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Main types of vegetation zonation on the mountains of the Caucasus

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Abstract

Typological diversity of vegetation zonation on the mountains of the Caucasus is defined first of all by (1) the geographic transitional position of the region between temperate deciduous broad-leaved forests and subtropical latitudinal zones; (2) the location of different phytogeographical provinces (Mediterranean, Minor Asian, Iranian) in the contact area; (3) the evolutionary history of the Caucasian native flora (during the ice ages there were two refugia of the Tertiary flora in the region). Basically, there are four types of vegetation zonation on the Caucasus mountains: West Caucasian (Colchic), East Caucasian, South Caucasian (Front Asian) and Southeast Caucasian (Hyrkanic).

Keywords: Altitudinal profile; Refuge; Vegetation zone.

Nomenclature: Cherepanov (1995).

Abbreviations: ZAP = Zonation-altitudinal profile.

Introduction

The Caucasus region covers an area of ca. 500 000 km^2 in Armenia, Azerbaydzhan and Georgia, the North Caucasian portion of the Russian Federation, NE Turkey, and a small part of NW Iran. As to its origin, the Caucasus isthmus forms part of the huge mountain belt, the Alpine Orogene, which embraces the whole of Eurasia from the Pyrenees and Atlas Mountains in the west to the Malay Peninsula and Vietnam in the east. The Caucasus region was transformed into the present high mountain structure during the Neogene.

The Caucasus is a region of natural contrasts which includes several prominent elements (Fig. 1). These include the North Caucasian Plain (the eastern part of which is below sea level), the Great Caucasus Range (with Mt. El'brus as the highest peak at 5642 m), the Transcaucasian (South Caucasian) Depression, the Small Caucasus mountain chain (to 3500 m), and Transcaucasian Uplands (with Mt. Ararat as the highest point at 5165 m). There is a considerable relief, with erosion-tectonic and accumulation forms bordered by volcanic, glacier and karst forms. Not surprisingly, the climate is also variable. Mean annual precipitation in its southwestern (South Colkhic) part exceeds 2000 mm in the coastal area of the Black Sea (to 4000 - 4500 mm on the 1300 - 1400 m); in contrast, in the southwestern (lowland) part of the Caspian Sea coast, it rarely exceeds 150 mm. Mean annual air temperature in the Transcaucasian part of the Black Sea coast and Caspian Sea coast is 15 °C declining from south to north and with increasing altitude (with average fall 0.65 °C per 100 m).

The flora and vegetation of the Caucasus are very diverse, and they depend on both the physical features discussed above and the evolutionary history of the ecosystems. First of all, there are two refugia of the Tertiary flora in the region, the Colchic in the catchment basin of the Black Sea and the Hyrkanic in the extreme southeastern end of the Caucasus. Even now, many relict forms still appear as dominant or co-dominant in a number of plant communities.

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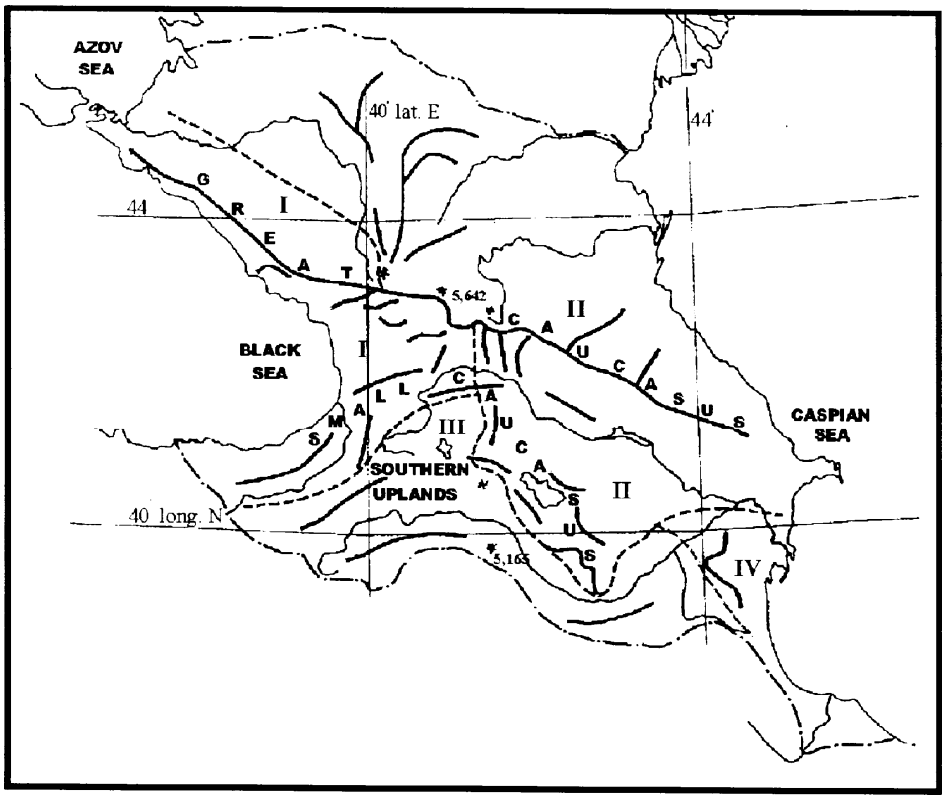

Fig. 1. Main types of mountain zonation in the Causasus. I. West-Caucasian (Colchic); II. East Caucasian: III. South Causasian (Front Asian); IV. Southeast Caucasian (Hyrkanic).

