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FLORIAN ŚWIĘS

Expansion of *Puccinellia distans* (Jacq.) Parl. in the city of Rzeszów

Ekspansja *Puccinellia distans* (Jacq.) Parl. na terenie miasta Rzeszowa

INTRODUCTION

Puccinellia distans occurs primarily in natural or derivative highly salt-affected habitats (40). It represents a group of species belonging to the broadly interpreted Euro-Siberian element (2, 4, 6, 23). In natural stations it is found almost in the whole of Europe, in the west-central-northern part of Asia and on the northwestern margin of Africa. However, as a brought-in plant in derivative salt-affected habitats, it spreads in the vast areas of Europe, Asia and North America.

In Poland, natural stations of *Puccinellia distans* occur in salt-affected Baltic areas and in the vicinity of inland salt-springs (6). In this country, first brought-in stations of *Puccinellia distans* in derivative salt-affected habitats have been known since the early 19th century (6, 15). Intensive expansion of the plant in anthropogenic domestic habitats took place as late as on the turn of the 1970s. This was caused mainly by the increasing degree of salinity and pollution of the substratum due to the more and more extensive use of salt for removing snow in towns, chiefly in the streets and squares. Currently, brought-in stations of *Puccinellia distans* occur in varying numbers almost in all regions of the country, except higher mountain areas (6, 15, 24).

THE SCOPE AND METHODS OF INVESTIGATION

This study describes the current state of *Puccinellia distans* occurrence in the city of Rzeszów. It has taken account of the history of expansion of the plant and the occurrence in plant communities and outside them.

Studies on *Puccinellia distans* occurrence in the area of Rzeszów were conducted during the vegetation season in 1996 and 1997. The earlier published and newly discovered stations of this plant in Rzeszów are localized in Figure 1.

Phytosociological studies on plant communities with *Puccinellia distans* were carried out in accordance with the accepted methods of phytosociological investigation (20). The studies were documented with 35 phytosociological records (Table 2-3, Fig. 1). The syntaxonomic structure of the investigated communities with *Puccinellia distans* was given mainly after Matuszkiewicz (13), Rivez-Martin (21) and Jackowiak (6), less often after Oberdorfer (180 and the author's own discretion (23, 24). The nomenclature of bryophyte and pteridophyte species, and flower plants was given after Kopponen et al. (10) and Mirek et al. (16).

In September 1997, nine soils samples were taken from major stations of phytosociological records of communities with *Puccinellia distans*. The soils were taken from the surface layer of the substratum with the highest degree of *Puccinellia distans* rooting. In the Provincial Chemical--Agricultural Station in Lublin, the following parameters were determined in the soil samples collected, according to specific methods of investigation: pH (using N-512 pH-meter), the contents of P_2O_5 and K_2O (with the Egner and Rhiem method), Ca, Cl and N-NO_3 (with the potentiometer method), Mg (with the photometric method) and general salinity (with the conductometric method).

In Poland similar studies like the present one on *Puccinellia distans* occurrence within town limits have been conducted before in Kraków (15), Poznań (50, Lublin (25) and Tarnów (26).

THE NATURAL ENVIRONMENT OF RZESZÓW

Basic information on the natural environment of the city of Rzeszów is to be found in studies 8, 11, 14, 22, and 26. This provincial capital is regarded as the largest in southeastern Poland within the Podkarpackie province (11, 26). It covers the area of 53.7 sq. km and has a population of 161, 300. It is relatively well industrialized and situated on the intersection of important commercial and railway routes. Rzeszów has been built in the wide valley of the Wisłok river. Within the city, this river has sparse dead arms and several tributaries in the forms of streams and torrents. At the southeastern city limit, a 120-ha storage reservoir was built on the Wisłok river in 1972. The city of Rzeszów is surrounded on all sides by ploughland with scattered groves and forest complexes of varying size. In the city itself worth noting are numerous city parks as well as cemeteries and allotment gardens planted with trees to a varying degree. On the Wisłok river channel there are scattered extant clusters of shrubs and riverside forests.

The climate in the area of Rzeszów is clearly transitional between the lowland-submontane and mountain climate types 14, 19, 26). Vegetation lasts ca 112 days. Snow remains for 62 days. Polar-maritime (62.2%) and polar--continental (31.2%) air-masses definitely dominate over arctic (2.9%) and tropical-continental (0.3%) air-masses. The average annual air temperature is

