

FLOOD-PLAIN RESEARCH AT DIFFERENT SPATIAL SCALES

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Abstract

This paper presents the main philosophy, aims and some preliminary results of the joint Rumanian—Hungarian ecological project carried out in the terrestrial habitats of River Mureş/Maros flood plains. The studies, scoping different spatial scales from the microcosms to the regions, have revealed the specificities of plant communities in very small patches (ant mounds), the role of an ant supercolony in structuring spatial pattern of the whole ant community, the differential effect of exogenous factors on the habitat selection of plant and different invertebrate assemblages, the restricted potential corridor function of the terrestrial habitats along River Mureş/Maros, and the scale-dependence of the faunal and community similarities.

Keywords: River Mureş/Maros, ecological communities, community organization, scales, scale-dependent patterns.

Introduction

There are two main paradigm shifts in the contemporary ecology. One is the recognition and acceptance of random processes and non-equilibrium dynamics (Pickett and White 1985, Diamond and Case 1986, Gallé 1998 and the citations therein), which includes the application of stochastic models, and the other is the change of the traditional spatio-temporal habitat scale of the classical ecological studies to both smaller (microcosm) and larger (landscape, region) directions (Lucas 1992, Haines-Young et al. 1993, Farina 1998, Margóczy 1998, Gaston and Blackburn 2000). Both views opened new perspectives for the ecological researches and their applications. Although the different patterns, processes and mechanisms of different ecological (supraindividual) biological units (e.g. populations, communities etc.) have been intensively studied and/or interpreted at different scales, the nomenclature remained very poor and besides the few names already given, such as metapopulation, sigma-communitites etc., many are yet missing (Table 1). The scale enlargement has been manifested in such theories and fields of studies, as interdemic selection, the dynamics of the metapopulations, metacommunities and sigma-communities (Wilson

1975, Hanski and Gilpin 1997, Hanski 1999). As an indication of the turn of interest to the macroscales, even new disciplines have appeared, which deal with the large-scale ecological research and conservation management (e.g. landscape ecology, macroecology, Haines-Young et al. 1993, Farina 1998, Gaston and Blackburn 2000). The application of the large-scale approaches is especially important for the river research in the Carpathian Basin. These sorts of approaches bring community and population ecology, faunistics and floristics, as well as biogeography closer to each other. At larger spatial scale, we have to emphasize the importance of the biotics (floristics and faunistics), which has been a neglected discipline for decades and it should get back its own right, as important representatives of the main sciences studying essential aspects of biodiversity.

In this paper we present the main objectives of the joint Hungarian-Rumanian terrestrial ecological project on the River Mureş/Maros.

The main philosophy of the Mureş/Maros joint ecological program of Cluj and Szeged universities is to study patterns, possible processes and their probably mechanisms at different spatial scales and to try to find the connections of the scales by interpreting their co-ordinatedness and complementarity at the terrestrial habitats along the River (for the first results, see Margóczy et al. 2000a, Gallé et al. 2000).

Table 1. Ecological objects at different scaling levels. The mark ● shows the scale at which the object in question has been traditionally studied. The question marks show those scales at which the specified unit is studied, but no name has been given to that. The name biogeocenosis is applied instead of widely used ecosystem because the latter term should be restricted to the cases, when systems analysis is done (see Juhász-Nagy 1986).

Unit	Scale				
	Micocosm	Local (habitat)	Landscape	Region	Global
Biogeocenosis		●	?	biom	biosphere
Community		●	meta-, sigma-	?	?
Population		●	meta-	?	species
Group	●	super-			
Individuum	●	●			

Table 2. Habitat attributes for characterization of study plots for invertebrates at Voslobeni, Upper-Mureş/Maros (after Gallé et al 2000)

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. height 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

Within-habitat scale

The first, smallest spatial levels of the investigations are the within-habitat ones, e.g. microcosms, between microcosms and habitats (see Table 1).

At the level of microcosm, among others, we studied the distribution of higher plants on the nests of *Lasius flavus* F. and their surroundings. *L. flavus* mounds act as very small islands (in order of 10^1 cm in both diameter and height, as a rule) for the vegetation. Although obtaining their plants from the surrounding biota, the species composition and frequency distribution of the ant mound plant assemblages significantly differ from the neighbouring ones (Fig. 1, after Margóczy et al. 2000b). On the ant mounds the plants cannot avoid each other's influence because of the small size of these microcosms (Margóczy et al. 2000b).

