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PROVOKED NON-FATAL ATTACKS TO DIVERS BY SANDBAR SHARK, *CARCHARHINUS PLUMBEUS* (CARCHARHINIFORMES: CARCHARHINIDAE), OFF TAŞUCU COAST (NE MEDITERRANEAN SEA, TURKEY)

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ABSTRACT

On 26 August 2019, two commercial divers, who were diving for the routine check and cleaning of the separate aquaculture net cages, were attacked by several sandbar sharks, Carcharhinus plumbeus. *Seven to 8 specimens of sharks attacked the divers, while they were cleaning the entangled dead farmed fishes from outside of the cages. Although, the sea bottom depth, where the aquaculture cages are anchored, is from 47 to 68 m, the incidents happened in midwater around 20 m deep. The present incidents were apparently provoked by the presence of excess amount of wounded and/or dead farmed fish, which caused a certain feeding frenzy of a shark species, normally considered not to be particularly dangerous.*

Key words: Sandbar shark, Carcharhinidae, aquaculture, provoked attack, conservation, feeding frenzy

ATTACCHI NON FATALI PROVOCATI A SUBACQUEI DALLO SQUALO GRIGIO, *CARCHARHINUS PLUMBEUS* (CARCHARHINIFORMES: CARCHARHINIDAE), AL LARGO DELLA COSTA DI TAŞUCU (MEDITERRANEO NORD-ORIENTALE, TURCHIA)

SINTESI

Il 26 agosto 2019, due subacquei che si stavano immergendo per un controllo di routine e la pulizia delle gabbie di una rete di acquacoltura, sono stati attaccati da diversi squali grigi, Carcharhinus plumbeus. *Circa sette-otto esemplari hanno attaccato i subacquei, mentre stavano pulendo i pesci morti impigliati, dall'esterno delle gabbie d'allevamento. Sebbene il fondo del mare dove sono ancorate le gabbie di acquacoltura si trovi a 47-68 m di profondità, gli incidenti si sono verificati a 20 m di profondità circa. Questi incidenti sono stati apparentemente provocati dalla presenza di quantità eccessive di pesci d'allevamento feriti e/o morti, che hanno causato una certa frenesia alimentare ad una specie di squalo normalmente considerata non particolarmente pericolosa.*

Parole chiave: squalo grigio, Carcharhinidae, acquacoltura, attacco provocato, conservazione, frenesia alimentare

INTRODUCTION

Sharks as a group are considered to be highly successful predatory fishes, and are generally asynchronous opportunistic feeders on the most abundant prey item, which are primarily other fishes (Motta & Wilga, 2001). The presence of blood in the water, as from an injured organism in the sea, has long been regarded as a strong motivator for shark attack (Randall, 1986). Moreover, abundance of prey, blood, and irregular movements like those of a struggling fish, creating assorted and numerous stimuli in the water, can trigger a type of behavior known as a "feeding frenzy" (Springer & Gold, 1989).

Although, aquaculture offers great potential providing sustainable sources of food fish, interaction and compatibility of aquaculture with the environment, and vice versa, is one of the main debated issue (Massa *et al*., 2017). Aggregation of wild fish nearby offshore aquaculture cages and the possibility of modifying the spatial and temporal extent of the aggregated fish is still a poorly understood phenomenon (Bacher *et al*., 2012; Özgül & Angel, 2013). Aquaculture farms can attract predatory fish, like sharks, due to the presence of easy food opportunities in form of unconsumed feed and farmed fish (Papastimatiou *et al*., 2010; Callier *et al*., 2018).

In the present article, authors report on two incidents of provoked non-fatal shark attacks, occurred on 26 August 2019, nearby an aquaculture cage, off Taşucu coast (northeastern Mediterranean Sea, Turkey).

MATERIAL AND METHODS

Since every opportunity to examine a dead wild animal has some potential research value, the selection of an appropriate sample for the present study was an instance of typical opportunistic research, consisting in dead animal sampling (Jessup, 2003). On 26 August 2019, during a site survey in the vicinity of an aquaculture cage farm off Taşucu Dana Island coast (Fig. 1), the second author of the present article has interviewed with the employees of the fish farm and gathered information about the incident of a shark attack to two divers. The locality of the aquaculture cages is nearly 4 km off the coast and no human settlement is present in the vicinity of the farm area. Moreover, entering or trepassing the farm area is prohibited and subjected to permission. The mentioned information included some photographs of the shark on board of the support vessel and of close up photos of the lacerated diving gears (Figs. 2, 3 & 4), and a video footage with an approximately 3 minutes. The photograph seen in figure 2, which is

Fig. 1: Map depicting the approximate locality of the shark attack incident.
Sl. 1: Zemljevid obravnavanega območja z lokaliteto, kjer je prišlo do napadov morskih psov.

Fig. 2. One of the sandbar sharks, *C. plumbeus****, which attacked the diver under stimulated foraging conditions (Photo: İbrahim Yörüsün).***
Sl. 2: Eden izmed sivih morskih psov, *C. plumbeus****, ki je vzdražen zaradi prisotnosti hrane napadel potapljača (Foto: İbrahim Yörüsün).***

depicting the shark from a very clear side view, was used to confirm the identification of the species of the shark, following the descriptive criteria proposed by Serena (2005) and Ebert & Stehmann (2013).