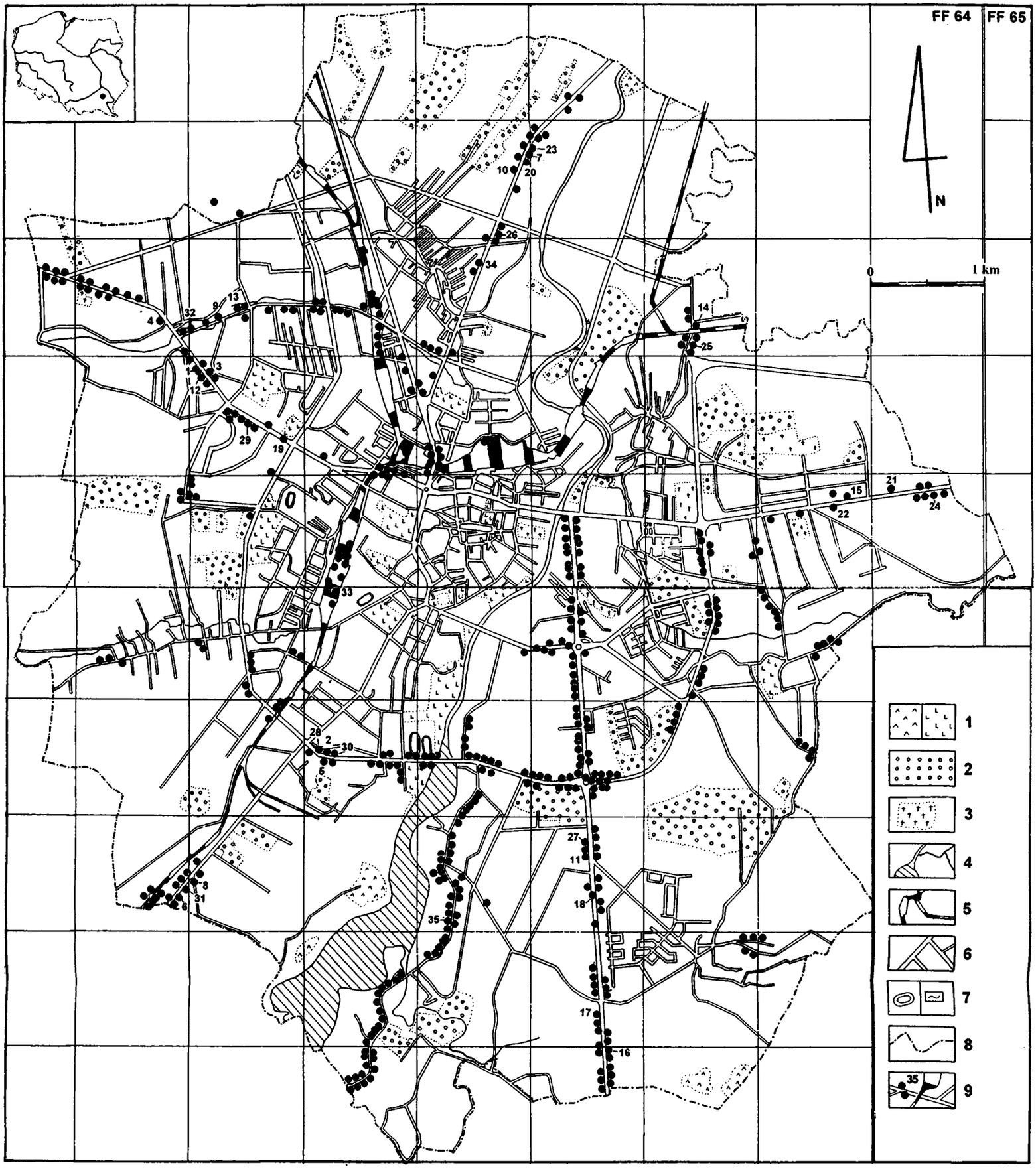

Fig. 1. Map of the occurrence of *Puccinellia distans* in the city of Rzeszów. Condition in years 1983-1997; 1 – forests, city park, 2 – allotment garden, 3 – cemeteries, 4 – river netwerk, ponds, reservoir lake on the Wisłok river, 5 – railway areas: trackage, railway station, 6 – highways, 7 – sport stadions and swimming pools, 8 – city limits, 9 – station of *Puccinellia distans* in phytosociological records (nos 1-35) and outside (unnumbered). NB. The map was superimposed on the ATPOL square no FF64 and FF65

Table 1. Some chemical properties of soils in Rzeszów area among ruderal comminities with *Puccinellia distans* (Tables 2-3)

Number of sample of soil	Depth	Number of		pH in		Content in mg/l							
		community	records	H_2O/dest.	1 n KCl	$N\text{-}NO_3$	P_2O_5	K_2O	Ca	Mg	Na	Cl	solinity of g KCl/l
1	5-20	1.1.	2	7,2	6,7	35,9	46	78	5060	220	1520	1646	2,7
2	5-20	1.2.	3	7,4	6,8	39,8	34	72	4990	165	2000	1449	2,1
3	5-20	2.1.	5	7,3	6,7	32,7	23	78	6000	225	1100	1148	1,9
4	5-20	2.1.	8	7,6	6,8	46,6	69	192	3900	220	700	1303	2,04
5	5-20	2.2.	9	7,3	7,0	6,5	34	60	3400	115	120	1360	0,09
6	5-15	2.2.	11	7,4	7,4	9,5	230	96	4850	115	700	1811	0,9
7	5-20	3.1.	18	7,4	7,1	8,1	161	48	4800	95	120	1190	0,09
8	5-20	3.2.1.	27	7,5	6,6	40,4	253	108	4990	145	3000	2889	4,5
9	5-20	3.2.2.	28	7,4	6,7	33,5	46	78	5060	125	1500	570	3,3

7.6°C, the average annual precipitation being 513 mm. The highest average precipitation falls on August (ca 90 mm) and the lowest on January (ca 28 mm). The warmest period of the year is in August (ca 18°C), the coldest in January and February (ca – 5°C).

