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Is the Variability of *Salix cinerea*-carrs in Slovakia Influenced by Geographical or Ecological Factors?

By

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With 2 Figures

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Summary

VALACHOVIČ M. & HRIVNÁK R. 2010. Is the variability of *Salix cinerea*-carrs in Slovakia influenced by geographical or ecological factors? – Phyton (Horn, Austria) 49 (2): 221–234, with 2 figures.

The paper refers to the relatively large ecological valence and geographical distribution of *Salix cinerea* (grey willow) carrs (Salicion cinereae) in Europe. The result of numerical classification and ordination do not allow to classify stands to one large association. On the other hand, the description of numerous local associations and temporary differences between them complicate the system of vegetation survey. The analyses based on 169 relevés resulted in the distinction of two associations: natural peat and wettest Salicetum pentandro-cinereae PASSARGE 1961, occurring predominantly in highlands, and semi-natural, slightly ruderalised and relatively dryer lowland willow stands of the Frangulo-Salicetum cinereae GRAEBNER & HUECK 1931. Differential taxa and description of ecological conditions are supplied with the distribution map of the associations.

Zusammenfassung

VALACHOVIČ M. & HRIVNÁK R. 2010. Is the variability of *Salix cinerea*-carrs in Slovakia influenced by geographical or ecological factors? [Ist die Variabilität von *Salix cinerea*-Gebüschen in der Slowakei durch geographische oder ökologische Faktoren bedingt?] – Phyton (Horn, Austria) 49 (2): 221–234, mit 2 Abbildungen.

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Die vorliegende Arbeit behandelt die ökologische Amplitude und die geographische Verbreitung der *Salix cinerea*-Gesellschaften (Salicion cinereae) in Europa. Die Ergebnisse der numerischen Klassifikation bzw. der Ordination sprechen gegen die Vereinigung aller Bestände in einer Assoziation. Andererseits kompliziert die Unterscheidung zahlreicher lokal gültiger Assoziationen und Entwicklungsstadien den Überblick im System der Pflanzengesellschaften. Die Analyse von 169 pflanzensoziologischen Aufnahmen aus der Slowakei führte zur Unterscheidung von zwei Assoziationen: dem Salicetum pentandro-cinereae PASSARGE 1961 auf den nassesten Standorten über Torf, das vorwiegend in Hochlagen vorkommt und dem Frangulo-Salicetum cinereae GRAEBNER & HUECK 1931 auf leicht ruderalisierten und relativ trockenen Standorten der Niederung. Die Differentialarten und die Beschreibung der ökologischen Verhältnisse werden zusammen mit der geographischen Verteilung der Assoziationen präsentiert.

1. Introduction

The area of *Salix cinerea* agg. covers a large portion of the European continent, West Siberia and the eastern part of North America; it is also a highly invasive plant in Australia (CREMER 2003). Stands of grey willow are usually called “carrs”. This term indicates stands of wet shrubs and alder woodlands (cf. KELLY & IREMONGER 1997). The development of willow carrs can start from various starting points e. g. marshes, mires, wet meadows, riverbanks or alluvial forest edges. From this point of view we might also expect a large spectrum in the structure and floristic diversity of plant communities with dominant grey willow. This fact is well known in Europe ranging from west to east. The question is how to deal with this variability from a syntaxonomical point of view, as the case may vary from one huge community to a plenty of strictly defined small vegetation units. Various different approaches are evident from the literature – let us have a look at some examples.

In Britain, RODWELL & al. 1991 distinguish only one community in a broad sense, the *Salix cinerea-Galium palustre* woodland. Later, in Cornwall, SOUTHALL & al. 2003 studied shrub of *Salix cinerea* subsp. *oleifolia* (SM.) MACREIGHT (syn. *S. atrocinerea* BROT.) along the succession gradient from poor fen and base-poor mires to woodlands and recognized eight understorey communities.

