FORESTRY IDEAS, 2020, vol. 26, No 1 (59): 132–152

CLASSIFICATION OF THE FOREST VEGETATION OF ETROPOLSKA STARA PLANINA MT. IN BULGARIA

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Received: 10 October 2019 Accepted: 21 Aptil 2020

Abstract

A new classification approach of the forest vegetation in Etropolska Stara Planina Mt. is applied in the paper. The dominant and most widespread forest stands in the region have been investigated. They are represented mostly by *Fagus sylvatica*, *Carpinus betulus*, *Quercus petraea*, *Betula pendula*, *Alnus glutinosa,* etc. In total, 71 relevés collected according to the Braun-Blanquet's methodology have been analyzed. As a result, five associations and three forest communities without phytosociological rank were identified. They were classified into four alliances and two classes: *Carpino-Fagetea sylvaticae* with *Luzulo-Fagion sylvaticae*, *Fagion sylvaticae* and *Carpinion betuli*, and *Alno glutinosae-Populetea albae* represented by the alliance *Alnion incanae*. The vegetation of the studied area demonstrates high similarity with the mesophilous to mesohygrophilous deciduous forests typical to Southeastern and Central Europe.

Key words: *Alno glutinosae-Populetea albae*, *Carpino-Fagetea*, Central Balkan Range, forest stands, syntaxonomy.

Introduction

According to the geobotanical zoning of Bulgaria (Bondev 2002), the main forest stands in Etropolska Stara Planina are dominated by *Fagus sylvatica*, *Fagus moesiaca* (considered as morphotype within *F. sylvatica*, Tutin and Akeroyd 1993, Denk 1999, etc.), *Quercus petraea* (treated as *Quercus dalechampii* in the Bulgarian phytoceonological sources), *Carpinus betulus*, and more limited of *Betula pendula*.

The forest vegetation of the region has not been sufficiently well investigated so far. Only few papers (Dodev 2016, Lyubenova and Dimova 2000, Iliev 1988) were found. Their purpose is not in the field of forest syntaxonomy or classification. Therefore, they affect the current research rather indirectly. Comparatively detailed information about the main forest phytocoenoses spread in the region is presented by Bondev (1991) in the vegetation map (1:600 000) of Bulgaria, but they were classified according to the Dominant approach (Velchev et al. 1969) The studied area was also object of some broader researches of vegetation types in Bulgaria. An ecological-phytocoenological characterization of beech forests in the upper forest belt of the Central Balkan Range has been done by Marinov et al. (1987). This study includes information

about their status, species composition, ecological peculiarities and distribution. Focused on the beech forests is also the work of Marinov et al. (1961) in the field of forest ecology and forestry practices. Species composition and distribution of the oak forests in the country have been published by Radkov and Minkov (1963). The work of Bondev et al. (2000) contains data about the vegetation and soil diversity of the Balkan Range. There are also some palynological and paleobotanical studies (Filipovich et al. 1997, 1998, Atanassova 2007) containing valuable information about the origin and historical background of the forest vegetation in Stara Planina Mt.

Research according to the Braun-Blanquet's methodology is almost missing in the region. Only the beech forests occupying considerable areas in the Balkan Range, respectively the studied region, were object of special research interest (Tzonev et al. 2006, Tzonev 2011). A specific type of forest vegetation distributed in Etropolska Stara Planina is the birch forests. Their syntaxonomy has not been studied in Bulgaria, excluding only one research, which deals with the birch forests distributed in some areas along the timberline in the Central Balkan Range (Nikolov and Dimitrov 2015). These forests are better investigated in some other European countries (Theodoropoulos et al. 2003, Exner and Willner 2004, Šilc et al. 2008). The region has a well-developed river network, which also favours development of alluvial forests dominated by *Alnus glutinosa* and some *Salix* spp., as well. Syntaxonomically, they are not yet investigated in the region and either on a national level. Only the floodplain (longoz) vegetation, which includes similar phytocoenoses, has been studied according to the Braun-Blanquet's methodology in Bulgaria until now (Soó 1957, Pavlov and Dimitrov 2002).These forests and their syntaxonomy have been studied in other European countries and on European level (Douda 2008, Sburlino et al. 2011, Douda et al. 2015).

The main aim of the current research is a syntaxonomic investigation of forest vegetation in Etropolska Stara Planina according to the phytosociological methodology of Braun-Blanquet (1964).

Material and Methods

Study area

The current study area is located in Western Bulgaria. It falls within the boundaries of the Central Balkan Range from the Arabakonak Pass to the western border of the Central Balkan National Park. It encompasses an area of 476 km^2 including the whole Etropolska Stara Planina and the most western part of Zlatishko-Tetevenska Stara Planina (Fig. 1). The region is typically mountainous with a narrow and monolithic main ridge, which is characteristic to the central parts of the Balkan Range. It has a distinct asymmetric profile with short and steep southern slopes and comparatively longer northern slopes, also with steeper parts and rocky rims (Penchev et al. 1989). The main geological units are Paleozoic crystalline metamorphic and magmatic rocks and also Mesozoic and Neozoic sediment rocks. The majority of bedrock types are acidic and with siliceous content (Aleksiev 2002). The highest peaks are Svishti Plaz (1888 m a.s.l.), Mara Gidiya (1790 m a.s.l.) and Etropolska Baba (1787 m a.s.l.). The soil cover is formed mainly by *Dystric* and *Eutric Cambisols* and *Gray Luvisols* (Ninov 2002). The river network is formed by

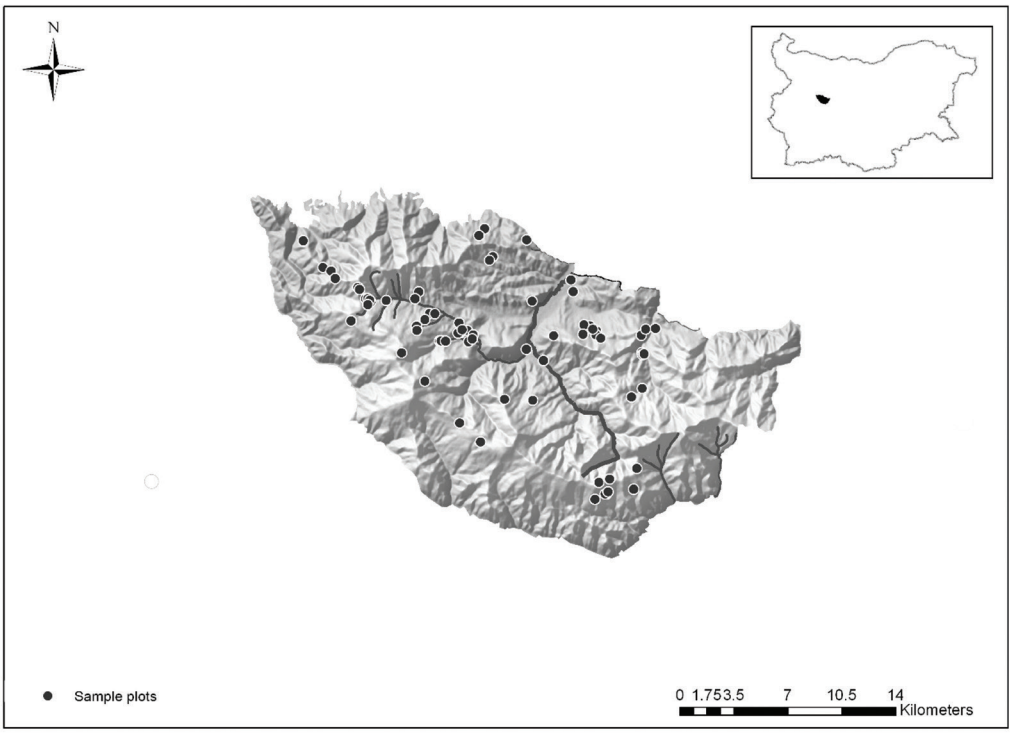

Fig. 1. Study area map with the locations of sample plots (relevés).

the Malak Iskar River and its tributaries, which cross the whole territory and form so-called Etropole Valley Extension (Stefanov 2002). The climate falls mainly in two climatic regions - the temperate-continental (in lower parts) and the mountainous (in higher parts) (Velev 2002). According to the closest climatic station situated on Murgash Peak (1687 m), the average annual temperature is 3.4 °C with highest average temperatures in August (12.4 °C) and lowest in January (-6.1 °C) (Kyuchukova et al. 1983). The average annual sum of rainfall is 882 mm (max. 130 mm in June and min. 44 mm in February). The highest snow cover is registered in January-March (Koleva and Peneva 1990). Despite the comparatively small area, there is great diversity of forest phytocoenoses in the region (see Bondev 1991). Forest vegetation occupies most of area with significant dominance of *Fagus sylvatica*. The value of the region is emphasized by many protected areas established especially to preserve some old growth forests, as well as landscapes of scenic beauty, waterfalls and rich biodiversity. Such areas are 'Batchishte', 'Belikata', 'Pantata', 'Manastir Sv. Troitsa' and the natural landmarks 'Grohotaka', 'Elaka', 'Varovitec', 'Kozi dol', 'Rudinata'. Especially 'Belikata' is a unique area to Bulgaria because it has been designated (Order № 754/13.08.1981) to protect rare for the country natural forests of *Betula pendula*. Small parts of the mountain are also included in Natura 2000 sites: BG0001043 Etropole-Bailovo (SCI) 'BG0001493 Tsentralen Balkan Buffer' (SCI) and 'BG0002128 Tsentralen Balkan Buffer' (SPA).

