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Cephalopods in the stomach contents of four Elasmobranch species from the northern Aegean Sea

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Stomach contents of four selachians Galeus melastomus *(RAFINESQUE, 1810),* Scyliorhinus canicula *(LINNAEUS, 1758),* Mustelus mustelus *(LINNAEUS, 1758), and* Raja clavata *(LINNAEUS, 1758) caught in the northern Aegean Sea, showed cephalopod remains. Two genera of cephalopods and eight species were identified. Identified cephalopod species are the well-known components of the teuthofauna of the northern Aegean Sea. This study showed that cephalopods are the common prey items of the examined selachians.*

Key words: northern Aegean Sea, selachians, feeding habits, cephalopods

INTRODUCTION

Sharks and rays are opportunistic predators, and their diet often contains a broad range of marine fauna. Cephalopods are one of the major prey items of many selachians (JARDAS 1972a, b; CAPAPÉ, 1974, 1975; CAPAPÉ and ZAOUALI, 1976; CAPAPÉ and QUIGNARD, 1977; JARDAS, 1979; MACPHERSON, 1980; EBERT, 1994; DIATTA *et al.*, 2001). The occurrence of cephalopods in the gastric contents of sharks and rays is important for the better understanding of the movements of these marine predators in a specific area. Its significance related to the better understanding of the local teuthofauna structure can not be neglected (CLARK and MERRETT, 1972; CLARKE and STEVENS, 1974; RANCUREL and INTES, 1982; BELLO, 1990).

Examination of the stomach contents of four elasmobranch species: *Galeus melastomus* (RAFINESQUE, 1810), *Scyliorhinus canicula* (LINNAEUS, 1758), *Mustelus mustelus* (LINNAEUS, 1758) and *Raja clavata* (LINNAEUS, 1758) caught in the northern Aegean Sea showed cephalopod remains. The present study aims to provide additional data to our knowledge on the role of cephalopods in the feeding of sharks and rays.

MATERIALS AND METHODS

G. melastomus, S. canicula, M. mustelus and *R. clavata* from northern Aegean Sea (Fig. 1) were caught by means of an otter trawl with a cod-end mesh opening of 22 mm from knot to knot, between October 1996 and December 1997.

