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PRODUCTION-ECOLOGICAL ANALYSIS OF THE BROAD-LEAVED FOREST ECOSYSTEMS HERB LAYER BIOMASS IN THE ŽALOSTÍNSKA VRCHOVINA UPLAND AND ZÁMČISKO (WESTERN SLOVAKIA)

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Abstract

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The contribution is focused upon detail production-ecological analysis of the total herb layer biomass (aboveground-belowground-total) in the broad-leaved forest ecosystems of the Žalostínska vrchovina upland (the westernmost part of the Biele Karpaty Mts) and Zámčisko (the only forested part of the Chvojnická pahorkatina hilly country). There were sampled all major vegetation types: *Stellario-Alnetum, Hacquetio-Carpinetum, Carici pilosae-Carpinetum typicum, Carici-Carpinetum melicetosum uniflorae, Carici-Carpinetum* type with *Mercurialis perennis* and *Carici pilosae-Fagetum.* Results (Table 1) are discussed and compared with those obtained from similar forest ecosystems of western Slovakia (Table 2).

Key words: broad-leaved forest ecosystem, herb layer biomass, Žalostínska vrchovina, Zámčisko

Introduction

The aim of this paper is to provide the basic information on the ecology and herb layer biomass of the most important broad-leaved forest ecosystems located in the southwestern corner of the Biele Karpaty Mts (its geomorphological unit Žalostínska vrchovina) and Chvojnická pahorkatina hilly country (geomorphological unit Zámčisko) (see Fig. 1). Of these, various oak-hornbeam forests (*Carpinion* I s s l e r 1931 alliance) present major zonal vegetation type in the lower parts (to about 400 m a.s.l.). Oak (*Quercus petraea* agg.)

