Sanguisorbo minoris-Anthericetum ramosi ass. nova – plant community of sliding chalk slopes in East Bohemia

***Sanguisorbo minoris-Anthericetum ramosi* ass. nova – rostlinné společenstvo bílých strání východních Čech**

Martin Duchoslav

Department of Botany, Faculty of Sciences, Palacký University, Svobody 26, 771 46 Olomouc, Czech Republic

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A new association (*Sanguisorbo minoris-Anthericetum ramosi*) of the alliance *Bromion erecti* Koch 1926 is described from the marl sliding slopes in East Bohemia (Czech Republic). A complex characteristics of this community are given.

Keywords: Chalk slopes, phytosociology, *Sanguisorbo minoris-Anthericetum ramosi*, *Bromion erecti*, Czech Republic

Introduction

Calcareous sediments represent an important geological substratum in Bohemia. Physicochemical properties of these sediments, together with their diverse relief and wide distribution in different mesoclimatic regimes, make possible the occurrence of rather diverse vegetation. The warmest parts of Bohemia, suitable for agriculture, were early deforested which caused the spread of subxerothermous and xerothermous grassland communities, mainly of the class *Festuco-Brometea*. Communities of the *Bromion erecti*-alliance, an important type among grassland vegetation, are prevailing on this type of geological substratum.

Phytosociologists have been attracted by the richness and the diversity of different *Bromion erecti* Koch 1926 alliance communities since the beginning of this century. Rough descriptions of vegetation mainly of NW part of Bohemia were published by Klika (1929, 1933, 1951), Šimr (1940) and others. Papers by Mikyška (1956, 1968), Neuhäusl et Neuhäuslová (1989), Kolbek et Kubíková (1985), Kopecký et Husová (1987), Kubíková (1977, 1982, 1987), Petříček (1980), Petříček et Kolbek (1994), Studnička (1978, 1980), Toman (1976, 1981, 1988) contributed significantly to the knowledge of this vegetation. The last survey of vegetation units of the alliance *Bromion erecti* Koch 1926 was presented by Kolbek (in Moravec et al. 1995) and by Toman (1988). At present, about 25 associations have been known, most of them having the centre of distribution in northern, central or south-western parts of Bohemia (e.g. the Bohemian Karst, the České Středohoří Hills, the Elbe Basin) and in south or central Moravia where they occur also on different geological substrata and soil types.

The analysis of grassland vegetation of the *Bromion* is complicated by (1) unsufficient knowledge of ecological conditions, mainly in the east Elbe Basin, (2) intensive agricultural exploitation (fertilizing, cutting, grazing, ploughing), or (3) the abandonment of these

areas, leading to the retreat of these localities because of successional processes associated with the establishment of woody plants and changes in species composition.

One of the most conspicuous habitats of the contemporary landscape in the study area are steep erosional (deforested) marl rocky slopes called "white slides" (Studnička 1978, 1980). The white slides are known mainly from the České Středohoří Hills, and occur in the Czech Plateau on structural slopes, breaks, cuestas, hills and ridges (cf. Demek et al. 1965). The present paper deals with vegetation units typical of white slides in the eastern part of the Pardubice Elbe Basin phytogeographical district (East Bohemia, Fig. 1).

Methods

The Zürich-Montpellier approach (Braun-Blanquet 1964) was used to classify the vegetation of the study area. New units are suggested according to the Code of Phytosociological Nomenclature (Barkman et al. 1988). Nomenclature of the higher syntaxa follows Moravec et al. (1995), that of taxa Neuhäuslová et Kolbek (1982).

Species diversity H' was computed using the Shannon formula (Magurran 1988), evenness e was expressed according to Pielou's formula (Pielou 1966). Cluster analysis (ordinal transformation – van der Maarel 1979; Euclidean distance, Ward's method – Jongman et al. 1987) was used for mathematical exploitation. Soil analyses were made according to the methods of Kubíková (1970) and Králová et al. (1990). The pH value was measured in water extract or in extract with KCl (0.1 M). Janka's lime-meter was used for the estimation of carbonate concentration. Carbon content was estimated by titration of redundant dichromate by Mohr's salt after oxidation by chrome-sulfur mixture.

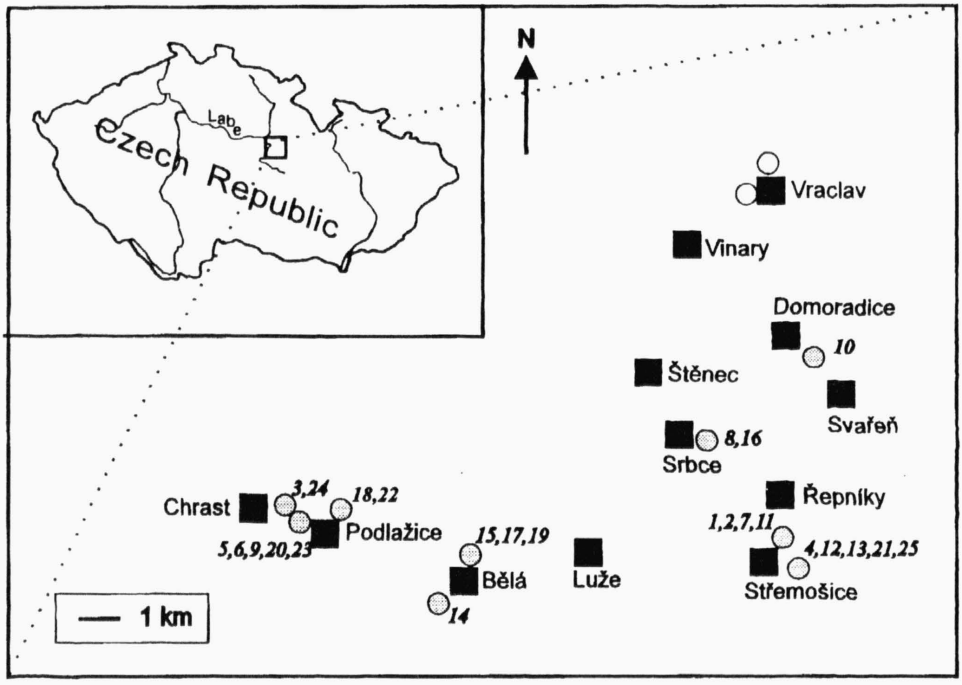

Fig. 1. – The distribution of *Sanguisorbo-Anthericetum* in East Bohemia (see Table 1 for relevé number).