Rzeszów is situated in the borderland region of the Sandomierz Basin and the step of Carpathian Foothills, in the area called the sub-Carpathian Channel (7) or Rzeszów Foothills (9). The central part of town extends on the vast terraces of the Wisłok river valley at 200-215 m above sea level. To the south and east, the city of Rzeszów is surrounded by hilly heights of 240-280 m above sea level, which respectively belong to Carpathian Foothills and High Plains of the Sandomierz Basin.

In the region of Rzeszów the oldest substratum is made up of various forms of Cretaceous and Older Tertiary rock (3, 7, 12). The Quaternary cover in this area is highly varied (7, 12, 26). On the surface of the wide valley of the Wisłok river, Pleistocene alluvial soils dominate, formed out of interbeddings of sands, gravels, loam and dust. The areas situated somewhat higher are spatially dominated by postglacial boulder clay with a gravel interbedding and sands arising from water-glacier accumulation. On the outskirts of Rzeszów, at the foot area of the surrounding heights there is widespread waste clay. Among those forms of Quaternary covers, there are often scattered larger or smaller expanses of typical loess or loess-like clay with a different degree of sand content and deliming.

On the surface of the described Quaternary formations basically two natural soil types dominate: alluvial soils (sandy-dusty, humous-loamy or sandy--gravely) or brown soils (dusty, clayey or loess). By nature they are soils moistened to a varying degree, deficient in potassium and calcium compounds and fairly rich in phosphorus compounds. In the investigated area there are at times podzolic, boggy and peat soils.

The natural soils in Rzeszów are artificially changed to a different extent in respect of their physical and chemical properties (26). They are strongest deformed in the densest built-up areas and along the full length of transport routes.

THE PHYTOSOCIOLOGICAL AND ECOLOGICAL DESCRIPTION OF PHYTOCENOSES WITH *PUCCINELLIA DISTANS*

Specification of phytocenoses

In the earlier published (26) phytosociological and ecological profile of synanthropic communities in the city of Rzeszów, twenty seven associations and seven communities of ruderal plants and two groups of complex communities of segetal plants were distinguished on the basis of 247 phytosociological records.

In this case the presence of *Puccinellia distans* was recorded only in two single phytosociological records belonging to separate associations defined at that time as (25): *Lolio-Plantaginetum* in a facies with *Trifolium repens* (table 2, record 22) and *Puccinellietum distantis* in a variant with *Puccinellia distans* (Table 2, record 25). According to their latest phytosociological taxonomy (6, 21) the earlier described phytocenoses (26) should be treated as follows:

– association *Lolio-Plantaginetum* in a facies with *Trifolium repens*, as a sub-association *L.-P. typicum* in a facies with *Trifolium repens* and *Puccinellia distans*,

– association *Puccinellietosum distantis*, in a variant with *Puccinellia distans* as a sub-association *Polygono-Matricarietum discoideae puccinellietosum* in a variant with *Puccinellia distans*.

The complementary investigations carried out on the stations of *Puccinellia distans* in Rzeszów demonstrate that this plant species occurs in the area of Rzeszów in different numbers in the following phytocenoses:

Class: *Molinio-Arrhenatheretea* Tx (1937) 1970
Order: *Trifolio fragiferi-Agrostietalia* (Oberd.1967) Tx. 1970
Alliance: *Agropyro-Rumicion crispi* Nordh. 1940
1. Association: *Potentilletum anserinae* Rapaics. 1927,
1.1. sub-association: *P. a. typicum* Święs 1992.
variant: with *Potentilla anserina*
1.2. sub-association: *P. a. puccinellietosum* Jackowiak 1984
variant: with *Puccinellia distans*.

Class: *Polygono-Poëtea annuae* Riv.-Mart. 1975
Order: *Polygono-Poëtalia annuae* Tx. 1972
Alliance: *Matricario-Polygonion avicularis* (Br.-Bl. 1931) Riv.-Mart. 1975
2. Association: *Lolio-Plantaginetum* (Beg. 1930) Siss. 1969,
2.1. sub-association: *L.-P. typicum* Święs 1992,
variant: with *Puccinellia distans*,
2.2. sub-association: *L.-P. puccinellietosum* Tx. 1970,
variant: with *Puccinellia distans*.
3. Association: *Polygono-Matricarietum discoideae* (Siss. 169) Tx. 1972,
3.1. sub-association: *P.-M. d. typicum* Święs 1992,
variant: with *Polygonum aviculare*,
3.2. sub-association: *P.-M. d. puccinellietosum* Gütte (1960) 1972,
variant: with *Polygonum aviculare*,
3.2.1. facies: with *Polygonum aviculare*,
3.2.2. facies: with *Puccinellia distans*,
3.2.3. facies: with *Bryum argenteum*.

