INDICATION OF HABITAT QUALITY AND ISOLATION BY AUCHENORRHYNCHA ASSEMBLAGES

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Abstract. The Auchenorrhyncha assemblages of 52 natural and seminatural grassland patches was studied to discover that they are isolated or not. According to cluster analysis based on Renkonen index Auchenorrhyncha assemblages distinguished 5 habitat groups corresponding more or less to the cluster groups derived from the plant associations. Correlations were calculated between similarity matrices based on composition of Auchenorrhyncha assemblages, of plant communities and distances between habitat patches. Demonstration of the distance effect referring to isolation was successful in the habitats that are differing from their surroundings, for example, in case of kurgans enclosed with agricultural areas and grassland patches.

Keywords: habitat fragmentation, Auchenorrhyncha assemblages, insect-plant relationships, nature conservation

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Introduction

Rates of habitat modification are currently so high that virtually all natural terrestrial habitats and protected areas are becoming ecological `islands` in surrounding `oceans` of habitats much altered by human activity. The size of these islands are continuously decreasing, the distances among them are increasing, which may result the isolation of their populations and communities (Gallé *et al.* 1990). The term of isolated habitats means that the migration of organisms between patches is lower than within them. In terms of conservation it is important to recognize the potential danger of the spatial isolation and the degree of the already existing isolation.

The theory of island biogeography dealt first with the isolation of communities (McArthur and Wilson 1967). In case of habitat islands the relation between species number and area is not evident in every assemblages of living organisms, because the habitat islands may have connections with surrounding (mostly agricultural) areas and smaller habitat islands are likely to receive invasive and degradation indicating species (Gallé *et al.* 1990). In several animal groups it was shown that there was higher similarity within habitat islands than among them even if there were different types of habitats inside the habitat islands (Gallé *et al.* 1990). The consequence of the above mentioned facts that the distance among sites may play a significant role in the similarity of communities. According to Krausz *et al.* (1995) the difference of Orthoptera assemblages is determined mostly by the spatial distance of the habitat patches and not by the composition of plant communities.

The main questions in this paper: Does any effect of distance exist in Auchenorrhyncha assemblages of fragmented grassland patches in the Great Hungarian Plain? If it is the case, what is its dependence in the different kinds of habitats? What kind of assemblages are the most endangered by isolation?

Material and Methods

The Auchenorrhyncha assemblages of 52 natural and seminatural grasslands of the Great Hungarian Plain were studied (Table 1, Fig. 1). Detailed data on vegetation and Auchenorrhyncha have already been published (Gallé *et al.* 1990, Györffy and Kincsek 1985, 1988, Györffy 1981), but were mainly unpublished, original data. The insects were collected by different number of pan traps depending on the patch size (minimum 10). Sampling was carried out in different years with different number of sampling periods, but at least 3 times in a year. As the number of individuals in the samples was very different each time we used relative frequencies of the Auchenorrhyncha species. In the case of plants the relative percentage cover of a species was considered in comparison with the total cover. The pooled number of Auchenorrhyncha species is 177 and of plant species is 361.

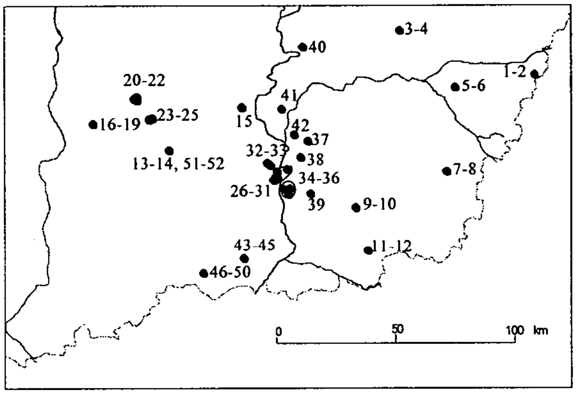

Fig. 1 The 52 habitats in the southern part of the Great Hungarian Plain

We calculated the similarity between sites based on composition of Auchenorrhyncha assemblages and vegetation by percentage of similarities (Renkonen index). Habitat groups were segregated on the basis of the dendrogram, obtained from the result of cluster analysis of Auchenorrhyncha assemblages and vegetation. Correlation was calculated between matrices. On the map we measured the distances between the 52 sites. Also, from these data similarity matrices were composed according to the habitat groups, and correlations were calculated between similarity matrices of Auchenorrhyncha, plants and distances. The establishment of significance level of similarities were performed by SYN-TAX program package (Podani 1993).

