Journal of the Marine Biological Association of the United Kingdom

cambridge.org/mbi

Original Article

Cite this article: Yemisken E, Navarro J, Forero M, Megalofonou P, Eryilmaz L (2019). Trophic partitioning between abundant demersal sharks coexisting in the North Aegean Sea. *Journal of the Marine Biological Association of the United Kingdom* **99**, 1213–1219. https://doi.org/10.1017/S0025315419000110

Received: 27 April 2018
Revised: 18 January 2019
Accepted: 1 February 2019
First published online: 27 March 2019

Keywords:
Aegean Sea; demersal sharks; feeding ecology; Gokceada Island; stable isotopes; trophic position

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Trophic partitioning between abundant demersal sharks coexisting in the North Aegean Sea

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Abstract

We examined the feeding ecology (diet, trophic width and trophic position) of five demersal shark species (*Mustelus mustelus* Linnaeus, 1758, *Galeus melastomus* Rafinesque, 1810, *Scyliorhinus canicula* Linnaeus, 1758, *Scyliorhinus stellaris* Linnaeus, 1758, *Squalus blainville*, Risso, 1826) coexisting in the north-eastern Aegean Sea (around Gökçeda Island) by combining stomach content and stable isotope analyses. The results indicate clear differences in diet between the five sharks. Cephalopods were mainly found in diet of *S. stellaris* and *M. mustelus* and the stomachs of *G. melastomus*, *S. canicula* and *S. blainville* included fish. *S. blainville* showed the highest trophic position in respect of stable isotope analysis ($TP_{sia} = 4.89$) around Gökçeada Island. It was followed by *G. melastomus* ($TP_{sia} = 4.57$). Direct isotopic values (both stable nitrogen and carbon) and isotopic niche width based on the Standard Ellipse Area (SEA) clearly differed among the five shark species. In particular, *S. blainville* was isotopically segregated from the other shark species studied, showing a narrow isotopic trophic niche and higher trophic level. In contrast, *M. mustelus* had the widest trophic niche of the five species studied. The niche width of *S. stellaris* was narrower than *M. mustelus* and *S. canicula* but wider than *S. blainville* and *G. melastomus*. SEA showed that *G. melastomus* has a specialized feeding strategy in the area. There is no overlap between *S. canicula* and *S. stellaris* in trophic width.

Introduction

Knowing the trophic ecology of marine predators is pivotal to understanding their trophic relationships and functional roles in ecosystems (e.g. AbdulMalak *et al.*, 2011; Barría *et al.*, 2015; Navia *et al.*, 2017). Sharks are considered important predators within marine ecosystems, although differences in their main trophic habits exist (Cortés, 1999; Barría *et al.*, 2015; Navia *et al.*, 2017). They frequently play a predatory role and their removal could affect the function of marine ecosystems (Baum & Worm, 2009). During the last few decades, elasmobranchs have become the focus of ecological studies (e.g. Ferretti *et al.*, 2013; Dulvy *et al.*, 2014; Navia *et al.*, 2017). However, few studies have focused on interactions among sympatric elasmobranchs, an essential element to understanding how ecologically similar elasmobranchs coexist in the same habitats (e.g. Albo-Puigserver *et al.*, 2015; Barría *et al.*, 2015; Navia *et al.*, 2017). Based on the principle of competitive exclusion, predators occupying similar trophic niches are expected to lead to ecological divergence or exclusion (Pianka, 2000). However, in some cases, closely related elasmobranchs coexist in the same communities and partitioning of food resources has been proposed as one of the main mechanisms to explain their coexistence (e.g. White *et al.*, 2004; Vaudo & Heithaus, 2011; Heithaus *et al.*, 2013; Albo-Puigserver *et al.*, 2015).

