Monitor National Marine Sanctuary Activities Report

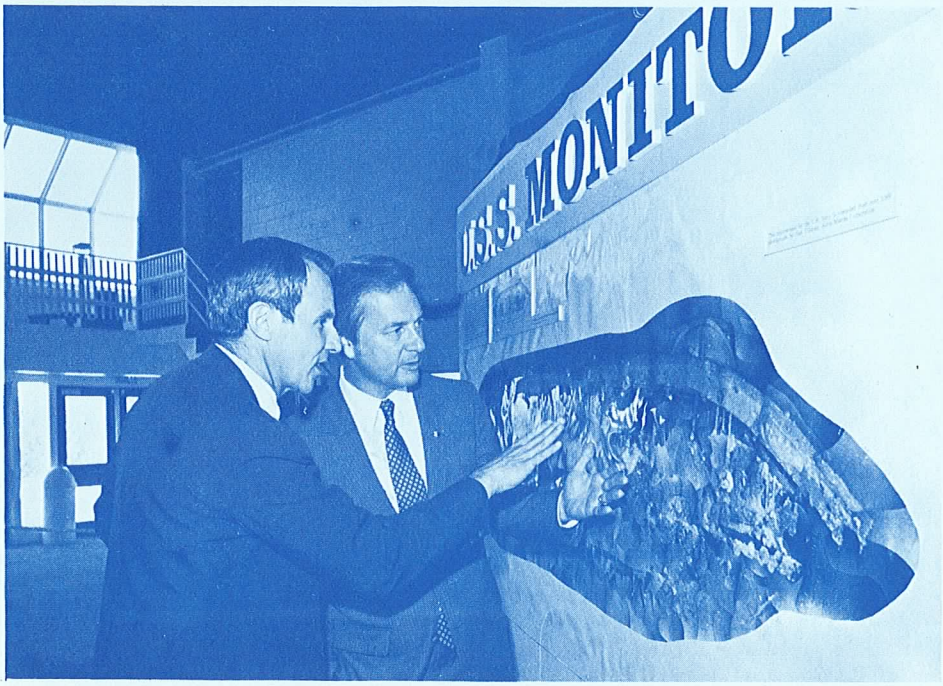
CHEESEBOX

Vol. 1, No. 1

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.



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.)*

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.

CHEESEBOX

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The editors of "Cheesebox" wish to express their appreciation to the National Oceanic and Atmospheric Administration (NOAA) and to Dr. Richard J. Podgorny, NOAA's Marine Sanctuary Projects Manager, for providing the opportunity to develop this publication. Their support and encouragement have been most gratifying.

Readers are encouraged to comment on "Cheesebox." All comments will be acknowledged and none will be published without the written consent of the author. Correspondence should be addressed to either Mr. Watts or Dr. Still at the University. We hope that you enjoy this first issue and look forward to hearing from you.

MONITOR PUBLICATIONS

Following is a list of ***Monitor*** National Marine Sanctuary publications. For information on obtaining any of these volumes, please contact the editors.

USS ***MONITOR*** NATIONAL MARINE SANCTUARY
Publications

Brennan, William J. "An Historic Ship Launches an Important Marine Program." NOAA Reprint. Vol. 5, No. 2, April 1975.

Childress, Lt. Cdr. Floyd. "The Lantern". NOAA Reprint. Vol. 7, No. 2, October 1977.

D'Angelo, Schoenewaldt Associates. *Preliminary Engineering Feasibility.* 1981.

Hill, Dina B. *Analysis and Preservation of Hull Plate Samples from the* ***Monitor.*** 1981.

Muga, Bruce. *Engineering Investigation of the USS* ***Monitor.*** 1982.

Southwest Research Institute. *A Feasibility Study for Transmission of a Live Television Picture of the USS* ***Monitor*** *to Visitor Centers Onshore.* 1982.

Still, William B. *Archival Sources: A Study of Unpublished Sources Found in Washington, D.C. area and New York City Concerning the Engineering and Technical Aspects of the USS* ***Monitor.*** 1981.

