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NATURAL FORESTS OF GEORGIA

(THE SOUTH CAUCASUS)

ILIA STATE UNIVERSITY
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Content

The book is devoted to one of the most pressing issues of botanical science in Georgia – the study of the current state of natural forests. It presents a large amount of factual material collected in reports of phytosociological and forestry research of the major forest formations of western and eastern Georgia. Attention is focused on rare, relict forests and ecosystems subject to transformations as a result of the ongoing global climate change (e.g., the treeline ecotone).

The book is intended for a wide range of readers: botanists, ecologists, foresters, other representatives of the natural sciences, researchers and lovers of Georgia's nature, and doctoral, master and bachelor-level students of universities.

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PREFACE

Forests are the most widespread terrestrial ecosystems on Earth. More than 80% of all plant and animal species known to date find shelter in them. In Georgia's vegetation cover, forests occupy a special place in many ways: Georgia is the most forested country in the entire Caucasus, there is a wide variety of forest formations, with high species richness and many relict and endemic taxa. There is another important circumstance that distinguishes the forests of Georgia: due to the complexity of the terrain, natural or close to natural forests are still preserved here – untouched by humans for a long time, including "living fossils" from the geological past. Rapid and radical global changes (climate, land use) in recent decades have given particular relevance to the botanical and ecological study of natural forests.

The reason for the special diversity and originality of the vegetation cover of the Caucasus and, in particular, Georgia is the diversity of physico-geographic, and hence climatic conditions. The Caucasus is located at the junction of plant landscapes of different genesis, so the diversity of its flora and vegetation is remarkable. In addition, the unevenness of the terrain and the configuration of the ridges contributed to the long-term geographic and ecological isolation of plant species complexes. The result is high endemism of the flora of the Caucasus and specifically Georgia. Significant elevation variability has formed various plant zones: from semi-deserts and steppes to alpine-nival zones. Among them, the forest occupies a special position: it begins at sea level, covers the foothills and slopes of mountains of various exposures and slopes, and in the highlands even extends up to 2700 m.

Several generations of Georgian and foreign botanists studied the forests of Georgia, about which Vakhushti Batonishvili gave us the first systematic information in the middle of the 18th century (1742). The researchers are of later period are: N. Albov, N. Bush, A. Grossheim, V. Gulisashvili, A. Dolukhanov, N. Ketskhoveli, A. Kolakovsky, A. Makashvili, L. Makhatadze, I. Medvedev, G. Nakhutsrishvili, M. Sakhokia, D. Sosnovsky, I. Shatilova, A. Kharadze, A. Javakhishvili and others. In general, attention was focused on the identification, systematization, phytosociological and ecological studies of forest formations and associations. However, since Georgian forests are characterized by great coenotic diversity and a wide elevational distribution range, many issues remain to be studied. One of them is natural and/or close to natural forests. They are preserved (mostly well) either within protected areas or in such inaccessible places where significant anthropogenic encroachment has not yet occurred. These are a kind of reference forests.

Why is it important to study natural forests? There are several reasons: 1) Due to the long stable period of their existence, natural forests are especially outstanding ecosystems with a variety of plants and animals. Natural forests are the only habitat and refuge for this biodiversity, including rare, relict, endemic, endangered species that cannot live in young forests. This is the primary ecological function of natural forests; 2) They play a key role in regulation of water balance, nutrient cycling, carbon sequestration much more effectively than young forests, and plantations, which means that they are extremely important to mitigate global changes; 3) In natural forests, a huge amount of carbon has accumulated over the centuries (in a form of humus, and if the soil is very wet, in the form of peat). When forests are destroyed or even degraded, carbon is released into the atmosphere in a form of greenhouse gases increasing the risk of global warming.

This book is issued based on research conducted within the framework of the grant projects supported by the Deutsche Gesellschaft für Internationale Zusammenarbeit – GIZ GmbH and contains phytosociological descriptions of natural forests of Georgia, forestry research reports and their primary analysis.

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ABBREVIATIONS AND SYMBOLS

E – the East
N – the North
S – the South
W – the West
° – degree
‘ – minute
m – meter
km – kilometer
ha – hectare
a.s.l. – above sea level
AD – Anno Domini
BC – Before Christ
circa – approximately
C – carbon
CO_2 – carbon dioxide
O_2 – oxygen
FAO – Food and Agriculture Organization of the United Nations
IUCN – International Union for Conservation of Nature
MCFPE – Ministerial Conference for the Protection of Forests in Europe
USFS – United States Forest Service
WWF – World Conservation Fund

DEFINITIONS OF TERMS

Forest stand is a combination of trees and other plants that form a forest.

Forest canopy is the aggregate of all crowns in forest vegetation, which is the combination of all foliage, twigs, branches, epiphytes as well as the interstices (air) in a forest (Parker, 1995).

Grove is small forest of natural or artificial origin, which includes trees, shrubs and other forest plants. It has specific characteristics (origin, species composition, shape, density, age, forest type, etc.), complex of which distinguishes it from other groves.

Saplings constitute a young generation of trees under the canopy of the forest or in forest glades, and are capable of forming the main layer of the forest in the future (thus distinguishing itself from the undergrowth). The saplings develop from seeds or vegetative diaspores.

Forest litter is dried and decaying organic matter on the forest floor and consists of fallen leaves, fruits, bark of trees and other plants, animal waste, microorganisms, fungi. This is the most densely populated horizon of the forest. Its function is the formation of humus, soil protection against mechanical compaction and washing out, regulation of soil water regime and aeration; accumulation of food elements for plants; makes habitat for numerous microorganisms, invertebrates, amphibians and reptiles.

Deadwood is fallen tree trunks, large and small branches of trees and shrubs (dry, rottening, rotten). Fresh deadwood supports rapid spread of forest fires, invertebrates such as bark beetles and pathogenic fungi to healthy trees. Rotten deadwood is safe for living trees and is a pool of nutrients becoming a part of humus. The deadwood protects soil and slopes. It temporarily or permanently shelters many microorganisms, fungi, arthropods, molluscs, amphibians, reptiles and small mammals. Some plant seeds require deadwood environment for germination. Deadwood is a carbon long-term reservoir, e.g., in a coniferous forest it accounts for 25-30% of the total carbon pool.

Standing deadwood is a rare kind of deadwood of dead trees which still stand.

Living ground cover consists of mosses, lichens, grasses and shrubs.

Forest layer is a clearly defined horizon of concentration of plant organs. A forest layer can be formed by one, two or more plants species. Temperate zone forests can have two layers, and tropical rainforests can have up to five.

Understory / undergrowth (shrub layer) is a forest layer of very low trees and/or shrubs. The understory trees never grow to the height of the major trees that make up the forest canopy, which differs them from **saplings**. In the undergrowth where the light conditions are constantly poor plants are shade-tolerant with low-intensity photosynthesis.

Forest regeneration is a process of forming a new generation of forest in clearings, after fire and in other damaged areas of the forest. The term includes natural and art ificial regeneration.

Herb-and-shrub layer consists of herbs and shrubs.

Herbaceous layer consists of various herbs.

Layer of bryophytes and lichens consists of mosses and lichens growing on soil and/or stones.

Forest underground layer (Rhizosphere) is the area of distribution of forest tree root system in the soil, and includes soil fauna, fungi and microorganisms.

Unlayered vegetation consists of creeping plants (vines), epiphytes.

Forest glade is an opening in a forest created by any reason (naturally dying tree, forest felling), which will later be filled by the major trees of the forest.

Forest edge is a transition zone between the forest and adjacent vegetation type. Usually, trees at the edge of the forest are completely leafy due to sunlight availability, shrubs, vines and young trees are more

abundant than in the forest. Some understory plants disappear at the forest edge. Instead, some species of adjacent ecosystem are present. Also, some animal species are strictly confined to forest edges.

Arid open forest is a forest type, in which the tree density is low. Trees are separated by relatively big distances from each other and do not form closed canopy. Therefore, the forest includes many open and, thus, illuminated areas. In arid open forest the ground surface is more shaded by tree trunks than in the savanna, but to a lesser extent than in a typical deciduous, coniferous or mixed forest.

Crook-stemmed forest is a forest consisting of trees with low trunks (3-7 m), which are clearly curved towards the slope. The curved trunks develop because of prolonged mechanical action of snow mass.

Treeline is a line of the sharp change in the tree dominant life form. It happens because at certain elevations development of a massive trunk and branches becomes impossible. The treeline roughly marks the line connecting the forest areas at the highest elevation on a given slope, or several slopes of the same aspect.

Habitat tree is a living or dead tree that has at least one microhabitat: hollow, crack, and others. As a hollow needs a long time to form only very old trees (>100-150 years old) have large trunks. The more such trees in a particular forest, the more intact is the forest.

Dominant species is a species, which prevails in abundance in a particular community (by the number of individuals, cover, or biomass).

Monodominant community is a community, species composition of which is more or less rich, but one species predominate and abundances of the other species are low.

Bidominant community is a community, which clearly has two dominant species. Such a community contains two well distinguishable dominants. The dominants are not necessarily present in equal ebundances, when the species present in lower abundance is called a sub-dominant.

Polydominant community is a community, where there are more than two dominants.

Edificator species is a dominant species that determines basic features of a plant community. The edificator asserts the most pronounced influence of the environment, transforms it and makes other species adapt to the environment it produced.

Forest type is a forest area (or a complex of forest areas) characterized by similar environmental conditions, composition of tree species, stratification and fauna. The name of the forest type reflects dominant and characteristic species.

Epiphyte is a plant that grows on another plant.

Epixylic organism is an organism living on tree bark.

Endemic species (or other taxon) is a species (or other taxon) occurring in one specific locality / area on Earth and nowhere else.

Soil pH is the level of concentration of hydrogen ions (H+) in the soil solution. The higher the pH of the soil, the higher its acidity and vice versa. Rhizosphere has pH 5.5, in deeper horizons it decreases to 4.8.

Edaphic factors are soil conditions that affect organisms. They include soil physical properties, fertility, its moisture content, pH, mineral composition.

Rhizosphere is a narrow layer of soil (2-5 mm) around plant roots; the rhizosphere is subject to direct effects of root secrets and soil microorganism action.

Ecotope is a specific complex of the substrate / soil, water, air, inhabited by organisms / their communities.

Coenotype is a group of organisms within a community with a similar functional position.

Synousia is a spatially and ecologically more or less isolated part of a plant community, made up of a group of individuals of the same (first-order synousia) or similar species (the second and third order synousia), or a single life form (ecobiomorphs).

CHAPTER 1. BRIEF DESCRIPTION OF THE NATURAL CONDITIONS OF GEORGIA

1.1 Location

Georgia is located in the South Caucasus, at the junction of Europe and Asia, specifically, Eastern Europe and Western Asia. Its extreme western and eastern borders pass along N41°07' and N43°35', and the extreme southern and northern borders along E40°04' and E46°44'.

1.2 Territory and Boundaries

The area of Georgia is 69,700 km^2. It is bordered by the Russian Federation to the north (the border passes over the orographic barrier, the Rocky range of the Great Caucasus); Azerbaijan to the east and south-east (here the border descends on the southern slope of the Great Caucasus and follows the lower part of the Alazani gorge; the distance from the eastern border to the Caspian Sea is about 300 km); Armenia to the south and Turkey to the southwest (here the border runs almost entirely on mountainous terrain, the Loki and Bambak ranges); the Black Sea is located the west. The total length of the country's border is 1970 km (315 km of the aquatic and 1655 km of the terrestrial border) (Maruashvili, 1969; Gobejishvili, 2011).

Often, locally and abroad, western Georgia is called Colchis (this name, as is known, was aquired from Greek mythology). The border of Colchis follows the Caucasus watershed range to the north, then passes through the Likhi range to the Adjara-Imereti and Shavsheti ranges, and ends at the estuary of the river Chorokhi, the Black Sea coast to the south. Sometimes Colchis is understood more strictly as only the Colchis lowland.

1.3 Terrain

The first more or less complete description of the geography of Georgia, along with the customs, landscapes, history, flora and fauna of different parts, from ancient times to the first half of the 18th century, was given in 1745 by the famous Georgian geographer, cartographer, historian-ethnographer and traveler Vakhushti Batonishvili (1696-1757) in the well-known work "Description of the Kingdom of Georgia" (Vakhushti Batonishvili, 1941). Many authors emphasize that Georgia's terrain has a diverse and complex morphology (Javakhishvili, 1926; Maruashvili, 1969, 1975; Gobejishvili, 2011; Tielidze, 2017). The diversity comes from the elevational zonation and exodynamic features, and the complexity comes from the geotectonic nature. Three morphostructural units are distinguished: 1) medium and high mountain zone of the Great Caucasus; 2) the intermountain lowland, and 3) the mountainous area of southern Georgia, i.e. the Lesser Caucasus. The terrain consists of high (> 4000 m a.s.l), medium and low mountains, plateaus and plains. The main orographic units have branches of various size. Vertically, the territory of the country extends from −1.5-2.3 m (territory between Poti and Kulevi swamps) to 5203 m a.s.l. (Mt. Shkhara on the Great Caucasus). Several peaks of Great Caucasus exceed 5000 m a.s.l. and are covered with permanent snow and glaciers. The Great Caucasus is divided into three sections by morphological and morphometric features: the Western Caucasus (from Mt. Avadhara to the Dalari pass), the Central Caucasus (from the Dalari pass to the Jvari pass) and the Eastern Caucasus (from the Jvari pass to Mt. Tinovroso). The maximum height of the southern mountainous area of Georgia (part of the Lesser Caucasus within the country) is about 2850 m a.s.l. More than 81.3% of the territory of Georgia is above 400 m a.s.l., and about 55% above 1000 m a.s.l. The southern slope of the Great Caucasus is divided into side ridges by river gorges. In the intermountain spaces there are lowlands (Colchis, Shida Kartli and Kvemo Kartli), plateaus, ridges and hills. The area of the triangle-shaped Colchis lowland is 13,000 km^2. It starts from the Black Sea and rises to the east of Imereti with the highest part of the Imereti plateau, the Likh ridge. To the east

the lowland is bordered by the Shida Kartli plain, its lowest parts are located at 750 m a.s.l. The Likhi range connects the Great Caucasus with the Meskheti range of the Lesser Caucasus. In addition, the Likhi ridge is a natural border (including climatic border) between eastern and western Georgia.

1.4 Climate

The earliest information about the climate of Georgia, as well as its geography, can be found in works by Herodotus and Hippocrates (the 5th century B.C.), who emphasized intolerability of the very humid and hot weather of Colchis, noted that the country has abundant swamps and a characteristically large amount of precipitation. According to Strabo (the first century B.C.), the air in Kartli and Hereti is dry, while in Kakheti it is soft and quite pleasant for life. Procopius of Caesarea (the 6th century B.C.) characterizes the weather of Javakheti as a long dry winter and short warm summer (cited by Elizbarashvili, 2017).

The long-term history of studies of the climate of Georgia, its features and connections with various factors are discussed in many works (Vakhushti Batonishvili, 1941; Kordzakhia, 1961; Kordzakhia, Javakhishvili, 1971; Climate of Georgia, 2003; Elizbarashvili, 2007, 2017, etc.). The diversity of Georgia's weather is emphasized as well as the fact that in a relatively small area numerous climatic zones are represented, ranging from humid subtropical to the eternal snow and glacier zone. The reasons for such a diversity are also given: 1) the location of Georgia on the border of the subtropical and temperate climate zones (this border runs along the main watershed ridge of the Great Caucasus), which contributes to the formation of almost all climate types of the subtropical zone; 2) natural barriers – the Great Caucasus Range and the Lesser Caucasus (protect from the invasion of cold air masses from the north and hot and dry air masses from the south); 3) a number of sublatitudinal and latitudinal ridges (Gagra, Bzipi Kodori, Egrisi, Racha, Likhi, Adjara-Imereti, Arsiani, etc.), which stop humid air from the Black Sea and make it condensate on the slopes facing the Sea, and 4) The influence of the Black Sea, which not only produces a large amount of moisture, but also neutralizes temperature fluctuations. Ridges of different heights and directions create local climatic differences in some places.

The air type of the southern part of the Black Sea coast (Adjara, Guria) is excessively humid subtropical. The weather in the northern part of the coast (Apkhazeti) is humid subtropical, as in the inner plains of western Georgia. In the Colchis mountains (mountains of Apkhazeti, Svaneti, mountainous Adjara-Guria) the climate is humid. On the Imereti plateau, signs of humid subtropical air remain, although less pronounced. The climate in Shida Kartli and Kvemo Kartli plains is dry subtropical. In the Kakheti region (Alazani Valley and surrounding Caucasus foothills) the weather is moderately humid subtropical. Dry continental climate prevails on the Iori plateau and in Meskheti. The weather on the Javakheti plateau is continental.

The entire territory of Georgia, with the exception of Adjara and certain parts of the Great Caucasus, are characterized by a large number of sunlight hours exceeding 2000 hours per year. The maximum is observed in summer, and is the highest, up to 348 hours in the Gardabani region. Long sunshine duration is typical for the Black Sea coast (Poti-Sokhumi section), Kvemo Kartli, Kakheti (Alazani valley, Shiraki) and mountains of southern Georgia (Elizbarashvili, 2017).

The configuration of the ranges and, namely, those of the Great Caucasus, has a significant influence on the trajectory of the circulation of air masses. Therefore, western and eastern winds predominate. The invasion of air masses from the Black Sea causes a drop in temperature, strong winds and thunderstorms. At this time, the amount of precipitation ranges between 60-430 mm western Georgia, and between 2-160 mm in the eastern part. With the invasion of air masses from the Caspian Sea into eastern Georgia, the temperature drops, clouds form, and precipitation increases, including horizontal precipitation (i.e., fog). While weather is clear and warm in western Georgia. Bidirectional intrusion of air masses (from the west and east) is a very rare phenomenon. At this time, up to 130 mm of precipitation falls in western Georgia, up to 80 mm in the east (Javakhishvili, 1981; Elizbarashvili, 2017). The decrease in annual

precipitation from the Black Sea to the east is accompanied by a decrease in the average winter temperature (from 4°C on the Colchis lowland to 0-2°C on the plains of eastern Georgia) and an increase in summer temperature (from 13-15°C in the Colchis lowland to 22 – 24°C on the Iory plateau), i.e., the continentality of the climate increases from west to east. Since the terrain of Georgia is mountainous, the climate, in particular the temperature, varies greatly with elevation. In the highlands, the average temperature is much lower: 3.4°C (Bakhmaro, 2050 m a.s.l.), −2-3°C (Mt. Mamisoni, 2854 m a.s.l.), 4.9°C (Kazbegi, 1800 m a.s.l.), and −5.1°C (Kazbegi, 3656 m a.s.l.). The absolute minimum temperature in Georgia is −42°C (Kazbegi, 3656 m a.s.l.). Very low temperatures are also observed in other mountainous regions: −41°C (Javakheti), −40°C (the village Kherga in the Shaori basin, Racha), −38°C (Jvari pass), −36°C (Bakuriani). In coastal regions, the minimum temperature does not fall below −10°C. The absolute maximum temperature (43°C) was recorded in Charnali (Khelvachauri municipality, Adjara), Lata (Apkhazeti) and Zestaponi (Imereti). High maximums were noted on the Kvemo Kartli plain, Alazani valley (42°C), Racha (41°C), Kutaisi (40.4°C), on the Iori plateau (40°C), in Tbilisi (39.8°C). Mountainous terrain also causes differences related to exposure: for example, on the southern slopes, spring can begin 2-3 weeks earlier than on the northern slopes.

Western Georgia is characterized by abundant atmospheric precipitation, especially on the coast of Adjara: 3145 mm (in Sarpi) and 2718 mm (in Batumi) per year. The maximum was recorded on the seaward slope of the Chakvi ridge, on Mt. Mtirala (1200 m a.s.l.), where the average annual precipitation is as high as 4500 mm, and in some years even more. For example, in 1897, the amount exceeded 5000 mm. Thus, the mountain is the “precipitation pole” of the region. In the coastal zone of Guria, bordering Adjara, the amount of precipitation decreases to 2000-2400 mm, and in Apkhazeti it does not exceed 1600 mm. In the interior parts of the Colchis lowland, the annual precipitation is 1200-1400 mm. The maximum amount of precipitation in a day (352 mm) was recorded at the village Jurukveti located on the Guria lowland at 0-30 m a.s.l. The influence of landform, gorge extension and slope exposure is reflected in the distribution of precipitation. For example, in sections of the Kodori, Enguri, Tskheniskali gorges of latitudinal direction, the amount of precipitation is 1000-1200 mm. On the other hand, on the slopes of the Bzipi, Kodori, Egrisi and Racha ranges facing the sea, precipitation is especially heavy (up to 2800 mm). Eastern Georgia is characterized by low precipitation: 650-1080 mm on the Alazani valley and Lagodekhi region, 500-800 mm on the Shida Kartli plain, 400-600 mm on the Kvemo Kartli plain. Particularly low precipitation (400-500 mm) falls on the Iori plateau, and its southeastern part (the Eldari valley), which is the “drought pole” of Georgia (375 mm). In the middle zone of the Caucasus mountains the amount of precipitation increases to 1000-1200 mm, and in its high mountainous part up to 2000 m. Southern part of Georgia is characterized by a small amount of precipitation (500-600 mm at the in the upper reaches of the river Khrami, on the Akhalkalaki plateau, 500-700 mm in Meskheti). Here, the highest amount of precipitation (1200 mm) is observed in the western part of the Trialeti range. The amount of precipitation does not always increase along with rising elevation. In some places (Javakheti plateau, Svaneti, etc.) it even decreases. The northern slopes of the Caucasus are characterized by continentality and moderate humidity. The maximum amount of precipitation is observed at 300-500 m to 3500 m in western Georgia, and at 1200-3500 m in eastern Georgia. Due to the complex orography and prevailing atmospheric circulation processes, the maximum precipitation in western Georgia occurs in winter or autumn, the minimum in spring or summer. In eastern Georgia, the maximum precipitation falls in early summer, the minimum in winter.

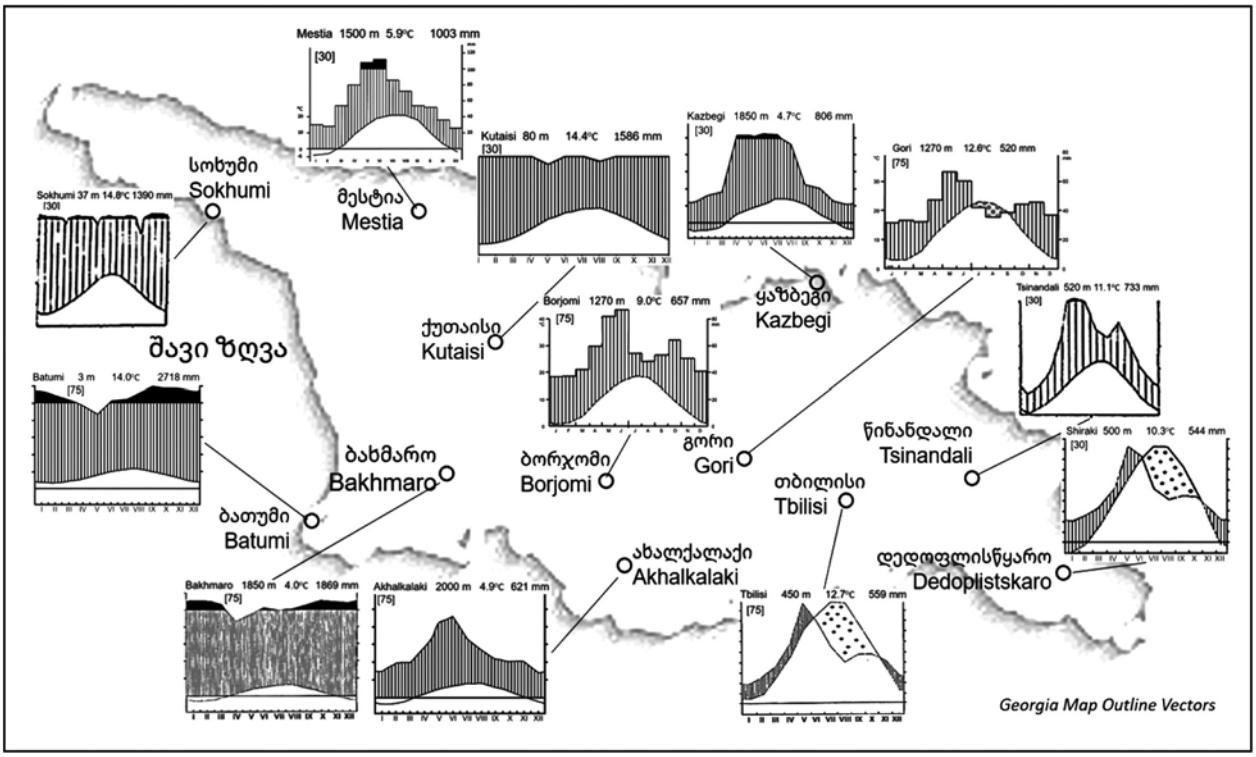


Fig. 1. Climate diagrams for various geographic locations in Georgia.

In the mountain forest region of western Georgia, the average annual temperature does not exceed 11-12°C, and the amount of precipitation exceeds 2000 mm. In the mountains of eastern Georgia, the average temperature is 10°C, the amount of precipitation reaches 1000-1500 mm. The winter minimum in eastern Georgia is −15°C, and in the western part of the country −20-25°C. At the treeline, the difference between the western and eastern parts of the country is no longer very obvious. The highlands are characterized by more severe climate; in the subalpine and alpine zones, the amount of precipitation is higher in the west (2114 mm at Klukhori pass) than in the east (1477 mm in Gudauri, 1190 mm in Kobi). This is also the reason for the high snowline in the eastern part of the Great Caucasus. Compared to the Western Caucasus, in some places it passes 1000 m higher.

Attention should be paid to the following circumstance: in Adjara-Guria, as in Colchis in general, survival of semi-prostrate shrubs of the Colchic undergrowth as well as the subalpine crook-stemmed forest outside Colchis depend on suffiecient and seasonally long-term snow cover. The snow cover protects the chionophyte plants against freezing and fading in winter, as well as against photoinhibition in conditions of rapid snowmelt in early spring (Larcher, 2003; Körner, 2021).

The climate diagrams for various geographic locations in Georgia shown in Figure 1 reflect a fairly wide variety of climates in a relatively small area.

1.5 Soils

A large elevationl range and diverse climatic conditions determine the existence of many types of soils in Georgia. In Georgia's soil classification scheme, three soil regions (western, eastern and southern), 18 soil types, and 45 subtypes are distinguished. The western Georgian soil region extends from the Black Sea coast to the Likhi range. It is divided into: lowland bog soils (peat bog and silty bog soils in the western parts of the Colchis lowland) and podzols (in the elevated eastern parts of the lowland), foothill red-yellow soils (in hilly terrain), mountain forest soils (in a large area of the middle mountain zone, where the main type is brown forest soils) and mountain meadow (in the subalpine and alpine belts) soil zones. The eastern Georgian soil region includes plains, foothills and mountains from the Likhi range to the eastern border of the country. Cinnamonic and chernozem soils (the latter are characterized by a powerful humus horizon) occupy the zone of steppes (Didi and Patara Shiraki), grey cinnamonic soils – the Eldari valley and the southern part of the Iory plateau. The zone of forest-steppe and forest soils includes the lowlands of Kartli and Alazani, as well as part of the Iori plateau. Mountain forest soils are common in the Caucasus, in the Trialeti and Loki ranges. The soil region of southern Georgia includes the lands, plains and ranges of Javakheti, Tsalka, Gomareti and Dmanisi. Mountain chernozems, meadow chernozems are common here. The process of soil formation and soil diversity is significantly influenced by the anthropogenic factor such as reclamation and agrotechnical measures (Sabashvili, 1965; Urushadze, 1997).

CHAPTER 2. BRIEF HISTORY OF FOREST VEGETATION IN GEORGIA

The history of forest vegetation in Georgia is considered in the context of the history of the flora and vegetation of the country, still insufficiently studied despite intensive paleobotanical research (Grossheim, 1948; Kolakovsky, 1974; Shatilova et al., 2012; Nakhutsrishvili, 2013).

The Palaeozoic Era. The earliest fossil flora on the territory of Georgia dates back to the Paleozoic era, namely the Lower and Middle Carboniferous periods. These are 13 species from seven families, including *Lepidodendron dichotomum* (Lepidodendraceae), a tree up to 40 m tall with the trunk diameter up to 2 m, *Mesocalamites ramifer* (Calamitaceae), *Asterotheca miltonii* (Asterothecaceae) and others. Their remains were found in the Khrami gorge. Findings of seed-producing ferns of the genus *Cordaites* (Cordaitaceae) belong to the same period. This group of plants had a strong, straight stem, the structure of which was similar to that of the modern conifers (Shatilova et al., 2012).

The Mesozoic Era. In the Lower Jurassic period, almost the entire territory of Georgia, with the exception of the Khrami, Loki and Dzirula massifs, was covered by sea. The climate was moderately warm (temperature 23-24°C), but later it became rather cold (7-15°C). During this period, horsetails and ferns were particularly widespread. The only species of Calamitales found in the sediments was *Neocalamites hoerensis*. Horsetail species were widespread in Lower Jurassic wetland habitats as they are in the modern times (Svanidze, 1972). Already at this time, vegetation differentiated on the territory of Georgia: several vegetation types forming specific landscapes developed (mangroves, swampy plains, dry plains, foothills and deep valleys and canyons) confined to specific topography.

In the subsequent Middle Jurassic period, the entire territory of Georgia was covered by water. At the end of the Jurassic period, first the eastern part and then the western part gradually uplifted. Formation of freshwater reservoirs and an intensive process of peat accumulation were characteristic to this period (Kakhadze, 1947). The flora of the Middle Jurassic was much richer than that of the Lower Jurassic. It was tropical with high degree of probability. The forests were dominated by cycads and ginkgos. The *Ginkgo* genus was represented by two species (*G. mziae, G. huttonii*). A group of the ancestors of flowering plants, Bennettitales was abundant. Microfossils of other plant groups were also found (Svanidze, 1972; Shatilova et al., 2012).

In the Upper Jurassic, Georgia with the exception of the territory of modern Svaneti and the south of the country, was still covered with water. At the end of the Jurassic, the intermountain region of the Caucasus turned into a landmass with predominantly low terrain. During this period, the role of the families Araucariaceae and Taxodiaceae increased. The territory of Georgia was covered with forests of *Araucaria* and *Pagiophyllum*, which indicates the low humidity of that time. Nevertheless, the role of ferns in the vegetation increased. These were mainly representatives of the genus Cladophlebis (Osmundaceae) together with Taxodiaceae species in humid habitats. *Angiopteris iberica* (Marattiaceae) is recorded in the fossil flora of the Upper Jurassic. It is worth noting that these archaic ferns disappeared from the flora of the Northern Hemisphere already in the Middle Jurassic. The Late Jurassic flora of the Caucasus was characterized by a wide representation of Equisetoides, ferns, Ginkgoales, the absence of *Czekanowskia*, the dominance of Cycadales and Bennettitales, as well as the abundance of *Pachypteris, Sagenopteris* and *Pagiophyllum*.

In the Upper Cretaceous period, representatives of the genera *Sequoia, Comptonia, Platanus, Fagus* and *Lauracea* became the main components of forests (Shatilova et al., 2012).

In general, two groups are distinguished in the Mesozoic flora: 1) taxa, the period of dominance of which was limited to the Jurassic, and only a few of them continued to exist in the next Cretaceous. After this, Mesozoic plants almost completely became extinct, although some taxa still exist today, for example, *Equisetum,*

Osmunda, Araucaria, Sequoia, Ginkgo; 2) Plants that occupied a subordinate position in the Mesozoic, started to flourish in the Cenozoic era. Some of them still exist in the Colchis refugium and exhibit the relict nature of its flora (Shatilova et al., 2012).

