COMPARISON OF THE ECOLOGICAL CHARACTERISTICS THE WILLOW-POPLAR FLOODPLAIN FOREST FRAGMENTS ON THE STANDS WITH DIFFERENT HEIGHT OF GROUNDWATER LEVEL

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Abstract

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The ecological characteristics of the floodplain forests fragments were evaluated in alluvia of the Váh river on stands with different level of groundwater. On analysed habitats there are communities *Salici-Populetum* fac. Fraxinetosum (Ďulov Dvor) and *Salici-Populetum typicum* (Čalovec). There were found differences in species structure and their abundance between stands with lower and higher groundwater level. There was confirmed expansion of the ruderal taxa mainly in the contact phytocoenosis near cultivated fields. There were identified invasive or potentially invasive species. The different hydrological conditions did not affect eco-physiological characteristics of the dominant woody plants. The leaves of both analysed species had low values of specific leaf area (SLA) and quite high values of the succulence degree. Poplars and willows reached good growth parameters, which correspond with age of the analysed woody plants and also with species characteristics. The diameter increment is affected mainly by age of the analysed trees. Dependence of diameter increment on changes of water regime is more evident on younger poplars and willows.

Key words: floodplain forests, groundwater, species structure, abundance, growth, specific leaf area, diameter increment

Introduction

Alluvia of the Váh river are conspicuously changed by human activity and natural environment has trails of direct or indirect human interventions. In the sites around watercourse

there were preserved several biotopes corresponding with the natural vegetation that was originally spread in larger area (Barančok, 1996). Just fragments of floodplain forests surround lowland alluvia of the Váh river. Willow-poplar floodplain forests are developed on young sediments on the most humid places of alluvial plains of bigger streams on the lowest points of topography and on higher stands of the riparian zone (Ružičková et al., 1996). The dynamics of alluvial floodplain communities is considerably influenced by water regime. Their species structure is diversified by at least one factor of the floodplain dynamics – inundation or underground water (Michalko et al., 1986).

As it is mentioned by Feranec and Oťaheľ (2003), the vegetation is significant indicator for solution of eco-stabilizing and socio-economic functions in the landscape. The vegetation shows abiotic and anthropogenic influences. The direct monitoring of flora has not yet been done on selected area, as for example within the floodland of the Danube river (Lisický et al., 1997; Uherčíková et al., 1999).

According to Penka et al. (1991), the floodplain communities of the alluvial plains are exceptional combination of the large species diversity and high productivity in the zone of temperate climate. The determining ecological factor is groundwater level corresponding with flood regime. This factor determines the species structure of stable plant communities. On stands, there are dominant woody plants willows, poplars and alders. The area and characteristics of the floodplain forest were developed under influence of constructed flood protection buildings, logging, partial cuttings and intensive agricultural production. The paper presents results of evaluating the biological characteristics of the floodplain forest fragments on alluvial plain of the Váh river from stands with different height of groundwater level.

Study area

The analysed localities belong to Komárno district, situated in southwest part of Slovakia and it is the lowest-lying territory in Slovakia. The localities with preserved fragments of the original vegetation were selected for evaluation. Stands are in the agriculturally exploited landscape, surrounded by arable land. The territory lies on Podunajská nížina lowland, its essential morphological trait is flatness and relatively little rugged topography.

The attribute of the terrain depression on Podunajská nížina lowland in reference to surrounding mountains is high concentration of the hydrological net with allochthonous rivers – Danube, Váh, Nitra, Žitava. All these rivers have mild gradient with regard to flatness of the territory. Allochthonous rivers with their permanent leakage into loose parent rocks conditioned accumulation of large groundwater resources.

Groundwater and terrain topography were determining factors for existence and large development of floodplain forests. The groundwater depth plays important role in the hydrological regime of soil and together with other properties it is determining factor for species structure of plant communities.

The territory is in warm, arid and quite windy area with mild winter, little snow cover and longer sunlight.

Material and methods

The monitory of the influence of hydrological changes on typical fragmentary climax communities of the floodplain forests at two different localities was investigated. There was done the first step of floristic and phytocoenological research. The research was done in agreement with determining phenological conditions of the mentioned localities according to Braun-Blanquet (1964). The modified Braun-Blanquet abundance/dominance scale was used for vegetation survey (Barkman et al., 1964). The scientific nomenclature is given according to Marhold, Hindák (1998) and Michalko et al. (1986).

Eco-physiological characteristics were done on leaves from bottom level of adult dominant woody plants *Salix* and *Populus*. Selected characteristics of research stands are documented in Table 1.

