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THE OCCURRENCE AND STATUS OF THRESHER SHARK (*ALOPIAS VULPINUS*) IN WATERS OFF SLOVENIA

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ABSTRACT

The authors report data on common thresher sharks, *Alopias vulpinus* (Bonnaterre, 1788) caught in Slovenian territorial waters. The sharks were captured largely during summer months, mainly August. Over the past five years three cases of immature sharks were recorded, which additionally confirms the fact that the area of northern Adriatic Sea is a nursery for thresher shark. The authors try to assess the current level of knowledge of thresher sharks based on older and recent landings and sightings of the species in the territorial waters of Slovenia.

Key words: thresher shark, *Alopias vulpinus*, incidental catches, feeding habits, nursery, northern Adriatic

PRESENZA E STATO DELLO SQUALO VOLPE (*ALOPIAS VULPINUS*) IN ACQUE AL LARGO DELLA SLOVENIA

SINTESI

Gli autori riportano i dati sulle catture dello squalo volpe, *Alopias vulpinus* (Bonnaterre, 1788), nelle acque territoriali slovene. Gli squali sono stati catturati soprattutto durante i mesi estivi, principalmente in agosto. Negli ultimi cinque anni sono stati registrati tre casi di squali immaturi, dato che inoltre conferma che l'Adriatico settentrionale è un'area di riproduzione dello squalo volpe. Gli autori cercano di valutare l'attuale livello di conoscenza sugli squali volpe in base ai dati degli sbarchi e degli avvistamenti più vecchi e recenti della specie nelle acque territoriali della Slovenia.

Parole chiave: squalo volpe, *Alopias vulpinus*, catture accidentali, abitudini alimentari, area di riproduzione, Adriatico settentrionale

INTRODUCTION

Thresher sharks (Alopiidae) are powerful large-sized pelagic sharks with an extremely long heterocercal tail. Two of them, the common thresher shark, *Alopias vulpinus* (Bonnaterre, 1788), and the bigeye thresher shark, *Alopias superciliosus* Lowe, 1841, are commonly recorded in the Mediterranean Sea. The common thresher shark is a mesopredator inhabiting temperate and subtropical waters (Compagno, 1984; Barrull & Mate, 2002; Gervelis & Natanson, 2013), widespread in the Atlantic, Pacific, and Indian Oceans, and in the Mediterranean. It is often associated with areas characterized by high biological productivity (Cartamil *et al.*, 2010). Young specimens mainly occur in shallow waters, whereas adults are more common over the continental shelf (Compagno *et al.*, 1989). At least one record of bigeye thresher shark (*A. superciliosus*) has been reported in the southern Adriatic to date (Madiraca *et al.*, 2015).

With regard to the abundance of common thresher shark in the Adriatic Sea in the past, the information is contrasting. Faber (1883), for example, reported that it was “general, but rare”, while Brusina (1888) mentioned it was not rare. In more recent reports the common thresher shark is considered a regularly occurring species in the Adriatic Sea (Tortonesi, 1956; Bini, 1967; Lipej *et al.*, 2004), especially in its northern part (Notarbartolo di Sciara & Bianchi, 1998; Lipej, 1999). However, recently published evidence seems to suggest that its population in the northern Adriatic Sea (Finotto *et al.*, 2016) and other areas (Ferretti *et al.*, 2008) is facing a substantial decline.

Together with some other rare and large-sized sharks, the common thresher shark is among the least studied species in the Mediterranean Sea (Kabasakal & Kabasakal, 2004; Kabasakal, 2007; Dimarchopoulou *et al.*, 2017; Mancusi *et al.*, 2020, and others). One of the aims of this paper is therefore to present a survey of new and older data on the occurrence of thresher shark in the Slovenian sea and its adjacent areas, and discuss the recent status of this epipelagic mesopredator in the closer and broader Adriatic areas.

MATERIAL AND METHODS

On 10th August 2020 a small-sized thresher shark was captured in bottom trawl 4 Nm off Izola, between Cape Ronek (Izola) and Koper, at approximately 20 m depth on muddy bottom. The specimen was delivered to the fishing port of Izola, where it was measured and weighed. After the specimen was dissected, its stomach was isolated and stored in a deep freezer for a diet analysis. In the laboratory, the full stomach was weighed and its content washed through sieves. Prey specimens were isolated and cautiously measured to the nearest 0.01 mm with

a calliper and weighed (wet weight) to the nearest 0.01 g using a Sartorius TE 1502S balance. Two weeks later, on 24th August 2020, another immature specimen was caught 3 Nm out off Izola. Of that, however, we were only able to obtain a photograph and data on the main body dimensions and weight provided by the fisherman who captured it. Both specimens were sold for human consumption.

