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CONTRIBUTION TO THE KNOWLEDGE OF THE DRY GRASSLAND VEGETATION ON THE HIGHLAND AREAS OF THE POHORJE MOUNTAIN (SLOVENIA)

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ABSTRACT

Collected relevés from the highland areas of Pohorje had been classified within secondary Mattgrass grasslands on acid soils (alliance Nardo-Agrostion tenuis, Nardetalia *order). Due to the nearby timber-line (nevertheless not reached on Pohorje!), also sub-Alpine species from natural Mattgrass stands (alliance* Nardion strictae) *penetrates into these grasslands. The mixture of sub-Alpine species, lowland* Nardetalia *and* Arrhenatheretalia *species is characteristic of the association* Homogyno alpinae-Nardetum *Mráz 1956. Association is species-poor, rather uniform, it varies due to the rockiness and soil humidity, eutrophisation level and shading effect.*

Key words: dry grasslands, silicates, Mattgrass stands, *Nardo-Agrostion tenuis, Homogyno alpinae-Nardetum,* Pohorje, Slovenia

CONTRIBUTO ALLA CONOSCENZA DELLA VEGETAZIONE DI PASCOLI ARIDI IN CIMA ALLA MONTAGNA DEL POHORJE (SLOVENIA)

SINTESI

I rilievi raccolti nelle aree in cima al Pohorje sono stati classificati come pascoli a nardo secondari su suolo acido (alleanza Nardo-Agrostion tenuis, *ordine* Nardetalia). *A causa della prossima linea boschiva (non raggiunta, tuttavia, sul Pohorje) pure specie sub-alpine di nardetei naturali (alleanza* Nardion strictae) *sono penetrate in tali pascoli. La mescolanza di specie sub-alpine e di specie di pianura appartenenti a* Nardetalia *e* Arrhenatheretalia *è caratteristica dell'associazione* Homogyno alpinae-Nardetum *Mráz 1956. L'associazione è povera di specie, piuttosto uniforme e varia a seconda della rocciosità, dell'umidità del suolo, del livello di eutrofizzazione e dell'effetto ombra.*

Parole chiave: pascoli aridi, silicati, nardetei, *Nardo-Agrostion tenuis, Homogyno alpinae-Nardetum,* Pohorje, Slovenia

INTRODUCTION

It is rather interesting the fact that grassland vegetation of Pohorje, dominating mountain area in NE Slovenia, remained unexplored till the end of 20th century. There are of course also exceptions, as for example forest vegetation and vegetation of raised bogs, which were investigated thoroughly by many researches *(e.g.* M. Wraber, 1953, 1954, 1955, 1956; Piskernik & Martinčič, 1970; Cenčič, 1985; Marinček, 1987; Zupančič, 1998; Culiberg & Šercelj, 2000). Regarding grasslands dominated by *Nardus stricta*, which occur on the top areas of Pohorje and are known as Pohorje mountain plains, we have numerous floristic data, which are rich and variegated, however they have more historic values as to their time distance. They were summarised and enriched by Hayek (1908-1956 1923), while they were freshened up during the visit of T. Wraber in 1970 (Wraber, 1971).

The present contribution is based on the expert's report *"Flora and vegetation of Pohorje plains"*, which was made by M. Kaligarič in 1993 (Kaligarič, 1993). Results of this report have already been summarised in the special issue of the Proteus, dedicated to Pohorje Mountains. In the year 2001 additional research of the vegetation of Matgrass grasslands were done in order to complete our knowledge about these grassland vegetation. Until now they were designated simply as "Matgrass swards", which – except that in these grasslands *Nardus stricta* could be found – does not tell much about this vegetation. Matgrass *(Nardus stricta)* is one of the commonest plants especially in the outer Alps (Ellenberg, 1996). At the same time it is one of the most successful plants on lime-deficient soils, not only at altitudes up to the alpine belt but also in the lower mountains of Europe and at all levels right down to the heathland areas on the plains. It avoids lime-rich soils because here it suffers from a disturbance in its nutrient balance and especially from an iron shortage (Gigon, 1971). In Slovenia Matgrass grasslands could be found in all altitudinal belts (from Prekmurje to sub-Alpine belts in Alpine region) as well as in all phytogeographical regions (from sub-Mediterranean to sub-Pannonian region, if we only take the longest diagonal).

