

# The dendroflora of the Bulgarian part of the Rhodopes Mountains: a review

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## Abstract

The current study aims to characterise the unique dendroflora of Bulgarian Rhodopes and to gather information for conservation-significant plant species. We found a total of 288 arboreal species belonging to 123 genera and 51 families. It represents 65.2 % of all species, 79.4 % of all genera, and 82.3 % of all families of Bulgarian dendroflora. We present a floristic analysis summarizing the information of species distribution across the Western, Central and Eastern Rhodopes floristic sub-regions and their floristic similarity. The analysis of systematic structure of the Rhodopean dendroflora by divisions, classes, families and genera is done for the whole mountains. The distribution of tree and shrub species by biological type and life form is also presented. The analysis of floristic elements follows the classification of Stefanov (1943). Thermophytes, mesotherms, and microtherms dominate in the mountain centre, while most tree species are stationary. Floristic elements according to Walter's classification show predominance of Mediterranean elements, followed by European floristic elements. Analysis of the altitudinal distribution of tree and shrub species is also presented. The analysis of conservation significance of the studied species compares data from the Red Data Book of Bulgaria (1984, 2015); the List of Rare, Endangered and Endemic Plants of Europe (1983), the 1997 IUCN Red List of Threatened Plants (1998), as well as Bulgarian national legislation acts (Biological Diversity Act 2002, 2007). Relic and endemic species for Rhodope dendroflora are presented. The dendroflora from the Bulgarian part of the Rhodope Mountains is the richest among the floristic regions of Bulgaria and has high conservation value for Bulgaria and Europe. Finally, we present a full systematic list of the dendroflora of the Bulgarian Rhodopes.

**Key words:** arboreal plants, conservation value, life forms, phytogeographical elements, systematic structure.

## Introduction

Rhodope Mountains are the most extensive and complex mountain range in Bulgaria. It covers a territory of 14,737 km<sup>2</sup>, 83 % (12,233 km<sup>2</sup>) of which lies within

Bulgaria (Georgiev 1986, Velkov et al. 1998). As part of the extensive Macedonian–Thracian massif, which occupies the central part of the Balkan Peninsula, they account for 13.3 % of Bulgaria's territory.

The Rhodopes are bordered by the

Upper Thracian Lowlands to the north, by Western (Aegean) Thrace to the south, and by the valleys of the Dreshnets and Jadenitsa rivers to the west. The Rhodopes are the oldest and most extensive mountain massif in Bulgaria. The mountain range stretches approximately 240 km from west to east and up to 100 km in width. The average elevation is 785 m, with the western sector significantly higher than the eastern (Nikolov and Jordanova 2002, Penin 2007).

Approximately 5.1 % of the area of the Rhodopes belong to the high mountain belt (above 1600 m), 35.4 % to the mid-mountain belt (1000–1600 m), 24.9 % to the low mountain belt (600–1000 m), 32.6 % to the hilly belt (200–600 m) and 2 % to the lowland belt (up to 200 m). The territories below 200 m a.s.l. correspond to the low parts of the deep valleys of the Arda and Byala Reka rivers in the Eastern Rhodopes (Gyuzelev 2012).

According to its physical-geographical, morphological and climatic features, the Bulgarian Rhodope massif is divided into three parts: the Western Rhodopes (from the Mesta River to the Vacha River), the so-called Central Rhodopes (from the Vacha River to the Borovitsa River and the Momchilgrad Valley), and the Eastern Rhodopes (up to the border with Greece). The specific position of the Rhodope massif within the Thracian–Macedonian mountain system influences three different phytogeographic areas: the European broad-leaved forest region, the Mediterranean sclerophyllous forest region, and the Eurasian steppe and forest-steppe region. Variations in relief, which redistribute the main climatic factors, largely determine the diversity of vegetation cover across these sub-regions (Velkov et al. 1998).

Differentiation of the Rhodopes by altitude shows that, in the Western Rhodopes,

the 1000–1500 m belt occupies almost two-thirds (61 %) of its territory, while in the Central Rhodopes the same belt covers 44 %. The highest peak in the Western Rhodopes is Mt Syutkya (2186 m), in the Central Rhodopes it is Golyam Perelik (2191 m), and in the Eastern Rhodopes it is Mt Veikata (Gyumurdzhi snowfield, 1483 m). Low-mountain and hilly terrains (200–600 m a.s.l.) prevail in the Eastern Rhodopes, covering 72 % of the area (Koprarev 2002).

Stranski (1921) summarised the data from his study in the Central Rhodopes (between the Vača River and the Chelarska River, including the surroundings of Peshtera and the Plovdiv hills) and reported a total of 775 species. The dendroflora comprised 72 tree species, including 7 gymnosperms (2 families and 3 genera) and 65 angiosperms (24 families and 42 genera).

Stefanov (1927) points out that the Rhodope Mountains occupy an isolated position and that changes in their vegetation composition should be interpreted in the context of geological transformations of the region. The author argues that the Rhodope flora and vegetation are autochthonous in nature and their formation is not linked to migratory events during the glaciations.

Stefanov (1943) examines various phytogeographical areas and centres, presenting the Rilo-Rhodope massif as part of Bulgaria's highlands. The separation of two phytogeographical centres within the Rilo-Rhodope massif – the Struma Valley and the eastern and northern parts of the Rhodopes – allows the author to highlight the specificity and phytogeographical characteristics of the species composition within the thermal belt. The northern slopes of the Rhodopes are distinguished by the highest floristic richness, with 799

species recorded. Stefanov's studies of the mountain centres of the Rilo-Rhodope massif (above 1000 m) emphasise the role of isolation, which increases with altitude, leading him to propose 5 isolated surfaces within the massif: Rila, Pirin (including Alibotush and Slavyanka), the Western Rhodopes, the Central Rhodopes, and the Eastern Rhodopes. Floristic richness is greatest in the Central Rhodopes (531 species), followed by the Western Rhodopes (515 species), and finally the Eastern Rhodopes (160 species), reflecting the distribution of species from the mountain and silvoboreal regions.

Kožuharov et al. (1988) established that the phanerophytic flora in Bulgaria comprises 359 species and 368 infra-specific taxa. The authors note that the Rhodope and Stara Planina floristic regions are the richest in woody plants, each with 210 species. Within the Rhodopes, the Central Rhodopes (167 species) constitute the subregion with the highest species richness, followed by the Eastern Rhodopes (138 species) and the Western Rhodopes (134 species).

Petrova (2004) reported a total of 1962 species of higher plants belonging to 123 families in the Eastern Rhodopes floristic region, including 10 gymnosperms and 1934 angiosperms. In terms of species richness, this subregion ranks second after the Central Rhodopes. The dendroflora comprises 183 species (75 trees, 86 shrubs, 5 woody lianas, and 17 semi-shrubs), representing approximately 10 % of the total flora of the Eastern Rhodopes. *Eriolobus trilobatus* (Labill. ex Poir.) M.Roem. (syn. *Malus trilobata* (Labill. ex Poir.) C.K.Schneid.), represented by two trees in the village of Belopolyane, is listed as a rare species.

Angelova et al. (2006; 2007a,b) studied the floristic elements and the system-

atic structure of the higher flora in the Western, Central and Eastern Rhodopes floristic regions. They recorded, respectively, for the Western Rhodopes: 1819 species, 569 genera and 110 families; for the Central Rhodopes: 1992 species, 607 genera and 122 families, and for the Eastern Rhodopes: 1950 species, 612 genera and 122 families. These findings highlight the high floristic richness of the Central Rhodopes.

The total forested area of the Rhodopes amounts to 921,000 ha (Velichkov et al. 2009).

A significant proportion of the natural coniferous forests is concentrated in the Western Rhodopes. Their area in this region amounts to 355,000 ha, representing 70 % of the forested area of the Western Rhodopes and approximately 32 % of coniferous forests in Bulgaria. The overall forest cover of the Western Rhodopes is 58 % (Shikov et al. 1984). Coniferous forests in the Rhodopes are represented by *Pinus sylvestris* L., *Picea abies* (L.) H. Karst., *Pinus nigra* J.F. Arnold, *Abies alba* Mill., and *Abies cephalonica* Loudon (Panayotov and Yurukov 2016).

The appearance of the Eastern Rhodopes differs from the Western Rhodopes and is mainly characterised by deciduous forests. Of the total forested area of approximately 282,000 ha, 121,373 ha are dominated by various types of oak woodland (Petkov and Bachvarov 1984). According to Velichkov et al. (2009), the largest beech forest massifs in the Rhodope Mountains are located within the territories of the forestry enterprises in Smilyan, Smolyan, and Slaveyno, as well as along the upper course of the river Arda and its tributaries. The total area of beech forests in the region is 107,000 ha, which constitutes about 12 % of the total forested area of the Rhodopes (921,000 ha).