Syntaxonomy

During the phytosociological investigation of the white slides of East Bohemia, some stands could not be identified with any known vegetation type and are thus considered as a new association:

Sanguisorbo minoris-Anthericetum ramosi ass. nova hoc loco

Table 1, relevés no. 1–25
Nomenclatural type: Table 1, relevé no. 3, holotypus

Diagnostic species: *Anthericum ramosum, Euphorbia cyparissias, Sanguisorba minor, Brachypodium pinnatum*

The community is assigned to the *Bromion* alliance.

Anthericum ramosum, a dominant species of the community (V, 2–4) is considered a differential species of the association. The group of typical species includes *Sanguisorba minor* (V, +–2), *Euphorbia cyparissias* (V, r–1), and *Brachypodium pinnatum* (IV, +–4). Some taxa belonging to other classes are present with low cover – *Viola hirta*, *Cirsium acaule*, *Potentilla neumanniana*, *Coronilla varia* (class *Festuco-Brometea*), *Knautia arvensis* (*Molinio-Arrhenatheretea*), *Bupleurum falcatum*, *Origanum vulgare* (*Trifolio-Geranietea*) – as well as some taxa without higher syntaxonomical relevance, e.g. *Linum catharticum*, *Convolvulus arvensis* (Table 1). Number of accidental species are typical of the community (Fig. 2). Mean number of species in a relevé is low, and the same holds for species diversity and equitability (Table 2).

Fig. 2. – Presence histogram of the *Sanguisorbo-Anthericetum* species.

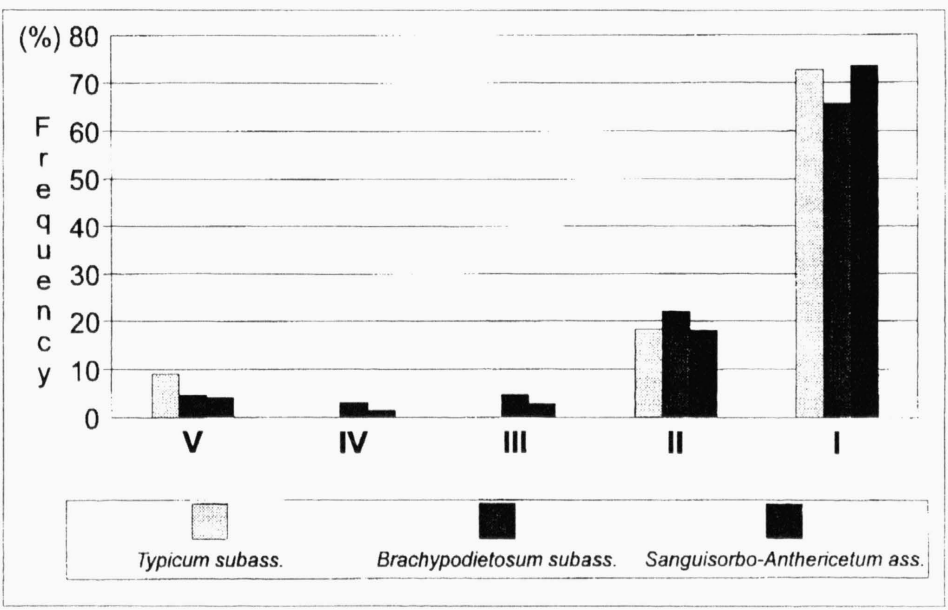

Table 1. – *Sanguisorbo minoris-Anthericetum ramosi* ass. nova

No. of relevé	1	2	3	4	5	6	7	8	9	10	C_1	11	12	13	14	15	16	17	18	19	20	21	22	C_2	23	24	25	C_3	C_4	C
No. of species	4	4	6	6	10	7	8	8	9	16	(%)	12	12	13	15	16	16	16	18	17	20	20	22	(%)	12	13	17	(%)	(%)	(%)
Altitude (m)	430	440	280	440	280	440	440	380	290	360		440	440	440	340	345	380	340	280	340	280	440	280		280	270	450			
Area (m^2)	4	9	4	9	4	9	9	4	9	9		9	9	9	9	9	4	12	16	9	9	9	16		9	9	9			
Orientation	S	S	WSW	S	SSW	SSW	S	WSW	SSW	SW		S	S	S	SSE	SSE	WSW	SSE	SW	SSE	SSW	S	SW		SSW	SSW	S			
Inclination (°)	45	45	20	10	20	30	45	25	20	50		40	35	40	35	35	30	35	30	35	15	10	30		10	10	10			
Cover E_1 (%)	40	60	70	50	60	50	35	70	50	55		85	85	75	80	80	90	75	85	80	95	90	80		95	90	95			
E_2 (%)	.	.	.	.	.	.	.	.	.	5		1	20	.	3	3	5	1	.	1	3	3	15		.	.	3			
E_2																														
Prunus spinosa	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	+	.	+	.	+	2	33	.	.	.	0	27	16
Rosa canina	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	+	+	.	17	.	.	+	33	20	12
Rosa subcanina	.	.	.	.	.	.	.	.	.	r	10	.	.	.	.	.	r	.	.	.	r	.	.	17	.	.	.	0	13	12
Fraxinus excelsior	.	.	.	.	.	.	.	.	.	.	0	.	.	.	+	+	+	.	.	.	.	.	.	25	.	.	.	0	20	12
Pinus nigra	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	r	.	.	8	.	.	r	33	13	8
Swida sanguinea	.	.	.	.	.	.	.	.	.	+	10	.	.	.	.	.	+	.	.	.	.	.	.	8	.	.	.	0	7	8
Cerasus avium	.	.	.	.	.	.	.	.	.	.	0	r	3	.	.	.	.	.	.	.	.	.	.	17	.	.	.	0	13	8
E_1																														
D - ass.																														
Anthericum ramosum	3	4	4	3	4	3	2	4	3	3	100	3	3	3	4	3	2	3	4	3	3	3	4	100	3	3	3	100	100	100
D - subass.																														
Brachypodium pinnatum	.	.	+	+	.	+	.	.	.	.	30	3	3	3	1	2	4	+	2	+	3	2	2	100	2	1	2	100	100	72
Centaurea jacea	.	.	.	.	.	.	.	.	.	.	0	+	.	+	+	1	+	+	.	+	.	+	+	75	+	+	+	100	80	48
Scabiosa columbaria	.	.	.	.	.	.	.	.	+	1	20	.	.	+	+	1	+	+	.	+	.	.	+	58	.	.	r	33	53	40
Galium verum	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	1	1	1	.	1	1	42	.	1	.	33	40	24
D - var.																														
Bromus erectus	.	.	.	.	.	+	.	.	.	.	10	.	.	.	.	.	.	.	.	.	+	.	.	8	3	3	2	100	27	20
Ch, D - *Festuco-Brometea*																														
Sanguisorba minor	.	+	+	1	1	+	1	+	1	2	90	1	+	+	+	+	.	+	1	+	+	+	+	92	+	1	1	100	93	92
Euphorbia cyparissias	+	.	r	+	+	+	r	+	1	1	90	+	+	+	+	.	+	+	1	+	+	+	+	92	.	+	.	33	80	84
Viola hirta	.	.	.	.	.	.	.	+	.	1	20	.	.	+	.	.	+	.	1	.	+	+	+	50	.	.	.	0	40	32
Cirsium acaule	.	.	.	+	.	.	.	.	.	+	20	.	+	+	.	.	+	.	.	.	.	+	r	42	.	.	+	33	40	32
Salvia verticillata	.	+	.	+	.	.	.	+	r	.	40	.	+	.	.	.	.	+	.	+	.	.	.	25	.	.	.	0	20	28
Festuca rupicola	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	+	.	+	.	+	.	2	.	33	1	1	1	100	47	28
Potentilla neumanniana	.	.	.	.	.	.	.	.	+	.	10	.	.	r	+	.	+	.	r	.	.	.	+	42	.	+	.	33	40	28
Coronilla varia	.	.	.	.	+	.	.	.	+	+	30	.	.	.	r	+	.	r	.	.	.	.	.	25	.	.	.	0	20	24
Salvia pratensis	.	.	.	.	.	.	r	.	.	.	10	.	.	.	.	.	.	.	+	.	+	1	.	25	r	+	.	67	33	24
Carex flacca	.	.	.	.	.	.	.	.	.	.	0	.	.	r	.	.	+	.	2	.	.	.	2	33	.	.	.	0	27	16
Centaurea scabiosa	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.	.	.	.	.	.	r	8	+	+	+	100	27	16
Medicago falcata	.	.	.	.	.	.	.	.	.	+	10	.	.	.	.	.	.	+	.	+	+	.	.	25	.	.	.	0	20	16

