

NOAA-Funded Seaweed Research Aids Aquaculture, the Environment

—By Peg Van Patten

Most people don't appreciate seaweed. It's merely the tangle in your toes at the seashore. Yet this common marine algae is valued worldwide at \$5.6 billion as an ingredient in cosmetics, pharmaceutical products and food, most commonly as sushi wraps.

Now, NOAA-funded National Sea Grant College Program researchers led by Charles Yarish at the University of Connecticut have discovered that one commercially important seaweed can also be a powerful tool to clean up oxygen-starved marine environments.

This environmental cleanup capacity, or bioremediation, could be a boon to the aquaculture industry, where fish or other aquatic animals are "farmed" in pens in coastal waters or in tanks with circulating water, then sold as food products when mature.

In Asian countries, the seaweed *Porphyra* is grown as a food product on nets hung in the water. Known as nori, it is a human dietary staple in Asia and can be found in American markets pressed and dried into sushi wrappers.

Scientific experiments done by Yarish and his international team show that some native New England species of nori are capable of removing nearly all of the nitrogen
continued on page 6

NOAA Helps Hunt for Navy's First Sub

—By David Hall

NOAA and the U.S. Navy have joined forces to uncover the secrets of an all-but-forgotten, sunken technological marvel of the Civil War: the *USS Alligator*, the Navy's first submarine.

Built in 1862, two years before the Confederate sub *H.L. Hunley*, *USS Alligator* represented a significant leap forward in naval engineering. But details about the vessel and its fate have eluded historians for decades.

With help from naval historians, maritime archaeologists, oceanographers, meteorologists, ocean explorers and students, NOAA and the Navy have unearthed new information about *USS Alligator* that is helping to fill large gaps in the history of the Union vessel and

determine what happened to the sub after it was lost in a storm off North Carolina in 1863.

"Through the *Alligator* Project, we are applying our knowledge of oceanography, meteorology and engineering to solve a mystery of national historical importance," said Daniel J. Basta, director of NOAA's National Marine Sanctuary Program, which houses NOAA's new Maritime Heritage Program. "This project is also about getting people young and old alike excited about marine science and exploration, and connecting the public to our nation's maritime heritage. It offers the perfect mix of history, mystery and technology."

Today, few are aware of *Alligator* and its place in history. Until
continued on page 2



David Hall/NOAA

National Marine Sanctuary Program director Daniel J. Basta (left), national partnership coordinator Catherine Marzin (center) and education coordinator Michiko Martin examine the blueprints of *USS Alligator*, the Navy's first submarine, which Marzin found in France.

Alligator

continued from page 1

recently, its existence was news even to lifelong U.S. Navy submariners, including Rear Adm. Jay Cohen, currently the chief of naval research.

"I had never heard of the *Alligator*. I had never read about or seen a reference to it. Nothing," Cohen said.

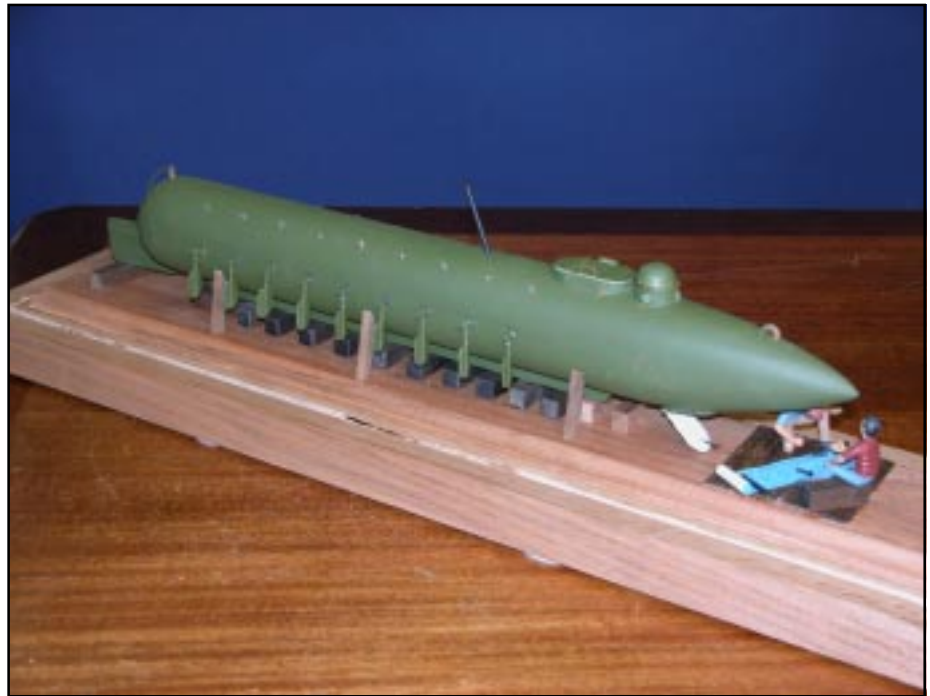
It was Cohen's wife who alerted him to it after reading an article about the sub in a Civil War magazine. Adm. Cohen was stunned. Most history books cite the better known *USS Holland*, launched in 1897, as the Navy's first sub. Eager to delve deeper into *Alligator's* story, Cohen shared the article with Basta and ocean explorer Robert Ballard.