Virgin forests in the Rhodope Mountains cover 8830.3 ha, of which 8475.5 ha are in the Western Rhodopes and 354.8 ha in the Eastern Rhodopes. Coniferous forests constitute approximately 77 % of these virgin forests (Raev 2005).

Over the last two decades, the composition of the dendroflora in the Rhodope massif has undergone dynamic changes. Floristic studies, mainly conducted by Bulgarian botanists, have led to the discovery of new taxa for the mountain and its individual sub-regions, as well as the identification of new anthropophytes resulting from anthropogenic activity and climate change. The dendroflora of the Red Wall Biosphere Reserve (Tashev et al. 2013e–g) and the Burnt Güne Maintained Reserve (Tashev et al. 2013c,d) has been studied in detail. Data on floristic and habitat diversity were also obtained for the 'Valchi dol' Reserve in the Eastern Rhodopes, where 9 habitat units and 303 species of higher plants were documented (Gushev et al. 1998).

A comprehensive characterisation of conservation-important plants in the Bulgarian forest territories, including all dendroflora representatives found in the Rhodope massif, has been provided (Tashev 1999). Localities of rare and endangered tree species in the Rhodopes have been described, including *Clematis alpina* (L.) Mill. (Tashev and Starokina 1998), *Spiraea salicifolia* L. (Tashev 2001c), *Eriolobus trilobatus* (Tashev 2001a, Petkova and Tashev 2007, Tashev and Petkova 2008), and *Taxus baccata* L. (Petrova et al. 1998). Taxonomic revision found that the species previously considered *Juniperus oxycedrus* L. in Bulgaria is actually *Juniperus deltooides* R.P. Adams (Tashev 2011a, Adams et al. 2015). A new combination was described for Central Rhodopes – *Juniperus communis* f. *pygmaea*

(K. Koch) R. P. Adams & A. N. Tashev, comb. nov. (Adams et al. 2014).

A new tree species for the Bulgarian flora was recorded in the Rhodopes – *Pinus brutia* Ten. (Tashev 2002a,b; 2003). A new large locality of *Pinus brutia* has been recorded in the Eastern Rhodopes near the town of Ivaylovgrad, at the foot of the hill 'Dupkata' above a plantation of *Pinus nigra* (pers. comm. A. Tashev, SOM 179675, 26.01.2021) (Fig. 1). This species is listed in the Red Book of the Republic of Bulgaria as 'critically endangered' (Peev 2015) and is protected under the Biodiversity Amendment Act (Anonymous 2007). In the Eastern Rhodopes, a locality of *Juniperus sabina* L., new for the region and considered critically endangered, was discovered (Tashev 2008, Tashev and Tashev 2020). A genetic study of the species described a new taxon for science – *Juniperus sabina* var. *balkanensis* R. P. Adams and A. N. Tashev, var. nov. (Adams et al. 2016).

New populations of rare and legally protected species have also been established in the mountain, including *Ilex aquifolium* L. in the Western Rhodopes (Tashev 2001b, 2010b), *Ribes nigrum* L. (Tashev 2011b), *Rubus sanctus* Schreb. (syn. *Rubus sanguineus* Friv. var. *truncatus* Mark.) (Tashev and Tashev 2020) in the Western Rhodopes, and *Mespilus germanica* L., which has naturalised in the Central Rhodopes (Vladimirov 2012a).

The Balkan endemic *Salix xanthicola* K.I.Chr. was discovered and described by Christensen from northeastern Greece in 1991 (Christensen 1991). A year later, the species was also found in Bulgaria by Zieliński (1992) in the Eastern Rhodopes. In 2006, Christensen et al. (2006) reported *Salix xanthicola* for the Middle Rhodopes as well.

The disease and death of the only indi-



**Fig. 1. Eastern Rhodopes, the new locality of the endangered and protected by the ZBR *Pinus brutia* in the area 'Dupkata' on the territory of the State Forestry Agency 'Ivaylovgrad'.**

(photo Al. Tashev 26.01.2021)

vidual of the unique species *Quercus thracica* Stef. & Nedjalkov has been reported (Tashev 2002b, 2010a). Furthermore, new localities of tree species were discovered in previously unrecorded floristic subregions, including the glacial relics *Dryas octopetala* L. and *Empetrum nigrum* subsp. *hermaphroditum* (Hagerup) Böcher in the Central Rhodopes (Ronikier and Ronikier 2010, Ivanova et al. 2011), *Rosa pimpinellifolia* L. (syn. *Rosa spinosissima* L.) in the Eastern Rhodopes (Sopotlieva et al. 2012), *Genista januensis* Viv. in the Eastern Rhodopes (Filipova and Vassilev 2015), *Genista lydia* Boiss. in the Central Rhodopes (Tashev et al. 2016), *Chamaecytisus ciliatus* (Wahlenb.) Rothm. (Dimitrov and Vutov 2019), *Satureja cuneifolia*

Ten. in the Central Rhodopes (Dimitrov and Vutov 2016), and *Celtis australis* L. in the Central Rhodopes (Karakiev 2023).

In 2020, Stoyan Stoyanov and Yulian Marinov described a new species for science from the Eastern Rhodopes (village Fotinovo, Kirkovo municipality, Kardzhali district) – *Thymus jalasianus* Stoyanov & Marinov (Stoyanov and Marinov 2020a,b). Zahariev et al. (2015) studied medicinal plants in the higher flora of the Rhodopes and recorded 714 species.

Localities of anthropophytes (alien taxa) that have naturalised and began to reproduce spontaneously in forest habitats were also identified. *Pseudotsuga menziesii* (Mirb.) Franco was recorded in all three floristic sub-regions of the Rho-

dopes (Tashev et al. 2012; 2013a,b), *Larix decidua* Mill. in the Central Rhodopes (Petrova and Gerasimova 2017), *Ficus carica* L. in the Central Rhodopes (Tashev et al. 2012), *Buddleja davidii* Franch. in the Western (Vladimirov 2012b) and Eastern Rhodopes (Kunev 2020), *Lavandula angustifolia* Mill. in the Western Rhodopes (Kunev 2018), *Broussonettia papyrifera* L. in the Western Rhodopes (Dimitrov and Vutov 2016), and *Laburnum anagyroides* Medik. (Vladimirov 2024). *Mahonia aquifolium* (Pursh) Nutt. (syn. *Berberis aquifolium* Pursh) was found in the Central Rhodopes in the area of the village of Petkovo, Smolyan region (pers. comm. A. Tashev, SOM 179680, 07.04.2024).

The present study aims to characterise the unique dendroflora of the Bulgarian Rhodopes and to provide new data on plant species of conservation significance.

Various additions or changes in the species composition of the flora, or dendroflora, that have occurred over the years require updating and additional analysis of the systematic structure, biological types and life forms, as well as the chorology and conservation significance of the specific Rhodope dendroflora.

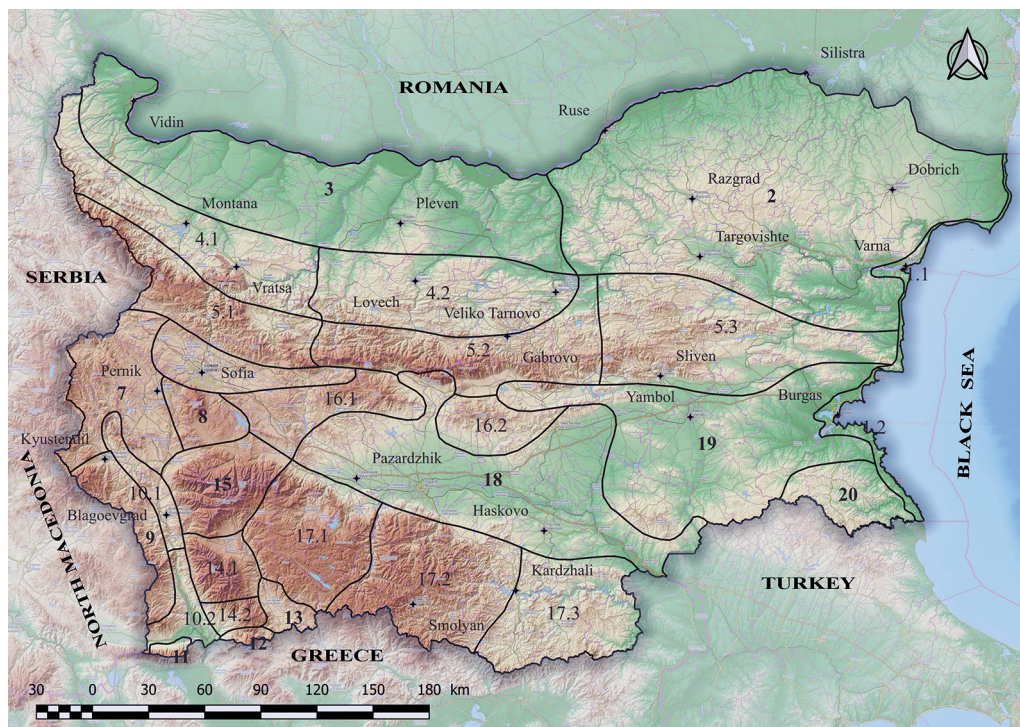
## Materials and Methods

According to the established floristic regionalisation, the territory of Bulgaria is divided into 20 floristic regions and 14 subregions. The floristic region 'Rhodopes' is subdivided into three subregions – Western (W), Central (C), and Eastern (E) – which differ significantly in their natural conditions and, consequently, in the composition of their dendroflora (Fig. 2).

