



First Confirmed Record of the Smalltooth Sand Tiger, *Odontaspis Ferox*, in Galicia (NW Spain)

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Abstract

The smalltooth sand tiger shark *Odontaspis ferox* (Risso, 1810) appears to have an extensive and fragmented distribution in tropical and warm-temperate worldwide oceans. One female of *O. ferox* was caught and released by a small-scale fishery vessel in Ría de Arousa (Northwest of Spain), subsequently stranded still alive on the coast (42°33'18.4"N 8°49'18.3"O) after a few hours. The individual (336 cm total length, weight ~300 kg) was identified based on a collection of features including the characteristic dentition, body morphology and by molecular assignment. This is the first confirmed record of *O. ferox* in Galician waters. This finding complements the knowledge of the geographic distribution and occurrence of this rare and sparse species in the Northeastern Atlantic.

Keywords *Odontaspis ferox* · Smalltooth sand tiger · first record · Galicia · North Atlantic Ocean

Introduction

Species distributions are undergoing changes in oceans worldwide. The geographic range of a species is a crucial issue for implementing effective conservation tools and fisheries management. If it is a rare or unusual species, its occurrence records are further critical, since they need to implement conservation actions on population and habitats (Santander-Neto et al. 2011). In this context, molecular methods have played a fundamental role in unravelling the Chondrichthyan species diversity (chimeras, rays and sharks), being used as an useful and reliable tool for a better understanding of their evolutionary history and the frequency of cryptic species (Steinke et al. 2017; Duncan et al. 2006; Feitosa et al. 2018; Ferrari et al. 2021). Nowadays, DNA barcoding is a genetic tool common to prevent or avoid problems of misidentifications in this species. In addition, the mitochondrial oxidized cytochrome I subunit COI fragment (Hebert et al. 2003) provides reliable elasmobranch identification (da Silva et al. 2019; Bernardo et al. 2020), which supports morphological taxonomy (Abdullah et al. 2020).

The smalltooth sand tiger shark *Odontaspis ferox* (Risso, 1810) is included in the family Odontaspidae and is a fish rarely observed or captured in comparison with others big sharks, indicating a relatively low density or local

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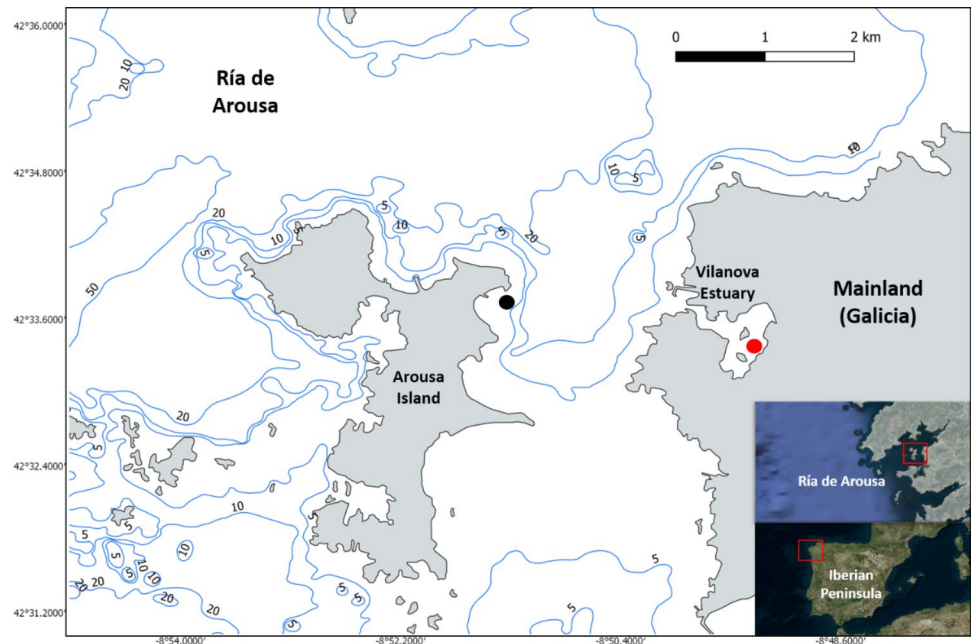
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Fig. 1 Map of the Ría de Arousa (Galicia) showing the location where the female *Odontaspis ferox* was captured and released alive near the Illa de Arousa (black dot), and the location of the stranding in the Vilanova Estuary (red dot)



