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First record of neonatal sandbar shark *Carcharhinus plumbeus* (Nardo, 1827) (Carcharhiniformes: Carcharhinidae) from the Southern Adriatic Sea

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This paper is describing a new finding of Carcharhinus plumbeus *(Nardo, 1927) caught at the insular shelves off the Sazan Island at the depth of 120 m, which is the southernmost record for a sandbar shark in the Adriatic Sea. The individual had a partially healed umbilical scar and is considered as neonatal. Examined shark appeared in good body condition with showed no macroscopic signs of diseases or macroscopic parasites. Detailed morphometric measurements are compared with four neonate and juvenile specimens from the north and central Adriatic Sea and are provided in the paper. Despite it is not possible to establish a certain conclusion on whether our specimen was born in the studied area or elsewhere, presented finding provides the very first evidence that neonatal sandbar sharks can be found along the coast of Albania. Knowing the exact locations and movements of both neonates and juveniles is of high importance for the effective long-term in-situ conservation.*

Key words: Albania; elasmobranchii; nursery; Mediterranean;0 sharks

INTRODUCTION

Predatory sharks maintain food webs and play a fundamental role in shaping marine ecosystems (MACHOVSKY-CAPUSKA & RAUBENHEIMER, 2020; HAMMERSCHLAG *et al.,* 2022). Mediterranean Sea has been heavily exploited by intensive coastal fishing for millennia (LOTZE et al., 2006), where numerous shark species have been severely depleted with concerning declines of over 99% (FERRETTI *et al.,* 2008). Today, the Mediterranean Sea is considered as a key hotspot of extinction risk for elasmobranchs (ABDULLA, 2004; DULVY *et al.,* 2014). Medium-sized and large species inhabiting the coastal shallow waters, such as sandbar shark, are the most exposed to fisheries, habitat destruction and pollution (FERRETTI *et al.,* 2008; DULVY *et al.,* 2014; GAJIĆ *et al.,* 2020). Despite being a common species in the Mediterranean Sea (JAMBURA *et al.,* 2021), sandbar shark is facing severe anthropogenic pressures, including overfishing (DULVY *et al.,* 2021), and is even considered locally extinct in certain parts of the Mediterranean (i.e., CAPAPÉ *et al.,* 2000; KABASAKAL, 2015, KABASAKAL 2019).

The sandbar shark, *Carcharhinus plumbeus* (Nardo, 1827), is a medium-sized, bottom-dwelling shark inhabiting shallow coastal waters

of temperate and tropical seas in the Atlantic and Indo-Pacific oceans (EBERT & DANDO, 2020). Adults attain a total length of 250 and possibly up to 300 cm (SOUFI-KECHAOU *et al.,* 2018). It feeds primarily on teleosts and invertebrates, including crustaceans and cephalopods (MCELROY *et al.,* 2006). Reproduction is placental viviparous (BAŞUSTA *et al.,* 2021), with gestation period of about 12 months, and litter size between 4 and 10 (MCAULEY *et al.,* 2007). In the Mediterranean Sea species reaches sexual maturity at total lengths between 154 and 160 cm for males and 166 and 172 cm for afemales (BRADAÏ *et al.,* 2005). The species is declared as endangered (EN) both globally (RIGBY *et al.,* 2021) and in the Mediterranean Sea (FERRETTI *et al.,* 2016). Further, sandbar shark is considered as a highly migratory species with the annual migration (PINET, 2012; BAŞUSTA *et al.,* 2021), moving in large schools, mostly segregated by age and sex (MERSON & PRATT, 2001; MCAULEY *et al.,* 2005), which aggravates conservation efforts.

