Ekológia (Bratislava) Vol. 30, No. 3, p. 315–321, 2011
doi:10.4149/ekol_2011_03_315

BIOMASS OF HERBACEOUS LAYER IN FLOODPLAIN FORESTS (SUBALLIANCE *Ulmenion* O b e r d. 1953) ON THE OUTSKIRTS OF BRATISLAVA

IVANA VYKOUKOVÁ, MÁRIA MÁJEKOVÁ

Department of Soil Science, Faculty of Natural Science, Comenius University, Mlynská dolina, 842 15 Bratislava, Slovak Republic; e-mail: vykoukova@fns.uniba.sk

Abstract

Vykouková I., Májeková M.: Biomass of herbaceous layer in floodplain forests (Suballiance *Ulmenion* O b e r d. 1953) on the outskirts of Bratislava. Ekológia (Bratislava), Vol. 30, No. 3, p. 315–321, 2011.

The paper is focused on production analysis of herbaceous layer biomas of hardwood floodplain forests (*Ulmenion* O b e r d. 1953) on the outskirts of Bratislava. For our research, three sample sites were established in Pečenský les forest (Petržalka), Dunajské ostrovy islands (Rusovce) and Topoľové hony forest (Podunajské Biskupice). The first two sites represent hardwoord forests within interdike space that experience regular flooding and minimal forestry influences. The third site reflects dryer site conditions outside interdike space, without flooding impact and with pronounced forestry interventions. Sites were chosen to reflect two slightly different associations within the *Ulmenion*: association *Fraxino pannonicae-Ulmetum* S o ó in A s z ó d 1936 corr. S o ó 1963 and association *Lithospermo-Ulmetum carpinifoliae* D ž a t k o 1972. Estimation of aboveground biomass was determined through indirect sampling modified for non-repeated field measurements (Kubíček, Brechtl, 1970). Total biomass was highest on the site Dunajské ostrovy islands 1041.64 kg.ha^{-1}, lowest total biomass was on the site Topoľové hony forest 404.12 kg.ha^{-1}. The results are compared with the results of Kubíček, Šomšák (1985) and Kubíček (1999).

Key words: biomass of herbaceous layer, floodplain forests, suballiance *Ulmenion* O b e r d. 1953, Bratislava region

Introduction

Biomass of herbaceous layer, although it forms only a small part of total production of forest communities, plays a very important role in the assessment of ecological characteristics and in classification of forest ecosystems. Study of biomass of herbaceous layer provides valuable information on its structure, productivity, and stability. It also mirrors the relationship between plant individuals, populations, or communities and their environment.

Jurko (1958) pointed out that it is not suitable to classify elm-ash floodplain forests for one association, because of great differences in the soil moisture, in the flooding degree,

in the chemical compossition of the soil and in the soil fertility. These aspects affect the productivity of the communities and also their floristic composition. Kubíček, Šomšák (1985) researched the productivity of different types of elm-ash floodplain forests, while one of the sites was located in Topoľové hony forest. Other researches of productivity of the herbaceous layer of floodplain forests was processed by Kubíček (1999), Kubíček et al. (2008, 2009).

The objective of this paper is to analyze and compare the biomass of herbaceous layer in floodplain forests on the outskirts of Bratislava. The three sites were located in the forests of Pečenský les forest (Petržalka), Dunajské ostrovy islands (Rusovce) and Topoľové hony forest (Podunajské Biskupice).

Methods

The processing of vegetation followed methods of the Zurich-Montpellier phytosociological school as they are published in the available literature (Braun-Blanquet, 1964; Moravec, 1994). These methods classify vegetation by analyzing the total species composition, taking into account the sociological characteristics of individual species. Species abundance was estimated using the combined Braun-Blanquet scale of abundances and dominances (r, +, 1, 2, 3, 4, 5). Plant taxa were identified and their nomenclature was united according to Marhold et al. (1998) and the plant communities according to Jarolímek and Šibík (2008).

Estimation of herbaceous layer biomass was determined through indirect sampling method modified for non-repeated field measurements (Kubíček, Brechtl, 1970). That method has been applied and verified in the processing of various plant communities (eg. Kubíček, Šomšák, 1982, 1985; Kubíček, 1999; Kubíček et al., 2008, 2009). As stated by Jurko (1990), indirect sampling is preferable, because it does not destroy the vegetation and the biomass measurements can be regularly repeated. Energetic value was made according to the coefficient of energy - 18.45 $kJ.g^{-1}$ (Cumins, Wuycheck, 1971). Phytosociological relevés and sampling were conducted during the summer season 2009 and 2010. Species with lower sociological values (+, r) were not sampled despite their presence in the selected experimental squares. The location of each site was determined using GPS in the coordinate system WGS-84.