In terms of vascular plant diversity, over 6300 species have been recorded in the Caucasus, and of these, more than 1600 are endemic. In addition, there are 17 endemic genera in the Caucasus.

It is noteworthy that the high biodiversity of the Caucasus is under strong human impact: the Caucasus is identified as one of the 25 biologically richest and also most endangered terrestrial ecoregions of the World (Zazanashvili et al. 1999; Myers et al. 2000).

The first scheme of mountain zonation for the Caucasus (i.e. its southwestern part) was elaborated by Wagner (1848). At the end of the 19th century and the beginning of the 20th century researchers often returned to zonation items (e.g. Kuznetsov 1890; Albov 1896; Busch 1898; Radde 1899; Sosnovsky 1915). Dolukhanov et al. (1942) analysed and summarized these studies for the Caucasus high mountains. Later Shiffers (1953) made the detailed scheme of mountain zonation for the northern slope of the Great Caucasus range. During preparations for an International Symposium 'Alps-Caucasus' (Grebenschikov & Zimina 1974; Golubev et al. 1974; Kolakovski et al. 1974) information on mountain zonation for western and northeastern parts of the Great Caucasus mountain range was collected by Russian and Georgian scientists with four river valleys as examples. Other zonation schemes for different parts of the Caucasus include three detailed schemes of altitudinal distribution of vegetation in eastern and Colchic parts of Georgia (Nakhutsrishvili 1999). Some publications contain generalized schemes (Stanukovich 1955, 1973; Gagnidze 1970).

In the presented paper the experience of a new generalization of mountain zonation in the Caucasus is used. It is hoped that a discussion on the phytogeographical position of these zonation types will be stimulated.

Some concepts and terms

First some concepts and terms will be explained. A *vegetation formation* is defined in its traditional, ecological-physiognomic meaning. A mountain *vegetation zone* is defined as a *combination of primary/climax formations*, which (1) has altitudinal/climatic limits (altitudinal ecological optimum) and therefore more or less evident altitudinal limits of distribution, and (2) is common on the regional/sub-regional level. A zone may consist of *belts* (subzones), which differ from each other by the proportion between characteristic formations of a zone (i.e. by *formation spectra*). For instance, in the Colchic zonation type *Castanea* and *Fagus-Castanea* forests are characteristic of the IA1 belt as well, but in the formation spectrum of IA2 they dominate; or, in the upper subalpine belt (ID2) elfin woods with *Betula litwinowii* and meadows are widespread, while other types of elfin woods, open wood-

lands and tall herbaceous vegetation predominate in the lower belt (ID1).

A *type of mountain zonation* is determined by a stable, altitudinally regular *combination of vegetation zones* (or *zonal altitudinal profile* - ZAP), which is repeated at least on the sub-regional level with certain variation and defines regional/sub-regional phytogeographical individuality. The concrete appearance of a *zonation type* is related to the geographical location of the area, regulation of natural macro-ecological factors (first of all to the regional circulation of air masses) and features of evolutionary development of ecosystems. A zonation type is a more or less general feature and encompasses the most characteristic and common aspects of *subtypes*. The characteristics of the latter are mainly determined by special meso-climatic, geomorphologic and lithologic features. Besides, *anthropogenic* subtypes for the regions with consequential level of human impact on the natural ecosystems may be considered.

The main types of vegetation zonation clearly exposed on the Caucasus mountains are described below. Besides, we take into consideration that the characteristic formations of certain zones often intrude into the adjoining zones. The transitional zones frequently cover large areas; indicators of altitude of relatively wide distribution outside the optimal zones and belts are given in brackets (the Latin names of dominant and co-dominant species characteristic to the formations are given in the corresponding brackets as well).

The following material has been used for the determination of the zonation types:
- published articles and monographs, part of which has been mentioned above;
- published and non-published cartographic information (including a map scale 1:200 000 prepared by us for ca. 7% of the Caucasus area);
- cosmic coloured photographs (1989; scale 1: 200 000);
- data from our field expeditions conducted in almost every region of the Caucasus.

Zonation typology

Four main zonation types and some subtypes are outlined (Fig. 1).

