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Beech forest communities in Bulgaria

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with 3 figures and 1 table

Abstract. Beech forests occupy considerable areas in the Bulgarian mountains. They are represented by communities of *Fagus sylvatica* (incl. *F. moesiaca*) and *F. orientalis*, and also by mixed stands of beech with *Abies alba*, *Carpinus betulus*, *Quercus cerris*, *Q. dalechampii* and *Q. polycarpa*. 494 relevés sampled across the country were analysed by numerical methods. They were classified into 12 groups of *Fagus sylvatica* forests and 3 groups of *Fagus orientalis* forests. The analysis of Bulgarian *Fagus sylvatica* communities did not show a distinct pattern of geographic differentiation and did not support the concept of the alliance Fagion moesiacum, as accepted by many earlier authors. The differentiation patterns in the Bulgarian *Fagus sylvatica* forests mainly follow the gradients in soils and climate, and are similar to those in the Central European beech forests. Therefore we accept a syntaxonomical scheme, which emphasizes variation due to edaphic and local topoclimatic factors rather than due to large-scale geographical differentiation. This scheme is very close to that proposed by Willner (2002) for the southern Central European beech forests, and includes the alliances Luzulo-Fagion (acidophilous beech forests), Asperulo-Fagion (nutrient-rich beech forests), and Cephalanthero-Fagion (thermophilous beech forests). The communities of *Fagus orientalis* are markedly different from the communities of *Fagus sylvatica*, have a distinct floristic composition, and belong to the Euxinian alliance Fagion orientalis.

Keywords: Fagion moesiacum, Fagion orientalis, Fagion sylvaticae, acidophilous beech forests, nutrient-rich beech forests, thermophilous beech forests, numerical methods, phytosociology, vegetation survey.

Introduction

Beech forests have a great importance in the vegetation cover of Europe, but their diversity in the south-eastern part of the continent has not been sufficiently investigated so far. Already Adamović (1907) noted that in the territory of the former Roman provinces of Illyria and Moesia these forests are remarkably rich in southern European, Balkanic, Carpatho-Dacian, Pontic, and other southern species, which may reflect the specific history of this vegetation and also some distinct features of the local climate. For

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this reason, some authors distinguished regional alliances of *Fagus sylvatica* forests in the comparatively well investigated northern and western parts of the Balkan Peninsula. These included Fagion illyricum in the area from the south-eastern Alps to Albania and Greece (Horvat 1938, Soó 1964), and Fagion dacicum in the Carpathian Mts. of Romania (Borhidi 1963, 1965, Soó 1964). The less well-known beech forests in the central and eastern part of the Balkan Peninsula have mainly been included in these alliances later, but most authors considered these assignments as preliminary. Horvat (1963) assigned the beech forests from Serbia and Macedonia to Fagion illyricum, but pointed out their different floristic composition and the smaller number of Illyrian elements than in the beech forests in Slovenia and especially in Croatia. Soó (1963, 1964) assigned the beech forests in south-eastern Serbia, Bulgaria and northern Greece to Fagion dacicum, in spite of the fact that many of the diagnostic species of this alliance are not present in these territories. He called them Moesian beech forests (*Moesische Fagion-Wälder*) and treated them as a separate vegetation type, with *Fagus moesiaca* as the differential species. The same author distinguished the alliance Fagion orientalis, which included the communities of *Fagus orientalis*. After the analysis of some new data and the extension of the study area, Horvat et al. (1974) described the alliance Fagion moesiacum, distributed in the area of a more continental climate in the eastern Balkans. They assumed a negative floristic differentiation of this alliance against Fagion illyricum and Fagion dacicum. They delimited the geographical range of the Fagion moesiacum alliance according to the tentative range of *Fagus moesiaca*, a taxon, which includes transitional populations between *Fagus sylvatica* and *F. orientalis*. The forests of *Fagus orientalis* were included in the alliance Fagion orientalis by Horvat et al. (1974), which was validated later by Quézel et al. (1992). Soó (1963) supposed that Fagion orientalis occurs throughout the south-eastern part of the Balkan Peninsula, Anatolian plateau and the Caucasus. After the more precise investigations of the forests of Anatolian mountains, Quézel et al. (1980, 1992) concluded that Fagion orientalis is restricted only to the Balkan Peninsula, and includes forests that are poorer in Euxinian species. For the typical oriental beech forests Quézel et al. (1980, 1992) created a new order, Rhododendro-Fagetalia, while the forests on the Balkan Peninsula they assigned to the order Fagetalia sylvaticae.

Several regional classifications of the south-eastern European beech forests have been proposed in the past two decades. Inside the alliance Symphyto-Fagion (the correct name of Fagion dacicum) several suballiances were distinguished (Boşcaiu et al. 1982, Coldea 1991, Sanda et al. 1999), and this splitting process resulted in Täuber's (1987) proposal of raising this alliance to the status of suborder Symphyto-Fagenalia. Török et al. (1989) replaced the illegitimate name Fagion illyricum with a new name, Aremonio-Fagion. They supposed that two of the analyzed associations, described from Serbia, belong to Fagion moesiacum. Marinček et al. (1992) made a nomenclatural revision of the associations within Aremonio-Fagion. Mišić (1997) accepted the name Fagion moesia-

cae Blečić et Lakusić 1972 for beech forests of Serbia, distinguished several suballiances at different altitudes, and created a new suborder, Fagenalia moesiacae Mišić 1997.

Modern broad-scale analyses of floristic differentiation within the southern Balkan beech forests were so far made only for the Former Yugoslav Republic (F.Y.R.) of Macedonia (Dzwonko et al. 1999, Dzwonko & Loster 2000) and Greece (Dzwonko & Loster 2000, Bergmeier & Dimopoulos 2001). Dzwonko & Loster (2000) revealed a strong geographic gradient in the floristic composition of beech forests from SE Serbia through F.Y.R. of Macedonia to central Greece. They assigned the northern communities (Serbia and F.Y.R. of Macedonia) to the suballiance Doronico columnae-Fagenion moesiacae Dzwonko et al. 1999 and the central Greek communities to the suballiance Doronico orientalis-Fagenion moesiacae Raus 1980. Bergmeier & Dimopoulos (2001) found a more complex pattern in Greek *Fagus* communities, which reflected both ecological and geographical variation, but ecological factors were dominant. They assigned most of the *Fagus sylvatica* communities of warm and dry habitats to the regional suballiances Geranio versicoloris-Fagenion (Gentile 1969) Bergmeier et Dimopoulos 2001 of western-central Greece and Doronico orientalis-Fagenion moesiacae Raus 1980 of eastern-central Greece. They suggested that the former suballiance extended its range from western-central Greece to southern Italy, as was also accepted in the Map of Natural Vegetation of Europe (Bohn & Neuhäusl 2000–2003, Bergmeier et al. 2004, Dierschke & Bohn 2004). Vegetation of *Fagus sylvatica* in cooler areas of northern Greece or at higher altitudes was classified to the suballiance Doronico columnae-Fagenion moesiacae by Bergmeier & Dimopoulos (2001), which included forests on different soils ranging from acidic through mesotrophic to calcareous.

Forests dominated by the *Fagus sylvatica* and *F. orientalis* are widespread in Bulgaria, occupying nearly 17 % of the total forested area of the country, i.e. approximately 600 000 ha (Garelkov & Stiptsov 1995). Despite this fact, their diversity has not been sufficiently described so far. The existing studies have a local importance and most of them have been made according to the methodology of the Russian school of vegetation classification according to dominant species (Stefanov 1924, 1927, Jordanov 1939a, b, Ruskov 1942, Vulev 1955, Stoyanov 1956, Penev 1960, Ganchev 1961, Garelkov 1967, Kochev 1969, Velchev 1971, Roussakova 1973, Pavlov 1978, Bondev & Lazarov 1995). Stoyanov (1941), Bondev (1991), and Pavlov (1998) made attempts at a comprehensive phytosociological classification of the Bulgarian beech forests. Similar results were obtained in the forest-typological classifications (Radkov 1963, Penev et al. 1969, Garelkov & Stiptsov 1995). The investigations following the Braun-Blanquet phytosociological method have only been made locally in recent years (Michalik 1990, 1992, 1993, Kurzyński 1993, Pavlov & Dimitrov 2003, Dimitrov & Glogov 2003).

In spite of the absence of a hierarchical classification of the beech forests for the whole of Bulgaria, some of the syntaxa published until now provide

some information on the existing syntaxonomical and habitat diversity in Bulgaria. Commonly, beech forests are divided into three main types: forests with *Fagus moesiaca* (mainly distributed at altitudes below 1000 m), forests with *Fagus sylvatica* (mostly at higher altitudes, extending to the coniferous forests belt), and forests with *Fagus orientalis* (only occurring in the eastern Stara Planina and Strandzha Mts.) (Stoyanov 1941, Bondev 1991, Garelkov et al. 1995). Within the forests dominated by *Fagus sylvatica*, mesic and hygro-mesic forests were distinguished on rich soils, and xeric and meso-xeric forests on poor soils and rocky terrains. The beech forests in the Stara Planina Mts. have been classified as mesophilous, thermophilous, and acidophilous (Michalik 1990, Kurzyński 1993).

The beech forests in Bulgaria have been very strongly exploited in the past. In recent decades, in accordance with the principles of sustainable use and reforestation, they restored their distribution range and also the natural structure and floristic composition. As a result of the political and socio-economical changes of the recent years, however, the degree of their exploitation for timber extraction has increased again.

The purpose of this study is to outline a phytosociological classification of the Bulgarian beech forests, using the original vegetation-plot data (relevés) sampled recently across the country. This study will provide a scientific background for habitat classification in the Bulgarian project of NATURA 2000.

Materials and methods

Vegetation sampling was performed in 1999–2004 in all areas of Bulgaria, where beech forest forms an important proportion of local land cover according to the vegetation map of Bulgaria (Bondev 1991). In the selected areas, relevé sites were selected subjectively in order to represent the maximum diversity of beech forest in the given region (Fig. 1). Plots of 200–500 m^2 were usually located in places that appeared to be representative of larger stands with homogeneous beech-forest vegetation. Besides pure beech forests of *Fagus sylvatica* (incl. *F. moesiaca*) and *F. orientalis*, also mixed stands with *Abies alba*, *Carpinus betulus*, *Quercus cerris*, *Q. dalechampii* and *Q. polycarpa* were sampled, provided that beech covered more than 60 % of the plot area. In each plot, a list of all vascular plants and bryophytes was made and each species was assigned a cover value according to the nine-degree Braun-Blanquet scale (Westhoff & van der Maarel 1978).

The relevés were computerized using the Turboveg data base management program (Hennekens & Schaminée 2001) with an electronic species list of Bulgarian vascular plants (according to Kozhuharov 1992) and bryophytes (according to Petrov 1975), which was prepared by Iva Apostolova in the Institute of Botany, Bulgarian Academy of Sciences in Sofia. The soil types follow FAO classification (Ninov 1998). *Fagus moesiaca* was not distinguished during the sampling, because recent studies consider it to be only a morphotype within *F. sylvatica* (Akeroid in Tutin et al. 1993,

