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COMPOSITION OF ORTHOPTERA ASSEMBLAGES IN GRASSLAND HABITATS AT LOWER-TISZA FLOOD PLAIN

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Abstract. The Orthoptera assemblages of continuous grassland strips on dike sides of rivers Tisza and Maros were compared with habitat islands of different distances from river flood plains. The species composition in habitat islands within 2-300 m distance is similar to the corresponding nearest dike-side meadow, whereas that of the assemblages sampled in a meadow of about 3 km from the river, differ from Tisza region. A multivariate statistical analysis shows that the differences between local Orthoptera assemblages are brought about by the distance of their habitats, while the influence of plant species composition and vegetation architecture is weaker within the range of the studied habitats.

Keywords: Orthoptera assemblages, dike sides of rivers Tisza and Maros, habitat islands, ecological corridors, Hungary

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Introduction

The degradation of flora and fauna and the decline of ecological diversity as a result of the fragmentation and isolation of natural habitats are among the main, world-wide problems of nature conservation. Therefore, these phenomena have drawn the ecologists' attention to different topics of landscape ecology, e.g., habitat fragmentation, isolation (see Wilson ands Willis, 1975; Diamond and May, 1976 as the first papers in this field) and the significance of stripe-like habitats, so called "ecological corridors" (Simberloff and Cox, 1987; Noss, 1987). The changes in agricultural management and the expansion of various human activities led to the disappearance of large natural areas and the isolation of the remaining fragments in the Great Hungarian Plain. The study of the possible role of "ecological corridors" is therefore a relevant field of conservation biology (cf. Gallé et al., 1995). River Tisza and other rivers in the Great Hungarian Plain were regulated in the last century. As a result of this regulation, the original flood plains are divided into two parts by dikes, i.e., "flood areas", which are regularly flooded, mostly in the spring, and "protected flood plains", without direct influence of flooding. The dikes, running along the river, are covered by grasslands and thus form continuous grassland-strip habitats, which are assumed to be "ecological corridors" .

The Orthoptera fauna of the Great Hungarian Plain has been studied from faunistical, zoosociological and various ecological aspects (Nagy, 1943, 1953, 1958, 1991; Gausz, 1969, 1970a, b; Gallé and Gausz, 1968; Gallé et al., 1995; Szelényi et al., 1974; Rácz, 1986). We know, however, much less of the similarities and differences between the Orthoptera faunas of the river flood plains and the neighbouring ecological islands. There are also gaps in the knowledge of the role of isolation and habitat corridors in structuring of Orthoptera assemblages.

We address the following main questions in this paper: (1) Do Orthoptera assemblages of the dike grasslands by the rivers and that of habitat islands in the protected flood plain differ in their density and species composition? (2) Is there any difference between the diversity of Orthoptera of the corridor-like grassland habitats along the river and of the isolated ones? (3) Whether the habitat structure or the distance of similar habitats has a stronger effect on the structure of the Orthoptera assemblages? (4)

Can the Orthoptera fauna be divided into correlated groups, called coalitions hereafter on the basis of their species local distribution?

Material and methods

Study sites

Orthoptera populations were sampled from June to September 1994 in seven habitats in the southern part of the Great Hungarian Plain. Four sampling plots were established on the dike meadow of the rivers Tisza and Maros and three in the nearby grasslands ("habitat islands") (Fig. 1).

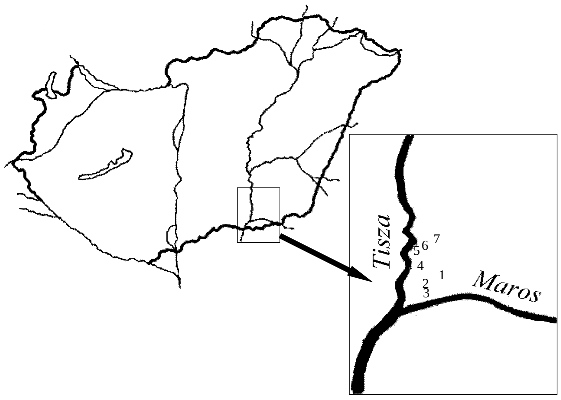

Fig. 1. Position of study sites by rivers Tisza and Maros. 1 = M1; 2 = M2; 3 = M3; 4 = T1; 5 = T2; 6 = T3; 7 = T4.