The most fundamental is to distinguish between natural and semi-natural (anthropogenic) Matgrass grasslands, which could be described also by vegetation belt in which they occur. The *Nardetalia* Oberd. ex Preising 1949 order is present at altitudes up to the montane belt, while higher occurs the *Caricetalia curvulae* Br.-Bl. in Br.-Bl. et Jenny 1926 order (Ellenberg, 1996). There are several schemes used for the classification of the European Matgrass grassland vegetation. We followed the *survey of Austrian plant communities (collected work "Die Pflanzengesellschaften Österreichs.")* (Mucina *et al.*, 1993; Grabherr & Mucina, 1993), where the most important surveys of European Matgrass vegetation (Preising, 1949; Oberdorfer, 1957, 1978; Krahulec, 1985, 1988) are considered and critically reviewed. In Slovenia Matgrass swards were mentioned by Aichinger (1933) for Karavanke Alpine Range.

The objectives of the present study were to present

1. classification of the vegetation of Pohorje Matgrass grasslands; 2. description of its phytogeographical and ecological characteristics and 3. dynamic of the secondary succession after the abandonment.

METHODS

Study area

Pohorje is the most dominant mountain range in the NE Slovenia. It is situated at the south-easternmost edge of the Central (non-carbonate) Alps. It links Central Alps in the north and proceeds to the lowland sub-Pannonian region in the east (Fig. 1). The northern and the western boundaries of Pohorje Mts. are determined by Drava valley from Dravograd to Maribor and by Mislinja river, while in the east and south its limit represents the road Maribor - Slovenska Bistrica – Oplotnica – Zreče – Vitanje - Mislinja. Pohorje is therefore geographically recognizable formation, which measures 50 km in length, 30 km in width and with the area of 84.000 ha (Jež, 1995).

Two geomorphological units could be distinguished, namely (1) central plateau, which is surrounded by peaks Klopni vrh, Žigartov vrh, Veliki and Javorski vrh with altitudes about 1300 m and (2) the round ridge of the western Pohorje, which begins with Rogla and continues over Planinka, Jezerski vrh and Črni vrh to Velika Kopa and Mala Kopa in western direction (Jež, 1995). Especially the latter chain, which peaks exceed 1500 m, has its top areas covered by dry grasslands – the Matgrass swards. The main characteristic of this grassland

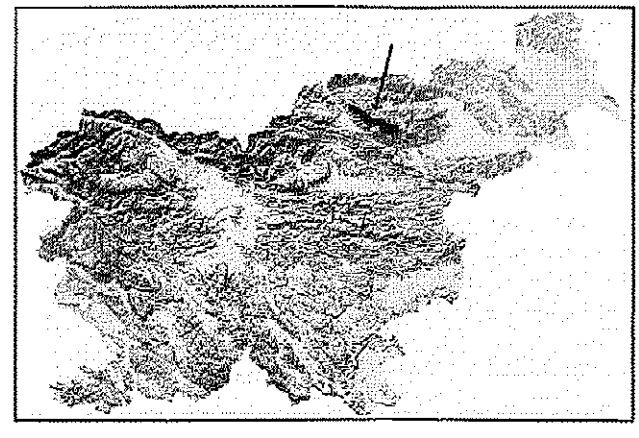

Fig. 1: Localities of the relevés of dry grasslands on the highland areas of the Pohorje Mountains.
Sl. 1: Lokalitete popisov suhih travišč na ovršnih predelih Pohorja.

vegetation is acid soil as the consequence of the non-carbonate geological bedrock. Predominating are metamorphic rocks and granodhiorythic lacolith (Hinterlechner-Ravnik, 1995). Gentle-sloping ridges are characteristic of the Pohorje Mountains as the result of the old geological formations on the top areas. Parts with bare surface and exposed rocks are only rarely to seen.

The study area has the montane climate. The average temperature in the coldest month is below –3°C and in the warmest month above 10°C. Such conditions are characteristic of altitudes between 1500 and 2000 m a.s.l.

Sampling methods and data analysis

In the years 1993 and 2001 32 phytosociological relevés of dry grassland stands on the top areas of Pohorje Mountains were collected (Fig. 1). They were compiled using standard procedure of the Braun-Blanquet approach (Braun-Blanquet, 1964; Westhoff & van der Maarel, 1973; Dierschke, 1994). All relevés were saved in the computer data base using program JODI 97 (Peterseil *et al., unpbl.).* For the classification procedure Two-Way-INdicator-SPecies ANalysis (TWINSPAN; Hill, 1979) was chosen. It was run using computer program VEGI (Reiter, 1998).

Ecological conditions of the stands were estimated by Ellenberg indicator values (Ellenberg *et al.*, 1991) for light, temperature, soil moisture, pH and nitrogen content. It should be noted that Ellenberg's N-value should be interpreted as a general indication of fertility, rather than as an index of nitrogen availability (Ellenberg *et al.*, 1991). For each relevé, indicator values were averaged over all species using species abundance as weight.

Geo-elements were determined according to Poldini (1991).