The nomenclature of arboreal species is based on Assyov and Petrova (2012), The Plant List (2013), Euro+Med Plant-

Base (2006 onwards) and POWO (2020). For determination of the national nature conservation status of the plant species of Bulgarian dendroflora, at the national level, the following sources were used: Velchev (1984), Petrova and Vladimirov (2010), Peev (2015) and national legislation documents related to the protection of plant species: Order No. 761 of the General Forestry Administration-1961 (Anonymous 1961); Order No. 718 of 20.06.1989 of the Committee for Environmental Protection-1989 (Anonymous 1989); Order No. RD-401 of the Ministry of Environment of 07.11.1995 (Anonymous 1995), Biodiversity Act-2002 (Anonymous 2002) and its Amendment (Anonymous 2007). The determination of the international status of the analysed species was based on the 1997 IUCN Red List of Threatened Plants (Walter and Gillett 1998), The List of Rare Threatened and Endemic Plants in Europe (Lucas 1983), European Red List of vascular plants (Bilz et al. 2011), Convention on the Conservation of Wildlife and Natural Habitats (Bern Convention 1979) and the European Directive 92/43/EEC, on the conservation of natural habitats and of wild fauna and flora (EUR-lex 2022), that is the basis for the establishment of the pan-European ecological network NATURA 2000.

The phytogeographic affinity of the species is determined according to Stefanov (1943) and according to Walter's classification, adapted for the Bulgarian flora (Assyov and Petrova 2012). The altitudinal distribution of the analysed species follows Assyov and Petrova (2012) and Tashev et al. (2013h). Biological types of the analysed species were determined according to the Flora of NR Bulgaria (Jordanov 1963–1979; Velchev 1982, 1989), Flora of R Bulgaria (Kožuharov 1995, Peev 2012), Handbook for



**Fig. 2. Floristic regions in Bulgaria (according to Jordanov 1966).**

Note: 1/ Black Sea coast (1.1 – Northern, 1.2 – Southern); 2/ North-Eastern Bulgaria; 3/ Danubian Plain; 4/ Fore-Balkan (4.1 – Western, 4.2 – Eastern); 5/ Stara planina Mt. (Balkan Range) (5.1 – Western, 5.2 – Central, 5.3 – Eastern); 6/ Sofia region; 7/ Znepole region; 8/ Vitosha region; 9/ West Frontier Mountains; 10/ Struma River Valley (10.1 – Northern, 10.2 – Southern); 11/ Belasitsa Mt.; 12/ Slavyanka Mt.; 13/ Mesta River Valley; 14/ Pirin Mt.; 15/ Rila Mt.; 16/ Sredna Gora Mt.; 17/ Rhodopes Mts. (17.1 – Western, 17.2 – Central, 17.3 – Eastern); 18/ Thracian Lowland; 19/ Tundzha Hilly Country; 20/ Strandzha Mt.

identification of the higher plants in Bulgaria (Kožuharov 1992); Guide to plants in Bulgaria (Delipavlov et al. 2011). The life forms of the species were determined according to Raunkiaer (1934). The relict species follow Zahariev (2016). Medicinal plants were classified according to Medicinal Plants Act (Anonymous 2000), Tashev and Tsavkov (2008) and Tashev and Dimitrova (2019). Sørensen index was used according to Pavlov and Dimitrov (2012).

The diversity of ecological conditions and their influence on the composition of the flora (in this case, the dendroflora) of a

given region can be effectively illustrated by the so-called generic coefficient ( $C.g$  – coefficient generique), introduced by Paul Jaccard in 1912. It was applied for the first time in Bulgaria by Boris Stefanov and Nikolay Stoyanov in 1922 in the characterisation of rock and meadow formations in the high mountain belt of Pirin. This coefficient is expressed as the ratio between the number of genera and the number of species within a given country, district, region or mountain system, multiplied by 100 (%) (according to Stanev 2010).

In Bulgaria, the generic coefficient was

first applied by Stoyanov and Stefanov (1922) to characterise rock and meadow formations in the high-mountain belt of the Pirin Mountains, as summarised by Stanev (2010). Lower values of the coefficient indicate greater diversity of environmental conditions, whereas higher values reflect more uniform environmental conditions.

Invasive species were identified based on national floristic literature and field observations, following commonly accepted criteria for invasiveness in Bulgaria.

## Results and Discussion

Vascular flora of the Bulgarian Rhodopes comprises 2478 species belonging to 702 genera and 131 families (Assyov and Petrova 2012; updated data from A. Tashev, pers. comm.).

Since 2000, a database of the Bulgarian dendroflora has been developed, which is continuously updated and supplemented with new floristic data from the literature and our own research.

Based on the database on the Bulgarian dendroflora developed by us, we found that the arboreal plants in Bulgaria comprise 442 species belonging to 155 genera and 62 families (Tashev and Tsavkov 2008, 2016).

Based on this database, the arboreal flora of the Bulgarian part of the Rhodope

Mountains comprises 288 species belonging to 123 genera and 51 families (Appendix 1). This represents 65.2 % of all species, 79.4 % of all genera, and 82.3 % of all families of the Bulgarian dendroflora. A total of 208 tree and shrub species occur in the Western Rhodopes, 228 in the Central Rhodopes, and 224 in the eastern part of the mountains (Table 1).

Phylum Pinophyta is represented by 4 families, 8 genera and 18 species, whereas Magnoliophyta includes 47 families, 115 genera and 270 species. Within Class Magnoliopsida there are 45 families, 112 genera and 265 species, while Classis Liliopsida includes 2 families, 3 genera and 5 species (Table 1). The families richest in tree and shrub species are Rosaceae (69 species), Fabaceae (36 species), Lamiaceae (17 species), Salicaceae (16 species), Fagaceae (14 species) and Pinaceae (10 species), followed by Oleaceae, Betulaceae, Ericaceae and Aceraceae, each represented by 8 species. Eighteen families are represented by a single species.

Among the genera, *Rosa* is the most species-rich, comprising 22 species, followed by *Chamaecytisus* and *Salix* with 12 species each, *Quercus* with 11 species, *Genista* with 10 species, *Sorbus* and *Rubus* with 9 species each, *Acer* with 8 species, while *Thymus*, *Prunus* and *Juniperus* are represented by 6 species each. Seventy-five genera are represented by a

**Table 1. Systematic structure of the dendroflora in the subregions of the Rhodope Mountains.**

| Systematic group     | Rhodopes | Western Rhodopes | Central Rhodopes | Eastern Rhodopes |
|----------------------|----------|------------------|------------------|------------------|
| <b>Magnoliophyta</b> | 270      | 193              | 213              | 212              |
| Liliopsida           | 5        | 4                | 4                | 5                |
| Magnoliopsida        | 265      | 189              | 209              | 207              |
| <b>Pinophyta</b>     | 18       | 15               | 15               | 12               |
| <b>Total</b>         | 288      | 208              | 228              | 224              |

single species only.

The generic coefficient of the dendroflora of the Central Rhodopes (228 tree and shrub species, 100 genera) is 43.9 %, the Western Rhodopes (208 species, 92 genera) 44.2 %, and that of the Eastern Rhodopes (224 species, 103 genera) 46.0 %. This relatively low coefficient indicates diverse environmental conditions, which is also the reason for the richer species composition.

At the national level, the generic coefficient for the dendroflora of Bulgaria is 35.1 %, while for the entire higher flora of the country it is considerably lower, 22.7 % (Vladimirov and Petrova 2018).

Table 2 presents the floristic similarity between the three sub-regions of the Rhodopes. The highest degree of similarity is observed between the Western and Central Rhodopes (87.3 %). In contrast, the similarity between the Western and Eastern Rhodopes and between the Central and Eastern Rhodopes is lower and nearly identical, amounting to 78.9 % and 78.8 %, respectively. These results indicate that the dendroflora of the Eastern Rhodopes differs more markedly from that of the other two sub-regions of the mountain.

