

On the Great White Shark, *Carcharodon carcharias* (Linnaeus, 1758), preserved in the Museum of Zoology in Lausanne

*À propos du grand requin blanc, Carcharodon carcharias (Linnaeus, 1758),
conservé au Musée zoologique de Lausanne*

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ABSTRACT

De Maddalena A., O. Glaizot, G. Oliver - On the Great White Shark, *Carcharodon carcharias* (Linnaeus, 1758), preserved in the Museum of Zoology in Lausanne. Mar. Life, 13 (1-2) : 53-59.

The cast of a 5.89 m female Great White Shark *Carcharodon carcharias* preserved in the Museum of Zoology in Lausanne (Switzerland), is the largest world-wide that has been reconstructed directly from a whole specimen. This specimen, captured off Sète, France (Mediterranean Sea), on 13th October 1956, is one of the three largest specimens ever measured accurately. Description and morphometrics of the shark cast are given.

RÉSUMÉ

De Maddalena A., O. Glaizot, G. Oliver – [À propos du grand requin blanc, *Carcharodon carcharias* (Linnaeus, 1758), conservé au Musée zoologique de Lausanne]. Mar. Life, 13 (1-2) : 53-59.

Le moulage d'un spécimen femelle de 5.89 m d'un grand requin blanc (*Carcharodon carcharias*) est conservé au Musée de zoologie de Lausanne (Suisse). C'est actuellement le plus grand spécimen de cette espèce directement moulé à partir d'un individu entier. Ce dernier fut capturé le 13 octobre 1956 au large de Sète, en France (mer Méditerranée) ; il est l'un des trois plus grands spécimens mesurés de manière précise. La description et la morphométrie de ce requin sont données.

INTRODUCTION

The maximum size of the Great White Shark, *Carcharodon carcharias* (Linnaeus, 1758), has long been debated and remains a subject of controversy. It is assumed that this species can reach at least six metres in total length. Furthermore, many larger specimens are mentioned in the literature, but almost always without verifiable evidence of their real size (Ellis, McCosker, 1991). De Maddalena *et al.* (2001) analysed photographic evidence of the largest white sharks caught in the Mediterranean Sea and they

concluded that *C. carcharias* can reach at least 640-660 cm in total length and very probably even more.

Unfortunately, specimens around six metres in length have been measured accurately only very rarely. Irrefutable evidence of very large specimens, represented by complete stuffed specimens or casts prepared directly from fresh specimens, are very rare. The primary cause of this paucity of data is the logistical difficulties presented by the preparation and preservation of large sharks. Methods of estimating the length of sharks on the basis of skeletal parts which have been preserved -in particular teeth, jaws

and vertebrae have been investigated by various authors (Randall, 1973, 1987; Gottfried *et al.*, 1996; Mollet *et al.*, 1996). However, the best and only irrefutable way to obtain the length of a large white shark remains accurate measurement directly from the complete specimen, if possible following the standards presented in Compagno (1984) and Mollet *et al.* (1996).

For the aforementioned reasons, the existence of a complete cast obtained directly from a 5.89 metres Great White Shark caught in the Mediterranean Sea, preserved in the Museum of Zoology in Lausanne (MZL), is of particular interest.

MATERIAL AND METHODS

On 13th October 1956, a large female White Shark was caught off Sète, in the Golfe du Lion, on the French coast of the Mediterranean Sea. The following details about the capture were reported by the local newspaper, *Midi Libre*. The shark was caught in the early morning 3 miles (4.8 kilometres) offshore from Maguelone (Hérault, France). It was caught in a tuna driftnet of the fishing vessel, "Rosina-Raphael". The shark was landed in Sète at about nine o'clock. It was reported to measure 5.89 metres in length and have a maximum girth of 4 metres. The liver alone weighed 360 kg and the total weight was estimated to be about 2 tonnes. Its stomach contained remains of two unidentified dolphins, each measuring about 1.80 metres (Anonymous, 1956). Some good photographs of the fresh specimen were taken

after its capture (unfortunately, it has not been possible to obtain permission to reproduce them in this work). The shark was examined by M. Euzet of the Marine Biological Station of Sète and Mr Baer of the University of Neuchatel, Switzerland. Thanks to the interest of the latter, the shark was acquired by the Museum of Zoology in Lausanne (Musée Cantonal de Zoologie de Lausanne), Switzerland. Here a good cast was prepared by the taxidermist Eugène Küttel. The model features the original fins and teeth, while the rest has been reconstructed by casts from the body of the original specimen (figure 1).