Nomenclature

Taxonomic nomenclature follows Martinčič *et al.* (1999), syntaxonomic nomenclature follows Mucina *et al.* (1993) and Grabherr & Mucina (1993).

RESULTS AND DISSCUSION

Vegetation classification

The basic dilemma, whether Matgrass swards of Pohorje belong to the natural sub-Alpine grasslands above the forest line, or to the secondary Matgrass grasslands below the forest line, seemed to be solved easily. Pohorje doesn't reach the forest line, although its top areas free from trees and with single plant species of sub-Alpine and Alpine belts have "subalpine" aspect (habitus). Some of those species belong to the class of the alpine acid-soil swards *Caricetalia curvulae*. However, their portion is too low and considering the floristic principle this relevés should be classified within the class of the Matgrass grasslands and dwarf shrub heaths *Calluno-Ulicetea*, namely to the *Nardetalia* order, which includes the lowland dry Matgrass swards. Additional confirmation of this classification is also slow but persistent spontaneous reforestation of studied Matgrass swards. Vegetation of *Nardetalia* order is spread mostly in Atlantic and sub-Atlantic Europe including Alpine region (Preising, 1949). While the lime-deficient substrates are characteristic of the larger part of the Europe where great part of the semi-natural pastures and meadows belong to that order, in Slovenia due to the prevailing calcareous bedrock, such dry pastures and meadows are not very frequent. Within *Nardetalia* order two more xerophilous alliances can be distinguished. The Matgrass swards could be therefore classified within (a) the alliance of the lowland and montane Matgrass swards *Violion caninae* Scwickerath 1944 or (b) within the alliance *Nardo-Agrostion tenuis* Sillinger 1933, which is spread mostly in the Carpathian Mountains and reaches also the edges of the Alps (Ellmauer, 1993). A central position within the *Violion caninae* has the *Polygalo-Nardetum* association. It is mainly found on very acid and nutrients poor soils from the lowland up to the altitudes about 1300 m a.s.l. and contains also sporadic alpine species (Steinbuch, 1995). Regarding bioproduction and species-richness these grasslands are richer and include more species of lowland intensive grasslands (*Arrhenatherion* alliance) than Matgrass swards of Pohorje. The latter are in general floristically poorer, but at the same time they are characterised by many species *(e.g. Gentiana pannonica, Potentilla aurea, Solidago virgaurea, Hieracium aurantiacum, Leontodon helveticus, Pseudorchis albida* and *Hypochoeris uniflora),* which do not appear in the *Polygalo-Nardetum* association. All this facts indicate that the dry grasslands from Pohorje can be assigned to the *Nardo-Agrostion tenuis* alliance, which is typical for montane belt.

Our analyses and comparisons with similar dry grassland stands from nearby Alpine region in south-eastern Austria (Steinbuch, 1995) confirmed, that within that alliance we can classify them in the association *Homogyno alpinae-Nardetum* Mráz 1956. In the study made by Steinbuch (1995) has also been reported about one high-altitude variant of the lowland association *Polygalo-Nardetum gymnadenietosum*, namely variant with the species *Homogyne alpina*, which at the higher altitudes passes directly into the *Homogyno-Nardetum* association. In such conditions it must be sometimes difficult to determine a boundary between both associations. This however is not the case in our study area: Pohorje plains are closed ecosystems, isolated on their altitudes and separated from lowland grasslands by large forests.

Relevés are presented in Tab. 1. Sequence of the relevés is according to the TWINSPAN analysis. Diag-

Tab. 1: Analytical table of the** Homogyno alpinae-Nardetum **Mráz 1956 association.
Tab. 1: Analitična tabela asociacije** Homogyno alpinae-Nardetum **Mráz 1956.

