TISCIA monograph series

Ecology of River Valleys

Edited by

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Szeged
2000

1.3. HABITAT CORRELATES OF GROUND INVERTEBRATE ASSEMBLAGES IN A FLOOD PLAIN LANDSCAPE COMPLEX

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1.3.1. INTRODUCTION

The wide recognition of the significance and the threat of biodiversity has drawn the attention to the study of ecological communities on both habitat and landscape level (cf. Tilman 1999). River valleys are regarded as agents in the maintenance of biodiversity both as core areas and stripe-like habitat complexes („ecological corridors"), which promote the migration and distribution of floral and faunal elements (Gallé et al 1995) and therefore they are important elements of so called ecological networks or econets (Nowicki et al 1996). Instead of slogans and general description of the landscape types by the rivers, however, detailed studies are necessary to reveal real ecological structure and processes of river valleys.

This paper presents a part of a complex regional project on river Maros/Mures. The aim of this research is to reveal the patterns of animal and plant communities from very small, within habitat scale (e.g. vegetation of ant mounds, distribution of ant individuals as a function of the distance from the top competitor's nest) to a regional level (e.g. distribution of different species and/or assemblage types along the whole river valley). Here we present our first results on the ground invertebrates (ants, ground and Staphilinid beetles and spiders) at the middle, i.e. between habitat scale within one landscape (for the first botanical results see Margóczi et al, this volume). The following questions are addressed: (1) What is the composition of ground invertebrate macrofauna in different habitat types at Upper-Maros valley? (2) How do different invertebrate assemblages indicate the diversity of habitat types within a landscape? (3) Which habitat attributes are correlated with the composition of ground invertebrate assemblages?

1.3.2. MATERIALS AND METHODS

Field studies were carried out in the Gyergyói medence at upper Maros/Mures region. A detailed sampling program was conducted in seven habitats: (1) peat-bog (*Carici stellulatae (echinatae) — Sphagnetum, Carici rostratae — Sphagnetum and Carici fluvae — Eriophoretum*); (2) wet meadow (*Molinietum coeruleae*); (3) a drier peat-bog (*Caricetum rostratae*); (4) wet bog-meadow (*Caricetum rostratae*); (5) wet pasture (*Agrosti — Deschampsietum caespitosae*); (6) mooreland bushy forest and (7) drier meadow (*Agrosti — Festucetum rubrae*).

We employed pitfall traps to sample ground surface animals. Traps were plastic jars with 6 cm diameter, with ethylene glycol preservative. Fifteen traps were used at each site, which were arranged in a grid with at least 5 m distance between the neighboring ones. The sampling period lasted for nine days in July. As an additional method, we carried out hand sampling, too, but in the present paper we restrict our evaluation to the data of pitfall samples.

For the characterization of the habitats, we used 177 scores grouped in three groups (Table 1): habitat architecture (19 scores), vegetation composition (155 scores) and soil (3 scores).

Table 1 Habitat attributes for characterization of study plots

Group	Attributes	No of categories
1 Habitat architecture (19 scores)	1.1 moisture degree	1
	1.2 total cover of higher plants, mosses and debris	3
	1.3 moss and debris thickness	1
	1.4 vegetation cover at 0-5, 5-15, 15-30 100-300, >300 cm	8
	1.5 maximum heights of plants	1
	1.6 no of stones	1
	1.7 no and condition of twigs on the ground	2
	1.8 heighth and cover of moss mounds	2
2 Vegetation composition	2.1 coverage of higher plant species	155
3 Soil	3.1 different soil parameters (pH, hardness, water content)	3

The community-level indication of habitat differences by the ground invertebrate assemblages was assessed with principal coordinate analysis (PCoA) and Bray-Curtis distance function (sometimes referred to as Czekanowski distance, Podani 1997, Tóthmérész 1993) between habitats computed on the basis of different assemblages. The external correlates of the studied assemblages were established with Spearman rank correlation of the between-habitat Bray-Curtis similarity matrices of the invertebrate assemblages and the habitat score groups. To avoid the consequences of the cross-correlation of the composed statistical tables, we employed Bonferroni corrections of the significance levels.

