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A REVIEW OF SHARK BIODIVERSITY IN TURKISH WATERS: UPDATED INVENTORY, NEW ARRIVALS, QUESTIONABLE SPECIES, AND CONSERVATION ISSUES

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ABSTRACT

Available data reveal that the current shark fauna of the Turkish waters includes 37 confirmed species: Hexanchus griseus, Heptranchias perlo, Echinorhinus brucus, Squalus acanthias, S. blainvillei, Centrophorus *cf.* uyato, Etmopterus spinax, Somniosus rostratus, Oxynotus centrina, Dalatias licha, Squatina aculeata, S. oculata, S. squatina, Carcharias taurus, Odontaspis ferox, Alopias superciliosus, A. vulpinus, Cetorhinus maximus, Carcharodon carcharias, Isurus oxyrinchus, Lamna nasus, Galeus melastomus, Scyliorhinus canicula, S. stellaris, Galeorhinus galeus, Mustelus asterias, M. mustelus, M. punctulatus, Carcharhinus altimus, C. brachyurus, C. brevipinna, C. falciformis, C. limbatus, C. obscurus, C. plumbeus, Prionace glauca, *and* Sphyrna zygaena. *Based on current information, the most significant threat to sharks in Turkish waters is the adverse impact of bycatch.*

Key words: Elasmobranchii, inventory, state of art, Turkey

REVISIONE DELLA BIODIVERSITÀ DEGLI SQUALI IN ACQUE TURCHE: INVENTARIO AGGIORNATO, NUOVI ARRIVI, SPECIE DISCUTIBILI E PROBLEMI DI CONSERVAZIONE

SINTESI

I dati disponibili rivelano che l'attuale fauna di squali delle acque turche comprende 37 specie confermate: Hexanchus griseus, Heptranchias perlo, Echinorhinus brucus, Squalus acanthias, S. blainvillei, Centrophorus *cf.* uyato, Etmopterus spinax, Somniosus rostratus, Oxynotus centrina, Dalatias licha, Squatina aculeata, S. oculata, S. squatina, Carcharias taurus, Odontaspis ferox, Alopias superciliosus, A. vulpinus, Cetorhinus maximus, Carcharodon carcharias, Isurus oxyrinchus, Lamna nasus, Galeus melastomus, Scyliorhinus canicula, S. stellaris, Galeorhinus galeus, Mustelus asterias, M. mustelus, M. punctulatus, Carcharhinus altimus, C. brachyurus, C. brevipinna, C. falciformis, C. limbatus, C. obscurus, C. plumbeus, Prionace glauca, e Sphyrna zygaena. *Sulla base delle informazioni attuali, la minaccia più significativa per gli squali nelle acque turche è l'impatto negativo della cattura accidentale.*

Parole chiave: Elasmobranchii, inventario, stato dell'arte, Turchia

INTRODUCTION

Historically, the willingness or priority to study shark species occurring in Turkish waters was remarkably low, like in the rest of the world (Camhi *et al*., 1998). In terms of timeline, we can say that the first efforts to record sharks living in Turkish waters started with a great white shark (*Carcharodon carcharias*) that was landed in the Bosphorus in February 1881 (Kabasakal, 2020a). Following this first case, several pioneering lists of shark species living in Turkish waters have been published by various researchers (*e.g*., Ninni, 1923; Deveciyan, 1926; Ayaşlı, 1937; Erazi, 1942; Akşıray, 1987), but they represent only a small part of the general ichthyology inventories. Nevertheless, these historical publications are a valuable treasure of information about the status of shark species that used to occur in Turkish seas.

Over the past three decades, we have witnessed a remarkable increase in the quality and quantity of studies on shark species occurring in Turkish seas (Kabasakal, 2019a). The shark species in question display considerable diversity in terms of habitat (coastal or open sea species, deep or middle water species, shallow or deep sea species), feeding strategy (large predators, planktivores, etc.), and maximum size (Kabasakal, 2020b). Nowadays, social media-based shark communication (i.e., shark capture or sightings) and internet media, the use of which has become widespread in recent years, as well as field research, have a large share in uncovering this rich shark biodiversity (Kabasakal *et al*., 2017; Bengil, 2020; Kabasakal & Bilecenoğlu, 2020). Thanks to this intense information flow, new data are being added to what is already known about shark biodiversity in Turkey. In this review article, which evaluates shark biodiversity in Turkish waters, the author discusses the status of the species that have been confirmed or are considered questionable in the region, as well as the issues related to conservation, in the light of current information.

MATERIAL AND METHODS

Sampling methodology

Since 54 percent of Mediterranean sharks are at a high risk of extinction (Dulvy *et al*., 2016), the current study is a typical instance of opportunistic sampling using internet data sources such as fishing blogs (Jessup, 2003). The websites of local and national newspapers and social media platforms were regularly scanned for the years 2006–2020. Since online communities and website administrators may react negatively to the use of their online content by researchers, all internet content scraping activity was carried out responsibly in order not to compromise any personal data or images, following the recommended ethical guidelines (Monkman *et al*., 2017). To extract data from electronic sources, a Boolean search was conducted in search engines, such as Google Scholar, ScienceDirect etc., with the following keywords: "sharks," "elasmobranchi," "Turkey," "Levantine," "Black, Marmara, Aegean OR Mediterranean seas," "distribution," "hexanchiformes," "lamniformes," "squaliformes," "carcharhiniformes." The aforementioned internet search was also carried out with the French and Italian equivalents of the relevant keywords. A manual search was made to extract data published in pre-2000 journals that were not accessible via internet.