PASSARGE 1961 addressed this matter in northern Germany lowlands and claimed both aspects of stands variability - ecological and geographical. First, from a syntaxonomical point of view, the ecological variability was expressed at the lower level of subassociations and variants. Then, geographical variability was displayed at the higher level of associations. In contrary to the boreo-atlantic community Myrico-Salicetum cinereae (ALLORGE 1922) R. TX. & PASSARGE 1960, a typical Central-European association was proposed, in recent surveys named Salicetum pentandro-cinereae (PASSARGE 1961) OBERD. 1964. These stands were classified according their ecological demands within a soft hierarchical structure of variants and subvariants. In addition to this highland community, SCHUBERT & al. 1995 also distinguished two further associations in Germany: the nitrophilous Urtico-Salicetum cinereae (ŠOMŠÁK 1963) PASSARGE 1968, and the Salicetum cinereae ZÓLYOMI 1931 – most typical however for lowland stands.

In Austria, GEISSELBRECHT-TAFERNER & WALLNÖFER 1993 accepted only the latter mentioned association, partly attended by the nitrophilous Phragmiti-Salicetum cinereae WEISSER 1970. The newly published comprehensive study of FRANZ & WILLNER 2007 went much farther including all stands with *Salix cinerea* to one broad association, the Frangulo-Salicetum cinereae GRAEBNER & HUECK 1931. The problem of the ecological variability within the association was solved by the description of three subassociations – urticetosum, typicum, and caricetosum elatae. The codominance of *Frangula alnus* is sometimes considered as an important differentiating element between the above-mentioned associations (cf. SIMON 1960). However, it occurs only sporadically or even misses (WEBER 1989).

To comprehend the variability of willow stands in Slovakia, ŠOMŠÁK 1963 described narrowly defined associations mostly according the ecological demands, especially moisture (duration of water table). Dryer types, widespread all over Slovakia, were distinguished as the Rubo-Salicetum cinereae association. Wet types that rarely occur on lowlands and highlands of mainly Eastern Slovakia were published under the unique names, e. g. Hydrocharo-Salicetum cinereae, Sphagno-Salicetum cinereae and Thelypteridi-Salicetum cinereae (cf. ŠOMŠÁK 1963, JURKO 1964).

The reason to address this problem in Slovakia lay upon the answering of two questions: 1) Does the variability of willow carrs reflect rather the local ecological factors or the general distribution in Central Europe? 2) Is it more suitable to use the concept of several small associations or a broad one to illustrate the variability in the syntaxonomical system?

2. Methods

A total of 72 phytosociological relevés were carried out in 2003–2007 according to the Zürich-Montpellier School (BRAUN-BLANQUET 1964) and entered to the Turboveg database (HENNEKENS & SCHAMINÉE 2001). Having included the published data obtained from the Slovak National Database (<http://ibot.sav.sk/cdf/index.html>; cf. HEGEDÜŠOVÁ 2007) we have completed the final dataset of 169 relevés. The average plot area was 74 m^2 (almost 75% of all plots varied between 40–100 m^2). All relevés fulfilled two conditions i) the cover of the shrub layer was more than 75 %, and ii) the moss layer was identified.

We have merged some narrowly defined species or subspecies as follows: *Agrostis stolonifera* agg. (*A. gigantea, A. stolonifera*), *Carex flava* agg. (*C. flava, C. tumidicarpa*), *Dactylorhiza majalis* s. lat. (*D. majalis, D. maculata*), *Dryopteris car-*

thusiana agg. (*D. carthusiana, D. dilatata*), *Eleocharis palustris* agg. (*E. palustris, E. uniglumis*), *Molinia caerulea* agg. (*M. caerulea, M. arundinacea*), *Myosotis scorpioides* agg. (*M. scorpioides, M. nemorosa*), *Plagiomnium affine* s. lat. (*P. affine, P. elatum, P. ellipticum, P. undulatum, P. rostratum*), *Quercus petraea* agg. (*Q. dalechampii, Q. petraea*), and *Valeriana officinalis* agg. (*V. sambucina, V. officinalis*). For the cluster analysis (beta-flexible linkage method with the coefficient β = –0.25 with the relative Sțrensen's distance as a measure of dissimilarity), the same species, which occurred in different layers, had been merged and all species' percentage covers were square-root transformed. The construction of the clusters was performed with the PC-ORD 4-5 version using JUICE program (TICHÝ 2002). The crispness of the classification procedure (BOTTA-DUKÁT & al. 2005), as available in the JUICE program, was used to determine optimal number of clusters. The same program was used for manual table work. The grouping of taxa into the phytocoenological system followed the concept of MUCINA 1997, further amended by JAROLÍMEK & al. 2008.

