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PHYTOSOCIOLOGICAL EVALUATION AND MULTIVARIATE ANALYSIS OF THE HABITAT OF *LINUM DOLOMITICUM* BORBÁS (LINACEAE) I.

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Phytosociological evaluation of *Linum dolomiticum* habitat has been carried out based on 45 relevés. The data matrices of the cover values and the phytosociological characters were analysed by a number of multivariate methods. The habitat shows the closest similarity to the following plant communities: *Seseli leucospermi-Festucetum pallentis, Stipo eriocauli-Festucetum pallentis* and *Seseli leucospermi-Brometum pannonici*. The phytosociological composition of a high number of relevés, taken from the *Linum dolomiticum* habitat, proved to be transitional among the dolomite grassland communities. With 2 tables and 6 figures.

Key words: *Linum dolomiticum*, phytosociology, multivariate analysis, dolomite rock grasslands

INTRODUCTION

Linum dolomiticum is a strictly protected, endemic, pre-glacial relict plant species of Hungary. The distribution of this species is extremely narrow: it lives only in a region of one square kilometre in Buda Hills near Pilisszentiván (47°36' N, 18°52' E). Its characteristic habitat is open and closed dolomite rock grasslands. It has one population only, which consists of several stands separated by closed forest. Formerly the population could be somewhat larger but its area of distribution was partly afforested by *Pinus nigra*, which mostly eliminated the grassland communities at the sites (CSONTOS *et al.* 1996, TAMÁS 2001).

Phytosociological studies of the *Linum dolomiticum* habitat were carried out by MÉSZÁROS-DRASKOVITS (1967). According to her studies the habitat belongs to two vegetation types: open and closed dolomite grasslands. The open grassland is identical with the *Seseleo leucospermi-Festucetum pallentis* Zólyomi 1966 plant community, and the closed one is a transition between two plant communities: *Seseleo leucospermi-Festucetum pallentis* Zólyomi 1966 (1) and *Festuco pallenti-Brometum pannonicae* Zólyomi 1966 (2). This transition was considered by Mészáros-Draskovits as a subassociation of the (1) community and she has given it a provisional name: *brometosum pannonici* (MÉSZÁROS-DRASKOVITS 1967). This subassociation has been described as a new plant community by BORHIDI (1996): *Seseli leucospermi-Brometum pannonici* Borhidi 1996.

Sampling of the *Linum dolomiticum* habitat by MÉSZÁROS-DRASKOVITS (1967) covered a relatively small part of the area of distribution only. Within the frame of the National Biodiversity Monitoring Program of Hungary the total distribution of *Linum dolomiticum* was mapped precisely in 2001 (DOBOLYI 2001). According to field experience *Linum dolomiticum* occurs not only in the described plant communities, but in other different vegetation types, too. Since both the species and its habitat have a relict character, phytosociological study of the complete area would be useful and informative for the better knowledge of the vegetation history of the Pannonian Basin.

On the basis of the species composition and dominance of the original relevés the following questions arise:

1) How homogeneous the vegetation of the *Linum dolomiticum* habitat is?

2) What are the phytosociological distances among the investigated habitat and the dolomite grassland communities listed in Table 2?

To find answers to these questions multivariate data analysis of the relevés made by MÉSZÁROS-DRASKOVITS (1967) has been performed. In the future based on my own new relevés, phytosociological analysis of the complete distribution area of *Linum dolomiticum* is planned.

MATERIAL AND METHODS

The multivariate data analyses were based on 45 phytosociological relevés of 2 m × 2 m size taken on the habitat of *Linum dolomiticum* near Ördögtorony in the vicinity of Pilisszentiván (MÉSZÁROS-DRASKOVITS 1967). Numbering of the original relevés in the present analyses is given in Table 1.

Five additional relevés were included in the multivariate analyses, each of them representing one of the dolomite grassland communities, marked by letters A to E (Table 2), which were compiled from the original descriptions (ZÓLYOMI 1958, BORHIDI 1996). All the five represented communities belong to the Bromo-Festucion pallentis Zólyomi 1966 alliance (BORHIDI 1996). These relevés served as references in the comparisons made by classification and ordination methods indicating the place of the five relevant plant communities.