syntaxonomical characteristic																																				
	Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32		
	Altitude (m a.s.l.)	1400	1500	1350	1540	1500	1480	1520	1450	1525	1430	1420	1520	1490	1410	1515	1460	1485	1360	1400	1490	1475	1430	1430	1465	1480	1510	1540	1490	1500	1350	1460	1400		
	Slope(°)	15	0	5	20	2	3	15	5	10	5	1	3	0	10	5	3	3	20	2	3	5	3	3	3	3	3	15	5	0	0	0	20		
	Aspect	S	/	SW	SW	S	SW	E	SW	W	W	SW	NW	/	S	NE	/	S	SW	SW	S	S	SW	SW	NW	SW	NE	W	E	/	/	/	/		
	Cover (%)	95	100	100	90	70	80	100	100	100	100	100	90	100	100	100	100	100	100	90	90	80	100	100	100	100	100	100	100	100	100	100	100		
	Plot surface (sq.m)	80	50	50	50	25	50	50	50	50	50	25	25	25	25	25	50	25	25	25	25	25	25	25	25	25	25	50	50	50	50	50	25		
	Number of species	14	16	15	13	12	14	16	16	13	13	15	22	12	18	23	18	16	21	13	15	19	15	15	13	12	19	13	15	19	26	15	25	Fr%	p
	Diagnostic species of the association																																		
	Solidago virgaurea	+	.	.	.	.	.	+	+	+	.	+	1	+	.	+	+	+	+	.	+	+	+	+	2	+	.	+	+	.	.	.	.	59	III
	Veratrum album subsp. *album*	.	.	.	.	.	.	.	+	+	+	+	.	+	.	1	.	+	+	.	.	+	+	.	+	.	+	.	+	+	.	+	.	+	50	III
VP	*Homogyne alpina*	.	.	+	.	.	2	+	+	.	+	.	2	2	1	2	.	.	.	1	.	.	.	.	1	.	+	.	+	.	+	+	.	.	47	III
CC	*Hypochoeris uniflora*	.	+	+	+	.	.	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	35	II
CC	*Gentiana pannonica*	.	.	.	.	.	+	.	.	+	.	.	+	.	+	.	+	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	22	II
CC	*Potentilla aurea*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	I
A,O	***Nardo-Agrostion tenuis* Sillinger 1933, *Nardetalia* Oberd. ex Preising 1949**																																		
	Nardus stricta	3	2	1	1	+	1	4	5	5	3	4	3	3	3	2	3	3	2	4	3	3	3	4	3	4	4	5	3	2	4	4	3	100	V
	Arnica montana	+	+	+	1	+	+	1	1	1	1	+	1	+	+	1	+	1	2	1	3	2	+	+	1	2	2	1	+	+	1	.	2	97	V
	Hieracium aurantiacum	.	.	+	.	.	.	.	+	.	.	.	+	.	+	+	.	.	.	.	.	.	+	+	.	.	.	.	.	+	+	.	.	28	II
	Hypericum perforatum	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	13	II
CU	***Calluno-Ulicetea* Br.-Bl. et R. Tx. ex Klika et Hadač 1944**																																		
	Potentilla erecta	+	+	+	+	+	+	1	1	+	+	2	1	1	2	1	+	1	1	1	1	1	+	1	1	+	1	1	+	+	+	+	1	100	V
	Calluna vulgaris	4	2	4	4	3	4	+	+	+	1	.	+	2	2	+	1	2	2	3	+	1	+	.	1	.	.	.	+	+	.	.	2	78	V
	Luzula campestris	+	+	.	.	.	.	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	+	.	+	+	+	.	41	III
	Carex pilulifera	.	.	.	.	.	.	.	.	.	.	1	+	.	1	1	+	.	1	.	+	.	1	1	.	.	+	.	.	.	.	.	+	+	34	II
	Antennaria dioica	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	+	+	+	+	25	II
	Anthoxanthum odoratum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	+	.	1	16	I
	Botrychium lunaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	6	I
	Polygala vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	6	I
	Phyteuma spicatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	6	I
CC	***Caricetea curvulae* Br-Bl. 1948**																																		
	Campanula barbata	+	+	+	+	+	+	+	+	.	+	+	+	.	+	+	+	.	+	.	+	+	+	+	.	+	+	.	+	+	+	.	.	75	IV
	Leontodon helveticus	+	+	+	.	.	+	2	+	.	.	.	2	.	+	+	1	.	+	.	.	.	.	.	+	.	.	1	.	.	+	.	.	+	47	III
	Pseudorchis albida	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	13	I
MA	***Molinio-Arrhenatheretea* R. Tx. 1937 em. R. Tx. 1970**																																		
	Festuca rubra agg.	.	.	.	.	.	.	+	+	.	1	.	.	.	+	1	+	+	+	.	2	3	.	.	+	1	.	+	2	2	.	1	.	50	III
	Lychnis flos-cuculi	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	+	.	.	+	.	+	.	.	+	.	+	+	+	+	+	.	38	II
	Deschampsia caespitosa	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2	1	2	.	16	I
	Cruciata glabra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	13	I
	Agrostis capillaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	+	.	.	+	.	9	I
	Leucanthemum vulgare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	9	I
	Ranunculus acris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	9	I
	Molinia caerulea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	6	I
	Euphrasia stricta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	6	I
VP	***Vaccinio-Piceetea* Br.-Bl. in Br.-Bl. et al. 1939**																																		
	Vaccinium vitis-idaea	+	+	2	2	1	1	1	.	+	.	+	+	+	.	+	+	1	1	1	2	2	+	.	.	.	2	.	.	.	+	.	+	69	IV
	Luzula pilosa	.	.	.	.	.	+	.	.	.	.	.	+	+	1	1	.	+	+	+	+	+	.	.	+	+	+	.	.	.	.	.	2	44	III
	Luzula luzuloides	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	+	.	.	.	+	+	+	+	2	1	1	1	+	+	.	+	.	41	III
S	***Other species***																																		
	Melampyrum pratense	.	+	+	+	1	+	+	1	+	+	+	1	+	2	1	+	2	1	+	1	.	.	.	1	2	1	1	+	.	+	.	.	75	IV
	Vaccinium myrtillus	+	+	2	.	2	2	.	+	+	+	+	1	+	1	2	+	+	2	2	.	.	.	.	.	.	+	.	.	+	.	+	1	66	IV
	Avenella flexuosa	.	.	.	.	+	1	.	.	.	.	2	2	2	+	2	2	2	2	2	+	+	3	3	2	3	2	.	.	1	.	.	2	63	IV
	Gymnadenia conopsea	.	+	+	.	.	+	+	+	.	+	.	+	.	.	+	+	.	+	.	.	.	.	.	.	.	+	.	.	.	+	+	+	44	III
	Hieracium laeviculae	.	.	.	+	.	.	.	.	.	.	+	+	.	+	+	+	.	.	.	1	+	.	+	1	+	.	.	.	+	.	.	.	41	III
	Luzula sylvatica	1	+	+	+	+	.	1	.	+	+	.	.	.	.	+	.	+	2	.	.	.	+	.	.	.	.	.	.	.	.	.	.	38	II
	Anemone nemorosa	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+	.	+	.	.	.	+	.	.	+	.	.	.	.	.	.	19	I
	Gentiana cruciata	.	+	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	19	I
	Crocus napolitanus	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	13	I
	Teucrium chamaedrys	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	6	I
	Hypericum montanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	6	I
	Stellaria graminea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	6	I
	Rhinanthus pulcher	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	6	I
	Veronica chamaedrys	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	6	I
	LICHENS:																																		
	Cladonia spp.	1	+	.	+	2	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	16	I
	Cetraria islandica	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	I

