Earth Sciences
2017; 6(5-1): 38-48
http://www.sciencepublishinggroup.com/j/earth
doi: 10.11648/j.earth.s.2017060501.16
ISSN: 2328-5974 (Print); ISSN: 2328-5982 (Online)

Diversity, Ecotopology and Hypsometric Distribution of the Endemic Flora in High- Mountain Phytolandscapes of the Caucasus

Shamil Shetekauri[1], Lali Kutateladze[2]

[1]Department of Biology, Faculty of Exact and Natural Sciences, Ivane Javakishvili Tbilisi State University, Tbilisi, Georgia

[2]Faculty of Exact and Natural Sciences, Department of Geography, Ivane Javakishvili Tbilisi State University, Tbilisi, Georgia

Email address:
shetekauri@yahoo.com (S. Shetekauri)

To cite this article:
Shamil Shetekauri, Lali Kutateladze. Diversity, Ecotopology and Hypsometric Distribution of the Endemic Flora in High- Mountain Phytolandscapes of the Caucasus. *Earth Sciences.* Special Issue: New Challenge for Geography: Landscape Dimensions of Sustainable Development. Vol. 6, No. 5-1, 2017, pp. 38-48. doi: 10.11648/j.earth.s.2017060501.16

Received: June 14, 2017; **Accepted**: June 19, 2017; **Published**: July 17, 2017

Abstract: The paper considers diversity, systematic-geographical, ecotopologic (biotopologic) structure and peculiarities of hypsometric distribution of the endemic flora in the high-mountain phytolandscapes in the western (Abkhazia, Samegrelo), central (Svaneti, Racha-Lechkhumi, Shida Kartli, Khevi) and eastern (Khevsureti, Tusheti, Mountainous Kakheti) parts of the Eucaucasus (Caucasus Mountains). Endemic calciphilous flora is especially characteristic of limestone lithological areas, which within the borders of Georgia are met only in Abkhazia, Samegrelo and Racha-Lechkhumi, whereas diversity of endemic flora of argillaceous slate and marly habitats is observed in Tusheti and Pirikita Khevsureti (the gorges of the rivers Pirikita, Gometsari Alazani and Arghuni-Andaki-Asa). These habitats are nowhere else met within the boundaries of Georgia. It should be noted that in the florogenesis of the high mountain endemism a significant role was played by orogenesis processes of the Caucasus, which was caused due to extinction of ancestral species at lower altitudes and resulted in their geographical isolation. This is proved by geographical and hypsometric vicarism of some species of generas Campanula, Cerastium, Silene, Erysimum, Pedicularis, Delphinium, and Jurinea. The western, central and eastern parts of the Caucasus are floristically different not only from each other, but also from neighboring mountain massifs. The above mentioned is conditioned by distinct geographic isolation of the mountain system of the Caucasus, different altitudes, petrology, and glaciogenic relief. Floristically, slate screes and rocky habitats are most diverse. The endemic species are unequally distributed in different mountain systems and phytolandscapes of the Eucaucasus. It again indicates to the significance of the phenomenon of the well expressed geographical isolation of the Caucasus Mountains.

Keywords: Caucasus, Endemism, Geographical Isolation, Hypsometric Distribution, Glaciation

1. Introduction

The Caucasus is distinguished by its various phytolandscapes, genetic diversity and variety of species among the botanical-geographical phenomena of the Mediterranean. It is caused by its edaphic-climatic conditions, high hypsometric levels of the Caucasus, relevantly well expressed geographical isolation and etc. Here, at vertically different heights from upper boundary of the forest, high-mountain dendroflora (trees, bushes), tall herbaceous cover, high mountain meadows, Caucasian rhododendrons, Alpine carpets, petrophyte and their creation, eco- and cenoton mosaic (multi-terrace) phytolandscape profile are presented (1800 (2200)-3800 (4000) m above sea level). Each of them is distinguished by its floristic core formed in phylocenogenesis and endemic species and taxons characteristic of concrete habitats, among them small quantity of arctalpine species.

The studied territory covers the western, central and eastern parts of the Eucaucasus, which are different from one another in hypsometry, glaciation level and edaphic-climatic conditions (Figure 1, 2).