I. West Caucasian (Colchic) type

This type is characteristic of the western sections of the Great Caucasus range and of the Small Caucasus mountain chain, mainly where the Caucasus embraces the Black Sea catchment basin, i.e. of that region, where one of the refugia of hygro-thermophilous representatives of the Tertiary flora existed during the ice ages. This type was formed under humid conditions – the mean annual

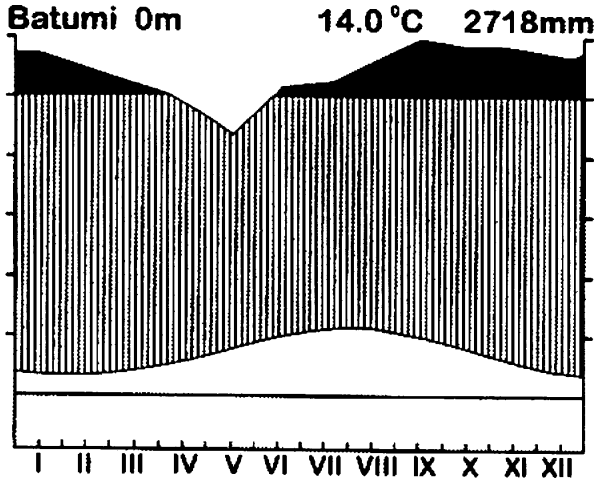

Fig. 2. Climate diagram for the southern Colkhis.

precipitation is mostly more than 2000 mm, in certain places it even exceeds 4000 mm (Fig. 2). This is clearly indicated by the concentration of Colchic relicts (Fig. 3). The main characteristic of this type is a wide distribution of Colchic relicts along the whole zonal altitudinal profile, almost from sea level up to 2300 m. Colchic relicts either form a 2 - 4 m tall dense understorey in different forest types, or they occur as independent shrub communities in certain habitats. Here, in the Transcaucasus (lower subalpine belt) endemic oak and birch elfin woods are found, with *Quercus pontica, Betula medwedewii* and *B. megrelica*; other endemic relicts include *Rhododendron ungernii, R. smirnowii, Epigaea gaultherioides* and *Corylus colchica*.

A characteristic ZAP of this type is well-developed in the south Caucasian part of the Black Sea catchment basin.

IA. Humid thermophilous Colchic broad-leaved forest zone. This zone occurs up to 1000 (1200) m.

IA1. Mixed broad-leaved forest belt. This belt occurs up to 500 (600) m and includes *Castanea sativa, Carpinus caucasica, Fagus orientalis, Quercus hartwissiana* and *Zelkova carpinifolia,* with a Colchic understorey including *Rhododendron ponticum, Laurocerasus officinalis* and *Ruscus colchicus* as well as the lianas *Hedera colchica, H. helix, Dioscorea caucasica* and *Vitis sylvestris* (Fig. 4). In relatively dry habitats thermophilous hornbeam-oak forests occur with *Quercus iberica, Carpinus caucasica* and *C. orientalis.* In southern Colkhic (from 200 m upwards) we find pine-oak forests with *Quercus iberica, Q. dshorochensis* and *Pinus kochiana* as well as Colchic thickets with *Rhododendron ponticum, Ilex colchica, Laurocerasus officinalis* and *Ruscus colchicus.*

