

CASE REPORT

John A. Lewis, Jr.,¹ D.D.S.; Calvin Y. Shiroma,¹ D.M.D.; Kanthi Von Guenther,² M.D.;
and Kenneth N. Dunn,¹ D.D.S.

Recovery and Identification of the Victims of the *Ehime Maru*/USS *Greeneville* Collision at Sea*

ABSTRACT: This paper describes the recovery and identification of crew members lost during a collision at sea. On 9 February 2001, south of Honolulu, Hawaii, the Japanese fishing training boat, *Ehime Maru* was struck by the USS *Greeneville* (SSN 772), a Los Angeles-class fast attack submarine. Witnesses estimate that the vessel sank within 5–10 min after the collision. Nine of the 35 crew members remained unaccounted for after rescue procedures were completed. The U.S. Navy attempted the unprecedented procedure of moving the boat from a depth of 610 m (2000 ft) into shallower waters so that the missing could be located and recovered. Eight of the nine crew members were recovered and identified by their dental records.

KEYWORDS: forensic science, forensic odontology, forensic pathology, dental identification, *Ehime Maru*, remotely operated vehicle

On 9 February 2001, at 12:00 p.m. local time, the Japanese fishing training boat, *Ehime Maru*, departed the Port of Honolulu and was on a heading of 166 deg enroute to a fishing exercise area at a speed of 11 knots (Hisao Ohnishi, personal communication). The USS *Greeneville* (SSN 772), a Los Angeles-class fast attack submarine, was conducting operations on a heading of 018 deg (1) at the same time and in the same vicinity. Both vessels were operating in waters 17 km south of Diamond Head off Honolulu, Hawaii. There were 35 crew members and students onboard the *Ehime Maru*. The 13 students were from the Uwajima Fishery High School.

At 1:43:20 p.m., the *Ehime Maru* was stopped by a “severe impact” which caused its stern to rise. The fishing vessel lost electrical power and began to quickly take on water. The submarine had struck the 830-ton *Ehime Maru* during the USS *Greeneville*’s emergency rapid ascent maneuver, causing significant structural damage.

The *Ehime Maru*’s ten life rafts were automatically activated and crew members began to board them. The bow of the boat was observed to rise up, assuming a vertical orientation just prior to sinking below the surface. Eyewitnesses estimated the time between the collision and the sinking of the boat to be 5–10 min (Hisao Ohnishi, personal communication). It was estimated that the *Ehime Maru* hit the ocean floor at a speed of 65 mph (105 km/h) (CDR Robert D. Fink, USN, personal communication), assuming an upright position. United States Coast Guard vessels initiated rescue operations

to recover the survivors. Twenty-six crew members were recovered but subsequent search and recovery operations failed to locate the other nine individuals.

Cultural Considerations

This incident substantially pressured relations between the United States and Japan. The families of the missing crew members and members of the Japanese Government were insistent that all possible efforts be made to recover the physical remains of the missing crew members. Navy officials consulted Japanese religious and cultural specialists in order to develop a greater appreciation for the cultural and religious protocols involved in planning and executing this type of recovery mission.

The primary religion of Japan is Buddhism. Followers of this religion believe that the souls of the dead are not disembodied but retain their physical needs. Japanese Buddhists are concerned about postmortem care and believe that if soul-bodies are not fed, they will become hungry ghosts. They would remain cold, hungry, and suffering until the remains could be recovered and cared for (Dr. George Tanabe, personal communication).

The actual recovery procedures were also influenced by cultural considerations. The recovery teams were advised to place the remains in the body bags feet first. This was in accordance with the custom of placing cremated remains into funerary urns feet first so that the deceased will not suffer the physical discomfort of being upside down (Dr. Tanabe, personal communication).

Recovery Operations

The Commander, U.S. Pacific Fleet, ordered Navy units to participate in the search for the sunken vessel on the ocean floor. The *Ehime Maru* was located in 610 m (2000 ft) of water on 16 February

¹Forensic Odontologist, Joint POW/MIA Accounting Command, 310 Worcester Ave., Building 45, Hickam Air Force Base, HI.

