

The status of the great white shark (*Carcharodon carcharias*) in Turkey's waters

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Forty-six individuals of Carcharodon carcharias were either recorded or sighted in Turkey's waters during a period from February 1881 to 28 September 2011. Total lengths (TLs) of the recorded great white sharks ranged from 85 cm TL to ~800 cm TL, and mass ranged between 12 kg and ~4500 kg. Three non-fatal shark attacks on boats of tuna hand-liners were also recorded. A North Aegean Sea specimen (85 cm TL; sp No. 45; Table 1) caught by a coastal trammel netter in Edremit Bay on July 6, 2011, is possibly the smallest neonate white shark from Mediterranean waters to date. Due to intensification of tuna fishing and the resulting decline or extinction of tuna stocks, C. carcharias is now apparently extinct from marmaric and bosphoric waters. Capture of 6 neonate great white sharks between 2008 and 2011, in the same period of the year (from late June to early July), in the waters of Edremit Bay (northern Aegean Sea, Turkey) suggests the possibility of a breeding ground in the region. The growing tuna farm industry offers a new possibility for encounters between humans and great white sharks off the Turkish coast.

Keywords: white shark, *Carcharodon carcharias*, Turkey, eastern Mediterranean, occurrence

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INTRODUCTION

The occurrence of the great white shark, *Carcharodon carcharias* (Linnaeus, 1758), in several parts of the western and central Mediterranean Sea has been well documented by several authors (e.g. De Maddalena, 2000, Adriatic Sea; Barrull & Mate, 2001, Catalanian Sea; Soldo & Jardas, 2002, in the eastern Adriatic Sea; Morey *et al.*, 2003, off the Balearic Islands; Soldo & Dulčić, 2005, eastern Adriatic Sea; Maliet *et al.*, 2013, off Corsica Island). In a recent work based on sequencing the mitochondrial control region of four great white sharks caught in different parts of the Mediterranean Sea, Gubili *et al.* (2010) suggested that Mediterranean great whites showed little genetic differentiation from Indo-Pacific lineages, but strong separation from geographically closer Atlantic/western Indian Ocean haplotypes.

Although the first writings on the occurrence of the great white shark in Turkey's waters dates back to the mid-16th Century (Bellonii, 1553), its presence in the mentioned area has always been subject to debate. In his monumental work, Petri Bellonii reported on the capture of a great white shark in waters off İzmir, a city on the Aegean seaboard of Turkey, with a short description of the specimen. Based on recordings of several neonates, juveniles and adults from the north-eastern Aegean Sea since 1991, contemporary presence of *C. carcharias* in Turkey's waters is validated without doubt (Kabasakal & Kabasakal, 2004; Kabasakal, 2008; Kabasakal & Gedikoğlu, 2008; Kabasakal *et al.*, 2009); however, it is still questionable whether the great white shark is a resident or a transient species in the seas of Turkey.

This paper is a critical review of existing literature and presents new records of the great white shark in Turkey's waters, as well as providing an updated insight on the status of *C. carcharias* in the mentioned region.

MATERIALS AND METHODS

Data of the present study were obtained from the following sources: (i) new records collected through field research; (ii) information obtained through interviews with fishermen and marine biology experts; and (iii) a review of the available data from scientific literature, daily newspapers and internet sources. Samples such as teeth, jaws, tissue samples, photographs, etc. were also obtained and preserved in the archives of the Ichthyological Research Society (IRS). Total length (TL) of fresh samples were measured; TL is the horizontal line from tip of snout to tip of the upper lobe of caudal fin, where the caudal fin depressed to body axis (Serena, 2005). The study area is shown on the map in Figure 1.

