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TYPES OF BEECH-FIR FORESTS ON MT. VELIKI JASTREBAC, SERBIA

M. MEDAREVIĆ and R. MILOŠEVIĆ

Faculty of Forestry, University of Belgrade, 11030 Belgrade, Serbia

Abstract - The results of typological studies and typological classification of beech-fir forests on Mt. Veliki Jastrebac, Serbia are presented. From the typological aspect, the forests are quite homogeneous, i.e. there are two types of forests: fir and beech (*Abieti-Fagetum moesiacae montanum typicum)* on deep acid brown soils on granodiorites; and beech and fir with fescue grass (*Abieti-Fagetum moesiacae montanum drymetosum*) on medium deep (often skeletal) acid brown soils on granodiorites. By their ecology and potential productivity, these forest types are identical with types at other localities in Serbia, i.e. beech-fir forests in Serbia do not show the regional character which is mostly expressed by the differences in the potential productivity within the same type. Based on the characteristics and elements on which the management and silvicultural measures are defined, the types determined at this locality are two significantly different entities. This fact requires a different approach in practical works in the selection of silvicultural and management measures in the aim of reaching the functional optimum, so their unification is not possible.

*Key words***:** Beech-fir forests, beech-fir forest types, Serbia, Mt. Veliki Jastrebac, Serbia

INTRODUCTION

The percentage of beech-fir forests in the Republic of Serbia is rather low; they are distributed over an area of about 11,000 ha, which accounts for 3% of the total growing stock in Serbia**.** They grow mainly fragmentarily at the localities Veliki Jastrebac, Zlatibor, Kopaonik, Prokletije, and Željin. It is only on the mountain Goč that they occupy significant areas, where they are a differentiated and homogenous spatial-ecological unit in the sense of a developed climate-regional belt.

Beech-fir forests in Serbia occur in different petrographic/geological, orographic and edaphic conditions. Parent rocks consist of granodiorites, quartz - diorites, schists, contact metamorphic rocks, peridotites and serpentinites, and the soils are acid brown soils (deep, medium deep, sometimes skeletal), rarely mull-rankers, and one fragment (of local character) is on very acid, brown, humus soil and podzolized acid brown soil (Jović et al., 1996, Milošević 2006).

The lowest site is located at the altitude of only 600 m on Mt. Veliki Jastrebac (Milošević 2006). The upper limit of these forests is at the altitude of 1,550 m on Kopaonik (Mišić 1964).

In addition to the dominant edifiers beech and fir (with the dominance of beech or fir depending on the forest type and stand situation), there are, mainly individually, also some noble broadleaves: maple (*Acer pseudoplatanus),* Norway maple (*Acer platanoides),* wych elm (*Ulmus montana*), and large-leaved lime *(Tilia grandifolia)*. Beech and fir forests are classified within the belt of mesophilous beech and beech-coniferous forest types (Jović et al.,*0* 1996). Regarding the ecological characteristics (primarily edaphic), they are rather heterogeneous (there are many ecological units of these forests). Regarding

the typological characteristics, this coeno-ecological group of forest types is quite homogeneous (Jović et al., 1991, Milošević 2006).

The definition of forest typology, and especially in case of these forests (considering the bioecological characteristics of beech and fir and their inter-relationship in the sense of ecological and coenological optimum and the dynamism in individual types of these forests), also defines the elements which are the basis and starting point of the correct and realizable selection of management goals and silvicultural and management measures based on the character and specificity of elements in each classification unit - forest type. This refers especially to potential productivity (as the base for analysis of the current level of the site potential utilization and identification of silvicultural and management procedures), ecological and coenological relations of the edifiers (the basis of identification of the optimal mixture proportion and thus functional optimum), selection of the optimal stand form (different structure depending on the stand typology), site typization, i.e. selection of tree species for afforestation, elements added during stand development, e.g. thinning (time and intensity, time and intensity in relation to the edifiers), etc.

In practical planning, the ratio of edifiers in the mixture is especially significant in beech-fir forests, i.e. the choice of an optimal mixture proportion taking into account the planned zonation of these stands and the choice of optimal stand form. The optimal mixture proportion and stand form have been the subjects of numerous studies in different climate and other conditions (Jović et al. 1991; Milošević 2009; Cestar, Hren 1971; Meštrović 2001, etc.).

The typological determination of beech-fir forests in Serbia also defines the optimal mixture proportion for each individual type (the most represented types).This proportion is in favor of fir or beech, and it is exclusively related to the stand typological classification.

The typological determination of beech-fir forests on Mt. Veliki Jastrebac will complete and round-up the study of beech-fir forests in Serbia from the standpoint of distribution, typological definition, and definition of silvicultural and management modalities.

The defined types with their characteristics at the study site will be compared to previously defined types, so that it can be seen if the types of these forests have a regional character. In this way, the management and silvicultural modalities for beech-fir forests will be completed, which is also an objective of this paper.

MATERIALS AND METHODS

The study of beech-fir forests was performed on the mountain Veliki Jastrebac. Beech-fir stands on this mountain occur mainly as fragments without clear spatial and ecological differentiation. Taking into account the character of forest typological classification and its practical application in forest management, the study was focused on the best-preserved stands, stands of relatively spontaneous development, and mature stands (aged 140 years).

