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Article

Vegetation and Landscapes of Georgia (Caucasus), as a Basis for Landscape Restoration ¹⁾

Elgene O. BOX ²⁾, Kazue FUJIWARA ³⁾, Giorgi NAKHUTSRISHVILI ⁴⁾,
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エグザル ザザナシュヴィリ ⁴⁾・ロバート J. リーバーマン ²⁾・宮脇 昭 ⁵⁾

Synopsis

Georgia (locally: *Sakartvelo*; Russian: *Gruziya*) is the ancient Greek name for the valley of Transcaucasia, home of the Kartveli people and of a very long cultural, agricultural and viticultural history dating back more than 3000 years. Natural landscapes include the montane and alpine belts of the Greater and Lesser Caucasus ranges, semi-evergreen forests of the Colchis (Black Sea lowlands), mesic deciduous forests in various areas, the fertile valley of Transcaucasia itself, and drier steppe and scrub areas to the east. Now that Georgia is an independent country, there is interest in rehabilitation of landscapes degraded by years of overuse. This paper describes the natural vegetation of Georgia and its environmental constraints, as a basis for further biogeographic and possible restoration work.

Keywords: arid woodland, central Caucasus, Colchic forest, Georgia (Caucasus), landscape restoration, meadow-steppe, mesophytic forest, potential natural vegetation, shibljak, Transcaucasia.

¹⁾ Contribution from the Department of Vegetation Science, Institute of Environmental Science and Technology, Yokohama National University, No.229.

²⁾ Department of Geography, University of Georgia, Athens, Georgia 30602-2502, United States of America.
アメリカ合衆国ジョージア大学地理学教室

³⁾ Department of Vegetation Science, Institute of Environmental Science and Technology, Yokohama National University, Hodogaya-ku, Tokiwadai 79-7, Yokohama 240-8501, Japan.
横浜国立大学環境科学研究センター植生学研究室 〒240-8501 横浜市保土ヶ谷区常盤台 79-7

⁴⁾ Institute of Botany, Georgian Academy of Sciences, Tbilisi 380007, Republic of Georgia.
ジョージア共和国ジョージア科学院植物学研究所

⁵⁾ Japanese Center for International Studies in Ecology (JISE), 32 Yamashita-cho, Naka-ku, Yokohama 231-0023, Japan.
生態学研究センター (JISE) 〒231-0023 横浜市中区山下町 32

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Introduction

Even before Alexander the Great took his Greek-Macedonian armies eastward toward Persia in the 330s BC, Greeks had entered the valley of Transcaucasia, between the Greater and Lesser Caucasus mountain ranges (see Figure 1), and encountered an accomplished agricultural and metalworking people which they named Georgians, after a Greek word *georgos* for farmer. According to their own histories, these people, the Kartveli, had already been tilling the soil, and producing wine, in the rich Transcaucasian valley for over a thousand years (see Nakhutsrishvili 1999a, Curtis 1994). Surrounded by mountainous but drier Armenia and Asia Minor (now Turkey) on the south, the steppes of Scythia (now the Ukraine) on the north, and the semi-deserts of Middle Asia across the Caspian Sea to the east, the valley of Transcaucasia and the naturally forested Caucasian foothills represent a fertile island in the generally drier crossroads region of southwestern Asia and adjacent southeastern Europe (e.g. Gulizashvili et al. 1975, Korovin 1961-62, Petrov 1966-67). As a result, Alexander was only one of many invaders whose influences have been survived and to some extent assimilated by the resourceful Kartvelian people (cf Goldstein 1993).

Just before 1800, the armies of the Russian Tsar built what was called the Georgian Military Highway (still the only major road over the central Greater Caucasus) and annexed the Transcaucasus. Since that time, *Sakartvelo* (the Georgian name for Georgia) has been known in

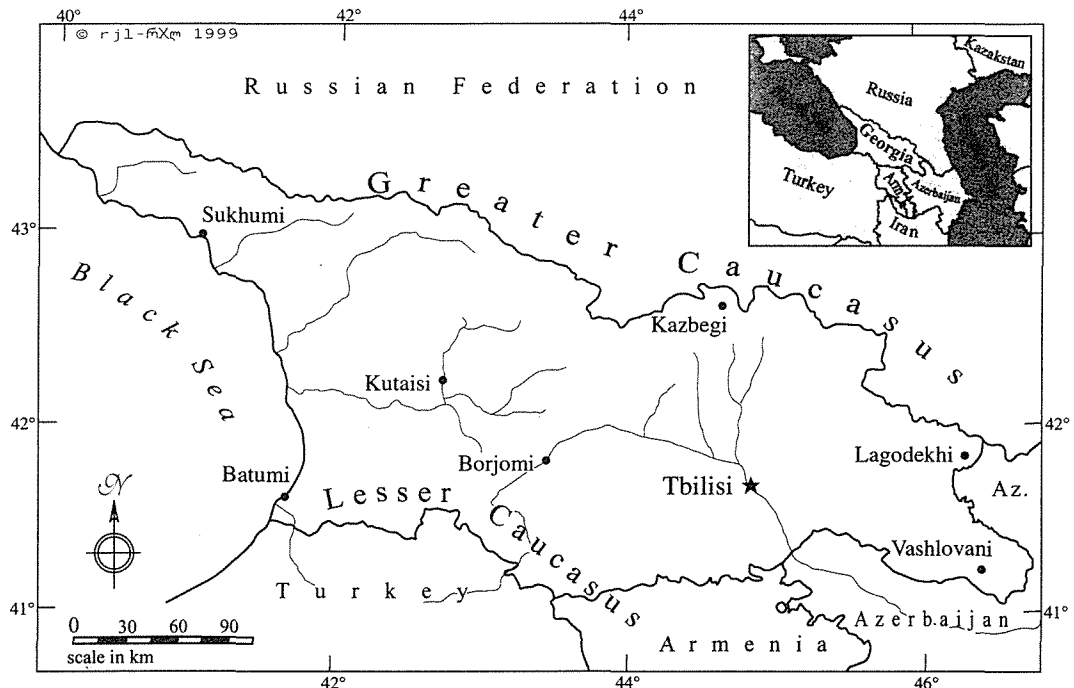


Figure 1. Location of Georgia, with Major Cities, Some Physical Features, and Study Sites.

Georgia occupies the Transcaucasian valley between the Greater Caucasus to the north and the Lesser Caucasus to the south. The country is divided into two roughly equal halves, eastern Georgia and western Georgia, by the Imeretian Highland (see also Figure 2) which connects the Greater and Lesser Caucasus west of Tbilisi. The Colchis is the lowland region along the Black Sea, extending south into Turkey and inland in Georgia about as far as Kutaisi. The central Greater Caucasus reaches slightly over 5000m near Kazbegi, with all passes over 2000m. The Lesser Caucasus reaches over 3000m and extends, with decreasing elevation, southeastward across northern Armenia into western Azerbaijan. The two main rivers are the Rioni, which drains the Colchic embayment, and the larger Mtkvari (Kura), which flows from the Lesser Caucasus through Tbilisi and on through Azerbaijan to the Caspian Sea. The names Lagodekhi and Vashlovani in eastern Georgia denote major nature reserves where natural landscapes were studied.

many parts of the world by its Russian name, *Gruziya*. Vegetation study in Georgia dates back at least to the founding of the Caucasian Museum in 1852 (see Nakhutsrishvili 1999a). During the Soviet period, botanical excursions began (e.g. Bush 1935, Sakhokia 1958), vegetation maps were produced (e.g. Ketskhoveri 1933, 1959; cf Zazanashvili et al. 1995), and much work was done on the vegetation of the high mountains (e.g. Gagnidze 1974, Nakhutsrishvili 1974) but also of the Colchis (e.g. Kolakovsky 1974, 1980; Gagnidze 1999). Most recently, comprehensive vegetation descriptions have appeared (e.g. Dolukhanov 1989, Shatilova and Ramishvili 1990) as well as a revised version of the "Flora of Georgia" (Institute of Botany 1971-87).

Over its long human history, the natural vegetation of the Caucasus region has been greatly modified by its inhabitants and invaders. Now that the Republic of Georgia has become an independent country, interest has turned to nature protection (cf Zazanashvili and Shishniashvili 1997), rehabilitation of degraded landscapes, restoration of natural vegetation in some areas, and possible effects of global warming (cf Nakhutsrishvili 1999b, Zazanashvili 1999). The best summary of the natural vegetation of Georgia, in English but drawing on much Georgian and Russian literature, is by Nakhutsrishvili (1999a). This work, including 34 photos, describes basic geography, vegetation composition and types, environmental relationships, and ecology of high-mountain plants in remarkable detail. The purpose of the present paper is to publish vegetation stand descriptions from Georgia and provide a basic overview of the main Georgian vegetation and landscape types, as a basis for further biogeographic and possible restoration work. Vegetation stands are described by Braun-Blanquet relevés (cf Fujiwara 1987) as well as photographs.

Natural Regions and Landscapes

Major physiographic features of Georgia are shown in Figure 1 and include the Greater Caucasus across the north, the Lesser Caucasus in the south, and the Transcaucasian valley. Also important is the Imeretian Highland in central Georgia, which connects the Greater and Lesser Caucasus and divides the country into western and eastern regions perhaps best known by their Greek names: the Colchis in the west, along the Black Sea, and Iberia in the east, inclining toward the Caspian lowlands. The central Greater Caucasus reaches well above 4000m, with subalpine, alpine, subnival and nival belts (Grossheim 1948, Dolukhanov 1966; cf Troll 1972). The Lesser Caucasus in Georgia has only scattered alpine areas, most accessible above Borjomi. The central valley narrows and rises eastward, to about 800m between the Rioni and Kura watersheds, then falls to about 500m at Tbilisi, gradually widening again southeastward, toward Azerbaijan. The main cities are Tbilisi the capital, Batumi on the southern Black Sea coast, Kutaisi in the interior Colchis, and Sukhumi in Abkhazia (northwestern Georgia).

The climate of Georgia ranges from severe winters and short cool summers in the high Caucasus to mild wet winters and very warm wet summers in the Colchis, with a dry region in the southeast. Average annual precipitation in the Colchis generally exceeds 1200mm and is well over 2000mm around coastal Batumi and in Abkhazia. Most of the central valley is temperate subhumid. Precipitation is around 500mm at Tbilisi but increases in the foothills and further upslope, reaching over 1000mm in most high mountains. Continentality increases eastward, with average precipitation in the east generally about 400-600mm per year and lower in Armenia and Azerbaijan. Most areas have an early-summer precipitation maximum, with relatively dry winters except along the coast and in the high mountains. In the interior Colchis, Kutaisi has recorded temperature as low as -17°C (Müller 1982), making it only borderline warm-temperate at best (cf Box 1995). Coastal Batumi, on the other hand, had recorded a low of only -7.0°C over 34 years (Walter 1974, p.19), making it a true warm-temperate climate despite January mean temperature of only about 6°C and mean annual temperature of only 14°C . Allée plantings along streets in Batumi include *Cinnamomum camphora* and *Quercus myrsinaefolia*, the latter of which also had many seedlings in the Batumi Botanical Garden. Climate diagrams and description for the region are given by Nakhutsrishvili (1999a) and by Walter (1974).

The main natural landscape regions of Georgia are shown in Figure 2. Major natural vegetation types are listed in Table 1 (from Nakhutsrishvili 1999a). These include the Colchic and mixed (inner Colchic) forests with evergreen understoreys; other mesic deciduous forests above the central valley; dry steppes and woodlands in eastern Georgia; conifer, mixed, and broad-leaved montane and subalpine forests; subalpine scrub; and subalpine and alpine meadows and mats in the high Caucasus. Each of these types is described below in some detail.