Study region

Turkey is a peninsular country surrounded by the Black Sea, Aegean and Levant Seas, and the Turkish Straits System (TSS), which runs along the Çanakkale Strait, Marmara Sea, and the Istanbul Strait. In general, the following points about the oceanographic characteristics of the seas around Turkey stand out: The high concentration of hydrogen sulfide in the Black Sea below 150 to 200 m is an important factor that prevents fish from dispersing in deep regions (Prodanov *et al*., 1997). According to Öztürk & Öztürk (1996), TSS plays an important and determinant ecological role in the distribution of living organisms between the Mediterranean and the Black Sea, as it creates a barrier, corridor or acclimatization zone for marine species. The Aegean Sea is topographically (at approximately 38° latitude) divided into two basins, the northern and southern Aegean (Papaconstantinou, 1992). Papaconstantinou (1987) defined the north Aegean Sea as an area of cold water fauna and the south Aegean Sea as a warm water fauna sea containing Lessepsian immigrants. Finally, with the opening of the Suez Canal in 1869 and the general warming of the world's oceans, the Mediterranean has been affected by a phenomenon known as "tropicalization," which causes temperate species to retreat to colder regions (Bianchi & Morri 2003).

Taxonomic nomenclature and status of species

Occurrence statuses of sharks present in Turkish seas are adopted from definitions proposed by Vas (1991). The sharks included in this review can be grouped in 3 categories based on their relative occurrence in Turkish waters: Residents (R) - specimens of these species can be found in Turkish waters all the year round; Seasonals (S) - these species occur in Turkish waters for part of the year only as a result of seasonal migrations; and Vagrants (V) - these species

occur rarely or infrequently in Turkish waters, usually as solitary specimens. The taxonomic classification of orders, families and species, and nomenclature are based on Serena *et al*. (2020).

RESULTS AND DISCUSSION

Shark biodiversity in Turkish seas

Altogether 38 shark species are reported for Turkish waters based on the current species lists (Kabasakal, 2020b; Kabasakal & Bilecenoğlu, 2020). The reason why previous lists mentioned 38 species is that *Centrophorus granulosus* was accepted as a valid species. However, Serena *et al*. (2020) stated that the Mediterranean species of the genus *Centrophorus* are still controversial and currently only one species, *Centrophorus* cf. *uyato*, occurs in the region. Based on the conclusions of Serena *et al*. (2020), the occurrence of *C. granulosus* in Turkish waters is questionable. Therefore, this species has been removed from the list compiled in the current review. In this same study, the presence of *Carcharhinus melanopterus* in the Mediterranean Sea is also considered questionable. Although not included in the species list presented in Kabasakal (2020b), Irmak & Özden (2021) have recently reported the presence of *Somniosus rostratus* in Turkish waters. Based on this new information, the current number of shark species occurring in Turkish seas has been corrected to 37 (Tab. 1). These species are represented by 5 orders and 18 families (Kabasakal, 2020b). This figure, which corresponds to 77 percent of the currently confirmed species number in the Mediterranean (n=48; Serena *et al*., 2020), reveals that there is a remarkable shark biodiversity in Turkish seas when evaluated on a Mediterranean basis. The taxonomic status, common names, occurrence status, and distribution of these species are presented in Table 1.

On the basis of their relative occurrence, approximately 42% of the species consist of vagrant and 42% of resident species, followed by seasonal sharks of approximately 17% (Table 1). Considering the distribution of sharks in Turkish seas, all species (100%) occur in the Mediterranean Sea, 83% of them in the Aegean Sea, about 47% in the Marmara Sea, and about 22% in the Black Sea (Table 1). Sharks of the order Carcharhiniformes are represented in Turkish seas with the largest number of species (4 families, 16 species, about 44% of the total species), followed by Lamniformes (4 families, 8 species, about 22% of the total species), Squaliformes (7 families, 8 species, about 19% of the total species), Squatiniformes (1 family, 3 species, about 10% of the total species) and Hexanchiformes (1 family, 2 species, about 6% of the total species).

Order Hexanchiformes

Family Hexanchidae Gray, 1851

The family Hexanchidae is represented in Turkish seas by 2 species. *Hexanchus griseus* (Bonnaterre, 1788) is distributed throughout the Turkish seas, while *Heptranchias perlo* (Bonnaterre, 1788) displays sporadic and seldom occurrences in Aegean and Mediterranean waters (Kabasakal, 2020b; Erguden & Bayhan, 2015a). The earliest records of hexanchid sharks, *H. griseus* and *H. perlo,* in Turkish waters were reported in general ichthyological inventories by Ninni (1923), Deveciyan (1926) and Akşıraş (1987); however, their contemporary occurrences in the mentioned marine region were confirmed by Kabasakal & İnce (2008), Kabasakal (2013a), Başusta (2015), Ayas *et al*. (2018) and Bayhan *et al*. (2018). Among these, studies by Kabasakal (2013a) and Başusta (2015) are certainly worth mentioning. On 19 November 2004, one male specimen of *H. griseus* of 300 cm TL, weighing 250 kg was captured by a commercial gill-netter nearly 3 miles off the coast of Amasra, and this single capture extends the Mediterranean distribution of *H. griseus* to the Black Sea (Kabasakal, 2013a). Recent reviews of large sharks caught by commercial fisheries in Turkish waters have shown that *H. griseus* is the predominant species, accounting for 43.2% (169 out of 392 specimens; Kabasakal *et al*., 2017) and 51.8% (139 out of 268 specimens; Kabasakal & Bilecenoğlu, 2020) of total captures.