RESULTS

Based on historical accounts, contemporary records and unpublished data of *C. carcharias*, 46 great white sharks were either recorded or sighted in Turkey's waters during a period from February 1881 to 28 September 2011 (Table 1 with relevant references therein) (Ninni, 1923; Devciyan, 1926, 1945; Ayaşlı, 1930; Akyüz, 1957; Güney, 1974; Fergusson, 1996; Kabasakal, 2003, 2008, 2011; Kabasakal & Kabasakal, 2004; Kabasakal & Gedikoğlu, 2008; Kabasakal *et al.*, 2009). Most of the available historical records of the great white shark in Turkey's waters were recorded in the

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Sea of Marmara and the Bosphorus Strait (N = 32; Table 1), and only 1 individual was recorded in İskenderun Bay in 1950's (Akyüz, 1957). Contemporary records of *C. carcharias* in Turkey's waters were recorded in the Aegean Sea, of which 12 of them were recorded in northern and central parts of the sea, and 1 specimen was recorded in the south-eastern part. Date and locality of capture, TL and weight, sex, summarized fishing data and reference of each individual are presented in Table 1. Total lengths of the recorded great white sharks ranged from 85 cm TL to ~800 cm TL, and mass ranged between 12 kg to ~4500 kg (Table 1).

In relation to historical records of *C. carcharias* in marmaric and bosphoric waters, most of the specimens (N = 28) have been caught mainly by tuna hand-liners; 1 individual (sp No. 3; Table 1) entrapped in a coastal fish trap and 2 individuals (sp Nos. 28 and 29; Table 1) harpooned near the coast, and 1 specimen (sp No. 33; Table 1) was sighted by a fisherman off the Kapıdağ Peninsula (southern Sea of Marmara).

Three non-fatal shark attacks on boats of tuna hand-liners were also recorded (sp Nos. 10, 14 and 16; Table 1) in the Bosphorus Strait, between 1930 and 1958. All of the attacks were provoked events during the struggle of the hooked great white sharks attempting to escape. Although no fatalities occurred, one of the fishing boats was seriously damaged and sank upon return (İrfan Yürür, personal communication).

Between 18 March 1991 and 28 September 2011, 13 individual *C. carcharias* were sighted or caught by commercial fisherman off Turkey's coast of the North Aegean Sea (Figure 1; Table 1). Aegean records of *C. carcharias* include neonates, juveniles and adults, of which their total lengths ranged from 80 to 550 cm, and mass varied between 12 and 3500 kg. Two of the specimens (sp Nos. 36 and 37; Table 1) were sighted by a commercial gill-netter and a diver, respectively. Three great white sharks (sp Nos. 34, 35 and 41; Table 1) caught by commercial purse-seiners and the remaining 7 individual *C. carcharias*, 6 of which were neonates, were entangled in coastal stationary nets (gill or trammel nets). Unhealed birth marks were visible in 6 neonates (sp Nos. 38, 39, 42, 43, 44 and 45; Table 1). Last of the neonate great white sharks (sp No. 45; Table 1) was transferred to a 25 ton seawater aquarium by the fishermen. Unfortunately, all attempts to keep the neonate alive were unsuccessful and upon the individual exhibiting signs of distress, it was released after a couple of hours captivity (Figure 2).

Stomach content records of several individuals revealed remains of bluefin tuna (*Thunnus thynnus*), swordfish (*Xiphias gladius*), bonito (*Sarda sarda*) and unidentified dolphin in adult great whites, as well as angler fish (*Lophius* spp.), gar fish (*Belone belone*) and hake (*Merluccius merluccius*) in one of the Aegean Sea juveniles (sp No. 40; Table 1).

DISCUSSION AND CONCLUSIONS

With the additional 16 records of great white sharks (11 historical and 5 contemporary records), the number of *C. carcharias* recorded from the seas of Turkey between 1881 and 2011, increased to 46 individuals (Table 1). The present results show that, although the great white shark has disappeared from the Sea of Marmara and Bosphorus Strait, it still occurs off the Aegean coast of Turkey, with low numbers of records. Moreover, all of the new observations (9 individuals) came from field surveys since 2008, emphasizing the importance of systematic data collection.