Tucker, Rockwell G. *Environmental Data.* 1981.

Watts, Gordon P. *Investigating the Remains of the USS* ***Monitor****: A Final Report on 1979 Site Testing in the* ***Monitor*** *National Marine Sanctuary.* 1982. (limited copies available).

Watts, Gordon P. and James A. Pleasants, Jr. *USS* ***Monitor****: A Bibliography.* 1981. ($2.00 per copy, make checks payable to: N.C. Division of Archives and History).

1982 ***Monitor*** National Marine Sanctuary Management Plan. 1982.

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

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.

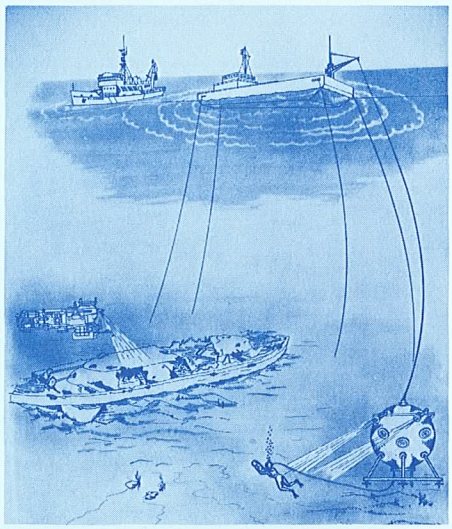
Diving Bells/ Saturation Systems

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. Continous 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.



Simulated barge with Bell/SAT system on four-point moor over U.S.S. *Monitor* wreck. R/V *Johnson* and the *Johnson-Sea-Link* submersible observe diving operations.

The greatest advantage in utilizing a submersible lies primarily in placing the human eye at the point of three-dimensional observation in the water. The support vessel does not require an elaborate multiple-point mooring system to maintain a precise position during a lockout dive. Both the submersible and support ship maneuver independently of one another. The surface vessel has electronic tracking equipment that monitors the vehicle's location at all times. This gives the submersible freedom to position itself for maximizing the lockout diver's access to the work area.

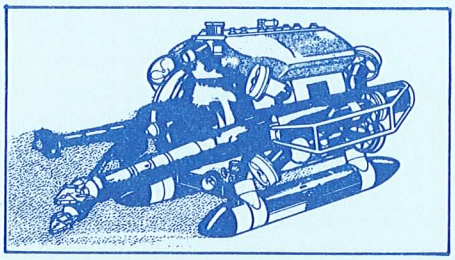
The greatest disadvantage in using a lockout submersible is the limited breathing gas and power supply available. Moreover, in cold water where a diver must be heated, his bottom time is greatly reduced as sufficient heat to warm him cannot be supplied for an indefinite period of time.

Diver Alternative Work Systems

The other major area for consideration is diver alternative work systems (DAWS). This is further divided into two subcategories: manned one-atmosphere systems and unmanned remotely-controlled systems. Since both types have less maneuverability than a diver and require use of mechanical arms and hands, they should be placed lower in priority for use in this type of work.

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 Duplus,*** 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).



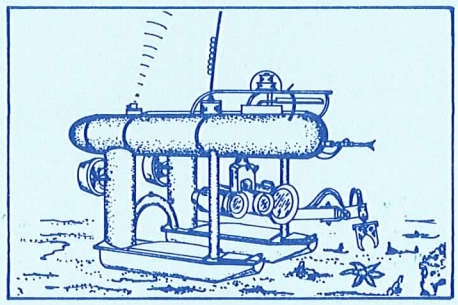
Osel Mantis Duplus

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. 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 vehicles around the world. They are used primarily in the offshore oil industry with a few being utilized for science and military applications. The main advantage is removal of man from the water. However, man still remains the most vital link in the system in 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 garage 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.