Results and discussion

Phytosociological description of the sample sites

Some of the best preserved areas with hardwood floodplain forests *Ulmenion* O b e r d. 1953 are, paradoxically, in the capital city. For our research, three sample sites were established in Pečenský les forest (Petržalka), Dunajské ostrovy islands (Rusovce) and Topoľové hony forest (Podunajské Biskupice). The first two sites represent hardwoord forests within interdike space that experience regular flooding and minimal forestry influences. The third site reflects dryer site conditions outside interdike space, without flooding impact and with pronounced forestry interventions.

Sites were chosen to reflect two slightly different associations within the *Ulmenion*:
Association: *Fraxino pannonicae-Ulmetum* S o ó in A s z ó d 1936 corr. S o ó 1963

(Pečenský les forest , Dunajské ostrovy islands)

Association: *Lithospermo-Ulmetum carpinifoliae* D ž a t k o 1972

(Topoľové hony forest)

The tree layer of the two sites of the *Fraxino pannonicae-Ulmetum* is dominated by European ash *Fraxinus excelsior*, accompanied by white poplar *Populus alba* or European white elm *Ulmus laevis* and bird cherry *Padus avium*. The tree layer of the site of *Lithospermo-Ulmetum carpinifoliae* D ž a t k o 1972 is composed of more xerophilous species: Turkey oak *Quercus cerris* and field maple *Acer campestre*. Here the shrub layer is also more developed and diverse.

The herb layer consits of 19, 26 and 32 species, respectively. The species of the first two sites mostly represent species composition typical for the *Fraxino pannonicae-Ulmetum*. In the second site, the impact of water proximity is notable by the presence of hygrophilous species like *Carex remota*, *Carex sylvatica* or *Phragmites autralis*. On the other hand, dryer site conditions are characterized by the presense of more xerophilous species in the *Lithospermo-Ulmetum carpinifoliae*: *Acer campestre*, *Convallaria majalis*, *Cornus mas* and *Lithospermum purpurocaeruleum*.

The two associations mentioned are characterized by following relevés:

1. *Fraxino pannonicae-Ulmetum*

   Bratislava- Petržalka, Pečenský les forest, interdike space, 48°8‘28,2“ N, 17°4‘1,7“ E, 400 m^2, E_3 75%, E_2 15%, E_1 80%, 18. 6. 2009

   E_3: *Fraxinus excelsior* 4, *Populus alba* 1

   E_2: *Crataegus monogyna* agg. 1, *Fraxinus excelsior* +, *Sambucus nigra* +, *Negundo aceroides* r

   E_1: *Impatiens parviflora* 4, *Aegopodium podagraria* 2, *Galium aparine* 1, *Hedera helix* 1, *Polygonatum latifolium* 1, *Parietaria officinalis* 1, *Viola mirabilis* 1, *Acer campestre* +, *Acer platanoides* +, *Euonymus europaeus* +, *Geranium robertianum* +, *Juglans regia* +, *Lamium maculatum* +, *Populus alba* +, *Salvia glutinosa* +, *Stachys sylvatica* +, *Anthriscus sylvestris* r, *Robinia pseudoacacia* r,

2. *Fraxino pannonicae-Ulmetum*

   Bratislava – Rusovce, Dunajské ostrovy islands, Horná Sihoť, interdike space, near a river branch, 48°03‘58,5“ N, 17°09‘30,5“ E, 400 m^2, E_3 85%, E_2 2%, E_1 70%, 13. 7. 2010

   E_3: *Fraxinus excelsior* 3, *Ulmus laevis* 2, *Padus avium* 1, *Ulmus minor* +

   E_2: *Padus avium* +, *Swida sanguinea* +

   E_1: *Carex remota* 2, *Carex sylvatica* 2, *Glechoma hederacea* 2, *Rubus caesius* 2, *Aegopodium podagraria* 1, *Brachypodium sylvaticum* 1, *Circaea lutetiana* 1, *Urtica dioica* 1, *Viola mirabilis* 1, *Arctium lappa* +, *Clematis vitalba* +, *Fraxinus excelsior* +, *Geum urbanum* +, *Lysimachia nummularia* +, *Negundo aceroides* +, *Padus avium* +, *Plantago major* +, *Populus alba* +, *Quercus robur* agg. +, *Populus nigra* +, *Solidago gigantea* +, *Swida sanguinea* +, *Impatiens parviflora* r, *Morus nigra* r, *Phragmites australis* r, *Taraxacum officinale* agg. r,

3. *Lithospermo-Ulmetum carpinifoliae*

   Bratislava – Podunajské Biskupice, Topoľové hony forest, near gamekeeper’s lodge Topoľové hony, 48°4‘45,8“ N, 17°12‘3,6“ E, 400 m^2, E_3 75%, E_2 40%, E_1 70%, 14. 7. 2010