The admiral knew they would immediately grasp the significance of the submarine to American maritime history and might be in a position to aid in the search for clues into the history and possible location of the long-lost sub.

They soon learned that *Alligator* was something right out of Jules Verne's *20,000 Leagues Under the Sea*.

Built to counter the threat of Confederate ironclads, the green, 47-foot-long, oar-propelled submarine was a vessel like no other. Among its most notable features was an airlock designed to allow a diver to exit the vessel while submerged and place an explosive charge on an enemy ship. *Alligator's* design also included an air purification system. Both are standard components of modern submarines.

Following its launch from a Philadelphia shipyard in 1862, *Alligator* was tasked with destroying bridges crossing the Appomattox River and clearing obstructions in the James River in Virginia. But to the dismay of its champions, *Alligator* would never get the



James Boyle/ONR

A model of the USS Alligator, the Navy's first submarine, on display at the Office of Naval Research in Arlington, Va., depicts the original oar-driven design.

chance to prove itself in battle.

After arriving in the combat zone, its captain and crew discovered that the waters of the James and Appomattox were too shallow to allow the sub to submerge. *Alligator* also proved to be less maneuverable than expected.

Fearing that it could be captured by the Confederacy, *Alligator* was withdrawn and towed to the Navy Yard in Washington, D.C., where it was refitted with a hand-cranked screw propeller. President Lincoln himself witnessed a demonstration of the improved vessel.

After declaring that the *USS Alligator* was ready for action, Rear Adm. Samuel Dupont ordered the sub to Charleston, S.C., in March 1863 to assist with the Union blockade of that strategically important city. It would be a fateful journey.

While heading south along the North Carolina coast, *Alligator* and its tow vessel, the *USS Sumpter*, encountered a storm so fierce that *Sumpter's* crew, facing the loss of their own ship, was forced to cut

the unmanned submarine loose. The Union sub was never seen again.

"We don't know what happened to the *Alligator* after its towline was cut," Basta said. "Did it sink right away? Did it float for days and then sink? Did it wash up on a beach somewhere? Is it still intact or has it succumbed to corrosion?"

To help answer those questions Basta enlisted the assistance of faculty and students at the U.S. Naval Academy. Three decades earlier, Naval Academy instructors and midshipmen had aided in the successful search for another Civil War vessel, the *USS Monitor*. The academy team formulated a number of theories about *Alligator's* fate based on the best information available.

Basta also looked internally for help. He knew that the key to success was learning more about *Alligator* and the man who invented it, French immigrant and self-described "natural genius" Brutus de Villeroi. Immediately, he

continued on page 6



Linda C. Skupien/U. South. Miss.

Sharon Walker.

Sharon Walker Is the Team Member of the Month

—By Jana Goldman

When Sharon Walker was notified that she was named the NOAA Team Member of the Month, she sent back a reply, “I’m afraid you must have the wrong Sharon Walker.” After being reassured that the caller did indeed have the correct Sharon Walker, she responded, “You made my day.”

Walker has been making days special for the thousands of students and adults who have benefited from her efforts in environmental education and literacy. Now administrator of the J.L. Scott Marine Education Center and Aquarium in Biloxi, Miss., and director of education of the Mississippi-Alabama Sea Grant Consortium, Walker started working with Sea Grant 20 years ago in Mississippi.