In comparison with other Mediterranean areas, research focusing on sharks inhabiting the North Aegean Sea (eastern Mediterranean Sea) is very limited, even though these waters host around 28 shark species, including threatened and rare species (Kabasakal, 2002*a*; Yığın *et al.*, 2015). Although there are some studies in the Aegean Sea reporting the diet of several species of sharks based on stomach contents (Kabasakal, 2002*b*; Çakır *et al.*, 2006; Filiz & Taşkavak, 2006; Filiz, 2009; Karachle & Stergiou, 2010), few studies have investigated different species simultaneously in the North Aegean Sea.

The diet of marine organisms has been traditionally studied through stomach content analysis (SCA) (Ellis *et al.*, 1996; Cortés, 1997, 1999). Although stomach content analysis allows high levels of taxonomic resolution, some marine predators such as sharks often show a high frequency of empty stomachs, and the prey items present in the stomachs are often skewed towards those that are more difficult to digest. Moreover, this methodology requires a large number of individuals, which can be difficult to obtain for elasmobranchs (Cortés, 1999; Stergiou & Karpouzi, 2001). Stable isotope analysis (SIA) of nitrogen ($\delta^{15}N$) and carbon

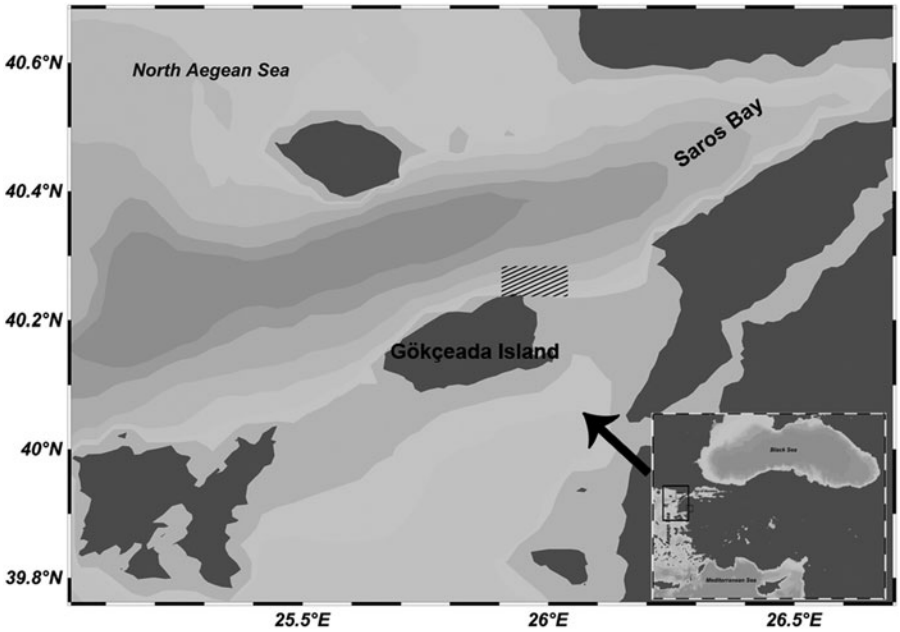

Fig. 1. Study area (Gökçeada Island, North Aegean Sea).

($\delta^{13}C$) has been used as a complementary tool to SCA to examine the trophic ecology of marine predators including sharks. SIA are useful to describe and understand the trophic position of species and explain trophic relationships in marine food webs (De Niro & Epstein, 1981; Peterson & Fry, 1987; Fry, 2007). $\delta^{13}C$ values can be useful to assess sources of primary production in marine systems, whereas $\delta^{15}N$ values are used for prediction of relative trophic level.

In this study, we examined feeding ecology (diet habits, trophic width and trophic position) of five sharks – blackmouth catshark *Galeus melastomus*, common smoothhound *Mustelus mustelus*, longnose spurdog *Squalus blainville*, small-spotted catshark *Scyliorhinus canicula* and nursehound *S. stellaris* – coexisting in the North Aegean Sea by using stable isotopic and stomach content techniques. Based on previous knowledge of the diet of these shark species and taking into account their coexistence, we expected some degree of trophic partitioning between the species (Kabasakal, 2002*b*; Karachle & Stergiou, 2010; Bradai *et al.*, 2012; Yığın *et al.*, 2015). Our study provides new insights into the ecological role of these five species within the demersal community, updating our knowledge of how these relatively abundant demersal sharks exploit available resources.