Order Lamniformes

Family Odontaspididae Müller and Henle, 1839

The family Odontaspididae is represented in Turkish seas with 2 species: *Carcharhias taurus* Rafinesque, 1810 and *Odontaspis ferox* (Risso, 1810). In an earlier report, *C. taurus* was reported from Saroz Bay (NE Aegean Sea) by Cengiz *et al*., (2011). Occurrence of *O. ferox* in Turkish waters has always been a matter of discussion. In a previous review of elasmobranch species inhabiting Turkish waters, Kabasakal (2002) included *O. ferox* in the inventory of sharks of Turkey, based on the list of Turkish marine fishes provided by Mater and Meriç (1996); however, the presence of this species in the mentioned area remained unconfirmed, until Fergusson *et al*. (2008) reported on the occurrence of three smalltooth sand tiger sharks in Turkish Aegean waters. Recently, a female specimen of *O. ferox* (400 cm TL) has been incidentally captured in Antalya Bay by a commercial otter-trawler (Kabasakal & Bayrı, 2019).

Order HEXANCHIFORMES	Common name	Occurrence status	Distribution in the region
Family Hexanchidae			
Heptranchias perlo (Bonnaterre, 1788)	sharpnose seven-gill shark	V	AS, MS
Hexanchus griseus (Bonnaterre, 1788)	bluntnose six-gill shark	R	BS, SM, AE, MS
Order SQUALIFORMES			
Family Echinorhinidae			
Echinorhinus brucus (Bonnaterre, 1788)	bramble shark	V	SM, AE, MS
Family Squalidae			
Squalus acanthias Linnaeus, 1758	spotted spiny dogfish	R	BS, SM, AE, MS
Squalus blainvillei (Risso, 1827)	longnose spurdog	R	BS, SM, AE, MS
Family Centrophoridae			
Centrophorus cf. uyato (Rafinesque, 1810)	little gulper shark	V	SM, AE, MS
Family Etmopteridae			
Etmopterus spinax (Linnaeus, 1758)	velvet belly	R	AE, MS
Family Somniosidae			
Somniosus rostratus (Risso, 1827)	little sleeper shark	R	MS
Family Oxynotidae			
Oxynotus centrina (Linnaeus, 1758)	angular rough shark	R	SM, AE, MS
Family Dalatiidae			
Dalatias licha (Bonnaterre, 1788)	kitefin shark	V	SM, AE, MS
Order SQUATINIFORMES			
Family Squatinidae			
Squatina aculeata Cuvier, 1829	sawback angelshark	R	AE, MS
Squatina oculata Bonaparte, 1840	smoothback angelshark	R	SM, AE, MS
Squatina squatina (Linnaeus, 1758)	angelshark	R	BS, SM, AE, MS
Order LAMNIFORMES			
Family Odontaspididae			
Carcharias taurus Rafinesque, 1810	sandtiger shark	V	AE, MS
Odontaspis ferox (Risso, 1810)	smalltooth sand tiger	V	AE, MS
Family Alopiidae			
Alopias superciliosus Lowe, 1841	bigeye thresher	S	SM, AE, MS
Alopias vulpinus (Bonnaterre, 1788)	thresher shark	R	BS, SM, AE, MS
Family Cetorhinidae			
Cetorhinus maximus (Gunnerus, 1765)	basking shark	S	AE, MS
Family Lamnidae			
Carcharodon carcharias (Linnaeus, 1758)	great white shark	S	AE, MS
Isurus oxyrinchus Rafinesque, 1810	shortfin mako	S	AE, MS
Lamna nasus (Bonnaterre, 1788)	porbeagle	V	SM, AE, MS
Order CARCHARHINIFORMES			
Family Pentanchidae			
Galeus melastomus Rafinesque, 1810	blackmouth catshark	R	SM, AE, MS
Family Scyliorhinidae			
Scyliorhinus canicula (Linnaeus, 1758)	smallspotted catshark	R	BS, SM, AE, MS
Scyliorhinus stellaris (Linnaeus, 1758)	nursehound	R	SM, AE, MS
Family Triakidae			
Galeorhinus galeus (Linnaeus, 1758)	tope shark	V	AE, MS
Mustelus asterias Cloquet, 1819	starry smoothhound	R	BS, SM, AE, MS
Mustelus mustelus (Linnaeus, 1758)	smoothhound	R	BS, SM, AE, MS
Mustelus punctulatus Risso, 1827	blackspotted smoothhound	R	AE, MS
Family Carcharhinidae			
Carcharhinus altimus (Springer, 1950)	bignose shark	V	MS
Carcharhinus brachyurus (Günther, 1870)	copper shark	V	MS
Carcharhinus brevipinna (Valenciennes, 1839)	spinner shark	V	AE, MS
Carcharhinus falciformis (Bibron, 1839)	silky shark	V	MS
Carcharhinus limbatus (Valenciennes, 1839)	blacktip shark	V	MS
Carcharhinus obscurus (Lesueur, 1818)	dusky shark	V	MS
Carcharhinus plumbeus (Nardo, 1827)	sandbar shark	S	AE, MS
Prionace glauca (Linnaeus, 1758)	blue shark	S	AE, MS
Family Sphyrnidae			
Sphyrna zygaena (Linnaeus, 1758)	smooth hammerhead	V	AE, MS

Tab. 1: Checklist of sharks in Turkish waters. R: Resident; V: Vagrant; S: Seasonal; BS: Black Sea; SM: Sea of Marmara; AS: Aegean Sea; MS: Mediterranean Sea. Occurrence statuses (R, V, S) of sharks are adopted from the definitions proposed by Vas (1991), with explanations of these definitions given in the Material and Methods section. Taxonomic classification of orders, families, and species is based on Serena et al. (2020).

