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AN ANALYSIS OF THE PHOTOGRAPHIC EVIDENCES OF THE LARGEST GREAT WHITE SHARKS, *CARCHARODON* *CARCHARIAS* (LINNAEUS, 1758), CAPTURED IN THE MEDITERRANEAN SEA WITH CONSIDERATIONS ABOUT THE MAXIMUM SIZE OF THE SPECIES

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ABSTRACT

We analysed photographic evidences of the largest white sharks *Carcharodon carcharias* caught in the Mediterranean Sea, reported in literature as measuring near to 6 metres or even more in length. We studied 7 specimens and estimated their lengths as TOT (total length with the caudal fin in the depressed position), TLn (total length with the caudal fin in the natural position) and PRC (precaudal length) on the basis of the measurements of a 583 cm TOT specimen preserved in the Museum of Zoology in Lausanne. The following TOT were obtained: 507 cm (Procida, Italy, June 1924), 597 cm (Enfola, Isola d'Elba, Italy, 12 August 1938), 666 cm (Ganzirri, Sicily, Italy, 19 June 1961), 492-547 cm (Piran, Slovenia, 22 October 1963), 594 cm (Favignana, Isole Egadi, Italy, May 1974), 668-681 cm (Filfla, Malta, 17 April 1987), 591 cm (Sète, France, 9 January 1991). Five specimens therefore measured over 590 cm and at least two of these, Ganzirri 1961 and Malta 1987, grossly exceeded the 6 m mark both as TOT and as TLn. Also, these two specimens could be the largest ever recorded world-wide. We discuss the more solid cases of other white sharks in the same size range (Kangaroo Island, Australia, 1987; Castillo de Cojimar, Cuba, 1945; Dakar, Senegal, 1982). We conclude that *C. carcharias* can reach at least 640-660 cm TOT and very probably even more.

Key words: great white shark, *Carcharodon carcharias*, size, Mediterranean Sea

UN'ANALISI DELLA DOCUMENTAZIONE FOTOGRAFICA DEI PIU' GRANDI SQUALI BIANCHI, *CARCHARODON CARCHARIAS* (LINNAEUS, 1758), CATTURATI NEL MARE MEDITERRANEO, CON CONSIDERAZIONI SULLE DIMENSIONI MASSIME DELLA SPECIE

SINTESI

E' stata esaminata la documentazione fotografica relativa ai più grandi squali bianchi *Carcharodon carcharias* catturati nel Mare Mediterraneo, la cui lunghezza è riportata in letteratura come uguale o superiore a 6 metri. Abbiamo preso in considerazione 7 esemplari, e stimato le loro lunghezze come TOT (lunghezza totale con il lobo superiore della pinna caudale disteso lungo l'asse del corpo dell'animale), TLn (lunghezza totale con la pinna caudale in posizione naturale) e PRC (lunghezza precaudale), sulla base delle dimensioni di un esemplare di 583 cm TOT conservato nel Museo di Zoologia di Losanna. Abbiamo quindi ottenuto le seguenti TOT: 507 cm (Procida, Italia, Giugno 1924), 597 cm (Enfola, Isola d'Elba, Italia, 12 Agosto 1938), 666 cm (Ganzirri, Sicilia, Italia, 19 Giugno 1961), 492-547 cm (Piran, Slovenia, 22 Ottobre 1963), 594 cm, (Favignana, Isole Egadi, Italia, Maggio 1974), 668-681 cm (Filfla, Malta, 17 Aprile 1987), 591 cm (Sète, Francia, 9 Gennaio 1991). Pertanto 5 esemplari misuravano oltre 590 cm e almeno due di questi, Malta 1987 e Ganzirri 1961, superavano ampiamente 600 cm sia come TOT che come TLn. Questi due esemplari potrebbero inoltre essere i più grandi mai registrati a livello mondiale. Vengono discussi i più solidi casi di squali bianchi situati nello stesso range di lunghezza (Kangaroo Island, Australia, 1987; Castillo de Cojimar, Cuba, 1945; Dakar, Senegal, 1982). Concludiamo che *C. carcharias* può raggiungere almeno 640-660 cm TOT e molto probabilmente anche dimensioni maggiori.

Parole chiave: squalo bianco, *Carcharodon carcharias*, dimensioni, Mare Mediterraneo

INTRODUCTION

The maximum size of the great white shark *Carcharodon carcharias* (Linnaeus, 1758) has long been debated and remains a subject of controversy. It has been proved that this species can reach at least 594.4 cm in length (Randall, 1987; Mollet *et al.*, 1996). Although if the methods to obtain the length of the white sharks from usually preserved skeletal parts (teeth, jaws, vertebrae) have been investigated and applied by various authors (Randall, 1973, 1987; Gottfried *et al.*, 1996; Mollet *et al.*, 1996), the best and irrefutable way to obtain the length of a large white shark remain accurate measurements directly taken on the complete specimen, if possible following the standards presented in Compagno (1984) and Mollet *et al.* (1996).

The three largest white shark specimens accurately measured and confirmed so far seem to be the 594.4 cm female captured off Ledge Point, Australia, on March 22nd 1984 (Randall, 1987; Mollet *et al.*, 1996), the 574 cm TLn female caught in Bunbury, Australia, on July 2nd

1991 (Mollet *et al.*, 1996), and the 583 cm TOT (565 cm TLn) female caught in Sète, France, on 13th October 1956, whose mould is kept in the Museum of Zoology in Lausanne, Switzerland (De Maddalena *et al.*, 2002) (TOT is total length with the caudal fin in the depressed position, while TLn is total length with the caudal fin in the natural position).

Many larger specimens, reaching and exceeding 6 metres, are cited in the literature, but almost always without the necessary evidence as to their precise length. The most interesting cases reported are listed in table 1. On some of the specimens cited herewith we shall return later in the Results and Discussion as well as in the Conclusions sections.

In this work we investigate the large white shark specimens reported as reaching or exceeding 6 metres in length, captured in the Mediterranean Sea, through examination of the preserved photographic evidences, looking for solid evidences demonstrating which is the maximum size that *C. carcharias* can reach.

