Food habits of the hollowsnout grenadier, *Caelorinchus caelorhincus* (Risso, 1810), in the Aegean Sea, Turkey

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ABSTRACT. Stomach contents of 148 hollowsnout grenadier, *Caelorinchus caelorhincus* (RISSO, 1810), were examined. Crustaceans were found to be most important prey group in the diet. Polychaetes constituted the second most important prey group. Chaetognathans were only occasionally eaten.

KEY WORDS : *Caelorinchus caelorhincus*, food habits, diet, Aegean Sea.

INTRODUCTION

The hollowsnout grenadier, *Caelorinchus caelorhincus* (Risso, 1810), is a benthopelagic species that lives at depths between 200 and 500m, but has been captured in waters as shallow as 90m and as deep as 850m. (COHEN et al., 1990). However, FROESE & PAULY (2006) gave a depth range of 1250m as the vertical distribution of *C. caelorhincus*. The species displays a "bigger-deeper" phenomenon (POLLONI et al., 1979) with smaller individuals distributed in shallower waters (<400m) and larger individuals in deeper (>500m) (MADURELL et al., 2004). This may indicate ontogenetic migrations of the species toward deep waters (MORANTA et al., 1998; LABROPOULOU & PAPAOCONSTANTINOU, 2000; MADURELL et al., 2004). The hollowsnout grenadier has a wide distribution from the Mediterranean northward to southern Norway and across to the Shetlands, the Faroes, off southern Iceland and south-eastern Greenland (WHITEHEAD et al., 1984; COHEN et al., 1990). The hollowsnout grenadier is also known from the Mediterranean coast of Turkey (BILECENOGLU et al., 2002).

The community structure (MORANTA et al., 1998; LABROPOULOU & PAPAOCONSTANTINOU, 2000; MADURELL et al., 2004), and age and growth (MASSUTI et al., 1995; D'ONGHIA et al., 2000; FILIZ et al., 2006) of this species were studied by various researchers in the Mediterranean. Length-weight relationships for this species are given by DIAZ et al. (2000), BORGES et al. (2003), MOREY et al. (2003), FILIZ & BILGE (2004), and FILIZ et al. (2006).

In the Aegean Sea, the three Macrourids (*C. caelorhynchus*, *Hymenocephalus italicus* and *Nezumia sclerorhynchus*) are often caught by commercial trawlers targeting deep-water shrimps, *Parapaneus longirostris* (Lucas, 1846) and *Plesionika heterocarpus* (Costa, 1871).

This paper provides the first information on the food habits of *C. caelorhynchus*, one of the most abundant bycatches (no commercial value) in the shrimp trawl fishery in Sigacik Bay; the eastern Aegean Sea, Turkey.

MATERIALS AND METHODS

We sampled 148 (ranging from 113 to 123mm total length) hollowsnout grenadiers on board a 23m commercial fishing vessel (F/V Hapuloglu; 550HP) on 22 March 2003 in Sigacik Bay, Aegean Sea (Fig. 1). A conventional bottom trawl net of 24mm cod-end mesh size was used and three hauls in same day were carried out from dawn to dusk and haul durations ranged from 1 to 3h. The vessel speed was maintained at 2.2-2.5 knots. Dept range of fishing ground was 145-296m (Table 1). The stomachs were individually preserved in 4% buffered formalin for 24 hours, stored in 70% ethanol in marked containers, and analyzed over some months.

Prey items in each stomach were identified to group level, measured, counted and weighed on an electronic balance (precision 0.0001g). Since the copepods were the principal prey group, we paid much more attention to this group and they were identified to the lowest possible taxonomic level.

Diet composition was evaluated using three measures described by HYSLOP (1980): the numerical index (%N); the gravimetric index (%W), and frequency of occurrence (%F). Based on CORTES' (1997) suggestion, the index of relative importance (IRI) was calculated and expressed as a percentage (%IRI).

Subsequently, food items were grouped into categories of preference using the method proposed by MORATO et al. (1998). The categories were defined as follows:

$IRI \geq 30*(0.15*\sum\%O)$. . . . main important prey (MIP)

$30*(0.15*\sum\%O) > IRI > 10*(0.05*\sum\%O)$ . . . . secondary prey (SP)

$IRI \leq 10*(0.05*\sum\%O)$. . . . . occasional prey (OP)

This formula was used for the fist time by Morato in 1995 during a study on feeding habits of *Serranus atricauda* (Personal com. with Morato), but the details of this formula were not given (MORATO et al., 1998). The most commonly used index is the one proposed by HUREAU (1970): Q=(%Nx%W). HUREAU (1970) classified prey as *Preferential* (if Q>=200), Secondary (if 20<Q<200) and Accidental (Q<20). Based on these limits (let take Q>200 as an example) we can calculate the minimum value each variable may have to be classified as preferential: [SORT(200)=14.14]. So, we have assumed that in order for a prey to be classified as preferential, it has to reach at least 15% for each of the variables. Transposing this to the IRI, where IRI=(%N+%W)x%O, we have that for a prey to be classified as preferential it should have 15% of the total %N+15% of the total %Wx15% of the total %O. We know that %N and %W sum 100%, but %O may sum more than 100%. Thus, the formula can be expressed as: (0.15*100+0.15*100)*0.15*%O. The lower limit was calculated assuming 5%: [(0.05*100+0.05*100) * (0.05*∑%O) or 10*(0.05*∑%O)].