According to their biological type, the arboreal plants of the Rhodopes can be classified in eight groups, five of which are transitional: shrubs comprise 124 species (43 %), including a group of woody climbers (lianas) such as *Asparagus acutifolius* L., *Asparagus verticillatus* L., *Clematis alpina*, *Clematis vitalba* L., *Clematis viticella*

L., *Cynanchum acutum* L., *Cionura erecta* (L.) Griseb., *Hedera helix* L., *Lonicera etrusca* Santi, *Parthenocissus quinquefolia* (L.) Planch., *Smilax excelsa* L. and *Vitis vinifera* L. subsp. *sylvestris* (C.C. Gmelin) Hegi. Species exhibiting an intermediate shrub–tree and tree–shrub habit account for 47 species (16 %), trees are represented by 69 species (24 %). Semi-shrubs include 15 species (5 %), and the transitional group between perennial herbs and semi-shrubs comprises 20 species (7 %) (Fig. 3, Table 3).

According to Raunkiaer's (1934) classification of life forms (Table 4), phanerophytes (Ph) dominate with 226 species, followed by chamaephytes (Ch) with 30 species. Transitional life forms in the Rhodopes (Ch-Ph, Ph-Ch) account for 12 species. Other species may shift between groups including 20 species that could be classified as hemicryptophytes (H, i.e. perennial herbs) under certain conditions. The trend is similar across the subregions, with the largest proportion of phanerophyte is observed in the Central Rhodopes (183 species).

The following 16 species occur only in the Rhodopes (including subregions), of all floristic regions in Bulgaria: *Arbutus andrachne* L., *Eriolobus trilobatus*, *Genista germanica* L., *Larix decidua*, *Lotononis genistoides* (Fenzl) Benth., *Pinus brutia*, *Potentilla fruticosa* L., *Quercus thracica*, *Ribes nigrum*, *Salix ardana* Ziel. & Petrova, *Salix velchevii* Ziel. & Pancheva, *Salix viminalis* L., *Salix xanthicola*, *Salvia officinalis* L., *Spiraea salicifolia*, *Thymus jala-*

**Table 2. Floristic similarity (Sørensen index) between the sub-regions of the Rhodope Mountains.**

| Subregion        | Western Rhodopes | Central Rhodopes | Eastern Rhodopes |
|------------------|------------------|------------------|------------------|
| Western Rhodopes |                  |                  |                  |
| Central Rhodopes | 87.3             |                  |                  |
| Eastern Rhodopes | 78.9             | 78.8             |                  |

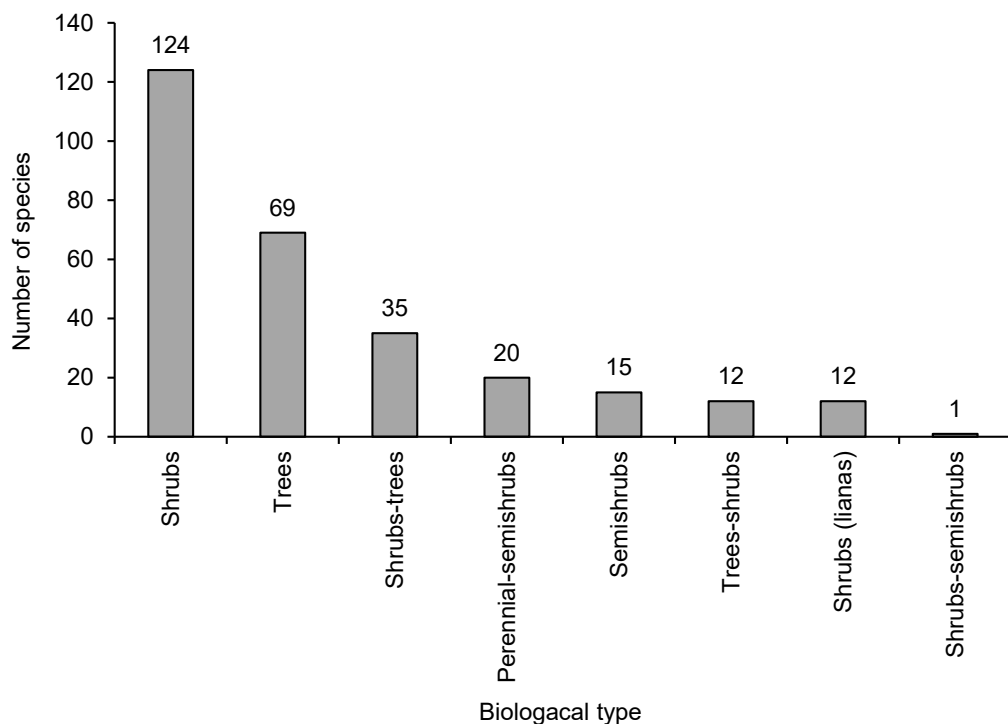


Fig. 3. Distribution of species of the Rhodopean dendroflora by biological type.

Table 3. Distribution of species of the Rhodopean dendroflora by biological type and sub-region.

| Biological type      | Rhodopes | Western Rhodopes | Central Rhodopes | Eastern Rhodopes |
|----------------------|----------|------------------|------------------|------------------|
| Trees                | 69       | 56               | 59               | 60               |
| Trees-shrubs         | 12       | 9                | 9                | 10               |
| Shrubs               | 124      | 92               | 103              | 86               |
| Shrubs (lianas)      | 12       | 6                | 5                | 10               |
| Shrubs-trees         | 35       | 23               | 29               | 29               |
| Shrubs-semishrubs    | 1        | 0                | 1                | 1                |
| Perennial-semishrubs | 20       | 10               | 12               | 16               |
| Semishrubs           | 15       | 12               | 10               | 12               |
| Total                | 288      | 208              | 228              | 224              |

*sianus*.

The following species occur only:

- in the Eastern Rhodope: *Arbutus andrachne*, *Eriolobus trilobatus*, *Pinus brutia*, *Quercus thracica*, *Salix ardana*, *Salix velchevii*, *Salvia officinalis*, *Thymus*

*jalasianus*.

- in the Western Rhodopes: *Genista germanica*, *Potentilla fruticosa*, and *Spiraea salicifolia*.

- in the Central Rhodopes: *Larix decidua*, *Salix viminalis*.

**Table 4. Distribution of species in the Rhodopean dendroflora by life-forms based on Raunkiaer's classification (1934).**

| Life forms | Rhodopes | Western Rhodopes | Central Rhodopes | Eastern Rhodopes |
|------------|----------|------------------|------------------|------------------|
| Ch         | 30       | 23               | 23               | 20               |
| Ch-H       | 8        | 4                | 5                | 7                |
| Ch-Ph      | 10       | 7                | 9                | 6                |
| H-Ch       | 12       | 6                | 7                | 9                |
| Ph         | 226      | 168              | 183              | 180              |
| Ph-Ch      | 2        | 0                | 1                | 2                |
| Total      | 288      | 208              | 228              | 224              |

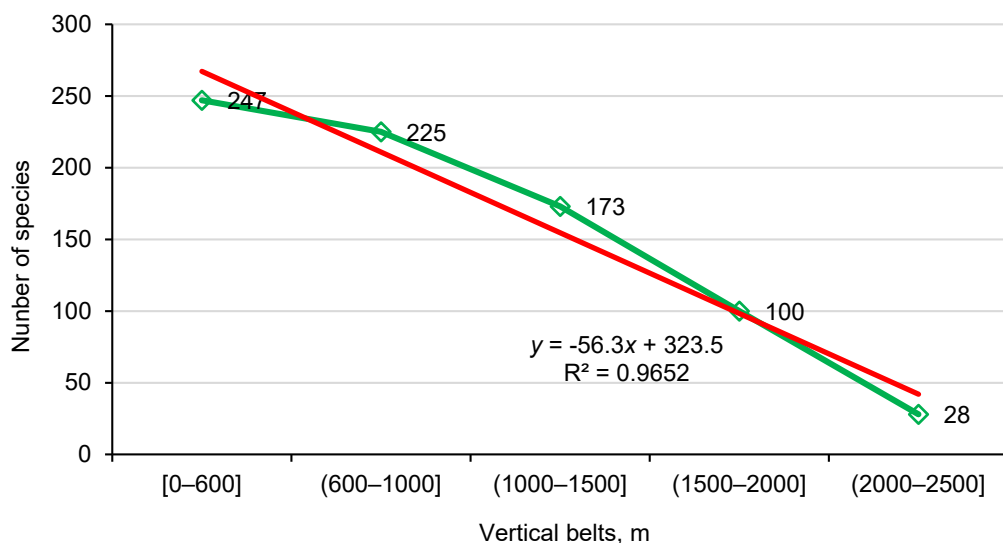
Note: Ph – Phanerophytes, Ch – Chamaephytes, H – Hemicryptophytes.

• in one other floristic region of Bulgaria (outside the Rhodope Mountains): *Arbutus unedo* L., *Broussonetia papyrifera* (L.) L'Her., *Buddleja davidii*, *Convolvulus boissieri* Steud., *Daphne laureola* L., *Erica arborea* L., *Juniperus excelsa* M. Bieb., *Saponaria stranjensis* Jordanov, *Satureja rumelica* Velen., *Sorbus mougeotii* Soy.-Will. et Godr., *Spiraea pseudosalicifolia* Silverside, and *Thymus leucotrichus* Halácsy.