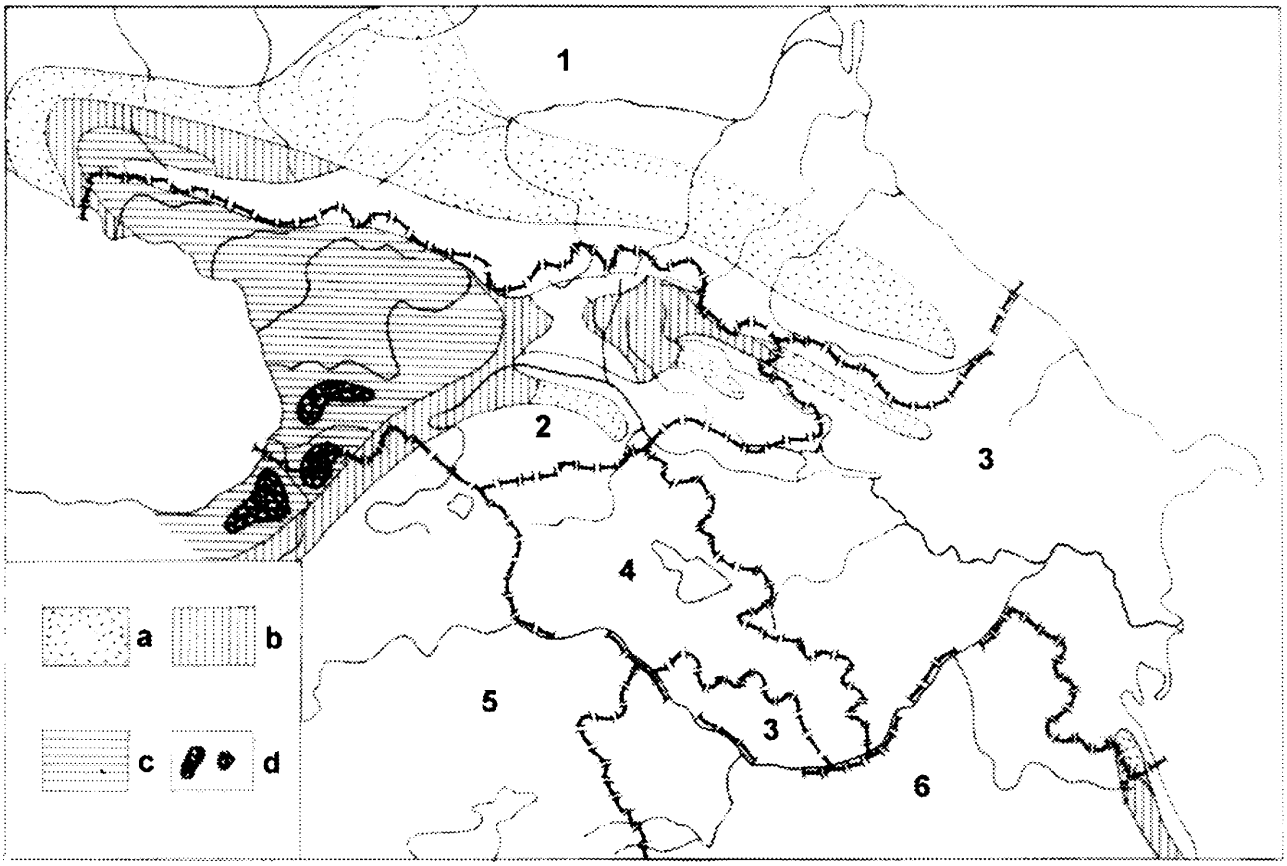

Fig.3. Distribution of semi-prostrate Colchic relicts in the Causasus: *Laurocerasus officinalis, Rhododendron ponticum, Rh. luteum, Rh. ungernii, Rh. smirnowii, Vaccinium arctostaphylos, Epigaea gaultherioides, Viburnum orientale, Ruscus colchicus, Ilex colchica, I. stenocarpa, I. hyrcana* – including *Rh.* × *sochadze* but excluding *Rh. causasicum*. a = areas with 1 - 2 species; b = 3 - 4 species; c = 5 - 8 species; d = 9 - 11 species (Dolukhanov 1980). 1 = Russian Federation; 2 = Georgia; 3 = Azerbaydzhan; 4 = Armenia; 5 = Turkey; 6 = Iran.

IA2. Chestnut forest belt. This belt is characterized by forests with *Castanea sativa* and *Fagus orientalis*, occurring from 500 - 1000 (1200) m with a Colchic understorey; further by thermophilous oak forests and Colchic thickets (see IA1 with *Vaccinium arctostaphylos*).

IB. Humid beech forest zone. A zone between 1000 (800) -1400 (1800) m with:
- *Fagus orientalis* forest often with a Colchic understorey;
- dark coniferous and mixed beech-dark-coniferous forests (*Abies nordmanniana*, *Picea orientalis*, *Fagus orientalis*), partly with a Colchic understorey;
- Colchic thickets (see IA1, with *Rhododendron ponticum, Rh. ungernii, Laurocerasus officinalis, Ilex colchica, Ruscus colchicus, Vaccinium arctostaphylos, Viburnum orientale*).

IC. Nemoral humid coniferous forest zone. This zone, from 1400 (1000) - 1800 (2100) m, includes forests with *Abies nordmanniana, Picea orientalis* and *Fagus orientalis*, partly with Colchic understorey. Colchic thickets occur as in I B.

ID. Subalpine elfin wood and meadow zone. This zone occurs from 1800 (1600) - 2400 (2700) m.

ID1. Lower subalpine belt. This belt occurs from 1800 (1600) to 2100 (2200) m and includes:
- beech, oak and birch elfin woods (*Fagus orientalis, Quercus pontica, Betula medwedewii, B. megrelica*), often with a Colchic understorey;
- tall herbaceous vegetation (*Heracleum ponticum, Ligusticum physospermifolium, Senecio cladobotrys*);
- dark coniferous and beech-dark coniferous forests often with a Colchic understorey;
- *Rhamnus imeretina, Sorbus subfusca* or *Corylus colchica* thickets;
- Colchic thickets (*Rhododendron ponticum, Rh. ungernii, Laurocerasus officinalis, Ilex colchica, Ruscus colchicus, Vaccinium arctostaphylos*);
- subalpine meadows (*Calamagrostis arundinacea, Poa iberica, Geranium platypetalum*).

Fig. 4. Mixed broad-leaved Colchic forest, southern Colchic, western Caucasus.

ID2. Upper subalpine belt. This belt, from 2100 to 2400 (2700) m, includes:
- birch/ash-birch elfin woods with *Betula litwinowii, Sorbus caucasigena*;
- *Rhododendron caucasicum* thickets;
- subalpine meadows on limestone (*Calamagrostis arundinacea, Festuca djimilensis)*;
- *Woronowia speciosa, Carex pontica*.

IE. Alpine grassland and thicket zone. This zone occurs between 2400 and 2900 (3000) m.
IE1. Lower alpine belt. This belt occurs from 2400 to 2750 m and includes:
- grasslands (*Nardus stricta, Festuca djimilensis, Agrostis lazica, Geranium gymnocaulon)*;
- *Rhododendron caucasicum* thickets.

IE2. Upper alpine belt, from 2750 to 2900 (3000) m, with:
- grasslands (*Festuca supina, Kobresia schoenoides* and *Geranium gymnocaulon*);
- mats (*Cerastium cerastoides, Ranunculus svaneticus, Potentilla crantzii*);
- rock and scree vegetation.

