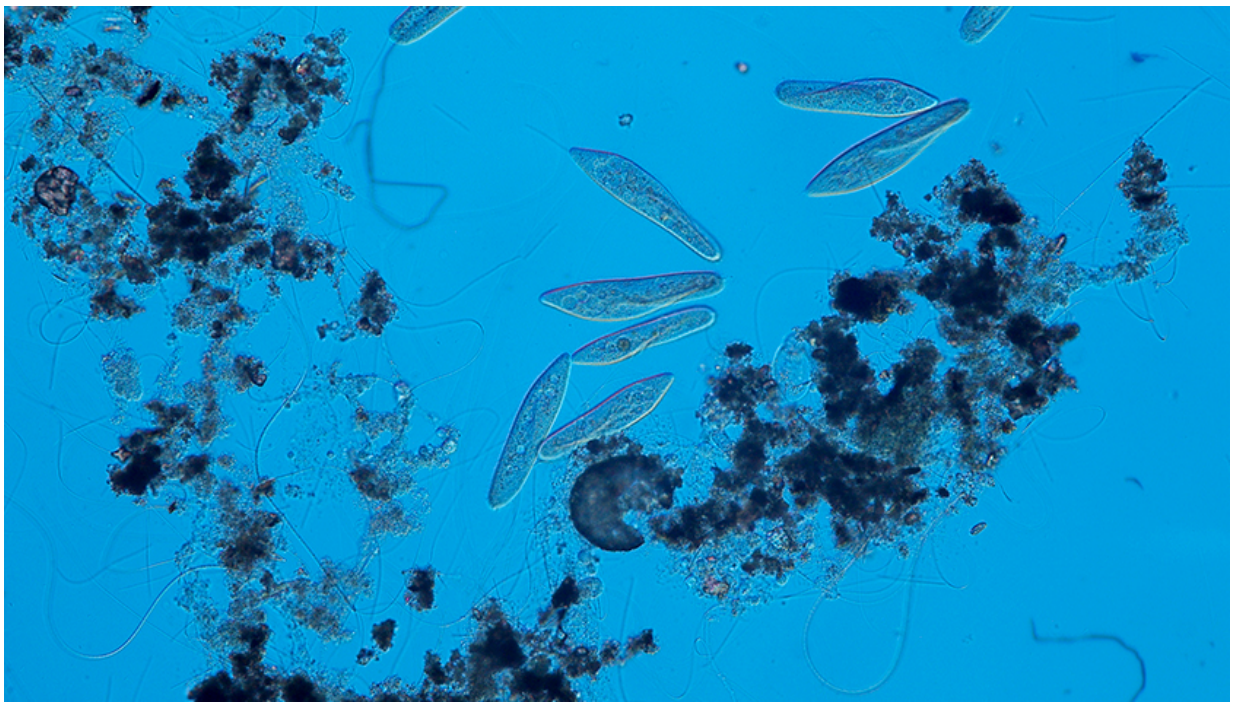


Biodiversity can also destabilize ecosystems

October 18, 2018 | Stephanie Schnydrig
Topics: Biodiversity | Ecosystems | Drinking Water | Pollutants

Species-rich ecosystems are more resistant to disturbances such as droughts, heatwaves or pesticide inputs – that, at least, is the view widely held by scientists and non-scientists alike. In fact, the situation is more complex, as ecologists from Eawag and Zurich University have now discovered. Under certain environmental conditions, increased species diversity can also lead to an ecosystem becoming more unstable.