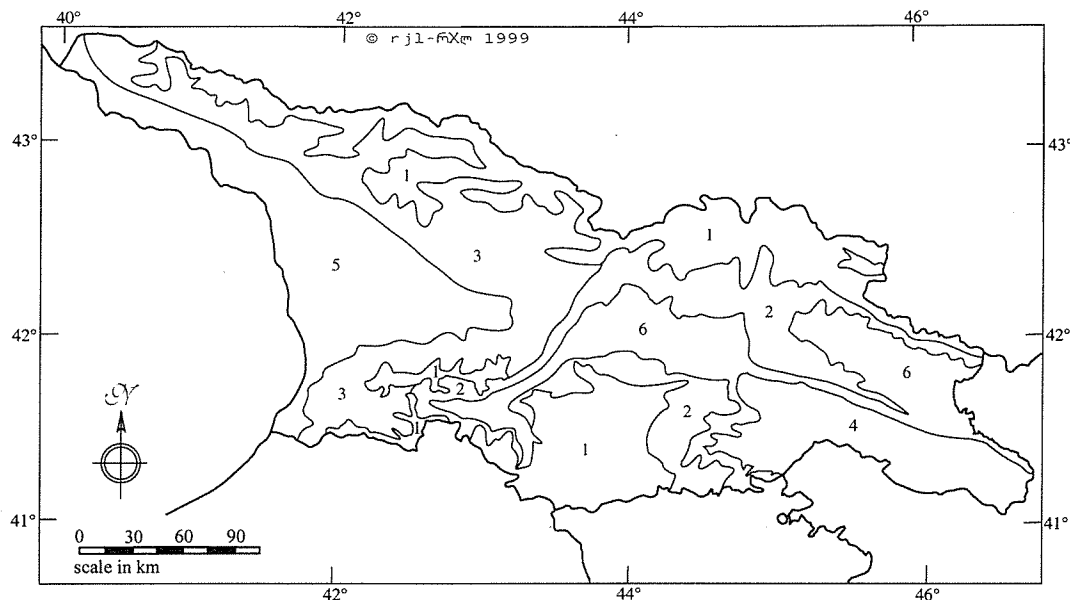


Figure 2. Main Natural Landscape (Vegetation) Regions of Georgia.

The division of Georgia into two halves, by the Surami Range (Imeretian Highland, following legend items 2 and 6), is shown more clearly in this map. The main natural landscape types, representing also natural vegetation regions, are as follow:

- 1 = Alpine belt and subalpine scrub/forest
- 2 = Mesic deciduous forest
- 3 = Mixed forest with evergreen understorey
- 4 = Steppe
- 5 = Colchic forest (deciduous with evergreen understorey)
- 6 = Shrubland and dry woodland/scrub

Sources: Antadze et al. (1967), Khatiashvili (1989), GUGK (1986).

Colchic Forests

The Colchis is the somewhat triangular region extending along the Black Sea from Abkhazia to northeastern Turkey and inland in Georgia (Rioni river valley) to Samtredia and Kutaisi. The region has long been known to European ecologists for its moist, mild climate and occurrence of evergreen broad-leaved taxa more characteristic of warm-temperate East Asia than of the Mediterranean region (cf Walter 1968, p.301). During the Pleistocene, the Colchis represented an important refuge for temperate east-European taxa (cf Kolakovsky 1974, Tumayanov 1955), along with the Hyrcanian refuge near the Caspian Sea. The Colchis also represents one segment of a very discontinuous transition zone (cf Sicily, the southern Balkan peninsula, northern Turkey), between

Table 1. Main Vegetation Types of Georgia (from Nakhutsrishvili 1999a).Forests (lowland)

Colchic lowland forests:

- Mesophytic forest (*Fagus orientalis*, *Castanea*, *Quercus*, *Carpinus*, *Zelkova*, etc.)
- Coastal *Pinus pityusa* forest
- Swamp forest (*Alnus*)

Eastern lowland forest (mesophytic *Quercus-Acer-Fraxinus-Tilia*)

Quercus iberica forest (eastern Georgia), plus *Qu. imeretina* (west), *Qu. dschorochensis* (Ajara)

Carpinus caucasica forests: Colchis, Kakhelia

Castanea sativa forests: west Georgia, Kakhelia

Floodplain forests (Colchis, east): *Pterocarya*, *Quercus pedunculiflora*, etc.

Woodland and Scrub (mainly eastern Georgia)

Arid woodland (*Pistacia mutica-Juniperus* etc. with *Botriochloa*, *Stipa*, *Salsola*)

Xerophytic shrubland (*shibljak*: *Paliurus*, *Cotinus*, *Berberis*, *Pyrus*, etc.)

Steppes and Semi-Desert (eastern Georgia)

Steppe (*Botriochloa*, *Festuca*, *Stipa*, *Koeleria*)

Semi-desert (*Nitraria*, *Salsola*, *Suaeda*, *Artemisia fragrans*)

Montane Forests

Montane *Fagus* forest: with shrub layer (Colchis), without shrubs, with conifers

Montane *Quercus macranthera* forest (east and south Caucasus)

Montane dark coniferous forests: *Picea*, *Abies*, *Picea-Abies*, *Fagus-Abies*

Montane pine forests: *Pinus kochiana* (Caucasus), *P. eldarica* (east Georgia-Azerbaijan)

Montane forests with *Taxus baccata* (east)

Subalpine Low Forests and Krummholz (incl. "elfinwoods")

Subalpine conifer forests (*Abies*, *Pinus*, *Picea*)

Subalpine *Fagus orientalis* scrub (mainly Colchis)

Subalpine *Betula* forest and scrub: Caucasus (especially *B. litwinowii*), Colchis

Subalpine *Quercus* scrub: *Qu. macranthera* (Caucasus), *Qu. pontica* (Ajara, with *B. medwedewii*)

High-Mountain Herbaceous Vegetation (Caucasus)

Subalpine tall-forb stands (*Aconitum*, *Cirsium*, *Delphinium*, *Heracleum*, *Lilium*, *Senecio*, etc.)

Subalpine meadows: grassy (*Festuca*, *Poa*, *Calamagrostis*, etc.), forb-grass (e.g. *Woronowia*, *Betonica*)

Subalpine "tragacanthic" cushion steppes (spiny *Astragalus*, etc.)

Alpine meadows: bunch, sedge, forb, tussock+forbs (*Festuca*, *Poa*, *Nardus*, *Carex*, *Geranium*, etc.)

Alpine "carpet-like" dicot swards (*Campanula*, *Carum*, *Veronica*, *Pedicularis*, *Sibbaldia*, etc.)

Alpine rubble vegetation (*Heracleum*, *Campanula*, *Arenaria*, *Draba*, *Anthemis*, etc.)

Subnival vegetation: individual plants, scattered bunches, meadow fragments, etc.

typical European deciduous forests to the north and (non-summerdry) “subtropical” vegetation to the south. This “Colchic zone” is characterized by deciduous forests in which “many” evergreen but mesomorphic, non-sclerophyll broad-leaved understorey elements occur, such as *Ilex aquifolium* and *Hedera helix* (as in Sicily), *Rhododendron*, *Laurocerasus*, *Buxus sempervirens*, and *Arctostaphylos*. The Colchis, along with the Hyrcanian region (southwest side of the Caspian Sea), is a small but floristically rich region in which many “eastern” species of common European deciduous-tree genera also occur, such as *Fagus orientalis* and *Acer laetum*, along with some genera from further east, such as *Zelkova* and *Pterocarya*. Most of these species are considered, in a European context, to be Tertiary relicts.

Very little of the original Colchic forest remains, and only in relatively inaccessible places in the mountains. Samples from a Colchic *Fagus* forest with evergreen understorey, from about 1000m on Mt. Mtirala near Batumi, are shown in Table 2. This very stately forest reaches 35m in height (see Photo 1). The forest, as represented by an area of 40 x 30 meters on a 30° mid-slope, is nevertheless an extremely simple forest, completely dominated by *Fagus orientalis* and containing a total of only nine species. The understorey is composed entirely of evergreen Colchic elements, mainly *Rhododendron ponticum* and *Ilex colchica* plus *Laurocerasus officinalis* and *Ruscus ponticus*. On a lower slope below the access road the forest was even taller, over 40m, but contained *Rubus nigra* (sensu lato) and *Castanea sativa* in place of *Vaccinium arctostaphylos* and *Viburnum orientale*. One 40 x 40m plot below the road contained a total on only six species, with only *Rhododendron ponticum* as a significant understorey. All plots showed some seedlings of *Fagus* or Colchic evergreens (mainly *Rhododendron*) in the herb layer, suggesting that the forest is regenerating and will remain if not destroyed by man.

Table 2. Colchic *Fagus* Forest Samples on Mt. Mtirala, near Batumi (relevés G-3, G-4, G-5)

	Relevé G-3 (1120m, 30° SSE)				Relevé G-4 (990m, 20° SSE)				Relevé G-5 (990m, 20° SSE)			
	T1 35m 85%	T2 12m 10%	S 3m 75%	H .2m 15%	T1 50m 80%	T2 20m 20%	S 5m 40%	H .8m 30%	T1 50m 80%	T2 20m 10%	S 4m 80%	H .8m 5%
<i>Fagus orientalis</i>	5.4	2.2			5.4	2.2	3.3	1.1	5.4	2.2	+2	+
<i>Castanea sativa</i>							1.1					
<i>Rhododendron ponticum</i>			3.4	1.2			2.3	+			5.4	1.2
<i>Laurocerasus officinalis</i>			2.3				2.3				+	
<i>Ilex colchica</i>			3.3	1.1			1.2	+				
<i>Vaccinium arctostaphylos</i>			+2									
<i>Viburnum orientale</i>			+									
<i>Euonymus latifolia</i> [sic]			+				+					
<i>Ruscus ponticus</i>			1.2	+			1.2	1.2				
<i>Rubus nigra</i> s.l.							3.4	3.3			+2	+2
<i>Hedera colchica</i>		+	+	2.2				1.2				+2
Total Number of Species:	9 spp				8 spp				5 spp			

All three relevés were made on a steep SSE-facing slope on Mt. Mtirala, inland from Batumi in southwestern Georgia (24 May 1999). The first relevé (G-3) represents a very steep upper slope, above a dense *Rhododendron* thicket just above the access road. The other two relevés were made at slightly lower elevation and below the access road. In this perhaps more moist location, the canopy trees were even taller. In this location below the road, however, the forest understorey was also more disturbed, as shown by the abundance of *Rubus*. (Relevé G-3: KF, EB, Z. Mahvelidze, RJL; relevés G-4 and G-5: AM, GN, Z. Mahvelidze, KF, EB, RJL.)



**Photo 1. Colchic *Fagus* Forest
above Batumi**

Colchic *Fagus* forests are tall (35-50m) but very simple forests dominated by *Fagus orientalis* and with dense understoreys of mostly evergreen broad-leaved shrubs, including especially *Rhododendron ponticum* and *Ruscus ponticus* as well as *Ilex colchica*, *Laurocerasus officinalis*, *Euonymus latifolia* and vines of *Hedera colchica*. The photo is at the site of relevé G-3 (see Table 2).

Interior Colchic Vegetation in the Lesser Caucasus

The Lesser Caucasus is a lower and more diffuse mountain range than the Greater Caucasus (see below) and runs mainly from northwestern Azerbaijan across northern Armenia into south-central Georgia. In this inland area of Georgia, winter temperatures are lower (even in the lowlands) and the evergreen Colchic understorey element is lacking in the forests. As near the coast, natural forests are gone from the lowlands and can be found only in the mountains, generally above 1000 meters in the Lesser Caucasus. The most accessible area is around Bakuriani, a ski center at roughly 1500m, above Borjomi. In this area there are *Fagus* forests approaching treeline, as well as *Betula* and *Picea* stands.

An example of a montane *Fagus-Picea* forest from about 1700m on a steep north-facing slope in this area is shown in Table 3. *Fagus orientalis* is the dominant species in all but the herb layer. *Picea orientalis* also occurs in the canopy but did not seem to be regenerating significantly in the *Fagus* forest. The herb layer is diverse, but the total cover (20 %) was low despite the relatively open canopy (60 %).

Treeline in this area occurs at about 2300m, where the treeline krummholz is composed mainly of *Salix arbuscula* and *Betula litwinowii*, within a matrix of dense *Rhododendron caucasicum* patches and grassy areas, as suggested by the relevé in Table 4 (see also Photo 2). There is also a significant moss cover.

Anthropogenic and perhaps some natural meadows also occur in this area, in the subalpine belt. An example of a subalpine hay meadow is shown in Table 5, from a steep north-facing slope at about 2050m. The species are mainly from typical temperate-Eurasian genera, but many are local species.

