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THE OCCURRENCE OF THE COMMON ANGEL SHARK *SQUATINA SQUATINA* IN THE ADRIATIC SEA

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ABSTRACT

The common angel shark Squatina squatina is considered a critically endangered species in the Mediterranean, so much so that in Croatian Adriatic waters it deserves the highest level of protection. While in the 19th and the first half of the 20th century it was a common species here, it has been very rarely encountered over the last few decades. This paper aims to present the data on two additional records of S. squatina from the Adriatic and discuss its recent status with a proposal for effective management measures.

Key words: angel sharks, *Squatina squatina*, critically endangered, Adriatic Sea, Mediterranean Sea

PRESENZA DEL PESCE ANGELO *SQUATINA SQUATINA* IN ADRIATICO

SINTESI

Il pesce angelo Squatina squatina, specie in grave pericolo di estinzione nel Mediterraneo, merita il più alto livello di protezione nelle acque adriatiche croate. La specie, precedentemente comune nel 19° e nella prima metà del 20° secolo, è stata trovata molto raramente durante gli ultimi decenni. L'articolo mira a presentare i dati su due ritrovamenti aggiuntivi di S. squatina nell'Adriatico e a discutere il suo stato recente, con una proposta di misure di gestione efficaci.

Parole chiave: pesce angelo, *Squatina squatina*, pericolo estinzione, Adriatico, Mediterraneo

INTRODUCTION

Angel sharks are a group of at least 22 species, all in the genus *Squatina* (Ellis *et al.*, 2020). Three species of angel shark are present in the Mediterranean with overlapping ranges. Of these, the sawback angelshark *Squatina aculeata* Cuvier 1829 is mainly documented in the central basin along the southern Mediterranean coast as far as the eastern basin, including the Aegean Sea (Başusta, 2002; Soldo & Bariche, 2016; Gordon *et al.*, 2019), but not in the Adriatic Sea, while the other two species, the smoothback angel shark *Squatina oculata* Bonaparte, 1840 and the common angel shark *Squatina squatina* (Linnaeus, 1758), are reported as Adriatic species (Lipej *et al.*, 2004).

Angel sharks have dorso-ventrally flattened bodies and broad pectoral fins, which gives them a ray-like appearance. However, the anterior margins of the pectoral fins are not fused to the side of the head, and the five pairs of gill slits are lateral, not ventral, thus distinguishing angel sharks from rays (Compagno, 1984; Gordon *et al.*, 2020). Unfortunately, the body shape and preference for coastal waters of many angel sharks makes them susceptible to capture by a variety of demersal fisheries, both commercial and recreational, from the very birth. As a result, angel sharks have been identified as one of the most threatened families of chondrichthyans (sharks, skates, rays, and chimaeras) in the world,

with many requiring urgent conservation action (Dulvy *et al.*, 2014). All three Mediterranean species are assessed as critically endangered in the Mediterranean due to past population declines, running an extremely high risk of extinction in the wild (Gordon *et al.*, 2019).

In relation to the Adriatic Sea, Brusina (1888) wrote that in the Gulf of Trieste and Dalmatia *S. oculata* was rarer than *S. squatina*; Jardas (1996) defined *S. oculata* as rare throughout the Adriatic Sea; and now, after several decades without any new records of *S. oculata* in the Adriatic, we can presume this species to be locally extinct.

The body in *S. squatina* is strongly flattened dorso-ventrally, with a very wide head and very wide pectoral and pelvic fins and no anal fin. The origin of the first dorsal fin is above the pelvic fin free rear tip, the caudal fin lower lobe larger than upper lobe. Nasal barbels are not fringed and spiracles are large. There are 5 pairs of gill slits, not visible when the shark rests on the sea bottom. Dorsal surface of light brown-gray color or dark with 1–3 straight dark bands on pectoral fins and small white and dark spots and dark patches; ventral surface white. Upper teeth with one cusp, small and pointed; lower teeth similar. *S. squatina* can reach a maximum size of 244 cm. The size at birth is 24–30 cm, at maturity the size of males is 80–132 cm, and of females 128–169 cm (Compagno, 1984; Lipej *et al.*, 2004).