• 94 species are found in all floristic regions incl. Rhodopes.

The altitudinal distribution of species of the Rhodopean dendroflora is shown in Figure 4. It can be seen that the higher the altitude, the fewer species are present. The empirical relationship is  $y = -56x + 322.4$ , where:  $x$  is altitudinal belt and  $y$  is the number of species. The regression coefficient is  $R^2 = 0.9633$ .

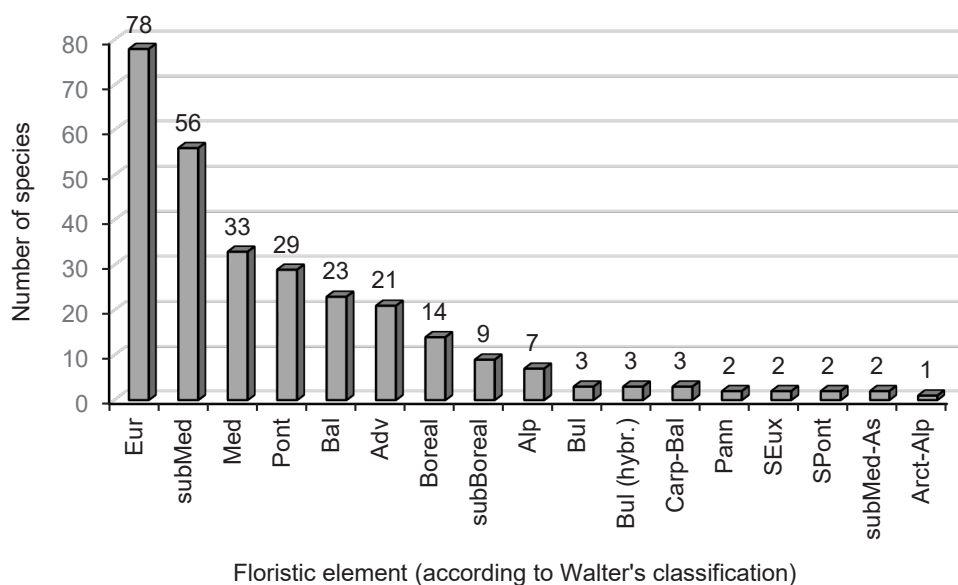
Among the chorological categories

**Fig. 4. Distribution of species of the Rhodopean dendroflora by altitudinal belt.**

Note: The green line presents all species of Rhodopean dendroflora, red line – linear model of species distribution

(geoelements) of the flora, classified according to the Walter system as adapted for the Bulgarian flora (Assyov and Petrova 2012), most species have a European-Mediterranean component (Med) – 89 species, including 33 mediterranean (Med) and 56 sub-Mediterranean (subMed) species. European elements (Eur) are represented by 78 species, followed by Pontic (Pont) elements with 29 species (Fig. 5). Adventive geoelements (Adv) account for 19 species (6.6 %). Of these, 5 species are from North America (NAM), 3 are Mediterranean, 7 are from Asia (As), including China and Japan; one species is from Europe (*Larix decidua*), two are Euro-Asiatic (Eur-As), and one is a hybrid (*Salix* × *pseudosalicifolia*), described in 1990 from the Western Rhodopes.

The Rhodope Mountains exhibit extraordinary ecological diversity and a specific history of the plant cover, which contributes to the richness of endemic species in the flora (or dendroflora) of the area. Balkan endemics (Bal) include 16 species (2 gymnosperms and 14 angiosperms). Of these, 13 species occur in the Central Rhodopes, 12 in the Eastern Rhodopes, and 9 in the Western Rhodopes. These include: *Abies borisii-regis* Mattf., *Acer heldreichii* Orph. ex Boiss., *Astracantha thracica* (Griseb.) Podlech., *Chamaecytisus absinthioides* (Janka) Kuzmanov, *Chamaecytisus calcareus* (Velen.) Kuzmanov, *Chamaecytisus jankae* (Velen.) Rothm., *Corothamnus agnipilus* (Velen.) Klásk. (syn. *Corothamnus rectipilosus* (Adamović) Skalická), *Crataegus heldreichii* Boiss.,



**Fig. 5. Distribution of species from the Rhodopean dendroflora according to floristic elements.**

Note: Eur – European, subMed – sub-Mediterranean, Med – Mediterranean, Pont – Pontic, Bal – Balkan endemic, Adv – Adventive, Boreal – Boreal, subBoreal – subBoreal, Alp – Alpine, Bul – Bulgarian endemic, Bul (hybr.) – Bulgarian (hybridogenous), Carp-Bal – Carpathian-Balkan, Pann – Pannonian, SEux – South Euxinian, SPont – South Pontic, subMed-As – sub-Mediterranean-Asiatic, Arct-Alp – Arctic-Alpine.

*Genista rumelica* Velen., *Genista subcapitata* Pančić, *Pinus peuce* Griseb., *Rhamnus rhodopeus* Velen., *Salix xanthicola*, *Saponaria stranjensis*, *Satureja pilosa* Velen., and *Thymus longedentatus* (Degen & Urum.) Ronniger.

Bulgarian endemics (Bul) are represented by 3 species (*Chamaecytisus frivaldszkyanus* (Degen) Kuzmanov ex Greuter, Burdet & G.Long., *Satureja rumelica*, *Thymus jalasianus*), while Bulgarian endemic hybrids include *Salix velchevii*, *Salix ardana*, and *Quercus thracica*. Other geoelement groups are poorly represented.

According to Stefanov's (1943) classification of phytogeographical elements, stationary and mobile thermophytes, mesotherms, and microtherms from the Mountain Centre predominate (146 species: 121 in the Central Rhodopes, 110 in the Eastern Rhodopes, and 104 in the Western Rhodopes), followed by stationary and mobile mesotherms and microtherms from the Sylvic-boreal Centre (41 species: 42 in the Western Rhodopes, 41 in the Central Rhodopes, and 27 in the Eastern Rhodopes), stationary and mobile thermophytes from the Mediterranean Centre (40 species: 23 in the Western Rhodopes, 25 in the Central Rhodopes, and 41 in the Eastern Rhodopes), stationary and mobile thermophytes from the Southern Continental Centre (27 species: 19 in the Western Rhodopes, 20 in the Central Rhodopes, and 27 in the Eastern Rhodopes), and stationary and mobile thermophytes from Northern Continental Centre (South Russian Plain) – 10 species. Overall, of the 288 species, 240 (83.3 %) are stationary, while only 20 species are mobile, occupying a wider ecological niche.

The dendroflora of the Rhodope Mountains includes 200 ornamental species (69 %), 206 melliferous species (72 %),

and 160 medicinal species (56 %), which are used in both official and traditional medicine (Anonymous 2000, Tashev and Tsavkov 2008, Tashev et al. 2015).

The Rhodope Mountains range – particularly the Western and Central Rhodopes – despite the relatively high elevation of many peaks (Golyama Syutkya – 2186 m a.s.l., Golyam Persenk – 2093 m a.s.l., Srebren – 1901 m a.s.l.), lacks well-developed typical subalpine vegetation. In the recent past, all major peaks were occupied by forest communities dominated by *Pinus sylvestris* and *Picea abies*. At present, only a limited subalpine forest belt is preserved on the highest peaks of Mount Syutkya and Mount Golyam Persenk.

A plausible explanation for this pattern is the remoteness of the Rhodopes from the major Pleistocene glaciation centers of the Rila Mountains, which limited glacial influence and favored the persistence of forest refugia during glacial periods. Consequently, during the interstadial phases, forest vegetation was able to expand relatively rapidly. Supporting evidence for this hypothesis is the high proportion of Tertiary relict species in the Rhodopes – 79 species (27.4 %) compared to only 3 glacial relicts (*Potentilla fruticosa*, *Dryas octopetala*, and *Empetrum nigrum* subsp. *hermaphroditum*).

The Rhodope Mountains possess exceptionally high conservation significance. A total of 112 dendrofloristic species – comprising relict, endemic, rare, and legally protected taxa – are of conservation importance, representing 38.9 % of the total dendroflora of the Rhodopes (Table 5). The Red Data Book of the Republic of Bulgaria (Peev 2015) includes 23 species, accounting for 8.0 % of the Rhodopean dendroflora. Additionally, 27 species (9.4 %) are protected under the Biological Diversity Act (Anonymous 2007).

