Article

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Floristic composition of *Spiraea hypericifolia* (*Rosaceae*) shrubberies of Georgia (Caucasus)

Abstract

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The floristic composition of *Spiraea hypericifolia* shrubberies distributed in Georgia is studied for first time. 256 species of vascular plants, which belong to 172 genera and 49 families, were recorded. Leading families by content number of species are: *Poaceae* - 28 species (10.9%), *Asteraceae* – 27 (10.5%), *Fabaceae* – 20 (7.8%), *Rosaceae* – 18 (7%), *Brassicaceae* – 16 (6.3%), *Lamiaceae* – 16 (6.3%), *Apiaceae* – 11 (4.3%), *Caryophyllaceae* – 11 (4.3%), *Asparagaceae* – 7 (2.7%). Spectrum of life forms is as follows: phanerophytes – 37 species (14.4%), chamaephytes – 8 (3.1%), hemicryptophytes – 109 (42.6%), geophytes – 33 (12.9%), therophytes – 69 (27%). Based on the analysis of the systematic structure of the flora, the composition and ratio of chorotypes and the composition of life forms, 4 main directions of florogenetic connections were identified: Mediterranea, South-West Asia, Europe and Eurasian steppe. It can be concluded that the formation of the *Spiraea hypericifolia* shrubberies in Georgia took place under the influence both of the Ancient Mediterranean and Boreal floristic centers. Nevertheless, the Ancient Mediterranean connections are more expressed. The dominance of local (Caucasian) species in the spectrum of chorotypes (14%) emphasizes the originality of the studied shrubberies.

Key words: systematic structure, chorotypes, life forms, florogenetic connections.

Introduction

The distribution area of the Iberian Spirea (*Spiraea hypericifolia* L.) extends from southwestern Europe (Iberian Peninsula) to China and Mongolia including southern parts of East Europe and Siberia, Crimea, Caucasus eco-region, Balkan Peninsula (Bulgaria), Middle Asia and partially South-West Asia.

The hypsometric range of the species in the Caucasus extends from the foothills to the subalpine belt.

Indications for the occurrence of plant communities of Iberian Spirea shrubberies in different regions of the Caucasus can be found in numerous scientific papers (Takhtadjan 1941; Rubtsov 1956; Prilipko 1970; Lachashvili & al. 2013; Fayvush & Aleksanyan 2016,

etc.). However, they do not contain any information on the distribution patterns, phytosociological structure and floristic composition of *S. hypericifolia* shrubberies.

In the Caucasus shrubberies dominated by *S. crenata* and/or *S. hypericifolia* are mainly distributed from foothills to middle mountain belt (Rubtsov 1956). But in the southern part of the South Caucasus (Armenia) they are common in the subalpine belt (Fayvush & Aleksanyan 2016).

In Georgia, particulary in the Tbilisi environs and on the Iori plateau, scant information about *Spiraea hypericifolia* shrubberies is available in the publications by Kakulia (1942) and Sakhokia (1961).

Recent research has revealed that shrubberies of *Spiraea hypericifolia* are one of the interesting and important components of the Eastern Georgia vegetation. In particular, Iberian Spirea shrubberies are one of the main and characteristic formations of the Tbilisi area vegetation (Lachashvili & al. 2013; Lachashvili & Eradze 2017). Its distribution patterns and typological composition in the Tbilisi environs are studied, the list of floristic composition and spectrum of the life forms are given (Lachashvili & al. 2019). In addition, in the context of digression successions of post-forest vegetation of the Tbilisi vicinity, the Iberian Spirea shrubberies are discussed in monograph of Lachashvili & al. (2015). The existence of Iberian Spirea communities on Iori plateau, particulary, in the David Gareji protected landscape is confirmed in the article by Lachashvili and Kereselidze (2020).

Spiraea hypericifolia formation is interpreted differently by researchers. Part of researchers (Rubtsov 1956; Sakhokia 1961; Prilipko 1970; Lachashvili & al. 2013; Lachashvili & al. 2015; Lachashvili & Eradze 2017; Lachashvili & al. 2019; Lachashvili & Kereselidze 2020, etc.) attribute it to the hemixerophilous shrubberies of shibliak type, and some researchers attribute it to the so-called steppe scrubs and consider it to belong to the Boreal vegetation (Fayvush & Aleksanyan 2016; Kamelin 2017).

The aim of our research was to determine the distribution area of Iberian Spirea formation in Georgia; study its floristic composition; and based on the analysis of the systematic structure of flora, composition of chorotypes and life forms to identify the main floristic connections.

Materials and Methods

Collection of floristic and phytosociological data was carried out over 2005-2021.

While separating the chorotypes, we were guided by the principles and methods of Ivanishvili (1978), Portenier (2000a, 2000b) and Gagnidze (2004). The concepts of Brovich (1989) as well as Meusel and Jager (1989) and the phytogeographical zoning of Earth by Takhtajian (1978) are also taken into account. As in our previous articles (Lachashvili & al. 2020; Lachashvili & al. 2021) emphasis was placed on detail when distinguishing chorotypes. Mono, double, triple, and in some cases quadruple regional chorotypes are separated. The chorotypes were selected in four major groups: (1) Boreal, (2) Ancient Mediterranean, (3) "conjunctive" and (4) widespread. Such methods have allowed us to analyze in detail. The borders of the Ancient Mediterranean and Boreal regions are defined according to Takhtajan (1978). Caucasus and Caucasian endemics are discussed in the boundaries of Caucasus eco-region (Solomon & al. 2013).

Taxa and their authors are given according to international plant databases [Euro+Med (2006-), The Plant List (2013), GBIF.org (2022), IPNI (2022), POWO (2022), Tropicos.org (2022), WFO (2022)].

The spectra of life forms are based on the classifications of Raunkiaer (1934) and Serebryakov (1964).

Soils and related terms are given according to Urushadze (1999, 2016). Climatic data are reconciled with data of Loladze (1967, 1970), Gobejishvili (2012) and Bolashvili & al. (2018).

Results

Description of the study area. – As a result of our research, it was found that the distribution area of the *Spiraea hypericifolia* formation in Georgia includes the central and western parts of the Iori Plateau, the foothills of the eastern endings of the Trialeti Ridge, the Kverknaki Ridge and the Shida Kartli Plain hills; rare on the northern foothills of the Saguramo Ridge and the southwestern foothills of the Gombori Ridge (Fig. 1).

The physical-geographical conditions of the area are more or less heterogeneous, which is primarily due to the characteristics of the climate and soil.

Distribution area of Iberian Spirea scrubs in Georgia is mainly located in moderately humid subtropical climate region. Nevertheless, different parts of the area belong to various climatic zones and are characterized by more or less different parameters.

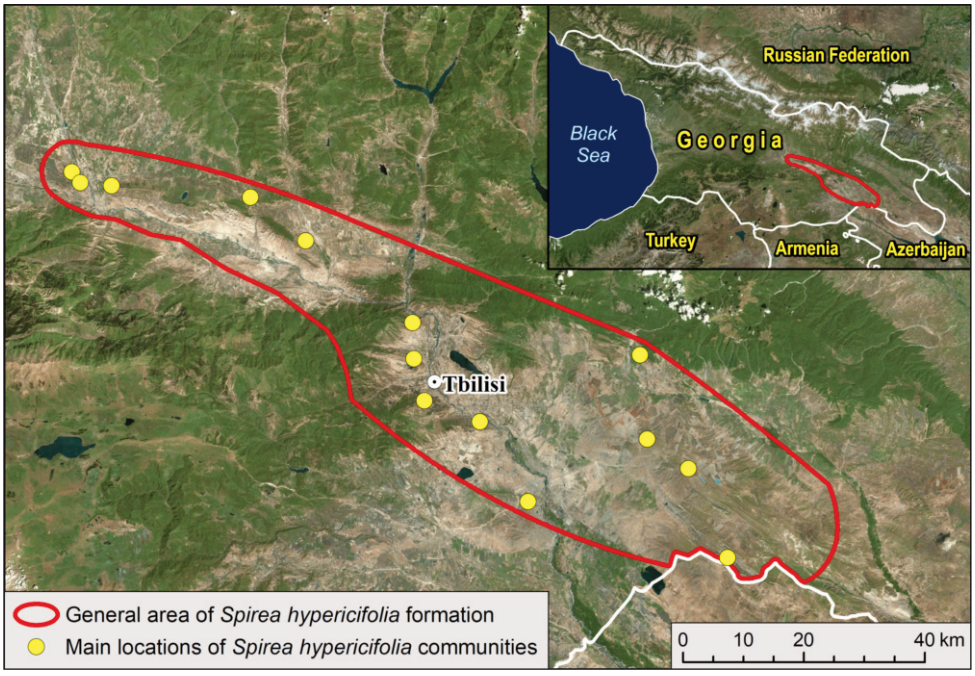

Fig. 1. Distribution area of *Spiraea hypericifolia* shrubberies in Georgia.