“I’ve been delighted to be a part of Sea Grant,” she said.

The feeling is mutual, as it was the Sea Grant program that nominated Walker for the award, calling her a “leader in helping NOAA

understand opportunities for a new mission in environmental education and literacy, identify its role in education and literacy and emerge as a national player in environmental education and literacy.”

Innovation in education is one of Walker’s many achievements. As an Interagency Personnel Act employee in the National Grant Office in 1999, she was responsible for several changes, such as soliciting additional funding from approximately 30 executive hosts for the Dean John A. Knauss Marine Policy Fellowship, thereby increasing the annual fiscal award for the recipients, as well as providing a modest portion of these awards for administrative needs. These additional administrative funds enabled the National Sea Grant Organization to hire an additional employee and enabled its education director to spend more time with its 30 state programs on educational issues and in seeking alternative mechanisms for funding, usually in partnership with other funding agencies.

She has also assisted in national policy level changes through her contributions to the Sea Grant education network strategic plan, the U.S. Commission on Ocean Policy and the Consortium for Oceanographic Research and Education, among others.

“My first funding from Sea Grant was in 1981. I was a high school teacher, and the grant came from Mississippi-Alabama Sea Grant,” Walker recalled. The grant paved the way for Walker to teach teachers as well as kids about a variety of marine subjects, including oceanography, global climate change and coastal processes.

“Some of our informal pre-college programs that began with modest funding from Sea Grant are now national models and self-sustaining,” Walker said.

continued on page 8



Wilfred VonDauster/NOAA

Lisa Taylor.

Lisa Taylor Is the NOAA Employee of the Month

—By John Leslie

NOAA’s January Employee of the Month is Lisa Taylor, a geophysicist at NOAA’s National Geophysical Data Center in Boulder, Colo. Although Taylor—a wife and mother of two sons—works part time, she juggles plenty of weighty responsibilities in the areas of diversity, management, international mapping and scientific research at the center.

“Lisa’s ability to handle so many tasks at once is just amazing,” said George F. Sharman, III, division chief of NGDC’s Marine Geology and Geophysics Division. “She is more productive than most who work full time,” he said.

Since joining NGDC in 1986, Taylor has performed a variety of jobs, displaying a unique range of organizational and leadership skills. She coordinates a work-study team of students from the University of Colorado at Boulder, manages a contract to digitize NGDC’s ocean data and was the NGDC point *continued on page 8*

Focus On...



Chris Smith/NOAA

At the docks in St. Petersburg, Fla., NOAA Fisheries port agent Pam Machuga holds a greater amberjack, one of several species of finfish caught by commercial fishers and sampled by NOAA to help manage the fishery.

NOAA Fisheries Port Agents

—By Chris Smith

Because scientific data about marine populations are essential components of stock assessments of marine species, NOAA Fisheries employs a network of port agents at key coastal ports, where they collect detailed information on fishing effort and landings.

“These data and the infrastructure required to collect them are vital to the implementation of fishery management regulations, which are central to keeping America’s fisheries sustainable and fishing communities economically viable,” said Guy Davenport, leader of the fisheries data monitoring team at NOAA Fisheries’ Southeast Fishery Science Center in Miami.

Davenport supervises 29 full-

time port agents located along both coasts of Florida and in Alabama, Mississippi, Louisiana and Texas, where the focus is on shrimp and finfish.

According to Davenport, the species that agents sample is based on a target species list developed by fishery assessment biologists. The data are entered into centralized data files and made available for analysis.

In addition to collecting information about landings and fishing effort, port agents also generally monitor fishery activities in their regions.

“We collect as much information as we can when we sample,” said Renee Roman, who’s served as a port agent for nine years, seven of which have been in St. Petersburg, Fla.

“We’re especially interested in collecting otoliths, which are the fishes’ ear bones that enable us to determine the fish’s age. We also weigh and measure the fish and collect gonads, when they’re available. In addition, we collect and report information about the fishing vessels operating out of each port, the type and amount of gear they use and the size of each vessel’s crew,” she said.

Agents submit weekly fishery activity reports that keep fishery managers current about relevant activities in each agent’s area of responsibility.

