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SHORT PAPER

Occurrence and Biological Observations on Angel Shark *Squatina squatina* (Chondrichthyes: Squatinidae) from the Turkish Waters (Eastern Mediterranean)

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Abstract

A new record of angel shark *Squatina squatina* (Linnaeus, 1758) in Turkish waters is reported in this note. A review of previous catch records of *S. squatina* from Turkish waters show that the species is relatively rare in the area. However, the observed specimen was a pregnant female suggesting that Gökova Bay could be a spawning area for *S. squatina* in the Turkish coast.

Keywords: Measurement, cloacal gestation, spawning, litter size, Gökova Bay, Aegean Sea.

Türkiye Sularında (Doğu Akdeniz) Keler Balığının *Squatina squatina* (Chondrichthyes: Squatinidae) Bulunuşu ve Biyolojik Gözlemler

Özet

Bu çalışmada, Türkiye sularında keler balığının, *Squatina squatina* (Linnaeus, 1758) yeni bir kaydı rapor edilmektedir. Türk sularından *S. squatina*'nın önceki av kayıtlarının derlenmesi bu türün göreceli nadirliğini göstermektedir. Aynı zamanda Gökova Körfezi, *S. squatina*'nın gebeliği nedeniyle Türkiye kıyıları boyunca bu balık için bir üreme alanı olabilir.

Anahtar Kelimeler: Ölçüm, cloacal gebelik, yumurtlama, yavru boyutu, Gökova Körfezi, Ege Denizi.

Introduction

Three species belonging to the genus *Squatina* (Duméril, 1806) were reported in the Mediterranean Sea: saw back angel shark *Squatina aculeata* Cuvier, 1829, smoothback angel shark *S. oculata* Bonaparte, 1840 and common angel shark *S. squatina* (Linnaeus, 1758) following Capapé and Roux (1980) and Roux (1984). These species were probably confronted to an overfishing and due to their k-selected characteristics, drastic declines of captures were reported in several regions and therefore classified as "Critically Endangered" (CR) globally on the IUCN Red List of Threatened Species (Morey *et al.*, 2007a, b; Ferretti *et al.*,2015).

Squatina squatina was not very abundant throughout the Mediterranean Sea, but regularly caught in some areas (Capapé, 1989). Captures of some specimens were formerly recorded off the French coast (Euzet, 1959), but since Quignard *et al.*(1962), no capture was reported in the area (Capapé *et al.*, 2000). Similar patterns were noted for other areas of the Mediterranean Sea (Kabasakal and Kabasakal, 2014) and the Adriatic Sea (Lipej *et al.*, 2004). Conversely, *S. squatina* was reported as relatively abundant off the Tunisian coast allowing Capapé *et al.* (1990) to study some traits of its reproductive biology, and to date, Bradai *et al.* (2002) noted that the species was regularly observed in the Gulf of Gabès, located in southern Tunisia.

Formerly, *Squatina squatina* was abundantly caught in Turkish waters during the 1920's according to Deveciyan (1926). Kabasakal and Kabasakal (2014) reported that squatinid species were targeted by spear fishermen in Marmara waters, basing on photographs from 1950's and noted that the occurrence of *S. squatina* was well documented in Turkish waters from Ninni (1923) to date. Additionally, Kabasakal and Kabasakal (2014) reported a female entangled in trammel-nets, the specimen measured 1740 mm in total length and weighed 35 kg.

Investigations were conducted in the Turkish waters focusing on *S. squatina* and supported by local fishermen aware of fishing grounds. So, in the wake of this cooperation, on 05 February 2015, a female *S. squatina* was captured by commercial trammel net of 56 mm stretched mesh size, off Akyaka coast (37°01'41''N - 28°18'13''E) in Gökova Bay at a depth of 20 m, on muddy bottom (Figure 1).

