The Pilot House

Since the location and identification of the remains of the U.S.S. Monitor in 1973 and the designation of the wreck as the United States’ first National Marine Sanctuary in 1975, the historic Civil War ironclad has been the object of considerable international interest. On-site and historical research related to the ship has generated waves of additional attention during the past five years. Despite this level of interest, there has been no vehicle for consolidating public interest in the Monitor. In addition to providing a focal point for this interest, this activities report will serve to enhance public awareness of the necessity for the continued scientific investigation as well as preservation of the remains of the ship. It will increase public access to the information generated through research at the site. The activities report will serve to bring the Monitor closer to you, the public, by communicating the historical and cultural information that is preserved within the Monitor National Marine Sanctuary.

Articles for the activities report will be included under the following classifications: Feature articles of 2,000 to 4,500 words dealing with technical and engineering subjects associated with the conduct of investigations at the site and/or recovery of the vessel, archaeological treatments of investigation in the Sanctuary and associated findings, and material that explores the future of the Monitor National Marine Sanctuary; Sanctuary Research Activity, describing management and research activities that are proposed or have been carried out in the Monitor National Marine Sanctuary; Technical Articles relating to the ship or material from the remains, the technology involved in investigation of the remains of the Monitor, and the technology associated with recovery of the ship, conservation, and display; Editorials; Correspondence; short news items associated with the Monitor and the Monitor National Marine Sanctuary and significant public events; and reviews of recently-published, Monitor-related books. Contributions to the activities report are encouraged. Anyone desiring to contribute an article or who has a suggestion for an article may contact the editors.

University Receives Grant

East Carolina University is pleased to announce the award of a grant from the National Oceanic and Atmospheric Administration to carry out several projects related to the Monitor National Marine Sanctuary. The projects include the publication of this semiannual activities report, preparation and publication of a plan for the next on-site expedition, and the establishment of the Monitor archival collection.

The activities report, to be published in December and June, will serve to keep Congress, the scientific community, and the general public informed as to current and future research at the site, public Monitor-related events and exhibits, published reports and articles, and studies that are being conducted. Historical notes, editorials, and summaries of official Monitor-related meetings will also be included.

The next expedition to the Monitor National Marine Sanctuary, tentatively scheduled for the summer of 1984, will include both archaeological and engineering objectives. Specific tasks for the expedition will be developed in accordance with recommendations made by the principals involved in the 1979 expedition to the site and by the authors of two studies currently underway. Efforts will be made to generate data that will assist in assessing the structural integrity of the remains of the vessel. The expedition plan will be completed by September, 1983.

The Monitor archival collection will be housed in the existing manuscript collection at the University and will include both modern and historical research material: monographs, correspondence, papers, articles, reports, photographs, film, slides, and video tape. Efforts are currently underway to identify and contact repositories and collectors who hold Monitor-related material. Donations of material to the Monitor archival collection will be gratefully accepted. Anyone wishing to donate Monitor material for inclusion in the collection or willing to permit Monitor-related material in their possession to be copied should contact William N. Still, Jr., Department of History, East Carolina University, Greenville, NC 27834.

Governor Jim Hunt and Dr. John V. Byrne, Administrator for the National Oceanic and Atmospheric Administration, discuss a photographic mosaic of the Monitor at the opening of an exhibit at the Fort Fisher Marine Resources Center. (Photo courtesy of Jane S. Patterson, Secretary of North Carolina Department of Administration. Please see related story on page 6.)
A Survey of Present Day Diving Technology That Could Be Utilized for Future Monitor Research

The wreck of the U.S.S. Monitor represents a significant challenge to archaeologists and engineers as well as professional diving system operators. To put man and/or machine in, on and around a wreck such as the Monitor for the purpose of taking measurements, recovering artifacts, and excavating with minimal damage to an already badly-deteriorated structure requires careful planning and consideration. This, in turn, will lead to the ultimate choice of a suitable diving system to meet these criteria. Having had the experience of diving on this wreck as pilot of the submersible, Johnson-Sea-Link I, I can relate intimately to some of the problems a diving expedition might encounter. I will briefly cover some of the many diving and submersible systems that might be used effectively on future expeditions to the Monitor.

First and foremost, the ability to put a diver on the wreck site in a free-swimming mode (tethered) is the most productive in terms of taking measurements and selectively recovering artifacts. The best way to accomplish this is to draw upon the vast diving experience of the offshore oil industry.

Diving Bells/ Saturation Systems

The Bell diving techniques, used in conjunction with an advanced saturation diving facility (Bell/Saturation systems), would certainly be applicable. These systems consist of a submersible decompression chamber (SDC), a transfer lock (TL), a deck decompression chamber (DDC), a control van and console, a handling winch, and palletized gas storage. A Bell/SAT system such as this could be installed on a barge and placed over the wreck in a four-point moor. This would allow divers to make lengthy excursions in exploring the wreck while remaining in saturation for many days before decompression. There could be several dive teams at work which would greatly reduce diver fatigue. Also with this type of system, there is unlimited power available for underwater tools and lighting. Hot-water diving suits can be employed and supplied from the surface. Continuous communications and video would be available via the diver’s umbilical and the diving bell tether to the surface.

This type of diving is used when considerable bottom time is required in an area to complete a series of predefined tasks. Weather and endurance of the divers are the only major limiting factors of Bell/SAT diving. Saturation at depth for over 30 days has been performed safely utilizing this technique. Decompression is quite lengthy and can last for several days depending on depth, but the divers need only decompress once at the end of the mission. Bell/SAT diving, as compared to surface-supplied diving, is much safer because the SDC is located at the work site and no in-water decompression is required.

Manned Submersibles

Manned submersibles, such as Johnson-Sea-Link, could also be employed as observation vehicles and for short-duration diver lockout (60 minutes bottom time). This could be very useful in getting key non-diving personnel on the bottom for firsthand observations and engineering decisions that would have to be made if large portions of the wreck, such as the turret, are to be recovered.

