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A Fatal Attack by a White Shark in Japan and a Review of Shark Attacks in Japanese Waters

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Abstract On March 8, 1992, a male professional diver was collecting the pen shell *Atrina pectinata*, Japanese name Tairagigai, at a depth of 22 m about 2.3 km offshore of Matsuyama, Ehime Prefecture, Japan. At about 15:20 he was attacked by a large shark, and only a severely damaged diving suit and helmet were recovered. The right half of the trunk and right leg of the suit were torn off. A rescue rope and a rubber radio cable, both of which connected the diver to a support boat were severed, but the diver's air tube remained intact. The diver's body was not recovered, nor was a shark captured that might have perpetrated the attack, despite extensive fishing efforts by local fishermen. A small piece of a broken shark tooth was recovered from the rubber surrounding the neck of the diving suit. The tooth fragment contained two large serrations of about 0.85 mm in width. The suit's steel shoulder protector had a single hole (6 mm × 3 mm), penetrated by a shark tooth. The edge of the hole showed regular minute undulations, and the cut surfaces on the rubber and the cable had minute parallel streaks, both apparently made by the serrations of shark teeth. Tracing of the scratches and cuts on the shoulder protector and back part of the diving suit made it possible to estimate a jaw size of about 40 cm in width, suggesting a very large shark. The water temperature was low about 11.6°C, at 20 m depth at a nearby locality. These facts support the contention that the shark involved in this incident was a white shark of about 5 m in total length. Shark attacks in Japanese waters were investigated, and at least sixteen shark attacks on people and boats were recognized.

The fatal shark attack of a professional diver in March 1992 at Matsuyama raised widespread public concern among those involved in sea fisheries, fish marketing and harbor construction. In addition, the unusual news competition by TV, radio, and newspaper media fueled a "Jaws"-like panic among sport fishermen, sport divers, wind-surfers and sea-bathers in the Seto Inland Sea area. In the month following the attack, unsubstantiated theories concerning the attack abounded, including suggestions that the death was attributable to a killer whale, or to murder. Therefore, I examined the diving suit retained at the victim's house in Saga Prefecture and weighed other evidence in an effort to better identity of the attacking species.

The present paper reports the circumstances surrounding the attack, identifies the attacking species and summarizes the shark attacks to date in Japan.

The attack

According to personal communication with Hiroshi Okuda, who was the captain of the support boat when this shark attack occurred, a 41 year old professional diver, Kazuta Harada, was engaged in fishing for pen shells (*Atrina pectinata*) at a depth of 22 m on sandy bottom, off Horie (33°54′N, 132°44′E), Matsuyama City in Ehime Prefecture on March 8, 1992 (Fig. 1; 1). He wore a steel helmet and a grayish diving suit with orange rubber patches around the neck, from the elbow to the wrist, on the upper back, and on the inner parts of the legs and hips. A rescue rope, a rubber-coated radio cable, and an air tube connected the diver to the support boat. It was about 15:20 that he suddenly shouted "pull up" through the radio. Just after his shout, and some unusual mechanical noises, the radio communication