The central and western parts of the Iori Plateau are characterized by a transitional climate 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 in the range of 10.4°C-12°C, the average annual precipitation - (400) 450-550 (600) mm, evaporability – (800) 900-1000 mm, humidity ratio - (0.4) 0.5-0.6.

Area of different climatic zones (BS-Cxa, Cxa, Cxb, Dxbk') are intersected in the vicinity of Tbilisi. Most part of the Tbilisi area, as well as central and western parts of the Iori Plateau is within the transitional climate zone from a moderate warm steppe to a moderate humid (BS-Cxa). The eastern endings of the Trialeti Ridge entering in the Tbilisi environs are characterized by a moderate humide climate with moderately cold winter and prolonged warm summer and two minimums of precipitation per year (Cxb). Average annual temperature is within 8°C-10°C (11°C), the average annual precipitation is from (570) 600 to 800 (870) mm, evaporability - (700) 800-900 mm, humidity ratio - in the range of 0.6-1. Climatic data of the southwestern foothills of the Gombori Ridge (around the village of Khashmi) and northern foothills of the Saguramo Ridge is similar. Only a small part of the Trialeti Ridge entering in the Tbilisi area (Kojori and etc.) is located in a moderate humid climate zone with modereately cold winter and prolonged cool summer and two minimums of precipitation per year (Dxbk').

The Kvernaki Ridge and the hills of the Shida Kartli Plain are also characterized by a transitional climate from a moderate warm steppe to a moderate humid with hot summers and two minimums of precipitation per year (BS-Cxa). However, the degree of aridity, compared to the Iori plateau and the Tbilisi area, is slightly reduced. In particular, average annual temperature is in the range of 10°C-11°C, the average annual precipitation is from 550 to 650 mm, evaporability – 800-900 mm and humidity ratio - in range 0.6-1.

Hypsometric range of *Spiraea hypericifolia* communities in Georgia is within 600-1000 (1100) m a.s.l. and mostly covers the foothills. They are distributed on the slopes of different inclination (15°-20° to 30°-45°). The macro exposure of the slopes is mostly northern, although they are also found on the southern exposure. They are developed on the various modifications of gray-cinnamonic and cinnamonic soils. In most cases the soil is thin or medium deep. Soils are skeletal. In some cases, bares of the sandstone of marine origin is observed. The inclination of *Spiraea hypericifolia* plant communities in the Caucasus to northern exposure is also noted by other researchers (Kakulia 1942; Rubtsov 1956; Sakhokia 1961). But the distribution of Spirea communities in the southern part of the South Caucasus (in particularl in Armenia) is different. Here they are common in the subalpine belt mainly on slopes of southern exposure (Fayvush & Aleksanyan 2016).

General regularities of the distribution of Spiraea hypericifolia shrubberies in Georgia. – The area of Iberian Spirea formation in Georgia is included, on the one hand, in the area of steppes and, on the other hand, in the area of deciduous forests of the foothills and lower mountain belt.

S. hypericifolia communities are rare in the natural area of steppe (climate zone BS-Cxa). They are most widespread in the transitional climate zones (Cxa, Cxb, Dxbk'), particularly on the eastern endings of the Trialeti Ridge entering in the Tbilisi environs. Here they are in contact with the deciduous forests, various secondary shrubberies and secondary plant communities of steppes and meadows.

S. hypericifolia communities are mostly developed on the slopes of the northern macro-exposure and it is relatively rare on the slopes of the macro-southern exposure.

S. hypericifolia communities are of both primary and secondary origin. The secondary plant communities belong to one of the stages of the digressive succession of the foothill deciduous forests. At present, the structure of primary and secondary communities is, in most cases, identical and it is impossible to draw a line between them (Lachashvili & al. 2015, 2019).

Although the Spirea communities in different parts of the area are in direct contact with the deciduous forests of the foothills, as well as with the steppe vegetation, they do not form a connecting "bridge" between them.

Systematic Structure of Flora. – 256 species of vascular plants were recorded in *Spiraea hypericifolia* shrubberies of Georgia. They belong to 172 genera and 49 families (Table 1).

Leading families by contains of genera are represented in form of a table (Table 2).

Crassulaceae, *Orchidaceae* and *Ranunculaceae* are represented by 4 genera each. Three families (*Caprifoliaceae*, *Oleaceae* and *Rubiaceae*) contain 3 genera each. 10 families are represented by 2 genera each and 22 families – by one genus each. The data makes it clear, that genera are unequally distributed among families. In particular, most of the families (32 families) contain only 24.4% (42 genera) of the total number of genera.

Like genera, species are disproportionately distributed by to families. The spectrum of the top families is given in the form of a table (Table 3).

Boraginaceae and *Rubiaceae* contain 6 species each. 5 families (*Caprifoliaceae*, *Euphorbiaceae*, *Iridaceae, Orchidaceae* and *Ranunculaceae*) are represented by 5 species each and 3 families (*Amaryllidaceae*, *Crassulaceae*, *Geraniaceae*) by 4 species each. 9 families contain 3 species each and 5 families – 2 species each. Almost 1/3 of the families (16 families) are represented by only one species.

Leading genera by species content are *Alyssum* and *Euphorbia* (Table 4).

Composition of chorotypes (Geographical Range Types). – The flora of *Spiraea hypericifolia* shrubberies of Georgia is characterized by a rich composition of chorotypes.

Table 1. General spectrum of vascular flora of *Spirea hypericifolia* shrubberies of Georgia.

Large Taxa		**Families**		**Genera**		**Species**	
		Number	%	Number	%	Number	%
Gymnospermae		2	4.1	2	1.1	3	1.2
Angyospermae		47	95.9	170	98.9	253	98.8
	Dicotyledonae	39	79.6	136	79.1	198	77.3
	Monocotyledonae	8	16.3	34	19.8	55	21.5
Total		49	100	172	100	256	100

Table 2. Number of genera by the leading families in *Spiraea hypericifolia* shrubberies of Georgia.

Family	Number of genera	%
1. *Poaceae*	18	10.5
2. *Asteraceae*	17	9.9
3. *Fabaceae*	14	8.1
4. *Lamiaceae*	12	7.0
5. *Brassicaceae*	11	6.4
6. *Rosaceae*	10	5.8
7. *Apiaceae*	9	5.2
8. *Caryophyllaceae*	7	4.1
9. *Boraginaceae*	6	3.5
10. *Asparagaceae*	5	2.9
Total	109	63.4

Table 3. Number of species by the leading families in *Spiraea hypericifolia* shrubberies of Georgia.

Family	Number of species	%
1. *Poaceae*	28	10.9
2. *Asteraceae*	27	10.5
3. *Fabaceae*	20	7.8
4. *Rosaceae*	18	7.0
5. *Brassicaceae*	16	6.3
6. *Lamiaceae*	16	6.3
7. *Apiaceae*	11	4.3
8. *Caryophyllaceae*	11	4.3
9. *Asparagaceae*	7	2.7
Total	154	60.1

Table 4. Number of species in genera of the vascular flora of *Spirea hypericifolia* shrubberies of Georgia.

Genus	Number of species	Genus	Number of species
Euphorbia	5	*Helianthemum*	3
Allium	4	*Inula*	3
Alyssum	4	*Iris*	3
Astragalus	4	*Poa*	3
Cotoneaster	4	*Silene*	3
Galium	4	*Stipa*	3
Prunus	4	*Tragopogon*	3
Salvia	4	*Viola*	3
Bromus	3	In the rest:	
Convolvulus	3	37 genera	2-2
Geranium	3	116 genera	1-1

256 recorded vascular plants were grouped into 36 geographic range types. Proportion of chorotypes is given in the form of a table (Table 5).

Endemics. – 27 species, which is 10.5% of the total floristic composition, are endemics of Caucasus. All of them belong to the Caucasian chorotype. They are divided into two groups: Caucasus endemics, whose distribution area includes both the North and South Caucasus and endemics of the South Caucasus. The first group includes 17 species. They are: *Acer ibericum* M. Bieb., *Bromus biebersteinii* Roem. & Schult., *Astragalus bungeanus* Boiss., *Centaurea ovina* Willd., *C. reflexa* Lam., *Cephalaria media* Litv., *Cotoneaster meyeri* Pojark., *C. saxatilis* Pojark., *Dianthus subulosus* Conrath & Freyn, *Gagea commutata* K. Koch, *Jurinea blanda* (M. Bieb.) C. A. Mey., *Onobrychis cyri* Grossh., *Ophrys caucasica* Woronow, *Primula woronowii* Losinsk., *Teucrium chamaedrys* subsp. *nuchense* (K. Koch) Rech. F., *Tragopogon tuberosus* K. Koch, *Verbascum formosum* Schrank. The endemics of the South Caucasus are: *Bellevalia montana* (K. Koch) Boiss., *Euphorbia boissieriana* (Woronow) Prokh., *Gypsophila stevenii* Schrank, *Heracleum antasiaticum* Manden., *Polygala transcaucasica* Tamamsch., *Prunus georgica* (Desf.) Eisenman, *Psephellus carthalinicus* Sosn., *Salvia garedjii* Troitsky, *Seseli grandivittatum* (Sommier & Levier) Schischk., *Thymus coriifolius* Ronniger.