THE SURVEY OF PHYTOCENOSES

1. *Potentilletum anserinae* (Table 2, rec.1-3)

In this association, on account of the ratio of quantitative co-participation of *Potentilla anserina* and *Puccinellia distans*, two sub-associations were distinguished, with single variants. These are phytocenoses with a highly simplified species composition:

1.1. *P.a. typicum* (Table 2, rec. 1, 2)

Floristically, the sub-association is characterized by the numerical domination of *Potentilla anserina* over *Puccinellia distans*.

1.2. *P.a. puccinellietosum* in a variant with *Puccinellia distans* (Table 2, rec. 33)

Floristically, this sub-association and variant are characterized only by the considerable numerical domination of *Puccinellia distans* over *Potentilla anserina*.

Both sub-associations formed in single specific variants occur on the similar types of substratum, minimally differing for their chemical properties (Table 1, profile 1, 2). These phytocenoses were recorded exclusively on the fringes of turf area of roads with a beaten, loamy-sandy surface with a small amount of gravel.

Phytosociological records: 1. In Krakowska St., the fringe of the turf area of the road with a flat, highly beaten, sandy-loamy surface with a negligible amount of gravel. 2. In Powstańców Warszawy St., the site and the substratum as in record 1. 3. In Krakowska St., the site and the substratum as in rec. 1, 2.

2. *Lolio-Plantaginetum* (Table 2, rec. 4-13)

This form of the association is formed in two sub-associations, each having one variant. Floristically, these phytocenoses are basically characterized only by a specific ratio of the percentage of two species: *Plantago major* and *Puccinellia distans*. Out of other plant species, only *Polygonum aviculare* and *Trifolium repens* occur comparatively most frequently and in greatest numbers.

2.1. *L.-P. typicum* in a variant with *Puccinellia distans* (Table 2, rec. 4-8)

Floristically, this association is characterized by a definite quantitative domination of *Plantago major* over *Puccinellia distans* and *Polygonum aviculare*.

Table 2. 1 – association *Potentilletum anserinae*, 1.1 – sub-association *P. a. typicum* in variants with *Potentilla anserina*, 1.2 – sub-association *P. a. puccinellietosum* in variants with *Puccinellia distans*. 2 – association *Lolio-Plantaginetum*, 2.1 – sub-association *L.-P. typicum* in variants with *Plantago major*, 2.2 – sub-association *L.-P. puccinellietosum* in variants with *Puccinellia distans*. x – syntaxonomic group only with sporadic species, listed at the bottom

Number of community		1.		2.									1.1.	1.2.	2.1.	2.2.
		1.	2.	1.					2.							
Number of record		1	2	3	4	5	6	7	8	9	10	11	12	13	Frequency	
Date		96-08-25	96-08-25	96-08-24	96-08-23	96-08-13	96-08-15	96-08-25	96-08-25	96-08-24	96-08-24	96-08-24	96-08-25	96-08-12		
Area of plot in	m^2	6	6	3	3	3	4	2	2	6	5	5	12	4		
Cover the layer in %	C	100	100	90	100	90	100	80	90	80	100	100	90	90		
	D	.	.	.	.	.	.	.	+	.	.	.	.	.		
Number of species in record		10	9	7	9	6	12	10	10	14	8	6	13	6		
I. Ch: a - Isoëto-Nanojuncetea, b - Bidentetea tripartiti (x)																
a Plantago intermedia		.	.	.	.	.	r	.	.	+	.	.	.	.	.	1	1
II. Ch: a - Molinio-Arrhenatheretea, b - Trifolio fragiferi-Agrostietalia, Agropyro-Rumicion crispi, c - Plantaginetalia majoris, Lolio-Plantaginion																
a Achillea millefolium		+	.	.	+	.	1	.	.	+	+	.	.	.	1	.	2	2
a Leontodon autumnalis		+	+	+	+	.	.	.	.	.	.	.	+	.	2	1	1	1
a Trifolium repens		+	+	.	.	.	+	.	.	+	+	+	+	.	2	.	1	4
a Taraxacum officinale		.	+	.	+	+	r	+	.	.	.	+	+	+	1	.	4	3
a Trifolium pratense		.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	1	1
b Potentilla anserina		5	5	3	.	.	.	+	.	.	.	.	.	.	2	1	1	.
c Plantago major		1	+	1	3	5	5	4	4	3	3	3	2	+	2	1	5	5
c Lolium perenne		.	.	.	2	+	r	.	.	.	.	.	.	+	.	.	3	1
c Chamomilla suaveolens		.	.	.	.	.	.	+	+	+	.	.	+	.	.	.	2	2
III. Ch: a - Polygono-Poëtea annuae, b - Puccinellion maritimae																
a Polygonum aviculare		1	1	+	2	1	2	+	1	1	1	2	+	+	2	1	5	5
b Puccinellia distans		+	2	4	+	1	3	3	2	4	4	4	5	5	2	1	5	5
IV. Ch: a - Secalietea (x), b - Chenopodietea, c - Artemisietea																
b Setaria viridis		.	.	.	r	.	.	+	.	+	.	.	.	.	.	.	2	1
b Echinochloa crus-galli ...		.	.	.	.	+	+	+	.	.	+	.	+	+	.	.	3	3
c Artemisia vulgaris		r	.	.	.	.	.	.	.	+	.	.	.	.	1	.	.	1
c Cichorium intybus		.	.	.	.	.	r	.	+	.	.	.	.	.	.	.	2	.
c Pastinaca sativa		.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	1	1
V. Others																
Medicago lupulina		+	.	.	.	.	.	.	.	+	.	.	.	.	1	.	.	1
Trifolium fragiferum		r	.	.	.	.	.	.	.	.	.	.	+	.	1	.	.	1
Agrostis capillaris		.	+	+	1	.	.	+	.	1	r	.	1	.	1	1	2	3
Conyza canadensis		.	.	+	.	.	.	.	.	.	.	.	+	.	.	1	.	1