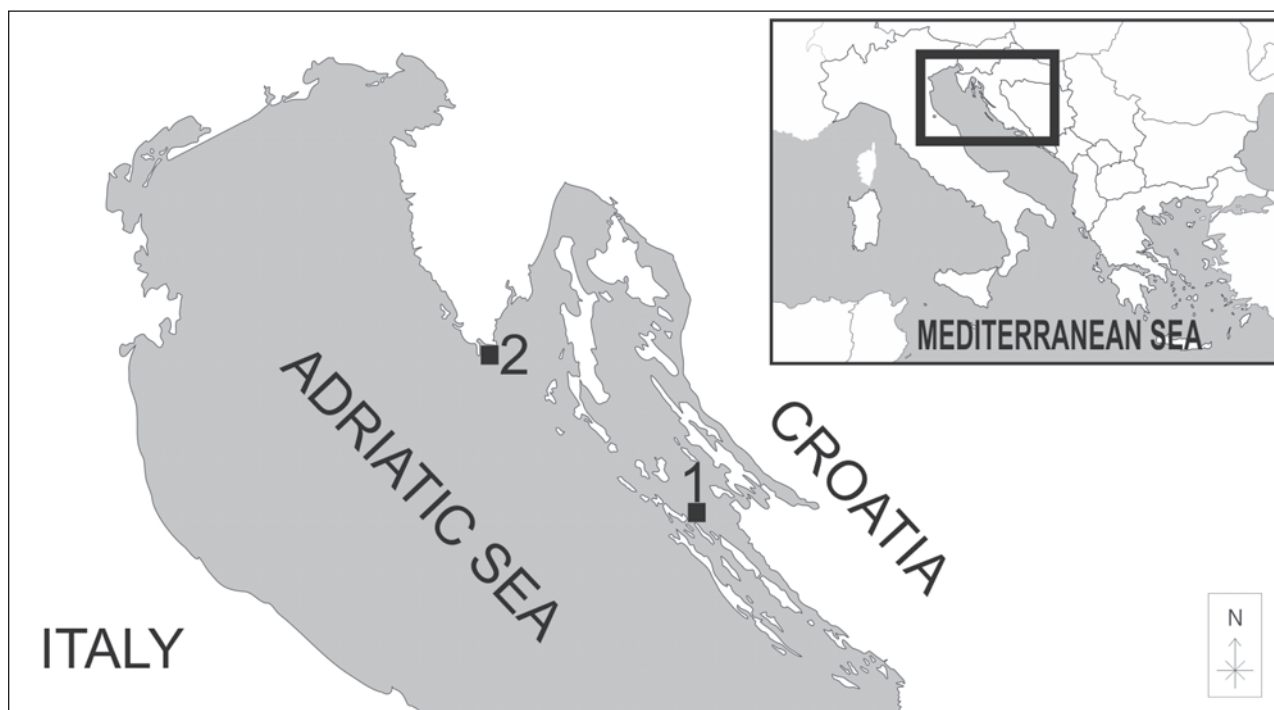


Fig. 1: Capture and release site of two male specimens of *S. squatina*.
Sl. 1: Mesto ulova in izpustitve dveh samcev sklata (*S. squatina*).

Brusina (1888) reported that (at his time) the common angel shark was abundantly caught in the Adriatic Sea. Jardas (1996) considered *S. squatina* to be rare throughout the Adriatic while only in the area of the Neretva River and Zadar did it seem to be more common. Bello (1999) wrote that the angel shark was infrequently caught in the southeastern part and rarely netted in the southwestern part of the Adriatic Sea. Matjašič *et al.* (1976) inserted *S. squatina* on the list of the fauna and flora of northern Adriatic. In the Kvarner region, this species was not registered between 1973 and 1996 (Jardas *et al.*, 1998).

Previous data indicate that *S. squatina* was often a by-catch of bottom trawls. Angel shark was reported as a caught species in 1948 during the Hvar expedition, but the Medits expedition which took place 50 years later, in 1998, failed to confirm the presence of this species (Jukić-Peladić *et al.*, 2001). Soldo (2006) considered both Adriatic angel shark species as very rare and critically endangered within the local area. Based on that opinion Croatia, within its waters, accorded both angel shark species the highest level of protection (strictly protected status) in the Adriatic.

In Croatia, angel sharks were historically targeted, in fact, one of the large mesh size gillnets was called *sklatara* after the Croatian term for the angel shark – *sklat*. Something similar was indicated by Fortibuoni *et al.* (2016), who reported that according to naturalists' accounts and historical documents, the species was so abundant in the Northern Adriatic in the 19th and early 20th centuries as to sustain targeted fisheries, and large quantities of *S. squatina* were sold in the main fish markets, but during the 1960s, the species collapsed and became economically extinct. However, Fortibuoni *et al.* (2016) also concluded that even if *S. squatina* was never detected in the area during scientific surveys conducted between 1948 and 2014, it emerged from interviews with fishermen that the species is not extirpated from the Adriatic Sea. Such conclusion was also supported by occasional records from the Adriatic; Holcer & Lazar (2017), for example, reported 4 records from the 2008–2016 period (two from the Murter area and two from Kvarner).

