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Press Release

A greater variety of food sources may decrease diversity in the microbial community

University of Tübingen study challenges assumption regarding the development of biodiversity in microbiomes

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Microbial communities are considered to be particularly diverse – in soil, in water, and in the human body. A common assumption in ecology is that the greater the diversity of available nutrients, the more species can coexist. A research team at the University of Tübingen has now shown that the opposite can be true. In experiments with bacteria, the diversity of microorganisms often decreased as the number of different available nutrients increased. The study by Dr. Christoph Ratzke, junior research group leader in the Cluster of Excellence “Controlling Microbes to Fight Infections” (CMFI), and Dr. Or Shalev, both from the Interfaculty Institute of Microbiology and Infection Medicine at the University of Tübingen, has been published in the journal *Nature Ecology & Evolution*.

Microorganisms, particularly single-celled bacteria, usually live in communities composed of different species. “Within these communities, species compete for nutrients, inhibit one another, or support one another – for example, by one species recycling the waste products of another,” says Or Shalev, the study’s lead author. Such communities can be highly diverse; for example, a single gram of soil may contain thousands of different species of microorganisms. In the human body, the individual gut microbiome aids digestion and can provide protection against pathogens. “We are generally interested in how diversity arises and is maintained in microbiomes,” says Shalev.

Experiments with artificial bacterial communities

The researchers first examined existing data from natural microbiomes. They analyzed data from the Earth Microbiome Project, which had recorded both microbial diversity and the composition of available organic nutrients. The samples included environmental samples, human stool samples, and plant and animal tissue samples. “However, this analysis

did not reveal any consistent correlation between nutrient diversity and microbial diversity," Shalev reports.

To test a possible connection under controlled conditions, the team cultivated artificial bacterial communities in the laboratory. They combined 14 bacterial strains into communities with varying compositions. Each community was provided with a certain number of different sources of nutrients, which they could use for energy and as building materials. The researchers then determined which bacterial species survived in the communities and in what proportions they were present. "The result was surprisingly clear: in many communities, species diversity decreased when more varied nutrients were available," says study leader Christoph Ratzke. The researchers then examined the interactions between the bacteria in more than 30,000 individual measurements. This allowed them to observe, across a wide range of nutrient conditions, how hundreds of bacterial strains influence each other in pairs.

Clear pattern

The pattern was clear, according to Ratzke: "As nutrient diversity increases, bacterial species enter into fiercer competition, which only a few can win. A greater supply does not automatically mean more peaceful coexistence." The loss of diversity is not an isolated case in a specific community but reflects a general principle. "Until now, the assumption was that more diverse nutrients create more ecological niches, and thus greater species diversity," says Shalev. "This does not always apply to microorganisms. Our results actually show the opposite: Under certain conditions, some microbes displace other species." But what accounts for this increased competitive ability? The researchers found that many bacterial species took up larger amounts than expected when faced with a more diverse nutrient supply. As a result, they grew more vigorously and were better able to outcompete other species. "Surprisingly, the change in entire communities could in some cases be traced back to a single metabolic trait in certain bacterial species," says Shalev.

Christoph Ratzke adds: "If we want to understand how microbiomes function, we need to understand the interactions between their members. The current study shows that even a change in the nutrient environment can be enough to fundamentally alter these interactions. The study thus makes an important contribution to basic research and provides insights into matters including dietary guidelines for humans – which have been based on the assumption that a wide variety of foods would lead to greater biodiversity in the gut microbiome. According to our new findings, this strategy may not work after all."

Publication:

Or Shalev, Xiaozhou Ye, Joachim Kilian, Mark Stahl, Christoph Ratzke: Increased nutrient diversity can induce loss of microbial diversity through enhanced resource uptake. *Nature Ecology & Evolution,* https://doi.org/10.1038/s41559-026-03111-4.

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