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Ruderal communities of the railway station Česká Třebová (Eastern Bohemia, Czechoslovakia) — remarks on the application of classical and numerical methods of classification

Ruderální společenstva železniční stanice Česká Třebová — příspěvek k aplikaci klasických a numerických metod klasifikace

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Kovář P.[1]) et Lepš J.[2]) (1986): Ruderal communities of the railway station Česká Třebová (Eastern Bohemia, Czechoslovakia) — remarks on the application of classical and numerical methods of classification. — Preslia, Praha, 58 : 141–163.

Zürich-Montpellier classification of a set of 61 phytosociological relevés of ruderal plant communities was compared with results of different numerical treatments. Various agglomerative methods, the relocation method and one polythetic divisive method (TWINSPAN) were used, each with various transformations of primary data. Possible biases of classification due to differences in subjective estimation of species abundances were evaluated by introducing random errors into primary data. Particular classifications were mutually compared using the coefficient of Goodman et Kruskal (1954). A high degree of congruence characterized the group of classifications formed by the classical Zürich-Montpellier method, the Ward's clustering method and the relocation method, the latter two based on data after ordinal transformation. These three classifications appear to describe optimally the similarity structure of our phytosociological table. On the contrary, the poorest results were obtained using the presence-absence data only. Bias resulting from random perturbation of estimates of species abundances was negligible in comparison with differences between results of particular numerical treatments. Results of classifications were further compared with DCA ordination.

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INTRODUCTION

Advancement in syntaxonomy of ruderal communities in Europe illustrates how contradictory approaches may exist within a single, "well-tried" classification school, such as that represented by Zürich-Montpellier phytosociology. Ruderal communities are the most "plastic" ones which can only be "satisfactorily" categorized by the personal experience and subjective judgement of a syntaxonomist. Such judgement seems to surpass use of such characteristics as dominance, homogeneity, combinations of species or species groups, all criteria commonly used by Z-M phytosociologists. As a result, there are many inconsistences in "conception" of associations and other syntaxons (i.e. the problem of "subject heterogeneity"), classification problems of communities without syntaxonomically significant species (and thus non-insertable into the hierarchical system), or on the contrary, formally well differentiated units which do not correspond empirically to the original type (due, for example, to presence of vicarious species, different geography or ecology).

Numerical methods are nowadays considered to be a useful tool that may help to overcome some difficulties and inconsistences in syntaxonomy of plant communities. However, the "objectivity" of numerical methods is often exaggerated. Several important subjective decisions must be made prior to numerical treatment. There are many methods of numerical classification and ordination. For numerical classification, one has to select mainly: (a) the means of describing vegetation in the field; (b) transformation of primary data; (c) measure of similarity between relevés; (d) type of clustering process (unhierarchical, hierarchical agglomerative, or divisive) and then the particular algorithm. The aim of this study is to classify and characterize ruderal vegetation using the "classic" Zürich-Montpellier approach and to compare this classification with results of various numerical treatments.

MATERIAL AND METHODS

Locality and collection of data

Geobotanical investigations of operationally exposed parts of the railway station Česká Třebová (Eastern Bohemia) gave about 60 phytosociological relevés.[1]) The Domin-Hadač eleven-member scale of abundance and dominance (HADAČ et al. 1969) was used. All relevés come from 1975. Microlocalities are not stated (the orientation points are missing and the terrain of the railway area is permanently changed), total area investigated is about 100 ha. Nomenclature of vascular plants follows ROTHMALER et al. (1976), nomenclature of bryophytes follows PILOUS et DUDA (1960). The guide for nomenclature of syntaxa was HEJNÝ et al. (1979).

Classical methods

The relevé material was subjected to classical tabulation elaboration (Tab. 1), and with adequate literature comparison, the communities were classified. A relatively weak (cautious) conception of units was applied. In other words, the groups of relevés delimited on the base of presence, dominance or high abundance of species with a wide ecological amplitude (the alliance, order or class characteristic species) were not classified as associations and/or subassociations but named only "community" without setting up a rank in the hierarchy. As in the case of intermediate or vague position with regard to superior units, the principle of consequential hierarchization was not kept (compare method of Kopecký: KOPECKÝ et HEJNÝ 1974). This procedure was necessary because data from ruderal habitats are less consistent than those from forests, wetlands, meadows or steppes (KOVÁŘ 1979, 1980, 1981, KOVÁŘ et VOLKOVA 1981). Groups of relevés, belonging to a parti-

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[1]) Floristic note: In comparison with the floristic inventory of this locality (Procházka et Kovář 1976, Jehlík 1978) it is conspicuous that the species number spectrum of the vegetation now recorded represents approximately one quarter of the species known from this area (but including "non-ruderal" habitats in the railway station area). An important fact is that adventive plants (including quarantine weeds) occur only sporadically in the relevé material — it seems binding of adventive weeds on ruderal communities is very weak, contrary to the statement of Grüll (GRÜLL 1979). This supports the hypothesis that weed spreading depends mainly on random germination of seeds in open habitats.

cular community are referred to in the text as Z-M groups. The procedure described was carried out by the first author, completely independently of the subsequent numerical treatment.

Numerical methods

The classic Zürich-Montpellier (Z-M) classification of relevés was compared with several numerical classifications and with DECORANA ordination. Different transformation of the original DOMIN-HADAČ scale, and different classification algorithms were used.

The following transformations were used:

(x — original value, transf (x) — transformed value, $x = 0$ for absent species)
a) transformation to presence — absence data (1 for presence, 0 for absence)
b) ordinal transformation

x	0	+	1	2	3	4	5	6	7	8	9	10
transf(x)	0	1	2	3	4	5	6	7	8	9	10	11

c) transformation to cover value

x	0	+	1	2	3	4	5	6	7	8	9	10
transf(x)	0	0.1	1	2	3.5	7	15	30	45	65	80	95

There are a lot of other possible transformations (cf. VAN DER MAAREL 1979 a,b), but we consider these three to represent well the range in possible approaches to taking into account population size in classification of relevés. At one extreme is the transformation to presence-absence, in which population size is ignored and classification is performed on a purely floristic basis. The transformation to cover values may be considered as another extreme in which the role of dominant species is stressed. This transformation corresponds to the transformation of TÜXEN et ELLENBERG (1937), related to the Braun-Blanquet scale. Ordinal transformation lies between these extremes. In terms of VAN DER MAAREL's (1979b) general model transf(x) = x^w, the three transformations considered here correspond roughly to 0,1 and 4 values w respectively.

Three methods of agglomerative hierarchical clustering, one divisive method and one relocation method were used. The following hierarchical classifications were used:

1. Average linkage method using Error Euclidean distance as the measure of dissimilarity (computed using CLUSTAN — WISHART 1978).
2. Ward's method (error sum of squares) using Error Euclidean distance as the measure of dissimilarity (computed using CLUSTAN).
3. MINFO — a classification program using the mutual information method (ORLÓCI 1969). Programmed according to GOLDSTEIN et GRIGAL (1972). The measure of dissimilarity, preassigned for this method, is the increase in mutual information.
4. We have used for comparison the Jaccard coefficient for presence-absence data as recommended by DZWONKO (1978). It is not compatible with the Ward's method (cf. WISHART 1978). Hence, other "long-hand" method — complete linkage — was used instead of the Ward's method.

5. Relocation classification was performed using the procedure RELOCATE of the CLUSTAN package (WISHART 1978). This method is discussed from the point of view of vegetational science by KORTEKAAS, VAN DER MAAREL et BEEFTINK (1976). Three types of initial groupings were used: random, from results of Ward's classification and from original classical classification. Error sum of squares was used as a dissimilarity measure. If different results were obtained using different initial classifications, then that with the least error sum of squares was considered.
6. The TWINSPAN procedure (HILL 1979b) was used for hierarchical divisive classification. The procedure was executed without pseudospecies (i.e. on a presence-absence basis only) and with three pseudospecies levels (2,5, and 10 degree of scale). Pseudospecies concept is explained e.g. in HILL 1979b. By means of pseudospecies, population size is taken into account. The minimum group size for division was 6 (i.e. groups that contain less than 6 relevés were not subjected to divisive procedure).

