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NOTES ON SMOOTHBACK ANGEL SHARK, *SQUATINA OCULATA* (SQUATINIFORMES: SQUATINIDAE) CAUGHT IN THE GULF OF ANTALYA

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ABSTRACT

A total of 15 specimens of Squatina oculata were incidentally caught in the Aegean and Mediterranean waters of Turkey between 1998 and 2018. The largest individual among them measured 95 cm in TL and 6000 g in TW. On the basis of the examined individuals, the a and b parameters of S. oculata in Turkish waters were found to be 0.003 and 3.27, respectively. The female smoothback angel shark (88 cm TL) caught in spring 2010 aborted 7 embryos following hauling on the deck of the trawler. The length-weight relationship parameters determined in this study for S. oculata undoubtedly provide length-weight data only for populations occurring in Turkish waters and are limited, considering the number of specimens studied. However, considering the critically endangered and rare status of S. oculata, this information can contribute to filling the current knowledge gap in relation to the species.

Key words: *Squatina oculata*, Levant Sea, biology, embryo, length-weight relationship

NOTE SULLO SQUADRO PELLE ROSSA, *SQUATINA OCULATA* (SQUATINIFORMES: SQUATINIDAE) CATTURATO NEL GOLFO DI ANTALYA

SINTESI

Un totale di 15 esemplari di Squatina oculata sono stati catturati accidentalmente nelle acque turche dell'Еgeo e del Mediterraneo tra il 1998 e il 2018. L'individuo più grande misurava 95 cm di lunghezza totale (TL) e 6000 g di peso totale (TW). In base degli individui esaminati, i parametri a e b di S. oculata nelle acque turche sono risultati essere rispettivamente pari a 0,003 e 3,27. La femmina di squadra pelle rossa (88 cm TL) catturata nella primavera del 2010 ha abortito 7 embrioni dopo essere stata trascinata sul ponte del peschereccio. I parametri del rapporto lunghezza-peso determinati in questo studio per S. oculata forniscono senza dubbio dati sulla lunghezza-peso solo per le popolazioni che si trovano nelle acque turche e sono limitati, considerando il numero di esemplari studiati. Tuttavia, considerando che la specie viene considerata rara e minacciata di estinzione, queste informazioni possono contribuire a colmare l'attuale vuoto di conoscenza in relazione alla specie.

Parole chiave: *Squatina oculata*, mare di Levante, biologia, embrione, rapporto lunghezza-peso

INTRODUCTION

The smoothback angel shark, *Squatina oculata* Bonaparte, 1840, is one of the 3 species of the family Squatinidae occurring in the Mediterranean (Serena, 2005; Giovos *et al.*, 2022). Its distribution range extends throughout the Mediterranean Sea and across the eastern Atlantic Ocean from Morocco to Angola (Serena, 2005). *S. oculata* is a bottom-dwelling shark found in sandy and muddy habitats at depths between 20 and 560 m, and commonly between 50 and 100 m (Serena, 2005). Although the maximum total length determined for this species is 160 cm (Otero *et al.*, 2019), there have been reports of individuals reaching up to 180 cm (Akşiray, 1987).

S. oculata is considered a critically endangered and rare shark species in the Mediterranean Sea (Mory *et al.*, 2019; Otero *et al.*, 2019). Our knowledge of the biology of the smoothback angel shark is mostly based on the results of studies of individuals caught in the western Mediterranean and tropical eastern Atlantic (Capapé *et al.*, 1990, 1999, 2002); published data related to the biology of this species in the eastern Mediterranean are limited, based on studies of sporadic individuals (Ergüden *et al.*, 2019; Yiğın *et al.*, 2019). In the present study, authors report on the developing embryos and length-weight relationship of *S. oculata* caught in Turkish waters.

MATERIAL AND METHODS

This study is a sub-study of an extensive bottom-trawl survey carried out between August 2009 and April 2010 on a seasonal basis by the first author, in order to obtain data on the catch composition of commercial trawlers in the Gulf of Antalya, between the depths of 25 and 200 m (Fig. 1). The Gulf of Antalya is located in the north-eastern Levant Basin and is characterised by a high temperature, salinity, and oligotrophy (Kebapçioğlu *et al.*, 2010). The geographical coordinates of 29 trawling areas at six stations vary between N 36°52'485 and 36°23'000, and E 31°32'322 and 30°29'488. The research was conducted seasonally, both during the “closed” fishing season (August 2009) and during “open” fishing season (November 2009; February 2010 and April 2010) in no-trawl zones as well as open areas. A total of 116 hauls were carried out at depths of 25, 50, 75, 100, 150, and 200 m, at six stations. The duration of each haul was limited to an hour. Specimens of *S. oculata* were caught in trawl hauling and towing at depths between 50 and 100 m.