The CANOCO 4.5 for Windows package (TER BRAAK & ŠMILAUER 2002) was used for the detrended correspondence analysis (DCA). Species data were square-root transformed, rare species were down-weighted. For the ecological interpretation of major gradients, the unweighted average ELLENBERG's indicator values of vascular plants (ELLENBERG & al. 1992) and the altitude of each sample were plotted onto the DCA ordination diagram as supplementary variables. Distribution maps were prepared using the DMAP program (MORTON 2005). Nomenclature of bryophytes and vascular plants followed KUBINSKÁ & JANOVICOVÁ 1998 and MARHOLD 1998.

3. Results

The species *Salix cinerea* covers in Slovakia suitable banks along watercourses and water bodies (oxbow lakes, ponds, pools) and is spread in depressions of wet meadows from lowlands to highlands (KOBLÍŽEK 2006). All areas manifest lacking surface drainage and different peat content. Favourable water conditions provide stands with good regeneration potential; even missing regular coppicing does not inhibit these stands to spread.

Preliminary analyses (TWINSPAN) and subsequently final cluster analysis brought very similar results - three stable clusters, which represented floristically and ecologically mutually well-differentiated groups. The essential synoptic table (Tab. 1) shows the principal differential taxa ordered into sociological groups. Although all relevés with a cover of the shrub layer below 30% were eliminated, the full cover of *Salix cinerea* in all three groups was not surprising. For the first cluster, the members of wet meadows (Calthion and Molinion species) are typical and due to the higher altitude, and sometimes to a specific type of substrate (fen) the species of the Scheuchzerio-Caricetea fuscae are more frequent. The dominant species *Salix cinerea* in shrub or tree layers is followed by subdominant *Salix pentandra* and *Alnus incana*.

The most common willow carrs in Slovakia occur under dryer, slightly ruderalised and nitrophilous conditions. This is supported by species of

Table 1. The abridged synoptic table of grey willow carrs vegetation in Slovakia, based on the cluster analysis of 169 relevés/517 species, with percentage frequency values: 1 – Salicetum pentandro-cinereae, 2 – Frangulo-Salicetum cinereae, drier variant, 3 – Frangulo-Salicetum cinereae, wetter variant.

Abbreviations in alphabetic order: AG – Alnetea glutinosae, aln – Alnion glutinosae, cal – Calthion palustris, GU – Galio-Urticetea, LE – Lemnetea, MA – Molinio-Arrhenatheretea, MC – Montio-Cardaminetea, Mol – Molinietalia, PM – Phragmito-Magnocaricetea, RP – Rhamno-Prunetea, SC – Scheuchzerio-Caricetea fuscae.

	Number of cluster		1	2	3
	Number of relevés	Layer	51	82	36
Phaneorograms (classes *Alnetea glutinosae*, Franguletea and *Rhamno-Prunetea*)					
	Salix cinerea	E_3	10	5	.
	Salix cinerea	$\mathbf{E_2}$	**100**	**100**	**100**
	Salix cinerea	E_1	25	44	17
	Salix pentandra	E_2	25	4	8
	Frangula alnus	E_2	12	4	14
	Alnus glutinosa	E_2	2	1	19
	Populus tremula	E_2	4	1	3
	Salix purpurea	E_2	20	10	.
	Prunus padus	E_2	12	2	.
	Viburnum opulus	E_2	14	5	.
	Viburnum opulus	E_1	14	12	.
	Prunus spinosa	E_1	2	23	.
	Crataegus monogyna	E_1	4	21	.
	Sambucus nigra	E_1	2	20	.
Diagnostic taxa of individual clusters					.
AG	*Alnus incana*	E_2	20	.	.
	Crepis paludosa	E_1	55	.	.
SC	*Valeriana simplicifolia*	E_1	35	.	.
Mol	*Galium uliginosum*	E_1	24	.	.
cal	*Caltha palustris*	E_1	90	16	.
cal	*Filipendula ulmaria*	E_1	78	10	.
	Plagiomnium affine s. lat.	E_0	41	9	.
cal, MC	*Myosotis scorpioides* agg.	E_1	45	6	.
cal, MC	*Geum rivale*	E_1	38	1	.
aln, MC	*Cardamine amara*	E_1	27	1	.
aln, cal, MC	*Chaerophyllum hirsutum*	E_1	27	1	.
aln	*Equisetum sylvaticum*	E_1	22	2	.
AG	*Rubus caesius*	E_1	4	44	.
MA	*Carex hirta*	E_1	8	39	.
GU	*Cucubalus baccifer*	E_1	2	27	.
GU	*Geum urbanum*	E_1	2	24	.
	Cirsium arvense	E_1	2	20	.
RP	*Cornus sanguinea*	E_1	.	22	.
GU	*Glechoma hederacea* agg.	E_1	.	22	.