Table 1. Numbering of the relevés in the multivariate data analyses

Number of the relevés in the multivariate data analyses	Number of the original relevés in Mészáros-Draskovits (1967)
1–20	Table 1, 1–20
21–45	Table 2, 1–25

Table 2. Plant communities represented by the additional relevés

Mark of the relevés in the multivariate data analyses	Plant community
A	*Seseli leucospermi-Festucetum pallentis* Zólyomi 1958
B	*Stipo eriocauli-Festucetum pallentis* Zólyomi 1958
C	*Chrysopogono-Caricetum humilis* Zólyomi 1958
D	*Seseli leucospermi-Brometum pannonici* Borhidi 1996
E	*Festuco pallenti-Brometum pannonici* Zólyomi 1958

The relevés were analysed by the following multivariate methods with SYN-TAX 5.1 and SYN-TAX 2000 program packages (PODANI 1993, 2001).

1) hierarchical classifications

distance optimising procedure: group average (UPGMA)

global optimisation

2) ordinations

centered principal component analysis (PCA)

principal coordinate analysis (metric multidimensional scaling; PCoA)

correspondence analysis (COA) (symmetric weighting)

3) block clustering (of raw data matrices), sum of squares

The applied distance coefficients: Euclidean distance, Bray-Curtis-index and similarity ratio (PODANI 1997).

All mentioned multivariate analyses were performed on two data matrices:

"Matrix A": relevé/species matrix: 50 objects/113 variables. The original cover values (MÉSZÁROS-DRASKOVITS 1967) were converted to a numerical scale of 0 to 9 (MAAREL 1979). Nomeclature of the plant names follow HORVÁTH *et al.* (1995).

"Matrix B": relevé/phytosociological character matrix: 50 objects/17 variables. The variable values were calculated in the following way: cover values of species having the same phytosociological character were summed pro relevés. The phytosociological characters of the plant species were taken from BORHIDI (1993).

RESULTS

Analyses of the data matrices provide information on the one hand about the phytosociological structure of the *Linum dolomiticum* habitat, on the other hand about the relations of the habitat to the dolomite grassland communities.

Results of all applied multivariate methods were used to determine the similarities and distances of the relevés. Ordinations play an essential part in the analysis of the data structure and were used first of all to determine the homogeneity of the groups of the relevés. The principal component analysis, the principal coordinate analysis and the correspondence analysis brought almost the same results.

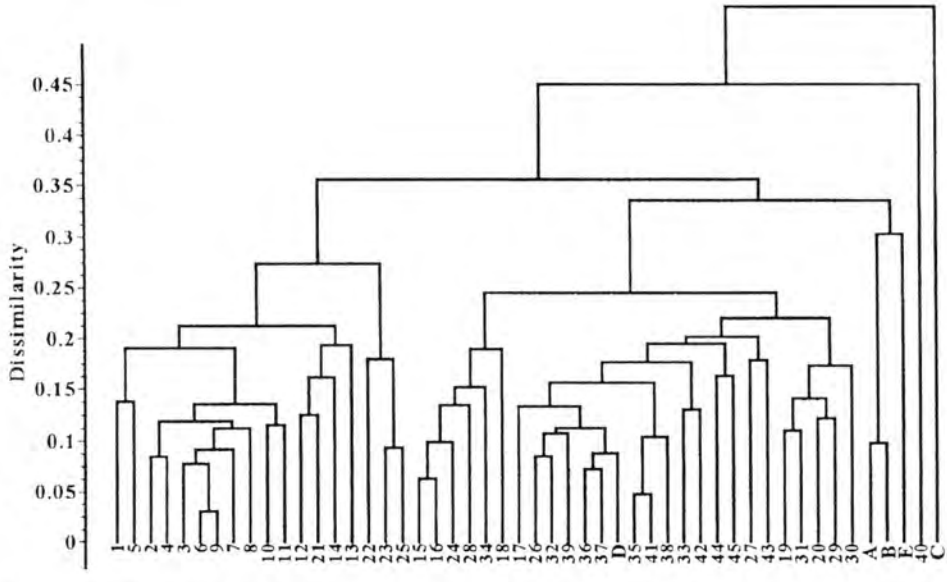

Fig. 1. Dendrogram of the relevés based on cover values (matrix A), group average (UPGMA), Bray-Curtis-index.

