Article

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Systematic structure and florogenetic connections of dendroflora of Tbilisi area (South Caucasus)

Abstract

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Tbilisi area is located in the central part of South Caucasus at the intersection of various floristic centres. The aim of the article is to clarify composition of dendroflora of Tbilisi area, analysis it's systematic and chorological structure and establish florogenetic connections. 166 species of trees and shrubs, which belong to 74 genera and 41 families, were recorded. The leading families by the ratio of species are: 1. *Rosaceae* – 32.6%, 2. *Salicaceae* – 7.2%, 3. *Fabaceae* – 4.8%, 4. *Sapindaceae* – 4.2%, 5. *Ulmaceae* – 3.6%, 6-7. *Cupressaceae*, *Rhamnaceae* – 3.0-3.0%. Based on composition and proportion of chorotypes, several directions of florogenetic connection are identified: (1) Boreal, (2) Mediterranean, (3) South-West Asian, (4) Euxinean and (5) Hyrcanean. Dominance of local (Caucasian) species is sharply expressed (19.3%). The composition and proportion of chorotypes points, that forming of dendroflora of Tbilisi area was going through the "struggle" of boreal and Ancient Mediterranean floristic centers. On the background of powerful competition, great number and different bioecological composition of local species emphasize originality of flora of Tbilisi area. We suppose that forming process of dendroflora of Tbilisi area was going on during a long period that not so small number of relict and endemic species speaks about.

Key words: trees, shrubs, floristic composition, chorotype, Ancient Mediterranean.

Introduction

Tbilisi area is located at the intersection of various floristic centers (Mediterranean, Boreal, South-West Asia, Turan) and represents distinctive "botanical junction" (Sakhokia 1961), which is clearly reflected in its biodiversity.

According to some researchers (Gagnidze & Davitadze 2000), the study area belongs to the Ancient Mediterranean world. In particular, these authors discuss most part of the Tbilisi area within the range of Submediterranean and the endings of the Mtkvari-Araks lowland entering in Tbilisi area belong to the South-West Asia-Turan region. Some of the researchers (Takhtadjan 1978) attribute the largest part of the Tbilisi area to the boreal

world, while the endings of Mtkvari-Araks lowland consider the Ancient Mediterranean (in particular to Turan province).

Tbilisi area are characterized by both floristic and ecosystem diversities. There are distributed approximately 1650 species of vascular plants (Makashvili 1952, 1953). Forests of foothill, lower and middle mountain belts, xeromesophilous and mesoxerophilous shrubberies, shrubberies of shibliak type and steppe are the main vegetation cover. They are presented by various modifications. Besides them, plant communities of desert-semidesert, xerophytic forests, tragacanthic shrubberies, meadow-steppe, meadows, saline meadow, floodplain forest and wetlands are distributed. Also there are rocks and scree-stones communities (Lachshvili & al. 2013).

The role of trees and shrubs is especially prominent in the creation of natural landscapes (forests and shrubberies of different types) of Tbilisi area. In addition, trees and shrubs are spread in almost all ecosystems, including herbaceous ecosystems. Therefore, there is a great interest in the origins of dendroflora of Tbilisi area and its florogenetic connections.

The aim of our research was to clarify floristic composition of trees and shrubs of Tbilisi area, the systematic and chorological characterization of this dendroflora; based on their analysis establishing their florogenetic connections.

Materials and methods

Presented research is based on the article of Lachashvili & al. (2017), in which conspectus of trees and shrubs of Tbilisi area are given. There are listed 177 species of trees and shrubs (included naturalized species) and for each species are indicated distribution area and habitat in Tbilisi area in this article. Systematic structure, composition of chorotypes and florogenetic connections are not discussed.

In recent years (2017-2020) floristic composition has been clarified and supplemented; according to new taxonomic data the name and volume of individual species was revised and clarified.

Chorotypes and their general areas correspond to the methods and principles of Ivanishvili (1973), Portenier (2000a, 2000b) and Gagnidze (2004). Phytogeographic zoning of Earth by Takhtadjan (1978) is taken into consideration. Brovich (1989) and Meusel & Jager (1989) approaches and concepts are also taken into account. During the selection of chorotypes detailing was emphasized. Mono, double, triple, and in some occasions fourfold regional chorotypes are selected. The names of all those main botanic-geographic units, that the chorotype area contains, are used in the names of chorotypes. During determination of chorotype of the species and subspecies, the main attention is directed to the center of gravity of the species (subspecies) spread. In case the plant is ranked as subspecies (subsp.), the chorotype of the subspecies is given. By mentioned methodology, in the most chorotypes (where there a need and an opportunity were) lower-ranking units – chorological groups are separated. The selected chorotypes are apportioned in four major groups. They are: (1) boreal, (2) Ancient Mediterranean, (3) “connective” and (4) “widespread”. Such attitude gave the opportunity to conduct more detailed analyzes (Lachashvili & al. 2020).

The boarders of the Ancient Mediterranean and Boreal regions are defined according to Takhtajan (1978). Caucasus and accordingly, Caucasus endemics are discussed in the bounds of Caucasus eco-region (Solomon & al. 2013).

Names and authors of taxa are reconciled with international databases of plants [The plant list (2021), Euro+Med (2006+), IPNI (2021), GBIF.org (2021), Tropicos.org (2021)]. Only several "narrow" species are given according to Solomon & al. (2013) and Davlianidze & al. (2018).

Description of study area

Tbilisi area (Fig. 1) is located in the central part of South Caucasus. The territory covers part of Mtkvari River basin from vil. Dzegvi to the section between Ponichala and Rustavi. Endings of large geographical units of different origin and geological age are gathered in the area of Tbilisi, which greatly conditions complexity of the relief. In particular, Tbilisi area comprises the Saguramo-Ialno (Kukheti) Ridge, the eastern part (Skhaltba Ridge) of Kvernaki Ridge, the eastern endings of the Trialeti Ridge (Satskepela and Armazi, Mskhaldidi and Lisi, Mtatsminda, Narikala, Tabori, Kojori, Teleti ridges), the extreme end of the north-west and western parts of Iori plateau (Samgori, Vaziani, Tbilisi Sea and its vicinities), the extreme north-west end of the Mtkvari-Araxi lowland – Kvemo Kartli lowland, in particular, Ponichala and Kumisi-Tsalaskuri plaines. Hypsometrical amplitude of Tbilisi area is about from 350 m a.s.l. to 1875 m a.s.l. (Maruashvili 1964; Kavrishvili 1964; Ukleba 1968, 1974; Tatashidze 2000).