Gulf of Mexico agents also report monthly on shrimp landings by species, size count, pounds and

continued on page 5



Chris Smith/NOAA

Machuga cuts through a gag grouper’s tissue and bone to reach the important otolith, a tiny bone in the fish’s ear that can be used to gage it’s age.

continued from page 4 price, as well as information provided by fishing vessels' captain about where they fished, how deep they fished and the numbers of hours they spent fishing in those areas.

Although port agents frequently contact participants in the commercial fishing industry by phone and mail, mainly they conduct interviews in person.

"I enjoy the relationships I've built with the dealers, processors, and fishermen in my area," Roman said. "I've gotten to know them well over the last seven years, and they're my key link to getting the information I need for NOAA. Their feedback is what makes my job so enjoyable and successful."

Many agents make observer trips, co-author technical memoranda and scientific papers and serve on fishery committees. They often attend public fishery meetings to broaden their understanding of local issues. In so doing, they have become integral participants in the communities where they live and serve.

"The field work is probably the draw for all of us," said Pam Machuga, who's worked with Roman in St. Petersburg for more than a year.

The work involves handling many different species of fish and invertebrates.

"Cutting into a fish isn't as easy as it looks," Machuga said. "You're trying to get a lot done in a very short time and it takes a lot of practice. Some species are easier to sample than others. You have to be really careful because you're handling knives and chisels that are very sharp, wet and slippery. You're cutting and chiseling through tissue and bone and you have to be careful not to get injured by a fish's sharp body parts or break the otoliths. When that happens it can be very disappointing."



Chris Smith/NOAA

After several minutes of intense effort, Machuga carefully extracts the grouper's otolith from behind the gill, deep inside the fish's head.

"Any time you deal with the public, there will be both ups and downs," Davenport said. "But over all, I believe they find their experi-

ences mainly positive and rewarding. Many of them have been publicly honored by local fishing communities." ☺



Chris Smith/NOAA

Machuga places the prized otolith into an envelope held by port agent Renee Roman (right) to send along with other samples to the NOAA Fisheries Panama City (Fla.) Laboratory.

Alligator

continued from page 2

thought of the National Marine Sanctuary Program's national partnership coordinator, Catherine Marzin, who hails from Villeroi's native France. Believing French historians might know something about Villeroi and *Alligator* and knowing that Marzin was already planning to visit relatives in France, Basta presented Marzin with a challenge: Find the *Alligator* blueprints!

Marzin's search for information about Villeroi and the sub led her to the French naval archives outside Paris. There she found a box labeled "System of Naval Construction, Submarine, Blueprints, de Villeroi, 1832-1882." The box contained a complete set of original drawings of *Alligator*, the only blueprints of it found to date.

"It was a very exciting moment," said Marzin of her discovery. "It was like hitting the jackpot."

With the drawings were a number of hand-written letters exchanged by Villeroi and the French government. The letters document Villeroi's repeated but unsuccessful attempts to persuade his own country to purchase his submarine designs.

The newly re-discovered blueprints are already helping *Alligator* Project team partners, including NOAA's Office of Ocean Exploration, refine their theories about the vessel's fate.

"The blueprints provide information that we can use to calculate how quickly the *Alligator* may have flooded and how fast it may have been going when it hit the sea floor," said the sanctuary program's national education coordinator, Michiko Martin, who was one of the Naval Academy instructors involved in the *Alligator* Project before joining NOAA in the fall of 2002.

The blueprints and other recent findings by the project team generated a lot of enthusiasm in October 2003 at a first-ever symposium about *USS Alligator*. Sponsored by NOAA and the Office of Naval Research and held, appropriately, at the Submarine Force Museum in Groton, Conn., the meeting sparked discussion about the possibility of locating and recovering the historically significant vessel.

Alligator Project team member NOAA Lt. (j.g.) Jeremy Weirich, a maritime archaeologist with the Office of Ocean Exploration, said that combining information from the blueprints with other historical and scientific data will "allow us to design a more reliable and systematic survey plan" and "give us a better chance of finding it" should a search begin in earnest.

