COMPARISON OF THE VEGETATION AND FLORA OF THE WEST BOHEMIAN VILLAGES AND TOWNS

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1. Introduction

West Bohemian ruderal floras have been studied extensively during the seventies (Pyšek, 1981; Pyšek and Pyšek, 1988a, b). This study aims to compare floras of villages and towns in the region and to demonstrate how environmental differences are reflected by features of the floras.

2. Localities investigated

The data on village floras were obtained from 59 settlements; their location as well as geobotanical and phyto-geographical characterization were presented by Pyšek (1981). Elevation above sea level was between 250 and 950 m, mean annual temperature from 4,8 to 7,0° C, amount of annual precipitation from 525 to 1263 mm (50 years average). The group of villages investigated consists of larger urbanized ones as well as typical villages and small recreation settlements. This enabled vegetation of various rural habitats to be recorded throughout the region.

A small town is represented by Chomutov (44,000 inhabitants) which was researched in 1973–74. It is located in a moderately warm climatic district (mean annual temperature 7,6° C, amount of precipitation 497 mm) and lies 305–380 m above sea level.

Vegetation and flora of a large West Bohemian town is exemplified by Plzeň which lies at the confluence of four rivers, 306–395 m above sea level. Mean annual temperature is 7,8° C, annual precipitation is 495 mm. During the research period (1967–74), the town had 171,000 inhabitants and covered an area of 125 km^2 (Pyšek, 1978). For both Chomutov and Plzeň, reconstructed natural vegetation units are the Alno-Padion along the rivers, Quercion robori-petraeae and Carpinion betuli.

3. Methods

Vegetation was studied using the methods of the Zürich-Montpellier school (Mueller-Dombois and Ellenberg, 1974). The nomenclature of syntaxa as well as the structure of the phytosociological system follow Hejný *et al.* (1979) and Moravec *et al.* (1983). The percentage proportions of the syntaxa were estimated from unit areas: this consisted of field estimation on 10 m^2 areas covered by a known community and later summation of these unit areas for each community under study (Pyšek and Pyšek, 1987). The vegetation diversity was expressed using Shannon formula

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(Peet, 1974); the importance values used for calculation were percentage portions of particular communities.

Composition of the vegetation cover of 8 selected villages was recorded once again in 1985. The comparison with the situation from 1971 made it possible to evaluate changes within the village ruderal vegetation during the last 15 years (Pyšek and Pyšek, 1987b).

Comparison of flora was based on the floristic lists of all the taxa recorded in villages and Plzeň, respectively. Spectra of life forms and classification of aliens were made on the basis of data from Ellenberg (1979) and Oberdorfer (1983).

4. Results and discussion

4.1 Habitat differentiation

The specifity of the village ruderal vegetation and its distinctiveness from that of the towns may be explained by following main reasons:
a) private keeping of domestic animals, especially poultry and waterfowls;
b) habitats related to agricultural production, *e.g.* dung-hills, dung-water pits, soils enriched by liquid nitrogen-rich wastes;
c) moist habitats, especially along the waterside of brooks and village-green ponds, moist ditches, bottoms of drained ponds and pools, etc.;
d) contact with the surrounding seminatural vegetation at the periphery of settlements.

Urban habitats of Plzeň may be classified as follows (Pyšek, 1978):
1. trampled sites – the road surface is mostly asphalt or paved, the trampling pressure is much heavier in comparison with rural habitats of the same type;
2. verges of the roads, habitats along the walls and fences;
3. industrial sites – plants, factories, railway installations;
4. nutrient-poor habitats arising from building activities, *e.g.* ruins and heaps formed by inorganic materials;
5. nutrient-rich habitats, *e.g.* dumps, compost-heaps, sillage-deposits, waste gardens, etc.

In addition, there are differences between rural and urban environment involving air pollution and climate; for example 'Urban heat-islands', with characteristic lower radiation, higher temperature, cloudiness and precipitation (Sukopp and Werner, 1983).

4.2 Comparison of the vegetation

Communities occurring more frequently in the villages than in urban habitats (Table 1) develop in response to the specific factors mentioned in the previous section, and include the effects of poultry (Urtico-Malvetum neglectae), waterfowls (Potentilletum anserinae), moisture (Bidentetum tripartiti) or the presence of verge habitats at the periphery of villages (Agropyro repentis-Aegopodietum podagrariae, Chaerophylletum aurei). The communities recorded only in the villages are as follows: Alliario-Chaerophylletum temuli, Coronopodo-Polygonetum avicularis, Imperato-