In a recent inventory study, De Maddalena & Heim (2012) gave details of 596 records of *C. carcharias* from the entire Mediterranean Sea and adjacent waters. Historical and contemporary occurrences of *C. carcharias* off Turkey's Mediterranean coast have been mentioned by several authors (Akyüz, 1957; Geldiay, 1969; Quero, 1984; Akşiray, 1987; Fischer *et al.*, 1987; Mater & Meriç, 1996; Serena, 2005; Golani *et al.*, 2006); however, with the exception of the İskenderun Bay specimen, recorded by Akyüz (1957), none of the remaining authors provided information on where the examined specimens were caught or stored for further inspection. Available historical and contemporary records (4 individuals) of *C. carcharias* from eastern Mediterranean waters can be summarized as follows: in 1934, a female of 425 cm TL caught off Agamy beach (Alexandria, Egypt) (Norman & Fraser, 1937, in Fergusson, 1996); and a juvenile (TL 200 cm) caught off Akko coast (Israel) (Ben-Tuvia, 1971). In 1993, a female of >500 cm TL was sighted by divers off Paphos (Cyprus) (Fergusson, 1996), and Greek swordfish and tuna long-liners caught a great white shark in eastern Mediterranean waters between 1998 and 2001 (Megalofonou *et al.*, 2005). *Carcharodon carcharias* was also recorded off Alexandroupolis, Kavala and Thassos (north-western Aegean Sea, Greek coast) (Konsuloff & Drenski, 1943), and off Thermaikos Gulf (north-western Aegean Sea, Greek coast) (Economidis & Bauchot, 1976), both references cited in Papakostantinou (1988). Combining the above data with the results of the present study, the rarity of occurrences of *C. carcharias* in eastern Mediterranean waters is obvious, with 51 specimens recorded to date from the region, which constitutes 8.5% of total records from the entire Mediterranean reported by De Maddalena & Heim (2012). North Aegean Sea neonates and the Marmaris specimen (sp. No 46 in Table 1; south-eastern Aegean Sea) are the most recent records of the great white shark from the eastern Mediterranean, as well.

The non-fatal bosphoric great white shark attacks on fishing boats, that occurred in 1930 (1 case) and 1958 (2 cases), should be considered as provoked attack events, which resulted from the struggle between fishermen and the hooked individuals. A clear correlation between the occurrence of the great white shark and the bluefin tuna fishery or migrations of bluefin tuna in Mediterranean waters, is emphasized by several authors (Fergusson, 1996; De Maddalena, 2000; Barrull & Mate, 2001; Soldo & Jardas, 2002; Morey *et al.*, 2003). According to De Maddalena (2000) and Soldo & Jardas (2002), occurrence of the great white shark in coastal waters of the eastern Adriatic was in relation to the high abundance of tuna in these waters during the 19th Century and the first half of the 20th Century. The same authors also stated that, the start of intensive fishing of tuna, especially during the 1970s, in open waters of the Adriatic, resulted in the disappearance of tuna in coastal waters of the eastern Adriatic. Studies on historical and contemporary occurrence of *C. carcharias* in the Catalanian Sea (Barrull & Mate, 2001) and around the Balearic Islands (Morey *et al.*, 2003), revealed a similar correlation between the seasonal occurrence of the great white shark in western Mediterranean waters and the migration of bluefin tuna heading towards the mentioned region.

Based on the historical accounts of the great white shark in the Sea of Marmara and Bosphorus Strait (Ninni, 1923; Devciyan, 1926; Ayaşlı, 1930; Güney, 1974; Üner, 1984; Akşiray, 1987; Kabasakal, 2003, 2008, 2011), the coexistence

Table 1. Historical and contemporary records of *Carcharodon carcharias* from Turkey's waters between 1881 and 2011.