1.3.3. Results

1.3.3.1. Generalists and specialists

No absolute generalist ant was found, which occurred in all habitats. *Myrmica scabrinodis* Nyl. and *Lasius platythorax* Seifert were present in six out of seven habitats, whereas several ants occurred exclusively at site 7: *Formica rufibarbis* F., *Lasius paralienus* Seifert and *Myrmica schencki* Em., however these species cannot be regarded as specialist elsewhere, in this case rather the range of the surveyed sites was special. From the spiders, *Pardosa pullata* (Clerck) was found at every site but one, while Pardosa palustris (L.) and *Trochosa spinipalpis* (Pickard Cambridge F.) lived at sites 7 and 1, respectively. The latter one is typical bog-specialist. The absolute generalist beetle was *Drusilla canaliculata* (F.) occurring at every site. Although *Harpalus affinis* (Bach.) and *Pterostichus niger* Schall. were of more restricted distribution, in one and two habitats, respectively, they cannot be regarded specialists either.

1.3.3.2. Indication of habitat differences

On the basis of the community-level distances, the vegetation is the most sensitive indicator of the site differences (Table 2). Ground beetles have high distance values, too. Wolf spiders perform the lowest distance average, but the great coefficient of variation indicates a clustering tendency in habitat differentiation. All values are higher than those of the habitat attributes, but do not differ markedly from the values of random references.

Table 2 Average distance and their coefficient of variation between habitats on the basis of habitat attributes, vegetation and different ground invertebrates

	Habitat attributes	Random reference	Vegetation	Ants	Wolf spiders	Ground beetles
Mean distance	0 60	0 75	0 88	0 76	0 68	0 86
S.D./mean distance	0.36	0 21	0 24	0 25	0 47	0 18

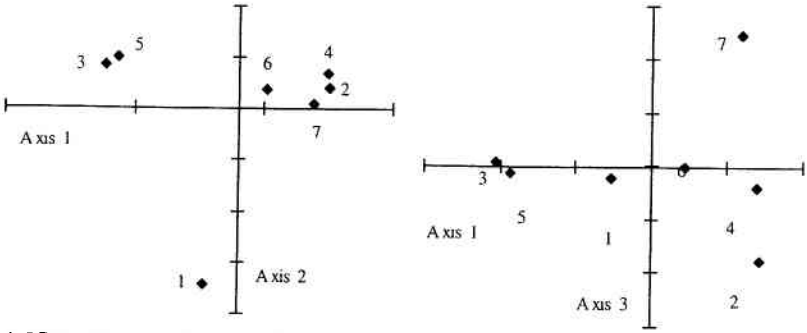

Fig 1. PCoA scattergram of ground beetle assemblages of seven studied habitats See text for habitat numbers