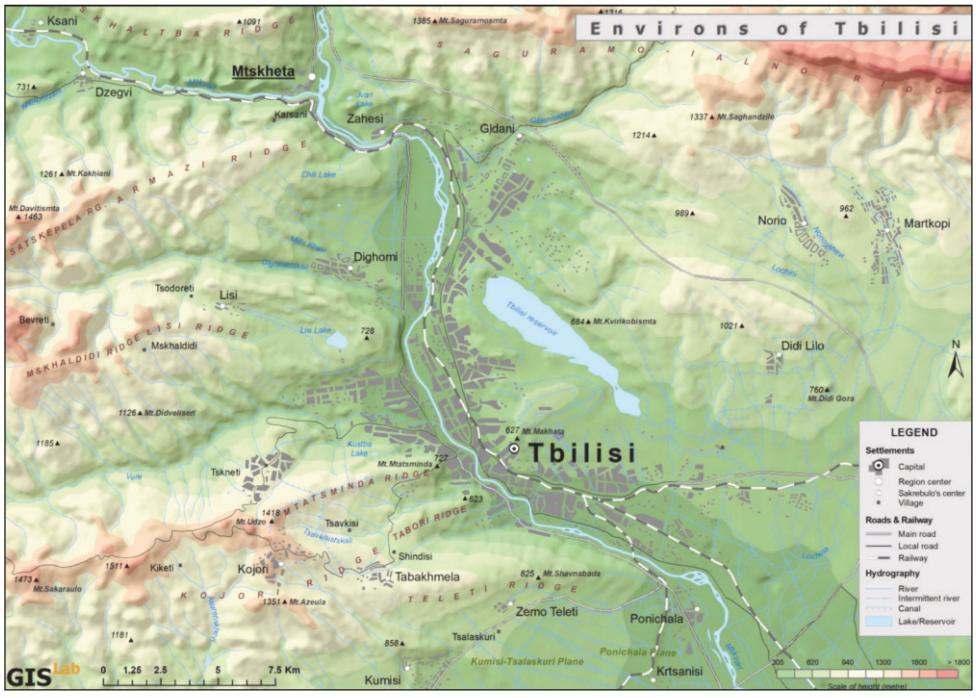

Fig. 1. Physical-geographic map of Tbilisi area.

The area of Tbilisi is characterized by a transitional climate from semi-arid to humid. Two main climate zones are expressed (Kavrishvili 1964; Ukleba 1968): (1) The climate with insufficient humidity, dry and hot summer and mild but well expressed winter, (2) moderately humid climate with moderately warm summer and moderately cold snowy winter. The first zone of the climate contains almost whole left side of the Mtkvari River, Ponichala and Kumisi-Tsalaskuri plains and the river floodplain as well. The second climate zone covers Saguramo-Ialno Ridge and the mountainous part of the right side of Mtkvari River. In the first zone annual evaporation exceeds the sum of precipitation. The average annual temperature is within 12°, while the average annual atmospheric precipitation is from 380 to 530 mm. In the most part of zone the dryness index equals to 2. In the second zone the average annual precipitation (550-780 mm) increases with elevation, while the average annual temperature decreases (from 10.8° to 7.4°). The humidity (precipitation-evaporation) ratio is 1. The highest amount of precipitation is in the crest part of the Saguramo Ridge – approximately 1000-1200 mm. A transition from semi-humid to humid climate is expressed in some parts of Tbilisi area.

Main soil types are grey-cinnamonic, cinnamonic and brown forest soils, which are presented by different modifications. On the terraces of rivers (especially along the Mtkvari River) there are alluvial soils developed. Besides them, there are rocky and scree-stony ecotypes and loamy and clayey-sandy badlands (Kavrishvili 1964; Ukleba 1968; Urushadze 1999, 2016; Tatashidze 2000).

Results

Systematical structure. – On the basis of own researches and literary data, 166 species of trees and shrubs are registered in Tbilisi area, which belong to 41 families and 74 genera.

Distribution of genera by families gives the following picture: with most of number of genera standout is *Rosaceae* – 12 genera (16.2%). By 5 genera represented *Fabaceae* (6.8%). 4 Families (*Anacardiaceae*, *Oleaceae*, *Rhamnaceae* and *Ulmaceae*) includes 3 genera each, 10 families – 2 and 25 families one genera each. Data demonstrates that most of the families (35 families) are presented by only 1-2 genera.

Number of species is distributed disproportionally in the families. 7 families standout by number of species (Table 1).

Table 1. Number of species by the leading families.

Family	Number of Species	%
1. *Rosaceae*	54	32.6
2. *Salicaceae*	12	7.2
3. *Fabaceae*	8	4.8
4. *Sapindaceae*	7	4.2
5. *Ulmaceae*	6	3.6
6. *Cupressaceae*	5	3.0
7. *Rhamnaceae*	5	3.0
Total	97	58.4%

8-12 places are shared by 5 families: *Celastraceae*, *Corylaceae*, *Fagaceae*, *Oleaceae* and *Viburnaceae***.** Any of them are presented by 4 species. 6 families (*Anacardiaceae*, *Betulaceae*, *Caprifoliaceae*, *Cornaceae*, *Tamaricaceae* and *Thymelaeaceae*) contain 3 species each, 8 families (*Araliaceae*, *Berberidaceae*, *Elaeagnaceae*, *Ericaceae*, *Grossulariaceae*, *Loranthaceae*, *Pinaceae*, *Polygonaceae*) 2 species each, and 15 family one species each.

Among 74 genera by content of species 11 genera standout (Fig. 2). 8 genera includes 3 species each and 13 genera – 2 species each. Greatest part of genera – 42 genera are presented by one species for each. So 55 genera, which make up 74.3% of whole composition of genera, are represented by only 1-2 species. Acorrdingly, floristic diversity is mostly conditioned by a great number of genera. It is noteworthy, that most of leading genera (7 genera) belong to *Rosaceae* family, that emprasizes one more time on the importance of this family in creation the dendroflora of Tbilisi area.

Composition of chorotypes (Types of geographic range). – We assign 166 species to 28 types of geographic range (chorotypes), which are united in 4 groups: boreal, Ancient Mediterranean, "conjunctive" and "widespread". Their proportions are given in Fig. 3.