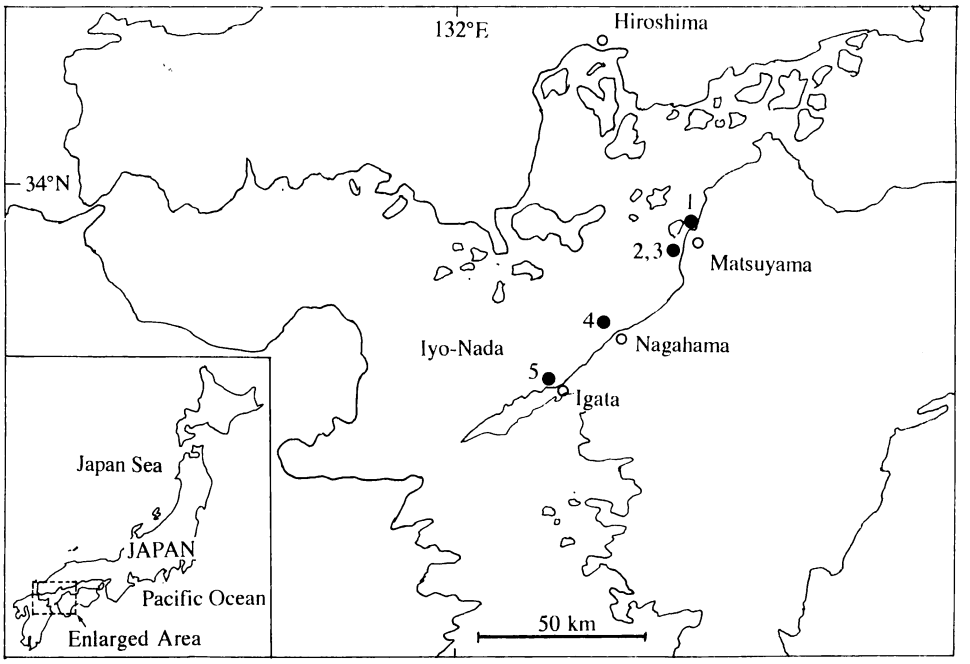

Fig. 1. Matsuyama and adjacent area showing places of shark attacks and shark approaches in 1992. *1*—Attack on Kazuta Harada on March 8; *2*—Approach to a diver on January 3; *3*—Attack on Koji Harada on February 14; *4*—Approach to a boat on March 8; *5*—Attack on a boat on June 17.

was cut. Immediately, Okuda and a crew member pulled on the rescue rope, but they were unable to retract it, although retraction is easy in normal situations. They also tried unsuccessfully to pull the air tube. Then they tied the air tube to the boat and pulled it by moving the boat very slowly. After this, they could haul in the air tube, but the rescue rope and the radio cable had been severed by then. Eventually the air tube was retrieved, resulting in the return of only a severely damaged diving suit and helmet. Okuda recalls that the time they needed to recover the diving suit was long but less than 30 minutes. Soon after this accident, an underwater search for the diver was conducted, but he has never been found. In addition, extensive, but unsuccessful fishing efforts for the perpetrating shark were made in the nearby waters using gill nets, long lines and other fishing gears for more than two months.

According to the observation by the Ehime Fisheries Experimental Station, it was 11.4°C at the surface, and 11.6°C at 20 m depth during 15 : 35–15 : 44 on March 9, 1992, at the nearest sea observation station, 14 km south west of the attack site. The transparency of the water was reported as 6 m.

Diving suit and tooth fragment recovered

I examined the diving suit and the helmet that were used by Kazuta Harada. The diving suit was badly torn with many bite marks, and the right half of the trunk and right leg of the suit had been lost (Fig. 2). The diver seems to have received at least one bite on the back part of the steel shoulder protector, resulting in a hole, and several bites on the right side of the trunk. The rescue rope and the rubber radio cable were cut off, and the air tube had received some bites. The left leg of the suit had been turned inside out when recovered, apparently suggesting that the diver was violently pulled out of the diving suit. The thick rubber around the neck covering the steel shoulder protector received a few deep and long cuts, from one of which (encircled part of Fig. 3, left) a small fragment of a shark tooth was recovered (Fig. 4). It is 5.1 mm in length and 2.6 mm in width. There are two large serrations on the fragment (Fig. 5, left), 0.85 mm and 0.86 mm in widths and 0.68 mm in height. Distance between tips of each serration is 0.94 mm. Edges of each serration are smooth and sharp. The back part of the steel

shoulder protector, which is about 1 mm thick, had one elliptical hole of 6 mm × 3 mm, and the edge of the hole showed regular minute undulations (Fig. 3, left). There were also some scratches, each composed of several short streaks, on the shoulder protector. In addition, the cut surfaces of the radio cable (Fig. 3, right) and the thick rubber around the neck of the diving suit were close-ribbed with minute parallel striations. I tore the cable by hand to see if such a rib structure would appear, but it did not. I also tried to cut the cable with a knife, but the cut surface was smooth with a few lines made by the dull edge of the knife. Therefore, it can be clearly concluded that the scratches on the steel shoulder protector, the rib structure or striations on the cut surfaces of the rubber parts, and the undulations on the edge of the hole were made by the serrations of the shark teeth.

