Article

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Trees and shrubs of the Vashlovani Protected Areas (East Georgia, South Caucasus)

Abstract

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The dendroflora of the Vashlovani Protected Areas situated in the East Georgia is studied. Its floristic composition and systematic structure are established. The floristic composition of trees and shrubs includes 99 species and subspecies belonging to 61 genera and 34 families. The leading families by content number of species are: *Rosaceae* with 23 species (23.2%), *Fabaceae* 7 (7.1%), *Salicaceae* 6 (6.1%), *Cupressaceae* 5 (5.1%), *Rhamnaceae* 5 (5.1%), *Amaranthaceae* 4 (4.0%), *Oleaceae* 4 (4%), *Anacardiaceae* 3 (3%), *Ulmaceae* 3 (3%). Based on the analysis of the systematic structure and the composition of the chorotypes, florogenetic connections are identified, the main directions of which are Mediterranean, South-West Asia, Europe, Euxine and Hyrcan. A complete list of trees and shrubs attached to the article. Key synonyms and chorotypes for each species are given.

Key words: Dendroflora, systematic structure, chorotype, boreal, Ancient Mediterranean, florogenetic connections.

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Introduction

Woody plants (trees and shrubs) are an important component of most ecosystems on Earth. They are distributed from sea level to the subalpine and alpine belts in the completely different physical-geographic conditions.

In addition to being the main constituent plants of various types of forests and shrubberies distributed from the lowlands to the alpine belt, trees and shrubs are also found in the desert and wetland habitats, and their separate individuals also invading into grassland ecosystems.

Trees and shrubs are an important component and characteristic feature of the regional floras. The physical-geographic conditions of the region, anthropogenic impact, ecological state and stability, as well as the dynamics of the vegetation cover, succession processes

and, often, the past of the vegetation cover are clearly reflect on the composition and structure of the dendroflora.

Trees and shrubs have a wide variety of uses, which is why they have been under strong anthropogenic pressure since time immemorial. In this regard, both massive deforestation and exploitation of forests, as well as large-scale fires, are particularly noteworthy. In addition, global climate change on Earth is most reflected on the trees and shrubs. As a result, the area of trees and shrubs is decreasing and their taxonomic diversity is threatened.

Based on the above, the study of dendroflora in the various directions is one of the current issues of modern biodiversity and ecological research. In the regional studies, it is first necessary to determine the composition and systematic structure of dendroflora, which is the basis of any research.

Particularly noteworthy in terms of diversity are the areas located at the intersection of different physical-geographic regions and floristic centers. To one such transitional and floristically interesting territories belongs the Vashlovani Protected Areas in the South Caucasus, namely, in Eastern Georgia (Map 1), where areas of various floristic centers (Southwest Asia, Turanian area, Mediterranean, Euxine, Hyrcanian, Europe, etc.) intersect; at the same time, the complex nature of physical-geographical conditions is clearly expressed. The mentioned circumstances determine the biodiversity of the Vashlovani Protected Areas. In the past, this area was under strong anthropogenic pressure (deforestation, grazing, artificial fires, etc.), which left its negative mark on the vegetation cover of the area.

All of the above-mentioned circumstances led to our scientific interest in the dendroflora of the Vashlovani Protected Areas and its selection as the object of research.

The aim of our research was to determine the composition and systematic structure of the dendroflora of the Vashlovani Protected Areas; based on the analysis of the systematic structure and composition of chorotypes to identify florogenetic connections; to determine the habitat of each species and assess their current state. The present article include the complete composition of trees and shrubs of the study area and discusses aspects of the systematic structure and florogenetic connections.

Materials and Methods

The research is based on both our researches of the latest years (2015-2024) and our publications of previous years (Lachashvili & al. 2004, 2007; Lachashvili & al. 2004; Lachashvili & Khachidze 2010; Lachashvili & al. 2020, etc.).

The separation of chorotypes is based on the methodology and principles used in our previous publications (Lachashvili & al. 2020; Lachashvili & al. 2021; Lachashvili & al. 2023, etc.). The concepts of Brovich (1989), Meusel and Jager (1989), Ivanishvili (1978), Portenier (2000a, 2000b) and Gagnidze (2004) are taken into account. The borders of the boreal and Ancient Mediterranean regions is based to Takhtajan's floristic division of the Earth (Takhtajan 1978). Caucasus endemics are discussed within the borders of the Caucasus ecoregion (Solomon & al. 2013).

The terrain and hydrological network characteristics of the study area are given according to Maruashvili (1964) and Lachashvili & al. (2004, 2007). Climatic data are reconciled

with data of Dzotsenidze (1964), Loladze (1967, 1970), Gobejishvili (2012) and Bolashvili & al. (2018). Soils and related terms follows Urushadze (1999, 2016).