The Cenozoic era. At the beginning of the Tertiary period, i.e. Paleocene, and in the subsequent Eocene, the Caucasus was a part of the Tethys Sea. Numerous islands that divided the Tethys Sea into separate basins formed one large long island. Later it became the main range of the Caucasus. At that time, the dominant position (66%) was already occupied by angiosperms (Myricaceae, Juglandaceae, Fagaceae). Among others, they were represented by evergreen beeches. The proportion of gymnosperms was only 25% of the flora, and that of the spore-producing plants was 9%. It was in the Eocene that a group of plants arose that gave rise to the formation of modern flora. At the same time, there migration of boreal cold-resistant plants was in progress, stared already in the Cretaceous period and resumed at the end of the Eocene. At the beginning of the Eocene, forest was the dominant vegetation type on the territory of Georgia. Along the elevation gradient, the plant cover had the following structure: 1) tropical (or subtropical) broad-leaved forest (*Celtis* sp., *Ailanthus, Cedrela, Meliosma, Ziziphus*) with sclerophyllous plant communities (of *Myrica, Echitonum*), in conditions of suitable terrain and mesoclimate; 2) evergreen rainforests (of *Podocarpus, Engelhardia, Dryophyllum, Castanopsis, Daphnogen, Laurophyllum, Phoebe*); 3) deciduous and coniferous forests of the temperate zone (*Pinus, Picea, Abies, Keteleeria, Cedrus, Betula, Corylus, Cornus, Tilia, Acer*).

The Oligocene is considered the beginning of the formation of the modern Caucasus terrain. The intermountain depression between the two mountain systems of the Caucasus was covered by the sea. The Great and Lesser Caucasus were areas of runoff, and only in some places small isolated reservoirs of the lagoon type were preserved (for example, in the Akhaltsikhe basin). Uplifted terrain supported increase in abundance of coniferous species, and the group of moderately thermophilous plants became more diverse. The number of extremely thermophilous species decreased. Tropical flora was well developed on numerous small islands. In western Georgia, in the area of modern Chiatura, remains of coniferous species (pines) were found in Oligocene deposits, which indicates migration of taxa distributed in the north to the Caucasus (Tumajanov, 1955; Shatilova et al., 2012; Nakhutsrishvili, 2013).

In the Lower and Middle Miocene, two large landmasses existed on the territory of Georgia, now known as the Great and Lesser Caucasus, and several small islands in the intermountain depression. The entire flora had a xerophytic appearance. The majority were legumes. In conditions of low humidity in eastern Georgia, laurels and evergreen beeches continued to thrive in the Lower Miocene, forming moist subtropical forests in the Paleocene. In wetter habitats along riverbanks, temperate plants grew suchas *Quercus*, and *Myrica*. In the Middle Miocene, the Great and Lesser Caucasus formed into mountain systems, while the plain area between them downlifted. Evergreen and deciduous forests were common, with ferns in the undergrowth. Of the remarkable fern diversity of that time, only *Hymenophyllum* survives nowadays. Among the gymnosperms of that period *Ginkgo, Podocarpus, Dacridium, Cataia, Keteleria, Cedrus, Pinus* were the most common. Less common were *Pikea, Tsuga, Taxodium, Cryptomeria, Sequoia*. Angiosperms were characterized by great diversity mostly represented by *Comptonia, Myrica, Tricolporopollenites, Platicaria, Engelhardia, Momipites*. The Middle Miocene floras of Georgia and the Mediterranean, unlike the Paleocene, were no longer the same.

In subsequent eras, floristic differentiation deepened. Western Georgia became an isolated region with high mountains. Although plant communitues similar to the previous periods still thrived but their area, composition, the dominant role of individual species and patterns of distribution were different. In particular, the role of conifers increased significantly. The area of polydominant forests decreased. Subtropical communities occupied the coastal plains and lower belt with suitable conditions for their survival. At a higher

elevations, the subtropical forest gave way to the temperate one, semi-hygrophilous vegetation extended its distribution range, the role of pines increased, which was related to climate change. In general, the vegetation retained the characteristics of the previous eras, but at the same time acquired new ones. At the end of the Miocene (about 7.1 million years ago), the vegetation of western and eastern Georgia was more or less separated for the first time. One-third of the flora of modern Apkhazeti was subtropical and well reflected the nature of the vegetation of the plains, riparian forests and lower montane belt. *Quercus codorica* and *Carya denticulata* dominated in lowland forests. Wetlands were dominated by *Alnus subcordata* and *Salix varians*. In the same region, but in a later period, the flora was poorer, which can be explained by climate. Because of this, a number of subtropical species became extinct. In many families (Fagaceae, Lauraceae, Berberidaceae, Aristolochiaceae, Hamamelidaceae, Araliaceae, Fabaceae, Anacardiaceae, Aquifoliaceae, Arecaceae) the number of genera decreased. Evergreen vegetation still occupied a significant area. In the polydominant forests of this period, plants adapted to temperate climates are found. Among them, three groups should be noted: 1) types of monsoon climate species, characteristic to the mountains of modern Asia; 2) moisture-loving species, ecologically close to species common in the plains and riparian forests of America; 3) Cold-resistant, but summer-loving plants, ecologically close to the components of the Mediterranean subtropical forests. In eastern Georgia (Shiraki plain), the existence of two types of vegetation is assumed: 1) riparian forests (*Alnus hoernesi, Populus populina, Acer saliense, Ulmus carpinifolia, Zelkova ungeri*) and 2) arid vegetation (open forest, shiblyak and maquis type of vegetation with evergreen and deciduous species: *Laurus, Quercus, Phillyrea, Pyracantha*).

Among the fossilized flora of the Tertiary period, it is worth noting the fossil forest in the upper reaches of the Goderdzi gorge, the municipalities of Adigeni and Khulo, within 1600-2100 m a.s.l. Here, a million years ago, a powerful volcanic eruption buried a diverse and impenetrable tropical forest, represented by evergreens (palms, camphor trees, laurel, magnolias, arachnids) and deciduous trees (figs, maples, oaks, hemlocks, birches, willows, beeches), shrubs, vines and ferns under the ashes. The remains of the Tertiary flora are represented by petrified tree trunks, branches and leaf imprints. Many fossilized remains have preserved annual rings. Currently, about 90 species have been identified here. This is one of the richest and best studied fossil floras of Georgia (Shatilova et al., 2012; Makadze et al., 2019).

At the border of the Tertiary and Quaternary periods, at the end of the Pliocene and the beginning of the Eupleistocene, the climate in western Georgia changed: humidity increased, temperature became unstable. Accordingly, the areas of polydominant and coniferous forests changed. There were two reasons for the change: 1) the formation of mountainous terrain and the emergence of new ecotopes with favorable conditions for conifers (today the optimum for conifers is between 1400-1900 m); 2) a decrease in temperature and an increase in humidity, which contributed to a elevational descent of conifers. In polydominant forests, representatives of Taxodiaceae predominated: *Fagus, Quercus, Zelkova, Carya, Carpinus*. The role of cedar and other thermophilous conifers weakened. The dominant species in riparian and wetland forests were: *Taxodium, Pterocarya, Ulmus, Alnus* and others. In the early Holocene, the level of the Black Sea was 50-60 m lower, and the treeline was also 800-850 m lower. *Tilia, Quercus, Castanea* and *Pterocarya* increased in area during this period, indicating warm and humid conditions. Later, the warming stopped, the sea level dropped by 1-1.5 m, and the lower boundary of the forest also descended. *Fagus* and *Abies* forests spread. Further, the so-called Atlantic period (lasting 3000 years) was characterized by a rapid upward shift of plant belts. The area of the wetlands expanded, reaching its maximum at that time (6000 B.C.). The climate also warmed up intensely in the mountains. In Apkhazeti, Svaneti and Adjara, the upper boundary of the forest ascended by 300 m, and in the highlands of southern Georgia by 500 m. It was during the Atlantic period that

agricultural settlements arose. *Alnus, Pterocarya, Tilia*, and *Quercus* grew in place of modern steppes. At that time, agriculture, horticulture, viticulture and beekeeping were well developed on the Javakheti plateau at elevations between 2000-2800 m. At that time, linden and Georgian oak grew here, which are now found only up to 1700-1800 m. During the Atlantic period, long-term warming was twice interrupted by short-term cooling. This phenomenon is well illustrated by the treeline and the sea level variations. Then the climate cooled sharply and the treeline lowered by 600 m. The range of thermophilous species decreased. Along with the temperature, the humidity dropped as well. About 3,800 years ago the climate changed again and the sea level reached that of the modern times. Warming affected not only the plains, but also the high mountain plateaus of southern Georgia. 2500 years ago, a short-term but sharp cooling was observed again, and the treeline dropped by 400 m. After five centuries it became warmer again. In ancient times, flax cultivation, diverse forms of agriculture, horticulture, and viticulture developed intensively. Olive culture came from Greece. This was followed by intensive deforestation on the Colchis lowland. In the 3rd-4th centuries A. D. he climate cooled and then warmed again in the 7th to the 11th centuries. In the 12-14th centuries the climate cooled, but in the 15-16th centuries it warmed up. In addition to viticulture, olives were still grown not only on the Colchis lowland but also in the headwaters of the river Khrami. This significant warming continued for 200 years, and in the second half of the 17th century the so-called minor glaciation occurred. Frost destroyed olive plantations. The Holocene climate of Georgia was similar to that of Southern Europe and the Middle East. This is an indication that climate fluctuations were global in nature.

Thus, in the history of the development of Late Cenozoic vegetation in Georgia, three intervals are distinguished: 1) dominance of subtropical vegetation; 2) a transitional period, when the vegetation retained its previous composition, but renewal tendencies were already noticeable: the beginning of the division of polydominant forest into separate communitis and their redistribution on the area; 3) the emergence of new features characteristic to modern vegetation. It was during this interval that the extinction of the Tertiary's relicts ended, although some of them continue to exist in the flora of Colchis today, since, despite the glaciation of the Quaternary period, favorable conditions for the existence of ancient flora (thriving in humid and warm climate) were preserved in Colchis and Hyrkan (Azerbaijan, Iran). This is a large refugium for the relicts of the Tertiary, or more precisely, Neogene in Western Eurasia. Many trees, shrubs and vines, as well as herbaceous plants, long extinct in Western Eurasia, take refuge here. They survived the most difficult conditions of the Pliocene and Pleistocene and occupied important phytocenological positions in Colchis. These are evergreen shrubs: *Rhododendron ponticum, Laurocerasus officinalis, Ilex colchica, Ruscus colchicus, R. ponticus*; in the subalpine zone there is also *Rhododendron caucasicum*. The species form the undergrowth at different levels of the Colchic forests. *Buxus colchica* grows in the second layer of the forest on calcareous soils. The characteristic elements of the Colchic undergrowth are evergreen vines: *Hedera colchica* and *H. helix*. Deciduous relict shrubs of the Neogene also participate in the Colchic evergreen undergrowth: *Rhododendron luteum, Vaccinium arctostaphylos, Staphylea colchica, S. pinnata, Sambucus nigra, Philadelphus caucasicus, Viburnum orientale* and others (Grossheim, 1948; Tumajanov, 1955; Kolakovsky, 1964, 1974; Kolakovsky, Shakril, 1976; Shatilova et al., 2012; Nakhutsrishvili, 2013).

CHAPTER 3. DEFINITIONS OF NATURAL FORESTS

Much of Europe's forests (primarily lowland and foothill forests) have been subject to significant anthropogenic pressure for millennia: forest habitats are becoming increasingly fragmented, more areas are cleared for crops, more timber is being cut down, more areas are being grazed by livestock, more introduced plants change the natural species composition of forests (Birks et al., 1988; Salbitano, 1988; Kirby and Watkins, 1998; Alexander et al., 2003; Knapp et al., 2021). Extensive anthropogenic impact has significantly altered natural processes. Thus, 35% of the Earth's ancient (pre-agricultural) forests no longer exist. The remaining forests cover approximately 4 billion hectares in tropical, temperate and boreal zones (Mackey et al., 2014; Kormos et al., 2018). Of these, only 1.3 billion hectares (32%) are natural forests (Morales-Hidalgo et al., 2015). Thus, natural forests have priority conservation value not only because they contain enormous biodiversity (Mackey et al., 2014), but also because they are culturally and spiritually important to the local communities and peoples who call such forests home (Diaci, 1999; Kormos et al., 2018). Thus, conservation of natural forests is a global goal (FAO, 2012).

Before characterizing the main types of natural forests in Georgia, we consider it appropriate to clarify what the term "natural forest" means. In English-language literature it has several equivalents: "Old forest", "Virgin forest", "Primeval forest", although nuanced, sometimes formal differences still exist (Parviainen, 2005). *A natural forest is one that has reached old-growth state without significant disturbance and thus has unique ecological characteristics and can be classified as a climax community.* Such a forest contains many structures associated with trees and plants that define many wildlife habitats. This helps to increase the biodiversity of the forest ecosystem. The concept of diversity of forest structure includes large and aged trees, standing and fallen dead trees, undergrowth, multi-layered forest canopy and open spaces between them (so-called forest glades), as well as various tree species and considerable amount of the litter (White and Lloyd, 1994). What would be the best indicator of a natural forest? It is believed that these may be large number of old trees. Biodiversity is richer in such habitats. Natural forests should be characterized by saproxylic, mycorrhizal and epiphytic communities, the presence of which indicates the long existence of such a forest (Butler et al., 2001).

According to WWF and IUCN, *a natural forest is a forest that has not been affected by human influence* (http://www.cbd.int/forest/definitions.shtml).

A more detailed definition of the term was given at the 1996 at MCFPE conference: *it is a forest that has never been subject to human intervention, and its structure and dynamics reflect natural development*. *The soil, climate, flora, fauna and life processes of such forests have not been disturbed or altered by logging, grazing or other direct or indirect human intervention* (Alexander et al., 2003).

The term "old forest" originated in the western United States in the 1900s. It was first used by loggers for late successional forests of large-trunked trees over 350 years old. In the 1980s in the United States and Canada, this term gained great importance in a long and heated debate between environmentalists, foresters, bureaucrats, politicians and wildlife lovers. Ultimately, old forests were linked to the level of biodiversity, and in 1989 the USFS developed the following definition: *An old forest is an ecosystem characterized by old-growth trees and associated structural characteristics such as tree and root size, number of forest layers, species composition, ecosystem functions* (Lund, 2001; WWF, 2001; Alexander et al., 2003).

FAO considers *natural forests to be those forests whose dynamics are similar to the natural species composition, age structure and regeneration processes of trees*; *it is characterized by sufficient geographical extent and no known human disturbance, or the last significant disturbance occurred so long ago that no trace of it remains in the forest* (FAO, 2012).

Thus, the term “natural forest” emphasizes several factors: the presence of large-trunked deciduous trees; natural processes of aging and decay; presence of species dependent on large old-growth trees; and the most important thing is the long-term preservation of the forest cover. It should also be noted that the degree of human impact is a complex continuum. Often, even seemingly “natural” forests are subject to negative anthropogenic impacts, whether from ancient indigenous populations or pollution from modern developed societies. Natural forests, preserved from ancient times without human intervention, are the most ecologically important forests on earth. About 1/3 of the world’s forests fall into this category.

CHAPTER 4. METHODS

4.1 Study design

Natural / close to natural forests of Georgia were studied in 2019-2022 in various historical-geographic regions of Georgia (Fig. 2). In total, the study was carried out in 10 regions (the numbers of forest plant communities studied are indicated in brackets): Adjara (11), Guria (18), Samegrelo (7), Svaneti (13), Racha-Lechkhumi (11), Samtskhe-Javakheti (5), Kvemo Kartli (2), Kartli (2), Khevi (6) and Kakheti (10). In total, 85 forest communities were studied with more than 500 species of vascular plants recorded.

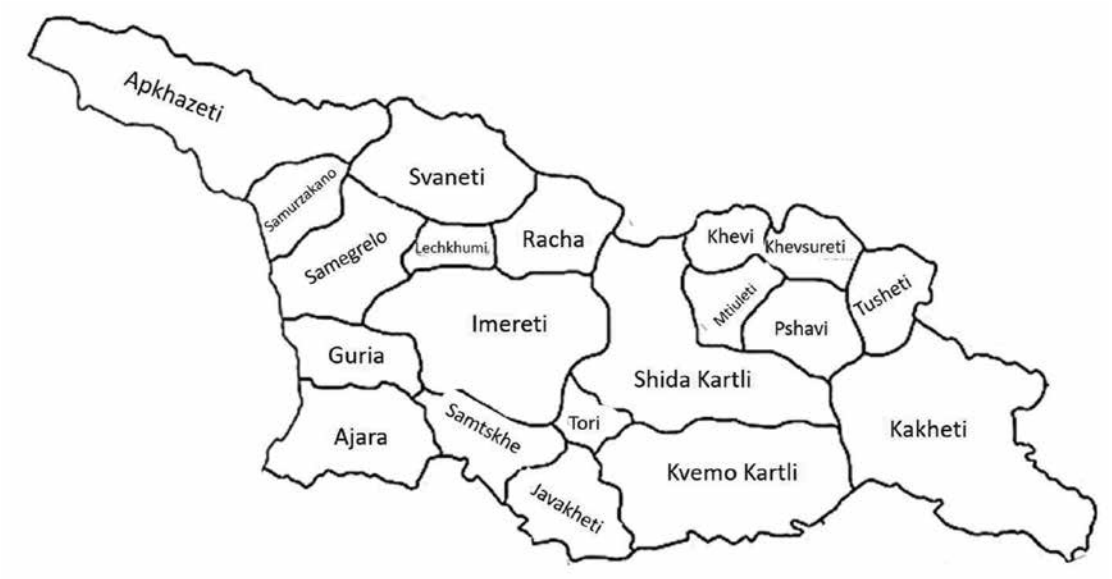


Fig. 2. *Historical-geographic regions of Georgia.*

The aim of the research was to survey as many natural / close to natural forest stands of at least 0.5 ha area of every possible forest type known in Georgia, which would not necessarily encompass all the historical-geographic regions. Some forest types were surveyed several times in different or the same regions, which enabled us to see differences in the species spectrum.

The same type of forest was simultaneously studied from both botanical-ecological and forest science assessment points of view.

4.2 Species identification

Botanical nomenclature follows “The Flora of Georgia” (1971-2013) and the “Nomenclature List of the Flora of Georgia” (2018). The appendix contains a list of species arranged in alphabetical order according to the international nomenclature (GBIF – Global Biodiversity Information Facility) with corresponding synonyms used in the book.

Georgian names of plants mentioned in the text (in the Georgian version of the book only) are given according to A. Makashvili's "Botanical Dictionary" (Makashvili, 1991).

The species were identified according to the "Key of Georgia's plants" (1964, 1969). Problematic species were identified by comparison with specimens preserved in the Herbarium (TBI) of the Institute of Botany of Ilia State University.

4.3 Determination of forest type

The forest type/subtype was determined according to the principle of dominance of the woody plant species, that is, by the name of the dominant tree species in a particular forest layer (Dolukhanov, 2010). For example, a forest dominated by *Fagus orientalis* was named beech forest (Fagetum), and a forest dominated by beech with hornbeam, but the latter present in relatively low abundance, was called Carpineto-Fagetum. The same principle was used to determine understory/grass cover. In cases when the dominance of one tree species (for example, beech) was obvious (others were present in small numbers only in a form of scattered individuals) and the undergrowth was made up of well-formed shrub (e.g., *Rubus*) or herb (e.g., *Festuca*) cover, then it was named accordingly Fagetum rubosum or Fagetum festucosum, respectively.

4.4 Characteristics of forest types and phytosociological relevés

A "typical site" of a given natural forest stand was selected with the area of 400 m^2 (20 x 20 m) using standard techniques (Fujiwara, 1986; Box, 2015). At this site, both adult and young individuals of all tree species were identified and the height of adult trees was determined. Shrubs and herbaceous cover were surveyed in five 25 m^2 (5 x 5 m) plots arranged in the envelope-shape manner within the 400 m^2 plot (Fig. 3).

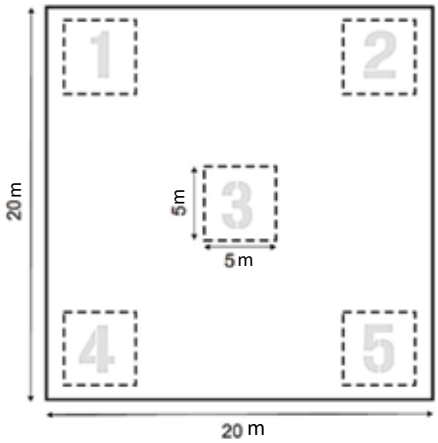


Fig. 3. *A general scheme of the experimental plot arrangement (tree species were recorded on 400 m^2; shrubs and herbs on five plots 25 m^2 each; along with standard relevé data, the ground surface cover (%), the litter thickness (cm) and dry weight (g), soil pH were determined.*

A forest type description fild data form along with species composition and cover, layer structure, heights of trees, shrubs and herb cover, also included ecotopological data (study area, GPS coordinates, landscape type, elevation, slope aspect and inclination). In addition, soil pH, litter thickness and dry weight, and percent cover of bare soil, rock, litter, deadwood, cryptogams, and plants were determined.

Coordinates of the study area and elevation were determined using GPS devices (Garmin, SummitTM, Switzerland). Slope aspect and inclination were determined using a compass-clinometer (Recta DP 6TM, Switzerland) in triplicate.

The landscape type was determined according to the following scheme: 1 – valley, 2 – ravine, 3 – lower part of the slope, 4 – upper part of the slope, 5 – middle part of the slope, 6 – mountain top, 7 – plain area, 8 – rocky area.

Soil pH was determined at a depth of 20 cm in the rhizosphere. The material was taken from each of the 25 m^2 quadrats where shrubs and herbaceous cover were recorded. The soil pH was determined in the laboratory of Ilia State University using a pH meter (IQ150 pH/mV/Temperature Meters, IQ Scientific, Spectrum Technologies Inc. USA) according to standard methods (Ji et al., 2014).

The litter thickness (from the surface to the humus layer) was measured in the field with centimeter ruler, on each of the 25 m^2 plots in 5 replicates.

To determine the litter dry weight, material was collected from the same plots of 25 m^2, where shrubs and herbs were recorder, from quadrates of 0.25 m^2 in 3 replicates. To determine absolute dry weight in laboratory conditions, the material was dried in an oven (forced air oven, BOV-TF; BIOBASE) at 80°C for 24 hours and weighed. To obtain the dry weight per 1 m^2 data, the results were multiplied by 16.

In each of three 25 m^2 quadrats, the cover of bare soil, rocks, cryptogams, litter, deadwood and plants (except trees) was viaually assessed (Coker and Kent, 1992; Kent, 2011).

Phytosociological descriptions – relevés were collected using the Braun-Blanquet (1964) method. Brown-Blanquet cover indices were determined for each species of trees, shrubs and herbs (including ferns) separately. Each of these can be converted to a corresponding percentage as follows: 5 = 65–100%, 4 = 50–64%, 3 = 25–49%, 2 = 5–24%, 1 = 1–4%, ++ = 0 .5-1%, + = 0.05-0.5%, R = < 0.05%.

4.5 Forest assessment

One of the goals of our research was to undertake forest assessment survey and create a basis for the restoration of forest areas.

- The objectives of the study were to determine the following indicators for each forest type:
- Stand structure;
- Spatial (vertical and horizontal) distribution of trees;
- Wood volume;
- Volume of dry wood (standing and fallen deadwood)
- Natural regeneration (seedlings, saplings)

To achieve the goal, the so-called Cluster approach was used, combining three sampling areas (Fig. 4). In each cluster, sample sites are arranged in the form of the Latin letter “L”. Sampling area No. 2 always represents the center and determines the spatial location of the entire cluster (of the remaining two sampling areas). Sampling area No. 1 is located 100 m north of the cluster center (i.e. sampling area No. 2), and sampling area No. 3 is located east of the cluster center, also at a distance of 100 m. Four layers of a given radius are placed in the sample area. The radius of the first layer is 5 m, the second is 10 m, the third is 15 m and the fourth is 25 m. Trees for measurement are selected based on their location in a layer of a certain radius.

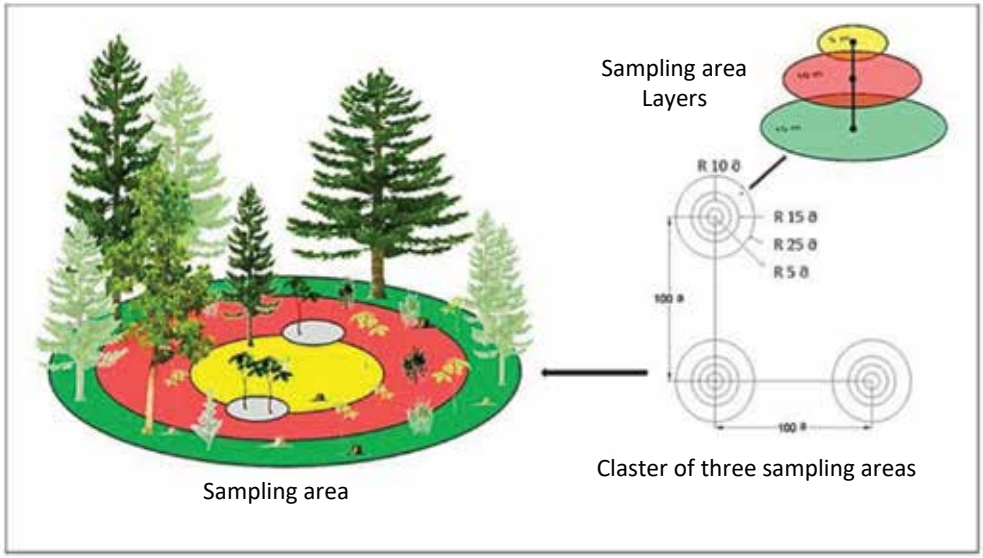


Fig. 4. Design of the cluster and sampling areas.

Field survey included the following components:

- Variables assessed at the cluster level: cluster identification number, field team leader, GPS coordinates of the starting point of movement into the cluster, associated error and time record. These variables are used in work arrangement, the workflow management and assessment of the time spent on work;
- General variables assessed in the sampling area: sampling site identification number, accessibility of the sampling site, forest, or other landcover, GPS coordinates of the center, reference feature information (including reference feature type, azimuth, horizontal distance and photograph), start time of measurements, information about the incomplete sampling area near the forest edge (including forest edge points);
- Variables assessed within 5 m radius from the sample plot: type of vegetation cover (and its percentage), understory woody species, understory cover (percentage), understory height (separately for each tree species);
- Variables assessed within a 15 m radius of the sample: erosion, soil degradation, forest type – landcover component, canopy closure, layers;
- Variables assessed within a radius of 25 m from the sample area: grazing, landscape elements;
- Deadwood assessed in the layers of 5 and 10 m on a samping plot according to diameter classes;
- Seedlings and saplings recorded 5 m north and south of the center of the sample plot, on a sample plot with a radius of 1.5 m;
- Tree unit variables: tree ID number, trunk ID number, tree azimuth, horizontal distance from center to tree, individual tree species, individual tree diameter, growing tree recording, coppice recording, standing dead tree recording, broken tree recording; Individual trees are assessed in 5, 10 and 15 m layers of sampling area according to diameter classes. A woody plant is assessed and measured as an individual tree, if its trunk diameter (at 1.3 m) is equal to or greater than 8 cm;
- Tree height measurement: three trees of per species are measured.

CHAPTER 5. GENERAL CHARACTERISTICS OF THE FOREST VEGETATION OF GEORGIA

5.1 Brief history of research of the flora and vegetation of Georgia

Georgia's complex orography and consequent diversity of its climate and soils, as well as location of the country at the junction of phytolandscapes of different genesis, has led to geographical and ecological isolation of species and plant communities. The isolation resulted in high species and ecosystem diversity and high level of endemism (Grossheim, 1948; Ketskhoveli, 1959; Kolakovsky, 1964; Nakhutsrsihvili, 1966; Dolukhanov, 1980; Nakhutsrishvili, 2013; Batsatsashvili et al., 2020): the flora of Georgia includes up to 4150 species of vascular plants (Flora of Georgia, 1971-2013; Nomenclatural checklist of the flora of Georgia, 2018), about 1400 of which are endemic to the Caucasus; the number includes 275 species endemic to Georgia (IUCN, 2009; www. iucnredlist.org; Solomon et al., 2014).

The richness of Georgia's flora has long attracted attention of botanists from various countries. Botanical studies started at the beginning of the 18th century, with visits of the French and German botanists: J.P. Tournefort (1656-1708) and A. Gundesheimer (1668-1715) to the Black Sea coast of Georgia in 1700-1702 as part of an expedition to southern Europe and western Asia to collect botanical material (Tournefort, 1717). A German artist C. Aubrier (1651-1743) participated in the expedition and created the first collection of sketches of local plants. The first and at that time quite complete data on the flora and vegetation of Georgia were collected and published by Vakhushti Batonishvili (1696-1757) in 1745 (Vakhushti Batonishvili, 1941). Later in 1770-1771 and 1773 a famous Baltic doctor, scientist, traveler and naturalist of German origin J. A. Güldenstädt (1745-1781) traveled in the North Caucasus and various parts of Georgia (Kakheti, Kartli, Imereti, Racha, Khevi). In Stepantsminda, where he spent a month, J.A. Güldenstädt collected a large body of herbarium material. Amount of the data on geography, natural resources, history, ethnography, flora and fauna of the country and the depth of the undertaken research are noteworthy (Güldenstädt, 1787-1791, 1815) at the same time reflecting the author's warm attitude towards Georgia and its people.

In the middle of the 19th century the first scheme of the vegetation vertical distribution in the Caucasus (Wagner, 1848) appeared along with the first map of the Caucasus vegetation (Koch, 1850). Since then, much attention was paid to vegetation studies and mapping (Albov, 1896; Radde, 1899; Sosnovsky, 1915; and others). Many other famous scientists traveled to the Caucasus (including Georgia), for botanical interests: A.F. Marshall von Bieberstein (1768-1826), C.C. Steven (1781-1863), F.J. Ruprecht (1814-1870), M.F. Adams (1780-1832), A. A. Musin-Pushkin (1760-1805), J.J.F.W.v Parrot (1791-1841), N.A. Desulavi (1860-1933), A. Rehman (1840-1917), N. Albov (1866-1897), G.F.R. Radde (1831-1903) and others. G. Radde founded the Caucasus Museum in Tbilisi in 1867 (now the National Museum of Georgia), where, together with other materials, many specimens of Georgia's flora were preserved. He was the director of the Museum and Tbilisi Public Library.

Studies of the flora and vegetation continued actively in the 20th century by A.A. Grossheim (1888-1948), D.I. Sosnovsky (1886-1953), Yu.S. Medvedev (1848-1923), N.A. Bush (1869-1941) and others.

In 1933 the Institute of Botany of the Georgian Academy of Sciences was established on the basis of the Herbarium and several research departments of Tbilisi Botanical Garden. The first comprehensive description of Georgia's vegetation cover by Grossheim (1948) became an important milestone in the history of regional vegetation studies. The second important milestone related to the classification of the vegetation cover of Georgia and the Caucasus ecoregion was the creation of a map of the natural vegetation of Europe (Bohn et al., 2003, 2007).

The Institute of Botany has been a part of the Ilia State University since its foundation (2006) traditionally playing the leading role in the research of the flora and vegetation of Georgia.

5.2 Diversity of the vegetation of Georgia

The significant difference between the climate of western and eastern Georgia led to a difference in vegetation. Humidity and temperature, these two components of climate, determine the originality of the vegetation of western Georgia. The phenomenon is reflected in the structure of the vegetation belts. In western Georgia, forested plains and foothills begin from the sea coast, and five vegetation belts can be distinguished: forest (0-1900 m a.s.l.), subalpine (1900-2500 m a.s.l.), alpine (2500-3000 m a.s.l.), subnival (3000-3600 m a.s.l.) and nival (> 3600 m a.s.l.) belts. In eastern Georgia, the vertical belt system is more complex with six belts: semi-deserts, dry fields and open arid forests (90-600 m a.s.l.), forest (600-1900 m a.s.l.), subalpine (1900-2500 m a.s.l.), alpine (2500-3000 m a.s.l.), subnival (3000-3700 m a.s.l.) and nival (> 3700 m a.s.l.). The vertical zonation of the vegetation of South Georgia is peculiar. Here, within the forest and subalpine belts, semiarid forest formations are found in places, and mountain steppe vegetation predominates (Nakhutsrishvili, 1999, 2000, 2013; Zazanashvili et al., 2000; Bohn et al., 2003; Dolukhanov, 2010).