²Chief Medical Examiner, City and County of Honolulu, Department of the Medical Examiner, 835 Iwilei Road, Honolulu, HI.

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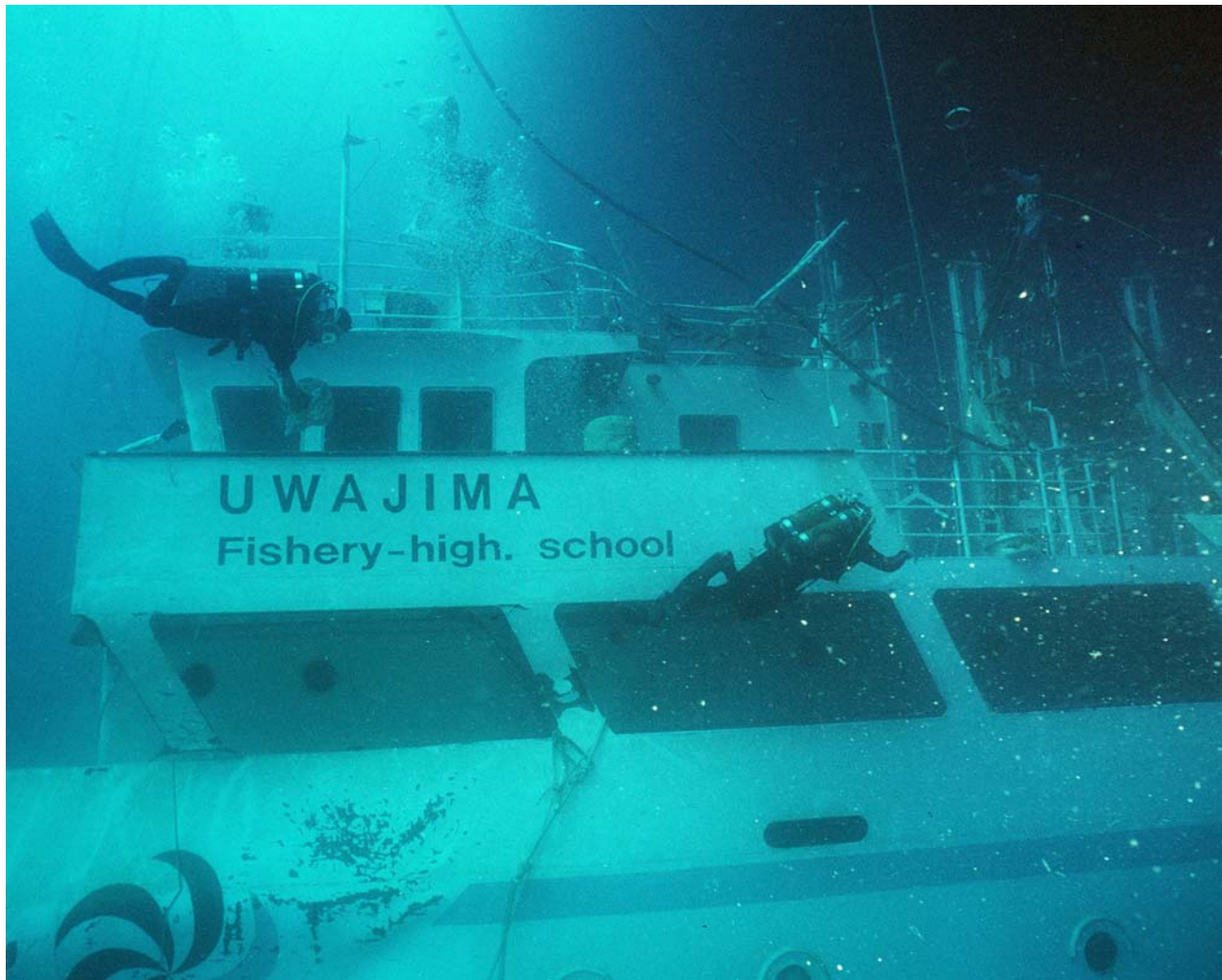


FIG. 1—Divers on Ehime Maru. Official U.S. Navy photo taken by Chief Petty Officer Andrew McKaskle.

