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RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

Diet composition of the five deep sea fish from the Aegean Sea

Ege Denizi'nde dağılım gösteren beş derin deniz balığının diyet kompozisyonu

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Özet: Ege Denizi'nde bulunan beş derin deniz balığı: *Argentina sphyraena*, *Glossanodon leioglossus, Chlorophthalmus agassizi, Hoplostethus mediterraneus* ve *Capros aper* 2003 bahar mevsimi süresince ticari trol balıkçıları tarafından hedef dışı av olarak elde edilen örnekler olarak çalışılmıştır. Türlerin besin kompozisyonlarını belirlemek için mide içerikleri incelenmiştir ve türlerin trofik durumlarının özellikle karnivor seviyede yer aldığı görülmüştür. Beş predator türün besin kompozisyonunda iki esas av grubu bulunmuştur: Crustacea (copepodlar ve isopodlar gibi) ve Chaetognatha (*Sagitta* spp.).

***Anahtar kelimeler*:** Diyet kompozisyonu, av, besin, derin deniz balıkları, Ege Denizi, Sığacık Körfezi.

Abstract: The diets of five deep sea fish: *Argentina sphyraena, Glossanodon leioglossus, Chlorophthalmus agassizi, Hoplostethus mediterraneus* and *Capros aper* from the Aegean Sea were examined in the specimens caught as bycatch and discarded by commercial trawl fisheries during 2003 spring. Stomach contents were analyzed to determine their diet composition, which indicates that the trophic status of these species can be assigned primarily to the carnivore guild. Two major prey groups were found in the diet composition of all five predators: Crustaceans (like copepods and isopods), and Chaetognathans (*Sagitta* spp.).

***Keywords*:** Diet composition, prey, food, deep sea fish, Aegean Sea, Sıgacik Bay.

INTRODUCTION

Below the euphotic zone is the realm of deep sea fishes. The depth zones of this major portion of the earth's oceans have been characterized by the physical feature and types of organisms present (Neighbors and Wilson 2006). In recent years, sustainable exploitation of natural sources has been increasingly enhanced. Deep water communities have received an increasing attention at a global scale because of the interest in new catching grounds and fisheries at bathyal depths (Cartes *et al.,* 2002). Moreover deep sea fisheries is a relatively new phenomenon, with deep sea ecosystems now being the ultimate target of industrial fisheries all over the world (Cartes *et al.,* 2004). Deep sea assemblages have only been identified in the western basin, while no such studies have been conducted in the eastern one (D'Onghia *et al.,* 2004).

In general, research on the feeding habits of deep sea fish has mainly focused on depth-related changes, whereas only few studies have dealt with aspects of seasonal or diel feeding cycles, primarily because of the difficulty to collect samples at such depths (Madurel and Cartes 2005). On the other hands, data of diet composition play a key role in fisheries research (Stergiou and Karpouzi 2002). Quality and quantity of food are among the most important exogenous factors to directly affect growth, maturation and mortality in fish, thus being ultimately related to fitness (Wootton, 1990).

Argentine, *A. sphyraena* has a wide distribution along all Turkish coasts except the Black Sea (Bilecenoglu *et al.,* 2002). It lives mainly on bottom-living polychaetes, molluscs, crustaceans, pelagic invertebrates and fishes (Cohen, 1984). The diets of this species have not in detail been described across Turkish and other seas.

Small-toothed argentine, *Glossanodon leioglossus*, has recently been recorded from the Aegean Sea and captured species for the first time recorded in the Turkish seas in 2005 (Bilecenoglu *et al.,* 2005). This study is the first attempt to describe diet of this species primarily since little is known about diet of this species, although Cohen (1984) reported that pelagic crustaceans occurred in diet, which has not comprehensively defined in Turkish and other seas as in *A. sphyraena.*

The shortnose greeneye, *Chlorophthalmus agassizi*, is a demersal fish that lives across the continental shelf and upper slope over muddy and clay bottoms of the Atlantic Ocean. It is also an abundant bycatch species of trawl fishing in the central and eastern basins of the Mediterranean Sea (Fischer *et al.,* 1987). The diet of *C. agassizii* consists mainly of bottom dwelling invertebrates (Sulak, 1984). It plays an important role in the Mediterranean deep sea assemblages (D'Onghia *et al.,* 1998). Therefore, much data of diet composition of *C. agassizi* in the Mediterranean Sea has been presented. Kabasakal (1999) and Macpherson and Roel (1987) published only preliminary results about the diet of several species, including *C. agassizi*, caught in the north eastern Aegean Sea and in Namibian coasts, respectively. Anastasopoulou and Kapiris (2008) studied on feeding ecology of this species, size and months in Ionian Sea.