Harbor Branch CORD II

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 technology available, the American public will be able to view major portions of the U.S.S. ***Monitor.***

Timothy M. Askew
Harbor Branch Foundation

References

Cook, R.W. and Prentice, J.R. An Evaluation of Diving and Submersible Systems, H.B.F. Technical Report #21.

Frey, Donald A. The Capistello Project, Saturation Archaeology for Deep Wrecks. Sea Technology, December 1978.

Gray, W.E. and Fridge, D.S. How To Select Diving Systems In Offshore Applications. Oceaneering International, Inc. Ocean Industry 13(4), 51-56, April 1978.

Osel Offshore Systems Engineering, Ltd. Brochure.

Perry Oceanographics, brochure.

Harbor Branch Foundation, Inc., Contribution No. 316

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. For 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 ***Eastward***	**August, 1973** This expedition, the first in the area, resulted in the location and identification of the remains of the ***Monitor.***
Alcoa Seaprobe	**April, 1974** The entire wreck was photographed and portions were recorded on television tape.
R/V ***Eastward***	**May, 1974** Dredging in the vicinity of the wreck resulted in the recovery of samples from the site, including a decklight cover.
CGC Chilula	**August, 1974** A side scan sonar recording was made of the wreck.
R/V ***Beveridge***	**August, 1974** An underwater television system was utilized to record the wreck.
R/V ***Eastward***	**June, 1976** Acoustic reflection measurements were made of the wreck.
R/V ***Cape Henlopen***	**April, 1977** 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***	**July-August, 1977**
R/V ***Sea Diver***	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***	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***	**August, 1979** Archaeologists conducted a test evacuation 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. Keeler
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 ships'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

As mountainous waves illustrated in *Harpers Weekly* foamed over the *Monitor* and filled her hull with seawater, the ironclad sank by the stern and capsized.

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's 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-soutwest 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

Technical Advisory Committee Meets

Editor's Note: The Technical Advisory Committee (TAC) was established in 1974 to assist the North Carolina Division of Archives and History and NOAA in the review of proposals to conduct research in the ***Monitor*** National Marine Sanctuary. The committee meets annually and includes in its membership experts from the fields of conservation, underwater archaeology, engineering, resource management, and geology.

The Technical Advisory Committee met in Raleigh, North Carolina, on November 8 and 9, 1982. In attendance were committee members Barto Arnold, underwater archaeologist with the Texas Antiquities Committee; W.A. Cockrell, underwater archaeologist with the Bureau of Historic Sites and Properties, Tallahassee, Florida; Dr. Donald Hamilton, conservator with Texas A & M University; Edward M. Miller, engineer with General Physics Corporation, Annapolis, Maryland; Dr. Bruce Muga, Professor of Civil Engineering, Duke University; Capt. Ernest Peterkin, USNR (Ret.), engineer, Camp Springs, Maryland; Curtiss Peterson, exhibits specialist, North Carolina Department of Cultural Resources; and Gordon P. Watts, Jr., Director of Underwater Research, East Carolina University.

Also attending were Dr. Richard Podgorny, Marine Sanctuary Projects Manager, NOAA; Richard W. Lawrence, Head of the Underwater Archaeology Unit, North Carolina Division of Archives and History, who serves as ***Monitor*** Operations Coordinator; Diana M. Lange, Sanctuary Coordinator with the Underwater Archaeology Unit, Division of Archives and History; Barbara L. Brooks, Underwater Archaeology Unit; William N. Still, Jr., Professor of history, East Carolina University; and Dina B. Hill, Research Associate, East Carolina University. The meeting was chaired by Thomas D. Burke, Chief, Archaeology Branch, North Carolina Division of Archives and History. Committee members Willard E. Searle of Searle Engineering Consultants, Alexandria, Virginia, and Stanley R. Riggs, Professor of Geology, East Carolina University, were unable to attend.

