OCCURRENCE OF GREAT WHITE SHARK, *CARCHARODON CARCHARIAS* (ELASMOBRANCHII: LAMNIFORMES: LAMNIDAE), OFF CORSICA (NORTHERN MEDITERRANEAN): HISTORICAL AND CONTEMPORARY RECORDS

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Abstract. The capture of a juvenile, male, great white shark, *Carcharodon carcharias* (Linnaeus, 1758), off the Corsican coast (Mediterranean Sea) in 2012 is reported in this note along with two other new records (1976 and 2011). Additionally, 8 other historical and more recent records from the same area are presented and commented. These records are compared with those reported from more distant areas. Conclusions drawn based on the presently analysed material indicate that a sustainable and isolated *C. carcharias* population has probably established in the Mediterranean Sea, although more new records are needed to confirm this hypothesis.

Keywords: Chondrichthyes, *Carcharodon carcharias*, population, migration, successful establishment, Strait of Sicily

The great white shark, *Carcharodon carcharias* (Linnaeus, 1758), is a large shark, of global distribution, common in temperate and tropical seas and oceans. Its occurrence is well documented in the Mediterranean Sea, where the majority of records occurred in its central part, especially in the Strait of Sicily (Fergusson 1996, 2002, De Maddalena 2002, 2006, Cristo et al. 2006, Saïdi et al. 2005).

Since November 2011 the species has been studied by members of the Corsica-Mediterranean Shark Research Group (Corsica-MSRG), in order to assess the present status of its population around Corsica. The actions of the group have been supported by local fishermen actively helping the researchers in reporting relevant sightings and collection of the specimens. In the wake of this cooperation, on 30 August 2012, we were informed that a male specimen of *Carcharodon carcharias* was captured by trammel-nets, at a depths range of 190 and 200 m, by 42°29'09.02"N and 8°34'79.20"E (Fig. 1, record 11), together with decapod species and some anglerfish, *Lophius piscatorius* Linnaeus, 1758. The specimen was 200 cm long (total length) and weighed approximately 200 kg (Fig. 2). Additionally, it exhibited developed and partially calcified claspers, suggesting that the specimen

was probably juvenile. Unfortunately, the great white shark could not be preserved as a whole specimen and it was discarded at sea.

Additionally, of the four teeth that have been removed from the shark, two were preserved in the Ichthyological Collection of the Corsican Section of the Mediterranean Shark Research Group located in Appietto (Corsica); they received the following catalogue numbers: Corsica MSRG Car.-car. 01 and Corsica MSRG Car.-car. 02, respectively (Fig. 3).

Basic data collected while browsing old literature, published documents, interviews with fisherman, and personal observations showed that *Carcharodon carcharias* has historically occurred in the Corsican marine waters (Fig. 1, Table 1), but no voucher specimens have been preserved for confirmation. The first record of the great white shark off Corsica was reported in 1758, as determined from the 'Libro Rosso' of Morsiglia Convent, which is deposited in Archives départementales de Haute-Corse of Bastia (Corsiaca, France) under the catalogue number E85/13 (Anonymous 1758 unpublished). The second record concerned a large specimen having less than 5 m in total length, captured in 1829 and reported in 'Journal du Département de la Corse', deposited in Bibliothèque Municipale of

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Ajaccio (Corsica, France), referenced under catalogue number FL-PER 1 (Anonymous 1829 unpublished).

Records 3 and 4 concerned shark attacks occurring in 1840, and reported in a document preserved in two copies, referred to as Fonds Ancien n° 42 N 8 and Fonds Corse FL 12.146, respectively, preserved in the Bibliothèque Municipale of Ajaccio (De Lempis 1844). Records 6, 7, and 8 were reported by shark specialists (Miniconi 1994, De Maddalena and Heim 2012). Record 9 was from Dr Cecilia

Volpi and although unpublished in scientific literature, it was well documented and mentioned in two Italian daily papers such as 'La Repubblica-Firenze' (1 July 2001) (Volpi 2001a) and 'Corriere Fiorentino della Sera' (1 July 2001) (Volpi 2001b), and concomitantly deposited in the archives of the Italian regional television (RAI). All records from 6 through 9 provided a thorough description of white sharks caught in the marine Corsican waters. Record 5 (from 1976) established by us, as a new record, was based

Fig. 1. Map of the Mediterranean Sea showing Corsica (inset) with all 11 captures sites of great white shark, *Carcharodon carcharias* (for complete information see Table 1)

Table 1

Historical and contemporary records of great white shark, *Carcharodon carcharias*, from the Corsican coast