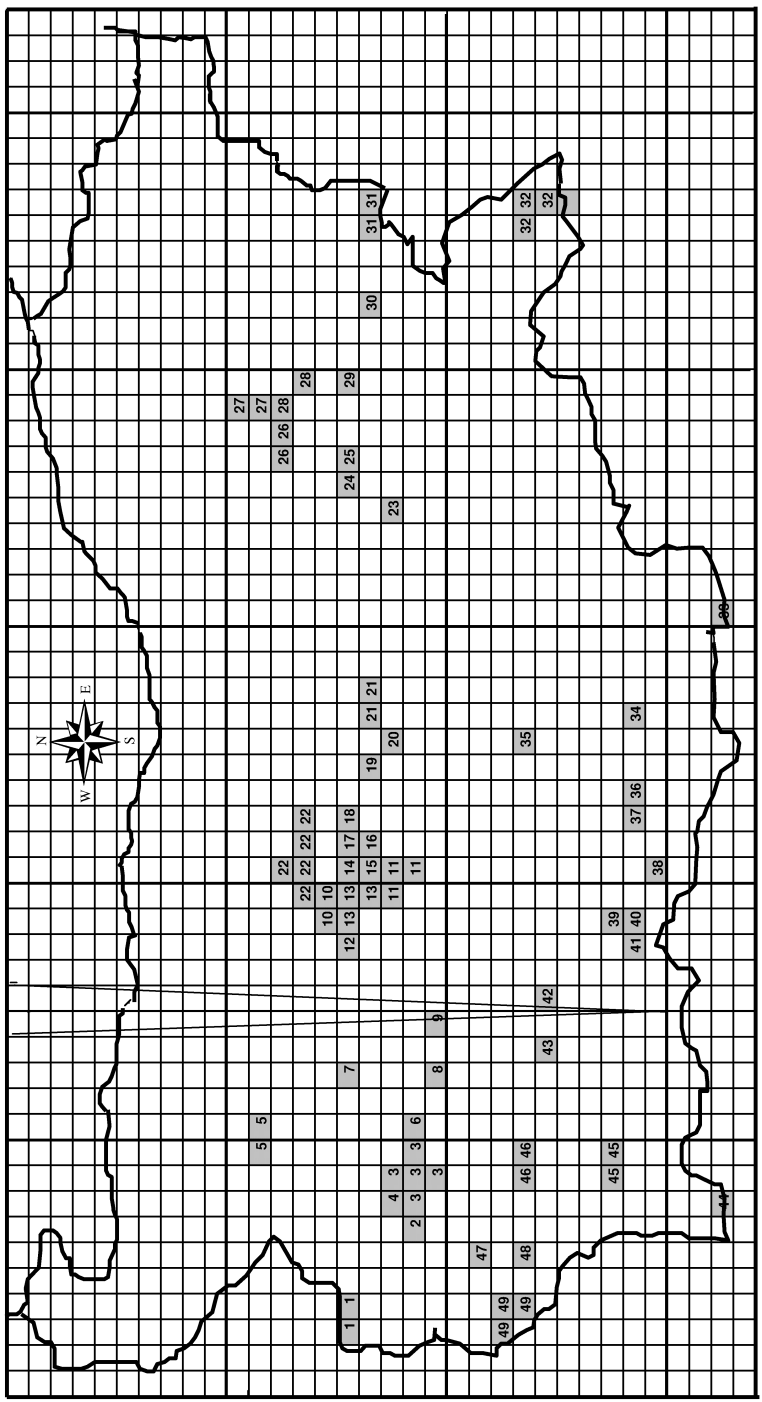

Fig. 1. Map of Bulgaria with a 10 × 10 km UTM grid (Michev 1999) and the locations of investigated beech forests. 1 – Rui Mts.; 2 – Golo Burdo Mts.; 3 – Vitosha Mts.; 4 – Lyulin Mts; 5 – Vrachanska Planina Mts.; 6 – Lozenska Mts.; 7 – Western Stara Planina Mts. (Vitinja pass); 8 – Ihtimanska Sredna Gora Mts. (Polyantsi); 9 – Ihtimanska Sredna Gora Mts. (Shindar); 10 – Vassilyovska Mts.; 11 – Sushtinska Sredna Gora Mts.; 12 – Central Stara Planina Mts. (Divchovoto); 13 – Central Stara Planina Mts. (Ribaritsa, Shipkovo); 14 – Central Stara Planina Mts. (Chiflik, Beklemeto, Beli Ossum); 15 – Central Stara Planina Mts. (Hristo Danovo); 16 – Central Stara Planina Mts. (Trojan); 17 – Central Stara Planina Mts. (Cherni Ossum); 18 – Central Stara Planina Mts. (Apritsi); 19 – Central Stara Planina Mts. (Tuzha); 20 – Central Stara Planina Mts. (Skobelevo); 21 – Central Stara Planina Mts. (Bulgarka); 22 – Mikrenski Hills; 23 – Eastern Stara Planina Mts. (Sinite kamuni); 24 – Eastern Stara Planina Mts. (Kotel); 25 – Eastern Stara Planina Mts. (Medven); 26 – Momino Plateau (Preslavska Mts.); 27 – Shumensko Plateau; 28 – Dragoevska Mts.; 29 – Eastern Stara Planina Mts. (Kamchiiska Mts.); 30 – Eastern Stara Planina Mts. (Ajtoska Mts.); 31 – Eastern Stara Planina Mts. (Eminska Mts.); 32 – Strandzha Mts. (Silkossiya and Uzunbozhak Reserves, Kondolovo); 33 – Eastern Rhodopi Mts. (Muglenizhki rid); 34 – Eastern Rhodopi Mts. (Kurdzhali); 35 – Western Rhodopi Mts. (Purvomai); 36 – Western Rhodopi Mts. (Davidkovo); 37 – Western Rhodopi Mts. (Slaveino); 38 – Western Rhodopi Mts. (Smolyan); 39 – Western Rhodopi Mts. (Devin); 40 – Western Rhodopi Mts. (Kazanite Reserve); 41 – Western Rhodopi Mts. (Kastrakli Reserve); 42 – Western Rhodopi Mts. (Rakitovo); 43 – Western Rhodopi Mts. (Yundola); 44 – Belassitsa Mts.; 45 – Northern Pirin Mts.; 46 – Rila Mts. (Rila Monastery); 47 – Konyavska Mts.; 48 – Vlahina Mts.; 49 – Ossogovska Mts.

Denk 1999, Gömöry et al. 1999). Cover values of Braun-Blanquet scale were replaced by mid percentage cover values for each degree and square-root transformed. Classification of the data set was performed with cluster analysis in the program PC-ORD 4 (McCune & Mefford 1999), using the relative Euclidean (chord) distance as a resemblance measure and the beta-flexible algorithm with $\beta = -0.25$ for dendrogram construction. As the classification sharply separated relevés with *Fagus orientalis* from those with *F. sylvatica*, the data set was divided into two, according to the dominant beech species, and each of the subsets was classified separately with the same methods and options as given above. The clusters accepted in the final classifications were selected subjectively from the resulting dendrogram so that they had a clear ecological and/or phytogeographical interpretation, and the ecological range they covered roughly corresponded to beech-forest associations or subassociations that are recognized in national vegetation monographs or regional studies from central and south-eastern Europe. Two clusters from the dendrogram were not interpreted because of their strictly local meaning.

Relationships between clusters of the final classification were visualised by ordination of a matrix of species by cluster centroids, in which square-root transformed percentage frequencies were used as the input data. Principal components analysis (PCA) on covariance matrix was run with the CANOCO 4.5 package (ter Braak & Šmilauer 2002). This ordination method, assuming a linear response of species to environment, was preferred to methods assuming a unimodal response, because of the relatively low heterogeneity in the matrix of species by cluster centroids.

Diagnostic species of each of the accepted clusters were determined in the JUICE 6.2 program (Tichý 2002) on the presence/absence basis by calculating the fidelity of each species to each cluster, using the phi coefficient of association (Sokal & Rohlf 1995, Chytrý et al. 2002b). In these calculations, each cluster was compared with the rest of the relevés in the data set, which were taken as a single undivided group. In this way, divisions of relevés in the rest of the data set did not influence the fidelity of species to the target cluster. As the unequal relevé numbers in individual clusters would generally result in higher Φ values yielded for larger clusters, each cluster was virtually adjusted to the size of 10% of the entire data set, while holding the percentage occurrence frequencies of the species within and outside the target cluster the same as in the original data set. The threshold Φ value for a species to be considered as diagnostic was set to 0.30. As the virtual adjustment of the cluster sizes could result in high Φ values, even for some rare species occurring in small clusters mainly by chance, the statistical significance of concentration of each species in each cluster was measured by Fisher's exact test (Chytrý et al. 2002b). Species whose occurrence in a cluster was not significantly different from random at $P < 0.001$, were removed from the groups of diagnostic species. When diagnostic species were defined in this way, one species could be diagnostic for more than one cluster. The results of the classification were summarised in a synoptic table of percentage species frequencies (constancies) in which

diagnostic species were ranked by decreasing fidelity, i.e. by a decreasing Φ value (Chytrý et al. 2002b).

Constant species presented in the text are those with an occurrence frequency exceeding 50 % for the given community. Dominant species were defined as those attaining a cover higher than 50 % in more than 50 % of relevés.

The species composition of each cluster was compared with major vegetation studies of beech forests from the Balkan Peninsula (e.g. Török et al. 1989, Dzwonko et al. 1999, Dzwonko & Loster, 2000, Bergmeier & Dimopoulos 2001, 2004), Central Europe (Willner 2002, Dierschke 1997, Dierschke & Bohn 2004) and Romanian Carpathians (Coldea 1991). On the basis of this comparison, a scheme of syntaxonomic classification of the Bulgarian beech forests was proposed, which tries to reflect local patterns of species composition, and at the same time to fit to the classification schemes already established in other countries. The new names of syntaxa were described according to the rules of International Code of Phytosociological Nomenclature (Weber et al. 2000).

Results

Classification and ordination

The dendrogram of cluster analysis was used to distinguish 15 plant communities (Fig. 2), which are presented in the synoptic table (Table 1).

The ordination reflects the ecological and geographical continuum of the studied plant communities (Fig. 3). The order of communities (Fig. 3a) along axis 1 reflects the geographically structured effects of ecological factors, which are changing both from the west to east and from the west to north-east. *Fagus orientalis* communities of eastern Bulgaria (13, 14 – Strandzha Mts. and 15 – eastern Stara Planina Mts.) are located in the right-hand part of the scatter plot, *Fagus sylvatica* communities from the north-eastern part of the country (3 – Shumensko Plateau) in the central part, and *Fagus sylvatica* communities from southwestern, western and central Bulgaria in the left-hand part. The order along axis 2 follows the gradients of moisture and pH. In the ordination diagram of species (Fig. 3b) species of coniferous forests and cool acidophilous beech forests (Luzulo-Fagion) are on the left. From these follow, in a clockwise direction, the neutrophilous beech forest species (Asperulo-Fagion), thermophilous beech forest species (Cephalanthero-Fagion) and finally the species of the Euxinian beech forests of Fagion orientalis on the right.

Based on the results of the numerical analyses, we propose the following syntaxonomic scheme of the Bulgarian beech forests:

Querco-Fagetea Br.-Bl. et Vlieger in Vlieger 1937
Fagetalia sylvaticae Pawłowski et al. 1928
Luzulo-Fagion sylvaticae Lohmeyer et Tüxen 1954
1. Luzulo luzuloidis-Fagetum sylvaticae Meusel 1937
2. *Geranium macrorrhizum-Fagus sylvatica* community

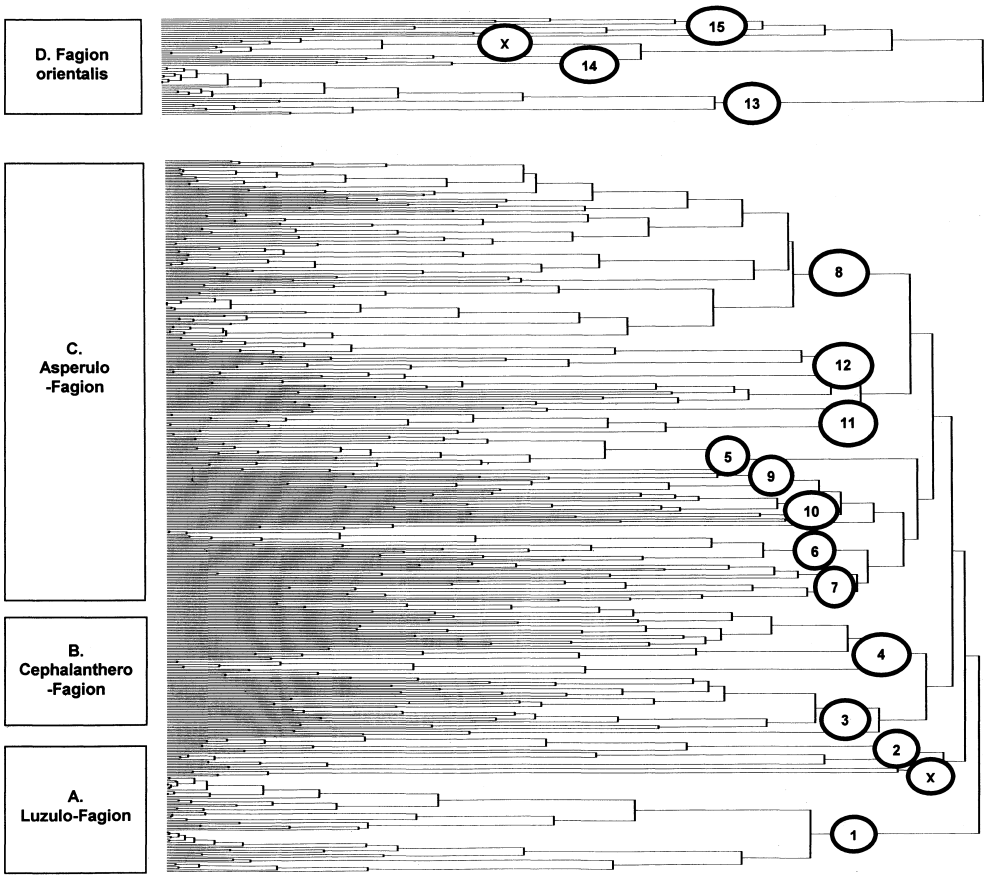

Fig. 2. Dendrograms from two separate cluster analyses of *Fagus sylvatica* and *F. orientalis* relevés. See Table 1 for the explanation of association/community numbers; clusters marked by letter X were not interpreted because of their strictly local meaning.

