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Diet composition of smooth-hound, *Mustelus mustelus* (Linnaeus, 1758), in Aegean Sea, Turkey

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Elasmobranch fishes are among the top predators in the marine environment and thus play an important role in marine ecosystems, potentially regulating, through predation, the size and dynamics of their prey populations (1; 2). Since elasmobranchs are frequently apex predators in marine ecosystems, information on the composition of their diet is essential for understanding trophic relationships in these systems (1).

Sharks are often typified as opportunistic predators, with a wide trophic spectrum that ranges from plankton to marine mammals. In general, oceanic elasmobranch species feed on squid and big fishes (3), whereas the coastal and benthic species feed on crustaceans, molluscs and small or juvenile fishes (4; 5; 6). A few species feed on other elasmobranchs, birds, reptiles or marine mammals (7; 8; 9). Ontogenetic variation in diet is well known (10; 11), with a strong tendency to ingest larger and more mobile animals with increasing size. However, it is noteworthy that, while all sharks are higher-level predators they are not all true apex predators (12).

Demersal sharks occupy open habitats, including sandy, as well as more complex, closed habitats such as rocky areas and coral reefs (12). Those sharks living on or near the seafloor generally have ventral mouths containing relatively small teeth as is the case in *Mustelus mustelus*. Members of the *Mustelus* genus (Chondrichthyes, Triakidae) are common throughout the Mediterranean (except for the Black Sea) and the eastern Atlantic (13). The smooth-hound, *M. mustelus* (Linneaus, 1758), is a small, bottom-living shark, which occurs at depths between 3 and 150m (14). The species is common in the northeast Atlantic and in the Mediterranean (14; 15). Although there is no directed fishery for smooth-hound, it is captured as by-catch in the trawls in Sigacik Bay and landed.

Published information about feeding of this species is limited despite its abundance. Data on trophic ecology only mention that they feed mainly on crustaceans, but also cephalopods and bony fishes (15). SAUER & SMALE (16) provided some data on diet composition in the Atlantic, and MORTE et al. (17) quantified the diet in the Gulf of Valencia (Mediterranean). CONSTANTINI et al. (18) gave information about feeding habits in the northern Adriatic Sea (Mediterranean). However, similar studies from Turkey's coasts are scarce. The only information about feeding in this species comes from KABASAKAL (19) for the Aegean Sea. Yet, such information is necessary to understand the role that this species plays in the trophic structure of coastal marine communities in this area (20). To resolve this, this study presents data on the feeding activity of smooth-hound from the Aegean Sea.

All specimens were sampled by a commercial trawl (F/V Hapuloglu, 23m length and 550 HP), in Sigacik Bay (Fig. 1). *M. mustelus* specimens (forty males, 38.3–85.2cm TL and thirty-two females, 44.0–97.5cm TL) were sampled from 2006 autumn to 2007 autumn seasonally. A conventional bottom trawl net of 24mm cod-end mesh size was used and three hauls in the same day were carried out from dawn to dusk; haul durations ranged from 1 to 3h. The vessel speed was maintained at 2.2-2.5 knots. Depth range of the fishing ground was 100-213m. In total 12 hauls were carried out; all were made in nearly the same location (Fig. 1). The specimens were stored on ice until returned to the laboratory. Stomachs of the individuals were excised from the oesophageal region and individually preserved in 4% buffered formalin for 24 hours, stored in 70% ethanol in marked containers, and analyzed. Evidence of regurgitation was not observed in any of the fish. In order to designate condition of stomach content, a scale proposed by ALBERT (21) was applied (Table 1). The items were carefully separated, weighed (to the nearest 0.01g) and identified to group level. Diet composition was evaluated as described by SEVER et al. (22).

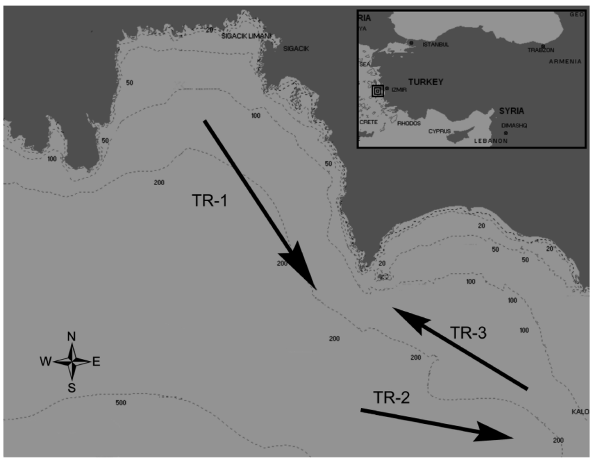

Fig. 1. – Map showing the location where sampling was carried out. Lines indicate true coordinates (TR: trawl).

TABLE 1

Definition of digestion status of prey

Status	Definition
I	Fresh; prey without signs of digestion.
II	Digestion just started; prey intact except for the more delicate parts
III	Moderately digested; prey clearly affected by digestion
IV	Severely digested; prey highly fragmented
V	Digestion almost complete; unidentifiable remains or indigestible parts only
VI	Digestion complete; stomach empty

In order to investigate the diet in the smooth-hound, I analysed the contents of seventy-two sharks. From these forty-three (59.7%) had food, twenty-nine (40.3%) were empty. According to the stomach content digestion scale (Table 1), the majority of the stomach contents (92.6%) was in category IV and higher, making it difficult to determine the prey items to low taxonomic levels. My data show that crustaceans and teleosts were the most important prey groups (MIP; IR≥137, and %IRI=75.29 and %IRI=21.98, respectively) in the diet. Cephalopods constituted the secondary prey group (SP; 137>IRI>15; %IRI=2.20), whereas polychaetes (%IRI=0.53) were an occasional prey group (OP; IR≤15) (Table 2). In order to determine whether any difference existed between seasons, stomach contents were examined for each season (Table 3). Generally, crustaceans and teleosts were found as important prey items in all seasons (Table 4).

