Betonica officinalis L. in the Czech Republic. I. Variability of morphological characteristics

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Summary

Variability of some morphological features (height and width of plants, length and width of basal leaves, length of inflorescences) were studied *in situ* and *ex situ* in Wood Betony (*Betonica officinalis*) originating from 10 natural sites of Czech Republic. The statistically significant differences in almost all studied characters were found between the plants from these localities *in situ* as well as *ex situ* in field cultivation in Olomouc.

Key words: *Betonica officinalis, Lamiaceae, Wood Betony, Stachys betonica, variability, morphology*

INTRODUCTION

Betonica officinalis L. (syn. *Stachys betonica* Bentham, *Stachys officinalis* (L.) Trevisan; *Lamiaceae* – Wood Betony, Bishopswort) is a perennial herb growing in deciduous forests, thickets, meadows and pastures throughout all Europe except the north and Mediterranean region [1] and also in western Siberia, Caucasus, north Anatolia and north-western Africa [2] up to 450 m above the sea [3]. It has erect, subglabrous to densely hirsute stem, 15–100 cm high, four-cornered, non-branched and rare foliaged. Basal leaves are long petiolate, upper leaves are sessile, oblong to ovate-oblong, 30–120 mm x 15–50 mm large, cordate at base, crenate. Face side of leaves is glabrous, underside hairy, highest leaves come to nearly lanceolate bracts. Verticillasters are composed in a dense spike, sometimes

interrupted below. Small flowers are bright reddish-purple, rarely pink or white and bloom in July and August. 2n = 16 [4-6]. The flowers are hermaphrodite and are pollinated by bees [7].

B. officinalis was very popular and commonly used as a medicinal plant in Roman period. The beneficial properties include antiseptic, adstringent, tonic, anthelmintic, digestive, mildly sedative, cholagogue. The chemical composition includes flavonoids and bitter compounds (e.g. stachydrine – a pyrrholidine alkaloid) [8]. It has been traditionally used for centuries both in folk and official medicine in the Middle Ages but nowadays it is much less used for healing properties. It is not included in European pharmacopoeias probably due to decreasing of its natural occurrence areas and connected narrow stock for collecting [9]. Nevertheless *B. officinalis* plays an important role in natural phytocenosis – beyond its high ornamental value it is highly melliferous [10]. It is as a perspective genus also recommended for founding of flowering meadows and making of soil-conserving mixtures [11].

Although *B. officinalis* was relatively common in larger part of Europe, the number and area of *Betonica* populations is decreasing now, particularly in lowland areas [1]. This trend is also expressed in the Czech Republic and the staff of Czech protected landscape areas asked for help in study of causes and possibilities of the reintroduction of natural genotypes into original localities. This paper is focused on variability of morphological characteristic of *B. officinalis* populations from several localities in the Czech Republic, as a model sample of the situation in natural places of occurrence. The aim of work was also to verify the genotypic variability of *B. officinalis* in the Czech Republic.

MATERIALS AND METHODS

Collecting of plant material

For studying of *B. officinalis* populations, 10 natural sites in 4 protected landscape areas (or in the localities neighbouring to them) in the Czech Republic (tab. 1, fig. 1) were chosen in collaboration with protected landscape areas staff. In 2004 the characterisation of localities and basic evaluation of *B. officinalis* populations was made and first morphological characters of average 10 plants were measured there.

Table 1.