Table 3. Montane *Fagus-Picea* Forest above Bakuriani (relevé G-8)

Location: Above Bakuriani, roadside slope below treeline (25 May 1999)

T1	25 m	60 %	1700 m, Slope: 30° to NW
T2	18 m	20 %	
S	3 m	10 %	
H	0.5 m	20 %	
M		1 %	
			30 x 30 m AM, GN; KF, <u>EB</u> , RJL
T1:	4.4	<i>Fagus orientalis</i>	2.2 <i>Picea orientalis</i>
T2:	2.2	<i>Fagus orientalis</i>	
S:	2.2	<i>Fagus orientalis</i>	+2 <i>Picea orientalis</i>
	+	<i>Carpinus caucasica</i>	
H:	2.2	<i>Dryopteris filix-mas</i>	2.3 <i>Arum albispathum</i>
	1.2	<i>Myosotis sylvatica</i>	1.2 <i>Asperula odorata</i>
	1.2	<i>Polygonatum verticillatum</i>	1.2 <i>Arabidopsis thaliana</i>
	1.2	<i>Paris quadrifolia</i>	+2 <i>Petasites albus</i>
	+2	<i>Urtica dioica</i>	+ <i>Rubus saxatilis</i>
	+	<i>Veronica peduncularis</i>	+ <i>Calamagrostis arundinacea</i>
	+	<i>Anthriscus sylvestris</i> var. <i>nemorosa</i>	+ <i>Geum rivale</i>
	+	<i>Carex sylvatica</i>	+ <i>Campanula rapunculoides</i>
	+	<i>Asplenium</i> cf. <i>nigrum</i>	+ <i>Ribes biebersteinii</i>
	+	<i>Senecio rhombifolius</i>	+ <i>Ligusticum alatum</i>
	+	<i>Senecio</i> sp. ("caucasica")	+ <i>Erodium cicutarium</i>
	+	<i>Taraxacum</i> sp.	+ <i>Geranium</i> sp.
	+	<i>Orobancha</i> sp.	+ Umbelliferae sp.
M:	+	<i>Polytrichum commune</i>	

Total Number of Species: 30

Personnel: authors denoted by their initials, others by full last name and initial; scribe underlined.

Table 4. *Rhododendron-Salix* Treeline Krummholz, above Bakuriani (relevé G-6)

Location: Treeline above Bakuriani, embankment along road (25 May 1999)

S1	2.0 m	40 %	2300 m, Slope: 30° to NW
S2	1.0 m	90 %	
H	0.1 m	30 %	
M		40 %	5 x 10m KF, GN, <u>EB</u> , RJL
S1:	3.3	<i>Salix arbuscula</i>	2.3 <i>Betula litwinowii</i>
	+	<i>Salix apoda?</i>	
S2	5.4	<i>Rhododendron caucasicum</i>	1.2 <i>Vaccinium myrtillus</i>
H:	2.3	<i>Deschampsia caespitosa</i>	2.3 <i>Calamagrostis arundinacea</i>
	1.2	<i>Poa longifolia</i>	1.2 <i>Agrostis planifolia</i>
	1.2	<i>Alchemilla retinervis</i>	1.1 <i>Betonica macrantha</i>
	1.1	<i>Polygonum carneum</i>	1.1 <i>Athyrium filix-femina</i>
	+	<i>Daphne glomerata</i>	+ <i>Vaccinium vitis-idaea</i>
	+	<i>Oxalis acetosella</i>	+ <i>Primula ruprechtii</i>
M:	3.3	<i>Hylocomnium</i> sp.	1.2 <i>Pleurozium schreberi</i>
	+2	<i>Dicranum elongatum</i>	

lichen: +2 *Cetraria islandica*

Total Number of Species: 21



Photo 2. Subalpine *Salix-Rhododendron* Krummholz above Bakuriani (interior Colchis).

Tree line krummholz in the Lesser Caucasus area near Bakuriani (above Borjomi, see Figure 1) involves mainly *Betula* and *Salix* species, here mainly *B. litwinowii* and *S. arbuscula*, plus thickets of shorter *Rhododendron caucasicum* which remains evergreen under the snow cover. The photo is at the site of relevé G-6 (see Table 4).

Table 5. Subalpine Hay Meadow, above Bakuriani (relevé G-7)

Location: Above Bakuriani, roadside slope below treeline (25 May 1999)

S	3 m	2 %	2050 m, Slope: 30° to NNW
H	0.3 m	95 %	
			5 x 10m KF, GN, <u>EB</u> , RJL
S:	+ <i>Betula litwinowii</i>		
H:	2.2	<i>Poa alpina</i>	2.2 <i>Geranium ibericum</i>
	2.2	<i>Scilla rosenii</i>	2.2 <i>Viola somchetica</i>
	2.2	<i>Primula ruprechtii</i>	1.2 <i>Heracleum asperum</i>
	1.2	<i>Astrantia maxima</i>	1.2 <i>Alchemilla retinervis</i>
	1.2	<i>Bromopsis variegata</i>	1.2 <i>Agrostis tenuis</i>
	1.1	<i>Veratrum lobelianum</i>	1.1 <i>Trollius patulus</i>
	1.1	<i>Angelica tatianae</i>	1.1 <i>Campanula collina</i>
	+2	<i>Taraxacum confusum</i>	+ <i>Anemone caucasica</i>
	+	<i>Anemone fasciculata</i>	+ <i>Ligularia sibirica</i>
	+2	<i>Gentiana</i> sp.	+ <i>Cirsium</i> sp.

Total Number of Species: 21

Vegetation of the High Central Greater Caucasus

The Greater Caucasus is a relatively straight, narrow, well defined mountain range which rises fairly abruptly from Transcaucasia (and the Ukrainian steppes on the north side) to well over 3000 meters over most of its length (reaching 5642m at Mt. Elbrus in the west). Access is difficult except via the Georgian Military Highway, built by the Russians in order to conquer Transcaucasia around 1800. Slopes are steep, and glacial and periglacial features are common. The montane forests, before destruction, were composed largely of *Fagus*, *Quercus* and *Carpinus*, with subalpine conifer forests (*Picea* and *Abies*) only in the western part. In the central and eastern Greater Caucasus, the deciduous montane forests carried right on over into the subalpine and alpine meadows, but with characteristic subalpine woods of *Betula* (see Photo 3, from the Kazbegi area). Most of these birch woods have been destroyed also.



Photo 3. Spring Aspect of Open Subalpine *Betula* Forest in the Greater Caucasus (Kazbegi area)

Betula forest, with *Salix*, *Sorbus* and *Populus*, formed the subalpine belt in much of the central Greater Caucasus before it was cut. This photo shows a wet seepage area in a somewhat open portion of *Betula litwinowii* forest, with spring forbs (photo date: 27 May 1999).

Various types of subalpine and alpine meadows still do occur in the Greater Caucasus, even in accessible areas. A wet meadow, with dwarf *Rhododendron luteum*, is shown by the relevé in Table 6. Table 7 shows a sample of a (grazed) subalpine *Galanthus-Alchemilla* meadow near the Jvari Pass (2300m) on the Military Highway over the Greater Caucasus. The species total is again somewhat small, but the species are interesting local species from familiar Eurasian genera. At Kazbegi, at about 1800m on the north slope of the Greater Caucasus, the Georgian Academy of Sciences maintains a new Kazbegi Research Station where scientists can be housed and study the subalpine environment and its conservation and restoration potential. An anthropogenic dry

Table 6. Wet Subalpine Hay Meadow in Greater Caucasus (relevé G-9)

Location: Gudauri, behind Hotel Gudauri (26 May 1999)

S	1 m	60 %	2025 m, Slope: 15° to SE
H	0.2 m	40 %	5 x 5m (patch) KF, GN, <u>EB</u> , RJL

S: 4.3 *Rhododendron luteum*

H:	2.3	<i>Calamagrostis arundinacea</i>	2.2	<i>Nardus stricta</i>
	2.2	<i>Campanula collina</i>	1.2	<i>Brachypodium sylvaticum</i>
	1.2	<i>Geranium ibericum</i>	1.2	<i>Euphorbia</i> sp.
	+2	<i>Cruziata laevipes</i>	+	<i>Ranunculus oreophilus</i>
	+	<i>Anemone caucasica</i>	+2	<i>Carex</i> sp.

Total Number of Species: 11

Table 7. Subalpine *Galanthus* Meadow (grazed) near Jvari Pass on the Georgian Military Highway over the Central Greater Caucasus (relevé G-10)

Location: Jvari Pass, Georgian Military Highway, south side (27 May 1999)

H	0.3 m	75 %	2300 m, Slope: 5° to SEE
			10 x 10m KF, GN, <u>EB</u> , RJL

H:	3.4	<i>Galanthus platyphyllus</i>	3.3	<i>Alchemilla retinervis</i>
	2.2	<i>Rumex alpinus</i>	2.2	<i>Festuca supina</i>
	2.2	<i>Phleum alpinum</i>	2.2	<i>Rumex acetosa</i>
	1.2	<i>Sedum oppositifolium</i>	1.2	<i>Gagea</i> cf. <i>supranivalis</i> (yellow flower)
	1.2	<i>Veratrum lobelianum</i>	1.2	<i>Cirsium ovavallatum</i>
	1.1	<i>Fritillaria latifolia</i>	+2	<i>Ligusticum alatum</i>
	+2	<i>Lamium album</i>	+2	<i>Poa alpina</i>
	+2	<i>Geranium</i> sp.		

Total Number of Species: 15

Table 8. Subalpine Dry Meadow (anthropogenic) above Kazbegi (relevé G-11)

Location: Along path above Kazbegi Research Station (27 May 1999)

H	0.1m	85 %	1880 m, Slope: 25° to SSW
			3 x 5m (patch) KF, GN, <u>EB</u> , RJL

H:	3.2	<i>Festuca ovina</i>	3.2	<i>Bromopsis variegata</i>
	2.2	<i>Pulsatilla violacea</i>	2.2	<i>Plantago caucasica</i>
	2.2	<i>Thymus collinus</i>	1.2	<i>Veronica gentianoides</i>
	1.2	<i>Leontodon hispidus</i>	1.2	<i>Veronica polita</i> ?
	1.1	<i>Minuartia circassica</i>	+2	<i>Trifolium ambiguum</i>
	+2	<i>Potentilla crantzii</i>	+2	<i>Astragalus captiosus</i>
	+	<i>Carex buschiorum</i>	+	<i>Androsace villosa</i>
	+	<i>Cerastium arvense</i>	+	<i>Draba siliquosa</i>
	+	<i>Pedicularis chroorrhyncha</i>	+	<i>Achillea millefolium</i>
	+	<i>Euphorbia iberica</i>	+	<i>Ranunculus oreophilus</i>

Total Number of Species: 20



Photo 4. Subalpine Meadow with numerous forbs, in the Greater Caucasus (Kazbegi area)

Subalpine and alpine meadows in the Greater Caucasus are varied and diverse. These include very grassy types dominated especially by *Festuca*; wetter types with *Anemone fasciculata* (whitish), *Primula amoena* and many other forbs (show here); and wet but grassy types with patches of dwarf *Rhododendron luteum* (cf Tables 6-8).

meadow near this research station is shown in Table 8. This meadow was dominated by *Festuca ovina* and *Bromopsis variegata*, along with *Pulsatilla violacea*, *Plantago caucasica*, *Thymus collinus*, *Leontodon hispidus*, *Minuartia circassica*, two *Veronica* spp., etc. (total of 20 species in a 3x5m plot). A subalpine meadow with numerous forbs, from the area above the Kazbegi Research Station, is shown in Photo 4.

Vegetation of the Tbilisi Area

Tbilisi the capital is at about 550m elevation in the valley of the Mtkvari River, which flows from the Lesser Caucasus through Borjomi, Tbilisi, and southeastward through Azerbaijan, eventually forming a large delta south of Baku before flowing into the Caspian Sea. The climate in the valley bottom, near Tbilisi and eastward, is subhumid, and the natural vegetation was apparently a woodland mosaic involving *Juniperus*, *Pistacia*, *Cotinus*, and other shrubs within a matrix of dwarf-shrubs, grasses and forbs. Above about 600-700m the climate becomes more mesic, however, and the original vegetation on these foothills of the Caucasus was deciduous *Quercus iberica* forest, with *Fagus orientalis* and *Carpinus caucasica* forest above the *Quercus* forest (and on some lower north slopes).

Essentially all of the potential woodland and *Quercus* forest area near Tbilisi and throughout much of the Transcaucasian valley has been converted to secondary deciduous scrub very similar to the *shibljak* landscapes of the Balkan peninsula (cf xeric shrubland in Table 1). The main species of Georgian *shibljak* are *Paliurus spina-christi*, *Berberis vulgaris*, *Cotinus coggygria*, *Punica granatum*, and *Carpinus orientalis* (Nakhutsrishvili 1999a), along with other shrubby or low-arborescent taxa

such as *Pyrus* spp., *Cotoneaster racemiflora*, *Spiraea hypericifolia*, *Amygdalus georgica*, *Prunus spinosa*, *Rosa canina*, *Rhamnus cathartica*, and *Hypophaea rhamnoides*. Restoration of natural vegetation in the Tbilisi area would involve restoration of the subhumid *Juniperus* woodland and the deciduous *Quercus iberica* forest.