The typological determination of beech-fir forests was performed by a standard methodological procedure, i.e. the procedure for forest typological research and definition. (Symposium on the Application of Typology in Modern Forest Management Planning, Belgrade, 1976) (Medarević and Milošević 2005).

The research was performed on permanent sample plots established for the field identification of ecological-coenological diversity in the study area. Special attention in the reconnaissance and field experiments was focused on the differences in ecological-oenological character. In the establishment of permanent sample plots, special attention was paid to the character of typological definition (forest type defines the potential productivity). Sample plots were established in the oldest, best-preserved stands and in stands of sufficient age and structural homogeneity both intra and inter the ecological units of these forests.

Table 1. Climate classification by Thornthwaite

Elevation (m)	Humidity index (Ih)	Aridity index (Ia)	Climate index (Im)	Climate Type	Climate
650-800	64.34		64.34	B2	moderately humid
900-1000	91.46		91.46	B4	very humid

Homogeneous ecological units, as the starting point for further typological determination, were formed based on the synthesis and analysis of numerous factors, which were the basic information for the all-inclusive and real ecological definition of these stands (macro- and microclimate characteristics, parent rock, soil, vegetation). Parent rock was determined by samples taken in the field and their determination at the Faculty of Forestry Laboratory for Petrography and Geology. Hydrologic balance was determined by Thornthwaite's method. The soil characteristics were determined using the samples taken in the field and their laboratory testing. Laboratory analysis of the soil samples was performed at the Faculty of Forestry Laboratory for Forest Pedology. The study and definition of vegetation was carried out by the method of the Braun-Blanquet French-Swiss school.

Based on the characteristics of the above factors and their synthesis, it was possible to form ecologically and vegetationally homogeneous units - ecological units.

Each ecological unit was divided into four sample plots. The number of sample plots was determined based on the diameter and height variability and the predetermined criteria. In this way, the required minimum of four replicates of each treatment was satisfied (Hadživuković 1991).

The following characteristics of the stands in each ecological/vegetation unit were assessed: potential level of production, dynamism, and structure - by stand estimation indicators, and indicators of dominant trees - by standard dendrometric procedures. The typological classification of these stands can be concluded through an assessment of the above-mentioned characteristics and their analysis and synthesis, as well as the calculation of differences in statistical significance between the ecological units. The production level and the development of ecological units were assessed by different mathematical and statistical models. The homogeneity of the treatment (ecological units) was calculated by the analysis of variance. The differences between ecological units as regards the significance of the average values of the main productive indicators and their development were calculated by LSD test.

RESULTS

According to Thornthwaite's classification, the coeno-ecological group of beech and fir forest types on Mt. Veliki Jastrebac grows in conditions of humid (B_2) to very humid (B_4) climate. The climate of the stands at the altitudes of 650-800 m is moderately humid (B_2). The stands ranging from 900 to 1000 m grow in a very humid (B_4) climate. It can be concluded that the climate of this site is optimal for the growth and development of high forests, i.e., these forests grow within their climate-physiological optimum (Table 1).

Edaphic conditions are quite homogeneous. Parent rocks are formations of magmatic eruptive rocks, i.e. a group of granodiorites. The soils are acid brown, medium deep (mostly skeletal) and deep.

In addition to beech (*Fagus moesiaca)* and fir (*Abies alba*) (the dominance of beech or fir is conditioned by the stand typology), the following species also occur in the upper story, mainly individually (+): maple (*Acer pseudoplatanus),* Norway maple *(Acer platanoides),* wych elm *(Ulmus montana),* large-leaved lime *(Tilia grandifolia),* white ash *(Fraxinus*

Table 2. Phytocoenological Table.

Association	*ABIETI-FAGETUM MOESIACAE* Jovanović 1953									Degree of presence
Subassociation	typicum									
Locality	Veliki Jastrebac									
Relevé number	3/99	20/00	21/00	22/00	34/00	49/00	50/00	51/00	52/00	
Elevation (m)	970	610	610	590	810	800	760	750	730	
Exposure	NW	E	NE	NW	W	ESE	ENE	N	ESE	
Inclination (^{0})	35	30	20	30	30	25	5	25	5	
Bedrock	Grano-diorites	Grano-diorites	Grano-dior-ites	Grano-dior-ites	Grano-dior-ites	Grano-dior-ites	Grano-dior-ites	Grano-dior-ites	Grano-diorites	
Soil	Deep acid brown	Deep acid brown	Deep acid brown	Deep acid brown	Deep acid brown	Deep acid brown	Deep acid brown	Deep acid brown	Deep acid brown	
I layer										
Canopy	0.6	0.9	0.9	0.8	0.8	0.5	0.6	0.7	0.5	
Mean height (m)	35	28	28	25	19	28	30			
Mean diameter (cm)	40	35	30	35	18	40	50			
Mean distance (m)	7	5	5	6	3	7	6	6	7	
Fagus moesiaca	1.2	4.5	4.5	4.4	+.2	1.1	1.2	1.2	1.2	**V**
Abies alba	3.3	1.1	1.1	1.2	2.2	3.3	2.3	2.3	2.3	V
Betula pendula			1.1							**I**
Tilia parvifolia					+					**I**
Tilia grandifolia							+			**I**
Fraxinus excelsior				+	+					I
II layer										
Canopy	0.2	0.1	0.2	0.4	0.3	0.6	0.8	0.9	0.9	
Mean height (m)	5	3	4	2	5	1	4.5	4	5	
Abies alba	1.2	+	+	2.2	2.2	3.3	1.2			IV
Fagus moesiaca	+.2		+	1.2	+.2	1.2	1.2	1.2		IV
Sambucus nigra	1.2	+	+	+			+	+.2	1.2	III
Corylus avellana	+		+				+		1.2	II
Acer pseudoplatanus	+						+	+	+	I
Euonymus latifolia	+	+								I
Acer platanoides								+.2		I
Ulmus montana	+.2									I