Description of study area

Physical-geographical conditions. – Vashlovani Protected Areas are located in the south-eastern and eastern parts of the Iori Plateau (East Georgia) (Fig. 1). It consists of several objects with different statuses. These are: 1. Vashlovani Nature Reserve (9962 ha), 2. Vashlovani National Park (25021 ha), 3. Alazani Floodplain Forests Natural Monument (201 ha), 4. Artsivis Kheoba Nature Monument (98 ha), 5. Takhti-Tepha Natural Monument (10 ha) (Fig. 2). The total area of the study areas is (35292 ha). Vashlovani Nature Reserve and Vashlovani National Park are adjacent to each other and form a single natural system; and Artsivis Kheoba and Takhti-Tepha Natural Monuments are quite far from them and represent independent fragments. Alazani Floodplain Forests Natural Monument is to some extent a continuation of Alazani River floodplains entering the territory of the Vashlovani National Park.

Hypsometrical amplitude of the Vashlovani Protected Areas is about from 90 to 800 m a.s.l.

The area is characterized by a difficult terrain. In the Vashlovani Nature Reserve and Vashlovani National Park, the complex alternation of peneplainized plains and asymmetric low ridges is expressed. Most of low ridges are lessons with dry gorges and ravines and

Fig. 1. Location of the Vashlovani Protected Areas in the Caucasus Ecoregion and Georgia (the study area is marked in red).

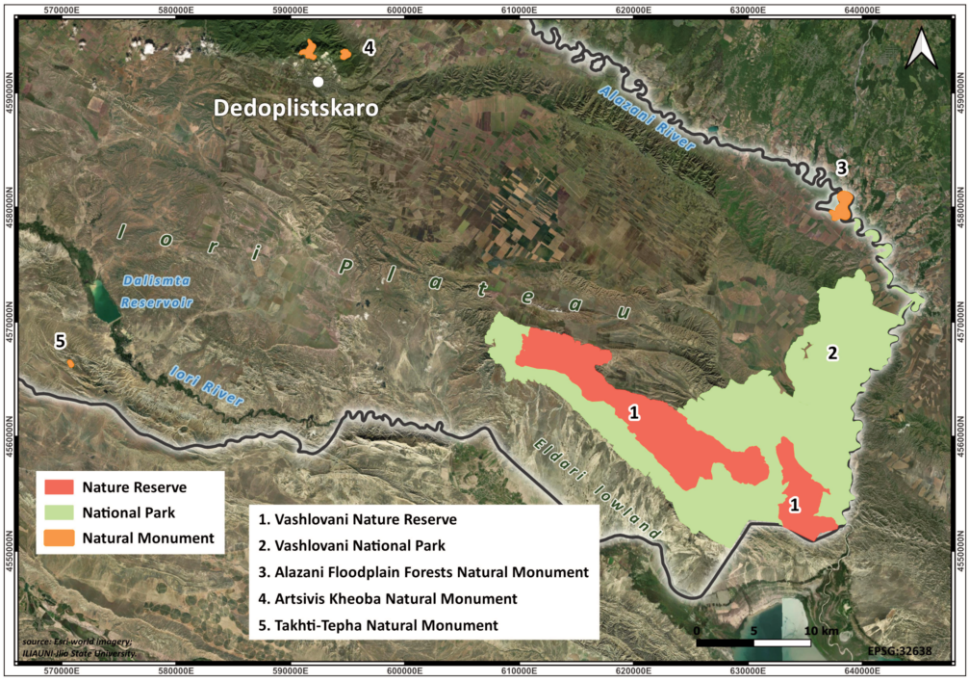

Fig. 2. Map of the Vashlovani Protected Areas.

are characterized by gullies terrain. Canyon-like gorges are not uncommon. Badland low ridges occupy a prominent place in the terrain of the study area. In the various parts of the area, hilly relief is also well expressed.

A narrow bed and narrow floodplains mostly characterize the Alazani River valley in the study area. Not infrequently, the slopes and low ridges are almost directly adjacent to the river.

Artsivis Kheoba Nature Monument characterized by rocky limestone massifs. Itself the Artsivis Kheoba ("Eagle Gorge") presents a narrow rocky canyon.

Despite the non-large area of the territory, the zonal change of climate from south to north is expressed, which is consistent with hypsometric amplitude. Four types of the climate are distinguished in the research area.

Hypsometrically the lowest extreme southern part belongs to moderately warm steppe climate zone with hot summer and precipitation with two minimum per year (BSxa). The average annual temperature is within 13°–14°C, while the average annual atmospheric precipitation is from 350–400 mm, evaporability is up to 1000 mm, humidity ratio 0.4–0.5.

Small part of the territory is located in the transitional climate zone from a moderate warm steppe to a moderate humid with hot summer and two minimums of precipitation per year (BS-Cxa). The average annual temperature is approximately 11–12°C, while the average annual atmospheric precipitation is within 400–450 mm, evaporability approximately 900–1000 mm; the humidity ratio is within 0.6.

