HERB LAYER BIOMASS OF THE MORAVA RIVER FLOODPOLAIN FORESTS

FERDINAND KUBÍČEK, VOJTECH ŠIMONOVIČ, JOZEF KOLLÁR, ROBERT KANKA

Institute of Landscape Ecology of the Slovak Academy of Sciences, Štefániková 3, P.O.Box 254, 814 99 Bratislava, Slovak Republic; e-mail: ferdinand.kubicek@savba.sk

Abstract

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The paper is focused upon detail production-ecological analysis of the herb layer in two floodplain forest categories – transitional ash-poplar and hardwood ash-elm forests. The basic results of the total herb layer biomass (aboveground, belowground) are varied in transitional floodplain forests between 800–1600 kg.ha^{-1} and in hardwood floodplain forests between, 750–1350 kg.ha^{-1}. At both forest types is essentially higher aboveground biomass than belowground one. Obtained results are compared with other ones in the Danube and Morava rivers alluvium.

Key words: floodplain forest ecosystem, herb layer biomass, Morava river

Introduction

The Morava river and mainly its inundation area is a very important territory as from national as from international point of view regarding to preservation of its biological and ecological value. In the time, when an intensive management of such flows was performed in the middle Europe, the Morava river was as a border territory very strictly closed and inaccessible for public during several decades (since 1948 till 1990). It is possible to say, that the Morava river was preserved, even in spite of flow regulation, itself natural character from the estuary of the Myjava river up to the estuary of the Rudava river and from the village Záhorská Ves up to the confluence with the Danube river at the village Devín. Floodplain forests cover about 3020 ha of this territory and represent a very important landscape-ecological element, forming a total natural character of the Morava river alluvium and in the final consequence even whole bordered Záhorie region.

The aim of this paper is to provide basic information on the herb layer biomass of two prevailing floodplain forests of the Morava river – transitional ash-poplar forests and hard-wood ash-elm forests.

Methods

Estimation of the herb layer biomass (aboveground, belowground, total) was made on selected sample plots applying the method of indirect sampling (Kubíček, Brechtl, 1970) modified for non-recurrent sampling (Kubíček, Jurko, 1975; Kubíček, Šomšák, 1982). Phytocoenological relevés in field and classification of communities were done according the Zürich-Montpellier school, the names of plants are according to Dostál, Červenka (1991, 1992).

Characteristic of forest communities on the Morava river alluvium

In spite of flood-control dikes in the Morava river alluvium built in 1911 till 1933 and finished in 1954, the nature of this area was intensively influenced since the Middle Age. Originally the large floodplain forests were still really reduced in the last century and replaced by, in majority, grasslands ecosystems. Forest management in this area of alluvium was mainly tended to production of fuel wood. The widening case of management was coppice one, at which on small areas was utilized also natural reforestation from seeds, mainly in stands with prevalence of oak. The stand tree composition was mostly from autochtonous tree species with a very abundant shrub layer except of the most humid communities. To the wider planting of fast-growing cultivated poplars has come in 1940's and also to rare planting of black walnut (*Juglans nigra*) and black locust (*Robinia pseudoacacia*) during the 19th and 20th century.

At the evaluation of present forest vegetation it is necessary to take to consideration some changes of environment, to which came in Morava river alluvium during the last decades. General decreasing of the groundwater level, drying out of the alluvium and also an absence of fluvial types of alluvial biotopes influenced present state of forest ecosystems. Now it is possible to find on the Morava river alluvium, except very valuable forest stands with almost original tree composition and with inside building and architecture close to natural (e.g. Kútsky les forest) also stands where tree composition is influenced by forest manager. Plantings of cultivated poplar monocultures, but also other tree species are a strange element in the alluvium.

In the Morava river alluvium floodplain forests of the suballiance *Ulmenion* prevail remarkably. Soft-wood floodplain forests (*Salici-Populetum*), being bound with the deepest depressions and river banks, are much rarer. Within the suballiance *Ulmenion*, there can be distinguished two basic forest types (Table 1):

1. **Transitional ash-poplar floodplain forests** (association *Fraxino-Populetum* Jurko 1958, Ulmeto-Fraxinetum populeum according to Zlatník forest typological school (1959)

These forests are in a narrow contact with soft willow-poplar forests. The borderline is given by their occurrence on areas non-flooded by surface water. They cover localities wetted by the groundwater, which rises up to the soil surface in time of floods. An existence of this forest category is bound on a higher up to high groundwater level, respectively on periodic floods. It is located on moderately depressed flat terrains, which are flooded every year, mainly during spring. An optimum of their widening is in inundated space of the alluvium. An expressive soil-creating factor are spring floods, which bring fine sediments. Therefore Gleysols and its transitions to Fluvisols are typical soils here, also they are texturally heavier.

