4.00	3.09				
Decapoda Reptantia		24.74		6.25		2.15
Scyllaridae	5.00			1.04		
Galatheidea	22.00		3.30		1.09	
<i>Galathea sp.</i>	22.00	22.68	7.69	7.29	1.09	4.30
<i>Munida sp.</i>	1.00		12.09	18.75	1.09	5.38
Grapsidae		7.22				
Gonoplacidae		8.25				
Pomacentridae	31.00	7.22	8.79	2.08		
Maiidae	10.00	3.09		1.04		
<i>Inachus sp.</i>	4.00	13.40	1.10			
Anisopoda		5.15				
Amphipoda	6.00	1.03		2.08	1.09	2.15
Gammaridea	27.00	38.14	5.49	1.04	13.04	10.75
<i>Lysianassa longicornis</i>	6.00				1.09	7.53
Cumacea	3.00	6.19			2.17	6.45
Isopoda	14.00	7.22	1.10	3.13	2.17	8.60
Polychaeta		7.22				
Mollusca	3.00		1.10			
Cephalopoda	12.00	6.19	1.10	4.17		
Fish	4.00					
Gobiidae		6.19		22.92		
Fish larvae	6.00		2.20			
Fish eggs	5.00	25.77				

Lophogaster typicus (45.2%), unidentified Mysidacea (44.1%) and unidentified Decapoda natantia (22.6%) were the species most frequently found.

Index of Relative Importance (IRI)

During May the most important family upon which rock gurnard preyed according to the IRI was unidentified Mysidacea (2691.80), *Paramysis hellery* (1072.78) and Pomacentridae (562.71) (Table 5). Whereas in September, the most important prey species were, unidentified Gammaridae (539.66), *Galathea sp.* (418.52), fish eggs (388.36) and unidentified Mysidacea (303.13).

The most important prey species found in

May in red gurnard diet *Lophogaster typicus* (5286.3), Euphausiacea (474.34) and *Munida sp.* (384.48). In September *Munida sp.* (1153.72), Gobiidae (808.55) and unidentified Mysidacea (471.53) were the most important.

In large scaled gurnard diet, in both seasons *Lophogaster typicus* (3493.68 in May and 5042 in September) and unidentified Mysidacea (2510 in May and 1797.42 in September) were by far the most important prey species.

Food overlap between the species

There were no important seasonal changes in the diets of these species. Large

Table 5
Index of relative importance (IRI) of the preys in the diet of the studied species per season.

Species	Rock gurnard		Red gurnard		Large scale gurnard		
	Prey taxa Season	May	September	May	September	May	September
Euphausiacea		46.53	0.16	474.34	6.21	205.21	0.62
Mysidacea		2691.80	303.13	233.06	471.53	2510.94	1797.42
<i>Lophogaster typicus</i>		264.58	20.49	5286.30	665.25	3493.68	5042.83
<i>Paramysis hellery</i>		1072.78	173.65	180.08	176.25	512.05	169.01
<i>Anchialina agilis</i>		19.56	184.01	3.69	7.22	52.32	318.02
Decapoda Natantia		5.80	2.32	51.25	0.53	39.36	
Crangonidae			25.17		4.68		6.60
<i>Aegeon sp.</i>		155.87	94.73				
<i>Pontophilus scupultus</i>			57.04				
Decapoda Reptantia			64.36		8.89		8.34
Scyllaridae		13.23			0.67		
Galatheaidea		171.25		3.80		0.67	
<i>Galathea sp.</i>		138.20	418.52	24.93	63.66	0.22	7.48
<i>Munida sp.</i>		0.46		384.48	1153.72	2.36	19.79
Grapsidae			53.84				
Gonoplacidae			73.55				
Pomacentridae		562.71	108.39	62.08	6.76		
Maiidae		44.91	9.88		0.88		
<i>Inachus sp.</i>		8.70	141.14	3.33			
Anisopoda			19.60				
Amphipoda		4.26	8.64		1.55	0.22	1.07
Gammaridea		139.79	539.66	6.41	0.22	77.25	26.79
<i>Lysianassa longicornis</i>		6.57				0.22	9.62
Cumacea		3.08	9.62			1.20	6.43
Isopoda		95.54	12.46	0.18	2.20	1.15	63.67
Polychaeta			29.71				
Mollusca		0.71		0.18			
Cephalopoda		293.29	39.95	4.48	36.56		
Fish		2.52					
Gobiidae			22.65		808.55		
Fish larvae		3.31		0.73			
Fish eggs		5.13	388.36				

scale gurnard presented high overlap indexes in terms of number and weight (0.68 and 0.84 respectively) (Table 6). The diets of rock gurnard and red gurnard were similar in both seasons, ($C_{xy} = 0.42$ by number and 0.52 by weight and $C_{xy} = 0.44$ by number and 0.48 by weight respectively). Except for large scaled gurnard the degree of seasonal dietary overlap was higher in terms of biomass.

The overlap index showed some interspecific differences. Rock and red gurnard presented similar diets in terms of number (0.37 in May and 0.38 in September) and different in terms of weight (0.27 in May and 0.22 in September) (Table 6). In May the diets of rock and large scaled gurnard presented high similarity by number (0.74)

and low similarity by weight (0.20). On the other hand, in September, these species had medium similarity by number (0.36) and low similarity by weight (0.11). In May, the diets of large scale and red gurnard were highly similar by number (0.55) and by weight (0.60), whereas in September they had medium similarity by number (0.43) and low similarity by weight (0.23). The degree of dietary overlap between the species was higher in terms of number.

Diversity

According to Shannon-weaver diversity index, rock gurnard had the most diverse diet in both seasons (Table 7). Red gurnard fol-

Table 6
Schoener's overlap index between species and seasons.