Origin of plant material and characterisation of localities

territory (protected landscape area)	locality	characterisation of locality	geographical coordinates and elevation
Bílé Karpaty	Suchov	village Suchov – Suchovské mlýny; scythed and grazed meadows on the fringe of orchard near the farmhouse	N 48°52´98,6´´ E 17°34´26,1´´ 373 m a. s.
České Středohoří	Malečov	village Malečov – Čeřeniště – Babinské louky; natural monument; 1 km south-east from village Čeřeniště; humid piedmont fenny hayfield	N 50°35´54,6´´ E 14°07´38,6´´ 545 m a. s.
	Mentaurov	Hradiště hill – base Mentaurov; hillside and shrubs margin of road, south from the village; grazed in past, now spontaneously grown over by air-raid shrubs	N 50°33´51,8´´ E 14°07´23,3´´ 380 m a. s.
Moravský kras	Blansek	ruin of Blansek castle; north part of Moravský Kras – border of thermophilic oak wood on the limestone in national natural monument Vývěry Punkvy (Punkva springs)	N 49°17´02,6´´ E 16°44´50,9´´ 464 m a. s.
	Hády	wilderness area Hádecká planina; area of thermophilic vegetation on forest borders of Hádecká planina (Hády plain)	N 49°13´10,5´´ E 16°40´31,7´´ 407 m a. s.
	Jedovnice	village Jedovnice – Olšovec pond; upper part of the bank of Olšovec pond, the overgrowth under natural seeding of pine-trees	N 49°19´95,4´´ E 16°45´96,1´´ 471 m a. s.
Šumava	Dobrá	village Stožec – Dobrá; meadows in river flood-plain about 500 m north from village Dobrá, right bank of Vltava river – alluvial flushing damp meadows	N 48°53´52,7´´ E 13°50´00,5´´ 732 m a. s.
	Nebe I.	village Kašperské Hory – Nebe; west part of natural monument Nebe about 750 m south-east from village Kašperské Hory – damp meadow, badly degraded due to long time waste period	N 49°08´23,0´´ E 13°34´27,1´´ 757 m a. s.
	Nebe II.	village Kašperské Hory – Nebe; margin of scythed mesophilic meadow under the gamekeeper´s lodge Nebe about 900 m east from village Kašperské Hory	N 49°08´28,2´´ E 13°34´45,8´´ 807 m a. s.
	Vinice	village Kašperské Hory – Vinice; south slope upon the sheep-fold; meadows long time laid fallow and damper parts contacted hazel-trees linear to the balk	N 49°08´23,8´´ E 13°32´13,2´´ 669 m a. s.

A – Bílé Karpaty	1 – Suchov
B – České Středohoří	2 – Malečov
	3 – Mentaurov
C – Moravský kras	4 – Blansek
	5 – Hády
	6 – Jedovnice
D – Šumava	7 – Dobrá
	8 – Nebe I.
	9 – Nebe II.
	10 – Vinice

Figure 1. The origin of plant material

Mother plants (2004) and seed samples (2004 and 2005) of *B. officinalis* were collected at the natural localities and used for establishing of *ex situ* collection at the experimental field in Olomouc. The collecting of original plant material was realised as follows: 10 fresh mother plants, together with ball of soil, were picked up at each locality and rooted to the *ex situ* collection next day. Seed samples were taken away only in the amount which did not threaten the original population (2–6 g according to size of population); seeds were dried in drier with controlled air flow and the 1000-seed weight was measured. 1/3 of seeds was saved in seed bank of plant genetic resources as a security stock and the rest of seeds was sown to the boxes and placed outside to the safety place where it wintered.

Analysis of the soil

Soil samples at original localities and also at the experimental field in Olomouc were taken away according to Promulgation No. 275/1998 Sb. [12]. Soil samples were dried on air, sent to accredited laboratory Litolab, s.r.o. and there analysed according to usual methods. The value of pH and content of elements Ca, P, Mg, K, N, C (ox.), Mn, Fe, Zn, Cu as well as the cation exchange capacity were evaluated.

Establishing of ex situ collection

Mother plants from original localities in the *ex situ* collection were organised in 50 m long rows with 2 m spacing for mechanical cultivation and needs of technical isolation. In autumn 2005 also the seedlings grown from the seeds brought from original localities were organized the same manner (fig. 2). During all the vegetative season a common mechanical cultivation and irrigation was done in both parts of *ex situ* collection the same way. Soil and climatic conditions of experimental field of CRI, Dept. of vegetables and special crops Olomouc are shown in tab. 2.

Table 2.

Soil and climatic conditions of experimental field of CRI, Dept. of Vegetables and Special Crops Olomouc

geographical coordinates	N 49° 34´ 25.6´´ E 17° 16´ 52.4´´
elevation (m above sea)	250
subsoil	quaternary sediment
soil type	cambisol
depth of topsoil [cm]	30
soil type	land loam - loam
pH	6.9–7.2
annual average temperature [°C]	8.7
annual precipitation [mm]	570
annual sunshine duration [h]	1616.7

Figure 2. *Betonica officinalis* L. (two-year-old plants) growing in field nursery in Olomouc

Evaluation of morphological characters

For evaluation of morphological characters of separated genotypes The minimal set of descriptors (internal document) was designed. Evaluated characteristics were: height of plant (from the surface of the soil up to the top of highest inflorescence), width of plant (diameter of plant measured upright to the row), lenght of basal leaf (petiole and leaf blade – measured in 10 leaves of each plant), width of basal leaf (measured in 10 leaves of each plant) and length of inflorescence (measured from the first branching to the top in 10 inflorescences of each plant).