Ajuga genevensis										0	+		r			+	+						33				0	27	16
Stachys recta			+			+				20													0			+	33	7	12
Galium glaucum										0											1		8	1		2	67	20	12
Ononis spinosa										0		r						+				r	25				0	20	12
Koeleria pyramidata										0								+			+	+	25				0	20	12
Helianthemum nummularium										0	r							+					17				0	13	8
Fragaria viridis									1	10													0	+			33	7	8
Ch, D - *Molinio-Arrhenatheretea*																															
Knautia arvensis				r		r		+		30								+		r		+	25			r	33	27	28
Achillea millefolium				+						10											+		8		1	1	67	20	16
Lotus corniculatus									+	10				+				1					17				0	13	12
Arrhenatherum elatius									+	10										+	1		17				0	13	12
Galium album								+	1	20													0				0	0	8
Ch, D - *Trifolio-Geranietea*																															
Bupleurum falcatum			+		1		r			30	r	+	+	+	1		+	1	+		+		75				0	60	48
Origanum vulgare										0					1		+		1				25				0	20	12
Pyrethrum corymbosum										0										+	+		17				0	13	8
Companions																															
Convolvulus arvensis	+				+	+				30		+		r	r					r			33				0	27	28
Lembotropis nigricans										0	r		+			r							25	1	1	1	100	40	24
Linum catharticum								r		10					+	+						r	25	+		+	67	33	24
Hieracium sabaudum										0							r		+		+		25				0	20	12
Chamaecytisus supinus										0									+	+	1		25				0	20	12
Reseda lutea	+					+				20													0				0	0	8
Campanula rapunculoides		+					+			20													0				0	0	8
Carex digitata							1			10		3											8				0	7	8
Hieracium pilosella										0	+											+	17				0	13	8
Melilotus alba										0				+	+								17				0	13	8
Carex montana										0								2	+				17				0	13	8
Solidago virgaurea										0								2				2	17				0	13	8
Thymus pulegioides										0								1				+	17				0	13	8
Genista tinctoria										0										1	1		17				0	13	8

Species recorded in one relevé only:
E_1: *Agrimonia eupatoria* 20: +, *Carlina acaulis* 5: +, *Clinopodium vulgare* 22: r, *Daucus carota* 5: r, *Hypericum perforatum* 15: +, *Inula conyza* 10: +, *Lithospermum officinale* 10: r, *Peucedanum cervaria* 11: r, *Pimpinella saxifraga* 15: +, *Plantago media* 20: +, *Poa angustifolia* 18: +, *Polygala comosa* 15: r, *Taraxacum officinale* 16: r, *Vicia cracca* 22: r
E_2: *Crataegus laevigata* 5: +, *Populus tremula* 14: r, *Rubus fruticosus* agg.14: r, *Quercus robur* 12: r

Localities of relevés in Table 1: 1, 2, 7, 11: Střemošice - slope above the village, 19.8.1990; 4, 13, 25, 21, 12: Střemošice - slope 200 m W above Střemošice village, 19.8.1990; 3, 24: Chrast - slopes 500 m SE of the town, 12.9.1990; 5, 6, 9, 20, 23: Podlažice - slopes 1 km NW of the village, 12.9.1990; 8, 16: Srbce - slopes above the village, 12.9.1990; 15, 17, 19: Bělá - slope above the village, 8.8.1990; 14: Bělá - slope 300 m SW of the village, 8.8.1990; 18, 22: Podlažice - slope 1 km E of the village, 9.8.1990; 10: Domoradice - slope 300 m SW of the village, 10.8.1989

Explanations: C_1 - presence of the *typicum* subass.; C_2 - presence of the *typicum* var. (the *brachypodietosum* subass.); C_3 - presence of the *Bromus erectus* var. (the *brachypodietosum* subass.); C_4 - presence of the *brachypodietosum* subass.; C - presence of the *Sanguisorbo-Anthericetum*

Table 2. – Mean species richness (N), diversity (H') and equitability (e) in the *Sanguisorbo-Anthericetum*.