rietum ostruthii, Rumici-Agropyretum repentis, Sisymbrietum sophiae. Similarly, the great portion of 'urban communities' in the vegetation of Plzeň can be explained by the effect of environments typical of urban agglomerations. This holds for building activity (communities with *Chenopodium* sp. div, Atriplicetum nitentis, Sisymbrietum loeselii), industrial pollution and flue-dust substrates (community of *Calamagrostis epigejos*, Agropyretum repentis, Hordeo murini-Brometum sterilis) and extensive areas temporarily abandoned where spontaneous succession occurs (Tanaceto-Artemisietum vulgaris, community of *Arrhenatherum elatius*). Agropyretum repentis, Sisymbrietum loeselii, Erigeronto-Lactucetum, Sisymbrio-Atriplicetum oblongifoliae, Onopordetum acanthii and the stands with prevailing species *Calamagrostis epigejos, Puccinellia distans, Solidago canadensis, Arrhenatherum elatius, Digitaria sanguinalis* represent communities recorded exclusively in the towns.

Obviously higher vegetation diversity was found in towns. The value of the Shannon index reached H' = 4,50 for Plzeň and H' = 3,79 for Chomutov. In contrast, the average value for villages was only H' = 2,71 (maximum 3,57). This is due to greater heterogeneity of man-made habitats and higher intensity and diversity of disturbances in towns. Human activity is a decisive factor determining the features and the dynamics of ruderal vegetation.

Annual species are the most successful colonizers of new sites because of their reproductive capacity and ecological, morphological and genetic plasticity (Harper, 1977; Grime, 1979; Kowarik, 1985; etc.). This is in accordance with the high portion (27,0–28,7%) of the communities with predominantly annual species, mostly from the class Chenopodietea, in Plzeň and Chomutov (Table 2). R-strategists (Grime, 1979) are the most frequent group of species in such communities (Klotz, 1987). On the other hand, the predominant syntaxa of the rural vegetation are those belonging to the class Galio-Urticetea (42,5%). These communities are from the syngenetical viewpoint closely related to the natural and seminatural coenoses (Kopecký, 1984).

Changes in the composition of village ruderal vegetation during 15 years (from 1971 to 1985) are presented in Table 1. Profound changes in the character of rural settlements appeared in this period due to urbanization, increase of the building activity, modernization of agriculture, reclamation of the ruderal habitats for aesthetic reasons as well as abandonment of private keeping domestic animals (Pyšek, 1983; Mucina, 1988). These activities resulted in the rapid disappearence of habitats suitable for typical village communities some of which became endangered (Brandes, 1981; Pyšek, 1983; Mucina, 1988). Increasing similarity between the rural and urban ruderal vegetation is demonstrated in Table 1. Most of the communities typical of the villages (a) have retreated, while the syntaxa characteristic of the urban environment have without exception increased (b).

Vegetation diversity decreased from H' = 2,68 in 1971 to H' = 2,41 in 1985 (Pyšek and Pyšek, 1987a, b), which indicates that the village ruderal vegetation is becoming progressively more uniform (Brandes, 1981; Pyšek, 1983; Sukopp, 1983; Wittig, 1984; for review see Mucina, 1988). Characteristic village communities, developed mostly in small scale habitats, have retreated in favour of stands formed by species with wide ecological amplitudes. The rural vegetation becomes therefore either impoverished or the stands are removed completely. In terms of the composition of vegetation cover, village vegetation is now more similar to that of the town than in

Table 1. Composition of the vegetation cover of the investigated localities. Data represent % proportion on the vegetation of the locality calculated from the number of unit areas. Rare communities were omitted. Data presented in the last column express the increase (+) or retreat (−) in the villages during 1971–85 (1971 = 100%).

	Villages	Chomutov	Plzeň	Dynamics 1971–85
a) communities concentrated in rural habitats:				
Bidentetum tripartiti	5,7	–	1,1	− 62,2
Urtico-Malvetum neglectae	5,2	0,1	1,7	− 70,9
Balloto-Chenopodietum	6,2	0,1	1,6	+ 22,2
Agropyro-Aegopodietum	25,7	5,4	6,8	− 8,4
Chaerophylletum aurei	2,1	–	0,1	− 86,7
Chenopodio-Rumicetum	2,7	0,1	–	+ 75,0
Potentilletum anserinae	10,1	0,1	1,9	− 26,4
Lolio-Plantaginetum majoris	21,5	9,0	10,0	+ 51,1
b) communities concentrated in urban habitats:				
Hordeo murini-Brometum sterilis	0,4	7,6	2,5	
Chenopodietum ruderale (Chenopodietum stricti, Chenopodietum albi-viridis)	1,8	2,9	9,6	+ 26,6
Atriplicetum nitentis	0,2	5,7	3,3	+ 75,0
Echio-Melilotetum	0,1	7,1	2,4	
Tanaceto-Artemisietum vulgaris	4,9	10,6	9,8	+ 293,5
Agropyretum repentis	0,6	6,6	3,8	+ 150,0
Calamagrostis epigejos community	–	8,7	6,0	
Sisymbrietum loeselii	0,2	6,3	3,3	
Erigeronto-Lactucetum	–	2,7	3,0	
Sambucus nigra community	0,2	–	4,6	
Arrhenatherum elatius community	–	–	5,1	
c) the other communities:				
Chenopodietum glauco-rubri	2,1	3,4	3,1	− 90,5
Poo-Tussilaginetum farfarae	3,1	4,6	4,0	− 34,6
Polygonetum avicularis	5,8	10,2	4,7	+ 41,8
total number of the unit areas recorded	8571	1423	6167	
number of the classified syntaxa	28	20	32	
vegetation diversity H′	2,71	3,79	4,50	