IF. Subnival zone. This zone occurs from 2900 - 3700 (4000) m and includes open plant communities (*Cerastium polymorphum, Minuartia trautvetteriana, Saxifraga scleropoda*).

IG. Nival cryptogam zone. This zone occurs > 3700 m.

II. East Caucasian type

This type is characteristic of the eastern sections of the

Fig. 5. Arid woodland with *Juniperus* spp. and *Pistacia mutica* in the submontane belt, eastern Caucasus.

Fig. 6. *Fagus orientalis* forest, eastern Caucasus.

Great Caucasus range and of the Small Caucasus mountain chain. The climate has continental features over most of the area: mean annual precipitation varies from 600 to 1000 mm. Besides, the northern slope of the Eastern Great Caucasus and the Small Caucasus are drier than the southern slope of the Eastern Great Caucasus, which is reflected on the zonation sub-type level. Furthermore, in comparison with the humid Colkhic, corresponding zones are located 100 - 200 m higher here. Due to the absence of refugia the zonation is relatively simple.

IIA1. Riverside and foothill forest belt. This belt, situated at < 500 - 600 (1000) m, includes:
- riverside oak and poplar-oak forests (*Quercus pedunculiflora, Populus hybrida, P. nigra* with *Acer velutinum, Ulmus suberosa*);
- thermophytic-hemixeric hornbeam-oak forests on the slopes (*Quercus iberica, Carpinus orientalis*);
- arid woodlands (*Pistacia mutica, Juniperus polycarpos, J. foetidissima, Celtis caucasica*); see Fig. 5;
- shibliak (*Paliurus spina-christi, Rhamnus pallasii, Atraphaxis spinosa, Ephedra procera*).

IIA2. Lower mountain belt. This belt, from 500 - 1000 (1200) m, includes oak/hornbeam forests (*Quercus iberica, Carpinus caucasica*); beech and hornbeam-beech forests (*Fagus orientalis, Carpinus caucasica*).

IIB. Mesic beech forest zone. This zone occurs from 1000 - 1800 (2000) m. See Fig. 6.

IIB1. Middle mountain belt. At 1000 - 1500 m this belt includes *Fagus orientalis* and *Pinus kochiana* forests.

IIB2. Upper mountain belt. This belt, at 1500 - 1900 (2000) m, includes *Fagus orientalis* forests; *Quercus macranthera* forests; *Pinus kochiana* forests and woodlands (Fig. 7).

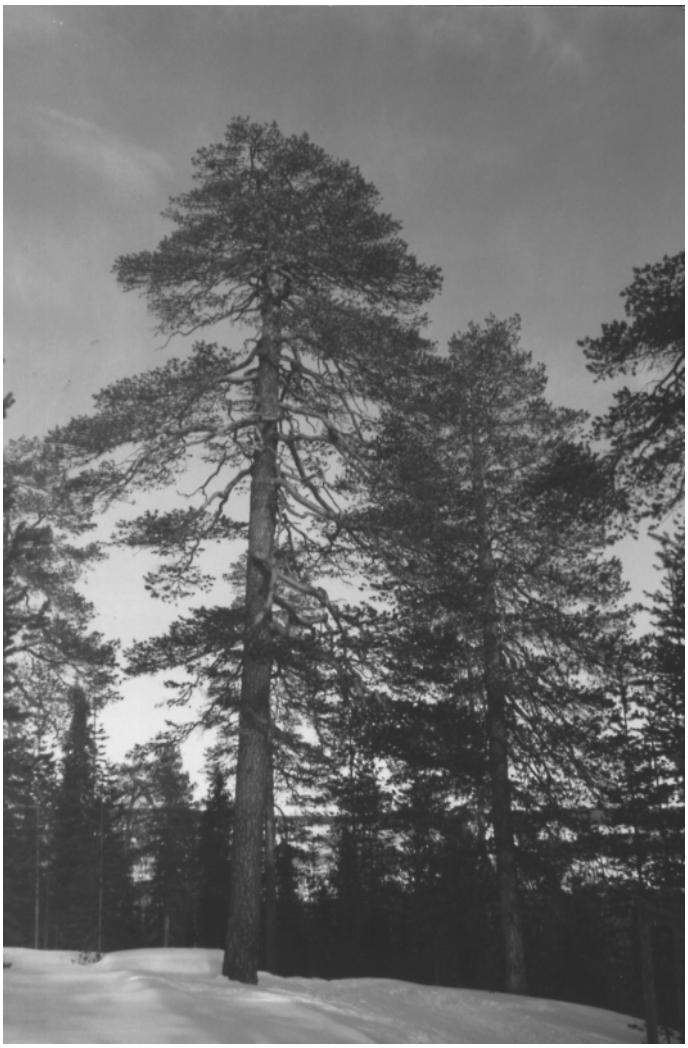

Fig. 7. *Pinus kochiana* forest, eastern Caucasus.