Another example of within-habitat studies is the research on the distribution of ant nests, the within-colony distribution of ant individuals and the structuring role of ecological interactions, especially interspecific competition in the spatio-temporal patterns of ant populations in the supercolony of *Formica exsecta* F. The individual nests of the huge supercolony covering more than 1 sq. km are more or less randomly dispersed (Fig. 2). The effect of the *F. exsecta* on the spatio-temporal distributional and activity patterns of the other ant populations was studied by bait experiments and mini-pitfall-trap sampling, studying the density and activity of ants other than *F. exsecta* as a function of the density of *exsecta* individuals. The preliminary results show, that the role of *exsecta* in structuring the ant community is weaker than it was expected (Gallé and Markó 1999, Markó, Mabelis and Gallé in preparation).

Landscape scale

At the level of landscape (between-habitat scale), different ecological assemblages (i.e. plants, grasshoppers, spiders, ants, beetles and snails) of different habitats are compared within the same regions in details. These studies have been carried out in four regions by the River Mureş/Maros, i.e. at the upper stream (near Voslobeni, Roumania), in the vicinity of Zam and Deva (Roumania), at Arad-Pecica (Roumania) and at Maroslele, near Szeged (Hungary).

Besides sampling plant and invertebrate assemblages (e. g. wolf spiders, ants, grasshoppers ground beetles), the possible background factors (see Table 2) and their assumed effects were also assessed. As an example, we show here the results obtained at Voslobeni, where we selected seven study plots, which represented different habitat types (Margóczy et al 2000a, Gallé et al 2000). At these plots, nine plant assemblage types were distinguished (by Braun-Blanquet system, Margóczy et al 2000a). The Principal Coordinate Analysis (PCoA) of the vegetation showed that the plant assemblages of the region form four groups such as (1) wetlands characterized by *Carex* species; (2) meadows of *Molinietum coeruleae* plant associations; (3) dry pastures and (4) transitional vegetation (*Caricetum flavae juncosum subnodulosi*) between (1) and (2). The picture on the basis of different animal assemblages is not so unequivocal.



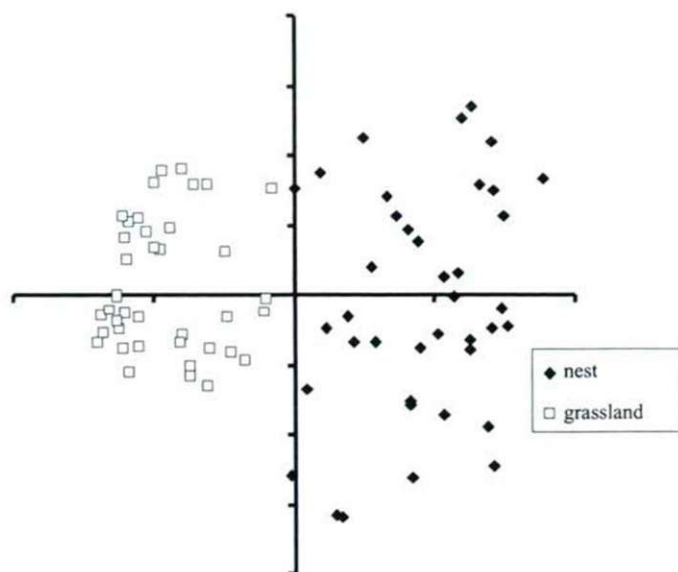


Fig. 1. Principal Coordinate scattergram (Jaccard distance function) of the vegetation on *Lasius flavus* mounds and in the neighbouring grassland at Voslobeni (After Margóczy et al. 2000a).

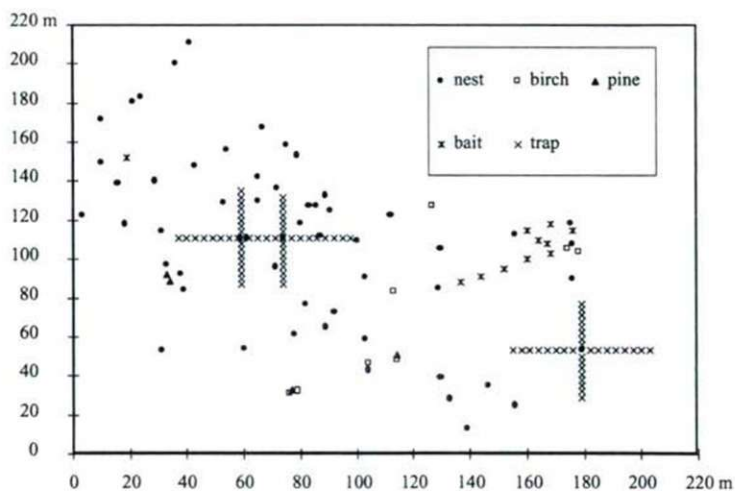


Fig. 2. Distribution of the individual nests of a *Formica exsecta* supercolony in a pasture at Voslobeni.