abundance with patchy worldwide distribution in temperate and tropical waters (Bonfil, 1995). This species inhabits an extensive depth range (10–900 m) mainly in bottoms around islands, seamounts or in continental shelves (Compagno 2001).

Little is known about the biology of *O. ferox* due to the relatively small number of reported captures worldwide (Graham et al. 2016), and limited *in situ* observations by recreational divers in shallow waters (Fergusson et al. 2008; Barriá et al. 2018). The maturity size is approximately 200 cm TL (total length) for males and 350 cm TL for females (Fergusson et al. 2008). The reproduction strategy is based on ovoviparity with oophagy and uterine cannibalism (Compagno 2001), and has a low reproductive rate, producing two neonates every two years.

In the Atlantic Ocean, we can find two genera (*Carcharias* and *Odontaspis*) of the family Odontaspidae, and three similar species (*Carcharias taurus*, *Odontaspis ferox*, and *O. noronhai*) (Compagno 2001; Ebert and Stehmann 2013). The shark *O. ferox* is not a targeted species but incidentally caught in trawl fisheries (Fergusson et al. 2008). The IUCN (International Union for Conservation of Nature) listed this shark as vulnerable globally (Graham et al. 2016) but in Europe and the Mediterranean is considered as critically endangered (Pollard et al. 2015). In Spain, *O. ferox* occurs mainly in the Balearic and Canary Islands. In the Canary Islands, records include specimens found dead (Fergusson et al. 2008; Brito 1991) and seasonal visual observations by recreational divers in shallow waters (Barriá et al. 2018).

Combining morphological and molecular identification, this work reports the first occurrence of an individual of *O. ferox* stranded in the Galician coast (NW Spain).

Materials and Methods

Sample Collection

The sampling location was the Ría de Arousa, Galicia, northwest of Spain (Fig. 1). The shark was accidentally captured by gillnet (manufactured in nylon) in shallower and coastal waters. The fishing boat involved in the capture belongs to the small-scale artisanal fishing fleet based in Illa de Arousa (a small island very close to the coast), and the position was approximately 42°33'42.0"N 8°51'28.3"W (Fig. 1). The shark was first stranded at the position 42°33'27.9"N 8°49'35.0"W. The last position recorded for the stranded shark was 42°33'18.4"N, 8°49'18.3"W. After confirming the death of the shark, biometrics and samples were taken. Clips from muscle and skin were collected, preserved in 100% ethanol and kept cold.

Molecular Data

Total genomic DNA was extracted from the muscle-fin tissue previously preserved in 100% ethanol, using the Jetquick tissue DNA Spin Kit (Genomed), according to manufacturer's instructions. A fragment of the CO1 gene of 677 bp was amplified using the universal pair of

Fig. 2 Detail of the particular morphological dentition of *Odontaspis ferox* in which three rows of small intermediate teeth can be observed between the rows of upper and lateral anterior teeth, and teeth mostly with two or three cusps on each side of the cusp, unique characteristics of this species



primers LCO1490 and HCO2198 (Folmer et al. 1994). Polymerase chain reaction was performed under the following parameters: initial denaturation at 94°C for 3 min, denaturation at 94°C for 30 s, annealing at 45°C for 40 s and extension at 72°C for 1 min. The whole process was repeated for 38 cycles and then a final extension step was made at 72°C for 10 min. The amplified product was sent to Macrogen (Spain) for purifying and Sanger sequencing,

using both forward and reverse primers. The quality of the sequences was checked visually with the software Chromas v 2.6.5 (Technelysium Pty Ltd). A consensus sequence for the forward and reverse fragment was obtained in Bioedit v 7.0.5.3 (Hall 1999) and deposited in GenBank under the accession number OP103960. The newly obtained sequence was blasted at NCBI and BOLD databases for species identification.

