Structure of bdelloid rotifer metacommunities in two alpine streams in northern Italy

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SUMMARY - Structure of bdelloid rotifer metacommunities in two alpine streams in northern Italy - Dispersal in freshwater invertebrates is one of the forces driving community composition of species. We analysed communities of small aquatic animals in submerged mosses in two different alpine streams in the Sesia Valley, northern Italy, using a recently developed tool for meta-community analysis, which deals with a matrix of presence of species in the communities. The animal model we choose were bdelloid rotifers, often numerically dominant in this kind of environment, and characterized by poor vagility, obligatory parthenogenesis and anhydrobiotic capabilities. The whole meta-community resulted significantly nested, although the two groups of communities from the two streams resulted well separated from each other in the ordered matrix. The resulted structure of the communities and meta-communities we described may be compatible with two different colonization patterns: 1) different abilities of dormant stages of different species to reach new areas, and 2) active animals that actively displace from one moss to next one inside a same riverine system.


Key words: Rotifera Bdelloidea, nestedness, metacommunity structure, meiofauna, Piedmont
Parole chiave: Rotifera Bdelloidea, nestedness, struttura di metacomunità, meiofauna, Piemonte

1. INTRODUCTION

Bdelloid rotifers are small (80-1500 μm long) aquatic animals, characterized by obligate parthenogenetic reproduction and by the ability to withstand unfavourable periods through anhydrobiosis (Gilbert 1983; Ricci 2001). Anhydrobiosis allows them to live in all aquatic habitats, mostly freshwater, and even in temporary waters: therefore bdelloid rotifers can be found in lakes, rivers, puddles and interstitial soil water. Bdelloid rotifers represent a major component of the fauna associated with mosses in lotic environments (Linhart et al. 2002a, 2002b; Wallace & Ricci 2002).

Since the ’80s, some authors approached the study of the species distribution in metacommunities in which the communities were hierarchically ordered (Taylor 1997; Wright et al. 1998; Davidar et al. 2002). Such ordered patterns of distribution (nestedness) occur when species assemblages of species-poor communities represent a sub-sample of species-rich ones (Patterson & Atmar 1986). The causes leading to nested patterns are generally referred to 1) different colonization abilities and/or 2) selective local extinction of different species (Lomolino 1996). Bdelloid rotifers represent a suitable animal model for the investigation of distribution pattern in metacommunities, for several reasons: (i) their vagility is rather poor (Donner 1965) but they can easily disperse due to their dormancy capacity (Cáceres & Soluk 2002); (ii) each single animal can start a new population due to obligatory parthenogenetic reproduction (Ricci
Bdelloids from mosses in stream

2. Material and Methods

2.1. Study area and sampling methods

Moss samples were collected from two alpine streams, Argnaccia and Res, in the Sesia Valley (Vercelli Province, Piedmont Region, northern Italy). Both streams are tributaries of the Sesia River. Argnaccia (named after its closest locality) runs in the municipality of Campertogno, while Res (named after Mount Res) in the municipality of Varallo Sesia. Submerged mosses were collected in both streams from 850 to 1000 m a.s.l., at 15 sampling sites (A1-A15, R1-R15) located at about 50 meters far apart (from A1 and R1 at the highest points to A15 and R15 at the lowest). Each sample had a surface of 5 cm². Samples were kept in small plastic bottles and were directly brought to the laboratory, where animals were maintained alive at 6 °C till identification according to Donner (1965).

2.2. Statistical analyses

The patterns of species distribution were tested for nestedness (Patterson & Atmar 1986) using the program “nested calculator” (Atmar & Patterson 1995). The program uses a thermodynamic model and measures the extent of order in a matrix. The data set was arranged in a presence/absence matrix with the species according to columns, and the communities according to rows. Ranking of rows and columns is obtained by ordering from the highest value to the lowest, and by minimizing unexpected absences and presences, in order to obtain the highest value of nestedness with the data set (Atmar & Patterson 1993). The probability of generating a matrix with lower/higher temperature (= more/less order) than the observed data set was tested by comparing its temperature to the temperatures of 500 matrices randomly generated by Monte Carlo simulations. Each matrix resulting from the simulation had a fixed number of occupied cells, equal to that resulting from the observed data set. The temperature of randomly generated matrices is roughly normal distributed. We called mean T the mean temperature of randomly generated matrices, σ its standard deviation, and T° the temperature of a metacommunity. Using a two tailed z test, if T < mean T - 1.96 σ, the probability that the matrix is as ordered as a random matrix is < 0.05, and the metacommunity is considered nested (Atmar & Patterson 1995).

T-test and Mann-Whitney U-test were used to discriminate between the streams (Sokal & Rohlf 1995). U-test was applied to the moss ranks obtained by ordering the matrix using reciprocal averaging (known also as correspondence analyses). Counting the number of “embedded absences” in this matrix and comparing it to the number of randomly generated matrices, we followed the method proposed by Leibold & Mikkelson (2002) to detect coherence of the matrix.

3. Results

Nineteen species were found in 30 samples in the two streams (Fig. 1). The overall matrix generated by...

Fig. 1 - Overall matrix, composed of species and samples, ordered using reciprocal averaging (Leibold & Mikkelson 2002). A1 to A15 are moss communities from Argnaccia, and R1 to R15 are those from Res stream.

Fig. 1 - Matrice generale della presenza delle specie nei 30 campioni esaminati, ordinata secondo “reciprocal averaging” (Leibold & Mikkelson 2002). Da A1 adA15 sono designate le comunità nei muschi campionate lungo il ruscello Argnaccia, da R1 a R15 quelle campionate lungo il ruscello Res.
“nested calculator” revealed a significant nested metacommunity, whose temperature was significantly lower than expected (Fig. 2). Although the matrix was significantly coherent (N of observed embedded absences = 124, N ± s.d. in simulated matrices = 258.9 ± 13.3, P < 0.001), the metacommunities of the two streams were almost completely separated on the opposite sides of the ordered matrix using reciprocal averaging (U15,15 = 0, P < 0.001). Also mean number of species per community was significantly lower in the communities living in the Argnaccia (5.4 ± 0.9) than in those found in the Res stream (7.6 ± 1.2) (t-test = 5.71, d.f. = 28, P < 0.001) (Fig. 3).

4. DISCUSSION

Bdellid rotifers are commonly assumed to disperse “blowing in the wind” or by animal transport as dormant dehydrated stages (Jenkins & Underwood 1998; Cáceres & Soluk 2002). This study suggests that colonization of bdellid rotifers can be related not only to passive transport of dormant stages, but that active bdelloids can move, at least along the continuous environment of one stream. The analysis of the bdellid metacommunities in the two streams, Argnaccia and Res, reveals the presence of a group of species that are shared (Adineta barbata, Adineta vaga minor, Habrotrocha collaris, Philodina flaviceps, Philodinavus paradoxus, Rotaria rotatoria), and of some species that occur in one stream only (Habrotrocha gracilis, Philodina nemoralis in Argnaccia, and the other 10 species in Res). This pattern may be produced by the dispersal capabilities of the dormant stages that might differ among different species; the “best dispersers” may colonize both streams, while the “poor colonizers” may reach one stream only. When a stream is colonized, active animals could actively occupy almost all submerged mosses, connected by presence of water.

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