No.	Date	Location	Total length (cm)	W (kg)	Sex	Remarks	Reference
1	February 1881	Bosphorus Strait	391	-	-	Stranded near Beylerbeyi coast	Fergusson (1996)
2	17 November 1881	Bosphorus Strait	470	1500	♀	Type of fishing gear unknown	Fergusson (1996)
3	1916	Sea of Marmara	~700	-	-	Entrapped in Salistra fish trap; shot by fishermen with 3 bullets in its head	Deveciyan (1945)
4	1920	Sea of Marmara	~500	-	-	Caught off Prince Islands and displayed to public in Taksim Square, İstanbul city (Figure 3)	Unpublished data
5	May 1920	Sea of Marmara	465	~1200	-	Caught off Sedef island; a bluefin tuna, weighing ~200 kg, remains of a swordfish, a few bonitos, and a small stone found in its stomach	Deveciyan (1945)
6	1923	Sea of Marmara	-	-	-		Ninni (1923)
7	Before 1926	Sea of Marmara	~400	-	-	Displayed in Istanbul Fish Market; eight large bonitos found in its stomach	Deveciyan (1926)
8	Before 1926	Bosphorus Strait	~800	~4500	?	Two large tunas weighing 200 kg, and one large dolphin found in the stomach	Ayaşlı (1930)
9	20 February 1926	Sea of Marmara	450	over 1500	-	Caught off Büyükada Island	Kabasakal (2003)
10	1930	Sea of Marmara	?	?	?	Attached to a fishing boat off San Stefano (Yeşilköy)	Unpublished data
11	30 March 1954	Sea of Marmara	450	1500	-	Caught off Tuzla Island	Kabasakal (2003)
12	15 April 1956	Sea of Marmara	618	~3000	♀	Caught off Prince Islands; its mass surely miss-estimated	Kabasakal (2003)
13	1957	Mediterranean Sea	-	-	-	Caught in İskenderun Bay	Akyüz (1957)
14	1958	Bosphorus Strait	~700	?	?	Caught off Ahırkapı, but escaped from the hook and attached to a fishing boat	Unpublished data
15	25 December 1958	Sea of Marmara	~700	~2000	♀	Caught off Prince Islands by fishermen Niyazi Dalgın, Cemil Unalır and Şadan Şalvarlı, then landed at Ahırkapı coast	Unpublished data
16	28 December 1958	Bosphorus Strait	~800	?	?	Caught off Ahırkapı coast by fishermen Yunus Potur and Ali Durmaz. Great white shark attacked the boat and caused damage	Unpublished data
17							
18							
19							
20	Between 1958-1960	Bosphorus Strait	500 to 700	~1500 to 4000	?	Seven great white sharks captured in bosphoric and prebosphoric area by the same fisherman, 'Samatyalı' İrfan Yürür	Unpublished data
21							
22							
23							
24							
25	February 1962	Bosphorus Strait	500 +	3750	♀	Mass surely miss-estimated	Fergusson (1996)
26	28 December 1965	Bosphorus Strait	500	~4000	♀	Caught off Dolmabağçe coast; mass surely miss-estimated	Kabasakal (2003)
27	28 December 1965	Bosphorus Strait	700	~3000	♀	Caught near Maiden's Tower	Kabasakal (2003)
28	13 January 1966	Bosphorus Strait	~400	~2000	-	Harpooned off Kabataş coast	Kabasakal (2003)
29	13 January 1966	Bosphorus Strait	~400	~2000	-	Harpooned off Kabataş coast; belly of the second specimen shown overturned on the left of the photograph presented in Kabasakal (2003)	Kabasakal (2003)
30	1967	Sea of Marmara	-	-	-	Caught off Büyükada coast by a tuna hand-liner	Kabasakal (2008)
31	March 1968	Bosphorus Strait	551	?	♀	Caught by a tuna hand-liner	Kabasakal (2011)