   E_3: *Quercus cerris* 3, *Acer campestre* 2, *Fraxinus pennsylvanica* 1, *Robinia pseudoacacia* 1, *Quercus robur* agg. +

E_2: *Cornus mas* 2, *Crataegus monogyna* agg. 2, *Acer campestre* 1, *Corylus avellana* 1, *Berberis vulgaris* +, *Clematis vitalba* +

E_1: *Impatiens parviflora* 3, *Viola mirabilis* 3, *Lithospermum purpurocaeruleum* 2, *Acer campestre* 1, *Galium odoratum* 1, *Parietaria officinalis* 1, *Acer pseudoplatanus* +, *Ailanthus altissima* +, *Alliaria petiolata* +, *Berberis vulgaris* +, *Brachypodium sylvaticum* +, *Clematis vitalba* +, *Convallaria majalis* +, *Corylus avellana* +, *Crataegus monogyna* agg. +, *Epipactis helleborine* +, *Fraxinus pennsylvanica* +, *Geum urbanum* +, *Ligustrum vulgare* +, *Lonicera xylosteum* +, *Melica nutans* +, *Polygonatum latifolium* +, *Polygonatum multiflorum* +, *Quercus cerris* +, *Rubus caesius* +, *Stachys sylvatica* +, *Tilia platyphyllos* +, *Ulmus minor* +, *Arctium tomentosum* r, *Pimpinella major* r, *Sambucus nigra* r, *Ulmus glabra* r.

Biomass of herbaceous layer

The results obtained from the herbaceous layer biomass measurements are summarized in Tables 1–3. The species composition was quite diverse in phytosociological terms and also in terms of biomass. At the first site in Pečenský les forest two species were dominant in terms of biomass – *Impatiens parviflora* and *Hedera helix*. Subdominants included *Aegopodium podagraria*, *Polygonatum latifolium* and *Parietaria officinalis* (Table 1). The site was located near Danube river on an elevated terrace. In the tree layer dominated *Fraxinus excelsior*, in herbal layer dominated mainly semi-sciophilous and sciophilous species and in terms of soil moisture conditions the plant community can be characterised as mesophilous. The species richness was lowest at this site, which is associated with nearly monodominant incidence of invasive neophyte species *Impatiens parviflora*. Because of its high abundance, *I. parviflora* was as well dominant in terms of production, despite its lowest average individual weight.

T a b l e 1. Aboveground biomass of herbaceous layer in the association *Fraxino pannonicae-Ulmetum* (Pečenský les forest).

Species	SV	F [%]	m [g]	n [m^2]	B [$g.m^{-2}$]	E [$kJ.m^{-2}$]	B [$kg.ha^{-1}$]
Impatiens parviflora (D)	4	100	0.19	121.2	23.028	424.8666	230.28
Aegopodium podagraria (SD)	2	80	0.41	34.2	14.022	258.7059	140.22
Hedera helix (D)	1	100	1.34	15.6	20.904	385.6788	209.04
Viola mirabilis	1	80	0.35	11.2	3.92	72.324	39.2
Parietaria officinalis (SD)	1	60	1.46	5.8	8.468	156.2346	84.68
Polygonatum latifolium (SD)	1	20	0.97	13.8	13.386	246.9717	133.86
Galium aparine	+	20	0.25	1	0.25	4.6125	2.5
Geranium robertianum	+	40	-	1.2	-	-	-
Stachys sylvatica	+	20	-	0.4	-	-	
Acer platanoides	+	20	-	0.2	-	-	
Total				204.6	83.978	1549.394	839.78

Abbreviations: D – dominants, SD – subdominants, SV – sociological value from phytosociological relevé, F – frequency, m – weight of individuals, n – number of individuals, B – biomass of individuals, E – energetic value.

T a b l e 2. Aboveground biomass of herbaceous layer in the association *Fraxino pannonicae-Ulmetum* (Dunajské ostrovy islands).

Species	SV	F [%]	m [g]	n [m^2]	B [$g.m^{-2}$]	E [$kJ.m^{-2}$]	B [$kg.ha^{-1}$]
Aegopodium podagraria	1	40	1.22	3.2	3.904	72.0288	39.04
Carex remota (SD)	2	60	0.12	70.8	8.496	156.7512	84.96
Carex sylvatica (D)	2	80	0.33	134	44.22	815.859	442.2
Urtica dioica	1	100	0.85	5.2	4.42	81.549	44.2
Viola mirabilis	1	40	0.3	13.4	4.02	74.169	40.2
Glechoma hederacea	2	100	0.16	30.6	4.896	90.3312	48.96
Circaea lutetiana	1	40	0.61	3.2	1.952	36.0144	19.52
Rubus caesius (D)	2	80	3.48	8.2	28.536	526.4892	285.36
Brachypodium sylvaticum	1	20	0.15	24.8	3.72	68.634	37.2
Negundo aceroides	+	60	-	1.8	-	-	
Solidago gigantea	+	20	-	0.2	-	-	
Padus avium	+	40	-	0.8	-	-	
Fraxinus excelsior	+	20	-	0.2	-	-	
Lysimachia nummularia	+	20	-	4.2	-	-	
Populus alba	+	20	-	0.2	-	-	
Total				300.8	104.164	1921.826	1041.64

Abbreviations: D – dominants, SD – subdominants, SV – sociological value from phytocoenological relevé, F – frequency, m – weight of individuals, n – number of individuals, B – biomass of individuals, E – energetic value.

