Un-beaching the whale: A non-trivial task to unearth important evolutionary insights

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Geology major Kat Turk ’16 and William & Mary paleontologist Rowan Lockwood take stock of the fossilized skeleton of Cornwallis, a baleen whale who swam more than seven million years ago. The foil wrappings are part of an extensive jacketing process to protect the massive—but fragile—fossils. Credit: Jesse A. Hyatt, U.S. Navy photographer

Cornwallis sank as he died, making a couple of revolutions on his way down, finally ending belly up and flippers akimbo, making a sort of "whale angel" on the ocean bottom.

The whale went the way of all flesh. Over time, his bones fossilized and

were buried in the sandy bottom. A few million years later, Cornwallis would be given his name—even if scientists believe that they can never determine his species. The whale would also become a significant piece in the scientific jigsaw-puzzle understanding of evolution, extinction and survival in the ancient seas of Virginia.

Cornwallis died at a time at which the ocean extended to a point between Williamsburg and Richmond. Cornwallis was discovered by a woman walking on the bank of the York River. The woman is a civilian contractor at the Yorktown Naval Weapons Station and likes to comb the beach at the base for fossils and other artifacts.

She found a set of fossils large enough to interest a paleontologist. Word was passed through channels, and Navy archaeologist Bruce Larson asked Rowan Lockwood to take a look at what the walker had found.

"I came out and said, 'Oh, my goodness! You know, we have several vertebrae here. We have bits and pieces of things that could be ribs,'" recalled Lockwood. A paleontologist and associate professor in William & Mary's Department of Geology, Lockwood is an expert on the marine fossils of the Chesapeake Bay. From the parts poking above the sand on the York River beach, she could tell that the fossils were the remains of a baleen whale.

Lockwood usually studies fossilized shellfish, though, and therefore can fit a few dozen specimens into a bucket. What was peeking through the sand was several orders of magnitude more sizable than even the largest clam.

"Excavating these fossil whales is a non-trivial task," she understated. To determine the best way of going about the non-trivial task, Lockwood called Alton Dooley, the curator of paleontology at the Virginia Museum of Natural History in Martinsville. Dooley came out in October 2012 and

found a mixture of promise and challenge.

On the plus side of the ledger, there were a number of vertebrae and some ribs visible. Dooley said it looked as if the whale might be a comparative rarity. Baleen whales are not uncommon finds in Virginia's Coastal Plain, mostly because they are large animals and therefore present more material to survive the endless creative destruction of geology.

But Dooley says that not all whales hold the same degree of scientific interest. Most fossil baleen whales on the east coast are taken from a geological stratum known as the Middle Miocene Calvert Formation, but the whale soon to be known as Cornwallis looked to be associated with the Eastover Formation, a layer that is considerably stingier with baleen whale fossils.

Dooley could see from exposed vertebrae the whale there on the York River beach was big, larger than many whales he had seen. It was, he decided, a good find and worth excavating.

The minus column of the ledger was the location. Both Lockwood and Dooley could see that Cornwallis wasn't going to be easy to extract. On one side of the whale was the York River. The tides and storm surge that uncovered Cornwallis could just as easily rebury him or even take him away off the beach.

"The fossils are about a foot above high tide," Dooley said. "We've taken out fossils by boat from other sites, but we couldn't bring a boat here because of the Navy's security concerns."

Land access to the site was via a steep, crumbling sand bank. Cornwallis would have to be extracted in pieces, and somehow each piece would have to be taken up that steep, unstable bank. To make it all perfect,

Hurricane Sandy was bearing down on the East Coast just then.

The whale would have to wait. Dooley applied a temporary field jacket to protect Cornwallis's remains from whatever Hurricane Sandy and other subsequent weather systems would bring.

Dooley and Lockwood came back in April. Lockwood had arranged for a number of William & Mary students to help with the dig. The students were joined by other volunteers from the Navy and from the Historic Rivers Chapter of the Virginia Master Naturalists. All the civilian diggers needed to obtain Navy clearance to work on the base, a nontrivial task in itself. Their first job was re-finding Cornwallis, who had disappeared from view under the sand.

"A lot of that sand came from Sandy—pun intended," Lockwood said. Cornwallis was so deeply buried in fact, that Dooley and Lockwood had to locate him by using photographs from the pre-Sandy site visit.