IIC. Subalpine elfin wood and meadow zone. This zone occurs between 1900 (2000) and 2500 (2700) m.

IIC1. Lower subalpine belt. This belt, at 1900 - 2200 m, includes:
- oak, pine and maple woodlands, including open woodlands (*Quercus macranthera, Pinus kochiana, Acer trautvetteri*);
- birch and ash-birch elfin woods (*Betula litwinowii, B. raddeana, Sorbus caucasigena*);
- tall herbaceous vegetation (*Heracleum sosnowskyi, Aconitum orientale*);
- low juniper open communities (*Juniperus hemisphaerica*) mainly on rocks and screes;
- *Rhododendron caucasicum* thickets;
- subalpine meadows (*Agrostis planifolia, Bromopsis variegata, Hordeum violaceum, Geranium ibericum*);
- meadow steppes (*Festuca ovina, Carex humilis, Bromopsis variegata, Thymus collinus*).

IIC2. Upper subalpine belt. This belt, at 2200 - 2500 (2600) m, is characterized by:
- birch and ash-birch elfin woods (see IICI);
- *Rhododendron caucasicum* thickets;
- subalpine meadows (*Festuca varia, Geranium ibericum, Betonica macrantha*).

IID. Alpine grassland and thicket zone. This zone occurs between 2500 and 3000 (3200) m.

IID1. Lower alpine belt. This belt, found between 2500 and 2800 m, includes:
- alpine grasslands (*Festuca varia, Carex tristis, Kobresia capilliformis, Nardus stricta*);
- *Rhododendron caucasicum* thickets.

IID2. Upper alpine belt. This belt, from 2800 - 3000 (3200) m, includes:
- alpine grasslands (*Festuca varia, Carex tristis, Kobresia schoenoides*);
alpine mats (*Sibbaldia parviflora, Carum caucasicum, Campanula biebersteiniana*).

IIE. Subnival open zone. In this zone, at 3000 - 4000 m, open plant communities with *Cerastium kasbek* and *Tripleurospermum subnivale* occur, with fragments of mats and grasslands (up to 3300 m).

IIF. Nival cryptogam zone. This zone is found at > 4000 m.

III. South Caucasian (Front-Asian) type

This type is characteristic of the uplands and mountains of the Southern Caucasus mainly composed of volcanic sediments. Here, representatives of the Caucasian relict flora do not occur: Anatolian-Iranian components predominate in the plant communities floristic composition; the typical forest zones are not characteristic of the zonal altitudinal profile which is formed in xerothermic, continental conditions: the mean annual air precipitation varies within 250 - 500 mm limits and increases in high-mountain regions. In comparison with humid regions in the Caucasus the corresponding zone limits are situated 300 - 400 m higher. The typical zonal altitudinal profile is as follows:

IIIA. Desert zone. This zone, at < 800 m, includes:
- dwarf semi-shrub deserts (*Artemisia fragrans, Salsola* spp. with ephemeroids. e.g. *Poa bulbosa, Catabrosella humilis*);
- deserts with *Halocnemum strobilaceum* and *Suaeda microphylla* on saline soils and salt marshes;
- thorn-cushion communities (*Artemisia microcephalus, A. vedicus, A. karjaginii*).

IIIB. Xeric grass and semi-shrub zone. This zone, at 800 (1200) - 1600 m, includes:
- tomillares (*Thymus kotschianus, Scutellaria* spp., *Stachchys inflata*);
- friganoids (*Ambliopogon* spp., *Caccinia rauwolfii, Hedysarum formosum*);
- thorn-cushion communities (*Astragalus microcephalus, Onobrychis cornuta, Acantholimon glumaceum*);
- steppes (*Stipa* spp., *Festuca valesiaca, Bromopsis riparia, Carex humilis*).

IIIC. Hemi-xeric woodland zone. This zone, at 1600 - 2300 (2400) m, includes:
- *Quercus macranthera* woodlands;
- low woodlands (*Pyrus* spp., *Acer hyrcanum, Crataegus* spp., *Juniperus polycarpos*);
- hemi-xeric shrublands (*Cotoneaster* spp., *Sorbus graeca*);
- steppes (*Stipa tirsa, Festuca valesiaca, Koeleria cristata, Nepeta grossheimii*);
- thorn-cushion communities (*Astragalus* spp., *Onobrychis cornuta, Acantholimon glumaceum*);
- meadow steppes (*Festuca ovina, Poa densa, Phleum phleoides, Carex humilis*).

IIID. Subalpine woodland and grassland zone. In this zone, between 2300 and 2800 (2900) m, we find:
- *Quercus macranthera* woodlands;
- steppes (*Festuca valesiaca, Koeleria cristata, Sesleria phleoides*);
- subalpine meadows (*Bromopsis variegata, Phleum nodosum, Koeleria caucasuca*);
- meadow steppes (*Festuca valesiaca, F. ovina, Bromopsis variegata, Sesleria phleoides*);
- thorn-cushion communities (*Astragalus aureus, A. lagurus, Onobrychis cornuta*).

IIIE. Alpine grassland zone. This zone, at 2800 - 3400 (3600) m, includes:
- alpine grasslands (*Festuca varia, F. chalcophaea, Alopecurus aucheri, Carex tristis*) and mats (*Sibbaldia parviflora, Alchemilla erythropoda*).

IIIF. Subnival open zone. Between 3400 and 4200 (4400) m open plant communities occur with *Draba araratica, Poa araratica* and *Saxifraga hirculus*.