Endemics. – One of the significant characteristic of any flora is endemism. High share of endemic species indicates to originality and uniqueness of flora. From 166 species of trees and shrubs spread in Tbilisi area 32 (19.3%) are endemics of Caucasus. They are: *Acantholimon lepturoides* (Jaub. & Spach) Boiss., *Acer ibericum* M. Bieb., *Alnus glutinosa* subsp. *barbata* (C. A. Mey.) Yalt., *Astracantha caucasica* (Pall.) Podlech, *Astragalus tanae*

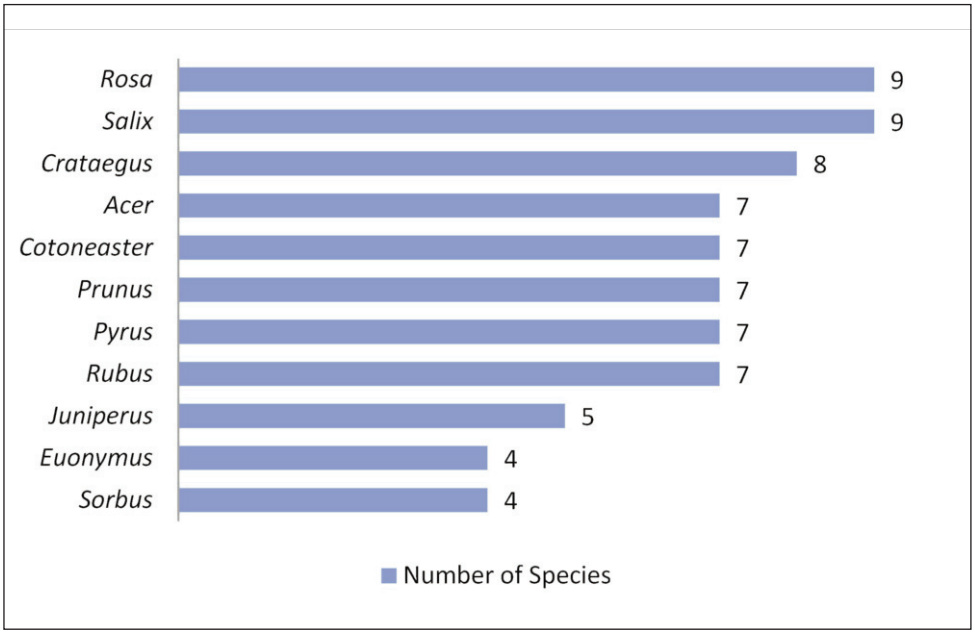

Fig. 2. Number of species by leading genera.

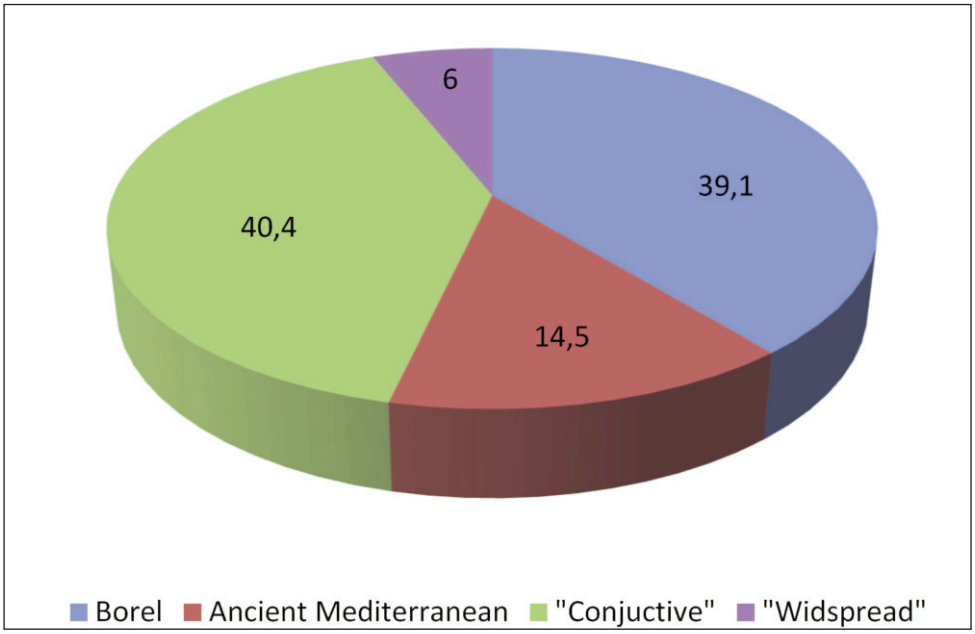

Fig. 3. Proportion (%) of boreal, Ancient Mediterranean, “conjunctive” and “widespread” chorotypes.

Sosn., *Berberis iberica* DC., *Cornus iberica* Woronow, *Corylus iberica* Kem.-Nath., *Cotoneaster meyeri* Pojark., *C. saxatilis* Pojark., *Crataegus caucasica* K. Koch, *Cytisus caucasicus* Grossh., *C. hirsutissimus* K. Koch, *Daphne axilliflora* (Keissl.) Pobed., *Daphne oleoides* subsp. *transcaucasica* (Pobed.) Halda, *Euonymus leiophloeus* Steven, *Philadelphus caucasicus* Koehne, *Picea orientalis* (L.) Peterm., *Prunus georgica* (Desf.) Eisenman, *Pyrus demetrii* Kuth., *P. fedorovii* Kuth., *P. georgica* Kuth., *P. ketzkhovelii* Kuth., *P. sachokiana* Kuth., *Rosa marschalliana* Sosn., *R. prilipkoana* Sosn., *R. transcaucasica* Manden., *Rubus caucasicus* Focke, *R. dolichocarpus* Juz., *R. ibericus* Juz., *Salix kuznetzowii* Goerz, *Sorbus caucasigena* Gatsch..

Various botanical references (by instance, Makashvili 1952; Gviniashvili 1984; Gagnidze 2005; Solomon & al. 2013; Lachashvili & Eradze 2017; Davlianidze & al. 2018) mentioned *Swida armasica* (Sanadze) Gvin. (*Telycrania armasica* Sanadze), which is local endemic of Tbilisi area. This species is not listed in international databases or is not discussed as accepted species. With that in mind, we have not included it in present article.

Relicts. – Relicts of the tertiary period deserve attention among the trees and shrubs of Tbilisi area. 13 relict species are distributed in Tbilisi area. They are: *Buxus colchica* Pojark., *Corylus iberica* Kem.-Nath., *Fagus orientalis* Lipsky, *Hedera pastuchovii* Woronow, *Ilex colchica* Pojark., *Prunus laurocerasus* L., *Quercus macranthera* Hohen., *Quercus robur* subsp. *pedunculiflora* (K. Koch) Menitsky, *Smilax excelsa* L., *Staphylea pinnata* L., *Taxus baccata* L., *Vaccinium arctostaphylos* L., *Viburnum orientale* Pall..