Despite being considered very rare in the previous decades (JARDAS *et al.,* 2008), last decade revealed quite a few reports on the occurrence of neonatal and juvenile sandbar sharks in the Adriatic Sea (i.e., COSTANTINI & AFFONTE, 2003; LIPEJ *et al.,* 2004; DRAGIČEVIĆ *et al.,* 2010; JAMBURA *et al.,* 2021). Surprisingly, majority of these individuals were recorded in the northern Adriatic Sea. In this paper we are describing a very first record of neonatal specimen of the sandbar shark caught off the Sazan Island, Vlorë County, southernmost Adriatic Sea.

MATERIAL AND METHODS

The research crew (all authors) boarded commercial and small-scale fishing vessels in Vlorë starting from January 2022 onwards to investigate the diversity, frequency, threats, and post-release survival rates in elasmobranch species. On the morning of 14th of April 2022, the neonatal sandbar shark was captured by bottom trawler at the insular shelf off the Sazan Island at 120 m depth (approx. 40.475572,19.197318) in southern Albania (Fig. 1).

Upon the retrieval, individual hasn't moved, and resuscitation was approached. The shark was placed on its side in a soft wet area with

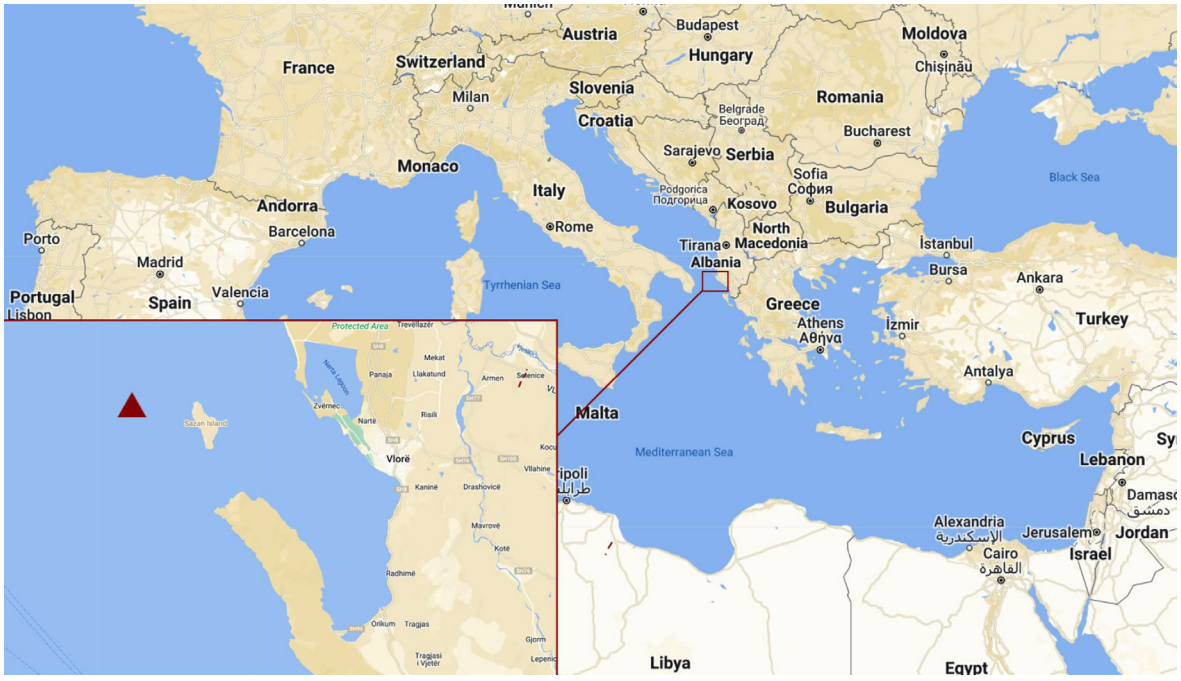

Fig. 1. Locality of the record of the neonatal female Carcharhinus plumbeus at the 120 m deep, off the Sazan Island (Vlorë, Albania) southern Adriatic Sea