Materials and methods

Study area and sampling procedures

The North Aegean Sea is one of the most productive areas in the Eastern Mediterranean Sea. Nutrient-rich Black Sea waters play an important role in sustaining high biological productivity and fish stocks in the North Aegean (Stergiou *et al.*, 1997; Pethiakis *et al.*, 2014). Some parts of the area have been identified as important habitats for seagrass (*Posidonia oceanica*) meadows, especially in Saros Bay and the northern part of Gökçeada Island for Turkish waters and there are also some spawning and nursery grounds for small pelagic and demersal fish (Machias *et al.*, 2007; Öztürk, 2009; Güreşen *et al.*, 2015).

A total of 26 blackmouth catsharks, eight smoothhounds, 12 longnose spurdogs, 64 small-spotted catsharks and 14 nursehounds were collected between September 2014 and April 2016 at depths ranging from 33 to 450 m, by commercial trawl vessels around Gökçeada Island (North Aegean Sea; Figure 1). All sharks were accidentally captured as by-catch of fishing operations. Individuals were taken to the laboratory in a freezer where body size (total length; TL, to the nearest mm) and weight (nearest g) were recorded.

Stomach content analysis

All prey items presented in the stomach of each individual were identified at a functional prey level (Annelid, Crustacea, Cephalopods and Teleosts) and species level when it was possible. Most prey were obtained as digested material in the stomach. Weight (W%) and frequency of occurrence (F%) of prey items were calculated (Cortes, 1997). The vacuity index (v; the percent age of empty stomachs) and the percentage of fullness of stomachs (Fullness %) were also calculated (Hyslop, 1980; Amundsen *et al.*, 1996). Based on the dietary composition (expressed as W%), the mean fractional trophic level of the species was estimated using the corresponding routine TrophLab and the equation: $TP_{stomach} = 1 + j = 1\sum GDCj*TP\ j$, where DCj is the proportion of the prey category j that makes up for the species diet, TPj is the trophic level of the prey category j and G is the total number of prey categories recorded in the species (Pauly *et al.*, 2000).

Stable isotope analysis

We collected a small portion of muscle from the pectoral fins of each shark species. Before stable isotope analysis, we extracted lipid from muscle samples using a chloroform-methanol solution (Kim & Koch, 2012; Kim *et al.*, 2012). Samples were subsequently freeze-dried and powdered and 0.28–0.4 mg of each sample was packed into tin capsules. Isotopic analyses were performed at the Stable Isotopes Laboratory at the Estación Biológica de Doñana CSIC (Seville, Spain). Samples were combusted at 1020°C using a continuous flow isotope ratio mass spectrometry system (Thermo Electron) by means of a Flash HT Plus elemental analyser coupled to a Delta-V Advantage isotope ratio mass spectrometer. Stable isotope ratios were expressed in the standard δ-notation (‰) relative to Vienna Pee Dee Belemnite ($\delta^{13}C$) and atmospheric N ($\delta^{15}N$). Based on laboratory standards, the measurement error was ±0.1 and ±0.3 for $\delta^{13}C$ and $\delta^{15}N$, respectively.

https://doi.org/10.1017/S0025315419000110

Table 1. Stomach content results of blackmouth catshark *Galeus melastomus*, common smoothhound *Mustelus mustelus*, longnose spurdog *Squalus blainville*, small-spotted catshark *Scyliorhinus canicula* and nursehound *S. stellaris* collected in the North Aegean Sea