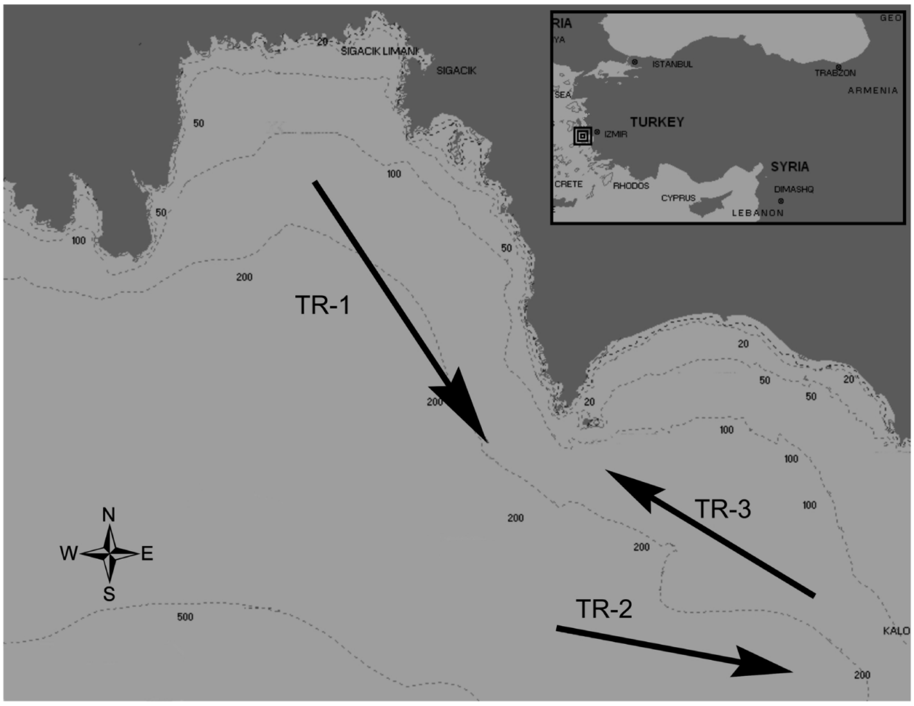

Fig. 1. – Map showing the location where sampling was carried out.

TABLE 1

Sampling locality and depths of specimens collected of *C. caelorinchus fr*om the Aegean Sea, Turkey.

Trawl No	Coordinates (trawl start)	Coordinates (trawl end)	Depth (m)
TR-1	37°88’290 N 26°42’980 E	38°00’760 N 26°49’270 E	150-180
TR-2	37°55’280 N 26°51’990 E	37°54’110 N 27°00’430 E	296-296
TR-3	37°56’286 N 27°01’215 E	37°59’754 N 26°54’075 E	145-165

RESULTS AND DISCUSSION

Of the 148 hollowsnout grenadier stomachs examined, 146 had food (98.6%) and 2 were empty (1.4%). Crustaceans were found to be most important prey group (MIP; IRI≥1196) in the diet. Polychaetes constituted the secondary prey group (SP; 1196>IRI>133), whereas chaetognathans were an occasional prey group (OP; IRI≤133). Crustaceans (especially copepods and decapods) constituted of 98.42% of the diet. Polychaetes and chaetognathans comprised 1.51% and 0.07% of the diet, respectively (Table 2).

Several studies of the diet of this species have been carried out in the north-west Atlantic (Langton & Bowman, 1980), north-east Atlantic (Mauchline & Gordon, 1984) and in the Mediterranean (Macpherson, 1979; 1981; Madurell & Cartes, 2006). Macpherson (1979) examined stomach contents of 160 specimens ranging from 5.0cm to 39.0cm TL and reported that the diet of *C. caelorhincus* consisted of polychaetes (%W=74.2) and benthic crustaceans (%W=25.8) for fish between 10.0-19.0cm TL. Macpherson (1981) also recorded both polychaetes (62.7%) and benthic crustaceans (37.3%) in the stomachs of this species. Langton & Bowman (1980) studied 11 specimens (mean fork length=19.3cm) and found that diet constituted of detritus (36.6%), polychaetes (35.8%) and crustaceans (27.6%). Finally, Madurell & Cartes (2006) examined 877 specimens (between 2.5 and 8.5cm; pre-anal length) for diet composition and stated that polychaetes (58.12% IRI) were the dominant prey for this species, followed by amphipods (19.13% IRI) and copepods (14.42% IRI). Macrourids are characteristically described as generalist feeders, with widely diversified diets (Macpherson, 1979; Mauchline & Gordon, 1984). This probably constitutes an adaptive advantage in the deep-water environments of low productivity inhabited by macrourids (Madurell & Cartes, 2006).