Elm (*Ulmus carpinifolia*), ash (*Fraxinus angustifolia*), oak (*Quercus robur*) and Russian elm (*Ulmus laevis*) were dominant in the original tree composition with mixed domestic poplars (*Populus nigra, P. alba*) and aspen (*P. tremula*). Present stands have preserved almost an original feature with an essential increasing of cultivated poplars (*Populus x canadensis*) areas, which have here the optimal production conditions and disappearing of elms after graphiosis in 1960's. Within the frame of this forest group, also monocultures of introduced American ash (*Fraxinus americana*) are occurred here.

T a b l e 1. Phytocoenological characteristic of selected communities.

Community	*Fraxino-Populetum*			*Fraxino-Ulmetum*		
Relevé No.	**2**	**4**	**5**	**3**	**1**	**6**
E3	75	75	70	70	80	80
E2	5	40	10	5	3	5
E1	75	60	90	100	85	70
height of E3	30	35	35	34	30	25
Tree layer						
Quercus robur		+	2	4	1	
Fraxinus excelsior et angustifolia	3	3	3	+	3	3
Carpinus betulus	1				2	2
Ulmus laevis	+	+				+
Acer campestre	1				+	+
Populus alba	1	+				
Ulmus minor		+	+			
Shrub layer						
Crataegus laevigata			1			1
Swida sanguinea	1	+		+	+	
Euonymus europaeus	+				+	
Fraxinus excelsior et angustifolia		+		+		r
Herb layer						
distinction of Fraxino-Ulmetum						
Carex sylvatica	1			1	1	+
Viola reichenbachiana				r	2	+
Rumex sanguinaulis			+	r		r
Melica nutans					+	
Galium odoratum				+		
Anemone ranunculoides					1	
distinction of FU convallarietosum						
Convallaria majalis					r	3
Polygonatum multiflorum						1
Lathyrus vernus						+
Salicion albae						
Rubus caesius	2	1	1	1	3	1
Iris pseudacorus			+			+
Ulmenion, Alno-Ulmion						
Circaea lutetiana	1	+	+	1	1	+
Carex remota				+	r	
Fagetalia, Querco-Fagetea						
Ficaria bulbifera					3	
Glechoma hederacea agg.	4	1	3	1	4	3
Geum urbanum	2	1	1	1	2	1
Stachys sylvatica	1				+	
Milium effusum	+		1	+	1	+
Brachypodium sylvaticum		+	+	1	1	

Viola mirabilis	1		+			
Acer campestre	1		+	1	1	+
Euonymus europaeus	+	+		+		1
Swida sanguinea					1	
Stellaria nemorum		1	1			
Carpinus betulus					+	
Others						
Urtica dioica	+	2	3	1	+	1
Festuca gigantea		+	+	+		
Galium aparine	3	3	3	3	2	2
Poa palustris			+	+		1
Crataegus laevigata		+		r		+
Lamium maculatum	1	3		+	1	+
Lysimachia nummularia		+	+	1		
Ajuga reptans		+		+	r	+
Impatiens parviflora	2	2	+	3	3	
Alliaria petiolata			1	2		1
Deschampsia cespitosa				+	r	
Paris quadrifolia	1				1	1
Ulmus minor		+	+	+		
Fraxinus excelsior	+		+	1	+	
Impatiens noli-tangere	+	r	+		+	
Quercus robur	r			+		+
Ranunculus lanuginosus	+				r	
Populus alba	1	r				
Agrostis stolonifera agg.			+	+		
Solidago canadensis			3	+		
Galeopsis speciosa		+	+			
Arctium lappa				r	r	