Nowadays, a valuable source of data is information shared through modern technology tools, such as the internet and the social media, which complete the traditional knowledge of the fishermen (*sensu* Raicevich *et al.*, 2010). We tried to collect all data published in the newspapers and on social media sites about thresher sharks in the territorial waters of Slovenia from 1900 to 2020. We also checked the available databases on fish landings of the Bios web (www.biosweb.org) of the Fisheries Research Institute of Slovenia (Bolje *et al.*, 2020).

RESULTS AND DISCUSSION

The two specimens caught in 2020 were identified as *A. vulpinus* on the basis of the following diagnostic characters (Compagno, 1984): head broad with short snout, forehead strongly arched, flanks above pectoral bases marked with a conspicuous white patch extending forwards from the abdominal area, no deep horizontal grooves on either side of the nape (typical of *A. superciliosus*), eyes not reaching the dorsal surface of the head.

Tab. 1: Biometric parameters of the immature specimen caught in the waters off Ronek on 10th August 2020.

Tab. 1: Biometrični parametri mladostnega primerka, ujetega pri rtu Ronek 10. avgusta 2020.

Biometric parameter	mm/kg
Fork length (mm)	1024
Prepectoral length	243
Prebranchial length	199
Preorbital length	43
Predorsal length	484
Prepelvic length	697
Precaudal length	982
Upper caudal lobe	836
Total length	1860
Eye diameter	25
Weight	30 kg



Fig. 1: Adult specimens of thresher shark (*Alopias vulpinus*) caught in Slovenian territorial waters. Legend: a – a 450 cm long specimen caught on 23rd September 1996 (Photo: B. Šuligoj), b – a 430 cm long specimen caught near Lazaret on 31st December 1997 (Photo: B. Šuligoj), c – a 350 cm long specimen caught on 19th August 2010 in the waters off Izola (Photo: L. Lipej), and d – a 370 cm long specimen caught on 25th May 2004 (Photo: L. Lipej).

Sl. 1: Odrasli primerki navadne morske lisice (*Alopias vulpinus*), ujeti v slovenskih teritorijalnih vodah. Legenda: a – 450 cm dolg primerek, ujet 23. septembra 1996 (Foto: B. Šuligoj), b – 430 cm dolg primerek, ujet blizu Lazareta 31. decembra 1997 (Foto: B. Šuligoj), c – 350 cm dolg primerek, ujet 19. avgusta 2010 v vodah blizu Izole (Foto: L. Lipej), in d – 370 cm dolg primerek, ujet 25. maja 2004 (Foto: L. Lipej).

The first specimen was an immature male with a total length of 186 cm, weighing approximately 30 kg (Tab. 1). The second specimen caught was of a similar size and weighed 30 kg. We were unable to determine its sex from the photograph alone.

The analysis of the stomach content showed the presence of three small pelagic fish species, in vast majority (80.7% in terms of numerical abundance N% and 74.9% in terms of biomass B%) pilchard

(*Sardina pilchardus*), the rest were anchovy (*Engraulis encrasicolus*) (N% = 15.8 and B% = 22.7) and Atlantic horse mackerel (*Trachurus trachurus*) (N% = 3.5 and B% = 2.3; Tab. 2). Only a few diet studies have been performed to date, but according to the available information the thresher shark preys mainly on small pelagic fish such as anchovies, sardines, mackerels and cephalopods (Young *et al.*, 2015). The thresher shark is often recorded together with large schools of

small pelagic fish (Preti *et al.*, 2001), on which it feeds close to the surface, stunning them with its tail-slaps (Aalbers *et al.*, 2010). Finotto *et al.* (2016) stated that the presence of thresher shark in the northern Adriatic Sea is positively correlated with the abundance of the species' preferred prey in the area, the European sardine.

Tab. 2: The stomach content of the immature thresher shark specimen caught on 10th August 2020. Legend: N – number of specimens of a particular prey species, B – biomass of all weighed specimens of a particular species, N% and B% relative abundance and biomass, respectively.

Tab. 2: Vsebina želodca mladostnega primerka morske lisice, ujetega 10. avgusta 2020. Legenda: N – število primerkov posamezne vrste plena, B – biomasa primerkov posamezne vrste plena, N% in B% relativna abundanca in relativna biomasa plena.

Species	N	N%	B	B%
<i>Trachurus trachurus</i>	2.0	3.5	8.1	2.3
<i>Sardina pilchardus</i>	46.0	80.7	258.3	74.9
<i>Engraulis encrasicolus</i>	9.0	15.8	78.3	22.7
sum	57	100	344.7	100

In the summer months of 2020, adult common thresher sharks were also sighted in the adjacent Italian waters of the Gulf of Trieste. In July 2020 a 400 cm long shark was caught and filmed near Trieste and subsequently released (Anonymous, 2020). In the very same period (19th July 2020) another specimen of common thresher shark, estimated at approximately 300 cm fork length, was captured and subsequently released in the waters of the Quarnaro archipelago in Croatia (Tomljanović, 2020).