For the evaluation both the original plants removed from natural sites and two-year-old plants cultivated from the seeds from natural localities were used as well as the plants growing *in situ* at the same localities. In the seed-born plant groups 10 randomly plants were measured.

Statistical evaluation

Statistical evaluation of obtained data was done by Anova, one-factor analysis of variance with level of importance $\alpha=0.05$ resp. 0.01.

RESULTS AND DISCUSSION

Analysis of the soil

The data obtained from the testing of soil samples from the natural localities and experimental field in Olomouc are shown in table 3. As visible, and also according to the geographical characterisation of localities, the natural sites differs one from another in many features. For example, according to pH (4.35–7.43), *B. officinalis* was found in all types of soil, it means from strongly acid to alkaline soil. Furthermore, the content of major as well as minor nutrients greatly varies so we can deduce that *B. officinalis* is a very adaptable species and a big variability in populations can be expected.

Table 3.

Characterization of the soil at natural localities and experimental field in Olomouc

locality	sampling (2004)	pH*	Ca*	P*	Mg*	K*	CEC*	N	C (ox.)	Mn	Fe	Zn	Cu
			(mg.kg^{-1} of dry matter)				(mol. kg^{-1})	(% of dry matter)	(% weight)	(mg·kg^{-1} of dry matter)			
BK Suchov	3.6.	7.30	6750	< 5	228	319	364	0.36	9.33	81.5	3620.0	68.7	21.6
ČS Malečov	25.5.	5.55	5760	1.0	500	112	331	0.68	18.00	49.7	3110.0	72.7	12.8
ČS Mentaurov	25.5.	6.48	5250	82.0	648	641	332	0.40	10.30	115.0	6050.0	71.9	34.2
MK Blansek	1.6.	6.62	7680	9.8	245	263	410	0.54	21.50	93.0	2500.0	49.2	10.1
MK Hády	1.6.	7.43	10700	10.0	219	321	560	0.52	13.60	130.0	2450.0	121.0	27.2
MK Jedovnice	1.6.	4.67	2550	< 5	478	122	170	0.29	10.00	48.8	2770.0	52.6	11.2
ŠU Dobrá	7.6.	4.35	1320	14	113	141	79	0.86	25.00	34.4	2880.0	60.8	22.0
ŠU Nebe I.	7.6.	5.04	1730	< 5	237	123	109	0.32	8.76	53.3	2470.0	55.8	13.1
ŠU Nebe II.	7.6.												
ŠU Vinice	7.6.	4.68	988	6.5	209	148	70	0.35	9.94	51.1	3120.0	74.8	15.5
Olomouc	26.5.	6.97	3610	284.0	230	173	203	0.14	4.45	30.5	2000.0	61.1	22.5
method		potenciometry	ICP OES				cumulative	gravimetric		ICP OES			

*Mehlich III extract

CEC – cation exchange capacity
ICP OES – coupled plasma optical emission spectrometry

Soil conditions of experimental field in Olomouc are medium in most factors. Only the content of phosphorus is markedly higher and other four elements (N, $C_{(ox.)}$, Mn, Fe) are little less involved in soil as compared to original localities. These results are possible to explain by different soil management (wild places and field) and/or previous mineral fertilization in Olomouc where residual amount of phosphorus does not change in subsequent years.

Establishing of *ex situ* collection

The cultivation of *B. officinalis* plants which were brought as mother plants from original localities, was managed with no problems and all the planted plants took roots. The term of seed collection (14 September – 27 October) seems also to be optimal for all populations and/or localities. The field emergence rate was not evaluated precisely but sufficient number of plants was reached from each population and it signifies better results than those of laboratory germination tests. Chosen organisation of overgrowth and following agronomical practises is suggested to be useful for stated project goal. Even relatively low reserve of accessible nutrients (tab. 3) does not influenced plant development negatively.

Open organization of overgrowth enables mechanical weeding and cultivation of spacing lines as well as easy evaluation of morphological characters of individual plants. Of course the denser plantation spacing should be used for drug or seed production purposes which could result in highest yield.