Methods

Vegetation sampling was done in 2017–2018 according to the Braun-Blanquet's methodology (Braun-Blanquet 1964, Mueller-Dombois and Ellenberg 1974). In total, 71 relevés were collected. Their plot sizes vary between 80 and 400 m^2. Minimal distance between plots was 200 m. Cover-abundance values were estimated according to the 9-degree scale and its transformation (Westhoff and van der Maarel 1978, van der Maarel 1979). The cluster analysis was performed using the SYN-TAX computer software (Podani 2001). The average-linkage method UPGMA was used as sorting strategy. The floristic similarity between relevés in the dissimilarity matrix was calculated by using the Horn's index (Horn 1966). Diagnostic species of each cluster were determined using JUICE 7.0 (Tichý 2002). The fidelity of each species to each cluster was calculated using the phi coefficient of association based on presence/absence (Sokal and Rohlf 1995, Chytrý et al. 2002). The size of target groups was fixed to 10 % of the total data set (Tichý and Chytrý 2006). The threshold phi (fidelity) value for the diagnostic species was set to 0.30 (multiplied by 100 in JUICE 7.0 software) and Fisher's exact test was calculated to give a zero value to those species whose fidelity was not statistically significant (p<0.01). Cover values of the woody species from different layers prior to analysis were merged.

Each group was described on the basis of its diagnostic, constant and dominant species. One of the relevés presented in the cluster dendrogram was not taken into account in the following analysis because of its complexity (Group 5, relevé No 6).The similarity between the two relevés included in group 5 was less than 35 %, which is due only to the presence of the beech. Because group 5 is represented by only one relevé, the referred diagnostic species are based on literature data (Tzonev et al. 2006). Species with low frequency percentage (equal or less than 14) without any diagnostic or characteristic value were removed from the synoptic table (Table 1). Species were considered as constant if their frequency exceeded 50 % for the group. Dominant species were defined as those reaching coverage higher than 50 %. The diagnostic species of each group are presented with their fidelity measures in brackets. The constant and dominant species are indicated by their percentage frequencies (constancy). The syntaxonomic nomenclature follows the checklist of Mucina et al. (2016). The names of the plant taxa are given according to Delipavlov and Cheshmedjiev (2003).

Results and Discussion

The dendrogram of the cluster analysis was used to distinguish eight groups of relevés (Fig. 2), which are presented in the synoptic table (Table 1). They were identified as five associations and three further plant communities without syntaxonomic rank and belong to four alliances and orders and two classes.

Based on the analysis, the following syntaxonomic synopsis was proposed for the forest vegetation in Etropolska Stara Planina:

Class *Carpino-Fagetea sylvaticae* Jakucs ex Passarge 1968

Order *Luzulo-Fagetalia sylvaticae* Scamoni et Passarge 1959

Alliance *Luzulo-Fagion sylvaticae* Lohmeyer et Tx. in Tx. 1954

1. Association *Luzulo luzuloid-*

Table 1. Synoptic table with percentage frequency (constancy values in percentages) and standardized fidelity index (Φ - phi coefficient values presented in superscript) of forest communities in Etropolska Stara Planina.

Alliances	**A**				**B**						**C**		**D**	
Group No	1		2		3		4		5		6		7		8	
No of releves	31		9		7		9		1		3		3		7	
Constancy (%), fidelity (*Φ*)	%	*Φ*	%	*Φ*	%	*Φ*	%	*Φ*	%	*Φ*	%	*Φ*	%	*Φ*	%	*Φ*
Association *Luzulo luzuloidis-Fagetum sylvaticae*																
Luzula luzuluides (Lam.) Dandy & Wilmott	94	50	.	---	57	---	33	---	.	---	.	---	33	---	.	---
Association *Galio odorati-Fagetum sylvaticae*																
Galium odoratum (L.) Scop.	45	---	100	39	43	---	33	---	50	---	.	---	33	---	.	---
Community of *Carpinus betulus* and *Fagus sylvatica*																
Carpinus betulus L.	23	---	56	---	100	43	22	---	.	---	100	---	100	---	.	---
Campanula sparsa Friv.	10	---	11	---	57	38	22	---	.	---	.	---	.	---	14	---
Association *Fago sylvaticae-Betuletum pendulae*																
Betula pendula Roth	.	---	.	---	14	---	78	79	.	---	.	---	.	---	.	---
Pteridium aquilinum (L.) Kuhn	.	---	.	---	.	---	33	56	.	---	.	---	.	---	.	---
Association *Umbilico erecti-Fagetum sylvatica* subass. *typicum*																
Phyllitis scolopendrium (L.) Newman	.	---	.	---	.	---	.	---	100	---	.	---	.	---	.	---
Lunaria rediviva L.	.	---	.	---	.	---	.	---	100	---	.	---	.	---	.	---
Association *Aremonio agrimonoidis-Fagetum sylvatica* subass. *allietosum ursini*																
Allium ursinum L.	.	---	.	---	.	---	.	---	.	---	67	80	.	---	.	---
Mixed communities of *Carpinus betulus*																
Quercus cerris L.	3	---	.	---	14	---	11	---	.	---	.	---	100	78	.	---
Community of *Alnus glutinosa*																
Rubus caesius L.	.	---	.	---	.	---	.	---	.	---	.	---	.	---	100	100
Alnus glutinosa (L.) Gaertner	.	---	.	---	.	---	.	---	.	---	.	---	.	---	86	92
Corylus avellana L.	3	---	11	---	.	---	.	---	100	---	.	---	33	---	86	68
Salix fragilis L.	.	---	.	---	.	---	.	---	.	---	.	---	.	---	57	74
Sambucus ebulus L.	.	---	.	---	.	---	.	---	.	---	.	---	.	---	43	64

Diagnostic for more than one group								
Helleborus odorus Waldst. & Kit.	6 ---	67 37	. ---	22 ---	. ---	100 55	67 ---	14 ---
Alliance *Luzulo-Fagion sylvaticae* (A)								
Prenanthes purpurea L.	16 ---	. ---	. ---	11 ---	. ---	. ---	. ---	. ---
Oxalis acetosella L.	13 ---	. ---	14 ---	11 ---	100 ---	. ---	. ---	. ---
Geranium macrorrhizum L.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Vaccinium myrtillus L.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Picea abies (L.) Karst.	6 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Abies alba Mill.	6 ---	. ---	. ---	. ---	. ---	. ---	33 ---	. ---
Alliance *Fagion sylvaticae* (B)								
Geranium robertianum L.	23 ---	33 ---	29 ---	56 ---	100 ---	. ---	. ---	. ---
Carex sylvatica Huds.	13 ---	22 ---	43 ---	22 ---	. ---	. ---	. ---	. ---
Athyrium filix-femina (L.) Roth	3 ---	11 ---	29 ---	. ---	. ---	. ---	. ---	. ---
Veronica montana L.	. ---	. ---	14 ---	. ---	. ---	. ---	. ---	. ---
Dentaria bulbifera L.	. ---	. ---	14 ---	. ---	. ---	. ---	. ---	. ---
Alliance *Carpinion betuli*(C)								
Lathyrus vernus (L.) Bernh.	. ---	11 ---	. ---	11 ---	. ---	33 ---	33 ---	14 ---
Pulmonaria officinalis L.	. ---	33 ---	. ---	11 ---	. ---	33 ---	33 ---	14 ---
Quercus petraea subsp. *petraea* (Matt.) Liebl.	. ---	22 ---	29 ---	. ---	. ---	. ---	33 ---	. ---
Class *Carpino-Fagetea sylvaticae*								
Fagus sylvatica L.	100 17	100 ---	100 ---	100 ---	100 ---	100 ---	33 ---	. ---
Viola reichenbachiana Jord. ex Boreau	52 ---	67 ---	43 ---	89 ---	100 ---	100 ---	33 ---	. ---
Mycelis muralis (L.) Dumort.	55 ---	78 ---	57 ---	33 ---	100 ---	33 ---	100 ---	. ---
Euphorbia amygdaloides L.	23 ---	56 ---	14 ---	78 32	. ---	33 ---	100 ---	. ---
Glechoma hirsuta Waldst. & Kit.	26 ---	44 ---	14 ---	33 ---	100 ---	33 ---	. ---	. ---
Potentilla micrantha Ramond ex DC.	16 ---	44 ---	14 ---	44 ---	. ---	33 ---	. ---	. ---
Rubus hirtus Waldst. & Kit	68 ---	56 ---	86 ---	78 ---	. ---	. ---	67 ---	14 ---
Melica uniflora Retz.	6 ---	56 ---	. ---	67 39	. ---	33 ---	33 ---	. ---
Hepatica nobilis Mill.	6 ---	11 ---	. ---	22 ---	. ---	67 ---	33 ---	. ---