Tracing of the scratches, holes and cuts on the shoulder protector and the back of diving suit made it possible to draw an arc of jaw of the assailant shark. The approximate maximum transverse width of the arc was about 40 cm.

Fig. 2. Back view of the diving suit in this fatal shark attack.

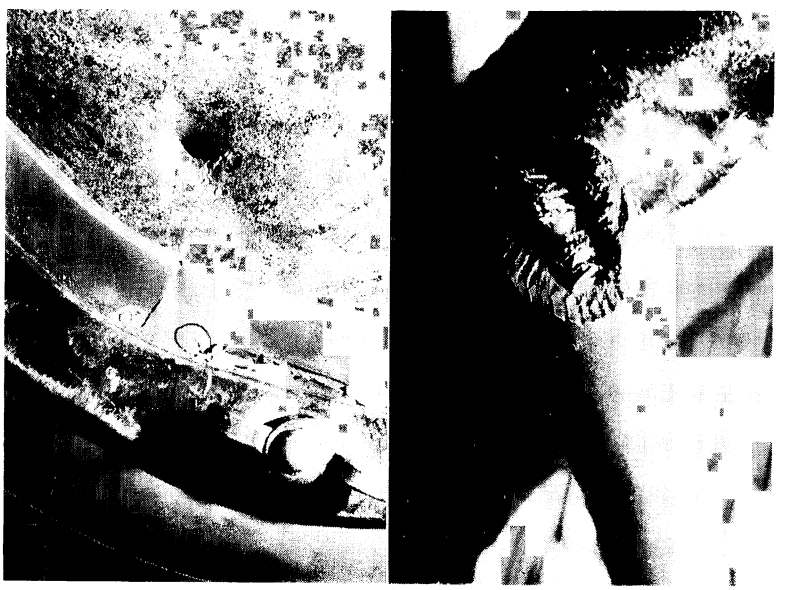

Fig. 3. Enlargement of diving gears. *Left*—margin of steel shoulder protector, showing a hole and some cuts on the rubber. A tooth fragment was recovered from the encircled area. *Right*—cut surface of radio cable, showing rib structure by shark tooth serration.

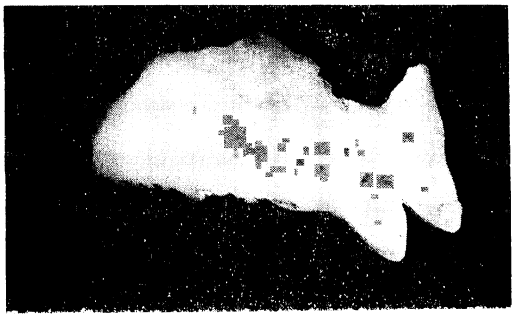

Fig. 4. Recovered tooth fragment, 5.1 mm in length and 2.6 mm in width.

Identity of the shark

Table 1 lists large dangerous shark species with serrated teeth, which have been known to occur in or near Japanese waters. The teeth of the tiger shark, *Galeocerdo cuvier*, are unique, because the margin of each serration has a few to several additional micro-serrations. As the margins of two serrations on the recovered tooth fragment are smooth and lack those micro-serrations, the attacking species is apparently not the tiger shark. As noted above, the jaw width of the attacker was estimated as 40 cm, and the maximum mouth widths were calculated for other species, using proportional data of Bass et al. (1973, 1975a, b). Most of the listed species, including the largest, have much narrower gapes than 40 cm. The following five species, however, attain such a large gape: the white shark (*Carcharodon carcharias*), the Galapagos shark (*Carcharhinus galapagensis*), the bull shark (*Carcharhinus leucas*), the oceanic white-tip shark (*Carcharhinus longimanus*) and the dusky shark (*Carcharhinus obscurus*).