Most of the natural vegetation has been greatly disturbed if not completely destroyed. An idea of the potential composition of natural *Quercus-Carpinus* forest on slopes around Tbilisi is given by the relevé in Table 9, from a secondary forest at about 1600m in the hills southwest of Tbilisi. The forest is short (10m) and young but contained 39 species in the 20 x 20m plot, including *Fagus orientalis*, *Acer campestre*, and various forbs characteristic of more mature mesic *Quercus iberica-Carpinus* forests of the region. Another suggestion of the potential composition of natural deciduous

Table 9. Semi-Natural *Carpinus-Quercus* Deciduous Forest near Tbilisi (relevé G-1)

Location: Just past Kojori along Kojori Road, beyond Botanical Institute (22 May 1999)

T1	10m	70 %	1600 m, Slope: 2-15° to SW
T2	6 m	10 %	
S	3 m	20 %	
H	0.4 m	70 %	20 x 20m AM, GN, KF, <u>EB</u> , RJL
T1:	4.4	<i>Carpinus caucasica</i>	2.2 <i>Quercus iberica</i>
	1.1	<i>Fagus orientalis</i>	
T2:	2.2	<i>Carpinus caucasica</i>	
S:	2.2	<i>Carpinus caucasica</i>	1.2 <i>Crataegus monogyna</i>
	1.2	<i>Corylus avellana</i>	1.1 <i>Acer campestre</i>
	1.2	<i>Lonicera caucasica</i>	+ <i>Cornus mas</i>
	+	<i>Viburnum lantana</i>	+ <i>Rosa canina</i>
	+	<i>Pyrus caucasica</i>	+ <i>Prunus divaricata</i>
	+	<i>Malus orientalis</i>	
H:	3.3	<i>Anthriscus</i> sp.	2.2 <i>Primula woronowii</i>
	1.1	<i>Galanthus caucasicum</i>	1.2 <i>Poa nemoralis</i>
	1.2	<i>Carex sylvatica</i> s.l.	1.1 <i>Galium</i> sp.
	1.1	<i>Cicerbita</i> sp.	+2 <i>Lathyrus</i> sp.
	+2	<i>Polygonatum verticillatum</i>	+2 <i>Cyclamen vernum</i>
	+2	<i>Taraxacum officinale</i>	+2 <i>Lonicera caucasica</i>
	+2	<i>Cruciata laevipes</i>	+2 <i>Viola odorata</i>
	+	<i>Quercus iberica</i>	+ <i>Fragaria viridis</i>
	+	<i>Carpinus caucasica</i>	+ <i>Campanula rapunculoides</i>
	+	<i>Acer laetum</i>	+ <i>Calamagrostis arundinacea</i>
	+	<i>Acer campestre</i>	+ <i>Primula macrocalyx</i>
	+	<i>Geum urbanum</i>	+ <i>Arum albispathum</i>
	+	<i>Paris quadrifolia</i>	+ <i>Potentilla</i> sp.
	+	<i>Galanthus</i> sp.	+ <i>Ranunculaceae</i> sp.
	+	<i>Labiatae (Nepeta?)</i> sp.	+ dioscoreoid vine

Total Number of Species: 39

Table 10. Secondary *Celtis-Fraxinus* Forest in Tbilisi Botanical Garden (relevé G-2)

Location: Tbilisi Botanical Garden (23 May 1999)

T1	15m	70%	610 m, Slope: 5° to NNE
T2	8 m	3 %	
S	3 m	20 %	
H	0.6 m	90 %	15 x 20m <u>KE</u> , GN
T1:	3.3	<i>Celtis caucasica</i>	2.3 <i>Fraxinus excelsior</i>
	1.1	<i>Tilia caucasica</i>	+ <i>Acer campestre</i>
	+	<i>Pyrus caucasica</i>	
T2:	1.1	<i>Acer campestre</i>	+ <i>Celtis caucasica</i>
	+	<i>Crataegus monogyna</i>	
S:	2.3	<i>Philadelphus caucasicus</i>	1.2 <i>Hedera helix</i>
	+	<i>Crataegus monogyna</i>	+ <i>Robinia pseudoacacia</i>
	+	<i>Ribes hypericifolia</i>	+ <i>Rhus coriaria</i>
	+	<i>Malus orientalis</i> ?	+ <i>Spiraea</i> sp. (<i>Sp. crenata</i> ?)
H:	4.4	<i>Stellaria media</i>	3.3 <i>Bromus japonicus</i>
	2.3	<i>Poa bulbosa</i>	2.2 <i>Physocaulis anthriscum</i>
	2.3	<i>Hedera helix</i>	1.2 <i>Viola odorata</i>
	1.1	<i>Veronica peduncularis</i>	1.1 <i>Muscari szovitsianum</i>
	+2	<i>Campanula rapunculoides</i>	+ <i>Aralia officinalis</i>

Total Number of Species: 39

forest is given by a relevé (Table 10) in a secondary *Celtis-Fraxinus* forest in the Tbilisi Botanical Garden, at 610m.

The potential composition of subhumid woodland is suggested by the relevé in Table 11, from the second terrace above the Mtkvari river about 15 km northwest of Tbilisi. The sample (15 x 15m) is from a concavity on a lower slope, ranging from 20° above to about 3° at the base and sloping toward the south-southeast. The canopy is low (7m), and the dense cover by *Fraxinus excelsior* is probably not representative of most of the slopes (see Photo 5). Otherwise the sample shows a composition which may be fairly typical, including *Juniperus*, *Prunus*, *Cotinus* and other shrub genera which were also seen in more natural stands of this vegetation type in eastern Georgia. At 48, the number of species in this plot suggests the diversity of these open woodland landscapes.

Table 11. Degraded *Fraxinus-Juniperus* Stand in concavity on Riverine Terrace near Tbilisi (relevé G-12)

Location: Northwest of Tbilisi, 2nd terrace above river (27 May 1999)

T	7m	85 %	540 m, Slope: 3-20° to SSE
S	3 m	20 %	
H	0.4 m	60 %	
			15 x 15m (patch) KF, GN, <u>EB</u> , R JL
T:	4.4	<i>Fraxinus excelsior</i>	2.2 <i>Juniperus oblonga</i>
	1.1	<i>Quercus iberica</i>	+2 <i>Prunus divaricata</i>
	+	<i>Cornus mas</i>	+2 <i>Cotoneaster racemiflorus</i>
			+ <i>Prunus spinosa</i>
S:	1.2	<i>Cotinus coggygria</i>	
	1.2	<i>Juniperus rufescens</i>	1.1 <i>Prunus divaricata</i>
	+2	<i>Cornus mas</i>	+2 <i>Juniperus oblonga</i>
	+	<i>Spiraea hypericifolia</i>	+2 <i>Cotoneaster racemiflorus</i>
	+	caraganoid shrub sp.	+ <i>Prunus spinosa</i>
H:	3.3	<i>Ruscus ponticus</i>	2.2 <i>Brachypodium sylvaticum</i>
	1.2	<i>Fraxinus excelsior</i>	1.3 <i>Juniperus rufescens</i>
	1.2	<i>Campanula rapunculoides</i>	1.2 <i>Dactylis glomerata</i>
	1.1	<i>Tanacetum vulgare</i>	1.1 <i>Fragaria viridis</i>
	1.2	<i>Viola odrata</i>	1.2 <i>Convolvulus</i> sp.
	1.2	<i>Eragrostis?</i> sp.	+2 <i>Draba</i> sp.
	1.2	<i>Nonea?</i> sp.	+2 <i>Stellaria media</i>
	+2	<i>Cruciata laevipes</i>	+ <i>Tragopogon graminifolius</i>
	+	<i>Asparagus officinalis</i>	+ <i>Euonymus caucasicus</i>
	+	<i>Dictamnus caucasicus</i>	+ <i>Astrodaucus orientalis</i>
	+	<i>Polygonatum verticillatum</i>	+ <i>Chelidonium majus</i>
	+	<i>Thalictrum foetidum</i>	+ <i>Taraxacum officinale</i>
	+	<i>Poa bulbosa</i> var. <i>vivipara</i>	+ <i>Geranium pallens</i>
	+	<i>Trifolium arvense</i>	+ <i>Euphorbia glareosa</i>
	+2	<i>Viburnum</i> sp.	+ <i>Carum</i> sp.
	+2	<i>Carex</i> sp.	+ <i>Orchis</i> sp.
	+2	Cruciferae sp.	+ <i>Vicia</i> sp.
	+	<i>Ajuga</i> sp.	+ <i>Avena</i> sp.
	+	Compositae sp.	+ Ranunculaceae sp.
	+	graminoid sp.	

Total Number of Species: 48

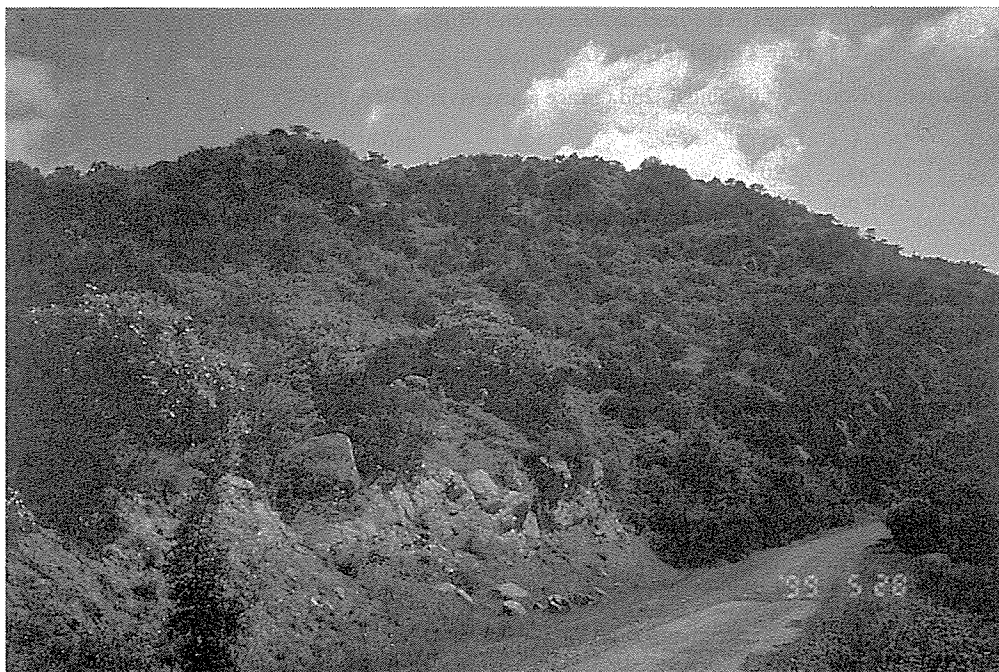


Photo 5. Degraded Dry Woodland above River Terrace in the Tbilisi Area

The lower slopes around Tbilisi are largely covered by shibljak-like degraded woodland vegetation, after cutting of earlier xeric woodlands and (at higher elevation) *Quercus* forests. The photo shows a degraded woodland dominated by *Juniperus* species but with many *shibljak* elements, such as *Carpinus orientalis*, *Paliurus spinachristi*, and *Rhamnus palasi*, as well as taxa of a Mediterranean character, such as *Thymus*. Relevé G-12 (see Table 11) was made in a more mesic concavity on a lower slope in this area.

Other Mesic Deciduous Forests

Mesic deciduous forests also represent the potential natural vegetation in other parts of Georgia, including lower and middle slopes of the Greater Caucasus in eastern Georgia. Some areas in the shadow of the eastern Greater Caucasus, such as Kakhetia (near the border with Russian Dagestan), have distinctly more precipitation and support mesophytic forests similar in richness to those of the Colchic lowland. Natural mesophytic forest in the east is especially well conserved in the Lagodekhi Nature Reserve, a *zapovednik* or strict nature reserve in the former Soviet system.

Much of the Lagodekhi reserve is covered by deciduous *Quercus iberica* forest, always with *Carpinus caucasica* and usually with *C. orientalis* as well. A relatively rich example of this forest, including also *Fraxinus*, *Acer*, and *Tilia*, is shown in Table 12, from a steep SSE-facing slope at 520m elevation (see also Photo 6). In this forest, *Cornus mas* grew to small-tree size, and there was a fairly rich understorey of *Rubus caucasicus*, *Festuca drymeja*, *Hedera pastuchowii* vines, and a good variety of herbs. A richer floodplain forest from the same area, with less *Quercus*, is shown in Table 13.

