Oyster Shells Tell Story

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USF researchers have discovered that oyster shells provide clues to the story of life and death in colonial Jamestown.

(PhysOrg.com) -- Some oysters provide pearls but all oyster shells have a story to tell, if you know how to look for them. One compelling story about North America's first successful English settlement has unfolded before University of South Florida researchers equipped with a special tool used in a unique way.

England's first attempt at colonizing the rich and abundant New World, in what is now called Virginia, looked promising at first. The first colonists wrote about seeing abundant oysters and other foods the day they landed in 1607. But serious challenges lay ahead: Native American resistance, disease and even hunger. It turns out oysters ended up saving many lives for a time and their shells have now provided clues to life and death at the ill-fated Jamestown settlement.

The isotopic chemistry of the shells has revealed the existence of a prolonged and harsh drought that put all life in the area at risk during what is known as "the starving time." University of South Florida geologist Gregory S. Herbert has co-authored an article titled *Reconstructing Early 17th Century Estuarine* Drought Conditions *from Jamestown Oysters*, with Juliana M. Harding (senior marine scientist with the Virginia Institute of Marine Science), Howard J. Spero (a geochemist from the University of California, Davis), Roger Mann (a professor of marine science and director of research and advisory science at the Virginia Institute of Marine Science at William & Mary) and USF Ph.D. candidate Jennifer L. Sliko for the *Proceedings of the National Academy of Science* Journal that explains how.

Due to crop failures, many of the colonists had to rely heavily on seafood, including oysters harvested from the James River. Lead author Harding and her colleagues found the shells yield data about the record dry conditions that killed nearly half of Jamestown's colonists. Once the oysters were consumed, the colonists discarded the shells and other refuse in a nearby well that was likely abandoned due to salt water intrusion during the drought. Harding and her colleagues dated the shells to between 1604 and 1612, near the end of the drought, and found that the oxygen isotopes of the shells yield data about the record dry conditions that killed nearly half of Jamestown's colonists.

They found that during that time period the James River was much saltier than today, due to decreased runoff from surrounding freshwater rivers. These conditions promoted oyster growth and extension of oyster reefs upriver towards the colonists. But it also allowed salt intrusion into the groundwater that fed their wells. The colonists had the small advantage of an increased oyster supply, but the large disadvantage of inadequate fresh water. From its findings, the group says the colonists harvested oysters around Jamestown Island and farther out into Chesapeake Bay.

“Our study tells us that the drought reduced river flow into the ocean and enabled the salt water/fresh water boundary to migrate upriver, where it poisoned the available drinking water for the colony,” said Herbert, as assistant professor in the USF Department of Geology.

He and Sliko were part of a team examining elements of the well’s detritus - some of the hundreds of thousands of artifacts being uncovered and sent out to experts worldwide. The well was discovered by William Kelso, director of research and Interpretation for the Association for the Preservation of Virginia Antiquities’ (APVA) Jamestown Discovery Project.

“Until recently, most historians thought the original Jamestown fort had been washed away, presumably into the river. Ongoing excavations by a determined Kelso finally located the fort, and that has made it possible to find wells and all sorts of other artifacts that help us reconstruct what actually happened to the colonists,” Herbert said.

The go-to experts on fossil shells were Herbert and Sliko. Sliko is an authority on paleoclimatological records preserved in the geochemistry of fossil corals. They used the same processing and analysis technique developed for Sliko’s work on corals to research the Jamestown oyster shells.

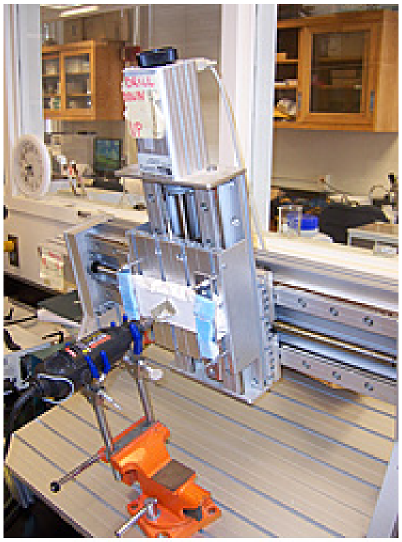
Similar to dendrochronology, the study of annual cycles preserved in biological remains - such as tree rings - sclerochronology studies annual cycles or rings preserved in skeletal biological remains. The technique they used, isotope sclerochronology, is a little more complex.