The widths of the two serrations on the recovered tooth fragment were 0.85 and 0.86 mm. Available data taken from the tooth specimens and those of Bass et al. (1975b) show that the width of one serration for the white shark ranges 0.76 mm (2.3 m total length [TL] specimen) to 1.07 mm (5.7 m TL specimen). Those of the recovered tooth clearly fall in this range. Comparison of serration width of the four *Carcharhinus* species with that of the smallest white shark (Table 1) suggests that at least three of them, *C. leucas*, *C. longimanus* and *C. obscurus*, have much smaller serrations, even in the largest individuals, and that the serrations on the recovered tooth fragment are too large for these species. *C. galapagensis* may possibly have serrations as large as those of the white shark, but Garrick (1982) gave Marianas

Table 1. Sizes of mouth and tooth serrations in selected large dangerous sharks in Japanese waters. Average width of one serration is that on main portion of cutting edge, not including small ones near tip and base

	Maximum size in m TL*	Maximum mouth width in cm**	Average width of serration in mm (TL of specimen)
Present shark	(ca. 5)	(ca. 40)	0.85, 0.86
Carcharodon carcharias	6.4	67	0.76 (2.3 m)† 0.89 (5.2 m)†† 0.94 (5.5 m)†† 1.07 (5.8 m)†††
Carcharhinus albimarginatus	3.0	35	
C. altimus	3.0	30	
C. brachyurus	2.9	26	
C. brevipinna	2.8	24	
C. falciformis	3.3	32	
C. galapagensis	3.7	43	0.62** (1.7 m)
C. leucas	3.4	42	0.43–0.57 (2.6–3.0 m)
C. limbatus	2.6	26	
C. longimanus	4.0	46	0.25** (2.38 m)
C. obscurus	4.0	45	0.55** (3.35 m)
C. plumbeus	3.0	29	
Galeocerdo cuvier	7.4	>100	
Prionace glauca	3.8	30	

*Data from Compagno (1984); **calculated using data of Bass et al. (1973, 1975a); †4th and 5th upper teeth of a specimen in Bass et al. (1975b, pl. 8); ††4th and 5th upper teeth; †††4th upper tooth.

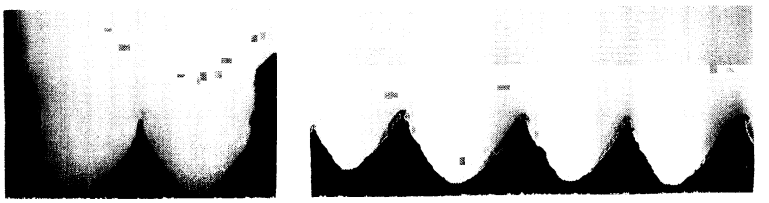

Fig. 5. Tooth serrations. *Left*—Enlargement of the two serrations of the recovered tooth fragment. *Right*—serrations of a white shark, 5.2 m TL.

(Guam) as a northernmost distribution for this species in the western Pacific. Later Taniuchi et al. (1985) reported this species from the Bonin Islands, and suggested its presence in Izu Island waters. These four species of *Carcharhinus* are said to be tropical-subtropical and/or oceanic species, and do not seem to occur in the inland waters of Matsuyama, especially during the coldest season of the year, when the water temperature was lower than 12°C. Actually, these species are rare or hardly caught in the Seto Inland Sea even in summer season. It is therefore very unlikely that any of these *Carcharhinus* species can be implicated in this incident.

The white shark, on the other hand, commonly occurs in waters of 11°C to 24°C (Casey and Pratt, 1985), and the temperature of the attack site was 11.6°C. Therefore, it is not strange for a white shark to have come in the waters of Matsuyama area in early March. In fact, on March 11, 1992, three days after the attack, a 3.7 m white shark was caught at the mouth of Kagoshima Bay on the southern end of Kyushu Island. This demonstrates that the waters of Matsuyama were inhabited by the white sharks during early March 1992.