Community	N	H'	e
Sanguisorbo-Anthericetum typicum (n=10)	7.8	1.78	0.90
Sanguisorbo-Anthericetum brachypodietosum (n=15)	15.9	2.59	0.94
Sanguisorbo-Anthericetum (n=25)	12.7	2.26	0.92

Sanguisorbo-Anthericetum is divided into two subassociations:

(a) ***typicum* subass. nova hoc loco**

Table 1, relevés no. 1–10
Nomenclatural type: Table 1, relevé no. 3, holotypus

The subassociation has no differential species. This early successional community, dominated by *Anthericum ramosum*, is very poor in species, and has a low diversity and equitability (Table 2). Herb layer rarely exceeds 60 % cover.

(b) ***brachypodietosum* subass. nova hoc loco**

Table 1, relevés no. 11–25
Nomenclatural type: Table 1, relevé no. 13, holotypus

Differential species: *Brachypodium pinnatum*, *Centaurea jacea*, *Galium verum*, *Scabiosa columbaria*

Species of the classes *Trifolio-Geranietea* and *Molinio-Arrhenatheretea* are rather over-represented in this community, which follows the stands of the previous subassociation in succession. The species number is doubled and species diversity and equitability are also higher compared to the subassociation *typicum*, the reason for it being lower level of stress and disturbance imposed on the stands of *brachypodietosum* subassociation (Table 2). The cover of herb layer usually exceeds 75 %.

Two variants were distinguished within the *brachypodietosum* subassociation:

(b1) ***typicum* var. nova hoc loco**

Table 1, relevés no. 11–22
Nomenclatural type: Table 1, relevé no. 13, holotypus

(b2) **variant with *Bromus erectus* var. nova hoc loco**

Table 1, relevés no. 23 – 25
Nomenclatural type: Table 1, relevé no. 24, holotypus

This community occurs in the contact with stands of *Bromus erectus* (cf. Fiedler 1985).

Two clusters corresponding to the above mentioned subassociations (*typicum* and *brachypodietosum*) were distinguished by cluster analysis (Fig. 3). Relatively high mutual similarity of the *typicum* relevés is caused by low species number and even occurrence of dominant species (*Anthericum ramosum*, *Sanguisorba minor*, *Euphorbia cyparissias*).

Within the subcluster representing the subass. *brachypodietosum*, the relevés 23–25 belong to the variant with *Bromus erectus* (Fig. 3).

Structure and physiognomy

The structure of the studied community is closely related to soil factors. The cover and complexity of vertical structure of the vegetation increases in succession.

Two strata may be distinguished in the herb layer (E_1):

(a) the lower stratum ($E_{1\alpha}$) up to ca 10 cm is formed by *Fragaria viridis*, *Viola hirta*, *Cirsium acaule*, *Potentilla neumanniana*, *Convolvulus arvensis*, *Linum catharticum*, *Helianthemum nummularium* and *Hieracium pilosella*.

(b) the higher stratum ($E_{1\beta}$) up to 30–50 (rarely to 70) cm is formed mainly by *Anthericum ramosum* and by species with low cover, i.e. *Sanguisorba minor*, *Euphorbia cyparissias*, *Coronilla varia*, *Scabiosa columbaria*, *Brachypodium pinnatum*, *Centaurea jacea*, *Reseda lutea*, *Lembotropis nigricans*, *Festuca rupicola*, *Carex montana*, etc.

Moss (E_0) and shrub (E_2) layers are rarely present, always with low cover. The latter is formed by *Prunus spinosa* and *Rosa canina*.

The herb layer, with cover 35–95 % (Table 1), is formed by sparse tussocks of *Anthericum ramosum* (Fig. 4). Other species occur rather sporadically. Erosion-resistant hemicryptophytes (*Sanguisorba minor*, *Bupleurum falcatum*, *Cirsium acaule*) play quite an important role, whereas grasses and grass-like species (*Brachypodium pinnatum*, *Bromus erectus*, *Festuca rupicola*, *Carex montana*) are found in less disturbed places. Hemicryptophytes prevail among life-forms (about 80 %), phanerophytes are also frequent, being, however, more rare in stands of the *typicum* subassociation. Chamaephytes and therophytes are very rare. The only geophyte is *Anthericum ramosum*.

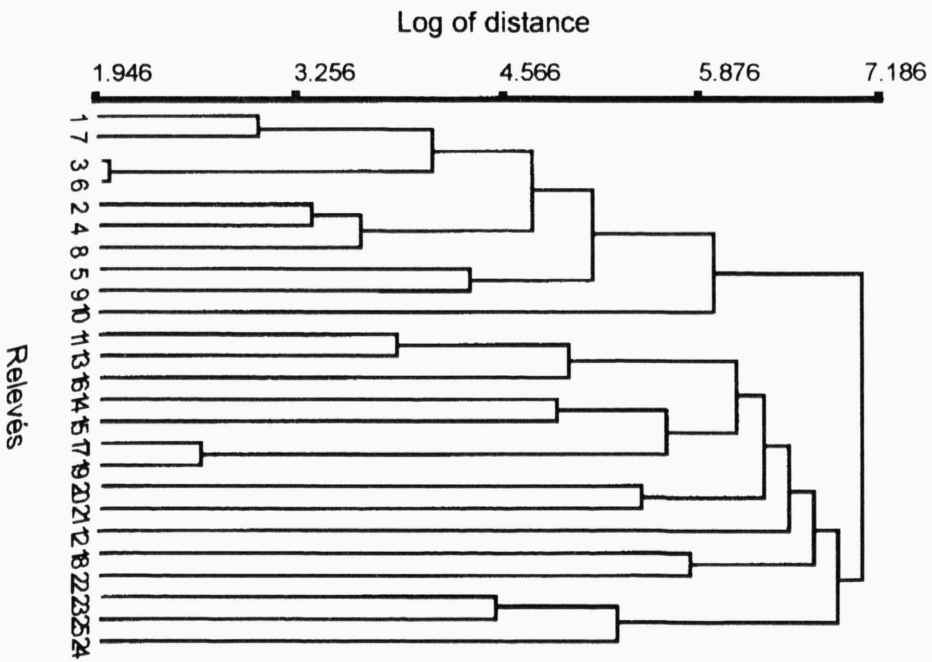

Fig. 3. – Cluster analysis of the *Sanguisorbo-Anthericetum*. For relevé numbers see Table 1.