Species identification was performed based on Serena (2005). The log-transformation formula of Le Cren (1951) was used to establish the length-weight relationship (LWR) of *S. oculata* in Turkish waters, which was based on unpublished data on specimens

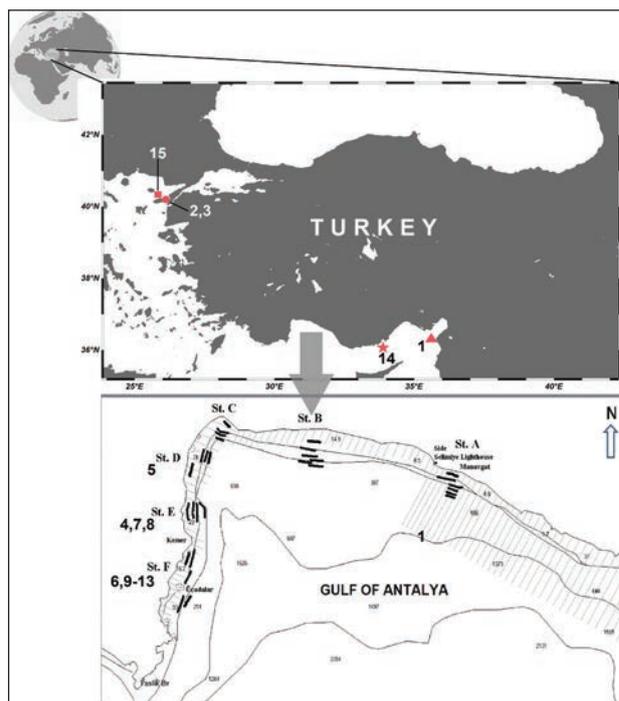


Fig. 1: Maps depicting the capture sites of previously published individuals (above map) and trawled individuals of *Squatina oculata* in Turkish waters. In the Gulf of Antalya, individuals of *S. oculata* ($n=10$) were caught in trawl hauling at stations D, E, and F. Numbers on the map correspond to those reported in Table 1.

Sl. 1: Zemljevid z označenimi lokalitetami, kjer so bili doslej ugotovljeni primerki pegastega sklata na podlagi objavljenih zapisov (zgornji zemljevid) in ujeti primerki v turških vodah. V Antalijskem zalivu so bili pegasti sklata (10 primerkov) ujeti na postajah D, E in F. Številke se ujemajo s tistimi v Tabeli 1.

captured during the trawl expeditions, as well as on length and weight data extracted from the literature (Başusta *et al.*, 1998; Kabasakal & Kabasakal, 2004; Ergüden *et al.*, 2019; Yiğın *et al.*, 2019). Although the weight of the smoothback angel shark (75.6 cm TL) mentioned in Başusta *et al.* (1998) was not reported, this information was communicated by the first author of the mentioned publication (Nuri Başusta, *pers. comm.*) After measuring their total lengths (TL, cm) and total weights (TW, g), smoothback angel sharks were released to sea alive as soon as possible, following the best practice procedure for shark bycatch (FAO & ACCOBAMS, 2018).

RESULTS

The combined results of the 2009–2010 trawling survey and specimens reported in previous publications (Başusta *et al.*, 1998; Kabasakal & Kabasakal,

Tab. 1: Data on individuals of *Squatina oculata* captured in Turkish waters. Jul: July, Sep: September; Aut: Autumn; Spg: Spring; Wnt: Winter; Nov: November; Mar: March.

Tab. 1: Podatki o primerkih pegastega sklata, ujetih v turških vodah. Okrajšave: Jul: julij, Sep: september; Aut: jesen; Spg: pomlad; Wnt: zima; Nov: November; Mar: Marec.