Cohen argued that the search for *Alligator* would be an excellent test of our ability to find a relatively small object on the sea floor, "in an intelligent way over a reasonable period of time and at a reasonable cost." He said that in the age of ultra-quiet diesel submarines and heightened concerns about the security of our ports and near-shore waters, it's the potential deployment of small, inexpensive submerged weapons that keeps him awake at night. "But if we can find the *Alligator*, we can find anything," he said.

The consensus among the symposium's participants was that the hunt itself is as important as actually recovering the craft.

"Whether we find the *Alligator* or not, the *Alligator* Project will help us move ocean science and exploration forward," said NOAA Capt. Craig McLean, director of the Office of Ocean Exploration. "We also will engage, and hopefully inspire, more than a few budding scientists and historians along the way." ☺

Seaweed

continued from page 1

and much of phosphorus that would be found in the waste effluent of a typical fish farm.

When nori nets surround fish pens or shellfish beds, the algae filter out nitrogen, phosphorus and even carbon dioxide from the water, soaking up excess nutrients into their tissues and incorporating them into the seaweed's body mass. Unless other pollutants come into play, the nutrient-packed nori is a very nutritious and potentially marketable food product for grazing animals such as abalone or shrimp, or even for humans.

With more vitamin C per serving than orange juice, more calcium than milk and typically up to 50 percent protein, nori is something of a miracle food.

The same nitrogen and phosphorus that in excess can be toxic to fish or trigger harmful plankton blooms in coastal waters, is necessary for protein-building and other basic physiological functions in living organisms—the same reason gardeners use fertilizer on land plants. Thus a healthy, valuable crop is produced and the environment is cleaned of pollutants.

Only one or two cells thick, nori resembles a soggy piece of plastic food wrap tinted brownish red. It is found in the wild in a rocky, subtidal marine habitat.

"Nori is a less visible marine plant that blooms in winter, so people don't notice it much," said Yarish, who has collected many seaweed specimens and maintains an extensive culture collection of various nori species and strains in his Stamford, Conn., laboratory.

Working with Sea Grant scientists in New Brunswick, New Hampshire and New York, Yarish has examined the morphological and genetic characteristics of these

continued on page 7

Seaweed

continued from page 6

algae and evaluated their potential for growth, cultivation and use in bioremediation. The team has active collaborators in China, Chile, Korea, Japan, Israel and Mexico as well.

The scientists found that for efficient nitrogen uptake, one square meter of nori will clean the wastewater from 10 kilograms of fish. That's about 22 nets seeded with nori to clean the waste from one ton of fish.

The idea of growing complementary species together, called integrated aquaculture, is an important step for sustainable healthy ecosystems in a world where protein is in high demand.

Yarish's eyes were opened to seaweed's potential a decade ago when he first visited China to observe existing aquaculture technology, with the encouragement and support of NOAA Research's Office of International Affairs.

Yarish said, "I saw duck farms in China doing fresh water bioremediation with aquatic plants, so I thought why not use the same principles in the marine environment?"

He also noticed that when China moved some of its coastal aquaculture operations offshore, there was an immediate increase in coastal harmful algal blooms. At a NOAA retreat in the 1990's, Yarish reported he had seen about three million metric tons of kelp, a brown seaweed also grown as food, remove up to 90,000 metric tons of nitrogen from Chinese coastal waters, showing its incredible potential for bioremediation.

The concept for the current project followed when Yarish and University of New Brunswick Sea Grant researcher Thierry Chopin noticed that nori plants placed on

nets near salmon pens were flourishing at a fledgling Sea Grant-supported nori farm in Cobscook Bay, Maine.

"The basic biophysiology of native *Porphyra* had not been investigated," Yarish said. "We never knew what we had on the East Coast. What we found in *Porphyra* was exactly the right characteristics to sequester nitrogen."

Although all four native New England nori species performed better in comparison to Asian cultivars currently marketed, until this project began their properties had not been investigated for potential domestication.

"The international travel made possible by NOAA Research's Office of International Affairs enabled me to broaden my horizons, establish close contacts and to observe technologies already in operation around the globe," Yarish said.

Yarish has also been able to implement his original ideas quickly overseas.

"People pressure can be an environmental catastrophe," Yarish said. "Aquaculture and bioremediation in some countries can be an absolute necessity for survival."