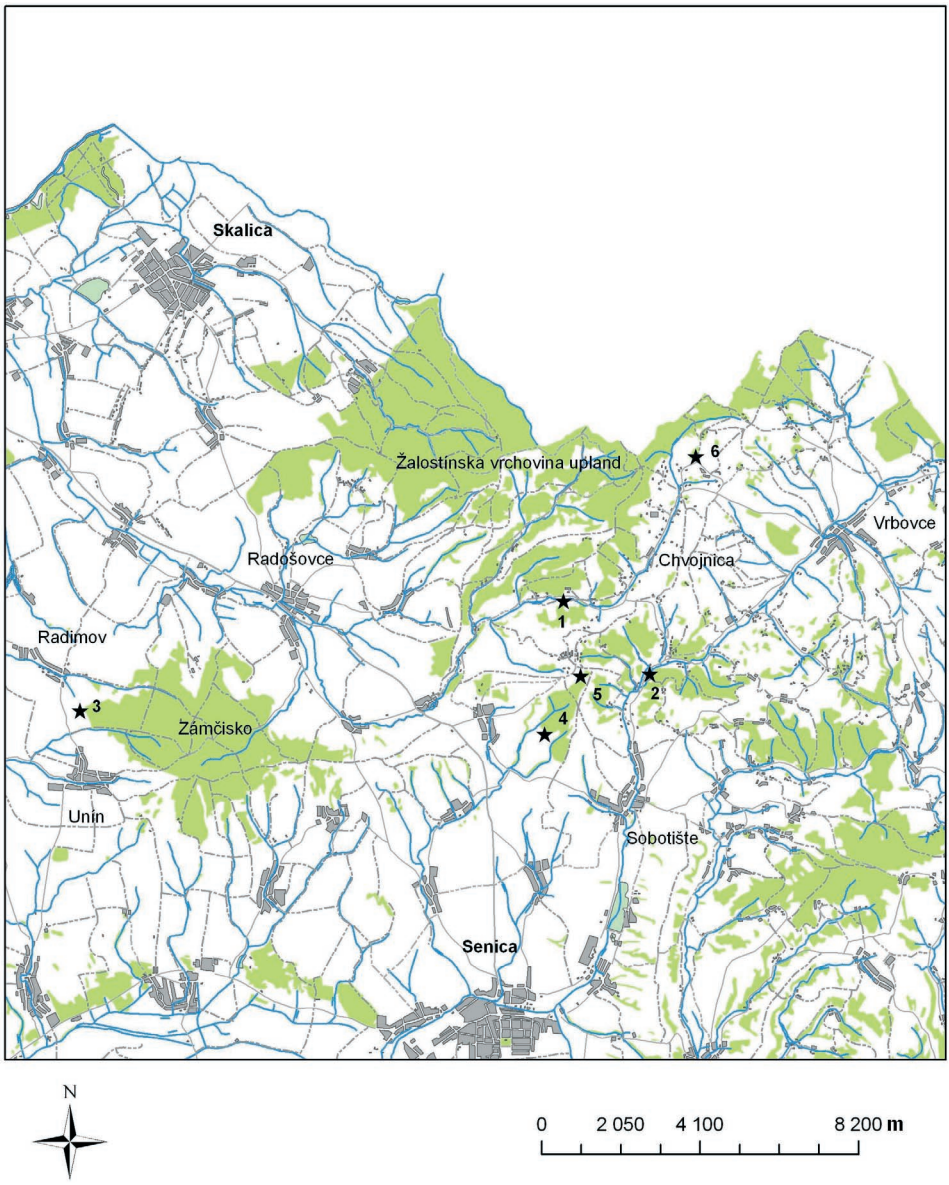

Fig. 1. Sampled sites in Žalostinská vrchovina upland and Zámčisko.
Abbreviations: 1 – *Stellario-Alnetum*, 2 – *Hacquetio-Carpinetum*, 3 – *Carici pilosae-Carpinetum typicum*, 4 – *Carici pilosae-Carpinetum melicetosum uniflorae*, 5 – *Carici pilosae-Carpinetum* type with *Mercurialis perennis*, 6 – *Carici pilosae-Fagetum*.

and hornbeam (*Carpinus betulus)* predominate here with an admixture of other deciduous trees as maple (*Acer campestre),* lime tree *(Tilia cordata)* or ash *(Fraxinus excelsior)*. As for higher altitudes (above about 400 m a.s.l.), beech forests (*Eu-Fagenion* O b e r d o r f e r 1957 suballiance) prevail with an admixture of *Acer pseudoplatanus, Fraxinus excelsior, Carpinus betulus* and *Quercus petraea* agg. These forest ecosystems represent the most productive forest types from the forest management point of view. Of azonal vegetation, black alder floodplain forests (*Alnenion glutinoso-incanae* suballiance) is the most spread, while scree forests (*Tilio-Acerion* K l i k a 1955 alliance) are only rarely scattered through the region.

Methods

Estimation of the total herb layer biomass was made on the selected sample plots applying the methods of indirect sampling (Kubíček, Brechtl, 1970) modified for non-recurrent sampling (Kubíček, Jurko, 1975; Kubíček, Šimonovič, 1975; Kubíček, Šomšák, 1982). Phytocoenological relevés in the field and classification of the forest communities (Table 1) were done according to the method of the Zurich-Montpellier school, the names of plants follow Dostál, Červenka (1991, 1992), while soil nomenclature is according to WRB classification (FAO, 2006). The coordinates are listed in WGS 84 system.

Study area

The study area is delimited by the units Chvojnická pahorkatina hills and Zámčisko. Both regions are very similar concerning natural conditions. They are formed by flysch bedrock. Cambisols present typical soil type. The altitudes range from about 250 m a.s.l. to 621 m a.s.l. (Žalostiná hill). Average year temperature is about 8.6–8.9 °C, while rainfall about 600–800 mm per year (according to SHMÚ data).

Characteristic of the sampled plots

1. Black alder forest, association: *Stellario-Alnetum* L o h m e y e r 1957

The plot presents typical black alder floodplain forest of the *Stellario-Alnetum* association accompanying water stream in the colline belt. Within the association, the stand presents drier type (*Stellario-Alnetum allietosum ursini* N e u h ä u s l o v á - N o v o t n á 1970 subassociation) occurred on Haplic Fluvisol with flysch rocks. Information on the location and floristic composition is given in the following phytocoenological relevé:

Locality: inundation of the Chvojnianka creek in the Chvojnica cadastre, 17˚22'38.40" E, 48˚46'42.80" N, date: 12.05. 2005, area: 400 m^2, covers: E_3 70%, E_2 20%, E_1 100%, soil and bedrock characteristic: Haplic Fluvisol, pH(H_2O): 7.76, pH($CaCl_2$): 7.35