The Mediterranean slimehead, *Hoplostethus mediterraneus*, is a common demersal fish in the north-eastern Atlantic and in the Mediterranean and also found in the Indian and South Pacific Oceans. The diet of *H. mediterraneus* is composed of some fragments of crustaceans (Maul, 1986). Caught as bycatch during bathyal trawling and of low commercial value, it is an abundant species on the middle slope in the eastern Mediterranean (Kallianiotis *et al.,* 2000; Labropoulou and Papaconstantinou 2000; Madurell *et al.,* 2004). In spite of being common as a bycatch in many fisheries, this species has received relatively little scientific attention and many aspects of its biology have yet to be known (Pais, 2002). The diets of this species consistently described as a benthopelagic feeder (Gordon and Duncan 1987; Kerstan, 1989; Pais, 2002) has not thus far described in Aegean Sea.

Boarfish, *C. aper*, prevails as a schooling species in Atlantic, northward to western Scotland, occasionally Shetlands Skagerrak and western Norway, also in Mediterranean (mainly western part), and feeds mainly on crustaceans, worms and molluscs (Quéro, 1984). The diets of *C. aper* have been studied in different sections of the Mediterranean (Macpherson, 1979; Santos and Borges 2001). A comprehensive study on biology of *C. aper* in Aegean Sea has just briefly touched on its diet composition (Kaya and Özaydın 1996).

The feeding habits of some deep see fish species have been studied in different parts of the western Mediterranean. In the Aegean Sea, however, only a few studies have been carried out on *C.aper* (Kaya and Özaydın 1996), *C. agassizi* and *H. mediterraneus* (Kabasakal, 1999) but the diets of *A. sphyraena* and *G. leioglossus* have not been described. Thus, the main purpose of this report is to provide basic data of diet composition of the fish caught in the Aegean Sea, which indicates feeding habits of the unexploited deep sea fish in the area.

MATERIALS AND METHODS

Accidentally caught specimens (bycatch) were obtained from deepwater by commercial trawlers to catch crustacean and fish in Sigacik Bay located between 38° 12' 0 N latitude and 26° 45' 0 E longitude in the Turkish coast of Aegean Sea. Sampling was merely conducted between March and May 2003 at the depths in 150-473 meters. A conventional bottom trawl net of 44 mm codend mesh size was used and three hauls on the same day carried out from dawn to dusk and haul durations ranged from 1 to 3 h. The vessel speed was maintained at 2.2-2.5 knots. Overall, 408 deep sea fish specimens [72 *Argentina sphyraena* (75-165 mm TL), 32 *Glossanodon leioglossus* (82-125 mm TL), 122 *Chlorophthalmus agassizi* (88-175 mm TL), 108 *Hoplostethus mediterraneus* (106-170 mm TL) and 74 *Capros aper* (42-69 mm TL)] were considered in order to analyze the stomach contents. The stomachs were individually preserved in 4% buffered formalin for 24 hours, stored in 70% ethanol in marked containers and analyzed over some months. The vacuity index (VI) [number of empty stomachs / number of stomachs examined] was estimated. Gut contents were sorted and preys identified to the lowest possible taxa under dissecting microscopy. A stomach was regarded to be empty with no contents in the stomach. Gut contents were examined by a SZX7 Olympus stereo microscope at 0.8-5.6x (zoom) and 10x resolution. Prey items were identified to the lowest possible taxon in case of digested copepods and identification established from body pieces under Rose (1933) and Brodskii (1967). Having been counted, the individuals of the same species were weighed together (wet weight to the nearest ±0.0001 g) after excessive moisture was removed by blotting prey items on tissue paper. One evaluated diet composition according to the three parameters by Hyslop (1980) the numerical index (N%), the gravimetric index (W%), and frequency of occurrence (O%) were established. The index of relative importance (IRI) (Pinkas *et al.,* 1971) was calculated and, based on the suggestion by Cortes (1997), expressed as a percentage (IRI%). By means of the method by Morato *et al.,* (1998), food items were thus grouped into categories of preference determined by the equations:

