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Faunistic assemblages of natural springs in different areas in the Swiss Nationalpark

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Abstract

Springs are spatially restricted ecotones that are inhabited by highly adapted organisms. We examined 36 springs in eight different areas in the Swiss National Park to understand, if the species assemblages of springs are isolated from each other or if they are interconnected communities. We sampled the macroinvertebrate assemblages of the springs and measured environmental parameters. The similarity of the species assemblages of the springs within and the dissimilarities between the different areas were relatively high. The differences of the macroinvertebrate assemblages can be mainly explained by substrate composition. We conclude that rather abiotic characteristics of the springs have an influence on the species assemblages than their geographical distance.

Keywords

alpine springs, substrate composition, macroinvertebrates, isolation

Introduction

Springs are isolated ecotones (CANTONATI et al., 2006), provide overall relatively stable environmental conditions and a mosaic-like substrate composition (VAN DER KAMP, 1995; CANTONATI et al., 2012). Ecologically, springs are unique habitats as the fauna inhabiting springs consists of species of all compartments: spring-specialists, so-called 'crenobionts', co-occur with rhithrobiont taxa, groundwater specialists and also taxa from the water-land-interface, the *fauna liminaria*. Many water mite species (GERECKE & DI SABATINO, 1996), but also some Diptera and Trichoptera larvae are meant to be bound to springs (e.g. FISCHEr, 1996; WARINGER & GRAF, 2011). The patch dynamics paradigm (PICKETT & WHITE, 1985) can be seen as a basic mechanism explaining the metacommunity concept, which assumes multiple similar habitat patches that are interconnected by dispersal (LEIBOLD et al., 2004). Therefore, springs can be seen as single interconnected communities of a superimposed metacommunity. In contrast, due to the relatively stable environmental conditions and their isolation from each other, springs can also be seen as island-like aquatic habitats (CANTONATI et al, 2006). For conservation issues it is crucial to know, if springs are isolated islands or interconnected patches of a naturally fragmented spring metacommunity. In this study we investigated 36 springs in the Swiss National Park to answer the question if springs can be seen as islands or interconnected patches of a dynamic spring network. Answering this question will help to predict if a loss of natural springs will lead to a loss of biodiversity in future.

Materials and Methods

The investigated springs are situated between 1780 and 2334 m a.s.l.. The springs in the park are completely free of anthropogenic disturbances and are located in different areas (Fig. 1). Springs were mapped using an evaluation sheet developed in Switzerland, which includes substrate composition (LUBINI et al., 2014). Water temperature, oxygen concentration, pH and electrical conductivity were measured in the field. The macroinvertebrates of the springs were quantitatively sampled with a small surber-sampler (VON FUMETTI et al., 2007). Specimens were identified to species level whenever possible. An ANOVA was performed to analyse the differences of the abiotic conditions and the taxon diversity of the springs between the areas. Combined environmental and species data were analysed using Redundancy Analysis (RDA). An analysis of similarities (ANOSIM) was used for testing the grouping of the springs. We subsequently ran a SIMPER (Similarity Percentages) analysis to assess faunistic similarities within each area and dissimilarities between the areas.

Results

The pH of the springs ranged from 6.2 to 8.5 and the oxygen concentration ranged from 4.6 mg l^{-1} to 10.6 mg l^{-1}. The electrical conductivity ranged from 198 µS cm^{-1} to 575 µS cm^{-1}. The water temperatures were between 3.6 °C and 10 °C**.** An ANOVA of the measured abiotic conditions showed that Elevation (ANOVA: $F = 148.9$; $p = 0.006$), electrical conductivity (ANOVA: $F = 4.548$; $p = 0.007$) and oxygen concentration (ANOVA: $F = 3.92$; $p = 0.004$) were significantly different between the areas.