Taking all these facts into consideration, it can be concluded that a white shark, *Carcharodon carcharias*, was the species involved in this fatal attack. As the estimated jaw width is almost the same as that of a 5.2 m specimen from Hokkaido (Nakano and Nakaya, 1987), the body size of the individual involved in this incident is considered to be about 5 m TL.

As will be mentioned later, there have been more than ten shark attacks in Japanese waters, and this is the first case in which the shark species involved in the accident was identified.

Other shark attacks and encounters in Matsuyama area

During the investigation of the present shark attack, it became clear that several additional shark attacks or underwater encounters with large sharks have occurred in Matsuyama and nearby waters since 1990.

According to pen-shell divers in Matsuyama, at least two divers were approached by a large shark three times in 1990, two in February and one in March. They reported that there were no problems with sharks in the next year (1991). In 1992, however, at least five shark attacks or encounters occurred during first half of the year.

A pen-shell diver was approached by a large shark at 15:15 on January 3 in the waters about 10 km southwest of the present attack site (Fig. 1; 2). The shark (reported as about 5 m in length) swam around the diver several times, and its caudal fin got caught in the air tube in an approach. Eventually the air tube was unraveled and the diver was rescued (Yomiuri Shimbun, March 17, 1992).

Koji Harada was collecting pen shells on February 14 at a depth of 25 m almost in the same place as that of the January 3 case (Fig. 1; 3). He was attacked by a large shark shortly before 10 o'clock in the morning, and bitten on the helmet. The shark swam by very close to him in the first approach, with its abdomen almost touching the sea bottom, and at the same time he saw the shark's first dorsal fin at the level of his head. He estimated that its height from lower surface of abdomen to tip of the first dorsal fin was more than 150 cm, suggesting a very large shark. In the second to fourth approaches, he was bitten on the steel helmet three times. He recalled that "large teeth" were coming toward him, and he quickly turned his steel helmet to the direction of the attacking shark to protect the soft parts of the diving suit. Subsequently the shark disappeared and he was safely recovered on the support boat. The shark left bite scars on the steel helmet. He estimated the size of the shark to be about five meters in total length. The water was turbid, and the transparency was only one meter or so (pers. comm., Koji Harada).

Table 2. Shark attacks in Japan

Case No.*	Date of attack	Name of victim	Locality	Fatal	Shark species
677	July 21, 1950	man	Ariake Bay, Saga Prefecture 33°15′N, 130°18′E	yes	—
1290	Oct. 2, 1954	boy	Oomura Bay, Nagasaki Prefecture 32°45′N, 129°52′E	yes	—
727	Aug. 30, 1955	Otamatsu Yoshii	Mikura-jima Island, Tokyo 33°53′N, 139°35′E	yes	—
672	July 25, 1959	Hideo Ishida	Ushimado, Okayama Prefecture 34°37′N, 134°10′E	yes	blue shark?
671	Aug. 11, 1959	Akira Tsuchiya	Isonoura Beach, Wakayama Prefecture 34°12′N, 135°10′E	yes	—
456**	Aug. 25, 1959	Masami Fukushi	Okushiri Island, Hokkaido 42°15′N, 139°33′E	no	porbeagle?
1343	Aug. 3, 1964	Yoshio Ukita	Saidaiji, Okayama Prefecture 34°34′N, 134°05′E	?	—
1518	Aug. 26, 1967	Masanori Ishikawa	Sakaide, Kagawa Prefecture 34°20′N, 133°51′E	yes	—
2304	Aug. 29, 1982	Yuko Yajima	Ariake Bay, Kumamoto Prefecture 32°37′N, 130°25′E	yes	—
2203***	June? 1989?	man	Sea of Japan	?	—
2137***	Jan.? 1992?	Mikado Nakamura	Sea of Japan (Kanazawa?)	no	—
2321	Jan. 3, 1992	man	Matsuyama, Ehime Prefecture 33°51′N, 132°40′E	no	—
2320	Feb. 14, 1992	Koji Harada	Matsuyama, Ehime Prefecture 33°51′N, 132°40′E	no	—
2322	Mar. 8, 1992	wooden boat	Nagahama-cho, Ehime Prefecture 33°38′N, 132°28′E	—	—
2104	Mar. 8, 1992	Kazuta Harada	Matsuyama, Ehime Prefecture 33°54′N, 132°44′E	yes	white shark****
2302	June 17, 1992	wooden boat	Igata-cho, Ehime Prefecture 33°30′N, 132°17′E	—	white shark****