Thus, this paper aims to present new and older data on the occurrence of common angel shark in the Adriatic and to discuss the recent status of this critically endangered species.

MATERIAL AND METHODS

The first specimen was caught on 8 March 2007 by a gillnet with 180 mm mesh size, at a depth of 50 m, near Point Križ – the Island of Sestrunj (Fig. 1). The second specimen was caught on 23 April 2021 with a trammel net at the depth of 23 m in front of Debeljak Bay, near Point Kamenjak (the southernmost tip of the Istrian Peninsula) (Fig. 1).

Tab. 1: Morphometric measurements of the specimen caught on 8 March 2007.

Tab. 1: Morfometrične meritve primerka, ujetega 8. marca 2007.

Morphometric parameter	mm/g
Total length - TOT	1080
Precaudal length - PRC	940
Pre-second dorsal length – PD2	825
Pre-first dorsal length – PD1	690
Preorbital length – POB	52
Prepectoral length – PP1	135
Preanal length – PAL	495
Dorsal caudal margin – CDM	160
Pectoral anterior margin – P1A	310
Pectoral base - P1B	160
Width with fins	635
Body width	245
Clasper inner length – CLI	165
Mouth width – MOW	135
Internarial space – INW	80
First dorsal height – D1H	95
First dorsal inner margin - D1L	80
First dorsal base – D1B	50
Total weight	11204
Liver weight	338
Stomach weight full	381
Stomach content weight	184

The first specimen was caught and landed dead during a scientific survey, and therefore fully measured to the nearest mm and weighed to the nearest 0.01 g. After the dissection of the specimen, its stomach was isolated and examined.

The second specimen was landed on a boat alive. The fisherman contacted the Pula Aquarium and their staff collected the specimen, taking it to the water tank in the aquarium, where it was kept alive.

RESULTS

Based on the diagnostic characteristics described by Compagno (1984) and Lipej *et al.* (2004), both specimens were identified as males of *S. squatina*. Morphometric measures of the first adult specimen (Fig. 2) taken according to the guidelines of Compagno (1984) are presented in Table 1.



Fig. 2: The adult male specimen of *S. squatina* caught on 8 March 2007 by gillnet.
Sl. 2: Odrasel samec sklata (*S. squatina*), ujet 8. marca 2007 v zabodno mrežo.

The analysis of the stomach content revealed an omnivorous diet for *S. squatina* as the content included a whole black scorpionfish *Scorpaena porcus* Linnaeus 1758, remains of gilthead seabream *Sparus aurata* Linnaeus 1758, as well as several beaks of squid and cuttlefish. Leaves of seagrass *Posidonia oceanica* were also found in it, but it could not be concluded whether they had been ingested intentionally or accidentally during the pursuit of prey. Interestingly, this specimen was caught in the very Zadar archipelago area that had been historically identified as the habitat of the common angel shark.

The second specimen was landed alive (Fig. 3) on a fishing boat on 23 April 2021 and transported and kept alive in the water tank of the Pula Aquarium. Their staff only performed basic measurements in order to keep the handling at a minimum and thus increase the specimen's chances of recovery. This immature male measured 68 cm in length, 37 cm in width, and weighed 3.2 kg. After nearly two weeks in the Aquarium, the specimen successfully recovered and it was decided it should be released alive on 4 May 2021 in the adjacent waters of the Marine Protected Area of the National Park Brijuni (exact location known but not publicly available).

DISCUSSION

Historically, *S. squatina* was common across large areas of coastal, continental and insular shelves of the Northeast Atlantic (southern Norway to Western Sahara), and the Mediterranean and Black Seas. Nowadays, records of this species are reported throughout the Mediterranean including the southern coasts of the western and central basins, the Ligurian, Northern Tyrrhenian, and Adriatic Seas on the northern coast, and the Levant and Aegean Seas in the eastern basin (Gordon *et al.*, 2019). It has also been documented in the Sea of Marmara and is the only angel shark species known to have been present in the Black Sea, with contemporary captures around the Bosphorus Strait (Serena, 2005).