Moderate humid climate with moderately cold winter and prolonged warm summer and precipitation with two minimum per year (Cxb) is expressed in the hypsometrically highest part. The average annual temperature is within 10.5–11°C, while the average annual atmospheric precipitation is 600–700 mm, evaporability 800–900 mm, humidity ratio 0.6–1.

A small part of the Alazani River valley entering the study area belongs to the moderate humid climate zone with moderately cold winter and hot summer and precipitation with two minimum per year (Cxa). The average annual temperature is within 14°C, while the average annual atmospheric precipitation is 400 mm, evaporability 800–900 mm, humidity ratio 0.4–0.5.

The hydrological network is poor. The main is transit river Alazani which borders the research area from the east. However, its influence extends only to the riverbed and narrow floodplains. The small river Lekistskali (Salty Water) also belongs to the permanent water stream. It is a salty and small debit river and its influence includes only the bed.

Instead, there are many periodically watered dry ravines in which water will pass as debris/mudflow during rains. There are also several springs that are largely saline. There are no lakes in the study area.

A diverse soil cover is expressed in this small area. According to literature data (Urushadze 1999, 2016; Gobejishvili 2012; Bolashvili & al. 2018), at least five soil types are developed in the study area. Such diversity and regularities of distribution of soil cover are related to climate and hypsometric variability and relief, as well as geomorphological processes.

Light grey-cinnamonic and grey-cinnamonic soils cover the largest area. The first of them mainly is developed on the plains and gently sloping slopes and is salinized to varying degrees. Sometimes white spots of the salts are on the soil surface. Highly salinized moist soils developed on the small places with depressed terrain are rare. Grey-cinnamonic soils mainly are skeleton (stony) and are common on the slopes and hills of different inclination. Compared to the light grey-cinnamonic soils, their salinization is mostly low or insignificant. Hypsometrically relatively high areas are characterized by cinnamonic light and cinnamonic calcareous soils. Alluvial calcareous soils are developed on the terraces of Alazni River.

One of the main ones in the Vashlovani Nature Reserve and Vashlovani National Park is clayey, loamy and clay-sandy badlands. They are mostly salinized - “plates” of salt (especially gypsum containing) sprinkled on the surface are not uncommon. Cemented conglomerate slopes and low ridges are also common. As already noted, the Artsivis Kheoba Nature Monument, located in the vicinity of the Dedoplistskaro stands out for its rocky limestone massifs. In the study area exposed rocky bedrock slopes are rare.

Flora and vegetation. – Vashlovani Protected Areas are distinguished by their floristic richness. Approximately 800–1000 species and subspeciesof vascular plants are distributed in this small area. Xerophilous and hemi-xerophilous plants form the main core of the floristic composition. Compared to them, the number of mesophilic and hydrophilic species is small.

As well as the floristic composition, the vegetation cover is characterized by a rich typological composition. The main types of vegetation are: arid open woodlands (xerophytic wodlands), steppe, hemixerophilous shrubberies, plain deserts, foothill deserts and phryganoid vegetation. Of the xerophilous vegetation, plant communities of tragacanthic shrubberies are rare. In comparison with xerophilous and hemi-xerophilous vegetation,

deciduous forests of the foothills and xeromesophilous shrubberies cover smaller areas.

Floodplain forests and mesophilic shrubberies are developed on the river terraces. Plant communities of the wetland ecotopes, which are mainly associated with riverbanks and terraces, are rare.

Florocomplexes of limestone and exposed rocky sandstones should be mentioned separately.

Results

Systematic structure. – The dendroflora of the Vashlovani Protected Areas includes 99 species and subspecies, which constitutes approximately 28.5% of the local dendroflora of Georgia. They belong to 61 genera and 34 families. The spectrum of the leading families by species content is presented in the form of a table (Table 1).

Most of the families are represented by two or one species (13 families with 2 species each, and 12 families with one species each).

Leading families by content number of genera are: *Rosaceae* – 10 genera (14.9%), *Fabaceae* 5 (7.5%), *Amaranthaceae*, *Anacardiaceae*, *Oleaceae* and *Rhamnaceae* 3 genera for each (4.5%-4.5%). 6 families are represented by 2 genera each, and 22 families by only one genus each. The number of the species is distributed disproportionally in the genera. Most of the genera are represented by one (37 genera) or two (16 genera) species. Only seven genera contain 3-5 species (*Juniperus* and *Pyrus* 5 species each, *Cotoneaster* and *Prunus* 4 each, *Crataegus*, *Populus*, *Rhamnus* and *Salix* 3 each).

Composition of chorotypes (Geographical Range Types). – 99 recorded species of trees and shrubs were distributed in 26 chorotypes, which are united in four main groups: Ancient Mediterranean, boreal, "conjunctive" and "widespread". In addition to main

Table 1. Number of species and subspecies by the leading families in the dendroflora of the Vashlovani Protected Areas.