Ms. Lange summarized the ***Monitor***-related activities of the North Carolina Division of Archives and History for the past year. Three studies were completed under contract to the Division: Capt. Peterkin compiled a catalog of engineering drawings of the ***Monitor***, which is scheduled for publication early next year. Mr. Miller carried out a study to determine the rate of deterioration of the remains, and Dr. Muga completed an engineering assessment of the wreck. Dr. Muga's report has recently been published by the Division, as has a study by Southwest Research Institute to determine the feasibility of transmitting live television pictures of the wreck to an on-shore visitors' center. Projects to be conducted by the Division in the coming year include the production of biographical sketches of the ***Monitor***'s officers, compilation of background information on the crew members, and the printing and distribution of color charts depicting various aspects of the vessel's history. A coloring book for elementary-level children is also being prepared.

Dr. Muga presented a report on his engineering assessment of the remains of the ***Monitor***. Included in the publication are discussions of the stability and structural integrity of the remains and the possibility of recovery of components of the wreck. Mr. Miller summarized the deterioration study, which was designed to develop an estimate of the rate of deterioration of the remains of the ***Monitor***; to determine what threat exists to the ***Monitor*** in its present highly-corrosive environment; and to assess these findings in terms of the overall goals of protection and preservation of the site. Mr. Miller also reported on his recent visit to England, where he met with persons involved in the restoration and preservation of several historically significant ships, including the ***Warrior***, ***Great Britain***, and ***Mary Rose***. (A detailed report of Mr. Miller's visit to England will appear in the next issue of "Cheesebox.")

Capt. Peterkin reported on two projects that he has undertaken for the North Carolina Division of Archives and History: the catalog of some two hundred engineering drawings of the ***Monitor***, which includes drawings contemporary with the construction of the vessel and some produced at later dates; and a study of the ***Monitor***'s contents at the time of sinking. The contents will be determined from examinations of allowance lists, sinking accounts, and the papers of Acting Paymaster William F. Keeler.

Mr. Watts briefly summarized East Carolina University's plans to conduct an on-site expedition in 1983 and/or 1984. (For additional information on the planned expedition, please see "University Plans Next On-site Expedition" in this issue.)

As one of the responsibilities of the TAC is an annual revision of the "***Monitor*** National Marine Sanctuary Management Plan," the 1982 version of the document was examined and suggested revisions incorporated. The revised plan is scheduled for publication by NOAA by the first of next year.

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 into 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 adminstered 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: 248,384; and Roanoke Island, 214,483.

Replica of the *Monitor*'s revolving turret highlighted the exhibit at the Roanoke Island Marine Resources Center.

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***.

A display 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 Craney 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 horseshoes, 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,

(continued on page twelve)

John Ericsson Honored on 179th Birthday

July 31, 1982, marked the observance of the 179th birthday of John Ericsson, creator of the U.S.S. ***Monitor***. This event was celebrated on July 30 with a colorful wreath-laying ceremony at the site of the John Ericsson Memorial in Battery Park, New York City. It was co-sponsored by the John Ericsson Society (JES) and the American Society of Swedish Engineers.

Wreath-laying ceremony at the site of the John Ericsson Memorial in Battery Park, New York City.

The ceremony began with a parade of the celebrants led by the Swedish and American flags. Fred Ekvall, JES vice president, acted as master of ceremonies. Representatives of the city and state of New York and the Swedish government presented proclamations honoring John Ericsson. July 30 was officially proclaimed "John Ericsson Day in New York City."

Miss Sweden Day, Christine Svensson, unveiled the wreath. Deputy Consul General Lars Carlsson 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 Washington, 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.

Alazar 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.

Alazar Templeton

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.