Cephalanthero-Fagion sylvaticae Tüxen 1955

3. Tilio tomentosae-Fagetum sylvaticae ass. nova
4. Galio pseudaristati-Fagetum sylvaticae ass. nova

Asperulo-Fagion sylvaticae Tüxen 1955

5. Festuco drymejae-Fagetum sylvaticae Reşmeriţă 1977 (syn: Festuco drymejae-Fagetum carpaticum Morariu et al. 1968 nom. illeg.)
6. *Luzula sylvatica-Fagus sylvatica* community
7. *Abies alba-Fagus sylvatica* community
8. Asperulo odoratae-Fagetum sylvaticae Sougnez et Thill 1959

9–10. Umbilico erecti-Fagetum sylvaticae ass. nova

9. Umbilico erecti-Fagetum sylvaticae typicum subass. nova

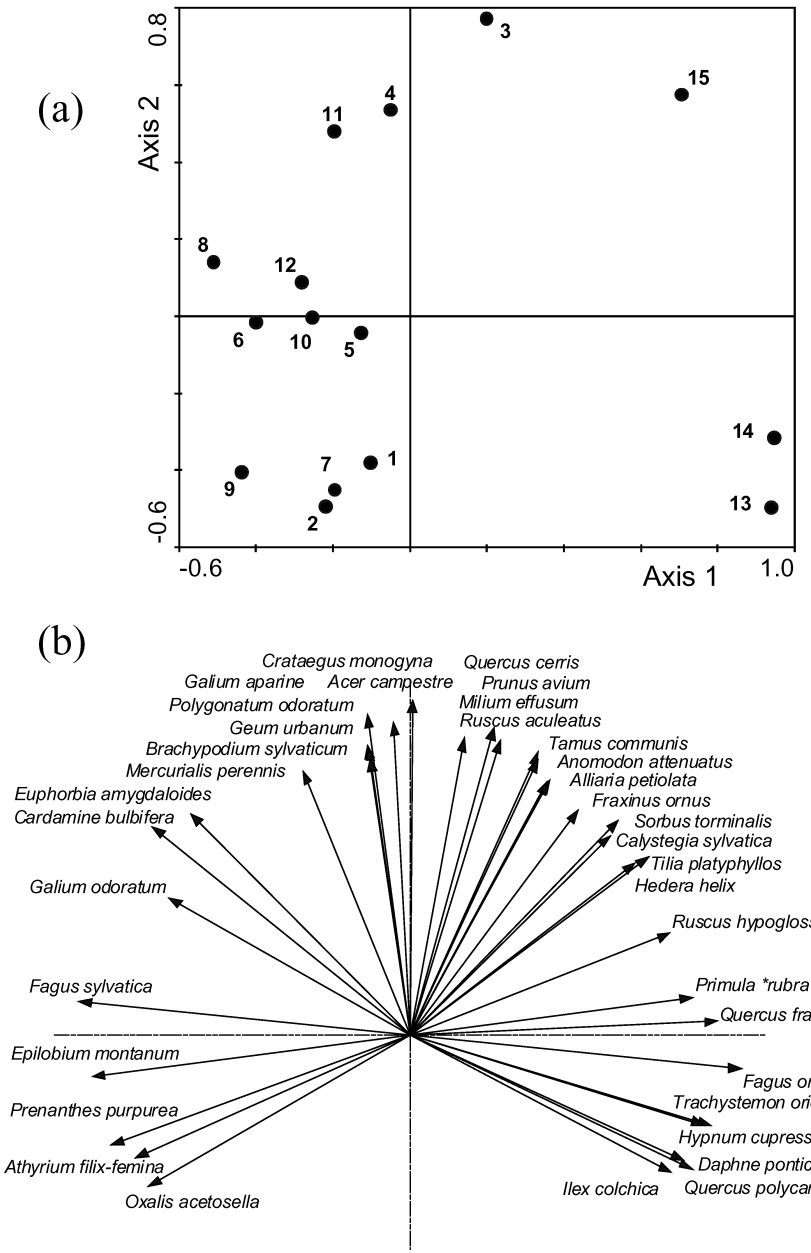

Fig. 3. PCA ordination of syntaxa (a) and species (b). See Table 1 for the explanation of association/community numbers.

Table 1. Synoptic table of the Bulgarian beech forests. Diagnostic species of individual communities are shaded and ranked by decreasing fidelity; only species with $\Phi > 0.30$ are included among diagnostic species. Species with less than 3 % frequency are omitted. A – Luzulo-Fagion, B – Cephalanthero-Fagion, C – Asperulo-Fagion, D – Fagion orientalis. 1 – Luzulo luzuloidis-Fagetum sylvaticae, 2 – Geranium macrorrhizum-Fagus sylvatica comm., 3 – Tilio tomentosae-Fagetum sylvaticae, 4 – Galio pseudaristati-Fagetum sylvaticae, 5 – Festuco drymejae-Fagetum sylvaticae, 6 – Luzula sylvatica–Fagus sylvatica comm., 7 – Abies alba-Fagus sylvatica comm., 8 – Asperulo odoratae-Fagetum sylvaticae, 9 – Umbilico erecti-Fagetum sylvaticae typicum, 10 – Umbilico erecti-Fagetum sylvaticae laurocerasetosum officinalis, 11 – Aremonio agrimonoidis-Fagetum sylvaticae violetosum reichenbachianae, 12 – Aremonio agrimonoidis-Fagetum sylvaticae allietosum ursini, 13 – Rhododendro pontici-Fagetum orientalis, 14 – Cyclamini coum-Fagetum orientalis, 15 – Primulo rubrae-Fagetum orientalis.

	A		B		C								D		
Group no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of relevés	60	20	37	46	23	20	25	112	29	7	42	18	25	15	9
No. of species with less than 3% occurrence	98	80	86	129	104	84	121	154	127	79	118	76	45	53	81
Luzulo luzuloidis-Fagetum sylvaticae															
Luzula luzuloides	100	5	.	24	30	40	48	33	21	.	29	17	4	.	33
***Geranium macrorrhizum-Fagus sylvatica* community**															
Geranium macrorrhizum	7	90	.	.	.	25	.	9	10	14	5	.	.	.	.
Isothecium alopecuroides	2	65	35	4	13	20	12	6	3	14	5	6	.	.	11
Oxalis acetosella	20	60	.	.	9	5	8	21	24	43	14	17	.	.	.
Plagiomnium affine	.	55	.	.	.	.	.	1	3	.	2	.	12	.	11
Vaccinium myrtillus	13	55	.	.	4	10	12	1	.	.	.	.	.	.	.
Lerchenfeldia flexuosa	5	45	.	2	22	30	4	2	3	14	.	6	.	.	.
Homalothecium lutescens	.	35	3	.	.	.	4	1	3	.	.	6	.	.	11
Festuca gigantea	.	30	3	7	.	.	.	4	.	.	10	.	.	.	.
Polytrichum formosum	3	25	.	.	.	5	.	1	.	14	.	.	.	.	.
Tilio tomentosae-Fagetum sylvaticae															
Acer campestre	2	.	76	43	9	.	4	4	3	.	21	11	.	.	22
Glechoma hederacea	2	20	73	.	4	.	.	6	3	43	.	.	.	.	.
Bromus ramosus	.	.	57	.	.	.	.	.	.	.	.	.	.	.	.
Tamus communis	.	.	57	35	.	.	.	.	14	.	14	.	4	7	22
Cornus mas	.	5	54	24	.	5	8	1	17	.	5	.	.	.	11
Crataegus monogyna	3	.	51	46	4	.	8	2	7	14	48	11	.	.	33
Lathyrus laxiflorus	2	.	41	26	9	5	20	1	.	.	5	.	4	7	.
Ruscus aculeatus	.	.	32	4	.	.	.	.	.	.	5	.	.	.	11
Tilia tomentosa	.	.	32	4	.	.	.	1	.	.	7	.	.	.	.
Muscari botryoides	.	.	32	7	13	.	16	5	.	43	.	.	.	.	.
Polygonatum odoratum	.	.	32	11	9	.	24	1	10	.	12	.	.	.	11
Polygonatum latifolium	.	.	30	2	.	.	8	1	.	.	.	.	.	.	.
Milium effusum	2	.	27	9	4	.	.	3	.	.	10	.	.	.	11
Dactylorhiza cordigera	.	.	24	2	17	.	8	.	.	.	.	.	.	.	.
Rosa canina	2	.	24	11	.	5	12	.	7	.	.	.	.	.	.
Glechoma hirsuta	.	5	19	9	.	.	.	.	.	.	.	.	.	.	.
Arctium lappa	.	.	14	.	.	.	4	.	.	.	.	.	.	.	.
Piptatherum virescens	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.
Galio pseudaristati-Fagetum sylvaticae															
Quercus cerris	.	.	22	28	.	.	.	.	.	.	12	.	.	7	11
Festuco drymejae-Fagetum sylvaticae															
Prenanthes purpurea	35	20	.	13	65	50	28	15	45	43	21	22	.	.	.
***Luzula sylvatica-Fagus sylvatica* community**															
Polypodium vulgare	2	20	.	4	.	50	4	5	17	14	.	.	4	.	11
Hieracium sabaudum gr.	3	5	.	4	4	35	20	7	10	43	.	.	.	.	.
Amblystegium serpens	.	.	.	.	4	15	.	.	.	.	.	.	.	.	.

Table 1. (cont.)