Some species of perennial plants has only limited persistence in cultivation conditions. Its habitus become weak after several years and plants have wintering troubles. It is suspected that *B. officinalis* is a long-living species [1] but its optimal period of cultivation is not mentioned in scientific literature and we can only compare it with similar species. The recommended cultivation period for *Salvia officinalis* is set to 3–7 years and according to our experiment this value could be used also for *B. officinalis*. Plants in field nursery are now, after 5 years of cultivation, in best condition and up to now no diseases and/or insect pests were observed. Also wintering passed over without losses.

Evaluation of morphological characters

Morphological characters were evaluated separately in populations at natural localities (2004 and 2005), plants brought from these localities as mother plants (2006 and 2007) and seed-born plants (2007). All three groups were compared to each other.

The limit (minimal and maximal) and average results of evaluation of morphological characteristics of all the measured plants in all the studied years are illustrated in figures 3–7. In comparison with literature data, where height of plants from 15 to 100 cm and size of upper leaves 3–12 cm x 1.5–5 cm is mentioned [4-6], our plants reached also bigger formats. The plants were found between 21 (2005) and 135 (2004) cm of height. Nevertheless, those differences are not very expressive. Basal leaves of our plants were 7.8 (2004) – 56.0 (2005) cm long and 2.0 (2007 – seed-born plants) – 14.0 (2006) cm in width but these data are not comparable with literature ones due to different leaves types. It seems logical that basal leaves (measured in our experiment) are usually larger than upper leaves (mentioned in publication). The comparison of characteristic width of plants (12 cm in 2005 – 101 cm in 2006) and length of inflorescences (2 cm in 2004 – 63 cm in 2007) – is not possible to compare due to missing literature data.

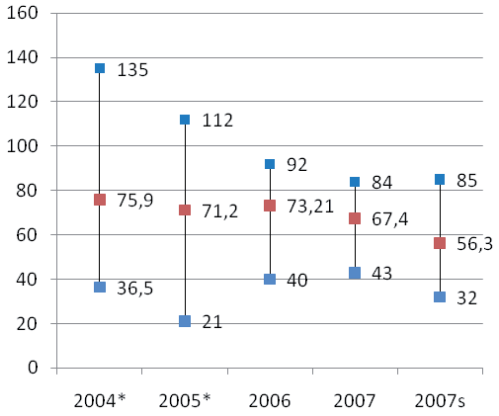

Figure 3. Height of plants [cm]

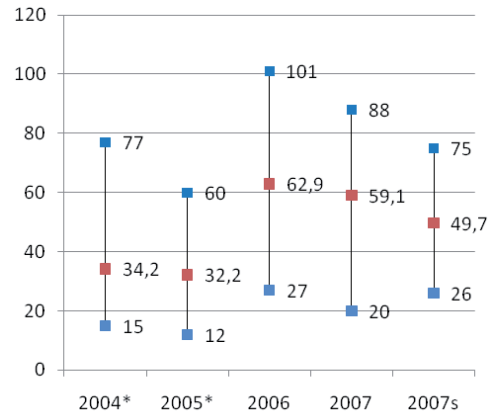

Figure 4. Width of plants [cm]

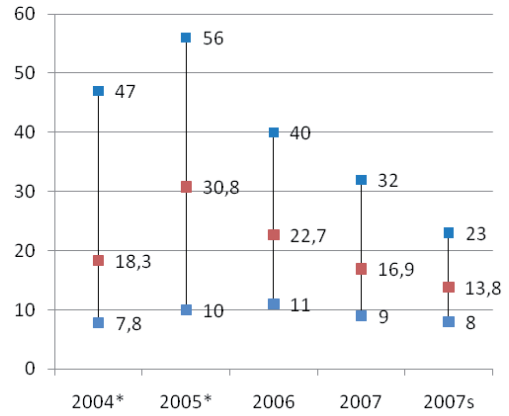

Figure 5. Length of leaves [cm]