E_3: *Alnus glutinosa* 3, *Fraxinus excelsior* 1, *Salix fragilis* +, *Tilia cordata* +
E_2: *Corylus avellana* 1, *Fraxinus excelsior* 1, *Crataegus monogyna* +, *Sambucus nigra* +, *Euonymus europaeus* +, *Tilia cordata* +
E_1: *Allium ursinum* 4, *Aegopodium podagraria* 3, *Ficaria bulbifera* 2, *Petasites albus* 1, *Anemone ranunculoides* 1, *Arum alpinum* 1, *Galeobdolon luteum agg.* 1, *Pulmonaria obscura* 1, *Impatiens noli-tangere* 1, *Astrantia major* +, *Brachypodium sylvaticum* +, *Bromus benekenii* +, *Circaea lutetiana* +, *Cirsium oleraceum* +, *Geum urbanum* +, *Ligustrum vulgare* +, *Phyteuma spicatum* +, *Alliaria petiolata* +, *Viola reichenbachiana* +, *Galium aparine* +, *Glechoma hederacea agg.* +, *Euonymus europaeus* +, *Lamium maculatum* +, *Carex sylvatica* +, *Primula elatior* +, *Mercurialis*

perennis +, *Rubus caesius* +, *Tithymalus amygdaloides* +, *Acer campestre* +, *Sambucus nigra* +, *Stachys sylvatica* +, *Anthriscus sylvestris* +, *Asarum europaeum* +, *Viola mirabilis* +, *Viburnum opulus* r, *Angelica sylvestris* r

2. Oak-hornbeam forest, association: *Hacquetio-Carpinetum* M i c h a l k o 1983

The plot is an illustration of the specific suboceanic oak-hornbeam forest, which Michalko (1983) described as distinct *Hacquetio-Carpinetum* association occurred in the West Carpathian flysch regions, especially in the Biele Karpaty Mts. As the following relevé demonstrates, its floristic composition is made of various mesophilous species.

Locality: Zelenkov Mlyn settlement (Sobotište), 17˚24'36.40" E, 48˚45'49.10" N, phytocoenological relevé: 12.05. 2005, area: 400 m^2, 300 m a.s.l., aspect: NW, slope: 20º, covers: E_3 80%, E_2 2%, E_1 75%, soil and bedrock characteristic: Haplic Cambisol on flysch substrate, pH(H_2O): 5.54, pH($CaCl_2$): 5.03

E_3: *Quercus petraea* agg. 3, *Carpinus betulus* 2
E_2: *Carpinus betulus* +, *Acer pseudoplatanus* +
E_1: *Carex pilosa* 3, *Isopyrum thalictroides* 2, *Hedera helix* 1, *Galeobdolon luteum* agg. 1, *Lathyrus vernus* 1, *Hacquetia epipactis* 1, *Crataegus monogyna* +, *Dactylis polygama* +, *Euonymus europaeus* +, *Tithymalus amygdaloides* +, *Fraxinus excelsior* +, *Anemone ranunculoides* +, *Galium schultesii* +, *Geranium robertianum* +, *Geum urbanum* +, *Arum alpinum* +, *Carex digitata* +, *Impatiens parviflora* +, *Acer campestre* +, *Ajuga reptans* +, *Ligustrum vulgare* +, *Melica nutans* +, *Melica uniflora* +, *Phyteuma spicatum* +, *Pulmonaria obscura* +, *Alliaria petiolata* +, *Quercus petraea* agg. +, *Viola reichenbachiana* +, *Orchis pallens* r, *Corylus avellana* r, *Acer pseudoplatanus* r

3. Oak-hornbeam forest, association: *Carici pilosae-Carpinetum typicum* N e u h ä u s l e t N e u h ä u s l o v á 1968

This plot captures the typical West Carpathian oak-hornbeam forest of the *Carici pilosae-Carpinetum* association. It is located within the Zámčisko hill presenting the only forested part of the Chvojnická pahorkatina hilly country. Its floristic composition is made of mesophilous species first of all, but it is partly synanthropized (see the relevé below)