Group no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
***Abies alba-Fagus sylvatica* community**															
Abies alba ssp. *alba*	8	25	.	.	.	5	52	12	17	29	5	.	.	.	.
Picea abies	7	.	.	.	.	5	20	4	.	.	5	.	.	.	.
Pinus sylvestris	2	.	.	.	.	.	16	1	.	.	.	.	.	.	.
Moehringia pendula	2	5	.	.	.	.	16	4	.	.	.	.	.	.	.
Castanea sativa	.	.	.	.	.	.	12	1	.	.	.	.	.	.	.
Umbilico erecti-Fagetum sylvaticae typicum															
Mercurialis perennis	.	5	57	26	9	.	8	20	69	43	33	44	.	.	67
Circaea lutetiana	.	.	14	4	9	.	.	3	52	14	17	11	4	.	22
Carex remota	.	10	.	2	9	.	8	1	38	14	.	.	.	.	.
Umbilicus erectus	.	5	.	.	.	.	8	1	31	.	.	.	.	.	.
Lunaria rediviva	.	.	.	.	.	.	4	2	28	29	.	.	.	.	.
Petasites albus	2	.	.	.	.	.	.	.	24	.	.	.	.	.	.
Cardamine pectinata	3	5	.	.	.	.	.	5	24	.	.	6	.	.	.
Senecio vulgaris	.	.	.	.	.	.	.	.	21	14	.	.	.	.	.
Phyllitis scolopendrium	.	.	.	.	.	.	4	.	21	14	.	6	4	.	11
Chrysosplenium alternifolium	.	.	.	.	.	.	.	.	14	.	.	11	.	.	.
Hypericum umbellatum	.	.	.	.	.	.	.	.	10	.	.	.	.	.	.
Umbilico erecti-Fagetum sylvaticae laurocerasetosum officinalis															
Euonymus latifolius	.	.	.	4	17	.	4	1	7	57	.	.	8	.	11
Daphne mezereum	.	.	.	2	4	5	8	7	17	57	2	11	.	.	.
Taxus baccata	2	.	.	2	4	.	4	3	.	29	.	.	4	.	.
Aremonio agrimonoidis-Fagetum violetosum reichenbachianae															
Aremonia agrimonoides	15	10	24	26	30	20	56	28	52	57	76	39	.	13	56
Lamiastrum galeobdolon	.	25	.	41	43	5	28	26	52	.	71	61	.	.	56
Viola reichenbachiana	2	10	.	37	17	.	32	15	14	29	60	6	.	7	.
Rosa arvensis	.	.	.	7	4	.	.	.	.	.	21	.	.	.	.
Aremonio agrimonoidis-Fagetum allietosum ursini															
Allium ursinum	.	.	.	2	.	.	.	4	7	.	26	83	.	.	11
Symphytum tuberosum	5	5	.	13	4	.	.	15	17	.	36	72	.	.	.
Geranium robertianum	5	25	27	4	13	10	28	20	48	29	38	72	.	7	22
Arum maculatum	.	.	38	11	4	.	.	8	28	14	21	61	.	.	.
Impatiens noli-tangere	10	5	.	.	.	.	.	12	14	.	2	56	.	.	.
Geum urbanum	2	.	49	28	13	5	12	12	7	14	24	56	.	7	33
Corydalis bulbosa	.	.	.	.	.	.	.	4	3	.	2	44	.	.	.
Rubus idaeus	5	.	5	2	.	15	4	12	3	14	5	39	.	.	.
Veratrum lobelianum	.	.	.	.	.	.	.	1	.	.	2	22	.	.	.
Scrophularia scopolii	.	.	.	2	.	.	.	3	.	.	.	22	.	.	11
Rhododendro pontici-Fagetum orientalis															
Rhododendron ponticum	.	.	.	.	.	.	.	.	.	.	.	.	100	7	.
Ilex colchica	.	.	.	.	.	.	.	.	.	.	.	.	36	7	.
Cyclamini coum-Fagetum orientalis															
Cyclamen coum	.	.	3	.	.	.	.	.	.	.	.	.	.	27	.
Primulo rubri-Fagetum orientalis															
Tilia platyphyllos	.	.	22	7	13	.	.	.	.	.	.	.	8	7	89
Acer pseudoplatanus	7	5	22	2	9	15	16	12	24	57	24	17	.	.	67
Lathyrus hirsutus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	56
Dactylis glomerata ssp. *lobata*	.	.	.	.	.	.	.	.	.	.	.	.	.	13	56
Lapsana communis	.	5	.	.	4	5	4	4	3	.	10	.	.	7	56
Campanula persicifolia	2	.	.	.	.	.	.	1	.	.	.	.	4	7	44
Acer hyrcanum	.	5	.	.	.	5	8	5	.	.	2	.	.	7	44

Table 1. (cont.)

Group no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Lathyrus aureus	.	.	.	.	.	.	.	.	.	.	.	.	.	13	33
Doronicum orientale	.	5	.	.	.	.	.	2	.	.	2	.	.	.	33
Dicranella heteromalla	2	.	8	4	.	.	.	2	.	.	2	.	.	.	33
Smyrnium perfoliatum	.	.	3	.	.	.	.	.	.	.	.	.	.	.	22
Species diagnostic for more than one community															
Rubus hirtus	22	70	35	7	65	5	12	9	17	14	40	6	4	27	.
Luzula sylvatica	15	60	.	9	17	100	28	12	31	.	.	.	.	.	.
Viola riviniana	8	.	68	7	26	5	20	13	14	.	2	72	.	.	.
Hedera helix	.	.	76	17	13	.	16	9	14	14	7	6	64	27	56
Ruscus hypoglossum	.	.	49	2	13	.	4	2	3	14	7	.	28	53	33
Carpinus betulus	7	.	68	59	48	20	8	5	55	.	24	.	12	7	89
Tilia cordata	.	.	30	28	.	5	8	1	.	.	.	.	.	.	.
Helleborus odorus	.	.	.	48	9	.	.	12	17	.	48	44	.	.	.
Festuca drymeja	17	20	43	15	100	35	4	7	7	43	2	22	56	93	56
Salvia glutinosa	5	.	.	7	9	15	24	8	52	43	21	50	.	.	11
Laurocerasus officinalis	3	.	.	.	4	.	.	.	.	71	.	.	28	.	.
Trachystemon orientalis	.	.	.	.	.	.	.	.	.	14	.	.	64	60	33
Hypnum cupressiforme	2	5	.	4	13	5	.	8	.	14	7	.	76	53	56
Quercus polycarpa	.	.	.	.	.	.	.	.	.	.	.	.	52	73	.
Quercus frainetto	.	.	3	20	.	.	.	.	.	.	7	.	44	87	11
Daphne pontica	.	.	.	.	.	.	.	.	.	.	.	.	24	67	.
Primula acaulis ssp. *rubra*	.	.	.	.	.	.	.	.	.	.	.	.	4	33	56
Fagus orientalis	.	.	.	.	.	.	.	.	.	.	.	.	100	100	100
Other species with high frequency															
Fagus sylvatica	100	100	100	100	100	100	100	100	100	100	100	100	.	.	.
Dryopteris filix-mas	30	85	11	9	39	30	52	42	83	14	62	56	4	7	11
Melica uniflora	3	25	46	50	43	10	24	33	14	29	62	33	4	13	67
Sanicula europaea	5	5	46	52	13	15	20	18	55	71	62	72	4	7	78
Mycelis muralis	52	40	51	61	43	55	80	63	72	57	81	56	.	27	100
Galium odoratum	35	75	49	35	70	35	24	65	79	71	93	78	.	7	67
Euphorbia amygdaloides	18	20	38	54	26	25	52	34	38	43	52	61	.	13	44
Cardamine bulbifera	20	35	46	57	35	10	28	61	69	43	81	78	.	.	33
Poa nemoralis	57	45	.	48	39	65	76	43	41	43	36	44	.	13	78
Epilobium montanum	20	20	8	2	17	15	32	21	14	14	21	22	.	.	.
Fragaria vesca	20	5	19	35	30	10	16	12	28	43	2	11	.	.	.
Hieracium murorum gr.	27	20	.	7	22	20	24	8	10	.	10	6	4	7	.
Corylus avellana	2	10	8	17	9	15	28	7	24	43	12	.	4	.	.
Galium pseudaristatum	8	5	.	22	17	20	8	4	31	29	5	.	.	13	44
Viola odorata	2	.	43	52	9	.	4	27	34	14	36	.	12	47	33
Galium aparine	2	.	49	22	4	.	20	14	10	14	43	6	.	7	33
Cephalanthera rubra	5	.	.	2	13	.	4	5	3	29	7	22	4	20	11
Pteridium aquilinum	12	10	.	17	4	10	8	10	3	.	17	.	20	27	.
Athyrium filix-femina	15	15	.	2	17	5	8	7	10	43	7	33	.	.	.
Potentilla micrantha	.	5	.	13	9	5	12	8	3	.	33	11	.	7	11
Fraxinus ornus	.	.	32	22	4	10	20	4	7	.	10	.	12	13	33
Acer platanoides	.	.	.	4	26	15	16	9	28	.	10	6	8	7	44
Festuca heterophylla	18	5	24	11	9	20	20	4	7	.	.	.	.	.	22
Dicranum scoparium	17	10	.	.	.	5	8	15	21	14	5	6	4	.	.
Veronica officinalis	12	10	.	4	26	20	24	6	10	.	5	.	.	.	11
Veronica chamaedrys	8	5	.	11	4	20	32	12	.	.	5	28	.	.	44
Brachythecium velutinum	7	15	11	15	.	.	.	12	3	.	31	11	8	.	56
Sorbus aucuparia	7	15	5	.	4	25	24	5	.	43	2	11	.	.	.
Cruciata glabra	5	20	.	26	13	20	24	2	7	.	24	11	.	.	.
Stachys sylvatica	3	5	19	4	17	.	.	1	3	.	5	11	.	.	11
Moehringia trinervia	10	.	.	2	13	.	16	9	17	14	10	6	.	.	22
Lathyrus vernus	2	.	32	43	17	5	28	8	3	.	26	17	.	.	.

Table 1. (cont.)

Group no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Aegopodium podagraria	.	10	14	15	.	.	16	11	31	14	19	22	.	.	22
Myrrhoides nodosa	.	5	8	9	9	10	20	8	17	29	.	.	.	.	11
Sorbus torminalis	.	.	19	28	4	.	16	1	3	.	5	.	4	33	44
Pulmonaria rubra	5	15	.	7	22	.	20	9	14	14	7	.	.	.	.
Veronica montana	3	5	.	.	4	5	.	4	14	14	5	6	.	.	.
Ajuga reptans	2	5	.	22	13	.	20	4	17	.	10	.	4	.	.
Senecio nemorensis	2	5	.	4	4	10	.	1	14	29	2	.	.	.	.
Lilium martagon	2	5	8	15	.	.	.	4	3	.	10	11	.	.	33
Dactylis glomerata ssp. *glomerata*	5	.	38	37	.	10	16	4	7	.	2	11	.	.	.
Populus tremula	5	.	3	4	.	15	16	2	3	.	.	.	16	20	.
Quercus dalechampii	3	.	19	28	22	35	8	4	3	.	12	.	.	.	.
Lathyrus niger	2	.	.	11	4	5	12	3	.	.	5	.	.	7	22
Polystichum setiferum	.	10	.	2	.	30	8	1	31	29	.	.	24	27	.
Brachypodium sylvaticum	.	5	27	22	.	5	16	4	24	.	26	.	.	.	33
Pulmonaria officinalis	.	5	5	11	17	.	.	7	14	.	26	6	.	.	11
Polygonatum verticillatum	.	5	.	4	13	5	8	3	.	14	.	6	.	.	11
Prunus avium	.	.	30	26	4	.	8	6	14	.	17	.	.	13	33
Sambucus nigra	.	.	19	4	9	5	.	8	38	.	21	.	.	7	33
Alliaria petiolata	.	.	11	2	4	.	4	4	3	.	5	.	.	7	33
Rubus rivularis	10	.	.	2	13	.	.	3	7	43	2	6	.	.	.
Myosotis sylvatica	7	5	3	.	.	5	4	1	14	.	14	.	.	.	.
Asplenium trichomanes	7	.	3	.	.	10	16	3	14	.	2	.	4	.	.
Neottia nidus-avis	5	.	.	13	9	.	16	18	.	.	36	.	4	.	11
Carex sylvatica	2	.	.	17	17	.	.	4	.	.	21	17	8	.	33
Hordelymus europaeus	.	5	.	7	9	5	.	9	3	.	7	6	.	.	.
Doronicum columnae	.	5	.	2	.	25	16	4	14	14	2	.	.	.	.
Calamagrostis arundinacea	8	15	.	4	9	25	16	2	.	.	.	.	.	.	.
Galeopsis speciosa	3	10	.	.	9	.	4	5	14	.	2	.	.	.	.
Urtica dioica	2	10	.	.	.	.	.	7	10	.	12	28	.	7	.
Saxifraga rotundifolia	2	10	.	2	.	15	20	6	14	.	.	.	.	.	.
Cystopteris fragilis	2	.	.	.	.	.	4	9	10	14	10	11	.	.	.
Primula veris	2	.	.	15	.	5	24	3	.	14	5	.	.	.	.
Anthriscus sylvestris	2	.	14	.	.	.	12	4	17	.	12	.	.	.	22
Physospermum cornubiense	.	.	19	33	13	10	16	3	.	.	12	.	.	.	.
Cephalanthera longifolia	.	.	16	2	.	5	4	1	3	29	.	.	.	.	.
Clematis vitalba	.	.	14	15	.	.	12	1	7	14	14	.	.	.	.
Orchis pallens	.	.	14	11	4	.	4	3	3	29	.	.	.	.	.
Orthilia secunda	.	.	3	2	13	5	12	4	3	.	.	.	.	.	.
Euonymus verrucosus	.	.	3	4	4	10	16	3	7	.	.	.	.	.	.
Lathyrus venetus	.	.	.	11	17	5	12	1	3	.	2	.	.	.	.
Isopyrum thalictroides	.	.	.	9	4	5	.	3	3	.	7	6	.	.	.
Galium rotundifolium	12	.	.	2	9	.	.	4	14	14	.	.	.	.	.
Hepatica nobilis	3	.	.	15	.	.	8	.	10	29	.	22	.	.	.
Actaea spicata	2	.	.	.	.	.	.	4	17	29	7	6	.	.	.
Carpinus orientalis	2	.	16	9	.	.	4	1	.	.	2	.	.	.	.
Campanula rapunculoides	.	.	.	26	4	.	.	6	10	14	29	.	.	.	.
Cephalanthera damasonium	.	.	.	13	.	.	.	8	3	14	7	6	.	.	.
Ostrya carpinifolia	.	.	.	.	13	5	20	2	10	14	.	.	.	.	.
Asarum europaeum	2	.	.	7	.	.	16	4	21	.	.	.	.	.	.
Luzula forsteri	5	.	.	.	9	.	12	5	.	.	.	6	.	.	.
Salix caprea	5	.	.	.	.	.	12	4	7	14	.	.	.	.	.
Erythronium dens-canis	.	.	14	13	.	.	.	3	10	14	.	.	.	.	.
Bromus benekenii	.	.	.	13	.	.	.	6	.	.	2	.	.	7	22
Campanula rotundifolia	.	.	8	4	.	.	16	.	14	.	.	.	.	.	.
Anemone ranunculoides	.	.	.	9	.	.	12	6	.	.	.	6	.	.	.
Lamium garganicum ssp. *garganicum*	.	.	.	.	.	.	4	12	.	.	5	.	.	.	.