Results

Five marked clusters were distinguished in the dendrogram of studied habitats based on the composition of Auchenorrhyncha assemblages (Fig. 2). Two sites (18; 9) of extreme sodic vegetation are highly separated from these clusters (cf. Table 1). The first cluster consists of closely connected sites with a vegetation suggesting wet habitats, but there is low similarity between them based on Auchenorrhyncha assemblages (characteristic Auchenorrhyncha species: *Adarrus notatifrons (*KBM.*), Anaceratagallia ribauti (*OSS.*), Doratura homophyla (*FL.*)*). The second cluster's areas are either loess grasslands that can be characterized by the dominance of *Festuca rupicola*, or grasslands on sodic soil where *Festuca pseudovina* is dominant (characteristic Auchenorrhyncha species: *Rhopalopyx vitripennis (*FL.*), Mendrausus pauxillus (*FIEB.*), Doratura homophyla (*FL.*), Anaceratagallia laevis (*RIB.*)*). The third cluster with the largest number of objects (19) contains kurgans (cemetery hills) and grassland patches near the river Tisza (characteristic Auchenorrhyncha species: *Artianus interstitialis (*GERM.*), Turrutus socialis (*FL.*), Doratura homophyla (*FL.*), Jassargus obtusivalvis (*KBM.*)*). These habitats have usually small size and can be considered mostly as patch-like habitats; their vegetation is not really natural. The fourth cluster consists of sandy grasslands (characteristic Auchenorrhyncha species: *Kybos hungaricus (*RIB.*), Jassargus obtusivalvis (*KBM.*), Psammotettix provincialis (*RIB.*)*). The Auchenorrhyncha assemblages of sodic areas form a separated cluster (it is the fifth cluster: *Lepidio-Puccinellietum, Agrostio-Caricetum distantis, Achilleo-Festucetum pseudovinae* plant associations) (characteristic Auchenorrhyncha species: *Psammotettix asper* RIB.*), Eurysa clypeata* HORV.). The explanation may be due to the extreme habitat circumstances.

On the basis of their vegetation the sodic areas also form a marked cluster (Fig. 3). If we look at the lower numbers of Fig. 3 it can be seen that the arrangement differs from random. Cluster groups derived from the classification of Auchenorrhyncha assemblages more or less correspond to the cluster groups derived from the plant associations. Correlation was calculated between the similarity matrices that served as the basis of the two dendrograms. The value of the correlation coefficient was 0.4131, the significance level was $p < 0.01$.

Comparison of the similarity matrices of the five clusters selected on the basis of their Auchenorrhyncha assemblages was also carried out separately (Table 2). In case of three clusters (2, 3 and 4) significant similarity was obtained between the Auchenorrhyncha assemblages and the vegetation. Between clusters of sodic habitats there was no significant correlation. Its explanation might be that the sodic grasslands are extreme habitats, the vegetation consists of drought-resistant and halophilic species, therefore the plants' salt content is high and the Auchenorrhynchas are adapted to these conditions. Species living in such habitats are usually polyphagous, so in case of presence of different proportion of plant species the composition of Auchenorrhyncha assemblages are very similar.

The habitat patches in the third cluster can be distinguished by the highly significant correlation between the similarity matrices of Auchenorrhyncha - vegetation, Auchenorrhyncha - distance and even vegetation - distance. The rather small size of these habitats may explain this correlation.