	Blackmouth catshark		Common smoothhound		Small-spotted catshark		Nursehound		Longnose spurdog	
N	26		8		14		64		12	
Total length (mm)	227 ± 35.6		911.5 ± 11.2		299 ± 37.8		478.71 ± 193.2		591 ± 79.3	
Fullness index	64.64 ± 20.48		76.55 ± 4.56		38.51 ± 18.6		57.87 ± 12.96		46.82 ± 30.35	
V (%)	7		0		8		3		14	
Trophic level	4.41		4.35		4.22		3.99		4.17	
Prey/Metric	FO%	W%	FO%	W%	FO%	W%	FO%	W%	FO%	W%
Annalida										
Polychaetes					4.7	3.2				
Crustaceans	12.5	10.28	87.5	16.9	25.6	25.9	28.6	33.5	24.2	37
Liocarcinus depurator			25	7.7						
Munida intermedia			12.5	4.02						
Parapeneus longirostris	12.5	10.28			12.5	17.3			4.26	16.31
Unidentified crustaceans			87.5	5	25.6	8.6				
Cephalopods	18.75	33.9	25	53.1	25.6	27	42.9	50.6	18.2	14.6
Illex coidetti			25	53.1						
Loligo vulgaris	4.76	12.7								
Unidentified cephalopods	14.28	17.6								
Teleosts	62.5	55.7	37.5	30	41.9	43.8	28.6	15.9	54.5	48.4
Engraulis encrasicolus			25	18.1					8.3	4.13
Unidentified teleost	62.5	55.7	25	11.9	41.9	43.8	28.6	15.9	46.2	43.9
Digested material		12.6		5.9		36.8		47.5		17.8

N, sample size; Total length of individuals; mean and standard deviation of fullness index; *V*, vacuity index; FO%, Frequency of occurrence; W%, weight.

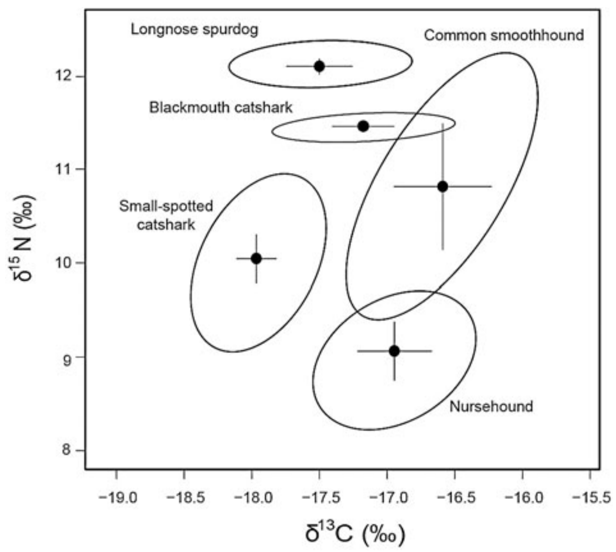

Fig. 2. Isotopic Bayesian Standard Ellipse Areas (SEAc) and Mean (±SE) of δ^{13}C and δ^{15}N values of blackmouth catshark *Galeus melastomus*, common smoothhound *Mustelus mustelus*, longnose spurdog *Squalus blainville*, small-spotted catshark *Scyliorhinus canicula* and nursehound *Scyliorhinus stellaris* from the north Aegean Sea.

Statistical analysis

As a measure of trophic width, Bayesian isotopic ellipse area (SEA) was calculated for each species by derivation of the stable isotope values (Jackson *et al*., 2011). This metric represents a measure of the total amount of the isotopic niche exploited by a particular predator and is thus a proxy for the extent of trophic diversity (or trophic width) exploited by the species (high values of isotopic standard ellipse areas indicate high trophic width). This metric uses multivariate ellipse-based Bayesian metrics. Bayesian inference techniques allow for robust statistical comparisons between data sets with different sample sizes. Isotopic standard ellipse areas were calculated using the routine Stable Isotope Bayesian Ellipses incorporated in the SIAR library (SIBER; Jackson *et al*., 2011; Shiffman *et al*., 2012). Also, C and N isotope values according to shark species were tested by using non-parametric variance analysis (Kruskal–Wallis and U Mann–Whitney) in Statistica software.