Tab. 1: Seznam vrst morskih psov v turških morjih. R: Rezidentna vrsta; V: Klatež; S: Sezonska vrsta; BS: Črno morje; SM: Marmarsko morje; AS: Egejsko morje; MS: Sredozemsko morje. Status pojavljanja (R, V, S) vrst morskih psov je bil privzet iz definicij, ki jih je predlagal Vas (1991), s pojasnili, ki jih navajamo v poglavju Material in metode. Taksonomska klasifikacija v smislu redov, družin in vrst temelji na delu Serena et al. (2020).

Family Lamnidae Bonaparte, 1835

The family Lamnidae is represented in Turkish seas with 3 species: *Carcharodon carcharias* (Linnaeus, 1758), *Isurus oxyrinchus* Rafinesque, 1810, and *Lamna nasus* (Bonnaterre, 1788). Historically, *C. carcharias* was listed in general ichthyological inventories of Turkish waters (Deveciyan, 1926; Ayaşlı, 1937; Akşıray, 1987). A detailed search in the archives of newspapers published between the early 1900s and late 1960s, revealed several specimens of *C. carcharias* incidentally captured by tuna hand-liners in the Istanbul Strait during the mentioned period (Kabasakal, 2003). Further research has revealed contemporary presence of *C. carcharias* in Turkish Aegean waters (Kabasakal & Gedikoğlu, 2008; Kabasakal *et al*., 2009 Kabasakal, 2014; Kabasakal & Kabasakal, 2015). Although available data suggest that *C. carcharias* is an extant lamnoid shark off the Turkish coast of the Aegean Sea, although currently not occurring in the Sea of Marmara (Kabasakal, 2020a), recently a young-of-the-year specimen has been incidentally captured in the southern entrance to the Dardanelles Strait, which might be a sign that the species is starting to recolonise its former habitat in the vicinity of the Sea of Marmara (Kabasakal & Bayrı, 2020).

Recent studies confirm the contemporary occurrence of *I. oxyrinchus* in Turkish Aegean and Mediterranean waters (Ergüden *et al*., 2013, 2021; Kabasakal & Kabasakal, 2013; Kabasakal, 2015a, Tunçer & Kabasakal, 2016; Kabasakal, 2017b). According to Kabasakal *et al*. (2017), *I. oxyrinchus* accounted for 5.3% of the total catch of large sharks captured by commercial fishermen during the 1990–2015 period, in Turkish waters. Occurrence of the porbeagle shark, *Lamna nasus*, in Turkish waters was reported by Deveciyan (1926), Akşıray (1987), and Kabasakal (2002). Kabasakal & Kabasakal (2004) reported on a porbeagle shark, 250 cm TL, caught off Bozcaada (northern Aegean Sea) on 11 April 2004. *L. nasus* is a rare shark in Turkish waters, and its questionable presence in Marmaric waters requires confirmation (Kabasakal & Karhan, 2015).

Family Cetorhinidae Gill, 1861

Occurrence data of *Cetorhinus maximus* (Gunnerus, 1765) in Turkish waters date back to the 1990s and consist of an anecdotal record of basking shark in northeastern Levantine waters (Kıdeyş, 1997), and further records of basking sharks off Turkish coasts, particularly in the Bay of Antalya (Kabasakal, 2013b) and Gulf of Mersin (Ergüden *et al.,* 2020a). In a recent review of the status of basking shark in the eastern Mediterranean based on an extremely low number of records off Turkish coast during the 1950s, Kabasakal (2013b) emphasised the rarity of *C. maximus* in Turkish waters.

Family Alopiidae Bonaparte, 1835

The Alopiidae family is represented in Turkish seas with 2 species: *Alopias superciliosus* Lowe, 1841, and *A. vulpinus* (Bonnaterre, 1788). The first record of bigeye thresher shark, *A. superciliosus*, in Turkish waters dates back to the early 2000s (Mater, 2005; Bay of Gökova, southeastern Aegean Sea); a few years later there was another record from the Sea of Marmara (Kabasakal & Karhan, 2008), followed by several other Aegean records (Kabasakal *et al*., 2011). The female specimen of bigeye thresher shark, 472 cm in TL, caught on 9 April 2019 off Çevlik coast (NE Levantine Sea) was one of the largest specimens of *A. superciliosus* ever recorded in the Mediterranean Sea and worldwide (Ergüden *et al*., 2020b). Despite its open water occurring habits, Kabasakal (2007) reported on the coastal occurrences of 19 common thresher sharks, *A. vulpinus*, which were incidentally captured by coastal stationary netters. Recently, Ergüden *et al*. (2015) reported on an incidental capture of a single male thresher shark, of 392 cm TL and weighing ca. 180 kg, in purse-seine fishery in İskenderun Bay, which was the first record of *A. vulpinus* from the northeastern Mediterranean coast of Turkey. Ayas *et al*. (2020) reported on the occurrence of pregnant and young specimens of *A. vulpinus* in the northeastern Mediterranean Sea, as well. Of the total number (n=392) of large sharks caught in Turkish waters by commercial fishermen between 1990 and August 2015, *A. superciliosus* and *A. vulpinus* accounted for a 2.5% and a 9.9% share, respectively (Kabasakal *et al*., 2017).

Order Carcharhiniformes

Family Pentanchidae Smith, 1912

Galeus melastomus Rafinesque, 1810, is a common deep-sea cat shark species in Marmara, and the Turkish Aegean and Mediterranean seas (Meriç, 1995; Kabasakal, 2002; Kabasakal & Kabasakal, 2004; Özütemiz *et al*., 2009; Oral, 2010). According to Bengil & Başusta (2018), *G. melastomus* is one of the species with major shares of shark bycatches in Turkish waters.

