Vertebrate decomposition study provides potential new tool for forensic science

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A new study led by the University of Colorado Boulder and the University of California, San Diego indicates unique and changing microbial communities present during the decomposition of human cadavers look to be a reliable "clock" for forensic scientists.

The study showed some microbial communities associated with humans tick in a predictable, clock-like succession following death, said CU-Boulder and UC San Diego Senior Research Associate Jessica Metcalf, who led the study with UC San Diego Professor Rob Knight. The study also showed the method could not only be used to estimate time of death in different seasons, but as a way to determine the original location of moved corpses and even help in locating buried corpses.

"We feel there is great promise that our findings could be used by forensic scientists," said Metcalf of CU-Boulder's Department of Ecology and Evolutionary Biology. "We view it as potential method that could be used with other lines of evidence by investigators attempting to solve suspicious crimes."

A paper on the subject is being published in the Dec. 10 online issue of *Science*.

The study involved 25 researchers from 11 institutions and Sam Houston State University's Southeast Texas Applied Forensic Science Facility (STAFSF), a seven-acre outdoor human decomposition research lab. Located in Huntsville, Texas, the facility contains cadavers previously

willed to STAFSF. These donations allow students, law enforcement officials, scientists and medical experts to study bodies in various decomposition stages, aiding them in forensic science situations.

In addition to studying human cadavers, the team studied the decomposition of mice on three different soil types: desert, short-grass prairie and high alpine forest. Surprisingly, the "decomposer" microbial communities under mice were similar in all three soils, much like the predictable succession in soils beneath the human cadavers. Metcalf said "decomposer" microbes are ubiquitous but rare in and on our bodies as well as in the environment before death occurs, but become abundant after death.

Each human harbors up to an estimated 100 trillion microbes - as many as 10 times the number of cells in the body - that undertake functions ranging from food digestion to strengthening of the immune system, said Knight, a professor in both the Department of Pediatrics and the Department of Computer Science and Engineering at UC San Diego. The team used powerful gene-sequencing techniques to chart microbes present on cadavers and associated soils in both time and location immediately following death.

"Advances in genetic sequencing technologies now allow us to find patterns in large, diverse populations of microorganisms, see how they associate with specific individuals, and understand how they change over time in a way we couldn't just a few years ago," said Knight, who leads the UC San Diego Microbiome and Microbial Sciences Initiative. "This study extends the techniques we developed using the microbiome to predict disease while a person is alive, and shows the microbiome can also provide useful information after death."

Knight was also part of a group of U.S. scientists who co-authored a recent *Science* paper calling for a nationwide Unified Microbiome

Initiative.

For both the mouse and human cadavers, skin and soil microbes provided good accuracy in predicting time of death, with a roughly a two-to-four-day error estimate over a span of 25 days, said Knight. The team also demonstrated that bodies decomposing on soils modify the soil microbial communities substantially, allowing detection of a decomposing human body via the soil microbial community even if a body has been moved.

The accuracy of lock-step changes in the microbiota after death is shown to be on a par with blowflies, a current and popular forensic tool and which are attracted to vertebrate corpses where they lay eggs that develop as larvae in known time increments. But unlike the blowfly method—which is of limited use by forensic scientists because of both cold seasons and corpse accessibility—the new technique has no such constraints, said Metcalf.

Co-author Sibyl Bucheli of Sam Houston State said the new study also shows the importance vertebrate decomposition plays in the function of terrestrial ecosystems. While plant litter makes up by far the largest percentage of organic material on Earth's surface, decaying mammals are an important contributor in biological nutrient cycling.

Decomposition is a fundamental microbial function that plays a major role in how ecosystems work," said study co-author Sasha Reed at the U.S. Geological Survey in Moab, Utah. "This research adds a novel perspective showing how microbes from very different environments assemble and function in similar ways that allow for the production of natural fertilizer."

More information: "Microbial community assembly and metabolic function during mammalian corpse decomposition" *Science*,