Table 1. The typical vegetation of the 52 sample sites, and the number of plant and Auchenorrhyncha species appearing in the analysis

Habitats	Vegetation	Plant sp.	Auch. sp.
1.	*Succiso-Molinietum*	37	22
2.	*Caricetum elatae*	30	18
3.	*Salvio-Festucetum rupicolae*	20	21
4.	*Agrostio-Alopecuretum pratensis*	26	18
5.	*Peucedano-Asteretum punctati*	37	24
6.	*Populetum canescentis*	20	11
7.	*Artemisio-Festucetum pseudovinae*	10	20
8.	*Salvio-Festucetum rupicolae*	44	25
9.	*Suaedetum pannonicae*	6	6
10.	*Festucetum pseudovinae*	14	17
11.	*Salvio-Festucetum rupicolae*	11	22
12.	*Artemisio-Festucetum pseudovinae*	6	15
13.	*Junipero-Populetum*	40	10
14.	*Festucetum vaginatae holoschoenetosum*	44	16
15.	*Alopecuretum pratensis*	37	35
16.	*Artemisio-Festucetum pseudovinae*	14	22
17.	*Lepidio-Puccinellietum*	4	6
18.	*Bolboschoenus maritimus*	1	2
19.	*Lepidio-Camphorosmetum*	4	6
20.	*Lepidio-Puccinellietum*	14	19
21.	*Agrostio-Caricetum distantis*	29	12
22.	*Festucetum vaginatae stipetosum capillatae*	20	20
23.	*Festucetum vaginatae*	22	13
24.	*Molinio-Salicetum rosmarinifoliae*	33	32
25.	wet *Molinio-Salicetum rosmarinifoliae* hay-field	23	19
26.	*Agropyron repens* (dominant)	10	18
27.	*Poa angustifolia, Arrhenatherum elatius* (dominant)	43	17
28.	*Alopecurus pratensis, Poa angustifolia* (dominant)	31	25
29.	*Festuca pseudovina, Alopecurus pratensis* (dominant)	10	10
30.	*Agropyron repens, Alopecurus pratensis* (dominant)	24	19
31.	*Poa angustifolia, Agropyron repens* (dominant)	15	20
32.	*Poa angustifolia, Achillea pannonica* (dominant)	31	16
33.	*Poa angustifolia, Arrhenatherum elatius* (dominant)	32	22
34.	*Agropyron pectinatum, Stipa capillata* (dominant)	16	41
35.	*Poa pratensis, Agropyron repens* (dominant)	16	42
36.	*Stipa capillata, Festuca pseudovina* (dominant)	13	57
37.	*Bromus tectorum, Agrostis stolonifera* (dominant)	13	36
38.	*Agropyron pectinatum, Festuca rupicola* (dominant)	12	16
39.	*Agropyron repens, Agropyron pectinatum* (dominant)	14	25
40.	*Festuca rupicola, Agropyron pectinatum* (dominant)	17	15
41.	*Phragmites australis, Poa pratensis* (dominant)	19	23
42.	*Festuca pseudovina, Trifolium campestre* (dominant)	9	13
43.	*Achilleo-Festucetum pseudovinae*	14	12
44.	*Achilleo-Festucetum pseudovinae*	14	18
45.	*Lepidio-Puccinellietum*	8	14
46.	*Festucetum vaginatae danubiale*	11	23
47.	*Astragalo-Festucetum rupicolae*	9	32
48.	*Festucetum vaginatae stipetosum*	12	25
49.	*Salix rosmarinifolia*	1	25
50.	*Festucetum rupicolae salicetosum rosmarinifoliae*	8	32
51.	*Festucetum vaginatae danubiale*	17	46
52.	*Molinio-Salicetum rosmarinifoliae*	24	29

Table. 2 Correlations between similarity matrices.

	insects - plants		insects-distance		plants - distance	
cluster	corr. coeff.	p	corr. coeff.	p	corr. coeff.	p
whole	0.4131	<0.01	0.1895	<0.01	0.122	<0.01
1th part	0.0561	n.s.	0.1485	n.s.	0.6509	n.s.
2nd part	0.4704	<0.01	0.0032	n.s.	0.023	n.s.
3rd part	0.4395	<0.01	0.2367	<0.01	0.2203	<0.05
4th part	0.673	<0.05	0.7731	n.s.	0.5174	n.s.
5th part	-0.2115	n.s.	-0.078	n.s.	-0.3108	n.s.