Detailed morphometric measurements were made of the Great White Shark cast at MZL by Manuel Fischer, following the methods of Compagno (1984), adding measurement of total length with the caudal fin in a "natural" position, TL_n, as indicated in Mollet *et al.* (1996). Since the mould also features the specimen's original teeth, the largest upper anterior tooth was measured following Mollet *et al.* (1996), but -since the tooth bases were not visible- only the measurements of the enamel (smaller enamel height UAE1, greater enamel height UAE2, enamel width UAW) were recorded.

Regarding the two ways in which the total length was measured, since the cast was prepared with the caudal fin in a "natural" position, the total length with the caudal fin in the natural position (TL_n) has been measured directly, while the total length with the caudal fin in the depressed position (TOT) has been obtained by adding the precaudal length (PRC) to the dorsal caudal margin (CDM).

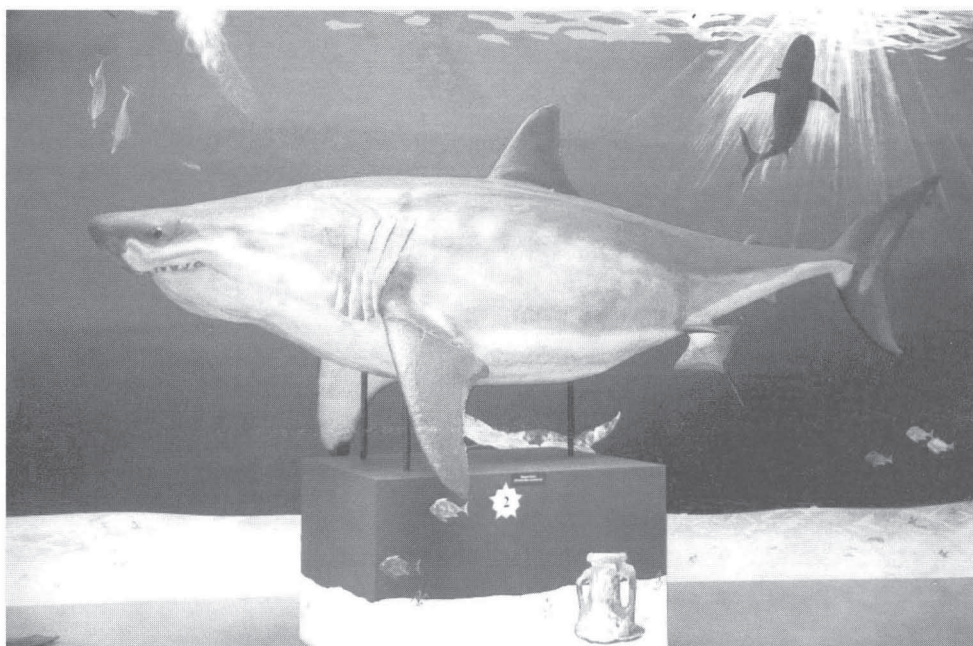


Figure 1 - The cast of the 5.89 metre Great White Shark caught off Sète, France, in 1956, featuring the original fins and teeth, on display at the Museum of Zoology in Lausanne (Photo by Guy Oliver). / Le moulage d'un grand requin blanc de 5.89 m capturé au large de Sète, France, en 1956, exposé au Musée de Zoologie de Lausanne. Les ailerons et les dents sont d'origine (Photo Guy Oliver).

RESULTS

Although the cast made by Küttel presents some deformations of the snout, lower jaw, and lower surfaces, it is evident that the taxidermist skillfully executed an accurate representation of the original specimen on which he had the rare opportunity to work. The deformations, particularly of the head, can be readily attributed to the partial deterioration to which the shark was undoubtedly subjected after its death. Moreover, these deformations were very probably accentuated by the specimen's storage during transport to Lausanne. With respect to the observable deformations of the lower parts of the cast, it must be borne in mind that the taxidermist received the shark after it was already gutted, with the belly cut and consequently deformed.