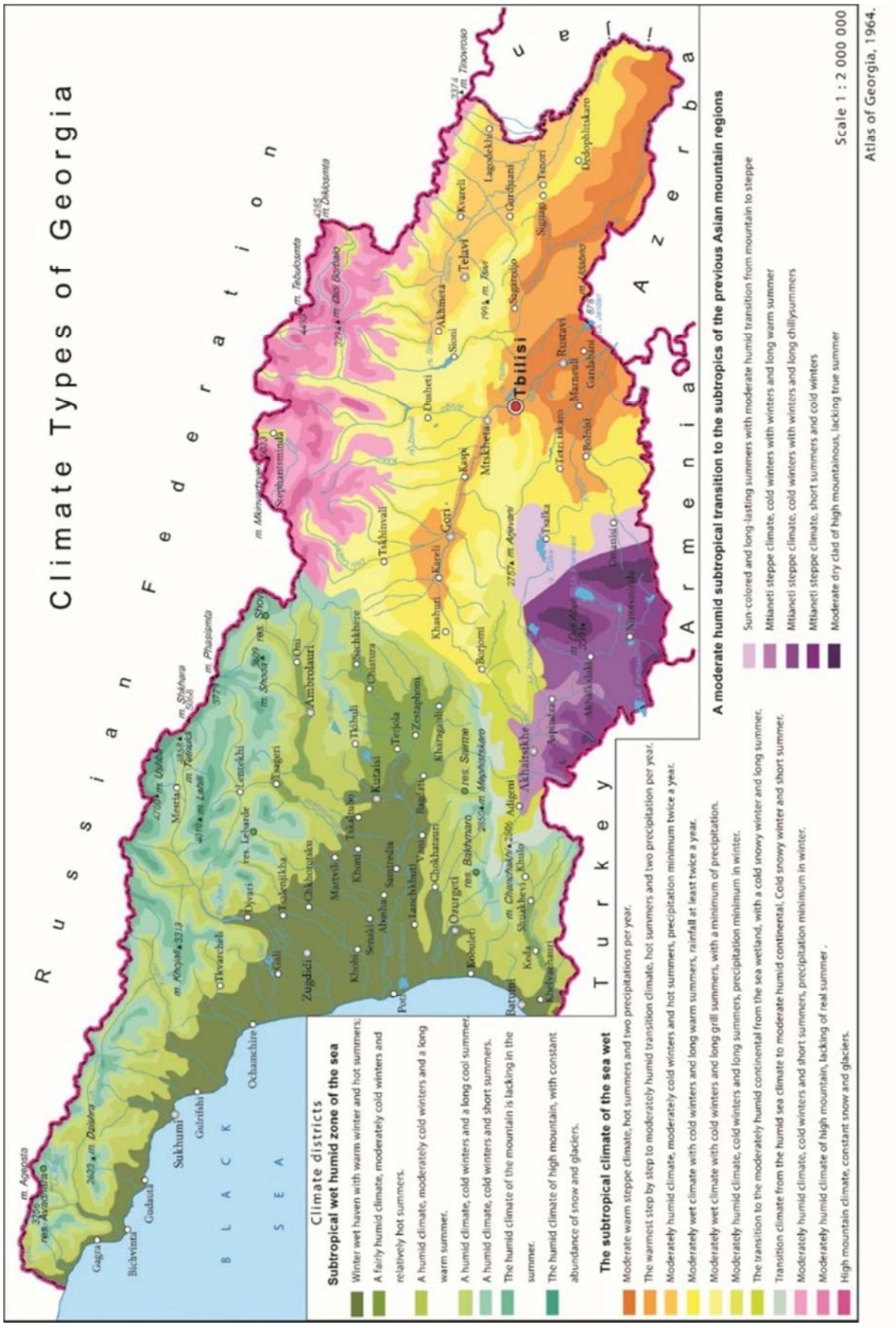

Figure 1. *Climate Types of Georgia.*

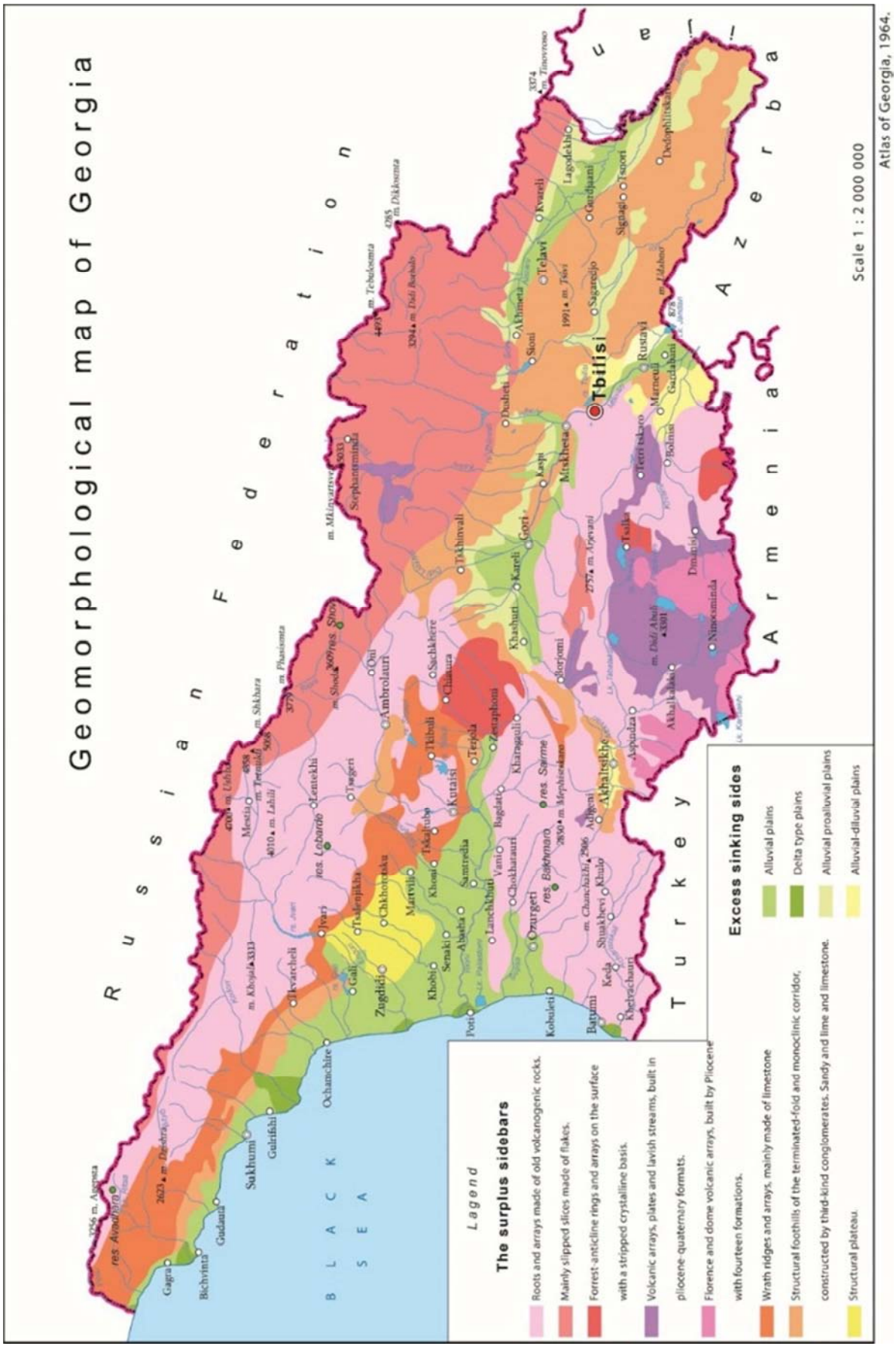

Figure 1. *Geomorphological map of Georgia.*

Among Holarctic regions the ecosystems of Palaearctic and Mediterranean, the Caucasian ecosystems are characterized with peculiar biodiversity. It is well known that diversity of species is determined according to the number of species, distributed in certain orographic unit, botanical-geographical system, country, geographical area, i.e. systematic structure of the flora.