Reflections

"...I suppose if you think of the Monitor, you would say that it is about as nonliving as any object you could think of. But I am not sure that is really the case. I think that anyone who has affection for the sea or affection for ships recognizes that ships have lives of their own. Certainly that is true in the case of the Monitor. The Monitor brings a sense of history; it brings a connection with another era; it brings a sense of a part of our heritage as Americans that we are proud to acknowledge. In one sense, it is a very real living resource..."

Dr. John V. Byrne
Administrator of NOAA
April 23, 1982
The manned one-atmosphere systems generally fall between true manned submersibles and diving bells. These vehicles derive their power from the surface via an umbilical and are, therefore, limited in maneuverability and bottom coverage. They do have unlimited power supplied from the surface. Some systems are equipped with force feedback manipulators that are almost as versatile as a man's hands and arms. There is at least one of these vehicles that can also be used as a diving bell.

One new arrival in the manned one-atmosphere category is the Mantis Duplex, developed by Osel Offshore Systems Engineering, Ltd. This vehicle can be used in dual roles, first as a one-atmosphere manned vehicle equipped with eight thrusters for maneuverability, two human equivalent arms and two TV cameras that can be controlled either by a pilot or on the surface via the tether cable. Secondly, this vehicle can be operated unmanned as a remotely-operated vehicle (ROV).

![Mantis Duplex](image)

Atmospheric diving suits (ADS) are basically armored diving suits that provide a one-atmosphere environment and carry their own life support systems. Some models have thrusters for more maneuverability and movable arms and legs. They must, however, be operated on a tether from the surface. Tasks that can be performed and the work area that can be covered using this method are quite limited.

![Harbor Branch CORD II](image)

The advantages of these suits are their small size, lightweight form and ease of transport and handling. The relative size of the surface support equipment is greatly reduced.

Unmanned remotely controlled systems are numerous, as there are many companies now producing these devices around the world. They are used primarily in the offshore oil industry with a few being used for scientific and military applications. The main advantage is removal of man from the water. However, man still remains the most vital link in the system that he controls it from the surface using a TV camera as his eyes.

Most remotely controlled systems operate from a current-deflection weight with a 100/150-foot excursion tether. The deflection weight is sometimes termed a garoo or, in the case of Harbor Branch Foundation's CORD (Cabled Observation Rescue Device) vehicle, a klunk. These can weigh several thousand pounds and care must be exercised as to where they are placed. This arrangement frees the vehicle from potential current drag on the umbilical, which can become critical in high current situations.

Unmanned vehicles are generally designed to perform specific tasks and would probably not be versatile enough to play a role as the primary diving system for an archaeological expedition. However, they could be used in a support role by documenting work progress by divers or perhaps remaining on station while a large object was being raised to the surface. In such cases, for safety, all divers are evacuated from the area.

The Monitor wreck presents an exciting challenge to the archaeological community. Photographic and video coverage of the wreck, as well as artifacts already recovered, only serve to stimulate further search for data that could be obtained by continued exploration of this unique piece of United States history. Perhaps one day in the near future, through the use of the vast resources of diving systems and the engineering capability available, the American public will be able to view major portions of the U.S.S. Monitor.

### References

### EDITOR'S NOTE: Timothy M. Askew is Chief Submersible Pilot with Harbor Branch Foundation, Inc., a not-for-profit corporation established primarily for research in the marine sciences and for the development of tools and systems for underwater oceanographic research.

Mr. Askew has logged over 400 missions in the Johnson-Sea-Link submersibles including the 1977 photogrammetric survey and the 1979 archaeological and engineering assessment of the U.S.S. Monitor.

### University Plans Next On-site Expedition

Each expedition to the Monitor National Marine Sanctuary has produced varying amounts of data related to different aspects of the wreck and its environment. In addition to providing the answers to specific questions, these expeditions have generated more questions that need to be answered in order to effectively evaluate the potential for recovery of the Monitor remains. By addressing these questions and the tasks outlined in the "Monitor National Marine Sanctuary Management Plan," as being necessary to the decision-making process, East Carolina University is currently compiling an expedition plan that will outline a series of tasks to be conducted on-site that will add to our overall understanding of the site and its potential for future research and possible recovery.

If funding and equipment can be secured to conduct an on-site expedition in the summer of 1983, archaeological and engineering studies to be carried out could include an examination of the propulsion units; structural documentation; main frame analysis; and recovery of coal samples from the engine room. Further studies in conservation of materials from the site, an attempt could be made to locate, identify, and possibly recover the vessel's ground tackle. Recovery of projectiles from the site may also be carried out.

For 1984, archaeological and engineering tasks could include more comprehensive structural documentation; investigations of the starboard and port armor belts; and investigation of the interior and base of the turret with excavation in both areas. In addition, environmental data could be collected.

As specific tasks for the next on-site expedition will be refined within the next few months, a more comprehensive article will appear in the next issue of "Cheesebox."

Editor's note: Following is a summary of the expeditions carried out to date in the Monitor National Marine Sanctuary.

- **R/V Beveridge**
  - **Date:** August, 1974
  - **Activity:** An underwater television system was utilized to record the wreck.

- **R/V Eastward**
  - **Date:** June, 1976
  - **Activity:** Acoustic reflection measurements were made of the wreck.

- **R/V Cape Henlopen**
  - **Date:** April, 1977
  - **Activity:** A current meter was installed outside the sanctuary; a sediment core was taken from the vicinity of the remains; and a horizontal view of the forward section of the wreck was recorded with a television camera.

- **R/V Johnson**
  - **Date:** July-August, 1977
  - **Activity:** A photogrammetric survey of the wreck was carried out and a hull plate and brass navigation lantern were recovered, as was a camera system that had been lost during the 1973 expedition.

- **R/V Calypso**
  - **Date:** Several dives from the surface resulted in film footage of the wreck, most of which was of little or no value due to extremely poor visibility.