T a b l e 1. Characteristics of the research stands.

Stand characteristics	Stand/locality	
	Ďulov Dvor	Čalovec
location	Near of town Komárno, part Ďulov Dvor – Zámocká pustatina, north part of the town, between points elevation 107.09 and 108.60 m a.s.l.	Near of village Čalovec, between points elevation 109.30 and 108.30 m a.s.l., south-eastward from village
average year air temperature	11.0 °C	11.0 °C
average temperature in growing season	15.7 °C	15.7 °C
sunlight	2100 hours	2100 hours
average annual sum of precipitation	520.28 mm	520.28 mm
average annual sum of precipitation in growing season	358.76 mm	358.76 mm
hydrogeological region	Quarternary of SW part of Podunajská rovina plain	Quarternary of SW part of Podunajská rovina plain
height of underground water level	2.20 m	1.82 m
soils	Calcaric Fluvisols	Calcaric Fluvisols
type of vegetation	oak forests zone, lowland subzone, plane area , wetland district	oak forests zone, lowland subzone, plane area , wetland district
syntaxonomical structure	*Salici–Populetum* fac. Fraxinetosum	*Salici–Populetum typicum*
average age of the dominant woody plant species	*Salix* 41 *Populus* 19	*Salix* 19 *Populus* 20

The objects of the eco-physiological research were dominant species from *Salix* and *Populus* communities. There were selected mainly adult plants at the age of 12–53 years, which has different localization in terrain relief. The tree position in stand structure was considered when taking off material. On analysed dominant species there were measured also dendrometric characteristics – height and breast height diameter (d1,3). The increment core method was used for sampling and according to annual growth-ring analysis the radial diameter increment ir was calculated. The age was also determined for analysed woody plants.

Within the scope of eco-physiological characteristics in dynamic sampling (June–October 2005) there were determined fresh weight (Fw), dry weight (Dw) and leaf area (A). The leaf area was determined on samplings collected from bottom level of the trees on height 2 meters. Sampling had volume 1 m^3 with prevalence of the sun

leaves. Leaf area was calculated from data of leaf scan with utilization of CorelDraw and AutoCAD programmes. It was expressed as dimensionless quantity. The values of specific leaf area (SLA) and succulence degree were calculated from the primary data.

Results and discussion

On the data of floristic and phytocoenological survey of the studied territory, there was confirmed the occurrence of 64 species of vascular plants and elementary syntaxonomic structure of vegetation, which consists of communities of the class *Phragmiteto–Magnocaricetea,* order *Alnetalia glutinosae* and association *Salici populetum* and *Carici elongatae–Alnetum*.

The influence of ruderal taxa starts in direct contact phytocoenosis of the intensive cultivated fields (*Cirsium arvense, Solidago canadensis*, *Galinsonga parviflora* – 12 species). The invasive species is *Negundo aceroides,* potentially invasive are species: *Cirsium arvense, Prunus cerassifera, Bryonia alba, Robinia pseudaccacia*, which may affect negatively the further development of vegetation on the both studied localities.

The following records of plant communities analyses are presented:

Čalovec

Relevé 1:

Stand height approx. 12 m, E_3 40%, E_2 1%, E_1 50%, area 100 m^2, leg. M. Sádovský, P. Eliáš jun. et T. Baranec

E_3: *Salix alba* 3, *Populus* × *canescens* r, *Salix fragilis* r

E_2: *Salix cinerea* r,

E_1: *Carex riparia* 2b, *Carex acuta* 2a, *Glyceria maxima* 1, *Lycopus europaeus* 1, *Berula erecta* +, *Lythrum salicaria* +, *Phragmites australis* +, *Stachys palustris* +, *Scutelaria galericulata* +, *Teucrium scordium* +, *Caltha palustris* r, *Galium palustre* r, *Iris pseudacorus* r, *Tithymalus palustris* r

Relevé 2:

Stand height approx. 15 m, E3 40%, E2 1%, E1 50%, area 100 m^2, leg. P. Eliáš jun. et T. Baranec

E_3: *Salix alba* 3

E_2: –

E_1: *Carex riparia* 2b, *Carex acuta* 2a, *Glyceria maxima* 2a, *Lycopus europaeus* +, *Berula erecta* r, *Phragmites australis* +, *Sonchus palustris* +, *Galium palustre* r, *Lysimachia vulgaris* +, *Solanum dulcamara* +, *Calystegia sepium* +, *Mentha aquatica* r

Ďulov Dvor

Relevé 1:

