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# Phenotypic plasticity of arctic charr *Salvelinus alpinus* at the individual and population scales in response to co-occurring environmental stressors during development

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## Abstract

Temperature is a key driver of many biological processes in aquatic ecosystems and plays as such a determinant role in development, growth, and metabolic rates of ectotherms. Although temperature is of crucial influence, freshwater biota is facing numerous distinct pressures that ought to be considered combinedly as the co-occurrence of several stressors might lead to additive or synergistic interactions.

The arctic charr (*Salvelinus alpinus*) is a stenothermic cold-water salmonid that is widely distributed in subarctic regions. In alpine and peri-alpine lakes, the charr lives at the Southern edge of its native range and seems highly vulnerable to climate change. Due to their inability to migrate to find more suitable environments, charr eggs and juveniles are particularly exposed to an array of environmental pressures such as pollutants or fine sediments that temperature might interact with.

Here we use a common garden approach to i) investigate individual phenotypic variation in early life in response to environmental constraints, and ii) explore how temperature might modulate the impacts of fine sediments, another common stressor in freshwater environments, on life history traits. We compare four arctic charr populations originating from thermally contrasted lakes by rearing embryos at an optimum or stressful temperature and in the presence or absence of a realistic sediment load. We link inter- and intra-population

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differences in fitness-related traits at hatching and physiological markers related to oxidative stress in order to investigate existing trade-offs between life history traits.

We report a synergistic interaction between our stressors such that temperature exacerbates strongly the negative effects of sediments on survival and energy expenditure during development. Charr populations respond differently to temperature increase, exhibiting differences in life history traits plasticity although the performance of individuals seems globally reduced.