New study on decomposing microbes could help transform forensic science

February 12 2024

Credit: CC0 Public Domain

For the first time, researchers have identified what appears to be a

network of approximately 20 microbes that universally drive the decomposition of animal flesh. The findings have significant implications for the future of forensic science, including the potential to provide crime scene investigators with a more precise way to determine a body's time of death.

"It's really cool that there are these microbes that always show up to decompose animal remains," said Colorado State University Associate Professor Jessica Metcalf, the senior author on the new work published in *Nature Microbiology*. "Hopefully, we're busting open this whole new area of ecological research."

Decomposition of dead biological material is one of Earth's most fundamental processes. Organic plant waste accounts for the vast majority of matter that is decomposed, a process that is relatively well understood. Comparatively little, however, is known about the ecology of vertebrate decomposition, including humans, and better understanding how humans decompose has the potential to advance forensic science.

This new study, a multi-year undertaking, involved decomposing 36 cadavers at three different forensic anthropological facilities—the University of Tennessee, Knoxville; Sam Houston State University; and Colorado Mesa University. The bodies were decomposed in different climates and during all four seasons. The research team then collected skin and soil samples during the first 21 days for each decomposing body.

Metcalf and her colleagues generated a significant amount of molecular and genomic information from the samples. They then used that information to construct an overall picture of the "microbial community," or microbiome, present at each site. "Essentially," Metcalf said, "what microbes are there, how did they get there, how does that change over time and what are they doing."

Surprisingly, she said, regardless of climate or soil type, researchers found the same set of approximately 20 specialist decomposing microbes on all 36 bodies. What's more, those microbes arrived like clockwork at certain points throughout the 21-day observation period, and insects played a key role in their arrival.

"We see similar microbes arrive at similar times during decomposition, regardless of any number of outdoor variables you can think of," Metcalf said.

A future in forensics

Identifying the decomposing microbiome's consistent makeup and timing has important implications for forensic science.

Using machine learning techniques and data from the new study, as well as previous work, Metcalf and her collaborators—David Carter, professor of forensic sciences at Chaminade University of Honolulu, and Rob Knight, director of the Center for Microbiome Innovation at the University of California San Diego—built a tool that can accurately predict a body's time since death, also known as the postmortem interval.

"When you're talking about investigating death scenes, there are very few types of physical evidence you can guarantee will be present at every scene," Carter said. "You never know if there will be fingerprints, or bloodstains or camera footage. But the microbes will always be there."

What's more, these microbes can be particularly useful, Carter said, under the types of conditions examined in the new study. "We're talking about outdoor death scenes," he said. "It can be difficult to gather information in those types of investigations."

The director of the National Institute of Justice, Nancy La Vigne, views

the research as particularly promising. "One of the principal questions of any death investigation is 'when did this person die?'" La Vigne said. "This continuing line of ... research is showing promising results for predicting time of death of human remains, aiding in identification of the decedent, determining potential suspects and confirmation or refutation of alibis."

In addition to identifying the universal decomposers, the research team also attempted to determine where this microbial community came from. Notably, Metcalf said, they couldn't find the microbes in soil microbiome databases or catalogs of human skin and gut microbiomes. They did, however, find the universal decomposers on insects. "It seems like the insects are bringing the microbes in," Metcalf said.

Other research applications

These latest findings build on more than a decade of work by Metcalf, Carter and Knight, including an early study that involved decomposing mice on different soils in a controlled lab setting as well as a follow-up that involved decomposing four cadavers at the Sam Houston State facility. Zach Burcham, a former CSU postdoctoral student in Metcalf's lab, helped lead the latest work.

"This research was a huge collaborative effort from a diverse team of highly knowledgeable scientists—a shining example of what can be accomplished when interdisciplinary teams join forces towards a common goal," Burcham said. "This dataset is truly one of a kind, with broad-ranging impacts from microbial ecology to forensic science."

In addition to the forensic applications, Metcalf sees other opportunities to put this new information to use. "I see a lot of potential applications across agriculture and food industries," said Metcalf, who is in CSU's Department of Animal Sciences.

Metcalf also intends to expand her research in this field, including potentially looking at the differences in the microbial ecology of small and large vertebrates. "I feel like we're opening a whole lot of avenues in basic ecology and nutrient cycling," Metcalf said.

More information: Jessica Metcalf, A conserved interdomain microbial network underpins cadaver decomposition despite environmental variables, *Nature Microbiology* (2024). DOI: 10.1038/s41564-023-01580-y.
www.nature.com/articles/s41564-023-01580-y

Provided by Colorado State University