- **R/V Johnson**
  - **Date:** August, 1979
  - **Activity:** Archaeologists conducted a test excavation in the vicinity of the captain's cabin and installed permanent reference points adjacent to the wreck. More than one hundred artifacts were recovered from the site for analysis and conservation.
The Monitor is No More

When commander J.P. Bankhead decided to send a prearranged distress signal to the Rhode Island, water in the Monitor had already "risen several inches above the engine room floor." When the Rhode Island finally hove to thirty minutes later, towing hausers attached to the Monitor's bow made the ship virtually unmanageable. Bankhead ordered them cut and brought the ironclad close under the lee of the Rhode Island before ordering all available steam to the vessel's pumps. The effect was limited, for only minutes later Second Assistant Engineer Joseph Waters reported that water covered the ash pits. The rising water allowed "very little air to reach the fires; at the same time the blowers used for producing a current of air to the fires were throwing a great amount of water," thus extinguishing the flames.

Without power to the engines, the vessel could no longer be kept headed into the seas. "Mountain waves" pushed the Monitor's bow to the west and into the troughs where the vessel rolled so heavily that boats from the Rhode Island could not approach without putting themselves in danger of being washed onto the partially-submerged decks. Hoping that the anchor would bring the vessel head up into the sea, Bankhead ordered it released with all available chain. Fortunately, this succeeded, allowing those of the crew willing to risk being washed over the side to board the boats. Although there were still men on the Monitor who refused to leave, Bankhead felt that he had done "everything in my power to save the vessel and crew" and boarded an already overcrowded launch.

"The Monitor is no more. What the fire of the enemy failed to do, the elements have accomplished."
—Acting Paymaster William F. Keeber
January 6, 1863

By the time Bankhead abandoned the Monitor, she had already shipped so much water that her "heavy sluggish motion" indicated that she could not remain afloat much longer. When Bankhead reached the Rhode Island, which according to Seaman Francis B. Butts had drifted "perhaps two miles leeward" of the sinking vessel, the distress signal burning from the Monitor's pennant staff above the turret disappeared. At this time Acting Master's Mate D.R. Browne, in charge of the first cutter, was already returning to the sinking vessel for the third time. Rowing against heavy seas and southwesterly head winds, the cutter had covered three-quarters of the one mile distance Browne estimated to separate the Rhode Island from the Monitor when the distress signal appeared to settle slowly into the sea.

"When we approached what he supposed to be the position of the vessel, he could perceive no other trace of her except an eddy apparently produced by the sinking of the vessel." The time recorded by Commander Bankhead was 1:30 A.M. on 31 December, 1862.

For more than a century these historical references represented the last evidence of Ericsson's historic ship. Today investigation of the remains of the Monitor have produced additional insight. The exact location of the sinking has been established at 35°00'23" North Latitude and 75°24'32" West Longitude. In addition, research at the site has shed light on the sinking sequence that no historical source could preserve.

An examination of the present position of the turret, hull, and anchor chain and the distribution of the contents of the hull confirm details of the sinking sequence that followed the disappearance of the ship's distress signal. As the Monitor's hull filled with sea water, the ship began to settle rapidly. Water rushing in through open engine room ventilators combined with the weight of engineering space machinery to send the ship down stern first. As
bouyancy decreased, the weight of armor attached to the Monitor's deck, armor belt, and forming the turret and the energy of wind-driven seas combined to cause the ship to capsize, sending the unsecured contents of the vessel cascading aft and to starboard. Sinking by the stern at an angle of from 45 degrees to 60 degrees and rolling to starboard, the Monitor's hull must have been only a short distance from, or in contact with, the bottom when the turret landed on the sand within approximately 50 feet of the stern point of impact. As air rushed forward through the false keel and ventilation passages below the bilge ceiling to escape through the anchor well, the Monitor settled to the south-southwest with the inverted port quarter coming to rest on the base of the turret. Although some structural damage to the stern may have occurred during the sinking process, the sediment record inside the hull forward of the admidships bulkhead existed in a relatively intact condition for an extended period before the structural collapse that contributed to the present condition of the wreck.

Gordon P. Watts, Jr.
East Carolina University

Researchers
Relish Recipes

The 1979 expedition of the Monitor National Marine Sanctuary was the most ambitious undertaken to date and resulted in the recovery of a variety of materials from the site. Perhaps the most interesting item brought up from the wreck was a glass storage jar with its seal still intact. Inside the sealed jar was relish, perfectly preserved after 117 years on the ocean floor. In order to learn what gifts from the garden had gone into making this condiment, which would most likely have graced the table of one of the officers aboard the Monitor, the North Carolina Division of Archives and History asked the National Food Processors Association of Washington, D.C., to analyze the relish and report on their findings. Their tests showed that the relish contained the following ingredients: cloves, onions, pepper seeds, cucumbers, mustard seeds, pepper corns, and mushrooms. The editors and staff of "Cheesebox!" discussed the possibility of recreating this relish based on the ingredients identified by the analysis. However, we soon encountered a problem: while we had all watched our grandmothers make relish, none of us had ever seen relish made with these particular ingredients, especially mushrooms. And so we would like to enlist the aid of our readers. If anyone has a mid-nineteenth century recipe for relish that calls for the exact ingredients contained in the Monitor relish, we would very much like to hear from you. We are also interested in knowing how the relish was cured and if there were any particular foods it was served with.

We will publish the results of our appeal for help in the next issue.

Dina B. Hill
East Carolina University

The sealed storage jar containing relish. Do you have the recipe?
North Carolina Marine Resources Center Hosts Monitor Exhibits

Governor Jim Hunt described the April 23 opening of the first public Monitor exhibit as "like the showing of artifacts from King Tut's tomb." And in many ways, it was.

We reached our past and we saw and learned, through exhibited objects, what it was like to have lived and to have fought on the remarkable ship that holds a special place in the history of our country and in naval history. From the pages of history books, the Monitor came alive for us through relics: a davit, the base of a brass lamp, a leather book binding, an intact English walnut, a brass thimble, a white porcelain soap dish, a wine or champagne bottle, mustard bottles, fragments of wood, iron, glass and ironstone plate.

I was pleased to have taken part in the formal opening of the exhibition, which attracted maybe a half million visitors in the six months it was displayed. I was even more pleased that the trio of independent exhibits were housed in the North Carolina Marine Resources Centers, which are administered by my department.

