Flora and vegetation of stony walls in East Bohemia (Czech Republic)

Flóra a vegetace zdí ve východních Čechách

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This paper deals with the flora and vegetation of stony walls (wall tops, vertical wall surfaces) in East Bohemia. In total, 207 species of vascular plants and 60 mosses were identified in 114 recorded relevés. Flora of walls is composed of a high number of accidental species. Only two species (*Poa compressa, Taraxacum* sect. *Ruderalia*) were frequently recorded on walls. Differences in species' traits (life strategy, life form, dispersal) and ecological requirements of plants (light, moisture) were analysed between vertical wall surfaces and wall tops. Due to high floristic heterogeneity, many communities can be classified only at the level of higher syntaxa. In total, 10 communities were reported on the studied walls. Communities on wall tops were dominated by *Poa compressa*, *P. palustris* subsp. *xerotica, P. nemoralis* subsp. *rigidula, Conyza canadensis* and *Syringa vulgaris*. Four communities dominated by *Corydalis lutea*, *Cymbalaria muralis*, *Asplenium ruta-muraria* and *Cystopteris fragilis* were identified on vertical wall surfaces. Their structure, species composition, ecology and distribution are briefly discussed.

K e y w o r d s : Wall tops, vertical wall surface, phytosociology, indicator values, plant traits, life strategies

Introduction

Walls represent a specific environment, which is partly similar to rocks and rock fissures (Woodell 1979). Nevertheless, their artificial origin, location in the urban and rural landscape and technology of wall building influence a range of plant species, which are able to colonize this habitat. The following habitat attributes principally differentiate walls from the rocks: (i) Walls consist of building materials, which are usually piled up using various binding materials of lower durability and chemical composition different from the building material. Disintegration of the binding materials is responsible for accumulation of fine-grain rubble in crevices and thus provides substrate with variable content of nutrients that generally allow early succession of vegetation. The succession can be accelerated if soil itself is used as a binding or covering material. (ii) By being repeatedly cleaned and fettled, walls are in essence a temporary habitat. Frequent disturbances of wall vegetation thus contribute to a high variation in species composition and exclude many species typical of rocks and rock fissures. (iii) Walls are usually isolated objects of small dimensions. Therefore, wall microclimate is more strongly influenced by fluctuation of climatic factors (precipitation, temperature and irradiation) than in the case of rocks. (iv) Walls consist of limited number of microhabitats. Crevices resemble each other and sidewalls are of uniform slope and microtopography. In contrast, rocks are of apparent microhabitat diversity. (v) Since walls are situated within urban and rural landscape, composition of wall flora is strongly influenced by the mass-effect from the surrounding ruderal and seminatural vegetation types.

Considering vertical division, walls usually consist of three different zones: (i) the base, (ii) the vertical wall surface with joints (fissures) and (iii) the wall top. Species composition of basal zone consists of plants growing on vertical surface and species of nearby vegetation. This is caused by favourable environmental conditions of the basal zone (more moisture and nutrients). The second zone is best developed on old walls of monuments and buildings in historical town centres, disintegrating castle fortification, shady walls in gardens, etc. Development of plant communities mostly depends on the level of disintegration of mortar, concrete or any other type of binding material. Besides some ferns (*Asplenium* sp. div., *Cystopteris fragilis*) and many ruderal plants, several alien species, typical of the Mediterranean region, can be often found in this habitat in Central Europe, mostly as a consequence of escape from cultivation (e.g. *Cymbalaria muralis*, *Corydalis lutea*, *Cheiranthus cheiri*). The latter zone is mostly typical of rural landscape, e.g. isolated walls usually surrounding cemeteries, courtyards and disintegrating castles. The development of vegetation is determined by disintegration of material on the wall tops. Here, meso-xeric communities are the most frequent ones (Korneck 1978, Kolbek 1997).

Much attention was paid to wall vegetation in southern, western and central Europe, e.g. in Spain (Rivaz-Martínez 1978, Carmona et al. 1997), Italy (Oberdorfer 1975, Hruška 1987), France (Géhu 1961), England (Kent 1961, Woodel 1979), Germany (Hilbig & Reichhoff 1977, Gödde 1987, Werner et al. 1989, Brandes 1992a,b, Oberdorfer 1992), Poland (Weretelnik 1982), Austria (Forstner 1983, Mucina 1993) and Slovakia (Valachovič 1995, Valachovič & Maglocký 1995). Comparison of flora and vegetation on walls of southern, western and central Europe was made by Segal (1969) and Brandes (1992a,b).

Hadač (1970) published the first relevé material of wall vegetation from the area of the Czech Republic. So far only a few papers have brought relevé material on this vegetation from the area of the Czech Republic (Kolbek & Kurková 1977, Klimeš 1986, Jehlík 1986, 1989, Homola 1990, Jirásek 1992, Duchoslav 1993, 1994, 1999, Kolbek & Sádlo 1994, Sádlo & Kolbek 2000). Kolbek (1997) discussed the reasons responsible for the lack of knowledge of wall vegetation in the Czech Republic. Among others, wall vegetation has been considered as very plastic with unstable structure and low species richness (cf. Kolbek 1997: 62). The last survey of plant communities on Czech walls was made by Kolbek (1997) who recognized twelve communities of the *Asplenietea trichomanis* class and three communities of the *Sedo-Scleranthetea* class.

After the Second World War, profound changes in landscape structure and land use occurred owing to so-called "collectivization". Land consolidation, sod ploughing and urbanization of villages had a decisive impact on the Czech rural landscape (Lipský 1994). As a result, many isolated walls were removed from the villages. Rebuilding of town walls increased during the last decade as a consequence of increased interest in conservation of historical monuments. This consequently stimulated my interest to collect data. The present paper deals with the wall flora and vegetation of lower and middle altitudes of East Bohemia (Czech Republic).

Studied area and methods

The studied area covers planar to upland belts [200–550 (600) m a.s.l.] of East Bohemia (area of ca. 5,000 km^2; Fig. 1). The central part of East Bohemia belongs to a warm region (mean annual average above 8°C) with a lower annual rainfall (below 600 mm). Higher elevations belong to a moderately warm region (mean annual average below 8°C) with a higher annual rainfall (above 600 mm; Vesecký et al. 1958).

The range of sampling stands included all types of walls (i.e. isolated walls in courtyard, fortification, city walls, walls of disintegrated buildings, monuments, etc.). The study was restricted to the wall tops and the wall joints, whereas the flora and vegetation of the wall bases (i.e. vertical surface up to 30 cm above ground) were not recorded. Localities were selected by occasional walking through rural landscape and by visits of towns with preserved historical centres, castles and chateaux. Data on flora and vegetation were collected only on walls fulfilling the following arbitrary rules: occurrence of at least two species of vascular plants and minimal cover of vegetation > 15% (wall top) or > 5% (vertical surface). Following these rules underestimated variability of species found on the walls, but it was necessary to avoid prohibitively time-consuming sampling, as well as problems with classification of early successional stages or of unique samplings. In total, 125 relevés had been collected (incl. those extracted from the published papers), but 11 relevés were excluded from the subsequent analyses due to their unique plant composition.

The classical Zürich-Montpellier approach (Braun-Blanquet 1965) was used. Where it was not possible to classify stands using the Zürich-Montpellier approach, the "deductive approach" (Kopecký & Hejný 1978) was used (d.c. = derived community; b.c. = basal community). Only mosses were estimated within the ground layer (E_0). Nomenclature of taxa follows Neuhäuslová & Kolbek (1982), that of the higher syntaxa Valachovič (1995) and Jarolímek et al. (1997).

Life strategies were classified according to Grime (1979), life forms, dispersal strategies and origin status of vascular plants were taken from Frank & Klotz (1990). Mosses were classified into respective life strategies according to During (1979). Light, temperature, moisture, reaction and nitrogen indicator values for vascular plants (Ellenberg 1979) and mosses (Düll 1992) were used to express plant requirements for basic ecological factors.

Results

Plants and technology of wall building

Development of vegetation on walls is influenced by technology of wall building. Isolated walls fencing courtyards or gardens in the countryside have usually been built from material easily available. Compact sandy marls (= clay slates), that are typical bedrock of middle elevations of East Bohemia, have been quarried in many local stone-pits and used for wall building. Absence of vegetation of wall tops in the central part of East Bohemia (Fig. 1) reflects an absence of isolated walls there: bedrock of flat lowland parts of East Bohemia is composed of non-compact clay marl, flood sediments or loess, which were not suitable as building materials. Stockades or wire fences are typical of this region.

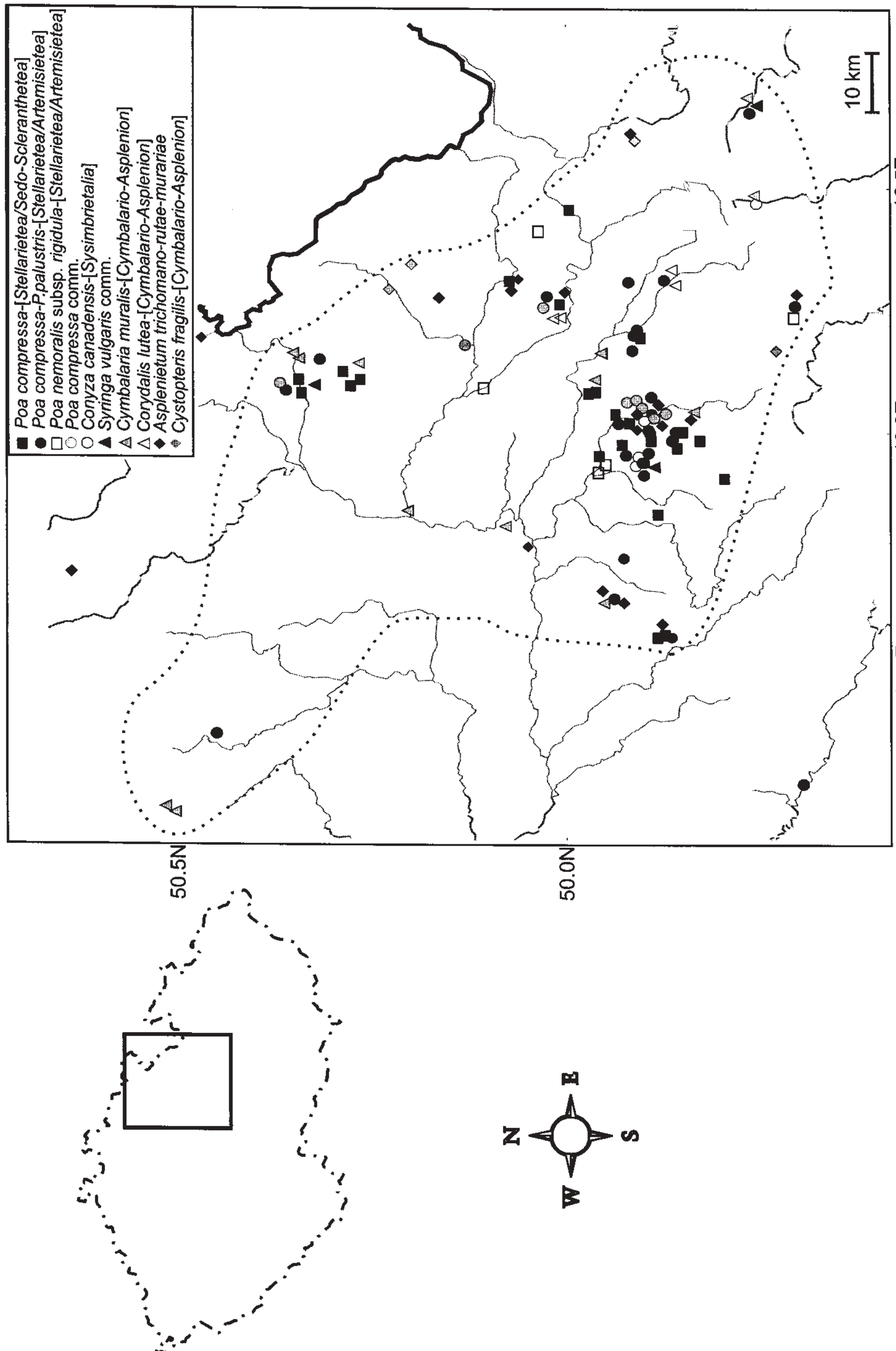

Fig. 1. – Map of the territory studied. Dashed curve specifies the territory, which was intensively studied. Distribution of the respective communities according to the relevé data is given.