Tab. 1: Most interesting cases of white sharks reaching or exceeding 6 metres in length reported in previous literature**Tab. 1: Najzanimivejši podatki o belih morskih volkovih, za katere so v literaturi navedli, da so merili 6 ali več metrov.**

DATE	LOCATION	SEX	REPORTED LENGTH (cm)	SOURCE	NOTES
February 1839	Civitanova, Italy	-	ca. 600	Bonaparte (1839), Metaxà (1839), Vinciguerra (1885-1892), De Maddalena (2000b).	Estimated to be 602 cm TL on the basis of the largest vertebra (De Maddalena, 1998).
1886	Piombino, Italy	-	800-1000	Biagi (1995)	
1945	Cojimar, Cuba	F	640.8	Bigelow & Schroeder (1948), Guitar-Manday & Milera (1974)	Length contested by Randall (1987).
16 March 1954	Camogli, Italy	F	700	Tortonese (1965)	Length contested by Fergusson (1996).
19 June 1961	Ganzirri, Sicily, Italy	F	> 600	Celona (2001)	Estimated to be ca. 640 cm long (Celona, 2001).
9 March 1965	Ganzirri, Sicily, Italy	-	620	Berdar & Riccobono (1986), Celona <i>et al.</i> (2001)	Hypothesised to be measured over the curve of the body; estimated about 560 cm TOT from photograph (Celona <i>et al.</i> , 2001).
18 September 1979	Gallipoli, Italy	M	620	Piccinno & Piccinno (1979)	
1982	Dakar, Senegal		> 800 TL	Barrull & Mate (2001)	Not accurately measured.
4 August 1983	Alberton, Prince Edward Island, Canada	F	609.6	Mollet <i>et al.</i> (1996)	Never measured (Ellis & McCosker, 1991).
17 January 1987	Gansbaai, South Africa	F	567-600 cm TOT	Gottfried <i>et al.</i> (1996), Mollet <i>et al.</i> (1996)	Never measured (De Maddalena <i>et al.</i> , 2002).
1 April 1987	Kangaroo Island, Australia	F	> 690	Jury (1987), Cappel (1998), Mollet <i>et al.</i> (1996)	Never measured.
17 April 1987	Filfla, Malta	F	714 cm TOT	Abela (1989)	Reported length doubtful (Mollet <i>et al.</i> , 1996). Estimated to be 520-550 cm (Fergusson, 1998).
16 July 1996	Malindi, Kenya	F	ca. 640	Cliff <i>et al.</i> (2000)	Estimated 570 cm TLn from vertebral size (Cliff <i>et al.</i> , 2000).

MATERIALS AND METHODS

We examined the photographic evidences of the largest specimens collected in the Italian Great White Shark Data Bank (Banca Dati Italiana Squalo Bianco), a program of data collection on the presence of *C. carcharias* in the Mediterranean Sea instigated in 1996. For every case examined, we searched for all available information, looking for all related bibliographical sources, trying to contact eyewitnesses and all other persons that were able to furnish us with new and unpublished details or unknown photographs of the specimens we are dealing with in our study. We considered it more useful and clear to include the so reconstructed reports of the captures in the Results and Dis-

cussion section instead of in the Material and Methods section.

The lengths of the specimens investigated were not clearly reported as measured accurately and following precise standards, such as those indicated in scientific literature (see Compagno, 1984 and Mollet *et al.*, 1996), and as in some cases the size reported are merely declared estimates, we believed it necessary to revise the reported data. In almost all cases even weights were reported in the sources, but it is never clearly specified whether the specimen was really weighed or merely estimated (as it is often likely) and in which condition (whole, gutted, beheaded or other). Moreover, it should be taken into consideration that it is not suitable to estimate the total length from the weight without consider-

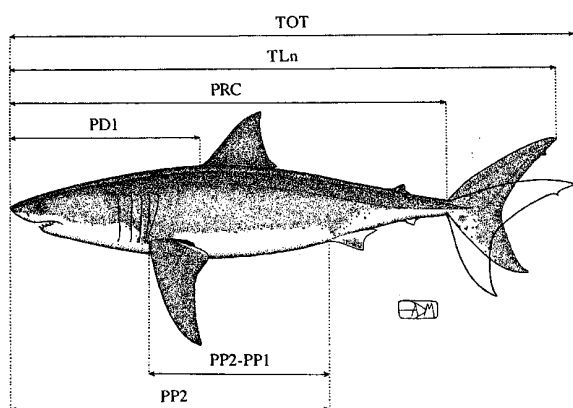


Fig. 1: Measurements of the white shark *Carcharodon carcharias* (Linnaeus, 1758) used in this work, based on Compagno (1984) and Mollet *et al.* (1996): total length with caudal fin in depressed position (TOT), total length with caudal fin in natural position (TLn), precaudal length (PRC), prepelvic length (PP2), pre-first dorsal length (PD1), prepelvic-prepectoral space (PP2-PP1). (Drawing: A. De Maddalena)

Sl. 1: Mere belega morskega volka *Carcharodon carcharias* (Linné, 1758), uporabljene v tem delu na osnovi Compagno (1984) in Molleta *et al.* (1996): celotna iztegnjena dolžina (TOT), celotna dolžina v naravni legi (TLn), predrepna dolžina (PRC), dolžina do trebušne plavuti (PP2), dolžina do korena prsne plavuti (PD1), razdalja od začetka prsne plavuti do začetka trebušne plavuti (PP2-PP1). (Risba: A. De Maddalena)

ing the girth of the body (Casey & Pratt, 1985), but precise girth was never reported by the sources. For these reasons we commented on the weight reported only in a few cases.

The model of a white shark preserved in the Museum of Zoology in Lausanne, Switzerland, is a mould reconstructed via casts from the original body of the specimen caught in Sète, France, on 13th October 1956: this is the largest white shark specimen whose complete morphometrics (made following Compagno, 1984) are available world-wide (De Maddalena *et al.*, 2002). Considering that the size of this specimen is very close to 6 metres (583 cm TOT, 565 cm TLn and 458 cm PRC), its measures can be utilised as a useful reference to effect precise estimates of the size of other specimens within 5-7 metres length range (Tab. 2).