The centers, located on Roanoke Island near Manteo, on Bogue Banks near Morehead City, and at Fort Fisher near Kure Beach, are often referred to as "windows to the sea." In the case of the Monitor exhibits, the centers were windows to history locked in the ocean's depths for well over a century.

Governor Hunt, who has taken a strong personal interest in the issues that so deeply affect our coast, was involved and very supportive of efforts to preserve and protect the Monitor and to make the exhibits possible. Joining the governor and me for the grand opening at Fort Fisher were Dr. John V. Byrne, administrator of the National Oceanic and Atmospheric Administration (NOAA), and Dr. John J. Little, administrator of the Archaeology and Historic Preservation Section of the North Carolina Department of Cultural Resources.

In addition to the North Carolina Departments of Administration and Cultural Resources and NOAA, other agencies cooperating in making the exhibits possible included the U.S. Department of the Navy and the U.S. Department of Commerce. The project was truly a cooperative effort. Many agencies and people were involved, and I am personally grateful to each of them for making the event possible.

Each center's display had its own unique look. The one at the Roanoke Island site, designed and coordinated by Dale Martin from the center's staff, was highlighted by a replica, but smaller version, of the Monitor's famed revolving gun turret. Fort Fisher featured a pavilion with display insets and boardwalk, designed and coordinated by Ellen Johnson of the Office of Marine Affairs. Bogue Banks had a modern, airy display with large photographs suspended from the ceiling and free-standing plexiglass display cases, designed and coordinated by Jay Barnes of that center's staff.

The Monitor exhibits represent only one aspect of the $5 million North Carolina Marine Resources Centers. The centers began as research facilities about six years ago but have broadened their roles to include a major public education effort. This public education effort varies from teaching people how to use unusual types of seafood, to hosting public meetings so that citizens can understand and be involved in the process of offshore oil and gas exploration. The centers, which are designed to meet the needs and interests of tourists and professional oceanographers alike, are open year-round, and admission is free.

Since the dedication of the Marine Resources Centers in September of 1976, over three million people have visited these facilities. This year, over 130,000 citizens will participate in the various educational programs, workshops and seminars conducted by the centers, and another 550,000 will visit the centers to view the aquariums and exhibits, such as the Monitor display, which perhaps attracted more acclaim than any other exhibit in the centers' history.

The "Graveyard of the Atlantic" claimed the Monitor for more than a century. The Monitor's artifacts, lost in the deep since 1862, were resurrected so that we may learn and we may better know the life and times of the famed Monitor.

Jane Smith Patterson Secretary North Carolina Department of Administration

EDITOR'S NOTE: Jane Smith Patterson, secretary of the N.C. Department of Administration, was among the officials participating in the April 23 grand opening of the exhibition of artifacts from the U.S.S. Monitor at the North Carolina Marine Resources Center at Fort Fisher.

The three marine resources centers are administered by the Office of Marine Affairs, North Carolina Department of Administration.

Actual visitor totals for the three Marine Resources Centers during the period of the Monitor exhibits are as follows: Fort Fisher: 180,352; Bogue Banks: 246,384; and Roanoke Island, 214,483.

Monitor Research and Recovery Foundation

Members of the Board of Trustees of the Monitor Research and Recovery Foundation held a meeting on Thursday, May 20, 1982, at the Foundation's headquarters in Norfolk, Virginia. Attending the meeting were trustees Denny Boyce, Calvin McGowan, and William N. Still. Also present were Irwin Berent, the Foundation's archivist, and Edward W. Wolcott, representing the city of Norfolk. Those present agreed to negotiate with the Museum at the Norfolk Navy Yard considering the possibility of relocating the Foundation's records, research materials, and artifacts there.

William N. Still East Carolina University

The Monitor in Miniature

In 1978 the Hampton Roads Ship Model Society asked John Newton of the Monitor Research and Recovery Foundation to speak at one of its functions. After talking with John, I became extremely interested in the Monitor and soon after, joined the volunteer staff of the foundation as an administrative assistant to Mr. Newton. Thus over a period of several years, I have had the opportunity to become more familiar with all of the various aspects of the Monitor.

In January, 1980, I was approached by Mike Curtain, curator of the Hampton Roads Naval Museum in Norfolk, Virginia, to construct a model of the Monitor that would replace one on display that was to be relocated elsewhere. As the time frame for completion of this new
model was very liberal, we decided to incorporate all of the most recent research data into the model, which would update it with regard to the many existing models on display. This new approach required a great deal of additional research and led to contact with many of the individuals whose work on the Monitor had spanned many years. By far the most helpful was Captain Ernest Peterkin, who has spent years researching the Monitor and is in the process of developing a set of plans for the state of North Carolina. Through the use of Captain "Pete's" many sketches and diagrams, we have been able to incorporate into our model much of the information resulting from visual contact with the remains of the vessel as well as from a great deal of research by many people. The projected completion date for the new Monitor is early summer of 1983. More concerning this project will appear in a later issue.

Tom Tragle
Hampton, Virginia

The author wishes to acknowledge the assistance he has received from numerous individuals in the construction of his model.

"Thunder at Hampton Roads"

On November 17 a special exhibition entitled "Thunder at Hampton Roads: Shipwrecks of the Civil War" opened at the Mariners' Museum, of Newport News, Virginia. The Museum treats all facets of maritime history, but has always made the Civil War one of its specialties. Much of the fighting took place in Tidewater Virginia, whose residents take an intense interest in the subject. The new exhibit concentrates on four warships that were intimately associated with the region: the U.S.S. Monitor, the C.S.S. Virginia, the U.S.S. Cumberland, and the C.S.S. Florida. Its displays of Monitor artifacts has been organized with the generous assistance of NOAA, the United States Navy, and the North Carolina Division of Archives and History. The objects include bottles, fragments of wood and metal, and various personal effects brought up from the officers' quarters. A panel of color photographs explains how the wreck is being explored. The Monitor section of the exhibit is completed by a set of superb contemporary plans, which are being lent by the American-Swedish Historical Foundation. The Mariners' Museum is fortunate to have in its archives copies of a rare set of plans of the Virginia. They were drawn by John L. Porter, a Confederate naval constructor who was intimately involved in the conversion of the Merrimack into an ironclad. Shortly after her battle with the Monitor the Virginia was blown up by her crew; her remains lay in the mud off Crane Island, on the south side of Hampton Roads, for the rest of the war. Afterwards the wreck was broken up, and pieces of it passed into the hands of businessmen and amateur collectors. Unfortunately the modern science of archaeology did not exist; objects that would be regarded as priceless artifacts today were turned into souvenirs, such as walking sticks and miniature guns, to make them saleable. As research tools they are useless, but they illustrated the progress that has been made in the field of historic preservation over the past century.