The technology of wall building was similar in most parts of the studied area. Stones were piled up with or without using mortar, clay or concrete for binding. They were usually put obliquely on the top of the walls in the villages, while a layer of soil (turf) sometimes topped walls fencing gardens or fields (cf. Klimeš 1986). Other materials (e.g. bricks, granite, gneiss, schist) were used less frequently. Only rarely the wall tops were covered by a protruding coping of other materials (e.g. roofing tile, slate board). Disintegration of the stones and stone joints due to climatic erosion, i.e. wind, frost, rains, and the effect of the vegetation itself were responsible for accumulation of fine-grain rubble in crevices, thus allowing further development of vegetation.

In essence, successful colonization of vertical wall surface by vascular plants depends on meeting two requirements: sufficient diameter of the wall and presence of crevices with disintegrated binding (or, rarely, building) material. Thin isolated walls (<30 cm) were typically not colonized by plants because of extreme microclimate variation. Similarly, vertical surface of walls that were built without a binding material (e.g. wall fences from clay slates) were rarely colonized by plants. The only exceptions in such case were the retaining walls, since the moisture and nutrients are supplied from the adjacent soil.

Plants on the walls: the analysis of phytosociological data

Overview of flora

On walls, there is a high number of vascular plant species occurring with a very low frequency. Whereas 207 species were recorded in total, 180 of them (i.e. 87%) attained frequencies below 20%, and 78 species (i.e. 38%) were found only in one relevé. The most common species – *Taraxacum* sect. *Ruderalia* and *Poa compressa* – occurred on 74 and 54% of studied walls, respectively. They were found on both vertical surfaces and wall tops. Totally, 43 families were recorded on studied walls; the most common were *Compositae* (17.1% of total flora), *Poaceae* (9.6%), *Brassicaceae* (7.0%) and *Lamiaceae* (5.4%).

The most frequent life strategies were C (30.4%), CSR (25.4%) and CR (18.8%); the most common life forms were hemicryptophytes (51%) and therophytes (26%). Native species comprised 77.2%, archaeophytes 13.0%, and neophytes 9.8% of the total species number. Anemochory (40.0%) and autochory (18.2%) were the most common dispersal strategies of plants growing on walls.

The flora on the walls consisted predominately of heliophilous to shade-tolerant plants, which indicate mesic to warm habitats and semi-dry to freshly moist soils. Reaction showed no clear pattern with more frequent species indicating neutral to basic soils. According to nitrogen requirements, the flora on walls indicated nutrient poor to moderately rich habitat (Table 1). Nevertheless, high coefficient of variation indicates bimodal distribution of indicator values for nitrogen, i.e. high frequency of plants requiring either high or very low concentration of nutrients.

Of the 60 species of mosses recorded on the walls, *Hypnum cupressiforme* (frequency 39%), *Bryum* sp. (28%), *Tortula muralis* (22%) and *Ceratodon purpureus* (22%) were the most common ones. These species inhabited both wall tops and vertical surfaces. Forty-two percent of mosses occurred only in one relevé.

Table 1. – Mean indicator value (± 1 s.d.) of selected ecological factors based on vascular plants (Ellenberg 1979) growing on studied walls. Differences between wall tops and vertical wall surfaces were tested using two sample t-test. CV – coefficient of variation (%); n.s. – non-significant.

	Total	CV	n	Wall tops	CV	n	Vertical surface	CV	n	
Light	6.8±1.4	20	175	7.1±1.2	18	129	6.5±1.6	24	100	P < 0.001
Temperature	5.5±0.9	16	95	5.5±0.8	15	72	5.6±1.0	17	54	n.s.
Moisture	4.6±1.4	29	162	4.4±1.3	30	118	4.9±1.3	27	95	P = 0.01
Reaction	6.2±1.9	30	97	6.0±2.0	32	69	6.4±1.8	29	55	n.s.
Nitrogen	5.4±2.4	44	148	5.2±2.4	46	112	5.5±2.4	44	85	n.s.

Acrocarpous mosses were more frequent on the walls than pleurocarpous ones (66 and 32%, respectively). Colonists (48.1%) and perennial stayers (38.5%) were the most common life strategies.

Mosses generally occurring on well-lit places, but also in partial shade, composed the moss flora on walls. Regarding moisture and reaction requirements, the mosses growing on the walls were indicators of dry to mesic sites on substrata with pH higher than 5 (Table 2).

Table 2. – Mean indicator value (± 1 s.d.) of selected ecological factors based on mosses (sensu Düll 1992) growing on studied walls. Differences between wall tops and vertical wall surfaces were tested using two sample t-test. CV – coefficient of variation (%); n.s. – non-significant.

	Total	CV	n	Wall tops	CV	n	Vertical surface	CV	n	
Light	6.3±2.0	32	54	6.4±2.0	31	43	6.0±1.8	30	27	n.s.
Temperature	3.4±1.1	32	37	3.4±1.1	34	27	3.7±1.0	26	18	n.s.
Moisture	1.0±1.7	43	54	3.6±1.6	43	42	4.3±1.8	42	28	n.s.
Reaction	6.0±1.7	28	51	5.8±1.7	30	39	6.5±1.3	20	25	n.s.

Comparison of wall tops and vertical surfaces

Considering that a lower number of relevés was recorded on vertical surfaces, the number of species recorded on wall tops did not exceed that on vertical surfaces (vascular plants: 159 and 117 species; mosses: 46 and 30 species, respectively). Nevertheless, species richness per relevé was significantly higher on wall tops (wall tops: 13.1±6.3; vertical surfaces: 8.8±4.6, Welch t-test, $t = 4.1$, $df = 112$, $P < 0.001$). Plants occurring on both vertical surfaces and wall tops represented only 32% of the total species numbers. The wall tops exhibited a lower number of families in comparison with the vertical surfaces (31 and 40 families, respectively).

Species possessing CR, R, SR and S strategies were more common on wall tops, while those with C, CS and CSR strategies prevailed on vertical surfaces (Fig. 2). Therophytes were more common on wall tops, hemicryptophytes and phanerophytes on vertical surfaces. The two habitats did not differ in the proportions of alien and native species. Anemochorous, autochorous and endozoochorous plants were more frequent on vertical surfaces, while epizoochorous plants prevailed on wall tops (Fig. 2).

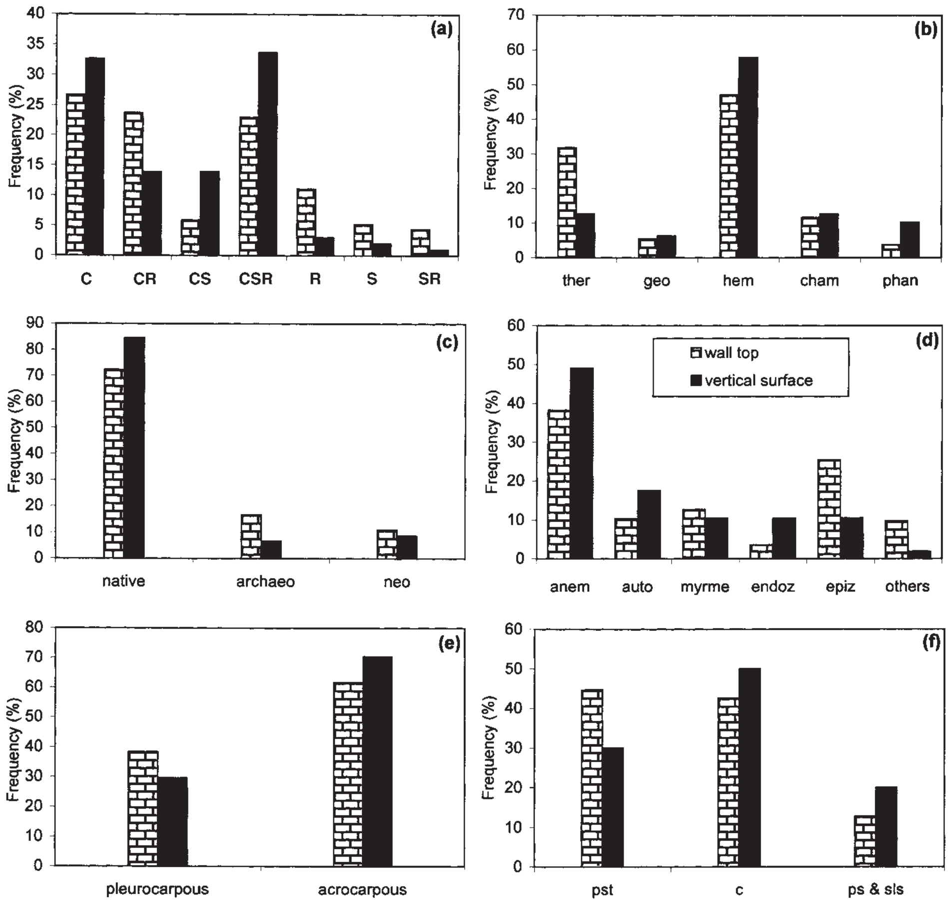

Fig. 2. Frequency distribution of flora characteristics on wall tops and vertical wall surfaces. (a) Life strategies according to Grime (1979). $\chi^2 = 18.8$, df = 6, P = 0.005; (b) Life forms: ther – therophytes, geo – geophytes, hem – hemicryptophytes, cham – chamaephytes, phan – phanerophytes. $\chi^2 = 17.6$, df = 4, P = 0.002; (c) Origin status: archaeo – archaeophytes, neo – neophytes. $\chi^2 = 3.8$, df = 2, P = 0.15; (d) Dispersal strategies of vascular plants: anem – anemochory, auto – autochory, myrme – myrmecochory, endoz – endozoochory, epiz – epizoochory, $\chi^2 = 14.9$, df = 6, P = 0.02; (e) Growth forms of mosses; $\chi^2 = 0.04$, df = 1, P = 0.85; (f) Life strategies of mosses (sensu During 1979): pst – perennial stayers, c – colonists, ps – perennial shuttle species, sls – short-leaved shutters. $\chi^2 = 3.1$, df = 2, P = 0.21.

The wall tops did not differ from the vertical surfaces in mean indicator values for temperature, reaction and nitrogen (based on vascular plants data). Significant differences between wall tops and vertical surfaces were found for light and moisture (Table 1). Higher shade tolerance of species growing on vertical surfaces compared to those occurring on wall tops was recorded. Similarly, more species with high moisture indicator values were found on vertical surfaces (Table 1).

Contrarily to the vascular plants, there were no differences between the wall tops and vertical surfaces in proportions of particular life strategies and growth forms of mosses (Fig. 2). Mean indicator values differed between the two habitats for none of the ecological factors studied, based on mosses data (Table 2).

Wall vegetation[1]

Communities on wall tops

b.c. *Poa compressa*-[*Sedo-Scleranthetea/Stellarietea*]

[incl. *Sedo acri-Poetum compressae brometosum* Klimeš 1986, *Saxifrago tridactylitis-Poetum compressae* (Kreh 1954) Géhu et Lericq 1957 p.p.?]

This species-rich (mean 16.4, range 4–27) thermophilous type (Table 3, rels. 1–26) is differentiated by frequent occurrence of succulents and species of semi-dry habitats. *Poa compressa* is less dominant and other grasses frequently accompany it. The herb layer has a cover from 35 to 80% (mean 61%). The group of typical species includes annuals to short perennials, some perennial species (e.g. *Taraxacum* sect. *Ruderalia, Poa angustifolia*) and annual ruderal species. The moss layer dominated by *Ceratodon purpureus* and/or *Hypnum cupressiforme* is developed with a variable cover from 0 to 80% (mean 44%). The community inhabits tops of disintegrating fortification of castles and bulwarks, plus tops of old isolated thicker walls in the villages (building material: clay slates, rarely granite and gneiss). The sites are strictly sun-exposed. Mostly shallow soils are of A-C type and contain a varying amount of skeleton and nutrients. The soil usually contains a high amount of carbonates since clay slate represents the prevailing building material. Broken relief, with zones of bare ground and crevices, characterizes the structure of the wall top. The habitats are only rarely mechanically disturbed by humans, but usually are heavily eroded. The community is distributed in the hilly parts of East Bohemia up to 520 m a.s.l. (Fig. 1).

d.c. *Poa compressa-Poa palustris* subsp. *xerotica*-[*Stellarietea/Artemisietea*]

(incl. *Sedo acri-Poetum compressae chenopodietosum* Klimeš 1986 p.p.)

The community (Table 3, rels. 27–53) is characterized by dense stands of dominant *Poa compressa* (cover of E_1: 25–90%, mean 62%) with lower species richness (mean 13.3, range 7–25) growing on usually thick soil layer (ca. 5–15 cm) with dark brown A-horizon. Besides *Poa compressa*, many stands are dominated by *Poa palustris* subsp. *xerotica.* Erosion is less important due to dense sward on stabilized soil layer; as a result, there are low frequencies of R-strategists (i.e. weeds). On the other hand, stands are differentiated by the presence of C and CR-strategists (e.g. *Artemisia vulgaris, Achillea millefolium*). The moss layer with dominant *Hypnum cupressiforme* has a lower cover with a mean of 29% (range 0–80%). The most typical stands of the community are the tops of wall fences in villages and old wall fences around cemeteries (building material: clay slates, rarely granite, bricks and schist), which were sometimes initially covered by soil layer. The soil contains lower amount of skeleton and higher amount of nutrients. The sites are either sun-exposed or shaded by surrounding trees. Widely distributed in the hilly part of East Bohemia up to 520 m a.s.l. (Fig. 1).

