Diatom diversity: the insurance for primary production in a changing world?

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Anthropogenic activities are currently causing an unprecedented decline in biodiversity (Rockström *et al.,* 2009). Since, over the past two decades, a multitude of theoretical and empirical studies has demonstrated that biodiversity increases the productivity and temporal stability of ecosystems (Cardinale *et al.,* 2012), it is important to understand how current and future diversity loss will affect our ecosystems (Hooper *et al.,* 2012). Here, we have evaluated how the relationship between diversity and ecosystem productivity changes in diatom communities exposed to an environmental stress gradient.

Diatoms, which are responsible for the bulk of primary productivity in the North Sea (Muylaert *et al.,* 2006), were collected in March 2013 on the Belgian continental shelf. Communities of 1, 2, 4, 6, 8 species were assembled from a pool of 8 randomly selected species. For each diversity level, 10 different assemblages were made to separate species identity from diversity effects (except for 1 and 8 where only 8 and 1 assemblage were possible). All communities were cultured in microcosms, and exposed for 4 weeks to 3 different concentrations of atrazine (0, 25 and 250 $\mu g.l^{-1}$). Although toxicants have only a minor impact on the current biodiversity decline (Naeem, 2012), they provide an excellent way to simulate the non-random extinctions caused by a deteriorating environment. As such, atrazine concentrations were chosen to represent no, low and high stress conditions that seriously impacted the growth of no, less than half, and more than half of the species, respectively.

The relationship between diversity and productivity increased with increasing environmental stress as productivity was better buffered in more diverse communities. This increase was solely driven by the replacement of sensitive by stress-tolerant species. Complementarity effects (i.e. the reduction in interspecific over intraspecific competition in mixtures due to niche complementarity or facilitative interactions between species) were unimportant for community productivity in both control and stress-treatments. Community productivity was thus predominantly determined by the dominant species. This is not uncommon in pelagic communities as they lack spatial heterogeneity, resulting in limited niche differentiation and, hence, strong interspecific competition. In the control condition and low stress treatment, the effect of diversity on productivity was limited since several dominant species could drive community productivity in a similar way. In addition, biodiversity even had a negative effect on productivity in the most diverse communities because of strong competition between species. However, in the high stress treatment, biodiversity had a strict positive effect on productivity as it increased the probability that some of few stress-tolerant species were present. Here, we have thus shown that biodiversity has a limited effect on productivity in control conditions, but that it is essential for preserving ecosystem function in stressed systems because it increases the probability of including stress-tolerant species in the community.

References

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