Family Scyliorhinidae Gill, 1862

The family Scyliorhinidae is represented in Turkish seas with 2 species: *Scyliorhinus canicula* (Linnaeus, 1758) and *S. stellaris* (Linnaeus, 1758). Contemporary occurrences of cat sharks *S. canicula* and *S. stellaris* in Turkish waters were confirmed by Kabasakal (2002), Kabasakal & Kabasakal (2004), İşmen *et al*. (2013), Kabasakal & Karhan (2015), Yağlıoğlu *et al*. (2015), and Başusta *et al*. (2016). In a recent review of chondrichthyan species as bycatch in Turkish waters, Bengil & Başusta (2018) stated that almost half of the bycatch recorded in Turkish waters consists of small spotted catshark.

Family Triakidae Gray, 1851

The family Triakidae is represented in Turkish seas with 2 genera and 4 species: *Galeorhinus galeus* (Linnaeus, 1758), *Mustelus asterias* Cloquet, 1819, *M. mustelus* (Linnaeus, 1758), and *M. punctulatus* Risso, 1827. Filiz & Mater (2002), Kabasakal & Kabasakal (2004), Yağlıoğlu *et al*. (2015), Başusta *et al*. (2016), and Kabasakal (2020b) confirmed contemporary occurrences of *G. galeus*, *M. asterias*, *M. mustelus,* and *M. punctulatus* in Turkish waters. Kabasakal *et al*. (2017) stated that *G. galeus* represented less than 2% of the total shark biomass recorded in the Turkish commercial fisheries between 1990 and 2015. Two specimens of starry smoothhound, *M. asterias*, were captured three miles off the coast of Şile (southwestern Black Sea) on 19 November 2000 at a depth of ca. 90 m, and this record extended the Mediterranean distribution of *M. asterias* into the Black Sea (Eryılmaz *et al*., 2011). Recently, Bengil (2020) recorded *M. asterias* in the Levantine Sea, and *M. mustelus* and *M. punctulatus* in Turkish Aegean waters.

Family Carcharhinidae Jordan and Evermann, 1896

The family Carcharhinidae is represented in Turkish seas with 2 genera and 9 species: *Carcharhinus altimus* (Springer, 1950), *C. brachyurus* (Günther, 1870), *C. brevipinna* (Valenciennes, 1839), *C. falciformis* (Bibron, 1839), *C. limbatus* (Valenciennes, 1839), *C. obscurus* (Lesueur, 1818), *C. plumbeus* (Nardo, 1827), and *Prionace glauca* (Linnaeus, 1758). Contemporary occurrences of *C. altimus*, *C. brachyurus*, *C. brevipinna*, *C. falciformis*, *C. limbatus*, *C. obscurus*, *C. plumbeus*, and *Prionace glauca* in Turkish waters were confirmed in several studies (Kabasakal & Kabasakal, 2004; Filiz & Kabasakal, 2015; Yağlıoğlu *et al.,* 2015; Kabasakal *et al.,* 2017; Bengil, 2020; Ergüden *et al*., 2020c,d; Kabasakal & Bilecenoğlu, 2020; Kabasakal, 2020b). Since the occurrence of *C. melanopterus* is based on an old record by Mater & Meriç (1996), and the questionable status of the species was emphasised by Serena *et al*., (2020), further investigation is needed to clarify its questionable status in Turkish waters. In an extensive survey on the chondrichthyan fishes of İskenderun Bay (northeastern Mediterranean Sea), Başusta *et al*. (1998) recorded the big nose shark, *C. altimus*, for the first time in Turkish waters, followed by a recent capture of a few specimens in Turkish Mediterranean waters (Ayas *et al*., 2020). Recent surveys confirm the occurrence of the dusky shark, *C. obscurus* off the Turkish coast of the Levantine Sea (Kabasakal *et al.,* 2017; Kabasakal & Bilecenoğlu, 2020). Occurrence of the spinner shark, *C. brevipinna*, was confirmed by Filiz & Kabasakal (2015) based on a specimen of the species photographed in Bay of Gökova, and several other specimens have recently been recorded in Antalya and Mersin gulfs (Ayas *et al*., 2019; Kabasakal & Bilecenoğlu, 2020). In an extensive survey of large sharks in Turkish waters, based on data mining from reliable online sources, *C. brachyurus* and *C. falciformis* were recorded for the first time in Turkish Mediterranean waters (Kabasakal & Bilecenoğlu, 2020). In terms of abundance, *C. plumbeus* and *P. glauca* are the most common carcharhinid sharks occurring in the Aegean and Mediterranean waters of Turkey (Kabasakal, 2020b).

Family Sphyrnidae Bonaparte, 1840

Our knowledge on hammerhead sharks (family Sphyrnidae) in Turkish waters is consisted of rudimentary data. Ulutürk (1987) and Kabasakal & Kabasakal (2004) reported on rare occurrences of the smooth hammerhead shark, *Sphyrna zygaena* (Linnaeus, 1758), off Gökçeada coasts (northern Aegean Sea). Recently, in August 2015, it was observed off the Kaş Peninsula (western Levantine basin) (Kabasakal *et al.,* 2017). Although its occurrence was confirmed, *S. zygaena* is considered as a rare shark in Turkish waters (Kabasakal, 2020b).

Order Squaliformes

Family Dalatiidae Gray, 1851

Kabasakal & Kabasakal (2002) reported rare occurrences of *Dalatias licha* (Bonnaterre, 1788), caught in deep-water bottom-trawl fishery in the northern Aegean Sea. Recently, an adult female of *D. licha*, 118 cm TL, became entangled in a trammel net set at a depth of 40 m in Iskenderun Bay (northeastern Mediterranean sea) (Ergüden *et al.,* 2017). In June 2018 a specimen of *D. licha* was stranded on Alanya coast (Gulf of Antalya, eastern Mediterranean Sea) (Kabasakal & Bilecenoğlu, 2020).