Without verification of multiplicity and qualitative diversity in endemic species it is impossible to consider historical issues of the flora of any basin, region or floristic area. Mainly, on the basis of the study of the number and qualities of endemic species it becomes easy to determine what makes the difference (or similarity) between the floras of some certain territory and its neigbouring one, or the flora of geographically distant phytochorion. Versatile (systematic, geographic, biotopologic, etc.) study of endemism just makes it possible to determine what kind of connections are between the historic and relatively current periods, what is the correlation between the endemic species and their varieties as a whole during the study period. Generally, diversity in endemic species indicates to long period of development of the flora of a certain territory.

Within the Georgian border the high mountain territories of the West, Central and East Eucaucasus botanically and geographically belong to the ancient Mediterranean region, sub-Mediterranean area and the provinces of Colchis, i.e. East Euxine, Elbrus-Kazbek, i.e. the North-Central Caucasus, Tusheti-Dagestan, i.e. the North-East Caucasus, Iberia, i.e. the East Transcaucasia [1; 2]. Phytochorions are distinguished at the level of provinces and districts on the basis of the peculiarity of the biodiversity of florocenotic complexes (floroceno-types) – number of species, topology of areas, endemism and etc.

Within the Georgian border the Eucaucasus covers several botanical-geographical provinces and districts, which differ from each other in their vertical belt structure of vegetation, floristic complexes, composition of endemic genera and species.

Abkhazia, Svaneti and Racha-Lechkhumi belong to the province of Colchis, i.e. East Euxine; Shida Kartli, Pshavi, Piraketa Khevsureti and Kakheti belong to the East Transcaucasian Province; Khevi belongs to the Central-North Ciscaucasian, i.e. Elbrus-Kazbek Province; Pirikita Khevsureti and Tusheti belong to the East Ciscaucasian, i.e. Tusheti-Dagestan Province.

2. Description of the Study Area

The Eucaucasus is a complex orographic system full of geomorphological and biodiversity contrasts, the reason of which is the hypsometric and morphologic peculiarities combined in its relief. Within the Georgian border a large segment of the southern slopes and some northern slopes of the Caucasus Mountains - Khevi, Pirikita Khevsureti and Tusheti are included [3; 4; 5).

The Eucaucasus is divided in three segments: western, central and eastern parts. Boundaries among them are set along the meridians of the Elbrus and the Mount Kazbek. The boundary between the western and eastern parts of the Eucaucasus is set at the source of the river Kuban (northern slopes) and at the confluence of the rivers Nenskra and Enguri, near village Jvari (southern slopes); the boundary between the central and eastern parts of the Eucaucasus is set at the upper flow of the Terek River (northern slopes) and at the Aragvi River in Mtiuleti (southern slopes).

The most part of the Caucasus Mountains is a territory between ridges, the upper mountain belt and the zone constantly covered with snow. It is presented as subalpine, alpine, subnival and nival belts. Thus, on the most territory of the Eucaucasus the forest-meadow belt is met. The nival belt is observed at high zones in Svaneti, Racha, Khevi and Tusheti. It is rarely met in Shida Kartli and Khevsureti; there is no nival belt in Mountainous Kakheti. The endemic diversity and features in certain parts of the Eucaucasus depends on its orographic properties.

3. Materials and Methods

The paper includes the results of botanical researches on the Greater and Lesser Caucasus carried out by the author during many years and also other existing botanical materials. Mobile, stationary and semi-stationary methods were used during the investigations. Different floristic complexes (dendroflora, tall herbaceous cover, high mountain meadows, Caucasian rhododendrons, Alpine carpets, petrophytes) and different expositions were selected as sample areas. Botanical-geographical profiles were constructed in high mountain systems. For verification of endemic species, we used the second edition of the Flora of Georgia [6]; Vascular Plants of Georgia. A Nomenclatural Checklist, Tbilisi, [7]; Vascular Plants of Russia and Adjacent States, The Former USSR, [8], Concept of Flora of the Caucasus [9], and other botanical literature about the regional investigations.

4. Results and Discussion

Study of endemism requires full description of endemic species and determination of alliance and age of endemic genera and species. These issues are well studied by the researchers of the Caucasian flora [10; 11; 12; 13; 14; 15; 16; 17; 18; 19; 20; 21; 22; 23; 24; 25; 26; 27; 28; 29; 30; 31; 32; 33; 34; 35; 36; 37; 38; 39; 40; 41; 42; 2].

17 endemic and subnival mono- and oligo-type genera are met in various quantities in more or less different hypsometric areas and lithologic habitats of the western, central and eastern parts of the Greater Caucasus:

Endemic genera of the West Eucaucasus:

(1) *Woronowia* Juz.

(2) *Albowiodoxa* Woronow

(3) *Chymsidia* Albov

(4) *Sredinskya* (Etein) Fed.