	Number of cluster		1	2	3
AG, PM	*Thelypteris palustris*	E_1	4	1	72
AG, PM	*Calamagrostis canescens*	E_1	2	1	53
AG, PM	*Peucedanum palustre*	E_1	2	1	44
PM	*Typha angustifolia*	E_1	.	6	44
PM	*Carex pseudocyperus*	E_1	.	2	61
	Persicaria amphibia	E_1	.	6	33
	Eurhynchium schleicheri	E_0	.	1	31
PM	*Cicuta virosa*	E_1	.	.	47
	Rumex hydrolapathum	E_1	.	.	39
	Hygrohypnum sp.	E_0	.	.	33
LE	*Salvinia natans*	E_1	.	.	33
LE	*Hydrocharis morsus-ranae*	E_1	.	.	28
LE	*Stratiotes aloides*	E_1	.	.	28
SC	*Menyanthes trifoliata*	E_1	.	.	25
Diagnostic taxa of the alliances *Calthion palustris* and *Molinion caeruleae*					
	Angelica sylvestris	E_1	47	20	.
	Poa trivialis	E_1	39	39	.
	Scirpus sylvaticus	E_1	41	12	.
	Mentha longifolia	E_1	16	5	.
	Cirsium oleraceum	E_1	25	5	.
	Cirsium rivulare	E_1	10	7	.
	Equisetum palustre	E_1	51	26	3
	Cirsium palustre	E_1	29	4	11
	Agrostis stolonifera	E_1	12	28	8
	Cardamine pratensis agg.	E_1	14	6	14
Diagnostic taxa of the class *Molinio-Arrhenatheretea*					
	Ranunculus repens	E_1	31	37	3
	Lysimachia nummularia	E_1	16	35	6
	Symphytum officinale	E_1	6	35	17
	Mentha aquatica	E_1	2	5	6
	Deschampsia cespitosa	E_1	41	26	.
	Lychnis flos-cuculi	E_1	18	13	.
	Brachythecium salebrosum	E_0	18	41	.
	Valeriana officinalis agg.	E_1	22	17	.
	Primula elatior	E_1	20	4	.
	Juncus effusus	E_1	20	9	.
	Brachythecium rutabulum	E_0	16	9	.
	Acetosa pratensis	E_1	16	9	.
	Lathyrus pratensis	E_1	16	5	.
	Ajuga reptans	E_1	14	4	.
	Ranunculus acris	E_1	12	10	.
	Heracleum sphondylium	E_1	12	5	.
	Galium mollugo agg.	E_1	12	1	.
	Dactylis glomerata agg.	E_1	10	9	.
	Cirsium canum	E_1	2	10	.
	Vicia cracca agg.	E_1	2	17	.