As to the life strategies (according to Grime 1979; extracted from Frank et Klotz 1990), the following are represented: CSR 38 %, C 35 %, CS 21 %. Species possessing ruderal and stress-tolerant strategies (and their combination) are either absent or present with a low frequency. A high percentage of species with competitive strategy is caused by their higher frequency in the *brachypodietosum* subassociation (grasses and some dicotyledons).

Submediterranean, Euroasian and Subatlantic floristic elements and their combinations (according to Oberdorfer 1962) are the most frequent among the species of *Sanguisorbo-Anthericetum* (about 65 %). The Continental, Subatlantic (s.s.) and Euroasian (s.s.) elements are less frequent. The Submediterranean element is more represented in the *typicum* subassociation whereas the Euroasian/Submediterranean element is more frequent in the subass. *brachypodietosum*.

Ecology

The *Sanguisorbo-Anthericetum* inhabits open sunny slopes (altitude 270–450 m a.s.l.) with S, SW and SE exposition and 10–50° inclination. The bed-rock in these sites is sandy marls (= clay slates) (Fig. 5), whose disintegration and jointing are easy.

The early successional *typicum* subass. occurs in raw marl disintegrated matter with undeveloped soil horizons. Raw soil is composed of fine-grain rubble mixed with clay. Chemical properties of this soil are analogous to those of the bed-rock (Table 3, rel. no. 7), i.e. a high content of carbonates and low content of organic carbon.

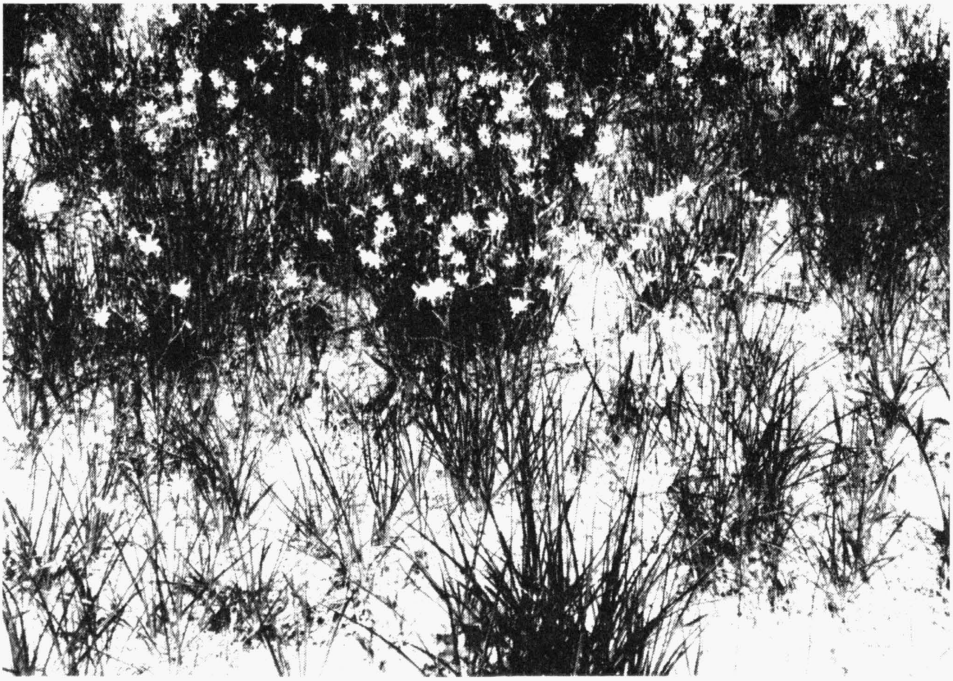

Fig. 4. – Stands of *Sanguisorbo-Anthericetum* (the Střemošická stráň Nature Reserve) with *Anthericum ramosum* (in flower) as the dominant species.

Table 3. Some physical and chemical properties of the soils covered by *Sanguisorbo-Anthericetum*

Relevé no.	Skeleton (%)	pH(H_2O)	pH(KCl)	$CaCO_3$ (%)	C (%)	Organic matter (%)
7	17	7,9	7,5	32	1,4	2,4
17	30,1	7,9	7,4	24	3,4	5,9
18	56	7,9	7,3	17	4,7	8,1

The *brachypodietosum* subass. occurs on rendsina soils. A-horizon (5–10 cm) is light brown, containg numerous roots. It lies on the matter rubble (Cd) and the bed-rock (C-horizon). The soil contains varying amount of skeleton, a lower concentration of carbonates and a higher concentration of organic carbon (Table 3).

The properties of marls and their influence on vegetation were studied by Studnička (1980). Because the clay represents the main component of soil, it is able to absorb a large amount of water which becomes almost inaccessible to plants. This, and some other properties together with the action of wind and radiation cause, mainly in winter, movement of the matter and of the skeleton. Rubble and soil are frozen, disintegrate and move downhill pulling out, covering up and damaging plants. The surface dries up in the summer and forms a hard crust, making the seed germination quite impossible. Also, the soil cannot absorb water during strong rainfalls, which transports skeleton downhill and denudes the rooting system of shallowly rooted plants. *Anthericum ramosum* is capable