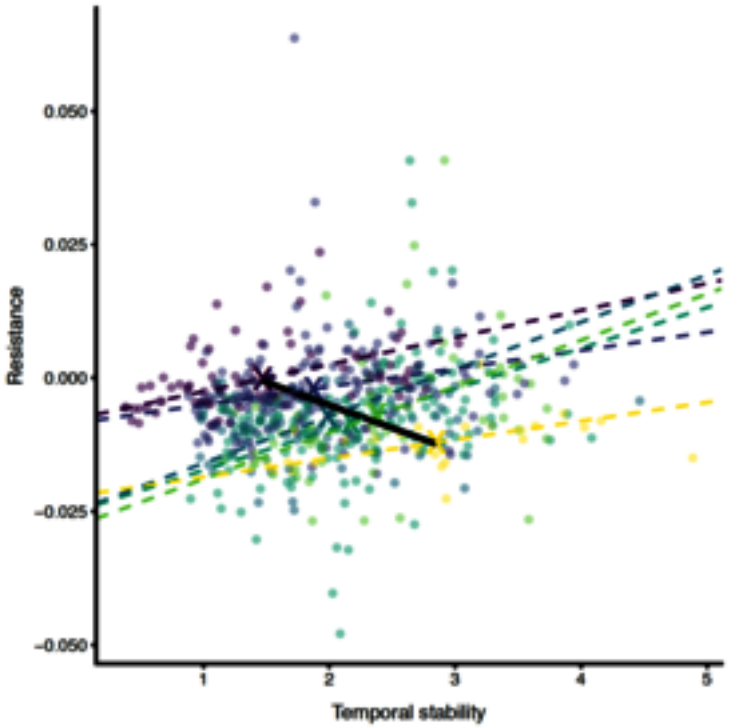
Ecosystems deliver a variety of essential services, providing food, water and other resources, as well as offering recreational areas. This makes it all the more important that the functional capacity and stability of these fragile systems should be maintained – in spite of climate change or environmental pollution. But what factors ensure ecosystem stability? This question has now been investigated in what Zurich University ecologist Frank Pennekamp proudly describes as “a unique experiment, probably the largest of its kind”.

In the study, scientists from Eawag and Zurich University examined how biodiversity affects the stability of ecosystems. For the experimental communities, they used six species of ciliates: various numbers and combinations of these single?celled aquatic organisms were placed in laboratory bottles to create micro-ecosystems, which were then kept at temperatures between 15 and 25°C. The higher temperatures simulated climate warming, as these ciliates are accustomed to a temperature of 15°C. To assess the stability of biomass production in the microcosms, the scientists employed a newly developed video analysis technique (see Box).

Opposing effects

The results of the study – published in Nature today – are surprising: biodiversity both increases and decreases ecosystem stability. “Ecological stability is complex, involving

various components. The experiment shows how diversity affects individual components of stability in different ways", explains first author Pennekamp. In particular, the higher the species richness of the community in a micro-ecosystem, the lower the variation in biomass production over time. However, the more species-rich the community, the less biomass is produced as temperatures rise.



The Figure illustrates the opposing effects of diversity in experimental communities: species richness increases the temporal stability of total biomass, but decreases resistance to warming.
(Source: Pennekamp et al., 2018)

Pennekamp concludes: "The fact that different components respond in different ways should be taken into consideration in the management of ecosystems since – depending on the weighting of the components – there may be non-linear relationships between diversity and overall ecosystem stability."

From the lab to the wild

But are the findings observed in such microcosms more widely applicable in nature? To resolve this question, Pennekamp and his colleagues examined numerous scientific studies investigating the effects of diversity manipulation on the various components of ecosystem stability. And, indeed, other scientists had also observed opposing stability-diversity relationships – for example, in grassland or algal communities. Pennekamp says: "The results make it clear that species richness is not in itself sufficient for overall ecosystem stability." What is required, as well as diversity, are species which can respond to environmental changes in different ways. "Nature is much more complex than we scientists might sometimes wish – but that's what makes it so fascinating," says Pennekamp, with a smile.

Automatic species classification thanks to video analysis and machine learning

The volume of data collected during the experiment was so large that manual species classification would not have been possible. The researchers therefore developed an algorithm to automate this process. Samples from the microcosms were pipetted into a counting chamber, and videos of the ciliates were then taken under the microscope. Morphology and movement data extracted from the roughly 20,000 video sequences could then be used to identify the species and measure the individual ciliates in the communities.

Original study

Frank Pennekamp, Mikael Pontarp, Andrea Tabi, Florian Altermatt, Roman Alther, Yves Choffat, Emanuel A. Fronhofer, Pravin Ganesanandamoorthy, Aurélie Garnier, Jason I. Griffiths, Suzanne Greene, Katherine Horgan, Thomas M. Massie, Elvira Mächler, Gian-Marco Palamara, Mathew Seymour, and Owen L. Petchey. Biodiversity increases and decreases ecosystem stability. Nature. October 15, 2018. https://doi.org/10.1038/s41586-018-0627-8

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