excelsior), and Balkan maple *(Acer heldreichii)*. In the shrub layer, together with the juveniles of the principal species, there are admixtures of other species: *Acer pseudoplatanus* (individually), *Acer platanoides* (individually), *Sambucus nigra,* and *Corylus avellana.* In the ground flora layer, in addition to the dominant (by abundance and the degree of coverage) blackberry *(Rubus hirtus)*, there are: *Asarum europaeum, Asperula odorata, Oxalis acetosella, Sambucus nigra, Corylus avellana, etc.* In the ground flora layer (de-

Continuation of Table 2

Association	*ABIETI-FAGETUM MOESIACAE* Jovanović 1953									Degree of presence
Subassociation	typicum									
Locality	Veliki Jastrebac									
Relevé number	3/99	20/00	21/00	22/00	34/00	49/00	50/00	51/00	52/00	
III layer										
Canopy	1.0	0.9	0.9	0.8	0.8	0.4	0.8	0.9	0.9	
Rubus hirtus	5.5	4.5	4.4	3.4	2.3	3.3	3.3		5.5	V
Abies alba		+	1.2	2.3		1.2	+.2			IV
Asarum europaeum		+.2	+.2	+	+.2	+.2	1.2	1.2	1.2	IV
Cardamine bulbifera	+.2	+.2	+	+	1.2					III
Ruscus hypoglossum	+.2				+.2			+		III
Galeobdolon luteum		1.2	+.2	-.2	1.2	1.2	+.2	1.2	1.2	III
Asperula odorata		2.2	2.3		+.2		2.2	2.2		III
Dryopteris filix-mas								+.2	+	III
Oxalis acetosella	+.2						1.2	2.2		II
Corylus avellana	+		+							II
Acer platanoides	+							+		II
Prenanthes purpurea	4-									II
Hedera helix	+.2			+						II
Polystichum aculeatum	+	+	+				+	+.2	+	II
Sambucus nigra		+	+							II
Athyrium filix-femina							+		+	II
Acer pseudoplatanus	+	+	+							I
Prunus avium	+	+								I
Ulmus montana	4-									I
Euonymus latifolia	+	+								I
Pteridium aquilinum							+	+.2	+	I
Polystichum aculeatum	+	+	+				+	+.2	+	I

pending on the stand typology), in addition to the dominant blackberry *(Rubus hirtus)* and fescue grass (*Festuca drymeia*), there are: *Asarum europaeum, Asperula odorata, Oxalis acetosella, etc*. In this layer, depending on the stand typology, the dominant plants are fir or beech.

Types of beech-fir forests

This coeno-ecological group was divided into special units of ecological, production potential, and silvicultural management character - types of beech-fir forests.

Forest type fir and beech (Abieti-Fagetum moesiacae montanum typicum) on deep acid brown soils on granodiorites

The stands of this typology are the most widely distributed, i.e. they cover the largest areas on the massif of Veliki Jastrebac. Their vertical distribution is not clearly differentiated, their altitude ranges between 900 and 1000 m, and their percentage is greater in the lower parts (altitude 600 – 800 m), and on cooler aspects (they are absent on south aspects), with a more humid microclimate.

Table 3. Production potential of the stands of this typology based on the forest estimation indicators at 140 years of age - locality Mt. Veliki Jastrebac.

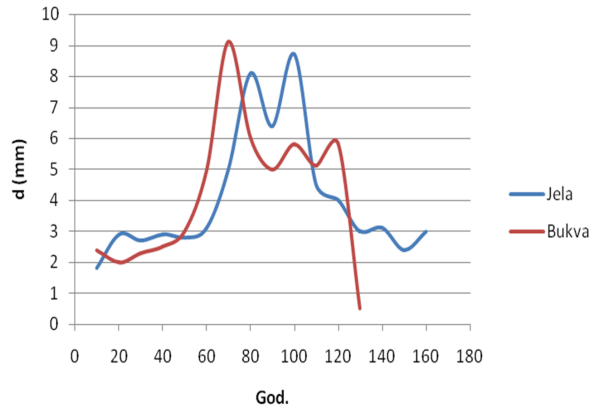
Tree species	T (yr)	N (trees)	g ($m^2 \cdot ha^{-1}$)	dg (cm)	dgmax (cm)	hg (m)	hgmax (m)	V ($m^3 \cdot ha^{-1}$)	Ivt ($m^3 \cdot ha^{-1}$)
beech	140	160	17.45	35.1	59.2	25,7	33.9	287..2	5.3
fir	140	100	22.10	52.1	69.3	30.8	35.5	342.8	3.6
total		260	39.55					630.0	8.9

The edaphic conditions are very favorable; the soils have a high ecological, productive potential - acid brown soil on granodiorite rocks, deep, with very favourable physico-chemical properties.