For every specimen we estimated three lengths (from Compagno, 1984 and Mollet *et al.*, 1996): the total length with the caudal fin in the depressed position (TOT), which is also the maximum length, the total length with the caudal fin in the natural position (TLn), and the precaudal length (PRC) (Fig. 1). To effect the es-

timates we proceeded as follows. First of all we chose a reference of the valuable size, as is the height of a man (estimated by comparison with other persons near him) very close to the shark. On this basis we then estimated the length of a segment of the shark that was in the photo not or just slightly distorted by the perspective, choosing the most suitable one from the parameters indicated by Compagno (1984), depending on the case: the prepelvic length (PP2), the pre-first dorsal length (PD1), the space between the origin of the pectoral and the origin of the pelvic fin, corresponding to the difference between prepelvic length and prepectoral length (we called it the prepelvic-prepectoral space, and we indicated it as PP2-PP1) (Fig. 1). Finally we made a ratio between this partial length to the same partial length of the Lausanne specimen reported in De Maddalena *et al.* (2002), and thus obtained the three lengths TOT, TLn and PRC (Tab. 2).

The problems encountered at the moment when an accurate estimate of the size of a large white shark from photographic evidences was effected were several. Greater difficulties occurred due to the following factors: a) position of the photographer not exactly lateral in respect to the shark; b) distance subject-photographer much too short; c) excessive closeness of the subject to the edges of the field of vision; d) difficulties in the evaluation of the size of the reference; e) different distances between shark and photographer and between reference and photographer; f) the smaller the segment of the shark that can be correctly estimated, the greater the possibility of an error.

All these factors made it impossible to use, in this work, the numerous photos collected in the Italian Great White Shark Data Bank, and thus included herewith only some of those that seem suitable for this kind of study. The necessity to choose correctly the longer segment not distorted by the perspective for the estimate has emerged clearly. We saw that the prepectoral length (PP1) could be noticeably deformed and shortened when the shark was suspended in vertical position. Namely, the reference has to be large, such as the entire height of a man or at least a large part of him, and it has to be placed exactly on the same plane as the shark: that is particularly important when a close-up was made. Evaluating the height of the man by comparison with other persons in proximity, we also considered that in some cases, being very old photos, the mean height of the persons had to be somewhat smaller than today. All the estimates of the men's height indicated herewith include the heels of their shoes and hats, if present. The estimates presented herewith are not the maximum sizes possible for these specimens, but are the sizes that, in our opinion, are closer to the real ones.

Tab. 2: Relations between the dimensions used in this study, obtained from morphometric data reported in De Maddalena *et al.* (2002) of the 583 cm TOT white shark *Carcharodon carcharias* kept in the Museum of Zoology in Lausanne.

Tab. 2: Razmerja med dimenzijami, uporabljenimi v tej študiji na osnovi morfometričnih podatkov, ki so jih predstavili De Maddalena *et al.* (2002) o 583 cm dolgem (celotna iztegnjena dolžina) belem morskem volku *Carcharodon carcharias*, razstavljenem v lausanskem Zoološkem muzeju.

MEASUREMENTS	TOT	TLn	PRC
TOT - total length (caudal fin in depressed position)	100.00%	103.19%	127.29%
TLn - total length (caudal fin in natural position)	96.91%	100.00%	123.36%
PRC - precaudal length	78.56%	81.06%	100.00%
PD1 - pre-first dorsal length	37.74%	38.94%	48.03%
PP2 - prepelvic length	56.60%	58.41%	72.05%
PP2-PP1 - prepelvic-prepectoral space	31.73%	32.74%	40.39%

RESULTS AND DISCUSSION

Procida, Italy, June 1924

In mid-June 1924, a large white shark was caught near Procida (Italy) with the tuna-trap (commonly called "tonnara" in Italian) "Simeone". In Anonymous (1924), where it is erroneously identified as a porbeagle *Lamna nasus*, it is said to measure ca. 6 m, with a weight of almost 12 q.

The source also features a photo of the shark (Fig. 2), where it is visible in whole, even if the body is not in a straight position. In any case, this caused no problem in the estimate of its length. The problems are the rather bad quality of the reproduced picture at our disposal and the fact that none of the several persons present on the photo, even if very close to the shark, can be seen in full (with the exception of the child sitting on the shark which, however, is not particularly fit for use); consequently the references turned out to be not accurate

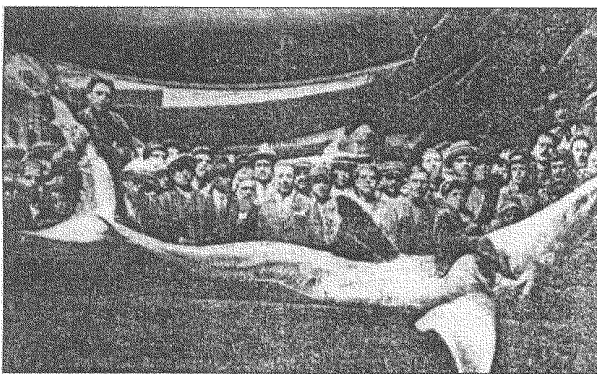


Fig. 2: Specimen caught off Procida (Italy) in June 1924. (Photo: from "La Domenica del Corriere" 15th June 1924)

Sl. 2: Primerek, ujet v bližini Procide (Italija) junija 1924. (Foto: iz časnika "La Domenica del Corriere" 15. junija 1924)

enough. To make an estimate we took, as reference, the visible part of the man holding the shark's caudal fin. Assuming that he was 175 cm tall, the shark's TOT was estimated at 507 cm, corresponding to 491 cm TLn and 398 cm PRC.

Enfola, Isola d'Elba, Italy, August 12th 1938

During the night of August 12th 1938, a white shark was caught with a small tuna-trap (tonnara) belonging to the Ridi brothers at Enfola, Isola d'Elba (Thyrrhenian Sea, Italy). Killed with harpoons and rifles, the shark was then towed to land, where, in its stomach, 2 dolphins were found. The shark was cut in pieces, carried to Florence and its meat sold at the market. It seems that the same specimen had been sighted a little earlier in the same area feeding on dolphins and tunas. The specimen is reported in Anonymous (1938), and afterwards cited in De Maddalena (1999) and probably in Fergusson (1996) (where it is reported without precise capture location and it is said to be probably a female). Anonymous (1938) state that it was ca. 6 m long, its girth exceeding 4 m, and weighing 1800 kg. Fergusson (1996) reported a total length of over 510 cm.