Specific endemic genera of the Greater Caucasus (Eucaucasus):

(1) *Trigonocaryum* Trautv.
(2) *Symphyoloma* C. A. Mey.
(3) *Pseudobetckea* (Hock) Lincz.
(4) *Petrocoma* Rupr.
(5) *Charesia* E. Busch
(6) *Pseudovesicaria* Rupr. (Spread also in the Lesser Caucasus and the Mount Aragats*)*
(7) *Mandenovia* Alava

Endemic genera of the Eucaucasus:

(1) *Agasyllis Spreng.*
(2) *Gadellia Schulkina* (also spread in Asia Minor and Middle East)
(3) *Cladochaeta* DC.
(4) *Grossheimia Sosn. et Takht*. (also spread in Asia Minor)
(5) *Paedorotella* (E. Wulff.) Kem.-Nath.
(6) *Kemulariella Tamamsch*. (also spread in Asia Minor).

The biodiversity of the endemic flora in the high-mountain phytolandscapes in the western, central and eastern parts of the Eucaucasus counts 483 species. Among them 223 species are met in the West Caucasus (Abkhazia, Samegrelo) with 171 (28) found in the Abkhazian high mountains and 92 (5) – in the high mountains of Samegrelo. In the Central Caucasus 402 endemic species are observed. Among them 250 (27) species are met in Svaneti, 241 (23) – in Racha-Lechkhumi, 225 (5) – in Shida Kartli and 247 (23) species – in Khevi (Kazbek) region. The biodiversity of the endemic flora in the high-mountain phytolandscapes of the East Eucaucasus comprises 234 species. Among them 120 species are met in Mountainous Kakheti, 199(4) – in Khevsureti and 200(2) – in Tusheti (Figure 3).

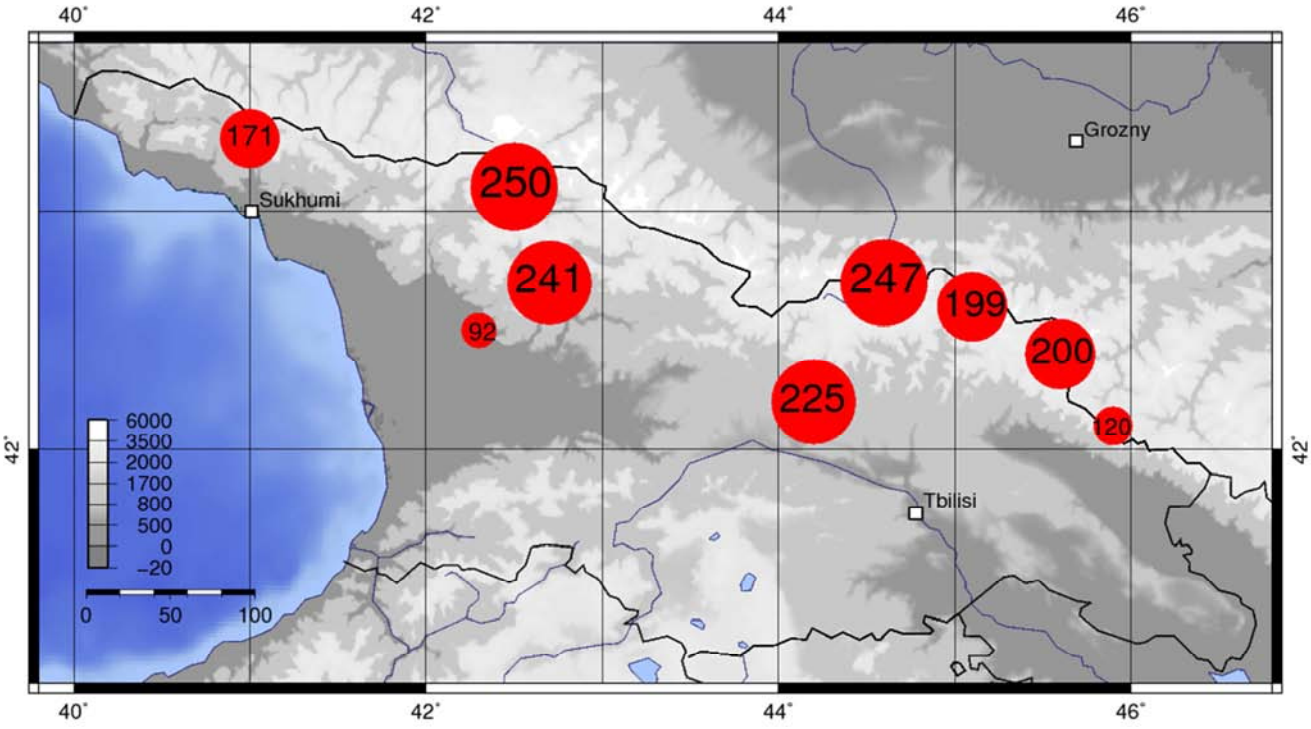

Figure 3. *Diversity of the endemic species of the Greater Caucasus Mountains in separate historical-geographical regions (Abkhazia, Samegrelo, Svaneti, Racha-Lechkhumi, Shida Kartli, Khevi, Khevsureti, Tusheti, Mountainous Kakheti) (after Sh. Shetekauri, 2017).*

The Central Eucaucasus counts 402 endemic species. Among them 250(27) endemic species are met in Svaneti, 241(23) – in Racha-Lechkhumi, 225(5) – in Shida Kartli and 247(23) – in the ethnofloristic region of Khevi.

In the East Eucaucasus the biodiversity of high-mountain endemic flora is made up by 234 species. Among them 120 species are found in Mountainous Kakheti, 199(4) – in Khevsureti and 200(2) – in Tusheti.

