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Modelling the outcome of climate change driven invasion: effects of apparent competition on the resident and invasive forest herbivore population dynamics.

Invasive species can have profound effects on the resident community via indirect interactions. Particularly, forest insect herbivores are known to be able to affect the invaded ecosystems by trophic interactions. Of the indirect mechanisms, apparent competition is a highly plausible but less frequently studied structuring phenomenon in terrestrial herbivore communities. Nevertheless, surprisingly few studies have been made of apparent competition in the context of invasive insect species. The tendency of long periodic cycles in herbivore population dynamics can make the observations of the indirect effects difficult using experimental setups. Furthermore, dynamic monophagy in established communities may prevent the observations of the effects of apparent competition on the community. However, the ongoing invasions of non-native species into new environments create a stage to observe apparent competition before adaptation obscures the interactions. Modelling invasions based on real invader-resident communities can therefore be of particular help when determining the undetectable and long term effects of invasive species.

The winter moth, a cyclic foliage feeding geometrid moth, has expanded its outbreak range during recent years due to warming winter temperatures. The mountain birches in the new invaded areas (the dominant green leafed tree in these areas) have previously been defoliated on a 9 to 10 year basis by the resident autumnal moth. The autumnal moth itself is able to cause drastic foliage loss in the mountain birch forests occasionally resulting in vast tree deaths. The new invader, the winter moth, has already been observed to be capable of total forest defoliation of similar magnitude. The two species share, in addition to the host tree, generalist predators and parasitoids in these Fennoscandian areas. Asymmetric preference at both parasitism and predation rates has been recently observed. In order to fully see the consequences of asymmetric effects of natural enemies on the 9 to 11-year population cycles, a modelling approach was called for. We were especially interested in, are these asymmetries able to cause asynchronous population cycles as seen in the area of sympatric occurrence. In addition, the long term effects of the invasion on the resident community are of particular interest, since recent evidence shows that winter moths are interacting in several ways with the local community and further range expansion of this forest pest does not seem to be restricted by neither abiotic nor biotic interactions.

We used empirical data from the recent invasion of the cyclic winter moths in northern Fennoscandia as a starting point and modelled the outcome of observed short term asymmetric effects via generalist predators and parasitoids on the long term population dynamics of the invasive winter and resident autumnal moths. Adaptive dynamics theory was used and invasion of the winter moth into the resident community was modelled. Based on the results, apparent competition and asymmetries in the effects of generalist predators are able to produce the observed asynchronous cycles. However, instead of evolutionary branching resulting in evolutionary stable coexistence of the two species, the system experiences cycles of evolutionary branching and extinction. Furthermore, independent of the modelled dynamics, the invasive species was observed have the potential to inflict drastic changes in the mountain birch community.