Composition of life forms. – Spectrum of life form (Raunkiaer 1934) is as follows: phanerophytes – 37 (14.4%), chamaephytes – 8 (3.1%), hemicryptophytes (with biennial plants) – 109 (42.6%), geophytes – 33 (12.9%), therophytes – 69 (27%).

Table 5. Proportion of chorotypes in the vascular flora of *Spirea hypericifolia* shrubberies of Georgia.

Chorotype	Number of species	%	Number of species	%
Boreal species				
Caucasian	36	14.0	60	**23.4**
European–Caucasian	6	2.3		
Eurasian steppe–Caucasian	12	4.7		
Eurasian steppe	1	0.4		
Caucasian–Euxinian	2	0.8		
Euxinian	2	0.8		
Euro-Siberian	1	0.4		
Ancient Mediterranean species				
Ancient Mediterranean	3	1.2		
Mediterranean	7	2.7	39	**15.2**
Mediterranean–South-West Asian	20	7.8		
Mediterranean–South-West Asian–Turanian	1	0.4		
Mediterranean–South-West Asian–Turanian–Central Asian	1	0.4		
South-West Asian	1	0.4		
South-West Asian–Turanian	3	1.2		
South-West Asian–Turanian–Central Asian	1	0.4		
Iran-Turanian	1	0.4		
Caspian	1	0.4		
"Conjunctive" species				
European–Ancient Mediterranean	4	1.6	109	**42.6**
European–Mediterranean	18	7.0		
European–Mediterranean–South-West Asian	17	6.6		
European–Mediterranean–South-West Asian–Turanian	1	0.4		
European–Caucasian–South-West Asian	2	0.8		
Mediterranean–Caucasian	3	1.2		
Mediterranean–Eurasian steppe	4	1.6		
Mediterranean–South-West Asian–Eurasian steppe	15	5.8		
Mediterranean–Eurasian steppe–Caucasian	4	1.6		
South-West Asian–Caucasian–Eurasian steppe	6	2.3		
Eurasian steppe–Caucasian–Anatolian	1	0.4		
Caucasian–South-West Asian	25	9.7		

Table 5. continued.

Caucasian–South-West Asian–Middle Asian	2	0. 8		
Caucasian–Middle Asian	1	0.4		
Caucasian–Turanian	1	0.4		
Caucasian–Hyrcanian	1	0.4		
Euxino–Hyrcanian	4	1.6		
Widespread species				
Palearctic	43	16.8	43	**18.8**
Holarctic	5	2.0	5	
All	256	100	256	100

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

Discussion

Systematic structure of flora. – The spectrum of leading families by content of species does not fit into the standard of any floristic center (Mediterranean, South-West Asia, Iran-Turan, Europe, etc.). The influence of various floristic centers is reflected on it.

First of all, a very high position (fourth place) of the family *Rosaceae* is especially noteworthy. The position of this family in the Mediterranean floras is not clearly defined - it is rarely included in the top ten. Instead it is one of the leading families of submediterranean, nemoral and Boreal floras (Turrill 1929; Tolmachev 1986; Chasapis & al. 2020; Vladimirov & al. 2020, etc.). In addition, its position in the floristic spectrum rises from south to north. A similar situation is observed in the Iran-Turan region of the Ancient Mediterranean, where its place in the floristic spectrum increases from non-forest regions to forests (Turril 1929; Kamelin 1973; Karamysheva & Rachkovskaya 1973; Tolmachev 1986; Lachashvili & al. 2007; Lachashvili & al. 2020). Consequently, in the forest regions of South-West Asia, the family *Rosaceae* is always included in the top ten, although it is mostly in the second half of the top ten (6-10 places). Judging from the information above, one can conclude that such a high position of the *Rosaceae* in the *Spiraea hypericifolia* scrub of Georgia indicates both Boreal and South-West Asian connections.

If not for the very high position of the family *Rosaceae* in the spectrum, otherwise the main characteristic features of the Ancient Mediterranean floras are clearly visible. Families *Brassicaceae*, *Caryophyllaceae*, *Apiaceae* and *Lamiaceae* are almost always in the top ten of the floristic spectra of the Ancient Mediterranean regions (Turril 1929; Kamelin & al. 1989; Gagnidze 2000; Asaadi 2009; Aghaei & al. 2013; Dehshiri & Jozipoor 2014; Ghollasimood & al. 2014; Roshan & Heydari 2014: Jafari & al. 2016; Kargar Chigani & al. 2017, etc.). Mentioned families together with *Fabaceae*, *Asteraceae* and *Poaceae*, form the core of the leading families of the Ancient Mediterranean floras. In the context of Ancient Mediterranean connections, we should also consider the presence of *Boraginaceae* and *Rubiaceae* in the top of spectrum (10-11 places).

Separately should be noted the families of *Monocotyledonae* such as *Asparagaceae* (7 species), *Amaryllidaceae* (4), *Liliaceae* (3) and *Colchicaceae* (1). If we consider these families with the older, larger volume of *Liliaceae* (s.l.), then the total number of species included in them would be 15 species and *Lilaceae* (s.l.) would be in the 7th position. Currently the family *Asparagaceae* ranks 9th, and *Amaryllidaceae* is in the second echelon of leading families. All this once again underscores Ancient Mediterranean influence (Mediterranean and South-West Asia). The second dozen of the floristic spectrum (*Caprifoliaceae*, *Euphorbiaceae*, *Iridaceae*, *Orchidaceae*, *Ranunculaceae*, *Amaryllidaceae*, *Crassulaceae*, *Geraniaceae*) emphasize the transitional nature of the flora.

Composition of chorotypes (Geographical Range Types). – The composition of chorotypes is one of the most important characteristics of any flora and best reflects the main directions of florogenetic connections. The number of Boreal chorotypes is 1.5 times higher than the number of Ancient Mediterranean chorotypes. The so-called "conjunctive" chorotypes are represented by the largest number of species (Fig. 2).

In the spectrum of chorotypes first of all a very high share of Caucasian species (14%) are noteworthy. In addition, 27 out of 36 Caucasian species are endemic of Caucasus. All this emphasizes the originality of *Spiraea hypericifolia* shrubberies of Georgia. Not only the high share of Caucasian chorotype is noteworthy, but also its diverse composition. Plants of all life forms and different bioecology are presented. However, a significant part of them are hemixerophilous and xerophilous and with their bioecology and systematic connections they are associated rather more with the Ancient Mediterranean region than the Boreal. *Prunus georgica* (Desf.) Eisenman (*Amygdalus georgica* Desf.), which is considered as an independent species according to the IPNI (2022), POWO (2022) and WFO (2022), stands out in this respect. This species is closely related to *Prunus tenella* Batsch, which is widespread in the steppe area of Eurasia, and should be considered as its vicarious species.

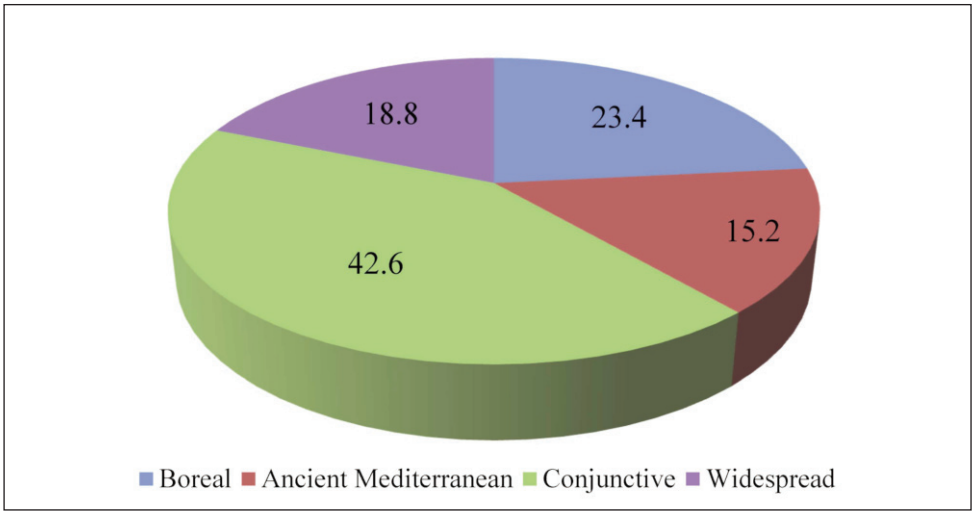

Fig. 2. Proportion (%) of Boreal, Ancient Mediterranean, "conjunctive" and widespread chorotypes.