Species occurring in 1 record:

Ib - Chenopodium rubrum 8/+. IIa - Holcus lanatus 9/r. IIb - Juncus compressus 2/+. IIc - Bryum argenteum 8/+. IIIa - Poa annua 6/+, Lepidium ruderale 8/1. IVa - Matricaria maritima subsp. inodora 10/+. IVb - Chenopodium album 8/+, Matricaria recutita 11/+. IVc - Tanacetum vulgare 9/r. V - Odontites serotina 6/+, Senecio vulgaris 12/+.

Table 3. 3 – association *Polygono-Matricarietum discoideae*, 3.1 – sub-association *P.-M. d. typicum* in variants with *Polygonum aviculare*, 3.2 – subassociation *P.-M. d. puccinellietosum* in variants with *Puccinellia distans* in facies: 3.2.1 – with *Polygonum aviculare*, 3.2.2 – with *Puccinellia distans*, 3.2.3 – with *Bryum argenteum*. x – as in Table 2

Number of community		1.						3.																			3.1.	3.2.
								2.																				
Number of record		14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	Frequency	Presence
Date		96-08-27	96-08-12	96-08-12	96-08-12	96-08-10	96-08-10	96-08-12	96-08-11	96-08-10	96-08-12	96-08-11	96-08-27	96-08-12	96-08-28	96-08-28	96-08-15	96-08-10	96-08-12	96-08-10	96-08-10	96-08-10	96-08-12		
Area of plot in	m^2	2	4	6	4	4	6	8	4	3	6	6	3	4	4	8	12	8	4	3	12	6	4		
Cover the layer in %	C	100	100	100	100	90	90	90	90	90	90	100	100	90	100	90	80	100	80	80	90	90	100		
	D	.	.	+	.	.	.	+	.	.	+	.	.	.	.	.	.	.	+	30	20	40	10		
Number of species in record		7	17	18	10	10	4	10	11	8	12	6	9	9	10	8	10	4	11	13	12	14	15		
I. Ch: Isoëto-Nanojuncetea																												
Plantago intermedia		.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	r	1	II
II. Ch: a - Molinio-Arrhenatheretea, b - Trifolio fragiferi-Agrostietalia, Agropyro--Rumicion crispi, c - Plantaginetalia majoris, Lolio-Plantaginion																												
a Trifolium repens		+	+	.	.	+	.	.	+	.	+	.	.	.	r	.	.	.	+	.	+	+	.	3	II
a Leontodon autumnalis		+	+	.	.	+	.	+	+	.	+	.	.	+	+	+	+	+	+	+	.	2	+	3	IV
a Taraxacum officinale		+	.	+	+	+	.	+	1	+	+	+	.	+	+	r	.	+	+	+	+	+	1	4	V
a Achillea millefolium		.	+	+	+	.	r	r	2	+	+	.	.	.	+	.	+	.	+	+	+	1	+	3	IV
a Plantago lanceolata		.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	r	+	+	.	r	1	II
b Potentilla anserina		1	r	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	2	I
b Chamomilla suaveolens		.	.	+	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
c Plantago major		.	+	1	1	.	.	+	1	r	1	+	+	+	1	+	+	.	.	1	1	1	.	3	V
c Lolium perenne		.	+	2	1	.	1	+	+	1	+	+	.	1	.	.	.	.	1	.	1	+	+	4	IV