The wrecks of two more Civil War vessels were discovered recently in the James River, a few miles from the Mariners' Museum. The sloop-of-war Cumberland was the Virginia's first victim during the rebel ironclad's rampage through the Union blockading squadron. The Florida, one of the notorious Confederate commerce raiders, was seized by a Union warship in the neutral harbor of Bahia, Brazil, in 1864. She was brought to Hampton Roads by a prize crew; in the midst of the heated negotiations between the Brazilian and American governments she mysteriously sank.

In 1981 the National Underwater and Marine Agency, a private concern organized by the novelist Clive Cussler, sponsored a search for the two James River wrecks. Divers from a contract archaeology firm called Underwater Archeological Joint Ventures, with help from several local watermen who remembered snagging their lines on old shipwrecks, eventually located and positively identified both the Cumberland and the Florida.

They lie in about sixty-five feet of brackish, muddy water a few yards from the James River ship channel. Warships and freighters on their way to and from Newport News Shipbuilding hampered the efforts of the divers, whose visibility was limited to eighteen inches. The upper hull timbers of the wrecks had fallen prey to the teredo worm, but the river current had deposited a protective layer of mud over what remained. It is hoped that a large-scale effort to explore both ships can be mounted in the near future; the artifacts brought up so far only provide a taste of what lies beneath the mud.

The exhibit at the Mariners' Museum marks the first time that the Cumberland and Florida artifacts, which have been under the care of a conservation laboratory, have been shown to the public. Most of the pieces are small, but they provide an intimate glimpse into what life at sea was like during the Civil War.

The most impressive finds from the Cumberland are her bronze bell, a rifle rack, and two heavy brass "pans" that probably covered the touch holes of her heavy guns. More personal items include fragments of pottery, veiled the wreck. Deputy Consul General Lars Carlson presented the greetings of the Swedish government and paid tribute to Ericsson with an inspiring address on the inventor's life and accomplishments. Kenneth Haber, representing the Borough of Brooklyn, read a dynamic proclamation. Greenpoint, Brooklyn, was the site of the construction of the Monitor in 1861. Harry Clifford, longtime JES member, presented the Society with a framed photograph of the John Ericsson statue from Wash-ington, D.C. This photograph and the proclamations will be added to the collection of Ericsson memorabilia on display in the John Ericsson Room at the Church of Sweden in New York City.

John Ericsson's Birthday Hailed in Sweden

Kjell Lagerstrom, president of the John Ericsson Society, was not present at the celebration in Battery Park because of his attendance at the John Ericsson Memorial Day-Sweden American Day Ceremonies in Filipstad-Varmland, Sweden, held Sunday, July 25, 1982. These events included presentations at Ericsson's Mausoleum in Filipstad.

Aizar Templeton

Monitor Presentation

Alazar Templeton presented her slide-lecture program, "U.S.S. Monitor," to researchers at American Cyanamid Co. in Princeton, New Jersey, on October 13, 1982. Approximately two hundred scientists and technicians were in attendance. Exterior and interior cutaway models of the Monitor created by Ms. Templeton were on display for study by the participants. The program was followed by a question and answer session and luncheon.

Aizar Templeton

(continued on page twelve)
Bryozoans Encrusting The 1862 Monitor Shipwreck Off Cape Hatteras

Introduction

PURPOSE

The U.S.S. Monitor, the first turreted ironclad warship in naval history, sank in a storm off Cape Hatteras in 1862. For over a century, before being relocated in 1973, the Monitor shipwreck lay on the shallow sandy sea floor, where it served as an artificial reef onto which settled and grew bryozoans and other invertebrates.

The Monitor was employed successfully to enforce the Union Navy’s blockade of the Confederate coast, early in the American Civil War. Beyond that, moreover, the Monitor changed the entire course of naval warfare, by being the first heavy-gunned warship protected by thick armor plating and armed with a revolving gun turret.

The great historic significance of this vessel is stimulating careful investigations of its shipwreck site. Consequently, the Monitor wreck furnishes an unusual opportunity to examine bryozoan encrustation, growth, and diversification upon a reef-like structure, after a long but precisely known time interval, in well-understood environmental circumstances.

ACKNOWLEDGEMENTS

We thank Robert E. Sheridan (Univ. Delaware) for calling our attention to scientific access to the Monitor shipwreck, and Gordon P. Watts, Jr., (currently at East Carolina University) for making pieces of the Monitor’s concretionary crust available for examination.

The Monitor Locality

The Monitor shipwreck lies on the continental shelf south-southeast off Cape Hatteras (Fig. 1; Dare County, North Carolina). It is 17 statute miles (13½ nautical miles or 27 km) S 30° E from the southern tip of the cape, and 12½ statute miles (11 nautical miles or 20 km) S 30° W from the Diamond Shoals light station; its position is about 35°00'01" N, 75°23'24" W (from Newton, 1975, p. 56; see other papers in this report volume).

The Monitor lies overturned, bottom-up, with its stern resting on top of its now broken-off turret. It is 220 ft (37 fms or 67 m) down, on a flat bottom consisting of loose, dark-colored (black), shelly sand veneering a clay stratum below (Newton, 1975; Sheridan, 1981, pers. comm.). The sea floor there is subject to gentle currents and periodic storm waves. Badly corroded and quite fragile, the wreck’s metallic portions are covered by a calcareous-ferruginous-arenaceous, concretionary crust. We examined recovered pieces of that crust for possible bryozoan involvement, and found several thin bryozoan encrustations thereon.