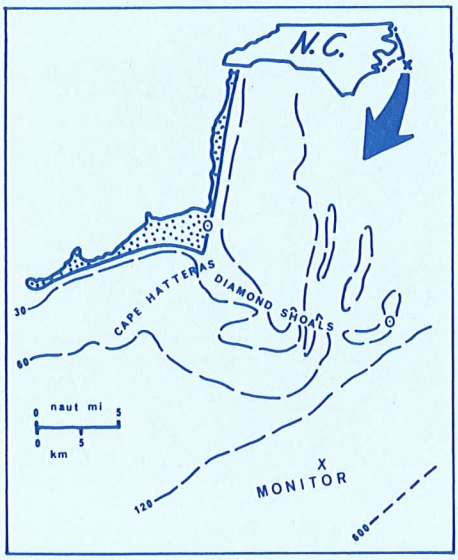


FIG. 1. Sketch map showing location of ***Monitor*** shipwreck (X; lighthouse and lightship, circles; bathymetric contours in feet; north toward top; redrawn from Newton, 1975, p. 56, and USGS Manteo 1:250,000 topographic quadrangle).

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 Cheilostomata, easily recognized because its polyps secrete box-like cases (zooecia).

The ***Monitor*** concretionary crust fragments examined yielded 11 encrusting cheilostome 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

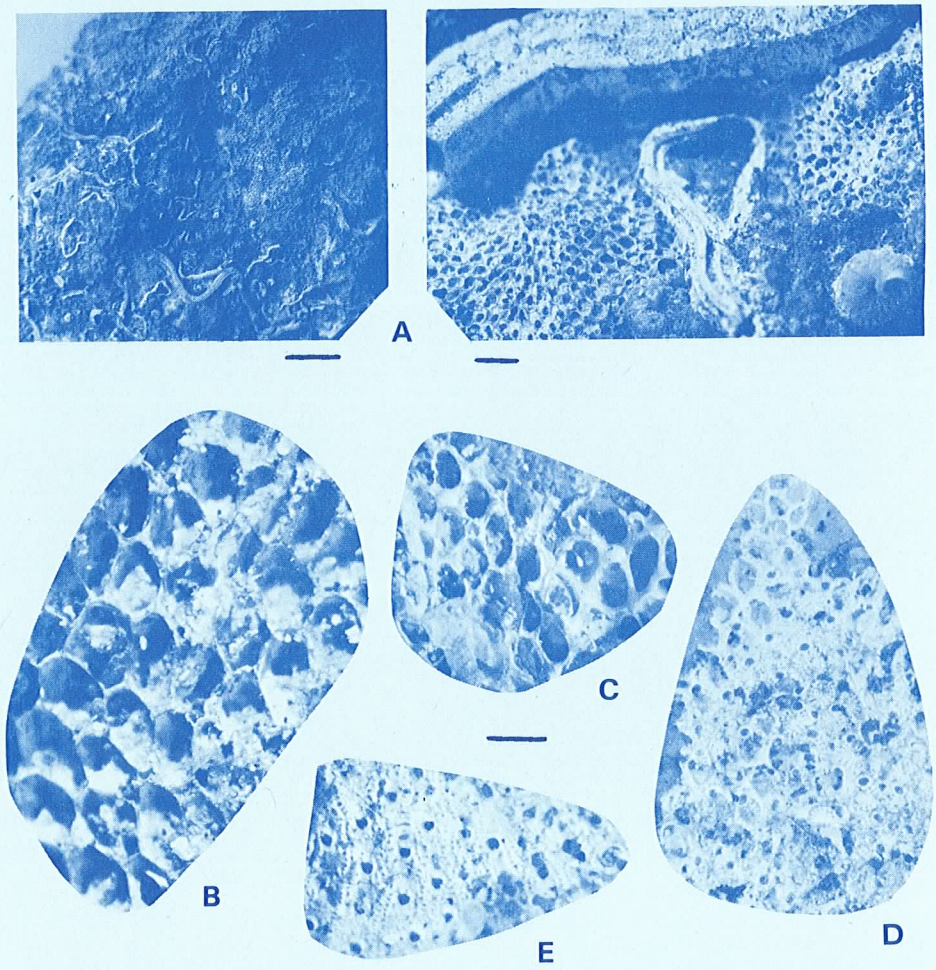


FIG. 2. ***Monitor*** bryozoan colonies. A, encrusting sheet-like cheilostomes, accompanied by serpulid tubes, on upper or outer surface of concretionary crust from wreck, in overview (left, scale bar 10 mm long) and close-up (right, scale bar 1 mm long). B-E, individual colonies, scale bar 0.5 mm long; B, *Aplousina gigantea;* C, *Parellisina latirostris;* D, *Cribrilaria radiata;* E, *Parasmittina spathulata.*

(Massachusetts) or in Chincoteague Bay (Virginia), nor like the bryozoan reef-rock at Joulters 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, ctenostome, 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.