The specimen was a pregnant female, measured 1560 mm in total length and weighed 32600 g (Figure 2A**).** It spawned during handling with embryo tails visible outside cloacal aperture (Figure 3A), and immediately released by the fisherman. Two days later, another fisherman caught the sam**e** female fish by trammel net (92 mm stretched mesh size) in the same area (37°01'12''N - 28°15'55''E), at a depth of 47 m, and once on board the female expelled four embryos which cannot be measured and weighed (Figure 3B). Morphometric measurements *Squatina squatina* was recorded to the nearest millimeter; they are summarized in Table 1 with percentages of total length (%TL).

The specimen was identified as follows: trunk very broad, eye diameter smaller than spiracle length; external nasal flap with two barbels bordering a median indented lobe; dermal folds on sides of head with a single triangular frontal lobe (Figure 2B, Figure 2C); pectoral fins very high and broad with broadly rounded rear tips; small spines present on midline of back and tail from head to dorsal fins and between the fin bases; dorsal surface rough; teeth 20/20 in upper and lower jaws; color greenish-brown with some dark spots, and belly beige. Description, measurements and percent in total length (Table 1), recorded in this specimen of *S. squatina*are in total accordance with Roux (1977, 1986), Capapé and Roux (1980), Compagno (1984), and Kabasakal and Kabasakal (2014).

The captured specimen was a pregnant female, carrying at least four developing embryos exhibiting a yolk sac and an internal yolk sac, with tail embryos visible due to the fact that embryos are located in the cloaca (Figure 3A, Figure 3B), so they cannot be considered as near-term, although they were probably at the end of the gestation, following Capapé *et al.* (1990). In angel sharks from southern Brasil, Sunye and Vooren (1997) described a ten-months gestation which ended by a cloacal gestation, lasting six months. Cloacal gestation was reported for *S. aculeata* from the coast of Senegal (Capapé *et al.*, 2005), and therefore such pattern constitutes a suitable hypothesis for the specimen of *S. squatina*, herein described.

Four embryos were expelled by the pregnant female during the second capture and probably two others during the first capture; at least the female carried 6 embryos. However, Sunye and Vooren (1997) noted that uterine-clocal chamber communicates directly with the external environment, therefore squatinid species easily abort. Conversely, Natanson and Cailliet (1986) and Capapé *et al.* (1990) noted that capture and transportation of angel sharks did not cause any loss of uterine contents. We suppose that it was not exactly the case for this female which was twice caught, in three days. Capapé *et al.* (1990) noted that litter sizes were related with female TL, and reported that in *S. squatina* from the Tunisian coast, litter size ranged between 7 and 18pups, in females measuring from 1280 to 1690 mm TL. The litter size of the present specimen was probably more

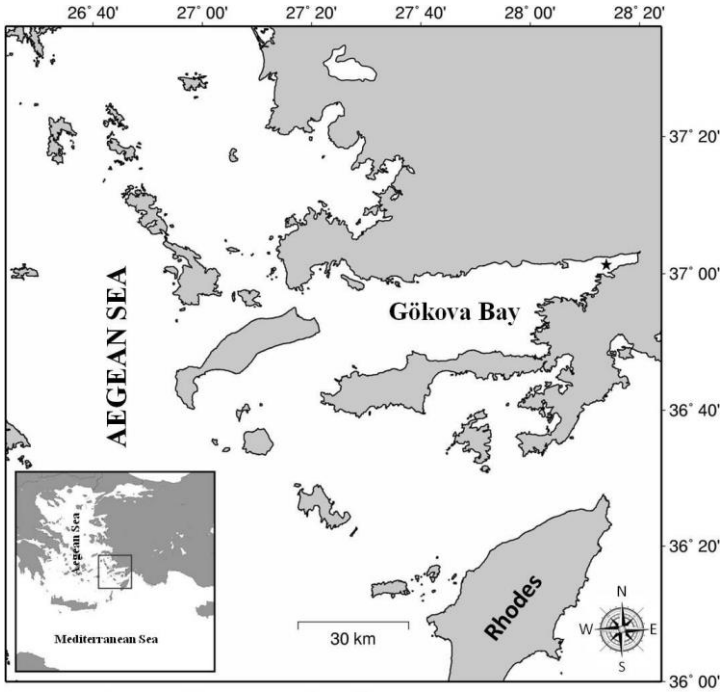

Figure 1. Map of Gökova Bay, SE Aegean Sea, showing the capture site of the specimen of *Squatina squatina* (black star).