No	Date	TL (cm)	W (g)	Sex	Depth (m)	Reference
1	1996	75.6	4000	?	60	Başusta <i>et al.</i> (1998)
2	Jul 1997	30	180	M	70	Kabasakal & Kabasakal (2004)
3	Sep 1999	95	6000	F	80	Kabasakal & Kabasakal (2004)
4	Aut 2009	80	4500	?	100	Present study
5	Spg 2010	50	850	?	100	Present study
6	Spg 2010	88	5550	F	50	Present study
7	Spg 2010	59	1600	?	50	Present study
8	Spg 2010	52	1000	?	100	Present study
9	Wnt 2010	67	1700	?	50	Present study
10	Wnt 2010	69	1800	?	50	Present study
11	Wnt 2010	66	2000	?	50	Present study
12	Wnt 2010	88	5500	?	50	Present study
13	Wnt 2010	24	71	?	50	Present study
14	4 Nov 2017	72.6	3450	F	65	Ergüden <i>et al.</i> (2019)
15	22 Mar 2018	87.5	5536	F	110	Yığın <i>et al.</i> (2019)

2004; Ergüden *et al.*, 2019; Yığın *et al.*, 2019) have revealed that a total of 15 specimens of *Squatina oculata* were incidentally caught in the Aegean and Mediterranean waters of Turkey between 1998 and 2018 (Tab. 1; Fig. 2). The TL and TW of these individuals, the fishing depths, and references of previously reported individuals are shown in Table 1. The largest individual measured 95 cm in TL and 6000 g in TW (TL range 24–95 cm; mean TL = 66.91 ± 20.98 cm; TW range 71–6000 g; mean TW = 2916.8 ± 2117.5 g). Based on the examined individuals, the *a* and *b* parameters of *S. oculata* in Turkish waters were found to be 0.003 and 3.27, respectively. The LWR of *S. oculata* in Turkish waters is shown in Fig. 3.

The female smoothback angel shark (88 cm TL; specimen no. 6; Table 1) caught in spring 2010 aborted 7 embryos following hauling on the deck of

the trawler; thus, it could not be determined how many embryos had been in each uterus (Fig. 4). After its length and weight had been measured, the pregnant female was immediately released back into the sea. In this female, symptoms resembling post-release stress such as fluttering on the water surface or sinking to the bottom by remaining motionless were not observed; instead, the individual swam away in a healthy way. It was observed that all 7 embryos had their stomachs filled with yolk and the yolk sac was still unabsorbed (Fig. 4). Therefore, it is clear that the embryos were still at the developing stage.

DISCUSSION AND CONCLUSIONS

According to Tsikliras and Dimarchopoulou (2021), *Squatina oculata* is one of the 46 uncommon chondrichthyan species occurring in the Mediterra-



Fig. 2: Individuals of *Squatina oculata* incidentally caught during 2009–2010 bottom trawl expeditions in the Gulf of Antalya (Photo: E. Özgür Özbek).

Sl. 2: Naključno ujeti primerki pegastega sklata na ribiških odpravah med 2009 in 2010 v Antalijskem zalivu.

near Sea on which there is a significant knowledge gap in relation to LWR data. Based on the lengths (TL range 29.1–79.5 cm) and weights (TW range 173–3750 g) of 6 smoothback angel sharks, Tsikliras and Dimarchopoulou (2021) calculated the a and b parameters of *S. oculata* occurring in Greek and Italian waters to be 0.0067 (range 0.0061–0.0076) and 3.04, respectively. Despite the slight differences, the a and b values in the present study (0.003 and 3.27, respectively) appear comparable to those calculated by Tsikliras and Dimarchopoulou (2021). The differences between these two studies may originate from environmental conditions or interindividual variability due to biological conditions. Since the expected range of $2.5 < b < 3.5$ was confirmed by Froese (2006), the b value found in the present study coincides within the safe limits, which is supposed

to indicate a tendency towards positive-allometric growth or an increase in relative body thickness of *S. oculata* in Turkish waters.

S. oculata is a lecithotrophic shark with a minimum one-year-long gestation period (Capapé *et al.*, 2002). Studies carried out off the Senegal coast showed that adult females exceeded 89 cm in TL (Capapé *et al.*, 2002). In Tunisian waters, the TL range in subadult females was 75–90 cm, and individuals between 100 and 121 cm TL were considered adults (Capapé *et al.*, 1990). Although the size of the pregnant female in the present study (88 cm TL) was within the limits of subadult females (Capapé *et al.*, 2002) and clearly below the lower limit (100 cm TL) for adults (Capapé *et al.*, 1990), our findings show that pregnant females of *S. oculata* can be shorter than the previously observed size ranges.