Table 12. *Quercus iberica* Forest in Kakhetia, Eastern Georgia (relevé G-13).Location: Lagodekhi State Nature Reserve, *Quercus* area (30 May 1999).

T1	25 m	85 %	520 m, Slope: 30° to SSE
T2	8 m	20 %	
S	4 m	20 %	
H	0.4 m	35 %	40 x 40 m
			EB, NZ, V. Pavliashvili, G. Mamukelashvili, G. Chaduheli, RJL
T1:	3.3	<i>Quercus iberica</i>	3.3 <i>Carpinus caucasica</i>
	2.2	<i>Fraxinus excelsior</i>	2.2 <i>Tilia begoniifolia</i>
	2.2	<i>Acer laetum</i>	
T2:	2.2	<i>Carpinus orientalis</i>	1.1 <i>Crataegus caucasica</i>
	1.1	<i>Cornus mas</i>	+ <i>Quercus iberica</i>
	+	<i>Fraxinus excelsior</i>	+ <i>Cerasus cf. sylvestris</i>
Vine:		+2 <i>Hedera pastuchowii</i>	
epiphyte:		+2 <i>Viscum album</i>	
S:	2.3	<i>Rubus caucasicus</i>	2.2 <i>Cornus mas</i>
	1.2	<i>Acer laetum</i>	1.1 <i>Carpinus orientalis</i>
	1.1	<i>Crataegus caucasica</i>	+ <i>Mespilus germanica</i>
	+	<i>Lonicera caprifolium</i>	
vine:	1.1	<i>Hedera pastuchowii</i>	
epiphyte:	+	<i>Viscum album</i>	
H:	3.3	<i>Festuca drymeja</i>	2.2 <i>Hedera pastuchowii</i>
	1.3	<i>Rubus caucasicus</i>	1.2 <i>Laser trilobum</i>
	1.2	<i>Aristolochia iberica</i>	1.2 <i>Geranium robertianum</i>
	1.1	<i>Galium aparine</i>	1.1 <i>Carex sylvatica</i>
	1.1	<i>Primula woronowii</i>	1.1 <i>Asplenium cf. speciosum</i>
	1.1	<i>Viola sp.</i>	+2 <i>Platanthera chlorantha</i>
	+	<i>Carpinus caucasica</i>	+ <i>Acer laetum</i>
	+	<i>Vicia crocea</i>	+ <i>Polygonatum verticillatum</i>
	+	<i>Alliaria officinalis</i>	+ <i>Dentaria quinquefolia</i>
	+	<i>Orchis kumana?</i>	+ <i>Ajuga genevensis</i>
	+	<i>Poa nemoralis</i>	+ <i>Lamium album</i>
	+	<i>Salvia glutinosa</i>	+ <i>Asplenium trichomanes</i>
	+	<i>Convolvulus sp.</i>	+ <i>Chaerophyllum sp.</i>
	+	<i>Scrophularia nodosa</i>	+2 <i>Vicia sp.</i> (large, lavender fl.)
	+2	<i>Vicia sp.</i> (pink fl., double lvs.)	+2 <i>Vicia sp.</i> (vicioid)
	(+)	<i>Silene wallichiana</i>	(+) <i>Anthemis fruticulosa</i>
	(+)	<i>Dactylis glomerata</i>	(+2) Labiatae sp. (axil. fl., not sq. stem)

Total Number of Species: 43

Table 13. Floodplain *Carpinus-Acer-Fraxinus-Tilia* Forest in Eastern Georgia (relevé G-14)

Location: Lagodekhi State Nature Reserve, plot "Matsimis Ubani" (30 May 1999).

T1	30 m	50 %	430 m Level (floodplain)
T2	12 m	50 %	
S	4 m	20 %	
H	0.5 m	60 %	40 x 20 m
M		15 %	EB, NZ, V. Pavliashvili, G. Mamukelashvili, G. Chaduheli, V. Maisugadze, J. Zinzadse, RJL
T1:	3.3	<i>Carpinus caucasica</i>	3.3 <i>Acer campestre</i>
	2.2	<i>Fraxinus excelsior</i>	2.2 <i>Tilia begoniifolia</i>
	1.1	<i>Pterocarya pterocarpa</i>	
vines :	1.1	<i>Hedera pastuchowii</i>	1.1 <i>Smilax excelsa</i>
T2:	3.3	<i>Carpinus orientalis</i>	2.2 <i>Acer campestre</i>
	+	<i>Alnus cf. glutinosa</i>	
vines:	1.2	<i>Hedera pastuchowii</i>	+2 <i>Smilax excelsa</i>
epiphyte:	1.2	<i>Viscum album</i>	
S:	2.2	<i>Carpinus orientalis</i>	1.1 <i>Carpinus caucasica</i>
	+	<i>Fagus orientalis</i>	+
	+	<i>Ulmus elliptica</i>	+
	+	<i>Mespilus germanica</i>	+
	+	<i>Corylus avellana</i>	+
	+	<i>Cornus mas</i>	+
	+	<i>Calystegia sepium</i>	+
H:	2.2	<i>Asperula odorata</i>	2.2 <i>Pachyphragma macrophyllum</i>
	2.2	<i>Sanicula europaea</i>	2.2 <i>Hedera pastuchowii</i>
	2.2	<i>Carex sylvatica</i>	1.3 <i>Oplismenus undulatifolius</i>
	1.2	<i>Geranium robertianum</i>	1.2 <i>Dryopteris filix-mas</i>
	1.1	<i>Primula woronowii</i>	1.1 <i>Deschampsia caespitosa</i>
	1.1	<i>Geum urbanum</i>	1.1 <i>Alliaria officinalis</i>
	1.1	<i>Galium aparine</i>	1.2 <i>Viola</i> sp.
	+2	<i>Asplenium trichomanes</i>	+2 <i>Geranium sylvaticum</i>
	+2	<i>Asplenium pseudolanceolatum</i>	+2 <i>Phyllitis scolopendrium</i>
	+2	<i>Sedum stoloniferum</i>	+2 <i>Convolvulus</i> sp.
	+	<i>Acer campestre</i>	+
	+	<i>Carpinus orientalis</i>	+
	+	<i>Ajuga orientalis</i>	+
	+	<i>Stellaria media</i>	+
	+	<i>Euphorbia macroceras</i>	+
	+	<i>Fragaria</i> sp.	+
	+	<i>Vicia</i> sp.	+
M:	2.2	<i>Mnium</i> spp. (3 spp.)	
Total Number of Species: 49			



Photo 6. Deciduous *Quercus iberica*-*Carpinus* Forest in Eastern Georgia (Kakhetia).

Deciduous *Quercus iberica* forests, essentially always involving *Carpinus* also, are the potential natural vegetation in the submontane belt of the Greater and Lesser Caucasus in eastern Georgia (see mesic deciduous forest in Figure 2). The photo shows a mesic *Quercus*-*Carpinus* forest on a SSE-facing mid-slope (about 520 m, see relevé G-13 in Table 12) in the Lagodekhi Nature Reserve in eastern Georgia (Kakhetia), near the Dagestan and Azerbaijani borders. Rainfall is greater in this area near the Caucasus, a winter snow cover of about 10 cm is normal, and the soil is brown forest soil over a slate substrate. This forest type represents the best expression of the potential forest of lower to middle slopes around Tbilisi.

Although not significantly richer in species per relevé, a more impressive forest is the primary mesophytic forest in the Racha Ubani area of the Lagodekhi reserve. A sample from this forest is shown in Table 14, from a very slight WSW-facing lower slope with rocky brown forest soil (see also Photo 7). This forest, which has apparently never been cut, has a canopy composed of *Fraxinus excelsior*, *Carpinus caucasica*, four *Acer* species, *Fagus orientalis*, *Juglans regia*, and scattered canopy-size individuals of *Cerasus sylvestris*. These are mostly typical European (or eastern European) species, but some elements of the Hyrcanian (east Caucasian-Caspian Tertiary) flora also appear in this forest, such as *Acer velutinum*, *Pterocarya pterocarpa*, and *Hedera pastuchowii*. The canopy on this plot had only 75 % cover, and the herb layer was correspondingly dense (90 %). On a nearby area the canopy reached 30 m and 90 % cover, with more *Fagus* and one individual of *Tilia begoniifolia* with 0.6 m-high plank buttresses. On this area, the T2 and S layers remained sparse and the herb-layer cover dropped to 50 %.

Table 14. Primary Deciduous Forest with Hyrcanian Elements, in eastern Georgia (relevé G-15)

Location: Lagodekhi State Nature Reserve, "Racha Ubani" section (30 May 1999).

T1	28 m	75 %	480 m, Slope: 2-3° to WSW
T2	12 m	10 %	
S	5 m	20 %	
H	0.4 m	90 %	30 x 30 m
EB, NZ, V. Pavliashvili, RJL			
T1:	3.3	<i>Carpinus caucasica</i>	3.3 <i>Fraxinus excelsior</i>
	2.2	<i>Acer laetum</i>	2.2 <i>Acer platanoides</i>
	2.2	<i>Juglans regia</i>	1.1 <i>Acer campestre</i>
	1.1	<i>Fagus orientalis</i>	1.1 <i>Acer velutinum</i>
	1.1	<i>Cerasus cf. sylvestris</i>	
T2:	2.2	<i>Carpinus caucasica</i>	1.1 <i>Carpinus orientalis</i>
vine:	+2	<i>Hedera helix</i>	
S:	2.2	<i>Corylus avellana</i>	1.1 <i>Fraxinus excelsior</i>
	1.1	<i>Fagus orientalis</i>	1.1 <i>Acer campestre</i>
	1.3	<i>Rubus caucasicus</i>	1.1 <i>Euonymus latifolia</i> [sic]
	+2	<i>Mespilus germanica</i>	+ <i>Ulmus elliptica</i>
	+	<i>Cornus mas</i>	+ <i>Prunus divaricata</i>
	+	<i>Hedera helix</i>	
H:	2.3	<i>Asperula odorata</i>	2.3 <i>Stachys sylvatica</i>
	2.2	<i>Alliaria officinalis</i>	2.2 <i>Aristolochia iberica</i>
	2.2	<i>Hedera helix</i>	1.2 <i>Oplismenus undulatifolius</i>
	1.2	<i>Stellaria media</i>	1.2 <i>Viola odorata</i>
	1.2	<i>Lamium album</i>	1.2 <i>Salvia glutinosa</i>
	1.2	<i>Geranium robertianum</i>	1.1 <i>Euonymus latifolia</i> [sic]
	1.1	<i>Carex sylvatica</i>	1.1 <i>Galium aureum</i>
	1.1	<i>Dentaria quinquefolia</i>	1.1 <i>Pachyphragma macrophyllum</i>
	1.1	<i>Sanicula europaea</i>	1.1 <i>Poa nemoralis</i>
	1.1	<i>Dryopteris filix-mas</i>	1.1 <i>Geum urbanum</i>
	1.1	<i>Athyrium distentifolium</i>	+2 <i>Phyllitis scolopendrium</i>
	+	<i>Fraxinus excelsior</i>	+ <i>Acer campestre</i>
	+	<i>Primula woronowii</i>	+ <i>Euphorbia macroceras</i>
	+	<i>Polystichum cf. sylvaticum</i>	+ <i>Moehringia trinervia</i>
	+2	<i>Orobancha</i> sp.	+ <i>Chaerophyllum</i> sp.

Total Number of Species: 44

Meadow-Steppe and other Steppe Vegetation

The far eastern part of Georgia becomes distinctly drier, with annual precipitation falling below 400mm near the border with Azerbaijan. The subhumid woodland in the Mtkvari valley around



Photo 7. Primary Mesophytic *Fraxinus-Carpinus* Forest in Eastern Georgia (Kakhetia).

The Lagodekhi Nature Reserve also contains a remnant of primary deciduous mesophytic forest, on somewhat rockier brown forest soil. This mesophytic forest is represented by relevé G15 (see Table 14) and includes *Fraxinus excelsior*, *Carpinus caucasica*, three *Acer* spp., *Fagus orientalis*, and *Juglans regia* in the canopy, with no *Quercus*. A nearby area with more *Fagus* had 90% canopy closure and less understorey. Large trees reach 60-80cm in diameter (DHB), and the understorey is rather open, as in most old-growth forests. The older trees are about 200 years old and may reach 300 years (400 years for *Tilia*, 600 years for *Quercus*). Groves of *Taxus baccata* have been protected here since the 12th Century.