The high-mountain endemic flora of the Caucasus Mountains (within the borders of Georgia) exceeds in quantity the floras of the Central Alps [43], the Carpathians of Ukraine, Azerbaijan, West Sian, Macedonia [44] and just lags behind the flora of the Taurodinaric megakarst (the biggest karst of the world) [45] and the one in Greece. The dominant families among the endemic flora of the Eucaucasus regarding quantity of endemic species are Asteraceae (92), Apiaceae (39), Rosaceae (38), Campanulaceae (37), Fabaceae (31), Caryophyllaceae (29), Brassicaceae (26), Scrophulariaceae (23), Ranunculaceae (20); the dominant genera regarding endemic species are *Campanula* (36), *Alchemilla* (18), *Cirsium* (16), Ranunculus (15), *Heracleum* (13), *Primula* (10), *Delphinium* (10) and etc (Table 1).

Table 1. *Distribution of the endemic species in the high-mountain florocenotic complexes of the Eucaucasus. The general spectre of the distinguished families and genera regarding quantity of endemic species.*

Family	Quantity of endemic species	%	Genus	Quantity of endemic species	%
Asteraceae	74	17.7	*Campanula*	26	6.2
Rosaceae	21	5.0	*Cirsium*	16	3.8
Apiaceae	30	7.1	*Ranunculus*	16	3.5
Campanulaceae	27	6.4	*Alchemilla*	13	3.1
Fabaceae	27	6.4	*Heracium*	11	2.6
Caryophyllaceae	26	6.2	*Delphinium*	10	2.3
Brassicaceae	21	5.0	*Primula*	9	2.1
Scrophulariaceae	21	5.0	*Senecio*	9	2.1
Ranunculaceae	20	4.7	*Astragalus*	8	1.9
Poaceae	18	4.3	*Hieracium*	8	1.9

5. The Geographic-Systematic Structure of the Endemic Species of the Caucasus Mountains

According to areologic structure the endemic flora of the Caucasus Mountains is divided in three groups:

(1) The endemic species of the Caucasus. These species are distributed on a relatively large area and are met in differenr parts of the Caucasus.

(2) The endemic species of the Eucaucasus. The species of this geographical unit are characterized with relatively stenotopic distribution. In its part the group is divided into a) the common endemic species of the Eucaucasus; b) the endemic species of the West Eucaucasus; c) the endemic species of the Central Eucaucasus; d) the endemic species of the Central and East Eucaucasus.

(3) The endemic species of Colchis. The endemic species combined in this group are met in the botanical-geographical province of Colchis. In their turn they are divided into: a) the endemic species of West Colchis; b) the endemic species of North Colchis and c) the common endemic species of Colchis.

Distribution of the endemic species of the Caucasus, the Eucaucasus and Colchis is connected to different florocenozic complexes (petrophyte, high mountain meadows, subalpine tall herbaceous cover, rhododendrons and the complex of high mountain dendroflora), ethnofloristic regions and vertical belts.

The petrophyte is distinguished by its diversity of endemic species, namely, 53%, i.e. 259 species of the endemic flora of the Eucaucasus are found in the petrophylic florocenotic complex.

Among the endemic species of the petrophyte of the Caucasus the most distinguished are *Androsace intermedia, Potentilla brachypetala, Draba bryoides, Gypsophila tenuifolia, Sedum involucratum, Campanula biebersteiniana, C. sphaerocarpa, Eunomia rotundifolia.*

Originality in botanical diversity of the East Eucaucasus is caused by *Symphyoloma graveolens, Aetheopappus caucasicus, Petasites fominii, Senecio karjaginii, Arabis kazbeki, Erysimum subnivale, Campanula argunensis, C. cryophila, C. saxifraga, Cerastium polymorphum, Dianthus dagestanicus, Minuartia trautvetteriana, Oberna lacera, Delphinium caucasicum, Primula bayernii, P. meyeri, Ranunculus lojkae, R. tebulossicus, Saxifraga pseudolaevis, Veronica telefiifolia, V.schistosa* and etc.

Among the calciphytes of Cochis the most distinguished are *Alboviodoxa elegans, Cirsium sosnowskyi, Jurinea pumila, Kemulariella colchica, Arabis colchica, A. sachokiana, Campanula dzaaku, Minuartia abchasica, M. colchica, Genista suanica, Corydalis vittae, Scutellaria helenae* and etc.

The Colchian species of endemic flora are mainly met in the West and Central Eucaucasus. Besides, formation of the endemic genera of the Eucaucasus (*Woronowia, Chymsydia, Alboviodoxa, Symphyoloma, Trigonocaryum, Mandenovia, Pseudobetckea*) and the Caucasus (*Pseudovesicaria*) are connected to petrophyte. Taking it into consideration we may suppose that cliffs, slide-rocks and such lithologic stations are the right areas for formation of endemic biodiversity [32; 33; 36; 37; 38). The geographical isolation especially well expressed in the Caucasus Mountains has played a great role in this process.

Some of the endemic species are met in the territories adjacent to Georgia: in the high mountains of Adygea-Karachay, Balkaria, North Ossetia, Dagestan, Chechnya, Ingushetia and Azerbaijan. Distribution of some certain endemics is connected to one concrete ethno-botanical region. There are 28 such endemics in Abkhazia (*Alopecurus longifolius, Allium candollianum, Psephellus abchasicus, Pyrethrum marioni, Kemulariella tuganica, K. abchasica, Campanula calcarea, C. dzyschrica, C. jadvigae, C. schistosa, C. paniutinii, Arabis sachokiana, Betonica abchasica, Omphalodes kusnetzovii, Chymsydia agasylloides* and etc.).