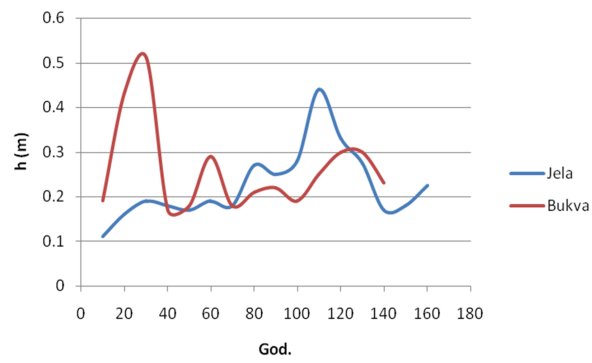
In addition to beech (*Fagus moesiaca*) and fir (*Abies alba*) as the dominant edifiers, there are also some individual noble broadleaves (+): maple (*Acer pseudoplatanus),* Norway maple (*Acer platanoides),* wych elm (*Ulmus montana*), and large-leaved lime *(Tilia grandifolia*). In the shrub layer, together with the plants of the principal species (fir is dominant both by abundance and by coverage), there are admixtures of other species: *Acer pseudoplatanus* (individually), *Acer platanoides* (individually), *Sambucus nigra,* and *Corylus avellana.* The species in the ground flora layer are: *Rubus hirtus, Asarum europaeum, Asperula odorata, Oxalis acetosella,* etc. In this layer, depending on the stand typology, the dominant plant is fir (2.3). Beech regeneration is in very short supply (+) (Table 2).

This forest type includes two ecologically different units - ecological units: typical forest of fir and beech *(Abieti-Fagetum moesiacae montanum typicum*) on deep acid brown soils on granodiorites; and fir and beech forest with a percentage of individual noble broadleaves (*Abieti-Fagetum moesiacae montanum aceretosum*) on deep acid brown soils on granodiorites.

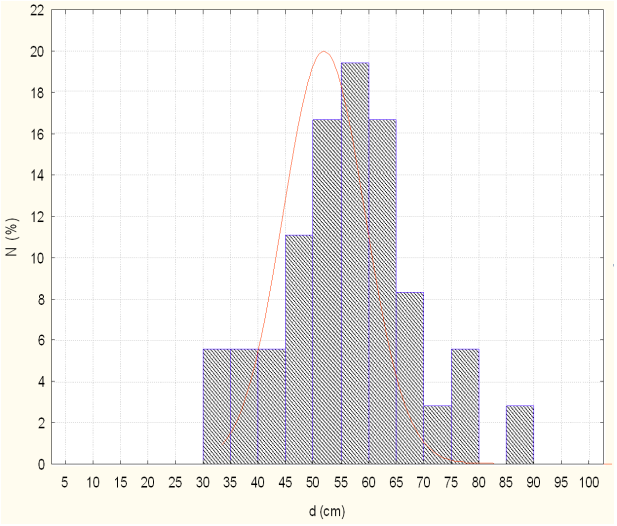
The stands of the above typology are distinguished by extremely high potential productivity (Table 3). In addition, it can be seen that the relationship of the edifiers as regards ecological and coenological optimum, is different. Fir in this forest type reaches significantly higher production effects. Fir trees are significantly larger, i.e., d_g and dg_{max} by 17 and 10 cm, respectively, and h_g and hg_{max} by 5 and 2 m, respectively. This indicates clearly that fir in this forest type is in its ecological optimum. Also, from the coenological aspect, fir is more stable and it is in its optimum (fir seedlings are more dominant both by abundance and by coverage (2.3-3.3) compared to beech (+)).