IIIG. Nival cryptogam zone. This zone is found at > 4200 m.

IV. Southeast Caucasian (Hyrkanic) type

This type is characteristic of the extreme southeastern part of the Caucasus, southeast Azerbaydzhan and the northwest Iranian mountains along the Caspian Sea coast. Here, the other refugium from the Tertiary flora, the Hyrkanic refugium, occurs. There is more difference than similarity between the Colchic and Hyrkanic refugia. In the Hyrkanic area evergreen species are less widely distributed and are of less phytocoenotic importance. Besides, if relicts range from sea level to alpine belt in Colkhic, communities in the Hyrkanic area, where relicts appear as dominants and co-dominants, reach only up to 1000 - 1200 m. Due to local climatic peculiarities, the lower zones of the mountains are more humid than the upper zones: the mean annual precipitation in the submountain area is 1700 mm (with a summer minimum), while the mean annual air precipitation above 2000 m is only 300 - 400 mm.

The mean annual air temperature in the foothill is not higher than 12-13 °C. According to a typical ZPA from the Talysh mountains a the following zonation types can be distinguished.

IVA. Humid thermophilous Hyrkanic broad-leaved forest zone. This zone occurs at altitudes < 1000 (1200) m.
IVAI. Mixed broad-leaved forest belt. This belt is found up to 600 m and includes:
- oak-parrotia, parrotia-hornbeam-oak, oak-hornbeam-azad forests (*Quercus castaneifolia, Parrotia persica, Zelkova carpinifolia, Carpinus caucasica, Albizzia julibrissin,*

Ficus hyrcana, Diospiros lotus, with shrubs and semi-shrubs: *Ilex hyrcana, Ruscus hyrcanus, Danaë racemosa,* and lianas: *Smilax excelsa, Periploca graeca, Hedera pastuchowii*);
- *Quercus castaneifolia* thermophilous forests.

IVA2. Oak forest belt. This belt occurs from 600 to 1000 (1200) m and includes:
- *Quercus castaneifolia* thermophytic forest sporadically with *Parrotia persica, Zelkova carpinifolia, Acer velutinum, Gleditsia caspia;*
- beech and beech-hornbeam forests (*Fagus orientalis, Carpinus caucasica*);
- *Quercus iberica-Carpinus caucasica* forests.

IVB. Mesic beech forest zone, from1000-1600 (1800) m, includes *Fagus orientalis* forests.

IVC. Steppe and xeric dwarf semi-shrub zone. From 1600 to 2300 (2500)m we find:
- steppes (*Stipa tirsa, S. lessingiana, Festuca valesiaca, Koeleria cristata, Nepeta* spp.);
- thorn-cushion communities (*Astragalus aureus, A. lagurus, Onobrychis cornuta*);
- meadow steppes (*Festuca valesiaca, Phleum phleoides, Koeleria cristata, Carex humilis*).

Besides the above-described types in the northwestern and southwestern Caucasus, the nearby Crimea peninsula (Russia) and the upper part of the Chorokh river basin (Turkey), we come across local fragments of Crimea-Mediterranean and Mediterranean types of zonation.

Conclusions

Generally, mountain zonation typology in the Caucasus is defined first of all by the (1) transitional geographic position of the region between temperate deciduous broad-leaved forests and subtropical zones, (2) the location of the different phytogeographical regions (Mediterranean, Minor Asian, Iranian) in the contact area, and (3) by the evolutionary history of the original Caucasian flora.

The refugial history of the area has greatly influenced the Colchic type of zonation: it is the basic factor behind the biodiversity and phytogeographical individuality of both the subregion and the whole region. Besides, the transitional location of the region may be considered as one of the reasons for the maintenance of the Colchic type. Analogies for a Colchic-type zonation can be found in areas characterized by transitional 'laurineous forests' (Klötzli 1988), semi-evergreen forests (Box & Fujiwara 1988) or 'warm evergreen *Fagus* forests' (Fujiwara 1998), particularly in the northern parts of the Southeastern United States and the Southern Andes (Hildebrand-Vogel et al. 1998) as well as in some other regions. Similar relations may be found with the Hyrkanic refugial type, but as mentioned above, evergreen elements are less distinctive in this type. If we compare the Colchic and Hyrkanic types with European mountain zonation types (Ozenda 1994), the convergentional features point rather to the southern Alps.

The similarity between the mountain zonations of West Caucasus and West Alps has been also mentioned earlier (Grebenschikov & Zimina 1974). The position of the South Caucasian type is more obvious – it should be united with the Front Asian (East Anatolian-West Iranian) group of mountain zonation types. The issue of the East Caucasian type requires additional investigation: this type, among other Caucasian types, holds a transient position. Here, on the one hand we find xerophytic elements in the lower belts, and on the other hand typical mesic beech forests and semi-humid subalpine elfin woods spread in the upper belt.

References

Alboff, N. 1896. Les forêts de la Transcaucasie occidentale. — Bull. Herbarier Boissier 4: 61-78.