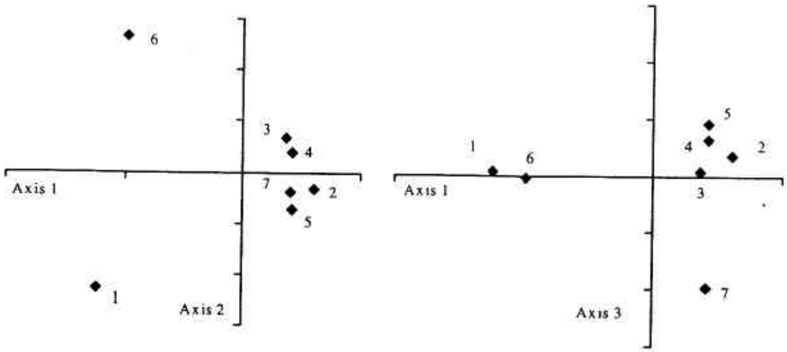

Fig. 2. PCoA scattergram of wolf spider assemblages of seven studied habitats

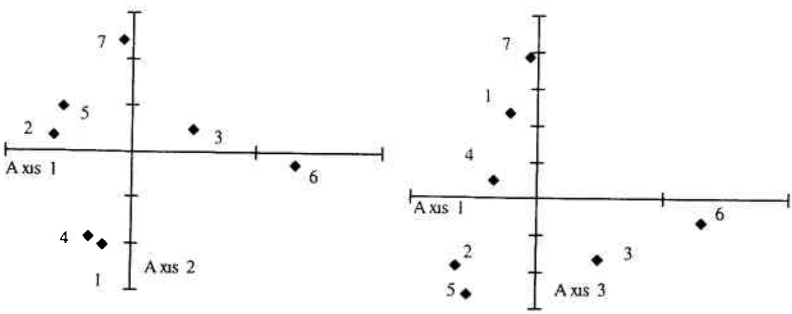

Fig. 3. PCoA scattergram of ant assemblages of seven studied habitats

In the PCoA scattergrams of the beetles and the spiders (Fig. 1 and 2) , sites 1, 6 and 7 are well separated from the others. The spider assemblages of sites 3 and 5 are very similar. In the case of ants, the assemblages of the drier peat-bog and the moore bushforest are the most similar (Fig. 3).

1.3.3.3. External correlates

On the level of habitat score groups and assemblages, ants and wolf spiders show significant correlation with habitat architecture, whereas the matrix of ground beetles is well correlated with the species composition of vegetation (Table 3). Interestingly, only the vegetation composition is correlated with the group of soil properties. The significant rank correlation between spiders and ants indicates that the assemblages of these two groups are similar in differentiating of habitats. Although the direct product-moment and rank correlation analyses between the soil properties and the number of individuals of the studied groups gave no significant coefficients, each coefficient was positive between pH and the density of the groups (ranked from 0.30 to 0.52) and negative between the water content and density (ranked from -0.42 to -0.50).

1.3.4. Discussion

In addition to the difficulties of the „habitat and non-habitat" distinction (Bevers and Flather 1999, Thomas and Kunin 1999), since the range of the habitats was rather extreme in this study, the specialist-generalist character of the studied species could not be established on the basis of their occurrence in the different habitats. The only species, which can be regarded as bog specialist is the wolf spider *Trochosa spinipalpis*. One could expect that the generalists i.e. the species , which are present in the majority of the studied sites, are locally abundant, too (Hanski 1982, Gaston 1999, Hartley 1998). Here we found several species having very high density but restricted to one or two habitats. The explanation could be the very different character of the habitat within this complex landscape, therefore the typical metapopulation and metacommunity processes (cf. Hanski 1999) do not work. If the conditions are extreme, we can expect close correlation between the habitat properties and the composition of the animal assemblages (cf. Gallé 1999). In this case the presumably most critical habitat properties, i.e. the pH and the water content of the soil were not significantly correlated with the studied properties of the assemblages neither as whole group of soil characteristics nor as individual scores. There are, however, several published data on the effect of water regimes and flooding on epigeic invertebrates, including spiders, ants and beetles (e.g. Gallé et al 1983, Holopainen et al 1995, Krumpalova 1999, Schlaghamersky 1999) and the wolf spiders are not so sensitive for some other, e.g. microclimatic conditions (Bayram and Luff 1993).