Locality: Radimov, Zámčisko hill, 17˚12'42.40" E, 48˚44'31.60" N, soil and bedrock characteristic: Haplic Cambisol on the flysch substrate, date: 06.05. 2008, area: 400 m^2, 300 m a.s.l., aspect: NW, slope: 3º, covers: E_3 750%, E_2 5%, E_1 70%, pH(H_2O): 7.06, pH($CaCl_2$): 6.69

E_3: *Tilia cordata* 4, *Quercus petraea* agg. +, *Cerasus avium* +, *Juglans nigra* +, *Carpinus betulus* +
E_2: *Tilia cordata* 1, *Sambucus nigra* +
E_1: *Convallaria majalis* 3, *Galium odoratum* 3, *Brachypodium sylvaticum* 1, *Impatiens parviflora* 1, *Melica nutans* 1, *Ajuga reptans* 1, *Viola reichenbachiana* +, *Carex sylvatica* +, *Tilia cordata* +, *Crataegus monogyna* +, *Galium aparine* +, *Euonymus europaeus* +, *Sambucus nigra* +, *Geum urbanum* +, *Acer campestre* +, *Cerasus avium* +, *Allium scorodoprasum* +, *Carpinus betulus* +, *Clematis vitalba* +, *Lathyrus vernus* +, *Ligustrum vulgare* +, *Arum alpinum* +, *Poa nemoralis* agg. +, *Primula veris* +, *Symphytum tuberosum* agg. +, *Ulmus glabra* +, *Viola odorata* +, *Acer pseudoplatanus* +, *Mycelis muralis* r, *Rosa canina* agg. r, *Viburnum opulus* r, *Ranunculus auricomus* s. lat. r, *Lilium martagon* r, *Anthriscus sylvestris* r, *Stachys sylvatica* r, *Pulmonaria officinalis* r

4. Oak-hornbeam forest, association: *Carici pilosae-Carpinetum melicetosum uniflorae* (K l i k a e x F u t á k 1947) N e u h ä u s l i n M o r a v e c e t a l. 1982

Within the oak-hornbeam forests, the sampled stand presents thermo- and heliophilous typ. It is caused by oak dominance (as a consequence of the forestry measures) and southward orientation. Detailed information is given below: Locality: Častkov, 17˚22'31.10" E, 48˚44'50.20" N, date: 16.6. 2005, area: 400 m^2, 356 m a.s.l. aspect: SW, slope: 3º, covers: E_3 65%, E_2 3%, E_1 95%, soil and bedrock characteristic: Haplic Cambisol on flysch substrate, pH(H_2O): 5.2, pH($CaCl_2$): 4.71

E_3: *Quercus petraea* agg. 4, *Sorbus torminalis* r
E_2: *Crataegus laevigata* +, *Acer campestre* +, *Cornus mas* +, *Sorbus torminalis* r
E_1: *Melica uniflora* 4, *Galium schultesii* 2, *Carex pilosa* 2, *Ligustrum vulgare* 1, *Dactylis polygama* 1, *Rubus fruticosus* agg. +, *Lathyrus vernus* +, *Cornus mas* +, *Acer campestre* +, *Geum urbanum* +, *Fragaria vesca* +, *Lathyrus niger* +, *Poa nemoralis* +, *Pulmonaria officinalis* +, *Impatiens parviflora* +, *Melittis melissophyllum* +, *Vincetoxicum hirundinaria* +, *Cerasus avium* +, *Euonymus europaeus* r, *Pyrus pyraster* r, *Salvia glutinosa* r, *Scrophularia nodosa* r, *Geranium robertianum* r, *Torilis japonica* r

5. Oak-hornbeam forest, association*: Carici pilosae-Carpinetum* N e u h ä u s l e t N e u h ä u s l o v á - N o v o t n á 1964 type with *Mercurialis perennis*

Within a wide variability of the oak-hornbeam forests, this stand illustrates the type contacting scree forests as indicated by the dominance of nitrophilous species *Mercurialis perennis* (see the relevé below).