Continued

Table 1. Continued

No.	Date	Location	Total length (cm)	W (kg)	Sex	Remarks	Reference
32	Before 1974	Sea of Marmara	–	ca. 2000	–	Caught off Prince Islands	Güney (1974)
33	May 1985	Sea of Marmara	~500	–	–	Sighted off Kapıdağ peninsula	Kabasakal (2003)
34	18 March 1991	Aegean Sea	~500	3500	♀	Caught off Foça coast by a commercial purse-seiner; transported to İstanbul Fish Market and displayed to public	Kabasakal (2008)
35	March 1996	Aegean Sea	550	–	♀	Caught off Bozcaada island by a commercial purse-seiner	Kabasakal & Kabasakal (2004)
36	April 1998	Aegean Sea	~450	–	–	Sighted by a gill-netter	Kabasakal & Kabasakal (2004)
37	May 1999	Aegean Sea	~500	–	–	Sighted by a diver off Büyükkemikli cape	Kabasakal & Kabasakal (2004)
38	1 July 2008	Aegean Sea	125.5	30	♂	Caught in Edremit Bay, off Altınoluk coast by a commercial gill-netter; unhealed birth mark was visible on the belly	Kabasakal & Gedikoğlu (2008)
39	4 July 2008	Aegean Sea	145	–	♂	Caught in Edremit Bay, off Altınoluk coast by a commercial gill-netter; unhealed birth mark was visible on the belly	Kabasakal & Gedikoğlu (2008)
40	21 February 2009	Aegean Sea	180	47.5	♀	Caught off Gökçeada island; two angler fish (<i>Lophius</i> spp.), one gar fish (<i>Belone belone</i>) and one hake (<i>Merluccius merluccius</i>) were found in the stomach	Kabasakal <i>et al.</i> (2009)
41	15 April 2009	Aegean Sea	300	102	♀	Caught off Çanakkale coast by a commercial purse-seiner; transported to İstanbul and displayed to public	Kabasakal <i>et al.</i> (2009)
42	2010; late June, early July	Aegean Sea	~80-100	–	–	Three juveniles captured by coastal gill- or trammel-netters in Edremit Bay, off Altınoluk	Unpublished data
43							
44							
45	6 July 2011	Aegean Sea	85	12	♀	Caught in Edremit Bay, off Altınoluk by a trammel-netter in inshore waters. After landing, the specimen transferred to seawater tank but upon observing stress signs, it was released after a couple of hours of captivity. A video of this specimen is available on the following link: http://vimeo.com/46296179	Unpublished data
46	28 September 2011	Aegean Sea	~500	–	–	Sighted by a diver at a depth of 15 m, while he was spearfishing off Marmaris coast. According to interview with the diver, great white shark approached to him, but no attack occurred	Unpublished data