Table 2. *Diversity of the species in the high-mountain endemic flora of the Eucaucasus according to ethno-botanical regions.*

Ethno-botanical regions	Quantity of endemic species	% in the common quantity of endemic species	Among them		
			Caucasus	Eucaucasus	Colchis
Abkhazia	171	35.4	46/0	31/3	94/25
Samegrelo	92	19.0	25/0	15/0	52/5
Svaneti	250	51.7	107/9	90/6	53/12
Racha-Lechkhumi	241	49.8	95/3	90/2	56/18
Shida Kartli	225	46.5	117/2	85/1	23/2
Khevi	247	51.1	148/13	95/10	4/2
Mountainous Kakheti	120	24.8	75/0	43/0	2/0
Khevsureti	199	41.2	121/2	75/2	3/0
Tusheti	200	41.4	122/1	75/1	3/0

In Svaneti there are 27 endemic species (Campanula circassica, Charesia akinfievii, Cnidium mandenovae, Paedorotella teberdensis and etc.), in Samegrelo – 5 endemic species (Allium albovianum, Campanula megrelica, Chymsydia colchica); in Racha-Lechkhumi – 23 endemic species (Asperula kemulariae, Campanula radchensis, Heracleum egrissicum); in Shida Kartli – 5 endemic species (Nepeta komarovii); in Khevi – 25 endemic species (Minuartia ruprechtiana, Primula darialica…); in Khevsureti – 4 endemic species (Mandenovia komarovii and etc.), in Tusheti – 2 endemic species (Scorzonera filifolia, Ranunculus tebulossicus).

The portion of endemic species is different in various habitats of the Caucasus High Mountains (Table 3).

Regarding quantity, the endemic species of the petrophylic flora are almost equally distributed in separate high mountain regions, e.g., there are 114 endemic species in Khevi, 112 – in Racha-Lechkhumi, 107 – in Svaneti. There are almost equal quantities of endemic species in the petrophylic floras of Shida Kartli, Tusheti and Khevsureti and their numbers are 89, 89 and 84, respectively. The only exception is Mountainous Kakheti, where just 52 endemic species are found. This may be explained by the following factors: 1. in Mountainous Kakheti the high mountains cover just a small area. Therefore, they are not as rich in flora as other high mountain phytochorions studied by us; 2. unlike Svaneti, Khevsureti, Racha-Lechkhumi and Tusheti, Mountainous Kakheti is less mountainous and less isolated. Consequently, there is less possibility for generation of endemic species [41].

Table 3. *Distribution of the endemic species in the Central and East Caucasus high mountains according to separate florocenotic complexes (after Shetekauri, 2018).*

Florocenotic complexes	Quantity of endemic species	% in the common quantity of endemic species	Among them		
			Cauc	Eucauc	Colch
Petrophytes	259	45.2	72	84	97
Meadows	164	38.9	90	47	26
Alpine carpets	4	0.9	3	1	_
Caucasian rhododendrons	_	_	_	_	_
Subalpine tall herbaceous cover	35	8.3	15	11	9
High mountain bogs	_	_	_	_	_
High mountain dendroflora	26	6.2	11	7	8
Total	488	100.0	192	151	140

In the florocenotic complexes of the high-mountain meadows of the Central and East Eucaucasus 37%, i.e. 164 species in the general quantity of the flora is endemic. Despite the high-mountain meadow flora (totally 440 species) significantly exceeds the petrophyte floristic core (316 species) the number of its endemic species is less than that of the petrophylic flora.

As the quantitative data of the endemic species show, unlike the petrophytes, in the meadow flora the endemic species of the Caucasus exceed the quantity of those of the Eucaucasus. This also means that meadow species have wider geographical distribution. However, it is also noteworthy that, like in the petrophyte, so called regional endemics of stenotopic distribution are frequently met here as well. They are presented mainly in botanical-geographical regions of Colchis.

Like in the high-mountain petrophyte, among the high mountain meadow endemic species the most distinguished are the endemics, which are found in one certain floristic region; among such endemic species the most distinguished ones are: *Cirsium cholorocomos, Hieracium sachocianum, Scabiosa corevoniana, Euphorbia scripta, Alchemilla epidasys* (met only in Svaneti); in Racha-Lechkhumi, Abkhazia and Samegrelo such stenochorial regional endemics are *Polylophium panyutinii, Gentiana oschtenica, Ranunculus abchasicus, Woronowia speciosa*; in Shida Kartli - *Centaurea ossetica, Astrantia ossica, Chaerophyllum confusum*; in Khevi - *Cirsium caucasicum, Primula kuznetzovii*; in Khevsureti - *Peucedanum pschavicum, Tragopogon otschiauriae.*

In the high-mountain meadows, regarding quntity of endemic species, the most dominant families are *Asteraceae* (30 endemic species), *Fabaceae* (15), *Rosaceae* (13), *Apiaceae* (12), *Ranunculaceae* (11), *Scrophulariaceae* (11), *Poaceae* (9), *Primulaceae* (6) and etc. The dominant genera are *Ranunculus* (9 endemic species), *Alchemilla* (9),

Hieracium (8), *Primula* (6), *Campanula* (4), *Cerastium* (3), *Astragalus* (3), *Potentilla* (3), *Cirsium (*3), *Vicia* (3). As the quantitative analysis of the species of the dominant genera distinguished by the quantity of endemic species showed, unlike the petrophyte endemic species, the meadow endemic species are mostly distributed in different genera but in small quantities, namely, there are 1, 2, 3 endemic species in each genus.

Separate elements of meadow endemic flora, unlike the petrophyte endemic species, are distinguished by their wide geographical distribution and large ecological-cenotic amplitude, synusial diversity and etc. Such conditions for these florocenotic complex endemics are created within favourable vertical belts due to diversity of subalpine and alpine humidity (moderately dry, moderately humid, temporarily over-humid, permanently over-humid biotopes and etc.) and thermal regime (moderately warm, moderately cold, cold biotopes and etc.), high ability of competition and cooperation (facilitation) in meadow species, complex vertical structure and etc. Of course, this may not be said of the ultraoreophyte "world" – the subnival belt [41].