2001, with the help of Remotely Operated Vehicles (ROV). The missing crew members were not found. It was not possible to send divers to the boat to conduct further searches at this depth. The attempted recovery operation would be unprecedented due to the depths and type of mission involved.

The U.S. Navy initiated a series of studies that estimated there was an 80% chance of successfully raising the fishing boat and moving it to a shallower depth where recovery operations could be conducted (2). The *Ehime Maru* had approximately 246 000 L (65 000 gal) of marine diesel fuel onboard at the time of the collision. A \$2 million Environmental Assessment (EA) was conducted because of the proposed movement closer to shores of Oahu. It was concluded that there would be no significant environmental impact (B. Walker, personal communication) but additional protective measures were instituted to protect the environment in the event of a spill.

A privately owned oilfield drilling and diving support vessel, the *Rockwater 2*, was contracted to serve as the work platform. Two large lifting straps were placed by ROVs forward and aft beneath the *Ehime Maru*. The boat was lifted 7.6 m (25 ft) off of the ocean floor when acceptable weather conditions became available. The *Rockwater 2* began its transit to shallower waters at an initial speed of 0.2–0.5 knots in the company of other support vessels. The speed was slowly increased and the ship was gradually raised as it entered shallower waters during the 14-nautical mile journey

(3). On 14 October 2001, the *Ehime Maru* was set down in 35 m (115 ft) of water, one mile off Honolulu International Airport's Reef Runway.

Divers from the U.S. Navy began the search for the remains of the missing crew members, personal effects, and shipboard items on 15 October 2001. The Navy estimated that it might be able to recover between five and seven bodies (4) based upon survivors' accounts. Seventy-three divers worked 14-h days while conducting dives during the daylight hours (Fig. 1). Divers were equipped with Viking dry suits during the early dives for protection from oil contamination (CDR Fink, personal communication).

Water temperatures at the initial site of the accident were reported to be between 5 and 6°C (41 and 43°F). The water temperature of the shallower waters where the remains were recovered was approximately 25°C (77°F).

Postmortem Findings

Seven sets of intact remains, along with an eighth set of partial remains, were recovered at the completion of the operation. Two individuals were found in the computer room, two in the engine room, one in the pilothouse, one in the student mess, one in the forecastle, and one in the main deck passageway. Three students, three crew

members, and two instructors were recovered. The remains of one student were not recovered.

Human remains were recovered during the period of 16 October to 6 November 2001. All seven sets of intact remains exhibited varying degrees of partial skeletonization, early to advanced stages of decompositional changes, and autolysis of internal organs. Adipocere formation was noted in six of the remains. The remains found in the engine room showed the most advanced decompositional changes. Water temperatures in the various areas of the boat rapidly assumed comparable temperatures because of the ship's mezzanine deck structure (CDR Fink, personal communication). The reason for the differences in body decomposition could not be ascertained.

Antemortem injuries were noted in only one set of intact remains and included a neck laceration and fractured nasal cartilage. Both injuries were considered non-fatal. The presence of pleural effusions and pulmonary edema, identified in six remains with intact, non-skeletonized chest cavities, was consistent with drowning.

The cause of death was classified as undetermined due to advanced skeletonization with absence of internal organs in one set of remains. The cause of death of the other recovered remains was determined to be asphyxia due to drowning.

The manner of death was ruled accidental with all eight remains.

Identification of Remains

Forensic dental identification was the sole means used to identify the eight sets of remains. This identification modality was determined to be the most efficient means available as there was considerable pressure to expedite the identification process.