*Shark attack case number of International Shark Attack File (ISAF), Florida Museum of Natural History, Gainesville, Florida 32611-2035, USA; **treated as doubtful in Schultz and Malin (1963); ***doubtful, needs re-investigation; ****identification by Nakaya.

At 10:15 a.m. on March 8, five hours prior to the fatal attack on Kazuta Harada, a boat fishing for yellow tails (*Seriola quinqueradiata*) was approached by a large shark at Nagahama, about 40 km south west of Matsuyama (Fig. 1; 4). According to the TV interviews to Yoshihiro Takasaki, his boat was approached by a large shark, with a trunk of drum-can size. The shark swam toward his boat with head up and mouth open. He himself and the boat sustained no damage, and he left the place immediately.

On June 17, a small wooden fishing boat (5.75 m in length) of Yoshiaki Ueda was severely attacked by a large white shark. This attack happened at Igata-cho, 60 km south west of Matsuyama (Fig. 1; 5). Ueda was preparing for jack-mackerel fishing at 1.5 km north off Igata-cho. He felt a strong shock on the boat at 12:30 p.m., as if his boat had collided with other boat. Then he found a large shark positioned alongside the boat, and soon the shark began to bite the wooden boat. He defended the boat and himself with a wooden pole for about five minutes, and the shark left the boat. I examined photographs taken by local government officers and those photographs clearly show that the shark approached the boat from the starboard and bit many places on the right side and bottom of the boat, leaving many deep cuts on the side board. Two large teeth were discovered from the bottom keel of the boat and I identified them as lower teeth of a white shark.

Shark attacks in Japan

Four fatal attacks were formally recorded from Japanese waters (Schultz and Malin, 1963). Since then, some ten shark attacks have been reported by newspapers or by other mass-media. However, no formal reports have been made on these attacks, and the records of Japanese shark attacks have become scattered. Therefore, it is appropriate to summarize all the known shark attacks and other shark incidents in Japanese waters. As shown in Table 2, sixteen shark attacks were found in Japanese waters, of which three are doubtful or need re-investigation. The suspected shark species have not been determined in all the cases except present two attacks (case nos. 2104 and 2302). Eleven cases of thirteen reliable shark attacks were on people and two were on boats. Eight of the eleven attacks on people were fatal. Eight cases were reported from the Seto Inland Sea area, three from the waters of western Kyushu, and one from Wakayama and Izu Islands. Four out of eight fatal attacks occurred in the Seto Inland Sea area, three in the waters of western Kyushu, and one in the Izu Island waters. The oldest Japanese shark attack in the list by Schultz and Malin (1963) was in 1950 at Ariake Bay, western Kyushu. Eight attacks occurred during the period of 1950 through 1991, and the remaining five occurred in 1992. I have located other presumed shark attacks from Japanese waters, but I did not list them in my table of attacks because they were poorly investigated. There must be other unreported shark attacks or incidents, and further investigation would undoubtedly uncover other fatal and many non-fatal shark attacks in Japanese waters. The sixteen cases reported here seem to be just a fraction of the shark attacks that have occurred in Japan. Therefore, I have only described the known facts and refrain from discussing Japanese shark attack problems. In order to prevent shark attacks in the future, it is important not only to uncover and analyze shark attacks in the past, but also to make a thorough examination of the circumstantial and material evidence when a shark attack occurs.