$IRI \geq 30 \times (0.15 \times \sum O\%)$……… main important prey (MIP)

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

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

Also differences in the diet composition of the five deep sea fish were determined by the Bray–Curtis similarity index, using percentage IRI.

RESULTS AND DISCUSSION

Argentina sphyraena

Of the stomach contents of 72 *Argentina sphyraena* examined, 56 included food (77.8%) and 16 were empty (22.2%). Crustaceans were found to be significant prey groups (MIP; IRI≥693; IRI%=88.17). Chaetognatha and Polychaeta constituted secondary prey groups (SP; 693>IRI>77; IRI%=8.38 and 2.48, respectively). Teleostei and Thaliacea were considered occasional prey groups (OP; IRI≤77; IRI%=0.81 and IRI%=0.54, respectively). Of crustaceans, the Decapoda were main prey (IRI%=76.69), followed by Brachyura (IRI%=6.76), Copepoda (IRI%=3.97) Euphausiacea (IRI%=2.45), Mysidacea (IRI%=0.59), and *Anilocra physodes* (Isopoda) (IRI%=0.13) by the order of

IRI%. Especially, the brachyuran crabs in megalopa stage were typically encountered. *Temora stylifera* of Copepoda was abundantly found (Table 1). Various zooplankton studies in the northeren Aegean Sea have stated that *Temora stylifera*, a neritic form, abound greatly (Moraitou-Apostolopoulou, 1972; Moraitou-Apostolopoulou, 1985; Sever, 2009). *Sagitta* spp. was the only Chaetognatha species to be present in the diet and also abundant species of holoplanktonic organisms in the pelagic zone (Isari *et al.*, 2007). Various studies (Pavlova, 1966; Moraitou-Apostolopoulou, 1985; Pancucci-Papadopoulou *et al.*, 1992) on zooplankton in different parts of Aegean Sea have reavealed widespread occurence of *Sagitta* spp. Information on the diet of this species is scarce; however, bottom-living Polychaeta, Mollusca and Crustacea, also pelagic invertebrates and fish have been reported by Cohen (1984). Consequently, since both the brachyuran crabs (megalopa stage) and the groups of Copepoda and Chaetognatha are the vital components of the pelagic zone, results of the analyses on the stomach contents of *A. sphyraena* point out that the species is not so much dependant on bentic feeding.

Table 1. Diet composition of Argentine, *Argentina sphyraena*, from the Aegean Sea expressed as percent by number (N%), weight (W%), frequency of occurrence (O%) and relative importance (IRI%) prey categories (N: number of fish; TL: total length of fish; SE: standart error).

Prey groups	N%	W%	O%	IRI	IRI%
Polychaeta	5.63	4.57	14.29	145.74	2.48
Crustacea*					88.17
Copepoda*					3.97
Temora stylifera	1.41	1.04	3.57	8.74	0.15
Candacia spp.	1.41	5.46	3.57	24.51	0.42
Calanoida	2.82	4.01	3.57	24.36	0.41
Mysidacea	1.41	8.27	3.57	34.57	0.59
Cumacea	1.41	1.82	3.57	11.53	0.20
Isopoda					
Anilocra physodes	1.41	0.69	3.57	7.50	0.13
Euphausiacea	4.23	9.20	10.71	143.86	2.45
Decapoda	42.25	24.10	67.86	4502.30	76.69
Brachyura	8.45	13.77	17.86	396.78	6.76
Chaetognatha					
Sagitta spp.	21.13	13.29	14.29	491.71	8.38
Thaliacea					
Salpa spp.	7.04	1.82	3.57	31.65	0.54
Teleostei	1.41	11.97	3.57	47.79	0.81
N	72				
Mean $TL_{(cm)}$	12.57				
SE	0.11				
% of empty stomachs	22.2				