**Table 5. Distribution of conservation-significant species from the dendroflora of the Rhodope Mountains by subregions.**

| Conservation indicator                                      | Rhodope Mountains (total) | Western Rhodopes | Central Rhodopes | Eastern Rhodopes |
|-------------------------------------------------------------|---------------------------|------------------|------------------|------------------|
| Total number of conservation-significant species            | 112                       | 77               | 82               | 86               |
| Tertiary relics                                             | 79                        | —                | —                | —                |
| Glacial relics                                              | 3                         | —                | —                | —                |
| Red Book of Bulgaria (1984)                                 | 29                        | 12               | 15               | 15               |
| Red Book of Bulgaria (2015)                                 | 23                        | 7                | 9                | 16               |
| Biodiversity Act (2002)                                     | 29                        | 11               | 14               | 18               |
| Biodiversity Act (2007)                                     | 27                        | 11               | 12               | 18               |
| ZUG – 761/1961                                              | 9                         | 6                | 4                | 4                |
| ZKOPS-718/1989                                              | 27                        | 11               | 13               | 14               |
| ZMOS-401/1995                                               | 24                        | 9                | 11               | 14               |
| IUCN Red List (1998)                                        | 3                         | 2                | 2                | 2                |
| European List of Rare, Threatened and Endemic Plants (1983) | 1                         | 1                | 1                | 1                |

Note: ZUG – Order No. 761 of the General Forestry Administration; ZKOPS – Order No. 718 of 20.06.1989 of the Committee for Environmental Protection; ZMOS – Order No. RD-401 of the Ministry of Environment of 07.11.1995; IUCN – 1997 IUCN Red List of Threatened Plants. Dash (—) indicates data not subdivided by subregion.

At the international level, three species are listed in the 1997 IUCN Red Lists of Threatened Plants (Walter and Gillett 1998): *Acer heldreichii*, *Pinus peuce*, and *Salix xanthicola*. *Satureja pilosa* is included in the List of Rare, Threatened and Endemic Plants of Europe (Lucas 1983). As shown in Table 5, the highest number of conservation-significant dendrofloristic species within the Rhodopes is recorded

in the Eastern Rhodope subregion.

Distribution of dendrofloristic species of the Rhodopes by IUCN threat categories (IUCN 2001) is presented in Table 6. The majority of species fall within the Least Concern (LC) category, while only one species is classified as Vulnerable (VU).

Distribution of dendrofloristic species of the Rhodopes by threat categories is based on published data from the Red List

**Table 6. Distribution of dendrofloristic species of the Rhodopes by IUCN threat categories (IUCN 2001), based on IUCN Red List data (2021).**

| Cate-gory | Total number of species in Rhodope Mountains | Western Rhodopes | Central Rhodopes | Eastern Rhodopes |
|-----------|----------------------------------------------|------------------|------------------|------------------|
| DD        | 18                                           | 12               | 15               | 17               |
| LC        | 137                                          | 106              | 109              | 111              |
| NT        | 3                                            | 2                | 2                | 2                |
| VU        | 1                                            | 0                | 1                | 1                |
| Total     | 159                                          | 120              | 127              | 131              |

Note: The table is compiled by the authors based on IUCN Red List assessments (IUCN 2021). DD – Data Deficient; LC – Least Concern; NT – Near Threatened; VU – Vulnerable.

of Bulgarian vascular plants (Petrova and Vladimirov 2009) and is summarised in Table 7. According to these assessments, the largest proportion of species falls into the Vulnerable (VU) category, while the Least Concern (LC) category is represent-

ed by only three species.

The most problematic invasive tree and shrub species recorded in the Rhodope Mountains include *Acer negundo* L., *Ailanthus altissima* (Mill.) Swingle, *Amorpha fruticosa* L. and *Robinia pseudoacacia*

**Table 7. Distribution of dendrofloristic species of the Rhodopes by threat categories, based on Red List of Bulgarian vascular plants (2009).**

| Category | Rhodope Mountains (total) | Western Rhodopes | Central Rhodopes | Eastern Rhodopes |
|----------|---------------------------|------------------|------------------|------------------|
| CR       | 7                         | 3                | 1                | 4                |
| EN       | 10                        | 3                | 6                | 6                |
| LC       | 3                         | 2                | 3                | 2                |
| VU       | 15                        | 8                | 7                | 10               |
| Total    | 35                        | 16               | 17               | 22               |

Note: The table is compiled by the authors based on data from the Red List of Bulgaria (2009). CR – Critically Endangered, EN – Endangered, VU – Vulnerable, LC – Least Concern.

L., which occur in all three floristic subregions (Western, Central and Eastern Rhodopes). Additional invasive species with more limited distribution are *Broussonetia papyrifera* (Western Rhodopes), *Buddleja davidii* (Western and Central Rhodopes), *Koelreuteria paniculata* Laxm. (Central Rhodopes), *Laburnum anagyroides*, *Lycium barbarum* L. (Eastern Rhodopes), *Mahonia aquifolium* and *Parthenocissus quinquefolia* (Central Rhodopes).

Table 8 summarises the distribution of these invasive species across the three floristic subregions of the Rhodope Mountains.

A total of 201 protected areas and 113 century-old trees are registered within the Rhodope Mountains. The com-

bined area of the protected territories, according to the register of protected areas of the Ministry of Environment and Water (MoEW), amounts to 29,990 ha, i.e. almost 30,000 ha, representing approximately 2 % of the total area of the Rhodope Mountains. Nearly half of the protected areas are situated in the Western Rhodopes, while the Central and Eastern Rhodopes each account for about one quarter (25 %) of the protected territories.

A total of 113 century-old trees are recorded in the Rhodopes, of which 33 are gymnosperms and 80 are angiosperms. Among the gymnosperms, *Picea abies* is represented by 18 individuals, followed by *Pinus nigra* with 8 individuals and *Pinus sylvestris* with 5 individuals. Among the

**Table 8. Distribution of invasive dendrofloristic species in the Rhodope Mountains by floristic subregions.**

| Rhodope Mountains (total) | Western Rhodopes | Central Rhodopes | Eastern Rhodopes |
|---------------------------|------------------|------------------|------------------|
| 10                        | 6                | 8                | 5                |

Note: The table presents an authorial synthesis based on field observations and published floristic records.

angiosperms, the most frequent species is *Platanus orientalis* L. with 33 individuals, followed by oak species (including *Quercus robur* L., *Q. petraea* (Matt.) Liebl. (s. l.), *Q. cerris* L., *Q. frainetto* Ten. and *Q. pubescens* Willd. (s. l.)) with 18 individuals, and *Fagus sylvatica* L. with 16 individuals.

In terms of spatial distribution, the highest number of century-old trees is recorded in the Western Rhodopes (58 individuals), followed by the Eastern Rhodopes (28) and the Central Rhodopes (27).

An important factor influencing the richness of the Rhodope flora (or dendroflora) and its role as a refugium for relict species is the region's climatic conditions. Of particular significance is the influence of the Mediterranean basin, which is most pronounced during the winter. Along the high peaks of the Rhodopes, especially in

the eastern part, this influence is evident, with areas south of this line experiencing a noticeable autumn–winter precipitation maximum.

Calciphilous species of the Rhodope dendroflora number 79 (27.4 % of the total dendroflora), comprising 60 facultative species (45 in the Western Rhodopes, 50 in the Central Rhodopes, and 49 in the Eastern Rhodopes) and 19 obligate species (10 Western, 15 Central, 12 Eastern). Of the total number of calciphilous species, 65 occur in the Central Rhodopes, 61 in the Eastern Rhodopes, and at least 55 in the Western Rhodopes. This distribution is consistent with the fact that much of the Rhodopes' karst terrain is located in the Central Rhodopes (Trigradsko Gorge, Devil's Throat, Yagodina, Kazanite, etc.) (Fig. 6).



Fig. 6. *Pinus nigra* subsp. *pallasiana* on karst terrains in the Central Rhodopes: Trigradsko Gorge (left) and near Yagodina (right).

## Conclusions

The meridional location of the mountain, the geological history, and the diversity of rocks, landforms, and climatic conditions contribute to an extremely rich vascular flora and a high proportion of forest communities. This is the richest floristic region in terms of dendroflora in Bulgaria, with 288 tree species recorded.

The present study investigates this dendrological richness and its distribution according to various indicators. For the first time, the diversity of the individual sub-regions has also been analysed.

The altitudinal distribution of the tree species is presented, which constitutes a key aspect of this study. A clear correlation between species number and altitude has been demonstrated. The phytogeographic affiliation of the species indicates a well-expressed autochthony of the dendroflora, reflecting the role of the Rhodopes as a refugium during the glaciations and the presence of numerous Tertiary relict species.

These data allow the conclusion that the Bulgarian part of the Rhodopes is the richest among all floristic regions in Bulgaria, possessing very high conservation significance both nationally and at the European level.