5.3 Diversity of forest vegetation in Georgia

A forest is a type of vegetation consisting of woody (trees, shrubs, lianas) and herbaceous plants, mosses and lichens, as well as animals (mammals, birds, insects) and microorganisms that are biologically interconnected during their lifetime influencing each other and the environment. Forest is a complex ecological system in which the main life form is a woody plant. Forest develops in areas where temperature in the warmest month of the year exceeds 10°C, and the annual rainfall esceeds 200 mm. Depending on the latitude, there are three main forest types: boreal (taiga), temperate and tropical (https://www.britannica.com/science/forest).

According to the definition of the the Global Forest Inventory of the Food and Agriculture Organization of the United Nations (FAO), forests are lands of more than 0.5 ha, with a tree canopy cover of more than 10 percent, which are not primarily under agricultural or urban land use. The trees should be able to reach a minimum height of 5 meters *in situ* (FAO, 2020; SDG indicator metadata, 2023).

Forest as a global ecosystem has enoumous ecological importance. It regulates $O^2 – CO^2$ balance, producing 50% of atmospheric oxygen. Forest helps to maintain the balance of the entire biosphere. It is the greatest solar energy converter, biomass creator and harvester. The biomass of forests is many tens of times greater than the biomass of other types of plant communities. This is the most important element of the landscape. Forest has a special function in terms of biodiversity: it is the habitat of many plant and animal species. It is the largest regulator of water balance. Forest protects soil from erosion, slopes from landslides, mudstreams and avalanches. It has great recreational and cultural significance. It is a source of many valuable raw materials. Forest is the most important natural wealth and treasure.

Forests of Georgia are quite well studied: forest floristic composition and typological structure, distribution patterns, natural regeneration and successional stages are figured out; effects of human agricultural activities on forest and shrubland vegetation is analyzed; recommendations for rehabilitation of degraded vegetation are developed; geobotanical and ecological mapping is done, etc. (Kolakovsky, 1961; Ketskhoveli, 1959; Gulisashvili et al., 1975; Dolukhanov, 1978, 1980, 2010; Sakhokia, 1980; Makashvili, 1995; Nakhutsrishvili, 1999, 2013; Zazanashvili et al., 2000; Dolukhanov, Nakhuts rishvili, 2003; Bohn et al., 2003, 2007; Nakhutsrishvili et al.,

2011, 2015). In the cited and many other works Georgia's vegetation cover is described as dominated by forest. The ecosystem occupies more than 36.7% (2.98 million hectares) of the country's territory. The most forested regions are Adjara (63%) and Racha (56%). Only 14% of Georgia's forests are located below 750 m a.s.l. Up to 70% of forests cover areas above 1000 m a.s.l. About 60% of mountain forests are located on slopes of 25-35°, and 24% are found on even steeper slopes of > 35°. The treeline passes at 2450-2550 m a.s.l. in eastern Georgia, while in western Georgia, is passes higher due to higher humidity.

In the Holocene with its present-day-like climate, forests occupied twice as much area as it is now. The entire Colchis lowland and mountain slopes of western Georgia were covered by forest from the sea level up to 2200-2500 m a.s.l. In eastern Georgia, forests reached the same elevations as now but in the subalpine belt the species composition was somewhat different. Only the semi-arid plains of eastern Georgia and certain areas on the Javakheti plateau in the south were treeless (Shatilova et al., 2012).

According to A. Dolukhanov (2010), a prominent researcher of the Caucasus and specifically Georgia's forests, there is a surprisingly large coenotic diversity of forest vegetation in Georgia, which is more apparent on the background of a poor dominant (more precisely, edificatory) species diversity in the forest formations. Among tree species, the most widespread is *Fagus orientalis*. Beech forests occupy 51% of the total forest area. Other forest dominants are: *Abies nordmanniana* (10%), *Quercus iberica* and other oak species (9.3% in total), *Picea orientalis* (6.3%), *Pinus sylvestris* var. *hamata* (3.6%), *Alnus barbata* (3.0%), *Castanea sativa* (2.1%), *Betula litwinowii* and other birch species (only about 2%). Insignificant areas (<1% of the total forest area) are dominated by: *Carpinus caucasica*, *Tilia begoniifolia*, *Acer platanoides*, *A. trautvetteri*, *Fraxinus excelsior*, *Alnus incana*, etc. The forest cover is unevenly distributed: while lowlands, foothills (starting from the sea level) and mountains of western Georgia are covered with forest, on the plains of eastern Georgia forests are restricted to riverbanks as riparian forests, they cover foothills and mostly mountain slopes. On the treeless plateau of Javakheti, a southern upland, small areas of secondary forests are preserved in gorges, while primary pine forests are present on the Tetrobi limestone massif. It is noteworthy that monodominant forests, except for beech forests, are not typical for Georgia. Pure *Abies nordmanniana*, *Castanea sativa*, *Quercus* spp., *Carpinus caucasica* are very rare. Georgia's forests are characterized by rare woody species admixtures. Some are relicts, others have a very narrow range, such as *Acer velutinum*, *A. sosnowskyi*, *Taxus baccata*, *Zelkova carpinifolia*, *Quercus hartwissiana*, *Pterocarya pterocarpa* (Ketskhoveli, 1959; Kolakovsky, 1961; Dolukhanov, 2010; Shatilova et al., 2012; Nakhutsrishvili, 2013).

Researchers of Georgia's forests give particular attention to Euxine forests, i.e. the Black Sea forests. They are located to the south and southeast of the Black Sea starting at the border between Bulgaria and Turkey, crossing the Bosphorus and following the Black Sea coast to Apkhazeti and even Crimea (Kolakovsky, 1961, 1974; Sakhokia, 1980). The Euxine forests extend from lowlands to the treeline. In the western part of the Caucasus, these forests are the most diverse both in view of their flora and vegetation. The Euxine forest flora contains a number of geographic elements. Of characteristic and dominant species the Caucasian plants prevail followed by Eastern Mediterranean and European species. Minor Asian and other elements are less numerous. Based on the annual precipitation, the Euxine forests are divided into two parts: forests with average annual precipitation of 1000-1500 mm in the eastern part of their distribution range, and those with precipitation of 1500-2500 (> 4000) mm in the western part. The border between these two parts passes along the river Meleti near Ordu in Turkey. To the west of this border, the forest is called Euxine, and to the east, Colchic. The Colchic forest, like the Hyrkanian forest of Azerbaijan and Iran, is the most important Arcto-Tertiary relict forest of Western Eurasia, characterized by great biodiversity and containing many relict, endemic and rare species. The Colchic forest is one of the "strong arguments", on the basis of which the entire Caucasus region is recognized

as a unique ecoregion among 200 ecoregions identified globally (Olson, Dinershtein, 2002). In 2021 the Colchic forest along with the forest wetlands and wetland forests of Colchis became a UNESCO World Heritage Site (Nakhutsrishvili et al., 2011, 2015; https://whc.unesco.org/en/list/1616/).

Currently, intact forests are preserved mainly in hard-to-reach and protected areas. The major part of Georgia's forests (95%), especially mountain forests, are soil protectors and water regulators, and exploitation of these forests should be strictly controlled (Nakhutsrishvili, 2000).

Below we present a list and general description of Georgia's forest types according to many authors (Grossheim, 1948; Gulisashvili, 1955, 1966; Ketskhoveli, 1959; Kolakovsky, 1961; Gulisashvili et al., 1975; Dolukhanov, 1980, 2010; Nakhutsrishvili, 1999, 2013; Box et al., 2000; Denk et al., 2001; Dolukhanov, Nakhutsrishvili, 2003; Bohn et al., 2003; Nakhutsrishvili et al., 2011, 2015).

The forest types are described in the following order:

(1) Forest wetland and wetland forest; (2) Riparian forest; (3) Temperate humid thermophilic Colchic rainforest, which includes: (3.1) Hygrothermophilic Colchis forest with lianas, (3.2) Mixed deciduous / polydominant Colchic forest, and (3.3) Chestnut forest; (4) Arid open forest, which includes: (4.1) Pistachio-tree forest, and (4.2) Juniper forest; (5) Oak forest; (6) Hornbeam forest; (7) Beech forest, which includes: (7.1) Beech forests with Colchic undergrowth, and (7.2) Beech forests without Colchic undergrowth; (8) Dark coniferous forest; (9) Pine forest; (10) Subalpine forest, including: (10.1) Birch forest, (10.2) Crook-stemmed beech forest, (10.3) Pontic oak forest, (10.4) High mountain oak forest, and (10.5) Pine forest.

(1) Forest wetland and Wetland forest. Less than a century ago the major portion of the Colchis lowland was covered by wetlands. At present most of the former wetlands are dried with separate fragments left in places. In Adjara-Guria region, such places are Kobuleti, Imnati, Grigoleti and other wetlands. These are typical peat bogs as well as herb-covered wetland variants (forb wetland, sedge wetland, rush wetland, cattail wetland, etc.). Trees and shrubs cannot thrive in wetland conditions. Only *Rhododendron luteum* and rarely *Rh. ponticum* occurs in places. However, in certain wetlands forest-like formations: forest wetlands or wetland forests are found. These two formations are somewhat different: in forest wetland trees and shrubs grow in water-covered areas, while in wetland forests they grow on convex land surfaces, i.e. islet-like small hills. Both formations are mainly made up of *Alnus barbata* accompanied by *Pterocarya pterocarpa, Populus canescens, Salix excelsa,* etc. Wetland forest woody undergrowth is made up of *Hipophaë rhamnoides, Laurocerasus officinalis, Vaccinium arctostaphylos, Sambucus nigra*. There are many lianas: *Hedera helix, H. colchica, Periploca graeca, Smilax excelsa*, etc. (Kolakovsky, 1961b 1974; Sakhokia, 1980; Denk et al., 2001; Nakhutsrishvili, 2013).

(2) Riparian forest. Riparian forest makes up about 3% of the country's forest covered area. Its general range includes regions with Atlantic and moderately continental climate. This is a type of azonal vegetation. Riparian forests are formed either on low alluvial plains along rivers, or on the proluvial terraces of mountain river valleys. In eastern Georgia, there are discontinuous fragments of the riparian forest (quite wide in places): Alazani, Mtkvari (downstream from Tbilisi), Iori, Khrami / Ktsia, Didi and Patara Liakhvi, Mashavera, Algeti, etc. In western Georgia: Rioni, Enguri, Khobistskali, Supsa, Natanebi, etc.

The main and characteristic trees of riparian forests are: *Salix excelsa*, *S. viminalis*, *S. alba*, *S. caprea* growing closest to the river, followed by a wider line of *Populus hybrida*, *P. nigra* and/or *Alnus barbata*, with *Quercus pedunculiflora*, *Ulmus suberosa, U. carpinifolia* on the next terrace, which is flooded relatively rarely and at smaller extent and where the groundwater flows at greater depths. In the lower course of the river Iori, on the last river terrace *Pistacia mutica* occurs. There are many shrubs in the undergrowth that are part of the lowland forests of eastern Georgia: *Crataegus kyrtostyla*, *Ligustrum vulgare*, *Hippophaë rhamnoides*, *Tamarix ramosissima*, *Daphne caucasica*, *Pyracantha coccinea* and others. The riparian forests of Alazani differ from

those of other rivers of eastern Georgia in their appearance and specific composition, namely by presence of Colchic-Hyrcan species *Pterocarya pterocarpa* and *Hedera pastuchowii.* In some places, creepers such as *Clematis vitalba*, *C. orientalis*, *Humulus lupulus*, *Periploca graeca*, *Vitis silvestris*, *Smilax excelsa*, *Hedera helix*, etc. are abundant. The creeping plants make the forest impenetrable along with thickets of *Rubus* sp. Such forests are more common in the humid western Georgia and uncommon in the dry continental plains of central part of the country. However, even in the semi-arid valleys of some tributaries of the river Mtkvari, local climate creates favorable conditions for development of this type of vegetation (Ketskhoveli, 1959; Dolukhanov, 1980, 2010; Nakhutsrishvili, 1999, 2013; Denk et al., 2001).

It should be noted that broad-leaved forests, including alder forests, are derivatives of the Tertiary's broad-leaved forests, which formed a wide belt on the Eurasian continent in the past. This analogue of the riparian forest is currently widespread in the plains, deserts and semi-deserts of East Asia, and are called Tugai forests. The tree species involved in the composition of the Tugai forests differ from the trees of the riparian forests of Georgia (Ketskhoveli, 1959; Sakhokia, 1980; Nakhutsrishvili, 2013).

(3) Temperate humid thermophilic Colchic rainforest: (3.1) Colchic forest with lianas. These forests cover significant areas in Samegrelo, Guria and Adjara regions, in the lower reaches of the rivers Rioni, Supsa, Natanebi, and others. The forests contain two zones: the lower zone spreading up to 150-200 m a. s. l. with forests growing on wet soils; they are characterized by abundance of lianas, mainly, *Smilax excelsa*, which often makes impassable thickets at forest edges. Perhaps such a forest was described by Herodotus (484-425 B.C.) with the following words: "There is a forest close to Poti where even a small bird cannot fly into it." Fragments of this forest are currently located on the coast of Lake Paliastomi and the riverbanks of Pichora and are a part of the Colchis National Park. In the second zone, from 150-200 to 500 m a. s. l. forest grows on relatively less moistened soil. Its dense undergrowth contains *Rhododendron ponticum*, *Laurocerasus officinalis* and *Ilex colchica*. Of deciduous shrubs the undergrowth contains: *Rhododendron luteum*, *Staphylea colchica*, *Ligustrum vulgare*, *Sambucus nigra*, etc. In forests of the Adjara-Guria region a rare plant *Osmanthus decorus* can be found. The major tree species of these forests is *Alnus barbata*. Alder forest often passes into hornbeam forest of *Carpinus caucasica*. In places *Fagus orientalis* and *Castanea sativa* stands occur. *Quercus hartwissiana* accompany these tree species on lowlands, while at somewhat higher elevations this oak is substituted by *Q. iberica*, also *Zelkova carpinifolia*, *Ulmus elliptica*, *Tilia begoniifolia*, *Fraxinus excelsior*, etc.

In places on wet silty soil very low-growing (6-15 m tall) and much thinned alder forest grows. A typical community is sphagnum alder forest. In wetland alder forest among other ferns, such characteristic species occur as *Matteucia struthiopteris*, rare *Osmunda regalis* (Ketskhoveli, 1959; Kolakovsky 1961, 1974; Gulisashvili et al., 1975; Dolukhanov, 2010; Nakhutsrishvili, 2013; Nakhutsrishvili et al., 2015).

(3) Temperate humid thermophilic Colchic rainforest: (3.2) Mixed deciduous / polydominant Colchic forest. In the past in foothills and lower montane belt of Colchis, poly-dominant deciduous forest thrived up to 1000-1100 m a.s.l.; certain areas were covered by mono- and bi-dominant forests. At present, the forests are almost completely destroyed; their remnants are more or less modified. The following trees compose the mixed deciduous forests (the species are listed without considering their position in the communities): *Fagus orientalis, Carpinus caucasica, Castanea sativa, Pterocarya pterocarpa, Alnus barbata, Quercus iberica, Q. imeretina, Q. hartwissiana, Zelkova carpinifolia, Tilia begoniifolia, Fraxinus excelsior, Acer platanoides, A. laetum, A. campestre, Ulmus elliptica, U. glabra, Malus orientalis, Pyrus caucasica, Diospyros lotus, Ficus carica*, etc. Undergrowth of typical Colchic shrubs is present; these species are: *Rhododendron ponticum, Laurocerasus officinalis, Ilex colchica, Rhododendron luteum, Vaccinium arctostaphylos, Viburnum orientale, Staphylea colchica, S. pinnata, Philadelphus caucasicus, Sambucus nigra, Euonymus latifolia, E. leiophloea, Daphne*

pontica, etc. In the mixed deciduous forests of the Adjara-Guria region in places the undergrowth includes endemic rhododendrons: *Rhododendron ungernii* and *Rh. smirnowii*. Of lianas *Hedera colchica* predominates. In places the diameter of its stem reaches 20 cm. Colchic ivy ascends the tallest trees and completely covers forest floor. *Smilax excelsa* and *Periploca graeca* are common. Herb cover is rich (we do not give species list here). Among them are many ferns such as *Matteucia struthiopteris, Dryopteris filix-mas, Athyrium filix-femina,* epiphytic ferns: *Polypodium serratum* and *Dryopteris alexeenkoana*; on moist rocks and soil *Phyllitis scolopendrium, Pteris cretica, Asplenium nigrum* and others grow (Kolakovsky, 1974; Dolukhanov, 1980, 2010).

The Tertiary relict range of *Zelkova carpinifolia* in the Caucasus includes Colchis, a small part of Kakheti, and Lenkhoran and Karabakh regions. Monodominant zelkova forests are very rare. Usually in western Georgia the species forms mixed forests with *Quercus iberica*, *Q. imeretina*, and in eastern Georgia with *Carpinus caucasica*, *C. orientalis*. In the west, it is best represented in the Ajameti Nature Reserve, and in the east in the Babaneuri Nature Reserve. In different regions of the Caucasus, outside of Georgia, vertical distribution of zelkova ranges from the sea level to 1200-1700 m a.s.l. In Georgia, it does not exceed 750 m a.s.l. In western Georgia, the species mostly grows on lowland and in eastern Georgia in the foothills, where slopes of all cardinal directions are occupied but northern slopes. It grows both on shallow and deep soils avoiding saline substrates. In western Georgia, zelkova grows on alluvial, sandy and loamy-sandy soils, and in Kakheti on peat and shallow soils (Sharashidze, 1967; Nakhutsrishvili, 2013).

Character of Colchis as a shelter of relicts of the Neogene flora is best exhibited in mixed deciduous forests of gorges in this area. A well-known researcher of the flora of Colchis A. Kolakovsky (1961) gave special attention to mixed deciduous forests of the gorges as a refugium of relict vegetation. These forests, better than any others in western Georgia, show properties of typical Colchis forests. The major climatic feature is equal air humidity throughout a year even during relatively dry seasons. The major reason of this characteristic is the local topography: almost perpendicular orientation of gorges and lowlands towards the Black Sea, which facilitates humid sea-born air mass flow into these areas. Another factor is abundant water flowing down along the sides of the gorges. Moreover, the closed canopy of the Colchis forest does not let sunlight to pass through it. All these conditions create a refugium ambience favourable to ancient plants of warm and humid climates. An interesting example: a peculiar fern *Hymenophyllum tunbridgense* occurs in one of such gorges in Adjara; botanists call this gorge "hymenophylic" gorge. A frond of this fern is made of a single layer of cells and does not have any morphological adaptation to moisture deficit. Its existence in Adjara indicates almost unchanged temperature and humidity regime along geological timescale.

On the gentle slopes of the mixed deciduous forests of the Colchis lowland, thickets of Colchic evergreen relict shrubs are noteworthy: *Rhododendron ponticum*, *Rh. caucasicum*, *R. ungernii*, *Laurocerasus officinalis*, *Ilex colchica*, *Ruscus hypophyllum.* The thickets grow in places of former forests disappeared on account of natural or human-induced processes. The first such community was described by S. Golitsyn (1939) in the gorge of the river Namtsvavistskali, a tributary of the river Korolistskali. The evergreen shrub thicket was called Shkeriani after a vernacular name of *Rhododendron caucasicum* (as thickets of evergreen prostrate *Rh. caucasicum* were called Dekiani; Ketskhoveli, 1959). The name is established in the botanical literature. Shkeriani is not a community of only evergreen shrubs, it also contains deciduous shrubs of the Colchis undergrowth: *Vaccinium arctostaphylos*, *Rhododendron luteum*, *Viburnum orientale*, *Frangula alnus*, *Corylus colchica* and others. The described community located at the river Namtsvavistskali sources probably formed after fire. It is noteworthy that "Namtsvavi" means "burnt". In the same Namtsvavistskali gorge, the Neogene relict *Epigaea gaultherioides* grows, which is endemic to Adzharia-Lazeti. The places of origin of two more species of this genus are very far

from Kolkheti: *Epigaea repens* in North America, *Epigaea asiatica* in Japan. *E. gaultherioides* is a very rare and exceptionally beautiful plant and its population requires special protection. Shkeriani is only forest undrestory, while peculiar formations of the treeline are attributed to the vegetation of the crook-stemmed forest and deciduous shrubland (Kolakovsky, 1961). Colchic subalpine vegetation can be considered as a living example of the ancient relict vegetation that has retained characteristic features of the Tertiary vegetation. Within the subalpine crook-stemmed forest vegetation (*Fagus orientalis*, *Acer trautvetteri*, *Betula litwinowii*), widespread in the Caucasus, *Betula medwedewii*, *B. megrelica*, representatives of the ancient relict flora occur. So far these species have not been found outside Colchis and only grow in the mountains of Guria and Adjara. The same is true for *Quercus pontica*, which is more common in Guria's mountains (Golitsin, 1939; Dolukhanov, 1980, 2010; Sakhokia, 1980; Nakhutsrishvili, 2013).

(3) Temperate humid thermophilic Colchic rainforest: (3.3) Chestnut forest. *Castanea sativa*, a thermophilous relict of the Tertiary, is widely distributed throughout Georgia, especially in the west, where it is quite common and covers a total area of up to 46,000 ha. Chestnut rarely forms a pure monodominant forest. It usually grows with *Fagus orientalis* and *Tilia begoniifolia* or both and is seldom associated with *Quercus hartwissiana* and *Q. iberica*. Chestnut forests are found on shaded or partially shaded slopes from 0-100 m to 900-1000 m a.s.l. In Apkhazeti chestnut grows up to 1200 m a.s.l. with some individuals reaching 1400 m (Sokolov, 1952). In the eastern part of Colchis, in Zemo Imereti, the upper limit of its distribution is 1400-1450 m a.s.l. (Gulisashvili, 1966). Above 1200 m a.s.l. closed canopy chestnut stands are not found (Dolukhanov, 2010). However, solitary chestnut trees were recorded even at 1800 m a.s.l. (Medvedev, 1919; Sokolov, 1952). In eastern Georgia, on slopes of the Kakhetian part of the Great Caucasus, a chestnut occurs from 400-500 m to 1350-1380 m but mostly between 700 and 1100 m a.s.l. (Dolukhanov, 2010).

For chestnut suitable is the average air temperature of the coldest month − 3.5°C, and that of the warmest month 23.5°C. The average annual precipitation ranges from 1000 mm to 3500-4000 mm. According to A. Kolakovsky (1961), for optimum growth of chestnut the annual precipitation should exceed 1000 mm, and the minimum winter temperature should not be lower than 11°C. However, single chestnut trees can also be found in places where the annual precipitation drops to almost 700 mm, and the annual amplitude of the average monthly temperature is 22.5°C. Relative air humidity is very important for the development of chestnut trees, and it should not be less than 70% (Gulisashvili, 1950). In general, this is the most important factor for the thermophilous Colchic forests.

A characteristic feature of the chestnut tree is its special need for soil conditions. It grows on moist, well-drained, more or less loose, relatively acidic, rich, yellowish-gray forest soil (Urushadze, 1987). A negative relation of chestnut to a limestone substrate is known but A. Kolakovsky (1961) reported chestnut growing on in a limestone substrate in Apkhazeti.

In the Adjara-Guria region chestnut forests with evergreen undergrowth are more common. Here *Rhododendron ponticum* is the major shrub of the evergreen undergrowth in the chestnut forest. These associations cover steep (30-40°) northern slopes of gorges up to 1200 m a.s.l. (mostly between 400-1000 m a.s.l.). Relatively rare is chestnut forest with *Laurocerasus officinalis.* The first layer of the chestnut forests with Colchis undergrowth contains *Fagus orientalis*, *Carpinus caucasica*,*Tilia begoniifolia*, *Ulmus elliptica*, etc.

Herbaceous association of chestnut forests exist: chestnut forest with *Trachystemon orientale*, various versions of chestnut forest with ferns. In rocky and scree-covered areas chestnut forest with *Corylus avellana*, with *Sambucus nigra*, etc. (Dolukhanov, 2010).

In the past much larger areas were covered by chestnut forests in Georgia and Colchis in general. Since

ancient times chestnut was logged for its durable and finely textured timber; the species was exported already in the antique period.

Chestnut forests are now strongly affected by parasitic fungi, especially, *Endothia parasitica, Blepharospora cambivora*, etc.

(4) Arid open forest: (4.1) Pistachio-tree forest. Typical arid open forests are distributed mainly in the eastern Georgia and are surrounded by steppes and semi-deserts. They are characterized by "openness" and "thinness". Hence many of names of these forests ("light forest", "thin forest", "arid forest", "xerophyte forest") came from. In open forests, trees are usually quite far apart. There is a lot of open and, therefore, well-lit areas. As a rule, in open forests, trees cover is 25-30% of the total forest area. The rest of the area is occupied by steppe and semi-desert vegetation. That is why the appearance of the trees that make up the woodlands differs from the trees growing in a closed-canopy forest. Crowns of the trees are predominantly rounded, freely growing in all directions. Trees often form dense groups: small groves of up to 20 trees. The main reason for the low tree density is the lack of water in the soil. In cases when a number of steppe and semi-desert communities can be found in a small area within open forest. The elevation limits of open forests distribution are 100-600 m a.s.l. They grow on plain areas, hills, mountain foothills, slopes of dry ravines (Sahokia, 1958; Ketskhoveli, 1959, 1980). Soils are black-like and brown (Urushadze, 1987).

There are two main types of xerophytic open forests in Georgia: deciduous with *Pistacia mutica* and evergreen coniferous with mostly *Juniperus foetidissima*. *P. mutica* open forests occur at lower elevations and therefore in less rugged terrain. It is important to note that each tree creates a special microclimate underneath, which differs significantly from the sunlit area outside its crown. In particular, due to the large shade, moisture remains under the tree crown longer, and the air and soil heat up less. Because of this, the vegetation of open areas differs notoceably from the undergrowth (Grossgeim and Prilipko, 1939). In addition to *P. mutica*, deciduous xerophytic open forests include: *Celtis caucasica*, *Acer ibericum*, *Pyrus salicifolia*. These trees are the most frequent, although other species found in these forests are: *Ulmus foliacea*, occurring rarely in relatively mesophilic conditions where water seeps to the bottom of the ravine; *Quercus iberica* growing along the periphery of open forests; *Quercus pedunculiflora* and *Tamarix ramosissima*, occurring where the open forests border riparian forests of the river Iori (Ketskhoveli, 1935, 1980; Sakhokia, 1958; Nakhutsrishvili, 2013).

(4) Arid open forest: (4.1) Juniper forest. Four juniper species make up juniper arid open forests: *Juniperus foetidissima*, *J. rufescens*, *J. polycarpos* and *J. oblonga*. There is also a transition between deciduous and evergreen woodlands when juniper is mixed with *Pistacia mutica*. Open juniper forests are found in conditions of steep and eroded terrain. In Georgia, their vertical limit rarely reaches 800 m. In the Vashlovani Protected Areas juniper forests descend to 200 m a.s.l. (Ketskhoveli, 1959; Sakhokia, 1959; Dolukhanov, 2010).

(5) Oak forest. Oak forests are among the floristically richest and diverse forest communities in Georgia (Grossheim, 1948; Sakhokia, 1958, 1980; Kolakovskiy, 1961; Ketskhoveli, 1959; Gulisashvili, 1966; Gulisashvili et al., 1975; Ekhvaia et al., 2018; Nakhutsrishvili, 1999, 2000, 2013; Novak et al., 2021). In the 1960s, they occupied 186,000 hectares (about 9% of the entire forest area of Georgia). In the prehistoric past, the area of oak forests must have been at least 2.5 times as large as they are now but long-term human agricultural activity affected them more than other forests. The reason is wide distribution of oak forest on the best lands for agriculture: plains and gentle slopes. The major portion of oak forests in Colchis are made up of *Quercus iberica*. Forests of *Quercus imeretina* occur in relatively small areas. In the foothills and the lower forest belt, deciduous forests contain admixture of individual trees and small groups of *Quercus hartwissiana.* In some parts of Adjara, small groves of *Quercus dshorochensis* are preserved.

A. Kolakovsky (1961) counted more than 230 trees and shrubs and up to 100 herbaceous species in the flora of the oak forests of Colchis. He distinguishes associations of *Quercus iberica* with: *Rhododendron ponticum*, *Rh. luteum*, *Euonymus latifolia*, *Hypericum xylosteifolium*, *Ruscus ponticus*, etc.

In the past, *Quercus imeretina* was widely distributed on the lowland and in the lower mountain belt of Colchis. In humid habitats, the species formed a monodominant forest mixed with *Carpinus caucasica*, *Zelkova carpinifolia*, *Pterocarya pterocarpa* and *Alnus barbata*. Now area of these forests is greatly reduced. *Quercus imeretina* forests are preserved along the right side of the river Rioni basin. The most extensive grove is protected in Adjameti Reserve.

Quercus hartwissiana, with rare exceptions, does not form a pure forest, but is mixed with forests made up of other tree species as a characteristic element. A possible reason might be its long and intense selective logging. *Q. hartwissiana* grows mainly in the foothills and the lower mountain belt, in places easily accessible to human. What we see today must be the heavily degraded remains of the former oak stands.

The remains of the *Quercus dchorochensis* forests are preserved in south-western Adjara, in the gorges of Adjarishkali and its tributaries (also in Turkey, on the river Chorokhi valley, in the area bordering Georgia). Branches of trees in these forest remains were repeatedly cut, and the trees each time produced new branches; signs of such treatment are visible in these stands. The cut branches were used to feed cattle in winter and the trees now almost do not have trunks. Nevertheless, in the degraded *Q. dchorochensis* forest, the following communities were distinguished: (1) oak forest with *Carpinus orientalis* and *Ostrya carpinifolia*; (2) oak forest with *Cistus salviifolius*, and (3) oak forest with *Rhododendron ponticum* and *Laurocerasus officinalis*.

In the Adjara-Guria region from 700 to 1600 m a.s.l. *Quercus pontica*, a species different from the other oaks of the region, makes up its communities. In the Great Caucasus the species occurs sporadically in the Kodori gorge, up to 2300 m a.s.l.; north of the Bzipi range it is not found. In places community of Pontic oak is 6-7 m tall and represents crook-stemmed forest. However, more often the height of the community does not exceed 1.5-2 m and has a form of a semi-prostrate scrub. Rarely the Pontic oak forest has the second layer of *Rhododendron ponticum*. Canopy of Pontic oak thicket is so closed that only a handful of extreme shade-enduring herbs can grow underneath.

In eastern Georgia, surviving remains of forests on the flat terrain, enable to reconstruct former forests covering the area, which must have consisted of oak and elm. Along riverbanks, *Quercus pedunculiflora* dominated the stands, interspersed with *Ulmus suberosa*. In the foothills, *Quercus iberica* mixed with *Ulmus foliacea* dominated the landscape. In the eastern part of plains of eastern Georgia *Celtis caucasica* and *Acer ibericum* occurred in these forests. Less common were: *Fraxinus excelsior*, *Acer campestre*, *Pyrus caucasica*, *Malus orientalis*, *Sorbus torminalis*, etc. Currently, only small remnants of these forests remain in Zemo Kartli, the Liakhvi gorge, Mukhrani, Samgori and Shiraki. Instead of these forests, the plain areas today are converted to either arable lands, or steppe with hemixerophilous scrub and phrygana-like communities. This type of forest combines features of three forest formations: riparian, arid open forest and foothill oak forest (Ketskhoveli, 1959). Today xerothermic *Quercus iberica* dominates the lower part of the forest belt (600-700 m a.s.l.). It occupies large areas in the South Caucasus and the eastern part of the northern macro-slope of the Great Caucasus (Ingushetia, Chechnya, Dagestan). Genetically, the species is close to *Q. petraea*, but has its own special ecological and phytosociological range. The oak constitutes several ecosystems: a monodominant oak forest, in which the undergrowth is underdeveloped or absent (rarely it is characterized by good seed reproduction, e.g., in Myussera reserve); *Carpinus orientalis-Quercus iberica* forest, occupying especially large areas on foothills in eastern Georgia; *Carpinus caucasica-Quercus iberica* is widespread in relatively humid conditions (Dolukhanov, 1966, 2010).