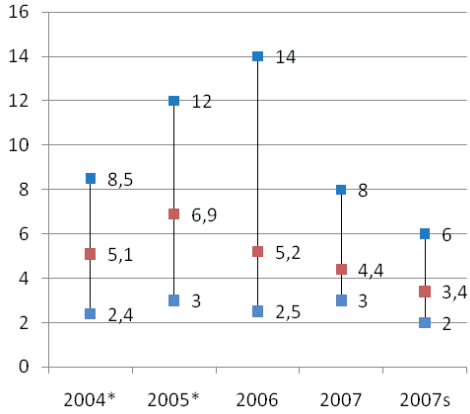

Figure 6. Width of leaves [cm]

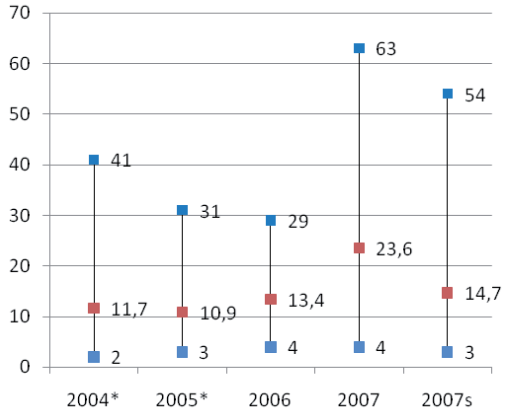

Figure 7. Length of inflorescences [cm]

Figures 3 – 7: 2004* and 2005* = populations evaluated at natural localities; 2006 and 2007 = plants brought from these localities as mother plants, evaluation in field nursery in Olomouc; 2007s = seed-born plants evaluated in field nursery in Olomouc, stocks diagrams present minimal and maximal values of evaluated plants and average value

Due to different types of evaluated plants and/or growing conditions the comparison of growing seasons is not possible, although, we can basically comment these plant groups and its results. Development at natural localities, where the plants have to compete with other plant species (grass, other dicotyledonous plants) of course influences its habitus. These plants were found higher, although, its width was not so large as compared to the plants growing in rows in field condition. Also the length and width of leaves were higher in plants at natural localities what is possible to connect with light management. On the other hand, the length of inflorescences was higher in field type of growing probably due to the fact that in the sufficiency of light plants branch earlier than plants in the me-

adows. Nevertheless, these deductions could be influenced also with the age of plants – age of plants at the natural localities was unknown but plants at the field nursery were at least two-year-old in 2006 and at least three-year-old in 2007. Seed-born plants were three-year-old during evaluation period in 2007. The age can be also the reason of different results in morphological characteristics between seed-born plants and plants brought as mother plants in 2007 but the explanation of different overgrowth founding is also possible.

Morphological characters of plants coming from different natural localities and areas of Czech Republic were also compared each other (tab. 4–6).

Table 4:

The evaluation of morphological characteristics of plants at the natural localities