However, although angel sharks are reported, their records are rare. Usually, these rely on fisheries data and reports of by-catch, as well as novel approaches such as citizen science, social media, and interviews with fishers aimed at increasing knowledge on distribution (Fortibuoni *et al.*, 2016; Gordon *et al.*, 2019). On the other hand, the usefulness of scientific surveys, which are normally



Fig. 3: The immature male specimen of *S. squatina* caught and landed alive on 23 April 2021.
Sl. 3: Mladostni primerek sklata (*S. squatina*), ki je bil ujet in izpuščen 23. aprila 2021.

considered a good source of various data, has been questioned in relation to detection of rare species, due to a complete lack of data on angel sharks in scientific trawl surveys conducted in the Adriatic Sea since 1948 (Jukić-Peladić *et al.*, 2001; Fortibuoni *et al.*, 2016; Holcer & Lazar, 2017).

An additional problem, quite common in the Mediterranean, is that frequently records from fisheries only classify angel sharks at genus level, which affects the possibility to determine the population status at species level. Precise data on angel sharks are thus hidden due to misreporting in fisheries or marketing under alternative common names. In many Mediterranean areas, angel sharks have been confused with other species, e.g. *Lophius* spp. or rays, particularly guitarfishes (species of the genus *Rhinobatus*). A recent analysis from the Adriatic Sea (Bakiu & Soldo, 2021) pointed to the reported landing of angel sharks and sand devils nei group (Squatinidae) in Albania. This Adriatic country was regularly reporting angel shark catches, with the largest catch stated in 2010 (78 tons). The last report dates to 2016, when a catch of 3 tons was declared. However, after conducting a scientific survey on

shark catches, including interviews with fishermen, Bakiu & Soldo (2021) concluded that the reported catches were likely misidentified, like presumably in some other Mediterranean countries (Gordon *et al.*, 2019).

Given the critically endangered status of angel sharks in the Mediterranean, there are several existing protective measures that can be implemented for these species. In a binding Recommendation adopted by the 24 parties to the GFCM (GFCM/36/2012/3, amended to GFCM 42/2018/2) it has been agreed that retention and sale of 24 elasmobranchs listed in Annex II of the Barcelona Convention, including all three species of the Mediterranean angel shark, should be prohibited. The European Union (EU) transposed the GFCM Recommendation into EU Regulation (EU 2015/2102), prohibiting the retention of all three species of angel shark in the Mediterranean and augmenting the prior listing of *S. squatina* as a prohibited species under the Common Fisheries Policy annual fisheries quotas (Gordon *et al.*, 2019). However, the implementation of full protection measures at national levels by EU Member States has been poor. A positive example is Croatia,

which is recognized as a champion in the protection of sharks and rays. The group of 28 species of sharks and rays that have been declared as strictly protected species, includes both Adriatic angel sharks. Nevertheless, being granted the maximum level of protection alone will not prevent the species from being caught, especially the angel sharks inhabiting the inshore area, where the fishing effort and the use of a broad range of bottom fishing gear in small- and large-scale fisheries are the most extensive. Therefore, the efforts of conservation action should not stop at the implementation of relevant international and regional obligations into national legislation, as fishery within angels sharks' habitats will continue. Although the results of this paper show that some angel sharks can indeed be landed alive and subsequently released back into the sea, proper management cannot rely on the possibility that the shark will be landed on a boat in good condition and that the fishermen involved will have the incentive and be motivated to release the protected species properly. Thus, the vital conservation issue is, after the implementation of conservation measures into national legislation, to identify and map the critical habitats occupied by angel sharks. As it

can be presumed that those habitats will be defined within the inshore area, where proclaiming a marine protected area is a very sensitive and lengthy (if even possible) process, with different responsibilities, authorities, and interests overlapping, usually between fishery and environmental protection administration, the goal should be to determine limited, but large enough habitats where the use of bottom fishing gear will be restricted exclusively to the selective gear that cannot be used to target angel sharks. Having a protected area where the use of large mesh size gillnets and trammel nets, as well as towing fishing gear (which is completely unselective to relatively larger marine species) will be forbidden could result in giving a chance to angel shark populations to recover from depletion and hopefully reach the levels where they would not be endangered anymore.

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POJAVLJANJE NAVADNEGA SKLATA (*SQUATINA SQUATINA*) V JADRANSKEM MORJU

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POVZETEK

Navadni sklat (*Squatina squatina*), danes opredeljen kot kritično ogrožena vrsta v Sredozemskem morju, ima v hrvaškem delu Jadrana najvišji nivo varovanja. To, še v 19. in 20. stoletju pogosto vrsto, so v zadnjih desetletjih le redko ujeli. Avtor v pričujočem prispevku poroča o dveh primerih ulova navadnega sklata v Jadranskem morju in razpravlja o njegovem trenutnem statusu ter predlaga učinkovite mere upravljanja z vrsto.

Ključne besede: sklati, *Squatina squatina*, kritično ogrožena vrsta, Jadransko morje, Sredozemsko morje

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