Table 2. Composition of the vegetation cover: proportion of the classes of the phytosociological system (in %, calculation based on the number of unit areas).

	villages	Chomutov	Plzeň
Bidentetea	5,7	–	1,1
Chenopodietea	9,9	28,7	27,0
Artemisietea	0,6	7,2	2,5
Galio – Urticetea	42,5	16,2	11,8
Agropyretea	3,7	28,6	14,8
Plantaginetea	37,7	19,3	24,2
Epilobietea	0,2	–	6,1
Molinio – Arrhenatheretea	–	–	5,1

the beginning of the seventies. However, the species diversity has decreased slightly because of the lack of habitats suitable for the development of spontaneous vegetation.

4.3 Comparison of the flora

Common species of the ruderal flora which are more or less obviously concentrated in either rural or urban coenoses are presented in Table 3. Species were quantified according to the constancy classes reached in the relevé material of the most frequent communities. It is interesting, that even in the very common species with wide coenological amplitude some differentiation was observed: *Urtica dioica* occurs more in the village stands, *Artemisia vulgaris*, *Agropyron repens* and *Cirsium arvense* represent the opposite case.

The floristic analysis is presented in Table 4. Total number of species found in the rural habitats is higher than in Plzeň. Village flora used to be enriched by the species penetrating from the surrounding landscape (especially those from moist, xerotherm or forest habitats). Moreover, the number of the localities investigated (59) contributes to the high total number of species. However, if the mean number of species per village is taken into account, the flora of Plzeň comprises many more species. Factors that are responsible for the enhancement of both vegetation and floristic diversity in towns are essentially the same. The total number of species recorded in the West Bohemian ruderal flora is 723.

It has been shown that the number of aliens, especially neophytes, depends upon the human pressure (Sudnik-Wójcikowska, 1988). According to Polish authors (Faliński, 1971; Kornaś, 1978), proportion of aliens may be assumed as one of the criteria differentiating urban and rural floras and this is confirmed here by the results obtained from the West Bohemian material – increase of the percentage of aliens in Plzeň is documented in Table 4. Concerning the spectrum of life forms, the higher proportion of therophytes in urban habitats was observed.

5. Concluding remarks

Comparison of the flora and vegetation of West Bohemian rural and urban habitats leads to following conclusions:

1. There are differences in the composition of ruderal flora between the village settlements and towns. Preference of one or another habitat type was observed in most of the communities investigated. Enhancement of the vegetation diversity in towns, in comparison with villages, is illustrated by quantitative data on the percentage proportion of particular communities.
2. Concerning the community structure and species composition, no clear differences have been found between the rural and urban coenoses. Comparison of mean number of species per relevé (Table 3) as well as the use of indicator values according to Ellenberg (1979) discovered only small distinctions within the relevé material. However, it was found that some common ruderal species with wide coenological amplitude occur more frequently in one or another habitat type.

Table 3. Species concentrated in either rural or urban coenoses. Numbers represent the constancy classes obtained from relevé material. Only the communities with sufficient number of relevés were included.