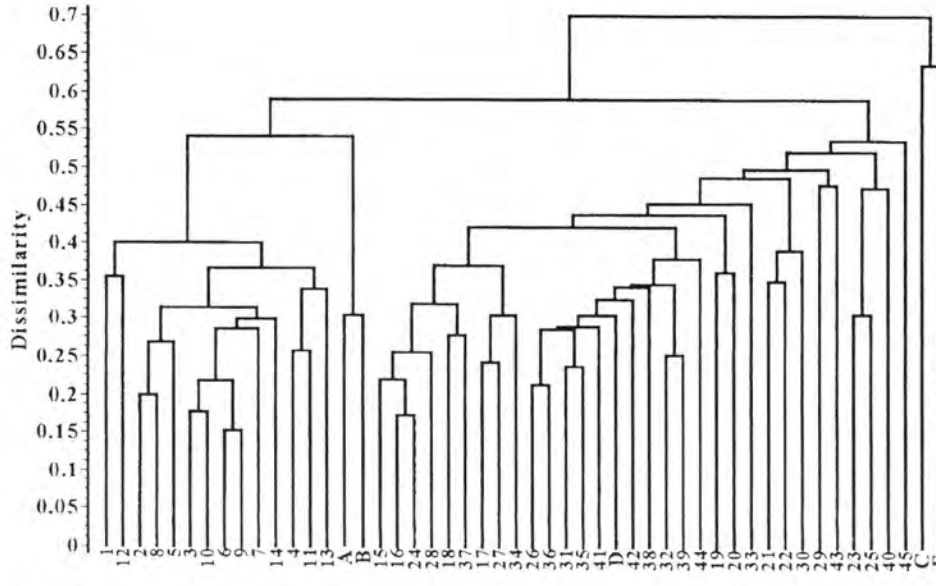

Fig. 2. Dendrogram of the relevés based on phytosociological character (matrix B), group average (UPGMA), Bray-Curtis-index.

Among the classifications the distance optimising group average method (UPGMA) and the global optimising method produced similar grouping inside the data matrices. Block clustering of the two data matrices shows the relations between the groups of relevés and the variables. All methods confirm that the relevés are extremely heterogeneous and cannot be divided into two clearly separate groups as done by MÉSZÁROS-DRASKOVITS (1967).

The most important results of the classifications, ordinations and block clustering are given in the Figs 1–6.

Relevés Nos 1–14 stand close to the *Seseli leucospermi-Festucetum pallentis* Zólyomi 1958 and to the *Stipo eriocauli-Festucetum pallentis* Zólyomi 1958 (Figs 1, 3) on the basis of the floral composition but in view of phytosociological character they are not identical with these two communities (Figs 2, 4).