(6) Hornbeam forests. Hornbeam forests in Georgia, especially in western Georgia are mostly secondary. However, primary hornbeam forests also exist in places. If a hornbeam forest is secondary, it usually derives from hornbeam-oak and hornbeam-beech forests. Such successions result from human intrusions. Hornbeam timber is calorie-rich fuel, for which reason the species was intensely logged for centuries and as a result of numerous natural regrowth cycles, primary forests transformed into present-day poorer state stands. Not much is known on phytosociological structure of hornbeam forests and distribution of particular associations. Sporadic data are available on certain Colchic associations of this forest type. Throughout Georgia Caucasian hornbeam forest sometimes reaches 1400 m but optimal conditions for its distribution are around 1000 m a.s.l. (Kolakovsky, 1961). Thus, the forest occurs mostly in the lower part of the montane forest zone where hornbeam outcompetes beech and oak. Hornbeam exhibits mesophilous nature but at less degree compared to beech. The species is also less demanding to soil fertility and thrives on humus-rich calcareous alluvial and semi-wetland substrates of Colchis coast as well as shallow stony substrate. In non-limestone mountains between 100-800 m a.s.l. hornbeam forest with *Rh. ponticum* rarely occurs. Rare is hornbeam forest with *Vaccinium arctostaphylos* as well. At 800-900 m a.s.l. on relatively sunlit and dry slopes hornbeam forest thrives with *Rhododendron luteum* in the undergrowth. Of other shrub and herb species of the undergrowth the following are found in Colchic hornbeam forests: *Laurocerasus officinalis, Ruscus ponticus, Ilex colchica, Buxus colchica, Trachystemon orientale, Epimedium colchicum*, ferns: *Polystichum setiferum, Dryopteris borreri* (Kolakovsky, 1961).

In eastern Georgia, hornbeam forest is usually widely represented between 800-1200 m a.s.l. Eespecially interesting are stands on the Gombori range, southeastern ridges of the Trialeti range, etc., where participation of other forest-forming species is relatively small. Two main types of hornbeam forests are commonly found in eastern Georgia: hornbeam forest with *Quercus iberica* at relatively low elevations and hornbeam forest with *Fagus orientalis* at higher altitudes (Ketskhoveli, 1959; Gulisashvili et al., 1975).

(7) Beech forests. In Georgia, as in Europe (Tüxen, 1981; Ellenberg, 1988) beech forest is the most widespread of the forest formations. According to data from the end of the 1960's they covered 1,035,800 ha, i.e. 51% of Georgia's forest area (Gulisashvili, 1966). *Fagus orientalis* occurs in almost all regions of the country except extremely continental parts of eastern and southern Georgia. The species grows from the sea level (as solitary trees) to subalpine elevations. Optimum habitat conditions are mean air temperature of August, the warmest month, between 17-19°C and mean annual precipitation not less than 700 mm. In the mountains of western Georgia, this optimum lies within 700-1400 m a.s.l., in relatively humid parts of eastern Georgia within 1000-1450 m a.s.l., and in its relatively arid parts within 1300-1600 m a.s.l. It occurs in conditions of various topography on gentle as well as steep slopes of 40° and even 45°; but the most favourable are mountain slopes of moderate and small inclination. In the mountains of western Georgia, where precipitation is especially heavy in winter, a narrow strip of subalpine crook-stemmed beech forest is developed in some places at the treeline. Beech distribution of depends more on climatic conditions than on the soil, as it grows well both on calcareous and non-calcareous soils (Kolakovsky, 1961; Dolukhanov, 1980, 2010; Sakhokia, 1980).

Beech forest is not floristically very rich and there are a small number of species confined to these forests. Such species are *Vaccinium arctostaphylos* and *Viburnum orientale* of bushes, *Trachystemon orientale* and *Pachyphragma macrophyllum* of herbs. However, beech forest is characterized by phytocoenotic diversity: (1) on plains and foothills, beech makes up monodominant forest and dominates the phytolandscapes up to 600-800 m a.s.l. Other, admixed species do not exhibit any degree of constancy; (2) beech participates with various ratios (sometimes rather high) in polydominant (including bidominant) forests as well such as beech-hornbeam, beech-chestnut, beech-spruce, beech-fir forests, etc.; (3) polydominant forests with beech as

one of the co-dominants; (4) forests where beech is only admixed as individual trees. A. Dolukhanov, a well-known researcher of the Caucasus forest vegetation, developed phytocoenological classification scheme of beech forests of Georgia. The scheme contains a number of associations and their variants. The major associations are:

(1) Beech forest with *Rhododendron ponticum,* one of the most common Colchis variants of beech forest. Some botanists, e.g. Rübel (1932), consider this forest as a typological variant of the beech forest of the Caucasus in general. This type thrives in all the forest covered parts of western Georgia except some closed gorges (e.g. Enguri gorge), which is connected with a so-called "rain shadow" effect. It is rare on limestone massifs.

(2) Beech forest with *Rhododendron ungernii.* Ungerni's rhododendron is a locally distributed endemic of the Adjara-Guria region. The species makes up undergrowth in montane rainforest close to the coast of Adjara in the gorges of the rivers Bartskhana, Chakvistskali, Korolistskali and Kintrishi, as well as in the western part of Guria, in the gorges of the rivers Bzhuzha, Natanebi, Bakhvistskali and possibly in the upper reaches of Supsa, from 1200 to 2000 m a.s.l. Annual precipitation in these areas is 3200-3500 mm. In places where fog is frequent in day hours, beech forest with *Rh. ungernii* descends to 800-600 m a.s.l. The undergrowth of this species is taller than that of *Rh. ponticum*: it reaches 3-4 m in a forest with canopy closure up to 0.3, and disappears where canopy closure exceeds 0.7.

(3) Beech forest with *Laurocerasus officinalis* resembles beech forest with *Rhododendron ponticum* both in its physiognomic and bioecological properties. This association is typical from 700-1000 m a.s.l. Human impact has affected this type of understory stronger than the former one, which is caused by high quality timber of *L. officinalis* traditionally used by population.

(4) Beech forest with *Ilex colchica*. Of the Colchic elements, *I. colchica* is best adapted to natural conditions of eastern Georgia, and thrives in beech forests of the Gombori range.

(5) Beech forest with *Ruscus ponticus*.

(6) Beech forest with deciduous shrubs: beech forest with *Vaccinium arctostaphylos* is the most widespread of the beech forest types with understory of deciduous shrubs and occurs from 1100 to 1900 m a.s.l., where mean annual precipitation is 1400-1500 mm; beech forest with *Rhododendron luteum* is characterized by wide geographic and ecological range; beech forest with *Viburnum orientale* occurs in many places from 900 to 1900 m a.s.l.

Of herbaceous associations of beech forest the following are worth mentioning:

(1) Beech forest with *Trachystemon orientale* is one of the beech forest types characteristic to Colchis.

(2) Beech forest with *Asarum caucasicum* and (3) beech forest with *Festuca drymeja* occur in the lower part of the montane zone of Colchis, on convex prolluvial river terraces. Along with *Asarum caucasicum* and *Festuca drymeja* the following herbs are constant elements of the herbaceous complex: *Symphytum grandiflorum, Aristolochia iberica, Paris incompleta*.

Beech forest with *Rubus hirtus, R. serpens, R. platyphyllus*, etc. are also described.

Beech forest with large ferns is a big group of associations. Beech forest with *Matteuchia struthiopteris*, with *Dryopteris filix-mas*, with *Athyrium filix-femina*, etc. are known. *Matteuchia struthiopteris* makes up rather dense thickets, which hamper forest natural regeneration (Sakharov, 1939; Grossheim, 1948; Ketskhoveli, 1959; Kolakovsky, 1961; Gulisashvili, 1966; Dolukhanov, 1966, 1980, 2010; Gulisashvili et al., 1975; Sakhokia, 1980; Nakhutsrishvili, 2000; Nakhutsrishvili, 1999, 2013).

Beech forest with dead ground cover (Fagetum nudum) is another association worthy of attention. On the Great Caucasus, it is developed mainly on moderately steep north-facing slopes of the southern macro-slope in the lower line of the beech vertical range (from 500-600 m to 1200 m a.s.l.). On the Lesser Caucasus, it is

only found westwards from the Borjomi gorge. In Armenia it is not recorded, and in Azerbaijan occurs only on the mountain slopes along the Alazani gorge. As an independent type of forest, it was described in Georgia in the 1930s (Povarnitsin, 1931; Sokolov, 1936; Dolukhanov, 1938). Their humus horizon is very weak compared to the soils in other types of beech forests. Hence rhizosphere is located close to the surface of the substrate and includes detritus (Urushadze, 1987). The epithet "dead ground cover" is incorrect in the strict sense, as the fauna in the rhizosphere and detritus is very diverse, although plants, with the exception of beech root suckers and juveniles, even on 1000 m^2, are not observed. Fagetum nudum differs from Fagetum seminudum (beech forest with "half-dead ground cover"), in which only degraded specimens of ivy and/or blackberry are noted (Dolukhanov, 2010). The phenomenon of "dead ground cover" is not studied. Some explained this phenomenon by dry soil due to the strong water regime of beech (Slavikova, 1958), others by shading of the lower layers of the forest due to the high forest density. There are important arguments against both suggested explanations (Dolukhanov, 1966, 2010; Sakhokia, 1980).

Beech forests are widespread also in Europe (Rübel, 1932; Tüxen, 1981; Ellenberg, 1988; European Forest Types, 2007) but unlike Western Europe, beech forests in Colchis often have almost impassable undergrowth made up of evergreen semi-prostrate shrubs. Species of this undergrowth show the relict nature of the Colchis forest. In florogenesis, they are similar to the subalpine vegetatively mobile crook-stemmed forests of Colchis, but differ in their higher shade tolerance (Sakharov, 1939) as well as wide vertical distribution (from the sea level to the treeline). A common feature of the Colchic undergrowth is a high demand for moisture and a more or less even distribution of precipitation throughout the year. The abundance of snow is especially important for successful wintering and protection from freezing. The Colchic undergrowth of intact beech forests often contains a single dominant species. When the natural structure is disturbed, the undergrowth becomes poly-dominant. Despite some peculiar similarities between the beech forests of Colchis and the nemoral broad-leaved forests, there are significant differences between them. First of all, this refers to the main core of the Colchis flora, i.e. species of the evergreen undergrowth being relict of the Tertiary. Moreover, herbaceous plants suchas *Festuca drymeja, Trachystemon orientale* and some others present in the Colchic beech forests are also relict species of the Tertiary. These constituents despite participation of relatively young boreal taxa, exhibit the relict nature of the entire ecosystem of the Colchic beech forest. In this regard, these forests differ remarkably from the European broad-leaved forest types, which underwent changes affected by the events of the Quaternary period (Kolakovsky, 1961; Dolukhanov, 1966, 2010).

To the east of the Likhi Ridge, forests including beech forests become gradually poorer in Colchic elements but *Rhododendron luteum* and *Vaccinium arctostaphylos* extend their distributions ranges quite far eastwards. In valleys surrounded by mountains and protected from hot winds, not only individual Colchic elements but entire ecosystems of Colchic forests including beech forests are preserved. Such "shelters" include the Borjomi valley, where, e.g., Banishkevi forest contains typical Colchic evergreen undergrowth. Thus, eastern Georgia is not so poor in Colchic elements, as previously well-known researchers of the flora of the Caucasus: N. Kuznetsov, N. Bush, D. Sosnovsky, A. Grossheim et al. believed (Ketskhoveli, 1959). In the beech forests of eastern Georgia, many associations are distinguished, from monodominant beech forest with *Rhododendron ponticum*, *Laurocerasus officinalis*, with ferns, grasses and forbs to beech-yew and beech-oak forests (with *Quercus iberica* at lower and *Q. macranthera* at higher elevations) (Dolukhanov, 2010). Another example is relict forest of Alazani basin, Batsara Reserve in the Pankisi gorge, where *Taxus baccata* makes associations with *Fagus orientalis* with the dominance of the latter. The mixed forest grows in a humid habitat along the right side of Alazani starting from the mouth of its tributary Batsaristskali. The forest extends to 6 km on a slope 30-40°(45°) between 1100-1350 (1500) m a.s.l. and covers an area of up to 900 ha. *T. baccata* trees are

30 m in height and 1.5 m in circumference. The age of some individuals reaches 1800 years. Presence of very old yew is not uncommon in the beech forests of western Georgia, it also is mixed as individual trees with *Quercus imeretina* in the Adjameti Protected Area but nowhere are the trees of *Taxus baccata* developed and preserved so well as in Batsara gorge being elsewhere found only in the form of single individuals. In eastern Georgia, there are no yew forests outside of the Batsara gorge. Only isolated trees or small groves are found in certain localities. The existence of intact yew-beech forest of Batsara indicates wide former distribution of *Taxus baccata* forests on the territory of Georgia (Ketskhoveli, 1959).

(8) Dark coniferous forests. Dark coniferous forests of fir and spruce follow beech forests with their area and economic significance. They occupy almost 16.3% of the country's forest-covered area. About 1/3 of the dark coniferous forests are made up of spruce and the other 2/3 of fir. The dark coniferous forests of Georgia belong to the eastern Euxine forests (Isachenko, 1980; Dolukhanov, 1980; Tumajanov, 1980). They occur in the western and central parts of the Great Caucasus, as well as on the Adjara-Imereti and Trialeti ridges of the Lesser Caucasus. The ranges of *Abies nordmanniana* and *Picea orientalis* basically coincide with each other, but spruce has a relatively wider ecological range and is quite widespread in the continental climate of eastern Georgia: to the Aragvi gorge on the Great Caucasus and to the Tezami gorge on the Lesser Caucasus. They mainly grow between 1400-1900 m a.s.l., although in places they descend to elevations below 1000 m along gorges or ascend above 2000 m a.s.l. Small stands of spruce and fir can be found even at elevations of 200-300 m and 2300-2350 m a.s.l. In the mountains of Svaneti, spruce is more abundant than fir. Spruce has a dominant position in the dark coniferous forests of the Lesser Caucasus as well. The upper limit of the distribution ranges of both species pass approximately at the same height but the lower limit spruce range passes at lower elevation that that of fir. The difference is subtle, not exceeding 50 m, in western Georgia but is much more, reaching 200-300 m, in the eastern part of the country. The development of coniferous forests in the mountains of the Caucasus was associated with a period of severe cooling. After the Glaciation, the forests retreated, on the one hand, to the north, and on the other, to the west, giving way to broad-leaved and pine forests. Although the areas of spruce and fir almost coincide with each other, fir as more demanding to air humidity, is gradually losing ground due to the strengthening of the continental climate. In western Georgia, in particular, in Apkhazeti fir is the major constituent of dark coniferous forests owing to substrate qualities (deep rich soil) fitting fir requirements while in Zemo Svaneti spruce less demanding to soil conditions is more abundant. At the end of the Ice Age, spruce was widespread eastwards of its present-day eastern distribution limit. The retreat of the eastern boundary is explained by increasing aridity in subsequent geological periods and frequent fires during the dry season (Gulisashvili, 1940; Dolukhanov, 1940; Nakhutsrishvili, 2013).

Abies nordmanniana and *Picea orientalis* make up both pure and polydominant forests with *Fagus orientalis* especially in fir co-dominated forest. In the dark coniferous forests of western Georgia, conditions are relevant for evergreen Colchic undergrowth. A pytocoenological classification system of the Colchic dark coniferous forests is based on diversity of the undergrowth shrubs. The following associations are identified in particular: (1) Dark coniferous associations with *Rhododendron ponticum*: spruce forest with *Rh. ponticum*, spruce-fir forest with *Rh. ponticum*, fir forest with *Rh. ponticum*, beech-fir forest with *Rh. ponticum*. The most important ecological condition for their development is high humidity throughout the year and moderately moist soil. This community avoids both dry and wet as well as calcareous slopes, where they are replaced by forests with *Laurocerasus officinalis* and *Ilex colchica*. The humid habitats of the Western Caucasus support beech-fir forests with a well-formed fern cover with *Athyrium filix-femina*. Here, the height of the fern in many places exceeds 1 m. In some places, another fern *Matteuccia struthiopteris* is also recorded. (2) Dark coniferous associations with *Laurocerasus officinalis*: spruce forest with *L. officinalis,* spruce-fir forest with *L. officinalis,* fir

forest with *L. officinalis,* beech-fir forest with *L. officinalis.* (3) Dark coniferous associations with *Ilex colchica*: spruce forest with *I. colchica*, spruce-fir forest with *I. colchica,* fir forest with *I. colchica,* beech-fir forest with *I. colchica.* (4) Analogous dark coniferous associations with *Vaccinium arctostaphylos*, etc.

(9) Pine forests. *Pinus sylvestris* var. *hamata* forests are distributed mainly on well-lit and relatively dry southern slopes. In eastern Georgia the largest pine forests occur in the basins of the rivers Mtkvari (up to Tbilisi) and Alazani, and in Tusheti. As a rule, these forests are developed in rocky areas, although in some places they are also found in ecotopes covered with soil. Pine is geographically isolated from beech, its strong competitor. Pine forests have vertical range from 700 to 2400 m a.s.l. (Gulisashvili, 1940, 1966; Dolukhanov, 1966, 2010; Tumajanov, 1980; Nakhutsrishvili, 2000, 2013). On the one hand, pine forests contain Colchic elements (in the Chorokhi gorge), and on the other, they are often found on rocks in arid conditions. For example, in limestone-rock habitats on the treeless plateau of Javakheti (Tetrobi Species and Habitat Management Area), plant communities contain a number of Anatolian xerophytes and local xerophytic endemics (*Scorzonera ketzkhowelii, S. dzhawakhetica*, etc.). Lower layer is made up of juniper scrub. Pine forests contain steppe elements in the Mariamjvari Nature Reserve, Sagarejo. Elements of subalpine vegetation occur in the pine forests of the Trialeti range, Borjomi gorge and Khde gorge (Kazbegi). The rocky pine forest of the Dariali canyon in Kazbegi is unique and unexplored. In the pine forest herb cover, *Carex buschiorum, Poa nemoralis, Brachypodium sylvaticum*, etc. should be noted. In Apkhazeti montane pine forests, *Chamaecytisus hirsutissimus* is a characteristic species, while the Trialeti range pine forests contain *Ch. caucasicus.* The climax pine forest of Tusheti, containing the taiga florogenetic complexes and occurring only in this region, deserves special mention (Tumajanov, 1938, 1980).

In southern Georgia between 1700-2400 m a.s.l. pine forests border mountain steppes and meadow steppes. As a result, ecologically unique park-like forest is found there with a very diverse floristic composition. Similar landscapes also occur in Turkey (Nakhutsrishvili, 2000).

In Apkhazeti, endemic *Pinus pithyusa* makes a forest stand on the Black Sea coast. In the shrub layer of this forest *Cistus creticus, Ruscus ponticus, Rhododendron luteum, Carpinus orientalis, Rhus coriaria, Cotinus coggygria, Paliurus spina-christi*; Among the herbs, *Sesleria anatolica, Brachypodium rupestre*, etc.

(10) Subalpine forests and scrub. In the subalpine zone of west Georgia, especially in the mountains of the Adjara-Guria region that are open towards the Black Sea, a special vegetation type of semi-prostrate crook-stemmed forest is noteworthy. They seem brought to Colchis from a different world (Dolukhanov, 2010).

The development of temperate mountain forests is associated with the protective effect of snow cover (Larcher, 2003; Körner, 2012, 2021). A dense forest of *Betula litwinowii* and *Sorbus aucuparia*, is distributed throughout almost the entire Great Caucasus and a significant part of the Lesser Caucasus. Notable are the crook-stemmed forests of Colchis,where many rare relict species are found: *Quercus pontica, Betula megrelica, B. medwedewii* and others. A characteristic feature of temperate forests is that the trees and shrubs that make them overwinter under snow. Subalpine forests of the temperate zone are formed by *Betula litwinowii* (2100-2600 m, in some places up to 2750 m a.s.l.), *B. medwedewii, B. megrelica* (endemic to Samegrelo), *B. raddeana* (Caucasus endemic, in the eastern part of the Great Caucasus), *Fagus orientalis* (in low-rainfall mountains and not above 2050-2100 m a.s.l.), *Quercus pontica* (Colchis endemic, up to 2100-2400 m a.s.l.), *Acer trautvetteri*. In the subalpine zone, forests of small trees are formed by *Corylus colchica, Rhamnus imeretina* and others. Their survival in severe winters is possible only under conditions of long and deep snow cover (Nakhutsrishvili et al., 2006; Nakhutsrishvili, 2013; Nakhutsrishvili, Abdaladze, 2017). In publications devoted to the forest vegetation of Colchis (Tumajanov, 1938; Kolakovsky, 1974; Zazanashvili et al., 2000; Dolukhanov, 2010) other types of subalpine forests are also mentioned: subalpine spruce forest, subalpine fir forest, subalpine maple forest of *Acer trautvetteri*, etc.

Presumably, such vegetation cover existed in mountains of Western Eurasia in the Neogene. In Adjara-Guria subalpine crook-stemmed forests beech forest is typical. Only beech (*Fagus orientalis*) of the tree species of Georgia can make up forests or participate in mixed forests up to 2350 m a.s.l. (A. Dolukhanov photographically documented existence of crook-stemmed beech forest at this elevation on the Adjara-Guria range, on Mt. Khino). In the subalpine zone the lower part (of 2-3 m length) of a tree trunk becomes crooked and prostrate; in winter snow almost completely covers a plant with only upper part of branches protruding. The snow cover protects the plant from freezing and drying. This property enable beech to grow above the treeline. The first layer of the crook-stemmed beech forest in usually monodominant and other trees: *Acer trautvetteri, Sorbus caucasigena* and *Betula litwinowii* are admixed to thinned stands. The undergrowth contains: *Vaccinium arctostaphylos, Ilex colchica, Ruscus colchicus,* rarely *Rhododendron ponticum*. The herbaceous cover is made up of *Festuca drymeja, Asperula odorata, Vicia crocea, Polygonatum verticillatum*, etc. Boreal species are also present such as *Gymnocarpium dryopteris, Oxalis acetosella, Solidago virgaurea, Pyrola* spp., etc.

The most typical for subalpine belt is *Betula litwinowii* crook-stemmed forest, which is rarely mono-dominant. *Vaccinium arctostaphylos* is constant in such forests. Typical is the birch crook-stemmed forest with *Rhododendron caucasicum*. Such birch forest is described on the Adjara-Guria range, at 2200 m a.s.l. *Vaccinium myrtillus* can be found in some places of birch forest with *Rhododendron caucasicum* in South Colchis. Subalpine forests are highly modified as a result of anthropogenic impact (Nakhutsrishvili, 1999, 2013; Nakhutsrishvili et al., 2005, 2006).

In the subalpine forests other tree species also make up their communities; these species are: *Betula medwedewii*, its close relative *B. megrelica, Quercus pontica, Rhamnus imeretina, Coryllus colchica*, etc. Deep snow cover enables them to survive in harsh subalpine conditions. In the communities of *Quercus pontica* and *Betula medwedewii* the undergrowth is made up of *Rhododendron ponticum, Laurocerasus officinalis* and *Ilex colchica* as well as *Ruscus colchicus*. They are common at 2100-2150 m a.s.l., rarely reach 2200 m a.s.l.

The geological age of the crook-stemmed forest as a special structural type of subalpine plant cover has not yet been established, however, the presence of highly specialized and well-adapted surviving relicts of the highlands is certain. Dolukhanov (Dolukhanov, 1980, 2010) suggests their rather ancient origin.

The upper part of the Colchis subalpine belt is the richest in relict dendrofloristc elements. It is interesting in cold comditions unfavourable for woody plants, species of the floras dominant in geological periods of subtropical climatic are concentrated between 1900-2259 m a.s.l.; these are: *Rhododendron ponticum, Rh. ungernii, Rh. smirnovii, R. luteum* (the latter from the sea level to 2100 m a.s.l.), *Rh. caucasicum* (within 2000-9050 m a.s.l.), *Vaccinium arctostaphylos, Ilex colchica, Ruscus colchicus, Viburnum orientale, Laurocerasus officinalis, Epigaea gaulterioides*. This list contains a significant proportion of evergreen species, which indicates their origin from the flora of a warmer climate (Nakhutsrishvili, 2000; Nakhutsrishvili, 2013).

CHAPTER 6. RELEVES FROM NATURAL FORESTS OF GEORGIA

6.1 Adjara

In Adjara the following major forest types were studied: several variants of the temperate humid thermophilic Colchic rainforest, namely, of mixed deciduous / polydominant Colchic forest; and dark coniferous and mixed forest.

Temperate humid thermophilic Colchic rainforest

6.1.1 Castaneto-Carpinetum

The forest of hornbeam, with chestnut as the co-dominant species, was described in Shuakhevi, Adjara. The following layers are distinguished in the studied forest: The first layer trees (30 m) are *Castanea sativa, Carpinus caucasica*; The second layer trees (20 m) are *Ostrya carpinifolia, Acer laetum*; The third layer shrubs (2 m) are *Osmanthus decorus, Rhododendron ponticum, Laurocerasus officinalis*; The fourth layer herbs and ferns (0.5-0.8 m) are *Festuca drymeja, Trachystemon orientale, Asplenium nigrum, Blechnum spicant, Athyrium filix-femina.* Weeds and species non-native to Adjara, are absent, which indicates closeness of this forest to its natural state. Abundance of ferns, which gave the stand appearance of dense forest is noteworthy.

It is important to note that hornbeam as well as beech and chestnut are thermophilous plants demanding fertile soils but hornbeam never defines the physiognomy of these communities (i.e., it is not the edificatory) and is only the dominant or more often a co-dominant species. Hornbeam often grows on stony soils and in many places replaces beech.

Table 1. *Relevés of Castaneto-Carpineta*

Releve No. 1	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.57137 lat; 41.86879 long				
Landscape type:	1				
Elevation, m a. s. l.:	263				
Cardinal point exposure (°):	NW				
Slope angle/Inclination (°)	35				
Litter depth (cm):	2				
Litter mass (g dry weight/m^2)	1019.2				
pH	5.58				
Surface cover (%):					
Bare soil	10	5	2	5	10
Stones	20	5	10	5	10
Litter	8	28	20	10	23
Dead wood	4	2	8	5	3
Cryptogams	5	7	10	5	4
Plants	50	53	50	70	50
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	28				
Castanea sativa	2				

Releve No. 1	**1**	**2**	**3**	**4**	**5**
Carpinus caucasica	2				
Ostrya carpinifolia	++				
Acer laetum	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.7	1.6	1.7	1.8	1.7
Osmanthus decorus	4	4	++	++	+
Rhododendron ponticum	++	++	++	++	
Smilax exelsa	++		++	++	++
Hedera colchica	++	++			++
Hypericum inodorum	+	R	+	+	+
Laurocerasus officinalis	R		R	R	R
Hypericum androsaemum	R		R	R	
Corylus avellana	R				R
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	85	55	55	75	65
Asplenium nigrum	+	+		R	R
Asplenium scolopendrium	+		++		
Asplenium trichomanes	R		+		R
Athyrium filix-femina	R			R	
Blechnum spicant	+	+			+
Dryopteris filix-mas				R	
Festuca montana	++	+		++	++
Polystichum aculeatum	+	+	+		+
Potentilla micrantha	R				
Pteris cretica	+			+	
Salvia glutinosa	R				
Tammus communis	R				R
Trachystemon orientale	+	+	+	+	

6.1.2 Fageto-Carpineto-Castanetum rhododendrosum pontici

Beech-hornbean-chestnut forest with Pontic rhododendron undergrowth (Fageto-Carpineto-Castanetum rhododendrosum pontici) was studied in Kintrishi Protected Areas, at 535 m a.s.l., on a NW slope. Plant cover is not large. Dominant trees are *Castanea sativa, Carpinus caucasica, Fagus orientalis*. Chestnut is the most abondant of the trees and beech is the least abundant, which is a rare case; tree hight is almost equal. Of shrubs *Rhododendron ponticum*, as expected, is the tallest, followed by *Laurocerasus officinalis*. Shrubs cover is very high and affects seed germination. All the recorded shrubs are widespread in Colchis. Of herbaceous plants, only large-leaved *Trachystemon orientale* is present and this species defined the ecosystem structure and function. The plant is not tall (0.35 m) but its cover is very large. The species occurs in various forest types from the sea level to almost subalpine zone mostly in beech, beech, beech-fir as well as fir and hornbeam-chestnut forests (Dolukhanov, 2010).

Table 2. *Relevés of Fageto-Carpineto-Castanetum rhododendrosum ponticum*

Releve No. 2	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.74389 lat; 41.9557 long				
Landscape type:	3				
Elevation, m a. s. l.:	535				
Cardinal point exposure (°):	NW				
Slope angle/Inclination (°)	40				
Litter depth (cm):	5				
Litter mass (g dry weight/m^2)	1787.52				
pH	5.76				
Surface cover (%):					
Bare soil	10	0	0	2	0
Stones	5	0	0	2	0
Litter	20	50	40	15	20
Dead wood	4	5	2	10	5
Cryptogams	1	2	0	1	0
Plants	60	30	58	70	75
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	28				
Castanea sativa	2				
Carpinus caucasica	1				
Fagus orientalis	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	3.5	3	3	2.7	2
Rhododendron ponticum	4	++	++	++	++
Laurocerasus officinalis	++		+		
Rubus caucasicus	+	+	+	+	+
Euonymus europaeus	R				
Hypericum inodorum	R			R	
Hedera colchica	R				+
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	35			40	
Trachystemon orientalis	R			R	

6.1.3 Fageto-Castaneto-Carpinetum rhododendrosum pontici

Beech-chestnut-hornbean forest with Pontic rhododendron undergrowth (Fageto-Castaneto-Carpineta-Rhododendrosum pontici) was studied in Kintrishi Protected Areas, at 450 m a.s.l., on a moderately humid SE slope of 20°. The ecosystem is not floristically very diverse: three tree species are present, of which hornbeam

is the dominant followed by abundance by chestnut and beech. Tree hight reaches 30 m, tree layers are not clearly distinguishable. Shrub layer is, in opposide rich in species with eight species mostly pertainibg to the Colchic element. This layer defines the level of the specific diversity of this community. *Rhododendron ponticum* and *Laurocerasus officinalis* have the largest cover. An interesting ancient relict plant *Vaccinium arctostaphylos* is noteworthy when speaking about Colchic shrubs. The closest relatives of the species with wide synecological area occur only in the Macaronesian Islands (Madeira) and Japan (Dolukhanov, 2012; Takhtajyan, 1978).

Bidominant formations of this forest type are relatively well preserved, which is particularly true for chestnut-beech polydominant forest with the undergrowth of *Rhododendron ponticum, Laurocerasus officinalis, Daphne pontica, Vaccinium arctostaphylos, Viburnum orientale*.

Of the herbaceous plants only *Dentaria bulbifera* was recorded.

Table 3. *Relevés of Fageto-Castaneto-Carpinetum rhododendrosum ponticum*

Releve No. 3	1	2	3	4	5
GPS coordinates:	41.73882 lat; 41.98009 long				
Landscape type:	3				
Elevation, m a. s. l.:	450				
Cardinal point exposure (°):	SE				
Slope angle/Inclination (°)	20				
Litter depth (cm):	3				
Litter mass (g dry weight/m^2)	775.2				
pH	6.06				
Surface cover (%):					
Bare soil	10	5	10	10	5
Stones	0	0	0	10	6
Litter	30	18	35	29	20
Dead wood	5	5	3	8	10
Cryptogams	5	2	0	8	5
Plants	60	70	62	35	44
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	28				
Carpinus caucasica	2				
Castanea sativa	1				
Fagus orientalis	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	2.5	2.8	2.2	2.2	1.8
Rhododendron ponticum	4	4	4	4	4
Laurocerasus officinalis	++	++			
Daphne pontica	+	+			
Corylus avellana	+	+			
Hedera colchica	+	+		+	+
Vaccinium arctostaphylos	R	R			

Releve No. 3	1	2	3	4	5
Euonymus europaeus	R	R			
Hypericum inodorum	R	R			
Rubus caucasicus		+	++		
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	12	10	30	20	15
Dentaria bulbifera	+	+	R	+	R

6.1.4 Polydominant forest (Picea orientalis-Quercus dschorochensis-Castanea sativa)

Picea orientalis-Quercus dschorochensis-Castanea sativa in Shuakhevi is a polydominant forest with equal abundance of eight species of trees, one of which is *Picea orientalis*. The N slope is quite steep and moderately. Plant cover is about 40%, cryptogam cover 5%, the ecotope is quite stony with stone cover of 15%, and litter is quite abundant, 30%. Shrub layer is absent but the other layers are well formed: The first layer of trees (25 m) with *Picea orientalis, Quercus dschorochensis, Castanea sativa*; The second layer of trees (17-20 m) with *Carpinus caucasica, Acer laetum, Ostrya carpinifolia*; The third layer of trees (10-15 m) with *Acer campestre, Sorbus torminalis*; The fourth layer of herbs (0.35-0.50 m) with *Festuca drymeja, Vicia crocea, Lathyrus vernus, Epimedium pubigerum, Sanicula europaea, Primula sibthorpii, Polypodium vulgare, Polystichum aculeatum.* Two species of lianas are recorded: *Smilax excelsa, Hedera helix.*

Oak trees mostly grow in inaccessible places, on rocks, stony slopes, very often with Mediterranean *Ostrya carpinifolia*, two species of maple, which are considered oak-accompanying species in the Caucasus. *Sorbus torminalis* occurs in other oak forests of the Caucasus as well, e.g. in the riparian and other moist oak forests of the North Caucasus, also Crimea. Herbs do not clearly differ by abundance but one of the most usual species in Colchic as well as other forests of Georgia is *Festuca drymeja*, a relict species. *Vicia crocea*, an element of a moist meadow and a fern *Polypodium vulgare*, occur in a stony ecotope. Of other species noteworthy are nemoral *Lathyrus* vernus, *Sanicula europaea* and *Primula sibthorpii*, Colchic *Epimedium colchicum*, eastern-Mediterranean *Dorycnium graecum*.

