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Short Communication

Southernmost record of the white shark *Carcharodon carcharias* (Chondrichthyes: Lamnidae) in the Mexican Pacific

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ABSTRACT. This study reports the first record of a white shark *Carcharodon carcharias* off the tropical coast of Nayarit and the southernmost record in the Mexican Pacific. The specimen was a juvenile female accidentally caught by artisanal fisheries in the locality of Playa Novillero, Nayarit. Oceanographic conditions at the time of capture were also recorded, with the aim of improving the knowledge on the ecology of this vulnerable and protected species.

Keywords: *Carcharodon carcharias*; distribution; bycatch; conservation; fisheries; Eastern Tropical Pacific

The white shark *Carcharodon carcharias* (Linnaeus, 1758) is one of the five living species of the family Lamnidae (Compagno, 2001). Although it is considered a cosmopolitan top predator, it is mainly distributed in temperate and subtropical waters throughout the world (Compagno, 2001; Sperone *et al*., 2012; Robertson & Allen, 2015).

Seasonal aggregation sites for white sharks include, for example, the Farallon Islands in the United States and Guadalupe Island in Mexico (Hoyos-Padilla *et al*., 2016), but it is commonly reported at low densities outside this type of aggregation sites (Compagno, 2001). In Mexican waters, the most coastal observations have been performed in the north and central region of the Gulf of California and, for this reason, it was considered as a rare species with just 38 records from 1964 to 2010 (Galván-Magaña *et al*., 2010).

This paper reports the first record of a white shark female specimen in Nayarit, Mexico, caught incidentally by artisanal fishermen (Fig. 1). The event was published in an online information note by Isla Isabel National Park, and the fisherman who reported the event confirmed it.

The shark was caught with a longline on December 28th 2016, 20 km off the shore of Playa Novillero (22º20'30''N, 105º53'35''W; Fig. 2); the bait used was Humboldt squid (*Dosidicus gigas*). Oceanographic data for the day of the capture was obtained from the MODIS-Aqua sensor and the HYbrid Coordinate Ocean Model (HYCOM; https://hycom.org) database. The taxonomic identification of the shark was performed by the analysis of the pictures provided by the fisherman, the dental formula, and the descriptions of Fischer *et al*. (1995), Compagno (2001), and De Maddalena (2009).

The specimen was identified as *C. carcharias* by its robust, fusiform body, lead-gray above and white on the belly, with flat, triangular, and highly serrated teeth with one cusp (Fischer *et al*., 1995; Compagno, 2001). According to De Maddalena (2009), the shape of the teeth must be similar in both jaws, but lower teeth are slightly smaller and narrower (Fig. 3). These lower teeth were prominent and visible at the time of capture. The dental formula was calculated by the observation of two upper anterior teeth, one upper intermediate, five upper laterals, and four upper posteriors; with three

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Figure 1. Juvenile white shark female accidentally caught in Nayarit, Mexico.

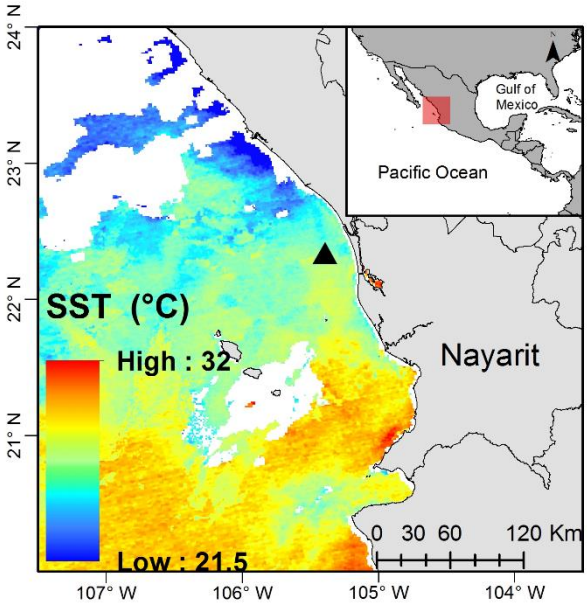

Figure 2. The position of the white shark caught on 28 December 2016 (▲) with data of sea surface temperature.