Tbilisi represents in fact a narrow westward extension of this subhumid eastern zone, which has steppe and "arid woodland" as its potential natural vegetation. Like the rest of the country, much of this area has also been successfully transformed into productive agricultural area, especially for field crops such as cereals. Compared with the rest of the country, the eastern area retains a steppe character reminiscent of the vast steppes of the Ukraine and southern Russia, even though the grassland there now is totally cultural.

Natural vegetation in the east is preserved in the Vashlovani Reserve in Kiziki, at the far southeastern end of Georgia, near the Azerbaijani border. The most interesting steppe type is meadow-steppe, the relatively tall (to 1m), forb-rich grassland type of the Ukraine (e.g. Walter 1974), equivalent to the true (i.e. tall-grass) prairie of North America. A sample from a small but representative patch of meadow-steppe in the Vashlovani Reserve is shown by the relevé in Table 15 (see also Photo 8). *Botriochloa* (= *Andropogon*) *is chaemum* is the dominant in this stand, as in most of the Georgian steppes. The relevé also, however, includes *Stipa pulcherrima*, one of several "feather grass" species characteristic of Ukrainian to Middle Asian steppes, as well as some *Paliurus spinachristi* shrubs, as characteristic of "savannoid" steppe areas extending westward at least as far as Tbilisi (cf. Nakhutsrishvili 1999a, Figure 4). Meadow-steppe undergoes a continuing metamorphosis during the growing season, mainly from April to June, as early forbs are replaced by taller forbs and grasses, which finally yield to the dominants of the early-summer aspect (cf. Walter 1968, pp. 610-616). As with other meadow-steppe areas, grasses make up most of the biomass. Only 12 of the 63 species in the relevé, however, are grasses.

Table 15. Meadow-Steppe Remnant in Easternmost Georgia (relevé G-16)

Location: Vashlovani Nature Reserve, border with Pantishara Gorge (31 May 1999).

S 2 m 5 % 550 m, Aspect: 5-10° to N
 H 0.8 m 85 % 10 x 30 m
EB, NZ, V. Pavliashvili, RJL

S:	1.1	<i>Paliurus spina-christi</i>	1.1	<i>Cotinus coggygria</i>
	+2	<i>Asparagus</i> sp.	+	<i>Convolvulus cantabrica</i>
	+	<i>Lonicera iberica</i>		
H:	4.4	<i>Botriochloa ischaemum</i>	2.2	<i>Koeleria cristata</i>
	2.2	<i>Stipa pulcherrima</i>	1.1	<i>Stipa capillata</i>
	1.1	<i>Cleistogenes bulgarica</i>	1.1	<i>Festuca valesiaca</i>
	1.1	<i>Bromus japonicus</i>	1.1	<i>Phleum phleoides</i>
	+	<i>Hordeum crinitum</i>	+	<i>Aegilops triuncialis</i>
	+	<i>Trachynia distachya</i>	(+.2)	<i>Dactylis glomerata</i>
legumes:				
	2.2	<i>Medicago caerulea</i>	2.2	<i>Onobrychis kachetica</i>
	1.1	<i>Medicago minima</i>	1.1	Leguminosae sp.
	+	<i>Onobrychis cyri</i>	+	<i>Astragalus brachycarpus</i>
forbs:				
	2.2	<i>Thymus tiflisiensis</i>	2.2	<i>Galium verum</i>
	1.2	<i>Filipendula hexapetala</i>	1.1	<i>Poterium</i> (=Sanguisorba) <i>polygamum</i>
	1.1	<i>Achillea nobilis</i>	1.1	<i>Potentilla recta</i>
	1.1	<i>Scorzonera biebersteinii</i>	1.1	<i>Tragopogon tuberosus</i>
	1.1	<i>Jurinea speciosa?</i>	1.1	<i>Plantago lanceolata</i>
	1.1	<i>Helianthemum salicifolium</i>	1.1	<i>Hypericum perforatum</i>
	1.1	<i>Teucrium chamaedrys</i>	1.1	<i>Euphorbia sequierana</i>
	1.1	<i>Teucrium polium</i>	1.1	<i>Inula germanica</i>
	1.1	<i>Scutellaria orientalis</i>	1.1	<i>Polygala transcaucasica</i>
	1.1	<i>Onosma armeniaca</i>	+	<i>Crepis marshallii</i>
	+	<i>Hippomarathrum crispum</i>	+	<i>Veronica arceuthobia</i>
	+	<i>Orobancha</i> cf. <i>speciosa</i>	+	<i>Seseli grandivittatum</i>
	+	<i>Picris strigosa</i>	+	<i>Dianthus inamoenus</i>
	+	<i>Bellevalia wilhelmsii</i>	+	<i>Malabaila sulcata</i>
	+	<i>Sisymbrium loeselii</i>	+	<i>Linum austriacum</i>
	+	<i>Echinops sphaerocephalus</i>	+	<i>Muscari caucasicum</i>
	+	<i>Crinitaria villosa</i>	+	<i>Ziziphora serpyllacea</i>
	+	<i>Thalictrum minus</i>	+	<i>Reseda lutea</i>
	+	<i>Cuscuta speciosa</i>	+	<i>Phlomis pungens</i>
	+	<i>Eryngium campestre</i>	+	<i>Falcaria sioides</i>

Total Number of Species: 63



Photo 8. Meadow-Steppe Remnant in the Dry Region of Southeastern Georgia.

Forb-rich meadow steppe extends across the Ukraine and into Middle Asia as the first (most moist) zone of natural grassland south of the deciduous forest, equivalent to the tall-grass prairie of North America. The meadow-steppe remnant shown here (relevé G-16, see Table 15) is on dark brown soil in the Vashlovani Nature Reserve in far southeastern Georgia (see Figure 1). The 20 x 30m relevé contained 63 species, including the regional steppe dominant *Botriochloa ischaemum*, two widespread *Stipa* spp., *Koeleria cristata*, scattered erect shrubs of *Paliurus spina-christi* (left, in photo), and 40 non-leguminous forb species.

“Arid Woodland” in Eastern Georgia

The other important landscape type from the east is the *Pistacia-Juniperus* “arid woodland” (see Photo 9), an open woodland on foothills and plains in the driest parts of eastern Georgia. Areas of arid woodland are also well represented in the Vashlovani Reserve, a sample of which is shown in Table 16. The main structural elements are three *Juniperus* species plus deciduous *Pistacia mutica*, all of which grow in the form of small trees. Spiny *Paliurus spina-christi* is a major understorey shrub, as are *Jasminum fruticans*, *Berberis iberica*, *Rhamnus palasii*, *Cerasus* spp., and younger individuals of the juniper species. On flatter terrain these woodlands generally constitute parklands of wooded patches (20-50% of the area) embedded within a grassy Stipetum matrix. This grassy matrix is not completely represented in the relevé (Table 16) but was similar to the meadow-steppe site of Table 15, dominated, as elsewhere in the region, by *Botriochloa ischaemum*, along with *Stipa* species such as *S. pulcherrima*. Although arid woodland may be considered a west Iranian community, dry woodlands and related shrublands are important throughout much of especially eastern Georgia, extending westward to Tbilisi and on through central Georgia along the Mtkvari river valley to the Meskheta region near the Turkish border (see Figure 2).

Table 16. “Arid Woodland” Mosaic in easternmost Georgia (relevé G-17)

Location: Vashlovani Nature Reserve, down road from field station (31 May 1999).

T	8 m	20 %	550m, Slope: 5-20° , rolling
S	3 m	30 %	
H	0.5 m	50 %	50 x 50 m
<u>EB</u> , NZ, M. Khaçhidze, P.Khumagashvili, R.JL			
T:	2.4	<i>Pistacia mutica</i>	2.4 <i>Juniperus foetidissima</i>
	1.1	<i>Juniperus polycarpus</i>	1.1 <i>Juniperus rufescens</i>
S:	3.4	<i>Paliurus spina-christi</i>	3.4 <i>Jasminum fruticans</i>
	2.4	<i>Juniperus foetidissima</i>	1.1 <i>Juniperus polycarpus</i>
	1.1	<i>Juniperus rufescens</i>	1.1 <i>Rhamnus pallasii</i>
	1.1	<i>Berberis iberica</i>	1.1 <i>Cerasus incana</i>
	1.1	<i>Cerasus microcarpa</i>	1.1 <i>Lonicera iberica</i>
H:	3.4	<i>Lasiagrostis bromoides</i>	1.1 <i>Achillea nobilis</i>
	1.1	<i>Polygala transcaucasica</i>	1.1 <i>Dactylis glomerata</i>
	1.1	<i>Potentilla recta</i>	1.1 <i>Cleistogenes bulgarica</i>
	1.1	<i>Falcaria vulgaris</i>	1.1 <i>Dictamnus caucasicus</i>
	1.1	<i>Campanula hohenackeri</i>	1.1 <i>Rumex tuberosus</i>
	1.1	<i>Koeleria cristata</i>	+ <i>Helianthemum salicifolium</i>
	+	<i>Teucrium chamaedrys</i>	+ <i>Silene boissieri</i>

Total Number of Species: 25

Table 17. Species for Restoration around Tbilisi.

<u>Tall-Tree species</u>	<u>Short-Tree species</u>	<u>Shrub species</u>
<i>Acer campestre</i>	<i>Carpinus orientalis</i>	<i>Cotinus coggygria</i>
<i>Carpinus caucasica</i>	<i>Cornus mas</i>	<i>Euonymus caucasicus</i>
<i>Fraxinus excelsior</i>	<i>Crataegus caucasica</i>	<i>Prunus spinosa</i>
<i>Quercus iberica</i>	<i>Juniperus oblonga</i>	<i>Spiraea hypericifolia</i>
	<i>Prunus divaricata</i>	<i>Ruscus ponticus</i> *

Tall trees may grow to 20-25m, short trees to 8-15m, and shrubs to 1-3m.

**Ruscus ponticus* is a Colchic element characteristic of more humid situations but does occur in the Tbilisi area (see Table 11), at least on more mesic sites.

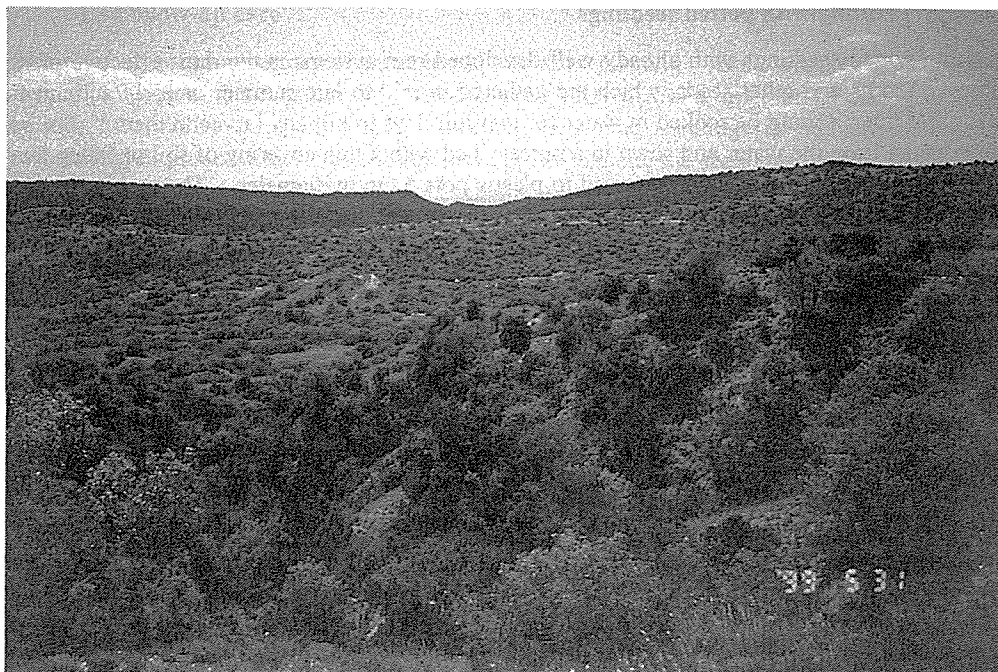


Photo 9. “Arid” *Juniperus-Pistacia* Woodland in the Dry Region of Southeastern Georgia.