Two photographs of this specimen appear in Anonymous (1938) and in De Maddalena (1999) (Fig. 3), but these are not easily applicable to produce an accurate estimate. We had the chance to examine another photograph (Fig. 4), evidently taken only some seconds after the one reproduced in De Maddalena (1999), and from side. We assumed as reference the visible part of the girl on the left, close to the shark's snout, who appears to be almost on the plane of the animal. The same girl is well visible on the photo that appears in De Maddalena (1999), and we assumed her height to be 170 cm. We estimated the PP2 at 338 cm, corresponding to 597 cm TOT, 579 cm TLn, 469 cm PRC. We calculated that if the girl's height was 175 instead of 170 cm (and this is surely possible by comparison with the heights of other persons) the shark's length would increase to 613



Fig. 3: Specimen caught off Enfola, Isola d'Elba (Italy), on August 12th 1938. (Photo: courtesy of A. Zanoli)
Sl. 3: Primerek, ujet v bližini Enfole, Isola d'Elba (Italija), 12. avgusta 1938. (Foto: z dovoljenjem A. Zanolija)

cm TOT, 594 cm TLn, 482 cm PRC. We noted that, according to Mollet & Cailliet (1996), our estimates agreed with the weight reported by Anonymous (1938).

Ganzirri, Sicily, Italy, June 19th 1961

In 1961, a great female white shark was captured off Ganzirri, Sicily (Italy). It was June 19th: the specimen was harpooned offshore by the fisherman Domenico Sorrenti from his boat, at 12 o'clock. The shark was estimated to be about 640 cm long and weighing about 1500 kg; in its stomach a large dolphin cut in two parts was found (Celona, 2001).

A photo of this specimen appears in Celona (2001) (Fig. 5). The shark is not shown in full, but the position from which the picture was taken, exactly laterally from it, and the closeness of the shark and the people on the

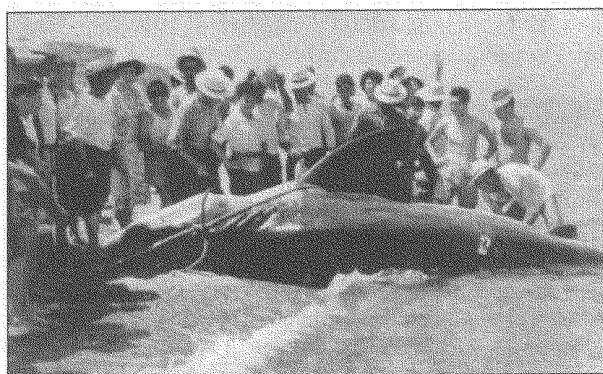


Fig. 5: Specimen caught off Ganzirri, Sicily (Italy), on June 19th 1961. (Photo: courtesy of D. Sorrenti)
Sl. 5: Primerek, ujet nedaleč od Ganzirrija na Siciliji (Italija) 19. junija 1961. (Foto: z dovoljenjem D. Sorrentija)

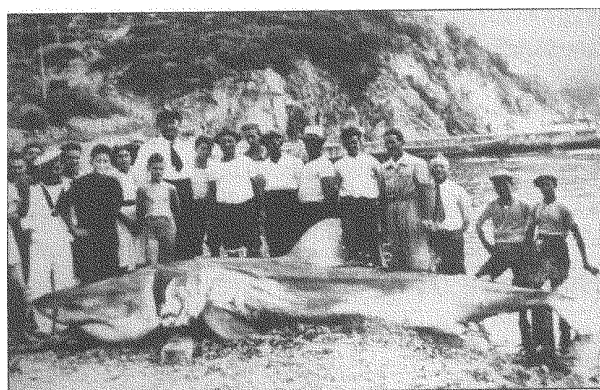


Fig. 4: Specimen caught off Enfola, Isola d'Elba (Italy), on August 12th 1938. (Photo: courtesy of A. Zanoli)
Sl. 4: Primerek, ujet v bližini Enfole, Isola d'Elba (Italija), 12. avgusta 1938. (Foto: z dovoljenjem A. Zanolija)

photo allowed us to make a very good length estimate. We chose as reference the man wearing a white shirt and short pants located very close to the shark's snout and on the same plane. We assumed its height to be 170 cm. We estimated the PP2 to be 377 cm, corresponding to 666 cm TOT, 645 cm TLn, 523 cm PRC.

Piran, Slovenia, October 22nd 1963

On October 22nd 1963, a large white shark was caught off Salvo in the Gulf of Piran (Slovenia and Croatia) (Fig. 6). It approached a fishing boat belonging to the Delamaris fish processing company, while fishermen were turning in their nets, and was killed with 23 rifle shots. Its stomach contained a dolphin weighing about 200 kg. This case has been reported by Bošnjak & Lipej (1992-1993), Lipej (1993-1994), De Maddalena (2000a), and Soldo & Jardas (2001). One of the authors (L. Lipej) interviewed a fisherman who had at that time been on board the fishing boat, and the latter declared that the shark must have been about 6 m long and weighing about 1100 kg (Bošnjak & Lipej, 1992-1993; Lipej, 1993-1994), while the local newspaper "Primorske novice" indicated it to be 4 m long and weighing ca. 700 kg (Anonymous, 1963).

Photos of the specimen have been published in Bošnjak & Lipej (1992-1993) and Lipej (1993-1994): unfortunately these pictures cannot be used for an accurate estimate of the specimen's size on the basis of the people appearing near the shark. One of the authors (L. Lipej) eventually went to the Izola harbour to examine the precise place where the shark had been photographed after its landing. The blocks of cement of the harbour paving have sides measuring from 45 to 50 cm. On the two photos of this specimen, there are almost exactly 10 blocks in line from the shark's snout to the



Fig. 6: Specimen caught off Piran (Slovenia) on October 22nd 1963. (Photo: L. Lipej's archive)

Sl. 6: Primerek, ujet v bližini Pirana (Slovenija) 22. oktobra 1963. (Foto: Arhiv L. Lipeja)

apex of the upper lobe of its caudal fin. Considering that the shark is even in a slightly curved position (its axis being not perpendicular to the parallel lines of the paving), its length was estimated at 477-530 cm TLn, corresponding to 492-547 cm TOT, 387-430 cm PRC. Due to the 5 cm difference in the reference's size, no precise estimate could be made. We also noted that, according to Mollet & Cailliet (1996), our estimates agreed with the approximate weight reported by the fisherman.