As the analysis of the altitudinal distribution of the high-mountain meadow endemic flora shows the optimal zone for the species distribution is the subalpine and alpine belts. There are 83(43. 9%) endemic species in the subalpine belt, whereas the general quantity of the species which are spread in both subalpine and alpine belts is 76 (40.2%); in the subnival belt there are only several endemic species spread, among them *Comostoma dechianum, Bromopsis variegata, Helictotrichon adzharicum* and etc.

Among the flora of the high-mountain subalpine tall herbaceous cover of the Eucaucasus more than its half, 35 species, i.e. 59.3% in this florocenotic complex is endemic. The most of the common quantity of the endemics are the endemic species of the Caucasus – 15 (25.4%), namely, *Xanthogalum tatianae, Heracleum mantegazzianum, H. sosnowskyi, Cicerbita macrophylla, C. petiolata, Senecio subflocosus, S. rhombifolius, Aconitum nasutum* and etc.

In the Eucaucasus the number of endemic species is 11 (28.2%) - *Cirsium hydrophylloides, Senecio pojarkovae, Delphinium bracteosum, D. elisabethae, D. ironorum, D. osseticum, D. speciosum, Lilium monadelphum subsp. Georgicum* and etc.

In Cochis there are 9 endemic species: *Heracleum mandenovae, Ligusticum physospermifolium, Cicerbita prenanthoides, C. bourgaei, Cirsium svaneticum, Senecio cladobotrys, Grossheimia polyphylla* and etc.

It must be noted that the endemic species of Colchis are mainly met in the phytochorion in Svaneti and Racha-Lechkhumi and thus create the well-known classical sample of the subalpine tall herbaceous cover of Colchis, which is unique in the world.

Vertical-altitudinal distribution of the subalpine tall herbaceous cover as well as the whole flora of this florocenotic complex is not observed beyond the forest and subalpine belts.

By the properties of eco-topological and ecological-geographical distribution the subalpine tall herbaceous cover is connected to damp and over-humid biotopes. Therefore, the role of tall herbaceous cover in creation of high-mountain landscape in the eastern part (Khevi) of the Central Eucaucasus and in the East Eucaucasus (Khevsureti, Tusheti) is insignificant, whereas in Pirikita Khevsureti, in the gorge of the Andaki River (villages Khonne and Khakhabo) thick undergrowth created by Heracleum sosnowskyi is met in over-damp clay biotopes [40].

The tall herbaceous cover complex is one of the ancient complexes formed in the Tertiary period in the moderately warm and humid mountain belt. The high mountain belts must have been formed in the Miocene and the subalpine belt must have been one of the centers of the florogenesis processes. The floristic composition of the tall herbaceous cover as well as the high mountain flora of the Caucasus Mountains, in general, underwent changes in the Pleistocene. In the following periods of tectonic and volcanic activities and glaciations phases the areas of the tall herbaceous cover decreased and its floristic composition became poor [24].

Like the subalpine tall herbaceous cover and high-mountain petrophyte, the high-mountain dendroflora of the Eucaucasus, in percentage terms, is rich in endemic species. 25 species in this florocenotic complex, i.e. 50% of the high-mountain dendroflora is endemic, among which the most, 11 species are the endemics of the Caucasus: *Betula raddeana, Rhamnus depressa, Rosa buschiana, R. ermanica, Sorbus subfusca, S. caucasica, Salix opoda, S. Kazbekensis* and etc.

Among the Central and East Eucaucasian high-mountain dendroflora 7 species are endemic: *Sorbus buschiana, S. fedorovii, Rosa oxyodon, Salix kuznetzowii, S. pantosericea* and etc.

In Colchis there are 7 endemic species - *Arctostaphylos caucasica, Rhamnus imeretina, Sorbus colchica, Rosa doluchanovii* and etc.

The most of the endemic species of the high-mountain dendroflora are characterized with wide geographical and ecological distribution. Among them the most distinguished are the representatives of the genera *Sorbus, Salix, Rosa*. At the same time these genera are distinguished for their diversity in endemic species of high-mountain dendroflora.

Among the endemic species of the dendroflora so called regional endemics are only *Rosa doluchanovii* (met only in Svaneti) and *R. ermanica* (met only in Shida Kartli).

Among the florocenotic complexes of the Alpine Carpets there are only 4 endemic species, 3 (*Pedicularis crassirostris, Carex medwedewii, Colpodium versicolor*) of which belong to the Caucasus and just one (*Ranunculus oreophylus*) is an endemic of the Eucaucasus.

Endemic species are unequally distributed in lithologically different biotopes. Their distribution in lithologically same but structurally different biotopes (motionless, moveable, less moveable, fine- and thick-structure slide-rocks, detritus and etc.) is also unequal [31; 33; 36; 37; 38; 40].

Biodiversity of the high-mountain endemics of the Eucaucasus is linked to lithologically rich biotopes (slates, granite, porphyry, marl, clay, limestone cliffs, slide rocks,

detritus). In the high mountains following ecomorphes are distinguished: obligatory and facultative chasmophytes, lapishistophytes, morenophytes and glareophytes (Shetekauri, 1998). The obligatory chasmophytes are distinguished by diversity of species: (*Saxifraga ruprechtiana, Draba bryoides, Silene linearifolia, Scrophularia lateriflora, Jurinea filicifolia* – met in slate biotopes; *Draba mingrelica, Campanula dzaaku, C. fonderwisii, Arabis colchica, A. sachokiana, Scutellaria helenae* - met in limestone biotopes) and lapishistophytes - *Silene caucasica, S. humilis, Ranunculus tebulossicus, Delphinium caucasicum, Cerastium kazbek, Pseudobetckea caucasica, Sobolewskia caucasica, Trigonocaryum involucratum* and etc., met in slate slide rock-detritus.