Stand height approx. 25 m, E3 50%, E2 60–70%, E1 50%, area 100 m^2, leg. M. Sádovský, P. Eliáš jun. et T. Baranec

E_3: *Salix alba* 3, *Populus* × *canescens* 2a, *Negundo aceroides* 1, *Salix fragilis* 1

E_2: *Sambucus nigra* 3, *Negundo aceroides* 2a, *Clematis vitalba* +, *Crataegus monogyna* +, *Euonymus europaeus* +, *Humulus lupulus* +, *Swida sanguinea* +, *Viburnum opulus* +,

E_1: *Rubus caesius* 2b, *Galium aparine* 2a, *Agrostis stolonifera* 1, *Aster lanceolatus* 1, *Cucubalus baccifer* 1, *Negundo aceroides* juv. 1, *Glechoma hederacea* 1, *Urtica dioica* 1, *Epipactis heleborine* +, *Viburnum opulus* juv. +, *Crataegus monogyna* juv. +, *Swida sanguinea* juv. +, *Iris pseudacorus* +, *Leucojum vernum* +, *Geranium robertianum* +, *Torilis japonica* +, *Galeopsis pubescens* +, *Carex acuta* +, *Populus canescens* juv. +, *Vicia cracca* +, *Rhamnus cathartica* +, *Atriplex patula* +, *Viola hirta* +, *Viola odorata* +, *Prunus cerasifera* +, *Calamagrostis epigejos* +, *Fallopia dumetorum* +, *Epipactis tallosii* r

Relevé 2:

Stand height approx. 25 m, E3 50%, E2 60–70%, E1 50%, area 100 m^2, leg. P. Eliáš jun. et T. Baranec

E_3: *Populus* × *canescens* 2a, *Salix alba* 3

E_2: *Sambucus nigra* 3, *Crataegus monogyna* 1, *Populus* × *canescens* +, *Swida sanguinea* +,

E_1: *Rubus caesius* 2b, *Aster lanceolatus* 1, *Cucubalus baccifer* 1, *Negundo aceroides* juv. 1, *Glechoma hederacea* 1, *Urtica dioica* +, *Viburnum opulus juv.* +, *Crataegus monogyna* juv. +, *Swida sanguinea* juv. 1, *Geranium robertianum* +, *Galeopsis pubescens* +, *Carex acuta* +, *Populus canescens* juv.1, *Rhamnus cathartica* +, *Atriplex patula* +, *Viola odorata* +, *Prunus spinosa* +, *Calamagrostis epigios* +, *Fallopia dumetorum* +, *Epipactis tallosii* r, *Bryonia alba* r, *Symphytum officinalis* r, *Agropyron repens* r, *Frangula alnus* r

For interpretation of the differences within floristic and phytocoenological analysis of stands it is important to know also eco-physiological characteristics of the dominant woody plants in the presented records.

The results of biomass values of the leaves of poplars and willows that were measured during summer and autumn vegetation period (Table 2) confirm species conditionality of production and accumulation of organic mass in different hydrological conditions. Willow is more responsive to higher level of groundwater, has higher biomass production and also bigger leaf area.

T a b l e 2. The values of dry weight of leaves and leaf area of the dominant woody plants on experimental stands.

Stand	Species		VI.		VII.		VIII.		IX.		X.	
			Dw	A	Dw	A	Dw	A	Dw	A	Dw	A
Ďulov Dvor	*Populus*	Ø	79.28	0.8248	81.84	0.8598	83.51	0.9124	82.20	0.8706	45.53	0.5251
		v	5.7	4.9	4.2	4.1	5.6	3.8	7.5	6.5	19.3	13.8
Čalovec		Ø	55.48	0.6039	59.80	0.6965	70.98	0.7839	68.76	0.7705	32.69	0.3566
		v	12.1	14.6	11.6	20.4	10.3	17.9	10.4	20.5	20.7	19.9
Ďulov Dvor	*Salix*	Ø	46.55	0.5449	46.77	0.5469	49.63	0.5735	48.48	0.5473	41.78	0.4905
		v	15.2	11.5	19.6	9.5	22.3	9.5	20.1	9.2	19.6	20.3
Čalovec		Ø	56.39	0.6601	57.72	0.6913	65.95	0.7776	64.76	0.7622	34.83	0.4369
		v	6.7	6.7	14.1	13.4	6.1	7.9	5.3	5.2	19.9	20.4

Notes: Ø – mean, v – coefficient of variance (%), Dw – dry weight of leaves (g.m^{-3}), A – leaf area (m^3)

The hydratation of the poplar leaf tissues is relatively low, what confirm also very low values of SLA (Table 3) 4.24–4.71 $mm^2.mg^{-1}$ (Čalovec) and 4.40–4.51 $mm^2.mg^{-1}$ (Ďulov Dvor). Similarly, the willow leaves had high values of dry matter and low water content (SLA 4.80–4.90 $mm^2.mg^{-1}$ (Čalovec), 4.61–4.82 $mm^2.mg^{-1}$ (Ďulov Dvor).