Family	Number of species & subspecies	%
Rosaceae	23	23.2
Fabaceae	7	7.1
Salicaceeae	6	6.1
Cupressaceae	5	5.1
Rhamnaceae	5	5.1
Chenopodiaceae	4	4.0
Oleaceae	4	4.0
Anacardiaceae	3	3.0
Ulmaceae	3	3.0
Total	60	60.6

Remark: only the genus *Fraxinus*, within the family *Oleaceae*, contains two subspecies.

groups, non-local (alien) species are separated. Quantitative and percentage proportions of chorotypes are given in the tabular form (Table 2).

Endemics. – 8 out of 99 species and subspecies are endemics of the Caucasus. These are: *Acer ibericum* M. Bieb., *Alnus glutinosa* subsp. *barbata* (C.A. Mey.) Yalt., *Astracantha caucasica* (Pall.) Podlech, *Berberis iberica* DC., *Cotoneaster meyeri* Pojark.,

Table 2. Proportion of chorotypes in the dendroflora flora of the Vashlovani Protected Areas.

Chorotype	Number of species	%	Number of species	%
Ancient Mediterranean species				
Mediterranean	6	6.1	32	32.3
Mediterranean–South-West Asian	9	9.1		
Mediterranean– South-West Asian–Turanian	1	1		
South-West Asian	5	5		
South-West Asian–Turanian	3	3.0		
South-West Asian–Turanian–Central Asian	7	7.1		
Caspian	1	1		
Boreal species				
Caucasian	10	10.1	19	19.2
European–Caucasian	6	6.1		
European	1	1		
Euro–Siberian	2	2.0		
“Conjunctive” species				
Caucasian–South-West Asian	10	10.1	39	39.4
Caucasian–South-West Asian–Middle Asian	1	1		
Caucasian–Middle Asian	1	1		
Submediterranean	3	3		
Mediterranean–Eurasian steppe	1	1		
Euxino–Hyrcanean	8	8.1		
Caucasian–Hyrcanean	1	1		
European–Mediterranean	8	8.1		
European–Mediterranean–South-West Asian	4	4.1		
European–Mediterranean–South-West Asian–Central Asian–East Asian	1	1		
Euro–Siberian–Central Asian	1	1		
Widespread species				
Palearctic	6	6.1	7	7.1
Holarctic	1	1		
Non local species				
North American	1	1	2	2
Central Asian (Central and North China)	1	1		
All	99	100	99	100

Remark – “Middle Asian” means mountainous Middle Asia (Pamir-Alay, Tian Shan, etc.).

Crataegus caucasica K. Koch, *Pyrus georgica* Kuth., *Pyrus sachokiana* Kuth. Of these, only *Alnus glutinosa* subsp. *barbata* (C.A. Mey.) Yalt. is a Euxino–Hyrcanean plant and the rest belong to the Caucasian chorotype.

Discussion

Systematic structure and habitats. – In the systematic structure, dominance of family *Rosaceae* is expressed. It is one of the characteristic families of the Nemoral, Sub-mediterranean and Boreal floras. It is also noteworthy that the location of *Rosaceae* in regional floristic spectra decreases from humid to arid regions. At the same time, it is one of the characteristic and leading families of forests and shrubberies. Accordingly, its share decreases from forested to non-forested regions (Turrill 1929; Tolmachev 1986; Lachashvili & al. 2007; Chasapis & al. 2020; Lachashvili & al. 2020; Vladimirov & al. 2020; Lachashvili, & al. 2021, etc.).

Considering the climatic conditions and vegetation cover of the Vashlovani Protected Areas, the dominance of *Rosaceae* in the systematic spectrum of its dendroflora is completely natural.

However, if we compare it with the dendroflora spectrum of the Tbilisi area (Lachashvili, & al. 2021), its share is reduced (32.6% and 23.4%, respectively). This, in our opinion, is related, on the one hand, to the location and physical-geographical parameters of the territories and, on the other hand, to their vegetation cover. Namely:

- Compared to the Tbilisi area, the climate in the Vashlovani Protected Areas is more arid;
- Soil conditions should also be taken into account - various modifications of grey-cinnamonic soils are predominant in the Vashlovani Protected Areas (including relatively dry and saline soils to varying degrees), while cinnamonic soils are of limited distribution; In addition, brown forest soils are not spread at all;
- In the vegetation cover of the Vashlovani Protected Areas, the role of deciduous forests of the foothills and lower mountain belts has sharply decreased, while the role of xerophilous and semi-xerophilous vegetation has increased;
- Compared to the Tbilisi area, the Vashlovani Protected Areas are more closely connected to the arid and semi-arid regions of the South Caucasus and their ecosystems, which leads to a weakening of the influence of the boreal world.

On the contrary, the presence of *Amaranthaceae* (*Chenopodiaceae*) in the top ten is noteworthy, which is one of the characteristic and leading families of the Irano-Turanian (and in general, Sahara-Gobi) deserts (Lavrenko 1962; Bykov 1978; Quesel 1979; Agakhanyants 1986; Wickens 1984; Abd El-Ghani 2000; Lachashvili & al. 2007; Baayo 2008; Lachashvili & Khachidze 2010; Salama & al. 2014; Dhief & al. 2022; Rekis 2023, etc.). Its presence in the top ten is related to the distribution of desert vegetation in the study area.