[1] The following types were found only rarely in East Bohemia and require further study: (i) Stands with dominant *Calamagrostis epigejos* were rarely found on wall tops of demolitions. (ii) *Senecioni fuchsii-Sambucetum racemosae* Noirfalise in Lebrun et al. 1949 (*Sambuco-Salicion capreae* R. Tx. et Neumann in R. Tx. 1950): fragmentary stands of the community were found on wall tops in higher altitudes (surrounding of the town of Polička). (iii) Species-poor stands with dominant *Gymnocarpium robertianum* were rarely found in wall joints. In addition to the dominant species, only *Asplenium ruta-muraria* occurred frequently within such stands. Such stands represent fragments of the *Asplenio rutae-murariae-Gymnocarpietum robertiani* Kolbek et Sádlo 1994 association that occurs primarily in fissures of lime rocks or basic silicate rocks with content of calcium ions (Kolbek & Sádlo 1994).

d.c. *Poa nemoralis* subsp. *rigidula*-[*Stellarietea*/*Artemisietea*]

(incl. *Sedo acri-Poetum compressae chenopodietosum* Klimeš 1986 p.p.)

The community (Table 3, rels. 54–58) is characterized by dense stands of dominant *Poa nemoralis* subsp. *rigidula*, which completely replace *Poa compressa* on many walls. Floristic composition and habitat conditions of the community are similar to the d.c. *Poa compressa-Poa palustris* subsp. *xerotica*-[*Stellarietea*/*Artemisietea*].

Poa compressa community

(incl. *Sedo acri-Poetum compressae* Klimeš 1986 p.p.)

The species-poor community (mean 6.5, range 2–15) comprises stands dominated by *Poa compressa* (Table 3, rels. 59–66). Most of the diagnostic species of the communities mentioned above are lacking. It is typical of tops of isolated walls with thick and undisturbed soil layer. *Poa compressa* develops compact dense sward (cover of E_1: 35–80%, mean 61%; cover of E_0: 0–90%, mean 12%) that competitively displaces other species (esp. mosses) in the course of succession. Widely distributed in the hilly parts of East Bohemia (Fig. 1).

b.c. *Conyza canadensis*-[*Sisymbrietalia*]

The species-poor community (mean 8.3, range 6–11) comprises stands dominated by *Conyza canadensis* (Table 3, rels. 67–69). The mean cover of herb layer is 52% (range 35–70%), moss layer is not developed. The community represents initial successional stage on tops of ruins or tops of walls that are built from hard materials and jointed with concrete or mortar. Rubble matter and coarse sand are typical substrates of this vegetation type. It is reported from three localities in East Bohemia but is probably widely distributed over the territory (Fig. 1).

Syringa vulgaris community

Shrub vegetation dominated by *Syringa vulgaris* was found only rarely on the tops of isolated walls (Table 3, rels. 70–72). *Syringa vulgaris* composes 1–3 m tall, dense stands with a high cover (mean 65%, range 40–100%) and low species-richness (mean 8.7, range 3–17). Due to strong shading from the lilac, herb and moss layers are only sporadically developed (cover of E_1: mean 25%, range 1–70%; E_0: mean 22%, range 0–40%) and consist of a number of accidental species. The community inhabits wall tops with very thick soils (ca. 10–30 cm) in later stages of soil accumulation. The stands originated by plantation of lilac or, less frequently, by its seeding or intergrowth from shrubs adjoining the walls. It was found only rarely on old walls in lower parts of East Bohemia (Fig. 1).

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Table 3. – Wall vegetation in East Bohemia: b.c. *Poa compressa*-[*Sedo-Scleranthetea/Stellarietea*], rels. 1–26; d.c. *Poa compressa-Poa palustris* subsp. *xerotica* [*Stellarietea/Artemisietea*], rels. 27–53; d.c. *Poa nemoralis* subsp. *rigidula*-[*Stellarietea/Artemisietea*], rels. 54–58; *Poa compressa* comm., rels. 59–66; b.c. *Conyza canadensis*-[*Sisymbrietalia*], rels. 67–69; *Syringa vulgaris comm.*, rels. 70–72; b.c. *Cymbalaria muralis*-[*Cymbalario-Asplenion*], rels. 73–86; b.c. *Corydalis lutea*-[*Cymbalario-Asplenion*], rels. 87–90; *Asplenietum trichomano-rutae-murariae typicum*, rels. 91–100; *geranietosum robertiani*, rels. 101–110; b.c. *Cystopteris fragilis*-[*Cymbalario-Asplenion*], rels. 111–114.

Relevé no.	1–26	C (%)	27–53	C (%)	54–58	C (%)
Diagnostical taxa:						
E_1						
Sedum acre	+ . 1 3 + 3 3 1 . . . . 3 1 . 2 1 . . . 1 1 . . . 2	54	. . . .		. . . . .	
Potentilla argentea	. . 2 1 . + . . 2 2 2 3 . . 1 + . . 2 . . 1 2 . 1 .	50	. . . . + ...	4	. . . . .	
Arenaria serpyllifolia	. . . + . + ... 2 . 2 2 1 + . . 2 2 + 2 2 .	46	. . . . + . . 1 . . . 1	11	. . . . .	
Elytrigia repens	. . . . 3 + . . 2 . . . 1 . . 1 1 2 . .	27	. . . . . + ... 3 . . . . 1 . . .	11	. . . . .	
Arrhenatherum elatius	. . . . . + + + . . . + ... + ...	19	. . . . . r . . . . + ...	7	. . . . .	
Sedum sexangulare	. 2 . . . . 3 1 1 .	15	. . . .		. . . . .	
Thymus pulegioides	+ 2 . . + ...	12	. . . .		. . . . .	
Plantago media	+ 1 . . . . 2	12	. . . .		. . . . .	
Erophila verna	. . . . + . 1 2 .	12	. . . .		. . . . .	
Festuca rupicola	. . . . 2 . . . . 3 3	12	. . . .		. . . . .	
Sedum spurium	. . . . 3 2 . . + ...	12	. . . .		. . . . .	
Sempervivum tectorum	. . . r . . r	8	. . . .		. . . . .	
Bromus tectorum	. . . . 1 + ...	8	. . . .		. . . . .	
Artemisia vulgaris	. . . . 1 . . 1 . . 2 . + ... + . +	23	. . 1 . 1 r . + + ... 3 3 2 . r . . + + . 2 . 1 .	48	1 1 . . 1	60
Achillea millefolium agg.	1 . . . . . 1 . . . . r + 1 . . . . . . r . .	23	r 2 . . 1 . . 2 + ... 2 3 . . . 2 r . . . r 2 +	44	2 1 + . .	60
Poa palustris subsp. *xerotica*	. . . . 2 . . + ... 1	12	. 4 3 . . . 2 4 3 . . 2 . . . + . . . 3 . . 3 3 . 1 .	41	. r . . .	20
Lamium album	. . . . + + + ...	12	. . . . 2 1 . . 1 + 1 r + + ... 1	33	+	20
Sonchus oleraceus	. . . . 1	4	. . . r + r . . r + r . . . . r .	26	. . 1 r .	40
Geum urbanum	. . . . + ...	4	. . . . . . r . . + . + . + r	19	. . . . .	
Ballota nigra	. . . . + ... + . .	8	. . . . . . + ... 2 . . . . . r + ... 2 . . .	19	. . . . .	
Stellaria media	. . . . + 1	8	. . . . . + 2 . . . 1 + ... + . . .	19	. . . . .	
Lactuca serriola	. . . . . . r	4	. . . . r . . . . + ... + ... r	15	. . . . .	
Galium aparine	. . . .		. . . . . + . . r . . + r	15	. . . . .	
Cerastium holosteoides	. . . . + ...	4	. . . . + . 1 + 1	15	. . . . .	
Poa nemoralis subsp. *rigidula*	. . . 2 . 2 . . 1 . . + ... r . . . . . 2 .	23	. . . . 1	4	4 2 3 3 3	100
Conyza canadensis	. . . .		+ . . . . . r . . . . + . + ...	15	. . . . .	
Syringa vulgaris (E_2)	. . . .		. . . .		. . . . .	
Medicago lupulina	. 2 1 1 + 1 1 . . r . + 1 . + 1 1 1 2 . + 1 . . 2 .	65	. . . . r . + 1 2 + . . r . . . . . . +	26	. r . . .	20
Capsella bursa-pastoris	. . . + . + ... + . 1 . . . . . . + . + . .	23	. . . . 1 . r . . . + . . . + + r . . . . +	26	. . . . .	
Poa angustifolia	. 2 . . . . 2 . . . . 1 . 2 . . . . . + 2 3 .	27	. . . . . + ... 2 . . . . 2 2	15	. . . . .	
Myosotis arvensis	. . . . 2 . . . . r . . . . . + . + . + .	19	r . . . . + 1 . . . . . + ... + + . . .	22	. . . . .	
Festuca rubra	2 . . . . + . + ... + . . . 1 . 2 . .	23	. . . 3 . . . . 4 . . . . + ...	11	. . . . .	
Chenopodium album agg.	. . . 1 . 2 . . . . . + . . . + ... + 1 .	23	1 . . . + . r	11	. . . . .	
Dactylis glomerata	. . . . + ... + .	8	. . . . . . + ... + r . . . . + . . . r 1 .	22	. . . r .	20
Erysimum cheiranthoides	. . 1 . . . . + + ...	12	. . . . . + 1 . . . . r + ...	15	. . . . .	
Viola arvensis	. . . . 1 . r . . . + ...	12	. . . . + ... 1	7	. . . . .	
Sisymbrium officinale	. . 1	4	. . . . r . . . + ...	7	. . . . .	
Poa compressa	2 1 3 . 2 1 2 4 . 2 2 1 + 2 3 2 3 + 3 2 3 . . 3 2 4	85	4 . 1 3 3 3 3 . . 5 3 + 2 2 1 1 3 . 3 . . 3 . 2 2 . .	67	. . . . .	
Cymbalaria muralis	. . . .		. . . .		. . . . .	
Corydalis lutea	. . . . 1	4	. . . .		. . . . .	
Asplenium ruta-muraria	. . . . . . 1 . . . . + ...	8	. . . . 1 . .	4	. . . . .	
Asplenium trichomanes	. . . .		. . . .		. . . . .	
Cystopteris fragilis	. . . .		. . . .		. . . . .	
Geranium robertianum	. . . . + ...	4	. . . r . . . . + ... 1 r . . .	15	. . . r .	20
Epilobium montanum	. . . .		. . . .		. . . . .	
Campanula rotundifolia	. . . .		. . . . 1 . .	4	. . . . .	
Fragaria vesca	. . . .		. . . .		. . . . .	
Moehringia trinervia	. . . .		. . . .		. . . . .	
Polypodium vulgare	. . . .		. . . .		. . . . .	
Mycelis muralis	. . . .		. . . . + ...	4	. . . . .	
Poa nemoralis subsp. *nemoralis*	1 . . . . + ...	8	. . . . 2	4	. . . . .	
Campanula rapunculoides	. . . . + ...	4	. . . . 1 . .	4	. . . 1 .	20
Sedum maximum	. . . . 1 + ...	8	. . . . + . .	4	. . . . .	
Aegopodium podagraria	. . . .		. . . .		. . . . .	
Common taxa:						
Taraxacum sect. *Ruderalia*	+ . 1 + + 1 r + . + 1 2 + . 1 + + + + . + + + . + .	77	r 1 + + 1 + 1 1 1 1 2 + 1 1 + 1 1 + + 2 + + 1 + r + +	100	+ + + + +	100
Chelidonium majus	. . . . + . 2 r + ... r . . .	19	. . . . . . 1 . . + . 1 + . + r + . + + r . . . r . .	41	. . . . .	
Urtica dioica	. . . . 1 . 1 . . . . +	12	. . 1 . . . . + ... r r . 1 . . .	19	. . . . .	
Impatiens parviflora	. . . . + ... r . .	8	. . . . 1 . . . . . + ...	7	. . . . .	
Fallopia convolvulus	. . . + . 1 . . . . . r 1 . + ...	19	. . . . + ...	4	. . . . .	
Atriplex patula	. . . . 2 . . + ...	8	. . . . r . + . . . + ... + . . .	15	. . . . .	
Senecio viscosus	. . . .		. . + r . . . . + ...	11	. r . . .	20
Hieracium lachenalii	+ . . . + ...	8	. . . . r . . . . 1 . .	7	. . . . .	
Glechoma hederacea	r	4	. . . . + + ... + ...	11	. . . . .	
Leucanthemum vulgare agg.	. + ... r . . . . + . 1	15	. . . . 2	4	. . . . .	
Anthriscus sylvestris	. . . . r	4	. . . . r	4	. . . . .	
Leontodon autumnalis	. . . . + . . .	4	. . . .		. . . + .	20
Poa annua	. . . .		. . . . . + ...	4	. . . . .	
Cerastium arvense	. . . . + ...	4	. . . . 1	4	. . . . .	
Galinsoga parviflora	. . r r . + ...	12	. . . .		. . . . .	
Galeopsis pubescens	. . + ...	4	. . . .		. . . . .	
Senecio vulgaris	. . . . . + ... + . r	12	. . . . . + ...	4	. . . . .	
Galium album	+ 2 . . + ...	12	. . . . + ...	4	. . . . .	
Calystegia sepium	. . . . + ...	4	. . . . r	4	. . . . .	
Poa pratensis	. . . . + ...	4	. . . . 2	4	+ . . 1 .	40
Plantago major	. . . . r . .	4	. . . .		. . . . +	20
Galinsoga ciliata	. . . .		+ . . . + ... r	11	. . . . .	
Pimpinella saxifraga	+ + ... + ...	12	. . . .		. . . . .	