	height of plants*		width of plants*		length of leaves*		width of leaves*		Length of inflorescences*	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
protected landscape area/locality										
BK/Suchov	64.7±8.2	42.6±16.1	30.5±5.9	19.4±6.3	14.0±2.2	18.8±5.8	4.3±0.5	5.8±1.1	10.3±7.6	5.0±0.8
ČS/Mentaurov	70.2±10.0	61.1±11.1	42.2±8.3	29.3±4.7	18.4±4.27	27.2±6.8	6.2±1.0	6.3±1.5	11.6±4.8	6.0±1.9
ČS/Malečov	86.8±12.9	86.2±11.2	27.7±4.9	30.0±5.3	33.1±8.5	31.7±5.0	6.2±1.3	6.2±1.1	9.3±5.1	15.5±4.6
MK/Jedovnice	56.1±14.7	71.0±10.2	23.3±2.5	32.0±6.1	11.9±2.8	28.9±4.8	3.6±0.7	6.6±0.9	6.4±2.5	7.0±2.2
MK/Hády	45.4±6.7	78.6±10.2	26.3±6.5	41.0±7.2	14.2±2.9	27.0±7.2	3.5±0.7	8.0±1.8	7.5±5.2	14.4±5.1
MK/Blansek	63.7±12.0	n	25.9±4.5	n	19.1±3.5	n	4.7±1.1	n	5.2±3.1	n
ŠU/Vinice	96.8±15.0	56.3±10.1	42.6±14.3	21.0±4.0	16.7±4.6	22.9±3.5	5.4±1.1	5.6±0.7	17.1±6.0	7.2±2.7
ŠU/Nebe I.	92.4±4.8	87.8±9.3	37.2±15.2	40.4±3.4	16.0±6.9	41.1±9.4	4.6±1.4	8.3±1.7	17.8±13.3	17.7±6.4
ŠU/Nebe II.	86.5±5.2	90.9±8.7	35.9±6.0	43.9±9.5	18.6±3.5	42.5±6.9	5.6±1.3	9.8±1.9	12.4±5.0	13.8±6.4
ŠU/Dobrá	74.3±5.7	75.1±11.0	45.7±9.2	36.4±4.0	25.5±8.2	40.9±5.3	4.8±1.7	6.3±1.0	15.0±6.6	15.0±5.1
average	75.9±19.0	71.2±19.6	34.2±11.3	32.2±10.2	18.3±8.2	30.8±10.3	5.1±1.5	6.9±1.9	11.7±7.9	10.9±6.3
protected landscape area										
Bílé Karpaty (BK)	64.7±8.2	42.6±16.1	28.1±6.1	19.4±6.3	14.0±2.2	18.8±5.8	4.3±0.5	5.8±1.1	10.3±7.6	5.0±0.8
České Středohoří (ČS)	82.8±11.8	73.7±16.8	37.3±11.1	29.7±5.0	25.8±10.0	29.4±6.4	6.2±1.2	6.2±1.3	10.5±5.1	10.7±5.9
Moravský kras (MK)	61.0±14.7	74.8±10.9	23.3±2.5	36.5±8.1	15.6±4.5	28.0±6.1	4.1±1.1	7.2±1.6	6.2±3.9	10.2±5.3
Šumava (ŠU)	87.5±12.1	64.4±12.2	40.4±12.1	35.4±10.5	19.1±7.2	36.9±10.5	5.1±1.4	7.5±2.2	15.6±8.8	13.2±6.6
statistically significant differences										
locality	++	++	++	++	++	++	++	++	++	++
protected landscape areas	++	++	++	++	++	++	++	++	++	++

*average ±standard deviation n – Blansek locality was not studied in 2005

++ statistically high significant differences

Table 5.

The evaluation of morphological characteristics of plants at field nursery – plants coming from the natural localities as mother plants

	height of plants*		width of plants*		length of leaves*		width of leaves*		length of inflorescences*	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
protected landscape area/locality										
BK/Suchov	77.5±10.7	70.1±11.1	58.5±17.5	51.0±15.7	25.3±6.5	16.5±3.3	5.8±1.4	4.2±1.0	11.8±5.8	36.0±11.5
ČS/Mentaurov	n	n	n	n	n	n	n	n	n	n
ČS/Malečov	69.0±14.2	64.8±6.5	59.8±15.1	53.2±10.6	20.7±5.4	16.1±2.6	4.6±1.2	4.2±0.8	15.7±5.8	24.4±8.9
MK/Jedovnice	91.0±0.8	76.3±7.9	63.7±2.6	62.5±6.1	20.7±3.1	18.8±4.4	4.5±0.8	4.7±1.5	19.3±4.5	27.1±11.3
MK/Hády	60.3±7.8	n	44.3±8.7	n	22.2±3.5	n	4.9±0.8	n	17.6±4.4	n
MK/Blansek	81.0±5.2	66.8±7.2	47.0±6.7	54.3±4.9	20.6±3.5	14.7±2.9	4.7±0.6	4.8±1.1	15.2±4.4	23.0±11.9
ŠU/Vinice	64.0±10.1	62.0±10.7	60.3±22.0	60.0±11.5	23.8±5.1	16.1±3.0	5.5±1.2	4.3±0.8	13.2±4.5	18.0±5.6
ŠU/Nebe I.	81.0±5.2	62.4±11.0	81.2±15.7	67.6±17.7	24.5±4.9	17.9±3.3	4.6±0.6	4.3±0.7	11.9±3.9	26.8±7.8
ŠU/Nebe II.	75.8±6.8	68.4±7.4	78.8±16.9	69.6±8.5	29.8±4.8	18.8±3.7	7.0±1.8	5.0±1.0	10.2±4.0	15.8±9.7
ŠU/Dobrá	60.6±10.8	68.0±7.3	66.0±9.5	58.0±10.6	22.6±4.8	16.2±4.1	4.8±1.0	3.6±0.8	10.1±4.3	14.8±5.8
average	73.4±13.1	67.4±9.8	62.2±18.4	59.1±13.6	23.3±5.6	16.9±3.6	5.1±1.3	4.4±1.0	13.9±5.4	23.6±11.8
protected landscape area										
Bílé Karpaty (BK)	77.5±10.7	70.1±11.1	58.5±17.5	51.0±15.7	25.3±6.5	16.5±3.3	5.8±1.4	4.2±1.0	11.8±5.8	36.0±11.5
České Středohoří (ČS)	69.0±14.2	64.8±6.5	59.8±15.1	53.2±10.6	20.7±5.4	16.1±2.6	4.6±1.2	4.2±0.8	15.7±5.8	24.4±8.9
Moravský kras (MK)	77.8±13.3	71.5±9.0	51.2±10.5	58.4±6.9	19.8±2.5	16.8±4.3	4.7±0.7	4.7±1.3	14.0±4.8	25.0±11.8
Šumava (ŠU)	40.4±12.1	65.4±9.6	71.8±18.4	64.0±13.5	19.9±3.2	17.4±3.6	5.4±1.5	4.3±0.9	7.0±4.4	18.6±8.9
statistically significant differences										
locality	++	-	+	-	++	++	++	++	++	++
protected landscape areas	-	-	+	-	++	-	++	++	++	++