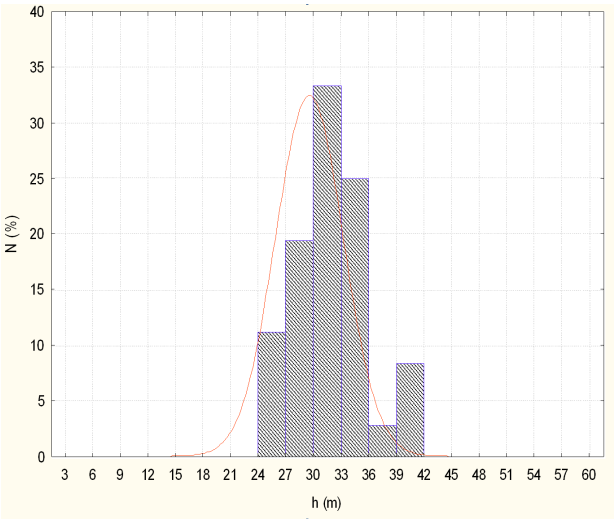
Graph 1. Current diameter increment



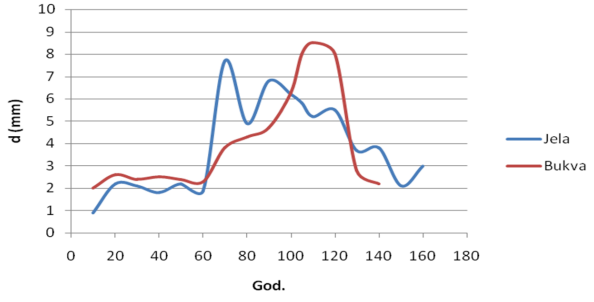
Graph 2. Current height increment



Graph 3. Diameter structure, forest type 1

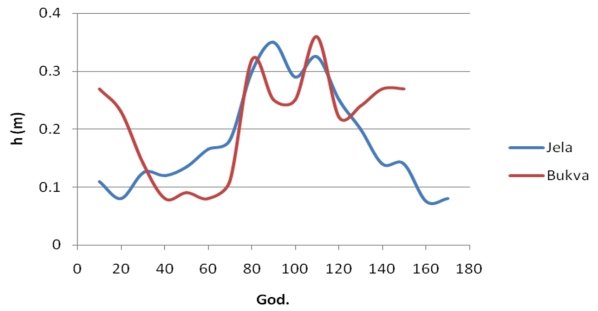


Graph 4. Height structure, forest type 1

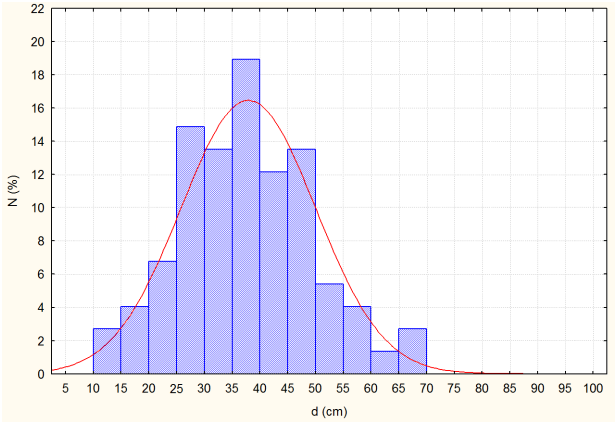


Graph 5. Current diameter increment

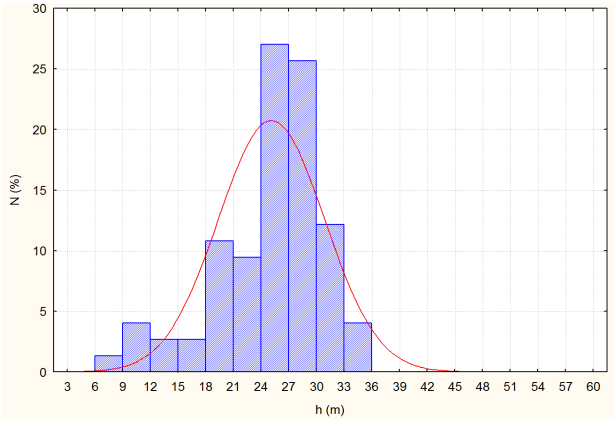
The dynamics of development of the main forest estimation indicators of both edifiers is very different. This is shown by the culmination times and by culmination values (Graphs 1 and 2). Namely, beech diameter increment culminates at the age of 70, and fir diameter increment culminates about the age of 100 years (Graph 1); the culmination of beech height increment occurs at the age of 30



Graph 6. Current height increment



Graph 7. Diameter structure, forest type 2



Graph 8. Height structure, forest type 2

Table 4. Statistical indicators of diameter structure.

Tree species	Mean diameter (ds)	Median	mod	Min. height	Max. height	Stand. deviation	Stand. Error	Coef. of skew.	Coef. of kurtos.	Coef. var.
	cm			cm				(α3)	(α4)	%
Beech	30.45	25.50	Multiple	10.50	81.00	17.64	2.17	1.00	0.40	57.94
Fir	51.64	54.50	Multiple	19.00	98.00	16.22	1.84	-0.10	-0.18	31.40

Table 5. Statistical indicators of height structure.

Tree species	Mean diameter (ds)	Median	mod	Min. height	Max. height	Stand. deviation	Stand. error	Coef. of skew.	Coef. of kurtos.	Coef. var.
	cm			cm				(α3)	(α4)	%
Beech	22.50	21.30	Multiple	10.40	35.20	8.61	1.06	0.08	-1.52	37.98
Fir	30.78	32.30	32.00	10.00	39.40	6.14	0.70	-1.66	3.35	20.03

years, and fir culminates much later, at the age of 110 (Graph 2).

