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## On the presence of the Endangered white skate *Rostroraja alba* in Sardinian waters

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### Abstract

The white skate *Rostroraja alba* is assessed by the International Union for Conservation of Nature as Endangered globally and is now considered rare in the Mediterranean. This species has never been recorded in Sardinian seas (central western Mediterranean), but an empty eggcase was collected on a sandy bottom off the western Sardinia coasts during the MEDiterranean International Trawl Survey (MEDITS) program in 2019. A morphometric and morphological description of the Sardinian eggcase, after a comparison with measurements from other Mediterranean and Atlantic specimens, showed it to be clearly ascribable to *R. alba*.

**Keywords:** Eggcase; Rajiformes; Rajidae; morphology; central western Mediterranean.

### Introduction

The Mediterranean Sea is considered a key hotspot of extinction risk for elasmobranch fish (Dulvy *et al.*, 2014). Of the 88 elasmobranch species recorded in the basin (Otero *et al.*, 2019), more than half (at least 53%; Dulvy *et al.*, 2016) are threatened because of overfishing and are classified by the International Union for Conservation of Nature classification as Vulnerable, Endangered or Critically Endangered (Dulvy *et al.* 2014, 2016). Among them, the white skate *Rostroraja alba* (Lacepède, 1803) is currently assessed as Endangered globally and in the Mediterranean (Dulvy *et al.* 2006, 2016), and Critically Endangered in European seas (Ellis *et al.*, 2015).

*Rostroraja alba* is a demersal species occurring on sandy and detrital bottoms from coastal waters to the upper slope region, at depths from 40 m to 500 m (Stehmann & Bürkel, 1984; Serena *et al.*, 2005; Ellis *et al.*, 2015). It is distributed in the eastern Atlantic, from the British Isles to southern Africa, including the Mediterranean Sea (Dulvy *et al.*, 2006; Froese & Pauly, 2006), and may extend into the Indian Ocean (Stehmann & Bürkel, 1984).

During the 1960s and 1970s, *R. alba* was captured frequently in the western Mediterranean, including off Tunisia and Morocco (Capapé, 1976). It is, however, now considered rare along Mediterranean coasts (Serena *et al.*, 2010) and is believed to have undergone a significant decline in abundance (Dulvy *et al.*, 2006; Ellis

*et al.*, 2015). Nevertheless, a recent study on the presence and abundance of chondrichthyans in the northern Mediterranean Sea highlighted the presence of *R. alba* around the Balearic Islands and Corsica as well as in the Strait of Sicily and the northern Adriatic Sea (Follesa *et al.*, 2019). This species has not been recorded, at least in recent times, in Sardinian waters (central western Mediterranean), as indicated by analyses of scientific trawl surveys from 1994 to 2015 (Marongiu *et al.*, 2017). In this paper, the finding of a *R. alba* eggcase in Sardinian seas is reported, and its morphological and morphometric description is given. Given the lack of contemporary data on *R. alba* in European waters, the reporting of available information on this species is required to inform conservation plans.

### Materials and Methods

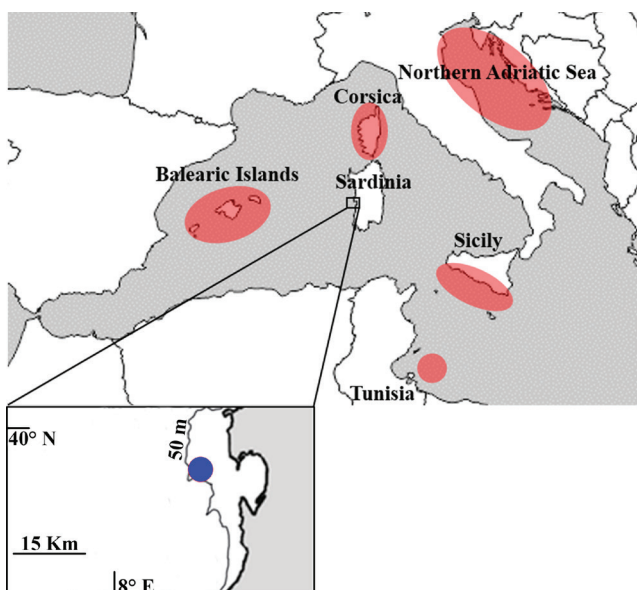
One empty eggcase of *R. alba* was taken in a trawl haul in Sardinian waters (Fig. 1) during the MEDiterranean International Trawl Survey (MEDITS) program (Spedicato *et al.*, 2019) on 19 June 2019 at a 44 m depth off the Oristano Gulf in western Sardinia (39°49'77" N; 8°21'50" E; Figure 1). The eggcase was photographed using a Canon EOS 1100D, preserved frozen and deposited in the collection of the Department of Life and Environmental Sciences, University of Cagliari (Italy). As reported by Gordon *et al.* (2016), the term "anteri-