lower anterior, five lower laterals, and four lower posteriors (2.1.5.4/3.5). This count corresponded to the dental formula previously reported for *C. carcharias* and confirmed the identification of the species (De Maddalena, 2009). The female white shark measured 2.5 m total length and was classified as juvenile according to Compagno (2001). The stomach was empty, and there were no signs of ectoparasites on the shark's skin. The physical oceanographic conditions at the time of capture were a sea surface temperature of 25.92°C, a salinity of 34.64, 0.69 mg m^3 of chlorophyll-*a* and current velocity of 0.10 m s^{-1}. Water depth at the capture site was 48 m. According to the fisherman, the specimen's caudal fin got caught in the fishing line and, as a result, the shark died from asphyxia.

The area where the shark was caught is influenced by the Gulf of California, the Mexican Coastal Current, and the California Current System (Lavín *et al*., 2009). In this area, cold-water filaments have been previously observed as part of a major mesoscale event originating from the California Current System (Pantoja *et al*., 2012). This could partially explain the presence of the shark since some temperate fishes, including the white shark, have been shown to undertake latitudinal movements into subtropical waters (Weng *et al*., 2007; Curtis *et al*., 2014).

Juvenile white sharks usually inhabit shallow waters close to the coast to feed on other elasmobranchs, bony fishes, or cephalopods (Compagno, 2001; Fergusson *et al*., 2009; Santana-Morales *et al*., 2012). In the Mexican Pacific, adult white sharks have been reported in Guadalupe Island and the central part of the Gulf of California (Galván-Magaña *et al*., 2010; Hoyos-Padilla *et al*., 2016), while the juveniles have been frequently observed on the west coast of the Baja California Peninsula (Santana-Morales *et al*., 2012; Oñate-González *et al*., 2015). Although there is evidence of white sharks feeding on cephalopods and pinnipeds in the Gulf of California (Jaime-Rivera *et al*., 2014), there is scarce information about other prey or differences in diet regarding ontogeny from white sharks in this area. Recent records of juvenile white sharks in the south part of the Gulf of California suggest that the area can be used by this species to feed (Jaime-Rivera *et al*., 2014; Márquez-Farías & Lara-Mendoza, 2017), as the presence of other potential prey like the longtail stingray *Hypanus longus*, the black skipjack *Euthynnus lineatus*, and the yellowfin tuna *Thunnus albacares* have also been reported (Ulloa-Ramírez *et al*., 2008). Regarding the preference for the Humboldt squid *D. gigas* reported by Jaime-Rivera *et al*. (2014), it is possible that juvenile white sharks are moving south due to the prolonged decline of this squid in the Gulf of California (Robinson *et al*., 2016; Márquez-Farías & Lara-Mendoza, 2017). The lack of stomach content in the white shark presented, as well as in the one analyzed by Márquez-Farías & Lara-Mendoza (2017), could be a sign of decreased prey availability in the Gulf. However, the confirmation of this hypothesis is beyond the present paper and must be considered in further studies.

Coastal environments provide protection for juveniles until they reach maturity (Weng *et al*., 2007; Santana-Morales *et al*., 2012), but it also makes them vulnerable to fisheries near the coast (Fergusson *et al*., 2009; Santana-Morales *et al*., 2012). Studies on habitat use, along with the fishery activities in coastal habitats, are an important component of conservation

Figure 3. The jaw from the juvenile white shark described in the present paper.

efforts that must be performed (Galván-Magaña *et al*., 2010). Knowledge on habitat use of juvenile white sharks may be particularly important in this regard because the natural mortality of juveniles may make fishing mortality a significant factor in the population dynamics of this threatened species.

The white shark is a protected species in countries like Mexico (DOF, 2010), South Africa, Australia, New Zealand, and the United States (Compagno, 2001; Fergusson *et al*., 2009). It is a vulnerable species according to the IUCN Red List of Threatened Species and is included in Appendix II of CITES (Fergusson *et al*., 2009). In Mexico, the information available on the distribution of white shark juveniles is currently limited to the western coast of Baja California (Weng *et al*., 2007; Oñate-González *et al*., 2015; Hoyos-Padilla *et al*., 2016). Thus, the information reported here represents a relevant record that may increase such knowledge in Mexican waters.

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