The raw data deck was used. For Ward's and average linkage clustering methods the standardization to z-score $\left(z = \frac{x - \bar{x}}{\sqrt{\text{var } x}}\right)$ was examined. In this case, standardization appears to be extremely undesirable; the importance of species with low frequencies (often accessoric) was highly exaggerated. Results obtained using this standardization were unacceptable from the point of view of vegetation science and will not be considered further in this paper. Other standardizations may be more useful. Their effect has been studied by different authors (e.g. NOY-MEIR 1973, WALKER et WILLIAMS 1975, ORLÓCI 1978).

To assess possible bias in classification, introduced by eyeball estimation of degrees of scale, we have constructed a computer programs which we call the "mistaking student of geobotany". The current version of the phytosociological table was taken as a base, and the "mistaking student" perturbated each positive value in the following manner using the Monte Carlo method: with probability $P_0 = .34$, he determines the proper value, with probability $P_+ = .30$ and $P_{++} = 0.03$ he overestimates the value by one and two degrees respectively, and with probability $P_- = 0.3$ and $P_{--} = 0.03$ he underestimates the value by one and two degrees respectively. However, species cannot have values outside the range of scale used. Data perturbed by the "mistaking student" were then subjected to numerical classifications. Only the ordinal transformation (which appears to be the most useful one for our purposes) was used for these data.

In this way we obtained 21 different classifications (classical, four clustering methods, each for three transformations of original data and for ordinal transformation of perturbed data, two methods using Jaccard coefficient for presence-absence data and two TWINSPAN classifications). These classifications were compared using the coefficient suggested by GOODMAN et KRUSKAL (1954), according to the GOODM program in GOLDSTEIN et GRIGAL (1972). The coefficient ranges from zero to one with larger values, indicating greater similarity of the classifications. As the original Z-M classification includes 14 groups of relevés, cut off levels in all hierarchical classifications were applied to determine 14 groups; similarly, the relocation procedure was performed for 14 clusters. In this way, we have obtained a similarity matrix for 21 classifications. On the basis of this matrix, classifications were classified using complete linkage method.

The choice of the 14 groups cut off level is based on the results of Z-M classification and hence it may be considered as subjective. This point is open to criticism and has, at least partly, influenced our results. However, we feel that the application of any automatic determination of optimal cut off level is of limited usefullness in phytosociology. Moreover, the choice of the method would perform further subjective decision.

The following *ad hoc* "two way" coefficient was used to evaluate how distinctly particular Z-M communities are recognized by different numerical methods:

$$\frac{a}{b} \Big/ \frac{a}{c},$$

where a is the number of common relevés, included in both the Z-M group and in the numerically determined group most similar to the Z-M group under consideration; b is the number of relevés in the Z-M group and c is the number of relevés in the most similar numerically determined group. The comparison was carried out between the Z-M classification and numerical classifications based on ordinal transformation of data and TWINSPAN classification with pseudospecies (i.e. using quantitative data).

The numerically determined groups were always considered on the hierarchical level of 14 communities. If x, x_1 and x_2 are positive numbers, less than 1, then the coefficient $1/1$ designated complete agreement, $1/x$, that the numerically determined group was broader and $x/1$ that the numerically determined group was narrower than the Z-M group. x_1/x_2 designated partially overlaping groups.

As Ward's method of clustering combined with ordinal transformation appears to be the most useful numerical method, it was used for the compilation of the extended results of numerical classification. Although the 14 group hierarchical level was used here, the described procedure could be carried out on any hierarchical level. For each group the following characteristics were stated:

(1) the characteristic species combination — all species contained in at least 70 % of relevés (other values may be used depending on the object of study);

(2) characteristic species within the set under study — species contained in at least 25 % of relevés of the group and with its V statistic higher than a stated value ($V > 0.5$ used in this study). The V statistic was computed from the following table:

		relevé belonging to the group	relevé other
species	present	a	b
species	absent	c	d

Tab. 1. Original data in classical table.

Table 1

Relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Community		1		.		2			.	3	.		4		.		5			.	6		.
Intra-community counts	1	2	3	4	1	2	3	4	5	1	2	1	2	3	4	1	2	3	4	5	1	2	3
Area analyzed (m^2)	8	6	8	8	10	10	10	16	16	10	8	20	8	25	8	10	8	16	20	8	10	16	10
Total cover (%)	70	90	90	70	50	80	80	70	65	95	70	60	90	60	60	85	80	80	60	70	80	90	70
Number of species	9	9	11	7	7	9	9	8	9	9	9	9	11	13	13	16	18	17	17	12	18	15	14
Artemisia vulgaris	2	+	4	+	.	2	.	2	.	2	3	+	2	3	4	4	5	5	4	4	8	7	3
Matricaria maritima	2	+	1	.	.	3	1	+	1	3	2	3	2	2	3	2	2	.	2	.	2	2	4
Senecio viscosus	2	2	+	2	3	.	2	.	1	.	2	2	+	2	2	2	+	.	3	.	+	.	2
Taraxacum officinale	1	+	1	.	1	.	.	+	1	.	.	1	.	1	2	.	2	+	2	.	5	.	+
Tussilago farfara	.	2	.	1	.	.	.	3	.	.	3	.	.	.	.	+	3	2	2	2	.	.	4
Poa annua	3	.	3	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cirsium arvense	.	.	.	.	.	.	.	.	.	2	.	.	.	1	1	1	.	.	2	1	4	5	.
Oenothera biennis	.	.	.	.	.	.	.	2	.	.	.	.	.	.	7	.	9	8	7	7	.	.	2
Carduus acanthoides	.	.	.	.	.	.	.	.	.	.	.	1	.	2	2	.	.	.	.	.	1	5	2
Poa compressa	.	.	.	.	.	3	.	2	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agropyron repens	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	3	3	.
Linaria vulgaris	.	.	.	.	5	8	8	8	7	.	.	.	.	2	.	.	.	.	.	.	.	.	.
Calamagrostis epigeios	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	1	2	2	.	2	.	.
Trifolium repens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	4	.	4	.	.	.
Melilotus officinalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	2	.	2	.	.
Digittaria ischaemum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sisymbrium altissimum	.	.	.	.	2	.	.	.	+	9	7	.	1	8	.	.	.	.	.	.	.	.	.
Pastinaca sativa	.	.	.	.	.	.	.	.	.	1	.	.	.	2	.	3	.	2	.	.	.	2	.
Verbascum densiflorum	.	.	.	.	.	.	.	.	.	.	.	7	6	6	2	.	+	.	+	.	.	.	.
Echium vulgare	.	.	.	.	.	.	.	.	.	.	+	+	8	2	2	.	.	+	.	1	.	.	.
Arctium lappa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	8	7
Carex hirta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Polygonum arenastrum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chamomilla suaveolens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygonum aviculare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chenopodium album	1	1	6	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.
Polygonum lapathifolium	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Cirsium vulgare	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	+	.	.	.	.	.	.
Festuca rubra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.
Convolvulus arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.
Atriplex patula	6	9	3	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Reseda lutea	.	.	.	.	4	1	1	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Achillea millefolium	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.
Ceratodon purpureus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	.	.	2	6	.	.	.	.
Plantago major	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agrostis stolonifera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	4	.	.	.
Oenothera depressa	.	.	.	.	.	.	.	.	.	.	.	1	.	6	.	4	2	.	.	5	.	.	.
Epilobium roseum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	4	2	.	.	.
Trifolium hybridum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.
Silene alba	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	.	.	.	.
Potentilla norvegica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hypericum perforatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Chenopodium ficifolium	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chenopodium glaucum	8	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Amaranthus retroflexus	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galinsoga parviflora	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Erysimum cheiranthoides	.	.	.	.	.	4	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Viola arvensis	.	.	.	.	.	.	7	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Conyza canadensis	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Epilobium collinum	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactylis glomerata	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bromus tectorum	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oenothera rubricaulis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.
Descurainia sophia	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.
Sonchus oleraceus	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Verbascum phlomoides	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	+
Salix caprea juv.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.
Verbascum thapsus	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.
Medicago lupulina	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.
Lolium perenne	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Melilotus albus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	.	.	.	1	.	.	.
Lotus corniculatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	1	.	.	.	.