The morphometric measurements taken from the mould of the shark and on the largest of its upper anterior teeth are reported in table I. It must be noted that some of the reported measurements present some differences with respect to the proportions of the original specimen, due to the observed deformations of the cast. Authors compared morphometric measurements taken from this specimen to measurements taken from a well prepared 4.0 m TOT stuffed White Shark preserved in the Museum of Natural History in Genoa, Italy, with catalogue number C.E. 27517 (De Maddalena, 2000 b) and the resulting proportions were very close.

The 5.83 m value obtained for TOT confirm the accuracy of the length of 5.89 m reported for the fresh-caught specimen in Anonymous (1956). The small (6 cm) difference in TOT is attributable to various factors, such as differences in the way measurements were taken, artefacts of preparation of the cast, the deformations noted, and differences in position of the specimen while the measurements were taken.

The specimen discussed in this work has been reported previously in de Beaumont (1957), indicating an approximate length of 5 m and a weight of "at least 1.5 tonnes", and Quignard *et al.* (1962), but the length reported by this source (490 cm) was erroneous; moreover it has been cited in Séret (1996). The specimen cited in Fergusson (1996) dated 1976 and reportedly but unconfirmedly measuring 4.5 metres is almost certainly based on the same specimen as that described in this work, reported with an erroneous date and length.

This specimen is not the only White Shark recorded from Sète, as three other specimens have been caught in the same area: a specimen about 4 m long was captured in August 1875, a 2.42 m specimen caught in 1876 were reported by Moreau, 1881; and a female specimen with a reported length of 6 m was caught on January 9th 1991 (Anonymous, 1991; Quignard, Raibaut, 1993; Séret, 1996). On the basis of photographic evidence, De Maddalena *et al.*

(2001) estimate that the latter specimen measured 5.9 m TOT. This specimen was bought by a wholesale fishmonger in Sète, offered for sale in the Rungis market, and bought by a supermarket in Montargis (Licciardi, Azais, personal communication). Touret (1992) reported the same history for a specimen caught in Antibes during the same month, but according to F. Calviera, a fisherman in Antibes since 1956, it was not a Great White Shark that was caught there. Consequently it seems that only one Great White Shark was caught in Sète in January 1991.

DISCUSSION

Worldwide, two other comparably large White Sharks have been preserved complete: a 5.22 m TLn female caught in Kvarner, Croatia, on May 29th 1906, preserved by taxidermy in the Trieste Natural History Museum, Italy (De Maddalena, 2000 a, 2000 b), and a 5.3 m female caught near Cananéia, Brazil, on December 8th 1992 and preserved by taxidermy in the Victor Sadowsky Museum in Cananéia (Arfelli, Amorim, 1993; Mollet *et al.*, 1996; Mollet, personal communication). The shark described in the present work, of which a mould is preserved in the Museum of Zoology in Lausanne, is longer than both these specimens and so can be considered the largest of any complete white shark presently preserved.

Some reliable cases of White Sharks exceeding the size of the Lausanne specimen are reported in the literature, but most of these were not measured accurately and therefore their claimed sizes are estimates and consequently cannot be regarded as precise. A large specimen caught in February 1839 off Civitanova, Italy, was reported to measure approximately 6 m in length and was later estimated to be 6.02 m TL, but it is not clear if it was ever accurately measured (De Maddalena, 1998). An enormous specimen caught off Piombino, Italy, in 1886 was reported to measure approximately 8-9 m (Biagi, 1995), but to our knowledge it was never measured. A specimen caught off Enfoia, Italy, on August 12th 1938 was estimated to be 5.97-6.13 m TOT, but was never measured (De Maddalena *et al.*, 2001). A female of approximately 6.408 m was reportedly caught off Cojimar, Cuba, in 1945 (Bigelow, Schroeder, 1948; Guitart-Manday, Milera, 1974): even if the contestation of this case presented by Randall (1987) is not acceptable (De Maddalena *et al.*, 2001), it is not clear if the specimen in question was ever accurately measured. A male caught off Camogli, Italy, on March 16th 1954 was reported to measure 7 m in Tortonese (1965) but its length was contested by Fergusson (1996). A female caught off Ganzirri, Italy, on June 19th 1961 was estimated to be 6.66 m TOT, but was never measured (De Maddalena *et al.*, 2001). Another specimen caught off Ganzirri, Italy, on March 9th 1965 was reported to measure 6.20 m in length (Berdar, Ricco-