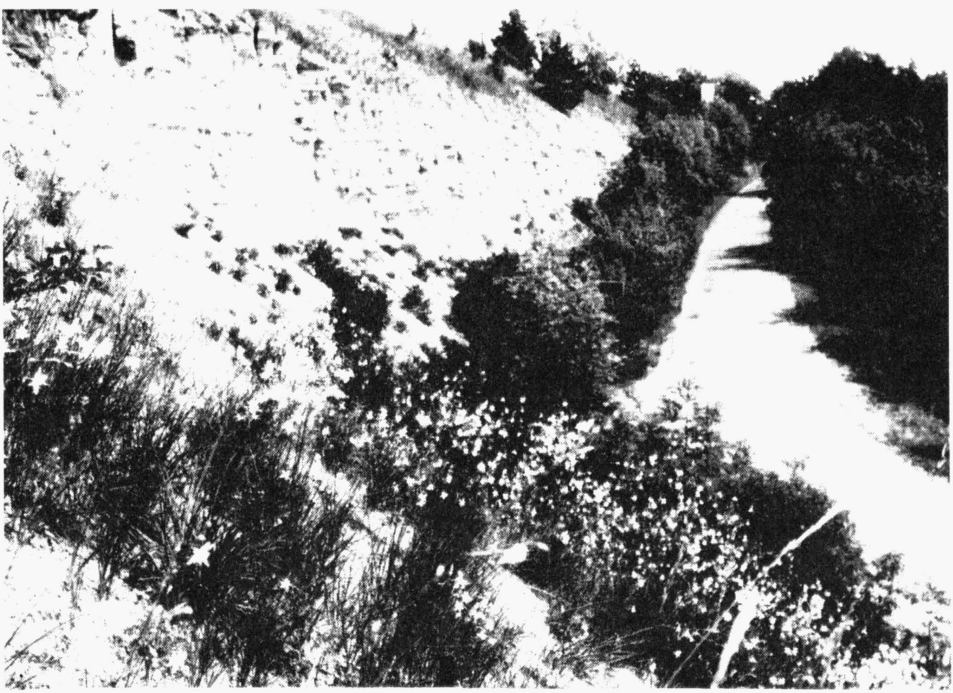

Fig. 5. – The *Sanguisorbo-Anthericetum* in the Střemošická stráň Nature Reserve.

of resisting these forces by forming large deeply rooted tussocks, which promote the subsequent development of other species.

Succession

The community develops on either (i) extreme treeless sites such as rocks, or (ii) deforested steep slopes after thermophilous forests exposed to erosion by water and wind or to grazing, trampling or other human influences (stone mining, transport etc.).

In the latter sites, the forest species retreat and those of warm and open habitats, either surviving so far as scattered populations in forests and glades or migrating from elsewhere, start to dominate. This is the case of *Anthericum ramosum* as well which species either occurs in E_1 of forests (e.g. *Melampyro nemorosi-Carpinetum primuletosum veris*, *Cephalanthero-Fagetum;* cf. Duchoslav 1992, Fiedler 1985) and then persists as one of the few species forming E_1 of the new community or regenerates from diaspores buried in the soil.

Further development of the community is variable, depending mainly on habitat conditions. *Anthericum* stands persist in eroded places, forming there so-called blocked successional stage (cf. Moravec 1969). Soil restoration is limited and the community persists for a long time (subass. *typicum*). If *Anthericum* is able to improve adverse abiotic and biotic conditions by fixing the slope, accumulating the soil in close neighbourhood and its enrichment by litter, other subxerothermous grasses and grass-like species (*Brachypodium pinnatum*, *Bromus erectus*, *Festuca rupicola*) and dicots (*Centaurea jacea*, *Galium verum*, *Scabiosa columbaria*, *Lembotropis nigricans*, *Knautia arvensis*) can colonize these less disturbed and less stressed stands. Competition, which is weak in the early stages, increases later on. Grasses are competitively superior to other herbs (cf. Table 1, *brachypodietosum* subass.). Qualitative and quantitative changes of the ecosystem occur and the community changes into *Scabioso ochroleucae-Brachypodietum pinnati* Klika 1933 (incl. *Bromus erectus* phytocoenoses) or the *Ononido spinosae-Cirsietum acaulis* Mikyška 1956 (for material from the studied territory see Fiedler 1985, Neuhäusl et Neuhäuslová 1989, Duchoslav 1996). These communities are characterized by higher number of species per relevé (ca 25–45), higher cover (ca 80–100 %) and a more complex structure. They are dominated by grasses such as *Brachypodium pinnatum, Bromus erectus, Festuca rupicola, Poa angustifolia* (*Scabioso-Brachypodietum*) and rosette hemicryptophytes such as *Cirsium acaule, Carlina acaulis, Plantago media* (*Ononido-Cirsietum*) (Table 4).

Distribution

At present, *Sanguisorbo-Anthericetum* is known to occur in the SE part of the phytogeographical district of the Pardubice Elbe Basin in the neighbourhoods of the villages of Chrast and Luže (Chrudim district) (Fig. 1). This area is situated at the border of Thermophyticum and Mesophyticum (Hejný et Slavík 1988) where the Elbe lowland rises up toward the Žďárské vrchy Hills. Reasons for the origin and existence of this vegetational type in this area are as follows:

(a) Average annual temperatures in this region are relatively high (8.2°C at Luže-Košumberk meteorological station – Vesecký et al. 1956). The course of temperature is very close to that of moisture at the end of August and September (see climadiagram in Fiedler 1985), indicating the occurrence of a dry period (cf. Studnička 1980:158).

Table 4. – Comparison of presence of selected species in *Bromion erecti* communities recorded in stands of the white slides.

Association	A[1]	B1[2]	B2[3]	C1[4]	C2[5]	C3[6]	D[7]	E1[8]	E2[9]	E3[10]	E4[11]	F4[12]
No. of relevés	25	10	20	10	24	20	5	16	10	20	7	20
Character and differential species of particular associations												
Anthericum ramosum	V	V	IV		I	I	I	I	I			I
Helianthemum nummularium	I	V	III			I		I	I		I	I
Cirsium pannonicum	(+)	V	IV				I	I	I			I
Globularia punctata		IV	I					I	I			I
Scorzonera hispanica		IV	III					I	I			II
Primula veris		III	I								I	I
Sesleria albicans		V	II									I
Convolvulus arvensis	II			V	V	I	I	I		III	III	I
Salvia verticillata	II		I	V	V	V		I		I	I	IV
Reseda lutea	I			IV	II	I				I		
Cirsium acaule	II	V	III	I	I	II	IV	V	V	III	III	I
Ononis spinosa	I	II	II	IV		II	V	V	V	II	II	I
Gentianella ciliata		II	I				IV	III	I			
Trifolium medium			I		I	I	II				II	III
Festuca rupicola	II		III	I		V	II	V	IV	III	I	III
Bothriochloa ischaemum			I			I		III	I	II		
Eryngium campestre						I		IV	II	III		I
Stachys recta	I	I	I					I	I	I	I	III
Origanum vulgare	I				I		I	I			III	V
Veronica teucrium		I	I				II					V
Pyrethrum corymbosum	I							I				II
Bromion erecti												
Brachypodium pinnatum	IV	III	V	II	II	IV	IV	V	V	III	V	V
Bromus erectus	I		II	III	I	II	I	II	I	V	II	I
Carex flacca	I	II	II			I		I	II	I	I	II
Carlina acaulis	I				I	I	III	I			III	I
Prunella grandiflora		IV	III						I	IV		I
Onobrychis viciifolia		I		I		I		I				(I)
Polygala comosa	I										III	
Brometalia												
Sanguisorba minor	V	III	III	V	V	IV	IV	IV	III	IV	III	IV
Centaurea scabiosa	I	II	II	I	I	IV	III	II	I	II	III	III
Koeleria pyramidata	I	II	II		I	I	V	I	I			II
Carlina vulgaris	I	III	III			II		II	III	I		II
Scabiosa columbaria	II				I			I				I
Teucrium chamaedrys		IV	II						II			I
Festucion vallesiacae and *Festucetalia valesiacae*												
Scabiosa ochroleuca		II	II	I		III		IV	IV	V	II	II
Centaurea rhenana		I			I	I	I	II	I	I	I	I
Carex humilis		V	IV			I		IV	III	II		II
Astragalus austriacus				I		I		II	I	V		
Stipa capillata								I		I		I
Festuca valesiaca								I		I		
Festuco-Brometea												
Euphorbia cyparissias	V	IV	V	III	IV	IV	V	III	IV	IV	V	IV
Plantago media	I	II	III		II	IV	IV	IV	II	IV	V	III
Salvia pratensis	II	II	II		I	III	II	I	II	III	II	III
Poa angustifolia	I	I	I		I	II	I			II	V	II
Pimpinella saxifraga	I	III				III	V	V	II	IV	V	II
Galium verum	II		I		I	II	V			III	IV	III
Thymus praecox		III	III	IV		III		V	II	II		I