Locations and sporadic taxa (lokacije in posamezne vrste):
1 - slope of Veliki Črni vrh; 2 - between Mali Črni vrh and Veliki Črni vrh, *Lycopodium clavatum*; 3 - Veliki Črni vrh - Otiše; 4 - slope of Velika Kopa; 5 - V. Črni vrh; 6 - V. Črni vrh; 7 - Mali Črni vrh; 8 - Črni vrh - Otiše; 9 - Mulejev vrh; 10 - Konjiška planja; 11 - Planinka; 12 - Jezerski vrh; 13 - Ostruščica; 14 - Otiše; 15 - Ribniška koča; 16 - Mali Črni vrh; 17 - Ostruščica; 18 - Veliko sedlo, Pungart; 19 - Otiše-V. Črni vrh; 20 - Ostruščica; 21 - Ostruščica-Rogla, *Molinia arundinacea, Carex pallescens*; 22 - Planinka; 23 - Planinka; 24 - Ostruščica; 25 - Ostruščica; 26 - Jezerski vrh; 27 - Ostruščica, *Blechnum spicant*; 28 - Konjiška planja, *Euphrasia rostkoviana, Danthonia decumbens*; 29 - Ribniška koča, *Cerastium glomeratum, Ranunculus platanifolius*; 30 - Otiše - saddle of Pungart, *Trifolium repens, Hieracium pilosella*; 31 - at the foot of Ostruščica; 32 - Velika Kopa-Otiše, *Carlina acaulis, Trifolium pratense*.
Legend (legenda): VP - *Vaccinio-Piceetea*, CC - *Caricetea curvulae*

nostic species of the association as well as the species of the class and alliance are well represented, considering that this are species-poor grasslands. In sampled relevés some species of the classes *Caricetea curvulae* and *Molinio-Arrhenatheretea* are present. Because of the nearby forest and spontaneous reforestation also a larger proportion of forest species is present.

Floristic composition

Four clusters of relevés were separated by TWINSPAN classification. The first 6 relevés represent the most dry and species-poor variant of Pohorje Matgrass swards. It is characterised by high cover of *Calluna vulgaris*, which gives to this grassland formation special physiognomic character. This stands are rich also in some others dwarf-shrubs, namely in *Vaccinium vitis-idaea* and/or *V. myrtillus*. According to some authors (*e.g.* Horvat *et al.*, 1974) they were named also as *"Nardo-Callunetum"*, which was a derivative of the wide interpreted association *"Arnico-Nardetum"*. Those grasslands however do not represent a separate association, but are parts of different Matgrass communities of different vegetation belts and phytogeographical regions. Heaths with *Calluna vulgaris* occur on very shallow soil, poor with minerals and with low pH values. These stands have often parts with bare surface and are more often exposed to erosion (inclination!) than typical variants of the association which predominately occur on flat ground. Relatively high is the proportion of lichens. Dominant are *Cetraria islandica* and different *Cladonia* species.