	villages												Plzeň												sum of constancy classes	
	Bidentetum trip.	Chenopodietum glauco-rubri	Urtico-Malvetum	Chenop. ruderale	Balloto-Chenopodietum	Tanaceto-Artemis.	Agropyro-Aegopodietum	Agropyretum repentis	Poo-Tussilaginetum	Potentilletum anser.	Lolio-Plantaginetum	Polygonetum avicul.	Bidentetum trip.	Chenopodietum glauco-rubri	Urtico-Malvetum	Chenop. ruderale	Balloto-Chenopodietum	Tanaceto-Artemis.	Agropyro-Aegopodietum	Agropyretum repentis	Poo-Tussilaginetum	Potentilletum anser.	Lolio-Plantaginetum	Polygonetum avicul.	villages	Plzeň
number of relevés	53	36	63	15	44	39	92	7	41	48	92	59	8	28	9	82	16	128	41	32	31	14	72	29		
mean species number per relevé	11	8	9	13	12	15	14	8	9	9	7	6	10	9	8	12	12	12	13	9	10	8	7	9		
a) species concentrated in rural habitats:																										
Aegopodium podagraria	I	.	.	I	I	I	V	.	I	.	.	.	.	.	.	.	II	I	IV	.	.	.	.	.	10	6
Anthriscus sylvestris	I	.	I	I	III	III	IV	I	I	II	I	.	I	.	.	.	III	I	III	.	.	I	.	.	18	9
Ballota nigra	.	I	I	I	V	II	I	I	.	I	.	I	.	.	I	I	V	II	II	.	.	.	.	.	14	11
Chamomilla suaveolens	I	II	III	I	I	I	I	.	I	II	IV	III	I	I	.	I	I	.	.	.	I	I	III	II	20	11
Chenopodium bonus-henricus	.	I	.	.	V	I	I	I	.	I	.	I	.	.	I	.	III	.	I	.	.	I	.	.	11	6
Geum urbanum	I	.	I	.	II	I	I	.	.	I	.	I	.	.	.	.	I	I	I	I	.	I	.	.	8	5
Lamium album	.	.	I	I	III	I	II	I	.	II	I	I	.	.	I	.	III	.	II	.	.	I	.	.	13	7
Malva neglecta	.	I	V	.	II	I	I	.	.	I	I	I	.	I	V	I	I	.	.	.	.	.	.	.	13	8
Urtica dioica	II	I	I	I	IV	IV	V	II	III	II	I	.	II	I	.	I	III	III	V	I	.	I	I	.	26	18
Urtica urens	.	I	IV	I	I	I	I	.	.	I	.	.	.	.	IV	I	.	.	.	.	.	.	.	.	10	5
b) species concentrated in urban habitats:																										
Agropyron repens	I	I	I	III	I	IV	V	V	III	I	I	I	II	I	II	II	III	V	V	V	III	II	II	I	27	33
Artemisia vulgaris	I	I	I	II	IV	V	III	III	III	I	I	I	III	III	.	IV	IV	V	V	V	V	III	II	II	26	41
Arctium lappa	.	.	.	.	I	I	I	.	.	.	.	.	.	.	.	I	II	II	II	.	I	I	.	.	3	9
Arctium minus	.	.	I	.	I	II	I	.	I	.	.	.	.	I	.	I	II	II	II	I	I	I	.	.	6	12
Calamagrostis epigejos	.	.	.	.	.	.	I	I	I	.	.	.	.	I	.	I	II	II	II	I	I	I	I	.	3	12
Cirsium arvense	I	.	I	I	I	IV	II	.	II	I	.	I	.	I	.	I	II	V	II	III	III	I	I	I	14	20
Conyza canadensis	.	.	.	.	I	.	.	.	.	.	.	I	.	I	.	I	I	I	.	.	I	.	I	I	2	7
Galinsoga parviflora	.	I	I	.	.	I	.	.	.	.	.	.	.	I	.	III	I	I	I	.	I	.	I	I	3	10
Hordeum murinum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	I	I	.	.	.	.	I	I	0	5
Lepidium ruderale	.	I	I	.	.	.	.	.	.	.	I	I	.	II	III	I	.	I	.	.	I	.	II	II	4	12
Sisymbrium officinale	.	I	I	I	I	.	I	.	I	I	I	I	.	I	II	II	II	I	I	I	I	II	I	I	9	15

Table 4. Comparison of the flora of villages and Plzeň (data in %, calculated from the number of species).

	villages	Plzeň
total number of species	623	530
mean number of species per village	198	
therophytes	22,8	28,5
hemicryptophytes	48,5	53,9
chamaephytes	5,4	4,0
geophytes	8,3	6,8
phanerophytes	12,4	6,8
apophytes (natives)	62,5	56,4
anthropophytes (aliens)	37,5	43,6
a) archeophytes	12,4	14,5
b) neophytes	16,9	20,6
c) ephemerophytes and ergasiophygophytes	8,2	8,5

3. Evidence of the disappearence of typical village ruderal communities and decrease of the vegetation during the period of last two decades has been found.
4. Flora of Plzeň comprises higher proportion of therophytes and aliens than flora of the village settlements. The town is richer in species than particular villages but the total number of species recorded at all the rural localities investigated exceeds the number of species found in Plzeň.

The relationships and trends found in some European towns (Kunick, 1974; Sudnik-Wójcikwska, 1988; Pyšek, 1989 and others) are in good accordance with our results, despite of differences in geographical and natural conditions. It may be expected that conclusions drawn from the West Bohemian data hold for the Central Europe in general.

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