RESULTS AND DISCUSSION

The shark species depicted in Figure 2 was identified as *Carcharhinus plumbeus* (Nardo, 1827). Although, not clearly seen on the photograph, an interdorsal ridge is present. First dorsal fin origin is over pectoral fin base, and first dorsal fin is extremely tall and semi-falcate (Fig. 2). Total length of the examined sandbar shark was 2.3 m.

On 26 August 2019, two commercial divers, who were diving for the routine check and cleaning of the net cages, were attacked by several sharks. The net cages are used for the farming of European sea bass, *Dicentrarchus labrax* (Linnaeus, 1758). Numerous dead farmed fish were seen while they were floating in midwater or sank on the bottom of the cages. The following reconstruction of the two separate shark attacks is based on the individual testimonies of the divers 1 and 2, and the detailed examination of the video footage. The first diver dived into cage at a depth of 68 m; however, diver 1 stopped descending around 20 m deep, and started cleaning and routine maintenance work. While he was performing a routine maintenance dive, he suddenly felt a bump from below and a shark has bitten his diving boots and fins (Fig. 3). Diver 1 emphasized that he didn't see the shark was approaching him. The second diver has also descended to nearly 20 m deep in the vicinity of another cage, where depth of the bottom is 47 m. Diver 2 has also started his daily routine clearance and maintenance dive, outside the cage. Since the sharks were already in a frenzied status, a group of sandbar sharks approached him, started

Tab. 1: Shark attack incidents caused by the sandbar shark and logged in Global Shark Attack File (GSAF). All of the localities are along northwestern Atlantic coast.
Tab. 1: Primeri napadov sivega morskega psa iz globalne podatkovne baze o napadih morskih psov (GSAF). Vse lokalitete so vzdolž severozahodne atlantske obale.

GSAF log No	Date	Provoked	Unprovoked	Locality	Remarks (TL)
2601	22/6/1966	✓		New Jersey	2.1 m female
2654	Aug 1967		✓	Bahamas	1.5 to 1.8 m
3133	25/3/1981		✓	Florida	1.2 to 1.5 m
3501	09/9/1989		✓	North Carolina	Not available
4324	26/7/2002		✓	South Carolina	1.2 m
4606	21/8/2005		✓	South Carolina	Not available
5233	10/5/2011	✓		Florida	ca. 2.5 m
5608	09/7/2014		✓	Delaware	1.2 to 1.5 m

Fig. 3: Lacerations on fin belonging to diver 1 (Photo: İbrahim Yörüsün).
Sl. 3: Raztrganine na plavutki prvega potapljača (Foto: İbrahim Yörüsün).

circling around the diver 2 and suddenly one of the frenzied sharks attacked his fins from below (Fig. 4). Interview with the divers, as well as the detailed examination of the video footage was revealed that 7 to 8 specimens of sharks attacked the divers. Both attacks have resulted in deep lacerations on the dive gears (Figs. 3 & 4), and except of non severe injuries, no fatalities occurred. Divers 1 and 2 have ascended the surface as soon as possible, meanwhile they were trying to fend off the frenzied sharks with a spear gun. They were hauled out of the water with the aid of support vessel's crew; however, frenzied sharks continued to prey on dead or alive fishes for nearly one hour more.

The Sandbar shark, *C. plumbeus*, is one of the well-documented representatives of the Mediterranean carcharhinids (Serena, 2005; Saïdi *et al.*, 2005, 2007). Reproductive biology, and food and feeding habits of *C. plumbeus* were extensively investigated, based on the specimens captured in Gulf of Gabes (southern Tunisia, central Mediterranean; Saïdi *et al.*, 2005, 2007). It is a coastal-pelagic shark on continental and insular shelves and in deep water to maximum depth of 280 m (Serena, 2005). Its contemporary occurrence in Turkish Aeagean and Mediterranean coasts is also well-documented (see Kabasakal, 2019, for relevant references), and sandbar sharks are known regularly aggregated in Boncuk Cove, one of the best known nursery areas of *C. plumbeus* in the Mediterranean, between March and November (Filiz, 2018). During a two-year underwater video census survey, Filiz (2018) counted 275 mature sandbar sharks in Boncuk Cove, and no aggressive encounters with the sandbar sharks ever happened. Although, Boncuk Cove is a marine protected area and no human activities is allowed,

many tourism and fishing activities in the vicinity of the cove area are present; however, no attack to humans by sandbar sharks were recorded outside the cove region (H. Kabasakal, *pers. obs.*).