Festuca drymeja Mert & Koch.	26 ---	. ---	. ---	56 ---	---	. ---	67 ---	. ---
Ulmus glabra Hudson	3 ---	44 42	. ---	11 ---	. ---	. ---	33 ---	. ---
Poa nemoralis L.	48 ---	33 ---	43 ---	56 ---	. ---	. ---	. ---	. ---
Sanicula europaea L.	10 ---	33 ---	14 ---	11 ---	. ---	. ---	. ---	. ---
Mercurialis perennis L.	13 ---	33 ---	. ---	22 ---	. ---	33 ---	. ---	. ---
Dryopteris filix-mas (L.) Schott	52 23	67 ---	29 ---	. ---	. ---	. ---	. ---	. ---
Aremonia agrimonoides (L.) DC.	16 ---	11 ---	. ---	56 39	. ---	. ---	. ---	. ---
Cruciata glabra (L.) Ehrend.	29 ---	11 ---	. ---	44 ---	. ---	. ---	. ---	. ---
Hordelymus europaeus (L.) C. O. Harz	3 ---	11 ---	. ---	. ---	. ---	33 ---	. ---	. ---
Stachys sylvatica L.	10 ---	22 ---	. ---	11 ---	. ---	. ---	. ---	. ---
Ajuga reptans L.	6 ---	. ---	43 ---	22 ---	. ---	. ---	. ---	. ---
Aegopodium podagraria L.	3 ---	22 ---	. ---	. ---	100 ---	. ---	. ---	. ---
Hedera helix L.	10 ---	. ---	. ---	. ---	. ---	33 ---	. ---	. ---
Anemone nemorosa L.	3 ---	. ---	. ---	. ---	. ---	33 ---	. ---	. ---
Hieracium gentile Jordan ex Boreau	3 ---	. ---	29 ---	. ---	. ---	. ---	. ---	. ---
Sorbus aucuparia L.	13 ---	. ---	. ---	11 ---	. ---	. ---	. ---	. ---
Festuca gigantea (L.)Vill.	3 ---	11 ---	. ---	. ---	. ---	. ---	. ---	. ---
Tilia cordata Miller	. ---	. ---	. ---	. ---	. ---	. ---	33 ---	. ---
Asarum europaeum L.	. ---	. ---	14 ---	. ---	. ---	. ---	. ---	. ---
Sambucus nigra L.	. ---	11 ---	. ---	. ---	. ---	. ---	. ---	. ---
Milium effusum L.	10 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Senecio nemorensis L.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Paris quadrifolia L.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Alliance *Alnion incanae* and Class *Alno glutinosae-Populetea albae*								
Geum urbanum L.	10 ---	11 ---	. ---	11 ---	. ---	33 ---	67 ---	57 ---
Brachypodium sylvaticum (Hudson) Beauv.	. ---	. ---	. ---	11 ---	. ---	33 ---	. ---	43 46
Fraxinus excelsior L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	29 51
Circea lutetiana L.	13 ---	. ---	14 ---	. ---	100 ---	. ---	. ---	29 ---
Carex remota L.	3 ---	. ---	14 ---	11 ---	. ---	. ---	. ---	29 ---

Urtica dioica L.	. ---	. ---	14 ---	. ---	. ---	. ---	. ---	29 ---
Impatiens noli-tangere L.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	14 ---
Myosoton aquaticum (L.) Moench	. ---	. ---	. ---	. ---	. ---	. ---	. ---	14 ---
Rumex sanguineus L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	14 ---
Chrysosplenium alternifolium L	. ---	. ---	. ---	. ---	. ---	. ---	. ---	14 ---
Other species								
Crataegus monogyna Jacq.	13 ---	44 ---	14 ---	22 ---	. ---	. ---	67 ---	86 43
Rosa canina L.	13 ---	33 ---	. ---	11 ---	. ---	. ---	100 56	57 ---
Acer campestre L	. ---	22 ---	14 ---	22 ---	. ---	. ---	33 ---	43 ---
Brachythecium velutine (Hedw.) Schimp	52 41	22 ---	. ---	33 56	100 ---	. ---	. ---	. ---
Physospermum cornubiense (L.) DC.	. ---	11 ---	14 ---	11 ---	. ---	. ---	33 ---	. ---
Calamintha grandiflora (L.) Moench	16 ---	22 ---	14 ---	11 ---	. ---	33 ---	. ---	. ---
Deschampsia flexuosa (L.) Trin.	16 ---	22 ---	14 ---	. ---	. ---	. ---	. ---	. ---
Prunella vulgaris L.	6 ---	. ---	29 ---	. ---	. ---	. ---	33 ---	14 ---
Lysimachia punctata L.	. ---	. ---	14 ---	11 ---	. ---	. ---	67 66	. ---
Dactylis glomerata L.	. ---	11 ---	. ---	. ---	. ---	. ---	33 ---	71 68
Lysimachia nummularia L.	3 ---	. ---	29 ---	. ---	. ---	. ---	. ---	57 53
Juglans regia L.	3 ---	22 ---	. ---	. ---	. ---	. ---	. ---	29 ---
Torilis japonica (Houtt.) DC.	. ---	11 ---	. ---	. ---	. ---	33 ---	. ---	29 ---
Brachypodium pinnatum (L.) Beauv.	6 ---	. ---	29 ---	. ---	. ---	. ---	. ---	43 ---
Galium rotundifolium L.	13 ---	. ---	. ---	22 ---	. ---	. ---	. ---	29 ---
Viola hirta L.	. ---	. ---	. ---	22 ---	. ---	. ---	67 66	. ---
Fraxinus ornus L.	3 ---	. ---	. ---	. ---	100 93	. ---	. ---	. ---
Galium aparine L.	13 ---	. ---	. ---	. ---	. ---	. ---	. ---	43 ---
Lapsana communis L	. ---	. ---	14 ---	. ---	. ---	. ---	. ---	14 ---
Fragaria vesca L.	. ---	. ---	. ---	. ---	. ---	. ---	33 ---	14 ---
Galeopsis speciosa Miller	. ---	. ---	. ---	11 ---	. ---	. ---	. ---	43 54
Galeopsis tetrahit L.	23 ---	11 ---	. ---	. ---	. ---	. ---	. ---	. ---
Acer pseudoplatanus L.	13 ---	33 ---	. ---	. ---	. ---	. ---	. ---	. ---

