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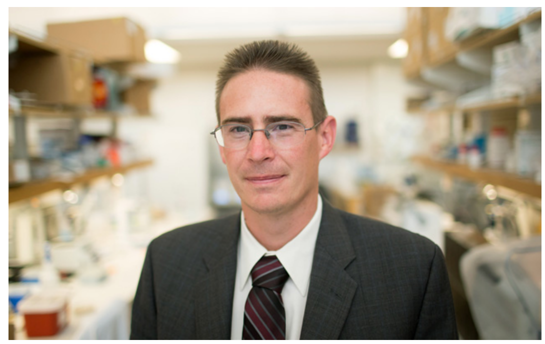
Vertebrate Decomposition Study Provides Potential New Tool for Forensic Science

Microbial communities associated with humans tick in predictable, clock-like succession following death



Rob Knight, PhD

Researchers at University of California, San Diego School of Medicine and University of Colorado Boulder have discovered that unique and changing microbial communities present during decomposition of human cadavers may provide a reliable "clock" for forensic scientists. The method could be used to estimate time of death in different seasons, as well determine the original location of moved corpses and help locate buried corpses.

The study, published by *Science*, appears online December 10.

"We feel there is great promise that our findings could be used by forensic scientists," said Jessica Metcalf, PhD, staff research associate at UC San Diego School of Medicine and CU-Boulder. "We view it as a potential method that could be used with other lines of evidence by investigators attempting to solve suspicious crimes."

Metcalf led the study with Rob Knight, PhD, professor of pediatrics, and computer science and engineering at UC San Diego.

Each human harbors up to an estimated 100 trillion microbes — as many as 10 times the number of human cells in the body — that undertake functions ranging from food digestion to strengthening the immune system. The team used a powerful gene-sequencing technique to chart microbes present on cadavers and associated soils immediately following death.

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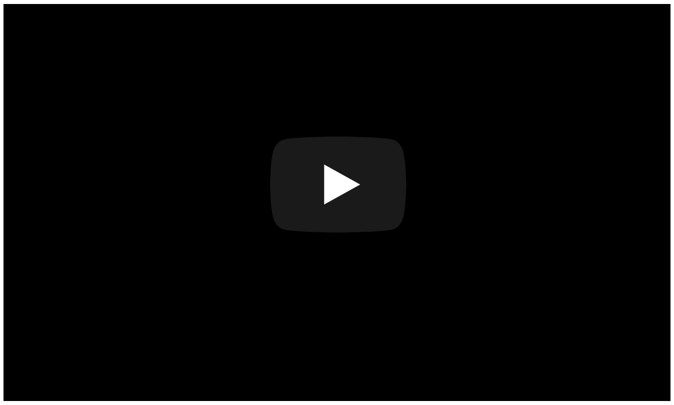

"Advances in genetic sequencing technologies now allow us to find patterns in large, diverse populations of microorganisms, see how they associate with specific individuals, and understand how they change over time — in a way we couldn't just a few years ago," said Knight, who leads the UC San Diego Microbiome and Microbial Sciences Initiative. "This study extends the techniques we developed to use 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.

The study developed its data using the Sam Houston State University's Southeast Texas Applied Forensic Science Facility, a 26-acre outdoor human decomposition research lab. The facility, the largest of its kind in the world, uses donated cadavers that allow students, law enforcement officials and scientists to study bodies in various decomposition stages, aiding them in forensic science situations.

In addition to examining 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, all undergoing predictable succession similar to that which occurs beneath the human cadavers.

For both mouse and human cadavers, skin and soil microbes provided good accuracy in predicting time of death, with 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 these changes in microbial communities after death is on a par with a current and popular forensic tool: blowflies. These insects 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 due to cold seasons and corpse accessibility — the new technique has no such constraints, Metcalf said. That's because all humans are toting a particular suite of bacteria that stand at the ready for the end of life.

“The invisible living systems we all carry around are already seeded with decomposition microbes,” Metcalf said.

Co-authors include: Zhenjiang Zech Xu, Embriette R. Hyde, Amnon Amir, Greg C. Humphrey, Gail Ackermann, and Luke R. Thompson, UC San Diego; Sophie Weiss, Alexander Bibat, Catherine Nicholas, and Matthew J. Gebert, CU-Boulder; Simon Lax, and Peter Larsen, University of Chicago; Will Van Treuren, Stanford University; Se Jin Song, CU-Boulder and UC San Diego; Naseer Sangwan, University of Chicago and Argonne National Laboratory; Daniel Haarmann, Aaron M. Lynne, and Sibyl R. Bucheli, Sam Houston State University; Christian Lauber, École Polytechnique Fédérale Lausanne; Joseph F. Petrosino, Baylor College of Medicine; Sasha C. Reed, Southwest Biological Science Center; Jack A. Gilbert, University of Chicago, Argonne National Laboratory and Marine Biological Laboratory; and David O. Carter, Chaminade University of Honolulu.

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