Kat Turk '16 saw Lockwood's call for volunteers on the geology department listserv. She jumped at the chance to dig into the sand and the nitty-gritty of fossil extraction.

"I have wanted to do paleontology since I was like three. I can't remember not wanting to study fossils," Turk said. "I would collect rocks when I was little. My favorite movie was The Land Before Time. I would always talk about fossils and stuff with my parents. I figured this was a good way to get some experience."

Turk was put to work digging out vertebrae and the bones from Cornwallis's fins. For the fine work of clearing dry sand from the fossil bones, she used a paintbrush. For the heavy, wet stuff, she was issued a dental pick. Even working with delicate tools, Turk found that it was all too easy to damage a relic that's millions of years old.

"I accidentally hit a little chunk and we had to glue it back on," she said. "It was my first day and I didn't know what I was doing."

Boatswain's Mate 3rd Class Jason Gray and Construction Mechanic 2nd Class Evan Zumdick secure a jacketed fossil of Cornwallis in a sling before signaling a crewman operating a modified forklift. Naval energy and ingenuity allowed paleontologists to get heavy fossils off the beach just hours before a storm hit. Credit: MCSA Jesse A. Hyatt, U.S. Navy photographer

She soon came to understand that the experienced paleontologists shared her anxiety about getting Cornwallis out of the ground in the proper number of pieces. Fossils can be quite massive, but they can also be quite fragile. Some parts of Cornwallis were coated by ferrocrete, which Lockwood describes as "iron-cemented sand." She said the ferrocrete probably formed fairly quickly around the whale; "fairly quickly" in paleontological terms meaning thousands of years.

The ferrocrete protected the bones and Lockwood added that the cradling effect of the soft sand also helped to preserve Cornwallis's

remains. Removing the fossilized bones from their sand cradle required a delicate, knowing touch to preserve what was left of Cornwallis.

"Whenever you're excavating vertebrate material you don't want to excavate too much of it because this material has been encased in sand that's been cradling it and protecting it for millions of years. As soon as you take that sand away, the bone starts to disintegrate," Lockwood explains. The Cornwallis dig was made more delicate by some unusual circumstances.

"First of all, when I dig up whalebone I'm used to it actually being hard, completely permineralized—what the public calls 'petrified.' But there were parts of this skeleton that were as hard as a rock and parts of the skeleton that were soft as butter," she said. "There were ribs that I could literally stick my finger through because they were so soft."

Indeed, parts of the whale they were working to preserve were literally falling apart under their hands. "It was really challenging to teach students the difference between what was bone and what wasn't," Lockwood said. "It was really much harder to tell than usual. Bits of it were basically degrading before our eyes."

Turk could stop fretting about that little chunk she knocked off the first day of the dig: Lockwood said the crew ending up using mass quantities of PaleoBond, a dilute form of Super Glue, "to help us glue this monster in place as we were trying to pull it out of the beach." Months later, Lockwood grimaces and shakes her head at the memory of the "buttery parts" and the anxiety they provoked.

"Honestly, I literally had nightmares as we were excavating it," she said. "At night I would dream about accidently putting my chisel through a bone or literally brushing the bone away because it was so soft."

The crew was able to find both flippers, part of the shoulder, some ribs and a number of cervical, thoracic and lumbar vertebrae. All the parts were jacketed to protect them for the trip up the bank and the long ride to Martinsville. Lockwood explained the jacketing process: Each piece is covered in tinfoil, then wrapped in plaster-soaked burlap strips. Each jacket would be opened with a bone saw back in Dooley's lab, where preparators reinforce the bones and put them back together.

Some of the vertebrae were preserved next to each other, so they were enclosed in a single jacket. The remains of Cornwallis were wrapped up in several tons of 17 plaster-coated lumps, the lightest around 50 pounds and the heaviest weighing 500 pounds.

The jackets —all 17 of them—had to go up that steep, crumbling sand cliff.

"I'm not going to lie to you," Lockwood said. "It was heavy and arduous work." But the Navy came to the rescue. Lockwood said the Navy were wonderful hosts throughout the Cornwallis extraction.