	III. Ch: a - Polygono-Poëtea annuae, b - Puccinellion maritimae																														
a	Polygonum aviculare	5	5	5	5	4	3	3	3	3	3	2	+	1	2	+	+	1	1	r	2	+	2	6	V
a	Poa annua	.	.	+	r	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	2	I
a	Bryum argenteum	.	.	+	.	.	.	+	.	.	+	.	.	.	.	.	.	.	+	2	2	3	1	1	III
b	Puccinellia distans	+	2	1	1	2	2	4	5	5	4	5	5	4	5	5	5	5	4	5	3	3	3	6	V
	IV. Ch: a - Secalietea, b - Chenopodietea, c - Artemisietea																														
a	Matricaria maritima subsp. **inodora** ..	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
b	Atriplex patula	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
b	Sonchus asper	.	.	r	.	r	.	.	.	.	.	.	.	.	.	.	+	.	r	.	.	.	.	2	I
b	Chenopodium album	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	1	I
b	Echinochloa crus-galli	.	+	r	.	+	.	.	r	.	.	.	+	r	.	.	.	.	.	+	.	+	.	3	II
b	Lactuca serriola	.	.	.	.	.	.	.	.	.	.	.	r	.	.	+	.	.	.	.	.	.	.	.	I
c	Tanacetum vulgare	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	2	I
c	Pastinaca sativa	.	r	r	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	r	2	I
c	Artemisia vulgaris	.	.	+	r	.	.	r	+	.	.	.	+	.	.	.	.	.	r	.	.	+	r	2	II
c	Daucus carota	.	.	r	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	r	1	I
	V. Agropyretea repentis																														
	Agropyron repens	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	1	I
	VI. Others																														
	Medicago lupulina	.	.	.	.	+	.	.	.	.	.	.	.	+	.	+	.	.	+	1	.	.		1	II
	Conyza canadensis	.	.	.	.	.	.	r	.	+	.	.	.	.	.	.	.	.	.	+	+	.		.	II
	Agrostis capillaris	.	.	.	.	.	.	.	.	+	+	.	+	.	r	+	r	.	.	.	.	.		.	II
	Odontites serotina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	+	.	I

Species occurring in 1 record:

IIa - Deschampsia caespitosa 16/r, Dactylis glomerata 35/+. IIb - Rumex crispus 15/r. IVb - Polygonum persicaria 15/r, Setaria viridis 32/r. IVc - Arctium lappa 15/r, Cichorium intybus 27/+, Melilotus officinalis 33/r. V - Carex hirta 23/+. VI - Inula britannica 14/+, Sinapis arvensis 32/r, Bryum microerytrocarpum 35/+.

2.2. *L.-P. puccinellietosum* in a variant with *Puccinellia distans* (Table 2, rec. 9-13)

As compared with the foregoing association, it is distinguished primarily by the far more distinct domination of *Puccinellia distans* over *Plantago major* and *Polygonum aviculare*.

The two sub-associations occur in similar habitats, mainly on the fringes of the area of bigger roads or in the local roads with beaten, loamy-sandy or sandy-loamy surfaces, rich in gravel and melted blast-furnace slag lumps.

Phytosociological records: 4. In Krakowska St., on the substratum of the exit section of a driveway, with a highly beaten, gravel-sandy-loamy surface with a scant amount of blast furnace slag. 5. In Powstańców Warszawy Ave., the flat fringe of the road's turf area with a highly beaten, rutty, loamy-sandy surface with a negligible amount of gravel. 6. In Podkarpacka St., the crossing of driveways with highly beaten, rutty, loamy-sandy surface with a small amount of gravel. 7. In Lubelska St., the flat fringe of the road's turf area with a highly beaten, sandy-gravel surface with a small admixture of blast-furnace dust and slug rubble. 8. In Wetlińska St., on the driveway, the substratum as in record 5. 9. In Wyzwolenia Ave., the flat fringe of the road's turf area with a beaten, loamy surface with a large amount of gravel and blast furnace dust and slag rubble. 10. In Lubelska St., the flat fringe of the road's turf area with a beaten, sandy-loamy-gravel surface. 11. In Sikorskiego St., the flat fringe of the road's turf area with a beaten, sandy-loamy surface with a scant amount of gravel and blast furnace slag. 12. In Krakowska St., the site and the substratum as in rec. 11. 13. In Wyzwolenia Ave., the site and the substratum as in rec. 5.

3. *Polygono-Matricarietum discoideae* (Table 3, rec. 14-35)

The present form of association characterized by the presence of *Puccinellia distans* exhibits a comparatively high internal diversity in respect of floristic structure and also of habitat conditions, although only to a small degree. Two sub-associations were distinguished, formed in single variants, one of them in three facies.

Generally, this is a phytocenosis rich in species. The main dominant plant species in it, whether single or mixed, are *Polygonum aviculare* and *Puccinellia distans*. Other plant species that occur comparatively most frequently and sometimes in great numbers include: *Plantago major, Lolium perenne, Taraxacum officinale, Achillea millefolium* and *Bryum argenteum*.

3.1. *P.-M. discoideae typicum* (Table 3, rec. 14-19)

A sub-association formed in a typical variant. It is primarily distinguished for the definite quantitative domination of *Polygonum aviculare* over *Puccinellia distans* and the other plant species recorded in it.

3.2. *P.-M. discoideae puccinellietosum* (Table 3, rec. 20-35)

A sub-association formed in a variant with *Puccinellia distans*. On the basis of the ratio of the numerical domination of *Puccinellia distans* over the other plant species occurring in it, three facies were distinguished: with *Polygonum aviculare*, with *Puccinellia distans* and with *Bryum argenteum*.