It is noteworthy that the ecological-geographical groups of endemics linked to mesophylic biotopes are mostly characteristic of the western part of the Eucaucasus. This group combines *Polylophium panjutinii, Cirsium sychnosanthum, C. Aggregatum* and also the endemic genera in the West Eucaucasus - *Woronowia* and *Sredinskya* (*W. speciosa, S. grandis*). The species of the ecological-geographical groups of the endemic mesoxerophytes and hemixerophytes are mainly distributed in the East Eucaucasus. These groups include *Scabiosa owerinii, Podospermum grigoraschvilii, Cirsium ketzkhovelii* and etc. The biotopes of these species are basically humidified by atmospheric precipitations unlike over-humid and humid biotopes, which are mainly humidified by soil water and run-off waters.

Regarding vertical distribution the most quantity of the endemic species is linked to the subalpine-alpine belt. Certain species are “offsprings” of the subalpine belt. Distribution of 20-30% of the endemics is linked to the alpine-subnival belt. Only several species are “devoted” to the subnival belt (*Cerastium kazbek, Ranunculus tebulossicus, Pseudobetckea caucasica*).

The petrophylic flora distinguished by endemic species in the Caucasus High Mountains is met in every landscape unit and vertical belt (subalpine, alpine, subnival). However, endemic diversity is characteristic of the alpine and subnival belts. Limestone biotopes and their unique endemic phytogene pool are especially widely presented in the West Eucaucasus. Namely, it is clear that in the Abkhazian subalpine belt the structure (taxonomical, geographical, eco-topological) of endemic biodiversity is different at various heights, for example, the forest and sub-alpine belt is more distinguished by ecosystem biodiversity and consequently, by various species than the upper alpine and subnival belts.

The gorges and the mountain systems of the Eucaucasus is different in glaciation intensity as well as in the volumes of different vertical belts (especially in different exposition conditions) and, of course, in relief peculiarities. Therefore, various parts of the Eucaucasus are different from one another regarding diversity in biotopes and species. It is proved by the floristic study of the adjacent and parallel high mountain gorges in the East Eucaucasus, namely, in Tusheti [31]. Each gorge of the Caucasus High Mountains is, more or less, a naturally isolated “impermeable” unit, which is mostly impermeable not only for the phytochorion floristic elements of neighborous Kakheti, Dagestan, Chechnya and Ingushetia but also for the ultraoreophytes, spread in the nearby parallel gorges.

The studies of the Eucaucasus high-mountain endemic biodiversity has once more proved the regularities, which was many times mentioned by the researchers of the high mountain flora of the Caucasus Mountains. Namely, the subnival belt is distinguished by its specific biodiversity: many rare and endemic species are combined in extreme conditions, though together with the increase in height (in the alpine and subnival belts) the number of species decreases. This phenomenon should be explained by ecological and geographical isolation of the high mountain ecosystems.

Thus, as the analysis of the florocenotic complexes of the Caucasus High Mountains shows the complexes differ from one another in the quantity of endemic species as well as in areas of distribution of separate endemics. The endemic species are unequally spread in lithologically different biotopes. Rare and endemic species are especially well observed in petrophyte and particularly in its slaty and limestone lithological stations, also in marly, clayey, limestone cliffs, slide-rocks, detritus. Floristically, granite and porphyritic ecotopes are characterized with less diversity. In the petrophyte the endemics of Colchis and the Eucaucasus are dominating. In the meadows – relatively wide ecological amplitude endemics of the Caucasus are dominant. In the tall herbaceous cover florocenotic complex, together with the endemics of the Caucasus and Eucaucasus, the endemics of Colchis (totally 9 species) are very significant.

Figure 4. *Some Endemic Generas of the Caucasus: 1. Pseudovesicaria (P. digitata; 2. Kemulariella (K. rosea); 3. Symphyoloma (S. graveolens); 4. Trigonocaryum (T. involucratum); 5. Mandenovia (M. komarovii); 6. Gadellia (G. lactiflora).*

6. Conclusion

According to the endemic species, the quantitative data of the dominant species and genera show that the portion of their (especially of genera) endemic species in various florocenotic complexes are different. This enables distinguishing the dominant "personal" genera of the high mountain petrophyte, tall herbaceous, meadows and etc.

As mentioned above, the Central and East Eucaucasus have 314 endemic species, i.e. 75.1% in common. Such significant similarity in endemic species between the eastern and western parts of the Caucasus Mountains, first of all, is caused by the floristic similarity between Central Transcaucasus, i.e. Khevi and East Transcaucasus, i.e. Tusheti-Khevsureti, the reason of which, in its turn, is territorial nearness, climatic and lithological similarity and etc. between these floristic regions.

It should be noted that in the florogenesis of the high mountain endemism a significant role was played by orogenesis processes of the Caucasus, which was caused due to extinction of ancestral species at lower altitudes and resulted in their geographical isolation.

This is proved by geographical and hypsometric vicarism of some species of generas *Campanula*, *Cerastium*, *Silene, Erysimum Pedicularis*, *Delphinium*, and *Jurinea*. The western, central and eastern parts of the Caucasus are floristically different not only from each other, but also from neighboring mountain massifs. Thus, sharp difference between the endemic floras of the Central and East Caucasus Mountains is made by existence of the so called regional endemics of Colchis and East Caucasus Mountains. Qualitative and quantitative properties of these regional endemics are caused due to difference in orographic, climatic and edaphic features of separate phytochorions.

Acknowledgement

The autors wish to thank Prof. D. Nikolaishvili for the technical assistance.

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