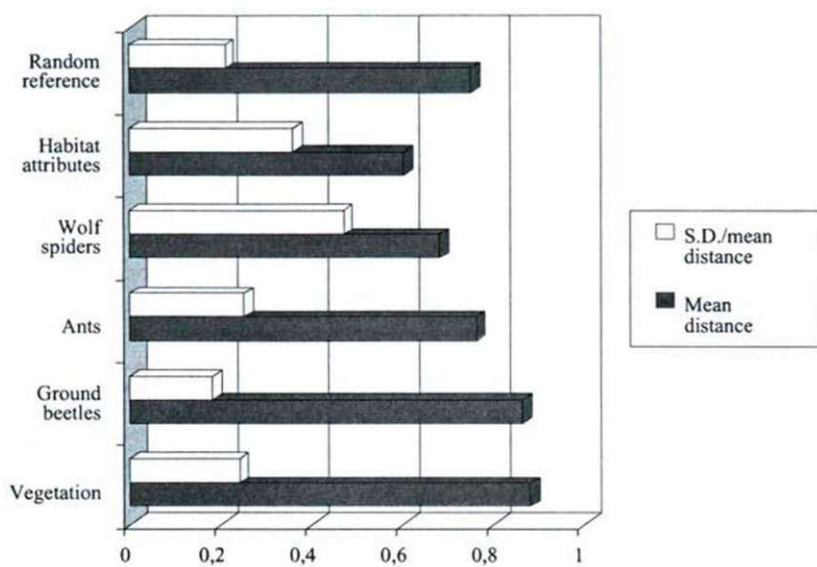


Fig. 3. Average habitat distances and their coefficients of variation computed on the basis of habitat attributes (Table 2), different assemblages and their random reference

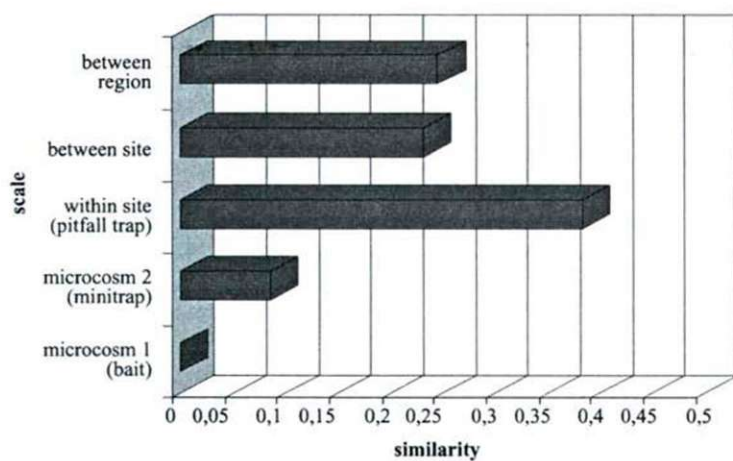


Fig. 4. Similarity values of ant assemblages and faunas as a function of spatial scaling levels: at two small, within supercolony (microcosm 1 and microcosm 2) scales; at habitat (within site) scale; at landscape (between site) scale and at regional (between region) scale, respectively.

Three habitat groups can be distinguished on the basis of ground beetle and wolf spider assemblages from their PCoA scattergrams, but different plots form groups. In beetles' scattergram, however, no well-defined groups are formed (Gallé et al 2000).

We interpreted the indication of the heterogeneity of the landscape by the different assemblages at Volobeni as of the average habitat dissimilarities (Bray-Curtis distance function, Podani 1997, Tóthmérész 1993) computed on the basis of the composition of different assemblages. The most sensitive indicators of landscape heterogeneity are the vegetation and the ground beetles (Fig. 3), whereas the distances on the basis of ant and wolf-spider assemblages do not exceed the values computed from fictive, randomly assembled communities.

A non-parametric correlation analysis shows that there is close correlation between the following assemblages and the groups of habitat scores: (1) vegetation composition and soil properties; (2) vegetation composition and Carabid beetles; (3) ants and habitat architecture (see also Gallé 1991, 1999, Gallé et al 1993, 1998); (4) ants and wolf spiders; (5) wolf spiders and habitat architecture; (6) ground beetles and vegetation composition. According to these results, those groups of habitat attributes could be assumed to be responsible for the composition of the ecological assemblages, with which they are correlated. Therefore, we can conclude that the composition of different assemblages are presumably conducted by different exogenous factors, the results of which are indicated by the above-mentioned response to the habitat heteromorphy.