Tanacetum parthenium (L.) Schultz Bip.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	14 ---
Moehringia trinervia (L.) Clairv.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	29 ---
Populus tremula L.	3 ---	. ---	14 ---	. ---	. ---	. ---	. ---	. ---
Platanthera bifolia (L.) Rich.	3 ---	. ---	. ---	22 ---	. ---	. ---	. ---	. ---
Hieracium racemosum Waldst. & Kit. ex Wi	6 ---	. ---	. ---	22 ---	. ---	. ---	. ---	. ---
Asplenium trichomanes L.	3 ---	. ---	. ---	. ---	100 ---	. ---	. ---	. ---
Tamus communis L.	6 ---	. ---	. ---	. ---	100 ---	. ---	. ---	. ---
Hypericum hirsutum L.	3 ---	. ---	. ---	. ---	. ---	33 ---	. ---	. ---
Peucedanum alsaticum L	3 ---	11 ---	. ---	. ---	. ---	. ---	. ---	. ---
Viola odorata L.	3 ---	11 ---	. ---	. ---	. ---	. ---	. ---	. ---
Ranunculus polyanthemos L.	3 ---	. ---	. ---	11 ---	. ---	. ---	. ---	. ---
Tilia tomentosa Moench.	3 ---	11 ---	. ---	. ---	. ---	. ---	. ---	. ---
Cornus mas L.	3 ---	11 ---	. ---	. ---	. ---	. ---	. ---	. ---
Polystichum setiferum (Forskal) Woynar	6 ---	. ---	. ---	11 ---	. ---	. ---	. ---	. ---
Polypodium vulgare L.	6 ---	. ---	. ---	11 ---	. ---	. ---	. ---	. ---
Acer platanoides L.	10 ---	. ---	. ---	11 ---	. ---	. ---	. ---	. ---
Stellaria nemorum L.	13 ---	. ---	. ---	11 ---	. ---	. ---	. ---	. ---
Pinus sylvestris L.	. ---	. ---	14 ---	11 ---	. ---	. ---	. ---	. ---
Veronica officinalis L.	13 ---	. ---	14 ---	. ---	. ---	. ---	. ---	. ---
Epipactis helleborine (L.) Crantz	. ---	11 ---	. ---	. ---	. ---	. ---	33 ---	. ---
Galium pseudoaristatum Schur	. ---	. ---	. ---	11 ---	. ---	. ---	33 ---	. ---
Cephalanthera rubra L. C. M. Richard	. ---	. ---	14 ---	. ---	. ---	33 ---	. ---	. ---
Epilobium angustifolium L.	10 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Tanacetum corymbosum (L.) Schultz bip.	6 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Epilobium parviflorum L.	6 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Primula veris L.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Tussilago farfara L.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---

Scrophularia nodosa L.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Carex ovalis Good.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Gnaphalium sylvaticum L.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Hypericum perforatum L.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Genista tinctoria L.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Crocus veluchensis Herbert	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Barbarea vulgaris R. Br.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Monotropa hypopitis L.	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Dactylorhiza cordigera (Fries) Soo	3 ---	. ---	. ---	. ---	. ---	. ---	. ---	. ---
Campanula rapunculoides L.	. ---	11 ---	. ---	. ---	. ---	. ---	. ---	. ---
Pinus nigra Arnold	. ---	11 ---	. ---	. ---	. ---	. ---	. ---	. ---
Castanea sativa Miller	. ---	11 ---	. ---	. ---	. ---	. ---	. ---	. ---
Campanula rapunculus L.	. ---	11 ---	. ---	. ---	. ---	. ---	. ---	. ---
*Alliaria petolat*a (Bieb.) Cavara & Grand	. ---	11 ---	. ---	. ---	. ---	. ---	. ---	. ---
Juncus sp.	. ---	. ---	14 ---	. ---	. ---	. ---	. ---	. ---
Isopyrum thalictrolides L.	. ---	. ---	14 ---	. ---	. ---	. ---	. ---	. ---
Peltigera sp.	. ---	. ---	. ---	22 ---	. ---	. ---	. ---	. ---
Cirsium vulgare (Savi)Ten.	. ---	. ---	. ---	11 ---	. ---	. ---	. ---	. ---
Hieracium umbellatum L.	. ---	. ---	. ---	11 ---	. ---	. ---	. ---	. ---
Carex pilosa Scop.	. ---	. ---	. ---	11 ---	. ---	. ---	. ---	. ---
Ruscus hypoglossum L.	. ---	. ---	. ---	11 ---	. ---	. ---	. ---	. ---
Polytrichum juniperinum Hedw	. ---	. ---	. ---	11 ---	. ---	. ---	. ---	. ---
Veronica chamaedrys L.	. ---	. ---	. ---	11 ---	. ---	. ---	. ---	. ---
Chamaecytisus hirsutus (L.) Link	. ---	. ---	. ---	11 ---	. ---	. ---	. ---	. ---
Cystopteris fragilis (L.) Bernh	. ---	. ---	. ---	. ---	100 ---	. ---	. ---	. ---
Arabis turrita L.	. ---	. ---	. ---	. ---	. ---	33 ---	. ---	. ---
Lathraea squamaria L.	. ---	. ---	. ---	. ---	. ---	33 ---	. ---	. ---
Campanula latifolia L.	. ---	. ---	. ---	. ---	. ---	. ---	33 ---	. ---
Carpinus orientalis Miller	. ---	. ---	. ---	. ---	. ---	. ---	33 ---	. ---
Clinopodium vulgare L.	. ---	. ---	. ---	. ---	. ---	. ---	33 ---	. ---

Silene viridiflora L.	. ---	. ---	. ---	. ---	. ---	33 ---	. ---	. ---
Agrimonia eupatoria L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	71 83
Erigeron annuus (L.) Pers.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	57 74
Plantago lanceolata L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	57 74
Potentilla reptans L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	57 74
Dipsacus fullonum L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	57 74
Ostrya carpinifolia Scop.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	43 64
Vicia sp.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	43 64
Clematis vitalba L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	43 64
Cornus sanguinea L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	43 64
Agrostis canina L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	43 64
Anthriscus sylvestris (L.) Hoffm.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	43 64
Salix alba L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	43 64
Mentha spicata L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	43 64
Heracleum sibiricum L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	43 64
Verbena officinalis L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	43 64
Geranium pratense L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	29 51
Cichorium inthybus L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	29 51
Prunus cerasifera Ehrh.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	29 51
Stellaria media (L.) Vill	. ---	. ---	. ---	. ---	. ---	. ---	. ---	29 51
Trifolium resupinatum L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	29 51
Euonymus europaeus L.	. ---	. ---	. ---	. ---	. ---	. ---	. ---	29 51

Note:

A: All. *Luzulo-Fagion sylvaticae*, B: All. *Fagion sylvaticae*, C: *Carpinion betuli*,D: *Alnion incanae.*

1: Ass. *Luzulo luzoloidis-Fagetum sylvaticae*, 2: Ass. *Galio odorati-Fagetum sylvaticae*, 3: Comm. of *Carpinus betulus* and *Fagus sylvaticae,* 4:Ass. *Fago sylvaticae-Batuletum pendulae,* 5:Ass. *Umbilico erecti-Fagetum sylvaticae* subass *typicum,* 6: Ass. *Aremonio agrimonoidis-Fagetum sylvaticae subass. allietosum ursini,* 7: Mixed communities of *Carpinus betulus,* 8: Comm. of *Alnus glutinosa.*

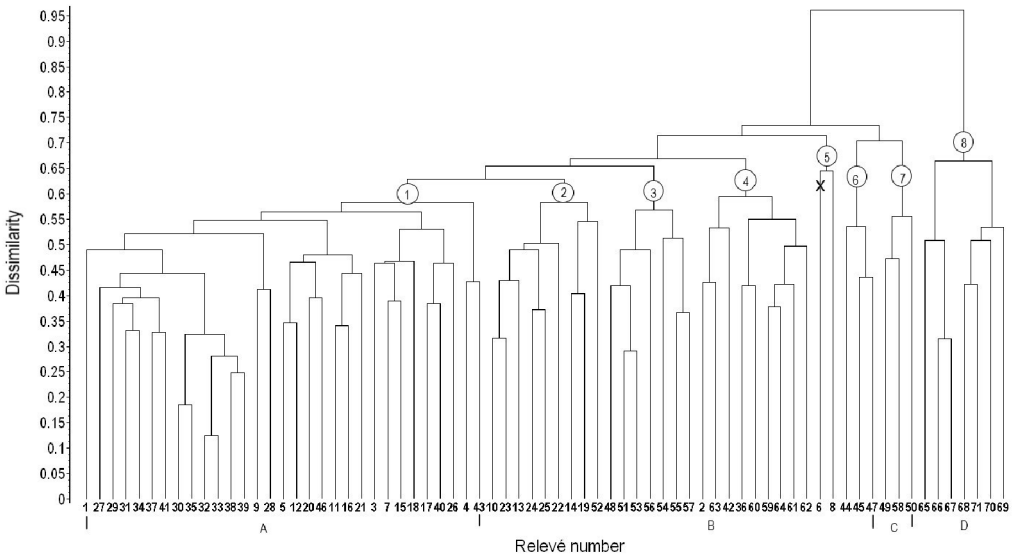

Fig. 2. Cluster dendrogram of the analysis of forest stands in Etropolska Stara Planina.
Note: A – *Luzulo - Fagion sylvaticae*, B – *Fagion sylvaticae*, C – *Carpinion betuli*, D – *Alnion incanae*; X – indicates a relevé number which is not taken into account in the following analysis.

is-Fagetum sylvaticae Meusel 1937

Order *Fagetalia sylvaticae* Pawłowski 1928

Alliance *Fagion sylvaticae* Luquet 1926

2. Association *Galio odorati-Fagetum sylvaticae* Sougnez et Thill 1959

3. Association *Fago sylvaticae-Betuletum pendulae* Theodoropoulos et al. 2003

4. Community of *Carpinus betulus* and *Fagus sylvatica*

5. Association *Umbilico erecti-Fagetum sylvaticae* Tzonev et al. 2006 subass. *typicum*

6. Association *Aremonio agrimonoidis-Fagetum sylvaticae* Boscaiu in Resmerita˘ 1972 subass. *allietosum ursini* Tzonev et al. 2006

Order *Carpinetalia betuli* P. Fukarek 1968

Alliance *Carpinion betuli* Issler 1931

7. Mixed communities of *Carpinus betulus*

Class *Alno glutinosae-Populetea albae* P. Fukarek et Fabijanić 1968

Order *Alno-Fraxinetalia excelsiori*s Passarge 1968

Alliance *Alnion incanae* Pawłowski et al. 1928

8. Community of *Alnus glutinosa*

Group 1: Association *Luzulo luzuloidis-Fagetum sylvaticae*

Number of relevés: 31.