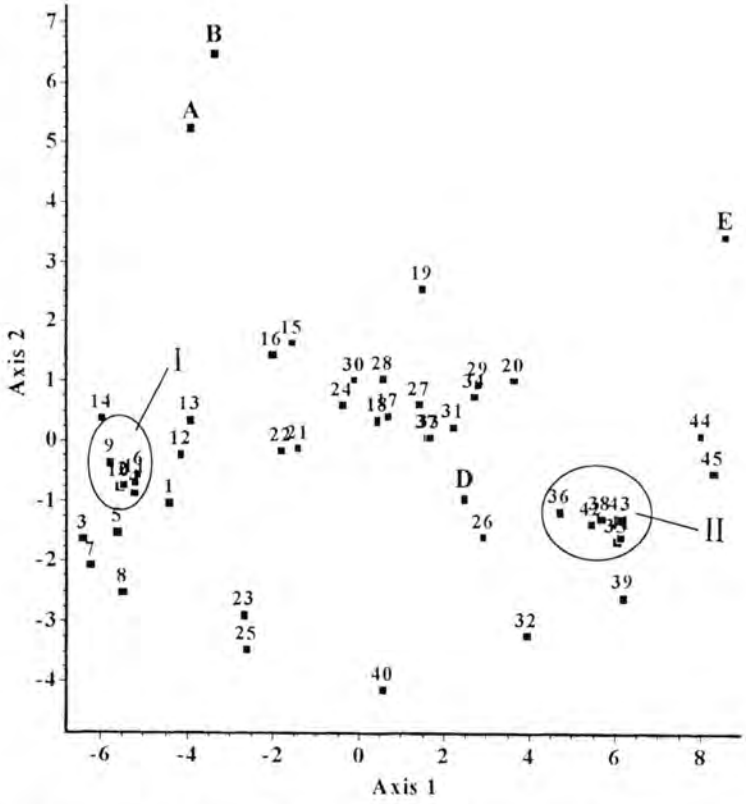

Fig. 3. Centered principal component analysis (PCA) of the relevés based on cover values (matrix A). The first two dimensions explain *ca* 47 per cent of the variance. Coordinates of the missing relevé "**C**" on the Axis 1 and Axis 2, respectively: 0.5, 11.7. (Relevés in the circle I: 2, 4, 6, 9, 10, 11, and in the circle II: 35, 36, 38, 41, 42, 43).

Based on all applied multivariate analyses the relevés Nos 35, 36, 38, 39, 41, 42, 43 belong to the *Seseli leucospermi-Brometum pannonici* Borhidi 1996. According to Borhidi (1996) the relevé No. 43 is the lectotypus of this community.

A number of the relevés cannot be included neither in the *Seseli leucospermi-Festucetum pallentis* Zólyomi 1958 nor in *Seseli leucospermi-Brometum pannonici* Borhidi 1996. The ordination methods show that these relevés stand between the two types of vegetation and their pattern is diffuse in the abstract space of the variables. These can be considered as several kinds of transitions among the open and closed dolomite grassland communities (Figs 3–4) and correspond to Zólyomi's coenotone hypothesis regarding survival of relict species (ZÓLYOMI 1987).

According to the block clustering of the "matrix A" the differentiating species between the closed and open dolomite grassland are *Bromus pannonicus, Phyteuma orbiculare, Campanula rotundifolia, Alyssum tortuosum* and *Fumana procumbens* (Fig. 5). The phytosociological characters have no characteristic part in separation of the vegetation types (Fig. 6).

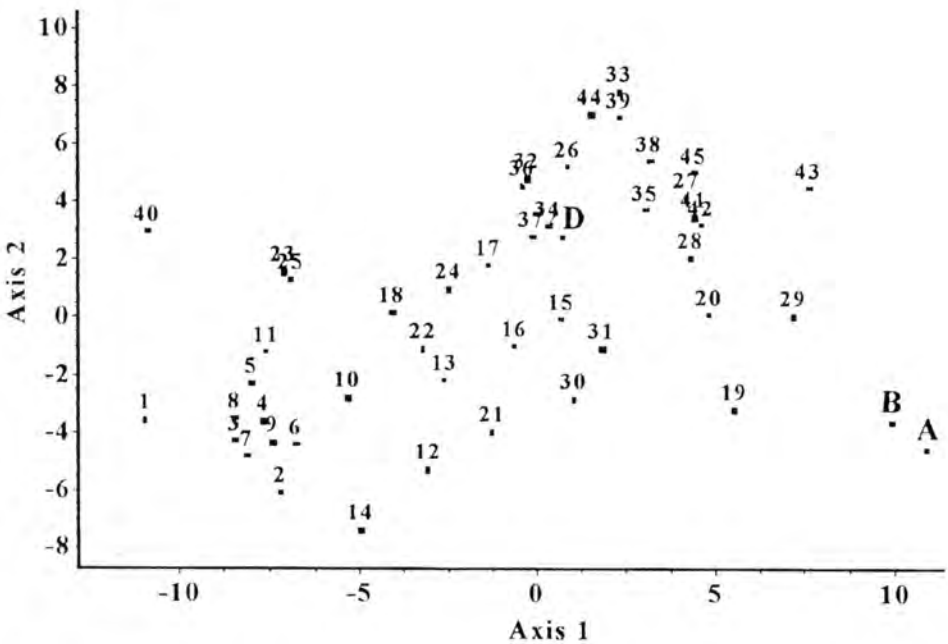

Fig. 4. Centered principal component analysis (PCA) of the relevés based on phytosociological character (matrix B). The first two dimensions explain *ca* 78 per cent of the variance. Coordinates of the missing relevés on the Axis 1 and Axis 2, respectively: "**C**": 31.0, –17.6; "**E**": 17.5, 9.1.