The presence of *Cupressaceae* and *Anacardiaceae* in the top ten also is directly related to the above.

The remaining leading families (except *Fabaceae*) mainly include woody plants and are characteristic of the dendroflora of different regions. Accordingly, their leading positions in the floristic spectrum are regular.

From the bioecological point of view, the composition of trees and shrubs of the

Vashlovani Protected Areas is very diverse, which is due, on the one hand, to the physical-geographical conditions and, on the other hand, to the diversity of the vegetation cover. Both xerophilic and mesophilic aspects are reflected in the composition of the dendroflora of the Vashlovani Protected Areas. In this regard, the composition of the leading families in terms of species content is particularly important.

In the study area the species of family *Rosaceae* are distributed in the different environments. They can be conditionally divided into three main groups: 1. trees and shrubs characteristic of arid woodlands and hemixerophilic shrubberies [*Prunus incana* (Pall.) Batsch, *Prunus microcarpa* C.A. Mey., *Pyrus salicifolia* Pall., *Cotoneaster morulus* Pojark.]; 2. species growing in the floodplains and other mesophilic environments [*Rubus anatolicus* Focke, *Crataegus pentagyna* Waldst. & Kit. ex Willd., *Sorbus torminalis* (L.) Crantz]; 3. shrubs and trees growing in the foothill deciduous forests and their edges [*Pyrus communis* subsp. *caucasica* (Fed.) Browicz, *Prunus cerasifera* Ehrh., *Mespilus germanica* L., *Cydonia oblonga* Mill., *Crataegus caucasica* K. Koch]. However, it should be noted that such differentiation is conditional, because some species are common in the various environments. It is obvious that the rich floristic composition of the *Rosaceae* family in the study area was also reflected in the bioecological diversity of species.

The species of the *Fabaceae* family distributed in the study area are characteristic of the vegetation cover of xerophilous and semi-xerophilous ecosystems (tragacanthic and hemixerophilous shrubberies, phryganoid vegetation, arid woodlands, rocky and stony ecotopes). Their composition is enriched by the invasive shrub *Amorpha fruticosa* L., which is widespread in floodplain forests and shrubberies developed on river terraces.

The high position of the family *Salicaceae* in the spectrum is associated with the presence of floodplain ecosystems (floodplain forests) in the study area. Whereas the high position of *Cupressaceae* is due to the characteristic and dominant trees and shrubs of arid (xerophytic) woodlands (*Juniperus* spp.).

Two species of the *Rhamnaceae* family – *Paliurus spina-christi* Mill. and *Rhamnus erythroxyloides* Hoffmanns. subsp. *erythroxyloides* – are widespread in the study area. They are one of the characteristic plants of arid woodlands, xerophilous and semi-xerophilous shrubberies. The other three species are rare in the study area. Of these, *Frangula alnus* Mill. is a very rare plant in the Vashlovani Protected Areas and its single individuals are distributed only in the floodplain forests. While *Rhamnus cathartica* L. and *R. spathulifolia* Fisch. & C.A. Mey. grows in various shrubberies.

The high position of the family *Amaranthaceae* in the floristic spectrum is related to the presence of desert vegetation in the study area. The Vashlovani Protected Areas are one of the extreme ends of the distribution range of the shrubs included in this family [*Halostachys caspica* (M. Bieb.) C.A. Mey., *Kalidium caspicum* (L.) Ung.-Sternb., *Suaeda dendroides* (C.A. Mey.) Moq., *S. microphylla* Pall.]. These species are very rare in the study area.

We also note that in the study area and its adjacent territories, *Amaranthaceae* is widely represented by semi-shrubs and annuals and is among the leading families in the general floristic spectra (Lachashvili 1989; Lachashvili & al. 2004, 2007).

The species of the *Oleaceae* family distributed in the study area are predominantly components of deciduous forests of the foothills and lower mountain belts [*Fraxinus excelsior* L. subsp. *excelsior*, *F. excelsior* subsp. *coriariifolia* (Scheele) A. E. Murray, *Ligustrum vul-*

gare L.] and their range in the study area is limited. The exception is *Chrysojasminum fruticans* (L.) Banfi, which is one of the characteristic plants of arid woodlands and various types of shrubberies and is widely distributed in the Vashlovani Protected Areas.

All three species in the family *Anacardiaceae* are components of arid woodlands and hemixerophilous shrubberies. Of these, *Pistacia atlantica* Desf. is the main dominant of arid woodlands.

Composition of chorotypes (Geographical Range Types). – The composition of the chorotypes reflects both Ancient Mediterranean and boreal roots.

The number of Ancient Mediterranean species is almost 1.7 times higher than the number of boreal species. The largest part of the study area belongs to semi-arid climate regions with appropriate soil types and vegetation (arid woodlands, deserts, hemixerophilous shrubberies, etc.), which determines deeper florogenetic connections with Ancient Mediterranean.