Table I - Measurements of the cast of a large great white shark and its largest upper anterior tooth, on exhibition at the Museum of Zoology in Lausanne (following terminology and parameters of Compagno, 1984, and Mollet *et al.*, 1996). All measurements are given in centimetres. / *Mesures du moulage du grand requin blanc exposé au Musée de Lausanne, ainsi que des plus grandes dents de la mâchoire supérieure (selon la terminologie de Compagno, 1984, et Mollet et al., 1996). Toutes les mesures sont données en centimètres.*

Abbreviation	Measurement	cm	%TOT
TOT	total length (caudal fin in depressed position)	583	100.00 %
TLn	total length (caudal fin in natural position)	565	96.91 %
FOR	fork length	510	87.48 %
PRC	precaudal length	458	78.56 %
PD2	pre-second dorsal length	400	68.61 %
PD1	pre-first dorsal length	220	37.74 %
HDL	head length	152	26.07 %
PG1	prebranchial length	122	20.93 %
POB	preorbital length	32	5.49 %
PP1	prepectoral length	145	24.87 %
PP2	prepelvic length	330	56.60 %
SVL	snout-vent length	340	58.32 %
PAL	preanal length	400	68.61 %
IDS	interdorsal space	130	22.30 %
DCS	dorsal-caudal space	55	9.43 %
PPS	pectoral-pelvic space	155	26.59 %
PAS	pelvic-anal space	50	8.58 %
ACS	anal-caudal space	50	8.58 %
PCA	pelvic-caudal space	100	17.15 %
VCL	vent-caudal length	225	38.59 %
PRN	prenarial length	22	3.77 %
POR	preoral length	35	6.00 %
ING	intergill length	40	6.86 %
GS1	first gill slit height	55	9.43 %
GS2	second gill slit height	58	9.95 %
GS3	third gill slit height	60	10.29 %
GS4	fourth gill slit height	60	10.29 %
GS5	fifth gill slit height	60	10.29 %
P1A	pectoral anterior margin	105	18.01 %
P1B	pectoral base	45	7.72 %
P1I	pectoral inner margin	25	4.29 %
P1P	pectoral posterior margin	85	14.58 %
P1H	pectoral height	95	16.29 %
CDM	dorsal caudal margin	125	21.44 %
CPV	preventral caudal margin	80	13.72 %
CPU	upper postventral caudal margin	90	15.44 %
CPL	lower postventral caudal margin	55	9.43 %
CFW	caudal fork width	50	8.58 %
CFL	caudal fork length	55	9.43 %
CST	subterminal caudal margin	8	1.37 %
CSW	subterminal caudal margin	15	2.57 %
CTR	terminal caudal margin	25	4.29 %
CTL	terminal caudal lobe	30	5.15 %