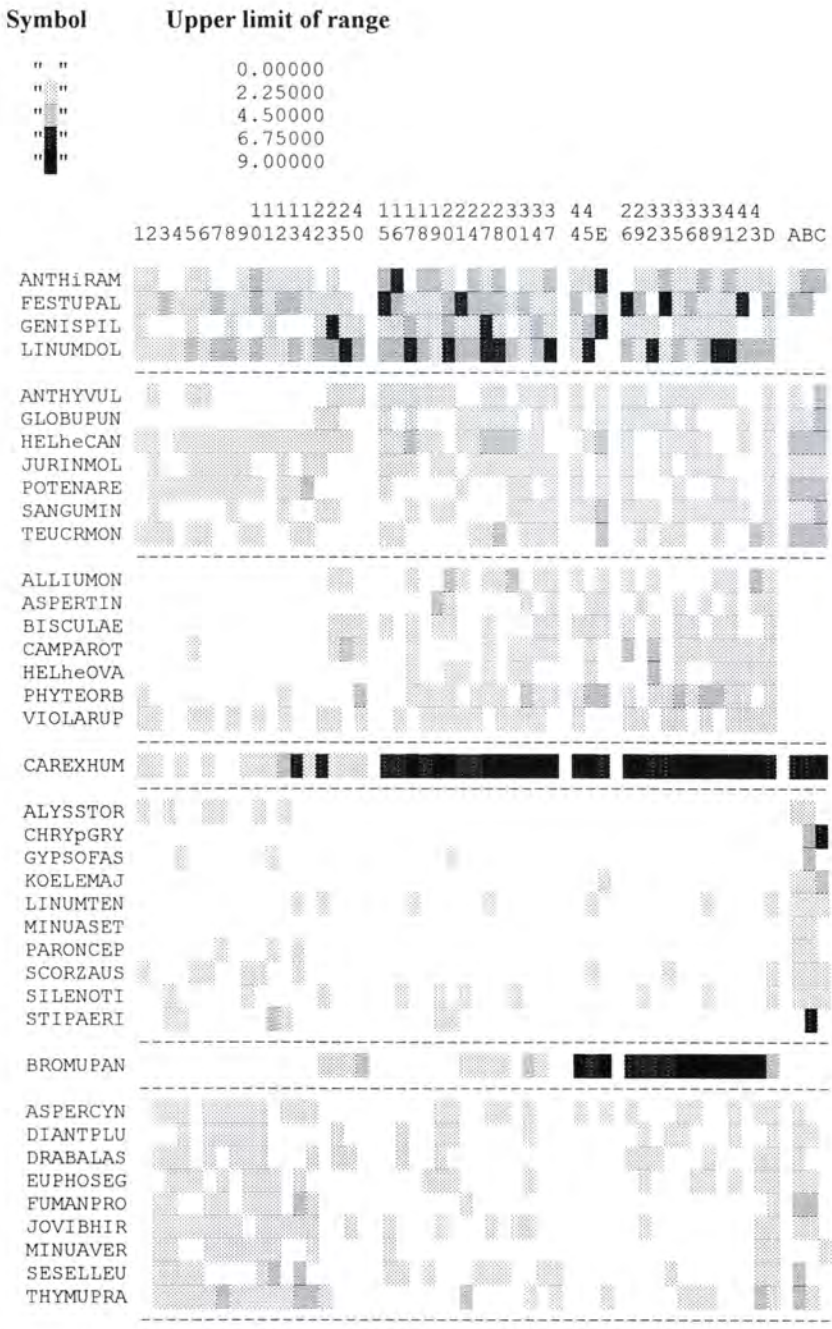

Fig. 5. Significant parts of block-clustering of the relevés based on cover values (matrix A). Abbreviations of the names of plant species follow the "MEMO" field in HORVÁTH *et al.* (1995).