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## Appendix A

## A systematic list of the dendroflora in the Bulgarian part of the Rhodopes

## Pinophyta

**Cupressaceae:** *Juniperus communis* L. (W, C, E); *Juniperus deltooides* R.P. Adams (W, C, E); *Juniperus excelsa* M.Bieb. (W, C); *Juniperus pygmaea* K.Koch (syn. *Juniperus communis* subsp. *pygmaea* (K.Koch) Imkhan., *Juniperus communis* var. *saxatilis* Pall.) (W, C, E); *Juniperus sabina* L. (E); *Juniperus sibirica* Burgsd. (syn: *J. nana* Willd., *J. alpina* S.F.Gray, *J. communis* subsp. *alpina* (Suter) Čelak.) (W, C); **Ephedraceae:** *Ephedra distachya* L. (W, C, E); **Pinaceae:** *Abies alba* Mill. (W, C, E); *Abies borisii-regis* Mattf. (W, C, E); *Larix decidua* Mill. (C); *Picea abies* (L.) H.Karst. (W, C); *Pinus brutia* Ten. (E); *Pinus mugo* Turra (W); *Pinus nigra* J.F.Arnold (syn. *Pinus nigra* Arnold subsp. *pallasiana*) (W, C, E); *Pinus peuce* Griseb. (W, C); *Pinus sylvestris* L. (W, C, E); *Pseudotsuga menziesii* (Mirbel) Franco (W, C, E); **Taxaceae:** *Taxus baccata* L. (W, C, E).

## Magnoliophyta

**Magnoliopsida:** **Aceraceae:** *Acer campestre* L. (W, C, E); *Acer heldreichii* Orph. ex Boiss. (W, C, E); *Acer hyrcanum* Fisch. & C.A.Mey. (W, C, E); *Acer monspessulanum* L. (W, E); *Acer negundo* L. (W, C, E); *Acer platanoides* L. (W, C, E); *Acer pseudoplatanus* L. (W, C, E); *Acer tataricum* L. (W, C, E); **Anacardiaceae:** *Cotinus coggygia* Scop. (W, C, E); *Pistacia terebinthus* L. (W, C, E); *Rhus coriaria* L. (E); **Apocynaceae:** *Vincetoxicum* L. (W, C, E); **Aquifoliaceae:** *Ilex aquifolium* L. (W, C, E); **Araliaceae:** *Hedera helix* L. (W, C, E); **Asclepiadaceae:** *Cionura erecta* (L.) Griseb. (E); *Cynanchum acutum* L. (E); **Berberidaceae:** *Berberis vulgaris* L. (W, C, E); *Mahonia aquifolium* (Pursh) Nutt. (syn. *Berberis aquifolium* Pursh) (C); **Betulaceae:** *Alnus glutinosa* (L.) Gaertn. (W, C, E); *Alnus incana* (L.) Moench (W, C); *Betula pendula* Roth (W, C, E); *Carpinus betulus* L. (W, C, E); *Carpinus orientalis* Mill. (W, C, E); *Corylus avellana* L. (W, C, E); *Corylus colurna* L. (W, C, E); *Ostrya carpinifolia* Scop. (W, C, E); **Brassicaceae:** *Aurinia saxatilis* (L.) Desv. (W, C, E); *Iberis sempervirens* L. (W); **Buddlejaceae:** *Buddleja davidii* Franch. (W, C); **Caprifoliaceae:** *Lonicera etrusca* Santi (E); *Lonicera nigra* L. (W, C); *Lonicera xylosteum* L. (W, C, E); *Sambucus nigra* L. (W, C, E); *Sambucus racemosa* L. (W, C); *Viburnum lantana* L. (W, C, E); *Viburnum opulus* L. (W, C, E); **Caryophyllaceae:** *Saponaria stranjensis* Jordanov (E); **Celastraceae:** *Euonymus europaeus* L. (W, C, E); *Euonymus latifolius* (L.) Mill. (W, C, E); *Euonymus verrucosus* Scop. (W, C, E); **Cistaceae:** *Cistus incanus* L. (syn. *Cistus tauricus* C.Presl.) (C, E); *Fumana procumbens* (Dunal) Gren. & Godr. (W, C, E); *Helianthemum nummularium* (L.) Mill. (W, C, E); *Rhodax alpestris* (Jacq.) Fuss (syn. *Helianthemum alpestre* Jacq., *Cistus alpestris* (Jacq.) DC.) (C); *Rhodax canus* (L.) Fuss (syn. *Helianthemum canum* (L.) Hornem.) (W, C, E); **Convolvulaceae:** *Convolvulus boissieri* Steud. (E); **Cornaceae:** *Cornus mas* L. (W, C, E); *Cornus sanguinea* L. (W, C, E); **Empetraceae:** *Empetrum nigrum* subsp. *hermaphroditum* (Hagerup) Böcher (syn. *Empetrum hermaphroditum* Hagerup) (C); **Ericaceae:** *Arbutus andrachne* L. (E); *Arbutus unedo* L. (E); *Arctostaphylos uva-ursi* (L.) Spreng. (W, C); *Bruckenthalia spiculifolia* (Salisb.) Rchb. (W, C); *Erica arborea* L. (E); *Vaccinium myrtillus* L. (W, C, E); *Vaccinium uliginosum* L. (W, C); *Vaccinium vitis-idaea*

L. (W, C); **Fabaceae**: *Amorpha fruticosa* L. (W, C, E); *Astracantha thracica* (Griseb.) Podlech (E); *Astragalus angustifolius* Lam. (C, E); *Astragalus gladiatus* Boiss. (C); *Chamaecytisus absinthioides* (Janka) Kuzmanov (W, C, E); *Chamaecytisus albus* (Hacq.) Rothm. (W, C, E); *Chamaecytisus austriacus* (L.) Link (W, C, E); *Chamaecytisus banaticus* (Griseb. & Schenk) Rothm. (C, E); *Chamaecytisus calcareus* (Velen.) Kuzmanov (W); *Chamaecytisus ciliatus* (Wahlenb.) Rothm. (W, E); *Chamaecytisus frivaldszkyanus* (Degen) Kuzmanov ex Greuter, Burdet & G. Long (C); *Chamaecytisus glaber* (L.f.) Rothm. (W, C, E); *Chamaecytisus hirsutus* (L.) Link (W, C, E); *Chamaecytisus jankae* (Velen.) Rothm. (W, C, E); *Chamaecytisus rochellii* (Wierzb. ex Griseb. & Schenk) Rothm. (W, C, E); *Chamaecytisus supinus* (L.) Link (W, C, E); *Chamaespartium sagittale* (L.) Gibbs (W, C, E); *Colutea arborescens* L. (W, C, E); *Coronilla emerus* L. (W, C, E); *Corothamnus agnipilus* (Velen.) Klásk. (syn. *Cytisus agnipilus* Velen., *Corothamnus rectipilosus* (Adamović) Skalická (syn. *Cytisus rectipilosus* Adamović)) (W, C, E); *Dorycnium germanicum* (Gremli) Rikli (E); *Genista anatolica* Boiss. (E); *Genista carinalis* Griseb. (W, C, E); *Genista depressa* M. Bieb. (W, C); *Genista germanica* L. (W); *Genista januensis* Viv. (W, C, E); *Genista lydia* Boiss. (W, C, E); *Genista ovata* Waldst. & Kit. (W, C, E); *Genista rumelica* Velen. (W, C, E); *Genista subcapitata* Pančić (C); *Genista tinctoria* L. (W, C, E); *Laburnum anagyroides* Medik. (C); *Lembotropis nigricans* (L.) Griseb. (W, C, E); *Lotononis genistoides* (Fenzl) Benth. (W, E); *Ononis spinosa* L. (E); *Robinia pseudoacacia* L. (W, C, E); **Fagaceae**: *Castanea sativa* Mill. (W); *Fagus orientalis* Lipsky (E); *Fagus sylvatica* L. (W, C, E); *Quercus brachyphylla* Kotschy (W, C, E); *Quercus cerris* L. (W, C, E); *Quercus coccifera* L. (E); *Quercus petraea* (Matt.) Liebl. (W, C, E); *Quercus erucifolia* Steven (W, C, E); *Quercus frainetto* Ten. (W, C, E); *Quercus pedunculiflora* K. Koch (W, C, E); *Quercus polycarpa* Schur (W, C, E); *Quercus pubescens* Willd. (W, C, E); *Quercus thracica* Stef. et Nedjalkov (E); *Quercus virgiliana* (Ten.) Ten. (W, C, E); **Globulariaceae**: *Globularia cordifolia* L. (W, C); **Hypericaceae**: *Hypericum olympicum* L. (W, C, E); **Juglandaceae**: *Juglans regia* L. (W, C, E); **Lamiaceae**: *Lavandula angustifolia* Mill. (W); *Salvia officinalis* L. (E); *Salvia tomentosa* Mill. (E); *Satureja coerulea* Janka (W, C, E); *Satureja cuneifolia* Ten. (W, C, E); *Satureja montana* L. (E); *Satureja pilosa* Velen. (W, C, E); *Satureja rumelica* Velen. (C); *Teucrium chamaedrys* L. (W, C, E); *Teucrium montanum* L. (W, C, E); *Teucrium polium* L. (W, C, E); *Thymus jasianus* Stoyanov & Marinov (E); *Thymus leucotrichus* Halácsy (E); *Thymus longedentatus* (Degen & Urum.) Ronn. (C); *Thymus pulegioides* L. (W, C, E); *Thymus thracicus* Velen. (W, C, E); *Thymus zygioides* Griseb. (E); **Loranthaceae**: *Arceuthobium oxycedri* (DC.) Bieb. (W, C, E); *Loranthus europaeus* Jacq. (W, C, E); *Viscum album* L. (W, C, E); **Moraceae**: *Broussonetia papyrifera* (L.) L'Hér. ex Vent. (W); *Ficus carica* L. (C, E); *Morus alba* L. (E); **Oleaceae**: *Fraxinus excelsior* L. (W, C, E); *Fraxinus ornus* L. (W, C, E); *Fraxinus oxycarpa* Willd. (syn. *Fraxinus angustifolia* subsp. *oxycarpa* (Willd.) Franco & Rocha Afonso) (E); *Fraxinus pallisiae* Wilmott (syn. *Fraxinus coriaraefolia* Scheele) (E); *Jasminum fruticans* L. (W, C, E); *Ligustrum vulgare* L. (W, C, E); *Phillyrea latifolia* L. (E); *Syringa vulgaris* L. (W, C, E); **Platanaceae**: *Platanus orientalis* L. (C, E); **Pyrolaceae**: *Orthilia secunda* (L.) House (W, C); **Ranunculaceae**: *Clematis alpina* (L.) Mill. (W); *Clematis recta* L. (W); *Clematis vitalba* L. (W, C, E); *Clematis viticella* L. (E); **Rhamnaceae**: *Frangula alnus* Mill. (W, C, E); *Frangula rupestris* (Scop.) Schur (W, C); *Paliurus spina-christi* Mill. (W, C, E); *Rhamnus cathartica* L. (W, C, E); *Rhamnus rhodopea* Vel-