24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
	7			.			8		.		9			.			10		.			11		.			12				.	13	.		14		
1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	6	7	1	2	3	1	2	3
8	4	6	8	8	16	20	16	16	25	10	20	16	16	10	8	10	10	16	10	8	6	20	10	16	8	8	8	8	6	4	6	10	8	6	8	8	6
60	50	40	70	80	70	90	90	95	100	80	100	100	100	70	60	70	50	90	80	60	80	100	95	100	85	95	85	70	90	85	60	90	100	95	80	60	80
12	12	9	11	14	12	9	9	10	8	9	11	12	11	11	14	12	11	14	10	7	8	8	8	9	9	8	9	14	12	12	10	9	9	9	6	9	5
1	2	2	.	.	2	3	2	4	2	.	.	2	.	2	.	2	+	4	3	.	1	3	2	2	+	3	.	3	1	2	.	+	.	1	.	.	.
4	3	4	3	5	.	.	.	.	.	.	.	.	.	2	4	5	3	2	+	.	1	2	3	+	6	+	.	.	1	1	.	3	1	2	.	2	+
1	2	2	2	8	.	.	2	.	.	2	.	.	.	3	5	3	1	.	+	.	1	+	+	.	+	+	2	3	.	3	.	1	.	.	.	2	.
2	2	.	+	.	+	.	.	.	.	.	1	2	+	2	1	.	2	2	3	.	.	.	.	.	+	.	.	1	.	1	2	+	+	1	.	+	.
.	1	.	3	2	2	1	4	1	.	.	2	.	.	.	1	+	6	3	3	2	2	.	.	.	.	3	.	.	.	.	2	.	.	.	.	.	.
.	1	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	2	3	.	3	+	9	8	8	.	.	3
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Tab. 1. — Continued

Species present in only one relevé (relevé, community): *Chenopodium polyspermum* 2 (1), *Aethusa cynapium* 2 (1), *Impatiens parviflora* 5 (2), *Cerastium holosteoides* 6 (2), *Plantago lanceolata* 7 (2), *Hordeum murinum* 7 (2), *Poa angustifolia* 13 (4), *Ranunculus repens* 13 (4), *Arenaria serpyllifolia* 15 (4), *Armoracia rusticana* 16 (5), *Symphytum officinale* 16 (5), *Polytrichum piliferum* 17 (5), *Verbascum nigrum* 18 (5), *Berteroa incana* 18 (5), *Alchemilla acutiloba* 21 (6), *Agrostis tenuis* 21 (6), *Crepis biennis* 22 (6), *Arrhenatherum elatius* 22 (6), *Erysimum durum* 22 (6), *Solidago canadensis* 29 (8), *Typha latifolia* 37 (9), *Alisma plantago-aquatica* 37 (9), *Juncus articulatus* 37 (9), *Carex nigra* 37 (9), *Plantago media* 37 (9), *Juncus inflexus* 37 (9), *Rumex acetosella* 38 (9), *Avena sativa* 39 (10), *Potentilla anserina* 45 (11), *Coronilla varia* 48 (11), *Vicia cracca* 48 (11), *Amaranthus chlorostachys* 52 (12), *Setaria viridis* 52 (12), *Rumex crispus* 56 (13).

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where $V = \dfrac{(\mathrm{ad} - \mathrm{bc})}{(a + b) \,.\, (a + c) \,.\, (b + d) \,.\, (c + d)}$

(3) dominant species; i.e. species with the mean importance value greater than a stated value (3 used in this study).
(4) characteristic dominants; species with the common t statistics, comparing the mean importance value of species in the group and outside the group, greater than a stated value ($t > 5$ in this study). As the importance value for particular species, the values of the Domin-Hadač scale subjected to the ordinary transformation were used. Hence, they are not assumed to have any particular statistical property. Hence, these statistics are used as *ad hoc* measures only and are not used for any tests of significance. However, the same type of data is used for all groups, and so the results for particular groups are directly comparable.

As with the characteristic species and characteristic dominants, the differential species and differential dominants may be determined, if we consider as the "rest" the relevés of the group to be differentiated. All these categories (characteristic, differential) are inspired by, but not identical with, corresponding categories of the Z-M school.

Note that all these characteristics are computed "à posteriori", i.e. after classification (not necessarilly numerical). For hierarchical classification they may be computed for different "reasonable" hierarchical levels. Similarly they may be computed for different classifications. They may be very useful in assessing the ecological interpretability of a particular classification and in choosing the ecologically most appropriate hierarchical level of classification. This procedure may be considered to be the checking of the results by measuring the relative success of the clustering produced (VAN DER MAAREL 1982).

For comparison, the DCA ordination of relevés (detrended correspondence analysis) was performed, using the program DECORANA (HILL 1979a). Ordinal transformation of data was used.

RESULTS

Short characterizations of (Z-M) plant communities (Table 1):

1. Community with *Atriplex patula*, relevés 1—4 (loosely allocatable to the association *Chenopodietum ficifolii;* superior units: *Chenopodion glauci, Sisymbrietalia, Chenopodietea*)

side shaded by idle trains). Total cover: about 80 %, total species number (tsn) in 4 relevés: 16, average species number (asn) in 1 relevé: 9.

This summer community occurs in the most salty (sometimes dusty) substratum in this area, often in shallow depressions along the lines (on the

2. Community with *Reseda lutea*, relevés 5—9 (without a rank, intermediate subordination to the orders *Onopordetalia acanthii*, (*Artemisietea vulgaris*) and *Sisymbrietalia* (*Chenopodietea*)).

The community position within the relevé material is at the most xerothermophytic part of the gradient. As a rule it occurs on highly drained, gravel substrata and occupies small areas, often on the convex, "cushion-like" surface between the tracks. This fact implies relatively frequent shade (mainly in those parts of the railway station appointed for storage of rail-cars). Total cover about 70 %, tsn: 20, asn: 12.

3. Community with *Sisymbrium altissimum*, relevés 10—11 (identical with the ass. *Sisymbrietum sophiae;* superior units: *Sisymbrion officinalis*, *Sisymbrietalia*, *Chenopodietea*).

All relevés of this community come from elevated, thermally exposed parts of sandy banks, often built for special purposes (e.g. allusions of closed lines). Total cover: about 90 %, tsn: 14, asn: 9.

4. Community with *Verbascum densiflorum*, relevés 12—15 (freely allocatable to the ass. *Echio-Verbascetum*, *Dauco-Melilotion*, or intermediate subordination between *Dauco-Melilotion* and *Onopordion*, *Onopordetalia acanthii*, *Artemisietea vulgaris*).

This physiognomically conspicuous community is of linear or fragmentary character and usually occurs along the lines on coarse, stony or drossy substrata. It has a relatively heterogeneous floristic composition owing to continual saturation with new plants from the trains. Total cover: about 70 %, tsn: 23, asn: 11.

5. Community with *Melilotus* sp., relevés 16—20 (identical with the ass. *Melilotetum albae-officinalis;* superior units: *Dauco-Melilotion*, *Onopordetalia acanthii*, *Artemisietea vulgaris*).

This community is distributed in operationally less exposed parts of the station area, in comparison with the previous, related community. Its substratum contains more loam particles, and it has a higher number of plant species. It occupies flat areas between the tracks or the upper parts of wide banks. Total cover: about 75 %, tsn: 37, asn: 16.

6. Community with *Artemisia vulgaris*, relevés 21—23 (in the broad sense identical with the ass. *Tanaceto-Artemisietum vulgaris;* superior units *Arction lappae*, *Lamio albi-Chenopodietalia boni-henrici*, *Galio-Urticetea*).

This community apparently follows the previous one in succession. A typical feature is relatively slow decomposition of the litter, much of which remained even midway through the vegetational season. The community is often present on the slopes, at their feet, and/or in depressions with the clayey-loamy soils). Total cover: about 80 %, tsn: 31, asn: 12.

7. Community with *Potentilla norvegica*, relevés 24—28 (without a rank, intermediate subordination between *Sisymbrietalia* (*Chenopodietea*) and *Onopordetalia acanthii* (*Artemisietea vulgaris*)).

This summer community is comprised of two layers, as a rule, with the upper layer consisting of erect wide-leaved herbs, the lower of relatively gracile, prostrate plants and graminoid-type plants. Part of the stand is formed with juvenile stadia. The community occurs mostly in little used areas near the old reloading ramps. It is associated with places between the tracks with the external lowered edges of the lines which contain muddy (sandy-loamy) substrata. A typical feature is stagnant water and/or periodically high soil moisture. Total cover: about 60 %, tsn: 23, asn: 12.

8. Community with *Calamagrostis epigeios*, relevés 29—33 (without a rank, possible subordination to the *Dauco-Melilotion*, *Onopordetalia acanthii*, *Artemisietea vulgaris*).