Diagnostic species: *Luzula luzuloides* (50).

Constant species: *Fagus sylvatica* (100), *Luzula luzuloides* (94), *Rubus hirtus* (68), *Mycelis muralis* (55), *Dryopteris filix-mas* (52), *Viola reichenbachiana* (52), *Poa nemoralis* (48).

Dominant species: *Fagus sylvatica* (100), *Luzula luzuloides* (94), *Festuca drymeja* (26).

These forest stands occur mostly in the high-altitudinal beech forest belt at 720–1550 m a.s.l. They are distributed mainly on steep slopes up to 40° with dif-

ferent exposition, but often east or with eastern component. The soil is mainly relatively poor and acidic, often eroded (*Dystric Cambisols*). The bedrock is predominantly silicate. Structurally, these phytocoenoses are organized in three layers. In some places the cover of the herb layer reaches 100 % while the shrub layer is often of low cover or missing. The tree layer is usually comprised only of *Fagus sylvatica.*

This is the most widespread association of acidophilous beech forests in the whole country. It was found in Stara Planina, Sredna Gora Mts., Ossogovska Mts., Western Rhodopi Mts., Vrachanska Planina, Vassilyovska Mts., Belassitsa Mts. (Tzonev et al. 2006). It was also described in some local studies from the Central Balkan Range (Pavlov et al. 2006, Pachedjieva 2012), as well as Western Bulgaria (Dimitrov and Petrova 2014). Divchovoto village and Boatin Reserve are the closest localities where this association was recorded (Tzonev et. al 2006). The poor species richness of these forests stands and the ecology put them very close to the Central European acidophilous beech forests (Leuschner and Ellenberg 2017).

Group 2: Association *Galio odorati-Fagetum sylvaticae*

Number of relevés: 9.

Diagnostic species: *Galium odoratum* (39), *Helleborus odorus* (37).

Constant species: *Galium odoratum* (100), *Fagus sylvatica* (100), *Mycelis muralis* (78), *Dryopteris filix-mas* (67), *Helleborus odorus* (67), *Viola reichenbachiana* (67)*, Melica uniflora* (56), *Euphorbia amygdaloides* (56), *Carpinus betulus* (56), *Rubus hirtus* (56).

Dominant species: *Fagus sylvatica* (100)*, Mercurialis perennis* (33)*, Carpinus betulus* (56).

These neutrophilous, species-poor forests occupy mostly lower parts of the beech forest belt between 620 and 1035 m a.s.l. on slopes with different exposition. In comparison with the previous forest type, these stands are developed on terrains with slight inclination predominantly between 10 – 25° and lower altitude. The soils are mainly rich in nutrients, neutral and slightly acidic. This is the most widespread beech forest association in Bulgaria (Tzonev et al. 2006). According to this study, the association was found in most of the Bulgarian mountains: Stara Planina, Sredna Gora Mts., Ossogovska Mts., Belassitsa Mts., Rhodopi Mts., Rila Mts., Pirin Mts., Rui Mts., Vlahina Mts., Konyavska Mts., Vassilyovska Mts. and Mikrenski Hills. It has also been recorded from Bulgarka Natural Park where its communities form specific aspects with the relict species *Prunus laurocerasus* and *Taxus baccata* (Pavlov et al. 2006), as well as in some local studies in Kamenshtica reserve (Pachedjieva 2012) and Ponor SPA (Dimitrov and Petrova 2014).

Group 3: Community of *Carpinus betulus* and *Fagus sylvatica*

Number of relevés: 7.

Diagnostic species: *Carpinus betulus* (42), *Campanula sparsa* (38).

Constant species: *Carpinus betulus* (100), *Fagus sylvatica* (100), *Rubus hirtus* (86), *Luzula luzuloides* (57), *Campanula sparsa* (57), *Mycelis muralis* (57).

Dominant species: *Carpinus betulus* (100), *Carex sylvatica* (86).

These forest stands are developed in the lower mountain region up to 1000 m a.s.l. on slopes mostly with north or northwest exposition. The group includes mixed forests of *Carpinus betulus* and *Fagus sylvatica.* There are relatively well-represented shrub and herb layers with many species typical for the beech forests (*Luzula luzuloides, Mycelis muralis, Rubus*

hirtus etc.). A high frequency of species typical for the alliances *Fagion sylvaticae* (*Mycelis muralis*, *Galium odoratum* etc.) and *Carpinion betuli* (*Carpinus betulus, Quercus petraea*, etc.) demonstrates their transitional character between the neutrophilous beech and oak-hornbeam forests. The species composition indicates a great similarity with the *Carpino-Fagetum* Pauca 1941 described earlier in Romania (Ardelean 2006, Morar 2013). Both plant communities include many species typical for the class *Carpino-Fagetea sylvaticae* and especially high participation as co-dominants of *Fagus sylvatica* and *Carpinus betulus*. But nevertheless we conclude that the forests described in Etropolska Stara Planina do not belong to the *Carpino-Fagetum* because it is related to the Carpathian alliance *Lathyro hallesteinii-Carpinion* (Ardelean 2006, Morar 2013), a geographical vicariant of the *Carpinion betuli* characterized by some typical Carpathian species such as *Dentaria glandulosa*, *Helleborus purpurascens, Lathyrus hallersteinii*, etc. Central-southern Balkan oak-hornbeam forests have been assigned to the *Aceri tatarici-Carpinenion* Košir et al. 2012, a suballiance of the *Erythronio-Carpinion,* but there are some disagreements about this alliance. For example, oak-hornbeam forests in Slovenia and Croatia are related to the *Erythronio-Carpinion* (Vukelić 2012, Košir et al. 2012), but it is not accepted by some other authors because of its insufficient characterization by diagnostic species (Willner and Grabherr 2007, Borhidi et al. 2012, Stupar and Čarni 2017). It is also recognized as synvicariant of *Carpinion betuli*. More studies are necessary to solve the problem with the syntaxonomical position of Bulgarian and even Balkan oak-hornbeam forest stands.

Group 4: *Fago sylvaticae-Betuletum pendulae*

Number of relevés: 9.

Diagnostic species: *Betula pendula* (79)*, Pteridium aquilinum* (58).

Constant species: *Fagus sylvatica* (100)*, Viola reichenbachiana* (89)*, Betula pendula* (78)*, Euphorbia amygdaloides* (78)*, Rubus hirtus* (78)*, Melica uniflora* (67)*, Aremonia agrimonoides* (56)*, Festuca drymeja* (56)*, Poa nemoralis* (56)*, Geranium robertianum* (56).

Dominant species: *Fagus sylvatica* (100), *Betula pendula* (78).

The forests of *Betula pendula* in Etropolska Stara Planina are distributed between 810 and 1330 m a.s.l. on slopes with different inclination and exposition. The soil cover is formed mainly by relatively rich *Cambisols* on silicate rocks. These forest stands are characterized by a high participation of *Fagus sylvatica*, which forms the lower forest sublayer in some places. This is an indicator for the stage of their successional development. It will probably finish with their transformation into *Fagus sylvatica* forests. Presumably these forests (described mostly in 'Belikata' Protected Area) were better developed during the Holocene, but after the last glacial period. The same processes were reported also for these types of forests from Vitosha Mts. (Bondev 2002). *Betula pendula* forests are fragmentarily distributed in all Bulgarian mountains because this species is a pioneer element, which naturally occurs in groups or single trees in mesophilous coniferous or beech forests (Bondev 1991). They are usually developed in places where the natural forest vegetation has been destroyed by some anthropogenic activities or natural disasters. Sometimes they could occupy also abandoned pastures and meadows (Dimitrov 2015b). The birch forests in Etropolska Stara Planina are among the

largest in the country (Dimitrov 2015b).