Because high nutrient loading has been identified as a critical pollution concern in coastal waters of the northeastern United States and the Canadian Maritimes, this research stands to directly benefit marine aquaculture industries that need to comply with stringent effluent discharge regulations.

The next stage of the research involves taking the technology from the laboratory to industry in the "real" world. Demonstration bioremediation facilities are currently under construction at Great Bay Aquaculture in Portsmouth, N.H., and at the regional aquaculture high school in Bridgeport, Conn. This new technique for integrating aquaculture and bioremediation, if widely utilized, promises a win-win situation for both the aquatic environment and the enhancement of world food supplies. ☺



Peg Van Patten/UConn

NOAA Sea Grant-supported researcher Charles Yarish maintains an extensive collection of seaweed in his University of Connecticut laboratory.

Walker

continued from page 3

One example is Project Marine Discovery, a three-hour program on topics such as marine mammals, fish printing and medicines from the sea. Real beach experiences are offered through mini-camps, one to three days in duration, where students and chaperones spend the night at a local hotel or in church or university-based housing and learn about water chemistry and quality, sea grasses, dunes and critters. The camp attracts students from all of the Gulf of Mexico states, the southeastern coastal states and some non-coastal states, as well.

"Every year we get students from Oklahoma, Arkansas and Tennessee," Walker said.

For those who want a longer experience, there is the week-long Sea Camp. And because education continues throughout life, Walker and her staff also work with Elderhostels, an education program for individuals over age 55.

"They love it," she said. Walker knows that once students of any age learn about the coast and what affects it, it changes their perspective.

"All our kids are good stewards. You whet their appetites and they want to learn and do more," she said. "It's a wonderful internal satisfaction to know that you have done that for someone else."

She noted that many young people who attended the camps or who have gone through her programs return as volunteers.

"We have so many of them we have to turn them away," she said.

Many of them also consider marine-related careers. "We reinforce the content of our lessons with hands-on activities," Walker said. "It's fun, it's relevant, it makes sense and it's not as difficult as they thought." ☺

Taylor

continued from page 3

person for the NOAA Survey Feedback Action.

Recently, Taylor was appointed the NGDC's diversity advisor. She will be a liaison between the NGDC staff and NOAA's Satellite and Information Service, developing programs that promote understanding of different cultures and enhance diversity among staff.

"Lisa's management of these important services is a huge benefit for not only NGDC, but the Satellite and Information Service and NOAA as a whole," said Gregory W. Withee, assistant administrator for NOAA's Satellite and Information Service.

While handling her many duties at NGDC, Taylor still finds time to pursue scientific research. In 2003, she co-authored "Northern Gulf of Mexico and Feature Names," which appeared in the publication of the Gulf Coast Association of Geological Societies.

Taylor's journey toward a NOAA career began even before she was a student at UC-Boulder in the early 1980s. She said while growing up she had been fascinated by the science and mystery of the oceans. So the Walnut Creek, Calif., native decided to make a career of it. At UC-Boulder, Taylor was part of the work-study program at NGDC.

As a sophomore, she participated in the Sea Education Association program, an intensive, six-week marine science program based in Woods Hole, Mass. Taylor studied closely with 23 other college students from diverse backgrounds.

"We all learned to depend on and trust each other, because we were in such a close environment. It was an eye-opening experience. We all learned to appreciate differences in other people," Taylor said.

After a brief stint working as an oceanographer with the Naval

Oceanographic Office in Mississippi, Taylor returned to NGDC and graduated from UC-Boulder in 1986. "It sounds strange to come back to Colorado since it doesn't have an ocean, but that's where my heart was," she said.

She now manages the work-study program she participated in while in school. Currently, there are three students digitizing ocean data, a program which goes back to the late 1980s. Taylor said such information is crucial for scientists, who create models of ocean currents and how those currents impact weather. Taylor said the data are also important for knowing ocean depths and for creating contour maps of the ocean floor.

Taylor has made significant contributions in other areas of NGDC, Sharman said. In the international arena, Taylor organized, hosted and managed a three-day board meeting of an Intergovernmental Oceanographic Commission group that gives names to basins, trenches and seamounts in international waters.

"Lisa impressed everyone by setting up such an important meeting among international players that ran without a hitch," Sharman said. "She continues to bring new ideas, new technology into everything she does, which makes us all look good." ☺

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