Family Etmopteridae Fowler, 1934

Occurrences of *Etmopterus spinax* (Linnaeus, 1758) in bottom trawl fishery have been reported from Turkish Aegean and Mediterranean waters (Kabasakal & Ünsal, 1999; Kabasakal & Kabasakal, 2004; Bilge *et al*., 2010; Başusta, 2015; Bayhan *et al*., 2018). Velvet belly is a more frequent bycatch in demersal fishery conducted in Aegean waters, where the occurrence of hundreds of neonates and juveniles suggests a bathyal nursery ground in the region (Kabasakal & Kabasakal, 2004; Bilge *et al*., 2010).

Family Somniosidae Jordan, 1888

Serena *et al*. (2020) considered *Somniosus rostratus* (Risso, 1827) as a rare shark in the eastern Mediterranean. Recently, Irmak & Özden (2021) reported the occurrence of this species in Turkish waters based on a specimen incidentally caught by a swordfish (*Xiphias gladius*) longline off Fethiye coast (southeastern Aegean Sea) in November 2008. Irmak & Özden (2021) also re-

ported that the longline was broken and dropped below at least a depth of 2500 m; thus, the sampling depth of the mentioned specimen is among the deepest observation points of the species in the Mediterranean Sea. *S. rostratus* is an extant, but rare shark in Turkish waters.

Family Oxynotidae Gill, 1863

Oxynotus centrina (Linnaeus, 1758) occurs in the Marmara, Aegean, and Mediterranean seas (Başusta *et al*., 2015; Yığın *et al*., 2016; Kabasakal, 2020b), and is considered as a rare and threatened species in Turkish waters. A recent review on the occurrence and status of *O. centrina* in the eastern Mediterranean (Kabasakal, 2015b) revealed that between the late 1800s and 2012, the highest number of *O. centrina* specimens (72%) was recorded in the Aegean Sea, followed by the Sea of Marmara (21.5%).

Family Centrophoridae Bleeker, 1859

In the recent field guide to the sharks of Turkish waters, two species of the Centrophoridae are listed, *Centrophorus granulosus* and *C. uyato* (Kabasakal, 2020b). However, the validity of *C. granulosus* and *C. uyato* is still debated among taxonomists (Serena *et al*., 2020). Some researchers suggest that the Mediterranean species of *Centrophorus* should be named *C. uyato*, while others propose a new description of the species with a new neotype (Serena *et al*., 2020). Following the current recommendations given by Serena *et al*. (2020), I consider *Centrophorus* cf. *uyato* (Rafinesque, 1810), as a valid species in Turkish waters. Although the specimens of *Centrophorus* from the Marmara Sea in the early 1990s were identified as *C. granulosus* (Benli *et al*., 1993), they should be re-examined for correct identification and naming. A single recording of *C.* cf. *uyato* from the northern Marmara bathyal has been reported by Meriç (1995). *C.* cf. *uyato* is an extant but rare shark in Turkish waters.

Family Echinorhinidae Gill, 1862

Although *Echinorhinus brucus* (Bonnaterre, 1788) had long been considered extinct in Turkish waters, in October 2002, a bramble shark *E. brucus* was imaged at a depth of 1,214 m in the northern Marmara Sea (Kabasakal *et al.,* 2005). Recent studies provide further records confirming the contemporary existence of *E. brucus* in Turkish waters (Kabasakal & Dalyan, 2011; Kabasakal & Bilecenoğlu, 2014; Kabasakal, 2017b). Available data reveal that *E. brucus* is an extant but rare shark species in Turkish waters.

Order Squatiniformes

Family Squatinidae de Blainville, 1816

The family Squatinidae is represented in Turkish seas with 3 species: *Squatina aculeata* Cuvier, 1829, *S. oculata* Bonaparte, 1840 and *S. squatina* (Linnaeus, 1758). Contemporary occurrences of S. *aculeata*, *S. oculata,* and *S. squatina* have been confirmed by Başusta (2002), Filiz *et al*. (2005), Başusta (2015), Yağlıoğlu *et al*. (2015), Ergüden & Bayhan (2015b), Ergüden *et al*. (2019), Kabasakal (2019b), Yığın *et al*. (2019), and Bengil (2020). *S. squatina* is considered as one of the largest sharks in Turkish waters and, historically, it was one of the commercially important shark species in Turkish demersal fishery (Kabasakal *et al*., 2017; Kabasakal, 2019b). However, there has been an alarming decrease recorded in angel shark populations and the survival of this species may be threatened. As recent surveys show, *S. squatina* accounts for less than 2% of the total shark biomass incidentally caught by Turkish fishermen (Yağlığlu *et al.,* 2015; Kabasakal *et al.,* 2017), and its populations has drastically declined since the early 2000s (Kabasakal, 2019b). All three species of *Squatina* are now considered as endangered species in Turkish seas.