Trophic position

The trophic position (TP) of each species was estimated by using isotopic values (TP_{SIA}). TP_{SIA} was performed according to Zanden & Rasmussen (2001): $TP_{consumer} = TP_{basal} + (\delta 15N_{consumer} - \delta^{15}N_{basal})/\Delta\delta^{15}N$, where $\delta^{15}N_{consumer}$ is the value for each shark species, $\delta^{15}N_{basal}$ is that of the crab *Monodaeus couchii* (7.1‰) sampled from the east Mediterranean Sea. We used 1.95 for Δ^{15}N values (Hussey *et al*., 2010), defined as the trophic enrichment factor between organism and diet. Trophic position was compared with total body length in each species by using Kruskal–Wallis test in Statistica software.

Results

Stomach content

A total of 124 stomachs were analysed belonging to five shark species. We found that 117 of these individuals had prey in

https://doi.org/10.1017/S0025315419000110

Table 2. Mean and standard deviation of $\delta^{13}C$, $\delta^{15}N$ and trophic level (TP_{SIA}) estimated with $\delta^{15}N$ of blackmouth catshark *Galeus melastomus*, common smoothhound *Mustelus mustelus*, longnose spurdog *Squalus blainville*, small-spotted catshark *Scyliorhinus canicula* and nursehound *S. stellaris*

Species	*n*	Sampling month	Depth range (m)	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	TP_{SIA}
Blackmouth catshark	9	February 2015	235–450	−17.17 ± 0.63	11.45 ± 0.15	4.54 ± 0.07
Common smoothhound	4	April 2015	180–250	−16.60 ± 0.61	10.82 ± 1.23	4.23 ± 0.63
Longnose spurdog	8	September 2015	150–315	−17.49 ± 0.63	12.12 ± 0.24	4.89 ± 0.12
Small-spotted catshark	12	September 2015	38–275	−17.95 ± 0.48	10.01 ± 0.91	3.81 ± 0.46
Nursehound	5	April 2015	33–150	−16.95 ± 0.54	8.96 ± 0.66	3.27 ± 0.34

their stomachs (Table 1). Taking into consideration all specimens, stomach content results indicated that the diet of lesser small-spotted catsharks, longnose spurdogs and blackmouth catsharks were composed mainly of teleosts. Cephalopods were mostly found in the diet of nursehounds, while crustaceans and cephalopods were predominantly found in stomachs of common smoothhounds. Annelids were only found in the stomachs of small-spotted catsharks. The crab *Liocarcinus depurator* was found in the stomach of the common smoothhound. The cephalopods *Illex coidetti* and *Loligo vulgaris* were identified in diets of the longnose spurdog and the blackmouth catshark. *Parapenaeus longirostris* and *Munida intermedia* were identified as crustacean prey in the diet of the small-spotted catshark and the teleost, *Engraulis encrasicolus* was found in the stomachs of the longnose spurdog.

Stable isotopic analysis results

$\delta^{13}C$ and $\delta^{15}N$ values differed between the five shark species (Kruskal–Wallis tests; $\delta^{13}C$, $\chi^2 = 14.87$, $P = 0.005$; $\delta^{15}N$, $\chi^2 = 24.11$, $P < 0.0001$). The U Mann–Whitney pairwise test indicated that for $\delta^{13}C$, the small-spotted catshark showed the highest values followed by the longnose spurdog, the blackmouth catshark, the nursehound and the common smoothhound (Figure 2, Table 2). For $\delta^{15}N$ values, nursehounds showed the lowest values followed by the small-spotted catshark and the common smoothhound, the blackmouth catshark and the longnose spurdog (Figure 2, Table 2). Similar to the $\delta^{15}N$ values, the longnose spurdog showed the highest trophic position, followed by the blackmouth catshark, the common smoothhound, the small-spotted catshark and the nursehound (Table 1).