“Arid woodland” is considered to be the potential natural vegetation in the driest areas of far southeastern Georgia and on into neighboring Azerbaijan. It can be a relatively uniform open woodland, as in this photo from the Vashlovani Reserve (see Figure 1), or a mosaic landscape of tree islands within a grassy matrix (as in relevé G-17, see Table 16). The lighter trees in the photo are *Pistacia mutica* and the darker trees are *Juniperus* spp., of which three were prominent: scale-leaved *J. foetidissima* and (more grayish) *J. polycarpus*, and *J. rufescens* with lighter green needles. Although few species are common to the shibljak landscapes of the Tbilisi area, the moisture conditions and physiognomy are similar.

Prospects for Restoration of Natural Forests around Tbilisi

The urban area of Tbilisi, especially along major roads, has traditional *Platanus* allées and buildings which provide a pleasant, stable street view. On the other hand, eroded, degraded hills are seen surrounding Tbilisi. Erosion occurs everywhere on bare slopes, a disaster which results from human activity. Natural forests can stop several kinds of disasters, and forested landscapes provide a “sense of place” for the people. Forest restoration around Tbilisi, with native tree species, might involve the following components.

1) Proposed species

The area in and around Tbilisi is already disturbed by human activities, and the vegetation has changed to secondary forests (cf Tables 9 and 10) or degraded dry forests (cf Table 11). Natural forest at similar elevation is located in the Lagodekhi State Nature Reserve. *Carpinus caucasica-Quercus iberica* forests are reported as the transitional zone between oak and beech forests (Nakhutsrishvili 1999a), and such forest with *Juniperus oblonga*, is suggested as the ideal forest surrounding Tbilisi, from 500 to 1000m. *Carpinus caucasica-Quercus iberica* forest in Lagodekhi State Nature Reserve contains more tree species, such as *Tilia begoniifolia*, *Acer laetum* *Carpinus orientalis*, *Crataegus caucasica*, and *Cornus mas*, as well as herbs such as *Festuca drymeja* and *Hedera pastuchowii*. In degraded areas around Tbilisi, *Juniperus* woodland is common, with ground cover involving *Ruscus ponticus* along with *Brachypodium sylvaticum*, etc.

2) Planting with potted seedlings

Planting potted seedlings with already well developed root systems is the most effective planting method. Acorns and other seeds, which are gathered in mid to late summer or early autumn from their mother trees, should be soaked in water for two full days to kill any larvae in them. The seeds are then taken from the water and sown in a nursery bed with a thin covering of soil or fallen leaves. When the seeds germinate, they are moved to plastic pots 5 cm in diameter. The soil in the plastic pots should be the same as the topsoil in the forest. In the nursery, the pots are kept touching each other, simulating the density of the subsequent planting. When they grow up to 50 to 80 cm and develop good, strong root systems, they can be planted on the planting sites.

3) Site Preparation

On degraded sites with no topsoil, the top 30cm should be plowed and decomposed organic material or fertilizer should be added in the planting holes. The holes for planting should be made 1.5 times larger than the width and depth of the potted seedlings. When there is not enough fertilizer or topsoil for the whole area to be planted, it should at least be applied to the holes for the potted seedlings.

4) Planting technique

One always hopes for planted seedlings to grow up immediately, but in reality they do not grow so fast, especially native climax species. If 50-80cm high seedlings with well-developed root systems are planted, densely and in appropriate species mixes, however, one can expect faster growth than in typical forestry plantations, due to the better preparation of the seedlings. The basic rule for restoration plantations is dense planting of species mixtures with mulching after planting using cut herbage, fallen leaves, etc.

(a) Dense plantation

Dense plantation, with 6-9 individuals per square meter, effectively promotes fast growth and high survival, since the density of the plant crowns immediately provides a protective microclimate which is more humid and shaded (Fujiwara 1997). Even species which are slower to begin growing in their new locations can grow faster than in plantations where seedlings are scattered more widely. Where winter temperature is very low, 2-3 individuals should be planted in the same hole. Dense planting promotes competition among individual seedlings for light, thus promoting growth, and the co-existence of plants in close proximity provides greater protection against low temperatures in winter. The seedlings of deciduous species generally have few or no side branches at first, developing them only later, within the first two to three years. Then they begin to compete for light and space, which promotes faster growth.

(b) Mixed species

When potted seedlings are planted, different species should be planted next to each other, or in the next holes if multiple individuals are planted per hole. The different species (and to a lesser extent different individuals) have somewhat different growth rates and shapes, and thus provide growing space for each other. Mixed-species plantation reduces direct competition among seedlings and promotes co-existence, helping the seedling to grow faster.

(c) Mulching after plantation

Both planted seedlings and soil need to retain moisture. After plantation, the sites should be mulched using organic materials such as fallen leaves, cut grass, wheat or rice straw, etc. The mulch not only helps retain soil moisture but also helps prevent soil erosion and becomes fertilizer.

5) Follow-up care

Basically, it is not necessary to manage the site after planting. Only weeding is necessary, not watering. Weeding is necessary for only 2-3 years after planting, once or twice a year until the seedlings grow taller than the weeds. Weeding helps the seedlings to outcompete weeds and promotes higher photosynthesis and competitive growth among the seedlings. Dead weeds can also be used for mulching. Basically, no management is best. It is not necessary to give water, since the mulching retains soil moisture.

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References

- Antadze, K. D., G. G. Gvelesiani, T. I. Devidze, V. Sh. Dzhaoshvili, and D. B. Ukleba 1967. *Gruziya*. "Sovetskii Soyuz – Geograficheskii Opisaniye" series, vol. 22. Mysl, Moskva. 320 pp. (in Russian).
- Box, E. O. 1995. Global and local climatic relations of the forests of East and Southeast Asia. In: *Vegetation Science in Forestry* (E. O. Box et al., eds.), Handbook of Vegetation Sci., vol. 12/1, pp. 23-55. Dordrecht:Kluwer.
- Bush, N. A. 1935. (*Botanical and Geographical Studies of the Caucasus*.) Izdat. Akad. Nauk SSSR, Moskva-Leningrad.
- Curtis, G. E. (ed.) 1994. Georgia – A Country Study. "Country Study" series. US Library of Congress, Federal Research Division, Washington, USA. Accessible also by Internet site: <http://lcweb2.loc.gov/frd/cs/getoc.html> (12 November 1999).
- Dolukhanov, A. G. 1966. (Regularities of geographical diversity of vegetation and upper timberline in the Transcaucasian mountains.) *Trudy Botan.* (Leningrad), 8:196-207 (in Russian).
- Dolukhanov, A. G. 1989. (*Forest Vegetation of Georgia*.) "Vegetation of Georgia" series, vol. 1. Metsniereba, Tbilisi (in Russian).
- Fujiwara, K. 1987. Aims and methods of phytosociology or "vegetation science." In: *Papers on Plant Ecology and Taxonomy to the Memory of Dr. Satoshi Nakanishi*, pp. 607-628. Kobe Geobotanical Society, Kobe.
- Fujiwara, K. 1997. (A Vegetation-Ecological Study for the Restoration and Rehabilitation of Green Environments based on the Creation of Environmental Protection Forests in the Japanese Archipelago.) Report for Monbusho Project no. 06454643. Yokohama National University, Institute of Environmental Science and Technology. 361 pp. (in Japanese, with English summary).
- Gagnidze, R. I. 1974. (*Botanical and Geographical Analysis of the Florocoenotic Complex of Tall Herbaceous Vegetation of the Caucasus*.) Metsniereba, Tbilisi (in Russian).
- Gagnidze, R. I. 1999. Arealogical Review of Colchic Evergreen Broad-Leaved Mesophyllous Dendroflora Species. In: *Conference on Recent Shifts in Vegetation Boundaries of Deciduous Forests, especially due to General Global Warming* (F. Klötzli and G.-R. Walther, eds.), pp. 199-216. Birkhäuser Verlag, Basel.
- Grossheim, A. A. 1948. (*Vegetation Cover of the Caucasus*.) MOIP, Moskva (in Russian).
- GUGK 1986. *Atlas SSSR*. GUGK SSSR (Main Admin. for Geodesy and Cartography of USSR), Moskva. 260 pp. (in Russian).
- Gulizashvili, V. S., L. B. Makhatadze, and L. I. Prilipko 1975. *Rastitel'nost Kavkazi* (The Vegetation of the Caucasus.) Moskva. 232 pp. (in Russian).
- Institute of Botany 1971-87. *Flora Gruzii* (Flora of Georgia). 2nd edition. Inst. of Botany, Georgian Academy of Sciences. Metsniereba, Tbilisi. 11 vols. (in Russian and Georgian).
- Ketskhoveri, N. 1933. "Vegetation Map of the Georgian Republic, scale 1:400,000". Tbilisi (in Georgian).
- Ketskhoveri, N. 1959. "Map of the Restored Vegetation Cover of the Georgian SSR, scale 1:600,000." Tbilisi (in Georgian and Russian).
- Khatiaishvili, N. M. 1989. *Atlas -- Resorts and Resort Resources, Georgian SSR*. GUGK SSSR, Moskva. 76 pp. (in Georgian, Russian and English).
- Kolakovskiy, A. A. 1974. (Vertical belts of Colchis forest vegetation in the Tertiary period.) *Trudy Tbilissk. Instituta Lesa* (Tbilishi), 21:98-116 (in Russian).
- Kolakovskiy, A. A. 1980. (*Flora of Abkhazia*.) 2nd revised supplemented edition, 4 vols. Metsniereba, Tbilisi (in Russian).
- Korovin, E. P. 1961-62. (*The Vegetation of Middle Asia and Southern Kazakhstan*). 2nd ed. Tashkent. 452 pp. + 577 pp. (2 vols., in Russian).

- Latschaschwili, I., and G. Mamukelaschwili 1986. *Conspectus: Florae Rezervati Publici Lagodechensis*. Georgian Academy of Sciences, Tbilisi. 107 pp. (in Georgian).
- Mabberley, D. J. 1987. *The Plant Book*. Cambridge Univ. Press. 706 pp.
- Makashvili, A. 1995. (*The Trees and Bushes of Georgia*.) Edited by G. Nakhutsrishvili and N. Zazanashvili. World Wildlife Fund for Nature, WWF Project Office Georgia, Tbilisi. 65 pp. (in Georgian, with Latin scientific names).
- Müller, M. J. 1982. *Selected Climatic Data for a Global Set of Standard Stations for Vegetation Science*. "Tasks for Vegetation Science," vol. 5. Dr. W. Junk (now Kluwer, Dordrecht). 306 pp.
- Nakhutsrishvili, G. 1974. (*Ecology of High-Mountain Plants and Phytocoenoses of the Central Caucasus*.) Metsniereba, Tbilisi (in Georgian).
- Nakhutsrishvili, G. 1999a. The vegetation of Georgia (Caucasus). *Braun-Blanquetia*, 15:1-74.
- Nakhutsrishvili, G. 1999b. Immergrüne Vegetation der Kolchis. In: *Conference on Recent Shifts in Vegetation Boundaries of Deciduous Forests, especially due to General Global Warming* (F. Klötzli and G.-R. Walther, eds.), pp. 167-179. Birkhäuser Verlag, Basel.
- Nakhutsrishvili, G., and O. Abdaladze (eds.) 1998. *Plant Life in High Mountains*. Proceedings of Kazbegi IV International Symposium (9-14 June 1996). Institute of Botany, Georgian Academy of Sciences, Tbilisi. 144 pp.
- Petrov, M. P. 1966-67. (*The Deserts of Central Asia*). 2 vols. Moskva-Leningrad. 274 pp. + 286 pp. (in Russian).
- Sakhokia, M. F. (ed.) 1958. (*Botanical Excursions over Georgia*.) Izdat. Akad. Nauk Gruz. SSSR. Tbilisi (in Russian).
- Shatilova, I. I., and Sh. Ramishvili 1990. *Rastitel'nost Gruzii* (Vegetation of Georgia). Materiali po istorii flori i rastitel'nosti Gruzii. Metsniereba, Tbilisi (in Russian).
- Troll, C. (ed.) 1972. *Geoecology of the High-Mountain Regions of Eurasia*. Erdwissenschaftl. Forschung, vol. 4. Franz-Steiner-Verlag, Wiesbaden.
- Tumayanov, I. I. 1955. (On the post-Pliocene history of forest vegetation on the northern Caucasus.) *Trudy Tbilissk. Botan. Instituta* (Tbilisi), 17:161-219 (in Russian).
- Walter, H. 1968. *Die Vegetation der Erde, in öko-physiologischer Betrachtung*. Vol. II: Die gemässigten und arktischen Zonen. Gustav-Fischer-Verlag, Jena-Stuttgart. 1001 pp.
- Walter, H. 1974. *Die Vegetation Osteuropas, Nord- und Zentralasiens*. "Vegetation der einzelnen Großräume" series, vol. VII. Gustav-Fischer-Verlag, Stuttgart. 452 pp.
- Zazanashvili, N. 1999. On the Colchic Vegetation. In: *Conference on Recent Shifts in Vegetation Boundaries of Deciduous Forests, especially due to General Global Warming* (F. Klötzli and G.-R. Walther, eds.), pp. 181-197. Birkhäuser Verlag, Basel.
- Zazanashvili, N., R. Gagnidze, and G. Nakhutsrishvili 1995. High-mountain vegetation on the new vegetation map of Georgia. *J. Veg. Sci.*, 6:157-158.
- Zazanashvili, N., (compiler) and R. Shishniashvili (editor) 1997. (*Protected Areas of Georgia: Present and Future*.) World Wildlife Fund for Nature, WWF Project Office Georgia, Tbilisi. 36 pp. (in Georgian, with English summary).

