Microbes can evolve into savvy traders

With this knowledge, agriculture can become more sustainable

Although hidden from the naked eye, micro-organisms are active in complex networks of trade, swapping nutrients, hoarding resources and bartering deals using the same strategies humans use to dominate markets. Now an international team of researchers, including scientists from the Vrije Universiteit Amsterdam (VU), University of Groningen and The Rockefeller University, argues in the scientific journal PNAS that, like many animals, microbes can evolve into savvy traders, selling high and buying low.

Microbial cooperation is widespread in nature

While we know such "biological markets" exist in nature between cognitive organisms, for example when primates groom each other in exchange for food, it is difficult to imagine markets emerging on a microscopic scale. All organisms, including humans, cooperate with beneficial symbiotic microbes. For instance, our gut bacteria give us vitamins and nutrients, and we give them 'board and lodging' in our gut in return. Gut bacteria are therefore considered to play a crucial role in our health. Microbes also cooperate with each other, for instance exchanging resources. For example, you can think of lichens as a market place in which algae and fungi swap carbon for water.

Microbial cooperation as market exchange

Microbes have complex social behaviors. Such interactions can drive the emergence of stable markets: when some microbes provide higher quality services than others and these differences can be detected, clever investment strategies begin to evolve. The authors discuss diverse economic strategies employed by microbes, including avoiding bad trading partners, saving for a rainy day and building local business ties.

Microbial markets

Previously, scientists focused primarily on trade in animals, leaving out potential microbial markets. VU PhD-Student Gijsbert Werner, and first author of the paper explains: "For biological markets to evolve, you actually only need that individuals can detect co-operators and respond by rewarding them with more resources. This can work through automatic responses. Organisms without cognition, like microbes, are also capable of automatic economic responses."

Microbial business strategies

VU-Professor Toby Kiers, senior author of the paper, has previously discovered that plants and some fungi form complex underground networks of trade, exchanging nutrients and sugars. Some fungi even hoard resources until they get a better deal. "We now see that such 'playing of the market' happens in microbes" says Kiers. "Previously I have also seen fungi chemically elbowing competitors out of their market place, in that case the fungus-garden in which ants grew them as crops" adds co-author Dr. Aniek Ivens, a Rockefeller University postdoctoral research, who recently finished her PhD at the University of Groningen on the evolution of these kinds of interactions between different species.

Applied use of microbial markets

Social behaviors of microbes are important because of their potential applied benefits, for example maximizing nutrient transfers to crops colonized by symbiotic root fungi. While ecosystem and human health depend on cooperation with microbes, so much is unknown. "If we can modify

microbial markets in our favour, this could have substantial benefits from disease suppression to reducing fertilizer input in agriculture", argues Werner.

Further information

The perspective paper 'Evolution of Microbial Markets' appeared online in the 'Proceedings of the National Academy of Sciences' (PNAS). For more information please contact the VU Press office, Gijsbert Werner, Aniek Ivens or Toby Kiers.

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