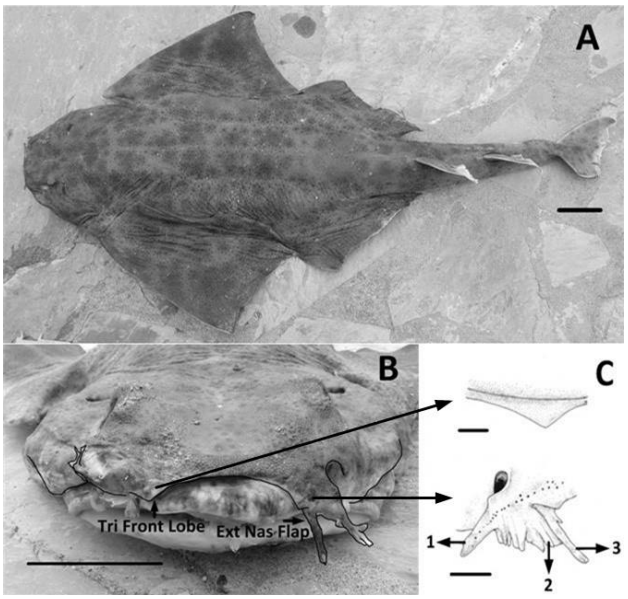

Figure 2. Specimen of *Squatina squatina*, captured in Gökova Bay (Scale bar = 100 mm), B. Frontal margin of Squatinasquatina showing triangular frontal lobe (Tri Front Lobe) and external nasal flap (Ext Nas Flap), fitted with hand (Scale bar = 100 mm), C. in upper: triangular frontal lobe (Scale bar = 10 mm), in lower: external nasal flap, showing external nasal flap with two barbels (1, 3) bordering a median indented lobe (2) (Scale bar = 5 mm).

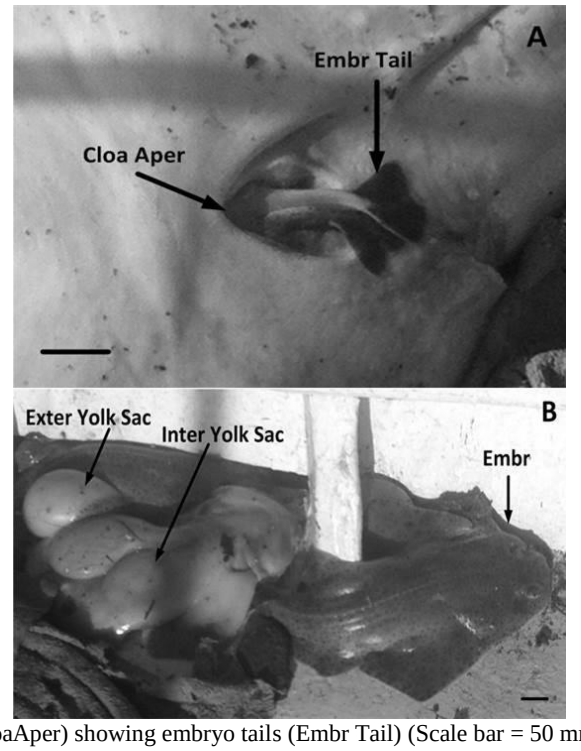

Figure 3. Cloacal aperture (CloaAper) showing embryo tails (Embr Tail) (Scale bar = 50 mm), B. Embryo (Embr), showing an external yolk sac (Exter Yolk Sac) and an internal yolk sac (Inter Yolk Sac) (Scale bar = 50 mm).

than 6pups; this assessment should be considered only as a suitable hypothesis. So, this large pregnant female entered to spawn into Gökova Bay to which is providentially a marine protected area of 827 km^2, including six no fishing zones of 24 km^2, marine rangers banning illegal fishing as well as closed areas for the large scale fisheries.