Isola la Formica, Isole Egadi, Italy, May 1974

The capture of a female white shark took place on a May 1974 morning with the tuna trap (tonnara) off Isola la Formica (Italy). At that time, the chief of this tuna-trap called "rais" in Sicilian, was Michele Grimaudo. Nitto Minneo, the diver who worked as inspector of the tuna-trap nets, examined the shark underwater when already dead with its head trapped in the net. The man extracted all the teeth from the large shark's mouth and eventually distributed them among the men working on board the tuna-trap (N. Minneo, *pers. comm.*).

This case has been reported by Anonymous (1974) and Fergusson (1996). Anonymous (1974) erroneously indicated the capture location to be the near the island of Favignana, where another important tuna-trap was

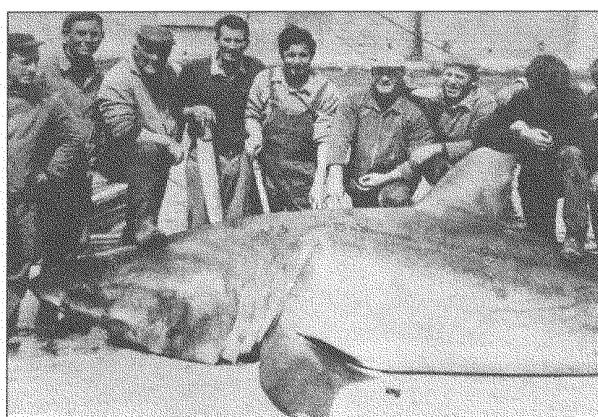


Fig. 7: Specimen caught off Isola la Formica, Isole Egadi (Italy), in May 1974. (Photo: A. De Maddalena's archive)

Sl. 7: Primerek, ujet v bližini otoka Isola la Formica, otočje Egadi (Italija), maja leta 1974. (Foto: Arhiv A. De Maddalene)

located. In Fergusson (1996), the specimen is cited three times, but every time with some minor differences. In its stomach were found a goat (*Capra hircus*), plastic bottles and plastic bags. The length was reported by Anonymous (1974) to be "almost 7 m", while Fergusson (1996) indicated it to be ca. 520-530 cm. The weight reported by Anonymous (1974) corresponds to 1500 kg, and this author also stated that the weight of the liver exceeded 300 kg.

Nitto Minneo reported its total length at 620-640 cm and specified that this measurement had been taken several times by the "rais", the fishermen and also by some tourists, when the shark was exposed to the curiosity of the people, as always when a large shark was captured with the tuna-trap. Mr. Minneo, too, reported that the shark weighed 2400-2600 kg. In his opinion, this specimen was probably the largest ever caught by tuna-traps off la Formica and Favignana. Moreover, even Gioacchino Cataldo, the "rais" of the Favignana tuna-trap, recalled the length of "640 cm, about 6 metres".

A good photo of the specimen is published in Anonymous (1974) (Fig. 7). For the estimate we chose, as reference, the man with a cap on his head and standing to the right of the man with his foot on the shark's head: since the two men are very close, even the one chosen as reference has to be very close to the shark. Presuming that the man was 175 cm tall, the PP2 was estimated at 336 cm, corresponding to 594 cm TOT, 575 cm TLn, 466 cm PRC.

Filfla, Malta, April 17th 1987

A large female white shark was caught in the morning of April 17th 1987 in the waters off Filfla, Malta, by

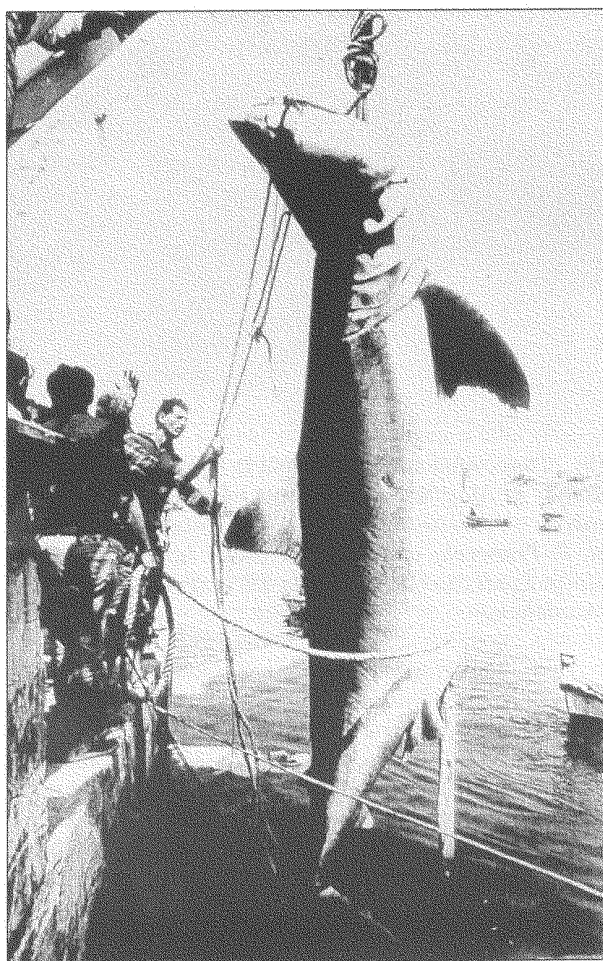
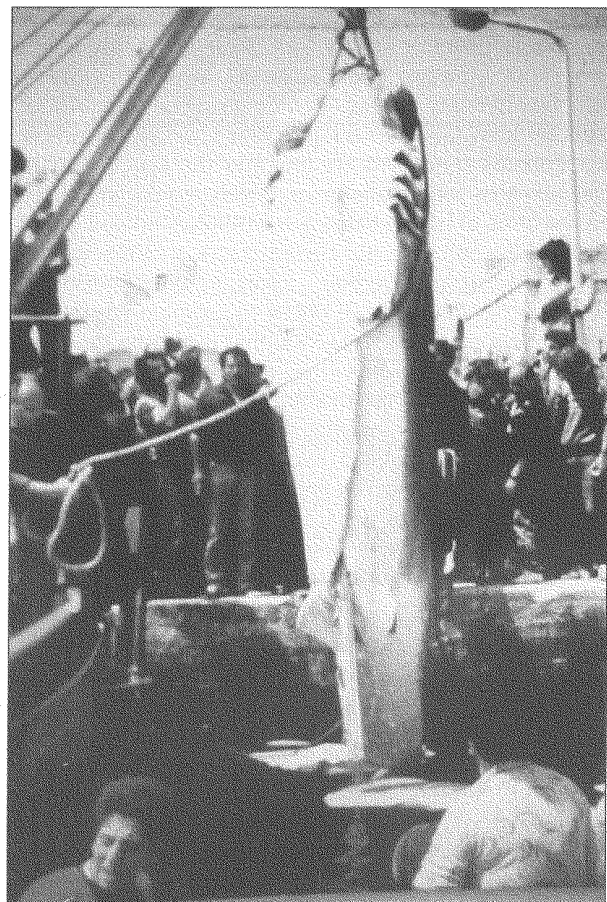


