

Metacommunity structure in a floodplain system: implications for conservation and restoration

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Abstract

We investigated the importance of local and regional processes in structuring aquatic communities in a river-floodplain-system. Both, environmental and spatial factors had a significant impact on the structure of the different communities. Metacommunity processes are thus of importance in river floodplain systems and must not be ignored in management. Our findings are of particular importance for the enhancement of the lateral integration between the river and its floodplain. The structure of the network is thereby significantly altered, with subsequent effects on the relative importance of spatial and local processes in structuring metacommunities.

Keywords

specialist, generalist, colonization, variance partitioning, neutral model, species sorting

Introduction

Traditionally community ecology has emphasized the discrete nature of ecological communities and dealt with the biotic interactions and environmental characteristics that permit coexistence at the local level. Biotic processes acting at the local scale include competition and predation; what also is emphasized is the importance of the abiotic environment. In freshwater ecology, current velocity, depth, and substratum have often been put forward in explaining the distribution of different species. These variables are also frequently used in species distribution models such as phabstim (physical habitat simulation models).

Over the past decades it has increasingly been recognised that local communities are products of both local (niche-assembly) and regional scale (dispersal assembly) processes (RICKLEFS 1987). The relative importance and interactions of these processes in structuring species assemblages is addressed by metacommunity ecology (LEIBOLD et al. 2004, LEIBOLD & MILLER 2004; COTTENIE 2005; DRISCOL, 2008).

Only few studies have analyzed metacommunities in river-floodplain systems. Most of these studies emphasize the significance of environmental heterogeneity in generating and maintaining biodiversity, only few studies stress the significance of dispersal (see WINEMILLER et al. 2010).

We used a river-floodplain system (RFS) as a model environment to analyse the significance of niche-assembly and dispersal assembly processes in structuring aquatic communities. Due to their spatial heterogeneity, their temporal stochasticity, and the network configuration of water bodies RFS's are especially challenging from a metacommunity point of view.

Methods

The structural connectivity of the aquatic network was assessed using a network centrality measure. Environmental variables included "hydrological connectivity", "depth", "solar radiation", "sinuosity" and "distance to the Danube".

To assess the relative importance of local (e.g. competition, predation) and regional (i.e. dispersal) processes in the structuring of the different communities we conducted a partial canonical correspondence analysis with forward selection (BORCARD et al. 1992). We used Canoco for Windows 4.5 to partition the variance between spatial and environmental variables.

Results & Discussion

Both, environmental and spatial factors had a significant impact on the structure of the different communities. The spatial configuration explained between 5 and 10 % of the differences between the local communities. Seven to 20 % were explained by environmental factors (Figure 1). Metacommunity processes are thus of importance in river floodplain systems and must not be ignored in management.

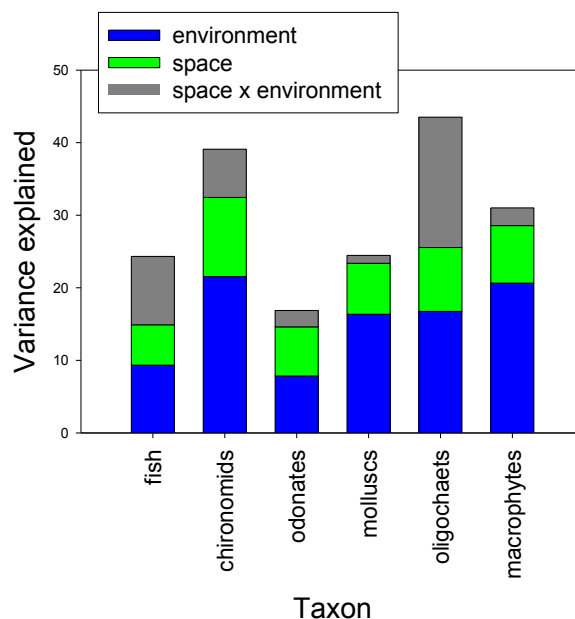


Figure 1: Results of multivariate variance partitioning (Borcard et al. 1992) for different aquatic communities using a CCA model: discriminating between the environmental factors (blue), the spatial configuration (green) and their intersection.

Our findings are of particular importance for the schemes to restore large rivers where the main emphasis is the enhancement of the lateral integration between the river and its floodplain (RECKENDORFER et al. 2006, SCHIEMER 1999, SCHIEMER et al. 1999, BUIJSE et al. 2005). The structure of the network and the habitat connectivity of the river-floodplain system are thereby significantly altered, with subsequent effects on the relative importance of spatial and local processes in structuring metacommunities. An understanding of the spatial context of river-floodplain networks is thus of central interest for planning measures for the restoration of rivers.

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