Number of cluster		1	2	3
Diagnostic taxa of the class *Scheuchzerio-Caricetea fuscae*				
Aulacomnium palustre	E_0	8	.	14
Calliergon cordifolium	E_0	6	.	14
Sphagnum squarrosum	E_0	2	.	19
Agrostis canina	E_1	4	1	6
Diagnostic taxa of the class *Lemnetea*				
Lemna minor	E_1	2	6	36
Lemna trisulca	E_1	.	2	22
Diagnostic taxa of the class *Phragmito-Magnocaricetea*				
Lythrum salicaria	E_1	14	40	67
Galium palustre	E_1	31	27	47
Equisetum fluviatile	E_1	27	4	33
Lycopus europaeus	E_1	22	34	81
Scutellaria galericulata	E_1	10	16	67
Phragmites australis	E_1	6	18	61
Iris pseudacorus	E_1	2	23	19
Carex acuta	E_1	6	17	22
Typha latifolia	E_1	6	9	44
Carex elata	E_1	2	2	36
Poa palustris	E_1	8	2	3
Carex acutiformis	E_1	2	28	6
Epilobium palustre	E_1	4	.	14
Phalaris arundinacea	E_1	.	22	3
Stachys palustris	E_1	.	11	22
Glyceria maxima	E_1	.	10	50
Carex riparia	E_1	.	18	31
Oenanthe aquatica	E_1	.	2	19
Sium latifolium	E_1	.	2	19
Sparganium erectum	E_1	.	2	17
Rorippa amphibia	E_1	.	1	17
Alisma plantago-aquatica	E_1	.	1	11
Diagnostic taxa of the class *Alnetea glutinosae*				
Lysimachia vulgaris	E_1	67	55	75
Solanum dulcamara	E_1	6	51	64
Carex elongata	E_1	8	1	33
Dryopteris carthusiana agg.	E_1	4	1	6
Calystegia sepium	E_1	.	30	22
Diagnostic and constant taxa of the class *Galio-Urticetea*				
Urtica dioica	E_1	39	52	.
Galium aparine agg.	E_1	29	50	.
Aegopodium podagraria	E_1	25	4	.
Impatiens noli-tangere	E_1	14	1	.
Anthriscus sylvestris	E_1	10	6	.
Alliaria petiolata	E_1	2	7	.
Geranium robertianum	E_1	6	2	.
Chaerophyllum aromaticum	E_1	4	2	.
Humulus lupulus	E_1	6	20	.
Eupatorium cannabinum	E_1	10	9	3

Number of cluster		1	2	3
Constant taxa of the alliance *Alnion incanae*				
Athyrium filix-femina	E_1	14	5	.
Fraxinus excelsior	E_1	10	4	.
Other species presented at least in two clusters with one frequency value >10%+A29				
Equisetum arvense	E_1	18	27	.
Potentilla erecta	E_1	14	4	.
Petasites hybridus	E_1	11	4	.
Cruciata glabra	E_1	11	3	.
Ranunculus auricomus s. lat.	E_1	11	5	.
Brachythecium velutinum	E_0	2	10	.
Calliergonella cuspidata	E_0	29	9	14
Brachythecium rivulare	E_0	6	.	22
Marchantia polymorpha	E_0	7	.	14
Bidens cernua	E_1	.	3	19
Leucanthemella serotina	E_1	.	1	11
Number of other hidden species		**233**	**107**	**33**
Total number of species		**340**	**323**	**100**

Cluster 1 (51 relevés): (18) these authors (unpubl.); (14) Kontriš J. 1981. Biol. Pr., Bratislava, 27/3: 1–164; (3) Špániková A. & Zaliberová M. 1982. Vegetácia ČSSR, B5, Bratislava, 302 pp.; (1) Urbanová V. & Zaliberová M. 1996. Vlast. Zb. Považia, Žilina, 18: 143–174; (1) Šoltés R. 2000. Ochr. Prír., 18: 41–49; (4) Šoltés R. & Novák A. 2001. Bull. Slov. Bot. Spoločn., 23: 51–56; (1) Háberová I. 2004. Príroda Nízkych Tatier, Banská Bystrica, 1: 89–95; (1) Hrivnák R., Šoltés R. & Rajtarová N. 2004. Ochr. Prír., 23: 163–181; (1) Kontriš J. & al. 2005. Acta Fac. Ecol., TU Zvolen, 13: 5–9; (2) Michalková D. 2006. Bull. Slov. Bot. Spoločn., Suppl. 2 (14): 59–90; (1) Fajmonová E. (unpubl.); (3) Watzka R. Diploma Thesis (unpubl.); (1) Staníková M. Diploma Thesis (unpubl.);

