Karstic ecology: How spring hydrogeomorphology structure macroinvertebrate fauna in the Haut-Doubs Valley, Jura Mountains, France?

1Patrick KAGERER, 2Guillaume BERTRAND, 3Coralie BERTHEAU-ROSELLE, 2Natacha THEVENIN, 2Christophe LOUP, 2Nadia CRINI

Current地址: Université Bourgogne Franche-Comté, Montbéliard, France; 1UMR 6299 CNRS-UBFC Laboratoire Chrono-Environnement, Université Bourgogne Franche-Comté, Montbéliard, France;

Abstract: The upper Doubs is a mountainous river system that includes the spring-fed Haut-Doubs Valley. Spring hydrogeomorphology is expected to strongly influence macroinvertebrate fauna. This study uses a combination of hydrobiological and geochemical analyses to assess how environmental and geomorphological changes affect spring fauna. We found that spring fauna are influenced by both physical and chemical factors, with some species showing a preference for specific water conditions. Future impacts under climate change are expected to alter these patterns, affecting the biodiversity of the area. This study highlights the importance of understanding spring hydrogeomorphology for biodiversity conservation and management.

Material and Methods

1) Sampling during winter and summer: Determination of surrounding environment (Forest/Grasslands), spring's morphology (Rheocrene/Limnocrene/Helocrene).
2) Evaluation of physico-chemical (T°C, pH, Eh, O2), pedological (sediment texture distribution), nutritive (Tot. Org. C [TOC]) parameters + water-rock interaction (WR) (Ca, Mg, HCO3) and environmental (Cl, NO3, Na, K, SO4) elements
3) Identification of fauna (annelids, arthropods, molluscs) and biodiversity indicators (Shannon / Pielou)
4) Multi Factorial Analysis (MFA) with fauna and biodiversity indicators as a supplementary data

Hierarchical Clustering favors grouping sites according to spring's morphology in the factor map.

Spring's morphology better discriminates springs in winter than their close environment.

Environmental and geomorphological patterns

Hierarchical Clustering leads to spring's repartition based on the spring's environment

Spring's close environment better discriminates springs in summer than their morphology.

Physicochemical and geochemical patterns and associated fauna distribution

• Opposition between physical variables (T°C, pH, speed...), elements from water rock interaction (Ca, Mg, HCO3) and environmental related elements (Na, K, Cl) and TOC
• Biodiversity's variables are poorly represented probably due to a lack of data in winter
• Biodiversity indicators positively but weakly correlate with physical variables (pH, T°C, speed and O2) and Ca

Synthesis and Perspectives

• Correlation of Environmental elements, org C, and helocrene due to weak ability to export organic matter due to marshy area?
• Rheocrene in grassland are related with environmental elements such as Na → Anthropic influence
• Food (TOC) and O2 are hardly concurrently favoured in the same springs as morphological aspects mainly controls physico-chemical conditions in winter. For instance, Rheocrene in grassland present greater oxygenation (related to speed, itself probably related to local slope).
• Biodiversity indices greater in forest's springs (especially with rheocrenes) due to less anthropogenic disturbances, more stable hydrological and physico-chemical conditions, presence of ecological corridors
• Rheocrene in grassland are associated with environmental ions (e.g., Na, Cl), O2 and speed influence of the local slope + land uses
• Food (TOC) and O2 may be concurrently present in the same springs as surrounding environmental conditions controls these parameters in summer. Combined with substrate constraints, this leads to either specific domination (e.g., gastropods for fine substrate) or to greater biodiversity, especially in forest springs

• Specific marls and calcareous lithologies alteration and related land use patterns structured spring ecosystem variability
• Seasonality of hydrological processes and related parameters are expected to increase with climate changes → Future Fauna adaptation changes?
• Land uses are currently impacted as well by climate changes with repeated severe droughts affecting forests → Future Impacts over summer biodiversity?
• Morphology diversity is highly dependent of private owner's care and vulgarization of the interest of these socio-ecosystems should be carried → Greater preservation of these hotspots of biodiversity feeding the river corridor?