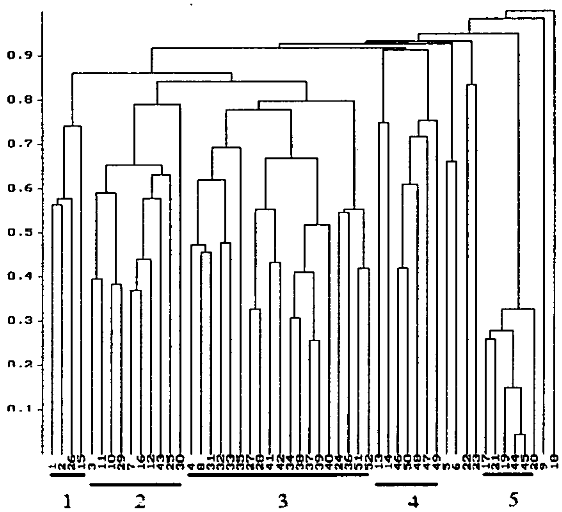

Fig. 2 Dissimilarity of the 52 habitats on the basis of Auchenorrhyncha assemblages (with Renkonen index). Under the figure numbering of the clusters can be seen.

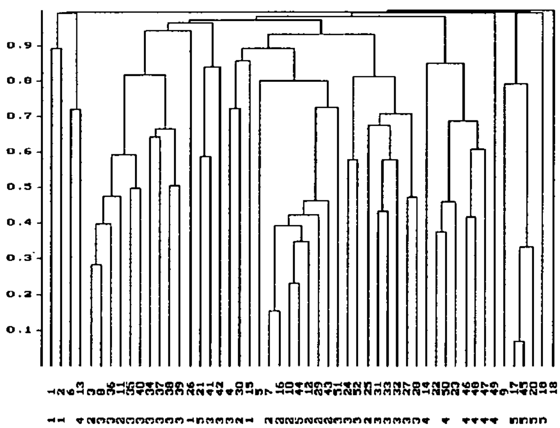

Fig.3 Dissimilarity of the 52 habitats on the basis of percentage cover of vegetation (with Renkonen index). The lower numbers are the numbers established on the basis of the dendrogram of Auchenorrhyncha assemblages.

Discussion

The difference between insect assemblages of two habitats may be caused by many factors. It may indicate different physical conditions, different development of the two assemblages, different form and size of the habitat patches, various kinds of disturbation effects, etc. In case of herbivore assemblages many factors express their effect through the screen of vegetation, in addition the plants are very important as food source, egg laying and shelter, etc. (Crawley 1983, Nault and Rodriguez 1985, Howe and Westley 1988, Denno and Perfect 1994, etc.). Therefore, the knowledge of the vegetation of different habitats is essential when Auchenorrhyncha assemblages are under comparison. After all these the isolation of habitats may be mentioned as a factor causing difference between assemblages.

In the case of the Auchenorrhyncha assemblages the degree of adherence to vegetation is rather high. This is indicated by the identity between the similarity matrices of the plant communities and herbivore assemblages, namely the similar indication features (Gallé *et al.* 1987). The Auchenorrhynchas have `coarse-grained` response, but the grasshoppers show rather `fine-grained` behaviour (Szőnyi and Kincsek 1986). Krausz *et al.* (1995) found that the difference between Orthoptera assemblages less depends on the habitat quality than on the distance of the habitat patches.

The similarity of Auchenorrhyncha assemblages is determined mainly by the properties of the habitat with the mediation of the vegetation. Therefore, relatively high correlation was obtained in case of the initial data matrices between the species composition of the vegetation and the Auchenorrhyncha. In the extremely sodic habitats only few Auchenorrhyncha species are able to tolerate the very salty host plants and the aridity which is typical despite periodic water covering. These assemblages with law species numbers differ definitely from the others, and we would lose special species groups with the cessation of these kinds of habitats. To verify the isolation is rather difficult here, because species of these habitats with high adaptability cannot or hardly can substitute at all. Similarly extreme arid habitats can be found in sandy grasslands. The Auchenorrhyncha assemblages of these habitats are characterized by stress-tolerant species. The species number is higher, because of the variety of non-characteristic species. Differences are higher, therefore, we suppose the effect of isolation. As the humidity conditions become more favourable, the number of Auchenorrhyncha species increases, whereas in the most humid habitats there are fewer species, but they are more characteristic (mainly Delphacidae).