10. Umbilico erecti-Fagetum sylvaticae laurocerasetosum officinalis subass. nova
11–12. Aremonio agrimonoidis-Fagetum sylvaticae Boşcaiu in Resmeriţă 1972
11. Aremonio agrimonoidis-Fagetum sylvaticae violetosum reichenbachianae subass. nova
12. Aremonio agrimonoidis-Fagetum sylvaticae allietosum ursini subass. nova

Fagion orientalis Quézel et al. 1992

13. Rhododendro pontici-Fagetum orientalis Stefanov ex Tzonev et al. ass. nova
14. Cyclamini coum-Fagetum orientalis ass. nova
15. Primulo rubrae-Fagetum orientalis ass. nova

The type relevés of the new associations are presented in Appendix I. The full relevé tables (electronic appendix) can be found on the internet web site www.natura2000bg.org/natura/eng/docs_disc.php

1. Luzulo luzuloidis-Fagetum sylvaticae
Diagnostic species: *Luzula luzuloides*
Constant species: *Fagus sylvatica*, *Mycelis muralis*, *Luzula luzuloides* and *Poa nemoralis*
Dominant species: *Fagus sylvatica* and *Luzula luzuloides*
Distribution: Stara Planina Mts., Sredna Gora Mts., Ossogovska Mts., Western Rhodopi Mts., Vrachanska Planina Mts., Vassilyovska Mts. and Belassitsa Mts.

This is the largest group of acidophilous beech forests, which are widespread across the country. They occur at altitudes mostly between 1200–1400 m and occupy gentle slopes of different aspects. The relevés were mainly made on acidic soils, such as dystric cambisols (CMd), umbric leptosols (LPu), and some of them also on eutric cambisols (CMe) such as in the calcareous area of the Vrachanska Planina Mts. Their low species richness and specific habitats make them very close to the Central European acidophilous beech forests; therefore we suggest including them in the alliance Luzulo-Fagion and the association Luzulo-Fagetum, which were originally described from Central Europe. There is a small regional variability, but it is not sufficient to distinguish subassociations.

Several authors (Zoller et al. 1977, Michalik 1990, Dzwonko & Loster 2000) supposed an occurrence of a syntaxon in the Balkans that is closely related to the central European acidophilous beech forests of the Luzulo-Fagion. There is the acidophilous association Orthilio secundae-Fagetum sylvaticae (Barbero et Quézel 1976) Bergmeier 1990, described by Bergmeier & Dimopolous (2001) from Greece, but it is the southernmost variant of the acidophilous beech forests and has some specific features, which are not found in the Luzulo-Fagion type forests in Bulgaria.

2. Geranium macrorrhizum-Fagus sylvatica community
Diagnostic species: *Festuca gigantea*, *Geranium macrorrhizum*, *Homalothecium lutescens*, *Isothecium alopecuroides*, *Lerchenfeldia* (= *Avenella*) *flexuosa*, *Luzula sylvatica*, *Oxalis acetosella*, *Plagiomnium affine*, *Polytrichum formosum*, *Rubus hirtus* and *Vaccinium myrtillus*
Constant species: *Dryopteris filix-mas*, *Fagus sylvatica*, *Galium odoratum*, *Geranium macrorrhizum*, *Isothecium alopecuroides*, *Luzula sylvatica*, *Oxalis acetosella*, *Plagiomnium affine*, *Rubus hirtus* and *Vaccinium myrtillus*
Dominant species: *Fagus sylvatica*, *Geranium macrorrhizum*, *Luzula sylvatica* and *Rubus hirtus*
Distribution: Ossogovska Mts., Vassilyovska Mts., Eastern Rhodopi Mts., Northern Pirin Mts., Belassitsa Mts., Rui Mts and Rila Mts.

This group includes beech forests on rock outcrops and screes. They are distributed at altitudes of 1100–1600 m on slopes of different, but mostly eastern, aspects. The herb layer is patchily distributed among stones, where some soil, mainly dystric cambisol (CMd), is developed. A typical species is *Geranium macrorrhizum*, which has a wide geographical distribution in south-eastern Europe. This community is divided into two groups – a group rich in bryophytes (in places with well-developed screes) and a group with a predominance of *Geranium macrorrhizum*. The former is restricted only to the Ossogovska and Vassilyovska Mts., while the latter is more common. A high frequency of some species typical of Asperulo-Fagion such as *Galium odoratum*, *Geranium robertianum* and *Lamiastrum galeobdolon* indicates the transitional character of this community between the alliances Luzulo-Fagion and Asperulo-Fagion.

Bergmeier & Dimopoulos (2001) described a *Geranium macrorrhizum-Fagus sylvatica* community from crystalline limestone at high altitudes in Greece. By contrast, the Bulgarian community occurs mostly on acidic rocks (granite, gneiss) at comparatively low altitudes. However, it is impossible to compare the Bulgarian and Greek communities in more detail because Bergmeier & Dimopolous (2001) did not analyse the moss layer, which is an important feature of the Bulgarian community.

3. Tilio tomentosae-Fagetum sylvaticae
Diagnostic species: *Acer campestre*, *Arctium lappa*, *Bromus ramosus*, *Carpinus betulus*, *Cornus mas*, *Dactylorhiza cordigera*, *Glechoma hederacea*, *Hedera helix*, *Lathyrus laxiflorus*, *Melissa officinalis*, *Mercurialis perennis*, *Milium effusum*, *Muscari botryoides*, *Piptatherum virescens*, *Polygonatum latifolium*, *P. odoratum, Ruscus aculeatus, R. hypoglossum*, *Tamus communis*, *Tilia cordata*, *T. tomentosa* and *Viola riviniana*
Constant species: *Acer campestre*, *Bromus ramosus*, *Carpinus betulus*, *Cornus mas*, *Crataegus monogyna*, *Fagus sylvatica*, *Glechoma hederacea*, *Hedera helix*, *Mercurialis perennis*, *Mycelis muralis*, *Viola riviniana* and *Tamus communis*
Dominant species: *Fagus sylvatica* and *Rubus hirtus*
Distribution: Shumensko Plateau and Dragoevska Mts.

This association is only found in north-eastern Bulgaria near the towns of Shumen and Preslav. Beech forests occur patchily there, in a landscape dominated by forests and bushes of deciduous *Quercus* species, *Carpinus orientalis* and *Tilia tomentosa*, at altitudes of 150–500 m. They occur on north-facing slopes or in small wet valleys. The soil type is luvic phaeozem (PHl) or rendzic leptosol (LPk). The foothill region of north-eastern Bulgaria has preserved many relicts and endemics, including the last remnants of natural communities of *Aesculus hippocastanum* and *Cercis siliquastrum* in the eastern part of the Balkan Peninsula, which occur in the region of Shumen. It determines the high specificity of the local beech forests. They belong to the thermophilous group, are similar in their species composition to the Doronico orientalis-Fagenion and Ostryo-Fagenion suballiances, but their affinity to the Cephalanthero-Fagion alliance is obvious. They are closely related to the next association.

4. Galio pseudaristati-Fagetum sylvaticae
Diagnostic species: *Helleborus odorus*, *Quercus cerris* and *Tilia cordata*
Constant species: *Cardamine bulbifera*, *Carpinus betulus*, *Euphorbia amygdaloides*, *Fagus sylvatica*, *Mycelis muralis*, *Sanicula europaea* and *Viola odorata*
Dominant species: *Fagus sylvatica*
Distribution: Stara Planina Mts., Vitosha Mts., Golo Burdo Mts., Lyulin Mts., Rui Mts., Dragoevska Mts., Mikrenski Hills, Lozenska Mts., Sredna Gora Mts., Eastern Rhodopi Mts. and Momino Plateau.

This thermophilous association is widespread across the country. The relevés are mostly from lower altitudinal belts of higher mountain ranges or from lower mountain ranges (350–1250 m), such as the Golo Burdo, Rui, Mikrenski Hills, Lyulin and many others. These forests occur commonly on shaded slopes on eutric cambisols (CMe) and rendzic leptosols (LPk). A remarkable feature is the presence of species typical of the Quercion frainetto forests (e.g. *Quercus cerris, Q. frainetto*, *Helleborus odorus, Lathyrus niger* and *Physospermum cornubiense*) and the presence of comparatively well-developed shrub layer with *Acer campestre*, *Corylus avellana, Crataegus monogyna* and *Fraxinus ornus.* Both groups of Bulgarian thermophilous beech forests are more closely related to the surrounding oak forests than to other beech forests.

5. Festuco drymejae-Fagetum sylvaticae
Diagnostic species: *Festuca drymeja*, *Prenanthes purpurea* and *Rubus hirtus*
Constant species: *Fagus sylvatica*, *Festuca drymeja*, *Galium odoratum*, *Prenanthes purpurea* and *Rubus hirtus*
Dominant species: *Fagus sylvatica* and *Festuca drymeja*
Distribution: Ossogovska Mts., Stara Planina Mts., Rui Mts., Rhodopi Mts., Sredna Gora Mts. and Mikrenski Hills.

This association includes forests on nutrient-poor to moderately rich soils (dystric and eutric cambisols; CMd, e), which are well supplied with water

due to their occurrence on shaded slopes at altitudes of 600–1450 m. Wet soils are indicated by meso-hygrophilous species such as *Eupatorium cannabinum* and *Prunella vulgaris*. *Festuca drymeja* has a broad habitat range in Bulgaria, but it was designated by Dzwonko et al. (1999) as a diagnostic species of the alliance Aremonio-Fagion and suballiance Doronico columnae-Fagenion. *Festuca drymeja* is a frequent species in the neutrophilous Bulgarian beech forests but rarely becomes a dominant species of the herb layer. It is confined to the areas of warmer climate; it is rare in Central Europe but tends to be increasingly frequent in beech forests of the Balkan Peninsula. Rather high frequencies of *Carpinus betulus* and *Quercus petraea* s. lat. reflect the position of these forests at the lower part of the beech belt, at altitudes of approximately 1000 m, in the transitional zone between the Asperulo-Fagion and Carpinion forests. *Festuca drymeja* is also often found in the thermophilous and wet communities of *Fagus orientalis*.

The floristic composition of the Bulgarian stands is very similar to the stands described from Romania (Morariu et al. 1968, Reşmeriţă 1977, Coldea 1991) as an association Festuco drymejae-Fagetum. Therefore, we assign them to this association, in spite of the fact that it was included in the suballiance Symphyto-Fagenion by Coldea (1991).

6. Luzula sylvatica-Fagus sylvatica community
Diagnostic species: *Amblystegium serpens*, *Hieracium sabaudum* s. lat., *Luzula sylvatica* and *Polypodium vulgare*
Constant species: *Fagus sylvatica*, *Luzula sylvatica*, *Mycelis muralis* and *Poa nemoralis*
Dominant species: *Fagus sylvatica*
Distribution: Central Stara Planina Mts., Belassitsa Mts., Ihtimanska Sredna Gora Mts., Rila Mts., Vrachanska Planina Mts. and Western Rhodopi Mts.