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

Glossanodon leioglossus

Stomach contents of 32 small-toothed argentine were examined and all contained identifiable prey. Crustaceans were found main prey groups (MIP; IRI≥788; IRI%=97.77), while Chaetognatha to be secondary (SP; 788>IRI>88; IRI%=4.01). *Sagitta* spp. was the sole chaetognathan species to prevail in the its diet (Table 2) which was dominated by copepods such as *Pleuromamma abdominalis*, *Clausocalanus* spp., *Clausocalanus arcuicornis, Corycaeus typicus, Lubbockia squillimana*, *Oncaea media*, *Lucicutia flavicornis*, *Clausocalanus furcatus*, *Acartia clausi*, *Aetideus armatus*, *Euchaeta marina*, *Candacia simplex*, *Ischnocalanus plumulosus*, *Nannocalanus minor*, *Corycaeus clausi*, *Candacia aethiopica*, *Oncaea mediterranea* and *Temora stylifera* by order of IRI% as main preys followed by *Anilocra physodes* (Isopoda) (IRI%=5.29). All of the Copepoda species were the pelagic. Despite the sampling area being close to coastline, it was of depths of 150-473 m. Thus, the Copepoda species we determined in this study were both oceanic (*Lucicutia flavicornis, Aetideus armatus, Oncaea mediterranea, Euchaeta marina, Clausocalanus arcuicornis, Lubbockia squillimana, Oncaea media*) and neritic (*Temora stylifera, Nannocalanus minor, Clausocalanus furcatus* and *Acartia clausi*). Similarly, the pelagic copepods found to be predominant according to the results of the zooplankton studies carried out in the area consisted of both oceanic and neritic species (Sever, 2009).

Table 2. Diet composition of small-toothed argentine, *Glossanodon leioglossus*, from the Aegean Sea expressed as percent by number (N%), weight (W%), frequency of occurrence (O%) and relative importance (IRI%) prey categories (N: number of fish; TL: total length of fish; SE: standart error).

Prey groups	N%	W%	O%	IRI	IRI%
Crustacea*					97.77
Copepoda*					90.77
Aetideus armatus	0.08	5.17	25.00	131.35	1.19
Corycaeus clausi	0.08	3.69	25.00	94.35	0.85
Lubbockia squillimana	0.17	4.86	50.00	251.33	2.28
Oncaea media	0.83	2.01	75.00	213.14	1.93
Nannocalanus minor	0.08	3.93	25.00	100.29	0.91
Oncaea mediterranea	0.17	1.28	25.00	36.13	0.33
Candacia aethiopica	0.08	1.43	25.00	37.71	0.34
Acartia clausi	0.08	6.52	25.00	165.15	1.49
Lucicutia flavicornis	1.66	2.52	50.00	209.27	1.89
Ischnocalanus plumulosus	0.08	4.04	25.00	103.03	0.93
Clausocalanus furcatus	1.83	1.55	50.00	169.17	1.53
Clausocalanus arcuicornis	3.00	3.18	50.00	308.71	2.79
Pleuromamma abdominalis	62.31	12.10	75.00	5580.64	50.52
Euchaeta marina	0.42	2.19	50.00	130.43	1.18
Corycaeus typicus	1.41	2.10	75.00	263.67	2.39
Clausocalanus spp.	4.99	1.57	75.00	492.23	4.46
Candacia simplex	0.33	1.97	50.00	115.31	1.04
Temora stylifera	0.25	1.00	25.00	31.36	0.28
Calanoida	19.30	7.66	50.00	1347.85	12.20
Isopoda					
Anilocra physodes	0.08	23.28	25.00	584.03	5.29
Decapoda	0.17	4.62	50.00	239.45	2.17
Chaetognatha					
Sagitta spp.	2.58	3.33	75.00	442.83	4.01
N	32				
Mean $TL_{(cm)}$	9.40				
SE	0.06				
% of empty stomachs	0				

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

Chlorophthalmus agassizi

Among 122 shortnose greeneye stomachs investigated, only 112 (91.8%) stomachs contained identifiable prey, with 10 being empty (8.2%). Crustaceans were discovered to be main important prey groups (MIP; IRI≥884; IRI%=92.65). Teleostei constituted secondary prey groups (SP; 884>IRI>98; IRI%=4.81). Chaetognatha, Foraminifera and Mollusca were regarded as occasional prey groups (OP; IRI≤98; IRI%=1.73, 1.30, and 0.09 respectively) (Table 3).