This nearly closed, graminoid ("grassland") community, with a dominant od wide ecological amplitude is associated with places between the lines, usually moderate depressions, and more rarely with low, flat elevations. The diversity of its floristic composition causes difficulties in the classification. Total cover: about 90 %, tsn: 23, asn: 10.

9. Community with *Agropyron repens*, relevés 34—38 (without a rank, subordination to the *Agropyretea repentis*).

This abundant community occurs on small areas, often between the lines, usually on clayey-loamy substrate with sporadic stone content. Liana-forms, typically common at the usual area of distribution of the community along the vertical props (e. g. fences, railings, pens), are missing. However *Convolvulus arvensis* sometimes forms dense prostrate "carpets". When a site becomes an active work site after completion of a line, this community is

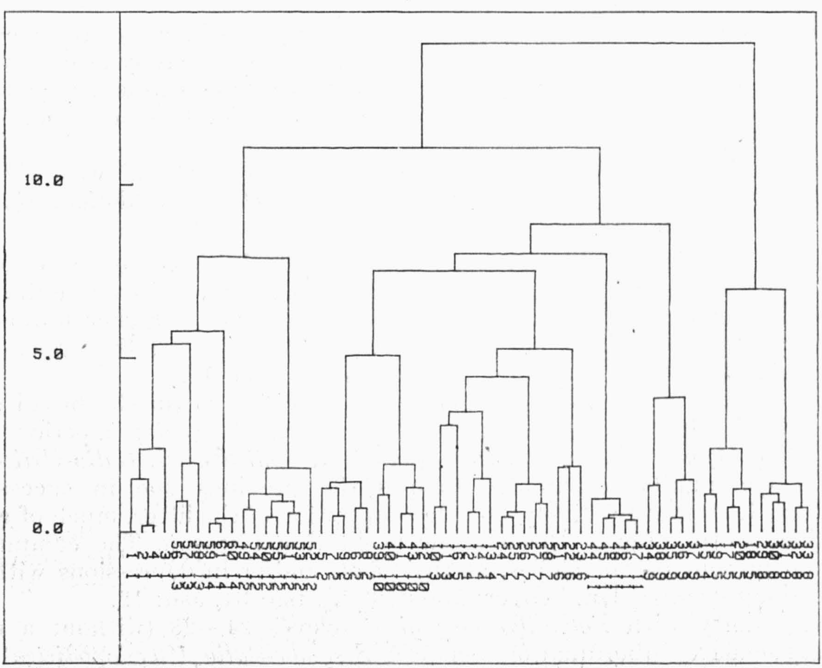

Fig. 1. — Results of Ward's clustering method applied to data subjected to the ordinal transformation. Dissimilarity measure is Error Euclidean distance. The number above is the number of the relevé; the number below corresponds to the Z-M group to which the relevé belongs.

replaced by the stand with *Calamagrostis epigeios*. Total cover about 90 %, tsn: 27, asn: 14.

10. Community with *Poa compressa*, relevés 39—43 (identical with the ass. *Plantagini-Poetum compressae;* superior units: *Convolvulo-Agropyrion*, *Agropyretalia repentis*, *Agropyretea repentis*).

This ruderal grassland occurs on heated, drained, stony or sandy substrata along the footpaths between lines and in small areas between tracks. It is widely distributed throughout the railway station. Total cover: about 70 %, tsn: 29, asn: 12.

11. Community with *Carex hirta*, relevés 44—48 (without a rank, intermediate subordination to the *Plantaginetalia majoris* (*Plantaginetea majoris*), *Agropyretalia repentis* (*Agropyretea repentis*), *Onopordetalia acanthii* (*Artemisietea vulgaris*).

The community occupies largely loamy habitats. It usually indicates a change in terrain: it often occurs at the periphery of the community with *Calamagrostis epigeios*, on flat edges of low banks, on elevated borders along the lines, and on the transitions to the moist depressions. Total cover: about 90 %, tsn: 24, asn: 8.

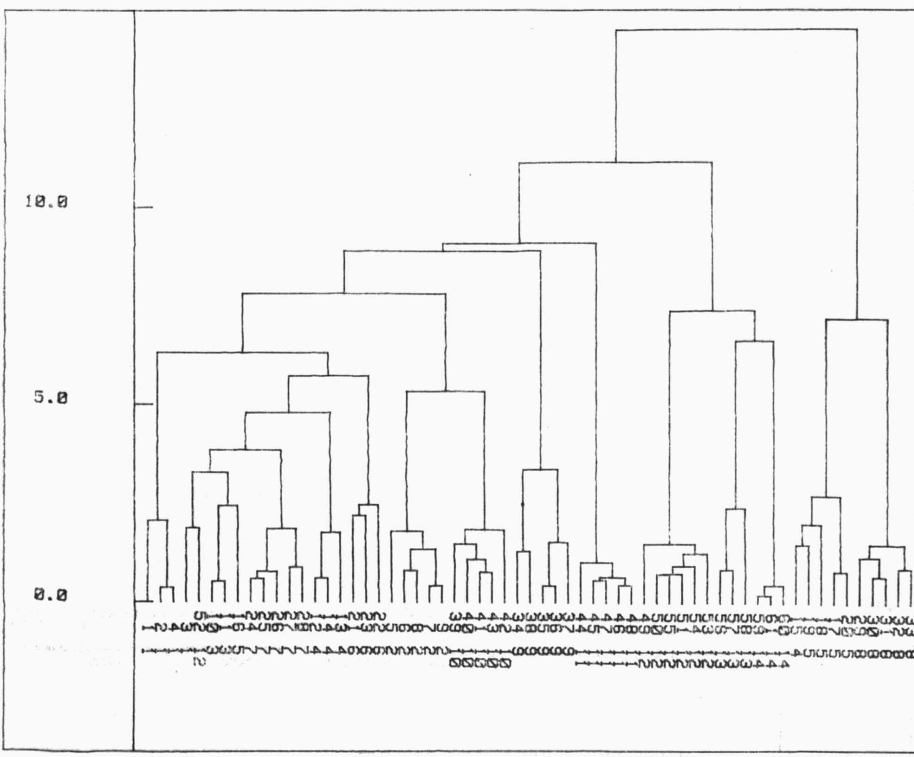

Fig. 2. — Results of Ward's clustering method applied to the data perturbed by "mistaking student" and subjected to the ordinal transformation. Dissimilarity measure is Error Euclidean distance. The number above is the number of the relevé, the number below corresponds to the Z-M group to which the relevé belongs.

12. Community with *Digitaria ischaemum*, relevés 49—55 (without a rank, or freely allocatable to the ass. *Eragrostio-Polygonetum*, superior units: *Polygonion avicularis, Plantaginetalia majoris, Plantaginetea majoris*).

This very frequent community is associated with trampled spots between lines or with packed down places between the tracks. The substrata contains middle size fractions of dross and gravel materials. All plants develop prostrate life forms. Total cover: about 80 %, tsn: 30, asn: 11.

13. Community with *Poa annua*, relevés 56—58 (allocatable to the ass. *Poetum annuae;* superior units: *Polygonion avicularis, Plantaginetalia majoris, Plantaginetea majoris*).

This is a shortgrass community with characteristic physiognomy and tolerant to trampling activity. In the study area it occurs mainly in the railway marshalling yard, in the engine watering places, or under the liquid storage tanks which stand on the tracks for a long time. Total cover: about 95 %, tsn: 17, asn: 9.

14. Community with *Polygonum arenastrum*, relevés 59—61 (allocatable to the ass. *Polygonetum avicularis;* superior units: *Polygonion avicularis, Plantaginetalia majoris, Plantaginetea majoris*).