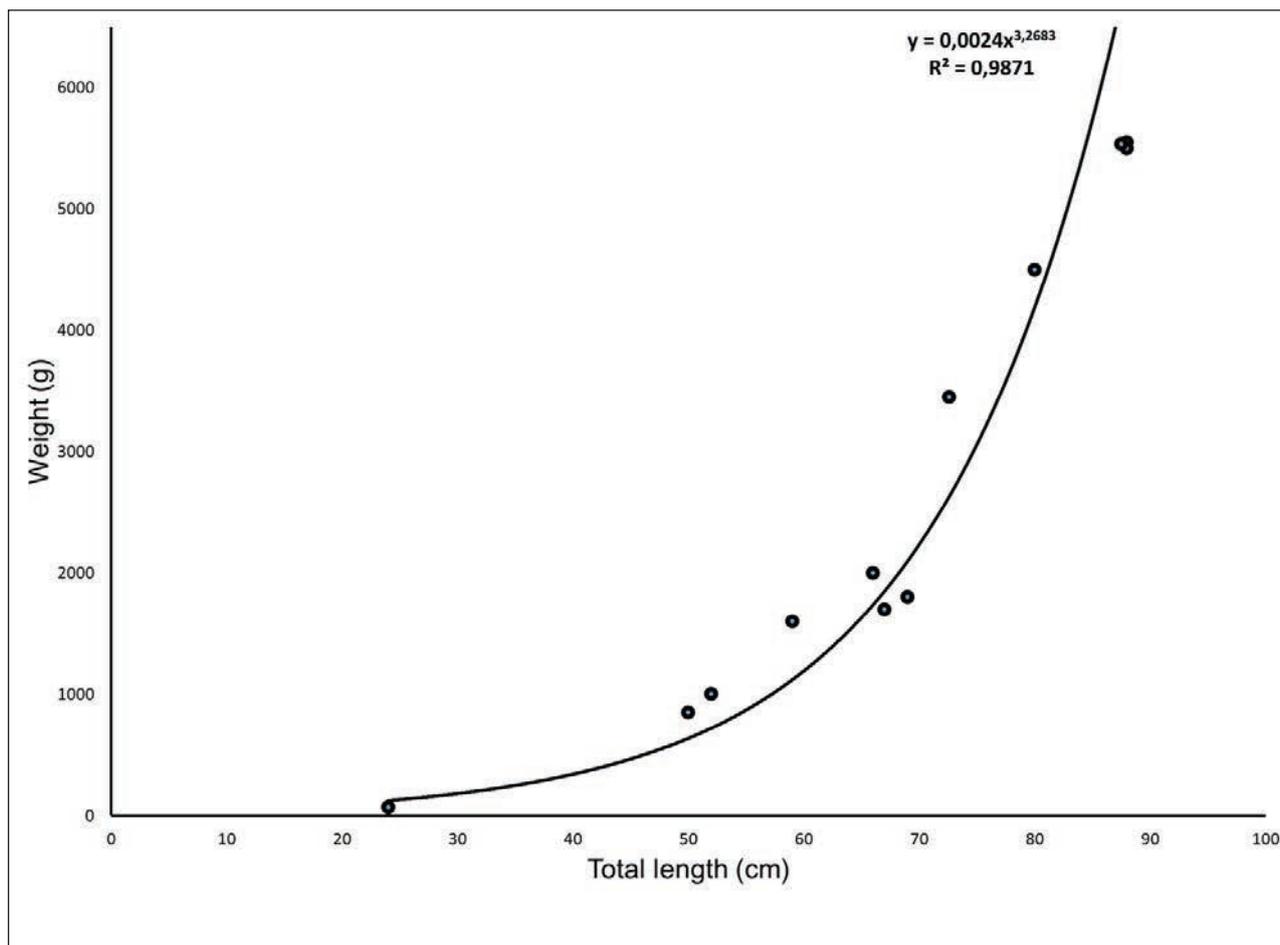


Fig. 3: Length-weight relationship graph of *Squatina oculata* based on individuals caught in Turkish waters (n=15; TL range 24–95 cm; mean TL = 66.91±20.98 cm; TW range 71–6000 g; mean TW = 2916.8±2117.5 g).