IMPORTANT SPECIES	INCIDENTAL SPECIES
Phylum Bryozoa or Ectoprocta	
Class Gymnolaemata or Eurystomata	
Order Cheilostomata	
Suborder Anasca	
Aplousina gigantea	
Parellisina curvirostris	
Parellisina latirostris	
Suborder Cribrimorpha	
Cribrilaria radiata	
	Membraniporella petasus
Suborder Ascophora	
	Hippothoa flagella
Microporella ciliata	
Cleidochasma contracta	
	Cleidochasma porcellana
	Parasmittina spathulata
	Porella thrincota

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

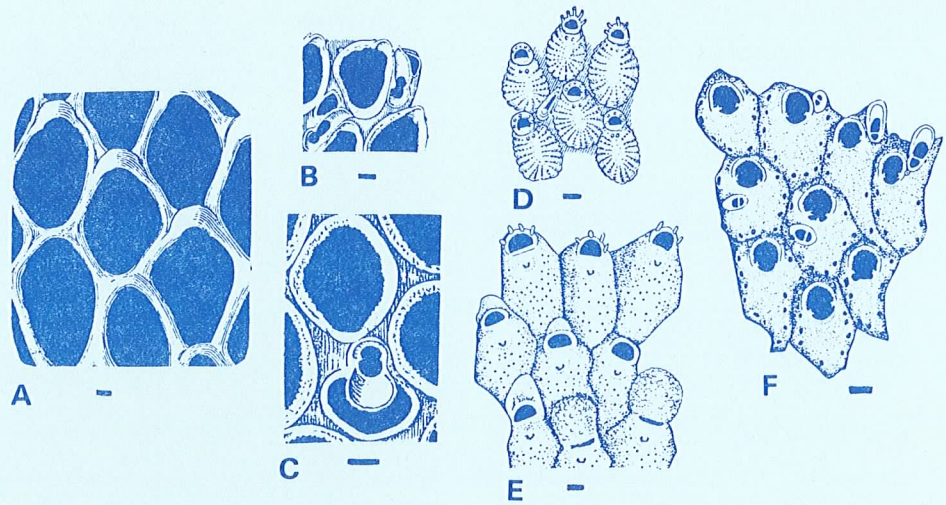


FIG. 3. ***Monitor*** bryozoans: the important species. (Modified from references cited; reproduced with permission; each scale bar 0.1 mm long). A, *Aplousina gigantea* (Bassler, 1953, p. 161); B, *Parellisina curvirostris* (Bassler, 1953, p. 165).; C, *Parellisina latirostris* (Osburn, 1940, p. 477); D, *Cribrilaria radiata* (Bassler, 1953, p. 185); E, *Microporella ciliata* (Rogick, 1964, p. 183); F, *Cleidochasma contracta* (Rogick, 1964, p. 183).

