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Global climate change and local factors cause hydrological intermittence in Alpine rivers: what are the impacts on biological communities?

Changement climatique global et facteurs locaux entraînent l'intermittence hydrologique dans les rivières alpines: quels impacts sur les communautés biologiques?

Introduction

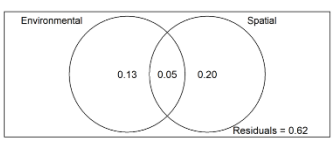
Alpine aquatic environments are considered particularly sensitive to climate change, as warming events reduce snowpack and ice cover and changes in the precipitation amount and distribution alter hydrological cycles. In particular, over the last decades Italian Alpine rivers have been affected by a conspicuous increase in frequency and intensity of drought periods.

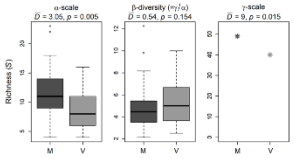
Aim of this study is to explore the impact of intermittence in previously perennial Alpine stream reaches, considering biodiversity, taxonomic and functional aspects.

Materials and methods

We present here the results of the first sampling year of the PRIN NOACQUA project in the Alpine area. In 13 alpine rivers, we have identified a 'perennial' reach (called CON - control) that permanently maintains the surface running water and an 'intermittent' section (called DIS - disturbed), characterized by a drying phase. Quantitative samplings of benthic communities (diatoms and macroinvertebrates) were performed in each of these sections. In addition, both allochthonous (CPOM amounts) and autochthonous (benthic chlorophyll-a) energy inputs were estimated. We report here only the preliminary results of the benthic macroinvertebrate community analyses.

A partial-RDA was performed to understand which environmental and spatial factors mainly affect benthic invertebrate communities. To investigate how water intermittency shapes the diversity of benthic communities, we partitioned total diversity (gamma diversity) into alpha (local diversity) and beta (turnover) diversity components in both permanent and intermittent sites, while an indicator species analysis (ISA) was performed to identify which taxa are indicators of perennial and intermittent sites. The response of several parameters of benthic communities, i.e. taxa richness, EPT richness and the abundance of functional groups (FFG, biological groups and ecological groups) to water scarcity and environmental parameters was tested by means of statistical models.

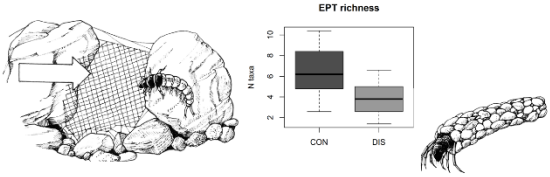




Results and Discussion

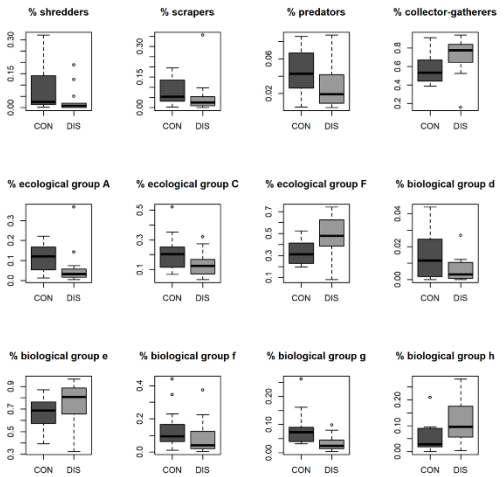
Results of partial-RDA showed that benthic macroinvertebrate composition is driven by both environmental factors and spatial limitation in alpine streams. In particular, dispersal of organisms is limited among streams, probably because adults cannot overcome mountain barriers. Their composition is also driven by several environmental factors, acting at different spatial scales: flow velocity (local scale), intermittency (reach scale) and physical-chemical parameters (stream scale).

The partitioning of total diversity (γ-diversity) of the entire sampling area into local diversity (α-diversity) and variation among streams (β-diversity) showed a balanced contribute of both alpha and beta diversity in perennial sites, while intermittent reaches are characterized by lower values of local diversity, indicating a depletion of taxa. These patterns were confirmed by the results of the indicator species analysis, which showed that EPT taxa are indicators of perennial sites (*Epeorus*, *Amphinemoura*, *Ecdyonurus*, *Isoperla*, *Leuctra* and Sericostomatidae), while there are no indicator taxa for intermittent reaches.



Results of statistical models showed that intermittent reaches are characterized by significant lower values of taxonomic richness compared to perennial sites and this is mainly due to the depletion of the most sensitive taxa (EPT taxa), indicating a homogenizing effect on benthic communities. From a functional point of view, reaches with permanent water are characterized by significantly higher abundances of shredders, as well as higher abundances of taxa belonging to the biological group f and the ecological group A, compared to intermittent reaches (Usseglio-Polatera et al., 2000).

In fact, we found that CON-communities are on average richer and more diversified than DIS-communities. Moreover, while CON-communities are highly heterogeneous, DIS-communities are much less differentiated. We hypothesize that hydrological intermittence acts as a filter that selects, even from different communities, species sharing the same life-history traits adapted to overcome the drought periods. Improving our knowledge on the possible evolution of Alpine lotic ecosystems is crucial, because these environments will be subject to an increasing human pressure under the current climatic scenario.



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