By structural characteristics (Graphs 3 and 4, Tables 4 and 5), the stands of this forest type belong to even-aged stands, which is a very good indicator for silvicultural operations, e.g. the selection of the optimal stand form taking into account the structure (spontaneous development) and the stand age. This refers especially to height distribution, which is more stable and indicative in this sense

Forest type beech and fir with fescue grass (*Abieti-Fagetum moesiacae montanum drymetosum*) on medium deep (often skeletal) acid brown soils on granodiorites

At the study locality, the forests of this type cover significantly smaller areas compared to the previous type. The stand ecology differs significantly from that of forest type 1. Stand altitude is most often 650 - 920 m, with the bulk between 700 - 800 m, in more xerothermic conditions, and more unfavorable soil conditions (soils shallower with more rock fragments), mainly on warmer aspects and steeper slopes.

The edifiers are beech (*Fagus moesiaca)* and fir (*Abies alba)*, but beech is dominant in almost all stand situations. In this forest type, there are no noble broadleaves, and the floristic poverty in all layers is very intense. The shrub layer consists of the regeneration of the dominant trees, with a higher percentage of beech (beech 2.2, fir 1.1). Fescue grass (*Festuca drymeia*) is dominant in the ground flora layer, and more rarely and mainly sporadically *Asperula odorata, Galium rotundifolium* and *Rubus hirtus* (Table 6).

In addition to great differences in ecology (primarily in orographic, edaphic and microclimate conditions), compared to forest type 1 there are also differences in the attained level of production, i.e. production potential, as well as in the ecological and coenological optimum of the edifiers.

The stands of forest type 2, by all elements of productivity, are significantly behind the stands of forest type 1 (Table 7).

Forests of this type are characterized by significantly different dynamism than the forests of the previous type, which is reflected both by the culmination time and culmination values of production

Table 6. Phytocoenological table

Association	*ABIETI-FAGETUM MOESIACAE* Jovanović 1953.						Degree of presence
Subassociation	drymetosum						
Locality	Veliki Jastrebac						
Releve number	23/00	32/00	33/00	47/00	48/00	25/00	
Elevation (m)	690	790	780	830	810	670	
Exposure	E	ENE	ENE	E	ESE	NE	
Inclination (^{0})	20	25	20	25	25	15	
Bedrock	Grano-diorites	Grano-diorites	Grano-diorites	Grano-diorites	Grano-diorites	Grano-diorites	
Soil	medium deep (often skeletal) acid brown	medium deep (often skeletal) acid brown	medium deep (often skeletal) acid brown	medium deep (often skeletal) acid brown	medium deep (often skeletal) acid brown	medium deep (often skeletal) acid brown	
I layer							
Canopy 0.9		0.8	0.7	0.6	0.6	0.9	
Mean height (m)							
Mean diameter (cm)							
Mean distance (m)	3	5	3	6	6	4	
Fagus moesiaca	4.5	2.1	1.2	1.1	2.1	4.5	**V**
Abies alba	1.1	3.2	2.3	3.4	3.3	1.2	**V**
Acer platanoides			+				II
Populus tremula		1.2	1.2				**I**
Tilia argentea	+						I
II layer							
Canopy	0.4	0.1	0.1	0.5	0.4	0.1	
Mean Height (m)	2	1.5	2	2	1	2	
Abies alba	2.2	1.2		1.2	2.2		IV
Fagus moesiaca	1.2		+	2.2	1.2	1.2	IV
Sambucus nigra						+	III
Corylus avellana					+		II
Prunus avium						+	I

indicators (especially culmination times of both beech and fir). Namely, beech diameter increment culminates at the age of 110 years, and fir diameter increment culminates at the age of 70, with significantly lower culmination values (Graph 5). Current height increment of beech culminates between the ages of 80 and 90 (the first notable culmination) and at the age of 110. Fir culminates at the age of 90, with significantly lower culmination values (Graph 6).

By structural characteristics, the stands of this forest type belong to even-aged stands (Graphs 7 and 8, Tables 8 and 9).

Continuation of Table 6

Association	*ABIETI-FAGETUM MOESIACAE* Jovanović 1953.						Degree of presence
Subassociation	*drymetosum*						
Locality	Veliki Jastrebac						
Releve number	23/00	32/00	33/00	47/00	48/00	25/00	
III layer							
Canopy	0.8	0.1	0.4	0.5	0.5	0.7	
Rubus hirtus	+.2	+.2	2.2		+	2.3	V
Abies alba	3.3	+		+.2	+.2	2.3	**IV**
Asarum europaeum						+.2	**IV**
Cardamine bulbifera	+		+				**III**
Galeobdolon luteum		+		+	+.2	+	**III**
Asperula odorata	+.2	1.2	2.3			+	**III**
Dryopteris filix-mas		+	+				III
Oxalis acetosella				+			**II**
Corylus avellana				+	+		**II**
Acer platanoides				+		+	**II**
Hedera helix			1.2			+	II
Athyrium filix-femina		+					II
Festuca drymeia	3.3	+.2	+.2	2.3	3.3	3.2	II
Fagus moesiaca					+	+	I
Viola silvestris	+			4-			I
Galium rotundifolium				+.2	+.2		I
Hieracium murorum				+	+		I

Table 7. Production potential of the stands of this typology based on the forest estimation indicators at 140 years of age.