Species with 1 occurrence
E3: *Alnus glutinosa* (1) +, *Populus nigra* (4) 1, *Tilia cordata* (6) +
E2: *Populus alba* (2) 1, *Acer campestre* (3) +, *Frangula alnus* (3) +, *Robinia pseudoacacia* (3) +, *Rosa canina* agg. (3) +, *Negundo aceroides* (4) +, *Sambucus nigra* (4) 3, *Ulmus minor* (5) 1, *Carpinus betulus* (6) +, *Quercus robur* (6) +, *Pyrus communis* (6) r, *Ulmus laevis* (6) +
E1: *Carpinus betulus* (1) +, *Geranium robertianum* (1) 1, *Rosa canina* agg. (1) r, *Swida sanguinea* (1) 1, *Allium scorodoprasum* (3) +, *Carduus crispus* (3) r, *Carex acutiformis* (3) +, *Cirsium vulgare* (3) r , *Dactylis polygama* (3) 2, *Lapsana communis* (3) r, *Ribes nigrum* (3) r, *Sambucus nigra* (3) r, *Tilia cordata* (3) +, *Viburnum opulus* (3) r, *Xanthoxalis fontana* (3) r, *Aegopodium podagraria* (4) +, *Cucubalus baccifer* (4) +, *Angelica sylvestris* (5) +, *Anthriscus sylvestris* (5) +, *Aethusa cynapium* (5) +, *Chaerophyllum temulum* (5) +, *Phalaris arundinacea* (5) +, *Symphytum officinale* (5) +, *Maianthemum bifolium* (6) +, *Ulmus laevis* (6) +

1. Skalica, in front of the dike, E3 80%, E2 3%, E1 85%, height of E3 30m, age 120 years, height of trees 30 m
2. Skalica, at camp, E3 75%, E2 5%, E1 75%, age 120 years, height of trees 30 m
3. Holíč, in front of border checkpoint, E3 70%, E2 5%, E1 100%, height of trees 34 m
4. Kopčany, in front of the dike, E3 75%, E2 40%, E1 60%, height of trees 35 m
5. Kútsky les forest, E3 70%, E2 10%, E1 90, height of trees 35 m
6. Kútsky les forest, E3 80%, E2 5%, E1 70%, height of trees 25 m

The shrub layer is well-developed, being formed by species as *Swida sanguinea, Sambucus nigra, Euonymus europaea, Crataegus laevigata* and others. In the herb layer, no characteristic species are to be found here – there is a combination of species common in all types of floodplain forests as *Urtica dioica, Galium aparine, Brachypodium sylvaticum, Rubus caesius* and others. On the other hand, some species typical for hardwood floodplain forests are mostly missing here (e.g. *Convallaria majalis, Melica nutans, Carex sylvatica, Viola reichenbachiana, Anemone ranunculoides*).

These forests present transitional stands between *Salici-Populetum* and *Fraxino-Ulmetum*. Compare to the stands of *Fraxino-Ulmetum*, it occupies the site of higher moisture. Hence, Gleysols and their transitions to Fluvisols are typical soils here. Also, they are texturally heavier.

From the forest management point of view this forest category represents a highly productive managed forests (Kubíček, 2003).

2. **Hardwood ash-elm floodplain forests** (association *Fraxino pannonicae-Ulmetum* S o ó in A s z ó d 1936 corr. S o ó 1963, *Ulmeto-Fraxinetum carpineum* according to Zlatnik forest typological school (1959)

This forest category represents one of the basic types in the Morava river alluvium. It occurs mainly on relative elevations or coherent areas on the flat terrains also further from the main river flow with a lower groundwater level. Supply of the soil profile by water depends in an essential scale on the fact, whether fluctuation of the groundwater level at least temporarily influences a soil profile. This forest category has preserved a relatively original tree composition contrary to the e.g. hardwood floodplain forests of the Danube river, although an influence of man is also visible here, mainly by an asserting of cultivated poplars (on small areas) against the original tree species. Two tree species have a prevalence in the tree layer – oak (*Quercus robur*) and ash (*Fraxinus angustifolia*). Elm (*Ulmus laevis* less *Ulmus minor*) is beginning to assert after graphiosis calamity in the sixties. Commonly are mixed domestic poplars (*Populus alba, Populus nigra*), lime tree (*Tilia cordata*), maple (*Acer campestre*), somewhere also hornbeam (*Carpinus betulus*). Seldom, also some areas of cultivated poplars are occurred.

Shrub layer species composition resembles previous association, but it is not so developed. In the herb layer, compare to *Fraxino-Populetum*, there is a higher number of species of suballiance *Ulmenion* and order *Fagetalia* (*Carex sylvatica, Melica nutans, Viola reichenbachiana* etc.). There can be distincted two types: first as described above and type we named subassociation *convallarietosum*. Compare to first type, it occupies drier sites, with loamy-sandy soils, without oxidation-reduction signs. It is distinguished by predominance of *Convallaria majalis* with an admixture of some others mesophilous species as *Polygonatum multiflorum, Lathyrus vernus* etc. Typical soils are represented by different Fluvisols.