The syntaxonomy of *Betula pendula* communities has not been fully studied in Bulgaria until now. Only one paper according to the Braun-Blanquet's methodology (Nikolov and Dimitrov 2015) and two local papers following the Dominant approach have been done (Penev 1960, Gorunova and Kochev 1991). Forest stands described earlier in Central Stara Planina by Nikolov and Dimitrov (2015) grow in higher altitudinal range (1400–1600 m), around the timberline, where spruce forests are also distributed. Birch phytocoesnoses from Etropolska Planina demonstrate huge similarity to the association *Fago sylvaticae–Betuletum pendulae* from Northern Greece (Theodoropoulos et al. 2003), which has similar floristic composition and structure, especially in the high participation of *Fagus sylvatica*. The high presence of *Pteridium aqulinum* as diagnostic species probably is an indicator that these communities have derived from a previous successional stage, the *Pteridio-Betuletum*. The latter association was described in Slovenia and Croatia (Trinajstić 2004, Šilc et al. 2008) as final stage of *Betula pendula* forests before its transition into the potential forest vegetation, which probably is the *Galio odorati-Fagetum sylvaticae* for the studied region.

Group 5: Association *Umblico erecti-Fagetum sylvaticae* subass. *typicum*

Number of relevés: 1.

Diagnostic species: *Phyllitis scolopendrium*, *Lunaria rediviva*.

Constant species: *Fraxinus ornus* (100), *Fagus sylvatica* (100), *Phyllitis scolopendrium* (100), *Lunaria rediviva* (100) etc.

Dominant species: *Fagus sylvatica* (100).

This phytocoenosis has been described close to the Varovitec Waterfall on 674 m a.s.l. It is developed on shady limestone rocks and *Eutric Cambisols* under the conditions of high air and soil humidity. It is similar to the wettest beech forests in Bulgaria, which are typical to the northern slopes of the Central Balkan Range, Sredna Gora Mts., Lozenska Mt. and Vassilyovska Mt. (Tzonev et al. 2006). Their species composition is comprised by many mesohygrophytes like *Carex remota, Chrysosplenium alternifolium* and *Circaea lutetiana*, etc. (Tzonev et al. 2006, Dimitrov 2015a). The herb layer of this stand is dominated by *Aegopodium podagraria* and *Phyllitis scolopendrium*. Other typical species with lower participation are *Lunaria rediviva, Circaea lutetiana, Asplenium trichomanes*, etc. The referred association is a geographic synvicariant to the Central European *Tilio-Acerion* alliance, or some specific Central European beech forests, which occur in wet and shady valleys.

Group 6: Association *Aremonio agrimonoidis-Fagetum sylvaticae* subass. *allietosum ursini*

Number of relevés: 3.

Diagnostic species: *Allium ursinum* (80), *Helleborus odorus* (55).

Constant species: *Carpinus betulus* (100), *Helleborus odorus* (100), *Viola reichenbachiana* (100), *Fagus sylvatica* (100), *Allium ursinum* (67), *Hepatica nobilis* (67).

Dominant species: *Fagus sylvatica* (100), *Allium ursinum* (67).

Forest stands of this association occupy slightly steep terrains with north or north-western aspect between 690 and 960 m a.s.l. They are developed on rich *Cambisols* with well-developed herb layer, which is comprised mainly by *Allium ursinum*, *Viola reichenbachiana*, *Hepatica nobilis*, etc. It has been pointed out for Vrachanska Planina Mt., Sredna gora Mt. and

Stara Planina Mt., where it occurs mostly on nutrient-rich and humid soils (Tzonev et al. 2006). We suppose that some future research could establish its wider distribution in Etropolska Stara Planina, where *Allium ursinum* could form the spring herb layer in many neutrophilous beech forests.

Group 7: Mixed communities of *Carpinus betulus.*

Number of relevés: 3.

Diagnostic species: *Quercus cerris* (78).

Constant species: *Carpinus betulus* (100), *Rosa canina* (100), *Quercus cerris* (100), *Mycelis muralis* (100), *Lysimachia punctata* (67), *Viola hirta* (67), *Crataegus monogyna* (67), *Helleborus odorus* (67), *Rubus hirtus* (67), *Festuca drymeja* (67), *Geum urbanum* (67), *Euphorbia amygdaloides* (33).

Dominant species: *Carpinus betulus* (100), *Festuca drymeja* (67), *Quercus petraea* (33).

These forest stands are distributed on terrains with different inclination and exposition on 690–780 m a.s.l. The presence of species like *Geum urbanum, Prunella vulgaris, Dactylis glomerata*, etc., show anthropogenic impact, which is probably a result of their closeness to the Etropole town. These phytocoenoses have transitional features between thermophilous beech forests and typical hornbeam-oak forests. Future research could clarify their syntaxonomic position not only in the studied area but also in other regions.

Group 8: *Alnus glutinosa* community.

Number of relevés: 7.

Diagnostic species: *Rubus caesius* (100), *Alnus glutinosa* (92), *Salix fragilis* (74), *Corylus avellana* (68), *Sambucus ebulus* (64).

Constant species: *Rubus caesius* (100), *Crataegus monogyna* (86), *Corylus avellana* (86), *Alnus glutinosa* (86), *Dactylis glomerata* (71), *Agrimonia eupatoria* (71), *Salix fragilis* (57), *Rosa canina* (57), *Potentilla reptans* (57), *Plantago lanceolata* (57), *Lysimachia nummularia* (57), *Geum urbanum* (57), *Dipsacus fullonum* (57), *Erigeron annuus* (57).

Dominant species: *Alnus glutinosa* (86).

The riverine forest stands (galleries), dominated by *Alnus glutinosa*, are distributed as narrow strips along the river banks, mostly on *Fluvisols*. They are strongly influenced by an anthropogenic impact because they are located mostly near Etropole town. The studied phytocoenoses are located on 490–710 m a.s.l. The species richness, especially of the herb layer, is comparatively high and includes typical hygrophytes (*Alnus glutinosa, Persicaria hydropiper*) and mesohygrophytes (*Lysimachia nummularia*), as well as many nitrophilous ruderals (*Geum urbanum*, *Urtica dioica*).

These forests are not among the well-investigated vegetation types in Bulgaria. However, only two studies according to the Braun-Blanquet's approach (Soó 1957, Pavlov and Dimitrov 2002) have been done until now. They both describe typical floodplain ('longoz') vegetation distributed along some larger rivers at the Black Sea Coast or South-eastern Bulgaria. The typical longoz communities are rich of lianas, herbaceous climbers and many woody species, which give them physiognomy similar to the tropical forests (Pavlov and Dimitrov 2002). In comparison, the communities of *Alnus glutinosa* in Etropolska Stara Planina are poorer in species composition, and their flooding is relatively limited in duration and dimension.

The phytocoenoses with dominance of alders are widely distributed in Europe. They are united mainly in the alliance *Al-*

nion incanae, which include azonal forest vegetation growing in localities with high groundwater table (Oberdorfer 1953; Bodeux 1955; Dierβen 1996; Neuhäuslová 2000, 2003). The most recent and comprehensive work concerning this type of vegetation is the paper of Douda et al. (2015), where the authors summarized a huge database of relevés collected across whole Europe and as a result presented detailed formalized classification of European floodplain forests and alder carrs. The phytocoenoses of alders are discussed also in studies on national level in several European countries, such as Romania (Coldea et al. 2015), Czech Republic (Douda 2008, Chytrý 2013), Italy (Sburlino et al. 2011), etc., where detailed syntaxonomy and classification of these forests is presented. At this stage we cannot relate the black alder phytocoenoses described in Etropolska Stara Planina *Alnus glutinosa* communities to any of the associations described so far because of the lack of diagnostic species for these associations and the small number of relevés. Future research of this type of vegetation in Etropolska Stara Planina will clarify their syntaxonomy and floristic classification.

Conclusion

The results of the present study refer to the forest vegetation of Etropolska Stara Planina. The dominating forest types belong to widespread Middle European neutrophiolus and acidophilous beech forests and mixed *Carpinus betulus* and *Quercus petraea* forests. It is also evidenced by the existing data that the class *Carpino-Fagetea sylvaticae* is represented by *Luzulo-Fagion sylvaticae*, *Fagion sylvaticae* and *Carpinion betuli*. Specific and still poorly known are the riverine galleries of *Alnus glutinosa*, which belong to the *Alno glutinosae-Populetea albae* and the *Alnion incanae*. They are typical for the South-eastern and Central European deciduous mesophilous to hygrophilous alluvial forests. However, more research is necessary to establish their syntaxonomical relationships and positions.