Locality: a plateau on the hill close to the Havran settlement (Častkov), 17°23'09.50" E, 48°45'41.60" N, 16.6. 2005, area: 400 m^2, 495 m a.s.l., covers: E_3 70%, E_2 3%, E_1 95%, soil and bedrock characteristic: Stagnic Cambisol on flysch substrate, pH(H_2O): 5.37, pH($CaCl_2$): 4.89

E_3: *Quercus petraea* agg. 3, *Carpinus betulus* 2, *Cerasus avium* 2
E_2: *Crataegus monogyna* +, *Cornus mas* +, *Crataegus laevigata* +, *Carpinus betulus* +
E_1: *Mercurialis perennis* 4, *Melica uniflora* 1, *Carex pilosa* 1, *Hacquetia epipactis* 1, *Isopyrum thalictroides* 1, *Polygonatum multiflorum* 1, *Quercus petraea* agg. +, *Viola reichenbachiana* +, *Aegopodium podagraria* +, *Galium odoratum* +, *Acer campestre* +, *Hedera helix* +, *Rubus fruticosus* agg. +, *Lathyrus vernus* +, *Crataegus monogyna* +, *Cornus mas* +, *Pulmonaria obscura* +, *Lilium martagon* +, *Tithymalus amygdaloides* +, *Staphylea pinnata* +, *Anemone ranunculoides* r, *Stachys sylvatica* r, *Fraxinus excelsior* r, *Scrophularia nodosa* r, *Lapsana communis* r, *Vicia sylvatica* r

6. Beech forest, association: *Carici pilosae-Fagetum* O b e r d o r f e r 1957

The plot represents beech forests of the lower altitudes on the well supplied soils. Concerning mostly colline character of the study area such stands are not wide spread here – they occupy only the highest or northward oriented positions. The plot characteristic is given below.

Locality: Chvojnica, 17°25'07.80" E, 48°48'54.00" N, date: 12.05. 2005, area: 400 m^2, 510 m a.s.l. covers: E_3 85%, E_2 0%, E_1 95%, soil and bedrock characteristic: Umbrisol, pH(H_2O): 4.43, pH($CaCl_2$): 4.9

E_3: *Fagus sylvatica* 5
E_1: *Carex pilosa* 4, *Galium odoratum* 2, *Mercurialis perennis* 2, *Fraxinus excelsior* 1, *Hacquetia epipactis* 1, *Tithymalus amygdaloides* 1, *Anemone ranunculoides* +, *Arum alpinum* +, *Lathyrus vernus* +, *Phyteuma spicatum* +, *Viola reichenbachiana* +, *Aegopodium podagraria* +, *Carex sylvatica* +, *Carex digitata* +, *Fagus sylvatica* +, *Acer campestre* +, *Hieracium murorum* +, *Maianthemum bifolium* +, *Melittis melissophyllum* +, *Ajuga reptans* +, *Polygonatum multiflorum* +, *Pulmonaria officinalis* agg. +, *Rubus fruticosus* agg. +, *Sambucus racemosa* +, *Sorbus torminalis* +, *Rosa canina* agg. r, *Actaea spicata* r, *Cerasus avium* r, *Corylus avellana* r, *Tilia cordata* r, *Viburnum lantana* r

Results

The basic results of the production-ecological analysis obtained from six sample plots presenting major vegetation types of the area – 1. *Stellario-Alnetum*, 2. *Hacquetio-Carpinetum*, 3. *Carici pilosae-Carpinetum typicum,* 4. *Carici pilosae-Carpinetum melicetosum uniflorae,* 5. *Carici pilosae-Carpinetum* type with *Mercurialis perennis,* 6. *Carici pilosae-Fagetum* – are

T a b l e 1. Herb layer biomass of the broad-leaved forests in the Žalostínska vrchovina upland and Zámčisko.

