Benthic biodiversity patterns in rapidly evolving Alpine proglacial ponds (Cevedale glacier, Italy)

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Introduction

What are proglacial ponds and which is their role in the Alpine biodiversity?

- Lentic water bodies directly linked to the glacier activity
- Ice-contact and ice-distal
- Increasingly represented ecosystems in the Alps due to deglaciation (Fig 1)
- Very rapid evolution, scarce knowledge

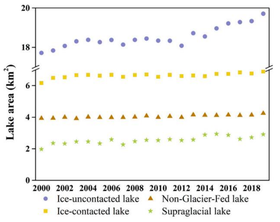


Fig 1. Mountain lake area in the Alps (from Ma et al 2021).

Aims

- To characterise the littoral benthic eukaryotic community composition in a cluster of recently formed proglacial ponds;
- To determine the possible effects of deglaciation processes on benthic biodiversity.

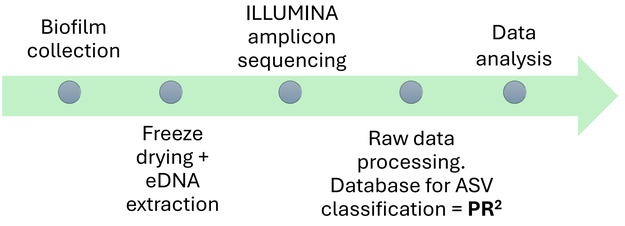
Methodology

❑ **When?** Monthly samplings during the ice-free seasons 2022 (Z1, Z2, Z4) and 2023 (Z2, Z3, Z4)

❑ **Where?** Cevedale glacier + Lake Marmotte (MA, clear lake)

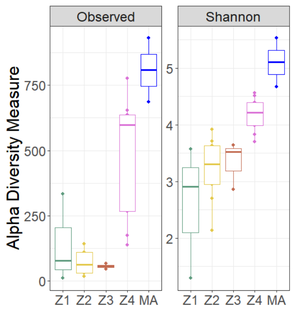
Fig 2. Left: Proglacial study area in Martell Valley (Stelvio National Park, BZ, Italy). Altitude = 2700-2900 m a.s.l. (Ortophoto Province of Bolzano). Right: Z1 and MA.

❑ **What?** eDNA metbarcoding → Eukaryotes (18S rRNA)



Results and discussion

1. α – diversity



Spatially increasing trend

Fig 3. α- diversity indices: observed n of eukaryotic ASVs and Shannon index.

2. β – diversity

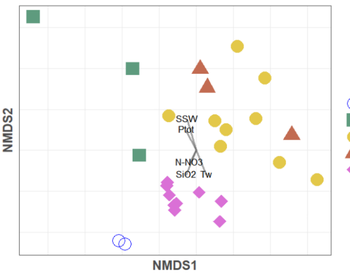


Fig 4. Non-metric multidimensional scaling ordination plot according to sites, for the ASV abundance dataset after normalisation.

Habitat differences mainly linked to the glacial influence (water temperature, total Phosphorus, suspended solids, SiO_2, $N\text{-}NO_3$).

3. Community composition

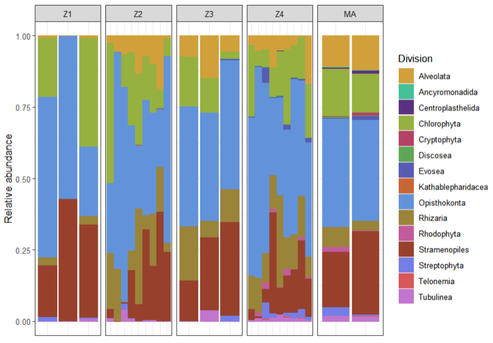


Fig 5. Community compositions at the Division level.

- Benthic **primary producers** (Chlorophytes, Cryptophytes, Chrysophytes, Bacillariophyceae) were well represented.

Windows of Opportunity for benthic growth occurring in periods of intense glacial runoff

- During the glacial ablation, periods of stable and dry metereological conditions induce a daily thermal stratification in the ponds (Fig 6).
- Thermal stability favour sedimentation of glacial flour.
- Reduction in the light limitation in the littoral zone = Windows of Opportunity for littoral primary producers.

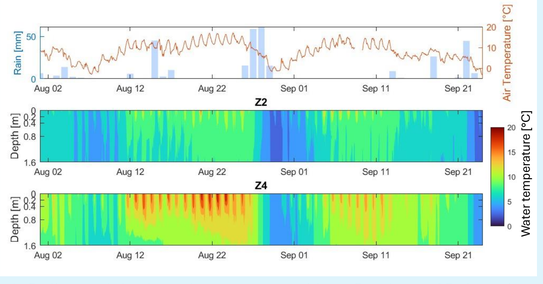


Fig 6. Daily precipitation, air temperature (data: Province of Bolzano) and water temperature profiles in Z2 and Z4, summer 2023.

Methodology pros and cons

✓
- ❑ Overview of Eukaryotic taxa
- ❑ Useful alternative to morphological methods. In turbid ponds: difficult microscopy observation due to inorganic particles

✗
- ❑ No quantitative information
- ❑ Taxonomical issues (reference databases)

Conclusion

- Spatial gradients in α-diversity as proxies of the climate-driven evolution of the proglacial ponds;
- Climate change is expected to accelerate the evolution of proglacial ponds towards less selective conditions by making Windows of Opportunity more prolonged and pronounced during dry summer periods.