This community occurs on very steep slopes at altitudes of 850–1500 m, on dystric cambisols (CMd). It is transitional between the Luzulo-Fagion and Asperulo-Fagion, containing many common species of Luzulo-Fagion, such as *Luzula sylvatica*, *Lerchenfeldia* (= *Avenella*) *flexuosa* and *Calamagrostis arundinacea*. It occurs only in western Bulgaria and most relevés are from the Belassitsa Mts. and the Western Rhodopi Mts. It reaches its north-western distribution limits in the Vitinja Pass in the western part of the Central Stara Planina. It is similar to the Central European subassociation Asperulo-Fagetum luzuletosum luzuloidis, which is a transitional type between Asperulo-Fagetum typicum and acidophilous beech forests. However, these forests contain some Balkan endemics or eastern sub-mediterranean species such as *Clematis viticella*, *Genista lydia*, *Hypericum rumeliacum* and *Senecio papposus* ssp. *wagneri*, which occur scarcely and are not very specific to the beech forests. Rather, they occur there due to propagule immigration from the surrounding open oak forests or grasslands, which is facilitated by the open canopy of many of these beech forests. *Pinus nigra* also represents a sub-mediterranean influence in

this vegetation type and indicates the position of this habitat at the ecological limit of *Fagus sylvatica*. Similar beech forests with *Pinus nigra* were documented in Greece, but not considered at the association level by Bergmeier & Dimopoulos (2001). Many sub-mediterranean, thermophilous and heliophilous species, including some endemics of the central Balkan Peninsula, occur there, but with a low constancy. It is similar to the suballiance Doronico columnae-Fagion, described by Dzwonko et al. (1999), which contains both neutrophilous and acidophilous species, but also to some subtypes of the Central European association Asperulo-Fagetum.

7. Abies alba-Fagus sylvatica community
Diagnostic species: *Abies alba* ssp. *alba*, *Castanea sativa*, *Melampyrum sylvaticum*, *Moehringia pendula*, *Picea abies* and *Pinus sylvestris*
Constant species: *Abies alba* ssp. *alba*, *Aremonia agrimonoides*, *Dryopteris filix-mas*, *Euphorbia amygdaloides*, *Fagus sylvatica*, *Mycelis muralis* and *Poa nemoralis*
Dominant species: *Fagus sylvatica*
Distribution: Stara Planina Mts., Western Rhodopi Mts., Rila Mts., Vitosha Mts., Rui Mts. and Belassitsa Mts.

This group represents mixed forests with *Fagus sylvatica* and *Abies alba*. Their stands occur in patches inside different types of coniferous forests of *Pinus sylvestris* or *Picea abies*, mostly at altitudes of 1000–1400 m. The soils are different types of cambisols (eutric, dystric and humic; CMe, d, u). These forests mostly occur in the Rhodopi Mts., the region of the largest coniferous forests in the Balkan Peninsula. Their intrazonal character implies the occurrence of coniferous forest species (e.g. *Melampyrum sylvaticum*, *Moehringia pendula* and *Picea abies*) as well as of some endemic or sub-mediterranean species (e.g. *Castanea sativa*, *Coronilla emerus*, *Fritillaria pontica* and *Ostrya carpinifolia*). The presence of fir indicates less extreme climatic conditions. This tree reached its largest distribution in Bulgaria during the Atlantic period (8000–4800 yrs BP), when the climate was more favourable than nowadays (Bozhilova 1986). This group is very similar to the association Abieti-Fagetum "moesiacum" of Horvat et al. (1974; accepted also by Dzwonko et al. 1999). At the same time, it is not very different from the Soldanello rhodopeae-Fagetum, described by Bergmeier & Dimopoulos (2001) from the southern slopes of the Rhodopi Mts., in spite of the fact that *Abies alba* is replaced by *Abies borisii-regis* there. The group of sub-mediterranean species reflects the position of these forests at the southernmost limit of spruce distribution in Europe.

8. Asperulo odoratae-Fagetum sylvaticae
Diagnostic species: none
Constant species: *Cardamine bulbifera*, *Fagus sylvatica*, *Galium odoratum* and *Mycelis muralis*

Dominant species: *Fagus sylvatica*
Distribution: Stara Planina Mts., Sredna Gora Mts., Ossogovska Mts., Belassitsa Mts., Rhodopi Mts., Rila Mts., Pirin Mts., Rui Mts., Vlahina Mts., Konyavska Mts., Vassilyovska Mts. and Mikrenski Hills.

This is a group of neutrophilous and species-poor beech forests with a small cover of herb layer. It is the most widespread type of beech forests in the mountain areas of Bulgaria, occupying mostly the middle part of the beech belt at altitudes of 1000–1400 m. The soils are different types of cambisols (eutric, dystric and humic; CMe, d, u). These forests have no diagnostic species and are very similar to the community of *Fagus sylvatica* and *Galium odoratum* described by Bergmeier & Dimopoulos (2001) from Greece. They reported this beech forest type to be the most common in Greece on deep brown soils. We suppose this community to belong to the Asperulo-Fagetum association, provided it is understood in a broader sense, according to Willner (2002).

9. Umbilico erecti-Fagetum sylvaticae typicum
Diagnostic species: *Cardamine pectinata*, *Carex remota*, *Chrysosplenium alternifolium*, *Circaea lutetiana*, *Hypericum umbellatum*, *Lunaria rediviva*, *Mercurialis perennis*, *Petasites albus*, *Phyllitis scolopendrium*, *Salvia glutinosa*, *Senecio vulgaris* and *Umbilicus erectus*
Constant species: *Aremonia agrimonoides*, *Cardamine bulbifera*, *Carpinus betulus*, *Circaea lutetiana*, *Dryopteris filix-mas*, *Fagus sylvatica*, *Galium odoratum*, *Lamiastrum galeobdolon*, *Mercurialis perennis*, *Mycelis muralis*, *Salvia glutinosa* and *Sanicula europaea*
Dominant species: *Fagus sylvatica*, *Galium pseudaristatum*, *Lunaria rediviva* and *Sanicula europaea*
Distribution: Central Stara Planina Mts., Sredna Gora Mts., Lozenska Mts. and Vassilyovska Mts.

This community is the wettest beech forest in Bulgaria. It occurs along the riverbanks and on the slopes of shady valleys within the altitudinal range of 750–1550 m. The soil type is eutric cambisol (CMe) and colluviosol (CL). The herb layer has low cover. Among many meso-hygrophilous plants within this community, there are Balkanic and eastern sub-mediterranean endemics such as *Angelica pancici*, *Daphne blagayana* and *Umbilicus erectus*. This association is geographically vicarious to the Central European Tilio-Acerion communities, or some specific Central European beech forests that occur in wet and shady valleys, as indicated by a group of hygrophilous species such as *Carex remota*, *Chrysosplenium alternifolium* and *Circaea lutetiana*. The Romanian association Phyllitido-Fagetum Vida (1959) 1963 is also similar, but it contains several Carpathian species, such as *Aconitum moldavicum*, *Hieracium rotundatum* and *Symphytum cordatum* (Coldea 1991). In Bulgaria this association occurs only in the mountains in habitats with high air humidity and rainfall. It occurs mostly in the lower part of the beech belt because in such locally cold places at higher altitudes beech probably cannot survive winters and late frosts in

spring. Most relevés are from the Central Balkan, an area with numerous rivers on the northern slopes, and the surrounding regions of Sredna Gora, Rui and Vassilyovska Mts. They are identical to the provisional subassociation described by Michalik (1990) from Boatin Reserve (Central Balkan National Park) as Asperulo-Fagetum lunarietosum redivivae.

This association is related to the beech forests of wet places in Greece, notably Lamiastro montani-Fagetum and *Geranium versicolor-Urtica dioica-Fagus sylvatica* community (Bergmeier & Dimopoulus 2001), but the species composition of both reflects the drier conditions typical of the Greek climate. In this respect, both Greek communities are more similar to Bulgarian groups 11 and 12, which are also wet, but less so than group 9.

10. Umbilico erecti-Fagetum sylvaticae laurocerasetosum officinalis
Diagnostic species: *Daphne mezereum*, *Euonymus latifolius*, *Laurocerasus officinalis* and *Taxus baccata*
Constant species: *Acer pseudoplatanus*, *Aremonia agrimonoides*, *Daphne mezereum*, *Euonymus latifolius*, *Fagus sylvatica*, *Galium odoratum*, *Laurocerasus officinalis*, *Mycelis muralis* and *Sanicula europaea*
Dominant species: *Fagus sylvatica* and *Laurocerasus officinalis*
Distribution: Stara Planina Mts.

This is a small but very specific group of beech forests, closely related to the community described by Jovanović (1973) from the Ostrozub Mts. in south-eastern Serbia, near the Bulgarian border, which is the westernmost locality of *Laurocerasus officinalis* in the Balkans. The Ostrozub Mts. is a continuation of the Stara Planina Mts. in Serbia. The Stara Planina, along with the Strandzha Mts. in the Bulgarian-Turkish border area, has preserved a relict Tertiary flora of Euxinian type. The subassociation Umbilico erecti-Fagetum laurocerasetosum, exclusively found in the Central Stara Planina Mts. at altitudes of 950–1400 m, is very probably a vegetation type of relict beech forests, perhaps closely related to the Balkan Ice Age refugia of beech (Bozhilova 1986). This relict character is indicated by the Euxinian species such as *Laurocerasus officinalis*, *Periploca graeca* and *Trachystemon orientalis*, as well as by the sub-atlantic/sub-mediterranean *Taxus baccata*. Through their floristic composition, these forests of *Fagus sylvatica* are related to the *Fagus orientalis* forests, which occur in the eastern Stara Planina Mts., and are most widespread in the Strandzha Mts.

11. Aremonio agrimonoidis-Fagetum sylvaticae violetosum reichenbachianae
Diagnostic species: *Aremonia agrimonoides*, *Helleborus odorus*, *Lamiastrum galeobdolon*, *Rosa arvensis* and *Viola reichenbachiana*
Constant species: *Aremonia agrimonoides*, *Cardamine bulbifera*, *Dryopteris filix-mas*, *Fagus sylvatica*, *Galium odoratum*, *Lamiastrum galeobdolon*, *Melica uniflora*, *Mycelis muralis*, *Sanicula europaea* and *Viola reichenbachiana*

Dominant species: *Fagus sylvatica* and *Melica uniflora*
Distribution: Stara Planina Mts., Vassilyovska Mts., Belassitsa Mts., Vlahina Mts., Konyavska Mts., Sredna Gora Mts., Pirin Mts., Eastern Rhodopi Mts., Rui Mts., Vitosha Mts., Mikrenski Hills.

This group is transitional between the typical Asperulo-Fagion forests and more thermophilous forests at lower altitudes (400–1100 m), and is similar to the previous one. These forests harbour many neutrophilous species typical of the Asperulo-Fagion alliance, such as *Cardamine bulbifera*, *Lamiastrum galeobdolon*, *Sanicula europaea* and *Viola reichenbachiana*, but the number of more thermophilous species is also high, including *Crataegus monogyna*, *Helleborus odorus, Potentilla micrantha*, *Pyrus pyraster* and *Rosa arvensis*. These forests are the richest and the most thermophilous group of Asperulo-Fagion in Bulgaria. A high abundance of *Allium ursinum* in some places indicates a high air and soil humidity and nutrient-rich soils, as well as relationships to the Central European beech forests. These Bulgarian forests are very similar to the association Aremonio-Fagetum described from Romania. Coldea (1991) noted that this association lacks some typical species of Symphyto-Fagion, but contains several thermophilous species. The Bulgarian and Romanian forests mainly differ in the presence of a few species of Carpathian flora, such as *Dentaria glandulosa* and *Helleborus purpurascens*, and are also similar in their abiotic environment, including high humidity, typical altitudes and slope aspects, and occurrence on nutrient-rich soils. Therefore we suggest assigning Bulgarian stands in the association described from Romania, but as geographically delimited subassociations.

12. Aremonio agrimonoidis-Fagetum sylvaticae allietosum ursini
Diagnostic species: *Allium ursinum*, *Aremonia agrimonoides*, *Arum maculatum*, *Corydalis bulbosa*, *Geranium robertianum*, *Geum urbanum*, *Impatiens noli-tangere*, *Salvia glutinosa*, *Scrophularia scopolii Symphytum tuberosum*, *Rubus idaeus*, *Veratrum lobelianum* and *Viola riviniana*
Constant species: *Allium ursinum*, *Arum maculatum*, *Cardamine bulbifera*, *Dryopteris filix-mas*, *Euphorbia amygdaloides*, *Fagus sylvatica*, *Galium odoratum*, *Geranium robertianum*, *Geum urbanum*, *Impatiens noli-tangere*, *Lamiastrum galeobdolon*, *Mycelis muralis*, *Sanicula europaea*, *Symphytum tuberosum* and *Viola riviniana*
Dominant species: *Fagus sylvatica* and *Impatiens noli-tangere*
Distribution: Vrachanska Planina Mts., Sredna Gora Mts. and Stara Planina Mts.