Table 4. *Relevés of Polydominant forest (Picea orientalis-Quercus dschorochensis-Castanea sativa)*

Releve No. 4	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.6216 lat; 42.26533 long				
Landscape type:	2				
Elevation, m a. s. l.:	547				
Cardinal point exposure (°):	N				
Slope angle/Inclination (°)	35				
Litter depth (cm):	2				
Litter mass (g dry weight/m^2)	3201.92				
pH	6.01				
Surface cover (%):					
Bare soil	5	20	8	10	10
Stones	15	20	5	10	10

Releve No. 4	**1**	**2**	**3**	**4**	**5**
Litter	30	20	50	35	35
Dead wood	5	5	5	5	5
Cryptogams	5	5	2	5	8
Plants	40	30	30	35	32
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	26				
Picea orientalis	++				
Quercus dshorochensis	++				
Castanea sativa	++				
Ostrya carpinifolia	+				
Carpinus caucasica	+				
Acer laetum	R				
Sorbus torminalis	R				
Acer campestre	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):					
Smilax exelsa	+	+	+	+	+
Hedera helix	+	+	+	+	
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	35	35	35	35	35
Dorycnium graecum	R			+	
Epimedium pubigerum	+		+		++
Festuca montana	++	+	+	++	++
Lathyrus vernus	+	+	+	R	
Melampyrum arvense	R			R	
Polypodium vulgare	++	++	+	R	+
Polystichum aculeatum	+		+		
Primula sibthorpii	R		R	R	R
Pteridium tauricum				+	++
Sanicula europaea	R		R	R	
Vicia crocea	++	++			+

6.1.5 Arbuto-Pineto-Quercetum herbae mixtosum

The study plot is located in the lower montane forest belt, at 550 m a.s.l., in Gorkhanauli, Shuakhevi. The slope is moderately dry. Plant cover contains many xerophytes and xeromesophytes. Dominants and at the same time edificators are *Quercus dshorochensis*, a xeromesophyte occurring in Georgia and Turkey, *Pinus sylvestris* var. *hamata*, a xerophyte widespread in the mountains of the Caucasus, *Arbutus andrachne*, a typical Mediterranean element, which in contrast to Abkhazeti, occurs in Adjara in a form of a very small population, *Cerasus avium*, an European nemoral species widespread in the Caucasus. Layers are easily distinguishable:

The first layer of trees (20 m) with *Quercus dshorochensis*, *Pinus sylvestris* var. *hamata*; The second layer of trees (10-12 m) with *Arbutus andrachne, Carpinus caucasica*; The third layer of shrubs with *Cistus salviifolius, Juniperus rufescens, Laurus nobilis, Swida australis, Hedera helix; Laurus nobilis,* a relict species of the Tertiary is noteworthy but is must be run out species rather than a remnant of the past flora. The fourth layer of herbs is rather diverse; we recorded 13 species with various abundances. Of these species *Teucrium nuchense, Hieracium pilosella, Clinopodium vulgare, Satureja spicigera* are hemixerophytes. These species pertain to different coenotypes, e.g. *Festuca drymeja, Lapsana intermedia, Viola* spp. are typical forest species; *Hieracium pilosella, Origanum vulgare, Coronilla varia, Clinopodium vulgare* are meadow species but occur in the forest. A number of rock and scree growing plants are also recorded; these are: *Teucrium nuchense, Coronilla varia, Satureja spicigera.*

Table 5. *Relevés of Arbuto-Pineto-Quercetum herbae mixtosum*

Releve No. 5	1	2	3	4	5
GPS coordinates:	41.57141 Lat; 42.86872 Long				
Landscape type:	5				
Elevation, m a. s. l.:	548				
Cardinal point exposure (°):	W				
Slope angle/Inclination (°)	35				
Litter depth (cm):	2.5				
Litter mass (g dry weight/m^2)	2132.8				
pH	6.08				
Surface cover (%):					
Bare soil	5	10	20	15	10
Stones	15	15	30	15	20
Litter	20	25	30	25	25
Dead wood	5	5	5	3	2
Cryptogams	10	15	25	2	20
Plants	55	30	40	39	60
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	25				
Quercus dshorochensis	4				
Pinus sylvestris var. hamata	++				
Arbutus andrachne	++				
Cerasus avium	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	3.5	1.2	2	1.8	1.7
Cystus salviifolius	R		+	R	+
Juniperus rufescens	R		+	R	R
Laurus nobilis	R	R			
Swida australis	R				

Releve No. 5	1	2	3	4	5
Hedera helix	R				+
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	40	33	37	30	53
Asplenium adianthum-nigrum	+	+		+	+
Clinopodium vulgare	+	+	+		+
Coronilla orientalis	R		R		
Dorycnium graecum	+	+	+	R	+
Festuca montana	++	++	+	+	R
Hieracium pilosella	++	++	++	+	+
Lapsana intermedia	+	+			
Lathyrus vernus	+	+	+	R	+
Origanum vulgare	R	R		R	R
Poa nemoralis					R
Satureja spicigera	R	R			+
Teucrium nuchense	R			R	R
Viola scotophylla	R	R	R	R	R
Viola sieheana	R				R

6.1.6 Arbuto-Pineto-Quercetum herbae cistosum

The forest in Skhepi, Shuakhevi, was studied in the lower line of the middle montane forest belt, in a moderately humid habitat of a SSW slope. A few woody species were recorded, of which the most constant is a shrub *Cistus salviifolius* and herbs: *Dorycnium graecum, Festuca drymeja, Lathyrus vernus*. The first layer of trees (20 m) contains *Pinus sylvestris* var. *hamata*, *Quercus dshorochensis*; the second layer of trees (12-15 m) *Acer laetum, Sorbus torminalis*; the third layer of shrubs (0.7 m) *Cistus salviifolius.* This species like *Arbutus andrachne* and several others witnessed plant dispersal along the Black Sea coast (Sakhokia, 1980). The fourth layer of herbs is more diverse but cover does not exceeds 45% as abundance of each species is quite low.

Table 6. *Relevés of Arbuto-Pineto-Quercetum herbae cistosum*

Releve No. 6	1	2	3	4	5
GPS coordinates:	41.6329 Lat; 42.2027 Long				
Landscape type:	5				
Elevation, m a. s. l.:	689				
Cardinal point exposure (°):	S-SW				
Slope angle/Inclination (°)	40				
Litter depth (cm):	2				
Litter mass (g dry weight/m^2)	2400.0				
pH	6.21				
Surface cover (%):					
Bare soil	8	0	5	10	12
Stones	10	10	5	20	18

Releve No. 6	1	2	3	4	5
Litter	30	35	44	30	21
Dead wood	2	2	3	2	2
Cryptogams	5	3	3	5	2
Plants	45	50	40	33	40
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	18				
Quercus dshorochensis	4				
Pinus sylvestris var. *hamata*	++				
Sorbus torminalis	R				
Acer laetum	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.6	0.5	0.5	0.6	0.5
Cistus salviifolius	4	+	+	+	4
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	40	30	25	30	40
Asplenium adiantum-nigrum				+	
Campanula rapunculoides	R			R	+
Clinopodium vulgare	R			+	+
Coronilla orientalis	R				+
Dorycnium graecum	++	+	++		++
Festuca montana	++	+			R
Galium album	R	R			
Hieracium umbellatum	R			R	R
Lathyrus vernus	+	+	+		+
Melandrium balansae	R				R
Tunica saxifraga	R				R

6.1.7 Fagetum vacciniosum arctostaphyli

In this type of forest, *Fagus orientalis* is a dominant (and edificatory) species. The second tree species *Castanea sativa* is a rare admixture. The forest grows on moist northwestern slope of 30° and has a quite large cover and a significant thickness of detritus. Cryptogam cover is absent. The tree layer extends up to 30 m; shrubs and lianas form the second layer with remarkably high species richness, and dominance of typical Colchis shrubs; The dense undergrowth creates very unfavorable conditions for the development of herbaceous cover, and therefore we find only one species of herbaceous plants *Dentaria bulbifera* in low abundance.

Table 7. *Relevés of Fagetum vacciniosum arctostaphyli*

Releve No. 7	1	2	3	4	5
GPS coordinates:	41.73264 Lat; 42.08727 Long				
Landscape type:	4				
Elevation, m a. s. l.:	1275				
Cardinal point exposure (°):	NW				
Slope angle/Inclination (°)	30				
Litter depth (cm):	6				
Litter mass (g dry weight/m^2)	1573.92				
pH	5.84				
Surface cover (%):					
Bare soil	0	0	0	0	0
Stones	0	0	0	0	0
Litter	30	20	20	25	25
Dead wood	5	5	5	5	5
Cryptogams	0	0	0	0	0
Plants	65	75	75	70	70
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	30	30	30	30	30
Fagus orientalis	4	5	6	7	8
Castanea sativa	++	++	++	++	++
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.5	0.3	0.4	0.5	0.35
Vaccinium arctostaphylos	4	++	4	++	4
Rubus caucasicus	++	+	++	4	+
Viburnum orientale	++		+	++	++
Daphne pontica	++	+			
Laurocerasus officinalis	R				
Ilex colchica	R				
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	12	10	30	20	15
Dentaria bulbifera	+	+	R	+	R

Dark coniferous and mixed forest

6.1.8 Piceetum rhododendrosum pontici

This is a typical Colchic ecosystem of the middle montane zone, on SW slope of moderate inclination. Plant cover is 70%, of which 3% falls on cryptogams (lichens and bryophytes), litter cover is 16%. Four trees are recorded with spruce dominance and slight admixture of hornbeam. The first layer (> 25 m) is constituted by spruce and beech and the second by hornbeam and chestnut. The third layer (3 m) is made up of shrubs with

Rhododendron ponticum as the dominant and other typical Colchic elements such as evergreen *Laurocerasus officinalis* and deciduous *Viburnum orientale, Vaccinium arctostaphylos, Rubus caucasicus*. The fourth layer is made up of ferns with large cover. This forest grows on prolluvial and alluvial as well as thin soils and soils of moderate thickness, on slopes of moderate inclination. On rotten trunks and ground large numbers of tree seedlings were found.

Table 8. *Relevés of Piceetum rhododendrosum pontic*i

Releve No. 8	1	2	3	4	5
GPS coordinates:	41.49883 Lat; 41.87688 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1020				
Cardinal point exposure (°):	SW				
Slope angle/Inclination (°)	30				
Litter depth (cm):	4				
Litter mass (g dry weight/m^2)	2232.64				
pH	5.77				
Surface cover (%):					
Bare soil	5	5	20	5	5
Stones	1	0	2	0	2
Litter	16	23	26	25	26
Dead wood	5	0	2	3	5
Cryptogams	3	2	5	2	2
Plants	70	70	45	65	60
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	30				
Picea orientalis	4				
Castanea sativa	++				
Fagus orientalis	++				
Carpinus caucasica	+				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	2.8	1.7	1.6	1.5	1.8
Rhododendron ponticum	5	4	++	5	4
Viburnum orientale	R				
Rubus caucasicus	R		+		++
Vaccinium arctostaphylos	R	R			R
Laurocerasus officinalis	R				R
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	80				75

Releve No. 8	1	2	3	4	5
Dryopteris filix-mas	R				R

6.1.9 Piceeto-Abietum herbae mixtosum

Dark coniferous forests are one of the common forest types in the Caucasus, and in particular in Colchis. They occur at various elevations and are in contact with subalpine meadows. The distribution of these forests is determined by a number of environmental factors. First of all, this is air and soil humidity throughout the growing season, weakened continentality, weak evaporation, in which the amount of precipitation exceeds evaporation. In the mountains, these forests are found at high elevations, where the climate is moderately cold and quite humid. The forest community we studied is distributed in the lower zone of the subalpine belt, in the vicinity of the village Goma of the Shuakhevi municipality, on a moist, gentle slope. The overall of vegetation cover has a medium value, while terricolous cryptogams are abundant. Because of the high elevation, the forest is naturally thin, but its layers are clearly distinguishable. In the first layer (> 30 m) there are *Abies nordmanniana* and *Picea orientalis*; in the second layer (15 m) *Sorbus boissieri* and *Salix caprea*; in the third layer of shrubs (< 2 m) *Vaccinium arctostaphylos*, *Laurocerasus officinalis*, *Rhododendron luteum*, *Rubus caucasicus*; the fourth, herbaceous layer (1.5 m) is made up of *Telekia speciosa, Ranunculus ampelophyllus, Gentiana schistocalyx, Geranium psilostemon, Cicerbita petiolata, Dryopteris filix-mas, Athyrium filix-femina*, also components of the subalpine tall herb communities, as well as meadow species *Galium rotundifolium, Alchemilla oxisepala, Dentaria bulbifera, Campanula collina, Centaurea salicifolia* and forest plants *Oxalis acetosella, Paris incompleta, Valeriana alliariifolia, Asperula odorata, Fragaria* sp.*, Orchis triphylla*.

Table 9. *Relevés of Piceeto-Abietum herbae mixtosum*

Releve No. 9	1	2	3	4	5
GPS coordinates:	41.56439 Lat; 42.11937 Long				
Landscape type:	4				
Elevation, m a. s. l.:	1810				
Cardinal point exposure (°):	N-NW				
Slope angle/Inclination (°)	10				
Litter depth (cm):	4				
Litter mass (g dry weight/m^2)	2082.56				
pH	5.06				
Surface cover (%):					
Bare soil	3	3	0	3	0
Stones	0	2	0	0	0
Litter	12	33	30	35	50
Dead wood	10	2	5	5	5
Cryptogams	10	20	10	12	10
Plants	65	40	55	45	45
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	31				
Abies nordmanniana	4				

Releve No. 9	1	2	3	4	5
Picea orientalis	++				
Sorbus boissieri	R				
Salix caprea	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.6	1.8	0.9	0.7	1.1
Vaccinium arctostaphylos	4	++	+	+	+
Rhododendron luteum	++	R			
Rubus caucasicus	+	+	++	+	R
Laurocerasus officinalis	R				R
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	85	73	80	75	73
Alchemilla oxysepala	++	++	++	+	++
Asperula odorata	R	R	+	R	+
Athyrium filix-femina	++	++	++	++	++
Calamintha grandiflora	+	R	+	+	+
Campanula collina	R		R		R
Carex pendula	R				
Centaurea salicifolia	R		R		
Cicerbita petiolata	R		+		+
Circaea alpina	R			R	
Dentaria bulbifera	+		+		+
Dryopteris filix-mas	++	R		++	++
Fragaria vesca	R				
Galium rotundifolium	++	++	++	++	++
Gentiana schistocalyx	+	+	++	+	+
Geranium psilostemon	R		+		
Mycelis muralis	R				R
Orchis triphylla	R		R		
Oxalis acetosella	++	++		++	++
Paris incompleta	R		+	R	+
Ranunculus ampelophyllus	++	++	++	++	++
Telekia speciosa	R		R		
Valeriana alliariifolia	R	R		+	+
Viola reichenbachiana	R				

6.1.10 Piceeto-Abietum vacciniosum arctostaphyli

The forest community was studied in the lower line of the subalpine belt, on moist slightly inclined slopes with 70% plant cover in the village Goma vicinity of Shuakhevi. The first layer of trees (32 m) is made up of *Abies nordmanniana*, *Picea orientalis*; the second layer of trees (20 m) of *Sorbus boissieri, Acer trautvetteri, Fagus*

orientalis; the third layer of shrubs (2-4 m) of relict species: *Vaccinium arctostaphylos, Salix caucasica, Rubus caucasicus, Laurocerasus officinalis, Rhododendron luteum,* and *Rubus caucasicus.* Rich is the herbaceous cover, which can be classified into several phytocoenotic categories. These are species of the subalpine tall herb communities, characteristic to the Caucasus mountains: *Dryopteris filix-mas, Athyrium filix-femina, Gentiana schistocalyx, Gadellia lactiflora*; subalpine meadow plants: *Galium rotundifolium, Alchemilla oxysepala, Dentaria bulbifera, Campanula collina, Centaurea salicifolia;* forest herbaceous species: *Oxalis acetosella, Paris incompleta, Valeriana alliariifolia, Asperula odorata.*

Table 10. *Relevés of Piceeto-Abietum vacciniosum arctostaphyli*

Releve No. 10	1	2	3	4	5
GPS coordinates:	41.56664 Lat; 42.11826 Long				
Landscape type:	4				
Elevation, m a. s. l.:	1830				
Cardinal point exposure (°):	N-NW				
Slope angle/Inclination (°)	8				
Litter depth (cm):	2.5				
Litter mass (g dry weight/m^2)	1924.32				
pH	5.87				
Surface cover (%):					
Bare soil	3	5	3	3	3
Stones	2	0	0	0	0
Litter	10	20	27	27	30
Dead wood	10	5	6	10	10
Cryptogams	5	10	10	15	15
Plants	70	60	60	45	45
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	32				
Abies nordmanniana	4				
Picea orientalis	++				
Fagus orientalis	R				
Acer trautvetteri	R				
Sorbus boissieri	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.5	1.4	0.7	1.7	1.4
Vaccinium arctostaphylos	4	4	++	++	4
Rhododendron ponticum	++			+	
Rubus caucasicus	+	+	R	+	+
Laurocerasus officinalis	R				
Salix caucasica	R				
Herbaceous plants 25 m^2 (5 X 5 m)					

Releve No. 10	1	2	3	4	5
Grass canopy height (cm):	135	120	85	120	115
Alchemilla oxysepala	+				
Asperula odorata	R				
Athyrium filix-femina	++	++	++	++	+
Calamintha grandiflora	R	R	R	R	R
Carex pendula		R		R	R
Cicerbita petiolata	R				
Dentaria bulbifera	R	R	R	R	R
Dryopteris carthusiana	R				
Dryopteris filix-mas	++				+
Gadellia lactiflora	R				
Galium rotundifolium	+				R
Gentiana schistocalyx	+	+	+	+	+
Geranium psilostemon	+		+		+
Oxalis acetosella	+	+	+	+	+
Paris incompleta	R	R		R	
Potentilla micrantha			+		
Ranunculus ampelophyllus	++	++	++	++	+
Trachystemon orientale					R
Valeriana alliariifolia	R				
Viola reichenbachiana	R				

6.1.11 Piceeto-Abietum laurocerasosum officinalis

Dark conoferous forest with Colchic undergrowth was studied in Khulo, in the upper montane belt, on quite steep SE slope where plant (only woody species) cover does not exceed 45% and herbs are absent. The first layer of trees (30 m) is made up of *Abies nordmanniana*, *Picea orientalis*; the second layer of trees (20 m) of *Fagus orientalis*; the third layer of shrubs (1.5-2m), which is the reason of the herbaceous cover absence is composed of evergreen *Laurocersus officinalis*, *Rhododendron ponticum,* deciduous *Vaccinium arctostaphylos* present in high abundance and cover. Large cover of litter and deadwood, which ranges from 35-40% and 5-10%, respectively, is noteworthy.

This and similar forest types are related to mountains with high precipitation and occur at almost all elevations above sea level up to the treeline including inaccessible rocky areas.

Table 11. *Relevés of Piceeto-Abietum laurocerasosum officinalis*

Releve No. 11	1	2	3	4	5
GPS coordinates:	41.589934 Lat; 42.430520 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1540				
Cardinal point exposure (°):	SE-E				

Releve No. 11	1	2	3	4	5
Slope angle/Inclination (°)	40				
Litter depth (cm):	8				
Litter mass (g dry weight/m2)	1786.56				
pH	5.65				
Surface cover (%):					
Bare soil	5	0	2	5	5
Stones	0	0	3	0	0
Litter	40	35	35	35	35
Dead wood	10	5	5	10	10
Cryptogams	0	0	0	0	0
Plants	45	60	55	50	50
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	30				
Abies nordmanniana	4				
Picea orientalis	++				
Fagus orientalis	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.8	1.8	2	1.9	1.8
Laurocerasus officinalis	4	4	4	4	5
Rhododendron ponticum	+	+	+	R	
Vaccinium arctostaphylos	R	R			
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	-	-	-	-	-
–	-	-	-	-	-

6.2 Guria

In Guria, 11 forest types were studied: wetland forest, wetland forest (of alder), temperate humid thermophilic Colchic rainforest: broad-leaved Colchic forest and mixed deciduous-polydominant Colchic forest, several variants of beech forest, chestnut, hornbeam, dark coniferous and mixed forest, subalpine forest: birch and Pontic oak forests.

Wetland forest

6.2.1 Alnetum

Relict monodominant alder forest was studied in Chkhakaura are in Bakhmaro, on a SE slope at 1060 m a.s.l., in the middle montane belt. Alder abundance is high, and tree height reaches 20 m. As a species well adapted to wetland conditions, alder successfully outcompetes other tree as well as shrub species and makes monodominant stands. On hillocks typical forest herb species grow such as *Festuca drymeja, Campanula rapunculoides* together with weeds: *Galeopsis bifida, Oplismenus undulatifolius, Salvia glutinosa*.

Table 1. *Relevés of Alnetum*

Releve No. 1	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.84304 Lat; 42.22833 Long				
Landscape type:	3				
Elevation, m a. s. l.:	1060				
Cardinal point exposure (°):	SE				
Slope angle/Inclination (°)	11				
Litter depth (cm):	2				
Litter mass (g dry weight/m2)	402.88 40.18				
Litter pH:	4.78 4.56				
Surface cover (%):					
Bare soil	0	0	0	3	0
Stones	5	0	5	2	5
Litter	5	2	2	5	2
Dead wood	5	10	8	15	2
Cryptogams	10	3	5	5	1
Plants	75	85	80	70	90
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	19				
Alnus barbata	4				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	-	-	-	-	-
-	-	-	-	-	-
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	70	60	65	50	80
Galeopsis bifida	3	3	4	+	5
Oplismenus undulatifolius	2	3		4	1
Geum urbanum	++		1		1
Festuca drymeja	1	+	1		
Salvia glutinosa	1			+	1
Bidens tripartita	1	1		+	
Phytolacca americana	R		R		
Lapsana grandiflora	+		+	+	
Urtica dioica		1		2	1

Releve No. 1	1	2	3	4	5
Knautia montana		+	+	+	
Campanula rapunculoides		++	+		1
Calystegia sylvestris		+			1
Geranium robertianum		+		1	1
Dryopteris filix-mas		+	1	1	1
Campanula rapunculoides	+				

6.2.2 Alnetum matteucciosum struthiopteris

Alder forest with ferns occurs on Bakhmaro, on a W slope of low inclination at 1610 m a.s.l., in the middle montane belt. Soil pH is weakly acid, plant cover is high (65-80%). Alger is a dominant species in the tree layer of the community. Only *Rubus anatolicus* occurs of shrubs. *Matteuccia struthiopteris* is pesent in high abundance and makes up dense cover in this Colchic forest community. *Petasites albus* grows along riverbanks as in other similar places in Colchis. The list of herbaceous species preset is quite long. Among them are relict weltand species protected in the area by their very requirement to high moisture supply: *Senecio jacquinianus, Heracleum grossheimii, Gadellia lactiflora, Pachyphragma macrophyllum, Cicerbita petiolata*.

A Tertiary relict *Festuca drymeja* mostly characteristic to forests of eastern Georgia is also recorded.

Table 2. *Relevés of Alnetum matteucciosum struthiopteris*

Releve No. 2	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.86852 Lat; 42.42102 Long				
Landscape type:	2				
Elevation, m a. s. l.:	1600				
Cardinal point exposure (°):	NE				
Slope angle/Inclination (°)	3				
Litter depth (cm):	4				
Litter mass (g dry weight/m^2)	1370.88 76.92				
Litter pH:	5.82 5.22				
Surface cover (%):					
Bare soil	3	3	0	0	0
Stones	2	3	3	0	0
Litter	7	5	9	5	5
Dead wood	15	15	13	15	10
Cryptogams	8	4	3	3	5
Plants	65	70	72	77	80
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	14				

Releve No. 2	**1**	**2**	**3**	**4**	**5**
Alnus barbata	5				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.2	-	1.0	1.2	-
Rubus anatolicus	1	-	1	1	-
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	120	100	90	100	120
Matteuccia struthiopteris	4	3	4	3	3
Petasites albus	1	2	1	3	3
Senecio jacquinianus	1	1	R		1
Paris quadrifolia	1	+		1	1
Viola alba	1	+			
Heracleum grossheimii	1	2	1		1
Gadellia lactiflora	1	1	+		1
Pachyphragma macrophyllum	1	2	1		+
Hesperis matronalis	+		+		
Urtica dioica	+		1	1	2
Hypericum caucasicum	+	+	R	+	+
Festuca drymeja	+	+	+	1	+
Chaerophyllum aureum	+	+	+		
Geranium robertianum	+				
Rumex acetosella	1				
Cicerbita petiolata	+				
Impatiens noli-tangere		R	+	1	
Aruncus vulgaris			1	+	+
Sedum stoloniferum			+		+
Rumex acetosella				1	
Lythrum salicaria				1	+
Actaea spicata		+		1	1

6.2.3 Alnetum with evergreen Colchic undergrowth

Alder forest wth Colchic undergrowth was studied at 590 m a.s.l., in the lower montane belt in Bakhmaro. The only tree species to accompany the dominant *Alnus barbata* is *Carpinus caucasica* but the latter occurs in very low numbers. Abundant moisture restricts growth of other species and ensures continuity of the old growth stand. Colchis evergreen understory is diverse with *Rhododendron ponticum, Ruscus colchicus, Laurocerasus officinalis* as well as liana *Hedera colchica*.

Of the herb cover species, a *Pachyphragma macrophyllum*, a relict of the Tertiary forests is important to mention.

Table 3. *Relevés of Alnetum with evergreen Colchic undergrowth*

Releve No. 3	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.9205 Lat; 42.2435 Long				
Landscape type:	5				
Elevation, m a. s. l.:	590				
Cardinal point exposure (°):	NE				
Slope angle/Inclination (°)	12				
Litter depth (cm):	4				
Litter mass (g dry weight/m2)	1506.72 105.61				
Litter pH:	5.22 4.58				
Surface cover (%):					
Bare soil	10	2	2	3	2
Stones	2	10	2	5	3
Litter	55	40	30	30	40
Dead wood	0	5	4	1	3
Cryptogams	3	3	2	1	2
Plants	30	40	60	60	50
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	18				
Alnus barbata	5				
Carpinus caucasica	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.5	2.0	1.2	1.5	2.0
Rhododendron ponticum	3				3
Ruscus colchicus	1	1	2	2	1
Laurocerasus officinalis	2	4	1	3	1
Hedera colchica	1	1	2	2	1
Rubus anatolicus		1	1		1
Sambucus nigra			R		R
Ilex colchica			1		1
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	20	25	20	30	30
Pachyphragma macrophyllum	2	1		+	
Viola alba	++				R
Dryopteris filix-mas	1		1		+
Phyllitis scolopendrium		1	1	+	++
Carex pendula				1	

6.2.4 Fageto-Alnetum with evergreen Colchic undergrowth

Alnus barbata forest community is one of the widespread communities of broad-leaved forests in Georgia and accounts for 3% of Georgia's forest area; its distribution range includes areas with Atlantic and temperate continental climates. Beech forest with alder was studied at Khidistavi. The studied Tertiary's relict community occurs in the middle forest zone, on a SW slope of moderate inclination with acidic soil, significant vegetation cover (55-72%). The studied forest is polydominant with alder being the major dominant species. Frequently in more moistened and wetland areas alder makes up impassable monodominant stands. After alder, beech and hornbeam were found the most abundant followed by chestnut, hornbeam and elm. The vertical profile of the forest is as follows: The first layer (*Alnus barbata, Fagus orientalis, Tilia begoniifolia, Castanea sativa, Carpinus caucasica*) – 20-25 m; the second layer (*Acer laetum, Ulmus glabra*) – 10-15 m.

The abundance of co-dominant species in the first layer in many cases is an indicator of anthropogenic disturbance of the forest, and according to some researchers (Sahokia, 1980) presence of *Carpinus caucasica* and *Alnus incana* is often secondary. However, we consider the studied stand as natural since well represented *Fagus orientalis, Tilia begoniifolia, Castanea sativa* are all species of the natural climax forest communities. Presence of Colchis lianas: *Hedera colchica*, a Colchic relict, and *Tamus communis*, an ancient Mediterranean relict, are also noteworthy. In the second layer the evergreen undergrowth typical of the Colchis is well formed. Two of the 11 evergreen shrubs of the Colchic undergrowth occurs there: *Laurocerasus officinalis, Ruscus colchicus* as well as deciduous shrubs: *Rubus anatolicus, Euonymus europaeus, Sambucus nigra*. *Laurocerasus officinalis* is worth special notes: development of the shrub largely depends on high humidity indices; according to Dolukhanov (2010), in conditions of 2000 mm annual precipitation, it spreads from the sea level to 2200-2250 m a.s.l. The most typical communities occur between 7000-2000 m a.s.l. At higher elevations, the species demands snow cover.

Herb cover in the Colchic forest is not diverse consisting of four species of ferns: *Pteris cretica, Phyllitis scolopendrium, Polystichum braunii, Dryopteris filix*. *Cardamine pectinata* is recorded in the community, which indicates high humidity of the habitat.

The life form analysis has shown that mega- and nano-phanerophytes are relatively widespread on the studied plot, hemicryptophytes are scanty, chamaephytes are not present, while geophytes are to be studied in spring and autumn seasons.

Table 4. *Relevés of Fageto-Alnetum with evergreen Colchic undergrowth*

Releve No. 4	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.85346 Lat; 42.14493 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1100				
Cardinal point exposure (°):	SE				
Slope angle/Inclination (°)	30				
Litter depth (cm):	3				
Litter mass (g dry weight/m^2)	1212.16 77.59				
pH	5.32 5.66				
Surface cover (%):					

Releve No. 4	**1**	**2**	**3**	**4**	**5**
Bare soil	3	2	4	3	5
Stones	5	3	1	5	0
Litter	10	25	15	10	15
Dead wood	8	10	5	8	8
Cryptogams	2	5	5	2	7
Plants	72	55	70	72	65
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	25				
Alnus barbata	3				
Fagus orientalis	2				
Tilia begoniifolia	2				
Castanea sativa	1				
Carpinus caucasica	1				
Acer laetum	R				
Ulmus glabra	++				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	2	1.5	1.5	2.5	2
Laurocerasus officinalis	3	3	4	4	3
Rubus anatolicus	1	2		1	
Ruscus colchicus	1				
Hedera colchica	2	2	2	2	2
Sambucus nigra	R			R	R
Euonymus europaeus		R	1		
Tamus communis		++		+	++
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	15	20	25	15	15
Phyllitis scolopendrium	++	+		1	
Cardamine pectinata	+		1		
Pteris cretica	+		+		
Dryopteris filix-mas	++	+	1	1	+
Polystichum braunii		+		++	+

Beech forest

6.2.5 Fagetum rhododendrosum lutei

The community occurs in Mt. Muchuta near Bakhmaro, on the NW slope of 20° of inclination in the subalpine belt. Dominant beach trees are about 30 m tall at maturity. Shrubs are diverse in the monodominant stand with five species constituting the undergrowth; two of these species: *Rhododendron caucasicum* and *Rh.*

ponticum are evergreen. The community monodominant in the first layer with diverse undergrowth resembles some of the communities in e.g. Himalayas but the latter is made up of only evergreen species.