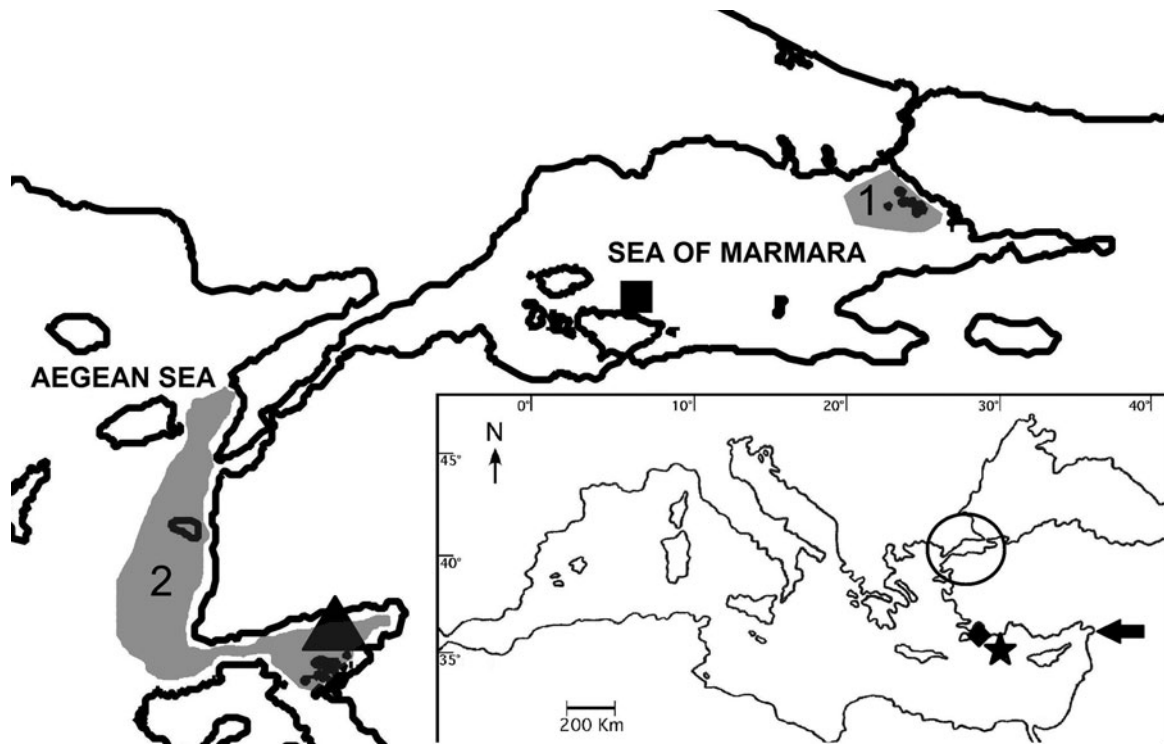


Fig. 1. Locations of historical and contemporary records of *Carcharodon carcharias* in Aegean and Marmara Seas. Shaded area (1) corresponds to approximate locality of historical marmaric records, and (2) contemporary Aegean records, of *C. carcharias* in Turkey's waters. (Δ) denotes the location where neonates of *C. carcharias* caught. (*) corresponds to approximate location where an adult great white shark sighted near a tuna farm cage. (◉) denotes the location of Iskenderun Bay record of the great white shark (specimen no 13 in Table 1); (■) denotes the location of last marmaric record of the great white shark. (∇) denotes the location of sighting of specimen No. 46 in Table 1.