Association	A[1]	B1[2]	B2[3]	C1[4]	C2[5]	C3[6]	D[7]	E1[8]	E2[9]	E3[10]	E4[11]	F4[12]
No. of relevés	25	10	20	10	24	20	5	16	10	20	7	20
Trifolio-Geranietea												
Bupleurum falcatum	III	II	IV	I	III	IV		IV	II	III	I	III
Hypericum perforatum	I		I			II	IV	I		I	IV	III
Peucedanum cervaria	I	III	IV			I	II					II
Molinio-Arrhenatheretea												
Lotus corniculatus	I		III	I	I	II	IV	I	II	II	III	III
Knautia arvensis	II	I	III	II	III	III	V			II	IV	IV
Centaurea jacea	III		I	I	I	III	II	II		III	I	III
Leontodon hispidus			II		I	II	III	I		I	III	II
Achillea millefolium	I		I			III	III			I	V	IV
Dactylis glomerata			I		I	III		I		I	IV	III

[1] *Sanguisorbo minoris-Anthericetum ramosi* ass. nova - this study: Table 1
[2] *Cirsio pannonici-Seslerietum calcariae* Klika 1933 - Klika (1951): 31-33
[3] *Cirsio pannonici-Seslerietum calcariae* Klika 1933 - Toman (1981): Table 21
[4] *Salvio verticillatae-Sanguisorbetum minoris* Studnička 1980 - Studnička (1980): Table 1
[5] *Salvio verticillatae-Sanguisorbetum minoris* Studnička 1980 - (in prep.)
[6] *Salvio verticillatae-Sanguisorbetum minoris* Studnička 1980 - Toman (1988): Table 14
[7] *Ononido spinosae-Cirsietum acaulis* Mikyška 1956 - Mikyška (1968): Table 9
[8] *Scabioso ochroleucae-Brachypodietum pinnati* Klika 1933 - Klika (1933)
[9] *Scabioso ochroleucae-Brachypodietum pinnati* Klika 1933 - Klika (1951): 34-39
[10] *Scabioso ochroleucae-Brachypodietum pinnati* Klika 1933 - Toman (1981): Table 17
[11] *Scabioso ochroleucae-Brachypodietum pinnati* Klika 1933 - Neuhäusl et Neuhäuslová (1989): Table 40
[12] *Salvio verticillatae-Origanetum vulgaris* Toman (1976) 1988 - Toman (1988): Table 15

(b) The area is situated on the border zone that is strongly tectonically broken. Diverse relief is characterized by some structural plateaus, ridges and steep slopes with favourable exposition (S, W, SW, SE) (Vítek 1993).

(c) These slopes could have served as a suitable habitat in the past, mainly in different periods of the Quarter, for the spread of thermophilous plant species to Bohemia as well as to Moravia (the territory studied is situated in the direction of the "Třebovská brána" gate; cf. Domin 1940, 1942). Indeed, the distribution of *Anthericum ramosum* in Bohemia as well as in Moravia is associated with the Illyro-Norican postglacial migration (Skalický 1959). *Anthericum ramosum* spread in a wide zone from the Danubian Basin through Moravia to Bohemia (Skalický 1974:46–47). Many localities were then suitable for the establishment of *Anthericum ramosum*. During the subsequent periods, non-forest vegetation retreated and *Anthericum ramosum* and other thermophytes receded into margins and warmer forests, survived on rocks or became extinct. Deforestation by humans in the 10th century (Skalický 1974) made it possible for some thermophilous plant species that had survived colder periods to come back. *Anthericum ramosum* probably expanded to the new localities at this time.

Discussion

Sanguisorbo-Anthericetum is rather specific from the floristical viewpoint in (a) being very poor in species and (b) consisting of abundant populations of *Anthericum ramosum*, *Sanguisorba minor*, *Euphorbia cyparissias* and *Brachypodium pinnatum* (Tables 1, 2). Although most of the species recorded in the community are common in the previously

known vegetation types, some groups of diagnostic species are absent, allowing this new unit to be defined negatively (Table 4). Namely the subassociation *typicum* represents a specific vegetation type and its floristic composition is very difficult to compare with other vegetation types. The classification of this community is therefore based on (a) dominance of *Anthericum ramosum* (differential species), (b) low presence of the species of *Bromion erecti* and those of higher units, and (c) absence or very low presence of character species of the related associations and species of *Festucetalia valesiacae*, *Trifolio-Geranietea* and *Molinio-Arrhenatheretea* units.

In previous studies from the Czech Republic, the existence of a community with dominant *Anthericum ramosum* was only briefly mentioned. Domin (1943) was the first who described it in more detail from the neighbourhood of the village Vraclav near Vysoké Mýto. Fiedler (1985) in the study of vegetation of the Střemošická stráň nature reserve near the village of Luže (Chrudim district) used the term "meadows with *Anthericum*".