Tree species	t (yr)	n (trees)	g ($m^2 \cdot ha^{-1}$)	dg (cm)	dg_{max} (cm)	hg (m)	hg_{max} (m)	V ($m^3 \cdot ha^{-1}$)	I_{vt} ($m^3 \cdot ha^{-1}$)
Beech	140	238	18.19	31.0	54.0	22.41	29.6	197.1	5.08
Fir	140	201	19.89	36.7	53.2	25.97	30.0	272.3	3.22
Total		439	38.08					469.4	8.30

Table 8. Statistical indicators of diameter structure.

Tree species	Mean diameter (ds)	Median	mod	Min. height	Max. height	Stand. deviatio.	Stand. Error	Coef. of skew.	Coef. of kurtos.	Coef. var.
	cm			cm				(α3)	(α4)	%
Beech	28.73	25.50	14.00	10.00	65.50	15.46	1.77	0.84	-0.30	23.81
Fir	37.89	37.70	Multi-ple	13.00	67.50	12.12	1.40	0.11	-0.17	31.99

Table 9. Statistical indicators of height structure.

Tree species	Mean diameter (ds)	Median	mod	Min. height	Max. height	Stand. deviatio	Stand. Error	Coef. of skew.	Coef. of kurtos.	Coef. var.
	cm			cm				(α3)	(α4)	%
Beech	22.18	23.30	15.80	5.50		6.74	0.77	-0.12	-0.65	30.40
Fir	25.12	26.50	28.00	6.50	33.00	5.76	0.67	-0.10	1.12	22.96

DISCUSSION

The stands of forest type fir and beech (*Abieti-Fagetum moesiacae montanum typicum*) on deep acid brown soils on granodiorites are more heterogeneous from the ecological aspect, which is reflected in their coenological characteristics and spatial distribution. This forest type includes two ecological units, and the stands of this typology occupy larger areas compared to the stands of the other forest type. The production potential of this forest type is extremely high. By the comparison of the potential of these stands with the potential of the stands of the same typology on Goč, in the typical climate/regional belt of beech-fir forests, it can be concluded that it is identical (Jović et al., 1991).This research also confirmed that beech-fir forests of the above typology are the most productive forests in Serbia.

In this forest type, fir and beech are completely different as regards production effects and potentials of natural regeneration. Fir is the dominant edifier, which is confirmed by the stands of this forest type on Goč. Consequently, fir should be given the advantage in the optimal proportion mixture, in the aim of reaching the functional optimum that is related to the production of highly valuable timber assortments. The optimal mixture proportion, previously defined on the basis of typological classification of these forests on Goč, is 70:30 in favor of fir (Jović et al., 1991). This mixture proportion is fully applicable in this forest type on Mt. Veliki Jastrebac, taking into account the typologically defined edifiers in this forest type on the one hand, and the identical typological characteristics of these stands with the stands on Goč, on the other hand.

The stands of forest type beech and fir with fescue grass (*Abieti-Fagetum moesiacae montanum drymetosum*) on medium deep, sometimes skeletal, acid brown soils on granodiorites are distinguished by specific synergetic effects of a great number of factors.

These stands have a significantly lower production potential. Also, the status of edifiers from the aspect of ecological and coenological optimum is completely different from forest type 1, i.e. beech is a more dominant edifier in this type. To be able to utilize optimally the site productive potential, beech should be given the advantage in these stands in practical silvicultural and management operations, i.e. the percentage of beech in the mixture should be higher. In the practical forest management planning of the same forest type on Goč, the optimal proportion mixture accounted for 60:40 in favor of beech (Jović et al., 1991). Taking into account that the regional character was not expressed, it can be seen that they are identical. Consequently, in the stands of this forest type on Mt. Veliki Jastrebac, the proportion of beech and fir accounting for 60:40 in favor of beech is fully applicable.

The edifiers of this forest type differ significantly in their dynamism and development, and they differ from the forests of forest type 1. The culmination of beech diameter and height increment occurs significantly later. The culmination of fir diameter and height increment occurs significantly earlier than that in forest type 1. This dynamism and the development of diameter and height increment lead to a conclusion that the culmination of diameter and height increment of beech occurs significantly later

in the forest type of the lower production potential and in edaphic conditions with the lower ecological-productive potential. In the case of fir, it is the opposite, i.e. the culmination of the above elements occurs significantly earlier in the forest type of the lower production potential and on the soil of the lower ecological, productive potential. In the case of fir, this dynamic of development is in full correlation with the characteristics of the stands of the same typology on Goč (Banković, 1981). In the case of beech, this causality was observed also in the types of monodominant mountainous beech forests (Milošević 2009).

CONCLUSION

The result of the typological determination of fir-beech forests and beech-fir forests on Mt. Veliki Jastrebac is the rounding-up and completion of the typological classification system of these forests in Serbia, from the aspect of distribution, typology and identification of silvicultural and management modalities.