Herb cover is well formed and consists of the following species: *Festuca drymeja, Asperula odorata, Oxalis acetosella, Sanicula europaea, Pyrola rotundifolia*, and other Caucasian forest herbaceous species. The herb layer height is 50-70 cm.

Life forms are diverse: mega-phanerophytes represented by a single species, nano-phaneerophytes and nano-chamaephytes being relatively numerous and hemicryptophytes in a small number of species.

Beech forest with Pontic azalea was studied on Mt. Muchuta, in the lower line of the subalpine belt; species composition indicated that the communitcan be considered as a relatively xeromorphic variant of the Colchis hygro-thermomesophilous vegetation. However, the community includes *Vaccinium arctostaphylos*, an "ultra"-Colchic element and *Rhododendron ponticum*, more widespread in the western Eurasia. Along with the predominant *Rhododendron luteum* and already mentioned *Rh. ponticum* and *V. arctostaphylos*, the understory of the community includes *Sorbus caucasigena, Rhododendron caucasicum* and *Rubus anatolicus*.

Table 5. *Relevés of Fagetum rhododendrosum lutei*

Releve No. 5	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.87279 Lat; 42.36196 Long				
Landscape type:	5				
Elevation, m a. s. l.:	2010				
Cardinal point exposure (°):	NW				
Slope angle/Inclination (°)	25				
Litter depth (cm):	3				
Litter mass (g dry weight/m^2)	1601.92 88.02				
pH	4.78 4.57				
Surface cover (%):					
Bare soil	8	5	7	12	5
Stones	12	8	6	6	3
Litter	20	20	18	30	25
Dead wood	4	10	5	7	4
Cryptogams	3	7	4	7	3
Plants	53	50	60	38	60
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	30				
Fagus orientalis	4				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.7	0.8	0.8	0.7	0.75
Rhododendron luteum	3	3	3	2	2
Vaccinium arctostaphylos	2	2	3	1	
Vaccinium myrtillus	1		1	1	1
Rhododendron caucasicum	1	1		R	

Releve No. 5	**1**	**2**	**3**	**4**	**5**
Rhododendron ponticum		1			2
Sorbus caucasigena		R		R	R
Rubus anatolicus	+		1		1
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	20	25	20	25	20
Festuca drymeja	2	1	1	1	2
Asperula odorata	1	1	1		1
Galium rotundifolium	+	1	+		+
Oxalis acetosella	+	++	1		1
Nepeta grandiflora	+	+	+	++	+
Cardamine pectinata	+		+		+
Sanicula europaea	R		+		+
Pyrola rotundifolia	+	+	+	R	+
Prenanthes purpurea		R	+	+	+
Polypodium vulgare		R	R	+	1
Luzula sylvatica			+	+	+
Dentaria bulbifera		+	1	1	1

6.2.6 Fagetum filicosum

Beech forest with ferns was studied at the village Chadrekili, on a NW slope of moderate inclination at 1935 m a.s.l. in the subalpine belt. The community is one of the good examples of the Tertiary's relict flora. The first layer (28 m) consists of *Fagus orientalis, Abies nordmanniana, Acer platanoides*. The second layer trees are absent but the saplings of the first layer trees. The undergrowth is absent and the herbaceous cover is made up of species typical of the region's forest habitats: *Oxalis acetosella, Asperula odorata, Paris incompleta, Dentaria bulbifera*; presence of species of relict subalpine tall herb communities is worth special emphasis; these are: *Valeriana alliariifolia, Geranium sylvaticum, Cicerbita petiolata, Gentiana schistocalyx, Senecio platyphylloides*.

Table 6. *Relevés of Fagetum filicosum*

Releve No. 6	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.87153 Lat; 42.32243 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1940				
Cardinal point exposure (°):	NW				
Slope angle/Inclination (°)	26				
Litter depth (cm):	4..5				
Litter mass (g dry weight/m^2)	476.96 98.14				
pH	4.49 4.37				

Releve No. 6	**1**	**2**	**3**	**4**	**5**
Surface cover (%):					
Bare soil	3	2	10	2	10
Stones	2	0	1	2	0
Litter	30	11	40	15	50
Dead wood	5	5	4	10	10
Cryptogams	1	2	5	1	5
Plants	59	80	40	70	25
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	28				
Fagus orientalis	4				
Abies nordmanniana	1				
Acer platanoides	1				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	-	-	-	-	-
-	-	-	-	-	-
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	35	50	30	60	15
Dryopteris filix-mas	3	3	3	4	1
Athyrium filix-femina	2	3			1
Oxalis acetosella	2	1	1	1	1
Asperula odorata	2		2	2	2
Geranium sylvaticum	1	1		1	
Euphorbia macroceras	++	+	+	1	
Valeriana alliariifolia	++	1	+		
Cicerbita petiolata	++	++			
Paris incompleta	R	++	R		
Nepeta grandiflora	1	2	1	1	2
Dentaria bulbifera	R	++	R		+
Senecio platyphylloides		2	++	+	R
Prunella vulgaris		+	++		
Sedum oppositifolium					R
Gentiana schistocalyx	R	R	++	2	

6.2.7 Fagetum rubosum anatolici

Beech forest with blackberry was studied on a massif on Bakhmaro, on a steep W slope. Plant cover and among other components, the detritus cover is high. The first layer (29-30 m) is made up of *Fagus orientalis, Tilia begoniifolia*, the second one (10-15 m) of *Sorbus caucasigena* and *Ulmus glabra*. Shrub layer is diverse and includes evergreen species such as *Hedera colchica, Ruscus colchicus*. Deciduous shrubs are represented by a higher number of species, of which *Rubus anatolicus* prevails. Presence of typical Colchic element *Trachystemon*

orientale is noteworthy. Lifeform spectrum is quite wide with mega- and nanop-phanerophyte on the once side and hemicryptophytes on the other. Subalpine tall herb community species are also found here: *Symphytum asperum, Gentiana schistocalyx, Senecio propinquus*, as well as ferns.

Table 7. *Relevés of Fagetum rubosum anatolici*

Releve No. 7	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.88698 Lat; 42.37109 Long				
Landscape type:	2				
Elevation, m a. s. l.:	1350				
Cardinal point exposure (°):	W				
Slope angle/Inclination (°)	25				
Litter depth (cm):	3				
Litter mass (g dry weight/m^2)	724.8 19.01				
pH	4.87 4.99				
Surface cover (%):					
Bare soil	1	1	2	1	2
Stones	1	0	2	1	2
Litter	20	30	25	29	27
Dead wood	3	2	3	2	3
Cryptogams	3	2	3	2	2
Plants	72	65	65	65	64
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	29				
Fagus orientalis	3				
Tilia begoniifolia	++				
Sorbus caucasigena	+				
Ulmus glabra	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.0	1.0	1.0	1.0	1.0
Rubus anatolicus	4	4	4	4	4
Hedera colchica	2	2	2	2	2
Ruscus colchicus	2	2	2	2	2
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	80	70	80	40	50
Dryopteris filix-mas	2	2	3	2	2
Trachystemon orientale	2	2	2	2	2
Cicerbita petiolata	2	2		1	
Carex pendula	+	+	1	1	1
Symphytum asperum			2	1	1

Releve No. 7	1	2	3	4	5
Senecio propinquus			+		
Impatiens noli-tangere			R		
Petasites albus	++	++	1	+	1
Epilobium algidum				+	
Gentiana schistocalyx	+	+	+	++	1
Fragaria vesca			+		
Nepeta grandiflora			+		
Athyrium filix-femina	++	++	+	1	2

6.2.8 Fagetum asperulosum odorati

Fagus orientalis-Abies nordmanniana-Picea orientalis forest studied in Bakhmaro mountains, on a NW slope of low inclination at 2040 m a.s.l. in the subalpine belt. Plant cover is uneven (15-40%, of which 5% is cryptogams). The forest layer is composed of beech and fir but beech is much more abundant. In even lower numbers *Picea orientalis, Acer pseudoplatanus* are present. It is notable that fir in the studied community grows in worse soil conditions (on stony substrate) than beech. No undergrowth is present. In the herb layer the Tertiary's relict species *Festuca drymeja*, boreal *Asperula odorata*, species of the relict tall herb communities: *Senecio platyphylloides, Gentiana schistocalyx, Euphorbia macroceras, Geranium sylvaticum,* ferns: *Dryopteris filix-mas, Athyrium filix-femina,* relatively dry habitat species: *Paris incompleta, Sedum album,* etc. constitute the herbaceous cover.

Table 8. *Relevés of Fagetum asperulosum odorati*

Releve No. 8	1	2	3	4	5
GPS coordinates:	41.8692 Lat; 42.32234 Long				
Landscape type:	5				
Elevation, m a. s. l.:	2050				
Cardinal point exposure (°):	NW				
Slope angle/Inclination (°)	28				
Litter depth (cm):	5				
Litter mass (g dry weight/m^2)	953.44 75.54				
pH	5.06 5.47				
Surface cover (%):					
Bare soil	10	5	3	5	5
Stones	0	2	2	0	0
Litter	65	48	50	60	55
Dead wood	5	10	2	2	2
Cryptogams	5	10	3	2	3
Plants	15	25	40	31	35
Trees per 400 m^2 plot (20 X 20 m)					

Releve No. 8	**1**	**2**	**3**	**4**	**5**
Tree canopy height (m):	28				
Fagus orientalis	5				
Abies nordmanniana	1				
Picea orientalis	R				
Acer pseudoplatanus	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	-	-	-	-	-
-	-	-	-	-	-
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	20	25	25	15	15
Asperula odorata	2	2	3	2	2
Nepeta grandiflora	2	2	1	2	1
Senecio platyphylloides	1	+		1	
Dryopteris filix-mas	+				
Athyrium filix-femina	++	+			
Dentaria bulbifera	+	+	++	1	1
Festuca drymeja	+		2		
Gentiana schistocalyx	R				
Geranium sylvaticum		+			
Euphorbia macroceras	R	+			
Oxalis acetosella		1		1	2
Scrophularia alata		++			
Epilobium montanum		+			
Paris incompleta		+		1	
Paris quadrifolia			++		1
Prunella vulgaris		+			
Sedum album		+			
Stellaria nemorum		1			
Fragaria vesca					+
Veronica filiformis					+

6.2.9 Fagetum rhododendrosum pontici

Fagetum rhododendrosum pontici was studied at Chkhakaura, in Bakhmaro, on a SE slope at 1100 m a.s.l., in the middle montane belt. Soil pH is weakly acidic, litter cover is significant, abundance of deadwood is noteworthy. Two tree species were recorded: dominant *Fagus orientalis* and its frequent accompanying species *Carpinus caucasica* in the first layer of trees (30 m). In the shrub layer *Rhododendron ponticum* is the dominant species. Other typical plants of Colchic communities are recorded such as *Hedera colchica, Vaccinium arctostaphylos*, also *Tamus communis*, and *Rubus anatolicus*.

Table 9. *Relevés of Fagetum rhododendrosum pontici*

Releve No. 9	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.84367 Lat; 42.22934 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1100				
Cardinal point exposure (°):	ES110				
Slope angle/Inclination (°)	45				
Litter depth (cm):	6				
Litter mass (g dry weight/m^2)	1286.72				
pH	4.83				
Surface cover (%):					
Bare soil	10	15	5	10	3
Stones	5	10	10	5	3
Litter	28	70	70	65	80
Dead wood	10	2	10	10	10
Cryptogams	5	2	3	5	2
Plants	42	1	2	5	2
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	30				
Fagus orientalis	4				
Carpinus caucasica	2				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	2.5	2.5	2.5	2.5	2.5
Rhododendron ponticum	5	5	5	5	5
Hedera colchica	1	1	1	1	1
Rubus anatolicus	1	1	1	1	1
Vaccinium arctostaphylos	+	+	+	+	+
Tamus communis	+			1	R
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	30	25	25	30	30
Dryopteris filix-mas	++		1	1	++
Salvia glutinosa	+	++	++		R

Chestnut forest

6.2.10 Castanetum

Chestnut forest was studied in Bakhmaro, on a S steep slope at 1215 m a.s.l., in the montane forest zone, i.e. elevation optimum of the community. Soil pH is acidic, plant cover is relatively high (55-65%). The forest is made up of three tree species: the first layer (23 m) by chestnut present in moderate abundance, the second

one (10-15 m) by hornbeam and alder with relatively low abundance. The shrub layer (0.5-1 m) is made up of a single species *Rubus anatolicus*. Herb cover (30-50 cm) is rather diverse.

Table 10. *Relevés of Castanetum*

Releve No. 10	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.905469 Lat; 42.380876 Long				
Landscape type:	3				
Elevation, m a. s. l.:	1220				
Cardinal point exposure (°):	S				
Slope angle/Inclination (°)	34				
Litter depth (cm):	4				
Litter mass (g dry weight/m^2)	400.64 31.11				
pH	5.26 5.45				
Surface cover (%):					
Bare soil	5	5	10	10	3
Stones	20	5	10	10	7
Litter	7	12	15	15	10
Dead wood	5	8	8	3	8
Cryptogams	3	5	2	2	7
Plants	60	65	55	60	65
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	23				
Castanea sativa	3				
Alnus barbata	2				
Carpinus caucasica	2				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	-	0.4	-	0.3	0.4
Rubus anatolicus		1		1	1
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	30	25	30	30	30
Oplismenus undulatifolius	3	3	2	2	3
Festuca drymeja	1	2	3		2
Lapsana grandiflora	1	2	1	+	2
Polygonum alatum	1				

Releve No. 10	**1**	**2**	**3**	**4**	**5**
Fragaria vesca	1	1	1		1
Galeopsis bifida	1			1	
Stenactis annua	1	+			1
Pyrethrum partheniifolium	1	1	1	++	++
Campanula rapunculoides	1	1	1	+	2
Geum urbanum	1				
Trifolium ambiguum				1	
Convolvulus arvensis	+			+	+
Dryopteris filix-mas	+	+		+	++
Ambrosia artemisiifolia	+				1
Asplenium adiantum-nigrum					1
Nepeta grandiflora	++	2	1	2	
Polystichum braunii	1				
Silene multifida		++	+		
Prunella vulgaris		1	++		
Salvia glutinosa		1			
Luzula sylvatica			1	1	
Clinopodium vulgare			+		1
Clinopodium umbrosum					++
Gadellia lactiflora				++	
Agrostis capillaris			+	2	
Commelina communis					+
Sedum oppositifolium				+	
Asplenium trichomanes				+	
Epilobium algidum			+	1	
Epilobium montanum		+			

Hornbeam forest

6.2.11 Carpinetum rhododendrosum lutei

The studied forest is located in the middle montane belt. Plant cover is lower (28-35%) than that of litter (45-52%), and cryptogam cover is noteworthy (5-10%). The layer structure complex with te first layer (22 m) made up of *Carpinus caucasica* and *Castanea sativa*, the second one (15-20 m) by *Fagus orientalis* and rarely *Acer laetum*. In the shrub layer (0.7-0.9 m) *Rhododendron luteum*, almost permanently accompanying hornbeam, is the dominant species; Colchic *Daphne pontica* is also present. Herb cover (10-20 cm) is not diverse and contains species typical of Georgia's forests: *Festuca drymeja, Cyclamen vernum*. Participation of the ancient Mediterranean *Tamus communis* is also noteworthy.

Table 11. *Relevés of Carpinetum rhododendrosum lutei*

Releve No. 11	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.8983 Lat; 42.4416 Long				
Landscape type:	3				
Elevation, m a. s. l.:	890				
Cardinal point exposure (°):	S				
Slope angle/Inclination (°)	33				
Litter depth (cm):	3				
Litter mass (g dry weight/m^2)	2565.76 120.31				
pH	5.07 5.62				
Surface cover (%):					
Bare soil	4	3	3	2	4
Stones	4	5	12	7	5
Litter	52	50	45	46	49
Dead wood	5	7	2	2	2
Cryptogams	5	5	10	8	7
Plants	30	30	28	35	33
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	22				
Carpinus caucasica	4				
Castanea sativa	2				
Acer laetum	R				
Fagus orientalis	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.7	0.6	0.8	1.0	0.8
Rhododendron luteum	3	3	3	3	3
Daphne pontica	1	1		1	
Tamus communis	1	1	+		+
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	15	15	15	17	20
Nepeta grandiflora	1	1	+		1
Silene multifida	+	R			+
Campanula cordifolia	+	+			+
Calystegia silvatica	++			+	+

Releve No. 11	1	2	3	4	5
Fragaria vesca	+			+	+
Viola alba	+			R	R
Vicia cracca	++				
Hypericum androsaemum	+				
Hypericum xylosteifolium			+		R
Festuca drymeja	+	++	1	1	1
Cyclamen vernum	R		+	+	R
Lapsana communis		+	1	1	+
Polystichum braunii		+	+		R
Oplismenus undulatifolius		1	+	1	1
Cicerbita petiolata		+	+	1	
Clinopodium vulgare		+	+		
Cardamine pectinata			+	+	+
Salvia glutinosa				R	1
Sanicula europaea		+	+		

Dark coniferous and mixed forest

6.2.12 Piceeto-Abietum rhododendrosum pontici

Dark coniferous forest belt elevations with high relative ait humidity, are close to optimum zone for Colchic plant growth after the broadleaved forest belt. In Bakhmaro mountains, we described two similar communities in the upper montane belt. The difference between these communities is dominance one of the two dark coniferous species: *Abies nordmanniana* in one of them, namely, Piceeto-Abietum rhododendrosum pontici, and *Picea orientalis* in the other, namely, Piceeto-Abietum festucosum drymejae. The former is recorded on a steep (25°) SE slope with acidic soil. In both communities, in the first layer of trees (28 m), abundance of *Abies nordmanniana* is twice as much as that of *Picea orientalis*. In the shrub layer (1.5 m), evergreen shrubs *Rhododendron ponticum, Ilex colchica, Ruscus colchicus,* liana *Hedera colchica* and deciduous shrub *Vaccinium arctostaphylos* are present. The third, herbaceous layer (25 cm) contains only five species.

Below comparative analysis of the two communitues is given.

Table 12. *Relevés of Piceeto-Abietum rhododendrosum pontici*

Releve No. 12	1	2	3	4	5
GPS coordinates:	41.87713 Lat; 42.41306 Long				
Landscape type:	4				
Elevation, m a.s.l.:	1880				
Cardinal point exposure,°:	SE				

Releve No. 12	**1**	**2**	**3**	**4**	**5**
Slope angle/Inclination,°	25				
Litter depth, cm:	3,5				
Litter mass (g dry weight/m^2)	3612.8 247.05				
pH	4.48 4.68				
Surface cover, %:					
Bare soil	5	3	5	2	0
Stones	0	2	0	5	0
Litter	25	20	10	18	15
Dead wood	5	5	10	10	2
Cryptogams	5	5	5	10	3
Plants	60	65	70	55	80
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	28				
Abies nordmanniana	4				
Picea orientalis	2				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	1.5	1.5	1.5	1.0	1.5
Rhododendron ponticum	4	4	4	4	5
Hedera colchica	1		2	1	1
Vaccinium arctostaphylos		R		R	
Ilex colchica	+		1		
Ruscus colchicus		++			+
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	25	20	20	15	25
Oxalis acetosella	1		++	1	+
Gentiana schistocalyx	+			+	+
Athyrium filix-femina	+	+			+
Dryopteris filix-mas		++	++		+
Polystichum braunii		R	+	+	

6.2.13 Piceeto-Abietum festucosum drymejae

The most obvious difference between Piceeto-Abietum festucosum drymejae and Piceeto-Abietum rhododendrosum pontici, discussed in the previous subsection, can be observed in the composition of their understories. In a community dominated by *Abies nordmanniana*, the undergrowth has high abundance of *Rhododendron ponticum*, and in the other community dominated by *Picea orientalis*, higher abundance of *Vaccinium arctostaphylos* is recorded. In both cases, the first layer (30 m) is made up of fir and spruce, and

abundance of fir is twice as large as the number of spruce. Evergreen shrubs are present in the second layer of both communities. However, the second layer of Piceeto-Abieta festucosa drymeja is low (40 cm) as it does not include *Rhododendron ponticum*. The structure and species composition of the second layer determines species richness of the community, which is three times as high as that of Piceeto-Abietum rhododendrosum pontici.

Table 13. *Relevés of Piceeto-Abietum festucosum drymejae*

Releve No. 13	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.87604 Lat; 42.41319 Long				
Landscape type:	4				
Elevation, m a. s. l.:	1850				
Cardinal point exposure (°):	SE				
Slope angle/Inclination (°)	20				
Litter depth (cm):	3.5				
Litter mass (g dry weight/m^2)	1159.2				
pH	4.93				
Surface cover (%):					
Bare soil	5	2	2	2	2
Stones	2	0	4	0	0
Litter	28	30	35	20	20
Dead wood	5	5	6	4	1
Cryptogams	5	3	3	4	2
Plants	55	60	50	70	75
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	30				
Picea orientalis	2				
Abies nordmanniana	4				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.4	0.4	0.3	0.25	0.4
Rubus anatolicus	1		1		1
Hedera colchica	++	1	+	1	
Vaccinium arctostaphylos	R		1	+	+
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	30	35	25	35	30
Festuca drymeja	3	3	3	4	3
Galium rotundifolium	2	1	1	1	3
Luzula sylvatica	1	1		+	+
Oxalis acetosella	1	2	1	++	++
Dryopteris filix-mas	+	1	+		

Releve No. 13	1	2	3	4	5
Nepeta grandiflora	+	1	+		
Cardamine pectinata	+		+		+
Asperula odorata	++		2		1
Carex pendula		+			
Prenanthes purpurea		+	+		
Viola alba		+			R
Pachyphragma macrophyllum		+			++
Paris quadrifolia			R	R	
Sanicula europaea			R		1

6.2.14 Abieta-Fagetum

Fir-beech with spruce and rowan is one of the typical Colchic communities spread in upper montane and subalpine belts; we studied the community on Mt. Bakhmaro, at 1950 m a. s. l. Ground cover reaches 93-96% but plant cover ratio in the ground cover is low (8-25%) and that of litter particularly high (55-75%). Soil has acidic reaction. Ground cover reaches 93-96% but plant cover ratio in the ground cover is low (8-25%) and that of litter particularly high (55-75%). Soil has acidic reaction. Forest canopy closure is 0.7. Trees in this belt tend to have crook trunks. Beech tree height reaches 30 m and their age in such communities is 200-300 years (Dolukhanov 2010).

The first layer (28-30 m) is made up of *Abies nordmanniana* and *Fagus orientalis*, the second layer (10-15 m) of *Picea orientalis*, and the third one (5-10 m) of *Sorbus caucasigena*. The undergrowth is made up of *Vaccinium arctostaphylos*, one of the commonest species of the undergrowth in beech forest of Colchis especially in conditions of relatively heavy precipitation both on the Great and the Lesser Caucasus (although comparatively rare in the eastern part of the Great Caucasus reaching the border with Azerbaijan). The specie's elevational range spreads from about 500 m a.s.l. to 2150 m a.s.l. and in less humid conditions from 1200 to 2000 m a.s.l. This is a relict Colchic species has the closest relatives in Macaronesian islands (Madeira) and Japan. This species has high affinity to beech forest contrasting the antagonistic relation of the evergreen shrubs of the Colchic understory. Species of tall herb communities: *Dryopteris filix-mas, Athyrium filix-femina, Cicerbita petiolata* are also present.

Almost all the herbaceous plants recorded in the community are Colchis forest plants, which indicates the natural state of the forest and even its primeval character. Bryophyte cover includes *Hylocomium splendens, Eurhynchium striatum, Pleurozium schreberi, Dicranum scoparium*, etc. Life form spectrum is as follows: mega-phanerophytes and hemicryptophytes predominate followed by chamaephytes and geophytes; therophytes are not present.

Table 14. *Relevés of Abieta-Fagetum*

Releve No. 14	1	2	3	4	5
GPS coordinates:	41.87209 Lat; 42.32089 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1950				

Releve No. 14	**1**	**2**	**3**	**4**	**5**
Cardinal point exposure (°):	SE101				
Slope angle/Inclination (°)	30				
Litter depth (cm):	6.0				
Litter mass (g dry weight/m^2)	1778.88				
pH	4.46 5.13				
Surface cover (%):					
Bare soil	3	2	5	4	2
Stones	2	2	0	3	3
Litter	75	68	70	55	75
Dead wood	5	10	7	8	5
Cryptogams	5	10	3	5	5
Plants	10	8	15	25	10
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	28				
Fagus orientalis	4				
Abies nordmanniana	3				
Picea orientalis	2				
Sorbus caucasigena	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.35	0.35	0.35	0.35	0.35
Vaccinium arctostaphylos	1	1	1	1	1
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	15	10	50	20	15
Dryopteris filix-mas	1				R
Galium rotundifolium	1	2	2	2	1
Nepeta grandiflora	1	1	1	1	1
Oxalis acetosella	1	++		1	1
Cicerbita petiolata	++				R
Athyrium filix-femina	+		2		
Cardamine pectinata		1	++	1	
Prunella vulgaris				1	
Dentaria bulbifera				R	

Subalpine forest: birch and Pontic oak forests

6.2.15 Betuletum vacciniosum arctostaphyli

Typical Colchic forest was studied on Mt. Muchuta in Bakhmaro, on a NW slope of 35° at 2030 m a.s.l., in the subalpine belt. Plant cover ranges from 60-75%. The litter cover (15-25%) is noteworthy; relatively high

is the ration of the bare ground (3-7%) and stones (2-4%). Tree species composition is diverse. Here classical endemic of the Colchic treeline, crook-stemmed light demanding *Betula medwedewii* is present also as well as *Betula litwinowii* widespread in the Caucasus, *Fagus orientalis*, *Picea orientalis* and *Sorbus caucasigena*. All the trees are low, < 4 m, which is far behind their usual height. Low stature is a plant strategy to survive winter low tempertures. The shrub layer is rather diverse with *Rhododendron ungernii* worth special mention. Another species to mention is Colchic relict *Vaccinium arctostaphylos*. At the same time a number of endemic Tertiary's relict species occur in the described community: *Kemulariella caucasica, Valeriana alliariifolia, Euphorbia macroceras, Gentiana* spp*., Digitalis schischkinii,* etc.

Table 15. *Relevés of Betuletum vacciniosum arctostaphyli*

Releve No. 15	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.87791 Lat; 42.40927 Long				
Landscape type:	4				
Elevation, m a. s. l.:	1970				
Cardinal point exposure (°):	N				
Slope angle/Inclination (°)	35				
Litter depth (cm):	6.5				
Litter mass (g dry weight/m^2)	3825.6 209.37				
pH	4.88 4.82				
Surface cover (%):					
Bare soil	4	5	7	6	3
Stones	3	2	3	4	0
Litter	25	15	15	25	17
Dead wood	3	5	2	5	0
Cryptogams	5	3	3	5	5
Plants	60	70	70	55	75
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	4.0				
Betula medwediewii	4				
Acer trautvetteri	1				
Acer platanoides	+				
Abies nordmanniana	+				
Fagus orientalis	+				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.0	1.2	1.3	1.5	1.5
Vaccinium arctostaphylos	3	3	3	2	3

Releve No. 15	**1**	**2**	**3**	**4**	**5**
Rhododendron luteum	1		2	2	+
Viburnum opulus	+				R
Sorbus caucasigena	+	R		R	+
Hedera colchica		1	1		
Laurocerasus officinalis		3	2	2	3
Salix caucasica		+		R	
Ilex colchica			2	1	
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	50	45	50	55	60
Dryopteris filix-mas		1	++	++	+
Festuca drymeja	2	2	1	1	3
Lapsana grandiflora	1	2	1	1	1
Gentiana septemfida	+	1	1		1
Gentiana schistocalyx	+	+	1		1
Geranium sylvaticum	1		1		+
Kemulariella caucasica	++		1		+
Valeriana alliariifolia	+		+		+
Carex pendula	+		1		++
Gadellia lactiflora	+		1	1	+
Agrostis capillaris	2		+	1	+
Trifolium ambiguum	1		++	1	+
Aruncus vulgaris	+	1		+	
Potentilla lazica	R	+		+	
Euphorbia macroceras	R	+		+	
Digitalis schischkinii	R			1	+
Rumex acetosella	+			+	+
Cirsium pugnax	+	++		1	
Saxifraga repanda	+	+		++	
Carum caucasicum		+	+	+	+
Hypericum caucasicum		+	R		
Alchemilla dura		+	R		
Prunella vulgaris		+	++	1	1
Veratrum lobelianum		1	R	+	+
Solidago virgaurea			+		+

6.2.16 Betuletum rhododendrosum ungernii

This type of forest was studied in the Bakhmaro mountains, at 2030 m on a very steep (45°) NW slope. Soil is highly acidic (4.81). Plant cover is much larger (80-95%) than in the similar forest types considered above (55-70%). There is a big difference in litter cover as well, being, respectively, 1-10% and 15-25%. Litter thickness is also significantly less, being respectively, 1.5 cm and 6.5 cm. The first layer (3.5 m) is made up of *Betula medwedewii, B. litwinowii*, each present in relatively low abundance (2-3). Four other tree species are recorded. In the second layer (1.0-1.3 m) several co-dominants occur: *Rhododendron ungernii, Rh. luteum* and *Vaccinium arctostaphylos*. Their abundances are approximately equal. The herbaceous layer is diverse but *Festuca drymeja* and *Lapsana grandiflora* are the most abundant species.

Table 16. *Relevés of Betuletum rhododendrosum ungernii*

Releve No. 16	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.87139 Lat; 42.36456 Long				
Landscape type:	4				
Elevation, m a. s. l.:	2030				
Cardinal point exposure (°):	NW				
Slope angle/Inclination (°)	45				
Litter depth (cm):	1.5				
Litter mass (g dry weight/m^2)	419.84 72.15				
pH	4.81 5.65				
Surface cover (%):					
Bare soil	1	3	1	2	1
Stones	2	3	1	2	1
Litter	10	3	2	5	1
Dead wood	5	0	1	1	1
Cryptogams	2	2	3	5	1
Plants	80	89	92	85	95
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	3.5				
Betula medwediewii	3				
Betula litwinowii	2				
Sorbus caucasigena	1				
Picea orientalis	R				
Fagus orientalis	R				
Acer platanoides	+				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.0	1.3	1.3	1.2	1.2

Releve No. 16	**1**	**2**	**3**	**4**	**5**
Rhododendron ungernii	3	3	3	2	3
Rhododendron luteum	3	3	3	3	3
Rhododendron caucasicum	1	1		1	
Vaccinium arctostaphylos	2	2	3	1	3
Vaccinium myrtillus	+	1			1
Salix caucasica	+				
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	50	45	50	55	60
Festuca drymeja	2	2	1	1	3
Lapsana grandiflora	1	2	1	1	1
Gentiana septemfida	+	1	1		1
Gentiana schistocalyx	+	+	1		1
Geranium sylvaticum	1		1		+
Kemulariella caucasica	++		1		+
Valeriana alliariifolia	+		+		+
Carex pendula	+		1		++
Gadellia lactiflora	+		1	1	+
Agrostis capillaris	2		+	1	+
Trifolium ambiguum	1		++	1	+
Digitalis schischkinii	R			1	+
Rumex acetosella	+			+	+
Euphorbia macroceras	R	+		+	
Aruncus vulgaris	+	1		+	
Carum caucasicum		+	+	+	+
Hypericum caucasicum		+	R		
Alchemilla dura		+	R		
Dryopteris filix-mas		1			
Cirsium pugnax	+	++		1	
Prunella vulgaris		+	++	1	1
Veratrum lobelianum		1	R	+	+
Solidago virgaurea			+		+
Dryopteris filix-mas			++	++	
Saxifraga repanda	+	+		++	
Potentilla lazica	R	+		+	

6.2.17 Quercetum ponticae

Pontic oak community was studied in Bakhmaro mountains, where this community is best represented in Colchis. The studied community occurs on W slope of low inclination at 1640 m a.s.l., in the upper montane belt. Plant cover (mainly at the expense of the Pontic oak itself) is high. Mature crook-stem trees are about 5 m tall. In the undergrowth typical Colchic evergreen shrub *Ruscus colchicus* is recorded. *Euonymus europaeus* widespread in the Caucasus occurs in low abundance.

