Marine Biodiversity Records, page 1 of 4.
doi:10.1017/S1755267215000226; Vol. 8; e44; 2015 Published online

Finding of a rare *Squatina squatina* (Linnaeus, 1758) (Chondrichthyes: Squatinidae) along the Tyrrhenian coast of the Strait of Messina and its maintenance in an aquarium

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The finding of a rare specimen of Squatina squatina *off the Sicilian coast of the Strait of Messina (Central Mediterranean Sea) and its maintenance in an aquarium is reported. The morphometric and meristic characters are presented. The record is proposed as a useful tool for raising attention to the state of this delicate species.*

Keywords: Squatinidae, *Squatina squatina*, angel shark, Mediterranean Sea

Submitted 19 December 2014; accepted 28 February 2015

INTRODUCTION

Angel sharks (Squatinidae) are benthic, bottom-dwelling, non-batoid elasmobranchs that occur circumglobally in tropical and temperate waters and have been found at depths ranging from near shore to more than 1000 m (Compagno, 1984). They are historically common over large areas of the coastal, continental and insular shelf of the North-East Atlantic, from Norway, Sweden and the Shetland Islands to Morocco, West Sahara, the eastern Canary Islands and the Mediterranean and Black Seas (Fricke *et al.*, 2007; Wirtz *et al.*, 2008).

In the Mediterranean Sea, three species of angel shark are present: *Squatina aculeata*, Cuvier, 1829, *Squatina oculata*, Bonaparte, 1840 and *Squatina squatina* (Linnaeus, 1758). *Squatina squatina* has been commonly reported in the historical faunistic list concerning the coasts of Sicily (Arena & Li Greci, 1973; Ragonese *et al.*, 2013; Giusto & Ragonese, 2014). Nowadays, *Squatina squatina* has almost disappeared and in 1985 only one specimen was sampled for the whole Strait of Sicily, close to Malta Island (Ragonese *et al.*, 2013). Intensive demersal fishing pressure throughout its range has resulted in significant declines, local extirpations and the contraction of its original range over the past 50–100 years. It is classified as globally 'Critically Endangered' on the IUCN Red List of Threatened Species (Morey *et al.*, 2006).

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However, except for rare information on the general biology, reproduction and distribution of this species (Capapé *et al.*, 1990; Scacco *et al.*, 2002; Bradai *et al.*, 2012), no other data was available with particular regard to its morphological or biological characteristics.

The aim of this paper is to present a record of *Squatina squatina* (Linnaeus, 1758) for the Strait of Messina, including its capture and maintenance in an aquarium.

MATERIALS AND METHODS

On 27 July 2008, a female specimen of angel shark, *Squatina squatina,* was caught using a nylon monofilament trammel net at a depth of 18 m, one nautical mile north-east off the coast of Rometta Marea (38°14′03.3″N 15°24′21.0″E), north Sicily, Central Mediterranean Sea (Figure 1). After the fish had been caught, it was transported to the aquarium and isolated in a seawater closed-circuit quarantine tank with a capacity of 200 l (at a constant temperature of 18°C, constant pH = 8, nitrites and nitrates absent). It measured 38 cm and weighed 1.9 kg. After an acclimation period of about 30 days, the animal was transferred to an open-circuit tank with a capacity of 350 l (at a constant temperature of 15.5°C, constant pH = 8, nitrites and nitrates absent) for 90 days and subsequently, to an open-circuit exhibition tank with a capacity of about 3000 l (at a constant temperature of 15.5°C, constant pH = 8, nitrites and nitrates absent) (Figure 2A). The fish became gradually accustomed to a diet of shellfish (squid) and fish (sardines and anchovies). The fish died on 30 August 2014 due to a malfunction of the ventilation system of the exhibition tank.

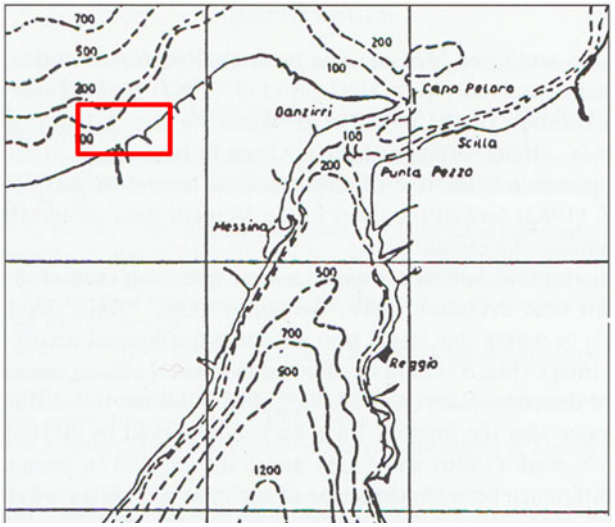

Fig. 1. Capture location of the specimen of *Squatina squatina* in the Strait of Messina (38°14′03.3″N 15°24′21.0″E, North Sicily, Central Mediterranean Sea).