Regional scale

At regional scale, our main aim has been to compare the above-mentioned four complexes of sites and to carry out faunistical "scanning" studies between these regions. At this level, we hoped to obtain results on the ecological corridor function of the River Mureş/Maros valley, too.

For the regional level comparison, the first question by an ecologist could be that whether an ecological pattern or mechanism is scale dependent. As an example, we demonstrate here the comparison of similarities of the ant (Formicoidea) assemblages/faunas at microcosm, within site (habitat), between habitat and regional scales, respectively (Fig. 4). The data originated from the following field samplings: (1) *microcosm 1*: bait experiments were conducted to follow the circadian rhythms of ants at very small spatial scale; (2) *microcosm 2*: data from mini pitfall traps arranged in 50x50 cm grids and employed to reveal the small spatial scale differences in the penetrated foraging territories of different species; (3) *within site (habitat) scale*: the data are from pitfall traps arranged in 5x5 m grids in the sampled sites and the catches of the individual traps is compared with similarity measurement; (4) *between site level*: comparison of the data from different sites within a landscape complex (e.g. within Vaslobin or Maroslele district) and (5) *between region level*: a comparison of the ant fauna of the different regions.

As it is seen on Fig. 4, no linear scale-dependent trend is observed, but there is a similarity maximum at within site scale. The low similarity values experienced at

microcosm level are resulted in by the segregation in the territories of the different species and also by the circadian activity differences (in the case of baits) in the presence of a supercolonial species. The high average similarity at within site shows that the sampled habitats are more or less homogeneous. The between site difference indicates the differences of sampled sites (the design of sampling involving different habitat types was our original intention in this study). One could expect even greater dissimilarities at the larger, between-region level, brought about by the geographical scale differences. The results, however, do not meet this expectation, probably because there are similar habitat types of the different studied regions, where the populations of the same, mostly widely distributed species were found. The alternative hypothesis could be that the habitat stripes along the river act as "ecological corridors", resulted in similar within-stripe faunas.

The ecological corridor and the ecological network are among the recent and fashionable buzzwords both in ecology and conservation biology. Rivers, both their water bodies, and the terrestrial habitat complexes of the flood plains are *a priori* regarded to be ecological corridors, as a rule. If we define ecological corridors as such stripe-like habitat, which promote the migration, the dispersion, and the distribution of plant and animal species, it is clear that no any habitat strip is ecological corridor *per se*. It depends on the studied ecological objects i.e. populations or communities, if a habitat strip is used as corridor or not. Therefore, the term ecological corridor is plural, similarly to the ecological environment. The corridor function of the flood plain of River Tisa has been demonstrated on plants, grasshoppers, ants, snails, birds and ground beetles (see Gallé 2002, Gallé et al 1995 and the citations therein). Since the flood plain is a complex of different habitat zones and ecological communities along River Tisa, there is a composed system of potential corridors, differently promoting the migration and distribution of different species either to the North or to the South. Besides these functions, the terrestrial habitats by the River, Tisa flood plain also acts as core areas for several populations and communities and promote the recolonization of these ecological units in habitats island outside the flood plain. In the case of River Mureş/Maros, the corridor role is not unequivocal, although the very first paper dealing with role of flood plains and especially floods themselves, as the promoters of insect migration and distribution was published on the beetles by the River Mureş/Maros (Erdős 1935). As one side we cannot dispute the results concerning the faunal (and probably also the floral) distribution by the flood by direct drive, the great differences of the fauna at the upper and lower streams of the river, the different geographical character of the different regions and especially, the interruptedness of the stripe-like habitats at the middle parts of the flood area, where the cultivated fields are adjacent to the riverbanks.

The ecological communities in the inundated part of the flood plain are regularly exposed to the disturbing effects of repeating floods and the processes of recovery result in a complicated dynamics, which can be described with the catastrophe theory. The recolonization of the formerly flooded sites takes place from the higher refuge, from the trees and from the unflooded areas outside. Both the longitudinal migration and distribution along the river ("corridor function") and the transversal migration

from to the flooded area (core area function and recolonization) form a complex, rather complicated dynamics of the riversides' biota. As our preliminary results have shown, however, in the case of River Maros, the corridor function is much more restricted.

References

Farina, A. (1998): *Principles and Methods in Landscape Ecology*. — Chapman & Hall, London.