Fig. 8: Specimen caught off Filfla (Malta) on April 17th 1987. (Photo: J. Gullaumier)

Sl. 8: Primerek, ujet nedaleč od Filfle (Malta) 17. aprila 1987. (Foto: J. Gullaumier)

fishermen Alfredo Cutajar and Vince D'Amato. The catch took place 3 miles off Blue Grotto, south of Filfla. The shark was caught with a fixed surface long-line belonging to Mr. D'Amato, but the line snapped and got entangled with a line belonging to Mr. Cutajar, who eventually landed the shark. The latter was taken to Wied-lz-Zurrieq, but since it was too heavy for the harbour winch, it was landed in Marsaxlokk. In its stomach a whole 220 cm blue shark, *Prionace glauca*, a 250 cm dolphin of unidentified species and bitten in two (or three according to some other sources), a marine turtle, *Caretta caretta*, having a 60 cm diameter carapace, and a plastic bag containing garbage were found (it is not known whether the lengths were originally taken in cm or in feet, and other sources reported the following sizes of these contents: blue shark 6 feet - 183 cm, dolphin 8 feet - 244 cm, marine turtle 2 feet - 61 cm). In the evening the shark was taken to Zurrieq and kept in a large

garage. A day later (April 18th) it was taken to the Valletta fish market. The jaws were preserved by John Abela and exhibited in the Museum of History and Culture on Gozo Island. The case was reported and discussed by several authors (Abela, 1989; Ellis & McCosker, 1991; Mollet *et al.*, 1996; Fergusson, 1996; Fergusson, 1998; De Maddalena, 1999; Fergusson *et al.*, 2000; De Maddalena, 2001). Unfortunately no fisheries officer measured the shark (M. Darmanin, *pers. comm.*). Abela (1989) reported to have measured accurately the shark's total length in a straight line (as TOT, according to Fergusson, 1998), measuring 714 cm, and he also specified a weight of 2730 kg. In a letter that the shark's capturer, Alfredo Cutajar, wrote in May 1991 to Mr. Giuliano Chiocca, it was stated that it was 723 cm long and weighing 2880 kg. A few years after, in the mid-1990s, Alfredo Cutajar and John Abela were interviewed for the Jeremy Taylor's documentary "Jaws in the Med": here Mr. Cutajar reported a length of 23 feet (701 cm) for this specimen, while Abela confirmed that he had accurately measured the shark twice while lying flat on the floor; apparently it was 23 feet 5 inches (714 cm) long. Recently, in 2001, Mr. Cutajar stated to have estimated the shark as being 23 feet (701 cm) long on the basis of the length of the pick-up truck on to which it was placed with its caudal fin hanging out (this statement clearly indicates that he did not measure the shark's length); moreover he declared that an approximate weight of 3 t was estimated on the basis of the shark's individual parts cut up and sold at the fishmarket (M. Darmanin, *pers. comm.*). Mollet *et al.* (1996) wrote, on the basis of discordant testimonies by John Abela, that Abela did not measure the shark's length but only estimated it. Fergusson (1998) stated that this shark's length was in the 520-550 cm TL range: he reached this conclusion after examining the photograph of this specimen taken by photographer John Gullaumier and published by the Maltese newspaper "In-Nazzjon-Taghna" (Anonymous, 1987), based also on the judgement by a forensic investigator who analysed the picture on the request of the BBC Natural History Unit. Some time after, Fergusson *et al.* (2000) again confirmed this estimate, stating that this specimen was no longer than 550 cm TL. This length agrees with the size reported by Anonymous (1987) who reported the shark's weight at 1.5 t and its length at "about 18 feet" (549 cm). According to Fergusson (1998), in an interview given by Abela to the BBC, he admitted that "he may have made a mistake in taking the measurement". Recently, in 2001, Abela re-confirmed the 714 cm total length, but added that he had taken the shark's measure with a rope which he eventually measured (M. Darmanin, *pers. comm.*). However, the "about 18 feet" length reported by Anonymous (1987) was not measured but merely estimated (A. Buttigieg, *pers. comm.*), and the same may be said of the 1.5 t weight reported by the same source (Anonymous, *pers. comm.*).



Figs. 9, 10: Specimen caught off Filfla (Malta) on April 17th 1987. (Photo: A. De Maddalena's archive)
Sl. 9, 10: Primerek, ujet nedaleč od Filfle (Malta) 17. aprila 1987. (Foto: Arhiv A. De Maddalene)

In the end, it was not possible to find anyone else that measured the shark, so it seems certain that John Abela was effectively the only person to have done it. We were able to collect testimonies of three eyewitnesses that had seen the shark. Mr. Alex Buttigieg, a person that asked to remain anonymous, and the fisheries officer Mr. Grezzju Grech. None of them had a chance to measure the shark (the anonymous witness went to the Valletta fish market early in the morning with a camera and measuring tape only a minute before the shark was cut up, but had no permission to take photos or measurements). Alex Buttigieg and the anonymous witness declared to have estimated the shark's length to be conspicuously less than the 714 cm TOT reported by John Abela, but larger than the 520-550 cm TL estimated by Fergusson (1998) and Fergusson *et al.* (2000). The anonymous eyewitness estimated the length at approximately "18,5-19,5 feet" (564-594 cm) or "close to 20 feet" (610 cm), made at a distance of about 12 feet, when the shark was placed on the floor at the Valletta fishmarket. Alex Buttigieg estimated it to be "less than 20 feet" (610 cm), from a distance of about 20 m. Mr.