Monitor Bryozoan Assemblage

FAUNAL OVERVIEW

Bryozoans, members of the phylum Bryozoa or Ectoprocta, are tiny polyps (zooids) which live in delicate colonies (zoaria) attached to hard objects on the sea floor. The dominant bryozoans in modern shelf seas belong to one order, the Chelostomata, easily recognized because its polyps secrete box-like cases (zoecia).

The Monitor concretionary crust fragments examined yielded 11 encrusting chelostome species (Fig. 2A), all previously described forms. Six of the Monitor bryozoan species (Table 1) are considered important, because they occur either commonly (numerous separate colonies) or extensively (fewer but larger, spreading sheets). None, however, can be described as dominant or abundant; nothing like the bryozoan nodular masses seen off Woods Hole.

![FIG. 1. Sketch map showing location of Monitor shipwreck (X; lighthouse and lightship, circles; bathymetric contours in feet; north toward top; redrawn from Newton, 1975, p. 56, and USGS Manteo 1:250,000 topographic quadrangle).](image)

![FIG. 2. Monitor bryozoan colonies. A, encrusting sheet-like chelostomes, accompanied by serpulid tubes, on upper or outer surface of concretionary crust from wreck, in overview (left; scale bar 10 mm long) and close-up (right; scale bar 1 mm long). B-E, individual colonies, scale bar 0.5 mm long; B, Aplousina gigantea; C, Parelissina latirostris; D, Cribrilaria radiata; E, Parasmittina spathulata.](image)
(Massachusetts) or in Chincoteague Bay (Virginia), nor like the bryozoan reef-rock at Joulter's Cays (Bahamas), is developed on or around the Monitor shipwreck. Five other cheilostome species (Table 1) are only incidental or rare associates of the other Monitor bryozoans. No cyclostome, cniostome, or entoproct bryozoans were seen on the Monitor crust pieces.

Many of the Monitor bryozoan encrustations are not well-preserved, and appear corroded or partly dissolved. Such a condition suggests that incipient diagenetic dissolution or recrystallization is already beginning to affect those colonies.

**TABLE 1.** Bryozoan species recovered from the Monitor shipwreck (in taxonomic order as in the text).

**SPECIES ANNOTATIONS**

Because all 11 of the Monitor bryozoan species are already known to science, full descriptions and synonymsies can be found in the available literature, and only appropriate annotations need be made here. Species arrangement follows Bassler (1953). Due to the poor preservation of most colonies (Fig. 2), the characteristics of each species are illustrated further (Figs. 3-4) by detailed drawings modified from standard monographs. Synonymous names, if any, under which the species appears in the earlier literature are indicated, as well as references to full morphologic descriptions of each form. Previously reported biogeographic and bathymetric distributions are also summarized.

**Phylum Bryozoa or Ectoprocta**

Class Gymnolaemata or Eurystomata

Order Cheilostomata

Suborder Ancas

Aplousina gigantea

*Parcellina curvirostris*

*Parcellina latirostris*

Suborder Cribriornphora

*Cribriaria radiata*

Membraniporellus petasus

Suborder Ascopora

Hippothoa flagella

*Microporella ciliata*

Cleidochisma contracta

Cleidochisma porcellana

Parasittina spathulata

Porella thriconta

**FIG. 3.** Monitor bryozoans: the important species. (Modified from references cited; reproduced with permission; each scale bar 0.1 mm long). A, Aplousina gigantea (Bassler, 1953, p. 161); B, Parcellina curvirostris (Bassler, 1953, p. 165); C, Parcellina latirostris (Bassler, 1953, p. 165); D, Cribriaria radiata (Bassler, 1953, p. 185); E, Microporella ciliata (Rogick, 1964, p. 183); F, Cleidochisma contracta (Rogick, 1964, p. 183).

**FIG. 4.** Monitor bryozoans: the incidental species. (Modified from references cited; reproduced with permission; each scale bar 0.1 mm long). A, Membraniporella petasus (Osburn, 1950, p. 252); B, Hippothoa flagella (Osburn, 1952, p. 528); C, Cleidochisma porcellana (Canu & Bassler, 1929, p. 320); D, Parasittina spathulata (Rogick, 1964, p. 185); E, Porella thriconta (Shier, 1964, p. 635).

Family Calloporidae

*Parcellina curvirostris* (Hincks, 1861)

Fig. 3B

*Former synonyms Membranipora, Callopora, and Ellisina curvirostris.*

Described by Canu & Bassler (1928, p. 32-33), Osburn (1940, p. 361).

Previously recorded south of Cape Hatteras, in Caribbean-Carolinian province at 150-1200 ft (50-375 m) depths; also tropicopolitan; important on *Monitor.*

*Parcellina latirostris* Osburn, 1940

Fig. 2C, 3C


Previously recorded south of Cape Hatteras; in Caribbean-Carolinian province at 25-300 ft (8-90 m) depths; important on *Monitor.*

Suborder Cribriornphora

Family Cribriiniidae

*Cribriaria radiata* (Moll, 1803)

Fig. 2D, 3D

*Former synonyms Eschara, Cribriina, Puellina, and Colletosia radiata or innominata.*


Previously recorded south of Cape Hatteras; in Caribbean-Carolinian province at 0-2550 ft (0-770 m) depths; also cosmopolitan; incidental on *Monitor.*

*Membraniporella petasus Canu & Bassler, 1928*

Fig. 4A

*Former synonyms Membraniporella aragoi or pacifica.*

Described by Canu & Bassler (1928, p. 36-37), Osburn (1940, p. 484), Osburn (1950, p. 174-175).