Discussion

Systematic structure. – Dominance of family *Rosaceae* which includes almost 1/3 of floristic composition is obvious. Such high share is completely regular, as *Rosaceae* is one of the characteristic families of the forests and, partly shrubberies. This family is always in the top ten families of nemoral, submediterranean and boreal floras (Turrill 1929; Tolmachev 1986; Chasapis & al. 2020; Vladimirov & al. 2020, etc.). Species diversity of the family *Rosaceae* considerably reduces from humid regions to the direction of semiarid and, especially arid regions (Tolmachev 1986; Lachashvili & al. 2007; Lachashvili & al. 2020). In the floristic spectrum of woody plants of Tbilisi area, diversity of this family is not expressed only in species diversity, but is represented by trees and shrubs of different bioecology which are spread in almost every ecosystem of Tbilisi area.

High location of *Salicaceae* in the floristic spectrum can be explained by diversity of species of genus *Salix*. 9 species from the 16 of the genus *Salix* common in Georgia (Davlianidze & al. 2018) are presented in the area of Tbilisi. They are spread in various moist ravines. However, distribution area for most of them in Tbilisi area is limited and their importance in creation of main landscape is small. From this side, species of genus *Populus* (*P. nigra*, *P. canescens*) are more important.

Conversely other leading families, *Fabaceae* in dendroflora of Tbilisi area is not presented by characteristic species of forests and xeromesophilous shrubberies but xerophilous and hemixerophilous shrubs (*Astracantha caucasica*, *A. microcephala*, *Astragalus tanae*, *A. cornutus*, *Caragana grandiflora*, *Colutea orientalis*). They are characterstic species of tragacanthic, hemixerophilous shrubberies of shibliak type, xerophytic forests and rocks and scree-stones communities. Distributed *Cytisus caucasicus* and C. *hirsutissimus* besides them, which are less xerophilous comparing with the rest species and should be belonged to xeromesophilous plants.

Families *Sapindaceae* and *Ulmaceae* unites mesophilous species characterised for forests. Besides them xeromesophilous species are also (*Celtis caucasica*, *C. planchoniana*, *Acer ibericum*, *Zelkova carpinifolia*). Accordingly, their high position in the floristic spectrum is relevant.

Considering that, family *Rhamnaceae* unites woody plants its being in the top ten of the floristic spectrum is regular. In Tbilisi area, this family is represented by shrubs and trees with different bioecological. Parts of them (*Paliurus spina-christi*, *Rhamnus pallasii*, *R. spathulifolia*) are components of hemixerophilous shrubberies of shibliak type and xerophytic forests, growing in the rocks and scree-stones communities too, whereas *Frangula alnus* and *Rhamnus cathartica* are distributed in the forest edges, xeromesophilous shrubberies and partially in forests.

High position of *Cupressaceae* is due to the participation of *Juniperus* species (*Juniperus communis*, *J. excelsa*, *J. foetidissima*, *J. oxycedrus*, *J. polycarpos*), a characteristic genus of xerophitic forests. These species besides xerophitic forests are spread in hemixerophilous shrubberies and in the rocks and scree-stones communities. It is noteworthy, that *J. communis* is presented by 2 subspecies: *J. communis* subsp. *hemisphaerica* and *J. communis* subsp. *oblonga*. Noted subspecies are given according to Imkhanitskaya (2003). These subspecies by some researchers (Gagnidze 2005; Shetekauri & Chelidze 2016; Davlianidze & al. 2018) until now are discussed in the independent species rank (*J. hemisphaerica* C. Presl, *J. oblonga* M. Bieb.).

Families *Celastraceae*, *Cornaceae*, *Corylaceae*, *Fagaceae Oleaceae* and *Viburnaceae*, which are presented by 4 species each mainly contains characteristic mesophilous trees and shrubs of forests and xeromesophilous shrubberies and their 8-13 position in floristic spectrum is natural. Moreover, main dominannts of forests (*Quercus petraea* subsp. *iberica*, *Q. macranthera*, *Quercus robur* subsp. *pedunculiflora*, *Fagus orientalis*, *Fraxinus excelsior*, *F. angustifolia* subsp. *oxycarpa*) belong to *Fagaceae* and *Oleaceae*.

Chorotypes (Types of geographic range). – Boreal and "conjunctive" chorotypes are represented by nearly equal number of species.

Greatest number of species belongs to so-called "conjunctive chorotypes". Their total number consists of 67 species (40.4%). In them, by capacity of species, European–Mediterranean, Euxino–Hyrcanian and Caucasian–South-West Asian chorotypes are distinguished.

Total number of boreal species are also big – 65 species (39.1%). First of all this is conditioned by wide participation of Caucasian species – Caucasian chorotype contains almost the half of boreal plants. Here we will remark that part of researchers (Gagnidze 2004; Shetekauri & Gagnidze 2000) Caucasian chorotype are considered within Ancient Mediterranean (in particular in submediterranean) region.

Comparing with "conjunctive" and boreal chorotypes, participation of Ancient Mediterranean species is small (24 species / 14.5%). Widespread species are presented by the smallest amount (10 species / 6%).

Among the chorotypes by content of species, Caucasian chorotype dominates (Table 2). It is important that 29 of Caucasian species are endemics of Caucasus and only 2 species have irradiation in South-West Asia [in particular to Anatolia (*Pyrus caucasica*) and North-East Iran (*Rhamnus spathulifolia*)]. Noteworthy that the species included in Caucasian chorotype are of different bioecology and belong to characteristic plants of various habitats. This emphasizes the highlighted role of this chorotype in creation of dendroflora of Tbilisi area.

In boreal chorotypes, after Caucasian, European–Caucasian chorotype is outstanding by its number of species. Not few number of these species points to the florogenetic connection with nemoral forests. These connections are firmed by the participation of Euro–Siberian and European species. Influence of Euxine floristic center is also expressed.

Florogenetic connection of two directions is obvious in Ancient Mediterranean species: Mediterranean and South-West Asian. It is noteworthy, that the area of species connected to the Mediterranean mostly comprises East Mediterranean. Turanian–Central Asian connections are weakly impressed as well. It is significant, that the plants, of which area spread in both directions – on the one hand, Mediterranean and, on the other hand, South-West Asia, Turan, Central Asia, have an important place.

From the side of florogenetic connections, composition and ratio of "conjunctive" chorotypes is important and interesting. These chorotypes by distributed area can be divided into several groups: chorotypes connected with Europe and Mediterranean (European–Mediterranean, Submediterranean), chorotypes connected with Europe, Mediterranean and Soth-West Asia (European–Mediterranean–South-West Asian, European–Mediterranean–South-West Asian–Central Asian), chorotypes connected with Caucasus and South-West Asia (Caucasian–South-West Asian, Caucasian–South-West Asian–Middle Asian, Caucasian–Anatolian and Caucasian–Middle Asian). Outstandingly, it is necessary to highlight the Euxino–Hyrcanian chorotype. First group emphasizes connections with

Table 2. Proportion of chorotypes in the dendroflora of Tbilisi area.