Cluster 2 (82 relevés): (54) these authors (unpubl.); (10) Šomšák L. 1963. Acta Fac. Rer. Nat. Univ. Com. Botanica, 8: 229–302; (1) Fraňo A. 1971: Acta Fac. Rer. Nat. Univ. Com. Botanica, 19: 3–193; (6) Zaliberová M. 1994: Ekologia, Bratislava, Suppl. 1: 107–114; (1) Hrivnák R. 1999: Ochr. Prír., 17: 73–88; (4) Zlinská J. & Kubalová S. 2001: Acta Enviromen. Univ. Com. 11: 1–120; (3) Watzka R. Diploma Thesis (unpubl.); (1) Ripka J. Diploma Thesis (unpubl.); (2) Staníková M. Diploma Thesis (unpubl.);

Cluster 3 (36 relevés): (25) Šomšák L. 1963. Acta Fac. Rer. Nat. Univ. Com. Botanica, 8: 229–302. (11) Berta J. 1970: Vegetácia ČSSR, B1, Bratislava, 371 pp.

the class Rhamno-Prunetea, as well as sciophilous and nitrophilous herbs such as *Carex hirta, Glechoma hederacea, Geum urbanum, Galium aparine*, and *Urtica dioica* (class Galio-Urticetea, see Tab. 1, cluster 2).

Conspicuous difference is visible in the third cluster, where the presence of phanerogams (shrubs and their saplings) is much lower, restricted to the taxa, which are able to grow in deeper water. From the syntaxonomical point of view, this cluster is an artefact, because the difference is based on the temporary occurrence of aquatic plants. The species from the

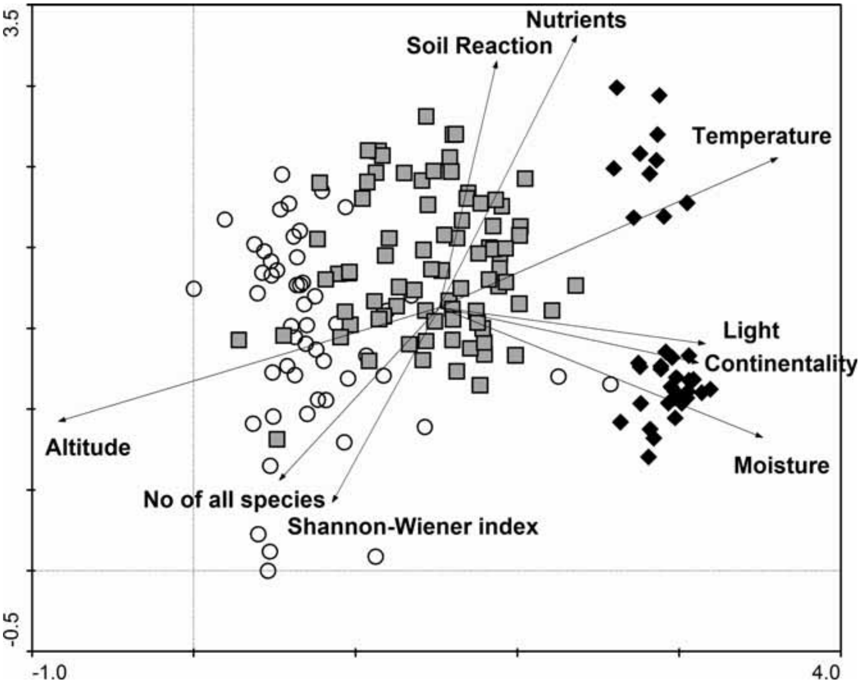

Fig. 1. Detrended correspodence analysis ordination diagram of relevés (total inertia 5.794, eigenvalues of the first two axes are 0.467 and 0.244). The average ELLENBERG's indicator values and altitude for relevés were plotted onto DCA ordination diagram as supplementary variables (cumulative percentage variance of species-environment relation for the first two axes are 29.4 % and 41.6 %). Weighted correlations between first two axes and environmental variables: Light – 0.5520 and –0.1389, Temperature – 0.6747 and 0.2633, Continentality – 0.5410 and -0.1806, Moisture – 0.6830 and – 0.3620, Soil reaction - 0.0836 and 0.5419, Nutrients – 0.2442 and 0.5828 and Altitude – –0.7663 and –0.1732.
Circles: Salicetum pentandro-cinereae – shaded squares: Frangulo-Salicetum cinereae, drier variant – full rhomboids: Frangulo-Salicetum cinereae, wetter variant.

classes Lemnetea and Potametea cannot be considered important for the definition of new units.