Abbreviation	Measurement	cm	%TOT
D1L	first dorsal length	62	10.63 %
D1A	first dorsal anterior margin	70	12.01 %
D1B	first dorsal base	49	8.40 %
D1H	first dorsal height	60	10.29 %
D1I	first dorsal inner margin	13	2.23 %
D1P	first dorsal posterior margin	60	10.29 %
D2L	second dorsal length	13	2.23 %
D2A	second dorsal anterior margin	14	2.40 %
D2B	second dorsal base	5	0.86 %
D2H	second dorsal height	10	1.71 %
D2I	second dorsal inner margin	8	1.37 %
D2P	second dorsal posterior margin	8	1.37 %
P2L	pelvic length	45	7.72 %
P2A	pelvic anterior margin	25	4.29 %
P2B	pelvic base	30	5.15 %
P2H	pelvic height	20	3.43 %
P2I	pelvic inner margin length	15	2.57 %
P2P	pelvic posterior margin length	40	6.86 %
ANL	anal length	18	3.09 %
ANA	anal anterior margin	15	2.57 %
ANB	anal base	10	1.71 %
ANH	anal height	8	1.37 %
ANI	anal inner margin	8	1.37 %
ANP	anal posterior margin	10	1.71 %
HDH	head height	100	17.15 %
TRH	trunk height	120	20.58 %
ABH	abdomen height	100	17.15 %
TAH	tail height	55	9.43 %
CPH	caudal peduncle height	15	2.57 %
DPO	first dorsal midpoint - pelvic origin	100	17.15 %
PDI	pelvic midpoint - first dorsal insertion	75	12.86 %
PDO	pelvic midpoint - second dorsal origin	40	6.86 %
DAO	second dorsal origin - anal origin	20	3.43 %
DAI	second dorsal insertion - anal insertion	20	3.43 %
MOL	mouth length	30	5.15 %
MOW	mouth width	50	8.58 %
INW	internarial space	30	5.15 %
INO	interorbital space	30	5.15 %
HDW	head width	95	16.29 %
TRW	trunk width	90	15.44 %
ABW	abdomen width	85	14.58 %
TAW	tail width	45	7.72 %
CPW	caudal peduncle width	25	4.29 %
GIR	girth	355	60.89 %
UAE1	largest upper anterior tooth enamel height	4	0.69 %
UAE2	largest upper anterior tooth enamel height	4,6	0.79 %
UAW	largest upper anterior tooth enamel width	4,3	0.74 %

bono, 1986) but Celona *et al.* (2001) hypothesised that it was measured over the curve of the body. A specimen caught off Isola la Formica, Italy, in May 1974 was reported to measure approximately 6.2-6.4 m (and later estimated to be 5.94 m TOT), but it is not known whether the length was measured as TOT or as TLn (De Maddalena *et al.*, 2001). A male caught off Gallipoli, Italy, on September 18th 1979 was reported to measure 6.20 m in length (Piccinno, Piccinno, 1979) but it is not known whether the length was measured in a straight line or over the curve of the body. A specimen caught off Dakar, Senegal, in 1982, was estimated to be longer than 8 m, but was never accurately measured (Barrull, Mate, 2001; De Maddalena *et al.*, 2001). A female White Shark caught on August 4th 1983 off Alberton, Prince Edward Island, Canada, reported to measure 6.096 m in Mollet *et al.* (1996) was, according to Ellis, McCosker (1991) never measured. A female caught in Gaansbai, South Africa, on January 17th 1987, reportedly 5.67-6.00 m TOT (Gottfried *et al.*, 1996; Mollet *et al.*, 1996), was likewise never measured accurately (Cliff, Ferreira, Mollet, personal communication). A female specimen caught on April 1st 1987 near Kangaroo Island, Australia, was estimated to be longer than 6.9 m, but was never measured (Cappo, 1988; Mollet *et al.*, 1996). Another female White Shark captured in Filfla, Malta, on April 17th 1987, previously claimed to be accurately measured and reportedly 7.14 m in length (Abela, 1989), has since fallen under serious doubt (Mollet *et al.*, 1996; Fergusson, 1998); later it was estimated to be 6.68-6.81 m TOT, but it remains not clear if it was ever accurately measured (De Maddalena *et al.*, 2001). A female caught off Malindi, Kenya, on 16th July 1996, reportedly about 6.4 m in length and estimated 5.7 m TLn from vertebral size, was never measured (Cliff *et al.*, 2000). For a 5.80 m female caught in Favignana, Italy, on April 24th 1980 (De Maddalena, 2002; Cataldo, personal communication), it is not known whether the length was measured as TOT or as TLn. On the basis of photographic evidence, the authors deem that the measurement was TOT.

In conclusion, it seems that only two White Sharks that were accurately measured exceed the length of the specimen that is described in this study. These are the following: a 5.944 m female captured off Ledge Point, Australia on March 22nd 1984 (Randall, 1987; Mollet *et al.*, 1996), and a female caught in Bunbury, Australia, on July 2nd 1991, that measured 5.74 m TLn (Mollet *et al.*, 1996) and 5.29 fork length (FOR) (Hubbell, personal communication); the 5.54 m TLn reported for this specimen by Hubbell (1996) is very probably erroneous.

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