Sl. 3: Diagram, ki prikazuje dolžinsko-masni odnos za primerke pegastega sklata v turških vodah (n=15; dolžinski razpon 24–95 cm; povprečna dolžina telesa = 66.91±20.98 cm; masni razpon 71–6000 g; povprečna telesna masa = 2916.8±2117.5 g).

Furthermore, Yiğın *et al.* (2019) observed a total of 6 symmetrically distributed developing oocytes in a female of *S. oculata* of 87.5 cm TL (specimen no. 15; Table 1), which supports our suggestion that females of smoothback angel shark can mature at smaller size ranges than published.

According to Capapé *et al.* (2002), the size at birth of *S. oculata* is between 225 and 266 mm TL (mean SD = 245.25 ± 11.95), and the weight between 129 and 151 g (mean SD = 142.20 ± 9.33). The TL and TW of the developing embryos (24 cm and 71 g, respectively) examined in the present study were within the range of TL reported by Capapé *et al.* (2002); while the TW was slightly below the lower limit. Considering that the examined embryos were aborted by a female captured during a spring expedition (April 2010), and Capapé *et al.* (2002) states that embryos are practically at the end of their development in Feb-

ruary and March, the examined developing embryos would have been born during the upcoming summer of 2010. Capapé *et al.* (2002) also observed fully developed fetuses in females caught from March to June, which supports our suggestion.

All three Mediterranean *Squatina* species (*S. aculeata*, *S. oculata*, and *S. squatina*) are currently considered to be critically endangered in the Mediterranean (Dulvy *et al.*, 2016; Giovos *et al.*, 2022). Although all three species are under protection in Turkish waters, it appears that legal measures are not sufficient to defend these critically endangered species. As a result of both historical and current overfishing, *Squatina* populations still tend to decrease significantly throughout the Mediterranean (Dulvy *et al.*, 2016). In a recent study on the life history of the common angel shark in Turkish waters, Kabasakal (2021) drew attention to seasonal aggre-



Fig. 4. (A) Developing embryos ($n=7$; total weight 500 g) aborted by a pregnant *Squatina oculata* (88 cm TL; specimen no. 6; Table 1); and (B) ventral view of an embryo, depicting yolk sac and ingested yolk (Photo: E. Özgür Özbek).
Sl. 4: (A) Razvijajoči se zarodki ($n=7$; totalna masa 500 g), ki jih je splavila samica pegastega sklata (88 cm telesne dolžine; primerek št. 6; Tabela 1); in (B) ventralni pogled na zarodek prikazuje rumenjarkovo vrečo in požrt rumenjak (Foto: E. Özgür Özbek).

gations of *S. squatina* in 5 different regions along the Turkish coast noting that these hot spots lead to a false perception of the species' abundance. Such misunderstanding or misinterpretation of seasonal aggregations of angel sharks in those hotspots may be used by fishermen as a justification for when they capture angel sharks or land incidentally captured individuals (Kabasakal, 2021). Therefore, it is clearly necessary and urgent to map and ban fishing in marine areas where angel sharks are known to aggregate seasonally. The importance of such

protected areas for the conservation of *Squatina* species has also been stressed in a recent study by Giovos *et al.* (2022).

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ZAPIS O PEGASTIH SKLATIH, *SQUATINA OCULATA* (SQUATINIFORMES:
SQUATINIDAE), UJETIH V ANTALIJSKEM ZALIVU

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POVZETEK

*Petnajst primerkov pegastega sklata (*Squatina oculata*) je bilo naključno ujetih v egejskih in sredozemskih vodah Turčije med leti 1998 in 2018. Največji med njimi je meril 95 cm v dolžino in tehtal 6000 g. Na podlagi preiskanih primerkov, sta bila koeficienta a in b za pegaste sklata v turških vodah 0,003 in 3,27. Spomladi 2010 ujeta samica pegastega sklata (88 cm telesne dolžine) je na palubi ribiškega plovila splavila 7 zarodkov. Dolžinsko masni odnos nedvomno temelji le na podatkih dolžine in mase le za turške populacije pegastih sklatov, obenem pa vzorec temelji na omejenem številu preiskanih primerkov. Glede na dejstvo, da gre za kritično ogroženo vrsto, ki ima status redke vrste, bodo ti podatki uporabni za zapolnitev vrzeli o poznavanju te vrste.*

Ključne besede: *Squatina oculata*, Levantsko morje, biologija, zarodki, dolžinsko-masni odnos

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