Chorotype	Number of species	%	Number of species	%
Boreal species				
Caucasian	31	18.7	65	**39.1**
European–Caucasian	10	6.0		
Eurasian steppe–Caucasian	2	1.2		
Caucasian–Euxinian	1	0.6		
European	7	4.2		
Euro–Siberian	7	4.2		
Euxinian	7	4.2		
Ancient Mediterranean species				
Mediterranean	6	3.6	24	**14.5**
Mediterranean–South-West Asian	9	5.4		
Mediterranean–South-West Asian–Turanian	1	0.6		
Mediterranean–South-West Asian–Turanian–Central Asian	1	0.6		
South-West Asian	3	1.8		
South-West Asian–Turanian	1	0.6		
South-West Asian–Turanian–Central Asian	2	1.2		
South-West Asian–Central Asian	1	0.6		
"Conjunctive" species				
Submediterranean	7	4.2	67	**40.4**
European–Mediterranean	17	10.3		
European–Mediterranean–South-West Asian	5	3		
European–Mediterranean–South-West Asian–Central Asian	1	0.6		
Euro–Siberian–Central Asian	1	0.6		
Euxino–Hyrcanian	15	9.0		
Caucasian–Hyrcanian	1	0.6		
Caucasian–South-West Asian	14	8.4		
Caucasian–South-West Asian–Middle Asian	2	1.2		
Caucasian–Anatolian	3	1.8		
Caucasian–Middle Asian	1	0.6		
Widespread species				
Palearctic	9	5.4	9	**6.0**
Holarctic	1	0.6	1	
All	166	100	166	100

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

nemoral forests. Simultaneously chorotypes of first group with chorotypes of second group strengthen the Mediterranean links. Chorotypes of second group play an important role in forming connection to South-West Asia direction and make conjunctive florogenetic bridge between Europe and South-West Asia. Chorotypes of the third group are distinguished: they make a kind of circle of florogenetic connection between Caucasus and South-West Asia. Most of species, which are united in these chorotypes, are hemixerophilous and xerophilous plants of dry ecotopes. Among the "conjunctive" chorotypes the species of Euxino–Hyrcanian chorotype deserve distinguished attention. Considering the location and peculiarity of physical-geographic conditions of Tbilisi area, their non-little

share is completely regular. Euxinian and Hyrcanian ties strengthen also by Caucasian–Hyrcanian (*Hedera pastuchovii*) and Caucasian–Euxinian (*Acer trautvetteri*) plants.

In correspondence with "conjunctive" chorotypes, Holarctic species *Juniperus communis* is noteworthy. As noted, in Tbilisi area it is represented by two subspecies: *Juniperus communis* subsp. *oblonga* and *Juniperus communis* subsp. *hemisphaerica*. The first subspecies of them belongs to Caucasian–South-West Asian chorotype and the second subspecies we assign to Mediterranean–Caucasian chorotype. Participation of these subspecies also increases importance of "conjunctive" chorotypes in the structure of dendroflora of Tbilisi area.

Among widespread species plants of Palearctic chorotype are the main. 9 Palearctic species are distributed in 3 groups of geographic area: Palearctic – 3 species, South Palearctic – 2, West Palearctic – 4. Palearctic species belongs to plants of different bioecology and are spread in various habitats.

Presented data indicates different directions of florogenetic connections. Principal directions among them are: European (nemoral forests), Mediterranean, South-West Asian, Euxinian, Hircanian. Relatively weak ties are to direction Siberia. The links of Central Asia, Middle Asia and Turan are much weaker. In spite of many-sided florogenetic connections and powerful competition, role of local (Caucasian) species in forming of dendroflora of Tbilisi area are very high.

Endemic species. – By distributed area among endemic species 3 groups separate out:

Endemics of Caucasus (their distribution area covers both South and North Caucasus) – 16 species (*Acer ibericum*, *Alnus glutinosa* subsp. *barbata*, *Astracantha caucasica*, *Cotoneaster meyeri*, *C.saxatilis*, *Crataegus caucasica*, *Cytisus caucasicus*, *C. hirsutissimus*, *Euonymus leiophloeus*, *Philadelphus caucasicus*, *Picea orientalis*, *Pyrus georgica*, *P. sachokiana*, *Rubus caucasicus*, *R. ibericus*, *Salix kuznetzowii*);

Endemics of South Caucasus – 15 species (*Acantholimon lepturoides*, *Prunus georgica*, *Astragalus tanae*, *Corylus iberica*, *Daphne axilliflora*, *D. oleoides* subsp. *transcaucasica*, *Pyrus demetrii*, *P. fedorovii*, *P. ketzkhovelii*, *Rosa marschalliana*, *R. prilipkoana*, *R. transcaucasica*, *Rubus dolichocarpus*, *Sorbus caucasigena*, *Cornus iberica*);

Endemics of East Caucasus (their main distribution area is in the eastern part of Caucasus) – 1 species (*Berberis iberica*).

From endemic species 2 (*Prunus georgica* and *Rosa transcaucasica*) are endemics to Georgia.

32 Caucasus endemic species by chorotypes are distributed in this way: Caucasian chorotype – 29 species, Euxinian chorotype – 2 (*Philadelphus caucasicus*, *Picea orientalis*) and Euxinian–Hyrcanian – 1 (*Alnus glutinosa* subsp. *barbata*).

For territory which localed in crossing area of different floristic centres, 19.3% of endemism should be considered as high indicator.

Florogenetic connections of dendroflora by habitats. – As it was designated, in Tbilisi area trees and shrubs are spread in almost every habitat. Tendencies of florogenetic connections revealed in the principal habitats are discussed below.

In the dendroflora of forests most of all reveals boreal roots, especially ties with nemoral forests. Ancient Mediterranean connections are weakened – these links are reflected in the participating of species of "connective" chorotypes (Euxinian–Hyrcanian, European–Mediterranean, Submediterranean).

In the dendroflora of hemixerophilous ecosistems (xerophitic forests, shrubberies of shibliak type, tragacanthic shrubberies, rocks and scree-stones communities) Ancient Mediterranean roots are expresed, whereas boreal links are weak. Boreal connections in many cases reveals in participation of plants of Caucasian and Caucasian–South-West Asian chorotypes. Participation of species linked with Europe is small. It is important, that Caucasian–South-West Asian species, in many cases, are plants of arid and semiarid regions. They, with their bioecological features and distribution area, have little in common with the boreal region. They, in our opinion, are more associated with Ancient Mediterranean ecosistems.