Previously recorded south of Cape Hatteras; in Caribbean-Carolinian province at 10-1200 ft (3-375 m) depths; also tropicopolitan; incidental on *Monitor.*

Family Hippothoidea

*Hippothoa flagella Manzoni, 1870*

Fig. 4B

*Former synonym Hippothoa distans.*


Previously recorded south of Cape Hatteras; in Caribbean-Carolinian province at 0-2350 ft (0-720 m) depths; also cosmopolitan; incidental on *Monitor.*

(continued on next page)
Monitor Bryozoan Implications

BIOGEOGRAPHY AND DISTRIBUTION

Species distributions of various invertebrates, particularly mollusks, long ago led to recognition of 4 temperate-controlled faunal provinces along the Atlantic continental shelf off eastern North America — the Boreal province north of Cape Cod, the Virginian from there down to Cape Hatteras, the Carolinian from there down to Cape Canaveral (and across into Texas), and the Caribbean from there on southward.

Bryozoan species distributions are likewise limited by temperature. About 215 species occur in this region of the Atlantic shelf; 30 range throughout, 20 more are found only north, and 165 additional only south, of Cape Hatteras (Maturo, 1968). However, the bryozoans are also influenced by other environmental factors, salinity and substrate, on the warmer portions of this shelf. Along shore, especially near and in bays or estuaries or sounds, brackish salinity excludes many species. However, offshore and out across the shelf, substrate availability governs bryozoan distributions, with only a few (5) lunulitiform species on the flat extensive plain-like sand bottom comprising the bulk of the shelf, and most (210) of the bryozoan species encrusting scattered local patches of harder bottoms (shell beds, bedrock pavements, reefs, ballast piles, and shipwrecks). Consequently, the bryozoan species south of Cape Hatteras blend together into a single provincial fauna (Carolinian), with many of the Caribbean forms ranging northward along the outer shelf into the Carolinian area wherever suitable hard-bottom conditions exist (Maturo, 1968).

The bryozoan species recovered from the Monitor wreck constitute a typical warm-water hard-bottom assemblage for this part of the continental shelf. All have been reported previously south of Cape Hatteras, within the Caribbean-Carolinian province, from the southeastern U.S. coast, Gulf of Mexico, Caribbean, and West Indies. Many (8 of the 11 species) are also wider-ranging (tropicipolitan or even cosmopolitan).

Previous surveys of continental-shelf bryozoans sampled several localities near Cape Hatteras (Maturo, 1968). In most cases, only 1 to 3 species were taken at each locality; in a few, 6 or 7. Thus, the Monitor wreck, yielding 11, seems comparatively rich for this area. However, it should be noted that these low numbers may well be an artefact of sampling or inaccessibility; occasional hard substrates have yielded almost 100 species upon extended examination (Maturo, 1968), and so it is possible that more bryozoan species are lurking down in the Monitor wreck for future divers to recover.

BATHYMETRY AND COLONY FORM

Among the Monitor bryozoan species, all but one (discovered only recently) have been found previously at depths as shallow as 220 ft (67 m) where the Monitor rests, so their recognition here does not significantly alter present understanding of their bathymetric ranges.

Bryozoan colony forms (zoarial growth forms) were originally thought to be directly correlated with water depths, but have since been found to be more complex and only partially correlatable with water movements, substrates available, and depositional rates. (Because those three environmental factors often do vary significantly with water depth, the simpler equaling is readily understandable as an initial approximation.)

All the Monitor bryozoans are encrusting cheilostomes, growing as thin sheets covering parts of the wreck's surface; these colonies are termed membraneform. None of the bryozoans here developed by adding successive sheets atop one another; that type of growth would have resulted in massive lumps (celleporiform colonies). Notably absent also are the various erect colony forms — flexible tuft-like branches (cellariform) and rigid branches, fronds, and lattices (viculariform, adeniform, and retetopiform, respectively). Likewise missing are hollow cup-like unattached colonies (lunuliform). Sheet-like encrusting (membraneform) colonies characteristic of all the Monitor bryozoan species are elsewhere found on hard substrates in rough or turbulent waters, but also flourish in quiet waters with little or no sedimentation. The Monitor wreck falls well within such ecologic conditions.

The observed absence of other colony forms seems largely respectable. The rigid erect forms all require more constantly quieter waters than are likely here off shore-swept Diamond Shoals. Lunuliform colonies occupy loose sand substrates, so would be living out on the bottom nearby, rather than up on the wreck itself. Tuft-like colonies might well be expected in this same environment where encrusting sheets are so dominant; perhaps the wreck surface is too crumbly or sandy to permit their attachment, or perhaps such colonies might have broken off during collection.

ENCRUSTATION AND SEDIMENTATION

Prior to the Monitor's sinking, its site was a flat loose-sand bottom, presumably devoid of bryozoans except for a few free-living dome-like (lunuliform) colonies. Arrival of the Monitor's upside-down hull instantaneously added an artificial reef, providing hard firm substrates up above the shifting sands on the surrounding bottom. At least 11 bryozoan species, all thin encrusting sheets and accompanied by other attached-epifaunal organisms, settled on the hull during the next 115 years, until the accumulated calcareous concretionary crust (by then as much as 40 mm thick in places) was partially recovered late in the 1970s.

FIG. 5. Monitor concretionary crust in peel-section; scale bars 0.2 mm long. A, upper or outer portion of crust, with abundant invertebrate skeletal fragments. B, lower or inner part of crust, mostly quartz sand grains cemented by nearly opaque iron-stained calcite.
The bryozoans constitute only thin sheets veneering the outer or upper surface of the concretionary crust developed on the Monitor shipwreck. Living with them on that surface are numerous barnacles and serpulid worm tubes, and a few small encrusting corals and cemented pelecypods (possibly spondyliids).

Continuing encrustations, overlapping and overgrowing one another, might be expected to develop a progressively more reef-like surface atop the wreck over the coming centuries, provided the hull does not disintegrate and scatter before the calcareous cover becomes large enough to effectively protect the remnants. If, eventually, thousands of years worth of encrustations were to build up on the Monitor site, these present 11 bryozoan species (and their encrusting sheet-like colony form) would be counted among the pioneer organisms within the resulting reef-like structure. Of course, the probability of this scenario becoming reality is difficult to predict, but well-developed fossil and living reefs have all passed through analogous phases.