TABLE 2

Percent number (%N), percent weight (%W), frequency of occurrence (%O), Index of Relative Importance (IRI) and percent Index of Relative Importance (%IRI) calculated for each prey item found in the stomachs of smooth-hound

Items		%N	%W	%O	IRI	%IRI
Polychaeta		4.12	0.79	2.56	12.58	0.53
Crustacea		76.47	31.77	16.67	1803.93	75.29
Cephalopoda		3.53	27.29	1.71	52.68	2.20
Teleostei		15.88	40.15	9.40	526.85	21.98
N	72					
% of empty stomachs	%40.3					

TABLE 3

Food items found for smooth-hound in Aegean Sea according to seasons.

Food Items	Spring		Summer		Autumn		Winter	
	IRI	%IRI	IRI	%IRI	IRI	%IRI	IRI	%IRI
Polychaeta	7.13	0.37	12.53	0.53	9.35	0.53	11.46	0.81
Crustacea	1324.77	68.27	1807.59	76.77	1392.93	79.13	1014.42	71.91
Cephalopoda	53.11	2.74	57.60	2.45	51.95	2.95	54.63	3.87
Teleostei	555.27	28.62	476.91	20.25	306.04	17.39	330.24	23.41
Total	1940.28	100.00	2354.63	100.00	1760.27	100.00	1410.75	100.00
N	22		14		18		18	
% of empty stomachs	38.89		42.86		38.89		38.89	

TABLE 4

Comparison of food prevalence of smooth-hound according to seasons

Food Items	Spring	Summer	Autumn	Winter
Polychaeta	OP	OP	OP	OP
Crustacea	MIP	MIP	MIP	MIP
Cephalopoda	SP	SP	SP	SP
Teleostei	MIP	MIP	MIP	MIP

The percentage of sharks with empty stomachs was 40.3%, which is somewhat higher than that found by Capape (23), Sauer & Smale (16), and Smale & Compagno (24) who reported 25.0, 13.3, and 8.7%, respectively. Both the percentage of empty stomachs and of the stomach contents in category IV (and higher categories) may be affected by long trawl hauls since the specimens were obtained from commercial trawl boats, and by the time interval that had elapsed between the field and the laboratory. In the lesser spotted dogfish, the time to evacuate food from the stomach varies according to the type of food and number of items consumed (25). For example, evacuation of 90% of the meal at 14ºC was completed in about 30h for one crustacean item with a thin exoskeleton, but evacuation took over 70h for two crustacean items with thicker, chitinous exoskeletons (25). The variety of prey items found in the diet of the smooth-hound implies that it may be a generalist. Smooth-hound prey on a wide range of items (polychaetes, crustaceans, cephalopods, fish); although crustaceans and fish are their main food groups (Table 2).

Some bottom-dwelling species, such as the *Mustelus* have teeth modified for crushing hard-shelled invertebrate prey such as crustaceans and molluscs (26). Since they have molariform teeth, the dominance of crustaceans in the diet of smooth-hound is expected and this finding agrees with previous studies. CAPAPE (23) found the diet of smooth-hound to consist of crustaceans (%O=59), fishes (%O=41), and cephalopods (%O=22). SMALE & COMPAGNO (24) noted that the diet was composed of crustaceans (%W=59.7), cephalopods (%W=27.4), fishes (%W=11.8), and invertebrates (%W=0.7). CORTES (1) recorded the diet as crustaceans (%IRI=54.7), cephalopods (%IRI=31.6), fishes (%IRI=13.1), and invertebrates (%IRI=0.6). In Sigacik Bay, commercial trawlers target deep-water shrimps such as *Parapaneus longirostris* (Lucas, 1846) and *Plesionika heterocarpus* (Costa, 1871). These and other crustaceans are caught in abundance, which may imply that smooth-hound may select these abundant and available food item.

In contrast, SAUER & SMALE (16) recorded that the diet consisted of cephalopods (%IRI=92.5), crustaceans (%IRI=6.5), and fishes (%IRI=0.1). KABASAKAL (19) found cephalopods in only 2 of 15 stomachs of smooth-hound but claimed that cephalopods are common prey items. However, it is an interesting finding that fishes are eaten by smooth-hounds as another main important prey item. Given that there is an intensive trawl fishery in the sampling area, this may suggest that the smooth-hound also feeds on wounded or dead animals in the fishing zone as an opportunist or scavenger.

In conclusion, this study indicates that the diet of smooth-hound is heterogenous and generalized. Crustaceans were consumed by most of the individuals, but teleosts represented a larger component of the total prey by mass. Cephalopods were less important numerically, but relatively more important gravimetrically. Polychaetes were relatively rare as prey. According to STERGIOU & KARPOUZI (27), fish that consume large decapods, cephalopods and fish (i.e. have a trophic level between 3.7 and 4.5) are considered as carnivores. With a trophic level of 3.8 (1), *M. mustelus* may also be considered as a carnivore.

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