or” used in this work refers to the part that forms first in the oviducal gland. Ten morphometric measures (Fig. 2A) were recorded in millimetres using a calliper following the methods of Concha *et al.* (2012) and Porcu *et al.* (2017): eggcase length (CL, measured longitudinally between the anterior and posterior apron borders); eggcase width (CW, the transverse width of the eggcase in its lateral plane, including the keels); anterior and posterior apron length (AAL and PAL, the distance from the central body eggcase to the apron border); left and right keel width (LKW and RKW, the transverse width of the case from the eggcase keel junction to the keel edge); left and right anterior horn length (LAHL and RAHL, the distance from the anterior apron border to the horn tips) and left and right posterior horn length (LPHL and RPHL, the distance from the posterior apron border to the horn tips). CW, AAL and PAL were expressed as a percentage of CL. The measurements in millimetres were also contrasted with data in the literature.

The associated benthic community, as inferred from the benthic bycatch in the same trawl sample, was recorded. All taxa were identified following the taxonomic guide for the Mediterranean (Riedl, 2005).

## Results

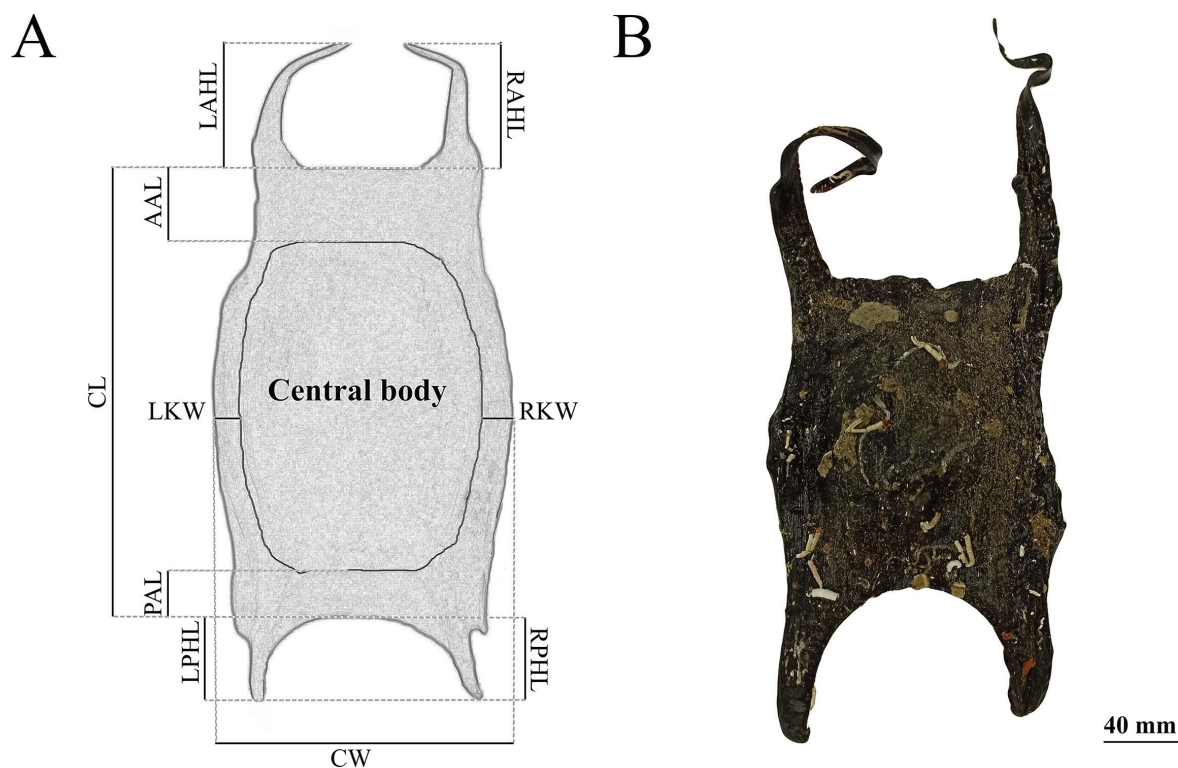
The eggcase was found laid on a sandy bottom mainly populated by purple heart urchin *Spatangus purpureus* (Müller, 1776) and in association with the rhizome layer of the seagrass *Posidonia oceanica* (Linnaeus) Delile 1813, with the sandstar *Astropecten aranciaceus*



**Fig. 1:** Map of the Mediterranean basin where the most recent captures of *Rostroraja alba* specimens have been recorded (Kadri *et al.*, 2014; Follesa *et al.*, 2019). The blue dot shows the area where the eggcase was found in Sardinian seas.