The occurrence of predatory sharks in the vicinity of marine aquaculture cages is well-documented in the Mediterranean Sea. Galaz and De Maddalena (2004) reported on a female white shark, *Carcharodon carcharias* (Linnaeus, 1758), with an estimated length of 5 m, tore the net of a 50 m diameter tuna cage, off Libya coast. Same authors also reported on blue sharks, *Prionace glauca* (Linnaeus, 1758), and shortfin mako sharks, *Isurus oxyrinchus* Rafinesque, 1810, trapped in tuna cages off Italian and Spanish coasts, respectively. Kabasakal (2014) reported on a white shark, which was attempting to tear the net of tuna cage, observed during the routine check of the condition of tunas by a diver. Although the shark has circled around the diver for a few times, fortunately, no attack occurred. Kabasakal & Gedikoğlu (2015) reported on a blue shark (≥2 m total length), which was observed near aquaculture cages in Güllük Bay (southeastern Aegean Sea). In an extensive research on the site fidelity and movements of sharks associated with ocean-farming cages in Hawaii, Papastamatiou *et al*. (2010) observed that ocean fish cages appear to aggregate sandbar sharks. In the eastern Mediterranean, off Israeli coast, sandbar shark aggregations were also observed near power plants, where there is a continuous warm water outflow (Barash *et al*., 2018).

C. plumbeus is a relatively large shark species armed with large, triangular teeth; however, this species has never been indicated to attack people, and is thought to be not particularly dangerous because of its strong preference for live fish (Compagno, 1984). Compagno (1984) summarized the aggressiveness of shark species in following three categories: (1) sharks that have attacked people or boats; (2) sharks suspected of attacking people; and (3) additional species of potential harmfulness, the last one which includes *C. plumbeus*, as well. Despite the Compagno's (1984) and Ebert & Stehmann's (2013) assessment that the sandbar shark is not particularly dangerous and has never been implicated on attacks to people, Caldicott *et al*. (2001) claimed that any shark that can grow larger than 1.8 to 2.0 m is potentially lethal to man. Ehrahardt *et al*. (1972) reported that sharks less than 2 m total lenght could be dangerous for humans. Their small size allow them to easily enter at lower depth in lagoons and attacks on divers or fishermen were recorded from French Polynesia. Fouques *et al*. (1972) reported an attack by a specimen of whitecheek shark *Carcharhinus dussumieri* (Müller & Henle, 1839), having 1.5 m total length. From this point of view, *C. plumbeus* can attain a maximum size of 3 m and common to 2.4 m TL (Serena, 2005; Ebert & Stehmann, 2013), thus, sandbar shark have enough potential to attack human, if provoked. From information collected from divers and fishermen Capapé *et al*. (1975) noted that the species could be considered as dangerous in Tunisian waters, as other carcharhinid species. Suspected shark of eight incidents listed in Global Shark Attack File (GSAF) is *C. plumbeus* (GSAF, 2020), of which the details are presented in table 1. Up to May 2020, 6523 shark attacks are logged in GSAF records.

Fig. 4: Lacerations on fin belonging to diver 2 (Photo: Özkan Karkın).
Sl. 4: Raztrganine na plavutki drugega potapljača (Foto: Özkan Karkın).

In conclusion, the present incidents were apparently provoked by the presence of excess amount of wounded and/or dead farmed fish, which caused a certain feeding frenzy of a shark species, normally not thought to be particularly dangerous. Fortunately, these provoked shark attacks have not ended with a

fatality; however, these incidents set forth the possibility of unexpected shifts in the behavior of a wild fish under stimulated conditions. A significant lesson learned from these incidents is that, as a precautionary measurement, aquaculture divers have been carrying out all diving operations related with routine clearance and maintenance of the fish farm, inside the cage, and no attack has been occurred since the date of the present incidents. *C. plumbeus* is a protected shark species in Turkish seas, and intentional or incidental captures, as well as landing of captured specimens, are strictly prohibited and any violations of the law, such as deliberately capturing and landing of a sandbar shark, would be imposed a cash fine. Aquaculture operations may have a potential to provide a significant and easy access source of additional forage to sharks. Since the ecological implications of the offshore or coastal cage farming are more complex to assess, future studies should be performed to determine the potential impacts of the cage farming on the foraging ecology of sandbar sharks, and other large predatory fish species with coastal occurrence in Turkish waters, as well.

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IZZVANI NAPADI SIVEGA MORSKEGA PSA, *CARCHARHINUS PLUMBEUS* (CARCHARHINIFORMES: CARCHARHINIDAE), OB OBALI TAŞUCU (SV SREDOZEMSKO MORJE, TURČIJA)

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POVZETEK

Šestindvajsetega avgusta 2019 je več sivih morskih psov (Carcharhinus plumbeus) *napadlo dva profesionalna potapljača na rutinskem potopu pri pregledovanju in čiščenju ribjih kletk. Sedem do osem morskih psov je sodelovalo v napadu na potapljača, ko sta odstranjevala v mrežo zapletene mrtve primerke rib na zunanji strani mreže. Globina, na kateri so ribje kletke zasidrane, je med 47 in 68 m, napad pa se je zgodil plitveje na globini okoli 20 m. Napade morskih psov je očitno sprožil prebitek ranjenih ali mrtvih gojenih rib in izzval skupinsko prehranjevalno razburjenost pri morskih psih, čeprav to vrsto ne smatrajo za agresivno.*

Ključne besede: sivi morski pes, Carcharhinidae, akvakultura, izzvan napad, ohranjanje, prehranjevalna razburjenost

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