From the side of composition of chorotypes and florogenetic connections, between the forests and hemixerophilous ecosystems, the dendroflora of post-forest secondary xeromesophilous and mesoxerophilous shrubberies holds transitional condition. In these habitats trees and shrubs of different bioecology (hemixerophilous, mesophilous, xeromesophilous) are gathered. Consequently, species of both boreal, Ancient Mediterranean and "connective" chorotypes are widely presented. Accordingly, in the floristic composition there are reflected as boreal or Ancient Mediterranean ties. We face strong competition between these two floristic worlds, where the one side (boreal) fights for survival and the other (Ancient Mediterranean) expands its area.

An important role of "connective" species is highlighted in the dendroflora of almost every habitat.

It is also noteworthy that Caucaian species are seen in every habitat.

Received results put emphasis one more time on transitional character of flora of Tbilisi area and its originality.

Relicts. – Distributed area of relict trees and shrubs in Tbilisi area is limited. Most of the relicts are gathered on Saguramo-Ialno Ridge in moist environment and are the components of beech, elm beech-hornbeam and hornbeam forests. They are: *Hedera pastuchovii*, *Vaccinium arctostaphylos*, *Viburnum orientale*, *Corylus iberica*, *Staphylea pinnata*, *Taxus baccata*, *Ilex colchica*, *Prunus laurocerasus* and *Buxus colchica*. *Corylus iberica* and *Staphylea pinnata* are also spread on the east endings of Trialeti Ridge. *Vaccinium arctostaphylos, Viburnum orientale, Ilex colchica* and *Prunus laurocerasus* are components of Colchic forests, and *Hedera pastuchovii* is a characteristic species of Hyrcanian forests. We meet *Quecus macranthera* on the east endings of Trialeti Ridge. The relicts spread in the floodplain forests and moist ravines are: *Quercus pedunculiflora* and *Smilax excelsa*.

General Conclusion

The composition of chorotypes and ratio between them gives us opportunity to express the following point of view: geographic location of Tbilisi area in the intersection areal of various floristic centers, diversity of physical-geographic conditions and geological past gave an opportunity of spreading trees and shrubs of either boreal or South-West Asian and Mediterranean origin. On the one hand, invasion and settlement of mesophilous and on the other hand, hemixeropilous and xerophilous species was possible from various regions. Accordingly, forming of dendroflora of Tbilisi area was going through the "struggle" of boreal and Ancient Mediterranean floristic centers. Such competition in the intersection

areal of various floristic centers conditioned wide assortment of "conjunctive" species. On the background of powerful competition, great number and different bioecological composition of local (Caucasian) species emphasize originality of flora of Tbilisi area. All that is stated above conditioned the complex character of dendroflora of Tbilisi area. We suppose that forming process of dendroflora of Tbilisi area was going on during a long period that not so small number of relict and endemic species speaks about.

Our expressed views based on chorotypes analysis reflect precisely transitional character of flora of Tbilisi area and are in complete concur with the view of M. Sakhokia (1961) about the fact, that Tbilisi area represent a kind of "botanical junction".

Floristic composition indicating chorotypes for each species in table form are given below (Table 3).

Table 3. Floristic composition of Tbilisi area dendroflora.

GYMNOSPERMAE		
Cupressaceae	*Juniperus communis* L. • *J. communis* subsp. *hemisphaerica* (J. Presl & C. Presl (Hyman) (*J. hemisphaerica* C. Presl; *J. depressa* Stevels) • *J. communis* subsp. *oblonga* (M. Bieb.) Galushko (*J. oblonga* M. Bieb.; *J. communis* var. *saxatilis* Pall.)	Holarctic • Med.–Caucasian • Caucasian–S.-W. Asian (conditionally)
	Juniperus excelsa M. Bieb. (*J. isophyllos* K. Koch)	Med.–S.-W. Asian (E. Med.–S.-W. Asian)
	Juniperus foetidissima Willd.	Med. (E. Med.)
	Juniperus oxycedrus L. (*Juniperus rufescens* Link)	Med.
	Juniperus polycarpos K. Koch	S.-W. Asian
Ephedraceae	*Ephedra major* subsp. *procera* (C. A. Mey.) Bornm. (*E. procera* C. A. Mey.)	Med.–S.-W. Asian (E. Med.–S.-W. Asian)
Pinaceae	*Picea orientalis* (L.) Peterm.	Euxinian (with irradiation) (Cauc. endemic)
	Pinus sylvestris var. *hamata* Steven [*P. sylvestris* var. *hamata* Steven; *P. kochiana* K. Koch; *P. sosnowskyi* Nakai]	Caucasian–Anatolian (with Crimean irradiation)
Taxaceae	*Taxus baccata* L.	European–Med.
ANGIOSPERMAE		
DYCOTYLEDONEAE		
Anacardiaceae	*Cotinus coggygria* Scop.	Palearctic (S. Palearctic)
	Pistacia atlantica subsp. *mutica* (Fisch. & C. A. Mey.) Rech. f. (*Pistacia mutica* Fisch & C. A. Mey.)	Med.–S.-W. Asian
	Rhus coriaria L.	Med.–S.-W. Asian
Apocynaceae *(Asclepiadaceae)*	*Periploca graeca* L.	Euxino–Hyrcanian (with E. Med. irradiation)
Aquifoliaceae	*Ilex colchica* Pojark.	Euxinian (Colchic, Colchic-Lazistanian)
Araliaceae	*Hedera helix* L.	European–Med.
	Hedera pastuchovii Woronow	Caucasian–Hyrcanian (E. Caucasian–Hyrcanian)
Berberidaceae	*Berberis iberica* DC.	Caucasian (Cauc. endemic)
	Berberis vulgaris L.	European–Med.

Table 3. continued.