On examination after its death (Figure 2B), the main morphometric parameters were measured according to the systematic keys of Compagno (1984) and Serena (2005) and recorded to the nearest mm (Table 1).

The total weight (TW), eviscerated weight (EW), liver weight (LW) and gonad weight (GW) was recorded to the nearest gram. Upon dissection, the liver and gonads were removed and weighed. The eggs were counted and measured in each ovary. Both ovaries were weighed together. The hepatosomatic index (HSI) and gonadosomatic index (GSI) were calculated using the respective formulas: HSI = 100 LW/EW and GSI = 100 GW/EW.

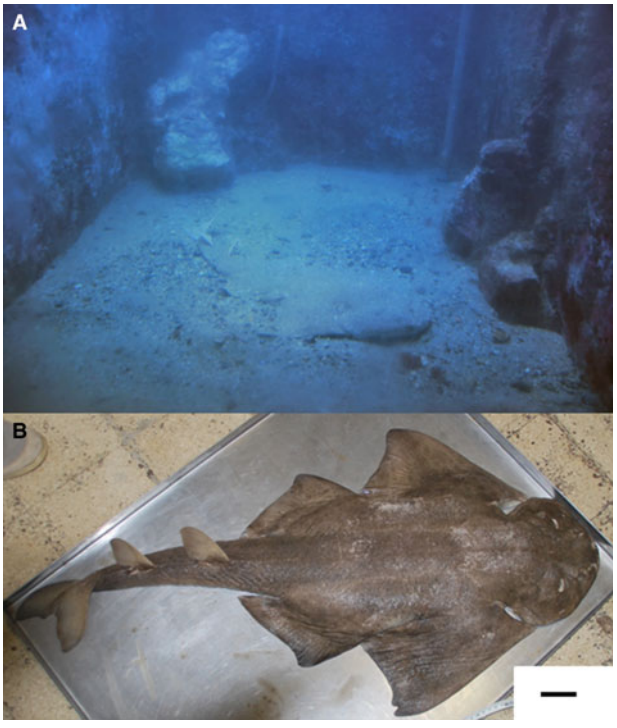

Fig. 2. The individual of *Squatina squatina:* (A) in aquarium; (B) after death. Scale bar: B, 100 mm.

Table 1. Morphometric measurements of *Squatina squatina* specimen (Compagno, 1984; Serena, 2005).

Measurement	mm	% TL
Total length	920	
Fork length	870	94.6
Precaudal length	810	88.0
Pre-second dorsal length	710	77.2
Pre-first dorsal length	597	64.9
Head length	160	17.4
Prebranchial length	123	13.4
Prespiracular length	75	8.2
Preorbital length	40	4.3
Prepectoral length	180	19.6
Prepelvic length	380	41.3
Snout-vent length	450	48.9
Preanal length	390	42.4
Interdorsal space	70	7.6
Dorsal-caudal space	60	6.5
Pectoral-pelvic space	110	12.0
Vent-caudal length	462	50.2
Eye length	18	2.0
Eye height	11	1.2
First-fifth gill slit height	650	70.7
Pectoral anterior margin	262	28.5
Pectoral radial length	202	22.0
Pectoral base	140	15.2
Pectoral inner margin	111	12.1
Pectoral posterior margin	180	19.6
Pectoral height	180	19.6
Dorsal caudal margin	126	13.7
Preventral caudal margin	140	15.2
Lower postventral caudal margin	96	10.4
Caudal fork width	80	8.7
Caudal fork length	85	9.2
Subterminal caudal margin	13	1.4
Subterminal caudal margin	55	6.0
Terminal caudal margin	61	6.6
Terminal caudal lobe	70	7.6
First dorsal length	70	7.6
First dorsal anterior margin	112	12.2
First dorsal base	45	4.9
First dorsal height	86	9.3
First dorsal inner margin	21	2.3
First dorsal posterior margin	71	7.7
Second dorsal length	72	7.8
Second dorsal anterior margin	100	10.9
Second dorsal base	40	4.3
Second dorsal height	80	8.7
Second dorsal inner margin	30	3.3
Second dorsal posterior margin	60	6.5
Pelvic length	220	23.9
Pelvic anterior margin	111	12.1
Pelvic base	160	17.4
Pelvic height	90	9.8
Pelvic inner margin length	75	8.2
Pelvic posterior margin length	150	16.3
Head height	65	7.1
Trunk height	60	6.5
Caudal peduncle height	22	2.4
Mouth length	32	3.5
Mouth width	122	13.3
Upper labial furrow length	22	2.4
Lower labial furrow length	30	3.3
Nostril width	9	1.0
Internarial space	65	7.1
Anterior nasal flap length	3	0.3