Relevés from 7 to 19 represent the most "typical" form of the *Homogyno-Nardetum* association. These stands are found on the gentle sloping ridges of the tops of Pohorje: from Volovica over Rogla, Mulejev vrh and Planinka; from Ribniško Pohorje over Črni vrh, Pungart to Mala Kopa and Velika Kopa. Species characteristic of this "central" variant are *Arnica montana, Veratrum album* subsp. *album, Homogyne alpina, Gentiana pannonica, Carex pilulifera, Hieracium aurantiacum, Festuca rubra* and *Leontodon helveticus*. Only occasionally also *Hypochoeris uniflora* and *Potentilla aurea* could be found. According to some historical data (Petkovšek, 1952) also *Gentiana acaulis* appears on Pohorje Mts. We could expect it also in this type of grassland stands unless it was found in lower altitude (at Pesnik) (Petkovšek, 1952; T. Wraber, 1967, *oral communication*). Since these stands are in the stage of slow spontaneous reforestation, it is possible, that *Gentiana acaulis*, because of the successful competition of (ungrazed) grass species, has firstly regressed and finally disappeared from Pohorje. Characteristic species of these Matgrass swards and specially those on higher altitudes is also *Rhinanthus pulcher*.

Cluster with relevés from 27 to 32 represent more eutrophic (mesophile) variant of Matgrass swards, characteristic of saddles, flat plains and even small hollow depressions when they are not too moist. Soil is deeper and richer with nutrients. Such grasslands are also of major economic value. They are used as meadows and pastures. Larger is the proportion of the *Molinio-Arrhenatheretea* species (Tab. 1), such as *Festuca rubra* agg., *Deschampsia caespitosa, Lychnis flos-cuculi, Cruciata glabra, Ranunculus acris etc.* Relevés from 20 to 26 are transitional forms from typical to the grasslands with higher eutrophication level.

Matgrass grasslands can also become marshy. Acid soil and additional acidification due to the water stagnation lead to the appearance of species of raised bogs and intermediate mires of the classes *Oxycocco-Sphagnetea* and *Scheuchzerio-Caricetea fuscae*. First *Molinia caerulea* begins to dominate. These stages in which still some Matgrass grasslands species could be found, become floristically poorer. *Nardus stricta* slowly gives way to mesophilous *Carex* and grass species (*e.g. Carex canescens, C. pilulifera, Danthonia decumbens*) and shortly afterwards *Eriophorum angustifolium* and *E. vaginatum* become dominant. Some authors (*e.g.* Wagner, 1954; Ellmauer, 1993) classify such intermediate stages still within the Matgrass swards. However, they present the separate atlantic alliance *Nardo-Juncion squarrosi* (Oberd. 1957) Passarge 1964. Our opinion is that such vegetation formation are already outside of grassland vegetation: *Nardus stricta* remains because of its tolerance of the humidity and acidity. Relevés of such stands were therefore not placed within vegetation discussed in these study.

Geo-elements

The chorological structure of the association (Fig. 2) with the absence of Illyrian species and with the high portion of European (including Alpine) geo-elements confirms geographical position of Pohorje Matgrass swards at the easternmost edge of the Central Alps. Almost one third of the species represent Circumboreal, Arctic-Alpine and Alpine geo-elements. Second third represent Eurasian, European and Eurosiberian geo-elements and the rest Mediterranean-Montane, Eurimediterranean and Cosmopolite species.

Ecological conditions

Ellenberg indicator values

Ecological conditions of the stands were estimated by Ellenberg indicator values (Ellenberg *et al.*, 1991) for light, temperature, soil moisture, pH and nitrogen content (Fig. 3). Mean values of weighted averages were calculated for each group (cluster) of relevés: (1) heath, (2) typical stands, (3) transitional stands between (2) and (4), (4) relatively eutrophic stands.