Acknowledgments

We want to express our thanks to the Scientific Fund of Sofia University ‘St. Kliment Ohridski’ because the part of this study was made during the PhD thesis work of Gabriela Petrova – Contract No 80.10 – 32/19.04.2017 for the project ‘Syntaxonomical research of the forest vegetation in Etropolska Stara Planina Mountain’.

References

Alexiev G. 2002. Morphostructural analysis. [Morfostrukturen analiz]. In: Kopralev I. (Ed.) Geography of Bulgaria. Physical and Socioeconomic geography. ForCom, Sofia: 86 p. (in Bulgarian).

Ardelean A. 2006. *Carpino-Fagetum* PAUCĂ 1941 association in Arad County. [Asociaţia *Carpino-Fagetum* PAUCĂ 1941 în judeţul Arad]. Vasile Goldis University Press 16: 47–52 (in Romanian).

Atanassova J. 2007. Pollen deposition in moss polsters and pollen traps in the Central Stara Planina Mts (2002–2005). Phytologia Balcanica 3(2): 223–228.

Bodeux A. 1955. *Alnetum glutinosae*. Mitt. Florist.-Soziol. Arbsgem. (Stolzenau/Weser) 5: 114–137.

Bondev I. 1991. The vegetation of Bulgaria. Map in 1:600 000.with an explanatory text. [Rastitelnost na Bulgaria, Karta v Mashtab 1:600 000 s obyasnitelen tekst]. Sofia University Press ‘Kliment Ohridski’. 183 p. (in

Bulgarian).

Bondev I. 2002. Geobotanic regioning. [Geobotanichesko rayonirane]. In: Kopralev I. (Ed.) Geography of Bulgaria. Physical and Socioeconomic geography. ForCom, Sofia: 336–352 (in Bulgarian).

Bondev I., Ninov N., Ljubenova M. 2000. Diversity of plants and soils in Stara Planina Mountains in Bulgaria. Journal of Balkan Ecology 3: 19–27.

Borhidi A., Kevey B., Lendvai G. 2012. Plant communities of Hungary. Akademiai Kiady, Budapest. 544 p.

Braun-Blanquet J. 1964. Pflanzensoziologie – Grundzüge der Vcgetationskunde, Wien, New York. 865 p.

Chytrý M. 2013. Vegetation of Czech Republic. Vol. 4. Forest and shrub vegetation. [Vegetace České republiky. 4. Lesní a křovinná vegetace]. Academia. 551 p. (in Czech with English summaries).

Chytrý M., Tichy L., Holt J., Botta-Dukat Z. 2002. Determination of diagnostic species with statistical fidelity measures. Journal of Vegetation Science 13: 79–90.

Coldea G. (Ed.) 2015. Vegetation associations of Romania. Vol. 3. Forest and shrub associations. [Les associations vegetales de Roumanie. Tome 3. Les associations forestrieres et arbustives]. Presa Universitara Clujeana & Accent. 282 p. (in Romanian).

Delipavlov D., Cheshmedjiev I. (Eds) 2003. Key to the plants of Bulgaria. [Opredelitel na rasteniyata v Balgariya]. Academic Press, Agricultural University, Plovdiv. 591 p. (in Bulgarian).

Denk T. 1999. The taxonomy of *Fagus* in western Eurasia. 2: *Fagus sylvatica* subsp. *sylvatica*. Feddes Repertorium 110: 381–412.

Dierben K. 1996. Vegetation Nordeuropas. Ulmer. 838 p.

Dimitrov M. 2015a. 09G1 Neutrophilic common beech forests. In: Biserkov V., Gussev Ch., Popov V., Hibaum G., Roussakova V., Pandurski I., Uzunov J., Dimitrov M., Tzonev R., Tsoneva S. (Eds). Red Data Book of the Republic of Bulgaria. Vol. 3. Natural habitats. MOEW-BAS, Sofia: 291–294.

Dimitrov M. 2015b. 25G1 White birch (*Betula pendula*) forests. In: Biserkov V., Gussev Ch., Popov V., Hibaum G., Roussakova V., Pandurski I., Uzunov J., Dimitrov M., Tzonev R., Tsoneva S. (Eds). Red Data Book of the Republic of Bulgaria. Vol. 3. Natural habitats. MOEW-BAS, Sofia: 330–331.

Dimitrov M., Petrova D. 2014. Forest habitats in Ponor Special Protection Area (Natura 2000), Western Bulgaria: Characteristics, Status Assessment and Management Recommendations. Acta zoologica bulgarica 5: 9–20.

Dodev J. 2016. Ecological and forestry characteristic of *Carpinus orientalis* Mill. in Etropolska Stara Plananina and opportunities for their sustainable management. [Ekologo-lesovadska harakteristika na gorite ot *Carpinus orientalis* Mill. v Etropolska Stara planina i vuzmozhnosti za ustojchivoto im stopanisvane]. PhD thesis. Forestry Institute. 179 p. (in Bulgarian).

Douda J. 2008. Formalized classification of the vegetation of alder carr and floodplain forests in the Czech Republic. Presila 80: 199–224.

Douda J., Boublík K., Slezák M., Biurrun I., Nociar J., Havrdová A., Doudová J., Aćić S., Brisse H., Brunet J., Chytrý M., Claessens H., Csiky J., Didukh J., Dimopoulos P., Dullinger S., FitzPatrick U., Guisan A., Horchler P., Hrivnák R., Jandt U., Kącki Z., Kevey B., Landucci F., Lecomte H., Lenoir J., Paal J., Paternoster D., Pauli H., Pielech R., Rodwell J., Roelandt B., Svening J-Ch., Šibík J., Silc U., Škvorc Ž., Tsiripidis J., Tzonev R., Wolhgemuth T., Zimmerman N. 2015. Vegetation classification and biogeography of European floodplain forests and alder carrs. Applied vegetation science. DOI: 10.1111/avsc.12201.

Exner A., Willner W. 2004. New syntaxa of shrub and pioneer forest communities in Austria. Hacquetia 3(1): 27–34.

Filipovich L., Stefanova I., Lazarova M., Petrova M. 1997. Holocene vegetation in Stara Planina (the Balkan range). Phytologia Balcanica 3(2–3): 15–39.

Filipovich L., Stefanova I., Lazarova M., Petrova M. 1998. Holocene vegetation in Stara Planina (the Balkan range). II. Phytologia Balcanica 4(1–2): 13–25.

Gorunova D., Kochev H. 1991. Vegetation cover in the Chepelarska river basin (western Rhodopes). II. [Rastitelnata pokrivka v basejna na reka Chepelarska (Zapadni Rodopi). II]. Fitologija 41: 3–27 (in Bulgarian).

Horn H. 1966. Measurement of 'Overlap' in comparative ecological studies. Amateur Naturalist 100: 419–424.

Iliev I. 1988. A study of the natural populations of common birch (*Betula pendula* Roth) in western Bulgaria and a selection of valuable decorative forms. [Prouchvane na estestvenite populatsii na obiknovena breza (*Betula pendula* Roth) v Zapadna Balgariya i otbor na tsenni dekorativni formi]. Thesis for Candidate of Science. VLTI / LTU. 157 p. (in Bulgarian).

Koleva E., Peneva R. 1990. Climatic reference book. Rainfall in Bulgaria. [Klimatichen spravochnik. Valezi v Balgariya]. Institute of Meteorology and Hydrology. BAS. BAS publishing house, Sofia. 169 p. (in Bulgarian).

Košir P., Cassavechia S., Čarni A., Škvorc Ž., Zivkovic L., Biondi E. 2012. Ecological and phytogeografical differentiation of oak-hornbeam forests in southeastern Europe. Plant Biosystems 147(1): 84–98.

Kyuchukova M. (Ed.) 1983. Climatic reference book. Vol III. Air temperature, soil temperature, frost. [Klimaichen spravochnik na Narodna Republika Balgariya. Tom 3. Temperatura na vazduha, temperature na pochvata, slana]. Institute of Meteorology and Hydrology State publishing house 'Science and Art'. Sofia. 822 p. (in Bulgarian).

Leuschner Ch., Ellenberg H. 2017. Vegetation ecology of Central Europe. I. Ecology of Central European forests. Springer. 971 p.

Lyubenova M., Dimova R. 2000. Contents of heavy elements in some dendromass fractions from the forest ecosystems in the region of Etropole. Annual of Sofia University 'St. Kliment Ohridski' 91(2): 129–138.

Marinov M., Nedyalkov S, Naumov Z. 1961. Beech forests in Bulgaria. [Bukovite gori v Bulgaria]. Sofia. 232 p. (in Bulgarian).