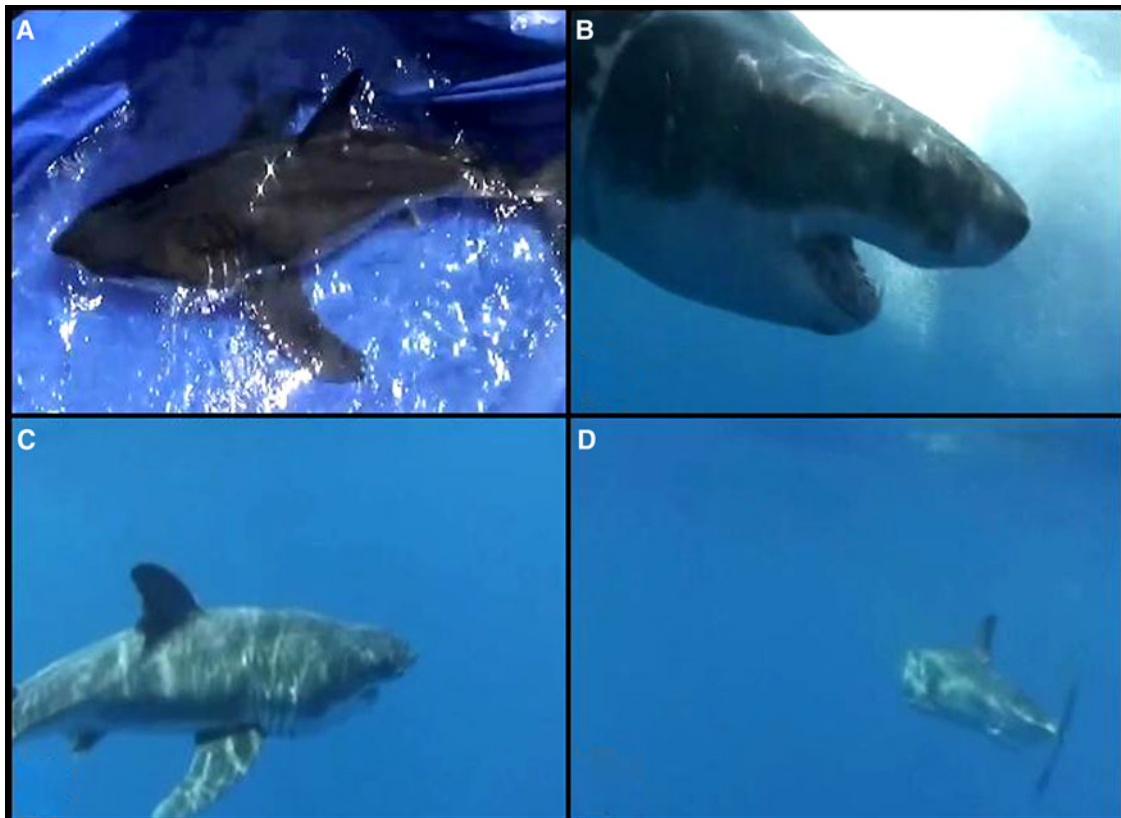


Fig. 2. Release of the neonate (sp No. 45 in Table 1) of *Carcharodon carcharias* in Edremit Bay. All images are captured from the video footage by Cenk Balkan. Neonate was first kept in a seawater tank (A), upon release it was stayed in almost motionless posture for a few minutes (B, C), and then swam away (D).



Fig. 3. Great white shark caught off Prince Islands, northern Sea of Marmara in the 1920s.

of *C. carcharias* and the bluefin tuna in marmaric and bosphoric waters, especially in the first half of 20th Century, emphasized a similar interaction, a vital link between the hunter and prey. In 1958, the highest number of the great white sharks were recorded in the Sea of Marmara and Bosphorus Strait (Table 1). During an interview with one of the surviving tuna hand-liners, who was active between the 1930s and 1990s in the Sea of Marmara, the fisherman stated that due to the discard of hundreds of tons of surplus bluefin tunas and bonitos in coastal waters, in the winter of 1958, large sharks, especially great whites occurred in the Bosphorus Strait for an unusually longer time than in previous years (İrfan Yürür, personal communication). This event is also proved by a report from a daily newspaper, published on 28 December 1958. (Both sources of evidence, voice record of the fisherman and the newspaper page are available on request.) The last record of *C. carcharias* in the Sea of Marmara (May 1985, sp No. 33; Table 1), coincides almost exactly with the collapse of the tuna fishery in the mentioned region in 1987 (Karakulak & Oray, 1994). Since the late 1980s, neither the great white shark nor the bluefin tuna have occurred in the Sea of Marmara or the Bosphorus Strait.

Due to intensification of tuna fishery and the resulting decline or extinction of tuna stocks, *C. carcharias* is now apparently extinct from marmaric and bosphoric waters; however, recent studies show that several lamniform sharks such as bigeye thresher shark, *Alopius superciliosus* (Lowe, 1839), common thresher shark, *A. vulpinus* (Bonnaterre, 1788), and porbeagle, *Lamna nasus* (Bonnaterre, 1788) which still occur in the Sea of Marmara (Kabasakal, 2002, 2007; Kabasakal et al., 2011), can penetrate into the aforementioned region in