Betulaceae	*Alnus glutinosa* subsp. *barbata* (C. A. Mey.) Yalt. (*A. barbata* C. A. Mey.)	Euxino–Hyrcanian (Cauc. endemic)
	Betula litwinowii Doluch.	Euxino–Hyrcanian
	Betula pendula Roth	Euro–Siberian
Buxaceae	*Buxus colchica* Pojark.	Euxinian (Colchic)
Caprifoliaceae	*Lonicera caprifolium* L.	European–Med. (C. European–Med.)
	Lonicera caucasica Pall.	Caucasian–S.-W. Asian
	Lonicera iberica M. Bieb.	Caucasian–S.-W. Asian
Celastraceae	*Euonymus europaeus* L.	European–Caucasian
	Euonymus latifolius (L.) Mill.	Submed.
	Euonymus leiophloeus Steven	Caucasian (Cauc. endemic)
	Euonymus verrucosus Scop.	European–Caucasian
Cistaceae	*Fumana procumbens* (Dunal) Gren. & Godr.	European–Med. (C. European–Med.)
Cornaceae	*Cornus iberica* Woronow [*Swida iberica* (Woronow) Grossh.]	Caucasian (Cauc. endemic)
	Cornus mas L.	Submed.
	Cornus sanguinea subsp. *australis* (C. A. Mey.) Jáv. [*C. australis* C. A. Mey.; *Swida australis* (C. A. Mey.) Grossh.]	European–Caucasian (conditionally)
Corylaceae	*Carpinus betulus* L. (*C. caucasica* Grossh.)	European–Caucasian
	Carpinus orientalis Mill.	Submed. (E. Submed.)
	Corylus avellana L.	European–Caucasian
	Corylus iberica Kem.-Nath.	Caucasian (Cauc. endemic)
Elaeagnaceae	*Elaeagnus angustifolia* L.	Palearctic (S. Palearctic)
	Hippophaë rhamnoides L	European–Med.–S.-W. Asian–C. Asian
Ericaceae	*Rhododendron luteum* Sweet	Euxinian (with European irradiation)
	Vaccinium arctostaphylos L.	Euxino–Hyrcanian
Fabaceae	*Astracantha caucasica* (Pall.) Podlech	Caucasian (Cauc. endemic)
	Astracantha microcephala (Willd.) Podlech	Caucasian–S.-W. Asian (S. Caucasian–S.-W. Asian)
	Astragalus cornutus Pall.	Eurasian steppe–Caucasian (with Iranian irradiation)
	Astragalus tanae Sosn.	Caucasian (Cauc. endemic)
	Caragana grandiflora (M. Bieb.) DC.	Caucasian–S.-W. Asian
	Colutea orientalis Mill.	Med. (E. Med.; Caucasian-Crymean)
	Cytisus caucasicus Grossh. [*Chamaecytisus caucasicus* (Grossh.) Holub]	Caucasian (Cauc. endemic)
	Cytisus hirsutissimus K. Koch	Caucasian (Cauc. endemic)
Fagaceae	*Fagus orientalis* Lipsky	Euxino–Hyrcanian
	Quercus macranthera Fisch. & C. A. Mey. ex Hohen.	Caucasian–S.-W. Asian
	Quercus petraea subsp. *iberica* (M. Bieb.) Krassiln. (*Q. iberica* M. Bieb.)	Caucasian–S.-W. Asian
	Quercus robur subsp. *pedunculiflora* (K. Koch) Menitsky (*Q. pedunculiflora* K. Koch)	Med. (E. Med.)
Grossulariaceae	*Ribes alpinum* L.	European
	Ribes uva-crispa L. [*Grossularia reclinata* (L.) Mill.; *R. reclinatum* L.]	European

Table 3. continued.

Hydrangeaceae	*Philadelphus caucasicus* Koehne	Euxinian (with irradiation) (Cauc. endemic)
Loranthaceae (*Santalaceae*, *Viscaceae*)	*Arceuthobium oxycedri* (DC.) M. Bieb.	Med.–S.-W. Asian
	Viscum album L.	Palearctic (conditionally)
Malvaceae *(Tiliaceae)*	*Tilia begoniifolia* Steven	Euxino–Hyrcanian
Moraceae	*Ficus carica* L.	S.-W. Asian
Oleaceae	*Fraxinus excelsior* L.	European–Caucasian
	Fraxinus angustifolia subsp. *oxycarpa* (Willd.) Franco & Rocha Afonso (*F. oxycarpa* Willd.)	Submed. (E. Submed.) (conditionally)
	Jasminum fruticans L.	European–Med.–S.-W. Asian
	Ligustrum vulgare L.	European–Med.
Plumbaginaceae	*Acantholimon lepturoides* (Jaub. & Spach) Boiss.	Caucasian (endemic)
Polygonaceae	*Atraphaxis caucasica* (Hoffm.) Pavlov	Caucasian–M. Asian
	Atraphaxis spinosa L.	Med.–S.-W. Asian–Turanian–C. Asian (E. Med.–S.-W. Asian–Turanian–Jungaro-Kashgarian)
Ranunculaceae	*Clematis vitalba* L.	European–Med.
Rhamnaceae	*Frangula alnus* Mill.	Euro–Siberian
	Paliurus spina-christi Mill.	Med.–S.-W. Asian
	Rhamnus cathartica L.	Palearctic
	Rhamnus pallasii Fisch. & C. A. Mey.	Caucasian–S.-W. Asian
	Rhamnus spathulifolia Fisch. & C. A. Mey.	Caucasian
Rosaceae	*Amelanchier ovalis* Medic.	European–Med. (C. European–Med.)
	Cotoneaster integerrimus Medic.	European–Med.–S.-W. Asian (conditionally)
	Cotoneaster melanocarpus Fisch. ex A. Blytt.	Euro–Siberian–C. Asian
	Cotoneaster meyeri Pojark.	Caucasian (endemic)
	Cotoneaster morulus Pojark.	Caucasian–S.-W. Asian
	Cotoneaster racemiflorus (Desf.) K. Koch	Caucasian–S.-W. Asian–M. Asian
	Cotoneaster saxatilis Pojark.	Caucasian (endemic)
	Cotoneaster suavis Pojark.	S.-W. Asian–C. Asian (conditionally)
	Crataegus caucasica K. Koch	Caucasian (endemic)
	Crataegus kyrtostyla Fingerh.	European–Caucasian (condotionally)
	Crataegus meyeri Pojark.	Caucasian–S.-W. Asian
	Crataegus microphylla K. Koch	Euxino–Hyrcanian
	Crataegus orientalis M. Bieb.	Med. (E. Med.)
	Crataegus pentagyna Willd.	Euxino–Hyrcanian
	Crataegus pontica K. Koch [*C. azarolus* var. *pontica* (K. Koh) K. I. Chr.]	S.-W. Asian
	Crateagus pseudoheterophylla Pojark.	Caucasian–S.-W. Asian
	Malus orientalis Uglitzk. [*M. sylvestris* subsp. *orientalis* (Uglitzk.) Browicz]	Caucasian–S.-W. Asian
	Mespilus germanica L.	Euxino–Hyrcanian

Table 3. continued.