Questionable species

In previous studies, Akşıray (1987), and Mater and Meriç (1996) included *Carcharhinus longimanus* (Poey, 1861), *C. melanopterus* (Quoy and Gaimard, 1824), *Sphyrna lewini* (Griffith and Smith, 1834), and smalleye hammerhead shark, *Sphyrna tudes* (Valenciennes, 1822), in the list of marine ichthyofauna of Turkey. However, there are no confirmed reports of living individuals of these species in Turkish waters. Furthermore, Akşıray (1987) has not given any information on where the specimens of these species were captured or are being preserved for further examination. The most recent review of species diversity of chondrichthyes in the Mediterranean Sea by Serena *et al*. (2020) does not include *C. longimanus* among the Mediterranean fauna and considers the occurrence of *C. melanopterus* as questionable. The status of occurrence of *S. lewini* and *S. tudes* in the Mediterranean Sea is considered as rare and vagrant, respectively (Serena *et al*., 2020). Bariche (2012) included the scalloped hammerhead shark, *S. lewini,* in his recent field guide of marine resources of the eastern and southern Mediterranean, but considers *S. lewini* very rare to absent in the region. For the moment, according to reports by Serena *et al*. (2020), *C. longimanus* cannot be included in the Mediterranean fauna. The occurrence statuses of *C. melanopterus, S. lewini,* and *S. tudes* in Turkish waters have always been a subject of debate, therefore these species, considered as questionable by contemporary ichthyologists, and are not included in current ichthyological inventories of the seas of Turkey (e.g., Bilecenoğlu *et al*., 2014; Kabasakal, 2020b). Further research is required to clarify the presence of *C. melanopterus, S. lewini,* and *S. tudes* in Turkish waters.

Nursery grounds of sharks along Turkish coasts

In terms of survival and management of shark populations, nursery grounds, where the parturition and development of new generations of sharks occur, are considered as critical habitats. Therefore, the mapping of these areas is of high importance. Following the surveys performed during the last two decades, four possible nursery grounds of sharks were discovered along the Turkish coast, three in the Aegean Sea and one in the northeastern Mediterranean Sea (Kabasakal & Kabasakal, 2004; Filiz & Gülşahin, 2015; Kabasakal, 2020c; Başusta *et al*., 2021).

Based on incidental captures of neonates with healing umbilical scars on the belly, Kabasakal & Kabasakal (2004) suggested that the bathyal grounds off the northern coasts of Gökçeada (northeastern Aegean Sea) may serve as a breeding ground for *Hexanchus griseus*, *Scyliorhinus canicula*, *Etmopterus spinax*, and *Dalatias licha*. According to Filiz & Gülşahin (2015), Boncuk Bay (southeastern Aegean Sea) is a confirmed nursery ground of *Carcharhinus plumbeus*, where yearly aggregations of pregnant females occur periodically from May to July (Filiz, 2018). According to Kabasakal (2020c), Edremit Bay (northeastern Aegean Sea) may serve as a nursery ground for *Carcharodon carcharias,* whereas the surrounding insular marine area outside of the bay waters may serve as a growing and feeding ground for juveniles until maturity. Last but not least, based on the records of neonate sandbar sharks in Arsuz coast (Iskenderun Bay) and Yumurtalık Bight (NE Mediterranean Sea), Ergüden *et al*. (2020c) and Başusta *et al*. (2021) suggested that this area may represent a second breeding and nursery ground for *C. plumbeus*, after Boncuk Bay, along the Turkish coast. The combined results of these studies provide solid evidence of the occurrence of multiple shark nurseries along the Turkish coasts, therefore an effective management of these grounds is crucial to the overall survival and biodiversity of Mediterranean sharks.

Bycatch of sharks in Turkish waters

There has been a considerable increase in the number of studies on the status of sharks incidentally captured during commercial fishing in Turkish waters. Bycatch of sharks were reported both in pelagic and demersal fisheries, emphasising a multimodal threat to the survival of sharks in Turkish seas (Bök *et al*., 2011; Ceyhan & Akyol, 2014; Yağlıoğlu *et al*., 2015; Filiz *et al*., 2018; Bengil & Başusta, 2018). According to Bengil and Başusta (2018), nearly half of the cartilaginous fish species (n=76) living in Turkish waters are particularly threatened from bycatch, which is a serious threat to the overall survival and future of cartilaginous fish in the eastern Mediterranean. In a recent study, Kabasakal *et al*. (2017) examined large shark species incidentally captured by commercial fishing gear in Turkish waters and the amount of catches of these species between 1990 and August 2015. Summing up, we can say that sharks are captured as "non-target species" in commercial fisheries in Turkish waters. In the recently published national action plan for the conservation of cartilaginous fishes of Turkish waters (Öztürk, 2018), bycatch in trawl, trammel net and purse seine unreported and unregulated fishing has been listed as the main threat for the cartilaginous species, occurring in the mentioned region.

Conservation of sharks in Turkish waters

Degradation of important nursery grounds and other critical coastal habitats due to marine pollution, overfishing, coastal urbanisation, and unplanned human occupation is another serious threat to the survival of sharks. A recent research on the extinction risk and conservation of globally distributed lineage of 1,041 chondrichthyan species emphasised that the extinction risk of chondrichthyans is substantially higher than that in most other vertebrates, and only one third of chondrichthyan species are considered safe (Dulvy *et al*., 2014). Following the revisions proposed in the national action plan (Öztürk, 2018), which were positively implemented in the fisheries act of Turkey (Official Gazette 2016, 2018; Öztürk, 2018; Official Gazette 2020), the following shark species are currently considered under protection: *Carcharhinus falciformis, C. plumbeus, Prionace glauca, Galeorhinus galeus, Sphyrna zygaena, Cetorhinus maximus, Isurus oxyrinchus, Lamna nasus, Alopias superciliosus, A. vulpinus, Squalus acanthias, S. blainvillei, Oxynotus centrina, Squatina aculeata, S. oculata*, and *S. squatina*. The fisheries act prohibits any person under Turkey's jurisdiction to kill and/or land the sharks from the list of protected species, and any violation of this law is sanctioned by a fine. It is an urgent necessity for some species, including large shark species, of whose population structures we still do not know much, to be included in the protection scope immediately. One of these species is *Carcharodon carcharias*, which is critically endangered in the Mediterranean Sea and was listed in Annex II (Endangered or Threatened species) of the protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean of the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean. Being a signatory state of the Barcelona Convention, Turkey should take immediate action to protect *C. carcharias*.