Box, E.O. & Fujiwara, K. 1988. Evergreen broad-leaved forests of the Southeastern United States: preliminary description. — Bull. Inst. Environ. Sci.Technol. Yokohama Natl. Univ. 15(1): 71-93.

Cherepanov, S.K. 1995. Plantae vasculares USSR. — Nauka Leningrad, 509 pp.

Dolukhanov, A.G. 1980. Colkhidian underwood. — Metsniereba, Tbilisi, 262 pp. (In Russian.)

Dolukhanov, A.G., Sakhokia, M.F. & Kharadze, A.L. 1942. On the zonation of high-mountain vegetation of the Caucasus. — Trans. Tbilisi Bot. Inst. 8: 114-130. (In Russian.)

Fujiwara, K. 1998. Competition between evergreen and summergreen broadleaved forests along their ecotone. — Stud. Plant Ecol. 20: 41.

Gagnidze, R. 1970. On the typology of altitudinal zonation in the Caucasus. Bull. Acad. Sci. Georgia 59(3): 673-676. (In Georgian.)

Golubev, G.N., Tushinski, G.K., Grebenschikov, O.S. & Zimina, R.P. 1974. Geomorphology and altitudinal belts of natural ecosystems. Baksan-Baksan river valley-Itkol. In: France-Soviet Geographical Symposium 'Alps-Caucasus': Guide of the Caucasus (Symposium materials), pp. 78-85. Institute of Geography of the Scientific Academy of the USSR. Nauka, Moscow-Tbilisi. (In Russian.)

Grebenschikov, O.S. & Zimina, R.P. 1974. Natural ecosystems and vertical belts. In: France-Soviet Geographical Symposium 'Alps-Caucasus': Guide of the Caucasus (Symposium materials), pp. 8-12. Institute of Geography of the Scientific Academy of the USSR, Moscow-Tbilisi. (In Russian.)

Hildebrand-Vogel, R., Flores T.L., Godoy B.R. & Vogel, A. 1998. Synecology of Nothofagetea pumilionis — comparison between south Andean and European deciduous forests. — Stud. Plant Ecol. 20: 34.

Klötzli, F. 1988. On the position of the evergreen broad-leaved (non-ombrophilous) forests in the subtropical and temperate zones. — Veröff. Geobot. Inst. Eidg.Tech. Hochsch. Stift. Rübel Zür. 98: 169-196.

Kolakovski, A.A., Maruashvili, L.I., Sokhadze, E.V., Ukleba, D.B. & Urushadze, T.F. 1974. Geomorphology and vertical belts of natural ecosystems. Sukhumi-Ritsa lake-Avadkhara. In: France-Soviet Geographical Symposium 'Alps-Caucasus': Guide of the Caucasus (Symposium materials), pp. 152-162. (In Russian.)

Kuznetsov, N. I. 1890. Geobotanical investigation of the Caucasus northern slope. Proc. Imper. Russ. Geogr. Soc.17, pp. 55-73. A.S. Suvorin' Typography, Sankt-Petersburg. (In Russian.)

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B. & Kent. J. 2000. Biodiversity hotspots for conservation priorities. — Nature 403: 853-858.

Nakhutsrishvili, G. 1999. The vegetation of Georgia (Caucasus). — Centro Audiovisivi e Stampa, Camerino, 74 pp.

Ozenda, P. 1994. Végétation du continent Européen. — Delachaux et Niestlé S.A., Lausanne, Paris, 271 pp.

Radde, G. 1899. Grundzüge der Pflanzenverbreitung in den Kaukasusländern. Die Vegetation der Erde, Vol. 3. — Wilhem Engelmann Verlag, Leipzig, 500 pp.

Shiffers, E.V. 1953. Vegetation of the North Caucasus and its natural ranges. — Publ. House of Acad. Sci. USSR, Moskva-Leningrad, 398 pp. (In Russian.)

Sosnovsky, D.I. 1915. Sketch of the vegetation of the Upper Svaneti. — Bull. Russ. Flora 1(3): 119-144. (In Russian.)

Stanukovich, K.V. 1955. General types of zonation for the mountains of USSR. — Proc. USSR Geogr. Soc. 87(3): 232-243. (In Russian.)

Stanukovich, K.V. 1973. Mountain vegetation of the USSR. — Donish, Dushanbe, 416 pp. (In Russian.)

Wagner, M. 1848. Reise nach dem Ararat und dem Hochland Armeniens. Mit einem Anhange: Beiträge zur Naturgeschichte des Hochlandes Armenien. — Verlag der Gottäfchen Buchhandlung, Stuttgart, Tübingen, XII+331 pp.

Zazanashvili, N. 1999. On the Colchic vegetation. In: Klötzli, F. & Walther, G.-R. (eds.) Conference on recent shifts in vegetation boundaries of deciduous forests, especially due to general global warming, pp. 181-197. — Birkhäuser Verlag, Basel.

Zazanashvili, N., Sanadiradze, G. & Bukhnikashvili, A. 1999. Caucasus. In: Mittermaier, R.A., Myers, N., Gil, P.G. & Mittermaier, C.G. (eds.) Hotspots: Earth's biologically richest and most endangered terrestrial ecoregions, pp. 269-273. — Toppan Printing Co., Japan.