As in our previous studies (Lachashvili & al. 2020; Lachashvili & al. 2021), we now note that the Caucasian chorotype by some researchers is considered within Ancient Mediterranean region, particularly in Submediterranean (Gagnidze 2004; Gagnidze & Davitadze 2000; Shetekauri & Gagnidze 2000). In such a case, the ratio of Boreal and Ancient Mediterranean chorotypes will change in the opposite direction.

Although European species have not been recorded, connections to Europe are expressed. These connections are mainly reflected in a wide range of "connecting" and European–Caucasian chorotypes. The total number of such species is 49 species (19.1%).

The links with the Eurasian steppes are also strong. The total number of species related to the Eurasian steppes in different ways is 43 (16.8%). It is obvious that in the floristic composition of the *Spiraea hypericifolia* formation of Georgia there is a kind of a circle of florogenetic connections between the Caucasus and the Eurasian steppes.

Ancient Mediterranean ties have two main directions - Mediterranean and South-West Asia. The main core of the Ancient Mediterranean chorotypes is Mediterranean–South-West Asian species – 20 species (7.8%). The number of directly South-West Asian–Turanian (–Central Asian) species is small – 6 species (2.4%). There are also few Mediterranean plants (7 species). The florogenetic connections with both the Mediterranea and South-West Asia are supported by a wide range of so-called "conjunctive" chorotypes. In this respect, the European–Mediterranean, European–Mediterranean–South-West Asian and Mediterranean–South-West Asian–Eurasian steppe chorotypes are important in relation to the Mediterranean, and the Caucasian–South-West Asian chorotype in relation to South-West Asia. The latter is the most numerous of the "conjunctive" chorotypes. Here we note that the Caucasus–South-West Asian (–Middle Asian) species form an important circle of florogenetic connections between the Caucasus and South-West Asia. In the direction of the Ancient Mediterranean, the weakest connection is with Turan and Central Asia. This is completely natural, because the hemixerophilous shrubberies of the Caucasus and Turanian deserts will not have a single "root" of origin.

The presented data show that both Boreal and Ancient Mediterranean connections of the most are revealed in a wide range of "connecting" chorotypes. The dominance of "conjunctive" chorotypes and their wide range, in our opinion, indicates the transitional nature of the floristic composition of Spirea shrubberies.

The very high share of widspread species in the spectrum of chorotypes attracts special attention. The most numerous are Palearctic species. They are divided into three groups: Palearctic – 25 species, West Palearctic – 12 and South Paleractic – 6. Palaearctic and Holarctic chorotypes are almost entirely represented by herbaceous plants (mainly with hemicryptophytes and therophytes). Nevertheless, among them so-called weed and ruderal plants are few.

The chorological analysis of the species compositions of the leading families turned out to be important and interesting. As mentioned, most of the top ten leading families are characteristics of the Ancient Mediterranean floras. In the chorological spectrum of all ten leading families mostly dominated are "conjunctive" chorotypes. Their wide range determines the florogenetic connections of different directions and no sharp influence of any floristic center is observed. However, certain tendencies are still evident. All the families of the top ten, except *Rubiaceae*, contain at least one Caucasian species. *Asteraceae* (6 species), *Fabaceae* (5) and *Lamiaceae* (4) are distinguished by the content of Caucasian

species. In the first ten leading families, compared to other connections, the strongest connection is expressed with South-West Asia, which is reflected in a wide range of "connecting" chorotypes. Species linked with South-West Asia dominate almost every family, including family *Rosaceae*. Compared to South-West Asia, the floristic connection of the European direction is significantly weakened, however, this is manifested to varying degrees in the floristic composition of all ten leading families. This connection is reflected in the " conjunctive" chorotypes. The species associated with the Eurasian steppes are disproportionately distributed. Their concentration is in three widely distributed families – *Asteraceae* (11 species), *Poaceae* (8) and *Fabaceae* (3). *Rosaceae* also includes three species. Most of the families characteristic of the Ancient Mediterranean floras (*Apiaceae*, *Brassicaceae*, *Caryophyllaceae*, *Rubiaceae*) do not contain species related to the Eurasian steppes. Only the family *Lamiaceae* is represented by two species of this group. Such a ratio of species associated with the Eurasian steppes, in our view, is perfectly natural. Almost all of the 10 leading families contain at least one widespread (Palearctic and Holarctic) species. Their highest concentration was observed in the families *Poaceae* (8 Palearctic and 1 Holarctic species) and *Brassicaceae* (7 Palearctic species). 5 Palearctic species include *Rosaceae*. At the same time, Palearctic and Holarctic species are negligibly present in the families *Asparagaceae*, *Apiaceae*, *Caryophyllaceae,* and *Fabaceae*, while *Asteraceae* does not contain such species at all.

The approximately similar situation is in the second echelon of leading families. "Conjunctive" chorotypes are mostly dominant in these families as well and no sharp influence of any floristic center is observed.

Based on the analysis of the systematic and chorological structure of the floristic composition, we can conclude that there is an influence of both Ancient Mediterranean and Boreal centers on the floristic composition of Iberian Spirea scrubs in Georgia and its formation was going through the "struggle" of these two floristic centers. If we do not take into account the local (Caucasian) species, which are considered differently by the researchers, then relatively strong florogenetic connections are expressed in the direction of the Ancient Mediterranean.

Composition of life forms. – The core of the flora consists of herbaceous plants (82.4%). Compared to them, the share of woody and semi-woody plants is much smaller (respectively, 13.7% and 3.9%).

One of the main characteristics of the life forms spectrum is the ratio of the share of hemicryptophytes and therophytes. In the life forms spectrum of Iberian Spirea shrubberies of Georgia the number of hemicryptophytes is almost 1.6 times higher than the number of therophytes.

The composition of hemicryptophytes is diverse. The main core is made up of plants characteristic of steppes, meadow-steppes and hemixerophilous shrubberies. Their composition is enriched, on the one hand, with forest components [*Aegonychon purpurocaeruleum* (L.) Holub, *Brachypodium sylvaticum* (Huds.) P. Beauv., *Poa nemoralis* L., *Primula veris* subsp. *macrocalyx* (Bunge) Lüdi, *P. woronowii*] and, on the other hand, with plants characteristic of stony ecotopes [*Gypsophila stevenii*, *Sempervivum transcaucasicum* Muirhead, *Euphorbia glareosa* Pall. ex M. Bieb., *Sedum pallidum* M. Bieb., *Phedimus spurius* (M. Bieb.) 't Hart, *Reseda lutea* L.].

It is noteworthy that in the composition of hemicryptophytes weed plants are very few [*Achillea arabica* Kotschy, *Convolvulus arvensis* L., *Eryngium caeruleum* M. Bieb., *Elymus repens* (L.) Gould], while the share of such plants among therophytes is much higher [*Aegilops tauschii* Coss., *Bromus japonicus* Thunb., *Camelina microcarpa* Andrz. ex DC., *Daucus carota* L., *Erodium cicutarium* (L.) L'Her, *Euphorbia helioscopia* L., *Filago eriocephala* Guss., *Hirschfeldia incana* (L.) Lagr.-Foss., *Geranium robertianum* L., *Lycopsis orientalis* L., *Trifolium arvense* L., *Carthamus lanatus* L., *Rapistrum rugosum* (L.) All., *Noccaea perfoliata* (L.) Al-Shehbaz, *Brachypodium distachyon* (L.) P. Beauv., *Filago pyramidata* L., etc.].

The share of phanerophytes is high (14.4%). The main core is made up of species characteristic of hemixerophilous shrubberies and arid open woodlands. Among them are also shrubs characteristic of stony, crumbling and rocky ecotopes. The composition of phanerophytes is enriched with the participation of the components of the deciduous forests of the foothills and the lower mountain belt [*Acer ibericum* M. Bieb., *Euonymus verrucosus* Scop., *Fraxinus excelsior* L., *Ligustrum vulgare* L., *Lonicera caprifolium* L., *Quercus petraea* subsp. *iberica* (Steven ex M. Bieb.) Krassiln., *Ulmus minor* Mill.], which are uncharacteristic and very rare plants for Iberian Spirea shrubberies.

With respect to life forms the ratio of characteristic (constant) plants is important. Study of Iberian Spirea shrubberies in the Tbilisi area revealed that the core of characteristic species consists of hemicryptophytes and phanerophytes (Lachahsvili & al. 2019). Some species of chamaephytes also belong to the constant species. Despite not that small number, there are no constant species in the composition of therophytes. They belong to the rare (uncharacteristic) plants. The data are also similar in the Iberian Spirea's communities common on the Iori plateau (Lachashvili & Kereselidze 2020).

An important picture is given by the mutual comparison of life forms and chorotypes. The main ties in the **phanerophytes** are to South-West Asia, Mediterranean and Europe. Caucasian–South-West Asian chorotype is represented by the largest number of species (9 species). Not that small number of local (Caucasian) species (6 species) deserves attention. The link with the Eurasian steppes is very weak - only *Spirea hypericifolia* belongs to Caucasian-Eurasian steppe chorotype. Local (Caucasian) species (4 species) predominate in **chamephytes**. The connections to Eurasian steppes and Mediterranean are weak.