	Prunus avium (L.) L. [*Cerasus avium* (L.) Moench; *C. silvestris* Garsault]	European–Med.
	Prunus divaricata Ledeb.	Med.–S.-W. Asian (E. Med.–S.-W. Asian)
	Prunus georgica (Desf.) Eisenman (*Amygdalus georgica* Desf.)	Caucasian (endemic)
	Prunus incana (Pall.) Batsch [*Cerasus incana* (Pall.) Spach]	Caucasian–S.-W. Asian
	Prunus laurocerasus L. (*Laurocerasus officinalis* M. Roem.)	Euxino–Hyrcanian
	Prunus mahaleb L. [*Cerasus mahaleb* (L.) Mill.; *Padellus mahaleb* (L.) Vassilcz.]	European–Med.–S.-W. Asian
	Prunus spinosa L.	European–Med.
	Pyracantha coccinea M. Roem.	Euxino–Hyrcanian
	Pyrus caucasica Fed. [*Pyrus communis* subsp. *caucasica* (Fed.) Browicz]	Caucasian
	Pyrus demetrii Kuth.	Caucasian (endemic)
	Pyrus fedorovii Kuth.	Caucasian (endemic)
	Pyrus georgica Kuth.	Caucasian (endemic)
	Pyrus ketzkhovelii Kuth.	Caucasian (endemic)
	Pyrus sachokiana Kuth.	Caucasian (endemic)
	Pyrus salicifolia Pall.	Caucasian–S.-W. Asian
	Rosa canina L.	European–Med.–S.-W. Asian
	Rosa corymbifera Borkh.	European–Med.–S.-W. Asian
	Rosa marschalliana Sosn.	Caucasian (endemic)
	Rosa micrantha Borrer ex Sm.	European–Med.
	Rosa mollis Sm.	European
	Rosa prilipkoana Sosn.	Caucasian (endemic)
	Rosa spinosissima L.	Palearctic (W. Palearctic)
	Rosa transcaucasica Manden.	Caucasian (endemic)
	Rosa tomentosa Sm.	European
	Rubus anatolicus Focke	Med.–S.-W. Asian (E. Med.–S.-W. Asian)
	Rubus caesius L.	Palearctic (W. Palearctic)
	Rubus caucasicus Focke	Caucasian (endemic)
	Rubus dolichocarpus Juz.	Caucasian (endemic)
	Rubus hirtus Waldst. & Kit.	European–Caucasian
	Rubus ibericus Juz.	Caucasian (endemic)
	Rubus idaeus L.	Euro–Siberian (Euro–W. Siberian)
	Sorbus caucasigena Gatsch.	Caucasian (endemic)
	Sorbus graeca (Spach) S. Schauer	European–Med. (C. European–Med.)
	Sorbus torminalis (L.) Crantz	European–Med.
	Sorbus turcica Zinserl.	Med. (E. Med.) (conditionally)
	Spiraea hypericifolia L.	Eurasian steppe–Caucasian
Salicaceae	*Populus canescens* (Aiton) Sm.	European (with irradiation)
	Populus nigra L.	Palearctic (W. Palearctic)
	Populus tremula L.	Euro–Siberian
	Salix alba L.	Palearctic (W. Palearctic)

Table 3. continued.

	Salix caprea L	Euro–Siberian
	Salix elbursensis Boiss.	Caucasian–S.-W. Asian
	Salix excelsa S.G.Gmel.	S.-W. Asian–Turanian
	Salix kuznetzowii Goerz	Caucasian (endemic)
	Salix micans Andersson	Caucasian–Anatolian
	Salix pseudomedemii E. L. Wolf	Caucasian–Anatolian
	Salix triandra L.	Euro–Siberian
	Salix wilhelmsiana M. Bieb.	Irano–Turanian–C. Asian (Irano–Turanian–Jungaro–Kashgarian)
Sapindaceae *(Aceraceae)*	*Acer campestre* L.	European–Caucasian
	Acer cappadocicum Gled. (*A. laetum* C. A. Mey.)	Euxino–Hyrcanian
	Acer hyrcanum Fisch. & C. A. Mey.	Euxino–Hyrcanian
	Acer ibericum M. Bieb. [*A. monspessulanum* subsp. *ibericum* (M. Bieb. ex Willd.) Yalt.]	Caucasian (endemic)
	Acer platanoides L.	European–Caucasian
	Acer pseudoplatanus L.	European (C. European)
	Acer trautvetteri Medv. [*A. heldreichii* subsp. *trautvetteri* (Medw.) A. E. Murray]	Caucasian–Euxinian
Staphyleaceae	*Staphylea pinnata* L.	Submed.
Tamaricaceae	*Myricaria germanica* (L.) Desv.	Palearctic
	Tamarix ramosissima Ledeb.	S.-W. Asian–Turanian–C. Asian (Irano–Turanian–C. Asian)
	Tamarix smyrnensis Bunge (*T. hohenackeri* Bunge)	Med.–S.-W. Asian–Turranian (E. Med.–S.-W. Asian–Turanian)
Thymelaeaceae	*Daphne axilliflora* (Keissl.) Pobed. [*D. caucasica* subsp. *axilliflora* (Keissl.) Halda]	Caucasian (endemic)
	Daphne pontica L.	Euxinian (with irradiations)
	Daphne oleoides subsp. *transcaucasica* (Pobed.) Halda (*D. transcaucasica* Pobed.)	Caucasian (endemic)
Ulmaceae	*Celtis australis* subsp. *caucasica* (Willd.) C.C. Towns. (*C. caucasica* Willd.)	Caucasian–S.-W. Asian–M. Asian (S. Caucasian–S.-W. Asian–M. Asian)
	Celtis planchoniana K. I. Chr. (*C. glabrata* Steven ex Planch., nom. illeg.)	Submed. (E. Submed.)
	Ulmus elliptica K. Koch	European–Caucasian
	Ulmus glabra Huds.	European
	Ulmus minor Mill.	European–Med.
	Zelkova carpinifolia (Pall.) K. Koch	Euxino–Hyrcanian
Viburnaceae	*Sambucus nigra* L.	European–Med.
	Viburnum lantana L.	European–Med. (C. European–Med.)
	Viburnum opulus L.	Euro–Siberian (Euro–W. Siberian)
	Viburnum orientale Pall.	Euxinian (with irradiation)
Vitaceae	*Vitis sylvestris* C. C. Gmel. [*V. vinifera* subsp. *sylvestris* (C. C. Gmel.) Hegi]	Med.–S.-W. Asian
MONOCOTYLEDONEAE		
Asparagaceae *(Ruscaceae)*	*Ruscus aculeatus* L. [*R. ponticus* Woronow; *R. aculeatus* subsp. *ponticus* (Woronow) Gagnidze]	European–Med.
Smilacacea	*Smilax excelsa* L.	Euxino–Hyrcanian

Abreviations: C. – Central, Cauc. – Caucasus, E. – East, M. – Middle, N. – North, S. – South, W. – West.; Med. – Mediterranean, Submed. – Submediterranean.

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