Continued

Table 1. Continued

Measurement	mm	% TL
Girt	465	50.5
Interorbital space	75	8.2
Spiracle length	9	1.0
Spiracle width	22	2.4
Eye spiracle space	19	2.1
Head width	152	16.5
Trunk width	201	21.8
Caudal peduncle width	35	3.8

RESULTS

The specimen was identified following the identification key by Compagno (1984). Table 1 presents all of the morphometric measurements carried out on the *Squatina squatina* female caught in the Tyrrhenian Sea in mm and as a percentage of total length (TL). The morphology, morphometrics and colour of the specimen are in agreement with descriptions given by Tortonese (1956) and Compagno (1984).

Throughout the period of its stay in the aquarium, the fish had become well-acclimatized and accustomed to captivity and its confined environment, and it had succeeded in living in perfect health for six years. In fact, on its arrival the specimen measured just 380 mm and weighed about 1900 g, and after its death it weighed 8406 g and contained no internal or external parasites as a result of an optimal state of captivity. The external examination of its body revealed an abnormal development of the pectoral fins, probably due to the limited freedom of movement induced by captivity (Figure 3).

Dissection showed that the liver ($W = 1906$ g) occupied a large area of the body cavity and a visible asymmetry between the two liver lobes was observed. The calculated HSI was 24.12. In the right ovary there were 17 yellow yolk oocytes, but only five in the left ovary. We noted that the oocytes were not equally distributed in both ovaries. The diameter of the oocytes ranged from 2 to 9 mm (mean 5.01 ± 1.9). Both ovaries were functional and together weighed 64.8 g. This contrasts with the marked asymmetry described in other species of angel sharks; in fact, in *Squatina argentina*, Cousseau (1973) described the right ovary as atretic, while Natanson & Cailliet (1986) reported a non-functional ovary in *Squatina dumeril* and *Squatina californica*.

Fig. 3. Particular shape of the pectoral fins (arrow).

The correct ovary functionality suggests that, even in captivity, the animal was carrying on a regular reproductive cycle, in accord with Capapé *et al.* (1990). Despite the state of captivity, dissection showed a considerable thickness of the abdominal muscle bundles.

DISCUSSION

In the Italian survey, captures of *Squatina squatina* were rarely reported (Relini *et al.*, 2000). *Squatina squatina* was reported from trawl surveys carried out in the Adriatic Sea in 1948, but some authors have indicated that this species may now be absent from this area (Jukic-Peladic *et al.*, 2001). Indeed, evidence points to angel sharks being absent nowadays from most of the Mediterranean coastline.

Even though angel sharks have represented a low value by-catch for Mediterranean commercial fisheries (Piccinetti *et al.*, 2000), their low resilience to exploitation has determined their near-disappearance from the bottoms and their inclusion among the endangered and even critically endangered species on the IUCN Red List (Froese & Pauly, 2013).

There is still a lack of data on the status of this species in the southern Mediterranean and active conservation measures must be made appropriate for the protection of this species. In fact, the OSPAR Commission, in its report entitled 'Background document for angel shark *Squatina squatina*' (Fowler, 2010), suggests the adoption of conservation and monitoring tools so that all stakeholders (legislative bodies, fishing operators and research bodies) are encouraged to acquire: historic records (location, dates and abundance); current location, dates and number of bycatch (returned to the sea) and sea angling records (including tag and release); and individuals in captivity (with a view to facilitating life history and genetic studies).

The present finding is the first documented occurrence of *S. squatina* off the north coast of Sicily in the last 25 years, in spite of the continuous surveying and monitoring of the fishing capacity in this Sicilian zone, and is proposed as a useful tool for raising attention to the state of this delicate species.

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