Connections with the boreal world are mostly related to the presence of foothill deciduous forests and floodplain forests in the study area, which occupy small areas.

In the composition of the Ancient Mediterranean species both Mediterranean and South-West Asian connections are expressed. Compared to them, links with Turan are small.

Within the Ancient Mediterranean, such directional links are completely regular. These connections, together with the location and physical-geographical conditions of the study area, are determined by the dominance of arid woodlands, hemixerophilous shrubberies and desert vegetation in the vegetation cover.

Both the scarcity of boreal chorotypes (4 in total) and the small number of boreal species are evident. The main ones are the Caucasian and European-Caucasian chorotypes.

In the chorological spectrum, Caucasian species share 1-2 places with Caucasian–South-West Asian, 10 species for each (10.1% for each). In addition, seven of the Caucasian species are endemics of the Caucasus, while the distribution range of the rest species slightly exceeds the Caucasus ecoregion. Such a level of endemism for the dendroflora of the territory located at the intersection of various floristic centers should not be considered a low indicator.

As in our previous publications (Lachashvili & al. 2020, 2021, 2023), we emphasize here that the Caucasian chorotype is attributed by various researchers (Gagnidze & Davitadze 2000; Shetekauri & Gagnidze 2000; Gagnidze 2004) to the Ancient Mediterranean world, namely the Submediterranean. In such a case, the number of boreal species in the dendroflora of the Vashlovani Protected Areas will be insignificant, and the proportion of "transitional" species will also decrease; against this background, the proportion of Ancient Mediterranean species will significantly increase. It is also worth noting that the majority of Caucasian species distributed in the study area are hemixerophilous plants and in their bio-ecology are closer to Ancient Mediterranean plants than to boreal ones. The same applies to Caucasian–South-West Asian species – most of them are also more similar in their bio-ecology to Ancient Mediterranean plants.

If we do not take into account the Caucasian chorotype, then the boreal connections will be reflected mainly in the diversity of the so-called "conjunctive" chorotypes.

In the chorological spectrum, the diversity of "conjunctive" chorotypes and the abundance of "transitional" species are first of all noteworthy. In our opinion, this is completely regular, since the study area is located at the crossing of the boreal and Ancient Mediterranean worlds.

Of the "conjunctive" chorotypes, the Caucasian–South-West Asian chorotype is the most numerous (10 species). These species, together with the Caucasian–South-West Asian–Middle Asian and Caucasian–Middle Asian species form a kind of floristic circle between the Caucasus and South-West Asia. At the same time, these chorotypes emphasize and strengthen the florogenetic connections of the Southwest Asian direction.

The connections of the European direction are also mainly reflected in the "conjunctive" chorotypes (European–Mediterranean, European–Mediterranean–South-West Asian). Accordingly, together with the European–Caucasian chorotype the European–Mediterranean–Caucasian–Southwest Asian florogenetic circle is formed.

One of the notable "conjunctive" chorotypes is the Euxine–Hyrcanian chorotype (8.2%). Given the intermediate location of the study area between the Euxine and Hyrcanian floristic centers, no small number of these species is completely natural.

The comparative analysis of the leading families' composition and chorotypes is interesting. The rich floristic composition of the *Rosaceae* family determines a wide range of chorotypes, which has been revealed in florogenetic links of various directions. The various directions of florogenetic connections (Europe, Mediterranean, Euxine, Hyrcan, Southwest Asia, etc.) are most reflected in the wide range of so-called "transitional" species (15 species). The Caucasian species (5 species) also deserve attention, of which four are endemics of the Caucasus.

Within the composition of the family *Fabaceae*, both Mediterranean (East Mediterranean) and Southwest Asian connections are clearly expressed. Boreal links are only associated with the Caucasian-Southwest Asian [*Astracantha microcephala* (Pall.) Podlech, *Caragana grandiflora* (M. Bieb.) DC.] and Caucasian [*Astracantha caucasica* (Pall.) Podlech] species.

As noted, the representatives of the *Cupressaceae* family (*Juniperus* spp.), common in the Vashlovani Protected Areas, are components of the xerophytic forests and their composition clearly shows Ancient Mediterranean florogenetic links. *Pistacia atlantica* Desf. and *Rhus corriaria* L. (*Anacardiaceae*) belong to the Mediterranean–South-West Asian species. In contrast, *Cotinus coggygria* Scop. is a South Palearctic species, although it is closely related to the Ancient Mediterranean. The shrubs of the family *Amaranthaceae*, distributed in the study area, are typical components of the Irano-Turanian deserts and their participation emphasizes the influence of the Ancient Mediterranean.

The location of the study area at the intersection of the boreal and Ancient Mediterranean worlds is well reflected in the species of the family *Salicaceae*. Both boreal [*Populus canescens* (Aiton) Sm., *Salix caprea* L.] and Ancient Mediterranean (*Populus euphratica* Oliver, *Salix wilhelmsiana* M. Bieb.), as well as Palearctic plants (*Populus nigra* L., *Salix alba* L.) are represented.