Kurgans and grassland patches are exposed to invasion of pest species, therefore pseudodiversity may occur, but also edge effect may strongly influence the composition of assemblages. These habitats may be considered as isolated ones. The connections (ecological corridors or stepping stones) between these patches are the least probable. Thus fragmentation of habitats in the Great Hungarian Plain reached the limit that endangers the existence of the most characteristic Auchenorrhyncha assemblages. It is not accidental that the tendency is more expressed in case of Orthopteras which need larger areas (Krausz *et al.* 1995).

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References

Crawley, M. J. (1983): Herbivory - The dynamics of animal-plant interactions . Blackwell Scientific Publications, Oxford.

Denno, R. F. and Perfect, J. T. (eds.)(1994): Planthoppers - Their ecology and management. Chapman & Hall, New York.

Gallé, L. (1987): Az ökológia és a természetvédelem távlati feladatai a Dél-Alföldön. - In: Környezet- és természetvédelmi kutatások 6. Tudomány-Természet-Társadalom Környezettudományi kutatások az MTA területi Akadémiai Bizottságainál I., Budapest pp. 55-68.

Gallé, L., Györffy, Gy., Körmöczi, L., Szőnyi, G. és Harmat, B. (1987): Különböző közösségtípusok élőhely heterogenitás indikációja homokpusztai gyepen. - In: Környezet- és természetvédelmi kutatások 6. Tudomány-Természet-Társadalom. Környezettudományi kutatások az MTA területi Akadémiai Bizottságainál I., Budapest pp. 230-271.

Gallé, L.(ed.)(1990): Ökológiai izolátumok szünzoológiai vizsgálata. - Technical report pp. 1-146.+11

Gallé, L., Györffy, Gy., Hornung, E., Kocsis, A., Körmöczi, L., Szőnyi, G. and Vajda, Z. (1991): Arthropod communities of ecological islands surrounded by agricultural fields. - Proceedings of the 4th ECE/XIII. SIEEC, Gödöllő 1991.

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

Györffy, Gy. (1981): Auchenorrhyncha of a sandy soil mosaic grassland: Quantitative relations, bionomic and ecological valence data. - Folia ent. hung. *43(1)*, 43-54.

Györffy, Gy. and Kincsek, I. (1985): The Cicadinea fauna of sodic zonations at the southern lowlands. - Acta biol. Szeged. *32*, 157-174.

Györffy, Gy. és Kincsek, I. (1988): Homoki gyepcönózisok és Cicadinea közösségeik a Dél-Alföldön. - Acta Acad. Paed. Szeged. (1987-1988) Ser. Biol. Geogr., 3-21.

Howe, H. F. and Westley, L. C. (1988): Ecological relationships of plants and animals. Oxford University Press, Oxford.

Krausz, K., Pápai, J. and Gallé, L. (1995): Composition of Orthoptera assemblages in grassland habitats at Lower-Tisza flood plain. - Tiscia *29*, 47-52.

MacArthur, R. H. and Wilson, E. O. (1967): The theory of island biogeography. Princeton University Press, Princeton, N. J.

Nault, L. R. and Rodriguez, J. G. (eds.)(1985): The leafhoppers and planthoppers. John Wiley & Sons, New York.

Podani, J. (1993): SYN-TAX-pc. Computer programs for multivariate data analysis in ecology and systematics. Version 5.0 user's guide. Scientia publishing, Budapest.

Szőnyi, G. and Kincsek, I. (1986): Indication of spatial heteromorphy and community structure of Acridoidea-communities in a sandy grassland. - Acta Biol. Szeged. *32*, 141-156.