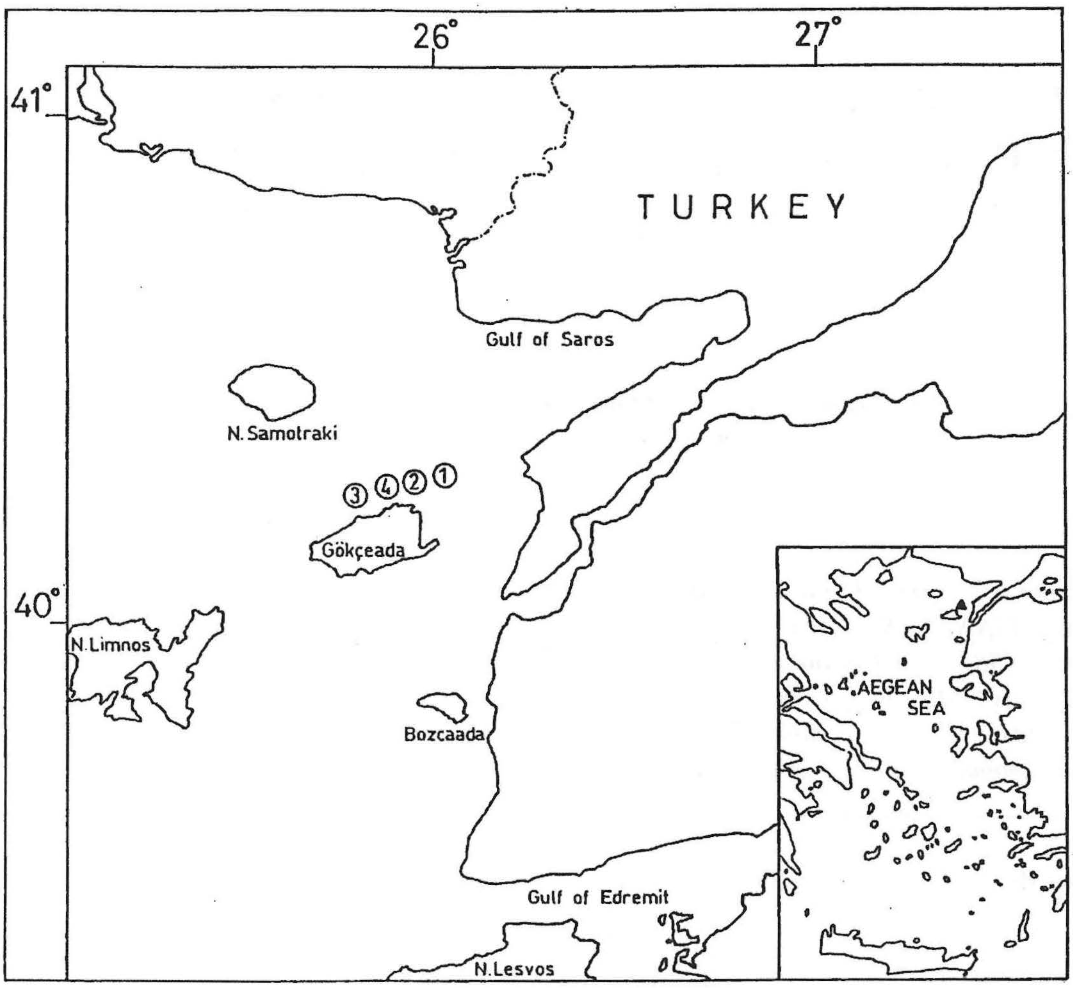

Fig. 1. Sampling stations (numbered circles) where the selachians were caught. Dark triangle on the small map indicates the approximate location of the sampling stations in the area investigated

These four elasmobranchs were selected for the study because they are relatively the most abundant in the area (KABASAKAL, unpublished data). Information about the examined elasmobranchs, including catches data is provided in Table 1.

All specimens were sexed and their total length (*TL*) was measured to the nearest mm. Digestive tract of each specimen was removed, then placed in a sieve with a mesh opening of 1 mm, and washed gently with tap water. Cephalopod remains consisted of whole specimens, cuttle bones, mantles, and upper and / or lower beaks. These remains were then preserved in 70% ethanol. Mantle lengths (*ML*) of whole specimens were measured to the nearest 0.05 mm with a vernier caliper. Identification of these whole cephalopods and one undamaged cuttle bone of *Sepia orbignyana* follow MANGOLD and BOLETZKY (1987). Identifications of upper and / or lower beaks follow CLARKE (1962), and MANGOLD and FIORONI (1966). Upper rostral length (*URL*) and lower rostral length (*LRL*) of beaks were measured with a vernier caliper to the nearest 0.05 mm or with a dissecting microscope equipped with an eyepiece micrometer (when small beaks were below 2 mm). Cephalopod's mantle length (*ML*) was estimated from the lower rostral length according to MANGOLD and FIORONI

Table 1. List of elasmobranchs examined for stomach content analysis, with catch data: N, number of examined stomachs and N. S. C., number of stomachs containing cephalopod remains

SPECIES	SEX	*TL* ± *SD*	STATIONS			STOMACHS	
			No	Depth (m)	Locality	N	N. S. C.
Galeus melastomus	9♂, 7♀	112-222 mm Mean=157 ± 30.42 mm	1	360	40° 17' 13" N 26° 00' 50" E	16	4
Scyliorhinus canicula	17♂,12♀	139-530 mm Mean=279.65 ± 91.96 mm	2	244	40° 16' 28" N 25° 58' 36" E	29	5
Mustelus mustelus	11♂, 4♀	560-1173 mm Mean=820.06 ± 186.85 mm	3	105	40° 15' 12" N 25° 49' 36" E	15	2
Raja (Raja) clavata	15♂, 16♀	290-793 mm Mean=556.58 ± 141.44 mm	4	154	40° 16' 01" N 25° 55' 00" E	31	10

(1966). However, when lower beak lacked, upper rostral length was used for the mantle length estimations.

RESULTS

Cephalopod remains were only found in the 21 out of the examined 91 stomachs (23.07 % of total examined stomachs). Two genera and eight species were identified from these remains. List of the identified cephalopods, their measurements (*URL*, *LRL* and *ML*), and elasmobranchs, containing cephalopod remains in their stomachs are given in Annex.