The composition and florogenetic connections of **hemicryptophytes** are diverse. First of all, a large number of Palearctic (24 species) and Caucasian (20 species) species are striking. At the same time, strong connections with the South-West Asia and Mediterranean are pronounced, which is due to the wide range of chorotypes. Connections with Eurasian steppes are also strongly expressed – 28 species of hemicryptophytes are associated with the Eurasian steppe area. In relation to the Eurasian steppes the so-called 3 florogenetic circles are well-defined: Mediterranean – South-West Asia – Eurasian steppes, South-West Asia – Caucasus – Eurasian steppes and Caucasus – Eurasian steppes. In addition, in the "conjunctive" chorotypes not so weak ties to direction of Europe are reflected (15 species). It is clear that both Ancient Mediterranean and boreal connections are pronounced in the rich floristic composition of hemicryptophytes.

Both Ancient Mediterranean and Boreal connections are expressed in the composition of **geophytes**. The most evident is the florogenetic link with South-West Asia. In this direction, the Caucasian–South-West Asian chorotype stands out (8 species). Relatively weak

connections are to the direction of Mediterranean, Europe, Eurasian steppes and Euxine. It should be noted that florogenetic connections in geophytes are due to a wide range of "conjunctive" chorotypes. Compared to the life forms discussed above, the participation of local species is small (4 species) and the Caucasian "roots" are mostly reflected in the "connecting" chorotypes.

Unlike other life forms, the role of the Caucasian species in the composition of **therophytes** is insignificant (only one species). The most widely represented are Palearctic (17) and Mediterranean–Southwest Asian (16) species. The links with the Ancient Mediterranean are well expressed (both of Mediterranean and South-West Asia direction). Connections to Europe are relatively weak. The participation of species associated with Eurasian steppes is small.

Based on the reconciled of life forms and chorotypes, the following became evident:

Caucasian species are widely represented in all life forms except therophytes, which emphasizes the originality of the Iberian Spirea shrubberies of Georgia;

Ancient Mediterranean connections (mainly in the direction of the Mediterranean and South-West Asia) are clearly visible in the composition of all life forms;

Connections with Eurasian steppes are formed mainly through hemicryptophytes, although these connections are reinforced by plants of other life forms;

The florogenetic link with Europe is represented mainly by hemicryptophytes and therophytes; this connection is reinforced by the corresponding species of phanerophytes and geophytes;

The core of the Palaearctic and Holarctic species consist of hemicryptophytes and therophytes.

Bilateral (boreal and ancient Mediterranean) connections are most reflected in the composition of herbaceous plants.

General Conclusion

Based on the analysis of the systematic structure of the flora, compositions of chorotypes and life forms, we can conclude that the formation of the Iberian Spirea shrubberies in Georgia took place under the influence of both the Ancient Mediterranean and the Boreal centers. The florogenetic connection of four main directions is expressed: Mediterranea, South-West Asia, Europe and Eurasian steppe. Florogenic connections of the most are reflected in a wide range of "connecting" chorotypes. If we do not take into account the local (Caucasian) species, which are considered differently by the researchers, then relatively strong florogenetic connections are expressed in the Ancient Mediterranean direction. At the same time, the Mediterranean and South-West Asian connections are strongly reflected in the composition of all life forms, while the florogenetic connections in the direction of the Europe and especially Eurasian steppes are not equally expressed in all life forms. The high share of local (Caucasian) species emphasizes the originality of the Iberian Spirea shrubberies of the Georgia. It is also noteworthy that Caucasian species are present in all leading families, as well as in all life forms except therophytes.

Floristic composition indicating main synonyms, chorotypes and life forms for each species are given below.

List of floristic composition of *Spiraea hypericifolia* formation of Georgia

Abbreviations
Ann – Annual plant, Bien – Biennial plant, PH – Perennial herbaceus plant, Sh – Shrub, SSh – Semi-shrub, dwarf semi-shrub & undershrub, T – Tree.
Ch – Chamaephyte, G – Geophyte, H – Hemicryptophyte (including biennial plants), Ph – Phanerophyte; Th – Therophyte;
C. – Central, E. – East, M. – Middle, N. – North, S. – South, W. – West.
Anat. – Anatolian, Anc. – Ancient, As. – Asian, Cauc. – Caucasian, Eur. – European, Euras. step. – Eurasian steppe, Eux. – Euxinian, Hyrc. – Hyrcanian, Ir. – Iranian, Med. – Mediterranean, Pan. – Pannonian, Pon. – Pontian, Tur. – Turanian.

GYMNOSPERMAE
Cupressaceae
Juniperus communis var. *saxatilis* Pall. [*J. oblonga* M. Bieb.; *J. communis* L. subsp. *oblonga* (M. Bieb.) Galushko] – Ph, Sh; Holarctic.
Juniperus oxycedrus L. (*J. rufescens* Link) – Ph, Sh; Med.

Ephedraceae
Ephedra major subsp. *procera* (C.A. Mey.) Bornm. (*E. procera* C. A. Mey.) – Ph, Sh; Med.–S.W. As. (E. Med.–S.W. As.).

ANGIOSPERMAE
DICOTYLEDONEAE
Anacardiaceae
Cotinus coggygria Scop. – Ph, Sh; Palaearctic (S. Palaearctic).
Rhus coriaria L. – Ph, Sh; Med.–S.W. Asian

Apiaceae
Bupleurum marschallianum C. A. Mey. – Th, Ann; Eux.–Hyrc. (conditionally).
Bupleurum rotundifolium L. – Th, Ann; Eur.–Med.–S.W. As.
Daucus carota L. – Th, Ann; Eur.–Anc. Med.
Eryngium campestre L. – H, PH; Eur.–Med.
Eryngium caeruleum M. Bieb. (*E. caucasicum* Trautv.) – H, PH; Cauc.–S.W. As.–M. As..
Falcaria vulgaris Bernh. – H, PH; Palaearctic (W. Palaearctic).
Heracleum antasiaticum Manden. – H, PH; Cauc. (S. Cauc. endemic).
Malabaila dasyantha (K. Koch) Grossh. [*Leiotulus dasyanthus* (K. Koch) Pimenov & Ostr.] – H, PH; Cauc.–S.W. As. (S. Cauc.–S.W. As.).
Seseli grandivittatum (Sommier & Levier) Schischk. – H, PH; Cauc. (S. Cauc. endemic).
Trinia leiogona (C. A. Mey.) B. Fedtsch. – H, Bien; Cauc.–Hyrc.
Zosima absinthifolia (Vent.) Link (*Zosima orientalis* Hoffm.) – H, PH; S.W. As.–Tur.

Apocynaceae
Vinca herbacea Waldst. & Kit. – H, PH; Med.–Euras. step. (E. Med.–Pan.-Pon.).

Asteraceae
Achillea arabica Kotschy (*Achillea biebersteinii* Afan.) – H, PH; Med.–S.W. As.–Tur. (E. Med.–S.W. As.–Tur.).
Achillea nobilis L. – H, PH; Med.–Euras. step. (with Eur. irradiation).