The isotopic Bayesian areas (SEA_C) showed a clear segregation between the five sharks (Figure 2). In particular, the blackmouth catshark (SEAc = 0.32) and the longnose spurdog (SEAc = 0.53) showed the lowest values, followed by the nursehound (SEAc = 1.33), the small-spotted catshark (SEAc = 1.38) and, with the highest values, the common smoothhound (SEAc = 2.36) (Figure 2).

Trophic level

The trophic levels estimated using stomach content ($TL_{stomach}$; Table 1) and isotopic values (TP_{SIA}; Table 2) were similar for the blackmouth catshark and the common smoothhound (Tables 1 and 2). For the small-spotted catshark, the nursehound and the longnose spurdog, TL was different between $TP_{stomach}$ and TP_{SIA}, the latter being lower (Tables 1 and 2). Based on TP_{SIA}, the highest and the lowest values were showed in the longnose spurdog and the nursehound, respectively (Table 2). Based on $TP_{stomach}$, the highest and the lowest values were found in the blackmouth catshark and the nursehound, respectively (Table 2). Trophic position was significantly different according to body length in each species ($P = 0.000017$; $P < 0.005$).

Discussion

In the present study, the trophic habits of five demersal sharks inhabiting the North Aegean Sea (east Mediterranean Sea) were studied by combining stomach content and stable isotopic analyses. These species are the most abundant shark species in trawl fisheries of the North Aegean Sea (unpublished data). Stomach contents provided a snapshot of the diet of each species, and muscle isotopic values identified the trophic habits integrated over the longer term (Peterson & Fry, 1987; Jenning *et al.*, 1997; Kim & Koch, 2012; Navarro *et al.*, 2014). Based on the results of both stable isotopes and stomach contents, we found clear differences in the trophic habits (diet composition, trophic niche and trophic level) among these five demersal sharks.

Overall, the results show that the five shark species displayed opportunistic feeding behaviour with priorities for different prey, mainly composed of cephalopods, fishes and crustaceans (Çakır *et al.*, 2006; Filiz & Taşkavak, 2006; Jardas *et al.*, 2007; Filiz, 2009; Karachle & Stergiou, 2010). Polychaetes and echinoderms have been included only as minor importance in their food (Filiz & Taşkavak, 2006; Bradai *et al.*, 2012). Cephalopods are a major prey for the longnose spurdog, the small-spotted catshark and the blackmouth catshark (Kabasakal, 2002*a*; Karachle & Stergiou, 2010; Bradai *et al.*, 2012). The nursehound catshark feeds in a smilar way to the small spotted catshark (Compagno, 1984; Eronat, 2012) (Table 3). In our study, we found that nursehound catsharks feed mainly on cephalopods, although teleosts were preferred by small-spotted catsharks. Differences observed in the stomach content between the two species in this study were confirmed with SIA results for both species. These may be explained by the resources available in their habitats.

A comparison between previous studies and the current one shows some differences because of regional variations in the Mediterranean Sea. According to Özütemiz *et al.* (2009), crustaceans were found to dominate the stomach contents of the blackmouth catshark in the central Aegean Sea, whereas in this study stomach contents were dominated by fish. In contrast, blackmouth catsharks were defined as specialist feeders in the west Mediterreanean Sea and a high overlap in diets was recognized for the sympatric species, blackmouth catsharks and small-spotted catsharks (Valls *et al.*, 2011). They predominantly consumed crustaceans in the area studied. Albo-Puigserver *et al.* (2015) noted that blackmouth catsharks preferred cephalopods and shrimp in the Gulf of Lion (western Mediterranean Sea). Differences between these results may be due to variations in the proportion of prey in different seasons and the variation in body sizes of individuals (Olaso *et al.*, 1998; Albo-Puigserver *et al.*, 2015). Although some studies indicate that the blackmouth catshark has a generalist and opportunistic

Table 3. Main prey groups in diet of blackmouth catshark *Galeus melastomus*, common smoothhound *Mustelus mustelus*, longnose spurdog *Squalus blainville*, small-spotted catshark *Scyliorhinus canicula* and nursehound *S. stellaris* from Mediterranean Sea