The association *Polygono-Matricarietum discoideae* is found on similar habitats as is the association *Lolio-Plantaginetum*. Most often these are turf areas situated on the fringe of roads or on driveways with beaten surfaces with different amounts of sand, gravel and blast furnace slag dust. It should only be stressed that the association *Polygono-Matricarietum discoideae* occurs on the substratum with a somewhat more beaten surface than in the associations *Lolio-Plantaginetum* and *Potentilletum anserinae*.

Phytosociological records: 14. In Załęska St., over a ditch, the slightly convex turf fringe of the road with a low-beaten, sandy-loamy surface with a negligible amount of gravel. 15. In Lwowska St., a slightly concave site in the depression near the road with a sandy-loamy surface with a negligible amount gravel. 16. In Sikorskiego St., the flat fringe of the road's turf area with a beaten, sandy-loamy-gravel surface. 17. In Sikorskiego St., the site and the substratum as in record 16. 18. In the middle of Sikorskiego St., the turf fringe of the green strip, with a surface as in rec. 16. 19. In the middle of Krakowska St., the turf fringe of the green strip with a beaten, gravel-sandy-loamy surface. 20. In Lubelska St., the site and the substratum as in rec. 14. 21. In Lwowska St., the substratum of the exit section of a driveway with a low-beaten, rutty, sandy-loamy surface with a small admixture of gravel. 22. In Lwowska St., the fringe of the road's turf area with a surface as in rec. 19. 23. In Lubelska St., the site and the substratum as in rec. 20. 24. In Lwowska St., the site and the substratum as in rec. 20 and 23. 25. In Załęska St., the site and the substratum as in rec. 20, 23, 24. 26. In Lubelska St., the flat fringe of the road's turf area with a beaten, sandy-loamy-gravel surface. 27. In Sikorskiego St., the flat fringe of the road's turf area with a beaten, sandy-gravel surface with a large amount of blast furnace slag dust. 28. In Al. Powstańców Warszawy Ave., the flat fringe of the road's turf area with a beaten, sandy-loamy area. 29. In Krakowska St., the slightly concave site in a depression below the road, with a beaten, loamy-sandy-gravel surface. 30. In Dominikańska St., the site and the substratum as in rec. 28. 31.In Podkarpacka St., a slightly concave area below the road, on the driveway with a low-beaten, rutty, gravel-loamy-sandy surface. 32. In Al. Wyzwolenia Ave., the flat fringe of the road's turf area with a highly beaten, sandy-loamy surface with the blast furnace slag dust. 33. The Staroniwa railway station, the fringe of the reloading yard with a beaten, gravel-sandy surface. 34. In Lubelska St., the flat fringe of the road's turf area with a beaten, gravel-loamy-sandy surface. 35. In Kwiatkowskiego St., the flat fringe of the road's turf area with a beaten, sandy-gravel-loamy surface.

DISCUSSION OF RESULTS

In Rzeszów, *Puccinellia distans* as a brought-in species appeared probably as late as the turn of the 1970s. In the synanthropic phytocenoses studied earlier (1983-1985) in Rzeszów (26), the presence of *Puccinellia distans* was reported in as few as two phytosociological records: one of them represented the sub-

-association *Lolio-Plantaginetum* typicum in a facies with *Trifolium repens* and *Puccinellia distans*, the other – the sub-association *Polygono-Matricarietum discoideae puccinellietosum* in a variant with *Puccinellia distans*. As a result of supplementary studies, carried out in 1996/97) on *Puccinellia distans* occurrence in Rzeszów, it turned out that the species grows there comparatively often, scattered, as single specimens and in a mass. Currently, *Puccinellia distans* occurs in the city of Rzeszów both among dense and typical ruderal communities, and among grass communities with an indeterminate phytosociological rank. Frequently, it also grows in places with an underdeveloped plant cover. It turned out, however, that in Rzeszów the number of phytocenoses marked with the presence of *Puccinellia distans* is far smaller than it is the case with other towns, for example in Lublin or Tarnów (25, 27). Altogether, *Puccinellia distans* grows in Rzeszów in the expanses of as few as three associations, formed in six sub-associations and variants as well as four facies (Tables 2, 3). It should be emphasized at the same time that this saline-habitat plant exhibits in Rzeszów far greater expansion in the expanses of the association *Polygono-Matricarietum discoideae* than in the stations of the associations *Lolio-Plantaginetum* and *Potentilletum anserinae* (Tables 2, 3).