The *Sanguisorbo-Anthericetum* is close to *Cirsio pannonici-Seslerietum calcariae* Klika 1933, described from the České Středohoří Hills. This community occurs in similar habitat, i.e. marl disintegrated matters on N, W and S slopes (Klika 1933, 1951; Studnička 1980; Toman 1976, 1981, 1988; Table 4). Many species occur in both communities. However, there are many species absent in the former, e.g. xerophytes (*Carex humilis*, *Teucrium chamaedrys*, *Globularia punctata*, *Achillea collina*, *Asperula cynanchica*, *Thymus praecox* etc.) and dealpines (*Sesleria albicans*). Because the community contains some relicts, Studnička (1980) suggested that the formation of *Cirsio-Seslerietum* started in the Boreal period. It may be supposed that *Cirsio-Seslerietum* and *Sanguisorbo-Anthericetum* had similar species composition and formed some primary vegetation type in the Boreal. During the subsequent periods this primary type developed into *Cirsio-Seslerietum* in Central Bohemia. Because of afforestation following the retreat of warm and dry climate during subsequent periods, this primary vegetation type probably diminished in East Bohemia (East Bohemia is less warm and dry region) than Central Bohemia. This assumption is confirmed by the rare findings of some diagnostic species of the *Cirsio-Seslerietum* in the stands of the white slides in East Bohemia, e.g. *Cirsium pannonicum*, *Linum flavum*, *Aster amellus* (Toman 1974). Deforestation by humans created sites suitable for the formation of *Sanguisorbo-Anthericetum* in East Bohemia.

Salvio verticillatae-Sanguisorbetum minoris Studnička 1980 represents another related community (Studnička 1980, Toman 1988, see Table 4). Floristic differences between *Sanguisorbo-Anthericetum* and *Salvio-Sanguisorbetum* reflect the different position of these communities on the gradient of habitat conditions. The former occurs on raw marl disintegrated matter mainly with fine-grain rubble whose surface dries out in the summer forming a hard crust. Plants are damaged in winter. *Salvio-Sanguisorbetum* was recognized (in East Bohemia) on slopes or in deluvium. The soil is composed mainly by skeleton (stone size up to 5–10 cm), a hard crust is not formed and the skeleton is transported downhill where the plants are buried. Rosette hemicryptophytes represent a prevailing life form in this community. The *Salvio-Sanguisorbetum* is characterized by the absence of *Anthericum ramosum* and high presence of the characteristic species *Salvia verticillata*, *Reseda lutea*, *Convolvulus arvensis* (Studnička 1980).

The subassociation *brachypodietosum* is most problematic from the syntaxonomical viewpoint. It occurs on relatively fixed substrat. Some relevés are similar to species-poor relevés of *Ononido-Cirsietum*, *Origano-Salvietum* and *Scabioso-Brachypodietum* (Klika

1951, Mikyška 1956, 1968, Studnička 1980, Toman 1981, 1988, see Table 4). The *brachypodietosum* subass. differs from the above mentioned communities in having the following features: (a) the absence or very low presence of most of their character species (e.g. *Eryngium campestre, Bothriochloa ischaemum, Ononis spinosa, Gentianella ciliata, Veronica teucrium*); (b) the absence or very low presence of diagnostic species of the *Festucetalia valesiacae* and *Trifolio-Geranietea*.

It can be concluded that *Sanguisorbo-Anthericetum, Salvio-Sanguisorbetum, Cirsio-Seslerietum* and *Potentillo reptantis-Caricetum flaccae* Studnička 1980 constitute one group of early successional communities of white slides.

Souhrn

V článku je popisováno rostlinné společenstvo *Sanguisorbo minoris-Anthericetum ramosi* ass. nova z bílých strání východní části fytogeografického okresu Pardubické Polabí (východní Čechy). Je rozebírána jeho synmorfologie, syntaxonomie, synekologie, syndynamika a synchorologie.

Sanguisorbo-Anthericetum je otevřené bylinné společenstvo s pokryvností 35–95 %. Diferenciálním asociačním druhem je *Anthericum ramosum*, který má též dominantní roli v porostech asociace. Dalšími diagnostickými druhy jsou *Sanguisorba minor, Euphorbia cyparissias, Brachypodium pinnatum* (tab. 1). V porostech převládají druhy sv. *Bromion* a nadřazených jednotek. Porosty asociace mají velmi nízkou druhovou bohatost a diverzitu (tab. 2). V rámci asociace lze rozlišit dvě subasociace: (a) *typicum* a (b) *brachypodietosum*. V rámci subasociace *brachypodietosum* byly rozlišeny dvě varianty: (1) *typicum* a (2) s *Bromus erectus*. Vzhledem k absenci většiny diagnostických druhů dosud známých vegetačních jednotek a většiny indikačních druhů ř. *Festucetalia valesiacae*, tř. *Trifolio-Geranietea* a tř. *Molinio-Arrhenatheretea* byla tato asociace vymezena negativně. Nejbližší vztahy jeví as. *Sanguisorbo-Anthericetum* k as. *Cirsio pannonici-Seslerietum calcariae* Klika 1933 a as. *Salvio verticillatae-Sanguisorbetum minoris* Studnička 1980 (tab. 4).

Porosty asociace se vyskytují na osluněných, otevřených (odlesněných), J, JZ a JV orientovaných svazích o sklonu 10–50°. Geologický podklad asociace tvoří písčité slínovce (= opuky). Iniciální subas. *typicum* se vyskytuje na surových slínovcových zvětralinách s nevyvinutými horizonty, subas. *brachypodietosum* se vyskytuje na půdním typu rendzina (tab. 3).

Asociace představuje iniciální sukcesní stádium. Společenstvo přetrvává na místech se silnou erozí jako tzv. blokované sukcesní stádium (subas. *typicum*). Na méně extrémních místech sukcese pokračuje přes subas. *brachypodietosum* k as. *Ononido spinosae-Cirsietum acaulis* Mikyška 1956 a/nebo k as. *Scabioso ochroleucae-Brachypodietum pinnati* Klika 1933. Od těchto asociací se nově popsané společenstvo odlišuje (a) absencí nebo velmi nízkou stálostí jejich charakteristických druhů v jeho porostech a (b) absencí diagnostických druhů tř. *Trifolio-Geranietea* a ř. *Festucetalia valesiacae*.

Doposud známé lokality asociace *Sanguisorbo-Anthericetum* jsou vázány na jihovýchodní část fytogeografického okresu Pardubické Polabí (východní Čechy), okolí Chrasti a Luže (okr. Chrudim, obr. 1).

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