When toxins preserve populations

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Some soil bacteria can alter their environment in such a way as to endanger their own survival – unless, that is, toxins do not impede their growth beforehand.

All living organisms have an impact on their environment. These modifications can have a positive effect on the growth of species that cause them and may also be of benefit to others. However, organisms

may also alter their habitats in ways that are not only deleterious to their own survival, but may even lead to their extinction. This phenomenon is known as ecological suicide. In a new study, Ludwig Maximilian University biophysicist Jonas Denk, together with Christoph Ratzke and Professor Jeff Gore of the Massachusetts Institute of Technology (MIT, Boston), have explored the underlying dynamics of the process. Their findings appear in the journal *Nature Ecology & Evolution*.

The three researchers analyzed the population dynamics of cultures of the soil bacterium Paenibacillus sp. When grown in weakly buffered medium with glucose as the major carbon source, this species secretes metabolic products that progressively acidify the medium and strongly reduce the local pH. When the pH value reaches approx. 4 the cells begin to die and, within less than 24 h, no viable cells are left. The more food is available, the quicker the population succumbs. However, disaster can be avoided if the buffering strength (which helps to maintain pH) of the medium is enhanced – which proves that the build-up of 'acid waste' is responsible for cell death.

"Each bacterium needs food to survive and reproduce, but the cumulative effects of byproducts of their metabolism ultimately cause the collective self-destruction of the population," says Denk. This in turn leads to the paradoxical effect that other toxic substances, such as alcohols, salts or antibiotics, can promote the survival of a population by inhibiting the growth and replication of its individual members." When populations of Paenibacillus are grown in a medium with a moderate buffering capacity survival becomes dependent on cell density, which gives rise to complex oscillatory dynamics. This emphasizes that besides interactions between different species, which have been thoroughly investigated in the past, interactions between a single species and its environment can be essential to understand the complex dynamics of a population.

Since many micro-organisms have the potential to alter their environment in detrimental ways, Denk and colleagues assume that the phenomenon has an important function in microbial ecology and evolution. Out of 21 soil bacteria, the researchers could indeed observe ecological suicide in five of them. "Soil bacteria in nature are part of complex biological communities," Denk points out. "An induced change in pH, for instance, may improve the survival in the short term if it enhances the community's overall ability to cope with a sudden alteration in environmental conditions."

More information: Christoph Ratzke et al. Ecological suicide in microbes, *Nature Ecology & Evolution* (2018). DOI: 10.1038/s41559-018-0535-1

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