Contrasted annual thermal regime effects on subalpine stream macroinvertebrates

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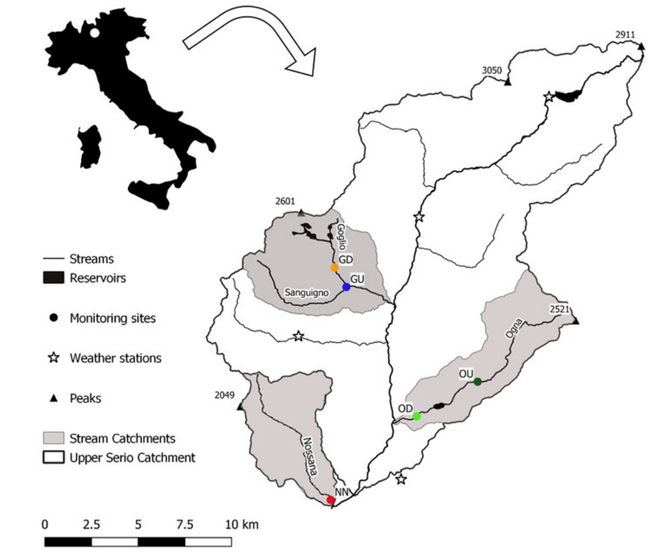
Introduction

Water temperature is recognized as one of the most important drivers shaping both aquatic ecosystem structure and functioning however, to date, only a few studies investigated simultaneously the effects of contrasted water thermal regimes together with the environmental variables on macroinvertebrate communities and taxa, especially in alpine streams.

Study Area



Methods

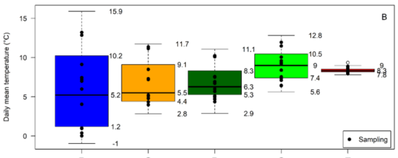
At five stream sites, each month for one year, we sampled macroinvertebrates and monitored environmental variables describing physico-chemistry, flood disturbance, and resource availability. Water temperature was measured continuously providing daily thermal metrics. We described spatiotemporal relationships between macroinvertebrate community structure and environmental conditions using co-inertia analysis and tested the contribution of the thermal regime compared to the other environmental conditions in driving the community structure based on regression approaches (e.g. mixed effect models).

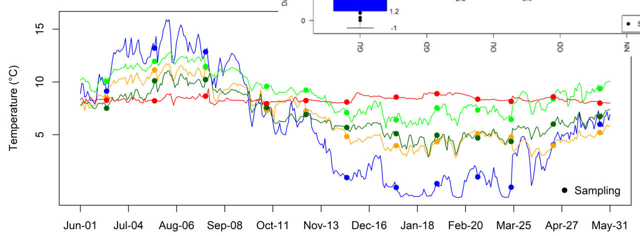
Aims

We expected that increased annual water thermal variability would generate temporal changes in macroinvertebrate assemblage structure, with important temporal variations in the abundance of stenothermal taxa such as Plecoptera. Concerning differences between sites, consistently, we expected more thermal generalists and higher seasonal dissimilarity in sites with variable thermal regimes.

Results:

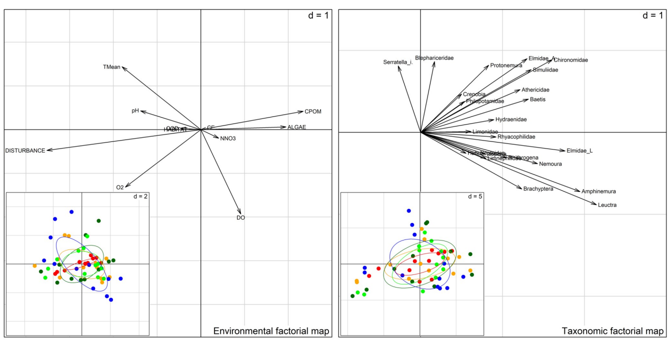
1) Water temperature





The five stream sites displayed very different annual variations in water temperature around comparable means.

2) Temporal co-structure

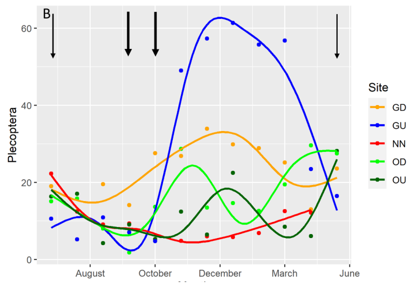


According to the within-site CoA DISTURBANCE (floods) mainly explained the common macroinvertebrate temporal pattern among sites with a negative effect on most taxa and resources availability (ALGAE and CPOM) while temperature is the second driver with low values associated to higher abundances of *Leuctra sp.*, *Brachyptera sp.* and *Amphinemurae sp.* and lower abundances of *Serratella ignita.* and Blephariceridae.

3) Macroinvertebrate response to environmental setting

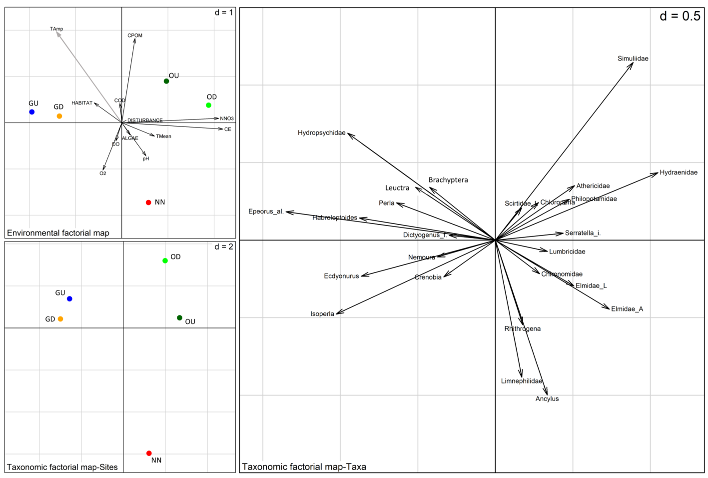
	Inter ± se	DIST ± se	CPOM ± se	Tmean ± se	R^2m	ICC_{adj}
log(Abundance)	7.170 ± 0.082	**-0.802 ± 0.091**	0.288 ± 0.091		0.71	0
%Plecoptera	18.436 ± 2.587		3.548 ± 1.489	**-8.456 ± 1.327**	0.50	0.27
%Ephemeroptera	40.176 ± 3.241		**-10.524 ± 2.094**		0.34	0.17
%Tricoptera	8.133 ± 1.862			3.901 ± 1.103	0.17	0.17

Plecopera are cold stenothermal taxa, they are particularly sensitive to warm temperature. They show a strong temporal pattern in the site with the highest water thermal amplitude.



4) Spatial co-structure

Between-sites CoA showed that sites are ordered along a gradient of annual thermal variability (TAmp) in both the environmental and taxonomic factorial maps so the different annual water thermal variability can influence the spatial taxonomic dissimilarities among sites, that experienced in turn, linked to the different temporal beta-diversity variations in community composition.



Conclusion: Water temperature is a pivotal driver of the temporal pattern in macroinvertebrate assemblage, especially for cold stenothermal taxa. Moreover, differences in water thermal amplitude explain the spatial dissimilarity in macroinvertebrate assemblages.

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