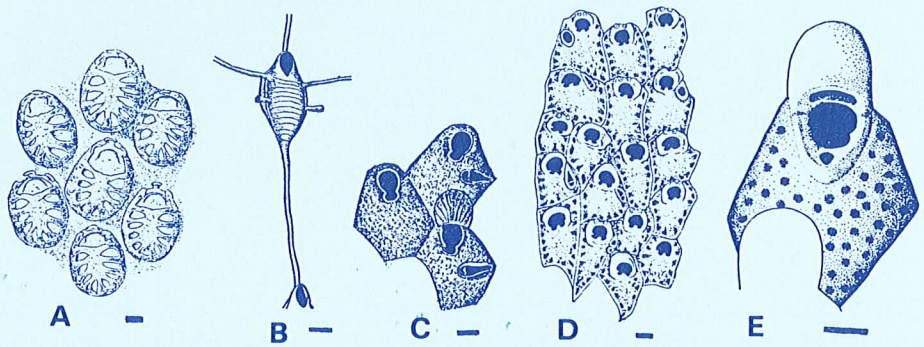


FIG. 4. ***Monitor*** bryozoans: the incidental species. (Modified from references cited; reproduced with permission; each scale bar 0.1 mm long). A, *Membraniporella petasus* (Osburn, 1950, p. 252); B, *Hippothoa flagella* (Osburn, 1952, p. 528); C, *Cleidochasma porcellana* (Canu & Bassler, 1929, p.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

SPECIES ANNOTATIONS

Because all 11 of the ***Monitor*** bryozoan species are already known to science, full descriptions and synonymies 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 Anasca
Family Hincksinidae
Aplousina gigantea Canu & Bassler, 1927
Fig. 2A, 2B, 3A

Described by Canu & Bassler (1928, p. 20-21), Osburn (1940, p. 357), Maturo (1957, p. 38-39), Shier (1964, p. 612-613), Winston (1982, p. 123).

Previously recorded south of Cape Hatteras; in Caribbean-Carolinian province at 30-350 ft (9-100 m) depths; important on ***Monitor***.

* * * * *

Family Calloporidae
Parellisina 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***.

* * *

Parellisina latirostris Osburn, 1940
Fig. 2C, 3C

Described by Osburn (1940, p. 361-362), Lagaaij (1963, p. 175-176), Winston (1982, p. 123).

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

* * * * * * *

Suborder Cribrimorpha
Family Cribrilinidae
Cribilaria radiata (Moll, 1803)
Fig. 2D, 3D

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

Described by Canu & Bassler (1928, p. 73-74), Osburn (1940, p. 405-406), Maturo (1957, p. 48), Shier (1964, p. 625-626), Winston (1982, p. 133-134).

Previously recorded south of Cape Hatteras; in Caribbean-Carolinian province at 30-1650 ft (9-510 m) depths; also tropicopolitan; important 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. 404), 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***.

* * * * * * *

Suborder Ascophora
Family Hippothoidae
Hippothoa flagella Manzoni, 1870
Fig. 4B

Former synonym *Hippothoa distans*.

Described by Canu & Bassler (1929, p. 247-248), Osburn (1940, p. 408), Osburn (1952, p. 278), Winston (1982, p. 150-151).

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)

(**ANNOTATIONS**, continued from page nine)

Family Microporellidae

Microporella ciliata (Linnaeus, 1758)

Fig. 3E

Former synonyms *Lepralia* and *Porellina ciliata.*

Described by Canu & Bassler (1928, p. 110-111), Osburn (1940, p. 432-433), Maturo (1957, p. 54-55), Shier (1964, p. 636).

Previously recorded both north and south of Cape Hatteras; in Boreal, Virginian, and Caribbean-Carolinian provinces at 10-425 ft (3-130 m) depths; also cosmopolitan; important on ***Monitor.***

* * * * *

Family Hippoporinidae

Cleidochasma contracta (Waters, 1899)

Fig. 3F

Former synonyms *Hippoporina, Perigastrella,* and *Lepralia contracta.*

Described by Osburn (1940, p. 428-430), Maturo (1957, p. 52), Lagaaij (1963, p. 189-190), Shier (1964, p. 632-633), Winston (1982, p. 148).

Previously recorded both north and south of Cape Hatteras; in Virginian and Caribbean-Carolinian provinces at 3-425 ft (1-130 m) depths; also cosmopolitan; important on ***Monitor.***

* * *

Cleidochasma porcellana (Busk, 1860)

Fig. 4C

Former synonyms *Hippoporina* and *Lepralia porcellana* or *cleidostoma.*

Described by Canu & Bassler (1928, p. 104-105), Osburn (1940, p. 428), Shier (1964, p. 633-634), Winston (1982, p. 147-148).