Species	Season	by number	by weight
Rock gurnard	May - September	0.42	0.52
Red gurnard	May - September	0.44	0.48
Large scale gurnard	May - September	0.68	0.84
Rock - Red gurnard	May	0.37	0.27
Rock - Large scale gurnard	May	0.74	0.20
Red - Large scale gurnard	May	0.55	0.60
Rock - Red gurnard	September	0.38	0.22
Rock - Large scale gurnard	September	0.36	0.11
Red - Large scale gurnard	September	0.43	0.23

lowed and the less diverse diet among the three species studied was large scale gurnard. Diversity was generally higher in September.

Discussion

Of the 600 stomachs of gurnards examined, Crustaceans were the most numerous prey digested. Among the Crustaceans, Mysidacea were present in greatest number and also occurred most frequently in the stomachs, *Lophogaster typicus*, was the most abundant prey item. Less abundant Crustaceans included Decapoda such as Crangonidae, Galatheididae and Portunidae, but those three were the most important by weight.

The dominant role played by Crustaceans in the diet of Gurnards is confirmed by all the authors who have studied the diet of this species in different places. Nevertheless, the main taxa are different according to some authors. MORENO & MATALLANAS (1983), and CARAGITSOU & PAPAConstantinou (1990) reported that the principal prey taxa for large scale gurnard were Mysidacea and

Amphipoda. The results obtained in the present work show that the principal taxa are Mysidacea, while Amphipoda and Decapoda are not those relevant. LABARTA (1976) noted Decapoda as the main food of red gurnard, while Mysidacea were found to be of minor importance. These findings are not in accordance with the current results as Mysidacea were by far, the principal taxa found in the stomach of red gurnard in both seasons. STEVEN (1930) and REYS (1960) found Decapoda reptantia as the principal prey taxa in the stomach contents of rock gurnard. This is in agreement with the results of the present work.

Very few data are available on the abundance of the prey organisms in the environment and therefore it is not clear whether the prey species are dominant and whether they are exploited in a density-dependent manner. However, the fact that coastal benthic population in the north-eastern Mediterranean is characterized by high diversity (ELEFTherIou & SMITH, 1991) is not reflected in the stomach contents of the fish species examined. Indicating that the species are selective predators, dependent

Table 7
Shannon-Weaver diversity index by number and by weight per season per species.

Species	Season	by number
Rock gurnard	May	0.93
Rock gurnard	September	1.16
Red gurnard	May	0.78
Red gurnard	September	0.85
Large scale gurnard	May	0.75
Large scale gurnard	September	0.77

mostly on one or two specific food organisms.

Rock gurnard had higher diversity values, highest degree of fullness and less empty stomachs than the other studied species. It has to be taken into account that rock gurnard is found in shallower waters than large scale and red gurnard, and therefore the availability of prey is different in the depth interval. Highest production occurs in shallow waters and close to the shore, and drops off relatively rapidly with depth (CADDY & SHARP, 1988) that could be an explanation for the higher diversity of prey in rock gurnard diet.

Mysidacea were the preferred consumed prey of large-scale gurnard and red gurnard in both seasons among which *Lophogaster typicus* was the most abundant single prey item. *L. typicus* is a planktonic species which undertakes nocturnal migrations (HATZAKIS, 1982). According to HATZAKIS (1982), catch rates of Mysidacea along the Greek coasts are highest near the bottom during the day and at the surface a few hours later (night). Taking into account that *L. typicus* is only found above 100 m during the night time (FRANQUEVILLE, 1971), and the bathymetrical distribution of these species, in the studied area, 54-216 m for large scale gurnard and 100-288 m for red gurnard, it can be said that red gurnard and large scale gurnard fed upon Mysidacea mainly during the day light period and upon the other benthic less active species during the night.

It should be pointed out that most of the prey species encountered in the stomach even though relatively big in size (Crangonidae, Galatheididae and Gobiidae) were found entire. This point, along with the fact that small stones and mud were present, suggests that the gurnards studied are chiefly sucker feeders. These species may swim over mud bottoms, passively wait for and consume the organisms encountered by sucking up and shifting through large quantities of mud. This is indicated especially by

the elongated jaws ensuring control over a large water volume and enabling the organism to catch prey in it.

Schoener's index values above 0.60 are usually considered to be biologically significant (ZARET & RAND, 1971; WALLACE, 1981). The value of the overlap index is sensitive to the taxonomic level at which food items are identified (STERGIOU, 1988). This renders any statistical method for the evaluation of the absolute value of the index unsuitable. Hence Langton's (1982) convention has been used: 0.00-0.29, low similarity; 0.30-0.60, medium similarity; >0.60 high similarity. ABRAMS (1980, 1982) has recently argued that Schoener's measure is one of the best indices for quantifying the similarity in resource use between species.

The diet of these species did not change through the year, as no relative differences were found between spring and autumn. The high overlap between rock gurnard and large scale gurnard in May in terms of number indicates that the two species fed on the same kind of food, mainly Mysidacea. The interpretation for the lower values of the overlap between the three species in terms of biomass is the change in the availability of big prey (Decapoda) which have a lower contribution in the diet of large scaled gurnard and red gurnard. Availability depends not only on prey abundance, but also on the interaction of other factors, including prey size, microdistribution, capture success and speed of movement (BAILEY & HARRISON, 1984; GRIFFITHS, 1975).

Sampling took place only during daylight and it was not possible to examine the feeding intensity around the clock. Differences in the degree of fullness and the composition of the preys could be better explained knowing the period when the fish were more active. The three gurnard species that were the subject of this study coexist in the same area. There are differences in the bathymetrical distribution and in the food overlap, even all of them feed mainly on Crusta-

ceans. These differences are the most important mechanism, which allows the coexistence of the three species.

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