pursuit the schools of prey fish, such as bonito (*Sarda sarda*), another favourable prey of the great white shark. Furthermore, small odontocetes are also an accessible, perhaps primary prey group, at least to adult great white sharks in the Mediterranean, first, as free swimming prey and second, as a source for scavenging (Fergusson, 1996). Altuğ et al. (2011) suggested that *Delphinus delphis* and *Stenella coeruleoalba* are distributed around Saroz Bay and Gökçeada during the year, where there are contemporary Aegean records of *C. carcharias* (see shaded area No. 2 in Figure 1). Furthermore, local populations of *Tursiops truncatus* inhabiting the Bosphorus and Dardanelles Straits, Sea of Marmara, and in waters of Gökçeada and Bozcaada islands, and Saroz Bay were also suggested by Altuğ et al. (2011). Local populations of dolphins in the northern Aegean Sea off Turkey's coast may be an inducing factor for the seasonal occurrence of *C. carcharias* in the area. According to Altuğ et al. (2011), the observation frequency for *Delphinus delphis* species which follow the pelagic fish, was high in the Turkish Straits System (TSS), Bosphorus and Dardanelles Straits, and Sea of Marmara. The same authors also supposed that dolphin presence in the TSS during the spring and autumn seasons, were related to the pelagic fish migration. Seasonal presence of dolphin populations in marmaric waters, as well as seasonal migrations of small odontocetes in pursuit of prey fish, between the Black and Aegean Seas, could create another clue for pursuance by the great white shark. Therefore, a monitoring programme is required to answer the following question: 'Does the distributional range of *C. carcharias*, in pursuit of dolphins or pelagic fish schools, still extend to the Sea of Marmara and beyond?'

Until 2008, the central Mediterranean Sea was supposed to be the only nursery ground of *C. carcharias*. Based on the spatiotemporal distribution of juvenile great white sharks <185 cm TL, Fergusson (1996) suggested that nurseries of *C. carcharias* existed in Sicilian and Tunisian neritic waters. A latter report of a pregnant female off the Tunisian coast (Saidi *et al.*, 2005) is in agreement with Fergusson's (1996) opinion considering the central Mediterranean Sea as a nursery site for the great white shark. Capture of 6 neonate great white sharks between 2008 and 2011, in the same period of the year (from late June to early July), in the waters of Edremit Bay (northern Aegean Sea, Turkey; Figure 1) suggests the possibility of another breeding ground in the region.

A small female juvenile of 142 cm TL, captured off Mazara del Vallo on 11 August 1983, was considered to be the smallest free-living great white shark from the Mediterranean Sea (Fergusson, 1996), until the capture of a neonate (125.5 cm TL) in the waters of Edremit Bay on 1 July 2008 (Kabasakal & Gedikoğlu, 2008). Therefore, specimen No. 45 (85 cm TL) of the present study is possibly the smallest neonate white shark from Mediterranean waters to date.

The growing tuna farm industry offers a new possibility for encounters between humans and great white sharks off Turkey's coast. Turkey's tuna farmers harvest juvenile tuna from several localities in the open waters of the eastern Mediterranean and transport them to main farm cages located off the central Aegean and Mediterranean coasts of Turkey. Several unconfirmed records of great white sharks were reported by the crews of towing boats; however, solid evidence is needed to describe the interactions between the great white sharks and Turkey's tuna farm industry. In at least one case, which occurred during the summer of 2009 off the Kaş Peninsula (south-western Turkey), a diver, who entered a towing cage for a routine check of the condition of tunas and net, observed a great white shark which was attempting to tear the net (★ on the map in Figure 1) (Hakan Kabasakal, unpublished data). Galaz & De Maddalena (2004) reported on a great white shark (~500 cm TL) trapped in a tuna cage off Libya, on 12 June 2002, which remained in the cage for two days. Since tuna is in high demand, and sold for high prices, in most cases fishermen first attempted to release the entrapped great white sharks, as well as other sharks to prevent predation on caged tuna; however, killing the shark would always be a last minute choice. Therefore, the vulnerable status of *C. carcharias* in the Mediterranean necessitates monitoring of the interactions between the great white sharks and the tuna farm industry, not only to take appropriate action to release the entrapped sharks in tuna cages, but also to fill the gaps in our knowledge about the occurrence and movements of great white sharks off Turkey's coast. Release of the Edremit Bay neonate (sp No. 45; Table 1), is therefore a remarkable change in the mindset of Turkey's fishermen and may be considered as the beginning of a promising era for the survival of *C. carcharias* off Turkey's coast, as well as the entire Mediterranean.

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