Fig. 2. A neonatal female specimen of Carcharhinus plumbeus *from the southern Adriatic Sea of Albania, photo: Andrej A. Gajić.*

eyes covered using a wet towel for additional stress reduction. The gills were ventilated with oxygenated running salt water through its mouth and moving the tail back and forth to prevent rigor mortis and plausibly enhance the circulation of oxygenated blood. Despite managing to revive numerous sharks caught in by-catch and return them back to the sea (especially *Mustelus spp*. and *Scyliorhinus spp*.), in this case our action didn't provoke a response and death of the animal was confirmed. Long-term survival rates of mentioned individuals remained unknown and are currently being studied. The specimen was identified according to the discriminative morphological features (i.e., enlarged dorsal fin which originates above or slightly anterior to the pectoral axis, trianguar and serrated upper teeth and narrower lower teeth) as described by COMPAGNO *et al.,* (2005), EBERT & DANDO (2020), and EBERT *et al.* (2021). Body measurements were taken to the nearest millimeter, according to the guidelines of COMPAGNO (1984) and HERNÁNDEZ *et al.* (2010) and the specimen was weighted to the nearest gram. Upon the detailed measurements, pathological and parasitological examination, and sampling of the tissues for further studies, full taxidermy of the specimen was prepared and is currently housed in the Sharklab ADRIA collection in Vlorë (Albania) under catalog number CPU/01/1404/22.

Fig. 3. Functional teeth of the upper and lower jaw of the described neonatal sandbar shark from the southern Albania, photo: Emina Karalić / Sharklab ADRIA

RESULTS AND DISCUSSION

The specimen of sandbar shark was a neonatal female (Fig. 2) which is the southernmost record of a neonate/juvenile sandbar shark in the Adriatic Sea. Observed neonate measured 811 mm and weighted 3,437 g, while eviscerated weight was 2,656 g. Examined shark appeared in good body condition showed no gross changes, nor were any macroscopic parasites observed. Stomach content examination revelated unidentifiable digested teleost.

Table 1. Measurements (given in millimeters) and percentages of total length determined for neonatal sandbar shark from Vlorë, Albania with comparison to recent records from the central (785 mm TL) and northern (705, 710 and 815 mm TL) Adriatic Sea.