“Oyster shells grow by depositing new shell material at the lip, with each year resulting in a visible band, similar to a tree ring,” Herbert said. “In a cross-section of an oyster shell, one can see a series of bands representing all the years of that oyster's life from beginning to end.”

They used a computer operated drill to grind bits of shell from within each annual layer and then analyzed those samples using an isotope mass spectrometer.

“The ratio of heavier and lighter varieties (isotopes) of oxygen in the shell changes as a function of temperature and salinity of the water in which they grew. With our sampling method, we could reconstruct the salt content of the water over sub-annual timescales. The isotope ratios we measured provided the key evidence that river salinity during the time of the Jamestown colony was much higher than today, and it was mostly higher in the winter, which today is the wet season,” he said.

This technique is most often used on corals. Few researchers around the world apply it to mollusk shells.



Jennifer Sliko wrote a new program for the computerized drill used to grind bits of shell so tiny they had to be encased in epoxy.

“Mollusks, and especially oysters, often have contorted and curved shell growth, and so it is important to know the animal's biology in detail before beginning sampling so that we can properly sample each year in the series,” Herbert said. “Oyster shells are also mineralogically complex, with part of the shell composed of aragonite and other parts composed of calcite. There are inherently different isotope ratios associated with each mineral type, so some expertise is also needed to determine which part of the shell to drill without mixing the two mineralogies.”

Herbert’s research expertise is molluscan biology, and isotope sclerochronology is one of the techniques frequently used. For her dissertation, Sliko had become proficient in using a special drill that proved to be essential for the success of their data collection.

“Instead of a hand-held drill, which cannot be held steady and does not allow for fine sampling, she used a computer-operated drill press that let us sample the Jamestown oysters in fine sub-millimeter increments,” Herbert said. “Without this approach, we could not have reproduced isotope records with sub-seasonal resolution. It was this combination of expertise and tools that led to our involvement in the project.”

Sliko had worked on far older fossil corals for her dissertation but the tiny shell fragments required that she write a new program to tell the computer exactly where to drill.

“Unlike fossil corals, which can be sliced into slabs and easily mounted on the drilling platform, we had to embed the oysters in epoxy to mount them on the drill,” she said. “There is a certain finesse to collecting the samples, as I typically collected less than 150 micrograms of ground-up oyster shell for each sample. At that sample size, even breathing near the sample could blow it away.”

According to Herbert, a tree ring study done years ago had already provided indications that during the period in question, the area had faced one of the most extreme droughts in centuries, but the oyster shells filled in some missing details.

“What our study adds is the first scientific evidence about the poor quality of their drinking water from the wells and especially from the river, both of which became increasingly salty and would have exacerbated disease and death related to food shortages,” Herbert said. “At the same time, however, the same oysters that tell us about the poor water quality were the same oysters that kept the Jamestown colony from becoming another ‘lost colony of Roanoke,’ which completely disappeared. The fact that oysters are found in the wells as food trash tells us the colonists were consuming them as food during the food shortages.

“The encroachment of salty water further upriver also enabled movement of salt water loving oyster reefs upriver and closer to the Jamestown colony where they could be collected with little effort. And, what's even more fascinating, is that one layer in the well provides us with oysters whose carbon isotope geochemistry is quite different from the others. It can only mean that those oysters were collected in a different area, which implies that the local oyster populations were rapidly depleted, and that colonists survived, in part, by harvesting oysters from elsewhere and transporting them back to the colony.”

Over time, the colonists have been blamed for their hardships; this new information may serve to question that image and perhaps provide a new back story for John Smith and Pocahontas.

“Were the colonists just inept English gentlemen who had no idea how to provide for themselves, or did they face unusual circumstances that would have challenged even the best-prepared settlers?”

Provided by University of South Florida

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