On the present-day Monitor wreck, its concretionary crust includes some swollen nodular portions, which superficially resemble the bryozoan reef-rock seen elsewhere (Joulter's Cays, Bahamas) as a result of the growth of many successive layers of bryozoan encrustations on one spot. However, cutting into the Monitor's crust revealed no such many-layered (multilaminar) encrustations, and so another explanation for those thickening must be sought. Because the Monitor shipwreck functions as an artificial reef, its bryozoans fit into recognized reef-ecologic roles (Cuffey, 1977). Those animals are accessory veneerers or cryptic encrusters, rather than principal skeletal-frame builders, in view of their thin sheet-like (rather than massive many-layered) encrustations. Moreover, their thin crusts are fragile, so that any fragments would not survive long enough to become sedimentary grains around the wreck (any such would be quickly ground down by the shifting quartz sand grains). None of the bryozoans rises above the surface enough to baffle or trap any loose sediment around it. However, the bryozoan and other encrustations do constitute a reservoir of soluble carbonate which could be recrystallized as future cementing material.

The Monitor bryozoans do not by themselves comprise a full-fledged Caribbean reefal assemblage (since such characteristically reef-dwelling species as Stegignonoporella magnilabris and Rhyynchonella rostratum are missing here). However, all but one of the Monitor species occurs on modern reefs in Florida, Bermuda, and the Bahamas, so that there is an obvious partial resemblance of the Monitor bryozoan encrustations to Caribbean reefal bryozoan suites.

DIAGENESIS AND LITHIFICATION

Cutting into the concretionary crust recovered from the Monitor shipwreck not only failed to find multilaminar bryozoan masses, but also encountered few recognizable skeletal remains except for occasional pelecypod and serpulid fragments. The sparseness of invertebrates within the crust (Fig. 5B) is in sharp contrast to the encrusting bryozoans, barnacles, and serpulids on its upper surface (Figs. 2A, 5A), the more so since that surface also exhibits projecting portions of numerous, obviously embedded shell fragments — many broken pelecypods, a few gastropods, and some echioid spines (as well as a great many quartz sand grains). Nevertheless, the inner portions of the concretionary crust are highly calcareous, but there the carbonate appears largely as intergranular cement.

Overall, therefore, the concretionary crust appears to be a calcareous-cemented, iron-stained, quartz-grain-and-shell-fragment sandstone, instead of a carbonate invertebrate skeletal build-up. The quartz grains are subangular to subrounded, and medium to coarse (a few very coarse) in size. Cement between the grains varies much in strength, on a very local (cm-sized) scale; some portions of the crust are hard enough to take a good polish upon grinding (for peel- or thin-sections), while others crumble during sawing. The cement is mostly calcite, but is stained with enough iron oxide to appear brown or reddish-black rather than white under a hand lens; portions could possibly be siderite instead.

The foregoing characteristics of the concretionary crust, plus the distribution and poor preservation of the (already partly corroded or dissolved) bryozoan encrustations, suggest a geologically rapid diagenetic or lithification process underway at the Monitor site. In brief, the Monitor's 19th-century iron or steel has been rusting or corroding steadily, various calcareous invertebrates have been growing on that rusting hull, and periodic storms have dusted the entire surface with temporarily suspended quartz and shell-fraction sands. The invertebrate encrustations (including bryozoans) and shell fragments seemingly have dissolved and then recrystallized as carbonate cement binding the quartz grains together, the whole being additionally stained or colored by the excess iron in solution or iron oxide in suspension in the water immediately adjacent to the ship's hull. Thicker portions of the crust appear to have developed rapidly, though possibly might have originated around spots with larger-volume encrustations (to supply more carbonate locally for greater cementation). The pieces examined are 5-40 mm thick, which indicate average rates of crust development of 0.04-0.35 mm/yr.

So, in the end, the bryozoans and other invertebrates may indeed be contributing to development of the concretionary crust on the Monitor wreck, but by providing soluble carbonate for diagenetic cementation, rather than by skeletal frame-building as in typical tropical reefs.

Conclusion

After 115 years, lying on the sandy continental shelf as an artificial "reef", the Monitor shipwreck off Cape Hatteras has developed a concretionary crust, on the surface of which dwell 11 species of encrusting cistiostome bryozoans, as well as barnacles, serpulids, corals, and pelecypods. These particular 11 species, as well as their thin sheet-like (membraniporiform) colony form, are typical of hard

(continued on next page)
(CONCLUSION, continued from page eleven)

bottoms on this warmer-water (Caribbean-
Carolina), middle-depth portion of the At-
antic shelf. Most of the Monitor bryozoans also occur on modern Caribbean reefs, but
collectively here do not comprise a full reefal
assemblage. The bryozoan (and other inverte-
brate) encrustations seem limited to the surface
of the Monitor’s concretionary crust, which
inside is largely calcareous-cemented iron-
stained quartz sandstone; these animals there-
fore may be contributing to development of the
concretionary crust by providing soluble carbone for diagenetic cementation, rather
than by building carbonate-skeletal frame-
works atop the wreck’s hull.

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(THUNDER AT HAMPTON ROADS,
continued from page seven)

the remains of an officer’s epaulet, and a crude
shaving mirror that some sailor made by im-
bedding a shard of broken glass into a scrap of
wood. The Florida yielded a brass-mounted
porthole, two large iron castings that may be
part of her gun tackle, and a box of rifle
bullets. An assortment of bottles and ceramics
apparently came from the surgeon’s quarters;
one delicate medicine cup bears the trademark
of a pharmacist’s office in Brest — the only
European port the Florida visited. Several
leather items have emerged from the conser-
vation process in remarkably good condition.
Perhaps the most poignant artifact is an intact
leather shoe.

“Thunder at Hampton Roads” will continue
through the summer of 1983. Civil War en-
thusiasts travelling in the Tidewater area will
want to include the Mariners’ Museum in their
itineraries.

John A. Tilley
Mariners’ Museum

EDITOR’S NOTE: The opening of “Thunder at
Hampton Roads” drew a capacity crowd of approxi-
mately 350 people, with numerous others being
turned away due to lack of seating or standing space.

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keeping us notified of any future change in your current address.

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