Two out of four on the dikes of both rivers, one of them was exposed to the flood area (referred to as "inner side" hereafter), the other one to the protected flood plain ("outer side") in both sites. The aspect of Maros dike sides were of NW-SE, while the dike sides of River Tisza had E-W aspect. The vegetation of dikes grasslands was described by Bodrogközy (1966) in details. According to a spring survey, Borhidi`s (1993) “naturalness value” of vegetation, is the highest at the outer side dike grassland of River Maros, and it is the lowest at the inner dike side of the same river (Margóczi et al., 1995). The plant species richness and the Shannon-Wiener diversity are the highest at the inner dike side of River Tisza. During summer, the vegetation of the outer dike side was less diverse, while the vegetation of the inner dike side of River Tisza became less dry. On the inner side dike grassland of River Maros (refered to as M3 hereafter), *Alopecurus pratensis* L., *Achillea millefolium* L., *Geranium dissectum* Jusl. were present with greatest coverage, and on the outer side of the dike (M2), *Festuca rupicola* Heuff., *Arrhenatherum elatius* L., *Bromus commutatus* Schrad., *Poa angustifolia* L., *Achillea millefolium* L., *Vicia hirsuta* S. F. Gray were predominant. The inner side dike grassland of Tisza (T2) was predominated by *Arrhenaterum elatius* L., *Poa angustifolia,* and to a lesser degree by *Alopecurus pratensis,* while on the outer side (T3), *Alopecurus pratensis, Glycyrrhiza echinata* were predominant. The dike meadows were regularly moved.

The remaining three sampling plots were more or less isolated grassland habitats in the protected flood plain, outside of the dikes. One of them (M1) was a small grassland (400 m^2) with rather weedy vegetation and about 0.5 km from the nearest sampling plot on the dike of River Maros. Its vegetation shows the lowest naturalness and diversity values (Margóczi et al., 1995). The number of plant-species was low, *Agropyron repens, Alopecurus pratensis* could be found in the greatest coverage, and *Artemisia vulgaris L., Ballota nigra L.* were present, as well. This plot was bordered by a small forest and a road.

The second plot (T1) was a large grazed meadow, about 3 km distance from the River Tisza. Its vegetation was more natural and diverse. Here *Carex melanostachya Willd., Poa angustifolia, Potentilla reptans L.* and *Carex praecox Schreb.,* were the predominant plant species. The last one (T4) was a dry grassland in the area of an abandoned farmland situated about 200 m from the dike of River Tisza. This plot was surrounded by alfalfa plantation. The predominant plants were: *Agropyron repens, Alopecurus pratensis, Poa angustifolia, Lathyrus tuberosus* L. The two sets of plots (by the River Tisza and River Maros respectively) were about 60 km from each other (Fig. 1).

Each sample plot was characterized by the relative coverage of plant species (estimated in quadrates of 2x2 m size), the vegetation architecture (i.e. the total coverage of vegetation heights 0-5, 5-10, 10-15, 15-20, 20-30, 30-50, 50-100, 100-150 cm), the orientation and the slope of the dike sides, the size of the plot and the composition of grassland fauna were collected in the same way as the grasshoppers.

Methods of sampling and evaluation

We sampled Orthoptera populations with sweep nets from 10 quadrates of 4x4 m size. The area of quadrates were carefully swept with the nets (by about 45 sweeps) three times. On the basis of the last catches we suppose that the Orthoptera individuals were completely collected from the area of the sample units. The sampling was repeated five times during the growing season between 25th June and 25th September, 1994.

The diversity of the Orthoptera fauna is given by the conventionally used diversity indices

(Shannon-Wiener, Simpson-Yule and Brillouin) and the diversity ordering (Tóthmérész, 1993a, b). The similarities and differences of the Orthoptera assemblages and their seasonal shifts are characterized by their pattern and its transformation in PCoA factor space, which was computed with Czekanowski's similarity coefficient (Tóthmérész, 1993a). We employed correlation analysis between the geographical distance of the sampled habitats and their Euclidean distance computed on the basis of the composition of the Orthoptera assemblages in order to establish the role of topographical distance in the differentiation of Orthoptera species composition of different habitats.

We attempted to classify Orthoptera species into correlated groups (referred to as coalitions hereafter) on the basis of their spacio-temporal distribution by employing cluster analysis with Czekanowski similarity indices and weighted average algorithm.