On Mt. Veliki Jastrebac, there are two types of beech-fir forests. These forest types have already been determined on Mt. Goč (Jović et al. 1991) in the typical climate/regional belt of beech-fir forests and on the largest site of these forests in Serbia. Consequently, it can be concluded that these two forest types are the most distributed types of beech-fir forests in Serbia.

The greatest portion of the forests on Mt. Veliki Jastrebac consists of fir-beech forests (*Abieti-Fagetum moesiacae montanum typicum*) on deep acid brown soils on granodiorites. The stands of this forest type are the most widely distributed in Serbia.

In these stands, fir is the principal tree species, i.e. it is significantly better adaptable to the microclimate characteristics of this area, which is expressed by the level of fir productivity and vitality. Fir reaches significantly higher production effects and it suppresses beech in natural regeneration.

The remaining part of these forests is defined as beech and fir with fescue grass (*Abieti-Fagetum moesiacae montanum drymetosum*) on medium deep, sometimes skeletal, acid brown soils on granodiorites. These beech-fir forests hold the second position as regards distribution rank in Serbia. In these beech-fir forests, beech is a more dominant edifier and it is within its ecological and coeno-ecological optimum.

The different typology of this forest type requires a different silvicultural and management approach and modality, i.e. it excludes the possibility of unification in the selection of silvicultural and management measures for the functional optimum.

From the aspect of forest management, this refers primarily to the optimal mixture proportion as the most important management characteristic for the achievement of the functional optimum in these forest types. In forest type 1, the optimal proportion mixture is 70:30 in favor of fir, and in forest type 2, the proportion is different and accounts for 60:40 in favor of beech.

Also, the different dynamics and status of the edifiers, both within the forest types and especially between the types, calls for a different approach in practical silvicultural operations, and a different approach in thinning intensity and time. Both forest types are even-aged stands, which must be considered in future management and silvicultural decisions (in the selection of the optimal stand and silvicultural forms, regeneration method, etc.); the character of the structure, i.e. spontaneous development in defined stand type and age must be taken into account.

REFERENCES

Banković, S., (1981): Proučavanja uticaja staništa i sastojinskih uslova na razvoj stabala jele na Goču i mogućnost njihovog korišćenja pri proizvodnom diferenciranju ekoloških jedinica. Doktorska disertacija, Beograd.

Banković, S., Medarević, M., Knežević, M., and *R. Milošević* (2003): Tipovi bukovih šuma Srbije. *Šumarstvo* **1-2**, 197-204, Beograd.

Cestar, D., and *V. Hren* 1971: O poziciji bukve u zajednici bukve i jele. U ediciji Bertović, S. i dr.: Kvalitativna i kvantitativna proizvodnja bukovih šuma u zapadnom dijelu Hrvatske, *Radovi* **18**, Zagreb

Hadživuković, S., (1991): "Statistički metodi sa primenom u poljoprivrednim i biološkim istraživanjima". Novi Sad.

Jović, D., Banković, S., and *M. Medarević* (1991): Proizvodne mogućnosti jele i bukve u najzastupljenijim tipovima šuma na planini Goč. Glasnik Šumarskog fakulteta **73**, *Šumarski fakultet Univerziteta u Beogradu*, 343 - 352, Beograd.

Jović, D., (1971): "Principi i metodika uređivanja šuma na tipološkoj osnovi". Beograd.

Jović, D., Banković, S., and *M. Medarević* (1985): Proučavanje strukturnih karakteristika bukovih šuma na Željinu. Godišnji izveštaj RZN Srbije, Beograd.

Jović, D., Banković, S., and *M. Medarević* (1991): Proučavanje razvoja proizvodnih karakteristika ekoloških jedinica bukovih šuma na Željinu i njihovo proizvodno diferenciranje. *Glasnik Šumarskog fakulteta*, **73**, *Šumarski fakultet Univerziteta u Beogradu*, Beograd.

Jović, D., Jovanović, B., Jović, N., Stefanović, V., Burlica, Č., Cestar, D., and *F. Gašperšič* (1976): "Primena tipologije u savremenom gazdovanju šumama u Jugoslaviji". Simpozijum o primeni tipologije, Šumarski fakultet, Beograd, i *Glasnik Šumarskog fakulteta (posebno izdanje)*, **53**, 5-23.

Jović, N., Tomić, Z., and *D. Jović* (1996): Tipologija šuma. Udžbenik, Šumarski fakultet Univerziteta u Beogradu, Beograd.

Medarević, M., and *R. Milošević* (2005): Tip šume, osnovna gazdinska kategorija, metodika diferenciranja. Monografija, "Tipovi šuma Nacionalnog parka Đerdap", 84-89, Beograd.

Milošević, R. (2009): Tipovi monodominantnih šuma planinske bukve na Velikom Jastrepcu, *Šumarstvo, Beograd* **3-4,** 81 – 90, Beograd

Milošević, R. (2006): Definisanje tipova bukovih i bukovo – jelovih šuma na Velikom Jastrepcu, doktorska disertacija, Beograd.