T a b l e 3. Specific leaf area (SLA) *Populus* and *Salix* in June – October 2005 ($mm^2.mg^{-1}$).

Stand	*Populus*					*Salix*				
	VI.	VII.	VIII.	IX.	X.	VI.	VII.	VIII.	IX.	X.
Čalovec	4.50	4.71	4.69	4.65	4.24	4.80	4.90	4.86	4.79	4.81
Ďulov Dvor	4.41	4.40	4.51	4.42	4.42	4.82	4.81	4.78	4.61	4.70

Succulence degree of the leaves, which expresses the water content per unit of leaf area, has quite high values (Table 4). The studied species have reduced transpiratory area neither on more arid stands (Ďulov Dvor).

T a b l e 4. Succulence degree of the dominant woody plant species *Populus* and *Salix* ($mg.cm^{-2}$).

Stand	*Populus*					*Salix*				
	VI.	VII.	VIII.	IX.	X.	VI.	VII.	VIII.	IX.	X.
Čalovec	13.04	12.64	12.28	12.60	14.40	12.29	12.04	12.10	12.35	12.83
Ďulov Dvor	13.06	13.19	13.01	13.21	13.96	12.20	12.23	12.25	12.85	12.76

Dominant woody plants on studied stands are fast-growing species with high requirements on water. Therefore it is possible to expect dependence of increments (mainly diameter increment) on changes of water regime on stand. From dendrometric data documented in Table 6 it is evident, that individuals on both localities (also in young age) reached good diameter dimension and height that corresponds with age and species characteristics. Height values of the poplars from Čalovec locality were in range 11–20 m, values of diameter at breast height (dbh) ranged from 212 mm to 534 mm. Evaluated poplars on Ďulov Dvor reached height dimensions 18–25 m and diameter dimensions (dbh) 440–950mm. For comparison of the obtained dimensional data – newly bred poplars at the age 15 years reached height 19.8–27.5 m, diameter (dbh) 206–398 mm on Východoslovenská nížina lowland (Kohán, 2003a). In 30-year populetum the height values ranged from 30 to 35 meters and diameter values ranged from 305 to 523 mm, (Kohán, 2003b). The individuals on analysed localities Čalovec and Ďulov Dvor have comparable diameter dimensions and they drag behind just in height growth, what is influenced by species characteristics, individual growth rate and also by favourable light conditions.

Within more detailed analysis of diameter increment (Table 5) it is possible to state its slightly decreasing tendency in general. We suppose among analysed plants this tendency is influenced mainly by age. Higher values of the mean increment (above 10 mm) we recorded mainly on younger individuals (up to 20 years), other woody plants have lower values of mean annual increment (PMAI). Such fast growing individuals were found on

both localities and they were mainly willows – tree 204 (PMAI = 13.48 mm), 234 (PMAI = 12.39 mm) on Čalovec locality, willow 232 (PMAI = 10.1 m) and poplar 217 (PMAI = 10.17 mm) on locality Ďulov Dvor.

Kohán (2003a,b) from 30-year populetum reports mean annual diameter increment (PMAI) ranging from 10.00 mm to 17.4 mm and for 15-years old poplars this author reports PMAI values ranging from 13.7 mm to 26.5 mm.

T a b l e 5. Dendrometric characteristics of the evaluated woody plants.

Locality	Genera	Evidence number	Age	Height (m)	dbh (mm)	PMAI (mm)
Čalovec	*Populus*	201	14	11	305	6.66
		202	12	12	212	6.35
		203	45	16	495	5.35
		208	20	20	534	9.60
		209	24	15	345	7.14
	Salix	204	19	16	805	13.48
		206	24	16	390	5.38
		207	17	16	467	8.08
		210	32	20	305	4.74
		234	15	16	318	12.39
Ďulov Dvor	*Populus*	217	26	18	683	10.17
		220	34	19	440	4.99
		222	39	20	534	6.32
		229	24	25	950	5.05
		241	21	25	495	8.41
	Salix	215	53	13	456	3.14
		230	28	20	730	7.08
		232	16	20	638	10.10

The pattern of changes of the current diameter increment on analysed species did not show meanwhile significant dependence on stand hydrological conditions. The hydrological conditions are just one factor that has influence on diameter growth of woody plants. The value of diameter increment in general is affected by species characteristics, site quality, stand density and climatic conditions (temperature and precipitation). Young plants expressed more evident changes of the radial diameter increment.