Marinov M., Stoyanova G., Popov G., Stiptsov V. 1987. Ecological and phytocoenological characteristics of the beech forests in the upper mountain belt in the Middle Balkan Range. [Ekologo-fitocentichna fitotsenotichna harakteristika na bukovite gori v gorniya planinski poyas na Sredna Stara Planina]. Forest Science 24(6): 10–19 (in Bulgarian).

Morar E. A. 2013. Research on the association of *Carpino-Fagetum* PAUCĂ 1941 on Oradea Hills. Analele Universitatii din Oradea, Fascicula Protectia Mediului 20: 129–136.

Mucina L., Bültmann H., Dierssen K., Theurillat J.-P., Dengler J., Carni A., Šumberová K., Raus T., Di Pietro R., Gavílan García R., Chytrý M., Iakushenko D., Schaminée J., Bergmeier E., Santos Guerra A., Daniëls F., Ermakov N., Valachovic M., Pignatti S., Rodwell J., Pallas J., Capelo J., Weber H., Lysenko T., Solomesh A., Dimopolous P., Aguiar C., Freitag H., Hennekens S., Tichý L. 2016. Vegetation of Europe: Hierarchical floristic classification system of plant, lichen, and algal communities. Applied Vegetation Science 19: 3–264.

Mueller-Dombois D., Ellenberg H. 1974. Aims and methods of vegetation ecology. John Wiley & Sons. 547 p.

Neuhäuslová Z. 2000. *Alnion incanae*. In: Moravec J. (Ed.) Vegetation Survey of the Czech Republic. Vol. 2. Hygrophilous, mesophilous and xerophilous deciduous forests. [Přehled vegetace České republiky, Svazek 2, Hygrofilní mezofilní a xerofilní opadavé lesy] Academia, Praha: 15–17 (in Czech).

Neuhäuslová Z. 2003. *Alnion glutinosae*. In: Moravec J. (Ed.). Vegetation Survey of the Czech Republic. Vol. 4. Riparian willow-poplar woods and swampy alder and willow carr. [Přehled vegetace České republiky. Svazek 4. Vrbotopolové luhy a bažinné olšiny a vrbiny]. Academia, Praha: 44–57 (in Czech).

Nikolov I., Dimitrov M. 2015. Boreo-Mountane forest phytocoenoses in Central Stara Planina. Forest Review 46: 43–54.

Ninov N. 2002. Soils. [Pochvi]. In: Kopralev I. (Ed.) Geography of Bulgaria. Physical Geography. Socioeconomic Geography. ForCom, Sofia: 277–317 (in Bulgarian).

Oberdorfer 1953. Der europäische Auenwald. Beitr. Naturk. Forsch. Südwestdeutschl. 12: 23–70.

Pachedjieva K. 2012. Phytocoenological characteristic of Kamenshtica Reserve and adjacent areas, Central Balkan Range. [Fitotsenlogichna harakteristika na rezervat Kamenishtitsa I prilezhashti teritorii, Centralna Star a Planina]. PhD thesis. Sofia University. 166 p. (in Bulgarian).

Pavlov D., Dimitrov M. 2002. A syntaxonomic analysis of the floodplain forests in the maintained reserves 'Dolna topchiya' and 'Balabana'. Forest Science 1: 3–19.

Pavlov D., Dimitrov M., Malinova D. 2006. Syntaxonomical analysis of the vegetation of main types of landscapes in Bulgarka Nature Park. Forest Science 1: 3–29.

Penchev P., Tishkov H., Daneva M., Gorunova D. 1989. Stara Planina region. [Staroplaninska oblast]. In: Mishev K. (Ed.) 1989. Geography of Bulgaria. Vol. 3. Physico-geographic and socio-economic regioning of Bulgaria. Publishing house of the Bulgarian Academy of Sciensis. 584 p. (in Bulgarian).

Penev I. 1960. Forest and shrub vegetation along the upper reaches of the river Blagoevgradska Bistritsa (Rila Mountain). [Gorskata i hrastova rastitelnost po gornoto techenie na reka Blagoevgradska Bistritsa, Rila planinia]. Izvestiya na Botanicheskia Institut 7: 107–164 (in Bulgarian).

Podani J. 2002. SYN-TAX 2000. Computer Program for Data Analysis in Ecology and Systematics. Scientia Publishing, Budapest. 53 p.

Radkov I., Minkov Y. 1963. The Oak forests in Bulgaria. [Dubovite gori v Bulgaria]. State Publishing, Varna. 260 p. (in Bulgarian).

Sburlino G., Poldini L., Venanzoni R., Ghirelli L. 2011. Italian black alder swamps: Their syntaxonomic relationships and originality within the European context. Plant Biosystems 145: 148–171.

Šilc U., Čarni A., Košir P., Marinšek A., Zelnik I. 2008. Litter-raking forests in SE Slovenia and in Croatia. Haquetia 1: 71–88.

Sokal R., Rohlf F. 1995. Biometry, the principles and practice of statistics in biological research. 3rd Edition. W.H. Freeman and Co., New York. 887 p.

Soó R. 1957. Pflanzengesellschaften aus Bulgarien. I. Ann. Univ. Sc. Budapest, Section Biololgy 1: 231–239.

Stefanov P. 2002. Morphographic characteristic. [Morfografska harakteristika]. In: Kopralev I. (Ed.) Geography of Bulgaria. Physical Geography. Socioeconomic Geography. ForCom, Sofia: 29–49 (in Bulgarian).

Theodoropoulos K., Eleftheriadou E., Tsiripidis J. 2003. Phytosociological research of the pure *Betula pendula* forests in Greece. Annali di Botanica 3: 75–90.

Tichý L. 2002. JUICE, software for vegetation classification. Journal of Vegetation Science 13: 451–453.

Tichý L., Chytrý M. 2006. Statistical determination of diagnostic species for site groups of unequal size. Journal of Vegetation Science 17: 809–818.

Trinajstić I. 2004. Nomenclatural-Syntaxonomic Analysis of Silver Birch (*Betula pendula* Roth) Forests in Croatia. [Nomenklaturno-sintaksonomska analiza šuma obićne breze (*Betula pendula* Roth) u Hrvatskoj]. Sumarski list 78(11–12): 627–632.

Tutin T.G., Akeroyd J.R. 1993. *Fagus* L. In: Tutin T.G., Burges N.A., Chater A.O., Edmondson J.R., Heywood V.H., Moore D.M., Valentine D.H., Walters S.M., Webb D.A. (Eds). Flora Europaea, vol. 1. Psilotaceae to Platanaceae. Second edition. Cambridge University Press, Cambridge: 72.

Tzonev R. 2011. The beech forests in Bulgaria – classification, ecology and nature conservation problems. In: Knapp H., Fichtner A. (Eds). Beech forests. Joint Natural Heritige of Europe. Workshop at the International Academy for Nature conseravtion, Isle of Vilm, October 19–22, 2010, BfN Scripten 297: 137–147.

Tzonev R., Dimitrov M., Chytrý M., Roussakova V., Dimova D., Gussev C., Pavlov D., Vulchev V., Vitkova A., Gogoushev G., Nikolov I., Borisova D., Ganeva A. 2006.Beech forest communities in Bulgaria. Phytocoenologia 36: 247–279.

Van der Maarel E. 1979. Transformation of cover-abundance values in phytosociology and its effect on community similarity. Veg-

etatio 39: 97–114.

Velchev V., Penev I., Bondev I. 1969. Development and recent problems of geobotany in Bulgaria [Razvitie i savremenni problemi na geobotanikata v Bulgaria]. In: Yordanov D. (Ed.), Proceedings of Second Natlional Conference of Botany. Bulgarian Academy of Sciences Press, Sofia: 149–157 (in Bulgarian).

Velev S. 2002. Climatic regioning. [Klimatichno rayonirane]. In: Kopralev I. (Ed.) Geography of Bulgaria. Physical Geography. Socioeconomic Geography. ForCom, Sofia: 155–157 (in Bulgarian).

Vukelić J. 2012. Forest vegetation of Croatia. Šumarski fakultet, Sveučilište u Zagrebu, DZZP, Zagreb. 403 p. (in Croatian).

Westhoff V., van der Maarel E. 1978. The Braun-Blanquet approach. In: Whittaker R. H. (Ed.) Handbook of vegetation science, part 5, Classification and ordination of communities. Junk, The Hague: 287–399.

Willner W., Grabherr G. (Eds). 2007. Die Wälder und Gebüsche Österreichs: Ein Bestimmungswerk mit Tabellen (in zwei Bänden). Spektrum Akademischer Verlag.