This subassociation is distributed mainly in the Vrachanska Planina Mts., where it occupies nutrient-rich and wet soils (eutric cambisols; CMe) and frequntly contains the Central European species *Allium ursinum*, which is rare in the Greek and Macedonian beech forests. The presence of *Rubus idaeus, Scrophularia scopolii* and *Urtica dioica* indicates human impact, better light conditions, or a naturally high nutrient supply.

13. Rhododendro pontici-Fagetum orientalis
Diagnostic species: *Fagus orientalis*, *Hedera helix*, *Hypnum cupressiforme*, *Ilex colchica*, *Laurocerasus officinalis*, *Rhododendron ponticum* and *Trachystemon orientalis*
Constant species: *Fagus orientalis*, *Festuca drymeja*, *Hedera helix*, *Hypnum cupressiforme*, *Quercus polycarpa, Rhododendron ponticum* and *Trachystemon orientalis*
Dominant species: *Fagus orientalis* and *Rhododendron ponticum*
Distribution: Strandzha Mts.

This group includes the communities of *Fagus orientalis* in the Strandzha Mts. that occur in the valleys and places with high air humidity, on soils belonging to the types of cambisols (CM), alisols (AL), and planosols (PL). The altitude is low, ranging from 200 to 250 m. Within the shrub layer, *Rhododendron ponticum* is the dominant species and in places it attains a cover of 80–90 %. Its leaf litter is poisonous and a small number of other species can survive in the herb layer (Çolak 1997). These forests have a similar floristic composition to the communities of *Fagus orientalis* in northern Turkey, with some evergreen Euxinian shrubs occurring besides *Rhododendron ponticum*, in particular *Daphne pontica, Ilex colchica* and *Laurocerasus officinalis*. However, they differ from the beech forests of northern Turkey in the higher representation of European and Balkanic elements. A similar association Ilici colchici-Fagetum orientalis, described by Quézel et al. (1980, 1992) from the north-eastern part of the Anatolian plateau, has many species that do not occur in the Strandzha Mts., including *Abies bornmuelleriana*, *Digitalis orientalis, Ranunculus brutius* and *Rhododendron flavum*. We suggest that the association Rhododendro-Fagetum occurs in Bulgaria and very probably also in the Turkish part of the Strandzha Mts., but not on the Anatolian plateau, which is an area of distribution of its geographic vicariant, association Ilici colchici-Fagetum.

14. Cyclamini coum-Fagetum orientalis
Diagnostic species: *Cyclamen coum*, *Daphne pontica*, *Fagus orientalis*, *Festuca drymeja*, *Quercus frainetto*, *Q. polycarpa* and *Ruscus hypoglossum*
Constant species: *Daphne pontica*, *Fagus orientalis*, *Festuca drymeja*, *Hypnum cupressiforme*, *Quercus frainetto*, *Q. polycarpa*, *Ruscus hypoglossum* and *Trachystemon orientalis*
Dominant species: *Fagus orientalis*, *Festuca drymeja* and *Trachystemon orientalis*
Distribution: Strandzha Mts.

This association has the widest distribution of all *Fagus orientalis* forest types in the Strandzha Mts. It is a transitional community between the open thermophilous forests of *Quercus polycarpa* and *Q. frainetto* (Quercion frainetto alliance) on the ridges, and the dark and wet Rhododendro pontici-Fagetum orientalis forests on the slopes of small valleys. Cyclamini coum-Fagetum occurs on more flat landforms, mainly on

the ridges. The Strandzha Mountains are the westernmost locality of the typical Euxinian beech forests, which are widely distributed along the southern coast of the Black Sea and in Georgia. Despite its transitional character, this community is a specific component of the Strandzha forests, which deserves a status of separate, endemic association.

15. Primulo rubrae-Fagetum orientalis
Diagnostic species: *Acer hyrcanum*, *A. pseudoplatanus*, *Campanula persicifolia*, *Carpinus betulus*, *Dactylis glomerata* ssp. *lobata*, *Dicranella heteromalla*, *Doronicum orientale*, *Euphorbia amygdaloides*, *Fagus orientalis*, *Lapsana communis*, *Lathyrus hirsutus*, *Primula acaulis* ssp. *rubra*, *Smyrnium perfoliatum* and *Tilia platyphyllos*
Constant species: *Acer pseudoplatanus*, *Carpinus betulus*, *Dactylis glomerata* ssp. *lobata*, *Fagus orientalis*, *Galium odoratum*, *Lamiastrum galeobdolon*, *Lapsana communis*, *Lathyrus hirsutus*, *Melica uniflora*, *Mercurialis perennis*, *Mycelis muralis*, *Poa nemoralis*, *Primula acaulis* ssp. *rubra*, *Sanicula europaea* and *Tilia platyphyllos*
Dominant species: *Carex sylvatica*, *Fagus orientalis*, *Galium odoratum* and *Melica uniflora*
Distribution: Eastern Stara Planina Mts.

These are the north-westernmost communities of *Fagus orientalis* in Bulgaria, distributed at low altitudes (between 100–500 m) in the eastern Stara Planina Mts. near the Black Sea coast. In the local maritime climate there is high air humidity and winter is not so cold. The soil is mostly dystric or chromic cambisol (CMd, x). These forests are transitional between Fagion orientalis and Cephalanthero-Fagion and contain many species that are more characteristic of the latter alliance. As the first division of the cluster analysis (Fig. 2), as well as PCA ordination (Fig. 3), demonstrated a closer similarity to the other *Fagus orientalis* forests than to the thermophilous forests of *Fagus sylvatica*, we assign them to the alliance Fagion orientalis. However, as they occur within a contact zone between *Fagus sylvatica* and *F. orientalis* communities, they share some characteristics of both alliances, including a mixture of species with different phytogeographical affinities.

Discussion

Fagus sylvatica communities

There are several issues concerning the classification of the south-eastern European beech forests, of which perhaps the most controversial concern the Bulgarian thermophilous beech forests. Relationships between the low-altitudinal Bulgarian and Greek beech forests were emphasized by Stoyanov (1941; see also Bondev 1991) and reflected in the term "Moesian beech forests", which was commonly used in Bulgaria, but had originally

more ecological than geographical meaning. These authors considered the low-altitudinal beech forests as "Moesian", as opposed to the high-altitudinal beech forests, which are more similar to the Central European forests of the Asperulo-Fagion and Luzulo-Fagion. They also hypothesized that the low-altitudinal beech forests are dominated by *Fagus sylvatica* subsp. *moesiaca*, while the high-altitudinal ones are composed of *Fagus sylvatica* subsp. *sylvatica* (Bondev 1966).

Later on, Moesian beech forests were considered to be a more geographical than ecological term, and geographical approach to the Balkan beech forest classification was followed by several authors, including those who proposed broad-scale divisons of European beech forests into regional alliances (Horvat et al. 1974, Dierschke 1997, Dierschke & Bohn 2004).

The present analysis of Bulgarian *Fagus sylvatica* communities does not show any distinct pattern of geographic differentiation. The differentiation of the Bulgarian beech forests follows edaphic and local topoclimatic gradients and is similar to that of the Central European beech forests, although there are some small differences in the species composition due to propagule pressure from the surrounding oak forests. These conclusions agree with those of Zoller et al. (1977), who revealed clear parallels in edaphic differentiation between the northern Greek and Central European beech forests. Therefore we accept a syntaxonomical scheme with edaphic and local topoclimatic rather than geographical emphasis, which is very close to that offered by Willner (2002) for the southern Central European beech forests; it includes the alliances Luzulo-Fagion (acidophilous beech forests), Asperulo-Fagion (nutrient-rich beech forests), and Cephalanthero-Fagion (thermophilous beech forests). We suggest that these alliances occupy the putative geographic range of Fagion moesiacum as outlined by Horvat et al. (1974). Luzulo-Fagion and Asperulo-Fagion correspond to the ecologically heterogeneous suballiance Doronico columnae-Fagenion moesicae as delimited by Dzwonko & Loster (2000) and Bergmeier & Dimopoulos (2001), while Cephalanthero-Fagion is close to their concept of Doronico orientalis-Fagenion moesiacae suballiance and to the Greek communities of *Fagus orientalis* that they assigned to the order of thermophilous oak forests of Quercetalia pubescenti-petraeae.

Generally, it is to be noted that floristic differentiation patterns in vegetation are usually too complex to be simplified in either strictly geographical differentiation, emphasizing the evolutionary and migration history of regional floras, such as that developed for European beech forests (Dierschke 1997, Dierschke & Bohn 2004), or in a strictly edaphic or local topoclimatic differentiation. Often these patterns are scale-dependent, showing stronger edaphic effects at finer scales and stronger geographic distinctions on broader scales (Chytrý et al. 2002a, Kuželová & Chytrý 2004). For many broad-scale data sets, however, edaphic, local topoclimatic and geographical factors can be of comparable importance and interact in complex ways to form vegetation pattern (Bergmeier & Dimopoulos 2001, Knollová & Chytrý 2004).

Fagus orientalis communities

Communities of *Fagus orientalis* are clearly distinguished from *F. sylvatica* communities through their specific floristic composition. Although Bulgaria is situated at the westernmost distribution limit of *Fagus orientalis*, these communities possess a distinct group of diagnostic species, which underlines the specificity of the new associations described by us for the first time from Bulgaria. The only typical Euxinian association, Rhododendro pontici-Fagetum orientalis, occurs in Bulgaria as a vicariant of the association Ilici colchici-Fagetum orientalis from northern Turkey. It has a poorer species composition than Turkish stands, but still harbours an important group of diagnostic species including *Ilex colchica, Laurocerasus officinalis* and *Rhododendron ponticum*.

The communities of *Fagus orientalis* that were described by Bergmeier & Dimopoulos (2001) from north-eastern Greece are very different from the Bulgarian ones. Although the beech populations with transitional characters between *Fagus sylvatica* and *F. orientalis* have a wider distribution in the Balkan Peninsula (Gömöry et al. 1999), the vegetation of Fagion orientalis is confined to south-eastern Bulgaria and the European part of Turkey. The species composition of the Primulo rubrae-Fagetum orientalis association from the eastern Stara Planina Mts. is transitional between *Fagus orientalis* forests from the Strandzha Mts. and those from Greece. Like the Greek communities, it is very similar to the neighbouring oak forests of the Quercetalia pubescenti-petraeae order, particularly of the Quercion frainetto alliance. Bulgarian Cephalanthero-Fagion forests, which include *Fagus sylvatica* communities on the plains and foothills, are also closely related by their floristic composition to the Greek communities of *Fagus orientalis*. It should be noted that Bergmeier & Dimopoulos (2001) refer to "true" *Fagus sylvatica* subsp. *orientalis* and "*spatulolepis*" form of Moesian beech, which often grow together. These beech populations may be very close to Bulgarian populations that have been usually determined in Bulgaria (Bondev 1966) as "typical" *Fagus sylvatica* subsp. *moesiaca*, and are treated as *Fagus sylvatica* in the present study.

Nature conservation

The Bulgarian beech forests are threatened communities. In the recent years they have suffered from an intense human impact, mainly clear-cutting. They need special activities for their preservation. Their inclusion in the European network of protected areas NATURA 2000 will be the first important step in this direction. Results of the present study show that the Bulgarian beech forests closely fit the main habitat types in Annex I of the Habitats Directive 92/43/EEC, including 9110 Luzulo-Fagetum beech forests, 9130 Asperulo-Fagetum beech forests and 9150 Medio-European limestone beech forests of the Cephalanthero-Fagion. The *Fagus orientalis* forests will be included in this network under a new code, 91S0 Stranja Oriental beech forests.

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Appendix I. Nomenclature type relevés of the newly described syntaxa

3. Tilio tomentosae-Fagetum sylvaticae ass. nov.
Relevé 486 (Electronic appendix, Table 3), author: A. Vitkova; 8 July 2004; plot size: 200 m^2; alt. 250 m; slope: 25° W; Shumensko plateau, north from the road above the village of Troitza; cover tree layer: 80 %, shrub layer: 10 %, herb layer: 60 %, moss layer: < 1 %.
Tree layer: 3: *Carpinus orientalis*, *Fagus sylvatica*; 1: *Acer campestre*; r: *Fraxinus excelsior*, *Tilia cordata*.
Shrub layer: 2: *Tilia tomentosa*; +: *Cornus mas*; r: *Fraxinus excelsior*, *Juglans regia*.
Herb layer: 2: *Bromus ramosus*, *Fagus sylvatica* juv., *Glechoma hederacea*, *Hedera helix*, *Viola odorata*; 1: *Carpinus orientalis* juv., *Cornus mas* juv., *Lathyrus laxiflorus*, *Milium effusum*, *Polygonatum latifolium*, *Quercus cerris* juv., *Ruscus aculeatus*; +: *Acer campestre* juv., *Cardamine bulbifera*, *Carpinus betulus* juv., *Dactylis glomerata* ssp. *glomerata*, *Euphorbia amygdaloides*, *Glechoma hirsuta*, *Melica uniflora*; r: *Alliaria petiolata*, *Aremonia agrimonoides*, *Cephalanthera longifolia*, *Dactylorhiza cordigera*, *Fraxinus excelsior* juv., *Rosa canina* juv.
Moss layer: r: *Paraleucobryum longifolium*.