59 60 61 62 63 64 65 66	C (%)	67 68 69	C (%)	70 71 72	C (%)	73 74 75 76 77 78 79 80 81 82 83 84 85 86	C (%)	87 88 89 90	C (%)	91 92 93 94 95 96 97 98 99 100	C (%)	101 102 103 104 105 106 107 108 109 110	C (%)	111 112 113 114	C (%)
. . . .		. . .		. . +	33	. . . .		. . . .		. . . .		. . . .		. . . .	
. . . . . . + .	13	. . .		. . 1	33	. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . +	33	. . . . +	7	. . . .		. . . .		. . . .		. . . .	
. . . . +	13	. . .		. . .		+ 1	14	. . . +	25	. . . . . . r . . .	10	. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . r	10	. . . +	25
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . r	25
+	13	. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . +	25
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . r	10	. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . +	33	. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. 1 .	33	r . .	33	. . r . . + ... +	21	. . . .		+	10	. . . + . . + . . .	20	. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . . r	10	. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . r . . . . . + ...	14	. . . +	25	. . . . +	10	. . . + ...	10	. . . .	
. . . .		. + 1	67	. . .		. . . . r	7	. r r .	50	. . . . . + ...	10	. . . .		. . . +	25
. . . .		. . .		. . .		. . . .		1 . . .	25	. r	10	+	10	. . . .	
. . . . . . + 1	25	. . .		. . .		. . . . . . r	7	. . . .		. . . .		. . . .		. . . .	
. . . . +	13	. . .		. . .		. . . .		. . . .		. . . .		+	10	. . . .	
. . . .		+ . r	67	. . .		. . . . + . . . r	14	. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . . +	7	. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		+ . .	33	. . . .		. . . .		. . . .		. . . .		. . . .	
. . . . . . r .	13	[4 2 1]	100	. . r	33	. . . . + ...	7	. . . .		. . + ...	10	. . . .		. . . .	
. . . . . . + .	13	. . .		[4 5 3]	100	 1	7	. . . .		. . . .		. . . 1	10	. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . 3	33	. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . 3	33	. . . .		. . . .		. . . . . . 1 . . .	10	. . + ...	10	. 1 . +	25
. . . .		. + .	33	. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . . . r	7	. . . .		. . . .		. . . .		. . . .	
. . . . +	13	. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . . +	13	. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
[3 3 4 4 4 3 . 1]	88	. . 3	33	. . 1	33	+ 1 . + + ...	29	. . . .		1 . . . . r + + + .	50	. + r	20	. . . .	
. . . .		. . .		. . .		[3 4 2 3 3 4 2 3 2 4 2 4 4 4]	100	. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . . 2 . . .	7	[4 3 3 3]	100	. . . .		. . . .		. . . .	
. . . .		. . .		. . .		[1 . 1 + + ... + + + .]	50	[. + + .]	50	[2 2 2 2 2 3 2 1 2 1]	100	[1 2 1 . . 2 1 . 1 2]	70	. . . .	
. . . .		. . .		. . .		. . . .		. . . .		[. + . . . + ...]	20	[+ . 1 + + . + 2 . .]	60	. . . .	
. . . .		. . .		. . .		. . . . +	7	. . . .		. + r . . . + . . .	30	[2 2 1 1 2 2 1 1 1 +]	100	[2 2 2 3]	100
. . r . . . 1 3	38	. . .		. + .	33	. . . r 1	14	. . + .	25	. . . .		[1 1 1 1 + . + + . .]	70	[. . 2 .]	25
. . . .		. . .		. . .		. . . .		. . . .		. . . . +	10	[. + . + . . + r + .]	50	[1 1 1 .]	75
. . . .		. . .		. . .		. . . .		. . . .		. . . . . . + . . .	10	[. . . + ... 2]	20	[+ r . .]	50
. . . .		. . .		. . .		. . . . + ...	7	. . . .		. . . .		[. . . . r . + . . .]	20	[r . . .]	25
. . . .		. . .		. . .		. . . .		. . . .		. . . . +	10	[. . . . . + .]	10	[r 1 + .]	75
. . . .		. . .		. . .		. . . .		. . . .		. . . .		[1 . . . .]	10	[. . . .]	
. . . .		. . .		. . .		[. . . . + . . r . . r . . +]	29	. . . .		. . . . . . + . . .	10	[+ . . 1 . r + + . .]	50	[. . . .]	
. . . .		. . .		. . .		[. . . . . . + . . . 2 . . .]	14	. . . .		. . . . + . .	10	[1 . . 2 . . 3 + . .]	40	[. . + .]	25
. . . .		. . .		. . .		[. + . . . + . . + ... 1]	29	. . . .		. . . .		[. . . + . . . r . .]	20	[. . . +]	25
. . . .		. . .		. . .		[. . . 1 1 . . . .]	14	. . . .		. . . .		[+ . . + . . 1 + . .]	40	[. . . .]	
. . . .		. . .		. . .		[. . . . . + ...]	7	1 . . .	25	. . . .		[. . . + ...]	10	[r . + +]	75
1 1 + . . 2 + +	75	+ + +	100	. . .		r . . + + . . r + + + . . +	57	. + r .	50	r + + . . + + + . r	70	. 1 . + ...	20	. + 1 r	75
. . . . 2 r + .	38	. + .	33	. . .		+ + + . . . + . + + . . . 1	50	1 1 . +	75	+ + . + + + . + . r	70	+ + . + . r . . 1 .	50	. . . .	
. . . + ...	13	. . .		. . .		+ . . r + ... +	29	+ . . .	25	. . . .		r . . . . + + + . r	50	1 r 1 +	75
. . . .		. . .		. . .		. . . . r . + ... r	21	. . . .		. . . .		. . . . r . .	10	. . . .	
. . . . . . + .	13	. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . . +	13	. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . . . . 2 .	13	. + 1	67	. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . . . . + . . .	10	. . + ...	10	. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . . r	10	2 . . .	25
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		+ r	20	. r . .	25
2 + ...	25	. . .		. . .		. . . . r .	7	. . . .		. . . .		. . . .		. . . .	
. . . .		1 . .	33	. . .		. . . .		. . . .		. . + ...	10	. . . .		. r + .	50
+ r	25	. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . . . r	10	. . . .		. . . .	
. . . .		. . .		. . .		. . . .		+ . . .	25	. . . .		. . . r	10	. . + .	25
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . . . + ...	7	. . 1 .	25	. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . r	33	. . .		. . . .		. . . .		. . . .		. r	10	. . . .	
. . . . +	13	. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	

Relevé no.	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	C (%)	27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53	C (%)	54 55 56 57 58	C (%)
Lotus corniculatus	r . . . 1 . . . . 1	12	. . . .		. . . . .	
Festuca pallens	. 2	4	. . . .		. . . . .	
Sedum album	. 1 . . . . + ...	8	r		. . . . .	
Aethusa cynapium	. . + ...	4	. . . . . . 1 . . . . + ...	7	. . . . .	
Matricaria maritima	. . . r	4	. . . . 1 . . . . + .	7	. . . . .	
Echium vulgare	. . . . r	4	. . . . r	4	. . . . .	
Jovibarba globifera	. . . . 1 . . . . + . . .	8	. . . . + ...	4	. . . . .	
Convolvulus arvensis	. . . . r . . . . + . .	8	. . . .		. . . . .	
Lolium perenne	. . . . r	4	. . . .		. . . . .	
Crepis biennis	. . . . + . . . + r . . .	12	. . . .		. . . . .	
Veronica chamaedrys	. . . . + . . r . .	8	. . . .		. . . . .	
Hieracium murorum	. . . . r	4	. . . .		. . . . .	
Geranium pratense	. . . .		. + ... r . . . . + ...	11	. . . . .	
Trifolium repens	. . . .		. . . . r . . . . +	7	. . 3 . .	20
Barbarea vulgaris	. . . .		. . . . 3 . . . . + . . .	7	. 1 . . .	20
Tanacetum vulgare	. . . .		. . . . 1 . . . r . .	7	. . 1 . .	20
Symphytum officinale	. . . .		. . . . r	4	. . . . .	
Calamagrostis epigejos	. . . .		. . . . + . . . 1 5	11	. . . . .	
Epilobium collinum	. . . .		. . . . 1 . .	4	. . . . .	
Cirsium vulgare	. . . .		. . . .		. . . . .	
Valeriana officinalis agg.	. . . .		. . . .		. . . . .	
Juveniles:						
Syringa vulgaris	. . . . + ...	4	. . . . r . + . . .	7	. . . . .	
Fraxinus excelsior	. . . .		. . + r	7	. . . . .	
Betula pendula	. . . .		. . . . + ...	4	. . . . .	
Grossularia uva-crispa	. . . .		. . . .		. 1 . . .	20
Sambucus nigra	. . . .		. . . .		. . . . .	
E_0						
Hypnum cupressiforme	. . 3 3 . 2 4 3 3 . . . . 4 3 . 4 3 1 . 3 2 .	50	1 2 . 2 3 5 1 2 . + 3 2 2 2 . 4 2 + . . 2 . 3 2 . . .	67	. . . 3 .	20
Bryum sp.	+ . + . . . 1 . . 1 + . 1 . . 2 + . . . 1 + . . 1 .	42	. + ... 1 1 . . . 1 . 1 . . . . 1 1 1 . . . . +	33	2 . + . .	40
Ceratodon purpureus	. + 1 3 . 2 + 2 2 1 + ... 1 . . 2 2 + + . 1 . .	58	. . . . . . + + . . . 1 . . 1 . . . . 1 . . 2	22	. . . 2 .	20
Camptothecium lutescens	. . . . 3 . 3 1 2 3 3 . . 2 . 2 2 .	35	. . . 1 . . . . + . . . 2 1 2	19	. . . . .	
Bryum argenteum	. . . . . . 1 . . . . + . . 2	12	. . . . . . + ... + + + ... 1 . . . . +	22	1 . + . .	40
Brachythecium rutabulum	. . . . 1 . . . . . . 3 . . . . 1 . . . . 1 .	15	. + . . 1 . . . . . . + 3 1 . . . . + . . .	22	. . 2 . .	20
Bryum capillare	. . . . 2 + + 2	15	. . . + ... + . . + ...	11	. . . . .	
Tortula ruralis	. . . . 2	4	. . . . + . . 1	7	1	20
Tortula muralis	. . . . + . 3 . . . . + ...	12	. . . . + . 1 . 1 . . . . + . . . 1 . + . 1 1	30	. . + . .	20
Barbula unguiculata	1 . . . + ... + . . + ...	15	. . . . 1 . 1 . . . + 1 . . 1 1 . . 3	26	. . . 1 .	20
Amblystegium serpens	. . . . 1 + + ... 2 .	15	. . . . 1 . . . . + ...	7	. . + . .	20
Camptothecium sericeum	. 3 . . . . 1	8	. . . . 2 . . . . . 3 2 . .	11	. . . 2 .	20
Bryum caespiticium	. 2	4	. . . . 3	4	1	20
Brachythecium velutinum	. 2 . . . . 1 . . . . . . 2 .	12	. . . . + ...	4	. . 1 . .	20
Didymodon rigidulus	. . . . + ... + ...	8	. . . .		. . . . .	
Eurhynchium hians	. . . . 1	4	. . . . + . 1	7	. . . . .	
Brachythecium salebrosum	. . . . 2	4	. . . . . . 3	4	. . 2 . .	20
Didymodon acutus	. . . .		. . . .		. . + 1 .	40
Encalypta streptocarpa	. 1	4	. . . .		. . . . .	
Polytrichum piliferum	. . . . + ...	4	. . . . 1	4	. . . . .	
Pohlia nutans	. . . . + ...	4	. . . .		. . . . .	
Plagiomnium undulatum	. . . . + ... + .	4	. . . .		. . . . .	
Hypnum lacunosum (Brid.) Hoffm.	. . . . 3 2	8	. . . .		. . . . .	
Bryum bicolor	. . . .		. . . . + ...	4	+	20
Brachythecium populeum	. . . . 2	4	. . . . + ...	4	. . . . .	