Community	*Stellario-Alnetum*				*Hacquetio-Carpinetum*				*Carici pilosae-Carpinetum typicum*				*Carici pilosae-Carpinetum melicetosum uniflorae*				*Carici piolosae-Carpinetum* type with *Mercurialis perennis*				*Carici pilosae-Fagetum*			
Species	A	B	T	A/B	A	B	T	A/B	A	B	T	A/B	A	B	T	A/B	A	B	T	A/B	A	B	T	A/B
Dominant species																								
Allium ursinum	231	701	932	0.33																				
Aegopodium podagraria	98	59	157	1.64																				
Geum urbanum	34	16	50	2.04					3	2	5	1.47												
Galeobdolon luteum agg.	62	29	91	2.08	20	14	34	1.43																
Rubus fruticosus agg.					681	402	1083	1.69					7	17	24	0.49	7	17	24	0.41	2	3	5	0.66
Hacquetia epipactis					65	153	218	0.42									22	56	78	0.40	3	12	15	0.20
Melica uniflora					44	30	74	1.49	6	3	9	2.00	122	368	490	0.33	1	1	2	1.00				
Arum alpinum	5	25	30	0.21	23	65	88	0.33																
Lathyrus vernus					13	32	45	0.40	1	3	4	0.33	1	1	2	1.00								
Convallaria majalis									98	142	240	0.69												
Polygonatum multiflorum					11	17	28	0.63	33	187	220	0.17					13	34	47	0.39	6	18	24	0.32
Ligustrum vulgare									35	49	84	0.71	122	70	192	1.75								
Viola reichenbachiana	1	1	2	1.00	5	3	8	1.81	45	29	74	1.54	1	1	2	1.00					1	1	2	1.00
Carex pilosa					2	1	3	2	57	15	72	3.91	434	319	753	11.35	103	66	169	1.55	312	205	517	1.52
Galium schultesii													55	95	150	0.58								
Mercurialis perennis	10	19	29	0.52													1214	1755	2969	0.69	249	421	670	1.52
Galium odoratum									62	20	82	3.13					58	21	79	2.70				
Galium sylvaticum																					20	12	32	1.67
Other species																								
Alliaria petiolata	19	3	22	6.19																				
Impatiens parviflora	7	2	9	4.84					15	2	17	10.60												
Ficaria bulbifera	9	4	13	2.25																				
Impatiens noli-tangere	8	2	10	4.00																				
Circaea lutetiana	13	5	18	2.42																				
Brachypodium sylvaticum	6	2	8	2.77					3	1	4	3.00												
Swida sanguinea	7	6	13	1.10																				
Euonymus europaeus	3	3	6	1.00																				
Fraxinus excelsior	14	8	22	1.70																	22	22	44	1.00
Pulmonaria officinalis	9	8	17	1.13	22	14	36	1.60																
Isopyrum thalictroides					1	8	9	0.11																
Melittis melissophyllum					7	7	14	1.00					2	3	5	0.66								
Hedera helix					7	8	15	0.80									17	20	37	0.83				
Quercus petraea agg.					3	5	8	1.44					1	1	2	1.00								
Acer campestre					39	31	70	1.26	19	25	44	0.76												
Ajuga reptans					12	3	15	4.50	5	1	6	5.00												
Galium sylvaticum					5	5	10	1.00																
Tithymalus amygdaloides					27	6	33	5.62													2	1	3	2.00

T a b l e 1. (Continued)

Fraxinus excelsior					3	1	4	3.00																
Cornus mas					30	10	40	3.00																
Symphytum tuberosum									1	2	3	0.50												
Melica nutans									17	9	26	1.94												
Clematis vitalba									19	14	33	1.42												
Carpinus betulus									7	4	11	1.78												
Tilia cordata									5	2	7	2.02												
Lilium martagon																	12	16	28	0.72				
Lathyrus niger													5	30	35	0.14								
Total	536	893	1429		1020	815	1835		431	510	941		750	905	1655		1447	1986	3433		617	695	1312	

Abbreviations: A – aboveground biomass, B – belowground biomass, T – total biomass, A/B – ratio between aboveground and belowground biomass, biomass values are listed in $kg.ha^{-1}$

summarized in Table 1. It contains the following information: Type of forest community, above-below-total herb layer biomass (A, B, T) in $kg.ha^{-1}$ and a ratio above-belowground biomass (A/B).

Black alder forest (*Stellario-Alnetum*) is the most productive forest community here regarding to the herb layer. In the herb layer sub-and nitrophilous species prevail in cover and also herb layer biomass. The decisive dominant species is presented by *Allium ursinum* with a very high total biomass, but mainly belowground one (A – 231, B – 701 and T – 932 $kg.ha^{-1}$). Of other species with high production, especially *Aegopodium podagraria, Galeobdolon montanum* and *Geum urbanum* are to be mentioned. Other species, even if their number is relatively high (13 species in sample), have lower biomass values. The total biomass is high – it reaches more than 1.4 $t.ha^{-1}$.