Results

Species composition and density

A total of 24 species were collected from the sampling plots (Table 1). The total cumulative densities (i.e. the seasonal sum of the estimated densities) vary from 2.8 and 12.7 ind./m^2. The greatest densities were found in the dike grasslands of River Tisza (12.7 and 10.8 respectively), and the lowest ones in the different habitats by River Maros (2.8-3.8 ind./m^2).

The habitats along the two rivers are more or less separated in the PCoA scattergram set up on the basis of their Orthoptera assemblages (Fig. 2) with the exception of the grazed meadow situated 3 km from the flood area of the River Tisza. The seasonal trends of the assemblages of Tisza habitats are more complicated than that of the River Maros. The latter show, however, the greater seasonal shifts in the PCoA factor space. Much clearer picture is yielded when the scattergram is set up on the basis of the cumulative density values of the populations (Fig. 3): the separation of the habitats belonging to the two rivers is clear and the special position of the grazed meadow mentioned above is well seen.

Diversities

The species diversities of the assemblages changed between 2.12 and 3.02 (Shannon-Wiener function), the smallest was observed at the abandoned farmland (T4) and the highest was at the Tisza inner dike side (T2). No significant diversity difference was found between the dike and "island" habitats. No clear diversity differences were observed on the basis of diversity ordering curves either (Fig. 4).

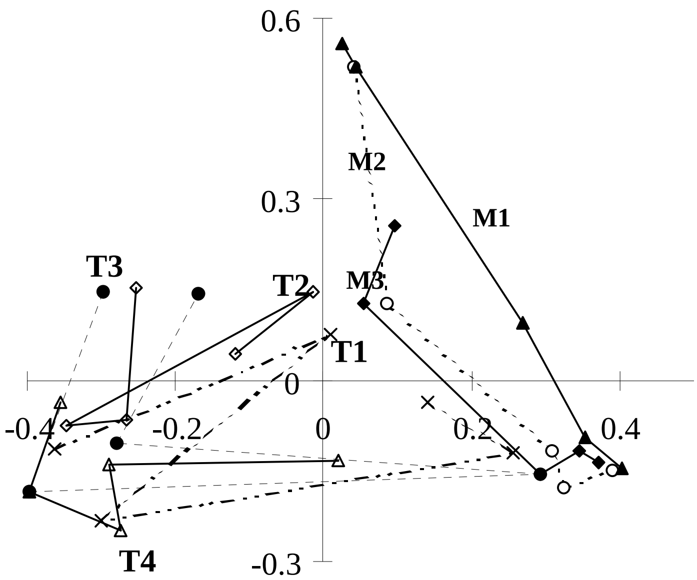

Figure 2. The PCoA scattergram set up on the basis of the relationships of the Orthoptera assemblages and their seasonal shifts in the studied habitats. The abbreviation of the plots is shown in Table 1. Samples were taken three-weekly from June to September, 1994. The first and the last sampling period is indicated by a circle.

Table 1. The composition and the cumulative population densities of Orthoptera assemblages. M1 = weedy grassland 0.5 km apart from Maros dike sample plots; M2 = Maros dike grassland of NW exposure; M3 = Maros dike grassland of SE exposure; T1 = grazed meadow 3 km from the dike of Tisza; T2 = Tisza dike grassland of NNE exposure; T3 = Tisza dike grassland of SSW exposure; T4 = abandoned farmland 200 apart from the Tisza dike sample plots. The figures in the table are the seasonal mean of the densities/m^2.

