From ancient DNA to decay: an interview with Jessica Metcalf

Jessica Metcalf of the University of Colorado is rapidly becoming an expert regarding the science of death. “I’ve been into dead things for a while,” she told eLife. “They hold a lot of information.”

Metcalf’s interest in death is not macabre; rather, she is a curious researcher interested in improving forensic science. Building on a wave of studies investigating the microbiome — the library of bacteria, pathogens and other microorganisms that coexist with the body, particularly in the digestive system — Metcalf has spent the past years intently analyzing how and when certain microbes congregate when animals decompose.

“My background is in ancient DNA — I’m [trained as] an evolutionary biologist studying genes of vertebrates,” Metcalf said. At first blush, her previous work may seem a far cry from her current interests examining the microbiome of dead animals. But in reality, her earlier research, which compared genetic signatures of old and new species samples, has provided her with the necessary knowledge to understand and analyze the microorganisms present in the body during decomposition.

Metcalf’s PhD thesis and early postdoctoral work focused on studying a particular endangered species: the cutthroat trout. Using some of the oldest samples of cutthroat trout collections at museums, such as the Smithsonian, she compared DNA signatures of fish that were more than 150 years old to present populations. Working with Andrew Martin (University of Colorado) and Alan Cooper (University of Adelaide) she used genetic analysis to study the fish in Colorado streams. The team found that fish thought to be the federally protected greenback cutthroat trout may in fact be another trout species, pointing to a major flaw in recent conservation efforts.

Metcalf jumped from studying old things to dead things when she went to Rob Knight’s lab at the University of Colorado for her second postdoc position. She had become an expert on ancient DNA analysis and Knight knew how to study the microbiome. The pair wondered how the microbiome changed once an animal died. “We were interested in asking fundamental questions about microbial ecology of decomposition, which obviously has an important forensic application,” Metcalf said.

When animals are alive, the highest concentration of microbes is in the digestive system. So using a mouse model where she placed the animals on the top of tiny dirt graves, Metcalf sampled the gut every three days postmortem. However, taking DNA samples from the gut of the dead mice meant destroying the sample itself. In order to get data that spanned a long period of time from the same animal, she also swabbed the skin of the mice. In a series of experiments, Metcalf discovered a reproducible community of microbes in the skin and surrounding soil that correlated to different stages of animal tissue decomposition, providing a ‘microbial clock’ that can accurately determine the time of death.

In the future she wants to repeat the mouse decomposition study, this time using three different types of soil. In this way she will be able to investigate whether the makeup of the dirt graves affects the microbial signature observed as animal bodies start to decay.

Looking further ahead, she also wants to study dead swine. After that she plans to coordinate studies across “body farms” — specialized centers that study decaying human bodies — to see if the microbes once again match up during different stages of deterioration.

Though most of her current work is focused on forensic science, Metcalf still dabbles in ancient DNA analysis, particularly as it relates to the gut. “That’s the cool thing about academics [and] science — you have one tool and you can answer completely different questions with it.”

By Brian Mossop - Freelance science and technology writer