Erdős, J. (1935): *Maros torkolatának árvízi és ártéri bogárvilága biológiai szempontból (The beetle fauna of floods and flood plains at the outlet of River Maros)*. — Thesis, Szeged pp. 84

Gallé, L. (1998): Ekvilibrium és nem-ekvilibrum koegzisztencia életközösségekben (Equilibrium and non-equilibrium coexistence in ecological communities). In: Fekete G. (ed.): *A közösségi ökológia frontvonalai (Frontiers of Community Ecology)*. —

Gallé, L. (2002): A Tisza-mente ökológiai és természetvédelmi jelentősége (The ecological and conservational significance of Tisa flood plain). In: Rakonczai, J. (ed.): *A Tisza vízgyűjtője, mint komplex vizsgálati és fejlesztési régió (Tisa Catchment Area as a Region for Complex Research and Management)*. — Tisza Vízgyűjtő Programrégió, Szeged, 75-81.

Gallé, L., Margóczy, K., Kovács, É., Györffy, Gy., Körmöczy, L., Németh, L. (1995): River valleys: Are they ecological corridors? — *Tiscia*, 29, 53-58.

Gallé, L., Körmöczy, L., Hornung, E., Kerekes, J. (1998): Structure of ant assemblages in a Middle-European successional sand-dune area. — *Tiscia*, 31, 19-28.

Gallé, L., Gallé, R., Markó, B., Mikó, I., Sárkány-Kiss, A. (2000): Habitat correlates of ground invertebrate assemblages in a flood plain landscape complex. In: Gallé, L., Körmöczy, L. (ed.): *Ecology of River Valleys*. — Dept. Ecology, Univ. Szeged, Szeged, 31-36.

Gallé, L., Györffy, Gy., Hornung, E. (1982): Flood as an ecological perturbation of epigeic animal communities I. Some preliminary hypotheses on the application of catastrophe theory by evaluating some Mártély-Körtvélyes data. *Tiscia*, 17, 155-162.

Gaston, K. J., Blackburn, T. M. (2000): *Pattern and Process in Macroecology*. — Blackwell, Oxford.

Hanski, I. (1999): *Metapopulation Ecology*. — Oxford Univ. press, Oxford

Hanski, I., Gilpin, M. E. (1997): *Metapopulation Biology Ecology, Genetics and Evolution*. — Academic Press, San Diego

Gurney, W. S. C., Nisbet, R. M. (1998): *Ecological Dynamics*. Oxford University Press, New York.

Haines-Young, R., Green, D. R., Cousins, S. H. (ed.) (1993): *Landscape Ecology and the GIS*. — Taylor and Francis, London.

Juhász-Nagy, P. (1986): *Egy operatív ökológia hiánya, szükséglete és feladatai (Shortage, Need and Duties of an Operational Ecology)*. — Akadémiai Kiadó, Budapest.

- Lucas, P. H.C. (1992): *Protected Landscapes*. — Chapman & Hall, London.
- Margóczy, K. (1998): *Természetvédelmi Biológia (Conservation Biology)*. — JATEPress, Szeged.,
- Margóczy, K., Drăgulescu, C., Macalik, K. (2000a): Vegetation description of the habitat complexes along the Maros (Mureş) River I. In: Gallé, L., Körmöczy, L. (ed.): *Ecology of River Valleys*. — Dept. Ecology, Univ. Szeged, Szeged, 37-42.
- Margóczy K., Németh A. Markó, B., Gallé, L. (2000b): Egy különleges szigetvilág: hangyafészkek növényzete (A special archipelago — vegetation of ant nests)– V. Magyar Ökológus Kongresszus, Debrecen. Kivonatok (Abstracts), 268. o.
- Markó, B., Gallé, L. (2000): A *Formica exsecta* Nyl. szuperkolónia hatása a hangyaközösségek térszerkezetére (The effect of *Formica exsecta* Nyl. supercolony on the spatial structure of an ant community).— Szünzoológiai Szünpózióm, Előadás-kivonatok, Budapest, 18.
- Nisbet, R. M., Gurney, W. S. C. (1982): *Modelling Fluctuating Populations*. - Wiley, Chichester.
- Pickett, S. T. A., White, P. S. (1985): *The Ecology of Natural Disturbance and Patch Dynamics*. — Academic Press, Orlando.
- Podani, J. (1997): *Bevezetés a többváltozós biológiai adatfeltárás rejtelmibe (Introduction to the Multivariate Analysis of Biological Data)*. - Scientia, Budapest Scientia, Budapest, 11-33.
- Tóthmérész, B. (1996): *NuCoSa: Programcsomag botanikai, zoológiai és ökológiai vizsgálatokhoz (NuCoSa: Progrma Package for Botanical, Zoological and Ecological Studies)*. - Scientia, Budapest.
- Wilson, E. O. (1975): *Sociobiology The New Synthesis*. Belknap, Harward, Cambridge, Mass.

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