A comprehensive examination of the network position hypothesis across multiple river metacommunities

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Abstract

The hierarchical branching nature of river networks can have a strong influence on the assembly of freshwater communities. This unique structure has spurred the development of the network position hypothesis (NPH), which states that the strength of different assembly processes depends on the community position in the river network. Specifically, it predicts that (1) headwater communities should be exclusively controlled by the local environment given that they are more isolated and environmentally heterogeneous relative to downstream reaches. In contrast, (2) downstream communities should be regulated by both environmental and dispersal processes due to increased connectivity given their central position in the riverscape. Although intuitive, the NPH has only been evaluated on a few catchments and it is not yet clear whether its predictions are generalizable. To fill this gap, we tested the NPH on river dwelling fishes using an extensive dataset from 28 French catchments. Stream and climatic variables were assembled to characterize environmental conditions and graph theory was applied on river networks to create spatial variables. We tested both predictions using variation partitioning analyses separately for headwater and downstream sites in each catchment. Only 10 catchments supported both predictions, 11 failed to support at least one of them while in 7 the NPH was partially supported given that spatial variables were also significant for headwater communities. We then assembled a dataset at the catchment scale (e.g. topography, environmental heterogeneity, network connectivity) and applied a classification tree analysis (CTA) to determine which regional property could explain these results. The CTA showed that the NPH was not supported in catchments with high heterogeneity in connectivity among sites. In more homogeneously connected catchments, the NPH was only supported when headwaters were more environmentally heterogeneous than downstream sites. We conclude that the NPH is context dependent even for taxa dispersing exclusively within streams.

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