The majority of species in the family *Oleaceae* are so-called "conjunctive" species. Accordingly, both boreal (Europe, Caucasus, Euxine) and Ancient Mediterranean (Mediterranean, Southwest Asia, Hyrcan) connections are expressed. *Ulmaceae* family trees (*Celtis caucasica* Willd., *C. glabrata* Steven ex Planch., *Ulmus minor* Mill.) are also belong to the "binding" species.

By chorotypes, the composition of species within family *Rhamnaceae* is "variegated", showing both boreal and Ancient Mediterranean connections.

The presented data show that in the majority of the leading families dominated so-called "conjunctive" species. Both Ancient Mediterranean and boreal connections in the most of

these families are reflected. The exceptions are the families *Cupressaceae*, *Chenopodiaceae* and *Anacardiaceae*, in whose compositions the Ancient Mediterranean connections are clearly expressed.

General Conclusion

The diversity of the physical-geographic conditions and vegetation cover determines the diversity of the dendroflora of the Vashlovani Protected Areas. The diversity is reflected in both species and bioecological diversity, which is consistent with the physical-geographic conditions of the study area.

The transitional location of the territory at the intersection of the boreal and Ancient Mediterranean floristic centers was reflected in the directions of the florgenetic connections of the dendroflora.

The number of Ancient Mediterranean species significantly exceeds the number of boreal ones, which is consistent with the climatic and soil conditions, as well as the vegetation cover of the study area.

The so-called "conjunctive" chorotypes dominate, the composition of which is represented by a wide spectrum. Ancient Mediterranean connections are expressed both in the Mediterranean and South-West Asian directions; links with the Turanian area are very weak. Boreal connections mainly cover Europe and the Euxine, and links towards Siberia are insignificant.

Analysis of the data reveals that, despite the multifaceted phylogenetic connections, the connections with the Ancient Mediterranean are sharper.

On the one hand, the florogenetic connections of various directions and, on the other hand, the high share of Caucasian species emphasize the originality of the dendroflora of the Vashlovani Protected Areas.

Floristic composition indicating key synonyms and chorotypes for each species are given in the Electronic Supplementary file 1 (ESF 1).

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References

Abd El-Ghani, M. M. 2000: Floristics and environmental relations in two extreme desert zones of western Egypt. – Global Ecol. Biogeogr. **9:** 499-516.

Agakhanyants, O. Ye. 1986: Botanicheskaya geografiya SSSR. – Minsk [in Russian].

Baayo, K. A. 2008: Floristic composition of Sahara Area in Libya. – Catrina **3(3):** 37-53

Bolashvili, N., Dittmann, A., King, L. & Neidze, V. 2018: National atlas of Georgia. – Stuttgart.

Browicz, K. 1989: Chorology of the Euxinian and Hyrcanian element in the woody flora of Asia. Pp. 305-314 in: Ehrendofer, F. (ed.), Woody Plants - Evolution and distribution since the Tertiary. – Wien.

Bykov, B. A. 1978: Struktura rastitel'nykh soobshchestv. – Pp. 3-8 in: Bykov, B. A. (ed.), Struktura i produktivnost' rastitel'nosti pustynnoy zony Kazakhstana. – Alma-Ata.

Chasapis, M., Samaras, D. A., Theodoropoulos, K. & Eleftheriadou, E. 2020: The vascular flora of Mt Tzena (northern Greece). – Fl. Medit. **30:** 55-63. https://doi.org/10.7320/FlMedit30.055

Dhief, A., Aschi-Smiti, S. & Neffati, M. 2022: Floristic diversity and plant composition of the arid and Saharan zones of southern Tunisia. – GSC Biological and Pharmaceutical Sciences **18(3):** 250-273. https://doi.org/10.30574/gscbps.2022.18.3.0081

Dzotsenidze, G. S. (ed.) 1964: Atlass Gruzinskoi SSR. – Tbilisi–Moskva [in Russian].

Gagnidze, R. 2004: Up to date problems and tasks of botanical geography of the Caucasus. – Not. Syst. Geogr. Inst. Bot. Thbilissiensis **44-45:** 8-52 [in Russian].

— & Davitadze, M. 2000: Adgilobrivi flora. – Batumi [in Georgian].

Gobejishvili, R. (Ed.-in-Chief) 2012: National atlas of Georgia. – Tbilisi [in Georgian].

Ivanishvili, M. A. 1973: The flora of the *Astragaleta tragacantha* formations of the Great Caucasus northern slope. – Tbilisi [in Russian with a summary in English].

Lachashvili, J., Lachashvili, N. & Khachidze, M. 2004: Synopsis of flora of the Vashlovani State Reserve. – Tbilisi.

—, — & — 2007: Conspectus of flora of Kiziki (East Georgia). – Tbilisi.