DISCUSSION

The aim of the stomach content analysis is to provide information on the contribution of different prey to the diet, indicating the position of a fish within the general trophic web (MACPHERSON, 1986). Furthermore, stomach content analysis of fish often giving a good indication of the marine fauna in a specific area. Eight cephalopod species found in the 21 stomachs are the well-known components of the teuthofauna of the northern Aegean Sea (MANGOLD and BOLETZKY, 1987). However, when comparing with the 27 cephalopod species, which have been previously reported from the northern Aegean Sea (MANGOLD and BOLETZKY, 1987), this small cephalopod collection from the gastric contents of the four examined elasmobranch species appeared to be rather poor and not very diverse. Moreover, they only represent the 29.62 % of these previously reported cephalopods from this area. Five of the identified cephalopods, *Sepia elegans*, *S. officinalis*, *S. orbignyana*, *Sepietta oweniana* and *Todaropsis eblanae*, are demersal, and 3 of them, *Loligo vulgaris*, *Illex coindetii* and *Todarodes sagittatus*, are semi-pelagic species (MANGOLD and BOLETZKY, 1987).

Although the examined selachians were demersal species, their diet also contained some semi-pelagic cephalopods, e. g. an upper beak of *T. sagittatus* was found in the stomach content of an individual of *G. melastomus* of 222 mm *TL* (Annex). It is possible to explain the occurrence of semi-pelagic cephalopods in the stomach contents of bottom-living fish, with the daily vertical migrations of cephalopods. For example, the specimens of *T. sagittatus*, especially the immature ones, live very close to the bottom during the daytime (MANGOLD and BOLETZKY, 1987), and in this case they become preys of demersal fish. Ontogenetic shifts in diet are common in sharks and rays which may be attributed to increased size of predators and appear to be adaptations to maximize energy intake, which is generally achieved by large fish switching to larger prey types (MACPHERSON, 1986; LOWE *et al.*, 1996). According to SMALE and COMPAGNO (1997) specimens of *M. mustelus* that have a *TL* ≥ 800 mm have an increased frequency of cephalopods in their diet. JARDAS (1972a) reported that, in the Adriatic Sea consumption of cephalopods by *R. clavata* is increased with the total length of the ray, and he also noted that cephalopods are one of the major prey items of the thornback ray that have a *TL* ≥ 460 mm. Among the examined specimens of *R. clavata* and *M. mustelus* in the present study, only the individuals that had a *TL* ≥ 500 mm and 1000 mm, respectively, contained cephalopod remains in their stomach contents. Examined specimens of *G. melastomus* and *S. canicula* consisted mostly of smaller individuals than 300 mm *TL*, with the exception of three specimens of *S. canicula* (*TL* 488 mm, 516 mm and 530 mm). It can be clearly seen that, these small catsharks consumed relatively large cephalopods with regard to their size (Annex). In general, cephalopods are considered as difficult-to-catch prey organisms if they are alive, and they also have an ability to hide themselves from the predators by various means (CLARKE and MERRETT, 1972), however, sharks' speed and aggressive qualities even in a small specimen could probably overcome this. In the present study, the largest catshark containing cephalopod remains in its stomach content was a mature male of *S. canicula* (*TL* 488 mm). JARDAS (1972a), CAPAPÉ and ZAOUALI (1976), JARDAS (1979), MACPHERSON (1980) and CİHANGİR *et al.* (1997) reported that, *G. melastomus* and *S. canicula* consume cephalopods during almost all stages of their growth. Therefore, *G. melastomus* and *S. canicula* do not exhibit an ontogenetic dietary shift, caused by the increased size of predator, for cephalopods.

There is always a competition between the fishermen and the marine predators feeding on the commercially valuable species, like cephalopods. It is, therefore, necessary to carry out more detailed research to a better understanding of the role of cephalopods for the feeding of sharks and rays in the northern Aegean Sea.