Rec.	Sex	TL [cm]	Weight [kg]	Depth [m]	Fishing gear/ kind of record	Fishing site	Part of Corsica	Capture date	Reference
1	—	—	ca. 653	>10	tonnara	Corsican Cape	N-W	7 Oct 1758	Anonymous (1758 unpublished)
2	—	<500	—	>10	tonnara	Gulf of Ajaccio	W	Jun 1829	Anonymous (1829 unpublished)
3	—	—	—	ca. 1	attack?	Gulf of Ajaccio	W	early 1840s	De Lempis (1844)
4	—	—	—	ca. 1	attack?	Gulf of Ajaccio	W	early 1840s	De Lempis (1844)
5	—	<600	—	ca. 48	trammel-net	Gulf of Ajaccio	W	8 Sep 1976	This study (new record)
6	—	ca. 527	ca. 1500	80–90	trammel-net	Les Moines	S-W	14 Sep 1984	Miniconi (1994)
7	—	ca. 600	—	ca. 1	sighting	Capo di Feno	S-W	Feb 1995	De Maddalena and Heim (2012)
8	—	350–450	—	ca. 1	sighting	Gulf of Ajaccio	W	Apr 2010	De Maddalena and Heim (2012)
9	—	<400	—	ca. 1	sighting	Capraia–Corsica	N-E	21 Jun 2011	Volpi (2001a, 2001b)
10	—	ca. 400	—	20–25	sighting	Off Calvi	N-W	10 Oct 2011	This study (new record)
11	♂	180–200	ca. 100	190–200	trammel net	Off Calinzana	N-W	30 Aug 2012	This study (new record)

Rec. = record No.

on an interview of a Corsican fishermen. Record 10 established by us, as a new record, was based on underwater observations carried out by two scuba divers, at the depth of 20–25 m, who spotted a shoal of thunnids chased by a white shark. All records observed in Corsican marine waters confirmed the occurrence of *Carcharodon carcharias* in the area, and consequently the species should be included in the list of local ichthyofauna. Unfortunately, these records did not constitute a sufficient statistical support to ensure that a local population of the great white shark is now established in the vicinity of Corsica.

A literature review based on comprehensive studies concerning white sharks and including local observations (Table 1) shows that 191 white shark records were reported, to date, in the western Mediterranean Basin and the Strait of Sicily (Fergusson 1996, 2002, De Maddalena, 2002, 2006, Bradai et al. 2004, Saïdi et al. 2005, De Maddalena and Revelart 2008, De Maddalena and Heim 2012). Francis (1996) noted that the length of a newly born white shark ranged from 1200 through 1500 mm, and the female length at maturity was between 4.5 and 5 m. The males of *Carcharodon carcharias* mature attaining a smaller length than females, as it is generally the rule in viviparous elasmobranch species (Mellinger 1989). Consequently, of the 191 specimens reported in the literature, 45 specimens having less than 4 m in total length were juveniles, and 146 other specimens had a larger size, exceeding 4 m, were adults, the latter significantly outnumbered the former ($\chi^2 = 38.37$, $P < 0.05$).

Gubili et al. (2010) sequenced mitochondrial DNA in four specimens of Mediterranean great white sharks, collected from four different sites at different periods of the year, and noted that juvenile sequences were identical. Gubili et al (2010) showed little genetic differentiation from Indo-Pacific lineages, but strong separation from geographically closer Atlantic and western Indian Ocean haplotypes. These observations suggest that an isolated Mediterranean population of white sharks remains a justified hypothesis. The first Mediterranean record of *Carcharodon carcharias* was reported by Rondelet in 1540 (De Maddalena and Revelart 2008), and between 1540 and the opening of Suez Canal, which occurred in 1869 (Berneron-Couvenhes 2007), several other records were reported (Fergusson 1996, Soldo and Jardas 2000, Soldo and Dulčić 2005, De Maddalena and Heim 2012). *C. carcharias* has never been recorded from the Red Sea (Golani 1999); additionally, Quignard and Tomasini (2000) consider it as an indigenous Mediterranean species, and not as a Lessepsian migrant (Por 1978, Golani et al. 2002), consequently migrations from the Red Sea into the Mediterranean Sea should be ruled out.

Captures of juvenile and adult males and females, and pregnant specimens (Norman and Frazer 1937, Saïdi et al. 2005, Kabasakal and Özgür Gedikoğlu 2008) could suggest that a sustainable population has been established in the Mediterranean, but the collected records do not constitute sufficiently strong argument for a definitive conclusion about the status of *C. carcharias* in the Mediterranean Sea.

Fig. 2. A specimen great white shark, *Carcharodon carcharias*, captured off the Corsican coast on 30 August 2012, on the deck of the fishing boat (photo Toussaint Lunardi)

Fig. 3. Teeth of great white shark, *Carcharodon carcharias*, captured off the Corsican coast on 30 August 2012; **A** An upper-jaw tooth; middle row, inner view (ref. Corsica MSRG Car.-car. 01); **B** The same, outer view; **C** A lower-jaw tooth; middle row, inner view (ref. Corsica MSRG Car.-car. 02); **D** The same, outer view; Scale bar = 5 mm

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