The growing expansion of *Puccinellia distans* within the city of Rzeszów, just like in other towns of the Carpathian Foothills region, is essentially connected with the progressive salinity of the turf road fringes, caused by the more and more widespread practice of removing snow from the streets by using salt (6, 15). One can say with a high degree of approximation that *Puccinellia distans* in Rzeszów occurred in the 1980s in a total of only 10-20 stations. This is evidenced by the earliest figures in literature for 1983-1985 (26) and the supplementary investigations of the stations of this plant in 1996 and 1997 (Fig. 1). Currently, *Puccinellia distans* occurs in Rzeszów far more often than in the 1980s. The number of stations of this species has successively grown every year. With time, in favourable habitats, more and more dense long-lasting turf phytocenoses (yet with fewer and fewer species) take root and are formed. The species spreads mainly in beaten, turf sites on the fringes of the busiest roads. It sporadically occurs on driveways leading from major roads towards densely developed housing estates. It also rarely occurs in the oldest city squares or railway stations. The almost total absence of this saline-habitat plant on railway tracks is worth noting. Far more commonly it grows in flat or slightly concave areas than in areas with a sloping surface. It is equally tolerant of intermittently highly over-desiccated or flooded habitats as is often the case on slightly concave turf areas situated on the fringes of roads. In Rzeszów, *Puccinellia distans* does not occur in habitats that are for example highly overshadowed, fertile or with a permanently moistened surface. It was not recorded at all in the communities with an abundant, dense plant cover. In many stations suitable for it, the species does not occur only because of the mechanical uprooting of its specimens,

e.g. when road fringes or squares are cleaned. In many of its potential habitats *Puccinellia distans* has probably not taken root yet (25, 27). In the city of Rzeszów this plant occurs equally often both as an annual and a perennial plant.

The interrelation between the occurrence of phytocenoses with *Puccinellia distans* and the chemical properties of the surface layer of their soil substratum is difficult to determine conclusively (Table 1). First of all, these are different forms of substratum with a highly artificially deformed surface, more or less beaten, easily permeable, of the sandy-loamy-gravel type. These soils are more or less highly saline in their surface layer and with a different degree of Cl content. Worth noting is a high diversity of the content of absorbable alimentary compounds such as N-NO_3, P_2O_5, K_2O and Mg. Most often this is a substratum in the surface layer with an alkaline pH and rich in $CaCO_3$.

The presented pattern of the occurrence, ecology and expansion of *Puccinellia distans* in the city of Rzeszów is almost the same in its main outlines as it was characterized earlier on the example of other towns, especially those situated in the Carpathian Foothills: Kraków, Tarnów, and Przemyśl (15, 27, 28). For the sake of comparison, figures should be presented to show that with regard to the intensity of *Puccinellia distans* expansion in the three towns, Kraków definitely comes first, with Przemyśl occupying the bottom position. Rzeszów and Tarnów are in the middle, between Przemyśl and Kraków.

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STRESZCZENIE

Scharakteryzowane właściwości struktury rozmieszczenia i warunków występowania *Puccinellia distans* na terenie Rzeszowa są w głównych zarysach takie same, jak je wcześniej przedstawiono na przykładzie innych miast polskich, a szczególnie położonych na progu Pogórza Karpackiego (15, 26, 27, 28). Wymieniona roślina na terenie Rzeszowa występuje w wyniku przypadkowego jej zawleczenia na wtórnie zasolonych siedliskach ruderalnych. Proces ekspansji *Puccinellia distans* wiąże się tu z postępującym stopniem zasolenia podłoża głównie w wyniku stosowania związków soli do odśnieżania szos, placów przeładunkowych i innych tego typu miejsc. Pierwsze zawleczone stanowiska *Puccinellia distans*, jak wynika z danych z literatury i własnych uzupełniających badań, pojawiły się w mieście prawdopodobnie na przełomie lat siedemdziesiątych i osiemdziesiątych. Obecnie *Puccinellia distans* występuje na terenie Rzeszowa dość pospolicie na stanowiskach rozproszonych pojedynczych lub grupowych oraz w niewielkich, ale silnie zwartych jej murawach. Najbardziej rozpowszechniona jest na obrzeżu najbardziej ruchliwych szos. Uwagę zwraca sporadyczne jej występowanie na torowiskach kolejowych, placach, koło zabudowań fabrycznych itp. Na wielu potencjalnych dla niej tam stanowiskach nie zdołała się jeszcze osiedlić lub została wyniszczona podczas porządkowania terenu i rozbudowy miasta. *Puccinellia distans* występuje na

omawianym obszarze zaledwie w płatach trzech zespołów: *Potentilletum anserinae*, *Lolio-Plantaginetum* i *Polygono-Matricarietum discoideae*, uformowanych w sześciu podzespołach i wariantach oraz w 4 facjach.

Na terenie miasta Rzeszowa *Puccinellia distans* występuje na siedliskach korzystnie oświetlonych, najczęściej stale mezofilnych. Zdecydowanie unika zbiorowisk o bujnie rozwiniętej warstwie roślin. Pokrywa glebowa w miejsach jej występowania cechuje się nawierzchnią najczęściej zbitą, udeptaną, dość dobrze przepuszczalną, typu piaszczysto-pylasto-żwirowego. Siedliska te wyróżniają się przede wszystkim mniejszym lub większym stopniem zasolenia, prawie jednakowym zasadowym odczynem, bardzo zróżnicowaną zawartością związków Na, $N\text{-}NO_2$ oraz stałą, ale niewielką obecnością związków Ca. Liczba stanowisk z *Puccinellia distans* na terenie Rzeszowa, podobnie jak w innych większych miastach Polski (25, 27), z roku na rok sukcesywnie wzrasta i to niemal wyłącznie na obrzeżach najbardziej ruchliwych szos.