Lachashvili, N. J. 1989: Strukturnyy analiz rastitel'nosti Yel'darskoy nizmennosti (Vostochnaya Gruziya). PhD thesis [in Russian].

—, Eradze, N. & Kereselidze K. 2021: Systematic structure and florogenetic connections of dendroflora of Tbilisi area (South Caucasus). – Fl. Medit. **31:** 135-152 https://doi.org/10.7320/FlMedit31.135

—, — & Khetsuriani, L. 2020: Floristic composition of pistachio-woodland (*Pistacieta atlantici*) of Georgia (South Caucasus). – Fl. Medit. **30:** 39-53. https://doi.org/10.7320/FlMedit30.039

—, Kereselidze, K., Eradze, N. & Khetsuriani, L. 2023: Floristic composition of *Spiraea hypericifolia* (*Rosaceae*) shrubberies of Georgia (Caucasus). – Fl. Medit. **33:** 131-156. https://doi.org/10.7320/FlMedit33.131

— & Khachidze, M. 2010. Desert Flora and vegetation of Georgia. – Tbilisi.

—, — & Iashaghashvili, K. 2004: Typology of the Juniper Communitens of the Iori Plateau. – Proc. Georgian Acad. Sci., Biol. Ser. B, **2(1-2):** 55-64.

Lavrenko, E. M. 1962: Osnovnyye cherty botanicheskoy geografii pustyn' Yevrazii i Severnoy Afriki. Komarovskiye chteniya, **15.** – Moskva–Leningrad.

Loladze, G. M. (ed.) 1967: Spravochnik po klimatu SSSR 14 – Gruzinskaya SSR, **2.** – Temperatura vozdukha i pochvy. – Leningrad [in Russian].

— (ed.) 1970: Spravochnik po klimatu SSSR 14 – Gruzinskaia SSR, **4.** – Vlazhnost' vozdukha, atmosfernye osadki, snezhnyi pokrov. – Leningrad [in Russian].

Maruashvili, M. 1964: Sakartvelos fizikuri geografia (Physical geography of Georgia). – Tbilisi [in Georgian].

Meusel, H. & Jäger, E. J. 1989: Ecogeographical differentiation of the Submediterranean deciduous forest flora. – Pp. 315-329 in: F. Ehrendofer (ed.), Woody Plants - Evolution and distribution since the Tertiary. – Wien.

Portenier, N. N. 2000a: Methodical aspects of the elaboration of geographical elements in Caucasian flora. – Bot. J. **85(6):** 76-84 [in Russian with a summary in English].

— 2000b: A system of geographical elements of the Caucasian flora. – Bot. J. **85(9):** 26-33 [in Russian with a summary in English].

Quesel, P. 1978: Analysis of the flora of Mediterranean and Saharan Africa. – Ann. Missouri Bot. Gard. **65(2):** 479-534.

Rekis, A., Elbar, Dj., & Laiadi, Z. (2023): Floristic diversity of a Saharan region in the south east of Algeria. – J. Algérien Rég. Arides **15(1):** 90-100.

Salama, F. M., Sayed, S.A, Abd El-Gellil, A.A. (2014): Plant Communities and Floristic Composition of the Vegetation of Wadi Al-Assiuty and Wadi Habib in the Eastern Desert, Egypt. – Not. Sci. Biol. **6(2):** 196-206.

Shetekauri, S. & Gagnidze, R. 2000: Diversity of high-mountain endemic flora of the Greater Caucasus. – Pp. 151-158 in: Beruchashvili, N., Kushlin, A. & Zazanashvili, N. (eds), Biological and landscape diversity of Georgia. – Tbilisi.

Solomon, J., Shulkina, T. & Schatz, G. E. (eds) 2013: Red list of the endemic plants of the Caucasus: Armenia, Azerbaijan, Georgia, Iran, Russia and Turkey. Monographs in systematic botany from the Missouri Botanical Garden (MSB) 125. – Saint Louis.

Takhtajan, A. L. 1978: The Floristic regions of the World. – Leningrad [in Russian].

Tolmachev, A. I. 1986: Metody sravnitelnoi floristiki i problemy florogeneza. – Novosibirsk [in Russian].

Turrill, W. B. 1929: The plant life of the Balkan Peninsula. – Oxford.

Urushadze, T. (ed.) 1999: Soil Map of Georgia. – Tbilisi.

— 2016: Soils of Georgia. – Tbilisi.

Vladimirov, V., Bancheva. S., Delcheva, M., Vassilev, K. & Pedashenko, H. 2020: Contribution to the knowledge of habitat and vascular plant diversity of Alibotush Reserve, Slavyanka Mountain (Bulgaria). – Fl. Medit. **30:** 19-32. https://doi.org/10.7320/FlMedit30.019

Wickens G. E (1984) Flora. – Pp. 67-75 in: Cloudsley-Thompson, J. L. (ed.), Sahara Desert. – Oxford, New York, Toronto, Sydney, Paris, Frankfurt.

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