4. Galio pseudaristati-Fagetum sylvaticae ass. nov.
Relevé 191 (Electronic appendix, Table 4), author: R. Tzonev; 24 May 2004; plot size: 200 m^2; alt. 450 m; slope: 45° W; Mikrenski Hills, village of Golec; cover tree layer: 95 %, shrub layer: 20 %, herb layer: 25 %, moss layer: 1 %.
Tree layer: 4: *Fagus sylvatica*; 2: *Quercus cerris*; +: *Acer campestre*.
Shrub layer: 2: *Acer campestre*, *Crataegus monogyna*, *Fagus sylvatica*; +: *Cornus mas*, *Quercus cerris*.
Herb layer: 2: *Melica uniflora*, *Poa nemoralis*; 1: *Campanula rapunculoides*, *Carex sylvatica*, *Clematis vitalba*, *Euphorbia amygdaloides*, *Fagus sylvatica* juv., *Galium pseudaristatum*, *Lathyrus vernus*, *Sanicula europaea*, *Sorbus torminalis* juv., *Viola odorata*, *V. reichenbachiana*; +: *Acer campestre* juv., *Aremonia agrimonoides*, *Carex remota*, *Carpinus betulus* juv., *Helleborus odorus*, *Hieracium murorum* s. lat., *Lathyrus niger*, *Luzula luzuloides*, *Mycelis muralis*, *Quercus frainetto* juv., *Stachys sylvatica*, *Tamus communis*; r: *Platanthera bifolia*.
Moss layer: +: *Atrichum undulatum*.

9. Umbilico erecti-Fagetum sylvaticae ass. nov. typicum subass. nov.
(Nomenclatural type of the association and of subassociation typicum)
Relevé 432 (Electronic appendix, Table 9); author: I. Nikolov; 3 July 2004; plot size: 300 m^2; alt. 1100 m; slope: 10° W; Central Balkan, Apriltsi, "Pruskalska reka"; cover tree layer: 80 %, shrub layer: 0 %, herb layer: 90 %, moss layer: 0 %.
Tree layer: 5: *Fagus sylvatica*.
Herb layer: 5: *Lunaria rediviva*; 2: *Carex remota*, *Dryopteris filix-mas*; 1: *Circaea lutetiana*, *Geranium robertianum*, *Mercurialis perennis*, *Umbilicus erectus*, *Viola odorata*; +: *Cardamine bulbifera*, *Mycelis muralis*, *Sambucus nigra* juv., *Sanicula europaea*, *Valeriana tripteris*; r: *Acer pseudoplatanus* juv., *Salvia glutinosa*, *Senecio nemorensis*.

10. Umbilico erecti-Fagetum sylvaticae laurocerasetosum officinalis subass. nov.
Relevé 395 (Electronic appendix, Table 10); author: V. Roussakova; 22 June 2004; plot size: 400 m^2; alt. 950 m; slope: 40° NW; Central Balkan, Bulgarka Nature Park; cover tree layer: 100 %, shrub layer: 50 %, herb layer: 85 %, moss layer: 15 %.
Tree layer: 5: *Fagus sylvatica*; +: *Abies alba* ssp. *alba*, *Acer pseudoplatanus*, *Taxus baccata*.
Shrub layer: 3: *Laurocerasus officinalis*; 1: *Abies alba* ssp. *alba*, *Fagus sylvatica*, *Taxus baccata*; +: *Clematis vitalba*, *Corylus avellana*, *Crataegus monogyna*, *Daphne mezereum*, *Euonymus latifolius*, *Hedera helix*, *Rubus rivularis*.
Herb layer: 3: *Festuca drymeja*; 1: *Fagus sylvatica* juv., *Polystichum setiferum, Taxus baccata* juv.; +: *Abies alba* ssp. *alba* juv., *Achillea grandifolia*, *Actaea spicata*, *Aremonia agrimonoides*, *Campanula rapunculoides*, *Cephalanthera longifolia*, *C. rubra*, *Doronicum austriacum*, *Euphorbia amygdaloides*, *Fragaria vesca*, *Galium odoratum*, *G. pseudaristatum*, *Glechoma hederacea*, *Hepatica nobilis*, *Hieracium sabaudum* s. lat., *Melica uniflora*, *Mercurialis perennis*, *Mycelis muralis*, *Myrrhoides nodosa*, *Oxalis acetosella*, *Poa nemoralis*, *Polygonatum verticillatum*, *Prenanthes purpurea*, *Pulmonaria rubra*, *Pyrola chlorantha*, *Salvia glutinosa*, *Sanicula europaea*, *Sorbus aucuparia* juv., *Viola reichenbachiana*.
Moss layer: +: *Bryum pallescens*, *Dicranum tauricum*, *Didymodon fallax*, *Diphyscium foliosum*, *Eurhynchium crassinervium*, *Fissidens taxifolius*, *Hypnum cupressiforme*, *Isothecium alopecuroides*, *Leucobryum glaucum*, *Plagiochila porelloides*, *Polytrichum formosum*, *Rhynchostegium murale*, *Tortella tortuosa*, *Tortula subulata*.

11. Aremonio agrimonoidis-Fagetum sylvaticae violetosum reichenbachianae subass. nov.
Relevé 148 (Electronic appendix, Table 11); author: R. Tzonev; 24 May 2004; plot size: 500 m^2; alt. 650 m; slope: 15° N; Mikrenski Hills, village of Leshnitsa; cover tree layer: 80 %, shrub layer: 10 %, herb layer: 70 %, moss layer: 0 %.

Tree layer: 5: *Fagus sylvatica*; +: *Acer campestre*, *Pyrus pyraster*.
Shrub layer: 1: *Fagus sylvatica*; +: *Crataegus monogyna*, *Rosa arvensis*.
Herb layer: 3: *Viola reichenbachiana*; 2: *Allium ursinum*, *Fagus sylvatica* juv., *Melica uniflora*, *Mercurialis perennis*, *Sanicula europaea*; 1: *Cardamine bulbifera*, *Dryopteris filix-mas*, *Galium odoratum*; +: *Acer campestre* juv., *A. pseudoplatanus* juv., *Aremonia agrimonoides*, *Arum maculatum*, *Carex sylvatica*, *Carpinus betulus* juv., *Cephalanthera damasonium*, *Galium pseudaristatum*, *Lamiastrum galeobdolon*, *Lathyrus vernus*, *Neottia nidus-avis*, *Poa nemoralis*, *Stachys sylvatica*.

12. Aremonio agrimonoidis-Fagetum sylvaticae allietosum ursini subass. nov.

Relevé 121 (Electronic appendix, Table 12); author: V. Vulchev; 23 June; plot size: 200 m^2; alt. 1250 m; slope: 15° N; Vrachanska Planina Mts.; cover tree layer: 95 %, shrub layer: 10 %, herb layer: 30 %, moss layer: 5 %.
Tree layer: 5: *Fagus sylvatica*.
Shrub layer: 2: *Fagus sylvatica*; +: *Acer pseudoplatanus*.
Herb layer: 2: *Allium ursinum*; 1: *Aremonia agrimonoides*, *Arum maculatum*, *Cardamine bulbifera*, *Carex sylvatica*, *Cephalanthera rubra*, *Corydalis bulbosa*, *Euphorbia amygdaloides*, *Fagus sylvatica* juv., *Galium odoratum*, *Geranium robertianum*, *Lamiastrum galeobdolon*, *Mycelis muralis*, *Poa nemoralis*, *Prenanthes purpurea*, *Sanicula europaea*, *Viola riviniana*, +: *Dactylis glomerata*, *Epilobium montanum*, *Festuca drymeja*, *Geum urbanum*, *Impatiens noli-tangere*, *Mercurialis perennis*, *Salvia glutinosa*, *Stachys sylvatica*, *Symphytum tuberosum*, *Veronica chamaedrys*.
Moss layer: +: *Plagiothecium nemorale*, *Polytrichum formosum*, *Pterigynandrum filiforme*.

13. Rhododendro pontici-Fagetum orientalis ass. nov.

Relevé 44 (Electronic appendix, Table 13); authors: Ch. Gussev and R. Tzonev; 28 July 2004; plot size: 300 m^2; alt. 200 m; slope: 20° E; Strandzha Mts., "Marina rjaka" Protected area; cover tree layer: 90 %, shrub layer: 80 %, herb layer: 5 %, moss layer: 5 %.
Tree layer: 5: *Fagus orientalis*.
Shrub layer: 3: *Rhododendron ponticum*; 2: *Laurocerasus officinalis*; 1: *Corylus avellana*, *Ilex colchica*.
Herb layer: 1: *Ruscus hypoglossum*; +: *Brachypodium pinnatum*, *Hedera helix*, *Trachystemon orientalis*.
Moss layer: 1: *Hypnum cupressiforme*.

14. Cyclamini coum-Fagetum orientalis ass. nov.

Relevé 23 (Electronic appendix, Table 14); authors: Ch. Gussev and R. Tzonev; 28 July 2004; plot size: 400 m^2; alt. 200 m; slope: 20° N; Strandzha Mts., village of Kondolovo; cover tree layer: 90 %, shrub layer: 10 %, herb layer: 20, moss layer: 1 %.
Tree layer: 5: *Fagus orientalis*; +: *Quercus polycarpa*.

Shrub layer: 2: *Fagus orientalis*; 1: *Daphne pontica*.
Herb layer: 2: *Festuca drymeja*, *Trachystemon orientalis*; 1: *Poa nemoralis*, *Primula acaulis* ssp. *rubra*, *Sorbus torminalis*, *Viola odorata*; +: *Acer platanoides* juv., *Aremonia agrimonoides*, *Asplenium adiantum-nigrum*, *Brachypodium pinnatum*, *Calamintha sylvatica*, *Campanula grossekii*, *C. persicifolia*, *Cyclamen coum*, *Dactylis glomerata* ssp. *lobata*, *Euphorbia amygdaloides*, *Fraxinus ornus* juv., *Galium pseudaristatum*, *Geum urbanum*, *Lapsana communis*, *Lathyrus aureus*, *L. laxiflorus*, *Melica uniflora*, *Mycelis muralis*, *Polystichum setiferum*, *Potentilla micrantha*, *Quercus frainetto* juv., *Symphytum tauricum*, *Veronica chamaedrys* ssp. *vindobonensis*.
Moss layer: +: *Hypnum cupressiforme*; r: *Leucobryum glaucum*.

15. Primulo rubrae-Fagetum orientalis ass. nov.
Relevé 7 (Electronic appendix, Table 15), author: Ch. Gussev; 10 June 2004; plot size: 300 m²; alt. 350 m; slope: 20° NNE; Eastern Balkan, Eminska Mts.; cover tree layer: 85 %, shrub layer: 40 %, herb layer: 30 %, moss layer: 1 %.
Tree layer: 5: *Fagus orientalis*; 1: *Tilia platyphyllos*; +: *Acer platanoides*, *A. pseudoplatanus*, *Fraxinus ornus*.
Shrub layer: 3: *Fagus orientalis*.
Herb layer: 2: *Bromus benekenii*, *Fagus orientalis* juv.; 1: *Dactylis glomerata* ssp. *lobata*, *Hedera helix*, *Melica uniflora*, *Mercurialis perennis*, *Poa nemoralis*, *Primula acaulis* ssp. *rubra*, *Sanicula europaea*; +: *Acer campestre* juv., *Aremonia agrimonoides*, *Brachypodium sylvaticum*, *Euphorbia amygdaloides*, *Fritillaria pontica*, *Lapsana communis*, *Lathyrus aureus*, *L. hirsutus*, *Luzula luzuloides*, *Mycelis muralis*, *Viola odorata*.
Moss layer: +: *Brachythecium rutabulum*, *B. velutinum*, *Dicranella heteromalla*.