Table 3. Diet composition of shortnose greeneye, *Chlorophthalmus agassizi*, from the Aegean Sea expressed as percent by number (N%), weight (W%), frequency of occurrence (O%) and relative importance (IRI%) prey categories (N: number of fish; TL: total length of fish; SE: standart error).

Prey groups	N%	O%	W%	IRI	IRI%
Foraminifera	37.04	1.79	1.66	69.11	1.30
Crustacea*					92.65
Copepoda*					11.63
Neocalanus gracilis	0.87	5.36	0.75	8.67	0.16
Candacia armata	0.65	1.79	0.54	2.14	0.04
Candacia longimana	1.09	7.14	0.46	11.07	0.21
Candacia simplex	1.31	5.36	0.37	8.98	0.17
Corycaeus sp.	0.22	1.79	0.34	1.00	0.02
Euchaeta marina	0.22	1.79	0.32	0.97	0.02
Calanoida	0.87	7.14	0.32	8.53	0.16
Labidocera wollastoni	1.74	14.29	0.84	36.97	0.70
Oncaea media	0.44	3.57	0.25	2.45	0.05
Pleuromamma abdominalis	4.58	12.50	0.63	65.06	1.23
Mysidacea	14.16	44.64	27.17	1845.14	34.77
Amphipoda	0.22	1.79	0.09	0.55	0.01
Isopoda	0.44	3.57	0.47	3.24	0.06
Euphausiacea	24.62	42.86	21.82	1990.40	37.50
Decapoda	5.88	32.14	22.15	900.93	16.98
Mollusca					
Sepiolidae	0.22	1.79	2.53	4.92	0.09
Chaetognatha					
Sagitta spp.	3.05	21.43	1.24	91.91	1.73
Teleostei	2.40	12.50	18.02	255.26	4.81
N	122				
Mean $TL_{(cm)}$	11.77				
SE	0.10				
% of empty stomachs	8.2				

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

Among the crustaceans, Euphausiacea (IRI%=37.50) seemed to be most important prey followed by Mysidacea (%IRI=34.77), Decapoda (IRI%=16.98) and Copepoda (IRI%=11.63) (*Pleuromamma abdominalis*, *Labidocera wollastoni*, *Candacia longimana*, *Candacia simplex* and *Neocalanus gracilis* by the order of IRI %). The groups of Euphausiacea and Mysidacea were found to be relatively more predominant than the group copepoda. The Copepoda species we determined were all pelagic ones. *Neocalanus gracilis* was reported as mesopelagic species (Pancucci-Papadopoulou *et al.* 1992). *Sagitta* spp. was the only chaetognathan species (IRI%=1.73) in the diet. Sediments must have been ingested during the hauling process since they were occasionally found in the diet. Sepiolidae (Cephalopoda) constituted 0.09% of the diet (Table 3). Several different benthic crustaceans were found in the stomachs of the few individuals examined in previous studies, and the species appears quite euryphagous. Stomach contents of *C. agassizii* caught off the north-western coast of Turkey (NE Aegean Sea) were examined and identified as prey items of the diets of *C. agassizii* dominated by crustacean remains and Amphipoda. Fish remains were also found occasionally (Kabasakal 1999). Bowman *et al., (2000)* found that the diet was composed of unidentified crustaceans (W%=68.8), detritus (W%=20.5) and Polychaeta (W%=10.7). *C. agassizi* showed a mixed feeding strategy, exploiting a wide range of preys including mesopelagic, benthic and endobenthic organisms (Anastasopoulou and Kapiris 2008). In general both our data and published ones show that Euphausiacea and Copepoda of the holoplanktonic forms and Mysidacea and Decapoda of the meroplanktonic forms were predominant in the stomach contents of *C. agassizi*. Thus, we may conclude that feeding mode of the species is mostly based on pelagic organisms rather than benthic ones.