This forest category represents in the Morava river alluvium managed forests and therefore it is under the permanent impact of forest management (Kubíček, 2003).

Results and discussion

The basic results of the production-ecological analysis of two studied floodplain forests are summarized in Table 2 (ash-poplar floodplain forests) and Table 3 (hardwood ash-elm forests). Tables contains following data: above (A) – belowground (B) – total herb layer (C) biomass in kg.ha^{-1} dry weight and ratio aboveground/belowground (A/B) biomass.

The floristic structure of transitional floodplain forests is relatively rich and also many species are shared on the biomass value. The decisive ratio have eight dominant species on all selected areas, but in the Skalický les and Kopčanský les forests prevails mainly *Glechoma hederacea* and *Galium aparine* and in more humid Kútsky les forest prevail other species as *Solidago canadensis, Urtica dioica* and *Alliaria petiolata*. As for total biomass

Table 2. Herb layer biomass of transitional ash-poplar floodplain forests on the Morava river alluvium.

Locality (relevé)	Skalický les forest (2)				Kútsky les forest (5)				Kopčanský les forest (4)			
Species	Biomass (kg.ha^{-1})				Biomass (kg.ha^{-1})				Biomass (kg.ha^{-1})			
	Above-ground (A)	Below-ground (B)	Total (C)	Ratio A/B	Above-ground (A)	Below-ground (B)	Total(C)	Ratio A/B	Above-ground (A)	Below-ground (B)	Total(C)	Ratio A/B
Dominant species												
Galium aparine	167	37	204	4.5	225	24	249	9.2	54	8	62	7.1
Geum urbanum	40	22	62	1.8	30	10	40	2.9	75	31	106	2.4
Rubus caesius	58	104	162	0.6	72	47	119	1.5	80	148	228	0.5
Glechoma hederacea	111	20	131	5.5	72	26	98	2.7	100	23	123	4.3
Ficaria bulbifera	41	68	109	0.6	-	-	-	-	-	-	-	-
Solidago canadensis	-	-	-	-	188	92	280	2.0	-	-	-	-
Alliaria petiolata	-	-	-	-	136	19	155	7.1	-	-	-	-
Urtica dioica	7	4	11	1.7	173	317	490	0.5	142	69	211	2.1
Other species												
Circaea lutetiana	20	8	28	2.6	-	-	-	-	7	2	9	3.5
Impatiens parviflora	13	4	17	3.5	-	-	-	-	10	9	19	1.1
Acer campestre	10	6	16	1.7	-	-	-	-	-	-	-	-
Paris quadrifolia	5	9	14	0.6	-	-	-	-	-	-	-	-
Stachys sylvatica	9	4	13	2.2	-	-	-	-	-	-	-	-
Lamium maculatum	10	3	13	3.3					38	23	61	1.6
Milium effusum	1	1	2	1.0	4	1	5	4.0	-	-	-	-
Impatiens noli-tangere	2	1	3	2.0	1	1	2	1.0	-	-	-	-
Viola reichenbachiana	1	1	2	1.0	-	-	-	-	-	-	-	-
Chaerophyllum temulum	-	-	-	-	59	6	65	9.6	-	-	-	-
Stellaria nemorum	-	-	-	-	9	1	10	9.0	7	1	8	7.0
Angelica sylvestris	-	-	-	-	35	16	51	2.2	-	-	-	-
Poa pratensis	-	-	-	-	3	2	5	1.5	-	-	-	
Rumex sp.	-	-	-	-	9	13	22	0.7	-	-	-	-
Iris pseudacorus	-	-	-	-	8	17	25	0.5	-	-	-	-
Sambucus nigra	-	-	-	-	-	-	-	-	27	15	42	1.9
Total	505	292	797		1024	592	1616		540	329	869	

T a b l e 3. Herb layer biomass of hardwood ash-elm forest on the Morava river alluvium.