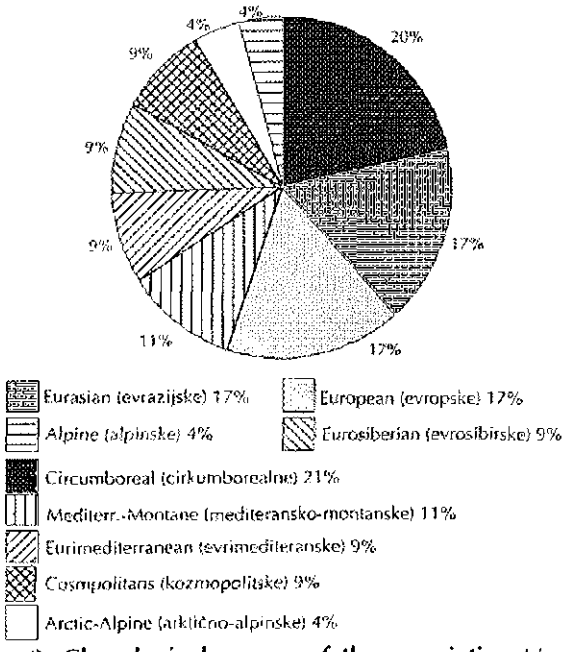

Fig. 2: Chorological groups of the association** Homogyno alpinae-Nardetum **in the area of Pohorje.
Sl. 2: Geoelementna sestava asociacije** Homogyno alpinae-Nardetum **na območju Pohorja.

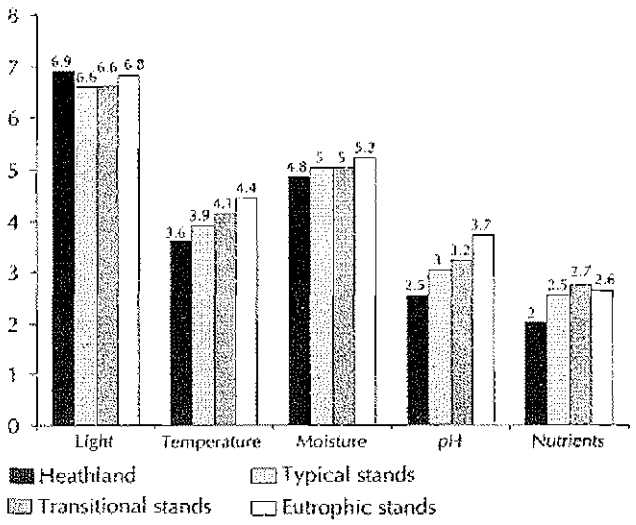

Fig. 3: Mean values of weighted averages of Ellenberg indicator values for four (4) groups (clusters) of relevés of** Homogyno alpinae-Nardetum **association.
***Sl. 3: Povprečje tehtanih (ponderiranih) srednjih vrednosti Ellenbergovih indeksov za štiri skupine (klastre) popisov asociacije** Homogyno alpinae-Nardetum.*

The Ellenberg light-values show, that in all stands heliophilous grasslands species are predominating. Apart from altitudinal levels we deal with species of open and sunny habitats. Indicator values for temperature show gradient from relevés of heaths (the lowest value) to eutrophic stands (the highest value), which we interpret with the occurrence of sporadic sub-Alpin species in heaths and in typical formation. In the eutrophic stands also some species of lowland intensive-used grasslands are present. Humidity doesn't vary much; the lowest value was calculated for heath and the highest for eutrophic stands, with deeper and therefore more humid and nutrients-rich soil. Ellenberg reaction values clearly show acidophilous character of studied Matgrass swards. According to the species, soil reaction is the lowest in heaths and the highest in eutrophic stands. Also soil fertility does not differ much between clusters. However heath stands appeared to be less fertile than others.

Spontaneous reforestation of Pohorje plains

Matgrass grasslands of Pohorje have a semi-natural origin, *i.e.* they had been developed and are maintained because of the human activities. Due to the changes in traditional land-use, most plains of Pohorje are no longer used for grazing and mowing and are increasingly being regrown by trees. The natural reforestation process is relatively slow and could be noticed throughout a longer period. Main factors which slow down this secondary succession are: 1. short vegetation season due to the montane climate; 2. absence of the shrubs, which generally play important role in the process of reforestation; 3. acid soil causes lower species-richness than lime-rich soil – lower species-richness has negative influence on the secondary succession; and 4. absence of invasive Umbelliferous species (*e.g. Laserpitium siler, L. latifolium* on limestone), which in many cases become competitive since the removal of man's influence. However, the process of spontaneous reforestation is making progress. A determining role play favourable edaphic conditions, *e.g.* in small depressions and on the slopes with deeper soil which has more water-holding capacity. In such stands *Carex brizoides*, which is otherwise typical for wet lowland forests, becomes absolutely dominant and can form pure stands. *Carex brizoides* become very invasive species, which overgrows other smaller plants and is spreading by rhizomes. Moisture and shade are favourable ecological conditions, which comes with its invasion. We can often observe how the isolated tree or group of trees in the middle of plains represent nucleus of spontaneous reforestation (Kaligarič, 1995). When the reforestation process starts with *Carex brizoides* stages, not concentric, but asymmetric patches are formed, due to the fact that there is more sedge on the shady than on the sunny site of the trees. Stands with *Carex brizoides* are very species-poor – heliophilous grassland species are reduced, while the penetration of forest species is very slow. At the same time two woody species appear – spruce *(Picea abies)* and mountain ash *(Sorbus aucuparia)*, and also sporadic forest species of the herbaceous layer: *Anemone nemorosa, Solidago virgaurea,*