Apart from numerous diagnostic taxa of individual groups (Tab. 1), there are many common species that connect the two or all three clusters. The expectation of simple differentiation on the association level is therefore exaggerated. Using ELLENBERG's indicator values, the result of the DCA (Fig. 1) shows that the first axes explain the moisture gradient, and the right part of the graph manifests grouped relevés from flooded stands (cluster 3). The opposite part contains clumped relevés where the less wet substratum facilitates the large amount of accidental species. Here the

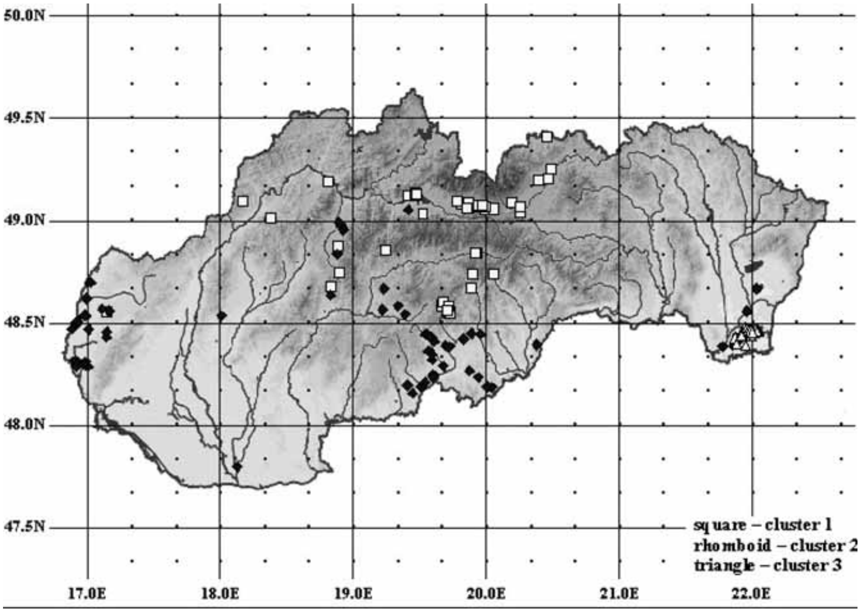

Fig. 2. Distribution map of grey willow carrs vegetation in Slovakia.

highest species numbers occur. The first DCA axis explains correlation with the altitude in the best possible way, where samples are arranged from higher to lower altitudes. The content of nutrients is significant for the explanation of variability along the second DCA axis. This factor provides some effect on the internal variability in all three vegetation types, e. g. in all groups of existing stands more or less influenced by nutrients. Their contents in most cases depend on the distance to a source (agricultural fields, manure meadows, strongly polluted water bodies etc). However, this fact cannot be automatically transferred into classification.

The groups' distribution is well demonstrated by the map (Fig. 2). The altitudinal gradient displays two basic types of stands. The first type of stands (cluster 1) differentiated by the presence of some mountain taxa, e. g. *Crepis paludosa, Valeriana simplicifolia, Chaerophyllum hirsutum, Geum rivale*, and *Alnus incana* is distributed at higher altitudes, especially in basins and the sub- to montane belts of the Western Carpathians. The second one (clusters 2 and 3) generally occurs in lowlands and south-central Slovakia basins from the Borská nížina in the western part of Slovakia to the Potiská nížina in the eastern part of Slovakia. While the first stand occurs close to riparian forests (the alliance Alnion incanae), the lowland type resembles to patterns of communities growing nearby alder swamp woods (the alliance Alnion glutinosae).