There were several obstacles encountered during the identification process. The odontologists were not allowed to remove the antemortem records from the medical examiner's office, in compliance with requests from the Japanese Government. There were antemortem records available for eight of the nine missing individuals. A professor from the Tokyo Dental College transcribed these records from Japanese into English. The available dental information was placed onto an Interpol-approved Victim Identification Form using the Federal Dentaire International (FDI) numbering system. Original radiographs were not available and the copies of radiographs were of varying quality, quantity, and type.

There were several incomplete dental records. One of the individuals had never sought dental care and did not have any dental records. His dental remains consisted of 32 unrestored teeth with severe anterior crowding. This person was identified by the exclusion of all other individuals involved in this incident.

Another descendant's radiographic dental record consisted of a lateral cephalometric radiograph taken when he was 7 years old. This individual was 17 years old at the time of the incident. The radiograph could not be used in the identification process due to significant dental changes. This individual did have a documented history of orthodontic care with the extraction of all four of his first premolars. No other individual associated with this incident presented with this type of extraction pattern. These remains could be identified by narrative similarities to the exclusion of all other individuals lost in this incident.

The recovered individuals were in varying states of decomposition. In general, all facial areas were partially or completely skeletonized. Remains that are immersed in an aquatic environment tend to lose soft tissue in the cranium and mandible due to these bones being thinly covered by soft tissue (5). It was not unusual to have multiple anterior teeth missing postmortem from the remains. Facial

soft tissue dissection was not required to access the dentition due to the state of decomposition. This access allowed for straightforward placement of the digital radiographic sensor.

Only one individual displayed postmortem "pink teeth." This phenomenon is caused by hemolysis of blood products (hemoglobin) into the dentinal tubules. Various authors have reported observing this phenomenon in moist or water environments (6-8).

Some of the transcribed antemortem dental records were apparently developed by interpretation of dental radiographs. One victim's panoramic radiograph was taken with the patient biting into occlusion. The amalgam restorations in the maxillary arch were superimposed on the mandibular teeth and were then charted as restorations on the mandibular arch due to this arrangement. Identical radiograph matches later allowed for a positive identification of this individual.

The remains of one individual consisted of six disarticulated teeth and several upper extremity bones. The recovered teeth were #5, #7, #9, #16, #25, and #26 (Universal Numbering System). Tooth #16 was an unrestored microdont recovered in 35 m (115 ft) of water under conditions of poor visibility. Tooth #5 was restored with a distal-occlusal amalgam and all of the other teeth were unrestored. Of the nine individuals lost in this incident, only one individual presented with a similar radiographic pattern for teeth #5 and #16. The available panoramic radiograph was of poor quality but its images were sufficient to allow for comparison with the postmortem radiographs.

All eight sets of remains were identified by dental comparison. Six of the identifications were considered to be positive and two were deemed to be probable dental identifications, using a modification of body identification terminology guidelines of the American Board of Forensic Odontology.

Discussion

United States Navy and Japanese civilian divers conducted their recovery operations from 15 October 2001 until 6 November 2001. They spent 435 hours of total bottom time while conducting 534 dives (CDR Fink, personal communication). Japanese Self-Defense Force divers verified the completeness of the recovery operation. The divers searched 120 accessible compartments of the *Ehime Maru* while working under conditions of poor visibility. Approximately 2200 personal effects were recovered, along with the ship's helm, bell, and anchors. The cost of this recovery operation and subsequent compensation was approximately \$88 million (Mr. Jon Yoshishige, personal communication).

On 25 November 2001, the *Ehime Maru* was moved 38.9 km (24.17 miles) to a point 19.3 km (12 miles) south of Barbers Point on Oahu. The *Ehime Maru* was resunk in 1800 m (5906 ft) of water.

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Pacific Fleet, provided essential background information of the recovery operations.

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Additional information and reprint requests:
John A. Lewis, Jr., DDS
Joint POW/MIA Accounting Command (JPAC)
310 Worcester Ave., Bldg. 45
Hickam Air Force Base, HI 96853-5530