Grezzju Grech, who was present when the shark was landed, affirmed that in his opinion it is possible that the specimen was 7 m long (M. Darmanin, *pers. comm.*). The several requests for more information about this case made recently by one of the authors (A.D.) to John Abela remained unanswered, but we have had some replies to our questions from him via Mr. Michael Darmanin, Senior Fisheries Officer at Malta Centre for Fisheries Sciences (Department of Fisheries and Aquaculture, Fort San Lucjan, Marsaxlokk): this last information, together with those from Mr. Buttigieg and the anonymous witness, helped us to reconstruct the entire story as reported herewith.

There are many photographs of this specimen, but most of them simply cannot be used for a reasonably good estimate to be made; the ample photographic evidence as far as this specimen is concerned demonstrates how much can be distorted as well as difficult to evaluate the size of a large specimen if photo is not taken adequately. For the reasons exposed in the Materials and Methods section, photos as the one showing the head of the shark suspended in vertical position with the

hand of a man placed near the axis of the pectoral fin (see Abela, 1989 or Ellis & McCosker, 1991) are totally unacceptable to produce a size estimate. After a careful selection of many photos (including several unpublished ones by John Gullaumier and other sources), we chose three photos to evaluate the length of this specimen. The first, taken by John Gullaumier, is very similar to the one on the basis of which Fergusson (1998) estimated the TL at 520-550 cm (Fig. 8). The photo is a close-up, and both the head and the caudal part are clearly distorted by the perspective, so we chose to estimate the prepelvic-prepectoral space, PP2-PP1, that is also on the same level of the person chosen as reference (the man with his hand raised and tartan shirt, and on the same plane as the shark). Assuming that the man was 175 cm tall, the PP2-PP1 would be 216 cm, which corresponds to 681 cm TOT, 660 cm TLn and 535 cm PRC.

Two other photos (Figs. 9, 10) were also taken into consideration that were taken from a longer distance, and for this reason can be quite suitable for an estimate to be made. In these cases, too, we estimated the PP2-PP1, since the head was in a strongly unnatural position. In both of these, we chose as reference the man with glasses and a rope in his hand, located on the same plane as the shark and, on the basis of his total height, assumed to be 175 cm, we calculated his visible partial height. For the first of these two photos (Fig. 9) we estimated the PP2-PP1 at 215 cm, corresponding to 678 cm TOT, 657 cm TLn, 532 cm PRC. For the second photo

(Fig. 10), the PP2-PP1 was estimated at 212 cm, corresponding to 668 cm TOT, 647 cm TLn, 525 cm PRC. The high proximity of the three estimates obtained (668-681 cm TOT) appears to be a solid confirmation of the accuracy of the result. We also noted that, according to Mollet & Cailliet (1996), our estimates agreed with the weights reported by Mr. Abela and Mr. Cutajar.

Therefore we concluded that there were no sufficient reasons to totally refute the 714 cm TOT indicated by John Abela. If he made an error measuring the shark, and we think it possible considering the way he measured the shark and in view of the results obtained by our study, the true shark's TOT was certainly not conspicuously shorter (33-46 cm by our estimates) than the one reported by him. According to our estimates and to the observations by 5 eyewitnesses (Abela, Cutajar, Grech, Buttigieg, Anonymous), the 520-550 cm TL indicated by Fergusson (1998) and Fergusson *et al.* (2000) is not acceptable.

Sète, France, January 9th 1991

A female white shark was caught on January 9th 1991 off Sète, France. This specimen was bought by a wholesale fishmonger in Sète, offered for sale in the Rungis market, and bought by a supermarket in Montargis (Anonymous, 1991; Quignard & Raibaut, 1993; Séret, 1996; De Maddalena *et al.*, 2001). It was reported by Anonymous (1991) as being 6 m long, by Séret (1996) and Fergusson (1996) as about 4.5 m long. The photograph published in Anonymous (1991). The same photo (Fig. 11) has been used here to produce a more precise estimate (after the photograph made by today already deceased Raymond de Neuville it has been impossible to find any other photographs or a better reproduction of the same).

The interpretation of the picture is particularly difficult, not only due to the position of the animal, but also because of the proximity of the photographer to the subject and the strong deformation given by the perspective. The persons cannot be used directly as references, since none of them is on the same plane as the shark; for this reason it has been necessary to project in perspective on the plane of the shark the man located on the left to be used as reference. We assumed that he was 175 cm high and estimated the PRC at 464 cm, corresponding to 591 cm TOT, 572 cm TLn. Considering even the particular position of the body of the specimen, we validated this estimate on the basis of PD1: we estimate it to be 222 cm, corresponding to 588 cm TOT, 570 cm TLn, 462 cm PRC. These last results strongly confirm those previous obtained.

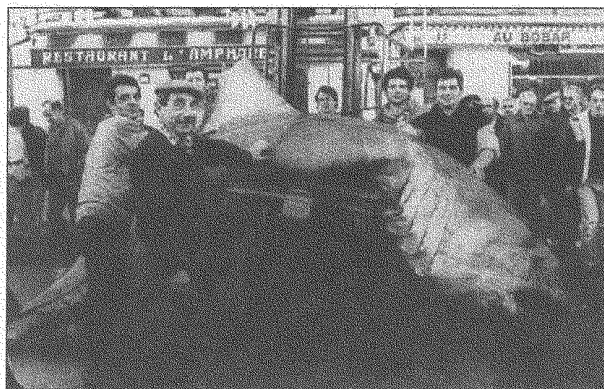


Fig. 11: Specimen caught off Sète (France) on January 9th 1991. (Photo: R. de Neuville)
Sl. 11: Primerek, ujet blizu Sèteja (Francija) 9. januarja 1991. (Foto: R. de Neuville)