Historically, *S. squatina* was mentioned only by name among the fishes of the Sea of Marmara (Ninni, 1923; Deveciyan, 1926; Kabasakal, 2002, 2003); Izmir Bay, Aegean Sea (Geldiay, 1969), Mersin-Iskenderun Bays, NE Mediterranean (Gücü and Bingel, 1994) and Antalya Bay, NE Mediterranean as a host of a parasitic leech, *Stibarobdella moorei* (Bulguroğlu *et al.*, 2014). Additionally, contemporary records in the Turkish waters during the last two

decades are summarized in Table 2. It appears that few specimens were captured, however of the 6 specimens recorded, 2 measured 232 mm (İşmen *et al.*, 2009) and 265 mm (Karakulak *et al.*, 2006). Capapé *et al.* (1990) noted that neonate TL inferred from measurement of near-term embryos ranged between 250 and 282 mm, so the smallest *S. squatina* from Table 2 were free-swimming specimens; the largest specimen recorded by Kabasakal and Kabasakal (2014) was an adult female.

The captures of large females, especially, a pregnant female carrying developing embryos and two free-swimming specimens suggest that the region could be a nursery area, *sensu* Castro (1993), for *S. squatina*; unfortunately, such attractive hypothesis is not supported by sufficient data and further records are needed to give a definitive statement. Additionally, in total agreement, with Kabasakal and Kabasakal (2014), these data confirms the contemporary occurrence of the species in the region, but the relative scarcity of captures showed that the presence of a sustainable population remains doubtful and *S. squatina* should be considered as a Critically Endangered (CR) species. Following Kabasakal and Kabasakal (2014) no regulatory measures were carried out in the area for the species which urgently needs a conservation action. However, recent outcomes and observations discussed in this paper could be considered as the first step which push decision makers to take necessary measures to enhance sustainability of the species in Turkish waters and the entire Mediterranean Sea.

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Table 1. Morphometric measurements in mm and as percentage of total length (TL%) recorded in the large female *Squatina squatina*, captured from Gökova Bay, south-eastern Aegean Sea

Measurements	**mm**	**% TL**
Total length (TL)	1560	100.0
Standard length (SL)	1320	84.6
Disc length	402	25.8
Eye diameter	25	01.6
Pre-orbital length	60	03.8
Spiracle length	34	02.2
Snout to mouth	8	00.5
Snout to first gill-slit	235	15.1
Snout to disc	230	14.7
Snout to first dorsal	960	61.5
Snout to pelvic	635	40.7
Snout to spiracle	120	07.7
First to second dorsal	176	11.3
Between dorsal bases	105	06.7
Pelvic to anal	90	05.8
Second dorsal to upper caudal	192	12.0
Anal to lower caudal	515	33.0
Pelvic to median tip	380	24.4
Upper caudal	165	10.6
Lower caudal	212	13.6
Mouth width	198	12.7
Inter-nasal width	92	05.9
Inter-spiracular width	120	07.7
Total tooth row in upper/lower jaws	2-2	
Total teeth in upper/lower jaws	20-20	
Total weight	32600 g	

Table 2. Contemporary records of *Squatinas quatina* from Turkish waters

Location	Depth (m)	Gear*	Record date	Number collected	Size, TL (mm)	References
Off Kapıdağ, Sea of Marmara	?	?	Nov. 1995	1	870	Kabasakal and Kabasakal (2014)
Gökova Bay, S Aegean Sea	?	TN	2000-2001	1	850	Öğretmen *et al.* (2005)
Gökçeada, N Aegean Sea	30	TN	2004-2005	1	265	Karakulak *et al.* (2006)
Saros Bay, N Aegean Sea	5-500	BT	2005-2008	1	232	İşmen *et al.* (2009)
Gemlik Bay, Sea of Marmara	50	TN	04 Jan. 2014	1	1740	Kabasakal and Kabasakal (2014)
Gökova Bay, S Aegean Sea	47	TN	05 Feb. 2015	1	1560	This study

*TN: Trammel net; BT: Bottom trawl

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