Checking the published data in newspapers, web sites and the social media 10 reports were found regarding thresher sharks in Slovenian waters in the past thirty years. If we also take into account the two immatures from 2020, we have 12 records of common thresher sharks in total (Tab. 3). The great majority of the reported sharks were adults, measuring from 350 cm to 500 cm in total length (Fig. 1). Most of the recorded thresher sharks were captured or sighted during the months of August and September, which corresponds well with seasonality recorded by Finotto *et al.* (2016) for the Italian part of the northern Adriatic Sea. Generally, much larger

thresher sharks would be reported from Slovenian waters. Apart from the common thresher sharks recorded in August 2020, only one specimen, captured on 18th August 2015, was small, reaching 150 cm in total length.

During the last five years the Statistical Office of the Republic of Slovenia reported on landings of thresher sharks every year except 2016. The biomass reported in 2015 was 6.5 kg, which fits well with the small-sized specimen mentioned above. According to the length vs age relationship examined in age and growth studies by many authors (Cailliet *et al.*, 1983; Mendizabal & Oryza, 1995; Smith *et al.*, 2008; Gervelis & Natanson, 2013) the specimens with a fork length of approximately 100 cm could be considered as 1 to 2 years old and the one shorter than 100 cm as less than one year old. Pups at birth measure approximately 60 to 70 cm in fork length (Cartamil *et al.* 2010). According to the von Bertalanffy growth model, the estimated size at birth of common thresher shark is between 114 and 156 cm total length (Bigelow & Schroeder, 1948; Compagno, 1984; Moreno *et al.*, 1989). Thus, the specimen caught in August 2015 could be regarded as a neonate thresher shark (Fig. 2).

The Gulf of Trieste and the northern Adriatic Sea may act as a nursery area for certain elasmobranch species, as was previously already pointed out by several researchers (e.g. Notarbartolo di Sciarra & Bianchi, 1998; Jardas *et al.*, 2008; Fortuna *et al.*, 2010). A nursery area is an environment where juvenile sharks and other elasmobranchs are supported by available food and reduced predation (Cartamil *et al.*, 2010). The area is productive, diversified in terms of habitat, and rather shallow (less than 30 m of depth). We have collected many neonates and immature elasmobranchs in the Gulf of Trieste that were captured as bycatch. Neonate specimens of sandbar shark (*Carcharhinus plumbeus* (Lipej *et al.*, 2000, 2008)), smoothhound (*Mustelus mustelus*), punctulated smoothhound (*Mustelus punctulatus*), pelagic stingray (*Pteroplatytrygon violacea*), starry skate (*Raja asterias*), marbled electric ray (*Torpedo marmorata*) and others were recorded in Slovenian coastal sea (*unpublished data*). Many blue sharks (*Prionace glauca*) less than 80 cm in total length have been caught as bycatch in the area. As for the adjacent regions, Fortuna *et al.* (2010) reported 13 common thresher sharks that were caught in the period between July 2006 and December 2008, 10 in the Veneto region and 3 in the Emilia Romagna region.

Many authors point out the fact that nowadays large sharks seem to be restricted to the eastern and southern Mediterranean Sea (Sperone *et al.*, 2012). Barausse *et al.* (2014) considered the common thresher shark and other large-sized shark meso-



Fig. 2: Immature specimens of thresher shark (*Alopias vulpinus*) caught in Slovenian territorial waters. Legend: a – immature specimen caught on 18th August 2015 (Photo: S. Radin), b – immature specimen caught on 10th August 2020 (Photo: J. Francé), and c – immature specimen caught on 24th August 2020 (Photo: I. Virant).

Sl. 2: Mladostni primerki navadne morske lisice (*Alopias vulpinus*), ujeti v slovenskih teritorialnih vodah. Legenda: a – mladostni primerek, ujet 18. avgusta 2015 (Foto: S. Radin), b – mladostni primerek, ujet 10. avgusta 2020 (Foto: J. Francé), in c – mladostni primerek, ujet 24. avgusta 2020 (Foto: I. Virant).

predators to have been largely depleted even before 1945 in the western part of the northern Adriatic Sea due to intensive exploitation. The study on the occurrence of thresher shark in the northern Adriatic Sea based on landings data (Finotto *et al.*, 2016) suggests the main cause of the decline of common thresher sharks to be their mortality in commercial target and bycatch fisheries. In addition, the majority of the specimens caught were juveniles (app. 90 %) and many of them weighed less than 10 kg (Finotto *et al.*, 2016). According to Moreno *et al.* (1989) this size is close to their size at birth. Hattour & Nakamura (2004) reported that small-scale fishery in Tunisian waters was targeting neonate specimens of thresher shark. Finotto *et al.* (2016) considered food availability to be a strong driver of the presence of *A. vulpinus* in the northern Adriatic Sea.