Table 17. *Relevés of Quercetum ponticae*

Releve No. 17	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.88916 Lat; 42.35925 long				
Landscape type:	4				
Elevation, m a. s. l.:	1640				
Cardinal point exposure (°):	W				
Slope angle/Inclination (°)	7				
Litter depth (cm):	5				
Litter mass (g dry weight/m^2)	1015.52 94.57				
pH	5.22 5.32				
Surface cover (%):					
Bare soil	1	2	2	0	0
Stones	0	0	2	0	1
Litter	7	10	13	5	10
Dead wood	5	3	4	2	5
Cryptogams	2	2	4	3	4
Plants	85	80	75	90	80
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	5.0				
Quercus pontica	5				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.5	1.0	1.5	1.2	1.2
Laurocerasus officinalis	2	3	3	2	3
Ilex colchica	2	2	3	2	3
Ruscus colchicus	2	2		3	2
Euonymus europaeus	R				
Rubus anatolicus	2	1	2	1	
Corylus avellana		1	2	3	2
Euonymus europaeus			R		
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	10	15	15	20	15

Releve No. 17	**1**	**2**	**3**	**4**	**5**
Impatiens noli-tangere	4		R		++
Prunella vulgaris	2	1	1	1	1
Dryopteris filix-mas	++	+	1	1	1
Urtica dioica	+	+	1	+	
Trachystemon orientale		+	+	+	
Symphytum asperum		+		R	1

6.2.18 Fagetum quercetosum pontici

Fagetum quercetosum pontici is one of the interesting local relict communities. It is spread in upper montane and subalpine belts. We studied the community on N slope of moderate inclination at 1690 m a.s.l. Plant cover is high.

In the first layer (20 m) *Fagus orientalis* and *Acer trautvetteri* predominate, in the second one (10-15 m) *Sorbus caucasigena*, in the shrub layer (3-5 m) *Quercus pontica* predominates as well as *Laurocersus officinalis*, an evergreen species of the Colchic undergrowth, and *Rubus anatolicus*. In the herbaceous cover species of subalpine tall herb communities: *Gentiana schistocalyx, Petasites albus, Symphytum grandiflorum*. As in the majority of the studied communities, almost all Raunkiaer's life forms are present except therophytes.

Table 18. *Relevés of Fagetum quercetosa pontici*

Releve No. 18	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.88450 Lat; 42.36281 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1690				
Cardinal point exposure (°):	N				
Slope angle/Inclination (°)	20				
Litter depth (cm):	4				
Litter mass (g dry weight/m^2)	1914.72 92.28				
pH	4.53 5.08				
Surface cover (%):					
Bare soil	5	8	8	5	2
Stones	1	4	3	0	2
Litter	55	60	50	55	70
Dead wood	4	5	7	5	15
Cryptogams	5	3	7	5	6
Plants	30	20	25	30	5
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	20				
Fagus orientalis	3				

Releve No. 18	**1**	**2**	**3**	**4**	**5**
Acer trautvetteri	1				
Sorbus caucasigena	2				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	5	5	5	5	5
Quercus pontica	4	4	4	5	4
Rubus anatolicus	2	2	2	2	1
Laurocerasus officinalis	1	R		1	
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	30	25	30	30	35
Dryopteris filix-mas	1	1	1	1	
Urtica dioica	1	1	1	1	
Polypodium vulgare	+	+	+		+
Athyrium filix-femina	+	+		1	+
Gentiana schistocalyx	R	R		++	+
Petasites albus			1	1	+
Symphytum grandiflorum			1	+	+

6.3 Samegrelo

In Samegrelo six forest types were studued: wetland forest (of alder); temperate humid thermophilic Colchic rainforest: mixed deciduous-polydominant Colchic forest, chestnut forest, subalpine forest: forests of Colchic hazel, Megrelian birch and Pontic oak.

Wetland forest

6.3.1 Alnetum

The forest dominated by *Alnus barbata* with participation of *Fagus orientalis* and *Picea orientalis* was studied in the lower montane belt at 670 m a.s.l., on a slightly inclined E slope. The mentioned tree species make up the first layer. Of the recorded shrubs, *Rubus anatolica* in the most abundant growing as impassable thickets. As in other stands of this type liana, in this case, *Hedera colchica* also defines the appearance of the forest. As forest species are present in low abundance, the layers are not well distinguishable. Of herbs *Pachyphragma macrophyllum*, a typical forest relict species is noteworthy.

Table 1. *Relevés of Alnetum*

Releve No. 1	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.64583 Lat; 42.43639 Long				
Landscape type:	3				
Elevation, m a. s. l.:	670				
Cardinal point exposure (°):	E80				

Releve No. 1	**1**	**2**	**3**	**4**	**5**
Slope angle/Inclination (°)	2				
Litter depth (cm):	5				
Litter mass (g dry weight/m^2)	943.36				
Litter pH:	8.34				
Surface cover (%):					
Bare soil	5	5	15	7	2
Stones	10	10	10	10	4
Litter	5	7	5	5	4
Dead wood	10	5	0	3	5
Cryptogams	3	5	5	10	10
Plants	67	68	65	65	75
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	28				
Alnus barbata	4				
Fagus orientalis	1				
Picea orientalis	1				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	100	90	100	100	150
Corylus avellana		R	R		
Hedera colchica	2	2	2	1	2
Laurocerasus officinalis	1	+			
Rubus anatolicus	2	1	2	1	2
Ruscus colchicus			R		
Sambucus nigra	R	R			R
Vaccinium arctostaphylos		+			
Viburnum opulus					1
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	50	60	55	60	50
Aconitum nasutum	R				
Asperula odorata	2	1		2	
Athyrium filix-femina	+	+	1	2	
Calystegia silvatica		1		1	
Carex pendula	+	+	+		1
Dryopteris filix-mas		2	+	1	2
Euphorbia macroceras	+	+	+	+	1

Releve No. 1	**1**	**2**	**3**	**4**	**5**
Fragaria vesca	1		1	1	
Galeopsis bifida			+	+	+
Galium odoratum					R
Geranium robertianum	+	1	1		
Geum urbanum	+				
Impatiens noli-tangere		+	+		
Lapsana grandiflora		R		++	
Mycelis muralis				1	
Nepeta grandiflora	2	1			2
Oxalis acetosella	1	1	1		
Pachyphragma macrophyllum	+		1		
Paris quadrifolia	+		+		1
Poa nemoralis		1	2		2
Polygonatum polyanthemum			+	R	
Polygonum hydropiper		+		+	+
Polygonum petiolatum	+		+	+	
Prunella vulgaris	1	2	1	1	1
Rumex acetosella				R	
Salvia glutinosa		1			
Sedum stoloniferum	1	1			1
Senecio propinquus	R	R			
Urtica dioica			1		
Viola alba	1	1		+	

Temperate humid thermophilic Colchic rainforest: mixed deciduous-polydominant Colchic forest

6.3.2 Fagetum with evergreen Colchic undergrowth

Fagetum with evergreen Colchic understory, a typical Colchic community, was studied in the Tekhura gorge, in the middle montane belt, at 975 m a.s.l., on a NW slope of low inclination, with high plant cover (75-88%). Layers are well distinguishable in this polydominant forest: the first layer (25 m) consists of *Fagus orientalis,* its frequent co-dominant *Abies nordmanniana* and also *Picea orientalis*; the second layer (20-24 m) of *Tilia begoniifolia*; the third layer (15-18 m) of *Alnus barbata, Diospyros lotus.* The fourth layer is made up of evergreen shrubs: *Rhododendron ponticum, Laurocerasus officinalis, Ilex colchica,* and *Ruscus colchicus*; deciduous: *Rhododendron luteum, Vaccinium arctostaphylos,* and evergreen liana *Hedera colchica.* The fifth layer of herbs is poorly developed (15-25 cm) and consists of *Festuca drymeja, Luzula sylvatica, Paeonia macrophylla, Oxalis acetosella, Alchemilla caucasica,* and fern *Dryopteris filix-mas.* All the species are typical Colchic high-mountain plants. Noteworthy is relation of beech with *Luzula sylvatica.* In contrast with western-

European beech forest, this forest type in western Georgia has dense undergrowth made up of semi-prostrate, mostly evergreen shrubs. Specific composition exhibits relict nature of Colchic vegetation. The undergrowth contains typical Colchic species connected to beech forest, e.g. relict *Vaccinium arctostaphylos*. A common feature of all the Colchic plants is necessity to grow in very humid environment. In case of the studied community this species are *Rhododendron ponticum, Laurocerasus officinalis, Ilex colchicus, Ruscus colchicus, Hedera colchica*. The most xeromorphic of the plants present here is a deciduous shrub *Rhododendron luteum*.

Table 2. *Relevés of Fagetum with evergreen Colchic undergrowth*

Releve No. 2	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.678312 Lat; 42.451065 Long				
Tekhura gorge					
Landscape type:	5				
Elevation, m a. s. l.:	975				
Cardinal point exposure (°):	NW330				
Slope angle/Inclination (°)	20				
Litter depth (cm):	6				
Litter mass (g dry weight/m^2)	721.28				
pH	6.08				
Surface cover (%):					
Bare soil	5	2	2	2	5
Stones	1	0	3	0	3
Litter	5	5	7	10	7
Dead wood	2	0	3	2	5
Cryptogams	5	5	5	3	5
Plants	82	88	80	83	75
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	25				
Fagus orientalis	3				
Abies nordmanniana	1				
Picea orientalis	+				
Tilia begoniifolia	1				
Diospyros lotus	++				
Alnus barbata	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.5	1.8	2	1.7	2
Rhododendron ponticum	3	3	3	3	3
Rhododendron luteum	1	1		1	1
Laurocerasus officinalis	2	3	3	2	3
Vaccinium arctostaphylos	1	1	1	1	2
Ilex colchica	++				

Releve No. 2	**1**	**2**	**3**	**4**	**5**
Ruscus colchicus	++	1			
Hedera colchica	1	1	1	1	
Ruscus aculeatus		++			
Rubus anatolicus			1	1	2
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	15	25	20	25	15
Alchemilla caucasica	+		1		+
Chamerion angustifolium		+		+	+
Dryopteris filix-mas	R	+			+
Festuca drymeja	+		+	+	+
Fragaria vesca		+			
Geranium robertianum		+			
Luzula sylvatica	+	+	+	+	+
Oxalis acetosella	1	1	+	++	1
Paeonia macrophylla	R				

6.3.3 Fagetum vacciniosum arctostaphyli

Fagetum vacciniosum arctostaphyli plant community, a typical Colchis forest formed on the limestone massif of Mt. Migaria, in the lower line of subalpine belt, on a slightly inclined NW slope with relatively low vegetation cover. Forest flora is rather poor. *Fagus orientalis* creates the background, *Abies nordmanniana* occurs in low numbers and both are in the firts layer (11 m). *Vaccinium arctostaphylos* dominates in the shrub layer (1-2 m). The following shrub by abundance is *Rubus anatolicus,* and evergreen *Laurocerasus officinalis, Rhododendron ponticum*. Non-woody layer (20-30 cm) is very poor and contains: *Petasites albus, Dryopteris filix-mas.* Low number of species can be explained by large cover of the shrubs and *Petasites albus*, which hampers seed germination and seedling growth.

Table 3. *Relevés of Fagetum vacciniosum arctostaphyli*

Releve No. 3	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.65472 Lat; 42.36028 Long				
Landscape type:	4				
Elevation, m a. s. l.:	1660				
Cardinal point exposure (°):	NW350				
Slope angle/Inclination (°)	7				
Litter depth (cm):	5				
Litter mass (g dry weight/m^2)	763.52				
pH	7.72				
Surface cover (%):					
Bare soil	10	5	10	5	3
Stones	5	0	0	5	0

Releve No. 3	**1**	**2**	**3**	**4**	**5**
Litter	45	60	55	40	48
Dead wood	8	2	0	5	2
Cryptogams	2	3	5	5	2
Plants	30	30	30	40	45
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	11				
Fagus orientalis	5				
Abies nordmanniana	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.2	1	1.2	1.5	1.2
Vaccinium arctostaphylos	3	3	2	3	3
Rubus anatolicus	1	1	+	2	1
Laurocerasus officinalis	1		1	2	1
Rhododendron ponticum	1		1	1	
Rhododendron luteum			1		1
Viburnum opulus		R			
Ruscus colchicus		R		+	+
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	30	25	30		20
Petasites albus	+	R			+
Dryopteris filix-mas	+		+		+

Chestnut forest

6.3.4 Castanetum

Castaneta plant community was studied in the river Tekhura gorge, in the upper montane forest belt, at 1360 m a.s.l., on a 20° NW slope. Both tree species are in the same layer (27 m). This elevation and shaded and semi-shaded slope is considered optimal habitat for chestnut. Since chestnut develops well on calcareous substrates, it should also be considered acceptable for the species. Colchic shrubs *Rhododendron ponticum, Laurocerasus officinalis, Vaccinium arctostaphylos, Rubus anatolicus* are widespread in western Georgia. In the undergrowth *Laurocerasus officinalis* predominates, which along with Pontic rhododendron grows in highly humid conditions with deep snow cover in winter. Another Colchic shrub in the undergrowth is *Vaccinium arctostaphylos*. Herbaceous synousia in these conditions (significant shading, high soil acidity) of well-formed Colchic shrub undergrowth is very weak and contains only 2-3 species on the studied plot.

Table 4. *Relevés of Castanetum*

Releve No. 4	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.6493 Lat; 42.372 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1357				
Cardinal point exposure (°):	NE40				

Releve No. 4	**1**	**2**	**3**	**4**	**5**
Slope angle/Inclination (°)	20				
Litter depth (cm):	5				
Litter mass (g dry weight/m^2)	827.68				
pH	6.16				
Surface cover (%):					
Bare soil	3	5	3	7	3
Stones	2	0	0	0	2
Litter	5	7	10	7	5
Dead wood	5	10	5	2	5
Cryptogams	5	5	5	4	5
Plants	80	73	77	80	80
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	27				
Castanea sativa	3				
Fagus orientalis	2				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	2	1.7	1.5	1.7	2.2
Laurocerasus officinalis	4	4	3	2	4
Rhododendron ponticum	1	1	3	1	3
Vaccinium arctostaphylos	1	2	1	2	
Rhododendron luteum		1	1	2	
Rubus anatolicus	1	+	1	1	
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	20	30	30	25	35
Calystegia silvatica	+			+	
Eupatorium cannabinum	+	+	+	+	
Athyrium filix-femina		R	R		R
Aruncus dioicus				++	

Subalpine forest

6.3.5 Coryletum colchici

The typical Colchic plant community situated on Mt. Migaria limestone massif, upper montane forest belt, 1670 m a.s.l., SE stony slope of low inclination with small trees and high overall vegetation cover. The layer structure is as follows: the first layer (3-4 m) is made up of *Abies nordmanniana, Picea* orientalis; the second layer (2-3 m) of *Fagus orientalis, Betula* megrelica; the third layer (1-1.5 m) of *Corylus colchica, Rhamnus imeretina, Sorbus migarica, Viburnum* lantana; the fourth layer of herbs (50-70 cm) consists of *Cyclamen colchicum* (autumn flowering)*, Alboviodoxa elegans, Potentilla divina, Luzula sylvatica, Woronowia speciosa.* All the listed tree species are characteristic to Colchis and particularly, Samegrelo mountains. Spruce saplings grow on more stony and skeleton soild, and fir individuals occupy deeper and more fertile soil layers.

Rare relict endemic *Betula megrelica* is related to more widespread *B. medwediewii* and is distributed on limestone slopes of Samegrelo. Noteworthy is the shrub synusia with *Corylus colchica* dominance and all the species being typical Colchis elements. Non-woody flora is this community is quite rich and contains typical Colchic endemic species such as limestone growing *Cyclamen colchicum, Alboviodoxa elegans, Woronowia speciosa*, and the other, forest herbaceous species: *Campanula latifolia, Gentiana septemfida, Fragaria vesca, Calamagrostis arundinacea, Luzula sylvatica* as well as subalpine meadow species*: Anthoxanthum alpinum, Trifolium ambiguum, Betonica macrantha, Carex tristis, Ranunculus oreophilus, Thymus caucasicus, Helianthemum hirsutum*.

Table 5. *Relevés of Coryletum colchici*

Releve No. 5	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.640331 Lat; 42.345828 Long				
Mt. Migaria					
Landscape type:	5				
Elevation, m a. s. l.:	1670				
Cardinal point exposure (°):	SE120				
Slope angle/Inclination (°)	15				
Litter depth (cm):	3				
Litter mass (g dry weight/m^2)	341.28				
pH	6.32				
Surface cover (%):					
Bare soil	0	2	0	2	0
Stones	20	25	35	30	25
Litter	3	2	2	5	3
Dead wood	0	0	0	5	0
Cryptogams	2	2	3	5	2
Plants	75	69	60	53	70
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	3				
Picea orientalis	++				
Fagus orientalis	++				
Betula megrelica	+				
Abies nordmanniana	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.5	1.3	1.5	1	1.5
Corylus colchica	3	4	1	3	3
Rhamnus imeretina	2				
Sorbus migarica	1		1		1
Viburnum lantana	1	+	1		1
Daphne pontica	1	+	1		+
Salix pantosericea	2	2	2	2	2

Releve No. 5	**1**	**2**	**3**	**4**	**5**
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	55	100	80	50	60
Woronowia speciosa	3	3	3	3	2
Alboviodoxa elegans	++			++	++
Anthoxanthum odoratum	1	+	2		1
Asplenium trichomanes	+	+	+		+
Betonica macrantha	1	1	1	1	1
Calamagrostis arundinacea	1	1	1		2
Campanula latifolia	+	++		R	1
Carex caucasica	1		1		1
Carex oreophila	1	++			++
Carex tristis	1	1	1		1
Coronilla coronata	+			+	1
Cyclamen colchicum	+			+	R
Fragaria vesca	1	1	++		1
Gentiana septemfida	+		+	+	+
Helianthemum hirsutum	++				+
Helianthemum nummularium			+	1	1
Luzula sylvatica	1	1	2	1	1
Plantago lanceolata	+	+		+	+
Potentilla divina	+		+		R
Ranunculus oreophilus	++	1	1	1	1
Rhinanthus minor		+		+	1
Solidago virgaurea		+	+	+	+
Thymus caucasicus	1	1	1	1	1
Trifolium ambiguum	2	2	2	2	++
Valeriana alliariifolia	+		+	R	++

6.3.6 Betuletum megrelici

Betula megrelica forest on Mt. Migaria limestone massif, dominated by *Betula megrelica* and also containing *Fagus orientalis, Picea orientalis, Abies nordmanniana, Acer pseudoplatanus* occurs in the lower line of subalpine belt, on a moderately inclined N slope with plant cover c. 70%. Layers are well distinguishable in this forest: The first layer, trees (15 m): *Abies nordmanniana, Betula megrelica, Fagus* orientalis; the second layer, trees (8-10 m): *Acer pseudoplatanus, Picea* orientalis; the third layer of shrubs (1-2 m): *Rhamnus imeretina, Rhododenron luteum, Vaccinium arctostaphylos, Salix pantosericea, Juniperus depressa*; the fourth layer of herbs: forest species: *Solidago virgaurea, Aruncus vulgaris, Gentiana schistocalyx, Lilium szovitsianum, Valeriana alliariifolia*; meadow components: *Poa pratensis, Agrostis planifolia, Festuca varia, Gentiana septemfida, Campanula latifolia, Alchemilla caucasica, Betonica macrantha, Astrantia maxima*.

All the shrubs except *Juniperus depressa*, which grows in stony ecotopes, are Colchis species. All the other shrubs are Colchic but deciduous, e.g. *Rhamnus imeretina, Vaccinium arctostaphylos* are typical Colchic species.

Salix pantosericea is a shrub of moist ecotopes at high elevations. *Rhododendron luteum* is widespread in the Caucasus and is the most xerophilous of all the Colchic shrubs. *Woronowia speciosa*, a limestone-growing endemic perennial is noteworthy. This brief analysis show that the studied community unites species of various ecology and growth forms.

Table 6. *Relevés of Betuletum megrelici*

Releve No. 6	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.640578 Lat; 42.340053 Long				
Mt. Migaria massive					
Landscape type:	5				
Elevation, m a. s. l.:	1650				
Cardinal point exposure (°):	N350				
Slope angle/Inclination (°)	20				
Litter depth (cm):	5				
Litter mass (g dry weight/m^2)	322.72				
pH	6.36				
Surface cover (%):					
Bare soil	10	5	15	5	15
Stones	2	5	0	0	5
Litter	8	10	10	10	5
Dead wood	5	2	5	5	0
Cryptogams	2	3	7	5	5
Plants	73	65	63	75	70
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	12				
Betula megrelica	3				
Fagus orientalis	1				
Picea orientalis	1				
Abies nordmanniana	R				
Acer pseudoplatanus	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.5	1.3	1.2	1	1.2
Rhamnus imeretina	1		R		
Rhododendron luteum	1	1	1		1
Vaccinium arctostaphylos	1	1	1	R	1
Salix pantosericea	1	1	2	1	2
Juniperus depressa	R				R
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	55	50	60	70	55
Aetheopappus caucasicus		1		1	1
Agrostis planifolia	1	2	+	2	

Releve No. 6	**1**	**2**	**3**	**4**	**5**
Alboviodoxa elegans		+	++		+
Alchemilla caucasica	1			1	1
Aruncus vulgaris	+		+	+	1
Astrantia maxima	R		+		R
Betonica macrantha	1	2	2	1	+
Campanula latifolia	+	+			1
Dryopteris filix-mas			R		
Euphrasia caucasica			+		+
Festuca varia	1	1	1	2	1
Gentiana schistocalyx	+	+			+
Gentiana septemfida	+	+	+	+	+
Heracleum leskovii		1		R	
Leontodon hispidus			1	1	+
Lilium szovitsianum	R			R	
Nepeta supina	+	+	1	1	
Phleum alpinum	+	1		1	1
Poa pratensis	1		2		
Prunella vulgaris	+		1		1
Salvia glutinosa	+		1	1	1
Silene multifida	R	+	R	++	+
Solidago virgaurea	1	1		1	1
Swertia iberica	+	+		1	+
Valeriana alliariifolia	+		1		1
Woronowia speciosa	1	2	1	2	1

6.3.7 Quercetum pontici

Quercetum ponticae forest massif was was studied on limestone Mt. Migaria, in the upper montane belt, at 1480 m a.s.l. on a slightly inclined N slope with significant plant cover (70-75%). Relatively big litter cover (7-10%) is also noteworthy. This crook-stemmed forest with prostrate shrubs represents the remains of the ancient endemic vegetation. *Q. pontica* grows in a form of relatively small groups. *Fagus orientalis* and *Picea orientalis* grow together with the dominant species. The oak has pronounces morphological elasticity and grows in a form of a tree, a shrub, or a prostrate plant. The layer structure is as follows: the first layer (20 m): *Fagus orientalis, Picea* orientalis; the second layer (17-18 m): *Quercus* pontica; the third layer (1-2 m): *Ilex colchica, Rhododendron luteum, Laurocerasus officinalis, Vaccinium arctostaphylos*; the fourth layer, herbs (50 cm): *Inula magnifica*, a subalpine meadow and tall herb community plant, *Carex sylvatica*, and *Juncus atratus*, wetland plants, *Brachypodium sylvaticum*, a forest plant.

The described layer structure well represents the existing picture of Samegrelo forest vegetation.

Table 7. *Relevés of Quercetum pontici*

Releve No. 7	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.6400 Lat; 42.36111 Long				
Landscape type:	4				
Elevation, m a. s. l.:	1480				
Cardinal point exposure (°):	N7				
Slope angle/Inclination (°):	15				
Litter depth (cm):	6				
Litter mass (g dry weight/m^2)	545.28				
pH	8.28				
Surface cover (%):					
Bare soil	10	15	5	10	5
Stones	0	2	0	0	7
Litter	10	7	10	10	10
Dead wood	2	3	5	2	2
Cryptogams	3	3	7	3	3
Plants	75	70	73	75	73
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	20				
Quercus pontica	4				
Fagus orientalis	2				
Picea orientalis	1				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	2	1.7	1.5	1.4	1.5
Sorbus caucasigena	R			R	R
Rhododendron luteum	2	3	2	2	2
Ilex colchica	1			1	1
Viburnum opulus	++				2
Laurocerasus officinalis	1		2		
Ruscus colchicus		++		++	++
Rubus anatolicus		2	2		
Laurocerasus officinalis		2			2
Vaccinium arctostaphylos	2	1	2	2	
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	25	20	22	20	25

Releve No. 7	1	2	3	4	5
Agrostis planifolia		+		+	
Brachypodium sylvaticum	+			+	+
Campanula lactiflora			+		+
Carex sylvatica	++			++	++
Dryopteris oreades		R	+	+	
Gentiana schistocalyx			+		+
Heracleum leskovii		+	R		+
Inula magnifica	R				
Juncus atratus	1			1	
Petasites albus		+	+		
Prunella vulgaris	+			++	+
Tussilago farfara		+	+		+

6.4 Svaneti

In Svaneti seven forest types were studued: oak forest made up of Georgian oak, riparian forest (of alder) in the middle and upper montane forest belt, dark coniferous and mixed forest, subalpine forest: forests of birch, montane oak and pine oak.

Oak forest made up of Georgian oak

6.4.1 Quercetum ibericae

Quercetum ibericae community was studied in the lower part of the montane forest belt at 1020 m a.s.l., on a steep SE slope with plant cover ranges between 55-67%. Relatively large cover of bare soil (10-25%) and stones (3-10%) is noteworthy. The community is floristically quite rich with six species of trees dominated by Georgia oak, four species of shrubs and 16 species of non-woody plants. Layers are well distinguishable. The layer structure is as follows. The first layer, trees (14 m): *Abies nordmanniana, Quercus iberica, Picea orientalis*; the second layer, trees (12-13 m): *Carpinus caucasica, Fraxinus excelsior*; the third layer, shrubs (3-5 m): *Mespilus germanica, Rubus caucasicum, Crataegus pentagyna;* the fourth layer, non-woody plants (25-45 cm): *Luzula sylvatica, Poa pratensis, Trfolium ambiguum, Asplenium trichomanes*, etc. The dominant oak does not make up a vegetation belt. On our study plot hornbeam, fir, spruce and ash are present in the forest as non-abundant admixture.

Oak forest tolerates the driest conditions compared with other broad-leaf species. In Colchis oak forest grows from 100 m a.s.l., only on southern slopes. Landscape role of these forests is insignificant. Less disturbed oak forests are preserved in places are floristically rich stands with relict Colchic and Hyrcanic species.

Noteworthy is participation of European nemoral *Fraxinus excelsior*, eastern-Mediterranean *Mespilus germanica*, European *Crataegus pentagyna*.

Table 1. *Relevés of Quercetum ibericae*

Releve No. 1	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	43.041841 Lat; 42.351239 Long				
Dezi, riv. Inguri gorge					
Landscape type:	5				
Elevation, m a. s. l.:	1020				
Cardinal point exposure (°):	SE140				
Slope angle/Inclination (°)	40				
Litter depth (cm):	3				
Litter mass (g dry weight/m^2)	837.76				
pH	7.5				
Surface cover (%):					
Bare soil	17	15	25	20	10
Stones	5	7	3	10	10
Litter	5	7	5	5	5
Dead wood	3	9	8	0	15
Cryptogams	3	5	4	8	5
Plants	67	57	55	57	55
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	14				
Quercus iberica	3				
Carpinus caucasica	1				
Fraxinus excelsior	++				
Picea orientalis	R				
Abies nordmanniana	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.6	0.7	0.5	1	0.6
Rubus caucasicus	+	+			1
Rosa canina	1	1		1	1
Crataegus pentagyna	+		+	R	
Mespilus germanica	+	+	+	+	+
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	45	30	25	30	25
Agrostis gigantea		1	1	+	+
Allium kunthianum	1	++	1		+
Asplenium trichomanes	+	+			R
Coronilla varia	1	1	1	1	+
Euphorbia pontica		R			R
Fragaria vesca	1	1	1	1	+
Galium verum	+	+	1		
Helleborus caucasicus		R			+

Releve No. 1	1	2	3	4	5
Hieracium pilosella	+		1	+	+
Hypericum perforatum	++		1	1	
Lotus corniculatus		+		+	++
Luzula sylvatica	1	1		1	1
Medicago lupulina	1		1	2	+
Origanum vulgare	1	1	++	++	1
Poa pratensis	1		1	1	2
Polypodium vulgare	+	1	+	1	
Primula macrocalyx			++		1
Pyrethrum partheniifolium		1	1	1	
Satureja spicigera	++		1	+	
Sedum caucasicum	R		R		
Sedum oppositifolium	1	1			1
Trifolium ambiguum	1	1	1	1	
Veronica beccabunga		1	1	1	

Riparian forest (of alder) in the middle and upper montane forest belt

6.4.2 Alnetum barbatae

Monodominant alder forest with low fir ratio was studied in Nakra gorge, in the upper part of the montane forest belt, at 1520 m a.s.l., on almost plain SW stony slope. Alder abundance is high. Layers are not well distinguishable but can be described as follows: the first layer, trees (17 m): *Abies nordmanniana*; the second layer, trees (8-10 m): *Alnus incana*; the third layer, shrubs (3-4 m) and *Hedera colchica*, including evergreen Colchic liana; the fourth layer, herbs (50-70 cm) contains 36 non-woody species (herbs, ferns) including components of European nemoral forests widespread in Colchic forest communities: *Asperula odorata, Poa nemoralis, Pachyphragma macrophyllum, Sanicula europaea, Galium odoratum, Oxalis acetosella, Senecio propinquus*, etc.

Table 2. *Relevés of Alnetum barbatae*

Releve No. 2	1	2	3	4	5
GPS coordinates:	43.122100 Lat; 42.401200 Long				
riv. Nakra gorge					
Landscape type:	3				
Elevation, m a. s. l.:	1520				
Cardinal point exposure (°):	SW255				
Slope angle/Inclination (°)	2				
Litter depth (cm):	3				
Litter mass (g dry weight/m^2)	823.68				
pH	6.64				

Releve No. 2	**1**	**2**	**3**	**4**	**5**
Surface cover (%):					
Bare soil	5	2	10	2	2
Stones	10	8	5	15	3
Litter	5	7	3	2	5
Dead wood	10	10	0	0	5
Cryptogams	3	3	2	10	5
Plants	67	70	80	71	80
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	17				
Alnus barbata	5				
Abies nordmanniana	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.5	1.2	1.3	1	1.2
Sambucus nigra	R	R			
Hedera colchica	2	2	2	1	2
Corylus avellana		R	R	1	R
Rubus anatolicus	2	2	2	1	2
Viburnum opulus			R		1
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	60	50	65	50	70
Asperula odorata	2				
Geranium robertianum	2				
Aconitum nasutum			R		
Asperula odorata		2		2	
Athyrium filix-femina	+	+	1	2	2
Calystegia silvatica		1		1	
Carex pendula	+	+	+	1	1
Dactylorhiza sp.			R		
Dryopteris filix-mas		2	+	1	2
Euphorbia macroceras		+	+	+	1
Fragaria vesca			1	1	
Galeopsis bifida		+	+	+	+
Galium odoratum			R	R	R
Geranium robertianum		2	3	1	
Geum urbanum			+	+	
Hydrocotyle ramiflora	1		1		
Impatiens noli-tangere		+	+		
Lapsana grandiflora		R	R	++	1
Mycelis muralis	1	1		1	

Releve No. 2	1	2	3	4	5
Nepeta grandiflora		2		2	2
Oxalis acetosella		1	1		
Pachyphragma macrophyllum			1		
Paris quadrifolia	+		+	1	1
Poa nemoralis		2	2	1	2
Polygonatum polyanthemum		R	+	R	++
Polygonum hydropiper		+	+	+	+
Polygonum petiolatum	+	+	+	+	
Prunella vulgaris	1	1	1	1	1
Rumex acetosella		R	++	R	
Salvia glutinosa		2		3	2
Sambucus ebulus	1		1		
Sanicula europaea			+		
Sedum stoloniferum		1	1	2	1
Senecio propinquus	R	R		1	
Urtica dioica		1	1	2	2
Viola alba		1		+	

6.4.3 Alnetum incanae

Alneta incani plant community was studied in the Dolra gorge, adjacent to Becho and Mazeri, at the treeline at 1645 m a.s.l., on a slightly inclined SE stony slope (with stone cover of 8-15%). Plant cover is quite high and ranges slightly (69-78%). Along with the dominant species, three other trees are recorded in low abundance: *Sorbus caucasigena, Salix alba, Fagus orientalis*. Shrubs are represented by a single species *Rhododendron luteum.* Herb synusia contains 37 species. *Alnus incana* is a widespread boreal species in the Caucasus. Its abundance in the first layer of the studied community exceeds that of the other species. *Rhododenron luteum* does not grow in a form of dense thickets and occurs as scattered individuals; its presence is the indicator of certain degree of dryness. Herb layer richness is high; it contains both subalpine meadow species: *Trifolium ambiguum, Agrostis tenuis, Gentiana schistocalyx, Swertia iberica, Leontodon hispidus, Coronilla varia*, and subalpine forest components: *Viola alba, Geranium robertianum, Fragaria vesca*.