Species	M 1	M 2	M 3	T1	T 2	T 3	T 4
1.Tetrix nutans Sahlb.	0	0	0	0	0.01	0.01	0
2.Tetrix subulata L.	0	0	0	0.03	0.05	0.01	0
3.Calliptamus italicus L.	0	0.02	0.01	0.01	1.10	0.54	1.72
4.Pezotettix giornae Rossi.	1.22	0.98	0.94	0.06	2.1	2.27	0.92
5.Aiolopus thalassinus Fabr.	0	0.02	0.09	0.07	0.29	0.03	0
6.Dociostaurus brevicolis Evers.	0	0	0.01	0	0.13	0.12	0
7.Omocestus ventralis Zett.	0.45	0.29	0.72	0.21	0.52	0.51	0.10
8.Glyptobothrus brunneus Thunbg.	1.00	0.05	0.01	0.06	0.33	0.19	0.08
9.Chortippus albomarginatus Beg.	0.32	0.39	0.19	2.49	3.55	4.22	5.30
1.Chortippus parallelus Zett.	0.06	0.07	0	1.94	1.54	0.31	0
11.Euchortippus declivus Bris.	0.86	1.00	0.48	1.41	1.56	2.31	2.34
12.Gryllus campestris L.	0	0	0	1.06	0	0.01	0.14
13.Oecanthus pellucens Scop.	0.01	0.03	0	0	0	0	0.01
14.Phaneroptera nana Fieb.	0.05	0	0.06	0	0.02	0	0
15.Leptophyes albovittata Koll.	0.04	0	0.02	0	0	0.05	0.02
16.Conocephalus dorsalis Latr.	0.10	0	0	0	0.02	0	0
17.Conocephalus discolor Fabr.	0	0.01	0.01	0.16	0.16	0.03	0
18. Ruspolia nitidula Scop.	0	0	0	0	0.02	0	0
19.Tettigonia viridissima L.	0.02	0	0	0	0	0	0
20.Gampsocleis glabra Herbst.	0	0	0	0	0	0.01	0
21.Decticus verrucivorus L.	0	0	0	0	0	0	0
22.Tesselana vittata Charp.	0	0.02	0.01	0	0.09	0.01	0
23.Roeseliana roeseli Hgb.	0.10	0	0	0.07	1.14	0.18	0.19
24.Bicolorana bicolor Phil.	0	0	0	0	0	0	0.19

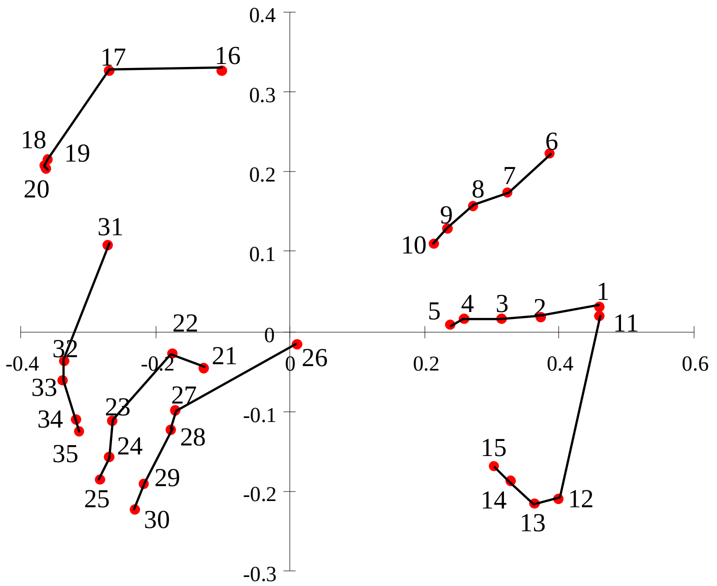

Figure 3. The PCoA scattergramm of the cumulative density values of the Orthoptera populations in five consecutive sampling dates. 1-5: M 1, 6-10: M 2, 11-15: M3, 16-20: T 1, 21-25: T 2, 26-30: T 3, 31-35: T 4. The increasing figures within each site indicate the temporal sequence of sampling.

Habitat structure versus habitat distance

In order to answer the third question, a correlation analysis was carried out between the geographical distance classes of the studied habitats and the Euclidean distances of the Orthoptera assemblages of the corresponding habitats in the PCoA factor space. The correlation coefficient was $r = 0.73$, $p < 0.001$. A similar analysis between the habitat structural characteristics and the composition of the Orthoptera assemblages resulted in a non-significant correlation ($r = 0.22$).