Results of all multivariate methods show that the investigated part of the *Linum dolomiticum* habitat does not belong to the *Chrysopogono-Caricetum humilis* Zólyomi 1958 and the *Festuco pallenti-Brometum pannonici* Zólyomi 1958 communities.

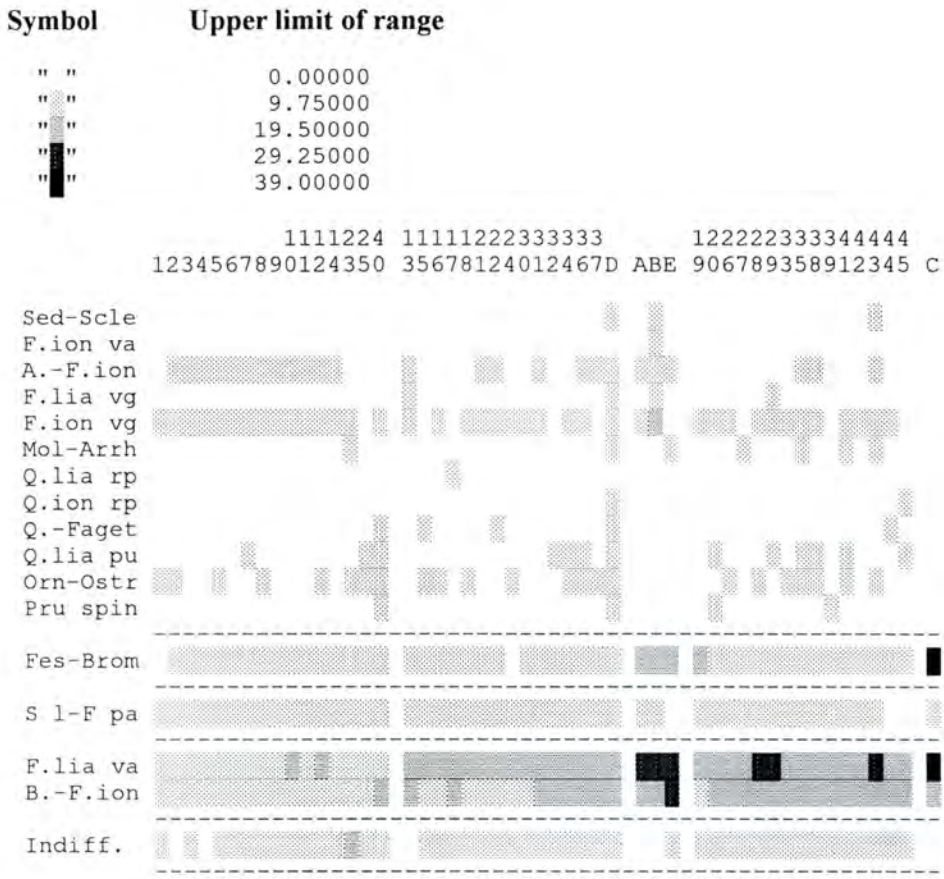

Fig. 6. Block-clustering of the relevés based on phytosociological character (matrix B). Abbreviations: Sed-Scle = Sedo-Scleranthetea, Fes-Brom = Festuco-Brometea, F.lia va = Festucetalia valesiacae, F.ion va = Festucion valesiacae, A.-F.ion = Asplenio-Festucion pallentis, B.-F.ion = Bromo-Festucion pallentis, S l-F pa = *Seseli leucospermi-Festucetum pallentis*, F.lia vg = Festucetalia vaginatae, F.ion vg = Festucion vaginatae, Mol-Arrh = Molinio-Arrhenatheretea, Q.lia rp = Quercetalia robori-petraeae, Q.ion rp = Quercion robori-petraeae, Q.-Faget = Querco-Fagetea, Q.lia pu = Quercetalia pubescentis-petraeae, Orn-Ostr = Orno-Ostryon, Pru spin = Prunetalia spinosae, Indiff. = Indifferent.