Hoplostethus mediterraneus

Stomach contents of 108 Mediterranean slimehead were investigated. 62 stomachs had food (57.4%) and 46 were empty (42.6%). The diet was dominated by Crustacea and Teleostei (MIP; IRI≥552) which comprised 88.31% and 15.35% of the diet respectively. Some of the fish were also feeding on Chaetognatha (SP; 552>IRI>61; IRI%=2.40). Appendicularia (IRI%=0.11) occurred only once and considered as occasional prey group (OP; IRI≤61) (Table 4). Among the crustaceans, Decapoda was principal prey (IRI%=78.50) followed by Isopoda (IRI%=3.50) and Mysidacea (IRI%=0.13). Sagitta spp. was the only chaetognathan species (IRI%=2.40) in the diet. (Table 4).

Table 4. Diet composition of Mediterranean slimehead, *Hoplostethus mediterraneus*, from the Aegean Sea expressed as percent by number (N%), weight (W%), frequency of occurrence (O%) and relative importance (IRI%) prey categories (N: number of fish; TL: total length of fish; SE: standart error).

Prey groups	N%	W%	O%	IRI	IRI%
Crustacea*					88.31
Mysidacea	2.83	0.96	3.23	10.80	0.13
Isopoda	7.14	36.36	6.45	281.24	3.50
Decapoda	52.38	40.65	67.74	6309.06	78.50
Chaetognatha					
Sagitta spp.	14.29	0.68	12.90	193.18	2.40
Appendicularia	2.38	0.33	3.23	8.73	0.11
Teleostei	21.43	21.02	29.03	1233.75	15.35
N	108				
Mean $TL_{(cm)}$	11.80				
SE	0.24				
% of empty stomachs	42.6				

*The values calculated for all prey groups of Crustaceans.

Several studies of the diet of this species have been carried out in the south coast of Portugal and north-eastern Atlantic (Gordon and Duncan 1987; Pais, 2002). The general impression from studies is that Mediterranean slimehead mostly feeds on crustaceans. Gordon and Duncan (1987) recorded that Decapoda, Mysidacea and Amphipoda occur in diet by order of importance. Pais (2002) found Isopoda and Euphausiacea as main prey; this species is a benthopelagic feeder, preying mainly on crustaceans. The dominant prey species encountered were the Euphausiacea and Amphipoda. Other important prey items ingested were fish (6.7 IRI %); however; the advanced stage of digestion of fish did not allow this prey group to be further identified. In conclusion, in a thermally stable environment such as the deep eastern

Mediterranean, food availability probably constitutes the main factor to influence food consumption and possibly the reproductive cycle of *H. mediterraneus*. Since this species is predominant in mid-slope assemblages, this conclusion may explain the general dynamics of the whole fish community (Madurell and Cartes 2005). According to Cartes *et al., (2002)* this species is non-migratory macroplankton feeder. To the contrary of seldom existence of pelagic Chaetognatha and Appendicularia, plenty of benthic decapods have indicated that feeding mode of the species mostly depends on the bottom. Similar to our study findings were obtained in the Wairarapa coast (North Island, New Zealand) (Jones, 2009).