Species	Region	Main prey group	Reference
Blackmouth catshark	Aegean Sea	Cephalopods, teleosts	Present study
Blackmouth catshark	Western Mediterranean	Cephalopods	Albo-Puigserver *et al.* (2015)
Blackmouth catshark	Ionian Sea	Cephalopods, teleosts, crustaceans	Anastasopoulou *et al.* (2013)
Blackmouth catshark	Aegean Sea	Crustaceans, teleosts	Özütemiz *et al.* (2009)
Blackmouth catshark	Adriatic Sea	Cephalapods	Bello (1997)
Blackmouth catshark	Western Mediterranean	Crustaceans, cephalopods	Fanelli *et al.* (2009)
Blackmouth catshark	Western Mediterranean	Crustaceans, teleosts, cephalopods	Valls *et al.* (2011)
Common smoothhound	Aegean Sea	Crustaceans, cephalopods, teleosts	Present study
Common smoothhound	Levantine Sea	Crustaceans, teleosts	Özcan & Basusta (2016)
Common smoothhound	Aegean Sea	Crustaceans, teleosts	Eronat (2012)
Common smoothhound	Central Mediterranean	Teleosts, cephalopods	Saidi *et al.* (2009)
Common smoothhound	Aegean Sea	Crustaceans, teleosts	Filiz (2009)
Common smoothhound	Aegean Sea	Cephalapods	Kabasakal (2002*b*)
Common smoothhound	Adriatic Sea	Teleosts, crustaceans	Jardas *et al.* (2007)
Small-spotted catshark	Aegean Sea	Crustaceans, teleosts, cephalopods	Present study
Small-spotted catshark	Aegean Sea	Crustaceans, teleosts, cephalopods	Kousteni *et al.* (2017*a*)
Small-spotted catshark	Levantine Sea	Crustaceans, teleosts	Özcan & Basusta (2015)
Small-spotted catshark	Aegean Sea	Crustaceans	Eronat (2012)
Small-spotted catshark	Adriatic Sea	Crustaceans, teleosts	Šantić *et al.* (2012)
Small-spotted catshark	Central Mediterranean Sea	Crustaceans, teleosts	Mnasri *et al.* (2012)
Small-spotted catshark	Adriatic Sea	Cephalopods	Bello (1997)
Small-spotted catshark	Aegean Sea	Crustaceans, teleosts	Filiz & Taşkavak (2006)
Small-spotted catshark	Aegean Sea	Crustaceans, teleosts	Kabasakal (2001)
Small-spotted catshark	Aegean Sea	Crustaceans, teleosts	Cihangir *et al.* (1997)
Small-spotted catshark	Central Mediterranean	Crustaceans, teleosts	Capape (1974)
Small-spotted catshark	Western Mediterranean	Crustaceans	Valls *et al.* (2011)
Small-spotted catshark	Western Mediterranean	Crustaceans	Barría *et al.* (2018)
Nursehound	Northern Aegean Sea	Cephalopods, crustaceans, teleosts	Present study
Nursehound	Aegean Sea	Teleosts	Eronat (2012)
Longnose spurdog	Aegean Sea	Teleosts, crustaceans	Present study
Longnose spurdog	Aegean Sea	Cephalopods, teleosts	Kousteni *et al.* (2017*b*)
Longnose spurdog	Aegean Sea	Crustaceans, teleosts	Özütemiz *et al.* (2009)
Longnose spurdog	Aegean Sea	Cephalopods	Kabasakal (2002*c*)

feeding strategy, some results have shown it to have a specialist feeding strategy in the Mediterranean Sea (Olaso *et al.*, 1998; Bozzano *et al.*, 2001; Fanelli *et al.*, 2009; Özütemiz *et al.*, 2009; Valls *et al.*, 2011; Anastasopoulou *et al.*, 2013). An explanation is that when food availability and prey diversity are high, it probably prefers specific prey. In our study we have shown blackmouth catsharks having a specialized feeding strategy with narrow niche width.