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Cefalopodi u sadržaju želudaca četiriju elazmobranhija iz sjevernog Egejskog mora

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SAŽETAK

U sadržaju želudaca četiriju elazmobranhija *Galeus melastomus* (RAFINESQUE, 1810), *Scyliorhinus canicula* (LINNAEUS, 1758), *Mustelus mustelus* (LINNAEUS, 1758) i *Raja clavata* (LINNAEUS, 1758) uhvaćenih u sjevernom Egejskom moru, pronađeni su ostaci cefalopoda. Identificirana su dva roda i osam vrsta cefalopoda. Pronađene vrste su poznati čimbenici teutofaune sjevernog Egejskog mora. U ovom radu je utvrđeno da su cefalopodi uobičajen plijen istraživanih selahija.

Ključne riječi: sjeverno Egejsko more, elazmobranhije, prehrambene navike, cefalopodi

ANNEX

List of cephalopods and selachians containing cephalopod remains in their stomach contents: URL, Upper Rostral Length; LRL, Lower Rostral Length; ML, estimated mantle length of cephalopods represented by beaks, or measured mantle length of whole specimens found in the stomach contents

ELASMOBRANCH PREDATORS			CEPHALOPOD PREYS	
Species	TL (mm)	Sex	Species	Type of the remain
Galeus melastomus	222	♂	*Todarodes sagittatus* (LAMARCK, 1798)	1 upper beak URL=5.87 mm LRL= --- ML=77.44 mm
G. melastomus	176	♂	*Todaropsis eblanae* (BALL, 1841)	1 upper beak, 1 lower beak URL=2.28 mm LRL=0.92 mm ML=24.86 mm
G. melastomus	150	♂	*Sepietta oweniana* (PFEFFER, 1908)	1 lower beak URL= --- LRL=1.52 mm ML=26.2 mm
G. melastomus	128	♂	Unidentified cephalopoda	1 piece of mantle
Scyliorhinus canicula	488	♂	*Todaropsis eblanae* (BALL, 1841)	1 upper beak URL=2.66 mm LRL= --- ML=23.75 mm
S. canicula	271	♂	*Sepia* sp.	1 whole mantle, 1 broken cuttle bone ML=37.8 mm
S. canicula	247	♀	*Illex coindetii* (VERANY, 1839)	1 upper beak URL=2 mm LRL= --- ML=21.5 mm
S. canicula	215	♂	*Sepia officinalis* LINNAEUS, 1758	1 upper beak URL=6.2 mm LRL= --- ML=50.81 mm
S. canicula	139	♀	*Sepia elegans* BLAINVILLE, 1827	1 upper beak, 1 lower beak URL=2.8 mm LRL=1.2 mm ML=34.28 mm
Mustelus mustelus	1173	♂	*Loligo vulgaris* LAMARCK, 1798	1 upper beak, 1 lower beak URL=2.56 mm LRL=1 mm ML=40 mm
M. mustelus	1000	♂	*Illex coindetii* (VERANY, 1839)	1 upper beak, 1 lower beak URL=8.93 mm LRL=4.46 mm ML=159.28 mm
Raja clavata	793	♂	*Illex coidetii* (VERANY, 1839)	1 whole specimen ML=51.7 mm
R. clavata	772	♀	*Sepia* sp.	1 whole mantle ML=43.35 mm
R. clavata	767	♀	*Sepia orbignyana* FERUSSAC, 1826	1 whole cuttle bone Length=59.55 mm
R. clavata	698	♂	*Sepia elegans* BLAINVILLE,1827	1 whole specimen ML=25.65 mm

ANNEX *cont'd*

R. clavata	672	♂	*Sepia elegans* BLAINVILLE,1827	1 whole specimen ML=34.95 mm
R. clavata	586	♀	*Sepia elegans* BLAINVILLE,1827	1 whole specimen ML=37.25 mm
R. clavata	550	♀	*Loligo vulgaris* LAMARCK, 1798	1 upper beak, 1 lower beak URL=2.8 mm LRL=1.32 mm ML=52.8 mm
R. clavata	545	♂	*Sepia* sp.	1 whole mantle ML=49.8 mm
			Sepietta oweniana (PFEFFER, 1908)	1 whole specimen ML=13.7 mm
R. clavata	527	♀	*Sepia elegans* BLAINVILLE,1827	1 whole specimen ML=38.85 mm
R. clavata	500	♂	*Sepietta* sp.	1 whole mantle ML=16.1 mm