4. Discussion

Heterogeneous species composition of both moss and herb layers on one side, homogeneous however in structure, determined by the absolute dominance of *Salix cinerea* on the other side, are typical features of old willow stands. Probably, this was the reason why LIBBERT 1933 decided to analyse only the shrub layer. LIBBERT l. c. gave up the idea of one large association, proposed by GRAEBNER & HUECK 1931. He was convinced, that all stands represent succession stages towards alder carrs.

This synusial approach based on the evaluation of the shrub layer also later used by FOUCAULT & JULVE 2001 is not accepted. Beside the herb layer, bryophytes also play a prominent role in ecology of willow cars. Moss species generally are distributed in a huge area, having though a relatively strict relation to actual ecological conditions – mosses are good indicators of moisture patterns and shade intensity.

PASSARGE 1961 considered stands with *Salix cinerea* in Pannonia as a poor offshoot of one huge association, however, local communities were also previously described in Hungary by ZÓLYOMI 1931 and SOÓ 1954. The geographical aspect was actually suppressed by this approach. Much later, ŠILC 2002 in Slovenia used ZÓLYOMI's old name Salicetum cinereae and proposed within this frame three subassociations with respect to the ground water table: i) subass. calthetosum (far the most flooded), ii) subass. typicum (moderate), and iii) subass. leucojetosum aestivi (the most dry), representing succession stages to alder woodland. From the nomenclatorial point of view, ŠILC l. c. disregarded the fact, that the relevés by ZÓLYOMI 1931 were rather problematic (plot area of 1 m^2) and the description of the association does not follow the ICPN code. According to WEBER 1998, this was the reason for the rejection of this name and we do agree with him. We also consider the ranking of the alliance and the order within the class Franguletea as correct, in contrary to the ranking of shrubs into the forest class Alnetea glutinosae.

According to our results, the first cluster in Table 1 belongs to the association Salicetum pentandro-cinereae. Diagnostic taxa are typical for wet meadows and spring vegetation, with more frequent occurrence of typical marsh species or nitrophilous plants as well as the species of sub- and montane belts. The other two clusters 2 and 3 belong to Frangulo-Salicetum cinereae. They represent the drier and wetter variant, respectively. Within this association, typical marsh species, some nitrophilous and meadows species are diagnostic for the drier variant, and some fen and aquatic species for the wetter variant (Tab. 1). Both variants are known from the southern lowlands and basins of West to East Slovakia.

The final syntaxonomical structure of the alliance in Slovakia is therefore stated as follows:

Class: Franguletea DOING 1962

Order: Salicetalia auritae DOING 1962

Alliance: Salicion cinereae Th. MÜLLER & GÖRS ex PASSARGE 1961

Association: Salicetum pentandro-cinereae PASSARGE 1961

Syn.: Salicetum cinereae ZÓLYOMI 1931 p.p.

Association: Frangulo-Salicetum cinereae GRAEBNER & HUECK 1931

Syn.: Salicetum cinereae ZÓLYOMI 1931 p.p., Calamagrostio-Salicetum cinereae SOÓ 1955; Rubo-Salicetum cinereae ŠOMŠÁK 1963; Sphagno-Salicetum cinereae ŠOMŠÁK 1963; Hydrocharo-Salicetum cinereae ŠOMŠÁK 1963; Thelypterido-Salicetum cinereae ŠOMŠÁK 1963; Phragmiti-Salicetum cinereae WEISSER 1970; Urtico-Salicetum cinereae auct.

Besides the numerous above-mentioned communities described by ŠOMŠÁK 1963, in Slovakia the name Salicetum cinereae ZÓLYOMI 1931 was also applied (cf. JAROLÍMEK & al. 2008). We include the majority of them into a broader unit – the Frangulo-Salicetum cinereae. Despite of the fact that WEBER 1998 incorporated the association Rubo-Salicetum cinereae ŠOMŠÁK 1963 into the Salicetum pentandro-cinereae, in our opinion it is better to consider these stands as a part of the Frangulo-Salicetum cinereae, namely of the subass. urticetosum dioicae.

FRANZ & WILLNER 2007 cope with the problem of transition from one type to another by the acceptance of only one association, in this case, the Frangulo-Salicetum cinereae. The types with peat species were all included into the Frangulo-Salicetum auritae. This model is not applicable in our case because of the absolute absence of *Salix aurita* in our data.

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