As expected from the stomach content results, interspecific differences in the isotopic values and trophic levels were found. In particular, the longnose spurdog was isotopically segregated from the other species, showing a lower isotopic trophic width and higher trophic level. The trophic width estimated with SEAs indicated that *G. melastomus* and *S. blainville* have specialized feeding behaviours, although the common smoothound and the small-spotted catshark showed a generalized feeding strategy.

Our TL estimates from stable isotopes differed from those of other studies available in the literature. For the blackmouth catshark the trophic level estimated by stable isotopes was higher than the trophic level estimated from other areas of the Mediterranean Sea (Özütemiz et *al.*, 2009; Albo-Puigserver *et al.*, 2015). TP of small-spotted catsharks was similar to the western Mediterranean Sea (Barría *et al.*, 2018), while it was lower than the trophic level estimated by stomach content from the North Aegean Sea according to Karachle & Stergiou (2010). Differences between TP_{sia} and $TP_{stomach}$ are to be expected considering that the estimated trophic levels from isotopic data are sensitive to the basic assumption of which basal sources are used (Olin *et al.*, 2013). However, differences observed in the

https://doi.org/10.1017/S0025315419000110

trophic position between the two methods in this study might be explained by long-term and short-term prey preference differences of shark species in the region. Besides, discrepancies between methodologies (TP_{sia} and $TP_{stomach}$) have revealed the need for caution when values of trophic levels are compared (Albo-Puigserver *et al.*, 2015). Also, we found differences in the TPs between species – especially for longnose spurdogs – using both the stomach analysis and stable isotope analysis approaches, due to the low number of stomach samples.

Several studies concluded that trophic partitioning within habitats reduced the potential for competition for resources (Macpherson, 1981; White *et al.*, 2004). Although the studied five shark species feed on the same groups of prey, they probably prefer different prey species in the area. The isotopic niche space (SEAc) results indicated that small-spotted catshark does not overlap any other sharks. However, common smoothhound shark overlapped with nursehound and blackmouth catshark, suggesting niche partitioning between species. Blackmouth catshark is distributed on the middle and upper slope and nursehound is distributed on the shelf slope. Both two species are distributed in different depth ranges in general. This means that the common smoothhound shark might have shown a wide distribution according to different depth zones. The middle slope is considered a habitat overlap among blackmouth catshark, common smoothhound shark, longnose spurdog and small-spotted catshark. Their distributions show similar depth ranges (Kabasakal, 2002*a*). Diet composition of these species could reflect the specific features of the different habitat distribution, because of the differences in food availability in the different areas. Kousteni *et al.* (2017*a*) described a similar situation for small-spotted catsharks in the Aegean Sea. The stable isotope results could indicate the relationship between feeding habits and species distribution overlap. However, we need more data in order to evaluate the overlapping situation between species.

In conclusion, this study presents new information regarding the feeding ecology of five relatively abundant demersal sharks in the north Aegean Sea. They exploit different trophic resources, segregating their trophic niche. The results indicate differences in diet between species, showing a clear feeding preference for teleosts in the case of the blackmouth catshark and the longnose spurdog and a diet composed of cephalopods in the case of the common smoothhound and the nursehound. Crustaceans with teleosts and cephalopods were preferred by the small-spotted catshark. Different bathymetric distribution and habitat richness could influence prey preferences not only between species but also among populations of the same species. These results provide new insights into the mechanisms supporting the coexistence of demersal predators and their ecological role. These results can be used by managers to conduct appropriate assessments and inform conservation strategies for these species.

Acknowledgements. We thank Onur Gönüal and Mert Kesiktaş for their help during the sampling and laboratory process and to Susana Carrasco for her help during the stable isotope analysis.

Financial support. JN was supported by Spanish National Program Ramón y Cajal. This study was partially funded by Istanbul University (project no: 52069) and TUBITAK 2214A (PhD student international scholarships programme).

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