Previously recorded south of Cape Hatteras; in Caribbean-Carolinian province at 50-1200 ft (15-375 m) depths; also tropicopolitan; incidental on ***Monitor.***

* * * * *

Family Mucronellidae

Parasmittina spathulata (Smitt, 1873)

Fig. 2E, 4D

Former synonyms *Smittina, Smittia,* and *Lepralia spathulata* or *trispinosa.*

Described by Canu & Bassler (1928, p. 114-115), Osburn (1940, p. 435-436), Maturo (1957, p. 55, 57), Winston (1982, p. 142-143).

Previously recorded south of Cape Hatteras; in Caribbean-Carolinian province at 0-240 ft (0-75 m) depths; also tropicopolitan; incidental on ***Monitor.***

* * *

Porella thrincota (Shier, 1964)

Fig. 4E

Former synonym *Smittina thrincota.*

Described by Shier (1964, p. 635, 637).

Previously recorded south of Cape Hatteras; in Caribbean-Carolinian province at 30-100 ft (9-30 m) depths; incidental on ***Monitor.***

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 two 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 (Caribbean—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 (tropicopolitan 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 the 220-ft depth 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 complexly 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 equating 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; such colonies are termed membraniporiform. 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 (cellariiform), and rigid branches, fronds, and lattices (vinculariiform, adeoniform, and reteporiform, respectively). Likewise missing are hollow cap-like free-living unattached colonies (lunulitiform).

Sheet-like encrusting (membraniporiform) 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 expectable. The rigid erect forms all require more constantly quieter waters than are likely here off shore-swept Diamond Shoals. Lunulitiform 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 (lunulitiform) 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.

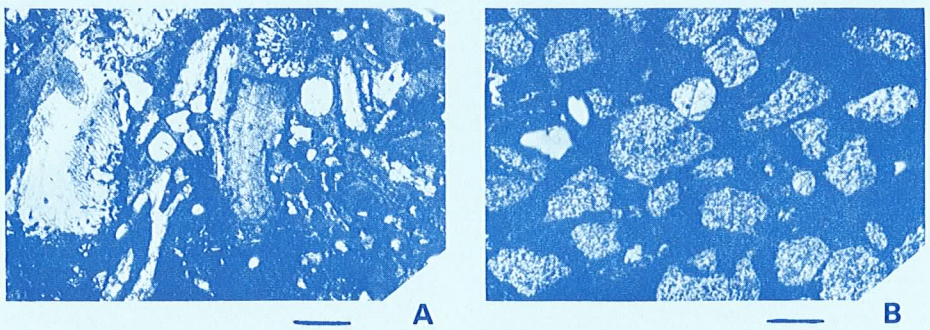


FIG. 5. ***Monitor*** concretionary crust in peel-section; scale bars 0.2 mm long. A, upper or outer portion of crust, with abundant invertebrate skeletal fragments. B, lower or inner part of crust, mostly quartz sand grains cemented by nearly opaque iron-stained calcite.

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 spondylids).

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 (Joulters 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 thickenings 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 *Steginoporella magnilabris* and *Rhynchozoon 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 echinoid 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 handlens; 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 resuspended quartz and shell-fragment 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 randomly, 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 cleilostome 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)

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*(**CONCLUSION**, continued from page eleven)*

bottoms on this warmer-water (Caribbean-Carolinian), middle-depth portion of the Atlantic 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 invertebrate) encrustations seem limited to the surface of the ***Monitor***'s concretionary crust, which inside is largely calcareous-cemented iron-stained quartz sandstone; those animals therefore may be contributing to development of the concretionary crust by providing soluble carbonate for diagenetic cementation, rather than by building carbonate-skeletal frameworks 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 imbedding 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 ground 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 conservation 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 enthusiasts 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 approximately 350 people, with numerous others being turned away due to lack of seating or standing space.

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