Artemisia alpina Pall. ex Willd. (*Artemisia caucasica* Willd.) – Ch, SSh; Cauc.–Euras. step. (Cauc.–Pan.-Pon.).
Artemisia fragrans Willd. – Ch, SSh; Cauc.–Tur. (with irradiation)
Carduus hamulosus Ehrh. – H, Bien; Cauc.–Euras. step.
Carthamus lanatus L. – Med.–S.W. As.
Centaurea ovina Pall. ex Willd. – H, PH; Cauc. (endemic).
Centaurea reflexa Lam. – H, PH; Cauc. (endemic).
Crepis foetida subsp. *rhoeadifolia* (M. Bieb.) Čelak. (*Crepis rhoeadifolia* M. Bieb.) – H, Bien; Eur.–Med.–S.W. As. (Eur.–E. Med.–S.W. As.).
Crepis sancta (L.) Bornm. – Th, Ann; Med.–S.W. As.–Euras. step. (E. Med.–S.W. As.–Pon.)
Crupina vulgaris Pers. ex Cass. – Th, Ann; Med.–S.W. As.–Euras. step. (E. Med.–S.W. As.–Pon.).
Filago eriocephala Guss. – Th, Ann; Med.–S.W. As.
Filago pyramidata L. – Th, Ann; Med.–S.W. As.
Galatella linosyris (L.) Rchnb. f. [*Crinitaria linosyris* (L.) Less.] – H, PH; Eur.–Med.
Galatella villosa (L.) Rchb. f. [*Crinitaria villosa* (L.) Cass.] – H, PH; Cauc.–Euras. step.
Inula aspera Poir. [*Pentanema asperum* (Poir.) G.V.Boiko & Korniy.] – H, PH; Medit.–Euras. step.
Inula germanica L. [*Pentanema germanicum* (L.) D.Gut.Larr., Santos-Vicente, Anderb., E.Rico & M.M.Mart.Ort.] – H, PH; Med.–Euras. step.–Cauc. (E. Med.–Euras. step.–Cauc. with Eur. irradiation).
Inula oculus-christi L. [*Pentanema oculus-christi* (L.) D.Gut.Larr., Santos-Vicente, Anderb., E.Rico & M.M.Mart.Ort.] – H, PH; Med.–S.W. As.–Euras. step. (E. Med.–S.W. As.–Pan.-Pon.)
Jurinea blanda (M. Bieb.) C. A. Mey. – H, PH; Cauc. (endemic).
Klasea radiata (Waldst. & Kit.) Á. Löve & D. Löve [*Serratula radiata* (Waldst. & Kit.) M. Bieb.] – H, PH; Cauc.–Euras. step.
Pilosella procera (Fr.) F.W. Schultz & Sch.Bip. (*Hieracium procerum* Fr.) – H, PH; S.W. As.–Cauc.–Euras. step. (conditionally)
Psephellus carthalinicus Sosn. – H, PH; Cauc. (S. Cauc. endemic).
Tanacetum sericeum (Adams) Sch. Bip. [*Pyrethrum sericeum* (Adams) M. Bieb.] – H, PH; Cauc. with E. Anat. iraadiation (S. Cauc. with E. Anat. iraadiation).
Tragopogon graminifolius DC. – H, PH; Cauc.–S.W. As.
Tragopogon pusillus M. Bieb. – H, PH; Cauc.–S.W. As. (Cauc.–Ir.).
Tragopogon tuberosus K. Koch – G, PH; Cauc. (endemic).
Xeranthemum squarrosum Boiss. – Th, Ann; Cauc.–S.W. As.

Boraginaceae
Aegonychon purpurocaeruleum (L.) Holub. [*Lithospermum purpurocaeruleum* L.; *Buglossoides purpurocaerulea* (L.) I. M. Johnst.] – H, PH; Eur.–Med.
Lappula barbata (M. Bieb.) Gürke – H, Bienn; Med.–S.W. As.
Lycopsis orientalis L. [*Anchusa arvensis* subsp. *orientalis* (L.) Nordh.] – Th, Ann; Palaearctic (S. Palaearctic).
Myosotis arvensis (L.) Hill; Th, Ann; Euro–Siberian.
Nonea lutea (Desr.) DC. – Th, Ann; S.W. As.–Cauc.–Euras. step. (SW. As. –Cauc.–Pon.)
Pontechium maculatum (L.) Böhle & Hilger (*Echium maculatum* L.; *Echium rubrum* Jacq.; *Echium russicum* J. F. Gmel.) – H, PH; Cauc.–Euras. step. (with irradiations).

Brassicaceae
Alyssum alyssoides (L.) L. – Th, Ann; Eur.–Cauc.–S.W. As.
Alyssum desertorum Stapf – Th, Ann; Palaearctic (S. Palaearctic).
Alyssum hirsutum M. Bieb. – Th, Ann; Med.–S.W. As.–Pon. (E. Med.–S.W. As.–Pon.).

Alyssum murale Waldst. & Kit. [*Odontarrhena muralis* (Waldst. & Kit.) Endl.] – H, PH; Med.–S.W. As.–Euras. step. (E. Med.–S.W. As.–Pan.-Pon.).
Arabidopsis thaliana (L.) Heynh. – Th, Ann; Palaearctic.
Arabis nova Vill. (*Arabis auriculata* Lam.) – Th, Ann; Eur.–Med.–S.W. As.–Tur.
Camelina microcarpa Andrz. ex DC. – Th, Ann; Palaearctic.
Draba nemorosa L. – Th, Ann; Palaearctic.
Draba verna L. [*Erophila verna* (L.) DC.] –Th, Ann; Palaearctic (W. Palaearctic).
Erysimum leptophyllum (M. Bieb.) Andrz. ex DC. – H, PH; Cauc.–S.W. As. (S. Cauc.–Anat.).
Hirschfeldia incana (L.) Lagr.-Foss. – Th, Ann; Med.–S.W. As.
Meniocus linifolius (Stephan ex Willd.) DC. (*Alyssum linifolium* Stephan ex Willd.) – Th, Ann; Palaearctic (S. Palaearctic).
Noccaea orbiculata (Steven ex DC.) Al-Shehbaz (*Thlaspi orbiculatum* Steven ex DC.) – Th, Ann; Cauc. (with E. Anat. irradiation).
Noccaea perfoliata (L.) Al-Shehbaz (*Thlaspi perfoliatum* L.) – Th, Ann; Eur.–Anc. Med.
Rapistrum rugosum (L.) All. – Th, Ann; Anc. Med.
Turritis glabra L. – H, PH; Palaearctic.

Caprifoliaceae
Cephalaria media Litv. – H, PH; Cauc. (endemic).
Lonicera caprifolium L. – Ph, Sh; Eur.–Med. (C. Eur.–Med.).
Lonicera iberica M. Bieb. – Ph, Sh; Cauc.–S.W. As.
Scabiosa columbaria L. – H, PH; Eur.–Med.
Scabiosa micrantha Desf. [*Lomelosia micrantha* (Desf.) Greuter & Burdet] – Th, Ann; Med.–S.W. As. (E. Med.–S.W. As.).

Caryophyllaceae
Arenaria serpyllifolia L. – Th, Ann; Palaearctic.
Dianthus subulosus Conrath & Freyn – H, PH; Cauc. (endemic)
Gypsophila bicolor (Freyn & Sint.) Grossh. – H, PH; S.W. As.–Tur.
Gypsophila stevenii Fisch. ex Schrank – H, PH; Cauc. (S. Cauc. endemic).
Holosteum marginatum C.A.Mey. – Th, Ann; Cauc.– S.W. As. (conditionally)
Holosteum umbellatum subsp. *glutinosum* (M. Bieb.) Nyman [*H. glutinosum* (M. Bieb.) Fisch. & C. A. Mey.] – Th, Ann; Anc. Med. (conditionally).
Petrorhagia prolifera (L.) P. W. Ball. & Heywood [*Kohlrauschia prolifera* (L.) Kunth] – Th, Ann; Eur.–Med.
Silene latifolia Poir. [*Melandrium latifolium* (Poir.) Maire; *M. boissieri* Schishk.] – H, Bien; Eur.–Med.–S.W. As.
Silene italica (L.) Pers. – H, PH; Eur.–Med.–S.W. As.
Silene cyri Schischk. – H, Bien; Caspian
Stellaria media (L.) Vill. – Th, Ann / Bien; Holarctic.

Celastraceae
Euonymus verrucosus Scop. – Ph, Sh; Eur.–Cauc.

Cistaceae
Helianthemum ledifolium subsp. *lasiocarpum* (Janques & Herincq) Nyman (*H. lasiocarpum* Janques & Herincq) – Th, Ann; Med.–S.W. As.
Helianthemum nummularium (L.) Mill. – Ch, SSh; Eur.–Med.
Helianthemum salicifolium (L.) Mill. – Th, Ann; Med.–S.W. As.

Convolvulaceae
Convolvulus arvensis L. – H, PH; Palaearctic.
Convolvulus cantabrica L. – H, PH; Med.–S.W. As.–Euras. step. (Med.–S.W. As.–Pan.-Pon.).
Convolvulus lineatus L. – H, PH; Med.–S.W. As.–Euras. step. (with irradiations).

Crassulaceae
Hylotelephium maximum subsp. *ruprechtii* (Jalas) Dostál [*Sedum maximum* subsp. *ruprechtii* (Jalas) Soo; *S. caucasicum* (Grossh.) Boriss.] – G, PH; Eur.–Cauc. (E. Eur.–Cauc.).
Phedimus spurius (M. Bieb.) 't Hart (*Sedum spurium* M. Bieb.; *S. oppositifolium* Sims) – H, PH; Eux.–Hyrc. (conditionally).
Sedum pallidum M. Bieb. – H, PH; Eux.–Hyrc. (with irradiations).
Sempervivum transcaucasicum Muirhead – H, PH; Cauc. (with E. Anat. irradiation).

Euphorbiaceae
Euphorbia boissieriana (Woronow) Prokh. – H, PH; Cauc. (S. Cauc. endemic).
Euphorbia glareosa Pall. ex M. Bieb. – H, PH; Cauc.–Eux. (with Pon. irradiation).
Euphorbia helioscopia L. – Th, Ann; Palaearctic
Euphorbia iberica Boiss. – H, PH; Cauc.–S.W. As.
Euphorbia seguieriana Neck. – H, PH; Med.–Euras. step.

