Baleen hormones increase understanding of bowhead whale reproduction

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Wild animals provide a unique challenge for physiologists because they are difficult to capture and monitor in their natural habitats. As a result, scientists are increasingly learning about organisms by extracting steroid hormones out of keratinized tissues. This includes hormones such as testosterone, progesterone, and cortisol that are deposited in feathers, human hair, and reptile claws as these tissues grow. A onetime capture and removal of a single sample can provide a scientist with a record of fluctuating amounts of hormone in the body over the growth period of the collected sample. This technique provides a wealth of information about an animal, including its reproductive history. Development of this method is now underway to monitor the reproduction of one of the largest organisms on earth, the bowhead whale.

"The fundamental problem is that there is no capture method for a live whale!" explains Dr. Kathleen Hunt about the current lack of understanding of whales. When she first began working with the bowhead whales, Hunt, a research scientist with the New England Aquarium, was shocked at how little was known about them. Basic information, such as how often they give birth, when they mate, and even how long they live, is unknown. But Hunt and her colleagues at the New England Aquarium in Boston and North Slope Borough in Alaska are working to change this. By using the method of measuring hormones in tissues made of keratin (like hair or fingernails), they hope to learn about the bowhead whales' current physiological condition, as well as obtain a record of their reproductive activity over the last 15-20 years.

Understanding the reproductive cycle of bowhead whales will allow researchers to monitor the overall condition of the population. In right whales, a species closely related to the bowheads, the interval between pregnancies is an indication of whether or not the population is in trouble. For example, if the period between calves becomes longer, this can be an indication that something is amiss. With an increase in commercial shipping and oil spills, as well as other large anthropogenic effects, is it difficult to predict how the bowhead whale's population may be influenced. Bowhead whales are currently legally hunted, and being able to monitor the overall success of the population is necessary. But, it is still unknown what is 'normal' for a bowhead whale. And without an understanding of what is normal, the researchers won't be able to tell when reproduction is altered, potentially for the worse.

But whales don't have fingernails or much hair, so how can keratin be used to study their physiology? The "light bulb moment" for the whale researchers came when they realized that whale baleen is essentially hair. Bowhead whales use baleen plates in their mouths to filter water and collect food. These long, overlapping plates can grow to more than three meters long and continually grow from the gum line at a rate of 15-20 centimeters per year, as the bottom of the plate wears off. With this in mind, they collected bowhead whale baleen to determine if there was in fact any hormone in the baleen and, if there was, whether the hormone profile within baleen made sense given what they knew about an individual whale.

Baleen cannot be extracted from a live whale, but bowhead whales are legally hunted by natives in managed subsistence hunts in Alaska. During the hunts, state and federal biologists are able to collect samples and data from the harvested whales. For their study, Hunt and her colleagues collected baleen samples from several pregnant females, non-pregnant females, and male bowhead whales. Once back in the lab, they ground down bits of baleen from select locations and measured progesterone

levels, a steroid hormone found in high amounts during pregnancy. The researchers predicted that the baleen closer to the gum line, which is most recently grown, would have higher levels of progesterone in currently pregnant females, lower levels in non-pregnant females, and the lowest levels in male whales.

As predicted, the researchers found that not only were steroids present in the baleen, but they also followed the anticipated pattern. In pregnant females progesterone levels were highest, while in non-pregnant females the levels were low in the most recently grown baleen, but high in the area of baleen grown in past years, suggesting that they had been pregnant recently. Male whales had low levels of progesterone in baleen, consistent with the fact that they had never been pregnant. These findings confirm that steroid hormones are deposited in whale baleen and should provide a profile of the whale's recent physiology.

Hunt and her colleagues are excited about the future of this field. Because steroids are known to persist in hair for decades and even centuries, it remains possible that not only can much be learned about the recent history of present whales, but also that of ancient whales from preserved baleen plates. But first, the researchers are working to validate this technique to understand the most fundamental questions about the organism. How often do they give birth? What season do they mate? How long is their gestation? Once they have the answers to these questions, they will be able to make more educated assessments of the health of these whales and aid in their protection.

Hunt presented her research at the 2015 annual conference of the Society for Integrative and Comparative Biology in West Palm Beach, Florida.

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