Appendix: Species Identified from Relevés in Georgia, May 1999.

Authorities for species identification were the Georgian authors and the local botanical guides (see Acknowledgements). Spellings were checked initially in Latschaschwili and Mamukelaschwili (1986), Makashvili (1995), Nakhutsrishvili (1999a), Nakhutsrishvili and Abdaladze (1998), and remotely in the *Flora of Georgia* (Institute of Botany 1971-87). Final spelling checks were made by Zazanashvili. Family membership follows Mabberley (1987).

Lichen

Cetraria islandica

Bryophyta

Dicranum elongatum

Hylocomnium sp.

Mnium sp.

Pleurozium schreberi

Polytrichum commune

Pteridophyta

Aspleniaceae

Asplenium cf. *nigrum*

Asplenium pseudolanceolatum

Asplenium cf. *speciosum*

Asplenium trichomanes

Athyrium distentifolium

Athyrium filix-femina

Dryopteris filix-mas

Phyllitis (= *Asplenium*) *scolopendrium*

Polystichum cf. *sylvaticum*¹

Gymnospermae

Cupressaceae

Juniperus foetidissima

Juniperus oblonga

Juniperus polycarpus

Juniperus rufescens

Pinaceae

Picea orientalis

Angiospermae: Monocotyledonae

Cyperaceae

Carex buschiorum

Carex sylvatica

Carex sp.

Gramineae

Aegilops triuncialis

Agrostis planifolia

Agrostis tenuis

Avena sp.

Botriochloa ischaemum

Brachypodium sylvaticum

Bromus japonicus

Bromopsis variegata (= *Bromus variegatus*)

Calamagrostis arundinacea

Cleistogenes bulgarica

Dactylis glomerata

Deschampsia caespitosa

Eragrostis? sp.

Festuca drymeja

Festuca ovina

Festuca supina

Festuca valesiaca

Hordeum crinitum

Koeleria cristata

Lasiagrostis (= *Achnatherum*) *bromoides*

Nardus stricta

Oplismenus undulatifolius

Phleum alpinum

Phleum phleoides

Poa alpina

Poa bulbosa

Poa bulbosa var. *vivipara*

Poa longifolia

Poa nemoralis

Stipa capillata

Stipa pulcherrima

Trachynia (= *Brachypodium*) *distachya*

Liliaceae

Asparagus officinalis

Asparagus sp.

Bellevalia wilhelmsii

Fritillaria latifolia

Gagea cf. *supranivalis*

Galanthus caucasicus

Galanthus platyphyllus

Galanthus sp.

- Muscari caucasicum*
Muscari szovitsianum
Paris quadrifolia
Polygonatum verticillatum
Ruscus ponticus
Scilla rosenii
Veratrum lobelianum
- Orchidaceae
Orchis kumana?
Orchis sp.
Platanthera chlorantha
- Angiospermae: Dicotyledonae**
- Aceraceae
Acer campestre
Acer laetum
Acer platanoides
Acer velutinum
- Anacardiaceae
Cotinus coggygria
Pistacia mutica
Rhus coriaria
- Aquifoliaceae
Ilex colchica
- Araceae
Arum albispalum
- Araliaceae
*Aralia officinalis*²
Hedera colchica
Hedera helix
Hedera pastuchowii
- Aristolochiaceae
Aristolochia iberica
- Balsaminaceae
Impatiens noli-tangere
- Berberidaceae
Berberis iberica
- Betulaceae
Alnus cf. *glutinosa*³
Betula litwinowii
Carpinus caucasica
Carpinus orientalis
- Corylus avellana*
- Boraginaceae
Myosotis sylvatica
Nonea? sp.
Onosma armeniaca
- Campanulaceae
Campanula collina
Campanula hohenackeri
Campanula rapunculoides
- Caprifoliaceae
Lonicera caprifolium
Lonicera caucasica
Lonicera iberica
Sambucus nigra
Viburnum lantana
Viburnum orientale
Viburnum sp.⁴
- Caryophyllaceae
Cerastium arvense
Dianthus inamoenus
Minuartia circassica
Moehringia trinervia
Silene boissieri
Silene wallichiana
- Celastraceae
*Euonymus caucasicus*⁵
Euonymus latifolia [sic]
- Cistaceae
Helianthemum salicifolium
- Compositae
Achillea millefolium
Achillea nobilis
Anthemis fruticulosa
Cicerbita sp.
Cirsium obvallatum
Cirsium sp.
Crepis marshallii
Crinitaria villosa (= *Aster villosus*)
Echinops sphaerocephalus
Inula germanica
Jurinea speciosa?
Leontodon hispidus
Ligularia sibirica
Petasites albus
Picris strigosa

- Scorzonera biebersteinii*
Senecio rhombifolius
Senecio sp.
Tanacetum vulgare
Taraxacum confusum
Taraxacum officinale
Taraxacum sp.
Tragopogon graminifolius
Tragopogon tuberosus
- Convolvulaceae
- Calystegia sepium*
Convolvulus cantabrica
Convolvulus sp.
Cuscuta speciosa
- Cornaceae
- Cornus mas*
- Crassulaceae
- Sedum oppositifolium*
Sedum stoloniferum
- Cruciferae
- Alliaria alliariaefolia*⁶
Alliaria officinalis
Arabidopsis thaliana
Dentaria quinquefolia
Draba siliquosa
Draba sp.
Pachyphragma macrophyllum
Sisymbrium loeselii
- Ericaceae
- Rhododendron caucasicum*
Rhododendron luteum
Rhododendron ponticum
Vaccinium arctostaphylos
Vaccinium myrtillus
Vaccinium vitis-idaea
- Euphorbiaceae
- Euphorbia glareosa*
Euphorbia iberica
Euphorbia macroceras
Euphorbia sequierana
Euphorbia sp.
- Fagaceae
- Castanea sativa*
Fagus orientalis
- Quercus iberica*
- Gentianaceae
- Gentiana* sp.
- Geraniaceae
- Erodium cicutarium*
Geranium ibericum
Geranium pallens
Geranium robertianum
Geranium sylvaticum
Geranium sp.
- Grossulariaceae
- Ribes biebersteinii*
*Ribes hypericifolia*²
- Guttiferae (Hypericaceae)
- Hypericum perforatum*
- Hydrangeaceae
- Philadelphus caucasicus*
- Juglandaceae
- Juglans regia*
Pterocarya pterocarpa
- Labiatae
- Ajuga genevensis*
Ajuga orientalis
Ajuga sp.
Betonica macrantha
Lamium album
Phlomis pungens
Salvia glutinosa
Scutellaria orientalis
Stachys sylvatica
Teucrium chamaedrys
Teucrium polium
Thymus collinus
Thymus tiflisiensis
Ziziphora serpyllacea
- Leguminosae
- Astragalus brachycarpus*
Astragalus captiosus
Lathyrus sp.
Medicago caerulea
Medicago minima
Onobrychis cyri
Onobrychis kachetica

- Robinia pseudoacacia*
Trifolium ambiguum
Trifolium arvense
Vicia crocea
Vicia sp.
- Linaceae
Linum austriacum
- Oleaceae
Fraxinus excelsior
Jasminum fruticans
- Orobanchaceae
Orobanche cf. *speciosa*
Orobanche sp.
- Oxalidaceae
Oxalis acetosella
- Papaveraceae
Chelidonium majus
- Plantaginaceae
Plantago caucasica
Plantago lanceolata
- Polygalaceae
Polygala transcaucasica
- Polygonaceae
Polygonum carneum
Rumex acetosa
Rumex alpinus
Rumex tuberosus
- Primulaceae
Androsace villosa
Cyclamen vernum
Primula macrocalyx
Primula ruprechtii
Primula woronowii
- Ranunculaceae
Anemone caucasica
Anemone fasciculata
Pulsatilla violacea
Ranunculus oreophilus
Thalictrum foetidum
Thalictrum minus
Trollius patulus
- Resedaceae
Reseda lutea
- Rhamnaceae
Paliurus spina-christi
Rhamnus pallasii
- Rosaceae
Alchemilla retinervis
Cerasus incana
Cerasus microcarpa
Cerasus cf. *sylvestris*
Cotoneaster racemiflorus
Crataegus caucasica
Crataegus monogyna
Filipendula hexapetala
Fragaria viridis
Fragaria sp.
Geum rivale
Geum urbanum
Laurocerasus officinalis
Malus orientalis
Mespilus germanica
Potentilla crantzii
Potentilla recta
Potentilla sp.
Poterium (= *Sanguisorba*) *polygamum*
Prunus divaricata
Prunus spinosa
Pyrus caucasica
Rosa canina
Rubus caucasicus
Rubus nigra s. l. (= *R. nigratus*)
Rubus saxatilis
Sorbus graeca
Spiraea crenata?
Spiraea hypericifolia
- Rubiaceae
Asperula odorata
Cruciata laevipes (= *Galium laevipes*)
Galium aparine
Galium aureum
Galium verum
- Rutaceae
Dictamnus caucasicus
- Salicaceae
Salix apoda?
Salix arbuscula

Scrophulariaceae

Pedicularis chroorrhyncha
Scrophularia nodosa
Veronica arceuthobia
Veronica gentianoides
Veronica peduncularis
Veronica polita

Smilacaceae

Smilax excelsa

Thymelaeaceae

Daphne glomerata

Tiliaceae

Tilia begoniifolia
Tilia caucasica

Ulmaceae

Celtis caucasica
Ulmus elliptica

Umbelliferae

Angelica tatianae
Anthriscus sylvestris var. *nemorosa*
Anthriscus sp.
Astrantia maxima
Astrodaucus orientalis
Carum sp.
Chaerophyllum sp.
Eryngium campestre
Falcaria sioides
Falcaria vulgaris

Heracleum asperum

Hippomarathrum crispum

Laser trilobum

Ligusticum alatum

Malabaila sulcata

Physocaulis (= *Myrrhoides*)

*anthriscum*²

Sanicula europaea

Seseli grandivittatum

Urticaceae

Urtica dioica

Violaceae

Viola odorata
Viola somchetica
Viola sp.

Viscaceae

Viscum album

Unknowns

anemonoid sp. (*Anemone caucasica*?)

caraganoid sp. (Leguminosae?)

Compositae sp.

Cruciferae sp.

graminoid sp.

Labiatae sp. (*Nepeta*?)

Leguminosae sp.

Ranunculaceae sp.

Umbelliferae sp.

dioscoreoid vine sp. (but *Discorea* only occurs in Abkhazia)

¹ Field identification (incorrect), but may be cf. *P. braunii*, known from mesic forests of shady valleys, up to 1800-2000m.

² From relevé in Tbilisi Botanical Garden but not in Georgian flora: may be an escaped alien species.

³ Two *Alnus* species are known in Georgia: *A. barbata* in lowlands and low mountains, and *A. incana* in ravines in low and mid-level mountains.

⁴ One other *Viburnum* species also occurs in Georgia: *V. opulus* up to mid-level mountains.

⁵ Field identification: could be *Eu. europae* [sic] of mid-montane forests; *Eu. leiophloea* [sic], occurring up to mid-mountain, or less likely *Eu. verrucosa* [sic] of low and middle elevations. Note that *Euonymus* species epithets normally end in -us (e.g. *Eu. caucasicus*, *Eu. japonicus*, *Eu. alatus*, *Eu. americanus*).

⁶ Field identification (incorrect): in Georgia there are only *Alliaria officinalis*, in forests up to mid-level mountains; and *A. brachycarpa*, in the alpine belt of the central Greater Caucasus.