DISCUSSION

Based on the results of the multivariate analyses we can come to partly different conclusions about the *Linum dolomiticum* habitat than MÉSZÁROS-DRASKOVITS (1967). The open dolomite grassland belongs to two plant communities not only to one. Phytosociological status of one part of the closed grassland was determined correctly by MÉSZÁROS-DRASKOVITS (1967), but further parts should be considered as transitions among several grassland communities.

Traditional descriptions of the plant communities are based first of all on the floral composition and dominance. Differences between the results based on the floral composition and the phytosociological character indicate the importance of species attributes when characterising of plant communities.

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REFERENCES

BORHIDI, A. (1993): *A magyar flóra szociális magatartás típusai, természetességi és relatív ökológiai értékszámai.* (Social behaviour types of the Hungarian flora, its naturalness and relative ecological indicator values.) – Janus Pannonius University, Pécs, 95 pp.

BORHIDI, A. (ed.) (1996): *Critical revision of the Hungarian plant communities.* – Janus Pannonius University, Pécs, 138 pp.

CSONTOS, P., HORÁNSZKY, A., KALAPOS, T. and LŐKÖS, L. (1996): Seed bank of Pinus nigra plantations in dolomite rock grassland habitats, and its implications for restoration of the grassland vegetation. – *Annls hist.-nat. Mus. natn. hung.* **88**: 69–77.

DOBOLYI, K. (2001): *A Linum dolomiticum Borbás monitorozása.* [Monitoring of Linum dolomiticum Borbás.] – (mscr., report for the Duna–Ipoly National Park Authority, Budapest, 51 pp.)

HORVÁTH, F., DOBOLYI, Z. K., MORSCHHAUSER, T., LŐKÖS, L., KARAS, L. and SZERDAHELYI, T. (1995): *Flóra adatbázis 1.2. Taxonlista és attribútum-állomány.* [Flora database 1.2. List of taxa and attributes.] – Vácrátót, 267 pp.

MAAREL, E. VAN DER (1979): Transformation of cover-abundance values in phytosociology and its effects on community similarity. – *Vegetatio* **39**(2): 97–114.

MÉSZÁROS-DRASKOVITS, R. (1967): A Linum dolomiticum Borb. cönológiai viszonyai. (Zönologische Verhältnisse von Linum dolomiticum Borb.) – *Bot. Közlem.* **54**: 193–201.

PODANI, J. (1993): *SYN-TAX – pc. Computer programs for multivariate data analysis in ecology and systematics. Version 5.0. User's guide.* – Scientia Kiadó, Budapest, 104 pp.

PODANI, J. (1997): *Bevezetés a többváltozós biológiai adatfeltárás rejtelmeibe.* [Introduction to the analysis of multivariate biological data.] – Scientia Kiadó, Budapest, 412 pp.

PODANI, J. (2001): *SYN-TAX 2000. Computer programs for data analysis in ecology and systematics. User's manual.* – J. Podani, Budapest, 53 pp.

TAMÁS, J. (2001): A feketefenyvesek telepítése Magyarországon, különös tekintettel a dolomitkopárokra. (Austrian pine plantations in Hungary with special attention to dolomite hills.) – *Természetvédelmi Közlemények* **9**: 75–85.

ZÓLYOMI, B. (1958): *Budapest és környékének természetes növénytakarója.* [The native vegetation of Budapest and its surroundings.] – In: PÉCSI, M. (ed.): Budapest természeti képe. [Natural history of Budapest.] – Akadémiai Kiadó, Budapest, pp. 509–642.

ZÓLYOMI, B. (1966): A pannóniai flóratartomány és a környező területek sziklagyepjeinek új osztályozása. (Neue Klassifikation der Felsen-Vegetation im pannonischen Raum und der angrenzenden Gebiete.) – *Bot. Közlem.* **53**(1): 49–54.

ZÓLYOMI, B. (1987): Coenotone, ecotone and their role in preserving relic species. – *Acta Botanica Hungarica* **33**(1–2): 3–18.

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