en. (W, C, E); *Rhamnus saxatilis* Jacq. (W, C, E); **Rosaceae**: *Amelanchier ovalis* Medik. (C, E); *Cotoneaster integerrimus* Medik. (W, C, E); *Cotoneaster nebrodensis* (Guss.) K.Koch (W, C, E); *Crataegus heldreichii* Boiss. (E); *Crataegus monogyna* Jacq. (W, C, E); *Crataegus orientalis* Pall. ex M.Bieb. (C, E); *Crataegus pentagyna* Waldst. & Kit. (E); *Dryas octopetala* L. (C); *Eriolobus trilobatus* (Labill. ex Poir.) M.Roem. (E); *Malus dasycphylla* Borkh. (W, C, E); *Malus praecox* (Pall.) Borkh. (W, C, E); *Malus sylvestris* Mill. (W, C, E); *Mespilus germanica* L. (C); *Potentilla fruticosa* L. (W); *Potentilla palustris* (L.) Scop. (W, C); *Prunus avium* L. (W, C, E); *Prunus cerasifera* Ehrh. (W, C, E); *Prunus cerasus* L. (W, C, E); *Prunus fruticosa* Pall. (E); *Prunus mahaleb* L. (C, E); *Prunus spinosa* L. (W, C, E); *Pyrus amygdaliformis* Vill. (syn. *Pyrus spinosa* Forssk.) (W, C, E); *Pyrus elaeagrifolia* Pall. (C, E); *Pyrus nivalis* Jacq. (W, C, E); *Pyrus pyraister* (L.) Burgsd. (W, C, E); *Rosa agrestis* Savi (W, C, E); *Rosa arvensis* Hudson (C); *Rosa caesia* Sm. (W, C, E); *Rosa canina* L. (W, C, E); *Rosa caryophyllacea* Besser (C); *Rosa corymbifera* Borkh. (W, C, E); *Rosa dumalis* Bechst. (W, C, E); *Rosa elliptica* Tausch (C); *Rosa galli-ca* L. (W, C, E); *Rosa jundzillii* Besser (C); *Rosa micrantha* Borrer ex Sm. (W, C, E); *Rosa mollis* Sm. (W, C, E); *Rosa myriacantha* DC. (W, C, E); *Rosa nitidula* Besser (C); *Rosa obtusifolia* Desv. (W, C); *Rosa pendulina* L. (W, C, E); *Rosa pimpinellifolia* L. (W, C, E) (syn. *Rosa spinosissima* L.); *Rosa pulverulenta* M.Bieb. (W, C, E); *Rosa pumila* Jacq. (C); *Rosa tomentosa* Sm. (W, C, E); *Rosa turcica* Rouy (C, E); *Rosa vosagiaca* Desportes (W, C, E); *Rubus caesius* L. (W, C, E); *Rubus canescens* DC. (W, C, E); *Rubus discolor* Weihe & Nees (W, C, E); *Rubus hirtus* Waldst. & Kit. (W, C, E); *Rubus idaeus* L. (W, C, E); *Rubus lloydianus* Genev. (W, C, E); *Rubus sanguineus* Friv. (W, C, E); *Rubus saxatilis* L. (W, C); *Rubus thyranthus* Focke (W, C, E); *Sorbus aria* (L.) Crantz (W, C, E); *Sorbus aucuparia* L. (W, C, E); *Sorbus austriaca* (Beck) Prain. (C); *Sorbus borbasii* Jáv. (C); *Sorbus domestica* L. (W, C, E); *Sorbus graeca* (Spach) S. Schauer (C); *Sorbus mougeotii* Soy.-Will. & Godr. (W); *Sorbus torminalis* (L.) Crantz (W, C, E); *Sorbus umbellata* (Desf.) Fritsch (W, C, E); *Spiraea chamaedryfolia* L. (E); *Spiraea media* Schmidt (W, C); *Spiraea pseudosalicifolia* Silverside (W); *Spiraea salicifolia* L. (W); **Rutaceae**: *Dictamnus albus* L. (W, C, E); *Ruta graveolens* L. (C, E); **Salicaceae**: *Populus alba* L. (W, C, E); *Populus canescens* (Aiton.) Sm. (W, C, E); *Populus nigra* L. (W, C, E); *Populus tremula* L. (W, C, E); *Salix alba* L. (W, C, E); *Salix ardana* Ziel. & Petrova (E); *Salix caprea* L. (W, C, E); *Salix cinerea* L. (W, C, E); *Salix eleagnos* Scop. (W, C, E); *Salix fragilis* L. (W, C, E); *Salix purpurea* L. (W, C, E); *Salix silesiaca* Willd. (W, C); *Salix triandra* L. (W, C, E); *Salix velchevii* Ziel. & Pancheva (E); *Salix viminalis* L. (C); *Salix xanthicola* K.I.Chr. (C, E); **Santalaceae**: *Comandra elegans* (Rochel ex Spreng.) Rchb.f. (W, C, E); *Osyris alba* L. (E); **Sapindaceae**: *Koeleruteria paniculata* Laxm. (C); **Saxifragaceae**: *Ribes alpinum* L. (W, C); *Ribes nigrum* L. (W, C); *Ribes petraeum* Wulfen (W); *Ribes uva-crispa* L. (W, C); **Simaroubaceae**: *Ailanthus altissima* (Mill.) Swingle (W, C, E); **Solanaceae**: *Lycium barbarum* L. (E); *Solanum dulcamara* L. (W, C, E); **Staphyleaceae**: *Staphylea pinnata* L. (W, C, E); **Tamaricaceae**: *Tamarix ramosissima* Ledeb. (E); *Tamarix tetrandra* Pall. ex M.Bieb. (E); **Thymeleaceae**: *Daphne laureola* L. (C); *Daphne mezereum* L. (W, C, E); *Daphne oleoides* Schreb. (C); **Tiliaceae**: *Tilia cordata* Mill. (W, C, E); *Tilia platyphyllos* Scop. (W, C, E); *Tilia tomentosa* Moench (W, C, E); **Ulmaceae**: *Celtis australis* L. (W, C, E); *Celtis glabrata* Steven ex Planch. (syn. *Celtis planchoniana* K.I.Chr.) (E); *Ulmus glabra* Huds. (W, C, E); *Ulmus*

*minor* Mill. (W, C, E); **Vitaceae**: *Parthenocissus quinquefolia* (L.) Planch. (C); *Vitis sylvestris* C.C.Gmel. (W, E).

**Liliopsida**: **Liliaceae (incl. Asparagaceae)**: *Asparagus acutifolius* L. (E); *Asparagus verticillatus* L. (W, C, E); *Ruscus aculeatus* L. (W, C, E); *Ruscus hypoglossum* L. (W, C, E); **Smilacaceae**: *Smilax excelsa* L. (W, C, E).

Note: The Latin names of the species in the list are given according to 'Conspectus of the Bulgarian Vascular Flora. Distribution Maps and Floristic Elements. Ed. 4' (Assyov and Petrova 2012). Family circumscriptions follow Assyov and Petrova (2012), with traditional family concepts retained for practical purposes. The floristic subregions in which each species occurs are indicated in parentheses after the species name: W – Western Rhodopes; C – Central Rhodopes; E – Eastern Rhodopes.