*average ±standard deviation
++ statistically high significant differences
- no statistically significantly different
n – not evaluated – plants were in bad condition
+ statistically significant differences

Between the results obtained at original localities no statistically significant differences in 2004 and 2005 in the high and width of plants and length of inflorescences were found – these characteristics showed more less identical data in both evaluated period. Statistically highly significant differences (the level of significance $\alpha=0.01$) were found in length of leaves (F critical value =6.78; F value =65.16) and width of leaves (F critical value =6.78; F value =52.11). There is no satisfactory reason for such results, just plants took into the evaluation were chosen randomly each year and gained results does not necessarily

come from identical plants in both years. Statistically high significant differences (α=0.01) were found in all studied characteristics in both years between plants at original localities as well as between plants from individual protected landscape areas (tab. 4).

In plants brought from original localities to Olomouc and cultivated in the field nursery different results were obtained. Statistically highly significant differences between the years (level of significance α=0.01; F critical value =6.67) were found in the length of leaves (F value =371.74), width of leaves (F value =86.66) and length of inflorescences (F value =235.44). Statistically significant differences (level of significance α =0.05; F critical value =3.97) were found in high of plants (F value =4.77) but width of plants were found nearly identical for both evaluated years 2006 and 2007. The differences between particular original localities and/or protected landscape areas were also different in these years – only width of leaves and length of inflorescences were characters highly significantly different in both years (tab. 5).

Statistically high significant differences (α =0.01) between particular original localities and/or protected landscape areas were found also in all five evaluated characters of seed-born plants (tab. 6).

Table 6.

The evaluation of morphological characteristics of plants at field nursery – seed-born plants

2007	height of plants*	width of plants*	length of leaves*	width of leaves*	length of inflorescences*
protected landscape area/locality					
BK/Suchov	n	n	n	n	n
ČS/Mentaurov	n	n	n	n	n
ČS/Malečov	72.1±9.6	61.0±10.6	15.4±2.8	4.0±0.8	15.0±7.3
MK/Jedovnice	51.7±4.6	39.3±5.4	12.6±2.1	3.2±0.6	10.0±6.7
MK/Hády	65.9±8.2	51.6±7.5	15.4±2.2	3.8±0.6	28.5±11.2
MK/Blansek	n	n	n	n	n
ŠU/Vinice	48.0±8.6	43.9±4.5	13.1±2.7	3.3±0.7	15.6±8.3
ŠU/Nebe I.	50.2±4.0	51.8±9.4	14.8±2.9	3.4±0.7	13.1±5.9
ŠU/Nebe II.	47.3±4.2	37.7±4.0	12.3±2.4	3.2±0.6	11.0±5.8
ŠU/Dobrá	56.3±9.2	42.0±9.3	13.5±2.3	3.0±0.4	9.2±3.6
average	56.3±11.7	49.7±12.5	13.8±2.8	3.4±0.7	14.7±9.7
protected landscape area					
Bílé Karpaty (BK)	n	n	n	n	n
České Středohoří (ČS)	72.1±9.6	61.0±10.6	15.4±2.8	4.0±0.8	15.0±7.3
Moravský kras (MK)	58.8±9.7	45.5±9.0	14.0±2.6	3.5±0.7	19.2±13.0
Šumava (ŠU)	50.5±8.1	43.0±8.4	13.3±2.7	3.2±0.6	12.1±6.7
Statistically significant differences					
Locality	++	++	++	++	++
Protected landscape areas	++	++	++	++	++