Capros aper

The stomach contents of 74 boar fish were examined. Only 40 (55%) stomach had food, while most of others had empty (45%). As a result of the analysis, Crustacea and Chaetognatha were found to be main important prey groups in *C. aper* diet (MIP; IRI≥1148; IRI%=75.59 and 24.75 respectively), while Chaetognatha made up the second important group (IRI%=24.75). Appendicularia and Thaliacea constituted secondary prey groups (SP; 1148>IRI>128; IRI%=20.62 and 13.21 respectively). Polychaeta (IRI%=0.31) were considered occasional prey group (OP; IRI≤128) (Table 5). Among the crustaceans, Copepoda (like *Clausocalanus* sp., *Nannocalanus minor, Corycaeus typicus, Oncaea media* and *Clausocalanus arcuicornis* by the order of (IRI %) were principal prey followed by Decapoda (IRI%=3.57); Brachyura (IRI%=1.19), Mysidacea (IRI%=0.62), Isopoda (IRI%=0.58) and Amphipoda (IRI%=0.38). *Sagitta* spp. was the only chaetognathan species (IRI%=24.75) to be found in the diet. *Oikopleura dioica* (Appendicularia) and *Salpa* spp. (Thaliacea) composed IRI%=20.62 and IRI%=13.21 of the diet, respectively (Table 5). The groups of Chaetognatha, Appendicularia, Copepoda and Thaliacea are found to be dominant in stomach analyses. These groups are holoplanktonic forms and have large distribution in pelagic region. These groups were widespreadly determined in various zooplanktonic research carried out in different small bays, inlets and gulfs of the Aegean Sea, with especially predominant copepods (Pavlova, 1966; Moraitou-Apostolopoulou, 1972; Pancucci-Papadopoulou *et al.,* 1992). *Oncaea media, Clausocalanus arcuicornis, Clausocalanus furcatus, Lucicutia flavicornis, Corycaeus typicus, Temora stylifera* and *Nannocalanus minor* which are found to be common among copepods were also found inhabiting the zooplanktonic studies done in the Aegean Sea (Moraitou-Apostolopoulou, 1985; Pancucci-Papadopoulou *et al.,* 1992; Sever, 2009). In the study carried out by Kaya and Özaydın (1996), copepods are the most available ones (numerically 85%), followed by Polychaeta (7%) and Mollusca (3%) in the south Aegean Sea. Santos and Borges (2001) found the diet composed of crustaceans like hyperiids (O%=35.0) and Euphausiacea, Teleostei such as Myctophidae (O%=2.0), and Mollusca (O%=2.0) in the Algarve, Portugal. According to Cartes *et al.,* (2002), this species is non-migratory macroplankton predator.

One should conclude our results to indicate the trophic status of five species examined are primarily attributable to the carnivorous guild. Two major prey groups were found in diets of all the five fish: Crustacea (like Copepoda and Isopoda) and Chaetognatha (*Sagitta* spp.). In addition to this, *H. mediterraneus* and *C. agassizi* also feed as piscivore. Appendicularia occurred only in diets of *C. aper* and *H. mediterraneus*. Polychaeta were consumed only by *A. sphyraena* and *C. aper*. *C. aper* was also found predator on Thaliacea, and *C. agassizi* on Mollusca and Foraminifera.

Table 5. Diet composition of boar fish, *Capros aper*, from the Aegean Sea expressed as percent by number (N%), weight (W%), frequency of occurrence (O%) and relative importance (IRI%) prey categories (N: number of fish; TL: total length of fish; SE: standart error).

Prey groups	N%	W%	O%	IRI	IRI%
Polychaeta	0.40	2.77	5.00	15.86	0.31
Crustacea*					75.59
Copepoda*					63.87
Candacia longimana	0.40	3.09	5.00	17.45	0.34
Candacia simplex	0.40	1.39	5.00	8.94	0.17
Clausocalanus furcatus	0.40	1.70	5.00	10.52	0.20
Candacia sp.	0.40	1.74	5.00	10.72	0.21
Corycaeus clausi	0.40	1.78	5.00	10.92	0.21
Lubbockia squillimana	0.40	1.15	5.00	7.75	0.15
Lucicutia flavicornis	0.80	5.27	5.00	10.34	0.59
Neocalanus tenuicornis	0.40	1.82	5.00	11.11	0.22
Sapphirina metallina	0.80	4.16	5.00	24.80	0.48
Pleuromamma gracilis	0.40	3.40	5.00	19.03	0.37
Pleuromamma abdominalis	3.61	0.99	10.00	46.04	0.89
Oncaea media	3.21	4.20	15.00	111.14	2.16
Temora stylifera	1.20	0.95	10.00	21.55	0.42
Calanoida	15.66	1.66	45.00	779.64	15.12
Corycaeus typicus	3.21	4.00	20.00	144.23	2.80
Clausocalanus arcuicornis	4.42	1.90	15.00	94.77	1.84
Nannocalanus minor	6.83	3.05	20.00	197.51	3.83
Clausocalanus sp.	5.22	1.90	30.00	231.63	4.14
Mysidacea	0.80	2.41	10.00	32.18	0.62
Amphipoda	0.40	3.56	5.00	19.82	0.38
Isopoda	0.40	5.58	5.00	29.92	0.58
Decapoda	2.01	5.34	25.00	183.81	3.57
Brachyura	1.20	4.91	10.00	61.14	1.19
Cypris larva	0.40	6.02	5.00	32.10	0.62
Chaetognatha					
Sagitta spp.	14.46	13.90	45.00	1275.90	24.75
Appendicularia					
Oikopleura dioica	18.88	4.75	45.00	1063.17	20.62
Thaliacea					
Salpa spp.	12.85	6.61	35.00	681.19	13.21
N	74				
Mean $TL_{(cm)}$	6.31				
SE	0.08				
% of empty stomachs	45.0				