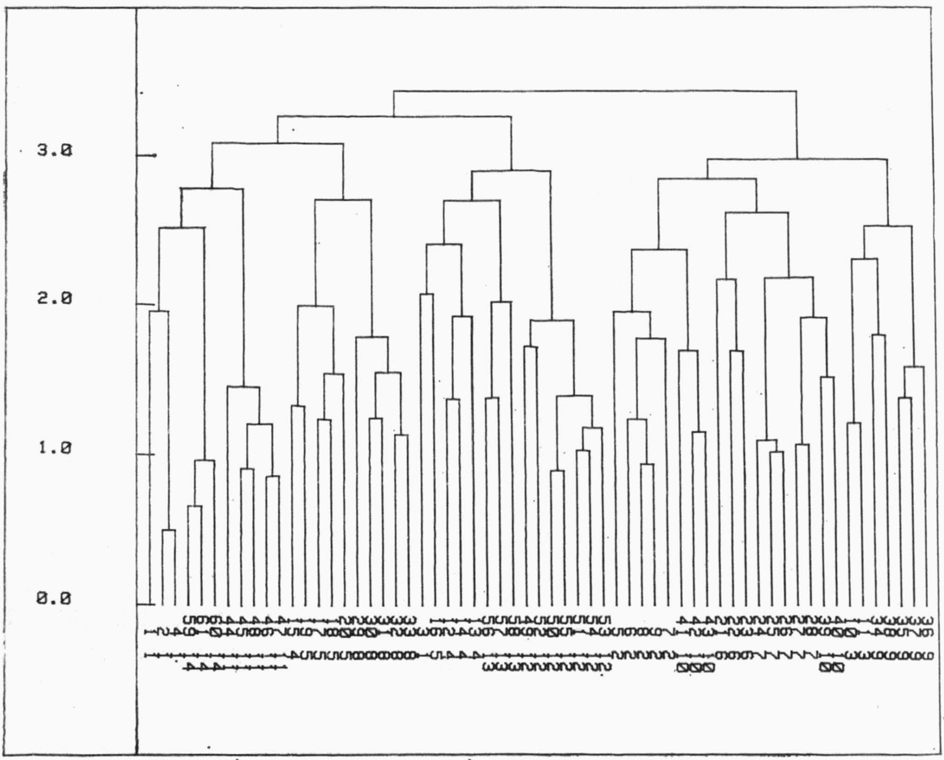

Fig. 3. — Results of the MINFO clustering method applied to the data subjected to the transformation to cover values. Dissimilarity measure is "mutual information"; it is plotted on the logarithmic scale (labels are decadic logarithms). The number above is the number of relevé, the number below corresponds to the Z-M group to which the relevé belongs.

This inconspicuous community, poor in species number, occupies dry trampled places in the immediate vicinity of the lines. All relevés have been taken on compact ash deposits. Total cover: 75 %, tsn: 14, asn: 7.

Numerical methods

Results of selected numerical classifications are presented in graphical and tabular forms. Results of Ward's clustering method with ordinal transformation of data (Fig. 1) have been used for compilation of extended results (Tab. 2). Total agreement in the unit delimitation is seen in 10 cases (the Z-M groups 1, 2, 6, 7, 8, 10, 11, 12, 13, 14) — in general, the results of Ward's method correspond well with the Z-M classification inclusive of "hidden assumptions". For example, the Z-M group number 4 (the community with *Verbascum densiflorum*) is one of the most problematic to place into the Z-M system (a consequence of low indication value due to mutual substitution by species of the genera *Verbascum* and *Oenothera*, high presence of species with wide ecological amplitude etc.). The sequence of the groups in the Z-M table is partly arbitrary (a problem of intermediate position of communi-

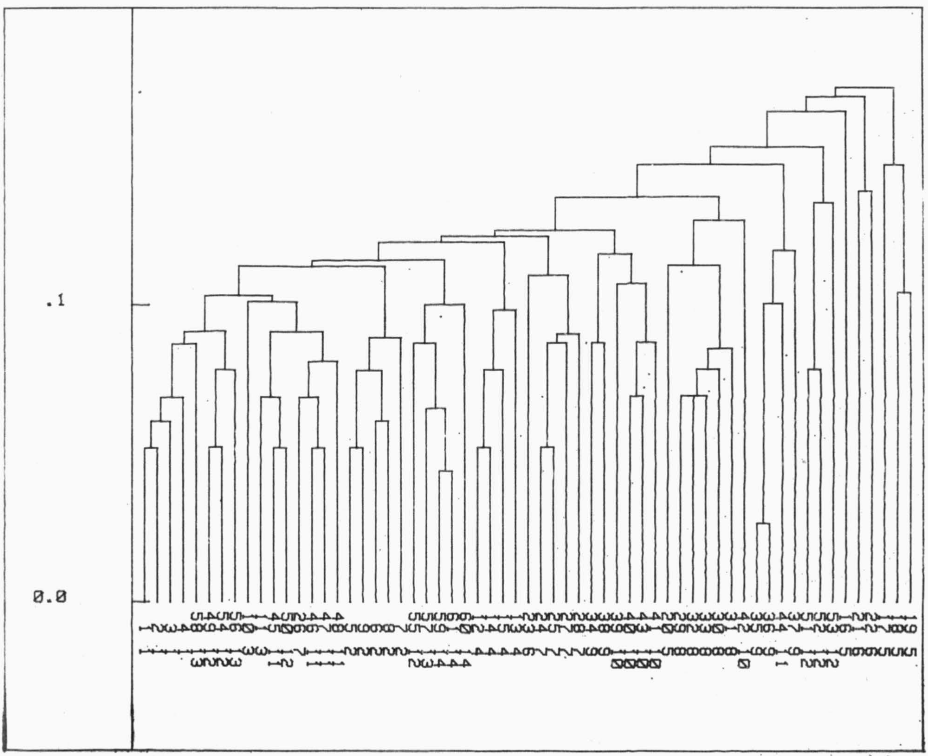

Fig. 4. — **Results of the average linkage clustering method applied to the presence-absence data. Dissimilarity measure is Error Euclidean distance. The number above is the number of relevé, the number below corresponds to the Z-M group to which the relevé belongs.**

Tab. 2. Extended results of Ward's method (with data after ordinal transformation). Meaning of symbols: s — species belonging to the characteristic species combination, c — characteristic species, d — dominant species, D — characteristic dominant, ! — complete agreement. The order of groups is arbitrary.

group no.	relevés	species	corresponding Z-M group
1	1—4	Atrip. pat. (s,c,d,D), Chenop. ficif. (c,D), Chenop. glauc. (c, D), Chenop. alb. (s,D), Artem. vulg. (s), Matric. mar. (s), Senec. visc. (s), Tar. of (s).	1!
2	5—9	Linar. vulg. (s.c.d.D), Reseda lut. (s.c.d.D), Matric. mar. (s), Senec. visc. (s), Tar. of. (s), Poa comp. (s).	2!
3	10—14 16	Sisymbr. altis. (s,d,D), Echium vulg. (s,c), Artem. vulg. (s,d), Matric. mar. (s,d), Verb. dens. (d,D), Oenoth. depr. (c), Desc. soph. (c), Senec. visc. (s).	3 4
4	15 17—20	Oenoth. bien. (s,c,d,D), Epil. ros. (s,c,D), Artem. vulg. (s, d), Cerat. pur. (c,d), Oenoth. rubr. (c,D), Salix cap. juv. (c,D), Lotus corn. (c,D), Agrost. stol. (c), Tar. of. (s), Tussil. farf. (s), Calam. epig. (s).	5
5	21—23	Arct. lappa (s,c,d,D), Card. acanth. (s,d,D), Tanac. vulg. (s,c,D), Equis. arv-(c,d,D), Artem. vulg. (s,d), Matric. mar. (s,d), Arct. tomen. (c,D), Cirs. arv. (d).	6!
6	24—28	Potent. norv. (s,c,d,D), Matric. mar. (s,d), Senec. visc. (s,d), Card. acant. (s), Digit. isch. (s).	7!
7	29—33	Calam. epig. (s,c,d,D), Achil. millef. (s,c,D), Artem. vulg. (s,d), Cirs. arv. (s,d), Tussil. farf. (s).	8!
8	34,38	Convolv. arv. (s,c,d,D), Sil. alb. (s,c,d,D), Fest. rub. (s,c, d,D), Agrop. rep. (s,d), Senec. visc. (s,d).	part of 9
9	35—37	Trifol. hybr. (s,c,d,D), Odont. vulg. (s,c,D), Agrop. rep. (s,d, D), Tar. of. (s), Calam. epig. (s), Epil. col. (D).	part of 9
10	39—43	Poa comp. (s,c,d,D), Matric. mar. (s,d), Tussil. far. (s,d), Artem. vulg. (s), Senec. visc. (s), Tar. of. (s), Fest. rubr. (c).	10!
11	44—48	Carex hirta (s,c,d,D), Artem. vulg. (s), Matric. mar. (s).	11!
12	49—55	Digit. isch. (s,c,d,D), Cirs. vulg. (c,D), Lepid. dens. (c,D), Artem. vulg. (s), Senec. visc. (s), Poa annua (s), Eragr. min. (c), Sol. nigr. (c).	12!
13	56—58	Poa annua (s,d,D), Matric. mar. (s,d), Chamom. suav. (d,D), Polyg. avic. (d,D), Polyg. avic. (d,D), Tar. of. (s).	
14	59—61	Polyg. aren. (s,c,d,D), Trif. rep. (s,d).	14!

ties with regard to superior units). Therefore it is not comparable to the other classifications. However, in many cases, grouping on high levels can increase (e.g. the groups 12, 13, 14) or decrease (e.g. groups 1, 4, 5) support for allocation into the same order or class.