CONCLUSIONS

Following the publication of *A Field Guide to the Sharks of Turkish Waters* in early summer 2020 (Kabasakal, 2020b), three remarkable events happened that have made the revision of the published species list a necessity. The first event was related to the first records of *Carcharhinus brachyurus* and *C. falciformis* in Turkish

waters (Kabasakal & Bilecenoğlu, 2020). The second was the publication of a milestone article on the species diversity, taxonomy, and distribution of Mediterranean and Black Sea chondrichthyans (Serena *et al*., 2020), which indicates *Centrophorus* cf. *uyato* as a valid species of the genus *Centrophorus* and reveals *Carcharhinus melanopterus* as a questionable species in the region. The last event was the confirmation of the presence of *Somniosus rostratus* in Turkish waters (Irmak & Özden, 2021).

Available data have revealed that the current shark fauna of the Turkish waters includes 37 confirmed species. Questionable occurrences of *C. melanopterus, S. lewini*, and *S. tudes*, which are included in relevant ichthyological inventories of Turkish waters (Akşıray, 1987; Mater & Meriç, 1996), require confirmation. Although, Akşıray (1987) also mentioned the occurrence of *C. longimanus* in Turkish shark fauna, the species is not included in the present inventory due to its absence in the entire Mediterranean (Serena *et al*., 2020).

When the results of the current study (n=37 species) are compared with the list, which was published in the early 2000s and includes 31 species (Kabasakal, 2002), it can be seen that remarkable changes have taken place over the past 20 years. It has been confirmed that *Carcharias taurus*, *Carcharhinus limbatus*, *C. obscurus*, and *Echinorhinus brucus*, which are listed as questionable in the list provided by Kabasakal (2002), occur in Turkish waters (Cengiz *et al*., 2011; Kabasakal *et al*., 2017; Kabasakal & Bilecenoğlu, 2020). Although Kabasakal (2002, 2020b) reported that *Centrophorus granulosus* and *C. uyato* occur in Turkish waters, in the light of current information (Serena *et al*., 2020), the status of the species of the genus *Centrophorus* in the region should be updated to that of *C.* cf. *uyato*. During this period, three new record species (*Alopias superciliosus*, *Carcharhinus brachyurus*, and *C. falciformis*) were included in the shark fauna of Turkey (Mater, 2005; Kabasakal & Bilecenoğlu, 2020).

Based on current information, it can be observed that the most important threat to sharks in Turkish waters comes from bycatch (Bök *et al*., 2011; Ceyhan & Akyol, 2014; Yağlıoğlu *et al*., 2015; Filiz *et al*., 2018; Bengil & Başusta, 2018). Although considerable efforts have been made in recent years to protect the generations of sharks and prevent them from being harmed by incidental captures, sharks cannot be safe from bycatch fishery. The necessity and value of legal regulations for the purpose of protection of shark species is unquestionable and obvious. However, fisheries news in published or internet media, as well as in social media, give the impression that these legal measures are not yet deterrent. Although fines have started to be imposed, it is a concrete fact that we are still far from an awareness of conservation based on ecological facts and where fishermen respect sharks as "the species that have a fundamental place in the balance of the ecosystem." Releasing sharks back into the sea is an important but not the only measure to implement, as their survival is also profoundly affected by the conditions during the handling. Fishermen must understand the need for sharks in the ecosystem. Only protective efforts will come to a conclusion if this awareness is achieved.

The last but not least important issue is the potential of the increasingly numerous aquaculture facilities to attract especially large sharks to the coasts. Although sharks are active predators, they can also be opportunistic feeders, which do not refuse the easy feeding environment that aquaculture facilities offer. Concentrations of predatory sharks are increasingly being recorded around aquaculture facilities off the Turkish coast, as in different parts of the world (Kabasakal & Gedikoğlu, 2015). A recent provoked sandbar shark (*Carcharhinus plumbeus*) attack on commercial divers near an aquaculture cage (Ergüden *et al*., 2020d) is representative of the potential threat to the public that can result from the stimulating effect of aquaculture facilities.

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PREGLED PESTROSTI MORSKIH PSOV V TURŠKIH MORJIH: DOPOLNJEN SEZNAM, NOVI PRIŠLEKI, VPRAŠLJIVE VRSTE IN NARAVOVARSTVENI PROBLEMI

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POVZETEK

Favna morskih psov v turških morjih šteje po do sedaj zbranih podatkih 37 potrjenih vrst: Hexanchus griseus, Heptranchias perlo, Echinorhinus brucus, Squalus acanthias, S. blainvillei, Centrophorus *cf.* uyato, Etmopterus spinax, Somniosus rostratus, Oxynotus centrina, Dalatias licha, Squatina aculeata, S. oculata, S. squatina, Carcharias taurus, Odontaspis ferox, Alopias superciliosus, A. vulpinus, Cetorhinus maximus, Carcharodon carcharias, Isurus oxyrinchus, Lamna nasus, Galeus melastomus, Scyliorhinus canicula, S. stellaris, Galeorhinus galeus, Mustelus asterias, M. mustelus, M. punctulatus, Carcharhinus altimus, C. brachyurus, C. brevipinna, C. falciformis, C. limbatus, C. obscurus, C. plumbeus, Prionace glauca, *in* Sphyrna zygaena. *Na podlagi zdajšnjih podatkov morske pse v turških morjih v največji meri ogroža prilov.*

Ključne besede: Elasmobranchii, seznam vrst, pregled stanja, Turčija

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