Manipulating organism-environment feedback strength affects nonlinearity and hysteresis in a microbial predator-prey system.

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Abstract

Organism-environment feedbacks have shown their importance in the context of global change mostly in theoretical ecology. These theoretical studies suggest that increasing the strength of feedback will 1) increase the likelihood of observing alternate stable states; 2) cause greater nonlinearity between an environmental change and ecosystem state; and 3) will increase the likelihood of hysteresis in response to an environmental change.
In an empirical test of the importance of organisms-environment feedback, we manipulated the metabolism-dissolve oxygen concentration feedback strength in an aquatic heterotrophic tri-trophic community in microcosms. The manipulation consisted of five levels, from low to high feedback strength: free gas exchange between the microcosm atmosphere and external air (metabolism not strongly affecting environmental oxygen), regular addition of 200, 100, or 50mL of air and no gas exchange. Additionally, to test for nonlinearity and hysteresis in response to environmental change, all microcosms experienced gradual temperature change from 15∘C to 25∘C, and then back to 15∘C. We measured regularly the oxygen concentration in both head and liquid phases, the densities of the predator *Spathidium*sp., the prey (*Colpidium striatum* and *Dexiostoma campylum*) and the bacteria (initially *Serratia fonticola* and *Bacillus subtilis*).

Composition and dynamics of the communities showed evidence of multiple clusters (potentially alternate states), though the likelihood of residing in one or multiple of these clusters did not depend on the feedback strength treatment. In contrast, there was evidence of greater nonlinearity and greater hysteresis of the response to temperature change in treatments with stronger environment-organism feedbacks. These empirical results are in broad agreement with the theory that stronger feedbacks increase nonlinearity and hysteresis, and represent one of the first direct empirical tests of the importance of feedback in such theory.

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