Table 2 shows the classification values of indication species (or characteristic species combination — s, characteristic — c and dominant — d species, characteristic dominants — D) as well. In the groups of the total delimination agreement (Ward's method against Z-M classification) criteria for indication species are fulfilled accordingly, as a rule — not only in presence/absence, but in dominance as well (= species carrying all indices: s, c, d, D or s, d, D). Some species of a wide ecological valency (occuring througout the complete relevé set from the locality) can appear in the classification as the species of a characteristic species combination — only with the s-index (e.g. *Matricaria maritima*, *Senecio viscosus*, *Taraxacum officinale*). The species that create the other communities as dominants in different places may participate in the characteristic species combinations mentioned above (e.g. *Digitaria ischaemum*, *Calamagrostis epigeios*, *Poa compressa*).

Total agreement in the Ward's and the Z-M classifications concerns both the Z-M units described in literature (1, 6, 10, 11, 12, 13, 14) and nondescribed (= without a valid nomenclatorical name: 2, 7, 8). Literary confrontation of the indication species may be performed only in the associations described. Perfect agreement in the species indication of the communities (see HEJNÝ et al. 1979) is in 1, 6 and 12 Z-M groups (the species that are simultaneously dominants and characteristic species). In other cases of the delimination agreement there are some partial overlaps in the species characterization (10, 11, 13, 14) — when the classification doesn't include some of the indication species used in literature and/or joints the other species. E. g. in the ass. *Plantagini-Poetum compressae* (10) we don't find the species *Agrostis tenuis*, *Leontodon autumnalis*, *Ceratodon purpureus*, but there is significant the presence of species *Matricaria maritima* (s, d), *Tussilago farfara* (s, d),

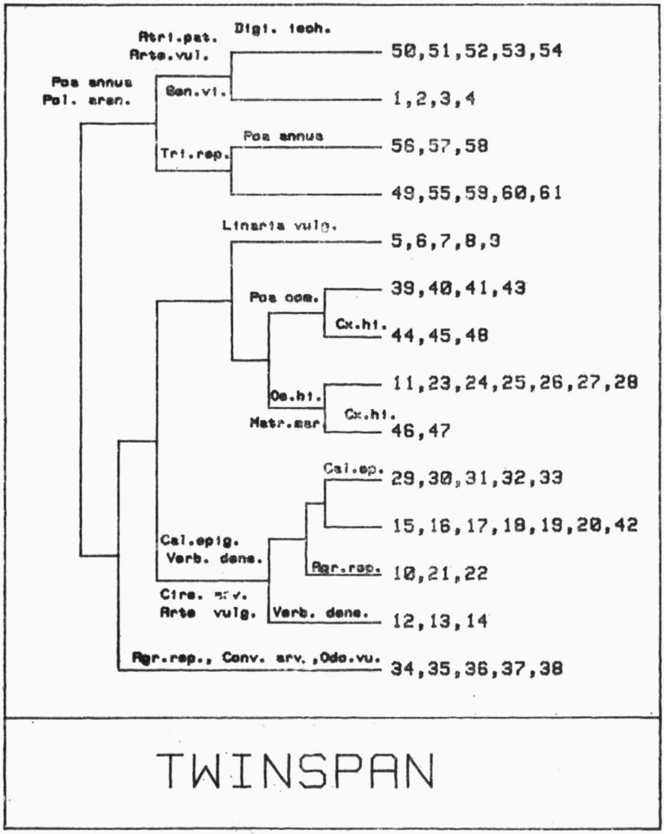

Fig. 5. — Results of the TWINSPAN classification. Each division is labelled with indicator species. Each final group is characterized with a list of relevés it contains. Particular indicator species are designated with abbreviation of name (full names are in Tab. 1).

Senecio viscosus (s) and *Festuca rubra* (c). It indicates a certain plasticity of the community structure. In cases when the Ward's classification partially or completely fuses the Z-M units, there is interesting to test indication value of the species. E.g. the Z-M associations 3 and 4 form the Ward's group 3: in this relevé set the species *Sisymbrium altissimum* (Z-M: 3) and *Verbascum densiflorum* (Z-M: 4) represent dominants, and *Descurainia sophia* (Z-M: 3), *Oenothera depressa* (Z-M: 3) and *Echium vulgare* (Z-M: 4) represent characteristic species. On the other hand, the Ward's classification divides the Z-M association 9 with the dominant *Agropyron repens* into two groups characterized by the species *Convolvulus arvensis*, *Silene alba*, *Festuca rubra* in the first case, and by *Trifolium hybridum*, *Odontites vulgaris* in the second case. However, this division is task of determination of the cut off level only. The physiognomical similarity of both these stands confirms the difficulty of the classification of the communities with *Agropyron repens* (see HEJNÝ et al. 1979).

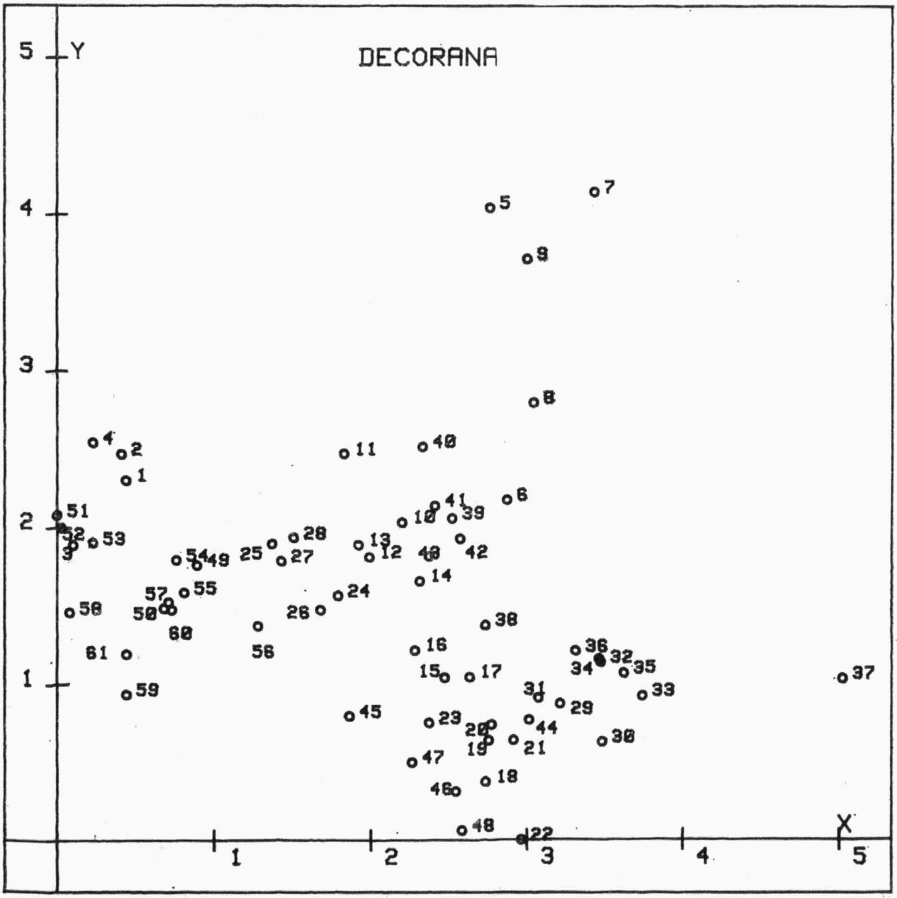

Fig. 6. — Scatter diagram of DECORANA ordination (data subjected to the ordinal transformation). Axes are labeled in units of S.D. (for derivation of these units see HILL 1979a).

