

Movement of chemical stressors changes the relationship between regional diversity and productivity

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Chemical stressors and nutrients in coastal and marine waters are not homogeneously distributed. As a result, environmental conditions vary among places, which generates differences in community composition. Such among-community variation can be expressed as beta-diversity. Beta-diversity decreases when the movement of individuals among patches, named biota dispersal, homogenizes community composition. Moreover, productivity can decrease when biota dispersal removes species from patches where they are best adapted to the local environmental conditions. However, not only biota but also environmental factors can move, which leads to a homogenization of the environmental conditions. Such homogenization potentially affects beta-diversity, productivity and the relationship between both. How the movement of environmental factors affects the relationship between beta-diversity and regional productivity has, however, hardly been studied. Therefore, this study examined this relationship across a stress dispersal gradient. To do so, we moved marine micro-algae and a toxicant independently (following a full-factorial design) between two patches, of which one patch initially contained the herbicide atrazine. The movement of the algae resulted in a gradient in beta-diversity, while the movement of the toxicant homogenized environmental conditions.

The relationships between beta-diversity and regional productivity were positive in the treatments with stress dispersal on day 8 and without stress dispersal on day 24. In contrast, these relationships were negative in the treatments with stress dispersal on day 24. The positive relationships between beta-diversity and regional productivity were caused by a biota transfer from the more productive non-stressed community to the stressed community. This transfer resulted in a productivity loss of the non-stressed community that could not be compensated by internal growth. Therefore, regional productivity decreased with decreasing beta-diversity. The negative relationships at high stress dispersal were caused by the inflow of biota to the stressed community, leading to an increase in productivity of the stressed community when stress levels decreased. The regional productivity thus increased with decreasing beta-diversity.

Our study shows that the relationship between beta-diversity and regional productivity changes when toxicant movement homogenizes the environmental conditions. Today, there is an increasing interest in how local environmental conditions regulate community composition and productivity. Based on this study, we argue that those studies should also incorporate the dispersal of biota as well as the movement of environmental factors.

Keywords: algae; beta-diversity; productivity; dispersal; toxicant; community