Observed measurement	Described individual		Dragičević *et al.,* 2010		Lipej et al., 2008		Lipej et al., 2008		Lipej et al., 2008	
	mm	%TL	mm	%TL	mm	%TL	mm	%TL	mm	%TL
Total length	**811**	100	**785**	100	**705**	100	**710**	100	**815**	100
Fork length	653	80.5	638	81.3	559	79.3	575	81.0	660	81.0
Head lengh	202	24.9	194	24.7	173	24.5	190	26.8	210	25.8
Head height	97	12.0	85	10.8	96	13.6	100	14.1	104	12.7
Precaudal length	615	75.9	574	73.1	510	72.3	525	73.9	605	74.2
Prebranchial length	147	18.1	157	20.0	133	18.9	145	20.4	165	20.2
Interdorsal space	181	22.3	174	22.2	168	23.8	165	23.2	175	21.5
Eye length	11	1.4	10	1.3	10	1.4	9	1.3	12	1.5
Mouth width	75	9.2	69	8.8	67	9.5	71	10.0	77	9.4
Pectoral fin length	121	14.9	114	14.5	83	11.8	81	11.4	93	11.4
Pectoral fin height	135	16.6	123	15.7	95	13.5	88	12.4	106	13.0
Pectoral fin anterior margin	137	16.9	135	17.2	102	14.5	102	14.4	108	13.3
Pectoral fin posterior margin	97	12.0	114	14.5	86	12.2	83	11.7	98	12.0
Pectoral fin base length	53	6.5	56	7.1	45	6.4	46	6.5	55	6.7
First dorsal fin total length	133	16.4	132	16.8	125	17.7	116	16.4	123	15.1
First dorsal fin base length	93	11.5	99	12.6	90	12.8	87	12.2	92	11.3
First dorsal fin height	80	9.9	80	10.2	66	9.4	66	9.3	83	10.2
First dorsal fin anterior margin	113	13.9	105	13.4	102	14.5	102	14.4	108	13.3
First dorsal fin posterior margin	87	10.7	90	11.5	86	12.2	83	11.7	98	12.0
Second dorsal fin total length	56	6.9	63	8.0	56	7.9	51	7.2	58	7.1
Second dorsal fin base length	33	4.1	33	4.2	29	4.1	29	4.1	29	3.6
Second dorsal fin height	23	2.8	24	3.1	18	2.6	24	3.4	28	3.4
Second dorsal fin anterior margin	40	4.9	33	4.2	28	4.0	32	4.5	33	4.0
Second dorsal fin posterior margin	42	5.2	41	5.2	38	5.4	35	4.9	37	4.5
Pelvic fin total length	65	8.0	65	8.3	60	8.5	54	7.6	65	8.0
Pelvic fin height	41	5.0	36	4.6	33	4.7	31	4.4	40	4.9
Pelvic base length	42	5.2	46	5.9	34	4.8	29	4.1	29	3.6
Pelvic fin anterior margin	50	6.2	46	5.9	37	5.2	36	5.1	47	5.8
Pelvic fin posterior margin	54	7.9	52	6.6	44	6.2	41	5.8	49	6.0
Anal fin length	55	6.8	63	8.0	55	7.8	54	7.6	60	7.4
Anal fin height	29	3.6	28	3.6	22	3.1	26	3.7	33	4.0
Anal fin base length	37	4.6	37	4.7	31	4.4	29	4.1	34	4.2
Anal fin anterior margin	49	6.0	51	6.5	45	6.4	40	5.6	51	6.2
Anal fin posterior margin	33	4.1	34	4.3	24	3.4	29	4.1	37	4.5
Caudal fork length	63	7.8	63	8.0	50	7.1	54	7.6	61	7.5
Dorsal caudal margin	213	26.3	205	26.1	190	26.9	197	27.8	215	26.4
Preventral caudal margin	77	9.5	79	10.1	72	10.2	73	10.3	81	9.9
Lower postventral caudal margin	39	4.8	38	4.8	50	7.1	48	6.7	57	7.0
Terminal caudal margin	43	5.3	48	6.1	40	5.7	40	5.6	52	6.4

Morphometric measurements are compared with four neonatal and juvenile specimens from the north and central Adriatic Sea (Table 1). Described female was similar in length to the neonatal specimens recorded in the Gulf of Trieste in 2010 (LIPEJ *et a*l., 2000), Gulf of Piran in 2007 (LIPEJ *et al*., 2008) and off Zaostrog in 2009 (DRAGIČEVIĆ *et al*., 2010). Our individual exhibited partially healed but still clearly visible umbilical scar, and we concluded that it was neonatal (according to DRAGIČEVIĆ *et al.,* 2010). On the other hand, the individual could be also considered as young-of-the-year (YOY), with estimated age no more than a few months as size at birth for sandbar sharks in the Adriatic and Mediterranean could range between 450 and 650 (BRADAÏ *et al.,* 2005; JARDAS *et al.,* 2008), and up to 750 cm (COMPAGNO, 1984). Northern Adriatic Sea is already designated as important nursery ground for sandbar sharks (LIPEJ *et al.,* 2008; DRAGIĆEVIĆ *et al*., 2010). Parturition time in the Adriatic Sea is suggested to be between late summer and autumn in the northern part (LIPEJ *et al.,* 2008). The presence of an almost headed umbilical scar further point out that the individual was born at least during the winter. Such conclusion is in accordance with explanation offered by DRAGIČEVIĆ et al. (2010), that the sandbar sharks might continue their nursery period along with the southward movement triggered by water cooling in the Northern Adriatic Sea. As JAMBURA *et al.* (2012) reported a single juvenile in Gulf of Piran (northern Adriatic) during December, such argument requires more attention. On the other hand, data on *C. plumbeus* in the Ionian Sea is very scarce with only a few recent records (SPERONE *et al*., 2012; TIRALONGO *et al.,* 2012). Rapid decline of requiem sharks, including *C. plumbeus*, in the Ionian Sea is already emphasized (SPERONE *et al.,* 2012). Such lack of records, especially neonates and juveniles, does not favor the possibility that our individual originates from not-yet described nursery area in the Ionian Sea. Anyway, drawing any serious conclusions regarding the nursery area(s) and potential movements of neonates and juveniles across both Ionian and Adriatic Sea certainly requires further research. Despite it is not possible to establish a conclusion on whether our specimen was born in the studied area or elsewhere, presented finding provides the very first evidence that neonatal/YOY sandbar sharks can be found along the coast of Albania which is extremely important for their long-term in-situ conservation.