It is always a dilemma for arthropod community ecologists, whether animal assemblages should be classified on the basis of plant communities of their habitats, or an attempt of independent classification should be made. This study shows, that although there was good correlation between ground beetles and the composition of vegetation, the assemblages of the other two groups are more correlated with structural habitat properties then plants. Successional studies showed uncoordinated steps between plant and insect community dynamics (Gallé et al 1998), different community structures and patterns

(Markó 1998) and different sensitivity in the indication of habitat heteromorphy (Gallé *et al* 1989) and the different types of community variability makes this picture even more complicated (cf. Micheli *et al* 1999). This latter study demonstrated that the vegetation is the most „coarse grained" community type in within-habitat indication of spatial heteromorphy. These conclusions are in concordance with the findings of the present paper at higher, landscape level.

1.3.5. Summary

In a set of seven habitats ranging from peat bogs to dry grassland by the upper stream of river Mures/Maros, the vegetation of the habitats was more different than the assemblages of three studied invertebrate groups. Among invertebrates, ground beetles are the most sensitive indicators of habitat differences, the average between-habitat distance of wolf spiders' assemblages is the smallest, but the great variation coefficients indicate a clustering tendency in their habitat differentiation. Ants perform a middle rank between-habitat differences. Ants and wolf spiders are well correlated with habitat architecture, beetles show a significant correlation with species composition of vegetation. There was a positive community level relation between ants and wolf spiders.

1.3.6. Acknowledgment

We thank Dr. Katalin Margóczi for the providing vegetation data. We are grateful to our local friends for providing us board and field work facilities, and to István Jusztin for his help in soil analysis. The study is supported by the FKFP, grant No 375/1999 by the Hungarian Ministry of Education, grant No 79/T by the Ministry of Environment and by the Hungarian National Research Fund (OTKA) grant No T 020 149.

1.3.7. References

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Consider this table to be the part of Chapter 1.3. (attached to p. 34)

Table 3. Spearman rank correlation matrix of the between-habitat similarity indices obtained on the basis of habitat architecture, soil properties, vegetation compositon and the different ground invertebrate assemblages, p= level of significance, $p_{Bonf.}$ = significance after Bonferroni correction. Values remaining significant after Bonferroni correction are in italics

	Habitat architecture	Soil	Vegetation composition	Ants	Wolf spiders	Ground beetles
Habitat architecture	—	-0.01 p >0.1 pBonf. > 0.5	0.20 p >0.1 pBonf. > 0.5	***0.52*** ***p = 0.016*** ***pBonf. =0.08***	***0.83*** ***p = 0.0005*** ***pBonf. =0.002***	0.30 p > 0.1 pBonf. > 0.5
Soil	-0.01 p >0.1 pBonf. > 0.5	—	***0.59*** ***p=0.0068*** ***pBonf. =0.034***	0.26 p >0.1 pBonf. > 0.5	-0.04 p >0.1 pBonf. > 0.5	-0.21 p >0.1 pBonf. > 0.5
Vegetation composition	0.20 p >0.1 pBonf. > 0.5	***0.59*** ***p=0.0068*** ***pBonf. =0.034***	—	0.41 p = 0.068 pBonf. =0.34	0.09 p >0.1 pBonf. >0.5	***-0.51*** ***p = .018*** ***pBonf. =0.089***
Ants	***0.52*** ***p = 0.016*** ***pBonf. =0.08***	0.26 p >0.1 pBonf. > 0.5	0.41 p = 0.068 pBonf. =0.34	—	***0.57*** ***p = 0.018*** ***pBonf. =0.09***	-0.10 p >0.1 pBonf. >0.5
Wolf spiders	***0.83*** ***p = 0.0005*** ***pBonf. =0.002***	-0.04 p >0.1 pBonf. > 0.5	0.09 p >0.1 pBonf. >0.5	***0.57*** ***p = 0.018*** ***pBonf. =0.09***	—	0.31 p >0.1 pBonf. >0.5
Ground beetles	0.30 p > 0.1 pBonf. > 0.5	-0.21 p >0.1 pBonf. > 0.5	***-0.51*** ***p = .018*** ***pBonf. =0.089***	-0.10 p >0.1 pBonf. >0.5	0.31 p >0.1 pBonf. >0.5	—