Hippos' constant defecating turns African pools into communal guts

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A group of hippos wallow in the Ngerende hippo pool in Kenya. Credit: Christopher Dutton

Hippopotamuses can eat nearly 100 pounds of food daily—and, as a result, they fill the pools where they spend much of their lives with huge amounts of poop.

All that excrement, new research has found, turns the pools into

extensions of the hippos' guts, as bacteria and other microbes expelled into the water survive and are shared among the congregating animals. This "meta-gut," as the researchers termed it, could have major impacts on the hippos' ecosystems.

The findings, led by University of Florida biology postdoctoral associate Christopher Dutton, were recently published in Nature's *Scientific Reports*. The research team also included UF Assistant Professor of Biology Amanda Subalusky, as well as collaborators from Yale University and the Cary Institute for Ecosystem Studies.

Dutton and his collaborators conducted fieldwork on the Mara River in East Africa, home to over 4,000 hippos. When they aren't eating on land, hippos spend much of their lives submerged in waterways, gathering in pools to wallow—and defecate. "In some of the hippo pools, there's so much feces floating on the surface that you can't tell there's water beneath it," Dutton said.

Through a series of field observations, experiments in natural and controlled settings, and the use of RNA sequencing methods, the researchers sought to find out how microbes from the guts of animals could influence their immediate ecosystems. All animals carry microbiomes specific to their individual guts. Inside the body, the microbes perform important functions such as aiding digestion—but what happens when animals poop them out into a shared environment?

Christopher Dutton (right) collects water from a hippo pool. Credit: Christopher Dutton

"In the last 20 years there has been a greater appreciation for the role that animal feces and urine can play in altering nutrient cycling and biogeochemistry within ecosystems," Dutton said. "We tried to go one step further—we wanted to understand the contexts in which gut-derived microbes were able to function in the external environment and what this might do to the environment."

They found that, based on the functioning microbial population within, the bottom of a hippo pool more closely resembles the hippo gut than a normal river. The researchers coined the term "meta-gut" to describe the changes to the hippos' environment once their gut microbiomes are

transferred to it. The phenomenon may benefit the hippos sharing their microbes with each other, making the water, Dutton said, "almost like a probiotic shake." But the way it alters the water's makeup may also affect other animals like fish.

"I think it's a really novel perspective," Subalusky said. "I don't think people thought that animals could have this strong of an influence on the shaping of microbial communities."

Amanda Subalusky collects hippo feces. Credit: Christopher Dutton

The meta-gut could have broader implications for the hippos'

ecosystems. In the pools of water with high accumulations of hippo feces, referred to as "high subsidy" pools, the researchers found a "screamingly high" concentration of methane gas, Dutton said. "The amount of methane coming off the pool would be declared an explosive hazard in the United States," he said.

Looking ahead, their research, funded by the National Science Foundation, will explore food web effects in an experimental stream facility on UF's campus. "These gut microbes from the hippo may go through the food web and throughout the different fish and invertebrate communities sharing the river, which has important implications for our understanding of how ecosystem function may change with the extirpation of larger wildlife," Dutton said. The scientists look forward to continuing to explore the "meta-gut" phenomenon in other species to gain a better understanding of the full array of ways that animals can influence ecosystems.

More information: Christopher L. Dutton et al, The meta-gut: community coalescence of animal gut and environmental microbiomes, *Scientific Reports* (2021). DOI: 10.1038/s41598-021-02349-1

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