Significant lack of data on neonatal and YOY sandbar sharks in both Adriatic and Ionian seas could be partly attributed to the misidentification with smooth hound sharks by fishers (*Mustelus spp.*) which is emphasized by LIPEJ *et al.* (2000). Such conclusion is directly supported by the fact that all the fisherman on our trawler also identified the shark as "peshkaqen pëllumb" which is the local neme for *Mustelus spp.* Furthermore, a significant increase in the use of social networks delivered numerous records of previously less-known or very rare species (TAKLIS *et al.,* 2020; GAJIĆ *et al*., 2022), including sandbar sharks in the Adriatic Sea (JAMBURA *et al.,* 2021). Thus, lack of cooperation between researchers and fishermen could be another reason for lack of data on records (LIPEJ *et al*., 2000).

Rapid population declines of large shark species are of global concern (FERRETTI *et al.*, 2008; DULVY et *al.,* 2014), which struck the Adriatic Sea as well (JARDAS et al., 2008; DRAGIČEVIĆ et al., 2010; GAJIĆ, 2020, GAJIĆ, 2022). As nursery areas are essential habitats for sharks (HEITHAUS, 2007; HEUPEL *et al.,* 2007; WARD-PAIGE *et al.*, 2007), knowing the exact locations of breeding/nursery grounds might be of utmost importance for further revitalization and/or protection. Effective long-term in-situ conservation of sharks, especially migratory species, can be achieved only through strong and uniform regional measures followed by fishermen and wider community.

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ETHICAL APPROVAL

All applicable international, national, and/or institutional guidelines for the care and use of animals were followed. All the necessary permits for research are obtained prior to the beginning of the study.

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Prvi nalaz mladunca psa trupana *Carcharhinus plumbeus* (Nardo, 1827) (Carcharhiniformes: Carcharhinidae) iz južnog Jadranskog mora

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SAŽETAK

Ovaj rad opisuje nalaz novorođenog psa tupana *Carcharhinus plumbeus* (Nardo, 1927) ulovljenog kod otoka Sazana (Albanija) na dubini od 120 m, što je najjužniji susret u Jadranskom moru. Opisana jedinka imala je djelomično zacijeljen pupčani ožiljak. Patološki pregled pokazao je da je jedinka bila u dobrom tjelesnom stanju, bez makroskopskih promijena i parazita, dok su uzorci tkiva uzeti za daljnje histološke analize. Detaljnji morfometrijski podaci uspoređeni su s četiri neonatalne i juvenilne jedinke iz sjevernog i srednjeg Jadrana, te su navedene u radu. Iako nije moguće sa sigurnošću utvrditi da li je naša jedinka okoćena u istraživanom području ili drugdje, predstavljeni nalaz daje prvi znanstveni dokaz da se neonatalni psi tupani mogu naći duž obale Albanije. Poznavanje točnih lokacija i kretanje tek okoćenih i mladih morskih pasa od velike je važnosti za učinkovito dugoročno očuvanje *in situ.*

Ključne riječi: Albania; elasmobranchii; kotilište; Sredozemlje; morski psi