Species present in only two relevés: E_2: *Swida sanguinea* 2: 1, 107: +; *Sorbus aucuparia* 2: r, 107: r; *Grossularia uva-crispa* 107: +, 108: 1. – Juveniles: *Rosa* sp. 49: r, 61: +; *Taxus baccata* 86: r, 91: +; *Acer pseudoplatanus* 86: r, 107: +; *Rubus idaeus* 111: +, 112: +. – E_1: *Acinos arvensis* 2: 1, 21: 2; *Melilotus officinalis* 2: +, 50: +; *Artemisia campestris* 2: +, 50: +; *A. scoparia* 5: r, 103: r; *Vicia tetrasperma* 6: +, 27: +; *Scleranthus annuus* 8: 1, 37: 1; *Artemisia absinthium* 10: +, 77: +; *Potentilla heptaphylla* 10: +, 91: +; *Medicago ×varia* 12: 1, 41: 2; *Lamium amplexicaule* 15: +, 38: +; *Arctium* sp. 16: r, 31: r; *Galium pumilum* 21: +, 107: +; *Polygonum aviculare* agg. 24: +, 25: +; *Camelina microcarpa* 32: +, 40: 1; *Rumex acetosa* 33: r, 45: r; *Silene nutans* 76: r, 77: +; *Alliaria petiolata* 78: +, 79: r; *Epilobium ciliatum* 81: r, 93: +; *Campanula trachelium* 97: r, 102: +; *Hypericum perforatum* 105: r, 107: +; *Scrophularia nodosa* 106: +, 113: +. – E_0: *Rhynchostegium murale* 80: +, 105: +; *Polytrichum formosum* 17: +, 18: +; *Bryum subelegans* Kindb. 18: 1, 83: r; *Brachythecium albicans* 8: 2, 24: 1; *Lophocolea bidentata* 24: +, 25: +; *Plagiomnium cuspidatum* 50: 1, 71: 2; *Mnium stellare* 105: 2, 108: +; *Atrichum undulatum* 111: 1, 112: +; *Barbula convoluta* 35: 1, 86: +; *Plagiomnium affine* 25: r, 111: 2

Species present in only one relevé: E_2: *Lonicera xylosteum* 21: r; *Hedera helix* 86: 1; *Fraxinus excelsior* 104: 1; *Acer pseudoplatanus* 104: +; *Rubus idaeus* 107: +; *Betula pendula* 107: +. – Juveniles: *Acer pseudoplatanus* 43: r; *Populus tremula* 75: r; *Fraxinus excelsior* 80: r; *Acer negundo* 83: +; *Populus nigra* 98: r; *Fagus sylvatica* 108: +; *Acer campestre* 113: +. – E_1: *Euphrasia stricta* agg. 1: +; *Daucus carota* 1: r; *Trifolium pratense* 2: 1; *Botrychium lunaria* 2: r; *Anthemis arvensis* 4: +; *Chamomilla suaveolens* 4: r; *Potentilla* sp. 5: 2; *Verbascum lychnitis* 5: r; *Poa* sp. 5: r; *Pyrethrum parthenium* 8: r; *Anthoxanthum odoratum* 8: 1; *Rumex acetosella* 8: 1; *Sempervivum* sp. 8: 2; *Thlaspi arvense* 10: +; *Vicia cracca* 11: +; *Chenopodium polyspermum* 12: +;

59 60 61 62 63 64 65 66	C (%)	67 68 69	C (%)	70 71 72	C (%)	73 74 75 76 77 78 79 80 81 82 83 84 85 86	C (%)	87 88 89 90	C (%)	91 92 93 94 95 96 97 98 99 100	C (%)	101 102 103 104 105 106 107 108 109 110	C (%)	111 112 113 114	C (%)
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. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . . + ...	10	. . . .	
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. . . .		. . .		. . .		. . . r r	14	. . . .		. . . .		. . . . . . + . . .	10	. . . .	
. . . . . . + r	25	. . .		. . .		. . . . r . + . .	14	. . . .		+	10	. . . .		. . . .	
. . . .		. . .		. . .		. . . .		. . . .		. . . .		r . . + ...	20	. . . .	
. . . .		. . .		. . .		. . . . + . . .	7	. r . .	25	. . . . . + ...	10	. . . . + +	20	. . . .	
. . . .		. . .		. . .		. . . . r	7	. . . .		. . . .		. . . r . r	20	. . . .	
. . . . r	13	. . .		. . .		. . . .		. . . .		. . . .		. . . + ...	10	. . + .	25
. . . . . . + .	13	. . .		. 1 2	67	. . . + . . + . . . 1 . . +	29	. . . .		. 1	10	3 + ...	20	. + 2 .	50
. . . . . . + .	13	. . .		. . 1	33	. . + + ... r . . .	21	. . . .		. . . . . + . . 2 .	20	. + ...	10	. + . .	25
. . . . . 5 + .	25	. . .		. . 1	33	. . . .		. . . .		. . . .		. . . . +	10	. . . .	
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. . + ...	13	. . .		. . .		2 . 3 + + . + + . . + . . .	50	. . . .		+ 1	20	. . + . + ...	20	. + . .	25
. . . .		. . .		. . .		. . . . . . + + ...	14	. . . .		. . . . + . .	10	. + + . + ...	30	. . . .	
. . . .		. . .		. . .		. . . . . . + + ... +	21	. . . .		. . . .		+ + ... 1 . .	30	. . . .	
. . . .		. . .		. 2 3	67	. . . 1 + ... +	21	. . . .		. . . . + . .	10	. . . . 1 . . 2 . .	20	. . . .	
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. . + ...	13	. . .		. . .		. . . . + . . .	7	. . . .		. . . .		. . + ... 1	20	. . . .	
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. . . .		. . .		. . .		. . . .		. . . .		+	10	. . . .		. . . .	
. . . .		. . .		. . .		. . . . + . . .	7	. . . .		. . . .		. . . . + . .	10	. + . .	25
. . . .		. . .		. . .		. . . .		. . . .		. . . .		. . . .		. . . .	
. . 1	13	. . .		. . 1	33	. . . .		. . . .		. . . .		. . . .		. . . .	
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. . . .		. . .		. . +	33	. . . .		. . . .		. . . .		2	10	. . 1 .	25

Geranium pusillum 15: r; *Leonurus cardiaca* 16: 2; *Descurainia sophia* 16: +; *Melandrium album* 17: +; *Potentilla neumanniana* 18: +; *Cerastium tomentosum* 19: +; *Setaria viridis* 22: 4; *Lepidium campestre* 23: 2; *Arabidopsis thaliana* 24: +; *Erodium cicutarium* 31: +; *Lapsana communis* 40: +; *Apera spica-venti* 41: +; *Arctium tomentosum* 41: +; *Melilotus alba* 41: 1; *Triticum aestivum* 44: r; *Veronica verna* 45: +; *Galeopsis* sp. 45: r; *Festuca pratensis* 47: +; *Polygonum arenastrum* 53: +; *Epilobium angustifolium* 56: +; *Plantago lanceolata* 57: r; *Stenactis annua* 65: +; *Crepis tectorum* 65: +; *Malva* sp. 67: r; *Sedum ochroleucum* 72: +; *Myosotis ramosissima* 72: +; *Fallopia dumetorum* 74: 2; *Arabis* sp. 75: +; *Centaurea rhenana* 75: r; *Epilobium* sp. 77: r; *Parietaria officinalis* 78: 1; *Cardaminopsis arenosa* 85: 1; *Verbascum thapsus* 85: r; *Phegopteris connectilis* 92: +; *Viola odorata* 92: +; *Gymnocarpium robertianum* 93: 1; *Sagina procumbens* 93: +; *Pimpinella major* 97: r; *Dryopteris* sp. 99: r; *Athyrium filix-femina* 100: r; *Lamium maculatum* 101: +; *Aquilegia vulgaris* 102: +; *Hieracium sabaudum* 102: +; *Lamium purpureum* 107: +; *Arabis hirsuta* agg. 107: +; *Chaerophyllum aromaticum* 107: r; *Epilobium tetragonum* 110: r; *Angelica sylvestris* 111: r; *Leontodon hispidus* 112: r; *Ranunculus repens* 114: r; *Lysimachia nummularia* 114: +; *Silene vulgaris* 114: +. – E_0: *Tortula subulata* 2: 1; *Polytrichum juniperinum* 8: 2; *Hedwigia ciliata* 8: 1; *Cephaloziella divaricata* 8: +; *Tortula latifolia* 16: r; *Neckera complanata* 21: 1; *Abietinella abietina* 24: 1; *Climacium dendroides* 24: 1; *Thuidium* sp. 25: +; *Tortula ruraliformis* (Besch.) Grout 31: 3; *Didymodon fallax* 31: +; *Mnium marginatum* 38: 2; *Cirriphyllum piliferum* 41: +; *Campylium calcareum* 57: +; *Barbula* sp. 73: 1; *Didymodon* sp. 79: +; *Pellia endiviifolia* 80: 2; *Rhynchostegiella tenella* 86: +; *Pseudocrossidium hornschuchianum* 91: +; *Conocephalum conicum* 101: +; *Plagiothecium cavifolium* 101: 1; *Rhizomnium punctatum* 101: 1; *Bryoerythrophyllum recurvirostre* 101: 1; *Didymodon ferrugineus* 105: +; *Marchantia polymorpha* 111: 1.

Communities on vertical wall surfaces

b.c. *Cymbalaria muralis*-[*Cymbalario-Asplenion*]

This species-poor (mean 10.5, range 3–27) and open community with a mean cover of herb layer 50% (range 15–80%) is dominated by *Cymbalaria muralis* (Table 3, rels. 73–86), forming large hanging carpets. The moss layer with a low cover (mean 7%, range 0–30%) is mostly characterized by *Tortula muralis*.

The stands of the community inhabit both sunny and shaded vertical wall surfaces. No relationship was found between the type of building material and floristic composition of the community – it was recorded on granite, phonolite, bricks or clay slates. Fortification of castles and old town centres, as well as walls surrounding churches and cemeteries are its most typical habitats in the study area. The community is distributed from lowlands to the hilly country of East Bohemia up to 480 m a.s.l. (Fig. 1).

b.c. *Corydalis lutea*-[*Cymbalario-Asplenion*]

This community has the lowest species richness among those studied – mean number of species per relevé was only 5.8 (range 5–6). *Corydalis lutea* dominates the community (Table 3, rels. 87–90). The cover of herb layer ranges from 35 to 85% (mean 51%); moss layer is not developed. The community was recorded at two localities in East Bohemia (Fig. 1). It inhabits joints of vertical, sunny to shady wall surfaces filled with disintegrating mortar or concrete.

Asplenietum trichomano-rutae-murariae ass.

This species-poor to moderately rich community (mean 12.5, range 2–25) with open canopy (mean cover of E_1: 23%, range 6–50%) is differentiated by a dominance of *Asplenium ruta-muraria* and *A. trichomanes* (Table 3, rels. 91–110). The group of common species include those with a wide ecological amplitude (*Chelidonium majus, Taraxacum* sect. *Ruderalia*). Moss layer with a low cover (mean 15%, range 0–60%) is formed by number of accidental species.

The community inhabits joints of sunny to shady vertical wall surfaces built from various materials (granite, gneiss, bricks, sandy marls, and slates) and jointed with mortar or concrete. The calciphilous *Asplenium ruta-muraria* (cf. Kolbek 1990) can successfully grow even on acidic substrata thanks to a high amount of $CaCO_3$ in disintegrating mortar. Regarding site exposition, level of shading and moisture condition, two subtypes were distinguished within the community: (i) Species-poor stands (*typicum* subass.) with simple structure (cover of E_1: mean 22%, range 6–35%) and low species richness dominated mostly by *Asplenium ruta-muraria* (Table 3, rels. 91–100) inhabiting dry walls with prevailing SE, S, and W orientation. The cover of moss layer is low (mean 4%, range 0–10%). (ii) Moderately rich stands (*geranietosum* subass.) with differential species *Cystopteris fragilis, Geranium robertianum, Epilobium montanum, Mycelis muralis* (cover of E_1: mean 22%, range 10–40%) inhabit slightly moist, half-shaded or shaded and nutrient richer habitats with prevailing N, NE and NW orientation (Table 3, rels. 101–110). The cover of moss layer is apparently higher than in the former subtype (mean 22%, range 1–50%).