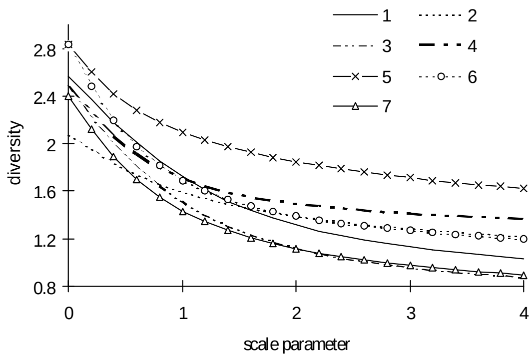

Fig. 4. The species diversities of the Orthoptera assemblages on the basis of diversity ordering curves. 1 = M1, 2 = M2, 3 = M3, 4 = T1, 5 = T 2, 6 = T3, 7 = T4

Existence of coalitions

A cluster analysis of the Orthoptera species (Fig. 5) on the basis of their occurrence rates shows that there are very few correlative groups among the sampled species. Only the pairs *Phaneroptera nana*-*Conocephalus dorsalis, Aiolopus thalassimus*--*Chortippus brunneus* show close association. The high co-occurrence rates of those species, which were rare in the samples could be the result of random coincidence. The coexistence rate of the species *P. giornae* and *E. declivus* can be explained by the fact that they are common at all study sites. Therefore, none of these groups or pairs of species can be regarded as real coalitions.

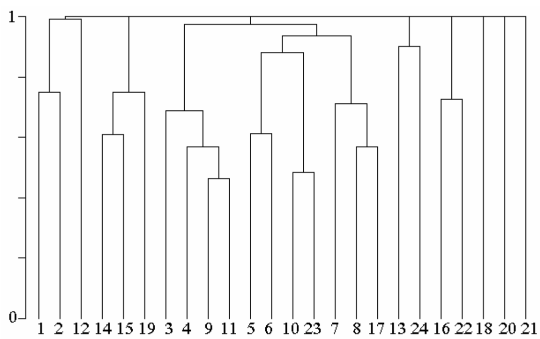

Figure 5. The cluster analysis of the Orthoptera species on the basis of their occurrence rates. For the figures of species see Table 1.

Discussion

It cannot be proved that the sets of Orthoptera populations we have studied in this paper formed real ecological communities. On the basis of the general concepts and conventions, we can define an ecological community as a set of coexistent populations, which interact in some ways, or at least they are arranged into such structural units (e.g. guilds), which indicate the presence of interactions. Neither direct interactions, nor species coalitions could be established in this study, therefore, these Orthoptera faunulae were considered only as species assemblages. The species composition of these assemblages is similar to those that were described by Gausz (1967, 1968) from the Middle and Lower Tisza districts. The Orthoptera fauna of River Maros district is not well known. Kis (1970) described the occurrence of two rare subspecies of *Isophia modestior* (*I. modestior modestior* and *I. modestior stysi*) from Bánát and Transsylvanian and N-Hungary part of this River. We could not find any of these taxons in the present study. *Isophya costata* Br. was also detected from the Dike-side of the Tisza at Mártély and one other female of *Isophia modesta* Friv. (or *costata*) was caught at the "inner side" of the dike at Klárafalva (Nagy 1981).

The relation great species richness of the dike-sides is probably due to the moderate disturbances and the special, stripe-like shape of these grassland habitats, which promotes the migration and recolonization of populations, and therefore compensates the stronger disturbances and extinction.

The third question addressed above refers to the relations between the geographical distance of the habitats and the similarities in their Orthoptera assemblages. Mabelis et al. (1994) studied this problem on several Orthoptera populations, Kindwall and Ahlen (1992) investigated this problem on the metapopulation of *Bicolorana bicolor* and they emphasized the importance of the distance for the presence of *B. bicolor* in habitat islands. It was given that this species can cover about 100 m distance and 0.5 hectare was established as the minimum habitat size for this species. Nagy (1992) consider the Bicolorana bicolor as "vagrant" species in the case of holopterous form, wich night be more effective in colonization process. In the present study, we found this species in a grassland habitat of about 200 m far from the nearest dike, in which it was not present.

Timár (1953), Gausz (1967), Gallé (1967) and Gallé et al. (1995) emphasized the importance of dike-sides habitats in the migration of plant and animal species. Gausz (1967) described that the stripe-like shape of dikes promotes the distribution of two Mediterranean species, *Pezotettix giornae* and *Phaneroptera quadripunctata* (=*Ph. nana*) to the North. In our sample plots *Pezotettix giornae* was a frequent species, with especially high densities on the dike-sides. We found *Phaneroptera nana* to be much rarer.

According to Rácz (1994) the structure of vegetation and the microclimate are the main factors in structuring Orthoptera assemblages. In this study, however, we found the distance between habitats to be a more important factor than the structural characteristics of the habitats.

Acknowledgments

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