All the cases reported here were given shark-attack case numbers (Table 2) by the International Shark Attack File, which is now kept at Florida State Museum of Natural History, Gainesville, Florida, USA.

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Maruyama (Wakayama Prefecture) gave me various information about the white sharks landed in their regions. Messers Yasushi Akazaki, Koji Shioda and Shozo Kuwabara (Ehime Prefecture) supplied me with sea observation data and the information of the white sharks recorded on Shikoku Islands, and took photographs of the attacked boat at Igata-cho. Shimamaki Fisheries Cooperative Organization helped me to obtain the data of the white shark captured at Shimamaki, Hokkaido. Yomiuri Shimbun Co., Hokkaido Shimbun Co., Hokkai Times Co., Minami-Nihon Shimbun Co., Nippon Houso Kyokai (NHK) and Takano Freezing Co. at Yoichi, gave various information, photographs and video tapes for the confirmation of the species. Mr. Christian O. Nyako (Faculty of Fisheries, Hokkaido University) checked English.

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愛媛県松山市沖のホホジロザメによる死亡事故，および日本におけるサメ被害

仲谷一宏

1992年3月8日午後，愛媛県松山市堀江沖 2.3 km，水深22メートルの海底でヘルメット式潜水器具を用いてタイラギ貝漁をしていた潜水夫が行方不明になった．この潜水漁を支援していた船の船長によると，作業中の潜水夫から突然「上げてくれ」という救助を求める声を聞き，20分程度かけてやっと引き上げたが，ズタズタに裂けた潜水服とヘルメットだけを回収したという．潜水夫は行方不明で，その後の捜索にもかかわらず，結局発見できなかった．

この事故直後に海上保安部などにより潜水服の調査が行われ，その結果サメによる事故とされた．しかし，その後は詳しい調査が行われず，サメ以外の説も出されるようになったため，佐賀県太良町の潜水士宅に保管されていた潜水服の再調査を実施した．その結果，潜水服は胸部から脇腹にかけての胴部右半分と右足が切断され，肩や腕などに多くの咬み傷のあることが改めて確認された．ヘルメットを固定する金属性の肩当て部分には強い力で穿孔されたと思われる穴や細かな平行な曲線からなる傷跡があり，通信用ケーブルやゴム部の切断面にも細かな平行のすじ状の模様があった．肩当て部分のゴムの深い傷から長さ約5 mm，幅約2.5 mmの歯の破片が発見され，これには2個の鋸歯が残されていた．また，肩当てや潜水服に残された咬み跡を調査して顎の幅を検討したところ，40 cmはあったと推定された．これらの証拠から，この潜水夫を襲ったのは歯の縁辺部に鋸歯をもつかなり大形のサメであったことが明白となった．

これらの歯の破片の特徴，潜水服などに残された傷跡，顎の大きさなどに加え，水温（当時の付近の水温は水深20 mで11.6°C）や四国近海での当時のサメ類の出現状況などを総合的に検討した結果，この潜水夫を襲ったのは全長5 m前後のホホジロザメであると結論された．

日本では以前からサメによる被害が新聞などで時々報道されているが，これらの記録は散逸し，被害の実態を捕らえることが出来ない．従って，日本のサメによる被害を調査したが，公認されているものも含め現時点で10数件の被害例を見い出した．しかし，これらの日本の事例においては，襲ったサメの種類調査など後の科学的調査がほとんどなされていないため，日本で被害を与えているサメについては種名すら分かっていないのが現状である．将来のサメによる事故を防ぐ意味からも，まだ埋もれているサメ被害例を発見し，分析してみる必要があろう．

なお，本研究で集められたサメによる被害については国際サメ被害目録（International Shark Attack File，事務局はフロリダ自然史博物館）に載せておいた．

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