Asplenietum trichomano-rutae-murariae is a widespread community in the study area (Fig. 1). The altitudinal range of this association varies approximately from 290 to 600 m a.s.l.

b.c. *Cystopteris fragilis*-[*Cymbalario-Asplenion*]

Moderately rich stands of the community (mean 15.0, range 13–18) with low to middle cover of herb layer (mean 28%, range 10–50%) are dominated by *Cystopteris fragilis* (Table 3, rels. 111–114). The community is differentiated from *Asplenietum* by the absence of *Asplenium ruta-muraria* and *A. trichomanes*. *Cystopteris fragilis* is accompanied by a group of species that is identical with those typical of the subass. *Asplenietum trichomano-rutae-murariae geranietosum robertiani*. Moss layer is well developed with mean cover of 27% (range 3–60%) but without specific edificators. The community inhabits shady and moist joints of vertical wall surfaces (various building material) with prevailing W, N and E orientation. It is frequently found on shaded bridge pillars or bank seatings. The community is distributed in higher altitudes of East Bohemia (Fig. 1).

Discussion

Plants on walls

Frequency analysis showed that the most common species on walls could be classified into two groups: (i) plants "specific" to wall habitats or habitats with similar ecological conditions, i.e. rock debris swards and their semiruderal derivates (e.g. *Poa compressa*, *Sedum* sp. div., *Arenaria serpyllifolia*) and rock fissures (e.g. *Asplenium* sp. div., *Cystopteris fragilis*); (ii) common species with a wide ecological amplitude, which colonize the walls due to mass-effect from the surroundings (e.g. *Taraxacum* sect. *Ruderalia*). High number of accidental species that reach only low covers on walls indicate the influence of surrounding vegetation on species composition on the walls (Holland 1972, Pyšek & Pyšek 1988, Borgegard 1990, Kolbek 1997), as well as strong limitation by wall environment and/or competitive exclusion in a small-scale habitat.

Although frequencies of respective dispersal strategies of plants occurring on wall tops do not differ from general pattern found in Central-European flora (cf. Frank & Klotz 1990), vertical inclination apparently favours the establishment and spread of anemochorous, autochorous and endozoochorous species. Aside from historical and topographical aspects, vertical surfaces are more frequently repaired as against wall tops in the studied territory. Regular disturbances thus discriminate especially in favour of establishment of the anemochorous plants. Surprisingly, the proportion of myrmecochorous plants on vertical surfaces does not exceed that on wall tops. It is caused by the absence or very rare occurrence of many myrmecochorous species that are common in wall fissures in sub-atlantic and sub-meditteranean parts of Europe (e.g. *Cheiranthus cheiri*, *Parietaria* sp. div.) in the studied territory. In addition, most native myrmecochorous plants, which are dispersed by ants both on wall tops and vertical surfaces, successfully grow on both habitats. The highest proportion of species of *Compositae* family found on studied walls is related to its high species number in Central Europe and the remarkable success of this family in terms of dispersal and establishment (Pyšek 1997).

The proportions of neophytes and archaeophytes found on the studied walls were similar to those found in the Czech settlements (Pyšek 1989). However, their representation was considerably higher than on European walls studied by Segal (1969). There are several reasons for this difference: (i) Although the difference was non-significant, this study found archaeophytes and neophytes more frequently on wall tops than on vertical surfaces. Since most of the published papers studied flora and vegetation on vertical surfaces only, they underestimated proportion of alien species. (ii) According to Segal (1969: 279) the proportion of alien species on walls is the largest in Central and Eastern Europe, where wall vegetation has not such a "special look" as in other areas of Europe.

The pattern of life forms recorded on the studied walls is the same as that found on walls in other parts of Europe (Segal 1969, Brandes 1992a,b). Higher proportion of therophytes on wall tops contrasted with a lower proportion on vertical surfaces. It is in agreement with higher proportion of R, CR and SR-strategists growing on wall tops, as opposed to the vertical surfaces. Especially winter annuals form a considerable part of vegetation of wall tops (Klimeš 1986), indicating a significant role of seasonal periodicity and disturbance. In contrast, a high frequency of hemicryptophytes and phanerophytes on vertical surfaces coincides with competition for limited space under relatively stabilized soil conditions.

The most widespread mosses on the investigated walls were reported as common on the European walls studied by Segal (1969). *Tortula muralis* was observed as the most ubiquitous pioneer in rather diverse sites including wall tops and vertical surfaces. Although many other pioneers adapted to extreme environments were recorded on the studied walls (e.g. *Bryum caespiticium, B. argenteum, Didymodon* sp. div.), mosses typically growing on hard substrata (e.g. *Tortula ruralis*) were rare there. This is because of soft stones (e.g. clay slates) being usually used as a building material for walls. High proportion of colonists coincides with the wall environment that is less predictable in time and space (During 1979). Although proportion of pleurocarpous and acrocarpous mosses did not differ between wall tops and wall surfaces, pleurocarpous mosses (e.g. *Hypnum cupressiforme, Camptothecium lutescens*) tended to be more-dominant on wall tops than on vertical surfaces. Such stands are typical of sites with uneven surface and thin A-C soils containing a higher amount of fine-grained soil and organic matter. Stands containing pleurocarpous mosses are mostly successional stages of communities with ultimately acrocarpous forms and are often found in places with more favourable water relations (Segal 1969). Competition with vascular plants is not as strong in these stands as in stands dominated by *Poa compressa* later in succession. These stands exhibit both very low species richness and low cover of mosses.

Indication of ecological conditions based on vascular plants clearly showed that wall tops and vertical surfaces differ in light and moisture: wall tops were drier and gained more incident radiation than vertical surfaces. On the other hand, indication based on mosses did not reveal any differences between the wall tops and vertical surfaces concerning the investigated factors. Presumably, this is related to a wide range of different microhabitats on vertical surface (e.g. surface of hard stones, joints) colonized by mosses, which contrast with vascular plants that colonize only fissures and joints.

In summary, ecological differentiation and contrasting topography of habitats are the factors which may explain the low number of species occurring both on wall tops and vertical surfaces. Moreover, physiological limits of early plant development exist: horizontal growth of radicle of young plants prevents many species from successful establishment and regular occurrence in horizontal fissures (Segal 1969).

Vegetation on wall tops

The phenomenon of wall tops is fully developed only on old isolated walls in the countryside. This is due to different construction and functionality of walls in villages and towns. Most of town walls lacked developed vegetation, owing to the use of concrete and compact and hard stones (e.g. granite) as a building material covered by protruding copings.

Klimeš (1986) classified the top structure of isolated walls in Central Moravia (the Czech Republic) into three types according to the prevailing ecological process: (i) erosion-accumulative, (ii) accumulative and (iii) erosion-type. Similar situation was recorded in the study area. The erosion-accumulative and erosion types have higher species richness with a large number of succulents and archaeophytes and lower cover of grasses. On the other hand, lower species richness and dominance by *Poa* sp. div. is typical of the accumulative type.

It is evident that classification of vegetation on wall tops (cf. Klimeš 1986) directly reflects the environmental heterogeneity mentioned above. Nevertheless, floristic differences within and among the relevé material concerning wall top vegetation from former Czechoslovakia (Klimeš 1986, Valachovič & Maglocký 1995, this study) point to a high variability in species composition that is related to untenably wide concept of the association *Sedo-Poetum compressae* Klimeš 1986, whose local stands are under influence of both different species pools and different meso- and macroclimate conditions of respective regions. Vegetation on wall tops consists of species which indicate many different syntaxonomic units of various ranks. Therefore, application of the classical phytosociological approach is limited. In fact, wall top vegetation formerly classified within *Sedo-Poetum* Klimeš 1986 comprises more types which can be classified at the level of basal or derived communities only. Somewhat similar types were reported from the railway embankments in Central Europe (e.g. Jehlík 1986).

Floristically similar community *Saxifrago tridactylitis-Poetum compressae* (Kreh 1945) Géhu et Lericq 1957 is widely distributed on wall tops and railway embankments in warmer parts of western and central Europe (cf. Géhu 1961, Korneck 1975, 1978, Hilbig & Reichhoff 1977, Forstner 1983). Kolbek (1997) predicted occurrence of the *Saxifrago-Poetum* on walls in warm regions of the Czech Republic. Floristic comparison of relevé material of these vegetation types (Géhu 1961, Korneck 1975, 1978, Hilbig & Reichhoff 1977, Klimeš 1986, Valachovič & Maglocký 1995, this study) shows that *Saxifrago-Poetum* has a more "extreme" character with many xerophilous species of *Sedo-Scleranthetea*, higher proportion of succulents and annuals, and lower presence of C-strategists, than the types included formerly within *Sedo-Poetum*. So far, no relevés of *Saxifrago-Poetum* have been published from the territory of the Czech Republic.

The basal community *Conyza canadensis*-[*Sisymbrietalia*] resembles vegetation types reported predominantly from railway habitats, injured soils near building plots and demolition areas over the whole Central Europe, frequently under the name *Erigeronto-Lactucetum serriolae* Lohmeyer in Oberdorfer 1957 em. Mucina 1978 (e.g. Pyšek 1974, Mucina 1978, Kopecký 1980, Jehlík 1986, Višňák 1996, Jarolímek et al. 1997).

Only the shrub community with dominance of *Syringa vulgaris* was frequently found on walls in East Bohemia but its low species richness and floristic heterogeneity does not allow its exact classification. According to Brandes (1992a), *Syringa vulgaris* is an "indicator species" of tops of old wall fences with very thick soil horizon. Stands to some extent similar to the mentioned type are reported from warm parts of the Czech Republic (South Moravia, Central Bohemia; J. Sádlo, unpubl.).

Vegetation on vertical wall surfaces

In contrast to twelve communities reported on vertical wall surfaces in the Czech Republic by Kolbek (1997), only five communities were recorded by this study in lower altitudes of East Bohemia. Relatively uniform building material of studied walls, similar macroclimate conditions within the study area and rare occurence of some diagnostical species of other communities are responsible for absence of some other types in the studied territory.

Asplenium ruta-muraria was found on most vertical surfaces in the study area (Table 3). Its widespread distribution contrasts with other ferns such as *Asplenium trichomanes* or *Cystopteris fragilis*. This is because *Asplenium ruta-muraria* is more resistant to considerable temperature fluctuation than other ferns (Segal 1969, Kolbek 1990, Brandes 1992b). *Asplenium ruta-muraria* often forms pure and sparse stands in wall joints in extreme environments or pioneer stages of succession in the study area. These species-poor stands were not included in the current analysis.

Differentiation among "typical" *Asplenietum trichomano-rutae-murariae* and wall communities dominated by species alien to Central Europe is problematic from the point of view of syntaxonomy. The number of diagnostic species is limited and many stands are floristically transitional: dryer climate and considerable fluctuation of the temperature are presumably limiting factors in continental parts of Europe (cf. Segal 1969, Brandes 1992a). This "continuity" was reflected in number of described types, mostly at the level of subassociation or "dominant community" (cf. Gödde 1987, Jehlík 1989, Brandes 1992a,b, Oberdorfer 1992, Valachovič 1995). From the Central European perspective, application of the deductive method of classification is thus required.

Data on basal communities *Corydalis lutea*-[*Cymbalario-Asplenion*] and *Cymbalaria muralis*-[*Cymbalario-Asplenion*] are scarce from the Czech Republic (Kolbek & Kurková 1979, Homola 1990, Duchoslav 1994, 1999) but both communities are probably widely distributed. Phytosociological material published so far from Central Europe under the names *Cymbalarietum muralis* Görs 1966 and *Corydalidetum luteae* Kaiser 1926 represent in fact fragmentary derivates, which should be classified as basal communities of the alliance *Cymbalario-Asplenion*. Weak floristic differentiation and low species richness of the b.c. *Corydalis lutea*-[*Cymbalario-Asplenion*] is caused by rapid colonization of so far bare cracked walls by *Corydalis lutea* via myrmecochory from neighbouring gardens where the species is cultivated. On the other hand, colonization of the walls by *Cymbalaria muralis* is slow, except of passive transport by water on river navigations (but see Härtel et al. 1996).