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

Fishes living in association with the deep sea floor complete the bathymetric profile in the open ocean in terms of trophic relationships in that they participate in the vertical transfer of energy between the productive surface waters and depth zones increasingly distant from the surface.

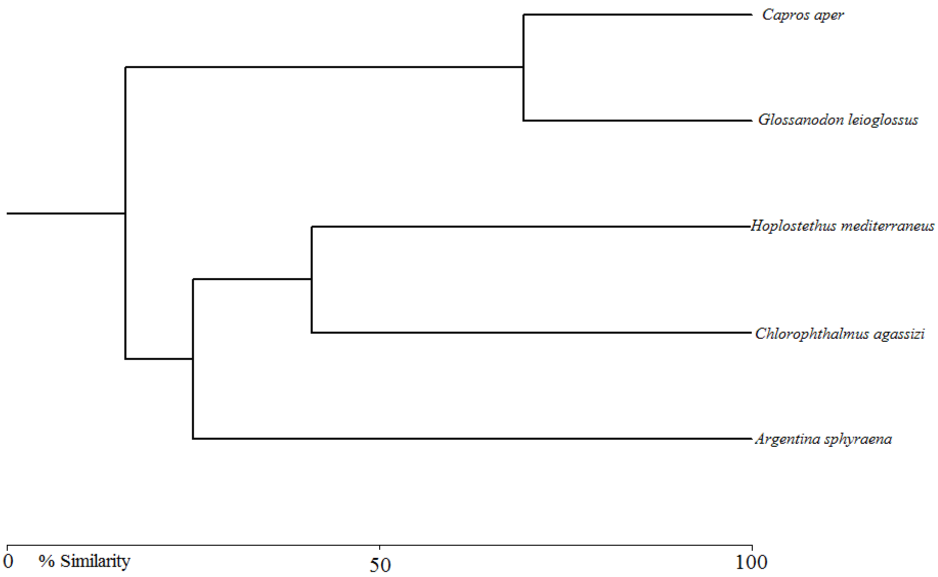

Figure 1. Dendrogram of the cluster analysis showing diet similarity (IRI%) in relation to fish using Bray-Curtis index.

Most of the prey species consumed by the five deep sea fish live in benthopelagic and epibenthic environments. The ingestion of small amounts of sand and detritus can provide a clue that is also foraged near the bottom. Therefore, it is apparent that they are not be dependent on benthic organisms for prey, since they can feed on benthopelagic and even pelagic and mesopelagic preys. This fact could allow us to admit that these deep sea fish can make vertical migrations in the water column. Crustaceans, especially copepods and euphausiids, provide the main food source for midwater fishes (Horn and Ferry-Graham 2006). However, the corroboration of these migrations and the definition of its periodicity require a sampling methodology conducted in different time of the day and a study should be done separately. A comparison of five deep sea fish IRI% values of prey groups based on Bray-Curtis index revealed that *C. aper* and *G. leioglossus* are similar, whereas the other fish (*H. mediterraneus, C. agassizi* and *A. sphyraena*) have diet similarity (Fig. 1). No data are available on the abundance of the prey organisms in the area, and therefore it is not clear whether the prey species are dominant and the predators are selecting their prey preferentially, whether the food resources are exploited in a density-dependent manner.

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