Figs. 2,3 and 4 give results of further selected agglomerative methods. Perturbation of data affects only slightly the results of Ward's classification with data subjected to the ordinal transformation (compare Figs. 1 and 2). In MINFO classification of data subjected to the transformation to cover values (Fig. 3) most Z-M groups are confirmed but agreement with Z-M classification is less than in the former case. Agreement between results of Z-M classification and average-linkage classification of presence-absence data (Fig. 4) is very poor. Mechanical application of cut off level yields

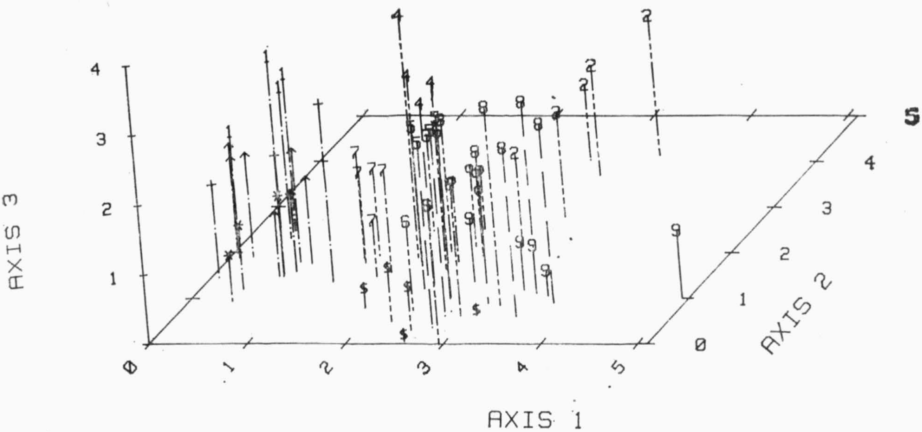

Fig. 7. — Three dimensional plot of results DECORANA ordination (data after ordinal transformation). Axes are in units of S.D. Numbers 1 to 9 correspond to the Z-M group to which the relevé belongs, groups 10 to 14 are designated: 10 — 0, 11 — \$, 12 — ∧ 1,3 — +, 14 — *. Different line types correspond to the four basic groups in Ward's clustering with data subjected to the ordinal transformation.

groups of strikingly unequal sizes. Only groups 1, 2, 4 and 12 are confirmed, but not on a 14 community hierarchical level. The confirmed groups may be considered as floristically well differentiated. Z-M group 4 is confirmed on the basis of presence-absence only. When population sizes are considered, the relevé 15 is classified in some other group.

The results of TWINSPAN classification (Fig. 5) using pseudospecies (i.e. with quantitative data) are not too different from Z-M classification. Z-M groups 1, 2, 8, 9 and 13 are confirmed completely. Designation of indicator species is an extremely valuable tool for phytosociological interpretation of results of numerical treatment. However, as the dichotomy is often asymmetric, the hierarchical level of division doesn't correspond to the degree of similarity between divided groups. If we want to evaluate the dissimilarity of groups after division, further information is needed (e.g. the distance in DCA ordination as suggested by Gauch and Whittaker 1981).

The confirmation of particular Z-M groups is summarized in Tab. 3. Only the results obtained using ordinal transformation of data and of TWINSPAN with pseudospecies were considered.

Results of the DECORANA ordination (Figs 6 and 7) display the relationships among particular groups and relevés. The third axis is of great importance for distinguishing some groups (e.g. 9 and 11). The majority of known Z-M groups may be recognized within the ordination diagram, but groups are difficult to distinguish *de novo.* On the other hand, outliers, transit types or discontinuities may be found.

The classification of classifications is displayed in Fig. 8. Classifications are grouped mainly according to the transformation of data used. Classifications based on data after ordinal transformation form one congruent group, and those based on data after transformation to cover values form another. The Z-M classification and TWINSPAN with quantitative data fall into the former group. The only exception is the MINFO classification based on cover values, which belongs to the former group. This is caused by the logarithmic

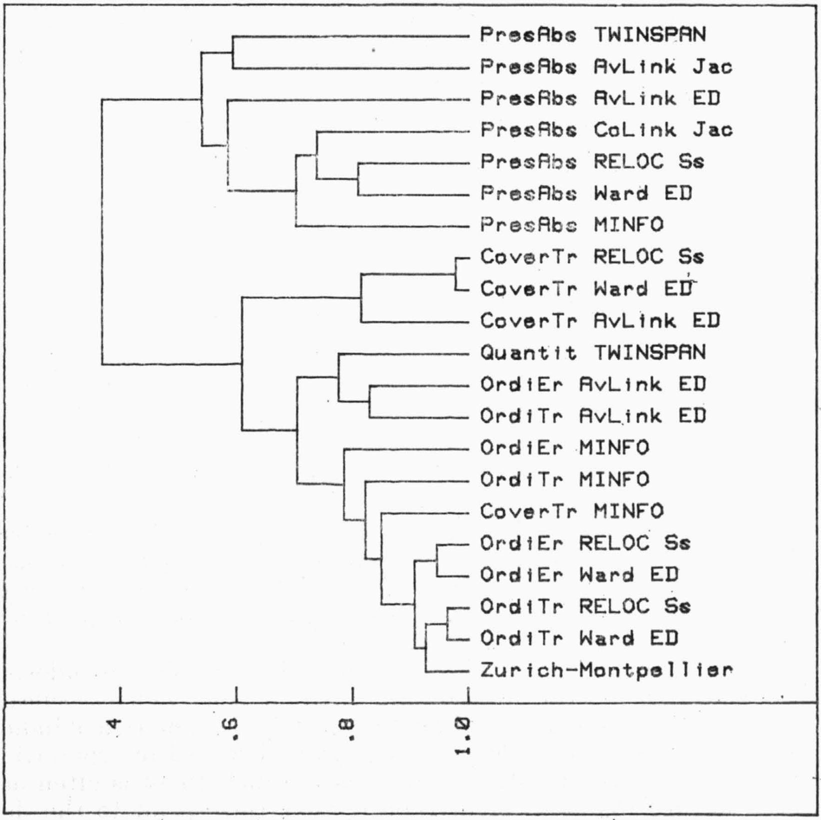

Fig. 8. — Classification of classifications (complete linkage, similarity of classifications is computed according to Goodman et Kruskal 1954). Transformations of data are designated: OrdiTr — ordinal transformation, OrdiEr — Ordinal transformation of data perturbated by "mistaking student", CoverTr — transformation to cover values, PresAbs — transformation to presence-absence data. Clustering methods: AvLink — Average linkage, Ward — Ward's clustering method, CoLink — complete linkage, RELOC — relocation method. Measures of similarity (dissimilarity): ED — Error Euclidean distance, Ss — sum of squares, Jac — Jaccard's coefficient; for MINFO, "mutual information" is preassigned. The TWINSPAN method was executed without pseudospecies (PresAbs) and with them (Quantit).

Tab. 3. The confirmation of particular Z-M groups by different numerical methods. Only results obtained using ordinal transformation of data and TWINSPAN with pseudospecies are used. Two way similarity coefficient is defined in the Methods paragraph.

Z-M group	WARD	RELOC	MINFO	Av. Link.	TWINSPAN
1	1/1	1/1	1/1	1/1	1/1
2	1/1	1/1	1/1	1/1	1/1
3	1/.33	1/.28	1/.66	1/.12	.5/.33
4	.75/.5	.75/.75	.75/1	.75/1	.75/1
5	.8/.8	.8/.8	.8/.66	.8/.8	1/.71
6	1/1	1/1	.66/1	.66/1	.66/.66
7	1/1	1/.72	1/1	1/.29	1/.71
8	1/1	1/1	.8/1	1/1	1/1
9	.6/1	.6/1	.6/1	.6/1	1/1
10	1/1	1/1	.6/1	.8/.23	.8/1
11	1/1	1/1	1/.83	1/.29	.6/1
12	1/1	1/1	1/1	1/1	.71/1
13	1/1	1/1	1/.5	1/1	1/1
14	1/1	1/1	1/.5	1/1	1/.6

nature of the information statistic, which is the predetermined similarity measure for this method. (The ordinal transformation is of roughly logarithmic nature with respect to the transformation to cover values). Classifications based on presence-absence data are distinct not only from all other ones, but from each other too. In each of these groups, the results of the average linkage method were the most distinct from Z-M classification.

Using the perturbed data (ordinal transformation only) results were very similar to those without perturbations (similarity ranges from 0.80 — MINFO to 0.91 — Ward's and relocation methods). Hence, Ward's and relocation methods seem to be both the most similar to Z-M classification and the most robust.