"The sailors would show up and we would explain what we were doing, and they would just dive in," she said. "It was so funny to watch, because we'd say we need to dig a trench here. You'd turn around and ten minutes later, the trench was dug—something that would have taken us an hour."

The Navy really came through when it came to getting the heaviest of the jackets off the beach, she said. It was the last day of the dig, storms were moving in and looming overhead was the very real possibility that the jackets would disintegrate in the rain and the whatever bones were left on the beach would wash away.

"They said, 'Oh, would you like a crane?'" Lockwood said. "Excuse me?

A crane? Yes. We would love a crane!"

What showed up was actually a modified forklift, brought to the cliff's edge at a more secure point near the dig. The jackets were manhandled down the beach and lifted on stretchers. The rainstorms began five hours after they got the last of Cornwallis safe and secure.

Today, Cornwallis rests in pieces. Most of the pieces are at the Virginia Museum of Natural History, but the sands of time separated some of the fossilized bones. The head and the tail are still missing. Both Lockwood and Dooley have said that they especially would have liked to have found at least part of Cornwallis's skull. Dooley says that whale skulls are often separated far from the rest of the body.

Turk was the only student working on the third day of the Cornwallis dig and took advantage of the opportunity to approach Dooley about the possibility of continuing to work on Cornwallis through a summer internship in his lab. Lockwood said Dooley had been watching Turk on the dig and was impressed with her work ethic. She got the internship.

In Dooley's lab, Turk processed Cornwallis's bones, preparing them for study and display. She treated them with a resin preservative known as Butvar.

"It gets into the matrix of the bone and solidifies it," she explained. "You can't break anything once you've treated it with Butvar—but you can't get any dirt off of it either."

Turk and the other paleontologists had to make sure that each piece of Cornwallis was as clean as possible, free of plaster jacket particles as well as sand and dirt. Accordingly, she renewed her acquaintance with the dental pick. The hours spent bent over a fossil haven't dulled Turk's love for paleontology.

"It's pretty tedious work, but I really love doing it," she said. "So if you don't love what you're doing, it's probably not a good idea to get into this."

Examination of the remains at the museum has led Dooley to declare that Cornwallis is an important find for a number of reasons. First of all, there's the sheer size: Cornwallis is the largest fossil whale in the collection of the Virginia Museum of Natural History.

"Given what we were found, there's no way that this whale was less than 14 meters in body length," Dooley said. "So something on the order of 45 feet—and that's on the low side. Fifteen meters is probably a more reasonable number. That about the same size as a modern humpback whale."

In fact, Cornwallis may be a relative of the humpback. Dooley said the whale is a likely member of the family Balaenopteridae, which includes modern blue whales as well as humpbacks.

Secondly, there's the matter of the whale's pedigree. Dooley cautions that there is no way to determine the species of Cornwallis from the remains at hand. He said the coastal plain of Virginia has produced four known—but unnamed—species of baleen whale fossils. Cornwallis could belong to one of these four extinct species, or be the first discovered specimen of an unknown fifth whale species, he explained.

Cornwallis is a whale from the Eastover Formation and, even though many important bits were not found, Dooley says that enough of Cornwallis was recovered—even without skull and tail—to make him or her an important specimen.

"It's possibly the most complete whale that's ever been collected from the Eastover Formation," he said. "And it's probably the largest whale

that's ever been successfully collected from the Eastover." The time period of seven to nine million years ago, frozen in the geology of the Eastover Formation, is interesting to Lockwood, Dooley and other paleontologists.

"Getting a whale like Cornwallis is important, because we have such a small amount of data from this time period," Dooley said. "Most of the whales that I work on are about 14 million years old," he said. "We have lots and lots of baleen whales from 14 million years ago."

Every one of those 14-million-year-old whales is a member of a family that is now extinct. On the other hand, Cornwallis and most of his fossil contemporaries—whales that swam a mere seven million years ago—belong to families that still survive.

"So the data suggest a complete changeover from 14 million years ago to seven million years ago," Dooley explained, "but very little change over the last seven million years in terms of the types of baleen whale families."

There could be any number of evolutionary drivers responsible for the whale changeover. What's the most current hypothesis?

"There isn't one," Dooley said. "We're still at the stage where we're trying to find out the question we need to be asking."

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