(Linnaeus, 1758), the brittle star *Ophiura albida* Forbes, 1839, the sea anemone *Adamsia palliata* (Müller, 1776), and the hermit crabs *Dardanus arrosor* (Herbst, 1796) and *Pagurus* spp. also present.

The eggcase specimen, covered by serpulid tubes (Fig. 2B), was long (126.9 mm CL) and large (CW = 117.4 mm, 92.5% of CL; Table 1). The eggcase surface was striated with densely-packed, fine, longitudinal ridges.



**Fig. 2:** A) Morphometric measurements performed in the eggcase. AAL anterior apron length, CL eggcase length, CW eggcase width, LAHL left anterior horn length, LKW left keel width, LPHL left posterior horn length, PAL posterior apron length, RAHL right anterior horn length, RKW right keel width, RPHL right posterior horn length. B) Eggcase analyzed in this study.

The anterior and posterior aprons were short, considering the size of the eggcase (17.7% of CL and 8.6% of CL, respectively). The lateral keels were thick, developed and striated longitudinally. The posterior horns were moderately long and sturdy, terminating with a hook, whilst the anterior horns were longer, thin and ribbon-like.

## Discussion

Skates (Rajiformes) are a highly diverse fish group, comprising more species than any other group of cartilaginous fishes, but are also morphologically conservative (McEachran & Dunn, 1998). One of the greatest issues characterising the skate families is they are historically linked to problematic taxonomy, due to the phenotypic similarity between some taxa and misidentifications (Porcu *et al.*, 2017). A useful tool to distinguish skate species from one another, after examining their external morphology, is to look at their eggcase morphology, as this is a species-specific feature (e.g. Hamlett & Koob, 1999; Ishihara *et al.*, 2012; Marongiu *et al.*, 2015). After a comparison of the measurements with those of other eggcases belonging to the same species (Table 2), it is clear that the eggcase found in Sardinian waters is ascribable to *R. alba*.

The unique record of *R. alba* until now can probably be related to a low population density and the reduced probability of it being encountered. Indeed, although *R. alba* shows shallow habits, it has also not been observed by artisanal fisheries, which use gill and trammel nets and are prevalent on the western coast of Sardinia (Marongiu *et al.*, 2017).

The historical picture of the occurrence and abundance of *R. alba* in the Mediterranean Sea brings to

light its rarity and its overall decline (e.g. Guijarro *et al.*, 2012), recently reported also by Colloca *et al.* (2020) in the Sicilian continental shelf. Indeed, on the basis of Sicilian fishers' "local ecological knowledge", *R. alba* is currently considered to have decreased by at least three times in comparison to 1981–2000, and nowadays it is considered extirpated from the area. The low occurrences of *R. alba* reported by Follesa *et al.* (2019) within MEDITS surveys in the western and central areas of the Mediterranean where Sardinia is midway (western: Balearics and central: Corsica, Sicily and Northern Adriatic) further confirm its rarity.

Our record sheds new light on the dispersion of this species in the Mediterranean basin, suggesting a probable presence of the species in Sardinian waters.

In addition to gathering data from scientific trawl programmes, such as MEDITS, other methods, such as remotely operated vehicles (ROVs), could better survey areas with recurring eggcase samples. The use of ROVs could guarantee the discovery and identification of eggcases laid on the bottom of the sea (e.g. Amsler *et al.*, 2015; Cau *et al.*, 2017) and the presence of females near the spawning sites (e.g. Bellodi *et al.*, 2017; Porcu *et al.*, 2020).

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**Table 1.** Eggcase morphometric measurements (in millimeters). AAL anterior apron length, CL eggcase length, CW eggcase width, LAHL left anterior horn length, LKW left keel width, LPHL left posterior horn length, PAL posterior apron length, RAHL right anterior horn length, RKW right keel width, RPHL right posterior horn length.

Species	CL	CW	AAL	PAL	RKW	LKW	RAHL	LAHL	RPHL	LPHL
<i>R. alba</i>	126.9	117.4	22.5	11.0	14.5	14.5	132.5	130.1	66.0	77.0

**Table 2.** *Rostroraja alba* eggcase dimensions reported in several geographical areas.

Area	Eggcase length (mm)	Eggcase width (mm)	References
<b>Atlantic Ocean</b>			
British Isles	127.8–190.0	104.3–145.0	Gordon <i>et al.</i> (2016)
South Africa	141.0	120.4	Ishihara <i>et al.</i> (2012)
<b>Mediterranean/Atlantic</b>	160.0–200.0	130.0–150.0	Stehmann & Bürkel (1984)
<b>Mediterranean</b>			
Sardinian waters	126.9	117.4	Present study (2020)
Tunisian waters	145.0–180.0	75.0–88.0	Kadri <i>et al.</i> (2014)



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