Results and Discussion

On the 2nd of June 2022, a large individual of 336 cm total length (281 cm fork length) and ± 300 kg of total weight of *Odontaspis ferox*, was stranded in the inter-tidal area of a small and partially closed estuary named “O Esteiro”. Previously, it has been incidentally captured close to the Cabodeiro beach of Illa de Arousa, a small island in the Ría de Arousa. After being released by fishermen, the shark swam back into shallower waters. The specimen was alive and active during the first examination, dying in the next few hours.

Morphological identification and diagnosis were based on the particular and prominent dentition, long and narrow teeth and 3 to 5 rows of small intermediate upper teeth (Fig. 2). Other taxonomical features were a conical snout with a long mouth, morphology of dorsal and pectoral fins, first dorsal fin that originates over the pectoral-fin free rear tips, and is much larger than the second dorsal and anal fins. Colour was brownish or grey above, lighter below with dark spots.

The individual, identified as a female, was not pregnant and presented developing ovaries with a size of 24×13.5 cm (right) and 15×10 cm (left). Females mature at 300 to 350 cm and have a maximum length of 450 cm (Ebert et al. 2013). The non-existence of stomach content was confirmed, indicating that the shark migrated during the last days. Parasites, e.g., *Anthosoma crissum* (copepods) were found in the mouth (Fig. 3), typical species found in other sharks.

The blast search of the CO1 sequence obtained in this work at the NCBI and BOLD databases confirmed the identity of the stranded individual as an *O. ferox* with a percentage match of 100%.

According to the available literature, this species might move over large distances by crossing submarine ridges, archipelagos and islands, or seamounts (Fergusson et al. 2008; Barcelos et al. 2018). Mature females of this species are likely to migrate to shallower waters in breeding periods

(RedPROMAR, 2022), and it can appear seasonally and periodically in specific places, as is the case of the El Hierro Island in the Canary Islands (Barría et al. 2018). However, the nature and explanation of these behaviours remains to be discovered.

The scarcity of capture records of *O. ferox* may be attributed to the low relative abundance of this species (Graham et al. 2016) but also to its deep-water habitat out of the depth range of most commercial and traditional fishing operations (Sheehan 1998). To this date, the most northerly record in North Atlantic for *O. ferox* is an individual caught at about 46° N 4° W in the Bay of Biscay (Fergusson et al. 2008). This work confirmed the eventual occurrence of the species in the northwest of Spain, at least in possible migration to other areas.

The *O. ferox* is protected in the waters of some countries in the Mediterranean Sea (Croatia, Malta, and Spain), and in Pacific Ocean (Malpelo Fauna and Flora Sanctuary in Colombia, New South Wales in Australia, and New Zealand). There are no specific protection measures in place for many countries of the Mediterranean (where is regionally assessed as Critically Endangered). Overall, further works are needed to accurately determine the abundance, distribution range and biology (including possible migrations and genetic connectivity between subpopulations, sexual segregation and sex ratios, reproduction data and fecundity) of this species. We suggest that the specimens that appear dead and stranded be sampled to fill in the information gaps on this species, as in this case, to obtain more relevant biological and genetic information.

Author Contributions GM, NVA wrote the main text and prepared the figures; UV, XP, AL collected the samples and field work; GSP carried out the lab work; GM, NVA, GSP, LFCC, EF interpreted and discussed the results. All authors edited and reviewed the final manuscript.

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Fig. 3 Detailed of parasites recorded in mouth of *O. ferox*. The arrows indicate three *Anthosoma crissum* located in the vomer of the individual



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Declarations

Conflict of Interest The authors declare that they have no conflict of interest.

Statement on the Welfare of Animals All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

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