The data on thresher shark in Slovenian marine waters, provided from different sources, show that the species is still present at least in summer months; however, there is a substantial lack of knowledge regarding basic data. Although the available data are mostly related to adult thresher sharks, they also include records of immature specimens and, in one case, a neonate. The rapid decline of common thresher shark during the last 75 years in the northern Adriatic Sea as reported by Finotto *et al.* (2016) is calling for urgent conservation measures. The com-

mon thresher shark is, like the majority of sharks and other elasmobranchs, a typical K-selected species, characterised by a slow population growth and long generation time. The species is nowadays listed on the IUCN Red List of Threatened Species as “vulnerable” to global extinction (Goldman *et al.*, 2007). The national Red List of marine fishes of Croatia (Jardas *et al.*, 2008) also defines the status of common thresher shark as “vulnerable”. In Italy, *A. vulpinus* has markedly decreased in abundance and is considered “critically endangered” (Rondinini *et al.*, 2013). In the Act on Protected Animal Species of Slovenia, the common thresher shark is not mentioned.

To date, no attempts have been made in the northern Adriatic Sea to prepare some conservation measures to reduce the fishing mortality. An immediate release of the still living captured shark specimens should become a practice. Since many arguments point out the importance of the northern Adriatic Sea as a nursery area for thresher shark and many other elasmobranch species, the countries sharing the northern Adriatic should adopt suitable legal acts and efficient conservation instruments for their protection. One of the first promising measures regarding thresher shark conservation at a national level would be a complete ban on its fishing in Slovenian waters. As this species is only caught as bycatch and captures are rare and as such not

Tab. 3: Documented evidence of the occurrence of thresher shark in Slovenian waters during the past 25 years.

Tab. 3: Dokumentirani primeri pojavljanja morske lisice v slovenskih vodah v zadnjih petindvajsetih letih.

n	date	locus	record	sex	TL (cm)	Weight (kg)	Photo/Source
1	20 Aug 1995	Slovenian marine waters	Caught	?	400	194	Dulčić & Lipej, 2002
2	22 Aug 1995	Bay of Piran	Sighted	?	400	?	Newspaper Delo
3	15 Sep 1995	Cape Ronek (near Izola)	Caught	?	500	300	Dulčić & Lipej, 2002
4	24 Sep 1996	Fiesa	Caught	?	450	300	Fig 1/a; Dulčić & Lipej, 2002
5	31 Dec 1997	Lazaret	Caught	?	430	230	Fig. 1/b; Dulčić & Lipej, 2002
6	25 Aug 2001	Bay of Piran, Slovenian waters	Caught	?	430	270	Dulčić & Lipej, 2002
7	2 Jan 1998	Lazaret (Koper)	Caught	?	430	200	Newspaper Delo
8	26 May 2004	Bay of Piran	Caught	?	370	200	Fig 1/d; Newspaper Delo
9	19 Aug 2010	Gulf of Trieste, off Izola	Caught	?	350	155	Fig 1/c; Newspaper Delo
10	18 Aug 2015	3 Nm, Slovenian waters	Caught	?	150	6.5	Fig 2/a; Biosweb, M. Radin
11	10 Aug 2020	Cape Ronek (Izola)	Caught	M	186	30	Fig 2/b; This work
12	24 Aug 2020	3 Nm off Izola	Caught	M	187	30	Fig 2/c; This work

financially important, a management strategy based on the release of the still living specimens should be developed.

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POJAVLJANJE IN STATUS NAVADNIH MORSKIH LISIC (*ALOPIAS VULPINUS*) V VODAH SLOVENIJE

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POVZETEK

Avtorji poročajo o pojavljanju navadne morske lisice (*Alopias vulpinus*) na podlagi ribiških ulovov v slovenskih teritorialnih vodah. Morske lisice so bile ulovljene praviloma v poletnih mesecih, predvsem avgusta. V zadnjem petletju so se v ribiške mreže zapletli trije mladostni primerki, ki še dodatno potrjujejo dejstvo, da je Severni Jadran razmnoževalno okolje navadne morske lisice. Avtorji nadalje poskušajo oceniti poznavanje stanja navadnih morskih lisic v slovenskem morju na podlagi razpoložljivih recentnih in starejših podatkov.

Ključne besede: morska lisica, naključni ulov, prehranjevalne navade, jaslice, Severni Jadran

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