Locality (relevé) Species	Skalický les forest (1) biomass (kg.ha^{-1})				Holíčsky les forest (3) biomass (kg.ha^{-1})				Kútsky les forest (6) biomass (kg.ha^{-1})			
	above-ground (A)	below-ground (B)	total (C)	ratio A/B	above-ground (A)	below-ground (B)	total (C)	ratio A/B	above-ground (A)	below-ground (B)	total (C)	ratio A/B
Dominant species												
Galium aparine	48	6	54	8.5	68	11	79	6.5	28	5	33	5.6
Geum urbanum	35	17	52	2.0	77	29	106	2.7	39	18	57	2.1
Rubus caesius	29	29	57	1.0	82	46	128	1.8	41	11	52	3.8
Glechoma hederacea	242	59	301	4.1	12	5	17	2.6	80	31	111	2.6
Ficaria bulbifera	30	125	155	0.2	-	-	-		-	-	-	-
Urtica dioica		-	-	-	30	25	55	1.2	39	31	70	1.2
Acer campestre	10	9	19	1.2	405	149	554	2.7	6	4	10	1.5
Impatiens parviflora	11	4	15	2.8	76	10	86	7.5	-	-	-	-
Alliaria petiolata	-	-	-	-	152	33	185	4.7	97	21	118	4.6
Convallaria majalis	-	-	-	-	-	-	-		68	114	182	0.6
Other species										-	-	-
Paris quadrifolia	1	1	2	1.0	-	-	-	-	3	11	14	0.3
Impatiens noli-tangere	3	1	4	3.0	-	-	-	-	-	-	-	-
Viola reichenbachiana	13	18	31	0.7	-	-	-	-	1	1	2	1.0
Anemone ranunculoides	2	8	10	0.3	-	-	-	-	-	-	-	-
Milium effusum	4	2	6	1.6	-	-	-	-	4	2	6	2.0
Carex sylvatica	12	7	19	1.2	-	-	-	-	-	-	-	
Stachys sylvatica	11	4	15	2.5	-	-	-	-	-	-	-	
Circaea lutetiana	8	3	11	2.4	7	1	8	7.0	-	-	-	
Ulmus minor	-	-	-	-	32	14	46	2.4	-	-	-	
Allium scorodoprasum	-	-	-	-	7	2	9	2.8	-	-	-	
Euonymus europaea	-	-	-	-	2	15	17	0.2	5	46	51	0.1
Lysimachia nummularia	-	-	-	-	5	3	8	1.6	-	-	-	-
Brachypodium sylvaticum	-	-	-	-	8	2	10	4.0	-	-	-	-
Fraxinus excelsior	-	-	-	-	26	11	37	2.2	-	-	-	-
Crataegus monogyna	-	-	-	-	-	-	-	-	6	14	20	0.4
Lathyrus vernus	-	-	-	-	-	-	-	-	5	8	13	0.6
Poa pratensis	-	-	-	-	-	-	-	-	2	2	4	1.0
Ajuga reptans	-	-	-	-	-	-	-	-	1	1	2	1.0
Rumex sanguineus	-	-	-	-	-	-	-	-	10	13	23	0.7
Polygonatum multiflorum	-	-	-	-	-	-	-	-	3	5	8	0.6
Total	458	293	751		989	356	1345		438	338	776	

data at all observed forests are essential higher aboveground biomass, the total biomass value varies between 800–1600 kg.ha^{-1}, at which the highest biomass we obtained in more humid type in the Kútsky les forest. As it is typical for floodplain forests, aboveground biomass is always higher than belowground one.

The similar results we obtain also in hardwood floodplain forest. There is a little higher number of dominant species (10), but five species are dominant in both observed forests. Four decisive dominants have total biomass values between 40–300 kg.ha^{-1} and the total values of the whole ecosystem are between 750–1350 kg.ha^{-1}. The aboveground biomass is again essentially higher than the belowground one. It is an unwritten rule that the richer community, the higher aboveground biomass. Both studied communities are typical floodplain forests of the Morava river alluvium and presented results are new information dealing with herb layer biomass of floodplain forest ecosystems in Slovakia.

The obtained results from these biomass studies is quite comparable with our previous results dealing with production of the herb layer in floodplain forests from other Slovak rivers, mainly Danube river. Total values of both forest types were found to be higher in Danube river alluvium – between 1.2–1.9 t.ha^{-1} at transitional floodplain forests and 2.2–3.1 t.ha^{-1} at hardwood forests (Kubíček, 1999). Very similar results obtained Šimonovič, Šimonovičová (1999) from hardwood forest near the Morava river alluvium on the Borská nížina lowland.

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