Polygonatum multiflorum, etc. However the sedge is not always the first coloniser of the fallow plains. On dry places first spruce or mountain ash start to germinate. They change microclimate by giving shadow and enable enlarging of the nucleus of reforestation (Kaligarič, 1995). Very successful is also spreading of already existent forest. Its frontal part slowly approaches the grassland centre and narrows its area. The smaller is grassland area the greater is effect of forest on the microclimate. The solar radiation is now converted at the level of the woodland canopy and cannot reach the lower growing plants. Decisive influences have higher humidity and lower temperatures in summer time. Many helio- and thermophilous herbaceous plants are being suppressed by dwarf-shrubs like *Vaccinium myrtillus* on dry and *Carex brizoides* on humid sites.

PRISPEVEK K POZNAVANJU VEGETACIJE SUHIH TRAVIŠČ OVRŠNIH PREDELOV POHORJA (SLOVENIJA)

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POVZETEK

Avtorja sta vzorčila sestoje suhih travišč – planj in resav na ovršnih predelih Pohorja po standardni Braun-Blanquetovi metodi. Ugotovila sta, da so travišča na najvišjih predelih precej uniformna, floristično skromna in da se počasi zaraščajo. Travišča pripadajo redu sekundarnih travišč na silikatih Nardetalia *Oberd. ex Preising 1949, zvezi volkovij* Nardo-Agrostion tenuis *Sillinger 1933. Ker so ta travišča že blizu gozdne meje (ki na Pohorju sicer ni dosežena) segajo vanje tudi vrste iz naravnih subalpinskih volkovij (zveza* Nardion, *razred* Caricetea curvulae). *Tako tvorijo mešanico z izrazito subalpinskim vplivom in hkrati prevladujočim kontingentom nižinskih nardetalnih in arenateretalnih vrst, kar smo – poleg nadmorske višine, ki ne dosega gozdne meje – upoštevali tudi pri uvrstitvi. Ugotovili smo asociacijo* Homogyno alpinae-Nardetum *Mráz 1956, ki je po vsem ovršnem delu Pohorja precej enotna, variira pa glede na talne razmere, zasenčenost in stopnjo evtrofiziranosti. Na plitkih tleh z razgaljeno matično kamnino je floristična sestava skromnejša. V večji meri se pojavljajo vrste* Calluna vulgaris, Antennaria dioica, *lišaji (npr.* Cetraria islandica *in vrste rodu* Cladonia *spp.), ind. Ta tip vegetacije je poznan pod imenom pohorske resave. V zasenčenih legah se pojavljajo gozdne vrste in* Carex brizoides, *v bolj evtrofiziranih razmerah pa arenateretalne vrste. Asociacija je optimalno razvita na sončnih, suhih rastiščih z rahlim naklonom.*

Geoelementna sestava z odsotnostjo ilirskih vrst in s prisotnostjo evropskih elementov, vključno z alpinskim, potrjuje lego pohorskih planj na zadnjem JV odseku Centralnih Alp. Sinekološke značilnosti obravnavane vegetacije smo ocenjevali z Ellenbergovimi indeksi za svetlobo, temperaturo, vlažnost, pH in hranilnost. Indeks za svetlobo kaže, da na teh travišćih prevladujejo heliofilne vrste. Medtem ko so najbolj topla, vlažna ter z najvišjim pH rastišča bolj evtrofiziranih sestojev, so najbolj zakisana in s hranilnimi snovmi siromašna rastišča resav.

Zaradi opustitve paše oziroma košnje se velik del pohorskih planj zarašča z gozdom. Zaraščanje je sicer počasnejše v primerjavi s tistim iz nižin ali na apnencu vendar kljub temu napreduje. Razlikujemo več tipov zaraščanja: (1) na tleh z več vlage poteka zaraščanje z migaličnim šašom (Carex brizoides), *(2) na suhih tleh se prične zaraščanje z uspešno kalitvijo smreke ali jerebike, ki ustvarita uspešno mikroklimo za večanje jedra zaraščanja in (3) širjenje že obstoječega gozda.*

Ključne besede: suha travišča, silikati, volkovja, *Nardo-Agrostion tenuis, Homogyno alpinae-Nardetum*, Pohorje, Slovenija

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