T a b l e 3. Aboveground biomass of herbaceous layer in the association *Lithospermo-Ulmetum carpinifoliae* (Topoľové hony forest).

Species	SV	F [%]	m [g]	n [m^2]	B [$g.m^{-2}$]	E [$kJ.m^{-2}$]	B [$kg.ha^{-1}$]
Impatiens parviflora	3	100	0.17	27.4	4.658	85.9401	46.58
Lithospermum purpuro-caeruleum	2	100	0.48	12.2	5.856	108.0432	58.56
Galium odoratum	1	100	0.17	18.8	3.196	58.9662	31.96
Viola mirabilis (D)	3	100	0.55	30.6	16.83	310.5135	168.3
Acer campestre	1	100	1.08	5.2	5.616	103.6152	56.16
Parietaria officinalis	1	20	1.33	3.2	4.256	78.5232	42.56
Ligustrum vulgare	+	20	-	0.2	-	-	-
Geum urbanum	+	60	-	0.8	-	-	-
Alliaria petiolata	+	60	-	0.6	-	-	-
Crataegus monogyna	+	20	-	0.2	-	-	-
Isopyrum thalictroides	+	20	-	0.2	-	-	-
Brachypodium sylvaticum	+	20	-	4.4	-	-	-
Quercus cerris	+	60	-	2	-	-	-
Melica nutans	+	20	-	3.8	-	-	-
Pimpinella major	r	20	-	0.2	-	-	-
Berberis vulgaris	+	20	-	0.2	-	-	-
Clematis vitalba (seedlings)	+	40	-	1.6	-	-	-
Polygonatum latifolium	+	20	-	0.6	-	-	-
Rubus caesius	+	20	-	0.4	-	-	-
Fraxinus pennsylvanica	+	20	-	0.2	-	-	-
Stachys sylvatica	+	20	-	0.2	-	-	-
Total				113	40.412	745.6014	404.12

Abbreviations: D – dominants, SD – subdominants, SV – sociological value from phytocoenological relevé, F – frequency, m – weight of individuals, n – number of individuals, B – biomass of individuals, E – energetic value.

At the second site in Dunajské ostrovy islands the highest biomass values were observed for *Carex sylvatica*, mainly because of its abundant population, and for *Rubus caesius*, which had the highest average weight of the individual. Somewhat lower values were observed for subdominant *Carex remota* (Table 2). Species richness was higher than at the previous site, partly because the occurrence of the species *Impatiens parviflora* was negligible here. In this community also prevailed semi-sciophilous to sciophilous and mesophilous species.

Viola mirabilis dominated the third site in Topoľové hony forest, while *Impatiens parviflora*, *Lithospermum purpurocaeruleum*, *Galium odoratum*, *Acer campestre* and *Parietaria officinalis* contributed to the production of biomass to a lesser extent (Table 3). This site had the highest species richness (32 species), however most species reached only low cover levels, which was reflected also in their minimal contribution to the herbaceous layer biomass.

Total biomass was highest in the *Fraxino pannonicae Ulmetum* (Dunajské ostrovy islands) 1041.64 kg.ha^{-1}, lowest total biomass was in the *Lithospermo-Ulmetum carpinifoliae* (Topoľové hony forest) 404.12 kg.ha^{-1}. Results indicate that biomass on the sample sites was positively correlated with the average number of individuals per square meter.

Kubíček, Šomšák (1985) analyzed the production of herbaceous layer of vegetation belonging to suballiance *Ulmenion* as well. The values of total biomass of their three sample sites ranged from 535.19 kg.ha^{-1} to 1496.79 kg.ha^{-1}, which is comparable to our values. Herbaceous layer biomass in the Danubian floodplain forests was assessed also by Kubíček (1999). In this case, the aboveground biomass of the original hardwood floodplain forests also reached comparable values of 320 kg.ha^{-1} to 770 kg.ha^{-1}.

Translated by Mária Májeková and James Dyer

Acknowledgements

This work was supported by EU Structural Funds - Centre of Excellence for Integrated Flood Protection of Landscape (IMTS cote of project: 26240120004) and grant VEGA Slovakia No. 1/0163/08.

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