It is not correct to identify b.c. *Cystopteris fragilis*-[*Cymbalario-Asplenion*] with *Cystopteridetum fragilis* Oberdorfer 1938 (*Cystopteridion* all.), a typical vegetation type of shaded moist limestone joints. Many diagnostic species of the latter type are absent from the stands of the b.c. *Cystopteris fragilis*-[*Cymbalario-Asplenion*], e.g. *Asplenium viride, Moehringia muscosa, Phyllitis scolopendrium* and *Valeriana tripteris* (Brandes 1992b, Mucina 1993, Valachovič & Maglocký 1995). Almost identical vegetation types as b.c. *Cystopteris fragilis*-[*Cymbalario-Asplenion*] are reported on walls from Austria and Germany as a "Fragmentgesellschaft" *C. fragilis*-(*Cymbalario-Asplenion*) (Mucina 1993) or *C. fragilis*-Dominantzgesellschaft (Brandes 1992b), respectively.

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Souhrn

Práce se zabývá flórou a vegetací zdí ve východních Čechách. Byly studovány dva výrazné ekotopy zdí: boky (vertikály) a koruny. Vedle městských, zámeckých a hradních zdí byly studovány i izolované plotní zdi, které jsou charakteristickým prvkem venkovské krajiny, ale jsou v posledních desetiletích nahrazovány kovovými či dřevěnými ploty.

Celkem bylo na studovaných zdech nalezeno 207 druhů cévnatých rostlin a 60 druhů mechorostů. Většina druhů se na zdech vyskytuje s velmi nízkou frekvencí, pouze dva (*Taraxacum* sect. *Ruderalia*, *Poa compressa*) se vyskytují s frekvencí vyšší než 50 %. Na zdech byly zaznamenány druhy ze 43 čeledí, z nichž dominovaly *Asteraceae, Poaceae, Brassicaceae* a *Lamiaceae*. Z hlediska životních strategií převažují C, CSR a CR stratégové, nejčastější životní formou jsou hemikryptofyty a fanerofyty. Podíl archeofytů je 13 % a neofytů 10 % na celkovém počtu druhů zaznamenaných na zdech. Anemochorní a autochorní druhy reprezentují nejčastější strategii šíření rostlin osídlujících zdi. Na zdech převažovaly akrokarpní mechorosty nad pleurokarpními. Z hlediska životních strategií mechorostů převažovaly na zdech kolonisté a vytrvalé druhy. Flóra zdí je tvořena druhy heliofilními až tolerantními vůči zastínění, které indikují teplá až mezická, na živiny chudá až středně bohatá stanoviště.

Srovnání flóry vrcholů a boků zdí ukázalo, že pouze 32 % druhů se zároveň vyskytovalo na obou typech stanovišť. Na korunách zdí převládaly druhy s R strategií (včetně kombinací tuto strategii zahrnujících), zatímco na bocích C, CS a CSR stratégové. Druhy anemochorní, autochorní a endozoochorní byly četnější na vertikálách, zatímco druhy exozoochorní na korunách zdí. Použití indikačních hodnot ukázalo rozdíly v nárocích cévnatých rostlin na světlo a vlhkost: druhy rostoucí na korunách indikují vyšší nároky na světlo a nižší nároky na vlhkost než druhy rostoucí na bocích. Rozdíly v dalších charakteristikách druhů nebyly nalezeny ani u cévnatých rostlin, ani u mechorostů.

Klasifikace vegetace zdí je vzhledem k vysoké druhové heterogenitě a nízké stálosti většiny druhů velmi obtížná a vyžaduje aplikaci deduktivní metody. Celkem bylo na studovaných zdech zaznamenáno 10 společenstev. Na korunách zdí jsou nejčastějším typem porosty společenstev s dominantními druhy *Poa compressa*, reprezentované b.s. *Poa compressa*-[*Sedo-Scleranthetea/Stellarietea*] a o.s. *Poa compressa*-*Poa palustris* subsp. *xerotica*-[*Stellarietea/Artemisietea*], a s *P. nemoralis* subsp. *rigidula*, představované o.s. *Poa nemoralis* subsp. *rigidula*-[*Stellarietea/Artemisietea*]. Porosty jsou druhově chudé až středně bohaté. První typ je charakteristický výskytem sukulentů a jednoletých druhů na výslunných a erozí silně ovlivňovaných korunách zdí. Další typy jsou charakteristické zvýšeným podílem C stratégů na stanovištích spíše mezofilních s vyšší vrstvou půdy. Společenstva jsou charakteristická pro koruny izolovaných plotních zdí (zvláště na venkově) v různých, spíše pozdějších stádiích rozpadu koruny a akumulace substrátu. Koruny zdí se silnou vrstvou substrátu osídlují druhově chudé porosty s dominantní *Poa compressa*. Typickým společenstvem korun zdí zbořenišť je b.s. *Conyza canadensis*-[*Sisymbrietalia*], osídlující hrubozrnný substrát tvořený převážně rozpadlou maltou. Zřídka byly v teplejších částech území zaznamenány keřové porosty s dominancí šeříku (*Syringa vulgaris*).

Nejčastějším společenstvem na vertikálách je asociace *Asplenietum trichomano-rutae-murariae* s dominantními druhy *Asplenium ruta-muraria* a *A. trichomanes*. Vlhčí porosty společenstva jsou diferencovány druhy *Cystopteris fragilis, Geranium robertianum, Epilobium montanum* (subas. *geranietosum robertiani*). Především na městských a zámeckých zdech se vyskytují další dvě společenstva: b.s. *Cymbalaria muralis*-[*Cymbalario-Asplenion*] a b.s. *Corydalis lutea*-[*Cymbalario-Asplenion*]. Vlhčí, často zastíněné boky zdí se severovýchodní orientací ve vyšších nadmořských výškách osídluje b.s. *Cystopteris fragilis*-[*Cymbalario-Asplenion*], slabě diferencované od předchozích vegetačních typů.

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Appendix 1. – Header data for Table 3.

Rel. no.	Year	Month	Day	Area (m^2)	Altitude (m a.s.l.)	Exposition (°)	Inclination (°)	Cover (%) shrubs	herbs	mosses
1	1999	08	01	2.0	500	.	0	0	85	5
2	1999	08	03	8.0	420	.	0	5	75	60
3	1993	07	19	5.0	310	.	0	0	50	25
4	1993	07	19	5.0	380	.	0	0	65	50
5	1999	08	01	6.0	500	.	0	0	40	3
6	1993	07	19	5.0	380	.	0	0	80	40
7	1995	08	04	2.5	270	.	0	0	75	70
8	1999	08	01	8.0	520	.	0	0	75	60
9	1999	08	01	5.0	340	.	0	0	30	75
10	1990	07	05	1.0	400	.	0	0	50	45
11	1990	07	05	1.0	400	.	0	0	70	25
12	1998	08	31	5.0	300	.	0	0	60	50
13	1998	09	06	5.0	275	.	0	0	60	50
14	1998	09	12	9.0	340	135	15	0	60	0
15	1999	07	17	3.0	280	.	0	0	65	70
16	1999	07	17	2.5	280	.	0	0	55	30
17	1999	07	17	2.0	250	.	0	0	60	70
18	1999	08	03	5.0	300	.	0	0	95	70
19	1999	08	03	5.0	300	.	0	0	80	65
20	1999	08	14	4.0	280	.	0	0	30	80
21	1999	08	14	2.0	450	.	0	0	75	65
22	1999	08	14	5.0	260	.	0	0	95	35
23	1999	08	14	4.0	280	.	0	0	85	0
24	1999	08	14	5.0	300	.	0	0	85	50
25	1999	08	14	5.0	300	.	0	0	85	50
26	1990	09	07	4.0	340	180	20	0	95	0
27	1993	07	19	4.0	300	.	0	0	75	5
28	1998	08	15	2.0	330	.	0	0	80	15
29	1998	08	31	2.0	300	.	0	0	85	15
30	1998	09	02	2.0	300	.	0	0	80	15
31	1998	09	06	2.0	380	.	0	0	80	60
32	1998	09	06	4.0	310	.	0	0	70	80
33	1998	09	12	4.0	320	.	0	0	70	45
34	1998	09	12	2.0	270	.	0	0	80	40
35	1998	09	12	2.0	270	.	0	0	45	15
36	1998	09	12	5.0	360	.	0	0	85	10
37	1998	09	12	2.5	460	.	0	0	60	50
38	1999	07	17	2.5	290	.	0	0	85	25
39	1999	07	17	2.0	250	.	0	0	80	40
40	1999	07	17	1.5	250	.	0	0	70	30
41	1999	07	17	2.0	260	.	0	0	55	5
42	1999	07	17	5.0	270	.	0	0	75	70
43	1999	08	01	2.0	290	.	0	0	45	20
44	1999	08	01	7.5	250	.	0	0	30	45
45	1999	08	01	2.5	300	.	0	0	50	2
46	1999	08	01	6.0	280	.	0	0	65	5
47	1999	08	02	5.0	520	.	0	0	25	10
48	1999	08	02	6.0	350	.	0	0	40	40
49	1999	08	02	2.5	400	.	0	0	55	60
50	1999	08	14	5.0	300	.	0	0	85	60
51	1996	08	12	10.0	400	.	0	0	40	10
52	1999	08	01	4.0	290	.	0	0	30	0
53	1998	08	15	5.0	390	.	0	0	90	30
54	1998	09	06	4.0	270	.	0	0	75	30
55	1999	08	01	3.0	290	.	0	0	30	0

56	1999	08	02	5.0	540	.	0	0	55	40
57	1999	08	03	5.0	420	.	0	0	50	60
58	1999	08	14	2.0	250	.	0	0	30	5
59	1990	07	09	2.0	340	.	0	0	60	0
60	1990	09	07	2.0	340	.	0	0	50	0
61	1998	08	15	2.5	340	.	0	0	80	5
62	1990	07	09	4.0	340	.	0	0	60	0
63	1990	08	19	1.0	300	.	0	0	70	0
64	1998	08	15	2.0	410	.	0	0	60	90
65	1999	08	14	8.0	270	.	0	3	35	3
66	1999	08	14	5.0	270	.	0	0	75	0
67	1999	08	01	4.0	290	.	0	0	70	0
68	1999	08	02	2.0	420	.	0	0	35	0
69	1999	08	01	3.5	290	.	0	0	50	0
70	1999	08	01	6.0	290	.	0	55	5	0
71	1999	08	14	10.0	280	.	0	100	1	25
72	1999	08	02	6.0	340	.	0	40	70	40
73	1995	07	11	5.0	410	225	90	0	60	15
74	1995	07	10	5.0	300	112	90	0	70	0
75	1996	07	15	12.0	290	338	90	0	20	30
76	1998	09	02	15.0	480	23	90	0	35	3
77	1998	09	02	9.0	480	45	90	0	40	4
78	1998	09	04	9.0	220	45	90	0	80	0
79	1999	08	01	10.0	290	270	90	0	15	2
80	1999	08	03	9.0	280	360	90	0	30	25
81	1999	08	02	8.0	420	270	90	0	25	4
82	1999	08	02	16.0	340	135	90	0	65	0
83	1999	08	03	15.0	280	90	90	0	30	5
84	1999	08	14	5.0	280	315	90	0	75	0
85	1999	08	14	25.0	360	90	90	0	75	0
86	1999	08	14	12.0	360	270	85	10	80	5
87	1990	09	07	4.0	340	270	90	0	85	0
88	1998	09	12	10.0	360	135	90	0	35	0
89	1998	09	12	8.0	360	135	90	0	45	0
90	1998	09	12	3.0	340	135	90	0	40	0
91	1999	08	01	10.0	290	270	90	0	25	1
92	1990	08	19	9.0	310	315	90	0	35	5
93	1991	09	26	5.0	380	270	90	0	25	0
94	1998	08	15	12.0	410	225	90	0	25	0
95	1998	08	15	9.0	410	203	90	0	20	0
96	1998	08	15	6.0	340	315	90	0	35	10
97	1998	08	30	10.0	600	45	90	0	20	10
98	1998	09	12	7.0	360	315	90	0	7	2
99	1998	09	06	6.0	310	90	90	0	25	10
100	1999	08	02	12.0	520	90	90	0	6	1
101	1996	08	20	10.0	390	90	90	0	30	50
102	1999	08	01	7.5	360	315	90	0	30	3
103	1999	08	01	6.0	500	45	90	0	10	1
104	1999	08	03	12.0	400	68	75	5	40	35
105	1999	08	03	6.0	400	248	15	0	10	10
106	1999	08	14	20.0	360	315	0	0	15	5
107	1999	08	14	12.0	450	315	90	5	25	45
108	1999	08	14	9.0	450	315	90	5	15	25
109	1967	08	03	0.5	410	360	90	0	?	n.e.
110	2001	08	30	12	214	360	90	0	25	5
111	1990	07	11	10.0	380	315	90	0	10	40
112	1999	08	01	6.0	590	45	90	0	15	3
113	1999	08	14	8.0	480	360	80	0	35	60
114	1999	08	14	4.0	400	180	90	0	50	4

Appendix 2. – Localities of relevés in Table 3.