For comparison, there are displayed values of radial diameter increment of willows, which grew together on one stand. On locality Ďulov Dvor (Fig. 1) there is evident the impact of age on size of annual increments, as well as on locality Čalovec (Fig. 2). More evident fluctuation of the values of annual increment appeared within poplar population, but these changes meanwhile do not document significant influence of the climatic and hydrological conditions of the stands**.** The impact examination of these factors on diameter increment of the woody plants needs more detailed analysis.

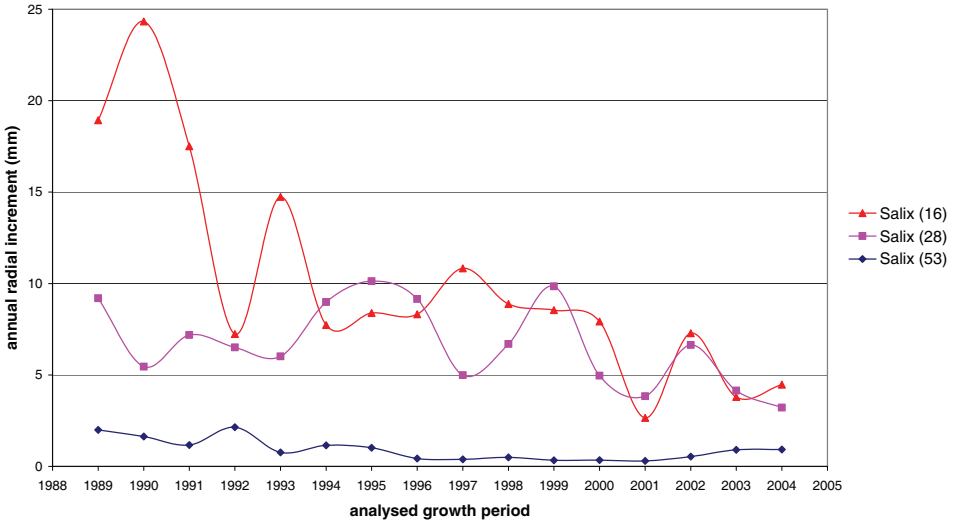

Fig. 1. Time course of radial diameter increment of willows on locality Ďulov Dvor (in abbreviations is given age of the plants).

Fig. 2. Time course of radial diameter increment of willows on locality Čalovec (in abbreviations is given age of the plants).

Conclusion

From results of the eco-physiological and phytocoenological research of fragments of the willow-poplar floodplain forests, it is possible to create the following conclusions.

The environment has the character of original fragmentary climax plant communities of floodplain forests, with quite high species diversity. Different number of species was found on stands with different hydrologic conditions. The stand with the lowest underground water level is typical by influence of ruderal taxa mainly in direct contact phytocoenoses of the surrounding cultivated fields. Consequently there are confirmed anthropogenous influences. As invasive species there was identified *Negundo aceroides* and four potentially invasive species – *Cirsium arvense, Prunus cerassifera, Bryonia alba, Robinia pseudaccacia*.

The significant difference in floristic structure of the analysed biotopes was found, also considerable degree of ruderalization as well as occurrence of invasive species. Eco-physiological characteristics of the leaves of dominant woody plants (*Salix, Populus*) did not confirm significant differences in species reactions on different stand hydrologic characteristics. High values of dry matter (low water content) and high values of succulence degree were found in willow and poplar leaves. Biomass production and forming of leaf area indicate that willow is more responsive to better water supply than poplar. There was not confirmed decrease of the transpiratory area values, considering this fact we can assume that underground water level remained in contact with root system of the analysed dominant woody plants.

Author Šmelko et al. (1999) who were running forestry research various hybrids of woody plants, confirmed tolerance of the willow and poplar stands to little changes of water regime.

Dendrometric characteristics of the *Salix* and *Populus* individuals on both localities correspond with species traits, their age structure and site quality. Dependence of diameter increment on changes of water regime is more evident on younger poplars and willows, it needs more detailed analysis not only of the hydrological data, but also of the climatic data and plant position within the stand. All mentioned factors have influence on changes of the diameter increment of woody plant. Older trees have probably physiologic predispositions for decrease of diameter increment and better mechanism of tolerance against water deficit, therefore there were not recorded their stronger reactions.

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