DISCUSSION

We have tried to compare the importance of particular subjective decisions in numerical classification of relevés, particularly the type of transformation of primary data and the type of clustering process. Of these, the type of transformation of primary data is strikingly more important. Changing the value in the general transformation formula $y = x^{w}$, we change the character of classification. High values of w correspond to vegetation types defined in terms of dominants, low values of w to floristically defined types. However, in this paper we have not paid attention to similarity coefficients. This problem is discussed by many authors (e.g. VAN DER MAAREL 1979a, GOODALL 1973a, ORLÓCI 1978, CAMPBELL 1978). Some measures are predetermined for particular methods. The choice of similarity measure often has an effect similar to the use of some transformation; some transformations may be included in computations of similarity values. Hence, the joint effect of transformation and of similarity measure must be considered (cf. CAMPBELL 1978). We may conclude that the results of numerical classification are most affected by the way in which the similarities between relevés are computed from primary data, particularly by the extent to which the quantity of particular species is taken into account.

Attempts to compare results of traditional approaches (e.g. of Braun-Blanquet's method) with results of numerical treatment are relatively old (e.g. Moore et al. 1970, Stanek 1973). As noted by Dale (1977), some of them stress similarities and favor numerical approaches, whereas others stress discrepancies and favor a particular traditional approach. The methods of numerical classification (and computer hardware) have progressed since the time of these first comparisons and are far more efficient now. It should be noted, that comparing results of different traditional approaches, we also obviously recognize some similarities and some discrepancies. Kovář et Volkova (1981) compared results of the classification systems of Sočava and that of Braun-Blanquet and found similar but not identical delineation of particular communities in the field, in spite of the different conceptions of the basic classification unit. Thus, it seems there is no single best method of classification, neither traditional nor numerical. However, some methods fit particular purposes better than others.

It seems reasonable to consider techniques of numerical classification and ordination as tools which may be used within different phytosociological schools. The degree of similarity between particular numerical and traditional methods depends considerably on the choice of parameters of numerical classification.

We found both Ward's and relocation classifications with data after ordinal transformation to be most similar to the Z-M classification. This or similar combinations are currently considered to be the most useful for classification of plant communities (e.g. Kortekaas, van der Maarel et Beeftink 1976, van der Maarel 1979a,b, Mucina 1982). Our conclusions are based on the study of ruderal plant communities only. However, agreement with results based on other types of vegetation (*Arrhenatherion*, *Spartinetea*) support our opinion, that this combination may be recommended for the study of a wide range of vegetation types. Similarly, Robertson (1979) found (on the base of simulated data) Ward's and MINFO classifications to be superior to average linkage clustering. Jensén (1978) concluded on the basis of study of lake vegetation that intermediate transformations always gave ecologically interpretable results, but the extreme transformations (i.e. cover values and presence-absence data) were less reliable. The optimal type of transformation (or optimal value of w in transformation formula) probably depends on the heterogeneity of the classified set. The value w should decrease with increasing heterogeneity of the set. Similar points have been made by Orlóci (1968), Goodall (1973b), and others, who suggest that species presence is an appropriate variable to use where the set is highly heterogeneous. Otherwise, quantitative values are preferable.

Our conclusions are based on corroboration of a relatively small data set (61 relevés). For large data sets (several hundreds of relevés) the effectiveness of agglomerative methods decreases. For such data, probably the most appropriate method is divisive polythetic classification (e.g. TWINSPAN). Gauch et Whittaker (1981) prefer the TWINSPAN method generally and we found it to be useful for our small data set too. Nevertheless, results of all methods depend strongly on the chosen transformation of primary data (in the case of TWINSPAN on the number of pseudospecies cutting levels).

The aim of phytosociological study is to recognize and describe vegetation types in an area. The effectiveness of our effort depends not only on our ability to classify relevés correctly, but also on our ability to collect a sufficient number of relevés. If the "objective quantitative" assessment of "species importance value" (e. g. the point quadrat method for estimation of cover) is required for numerical classification then the time required for data collecting is enormous. As a result, far fewer relevés may be obtained in comparable time than by traditional methods, and the method as a whole is less efficient (cf. SONESSON et KVILLNER 1980). The semi-quantitative "eyeball" estimates are currently commonly processed in numerical classifications (cf. VAN DER MAAREL 1979a,b). Our results support the suitability of this approach.

Classification seems to be more efficient than ordination for the initial relevé sorting in heterogeneous data sets, in which the community differentiation is directed by many environmental factors. However, the following ordination of relevés provides obviously useful additional information. Hybrid ordination-and-classification approaches are recommended by GAUCH et WHITTAKER (1981), because they combine the usefulness of classification for summarization with the effectiveness of ordination in revealing directions of relationship.

Numerical classifications may no longer be considered as unique objective methods for classification of vegetation. The human factor should not be neglected in phytosociology — any result of phytosociological study is necessarily subjectively influenced (cf. GAUCH 1982, p. 30). Nevertheless, the numerical treatment of vegetation data provides a highly efficient tool for organizing and ranking sets of relevés, a tool which may be used by different traditional schools (cf. VAN DER MAAREL 1975, DZWONKO 1977, MORAVEC 1975, WILDI et ORLÓCI 1980, DALE 1982). If any group is confirmed by different classification methods and recognizable in ordination diagrams, then it may be considered to be a well differentiated vegetation type (at least in the range of the set under study). Simultaneous use of several methods objectivizes the final classification and thus produces a clearer analytic model than any single technique (cf. GRIGAL et GOLDSTEIN 1971).

Thanks are due to Dr. Mike B. Dale for helpful comments on the earlier version of this paper.

SOUHRN

Ruderální rostlinná společenstva nádraží v České Třebové byla studována klasickými metodami curyšsko-montpelliérské školy. Získaný soubor snímků byl poté zpracován různými metodami numerické klasifikace a ordinace. Výsledky užití všech metod byly porovnány navzájem. Zdá se, že neexistuje jediná nejlepší (tzv. objektivní) metoda popisu a klasifikace vegetace.

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Süsswasserflora von Mitteleuropa 1
VEB Gustav Fischer Verlag, Jena 1985, 515 str., 1051 obr., cena váz. 115,— M. (Kniha je v knihovně ČSBS.)

Kniha Karola Starmacha, nestora polských algologů, je dalším svazkem čile doplňované řady určovacích klíčů, usnadňujících studium sladkovodních rostlin, především řas. Svou spíše klasickou koncepcí i obsahem navazuje na zpracování této skupiny, vydané jako 5. díl řady Flora słodkowodna Polski (1980). Jejím editorem i autorem citovaného svazku je rovněž profesor Starmach. Třída *Chrysophyceae* patří k několika řasovým skupinám, jejíž pojetí značně ovlivnily metody elektronové mikroskopie. Jednou z nejvýraznějších změn bylo ustavení nové třídy *Haptophyceae* CHRISTENSEN 1962, která je v recenzovaném svazku poprvé zpracována. Rody *Synura*, *Mallomonas* a další se již nedají určovat bez elektronmikroskopického vyšetření struktury křemitých šupin, pokrývajících jejich buňky. Metodu zavedl profesor Fott koncem padesátých let, dosud však žádná určovací pomůcka neobsahuje pokyn, jak preparát pro elektronovou mikroskopii připravit. V recenzovaném klíči je submikroskopická struktura šupin překreslována z elektronmikroskopických snímků jednoduchou pérovkou. Myslím, že taková kresba neposkytuje dostatečnou informaci o jejich stavbě. Taxonomii obtížně určitelných rodů *Chromulina* a *Ochromonas* výrazně ovlivňují poznatky o struktuře periplastu, jehož častou součástí jsou vymrštitelná tělíska, pozorovatelná po obarvení i ve světelném mikroskopu (gleosomy, diskobolocysty). Tyto struktury jsou stručně popsány v obecné části, ale v popisech rodů a druhů o nich není zmínky. Je pochopitelné, že mnohé zlativky jsou obtížně dostupné pro taxonomickou revizi pro jejich efemérní výskyt. Přesto by text měl obsahovat nové poznatky o starých taxonech, o jejich ekologii a podrobněji informovat čtenáře, které druhy bývají nalézány často a které se již staly mrtvými dušemi určovací literatury. Domnívám se, že snaha o formální zachycení co největšího počtu často špatně definovaných taxonů potlačuje originalitu přístupu a vlastní přínos autora, tj. ty přednosti, které oceňujeme ve floristicko-taxonomických dílech Paschera, Koršikova a Skuji.

T. Kalina