Fabaceae
Astragalus brachycarpus M. Bieb. – H, PH; Cauc. (with N.E. & E. Anat. irradiation).
Astragalus bungeanus Boiss. – H, PH; Caucasian (Cauc. endemic)
Astragalus cornutus Pall. – Ph; SSh; Euras. step.–Cauc. (conditionally).
Astragalus xiphidium Bunge – Ph, SSh; Cauc. (subendemic).
Caragana grandiflora DC. – Ph, Sh; Cauc.–S.W. As.
Colutea orientalis Mill. – Ph, Sh; Med. (E. Med. / Cauc.–Crymean).
Cytisus ruthenicus Wol. [*C. caucasicus* Grossh.; *Chamaecytisus ruthenicus* (Fisch. ex Wol.) Klásk.] – Ph, Sh; Eur.–Cauc. (E. Eur.–Cauc.).
Dorycnium pentaphyllum subsp. herbaceum (Vill.) Rouy (*D. herbaceum* Vill.) – H, PH; Med.–Cauc.
Halimodendron halodendron (Pall.) Voss [*Caragana halodendron* (Pall.) Dum.Cours.] – Ph, Sh; Ir.–Tur.
Lotus corniculatus L. – H, PH; Eur.–Med.–S.W. As. (with irradiations).
Medicago caerulea Less. ex Ledeb. [*Medicago sativa* subsp. *caerulea* (Ledeb.) Schmalh; *Medicago sativa* subsp. *microcarpa* Urb.; *Medicago lessingii* Fisch. & C.A. May. ex Kar.] – H, PH; Euras. step.–Cauc.
Medicago minima (L.) Bartal. – Th, Ann; Eur.–Anc. Med.
Melilotus neapolitanus Ten. – Th, Ann; Med.–S.W. As.
Onobrychis cyri Grossh. – H, PH; Cauc. (endemic).
Onobrychis radiata (Desf.) M. Bieb. – H, PH; Cauc. (with E. Anat. irradiation).
Securigera varia (L.) Lassen (*Coronilla varia* L.) – H, PH; Palearctic (W. Palearctic).
Sophora alopecuroides L. – H, PH; S.W. As.–Tur.–C. As. (with irradiations).
Trifolium arvense L. – Th, Ann; Palearctic (W. Palearctic).
Trifolium campestre Schreb. – Th, Ann; Eur.–Med.–S.W. As.
Vicia grandiflora Scop. – Th, Ann; Med.–Euras. step.–Cauc. (E. Med.–Pan.-Pon.–Cauc.).

Fagaceae
Quercus petraea subsp. *iberica* (Steven ex M. Bieb.) Krassiln. – Ph, T; Cauc.–S.W. As.

Geraniaceae
Erodium cicutarium (L.) L'Her – Th, Ann; Palearctic.
Geranium lucidum L. – Th, Ann; Eur.–Med.–S.W. As.
Geranium robertianum L. – Th, Ann; Eur.–Med.
Geranium sanguineum L. – H, PH; Palearctic.

Hypericaceae
Hypericum perforatum L. – H, PH; Palearctic.

Lamiaceae
Lamium amplexicaule L. – Th, Ann; Palearctic.
Nepeta racemosa Lam. (*Nepeta mussinii* Spreng. ex Henckel); H, PH; Cauc.–S.W. As.
Origanum vulgare L. – H, PH; Palearctic (W. Palearctic).
Phlomis herba-venti subsp. *pungens* (Willd.) Maire ex DeFilipps (*Phlomis pungens* Willd.) – H, PH; S.W. As.–Cauc.–Euras. step. (S.W. As.–Cauc.–Pon.).
Phlomoides tuberosa (L.) Moench (*Phlomis tuberosa* L.) – G, PH; Palearctic.
Salvia garedjii Troitsky – Ch, SSh; Cauc. (S. Cauc. endemic).
Salvia nemorosa L. – H, PH; Eur.–Med.–S.W. As. (Eur.–E. Med.–S.W. As.).
Salvia verticillata L. – H, PH; Eur.–Med.–S.W. As.
Salvia viridis L. – Th, Ann; Med.
Scutellaria orientalis L. – Ch, SSh; Cauc. (with Anat. irradiation).
Sideritis montana L. – Th, Ann; Eur.–Med.–S.W. As.
Stachys atherocalyx K. Koch – H, PH; Med. (E. Med.).
Teucrium chamaedrys subsp. *nuchense* (K. Koch) Rech. f. (*Teucrium nuchense* K. Koch) – Ch, SSh; Cauc. (endemic).
Teucrium polium L. – Ch, SSh; Med.–S.W. As.–Euras. step. (Med.–S.W. As.–Pon.).
Thymus coriifolius Ronniger – Ch, SSh; Cauc. (S. Cauc. endemic).
Ziziphora capitata L. – Th, Ann; Med.–S.W. As.

Linaceae
Linum austriacum L. – H, PH; Med.–S.W. As.–Euras. step.
Linum corymbulosum Rchb. – Th, Ann; Med.–S.W. As.

Oleaceae
Fraxinus excelsior L. – Ph, T; Eur.–Cauc.
Jasminum fruticans L. – Ph, Sh; Eur.–Med.–S.W. As.
Ligustrum vulgare L. – Ph, Sh; Eur.–Med.

Orobanchaceae
Melampyrum arvense L. – Th, Ann; Eur.–Cauc.

Papaveraceae
Glaucium corniculatum (L.) Rudolph – Th, Ann; Eur.–Med.–S.W. As.
Papaver arenarium M. Bieb. – Th, Ann; Cauc.–S.W. As.
Papaver dubium L. – Th, Ann; Eur.–Med.–S.W. As.

Plantaginaceae
Plantago lanceolata L. – H, PH; Palearctic (W. Palearctic).
Veronica multifida L. – H, PH; S.W. As.– Cauc.–Euras. step.

Polygalaceae
Polygala transcaucasica Tamamsch. – H, PH; Cauc. (S. Cauc. endemic).

Polygonaceae
Atraphaxis caucasica (Hoffm.) Pavlov – Ph, Sh; Cauc.–M. As.
Atraphaxis spinosa L. – Ph, Sh; Med.–S.W. As.–Tur.–C. As. (E. Med.–S.W. As.–Jungaro-Kashgarian)
Rumex tuberosus L. – G, PH; Med.–S.W. As.–Euras. step. (Med.–S.W. As.–Pon.).

Primulaceae
Cyclamen coum subsp. *caucasicum* (K. Koch) O. Schwarz (*Cyclamen vernum* Sweet) – G, PH; Cauc.–Eux. (with Med. irradiation).
Primula veris subsp. *macrocalyx* (Bunge) Lüdi (*Primula macrocalyx* Bunge) – H, PH; Palearctic (conditionally).
Primula woronowii Losinsk. – H, PH; Cauc. (endemic).

Ranunculaceae
Adonis flammea Jacq. – Th, Ann; Eur.–Med. (with W. Ir. irradiation).
Delphinium cyphoplectrum Boiss. – H, PH; Cauc.–S.W. As.
Delphinium ochroleucum Steven ex DC. – G, PH; Cauc. (with N.W. Ir. irradiation).
Ranunculus illyricus L. – G, PH; Med.–Euras. step.–Cauc. (E. Med.–Euras. step.–Cauc.) (with Eur. irradiation).
Thalictrum minus L. – H, PH; Holarctic.

Resedaceae
Reseda lutea L. – H, Bien; Eur.–Med.–S.W. As.

Rhamnaceae
Paliurus spina-christi Mill. – Ph, Sh; Med.–S.W. As.
Rhamnus pallasii Fisch. & C. A. Mey. – Ph, Sh; Cauc.–S.W. As.
Rhamnus spathulifolia Fisch. & C. A. Mey. – Ph, Sh; Cauc.

Rosaceae
Amelanchier ovalis Medik. – Ph, Sh; Eur.–Med. (C. Eur.–Med.).
Cotoneaster meyeri Pojark. – Ph, Sh; Cauc. (endemic).
Cotoneaster morulus Pojark. – Ph, Sh; Cauc.–S.W. As.
Cotoneaster racemiflorus (Desf.) K. Koch – Ph, Sh; Cauc.–S.W. As.–M. As.
Cotoneaster saxatilis Pojark. – Ph, Sh; Cauc. (endemic).
Filipendula vulgaris Moench – H, PH; Palearctic (W. Palearctic).
Fragaria vesca L. – H, PH; Palearctic.
Fragaria viridis Weston – H, PH; Palearctic (W. Palearctic).
Potentilla humifusa Willd. ex Schltdl. (*Potentilla adenophylla* Boiss. & Hohen.) – H, PH; Euras. step.–Cauc.–Anat.
Potentilla recta L. – H, PH; Palearctic (W. Palearctic).
Prunus georgica (Desf.) Eisenman (*Amygdalus georgica* Desf.) – Ph, Sh; Cauc. (S. Cauc. endemic).
Prunus incana (Pall.) Batsch [*Cerasus incana* (Pall.) Spach] – Ph, Sh; Cauc.–S.W. As.
Prunus microcarpa C. A. Mey. [*Cerasus microcarpa* (C. A. Mey.) Boiss.] – Ph, Sh; S.W. As.
Prunus spinosa L. – Ph, Sh; Eur.–Med.
Pyrus salicifolia Pall. – Ph, Sh; Cauc.–S.W. As.