The oak-hornbeam forests (alliance *Carpinion*) are represented by relatively similar four communities with a relatively high number of dominant species in biomass. The highest total biomass was estimated for the association *Hacquetio-Carpinetum* (more than 1.83 $t.ha^{-1}$) with five prevailing species, mainly *Hacquetia epipactis* and *Rubus fruticosus* agg. at which a ratio between aboveground and belowground biomass is moderate in favour of aboveground biomass (A – 1.02, B – 0.81 $t.ha^{-1}$, A/B – 1.25.

The other two communities – *Carici pilosae-Carpinetum typicum* and *melicetosum* have also relatively high number of dominants (6 and 4). In the first case, there are prevailing namely *Convallaria majalis, Polygonatum multiflorum, Galium odoratum,* while in the second one *Melica uniflora, Galium schultesii*; common dominant species for both communities is presented by *Carex pilosa.* The biomass values are a little lower than in *Hacquetio-Carpinetum,* they vary between 0.43–0.75 $t.ha^{-1}$ at aboveground biomass, 0.51–0.91 $t. ha^{-1}$ at belowground biomass and 0.94–1.66 $t.ha^{-1}$ at total biomass. On the other hand, in both communities, belowground biomass is higher than aboveground one (about 0.80).

Table 2. Herb layer biomass of the broad-leaved forests in the western Slovakia (t.ha^{-1}).

Author(s)	Locality	Vegetation type	Aboveground biomass (A)	Belowground biomass (B)	Total biomass (T)	Ratio (A/B)
Kubíček, Jurko (1975)	Malé Karpaty Mts	black alder forest	1.36			
		oak-hornbeam forest	0.69			
		scree forest	0.48			
		beech forest	0.36			
Kubíček, Šimonovič (1975)	Nitrianska pahorkatina hills pahorkatina (Báb forest)	oak-hornbeam forest	0.21–0.46	0.23–0.56	0.46–1.01	0.91
Kubíček, Šimonovič (1980)	Malé Karpaty Mts	acidophilous oak forest	0.69	1.59	2.28	0.43
		black alder forest	1.01	0.70	1.71	1.45
		oak-hornbeam forest	1.38	1.46	2.84	0.95
Kubíček (1983)	Western Slovakia	black alder forest	1.04			
		mixed oak forest	0.41–1.39			
		scree forest	0.15–0.85			
		beech forest	0.06–0.49			
Šomšák, Kubíček (1995)	Borská nížina lowland	oak-lime forest	0.36			
Šomšák, Kubíček (2000)	Borská nížina lowland	pedunculate oak forests	0.31–0.87			
Kubíček et al. (2006)	Borská nížina lowland	birch-oak forest	2.79	7.98	10.78	0.35
		birch-alder forest	1.66	1.01	2.67	1.65
Kollár et al. (2008)	Dolnomoravský úval valeúval	pedunculate oak forest	0.10–0.17	0.08–0.34	0.19–0.43	0.80
Kollár et al. (2010)	Biele Karpaty Mts	black alder forest	0.64	1.01	1.64	0.63
		oak-hornbeam forest	0.57	0.62	1.19	0.91
		scree forest	0.24	0.35	0.59	0.69
		beech forest	0.14	0.13	0.27	1.08

Similar picture as that observed for previous community (*Carici pilosae-Carpinetum melicetosum uniflorae*) we obtained for communities *Carici pilosae-Carpinetum* type with *Mercurialis perennis* and *Carici pilosae-Fagetum.* There are three or five prevailing species in biomass here but the main dominants in the total values in both communities are presented by *Mercurialis perennis* (T = 0.67–2.97 t.ha $^{-1}$) and *Carex pilosa* (T = 0.17–0.52 t.ha^{-1}) reflecting their absolute dominance in the undergrowth.. Regarding to the total obtained biomass values, it is necessary to state, that both studied communities have very high total values, mainly *Carici pilosae-Carpinetum* type with *Mercurialis perennis* – A = 1.45, B = 1.99 and T = 3.43 t. ha$^{-1.}$ Again as in majority of previous observed communities, belowground biomass is higher than aboveground one (R = 0.73 and 0.89).

The obtained biomass values of these broad-leaved forests are comparable with our previous result from western Slovakia (see Table 2).

Some differences in biomass values depend on different floristic structure of compared communities.

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