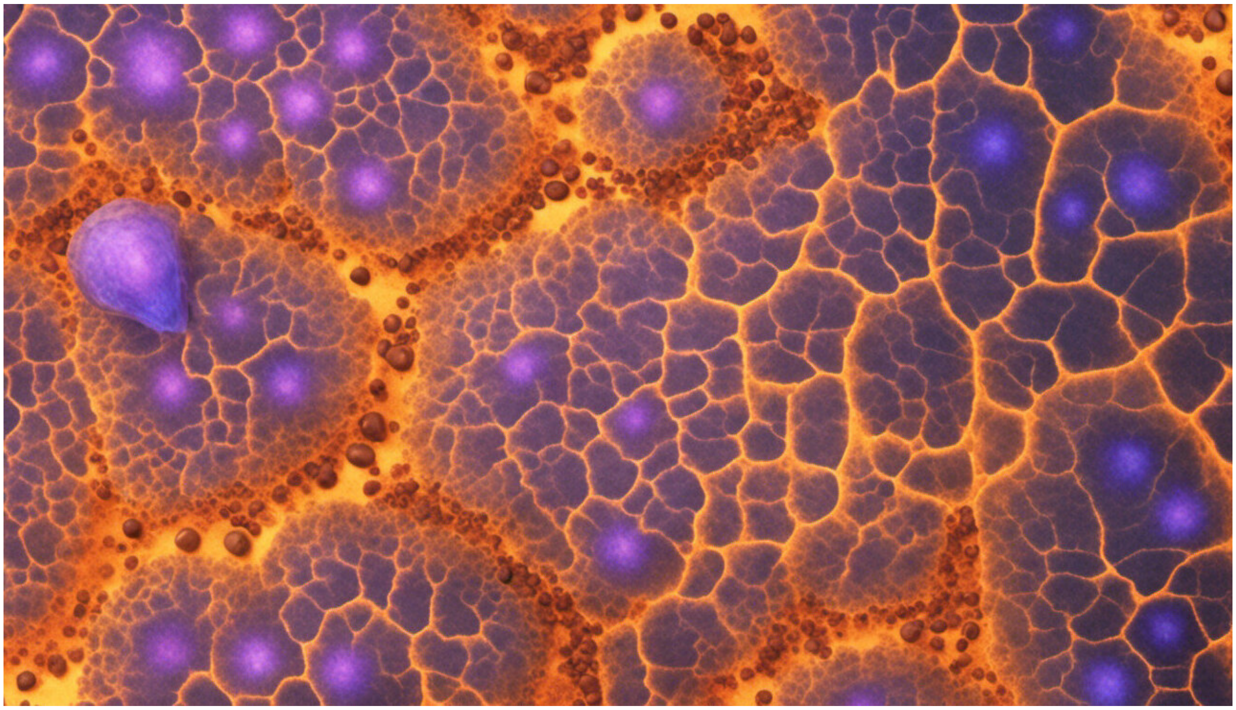
Study suggests gut bacteria helped shape mammalian evolution

September 27 2019, by Scott Schrage



Credit: AI-generated image (disclaimer)

The call to evolve could be coming from inside the house mouse.

Recent research from the University of Nebraska–Lincoln and University of California, Berkeley suggests that bacteria residing in the digestive tracts of mouse species have partly directed their evolution and divergence over the past few million years.

The study included four species of mice: *Mus musculus domesticus*, commonly known as the house mouse, and three other species from the same genus. The guts of each mouse species contained between 1,200 and 1,400 species of bacteria, some of which differed among the mouse species, as expected.

When the team examined the genetic makeup of bacterial species common to all four mouse species, it found that those bacteria began genetically branching apart around the same time as their respective mouse species—implying that the bacterial and mouse species evolved in tandem.

But the researchers suspected they could demonstrate a stronger, even causal, link between the evolution of gut bacteria and mice. To manage it, Amanda Ramer-Tait and her Nebraska colleagues first had to rear germ-free *M. domesticus* pups in a facility, among just a few of its kind in the United States, that could prevent bacteria from colonizing the rodents' guts at birth.

When those germ-free *M. domesticus* pups turned 10 days old, the Nebraska team implanted them with gut bacteria taken from one of three species—their own, the closely related *Mus spretus* or the more evolutionarily distant *Mus pahari*—or kept them germ-free.

Ramer-Tait's team then fed the four groups the same diet and amount of food, tracking their weight from four to 10 weeks of age. Weight gain during early development is often essential to survival in the wild, making it a simple but reasonable proxy for evolutionary fitness.

On average, the pups implanted with their species' native gut bacteria gained substantially more weight than pups with bacteria from either of the other two mouse species. And the weight-gain disparity between pups with bacteria from *M. domesticus* vs. *M. pahari*, which diverged roughly 6 million years ago, was greater than the difference between *M. domesticus* and *M. spretus*, which diverged only about 3 million years ago. Even the germ-free house mice—those with no gut bacteria at all—grew faster than those implanted with the *M. pahari* bacteria.

Those results suggest that the house mouse evolved not only with, but probably also in response to, the unique bacterial cocktail stewing in its gut, the researchers said.

"Anytime we observe a notable impact on host physiology by the microbiome, it's profound," said Ramer-Tait, associate professor of food science and technology. "This is an elegant experimental system that allows us to test how concepts in ecology and evolution apply to microbiome science."

The team found other evidence of the gut bacteria's evolutionary sway. Male house mice grew more muscle mass, and females put on more fat, when implanted with their native gut bacteria. Foreign gut bacteria also seemed to enlarge livers and stimulate a rise of inflammatory proteins in both male and female pups, indicating that the mismatched bacteria might impair the *M. domesticus* immune system.

Though the researchers acknowledged the need to verify the influence of gut bacteria by changing up which mouse species donate and receive them, they said the findings make a strong case for the microbiome's role in mammalian evolution.

Ramer-Tait said the study also reinforces the importance of considering evolutionary perspectives when trying to modify the human microbiome, which recent research suggests can both maintain health and drive disease in people.

"If we want to develop microbiome-based therapies in order to treat diseases, then we need to understand some of the ecological and evolutionary principles that govern the microbiome ecosystem—how it's established, how it's maintained, how it can be altered," she said. "Understanding how the host and microbiome have evolved together is an important component of developing those treatments.

"Our studies provide insight into how easy or difficult it may be to shape our own microbiome. If we want to change the abundance of a specific microbial member—maybe one that's causally linked to a disease—then we need to think about the consequences of making those changes if we have adapted along with our bacterial community. Can we do it? Should we do it? It's possible that the microbe we want to target has other effects on the host that we've not accounted for. Evolutionary perspectives are critical to consider when manipulating microbiomes."

The researchers published their findings in the journal *mSphere*.

More information: Andrew H. Moeller et al. Experimental Evidence for Adaptation to Species-Specific Gut Microbiota in House Mice, *mSphere* (2019). DOI: 10.1128/mSphere.00387-19. msphere.asm.org/content/4/4/e00387-19

Provided by University of Nebraska-Lincoln