Tab. 3: Estimates of the white shark lengths (in centimetres) obtained through examination of photographic evidences.**Tab. 3: Ocene dolžin (v centimetrih) primerkov belih morskih volkov na osnovi preučevanih fotografij.**

DATE	LOCATION	TOT	TLn	PRC
June 1924	Procida, Italy	507	491	398
12 August 1938	Enfola, Isola d'Elba, Italy	597-613	579-594	469-482
19 June 1961	Ganzirri, Sicily, Italy	666	645	523
22 October 1963	Piran, Slovenia	492-547	477-530	387-430
May 1974	Isola la Formica, Isole Egadi, Italy	594	575	466
17 April 1987	Filfla, Malta	668-681	647-660	525-535
9 January 1991	Sète, France	591	572	464

CONCLUSIONS

Of the 7 examined specimens, 5 were estimated to measure over 590 cm TOT (Tab. 3). Of these, at least two (Malta 1987 and Ganzirri 1961) greatly exceed 600 cm, both in TOT and in TLn. These two specimens could even be the largest ever recorded world-wide. But we should also consider the most solid cases of other possibly larger specimens reported until today. These are the following three.

The discussed specimen caught off Kangaroo Island, Australia, in May 1987 and reported to be over 7 m in length, but never measured (Jury, 1987; Cappel, 1998; Mollet *et al.*, 1996). The only photographic evidences known to us (published in Jury, 1987 and Ellis & McCosker, 1991) show the head only, cut at the level of the second gill slit, and a pectoral fin, but this picture, for the position of the photographer and of the reference, cannot be considered useful for a reliable estimate. Mike Cappel reported that Peter Riseley (the fisherman that caught the shark) measured the head length from first gill slit to be 53 inches (135 cm) (H. Mollet, *pers. comm.*), almost surely as PG1 (prebranchial length); Mollet *et al.* (1996) reported this PG1 as "estimated value". On the basis of the Lausanne specimen, 135 cm PG1 corresponds to 645 cm TOT, 625 cm TLn, 507 cm PRC.

About the specimen caught in 1945 off Castillo de Cojimar, Cuba, that was reported to be 640 cm in length (Bigelow & Schroeder, 1948; Guitart-Manday & Milera, 1974), the contestation of this case presented in Randall (1987) is not acceptable, since it is based on wrong assumptions. In fact we noticed that: a) the preserved vertebra was not necessarily the largest of the vertebral column, and therefore it could not be used to obtain the precise length of the specimen, b) in general it has come out that the size of the largest anterior tooth of the upper jaw cannot be considered as a sufficiently reliable index of the length of a large white shark, c) the girth of the body (and consequently the height of the body at the level of the first dorsal fin) shows wide variation from specimen to specimen, and depending even on the state

of preservation of the specimen, thus it is impossible to use it to estimate the length of the shark. In the end we believe that there is no reason to refute the 640 cm length reported for this specimen by the source. The only doubt remains about the fact that it is unknown whether this measure was taken as TOT, TLn or in another way.

In the end let us refer to the enormous specimen cited in Barrull & Mate (2001), reported by Dr. Juan Antonio Moreno. The shark was caught in 1982 off Dakar, Senegal. Dr. Moreno eyewitnessed the landing of the specimen, but he did not get the permission to measure the shark with a ruler, nor to take photographs. Dr. Moreno estimated its total length at over 800 cm: he reached this conclusion measuring it as TLn, twice, with its feet. Jaws of this specimen were sold to an American customer for 1000 U.S. dollars (J. A. Moreno, *pers. comm.*). Although the measure reported cannot be regarded as accurate, considering the unusual way it was taken (this is the reason why Dr. Moreno never published a report on this specimen), this case is undoubtedly of a special interest, being the only in which a so large specimen was examined by an ichthyologist and specialist in the study of sharks.

With this work we believe to have definitively demonstrated that *C. carcharias* can, in rare and exceptional cases, exceed 6 meters in length, reaching at least 640-660 cm TOT and very probably even more.

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ANALIZA FOTOGRAFIJ NAJVEČJIH BELIH MORSKIH VOLKOV *CARCHARODON CARCHARIAS* (LINNÉ, 1758), UJETIH V SREDOZEMSKEM MORJU

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POVZETEK

Avtorji pričujočega članka so analizirali fotografije največjih belih morskih volkov *Carcharodon carcharias*, ujetih v Sredozemskem morju in glede na obstoječo literaturo dolgih blizu 6 metrov ali celo več. Preučili so 7 primerkov in ocenili njihovo TOT (celotna iztegnjena dolžina), TLn (celotna dolžina v naravni legi) in PRC (predrepna dolžina), in sicer na osnovi mer, ki so jih predstavili De Maddalena et al. (2001) o 583 cm (TOT) dolgem primerku, razstavljenem v lausannskem Zoološkem muzeju. Celotne iztegnjene dolžine teh belih morskih volkov so: 507 cm (Procida, Italija, junij 1924), 597 cm (Enfola, Isola d'Elba, Italija, 12. avgust 1938), 666 cm (Ganzirri, Sicilija, Italija, 19. junij 1961), 492-547 cm (Piran, Slovenija, 22. oktober 1963), 594 cm (Favignana, Isole Egadi, Italija, maj 1974), 668-681 cm (Filfla, Malta, 17. april 1987), 591 cm (Sète, Francija, 9. januar 1991). Pet primerkov je torej merilo v dolžino več kot 590 cm, in vsaj dva od njih (Ganzirri 1961 in Malta 1987) sta temeljito presejala dolžino 6 m tako kar zadeva TOT kot TLn. Sicer pa bi ta dva primerka lahko bila največja, kar so jih kdaj ujeli na svetu. Avtorji obravnavajo tudi nekaj otipljivejših primerov drugih belih morskih volkov teh dolžin (Kangaroo Island, Avstralija, 1987; Castillo de Cojimar, Kuba, 1945; Dakar, Senegal, 1982) in zaključujejo, da je *C. carcharias* lahko dolg najmanj 640-660 cm (TOT), a da je po vsej verjetnosti še daljši.

Ključne besede: beli morski volk, *Carcharodon carcharias*, velikost, Sredozemsko morje

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