TABLE 2

Percent number (%N), percent weight (%W), frequency of occurrence (%F), index of relative importance (IRI) and percent index of relative importance (%IRI) calculated for each prey item found in the hollowsnout grenadier *C. caelorhincus.*

Prey Items	%N	%W	%F	IRI	%IRI
Polychaeta (larvae)	1.93	7.31	26.03	240.49	1.51
Crustacea*	97.22	92.36	95.89	15651.94	98.42
Copepoda°(pelagic)	74.71	45.54	89.04	10706.94	67.32
Calanoida	11.70	3.01	53.85	791.87	7.22
Nannocalanus minor	0.21	0.31	1.54	0.80	0.01
Calanus gracilis	0.31	0.52	1.54	1.28	0.01
Clausocalanus arcuicornis	0.10	3.36	1.54	5.33	0.05
Clausocalanus sp.	0.21	0.47	3.08	2.10	0.02
Temora stylifera	1.24	0.72	9.23	18.11	0.17
Scolecithrix bradyi	0.31	1.13	1.54	2.22	0.02
Aetideus armatus	80.54	27.11	92.31	9937.02	90.58
Pleuromamma abdominalis	0.21	4.04	3.08	13.06	0.12
Pleuromamma gracilis	0.10	0.20	1.54	0.47	0.00
Lucicutia flavicornis	0.10	0.31	1.54	0.64	0.01
Candacia aethiopica	0.10	1.29	1.54	2.14	0.02
Candacia armata	0.93	1.26	12.31	26.95	0.25
Candacia bispinosa	0.10	0.76	1.54	1.32	0.01
Candacia simplex	0.41	0.56	6.15	5.97	0.05
Candacia sp.	0.21	0.37	3.08	1.79	0.02
Acartia clausi	0.10	0.61	1.54	1.10	0.01
Acartia sp.	0.10	52.47	1.54	80.88	0.74
Cyclopoida	0.21	0.38	3.08	1.82	0.02
Oncaea media	0.10	0.59	1.54	1.07	0.01
Corycaeus typicus	2.69	0.53	23.08	74.31	0.68
Mysidacea	1.93	2.80	23.29	110.19	0.69
Amphipoda	0.23	2.05	4.11	9.36	0.06
Isopoda					
Gnathia vorax	0.54	1.08	9.59	15.50	0.10
Euphausiacea	0.54	9.28	2.75	26.92	0.17
Decapoda	18.87	30.95	95.89	4777.25	30.04
Brachyura (megalopa stage)	0.39	0.67	5.38	5.78	0.04
Chaetognatha	0.85	0.34	9.59	11.38	0.07
Sagitta spp.					

* The values calculated for all prey groups of Crustaceans and Copepods.

In contrast to our findings, the general impression of the previous studies is that hollowsnout grenadier predominantly feeds on polychaetes. In our study, however, copepoda and decapoda are the most dominant prey groups in the diet of this species. In our stomach contents analyses, pelagic copepoda, euphausiacea and chaetognatha of the holoplanktonic groups and brachyura (the megalopa stage) and polychaetes (the larval stage) of the meroplanktonic groups were found. Some benthic organisms including Amphipoda, mysidacea, isopoda and decapoda were also encountered in the stomachs of the species in our study. The pelagic groups were, however, found to be more dominant than the benthic groups in the diet of the species. Consequently, early juveniles of this species feed more on pelagic and less on benthic prey at our study site.

Aetideus armatus was found to be the dominant species of Copepoda in the diet of *C. caelorhynchus*. According to the results of the deep-sea zooplanktonic studies carried out in the Aegean Sea (Moraitou-Apostolopoulou, 1972), *Aetideus armatus* is more abundant than the other calanoid copepods. While the neritic species of copepoda such as *Temora stylifera, Acartia clause* and *Nannocalanus minor* are limited in number, the oceanic species are highly abundant (Table 2). This finding is consistent with the environment where the species lives.

The hollowsnout grenadier mouth shape has been suggested to have an effect on its feeding behaviour. It has an inferiorly positioned mouth and may forage on slow moving prey with the snout orientated towards the substrate (Madurell & Cartes, 2006). Madurell & Cartes (2006) claimed that hollowsnout grenadier has mostly a benthic diet and probably uses the rostrum to root in the sediment since infaunal organisms like polychaetes were common dietary items. As indicated above, in their study, they determined that polychaetes were the dominant prey for this species, followed by amphipods and copepods, according to the values of IRIs they computed. Although the %F value given by Madurell & Cartes (2006) for copepods was 64.5 (quite a high value in the overall stomach contents of *C. caelorhynchus*), the authors classified this group as being of unidentified habits since we know nothing about whether these are pelagic or benthic copepods. On the other hand, ontogenetic migrations of the species toward deep waters (Moranta et al., 1998; Labropoulou & Papaoconstantinou, 2000; Madurell et al.,

2004) have been well documented, i.e., smaller individuals reside in shallower waters (<400m) and larger individuals in deeper waters (>500m). Consequently, given the low occurrence of benthic organisms and the high occurrence of pelagic organisms in the stomachs of fish in our study may indicate ontogenetically based food preferences of *C. caelorhynchus* in the Aegean Sea.

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