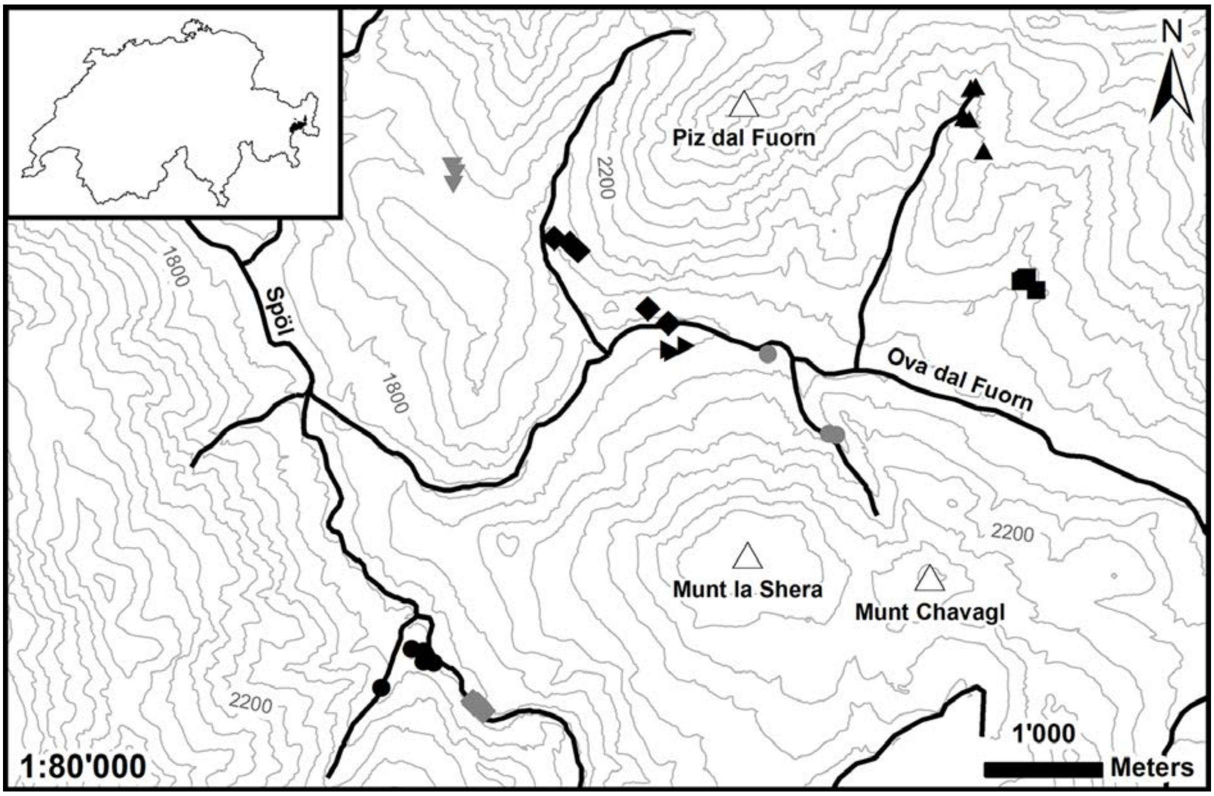

Figure 1: Map of the investigation area in the Swiss National Park (SNP). Springs located in the Val dal Botsch (VB), Val da Stabelchod (VS), Val Ftur (VF), Val Chavagl (VC), in the area Champlönch (CH) and the area God dal Fuorn (GF) discharge into the Ova dal Fuorn River, whereas the Val da l'Aqua (VA) and Punt Periv (PP) springs flow into the River Spöl. The linear distance between the areas ranges from 200 m (VF – GF) to 7.3 km (VB – VA). ● = Val da l'Acqua, ▲ = Val dal Botsch, ■ = Val da Stabelchod, ▼ = Champlönch, ● = Val Chavagl, ♦ = Val Ftur, ♦ = Punt Periv, ► = God dal Fuorn.

A total of 119 species and higher taxa were found. The number of taxa showed significant differences between the areas (ANOVA: $F = 5.632$; $p = < 0.001$). The Trichoptera (24 species) and the Hydrachnidia (20 species) were the most diverse taxa. The SIMPER-analysis showed that the species assemblages of the springs in the area PP were most similar (63 %), whereas the springs in the area VB showed the lowest similarity (36 %). The dissimilarity between two areas was highest between the neighbored areas VB and GF (79 %), whereas the lowest dissimilarity was found between the areas VC and VS. The ANOSIM significantly separated the eight areas (Global $R = 0.72$, $p = 0.001$). The RDA indicated differences between the springs and the areas. All environmental variables explained 58 % of the total variance. A forward selection revealed four significant explanatory variables: Elevation, boulder (both $p < 0.005$), roots and detritus (both $p < 0.05$). The first two axes indicated a separation of the macroinvertebrate assemblages according to the substrate composition of the springs. The areas are mainly split into two groups according to predominant substrate types: the springs in the areas PP, VS, GF and CH were dominated by organic substrates whereas springs in the areas VC, VB and VF provided mainly inorganic coarse substrates (Fig. 2a). As shown in the RDA plot, water mites tended to prefer springs which provide mainly organic substrates. Most Trichoptera taxa, especially species which belong to the genus *Drusus,* were mostly recorded in boulder dominated springs (Fig. 2b). Detailed results are given in VON FUMETTI & BLATTNER 2016.

