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BIODIVERSITY OF PLANKTON - NON-EQUILIBRIUM COEXISTENCE OF COMPETING SPECIES

Ulrike Feudel[1]*, Partha Sharathi Dutta[2], Ramesh Arumugam[2], Anshul Chaudhary[1], Helmut Hillebrand[3] and Bob W. Kooi[4]

[1]Theoretical Physics/Complex Systems, ICBM,
Carl von Ossietzky Universität Oldenburg,
PF 2503, D-26111 Oldenburg, Germany

[2]Department of Mathematics,
Indian Institute of Technology Ropar Rupnagar,
Punjab, 140 001, India

[3]Plankton Ecology, ICBM,
Carl von Ossietzky Universität Oldenburg
Schleusenstrasse 1, D-26382 Wilhelmshaven, Germany

[4]Department of Theoretical Biology, Faculty of Earth and Life Sciences,
VU University, de Boelelaan 1085, 1081 HV Amsterdam, The Netherlands

ulrike.feudel@uni-oldenburg.de (*corresponding author),
parthasharathi@iitrpr.ac.in,aramesh@iitrpr.ac.in,
helmut.hillebrand@uni-oldenburg.de, bob.kooi@vu.nl

Several solutions have been offered in the literature to solve the paradox of plankton which states that in equilibrium the number of coexisting species can not exceed the number of ressources. We study a competition model similar to the one introduced by Huisman and Weissing [1] who showed that coexistence of more species than ressources becomes possible in non-equilibrium states such as periodic or chaotic states. They called this phenomenon supersaturation. In contrast to the approach in [1] our model is based on the dynamic energy budget theory [2] which uses the concept of a synthezising unit. This concept is based on the mechanisms of enzyme kinetics and considers all ressources as complementary. Using this model we study the dynamics of the

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competing species which can exhibit competitive exclusion, heteroclinic cycles, stable coexistence in a fixed point and periodic solutions. Moreover, we find the coexistence of more species than ressources in parameter regions where periodic and chaotic solutions are possible. Hence we can show that supersaturation is possible in a model with a more realistic approach to the uptake of resources. Our study reveals the dynamical mechanism how supersaturation can occur: it is due to a transcritical bifurcation of limit cycles [3].

Furthermore, we study the relationship between biodiversity and ecosystem functioning. We show that productivity can be increased or decreased with increasing species richness, depending on the trait of the invading species which causes supersaturation. In general, the invasion of more (less) productive species compared to the residents lead to an increase (decrease) in productivity and resource use efficiency. The magnitude of this effect depends strongly on the environmental conditions, here considered as nutrient supply, and the individual traits of the species in the community. Additionally we show, how spatial heterogeneity in the distribution of nutrients promotes the coexistence of species.

References

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