Warming effects on predator-prey interactions – a resource-based approach and a theoretical synthesis

Sebastian Diehl*[1] and Wojciech Uszko[2]

[1]Umeå University (SWEDEN) – Sweden
[2]Umea University (SWEDEN) – Sweden

Abstract

Processes such as metabolism, growth and feeding typically speed up with warming over the so-called 'biologically relevant' temperature range. This view has been widely incorporated into models of consumer-resource interactions that describe warming effects on food webs. Despite a striking structural similarity of these models, their predictions can differ widely, and no single model can accommodate the full range of observations from warming experiments in consumer-resource systems. We explored the temperature dependence of predator-prey interactions with a dynamical model that makes broader assumptions than most previous work. (1) Temperature dependence of the prey's carrying capacity is not assumed a priori but emerges from the interaction of the prey with its own resources. (2) The entire physiologically tolerable temperature range is considered over which several rate parameters show hump-shaped relationships to temperature. (3) The predator's functional response can be of type II or type III. Depending on the mode of resource supply, prey carrying capacity can be near-independent, monotonically declining or strongly hump-shaped in temperature. Yet, the influences of temperature and resource enrichment on predator-prey dynamics are qualitative the same in all of these cases. When plotted against temperature and enrichment, predator persistence and stability boundaries are U-shaped functions of temperature when the predator has a type II response; i.e. predators persist - but also oscillate - at lower enrichment levels when temperatures are intermediate. If the functional response is of type III, the persistence boundary is also U-shaped but a large region of stability opens up at intermediate temperatures. Warming can thus predictably increase or decrease stability and predator persistence, depending on current temperature, enrichment and the predator's functional response. The results of most previous modeling studies can be mapped onto the U-shaped persistence and stability boundaries, suggesting that previous, contrasting predictions are special cases of the more general model.

*Speaker