Discussion

The macroinvertebrate assemblages of the springs were significantly different. This was mainly due to the location of the areas at different altitudes and the resulting abiotic conditions. Overall, no general spatial pattern was detected. The highest dissimilarity was not found between the areas with the largest distance to each other, as could have been expected assuming a strong isolation of the springs. Our findings indicate that the environmental prerequisites provided in a spring are much more important than the geographical distance between springs for the interchange of individuals. Especially for springs in a geographically isolated area such as in high alpine valleys the similarity or dissimilarity of the adjacent springs is of special importance. The lack of suitable nearby springs could prevent the dispersal of individuals despite short geographical distances. To this day little is known about the dispersal of crenobiont species. There is, however, evidence, that springs are less isolated than assumed and more often should be seen as complexes of one large metacommunity. If springs in a certain region are very different regarding their environmental conditions, the loss of one spring can lead to the loss of species. In those cases springs are island-like habitats and of special importance for conservation. Springs in protected areas can serve as reference sites for pristine springs and as potential stepping stones for taxa with high dispersal abilities. It has to be taken into account that only national parks guarantee total protection of nature.

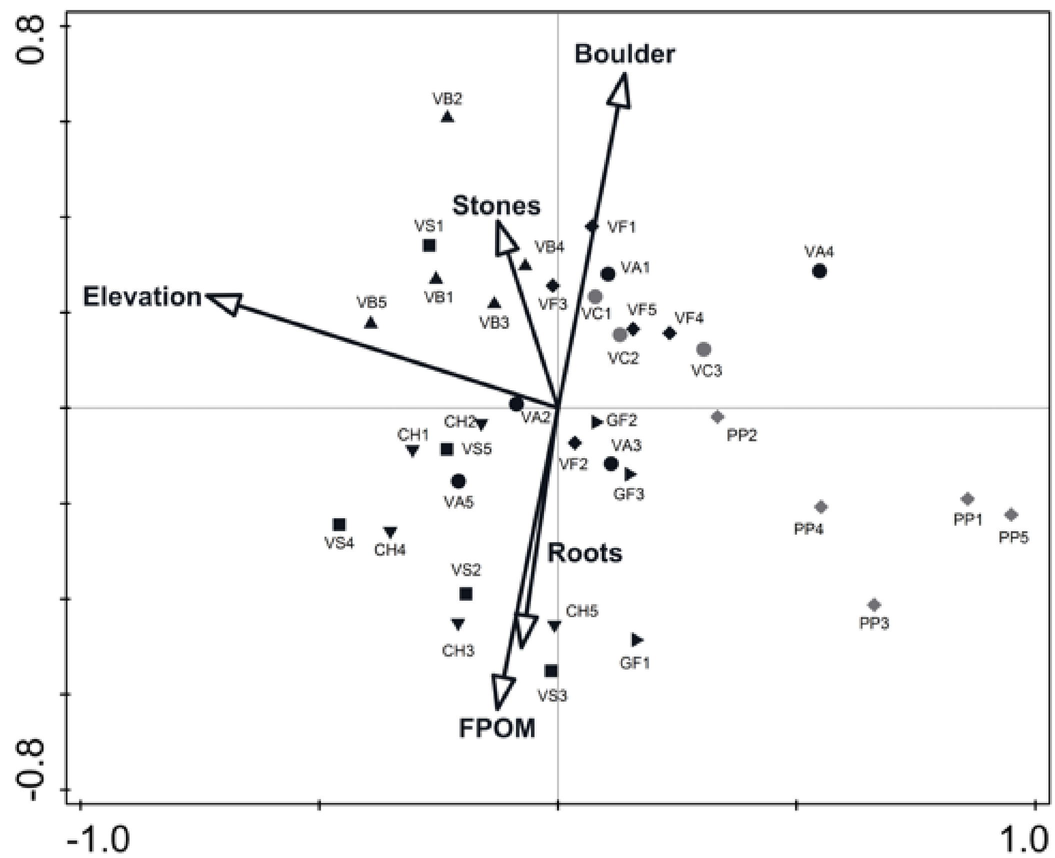

Figure 2 a: Ordination of 36 sites by a redundance analysis (RDA). The environmental variables with the highest explanatory power in the model are indicated by arrows.

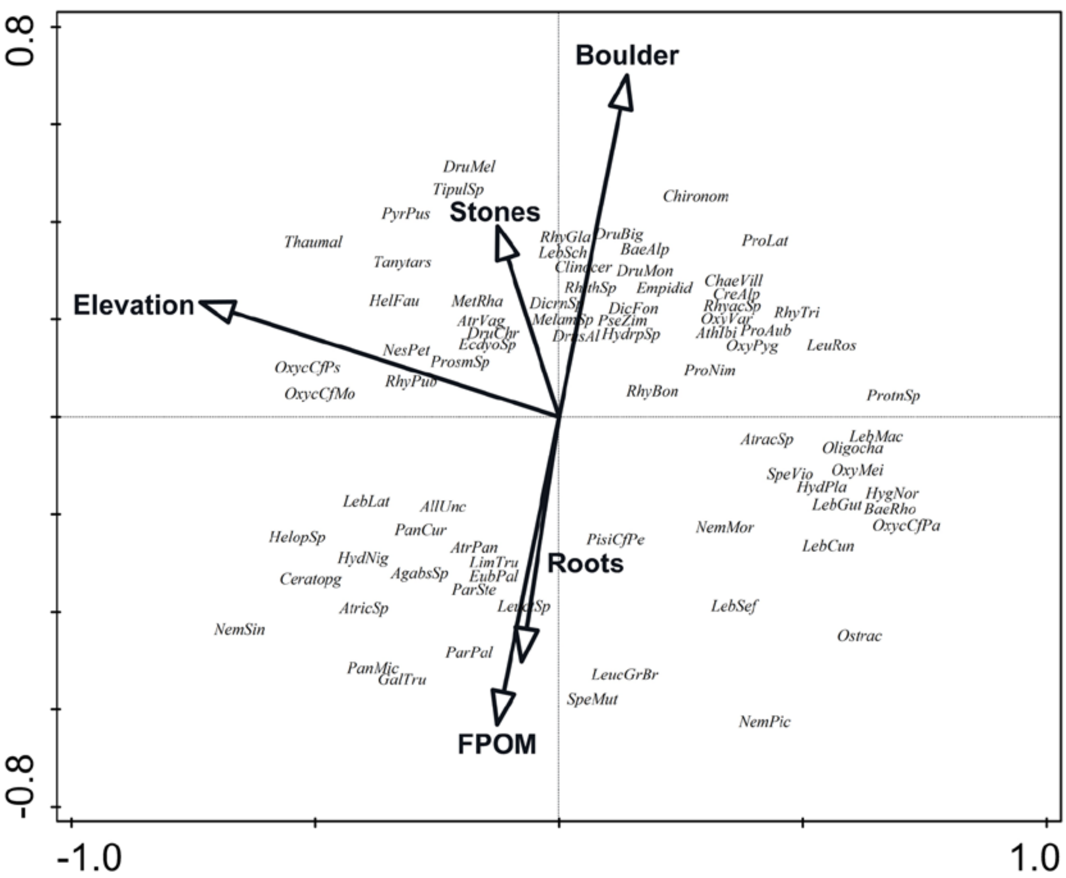

Figure 2 b: Ordination of 119 taxa by a redundance analysis (RDA). The environmental variables with the highest explanatory power in the model are indicated by arrows.

Conclusion

We were able to show that the geographical distance is less important than the environmental prerequisites for the macroinvertebrate assemblages. Neighbouring springs can be seen as interconnected patches of one large metacommunity if they share similar environmental parameters. If the abiotic conditions are very different, already the loss of a single spring can, however, have severe consequences for spring biodiversity.

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