*average±standard deviation n – not evaluated – plants were in bad condition

++ statistically high significant differences

Evaluation of morphological characters proved statistically significant difference between plants populations of different origin, respectively. These differences are not justifiable by diverse climatic and soil conditions of its natural localities because it was marked also after two years of planting in identical field conditions. The seed-born plants coming from these original habitats have different morphological characters as well.

CONCLUSIONS

1. Evaluation of morphological characters proved statistically significant differences between populations from 10 chosen natural localities and 4 protected landscape areas.
2. It is possible to evaluate *B. officinalis* as a very variable species. In order to prevent genetic erosion, the production of uniform seed mixtures for restoration of natural flowering meadows cannot be recommended.
3. *B. officinalis* is much less frequently used for healing properties nowadays as compared to previous periods. It is not included in European pharmacopoeias but the reason is disputable. The most probable possibility is due to decreasing of its natural occurrence areas and narrow stock for collecting.

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REFERENCES

1. Grime JP, Hodgson JG, Hunt R. *Stachys officinalis* (L.) Trevisan. In: Comparative Plant Ecology. London 1989:546-7.
2. Hanelt P, Institute of Plant Genetica and Crop Plant Research, eds. Mansfeld´s encyclopedia of agricultural and horticultural crops. Vol. 5: Angiospermae, Monocotyledones: Orchidaceae – Pandanaceae. 1st Engl. ed. Berlin 2001:2012-13.
3. Phillips R, Foy N. Herbs. London 1992:162.
4. *Ball PW. Stachys L. In: Tutin TG, Heywood VH, Burges NA, Moore DM, Valentine DH, Walters SM, et al. (eds.). Flora Europaea Vol. 3: Diapensiaceae to Myoporaceae. Cambridge 1972:151-2.*
5. Dostál J. Nová květena ČSSR. Vol. 2. Praha 1989:871.
6. Chrtek J. jun. *Betonica* L. – bukvice. In: Slavík B. (ed.) Květena České republiky 6, Praha 2000:626-8.
7. Fern K. Plants For A Future: Edible & Useful Plants For A Healthier World. Clanfield 1997:320.
8. Matkowski A, Piotrowska M. Antioxidant and free radial scavenging activities of some medicinal plants from the Lamiaceae. Fitoterapia 2006; 77:346-53.
9. Opletal L. Problems of *Betonica officinalis* use in medicine. Verbal information, cited 15th June 2010.
10. Kresánek J, Krejča J. Atlas liéčivých rastlin a lesných plodov. Osveta 1977:126.

11. Šrámek P, Kohoutek A, Ševčíková M, Odstrčilová V, Jongepierová I. Zvyšování biodiversity travních porostů. Zemědělské informace 2001; 21:21.
12. *Promulgation No. 275/1998 Sb*. – Vyhláška Ministerstva zemědělství ČR ze dne 12. listopadu 1998 o agrochemickém zkoušení zemědělských půd a zjišťování půdních vlastností lesních pozemků. (Promulgation of Ministry of Agriculture of the Czech Republic from 12. November 1998 about agrochemical testing of agricultural lands and determination of soil characteristics of forest lands) [in Czech]

BETONICA OFFICINALIS L. W CZECHACH. I. RÓŻNORODNOŚĆ CECH MORFOLOGICZNYCH

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S t r e s z c z e n i e

Badano różnorodność kilku cech morfologicznych bukwicy zwyczajnej (*Betonica officinalis*) pochodzącej z 10 stanowisk naturalnych w Czechach *in situ* i *ex situ* (wysokość i szerokość roślin, wysokość i szerokość liści bazowych, długość kwiatostanu). Statystycznie istotne różnice pomiędzy niemal wszystkimi badanymi okazami znaleziono w roślinach pochodzących z tych stanowisk przeniesionych do uprawy polowej w okolicach Ołomuńca.

Słowa kluczowe: *Betonica officinalis, Lamiaceae, bukwica zwyczajna, Stachys betonica, różnorodność, morfologia*