Rosa spinosissima L. – Ph, Sh; Palearctic (W. Palearctic)
Sanguisorba minor subsp. *balearica* (Nyman) Muñoz Garm. & C. Navarro (*Poterium polygamum* Waldst. & Kit.) – H, PH; Med.–S.W. As.–Euras. step. (Med.–S.W. As.–Pan-Pon.) (with irradiations).
Spiraea hypericifolia L. – Ph, Sh; Euras. step.–Cauc. (with irradiations).

Rubiaceae
Asperula arvensis L. – Th, Ann; Eur.–Med.
Crucianella angustifolia L. – Th, Ann; Med.
Galium album Mill. – H, PH; Eur.–Med. (with W. Siberian irradiation).
Galium tenuissimum M. Bieb. – Th, Ann; Med.–S.W. As. (E. Med.–S.W. As.).
Galium spurium L. (*Galium vaillantii* DC.); Th, Ann; Holarctic.
Galium verum L. – H, PH; Palearctic.

Rutaceae
Dictamnus albus L. – H, PH; Palearctic (S. Palearctic).

Santalaceae
Thesium arvense Horv. (*T. ramosum* Hayne) – H, PH; Euras. step.–Cauc.

Sapindaceae
Acer ibericum M. Bieb. [*A. monspessulanum* subsp. *ibericum* (M. Bieb. ex Willd.) Yalt.] – Ph, T; Cauc. (endemic).

Scrophulariaceae
Verbascum formosum Fisch. ex Schrankl – H, Bien; Cauc. (endemic).

Thymeleaceae
Thymelaea passerina (L.) Coss. & Germ. – Th, Ann; Palearctic (W. Palearctic).

Ulmaceae
Ulmus minor Mill. – Ph, T; Eur.–Med.

Valerianaceae
Valeriana officinalis L. – H, PH; Palearctic.

Violaceae
Viola alba Besser – H, PH; Eur.–Med.
Viola arvensis Murray – Th, Ann; Palearctic.
Viola kitaibeliana Schult. – Th, Ann; Eur.–Med. (C. Eur.–Med.).

MONOCOTYLEDONEAE
Amaryllidaceae
Allium pseudoflavum Vved. – G, PH; Cauc.–S.W. As.
Allium rotundum L. – G, PH; Eur.–Med.–S.W. As.
Allium rupestre Steven – G, PH; Eux. (with Cauc. irradiation).
Allium saxatile M. Bieb. – G, PH; Euras. step.–Cauc. (with Sub. Med. & Med. irradiations).

Asparagaceae
Asparagus officinalis L. – G, PH; Palearctic (W. Palearctic).

Asparagus verticillatus L. – G, PH; Med.–S.W. As.–Euras. step. (E. Med.–S.W. As.–Pon.).
Bellevalia montana (K. Koch) Boiss. – G, PH; Cauc. (S. Cauc. endemic).
Muscari armeniacum Leichtlin ex Baker (*Muscari szovitsianum* Baker) – G, PH; Med.–Cauc. (E. Med.–Cauc.).
Ornithogalum navaschinii Agapova – G, PH; Med. (E. Med. / Cauc.–Crymean).
Ornithogalum ponticum Zahar. – G, PH; Med. (E. Med. / Cauc.–Crymean).
Scilla siberica Haw. – G, PH; Eur.–Cauc.–S.W. As. (E. Eur.–Cauc.–S.W. As.) (conditionally).

Colchicaceae
Colchicum trigynum (Steven ex Adams) Stearn [*Merendera trigyna* (Steven ex Adams) Stapf] – G, PH; Cauc.–S.W. As.

Cyperaceae
Carex liparocarpos subsp. *bordzilowskii* (V. I. Krecz.) T. V. Egorova – H, PH; Cauc.–S.W. As.
Carex humilis Leyss. – H, PH; Palearctic.

Iridaceae
Crocus biflorus subsp. *adamii* (J. Gay) K. Richt. (*Crocus adamii* J. Gay) – G, PH; Eux. (conditionally).
Crocus speciosus M. Bieb. – G, PH; Cauc.–S.W. As.
Iris caucasica Hoffm. – G, PH; Cauc.–S.W. As. (S. Cauc.–S.W. As.).
Iris pumila L. – G, PH; Med.–Euras. step.–Cauc. (E. Med.–Pan-Pon.–Cauc.).
Iris reticulata M. Bieb. – G, PH; Cauc.–S.W. As.

Lilaceae
Fritillaria caucasica Adams – G, PH; Eux.–Hyrc.
Gagea chlorantha (M. Bieb.) Schult. & Schult. f. – G, PH; Cauc.–S.W. As.
Gagea commutata K. Koch – G, PH; Cauc. (endemic).

Orchidaceae
Anacamptis morio (L.) R. M. Bateman, Pridgeon & M. W. Chase (*Orchis morio* L.) – G, PH; Eur.–Med. (with Ir. irradiation).
Anacamptis pyramidalis (L.) Rich. – G, PH; Eur.–Med. (with Ir. irradiation).
Dactylorhiza romana subsp. *georgica* (Klinge) Soó ex Renz & Taubenheim [*Orchis flavescens* K. Koch; *Dactylorhiza flavescens* (K. Koch) Holub] – G, PH; Cauc.–S.W. As.
Neotinea ustulata (L.) R. M. Bateman, Pridgeon & M. W. Chase (*Orchis ustulata* L.) – G, PH; Eur.–Cauc.
Ophrys caucasica Woronow ex Grossh. – G, PH; Cauc. (endemic).

Poaceae
Aegilops neglecta Req. ex Bertol. (*Aegilops ovata* L.) – Th, Ann; Med.–S.W. As.
Aegilops tauschii Coss. – Th, Ann; S.W. As.–Tur.
Agropyron cristatum subsp. *pectinatum* (M. Bieb.) Tzvelev – H, PH; Med.–S.W. As.–Euras. step.
Avena sterilis subsp. *ludoviciana* (Durieu) Gillet & Magne – Th, Ann; Med.–S.W. As. (with Eur. irradiation).
Bothriochloa ischaemum (L.) Keng – H, PH; Anc. Med.
Brachypodium distachyon (L.) P. Beauv. [*Trachynia distachya* (L.) Link.] – Th, Ann; Med.–S.W. As.
Brachypodium sylvaticum (Huds.) P. Beauv. – H, PH; Palearctic.
Bromus biebersteinii Roem. & Schult. [*Bromopsis biebersteinii* (Roem. & Schult.) Holub] – H, PH; Cauc. (endemic).
Bromus japonicus Thunb. – Th, Ann; Palearctic.

Bromus squarrosus L. – Th, Ann; Palearctic (S. Palearctic).
Cleistogenes serotina (L.) Keng; H, PH – Euras. step.–Cauc. (Pan.-Pon.–Cauc.) (with irradiations).
Cynosurus echinatus L. – Th, Ann; Med.–Cauc. (with irradiations).
Dactylis glomerata L. – H, PH; Palearctic.
Echinaria capitata (L.) Desf. – Th, Ann; Med.–S.W. As.
Elymus repens (L.) Gould [*Agropyron repens* (L.) P. Beauv.; *Elytrigia repens* (L.) Nevski] – H, PH; Palearctic.
Elymus hispidus (Opiz) Melderis [*Agropyron intermedium* (Host) P. Beauv.; *Elytrigia intermedia* (Host.) Nevski; *Thinopyrum intermedium* (Host) Barkworth & D.R.Dewey] – H, PH; Med.–S.W. As.–Euras. step. (Med.–S.W. As.–Pan.-Pon.) (with irradiations)
Festuca valesiaca Schleich. ex Gaudin – H, PH; S.W. As.–Cauc.–Euras. step.
Koeleria macrantha (Ledeb.) Schult. (*Aira cristata* L.) – H, PH; Holarctic.
Lolium rigidum Gaudin – Th, Ann; Med.–S.W. As.
Melica transsilvanica Schur – H, PH; Euras. step.–Cauc.
Phleum paniculatum Huds. – Th, Ann; Eur.–Med.–S.W. As. (C. Eur.–Med.–S.W. As.).
Phleum phleoides (L.) H. Karst. – H, PH; Palearctic.
Poa angustifolia L. – H, PH; Palearctic.
Poa bulbosa L. – G, PH; Eur.–Anc. Med.
Poa nemoralis L. – H, PH; Palearctic.
Stipa capillata L. – H, PH; Med.–S.W. As.–Euras. step.
Stipa lessingiana Trin. & Rupr. – H, PH; S.W. As.–Cauc.–Euras. step.
Stipa pennata L. – H, PH; Euras. step. (with irradiations).

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