The structure and dynamics of planktonic trophic modules as affected by their physical environment

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Abstract

The structure and dynamics of food webs (notably their stability) depend on the strength and distribution of links between species. However, these links remain difficult to measure or predict. It has been shown that they depend on the traits of the interacting species, but they were also observed to be context-dependent. For example, the existence and strength of a link between two broadly-distributed species may depend on their local population densities. The local environmental conditions may also alter the link between the two species. Physical environmental factors, such as temperature, water flow in rivers, or turbulence in oceans, may determine whether predators are able to capture their prey or not. In order to study the effects of the environment on the structure and dynamics of food webs, we apply an ecomechanical approach to model the dynamics of planktonic food webs. We model first the effects of the physical properties of water (viscosity, density and turbulence) on the locomotion of planktonic organisms that forage for resources. We apply our approach to basal trophic modules (two to 4 interacting species, including phytoplankton), that can move, or be moved by water, along the depth of the water column. The existence and strength of a link between every possible pair of species is fully determined by light availability (for phytoplankton species), hydrodynamics and species traits, notably body size. The resulting model helps us understand how hydrodynamical factors result in basal food web modules that are organized spatially along the depth of the water-column, under a light gradient. A similar approach, pending future developments, should help predict how the structure and stability of larger food webs will evolve following changes in the major physical factors of the environment.

Keywords: ecomechanics, food web, movement, body size, plankton

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