1: Lichnice, ruins of the bulwalk of the Lichnice castle; 2: Lanšperk, ruins of the bulwark of the castle; 3: Bělá, top of wall near the southern part of the village; 4: Přibylov, top of wall along a road; 5: Lichnice, ruins of the bulwark of the castle; 6: Přibylov, top of wall along a road; 7: Hrušová u Vysokého Mýta, top of wall in the centre of village; 8: Hůrka u Hlinska v Čechách, top of wall fence along a road; 9: Lukavička, top of wall fence along a road in the centre of the village; 10: Štěpánov, top of wall in the centre of the village; 11: Štěpánov, top of wall in the centre of the village; 12: Běstviny u Dobrušky, top of wall fence near a road on the southern part of the village; 13: Jenišovice, top of wall fence in the centre of the village; 14: Sudličkova Lhota, vertical surface of the wall fence of the farm building near the village; 15: Lozice, top of wall fence along a road in the centre of the village, shaded by trees from one side; 16: Zalažany, top of wall fence along a main road; 17: Hrochův Týnec, top of wall fence along a road in the periphery of the village; 18: Vraclav, top of wall fence of the cemetery; 19: Vraclav, top of wall fence of the cemetery; 20: Opočno, top of wall fence of the church in the centre of the town; 21: Potštejn, disintegrating fortification of the Potštejn castle; 22: Pulice, top of wall fence in the centre of the village; 23: Lhota u Nového Města n. Metují, top of wall fence in the centre of the village; 24: Černčice, Pod Horou mill – top of wall fence along a garden; 25: Černčice, Pod Horou mill – top of wall fence along a garden; 26: Sudličkova Lhota, top of wall fence of the farm near the village; 27, 28: Bělá, top of wall in the centre of the village; 29: Opočno, top of wall fence near the railway station; 30: Valdice, top of wall near the railway station; 31: Přibylov, top of wall in the centre of the village; 32: Voletice, top of wall fence near the churchyard; 33: Bučina, top of wall fence in the centre of the village; 34: Hrušová, top of wall fence in the centre of the village; 35: Hrušová, top of wall fence in the centre of the village; 36: Litomyšl, top of wall fence of the chateau in the centre of the town; 37: Horní Sloupnice, top of wall fence in the southern part of the village; 38: Lozice, top of wall fence along a road in the centre of the village, shaded by trees from one side; 39: Blížňovice, top of wall fence around a garden at periphery of the village; 40: Blížňovice, top of wall fence around a garden in the centre of the village; 41: Rosice u Chrasti, top of wall fence along a road in the centre of the town; 42: Synčany, top of wall fence along a road in the centre of the village; 43: Chrast u Chrudimi, top of wall fence around the chateau; 44: Heřmanův Městec, top of wall fence around a castle park; 45: Třemošnice, top of wall around a homestead in the southern part of the village; 46: Stolany, top of wall fence around a collective farm; 47: Polička, top of wall fence around the cemetery in the centre of the town; 48: Moravská Třebová, top of wall of the ruin in the SE part of the town; 49: Skuteč – Vila, top of wall fence of the lonely house; 50: Osíček u Černčic, top of wall fence in the centre of the village; 51: Ledeč n. Sázavou, disintegrating fortification of the Ledeč castle; 52: Chrast u Chrudimi, top of wall fence in the centre of the town; 53: Střemošice, top of wall in the centre of the village; 54: Podlažice, top of wall in the centre of the village; 55: Chrast u Chrudimi, top of wall fence around the chateau garden in the centre of the town; 56: Kamenec u Poličky, top of wall fence of the mill; 57: Žampach, top of wall fence of the institute of social care; 58: Borohrádek, top of wall fence of the mill; 59: Srbce, top of wall in the centre of the village; 60: Srbce, top of wall in the centre of the village; 61: Luže, top of wall fence of the P. Marie church ("Chlumek"); 62: Sudličkova Lhota, top of wall fence of the farm near the village; 63: Voletice, top of wall in the centre of the village; 64: Košumberk, top of wall fence in the centre of the village; 65: Častolovice, top of wall fence in the centre of the town; 66: Doubravice, top of wall fence in the periphery of the village; 67: Chrast u Chrudimi, top of burned ruins in the centre of the town; 68: Svitavy, top of wall fence near bus station; 69, 70: Chrast u Chrudimi, top of wall fence in the centre of the town; 71: Osíček u Černčic, top of wall fence along a road in the village; 72: Moravská Třebová, top of wall fence near bus station; 73: Předhradí, vertical surface of wall near a church in the village, Duchoslav (1999: rel. 18); 74: Vysoké Mýto, vertical surface of wall in the centre of the town; 75: Kunětická hora, disintegrating fortification of the Kunětice castle; 76, 77: Trosky, vertical wall surface of the Trosky castle fortification; 78: Hradec Králové, vertical wall surface of the fortification in the centre of the town; 79: Heřmanův Městec, vertical wall surface of the wall around the castle park; 80: Vraclav, vertical surface of the bearing wall of the St. Mikuláš church; 81: Svitavy, vertical surface of the wall fence around the cemetery; 82: Moravská Třebová, vertical surface of the bearing wall of the house in the SE part of the town; 83: Vysoké Mýto, vertical surface of wall in the park near the centre of the town; 84: Opočno, vertical wall surface in the Mlýnská street in the centre of the town; 85: Nové Město n. Metují, vertical wall surface of the water moat around the chateau; 86: Nové Město n. Metují, vertical wall fence (fortification) of the chateau; 87: Sudličkova Lhota, vertical surface of the wall fence of the farm near the village; 88, 89: Litomyšl, vertical surface of the wall fence of the church in the centre of the town; 90: Sudličkova Lhota, vertical surface of the wall fence of the farm building near the village; 91: Heřmanův Městec, vertical surface of the wall fence of the church in the S part of the town; 92: Voletice, vertical wall surface in the centre of the village; 93: Lanškroun, vertical wall surface in the northern part of the town, Jirásek (1992: 240); 94: Košumberk, vertical wall surface of the castle fortification; 95: Košumberk, vertical wall surface of the castle fortification; 96: Luže, vertical wall surface of the P. Marie church ("Chlumek"); 97: Černý Důl, vertical surface of the church wall fence in the centre of the village; 98: Litomyšl, vertical surface of the wall fence of the church in the centre of the town; 99: Luže, vertical wall surface of the post office building; 100: Polička, top of wall fence of the cemetery; 101: Předhradí, vertical surface of the bridge in the village, Duchoslav (1999: rel. 17); 102: Kostelec u H. Městce, vertical wall surface in the centre of the town; 103: Lichnice, vertical wall surface of the castle ruins; 104: Brandýs n. Orlicí, vertical wall surface of the supporting wall of the church; 105: Lanšperk, ruins of the bulwark of the castle – ceiling of the corridor; 106: Rychnov n. Kněžnou, vertical wall surface of the chateau in the centre of the town; 107: Potštejn, vertical wall surface of the bulwark of the Potštejn castle; 108: Potštejn, vertical wall surface of the bulwark of the Potštejn castle; 109: Broumov: wall in the Máchova street, Hadač (1970: 233); 110: Pardubice: vertical wall surface of the furrow in the centre of the town; 111: Lanškroun, shaded vertical wall surface near the Pšenkův pond, Jirásek (1992: 240); 112: Borová u Poličky, vertical surface of the wall fencing church garden in the village; 113: Liberk, vertical wall surface of the wall fence in the village; 114: Skuhrov, vertical wall surface of the wall fence in the village.

Chytrý M., Kučera T. & Kočí M. (eds.)

Katalog biotopů České republiky

Agentura ochrany přírody a krajiny ČR, Praha 2001, 307 str., 157 barev. fotogr. v textu, 124 map. ISBN 80-86064-55-7.

Příprava na vstup do Evropské unie (přesněji snaha o postupné naplnění směrnice č. 92/43/EHS o ochraně volně žijících živočichů, planě rostoucích rostlin a přírodních stanovišť) přinesla naší přírodovědecké veřejnosti výpravnou brožuru popisující přírodní vegetaci České republiky. Publikace vznikla zcela účelově na objednávku Agentury ochrany přírody a krajiny ČR jako terénní příručka pro mapování biotopů pro projekty Evropské unie (EU) a Rady Evropy (RE) – Natura 2000 a Smaragd.

Základem díla je osm kapitol, které popisují přírodní vegetaci ČR. Dohromady s kapitolou „Biotopy silně ovlivněné nebo vytvořené člověkem“ tak tvoří devět vegetačních formací. Celkově tedy přehled umožňuje celoplošné mapování vegetace na libovolném území ČR. Jednotlivé kapitoly byly napsány našimi předními odborníky na klasifikaci vegetace nebo jejich nejlepšími žáky. Kniha je doplněna precizně zpracovaným vysvětlujícím aparátem, základní literaturou, rozsáhlými převodními tabulkami mezi všemi používanými (i nepoužívanými) systémy klasifikace vegetace ČR a nakonec rozsáhlým rejstříkem českých a latinských názvů rostlinných taxonů a jednotek všech klasifikačních systémů použitých v knize.

Základních devět formačních kapitol je rozděleno celkem na 167 vegetačních mapovacích jednotek (chcete-li biotopů). Každý popisovaný biotop pak v záhlaví obsahuje kód, název a tabulku převodů na jednotlivé vegetační klasifikace (např. fytocenologickou klasifikaci, lesnickou typologii, klasifikaci Natura 2000 apod). Následuje popis vlastností společenstva – tj. struktury, druhového složení, ekologie, rozšíření, ohrožení a managementu – doplněný o podkapitolu „Druhová kombinace“. V této kapitole jsou zvláště označeny dominantní a diagnostické druhy a uvedeny další hojnější druhy každého popisovaného společenstva (vše latinsky i česky). Popis je zakončen odkazy na nejdůležitější literaturu. V podkapitolce „Rozšíření“ je pro každý biotop též zpracována síťová mapa rozšíření dané vegetace v ČR. Jde o významný a v české fytocenologické literatuře výrazně novátorský počin! Škoda jen, že nelze rozlišit, zda je údaj v mapce založen na „přístupném“ fytocenologickém snímku nebo pouze na znalostech autora či dalších odborníků o rozšíření daného společenstva.

Nebudu se pouštět do hodnocení vymezení jednotlivých vegetačních jednotek. Na jedné straně je zčásti dané požadavkem na možnost převodu použité klasifikace na systémy Natura 2000 a Smaragd a na straně druhé jsou nejasnosti ve vymezení některých jednotek dány stavem současného fytocenologického poznání, které se doufejme i díky tomuto „popularizačnímu“ dílu dále rozšíří. Dovolte mi však závěrem několik obecnějších poznámek. Je velmi chvályhodné, že autoři (i zadavatel) nepodlehli možnosti jen vytvořit český popis přírodních jednotek („natural habitat“) uvedených ve směrnici EU a Rady Evropy. Základem tak zůstal ve střední Evropě vžitý fytocenologický (curyšsko-montpellierský) systém klasifikace vegetace byť upravený pro potřeby výše uvedených projektů. Jde tak u nás teprve o druhou příručku (po knihách o managementu vegetace – Míchal & Petříček 1999 a Petříček 1999: viz Preslia 73: 285–287), ve které autoři převedli desetiletí práce českých fytocenologů do řeči přístupné široké přírodovědecké veřejnosti. Nemýlím-li se, jde zároveň o první souhrnné dílo o aktuální vegetaci ČR, ve kterém jsou určité vegetační jednotky popsány na základě charakteristické druhové kombinace, diagnostických a dominantních druhů – tedy charakteristik, o kterých se běžně v botanické řeči hovoří, avšak valná většina z nás nefytocenologů jen matně tuší, co přesně pro konkrétní společenstva obnášejí. Česká fytocenologie tak po letech postupně vychází ze stadia, kdy její výstupy byly srozumitelné jen úzké skupině odborníků (někdy též mírně ironicky označované za společnost fytocenologických mágů, jejich učňů a těch, jež se za mágy sami prohlásili). Nezbývá než doufat, že výrazné souborné počiny české fytocenologie z posledních let (kromě výše uvedených děl ještě např. mapa potenciální vegetace – Neuhäuslová et al. 1997 a 1998, přehled rostlinných společenstev a jejich ohrožení – Moravec et al. 1995) budou pokračovat. Doufejme též, že bude dokončen vycházející Přehled vegetace ČR (prozatím vyšly dva díly – Moravec 1998 a Moravec et al. 2000), případně že někdy vznikne obdobně jako tento Katalog koncipované dílo s popisem vegetačních společenstev ČR zhruba na úroveň fytocenologických svazů.

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