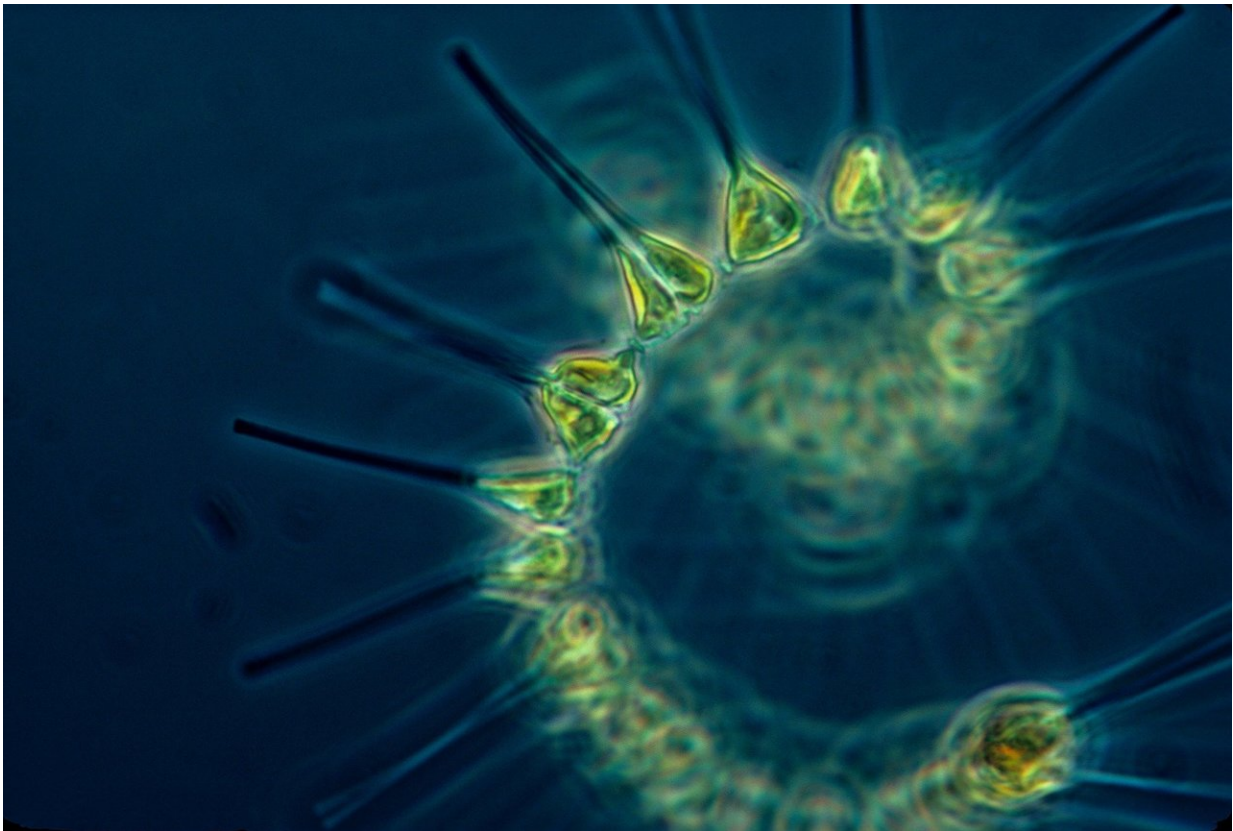


A mathematical model to explain the paradox of plankton

April 16 2018, by Bob Yirka



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A pair of researchers, one with The Simons Centre for the Study of Living Machines in India, the other with the University of Illinois in the U.S., has built a model to explain a paradox of plankton. In their paper

published in the journal *Physical Review Letters*, Akshit Goyal and Sergei Maslov describe their model and how well they believe it portrays actual bacterial communities.

As the [researchers](#) note, for many years, biologists have wondered how it is that communities of bacteria can be so diverse and yet so stable. In most such communities, many of the populations should grow exponentially, which would throw a [bacterial community](#) off-balance—but this does not happen. Instead, the community remains stable. This phenomenon has come to be known as the [paradox](#) of plankton. One of the leading theories to explain the paradox is based on two main ideas—one is that some of the bacteria consume the waste matter of another [species](#). The other is that potential new members of a community can only survive by filling a niche unoccupied by others, or by better at filling that niche. In this new effort, the researchers created a [mathematical model](#) to simulate this theory.

To create the model, the researchers started with some basic "rules" for their theoretical community. Each member only ever consumes one type of resource, and consuming it causes the production of exactly two new resources. The pair also assumed that any new members could only survive if there was an open niche, or if they were better at exploiting a resource than a current member.

In using the model to create a computer simulation, the researchers found that their simple rules led to a virtual community that, like real-world bacterial communities, was both diverse and stable, and in fact became increasingly stable as the organisms became more diverse. They noted that in the early stages of community development, sometimes avalanches of die-offs occurred, during which a new, more efficient species got a foothold, causing existing members of a species to die off, which resulted in a die-off of those species that fed on its waste, and so on. But as time passed and a community grew more stable, avalanches

became less common. The researchers also noted that their [model](#) explains why two communities under ideal conditions can develop so differently from one another—it all depends on the history of new membership.

More information: Akshit Goyal et al. Diversity, Stability, and Reproducibility in Stochastically Assembled Microbial Ecosystems, *Physical Review Letters* (2018). DOI: [10.1103/PhysRevLett.120.158102](https://doi.org/10.1103/PhysRevLett.120.158102) , On Arxiv: <https://arxiv.org/abs/1711.00755>

ABSTRACT

Microbial ecosystems are remarkably diverse, stable, and usually consist of a mixture of core and peripheral species. Here we propose a conceptual model exhibiting all these emergent properties in quantitative agreement with real ecosystem data, specifically species abundance and prevalence distributions. Resource competition and metabolic commensalism drive the stochastic ecosystem assembly in our model. We demonstrate that even when supplied with just one resource, ecosystems can exhibit high diversity, increasing stability, and partial reproducibility between samples.

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