Table 3. *Relevés of Alnetum incanae*

Releve No. 3	1	2	3	4	5
GPS coordinates:	43.0915 Lat; 42.5984 Long				
Dolra gorge, Becho, Mazeri					
Landscape type:	1				
Elevation, m a. s. l.:	1645				
Cardinal point exposure (°):	SE150				
Slope angle/Inclination (°)	3				
Litter depth (cm):	2				
Litter mass (g dry weight/m^2)	828.48				

Releve No. 3	**1**	**2**	**3**	**4**	**5**
pH	6.63				
Surface cover (%):					
Bare soil	5	5	8	3	5
Stones	15	15	8	10	5
Litter	2	2	7	5	2
Dead wood	2	2	5	8	5
Cryptogams	5	5	2	5	5
Plants	71	71	70	69	78
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	9				
Alnus incana	4				
Sorbus caucasigena	R				
Salix alba	+				
Fagus orientalis	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.4	0.3			
Rhododendron luteum	+	R			
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	20	30	25	25	20
Achillea millefolium		1	1		2
Agrostis tenuis	1	1	1		
Alchemilla caucasica				2	
Alchemilla dura	2				2
Carex digitata	1	+		1	1
Cerastium polymorphum		R	R		R
Cirsium svaneticum	R		R	R	
Clinopodium vulgare	++				++
Coronilla varia	+		+	+	
Dactylorhiza euxina	R			R	
Dryopteris filix-mas	+		+	1	+
Elsholtzia ciliata		R			
Fragaria vesca	+	+	1	+	+
Gentiana schistocalyx	+	+			+
Geranium robertianum	1	1	1	1	1
Hieracium pilosella		1			1
Hydrocotyle ramiflora		1	1		+
Juncus effusus	++		1		++
Leontodon hispidus	1	1	1	1	1
Oxalis acetosella		++			++

Releve No. 3	1	2	3	4	5
Phleum pratense		+	+	1	+
Plantago lanceolata		1	1		
Poa annua		1			
Potentilla elatior	+	+		+	+
Potentilla erecta	1	1			1
Prunella vulgaris	3	3	2	3	2
Ranunculus ampelophyllus				+	
Sedum gracile	+	+	+	1	+
Sibbaldia semiglabra		1			1
Silene italica	R			R	
Spiranthes spiralis		R	+		
Swertia iberica	R	R	R	++	R
Thymus grossheimii	1	1	1	1	1
Trifolium ambiguum	3	1		1	2
Veronica beccabunga	+	+	+	+	+
Viola alba	1	1			1

Dark coniferous and mixed forest

6.4.4 Fageto-Abieto-Piceetum

Polydominant Oriental spruce forest was studied in Nakra gorge, in the upper part of the montane forest belt, at 1585 m a.s.l., on a SE more or less stony slope of 15°, with moderate plant cover (45-72%). Litter layer is quite deep (4-7 cm), and its cover uneven (8-20%); the substrate has only small stone cover (0-10%). The community contains three tree species with fir being the tallest (28 m), two shrubs and 18 herbaceous plants. The first layer, trees (28 m) is made up of *Abies nordmanniana*; the second layer, trees (20-25 m): *Fagus orientalis, Picea orientalis*; the third layer, shrubs: *Sambucus nigra, Rubus anatolicus*; the fourth layer, herbs, composition is similar to previous lists: *Dryopteris filix-mas, Luzula sylvatica, Oxalis acetosella, Festuca drymeja, Gentiana schistocalyx*, etc.

Table 4. *Relevés of Fageto-Abieto-Piceetum*

Releve No. 4	1	2	3	4	5
GPS coordinates:	43.12453 Lat; 42.39856 Long				
Nakra gorge					
Landscape type:	5				
Elevation, m a. s. l.:	1585				
Cardinal point exposure (°):	SE105				
Slope angle/Inclination (°)	15				
Litter depth (cm):	7				
Litter mass (g dry weight/m^2)	681.6				
pH	7.8				

Releve No. 4	**1**	**2**	**3**	**4**	**5**
Surface cover (%):					
Bare soil	10	15	15	7	5
Stones	7	2	10	2	0
Litter	20	8	20	20	10
Dead wood	10	0	3	2	10
Cryptogams	3	5	7	4	3
Plants	50	70	45	65	72
Trees per 400 m^{2}2 plot (20 X 20 m)					
Tree canopy height (m):	28				
Fagus orientalis	2				
Picea orientalis	3				
Abies nordmanniana	2				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.8	0.8	1.0	1.2	0.8
Sambucus nigra	1	2	1		
Rubus anatolicus	3	3	2	2	2
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	50	40	45	55	65
Alchemilla caucasica	1	1		1	1
Asperula odorata		2	1	+	1
Digitalis schischkinii	R	+			
Dryopteris filix-mas	1	2	1		2
Euphorbia macroceras	R	R		1	
Festuca drymeja	2	2	1	2	3
Fragaria vesca	2	2	++	2	1
Gentiana schistocalyx	R	++	R		
Geranium robertianum	2		+	1	1
Lapsana grandiflora		R	R	1	
Luzula sylvatica	2	2	1		2
Nepeta grandiflora	1	1	R	1	1
Oxalis acetosella	1		+	++	1
Salvia glutinosa	R		1	R	R
Sambucus ebulus		+	1	+	1
Sedum oppositifolium		1	++		
Symphytum grandiflorum		1		1	1
Trifolium ambiguum	++	++	++	R	

6.4.5 Piceeto-Abietum

This typical Colchic dark coniferous community was studied in the lower line of the subalpine belt at 1680 m a.s.l., on SE slope of 10° with quite low vegetation cover (25-65%). High stone ratio in the ground cover (15-30%) and abundance of terricolous cryptogams (6-10%) is noteworthy. The community is bi-dominant with *Abies nordmanniana* and *Picea orientalis*, present in similar abundance in the first layer. Five species or shrubs, one liana species and ten species of herbs are also recorded. The community is a dark coniferous forest with Colchis undergrowth mainly composed of *Vaccinium arctostaphylos, Rhododendron luteum* and a liana species. Of herbaceous plants, the following are more abundant: *Festuca drymeja, Oxalis acetosella, Fragaria vesca, Calystegia silvatica, Senecio propinquus, Viola alba*. Floristic composition is autochthonous and related to Svaneti region.

Table 5. *Relevés of Piceeto-Abietum*

Releve No. 5	**1**	**2**	**3**	**4**	**5**
GPS coordinates: Mestiachala	43.11145 Lat; 42.7436 Long				
Landscape type:	3				
Elevation, m a. s. l.:	1680				
Cardinal point exposure (°):	SW110				
Slope angle/Inclination (°)	10				
Litter depth (cm):	7				
Litter mass (g dry weight/m^2)	660.32				
pH	7.7				
Surface cover (%):					
Bare soil	10	4	2	5	10
Stones	20	30	15	15	30
Litter	5	10	10	7	15
Dead wood	7	0	15	2	10
Cryptogams	10	10	10	6	10
Plants	48	46	48	65	25
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	25				
Picea orientalis	3				
Abies nordmanniana	4				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.5	1.2	1.5	2	1.3
Rhododendron luteum	2	2	2	2	1
Vaccinium arctostaphylos	2	2	2	2	1
Vaccinium myrtillus	1			1	+
Rubus anatolicus	1			1	+
Hedera colchica	1	1	1	1	++
Viburnum opulus		1			

Releve No. 5	**1**	**2**	**3**	**4**	**5**
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	35	40	35	25	25
Calystegia silvatica	R		R	R	
Dryopteris filix-mas		1	R	1	1
Euphorbia macroceras		R	R		+
Festuca drymeja	1	2	1	1	1
Fragaria vesca	2		2	2	
Galium album	+	+	+		+
Oxalis acetosella	2	2	2	2	1
Senecio propinquus	R	++	R	R	+
Valeriana alliariifolia		R	R	1	
Viola alba	+	+	+		

6.4.6 Abietum nordmannianae

Dark coniferous forests in the South Caucasus cover the largest areas in Colchis. This is the second forest type after beech forest according to areas covered. We studied fir forest in the Hatsvali gorge, in subalpine belt (2125 m a.s.l.) where plant cover ranges between 55-80%. Fir is quite tall here; the second tree *Sorbus caucasigena* is much shorter.

Shrub layer specific richness is not high; only two species of *Rubus* are recorded, of which *R. anatolicus*, a typical Colchic element, is widespread in western Georgia. Herb layer is quite diverse, which is rare in dark coniferous forests: 23 herb species are recorded. Almost all the species are typical of the eastern Euxinian dark coniferous forests: *Festuca drymeja, Luzula sylvatica, Oxalis acetosella, Poa nemoralis, Asperula odorata, Prenanthes purpurea*. The following species are relicts of pre-glaciation broad-leaf forests: *Geranium robertianum, Sanicula europaea*. *Dentaria bulbifera* is spring ephemeroid in Svaneti Abietum, which is at the same time widespread in beech forests. *Clinopodium vulgaris* grows in forest glades, on relatively dry ecotopes.

Table 6. *Relevés of Abieta nordmannianae*

Releve No. 6	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	43.0219 Lat; 42.7382 Long				
Landscape type:	5				
Elevation, m a. s. l.:	2125				
Cardinal point exposure (°):	W272				
Slope angle/Inclination (°)	25				
Litter depth (cm):	6				
Litter mass (g dry weight/m^2)	950.72				
pH	7.7				
Surface cover (%):					
Bare soil	3	5	5	5	5
Stones	3	1	0	0	5

Releve No. 6	**1**	**2**	**3**	**4**	**5**
Litter	10	7	10	13	10
Dead wood	15	5	10	2	15
Cryptogams	10	2	5	3	10
Plants	59	80	70	77	55
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	28				
Abies nordmanniana	5				
Sorbus caucasigena	1				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.5	0.5	0.5	0.5	0.7
Rubus anatolicus	1	1	1	1	1
Rubus idaeus	1			+	1
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	70	70	65	70	50
Aruncus vulgaris	R		+	1	
Asperula odorata	2	2		1	
Chamerion angustifolium	++				
Chamerion dodonaei		++	+	+	
Cicerbita petiolata	1			1	1
Clinopodium vulgare	+	1		+	
Dentaria bulbifera	++				
Dryopteris filix-mas	2	2	2	3	2
Euphorbia macroceras	+	R		+	+
Festuca drymeja	2	2	2	3	2
Geranium platypetalum	R	+	+		
Geranium robertianum	1		1	1	1
Impatiens noli-tangere		R	1	1	1
Luzula sylvatica	1	1	2	1	
Nepeta grandiflora	+	1	+	+	+
Oxalis acetosella	2	1	1	1	1
Paris quadrifolia			++	++	1
Petasites albus	1	2	1		1
Poa nemoralis	1	2		2	
Prenanthes purpurea	1	1	1	1	1
Sanicula europaea	1	1	1	1	1
Saxifraga repanda			++		++
Viola alba			+		+

6.4.7 Piceetum rhododendrosum lutei

The spruce community with *Rhododendron luteum* undergrowth was studied in the Hatsvali gorge, in subalpine belt (2010 m a.s.l.), on a NW slope with plant cover between 70-86%. The dominant plant is spruce, abundance of which reaches possible maximum (5). Fir is following with rather lowe abundance, while abundance of beech and hornbeam are remarkably lower. All the four species are typical high mountain plants characteristic to Colchis. The layer structure is as follows: the first layer, trees (20 m): *Abies nordmanniana, Picea orientalis*. Spruce is one of the main components of the dark coniferous forest, distributed throughout the northwestern part of the South Caucasus and, unlike *Abies nordmanniana*, which chooses richer soils, tolerates rocky habitats poor in organic matter. The second layer of trees (10-15 m) is composed of *Fagus orientalis, Acer trautvetteri*; the third layer, shrubs (1.5-2.5 m): *Rhododendron luteum, Vaccinium arctostaphylos*; the fourth layer of herbs and ferns (25-30 cm) is not species rich and consists of eight species: *Oxalis acetosella, Festuca drymeja, Clinopodium vulgare, Micelis muralis* etc.

Table 7. *Relevés of Piceetum rhododendrosum lute*

Releve No. 7	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	43.025102 Lat; 42.739203 Long				
Landscape type:	5				
Elevation, m a. s. l.:	2010				
Cardinal point exposure (°):	NW345				
Slope angle/Inclination (°)	23				
Litter depth (cm):	4				
Litter mass (g dry weight/m^2)	845.6				
pH	7.6				
Surface cover (%):					
Bare soil	1	5	10	2	0
Stones	2	0	0	7	0
Litter	2	10	5	10	15
Dead wood	4	10	0	1	2
Cryptogams	5	5	5	5	2
Plants	86	70	80	75	81
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	20				
Picea orientalis	5				
Abies nordmanniana	1				
Fagus orientalis	R				
Acer trautvetteri	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	2.5	2	2	1.5	2.2
Rhododendron luteum	3	2	3	2	3
Vaccinium arctostaphylos	1	1	2	2	++

Releve No. 7	**1**	**2**	**3**	**4**	**5**
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	25	30	25	30	25
Asperula odorata		1	2	+	++
Clinopodium vulgare	1			1	2
Festuca drymeja	2	3	3	2	3
Fragaria vesca	1	2	1	1	1
Mycelis muralis	1	1		1	
Oxalis acetosella	2	1	2	++	2
Polypodium vulgare	1	1	1	2	
Viola alba	R			+	

Subalpine forest: forests of birch, montane oak and pine oak

6.4.8 Betuletum pendulae rhododendrosum caucasici

This association of the birch forest is studied in the Hatsvali gorge, in the upper line of the subalpine belt (2310 ma.s.l.), on slightly inclined (10-17○) W slope. Plant cover ranges between 55-80%. Noteworhy is relatively large variability range of litter cover (10-30%). Tree hight is only 14 m. The following layers are distinguished: the first layer, trees (8-10 m): *Betula litwinowii, B. pendula, Pinus sylvestris* var*. hamata*; the second layer, trees (6-8 m): *Sorbus caucasigena, Salix caprea*; the third layer, shrubs (1.2 m): *Viburnum opulus, Rhododendron caucasicum, Rubus* sp.; the fourth layer, herbs and ferns (15-25 cm): *Oxalis acetosella, Athyrium filix-femina.*

Vertical distribution range of this pine is rather wide from 700 to 2400 m a.s.l. but at treeline its normal growth is quite limited and vitality worsened: trees are often prostrate or flag-shaped.

Betula pendula is widespread in the Caucasus and particularly, Svaneti. It often occurs up to the treeline together with *B. litwinowii*. In shrub layer *Viburnum opulus* and *Rubus* sp. grow along with endemic rhododendron.

Table 8. *Relevés of Betuletum pendulae rhododendrosum caucasici*

Releve No. 8	**1**	**2**	**3**	**4**	**5**
GPS coordinates: Hatsvali	43.018959 Lat; 42.737307 Long				
Landscape type:	4				
Elevation, m a. s. l.:	2310				
Cardinal point exposure (°):	W265				
Slope angle/Inclination (°)	15				
Litter depth (cm):	6				
Litter mass (g dry weight/m^2)	381.44				
pH	7.7				
Surface cover (%):					
Bare soil	3	2	1	3	1

Releve No. 8	**1**	**2**	**3**	**4**	**5**
Stones	2	5	2	3	2
Litter	30	18	15	30	10
Dead wood	5	2	8	2	5
Cryptogams	5	3	4	2	2
Plants	55	70	70	60	80
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	14				
Betula pendula	3				
Betula litwinowii	2				
Sorbus caucasigena	2				
Salix caprea	+				
Pinus sylvestris var. *hamata*	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.2	1.2	1	1.4	1.2
Rhododendron caucasicum	4	4	4	4	4
Viburnum opulus	1	1		1	
Rubus anatolicus			1		
Rubus sp.	R			R	
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	25	25	20	15	25
Athyrium filix-femina	+	1	+	1	
Oxalis acetosella	1	1	+	1	1

6.4.9 Betuletum litwinowiae rhododendrosum caucasici (1)

This is a typical association of the treeline and was studied in the Hatsvali gorge, on very moist NW quite steep slope. Plant cover ranges between 61-80%, litter cover between 15-25%, and cryptogam cover is insignificant not exceeding 2-5%. The layer structure is as follows: the first layer, trees (9-12 m): *Betula litwinowii, Abies* nordmanniana; the second layer, trees (5-7 m): *Salix caprea, Sorbus caucasigena*; the third layer, shrubs (1-1.3 m): *Rhododendron caucasicum, Viburnum opulus, Rubus idaeus;* the fourth layer, herbs and ferns (40-60 cm): *Dryopteris filix-mas, Festuca drymeja, Oxalis acetosella, Mycelis muralis, Chamaenerion angustifolium.*

Ecological conditions are harsh and during long winter, deep and long-lasting snow cover shelters the plants with crook-stemmed, prostrate forms and in case of herbaceous species buds at the ground surface or belowground. *Betula litwinowii*, the dominant tree species of Minor Asian-Caucasian origin occurs from 800 to 2300-2450 m a.s.l. and makes up the treeline in a form of crook-stemmed forest. It is interesting that *Salix caprea*, a boreal species from the middle and southern zones of taiga and occurring in mountains almost throughout the Caucasus, occurs in our study forest, mainly within the treeline ecotone. Of shrubs, *Viburnum opulus* is a different geoelement occurring in mountains of Colchis as well as in the eastern Caucasus very often together with alder. Evergreen *Rhododendron caucasicum* is widespread in high mountains of the Caucasus (2200-3000 m a.s.l.), on especially northern slopes. In winter, it is protected against frost by snow cover.

Herbaceous synusia contains a fern species, nemoral *Mycelis muralis*, relict *Festuca drymeja*, deep-shade-enduring *Oxalis acetosella* widespread in moutains of Colchis and beyond.

Table 9. *Relevés of Betuletum litwinowiae rhododendrosum caucasici*

Releves No. 9	**1**	**2**	**3**	**4**	**5**
GPS coordinates: Hatsvali	43.0190 Lat; 42.73943 Long				
Landscape type:	5				
Elevation, m a. s. l.:	2300				
Cardinal point exposure (°):	NW285				
Slope angle/Inclination (°)	32				
Litter depth (cm):	4				
Litter mass (g dry weight/m^2)	360.4				
pH	7.8				
Surface cover (%):					
Bare soil	0	2	0	5	0
Stones	3	3	0	5	3
Litter	25	20	15	25	20
Dead wood	7	5	3	0	10
Cryptogams	4	5	2	2	2
Plants	61	65	80	63	65
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	12				
Betula litwinowii	4				
Sorbus caucasigena	2				
Abies nordmanniana	R				
Salix caprea	1				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.2	1	1.3	1.2	1.1
Rhododendron caucasicum	4	4	4	4	4
Viburnum opulus	1		1	R	1
Rubus idaeus	1	1	1	+	1
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	60	50	60	40	45
Chamaenerion angustifolium			+	+	
Dryopteris filix-mas	+	+		+	+
Festuca drymeja	+		+		+
Mycelis muralis		+	+		+
Oxalis acetosella	+	+	+	+	+

6.4.10 Betuletum litwinowiae rhododendrosum caucasici

Betuleta litwinowiae rhododendrosum caucasici similar to the community described above is one of the polydominant subalpine associations typical of Colchis. It was studied at the base of Tetnuldi glacier, at 2400 m a.s.l., on a SE slope with significant plant cover ranging between 70-94%. The woody plants are represented by four species of trees, five species of shrubs and 13 species of non-woody plants. The layer structure is as follows: the first layer, trees (5-7 m): *Betula litwinowii, Picea orientalis*; the second layer, trees (3-4 m): *Acer trautvetteri*; the third layer, trees (2-3 m): *Sorbus caucasigena*; the fourth layer, shrubs (0.9-1.1 m): *Rhododendron caucasicum, Vaccinium myrtillus, Rosa* sp.; the fifth layer, herbs and ferns (30-60 cm): *Oxalis acetosella, Geranium gymnocaulon, Valeriana alliariifolia, Festuca drymeja.* Crook-stemmed relict *Betula litwinowii*, one of the dominant species of subalpine forests, has more or less conserved characteristics of the Caucasus Plants of the Tertiary. Ancient endemic birches (*B. medwiediewii* and *B. megrelica*) make patches within this vegetation. *Acer trutvetteri* is a Hyrkanian-Colchic species occurring up to the treeline.

Table 10. *Relevés of Betuletum litwinowiae rhododendrosum caucasici*

Releves No. 10	**1**	**2**	**3**	**4**	**5**
GPS coordinates: Tetnuldi	43.02663 Lat; 42.87927 Long				
Landscape type:	4				
Elevation, m a. s. l.:	2400				
Cardinal point exposure (°):	N-NE20				
Slope angle/Inclination (°)	10				
Litter depth (cm):	4				
Litter mass (g dry weight/m^2)	744.0				
pH	8.2				
Surface cover (%):					
Bare soil	2	4	1	0	3
Stones	0	2	3	0	10
Litter	5	1	8	2	7
Dead wood	7	4	2	2	5
Cryptogams	2	2	3	2	5
Plants	84	87	83	94	70
Trees per 400 m^2 plot (20 X 20 m)	15				
Tree canopy height (m):	7				
Betula litwinowii	4				
Sorbus caucasigena	3				
Picea orientalis	R				
Acer trautvetteri	1				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.9	1	1.1	0.8	1
Rhododendron caucasicum	4	5	4	5	4

Releves No. 10	**1**	**2**	**3**	**4**	**5**
Viburnum opulus		R			
Rubus idaeus		1	1		
Vaccinium myrtillus	2	2	2		1
Rosa sp.	R			R	
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	50	60	40	50	30
Alchemilla caucasica					+
Alchemilla sp	+				
Athyrium filix-femina	+	+	+	1	+
Betonica macrantha		+	R	+	
Chamaenerion angustifolium	+	+		+	+
Dryopteris filix-mas					
Festuca drymeja	++	1	++		+
Geranium gymnocaulon	+	+		+	
Mycelis muralis					
Oxalis acetosella	+	+	+	1	+
Polygonum carneum		+	R	+	
Senecio kolenatianus	+		+	+	
Valeriana alliariifolia	+	+	+		

6.4.11 Quercetum macrantherae

Querceta macrantheri was studied in Kuruldi Lake, Poshdeli, at the upper line of the montane forest belt, at 1640 m a.s.l., on a steep S slope with 55% plant cover. Trees are represented by seven species dominated by *Quercus macranthera*, followed by *Acer campestre*. The layer structure is as follows: the first layer, trees (10 m): *Quercus macranthera, Fagus orientalis*; the second layer, trees (8-9 m): *Acer campestre, Carpinus caucasica, Pyrus caucasica, Cerasus avium*; the third layer, shrubs (5-7 m): *Sorbus caucasigena, Berberis vulgaris, Rosa canina*; the fourth layer, herbs (0.50-1.0 m): *Festuca drymeja, Poa nemoralis, Agrostis planifolia, Chaerophyllum maculatum, Anthemis macroglossa, Athyrium filix-femina, Polygonatum glaberrimum.*

Querceta macranthera forests are only preserved on small areas; they are better represented in Armenia and Azerbaijan. They areas remarkably diminish from the east to the west. However, they still fragmentarily exist in Svaneti mountains. The gorges where these forests grow, have dry and continental climate (owing to the configuration of mountain ranges). One of the competitors for the Oriental oak forest is beech, which is the major limiting factor of oak distribution on the Main Watershed Range of the Great Caucasus: the oak does not grow westwards of Enguri and Tskhenistskali. As reported by Dolukhanov (2010), the lower limit of its distribution is 1650 m a.s.l. (which coincides with the selected study site elevation) and the upper one is 2150 m a.s.l. Elevation of our study plot corresponds to these data. The second tree species by abundance in this community, *Acer campestre* is widespread in European nemoral forests. The other tree species: *Fagus orientalis, Carpinus caucasica, Pyrus caucasica* have weaker position here. Of shrubs the following xerophytes typical shiblyak occur: *Berberis vulgaris, Rosa canina.*

Table 11. *Relevés of Quercetum macrantherae*

Releve No. 11	**1**	**2**	**3**	**4**	**5**
GPS coordinates: Poshdeli, Koruldi	43.0918 Lat; 42.5976 Long				
Landscape type:	4				
Elevation, m a. s. l.:	1640				
Cardinal point exposure (°):	S180				
Slope angle/Inclination (°)	45				
Litter depth (cm):	2				
Litter mass (g dry weight/m^2)	915.36				
pH	7.7				
Surface cover (%):					
Bare soil	25	30	20	25	15
Stones	5	2	5	5	10
Litter	5	7	5	5	3
Dead wood	7	3	0	5	0
Cryptogams	3	5	5	5	4
Plants	55	53	65	55	68
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):					
Quercus macranthera	3	3	3	3	3
Acer campestre	1	1	1	1	1
Crataegus pentagyna	R	R	R	R	R
Cerasus avium	R	R	R	R	R
Fagus orientalis	R	R	R	R	R
Pyrus caucasica	R	R	R	R	R
Carpinus caucasica	R	R	R	R	R
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.8	0.8	0.5	1.5	1
Rosa canina	1	1	1	1	1
Berberis vulgaris	1	1		1	1
Crataegus pentagyna	R	R	R		
Corylus avellana			+	+	
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	25	15	25	25	20
Achillea millefolium	+	+		1	
Agrostis planifolia	1				
Anthemis macroglossa	+		+	+	
Athyrium filix-femina	+	1	2		1
Campanula cordifolia	R			R	
Chaerophyllum maculatum	R		R		

Releve No. 11	1	2	3	4	5
Cirsium vulgare	R				
Clinopodium umbrosum		1		1	1
Festuca drymeja	1	1	+		+
Fragaria vesca	+	2	2	2	2
Genista suanica			R	+	R
Geranium renardii		R	R	R	+
Hesperis matronalis		R	R	++	R
Hypericum perforatum	R		R	++	1
Lapsana grandiflora		1		1	1
Origanum vulgare	R	R	+	R	2
Poa nemoralis	1	1			2
Polygonatum glaberrimum	R			R	
Potentilla recta	R	R	R	R	+
Pyrethrum partheniifoliium	R	R	++	R	+
Sedum oppositifolium	1	1	1	1	1
Silene italica	R	R	+	R	++
Trifolium ambiguum	+	1	1		1

6.4.12 Pinetum

Pine community was studied in the subalpine belt at 1835 m a.s.l., on very stony, moraine-covered (70-90%) NW slope. The forest contains spruce, birch, willow admixture. An endemic shrub *Genista suanica* is present in low abundance in the undergrowth. Non-woody species: *Dryopteris filix-mas, Valeriana alliariifolia, Mycelis muralis, Lapsana grandiflora* also grow in very low abundance. Pine occurrence is such an environment is a usual phenomenon. The other woody species are scattered among moraines. Due to the specifics of the subglacial area (length 9.35 km and area 8.50 km^2), the Chalaadi glacier cuts into the forest zone in the studued area and descends to the lowest absolute level of the glacier on the southern macroslope of the Great Caucasus, from sea level to 1960 m (Tielidze, 2017). The community's physiognomy is typical of Svaneti vegetation cover.

Table 12. *Relevés of Pinetum*

Releve No. 12	1	2	3	4	5
GPS coordinates: Mestiachala	43.112797 Lat; 42.740522 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1835				
Cardinal point exposure (°):	NW290				
Slope angle/Inclination (°)	15				
Litter depth (cm):	0.5				
Litter mass (g dry weight/m^2)	885.44				
pH	7.7				
Surface cover (%):					

Releve No. 12	**1**	**2**	**3**	**4**	**5**
Bare soil	5	2	5	10	1
Stones	80	85	80	70	90
Litter	1	1	1	1	1
Dead wood	5	0	10	7	0
Cryptogams	7	10	2	10	7
Plants	2	2	2	2	1
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	27				
Pinus sylvestris var. *hamata*	4				
Betula litwinowii	+				
Salix caprea	R				
Picea orientalis	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.4		0.4		
Genista suanica	R		R		
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	40	50	40	60	55
Dryopteris filix-mas	R	R		R	
Lapsana grandiflora			R		
Mycelis muralis		R			
Valeriana alliariifolia	R	R	R	R	R

6.4.13 Pinetum vacciniosum arctostaphyli

Pinetum vacciniosum arctostaphylos was studied in the Ughviri gorge, at the base of Tetnuldi glacier, in subalpine belt (1950 m a.s.l.), on slightly inclined (15-17°) SE slope with plant cover 60-88%. In this polydominant association eight tree species, four shrubs and five non-woody plants are recorded. The layer structure is as follows: the first layer, trees (20-25 m): *Pinus sylvestris* var. *hamata, Fagus orientalis, Abies nordmanniana, Picea orientalis*; the second layer, trees (15-20 m): *Quercus macranthera, Acer trautvetteri*; the third layer, trees (10-15 m): *Sorbus caucasigena, Betula litwinowii*; the fourth layer, shrubs (1.5-2 m): *Vaccinium arctostaphylos, V. myrtillus, Rhododendron luteum*; the firth layer, herbs and ferns (30-50 cm): *Luzula sylvatica, Oxalis acetosella, Festuca drymeja, Pachyphragma macrophyllum.*

Pine forest was studied within its optimum vertical distribution range from 1000 to 2200 m a.s.l. In some places, e.g. at sources of the river Enguri in Svaneti it occurs at 2450 m. Root system of *Pinus sylvestris* var.. *hamata* has very high plasticity, which enables the tree to grow over moraine-rocks, bare conglomerates, on stony soils, and soils with low pH. Beech the most widespread forest dominant in Georgia occurring from the sea level to the treeline but avoiding areas of pronounced continentality is another species of the studied community present in low wbundance. Beech can grow with fir, hornbeam, chestnut and more or less with spruce. As reported by Bondev et al. (1985) fir can reach 56-60 m in Svaneti, particularly, in Ormleti and Devra. Minor Asian-eastern Caucasian *Quercus macranthera* participates in the second layer. The Great Caucasus in Svaneti is considered as a western limit of distribution of this oak. In conditions of dry continental climate of

middle montane to subalpine belts, on montane brown soil this pine makes up thin and crook-stemmed forests. The community contains Minor Asian-Caucasian species: *Acer trauvetteri, Betula litwinowii, Fagus orientalis, Sorbus caucasigena, Picea orientalis* accompany the pine. According to Sochava (1946), these are forests with simple structure, a result of Pleistocene transformation of Tertiary's forests. In the most continental gorges of Enguri and Tskhenistskali, where the present study was carried out, we found populations of *Quercus macranthera*. The lowest point of its distribution is 1200 m a.s.l. and the highest is 2300 m a.s.l. The lower part of the subalpine belt contains the best places for its growth; here trees reach 30 m in height and the truck diametre 1 m. The second layer also contains *Acer trautvetteri*, which occurs at the treeline but unlike birches does not make crook-stemmed forest. Of deciduous trees *Betula litwinowii* is a tree species in the Caucasus, which makes crook-stemmed forests at higher elevations. *Sorbus caucasigena* is another tree of this layer. In the shrub layer *Vaccinium arctostaphylos*, an ancient Colchic plant, predominates. *Rhododendron luteum* unlike all the other Caucasus rhododendrons present in the community is deciduous and xeromesophilous. Another *Vaccinium* (*V. myrtillus*) is a subalpine-alpine plant. Herbaceous synusia consists of species of dark coniferous forests such as *Luzula sylvatica, Oxalis acetosella, Festuca drymeja, Mycelis muralis*, and *Pachyphragma macrophyllum*, a Tertiary's relict.

Table 13. *Relevés of Pineta vacciniosum arctostaphyli*

Releve No. 13	**1**	**2**	**3**	**4**	**5**
GPS coordinates: Tetnuldi	43.0286 Lat; 42.8319 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1950				
Cardinal point exposure (°):	SE138				
Slope angle/Inclination (°)	17				
Litter depth (cm):	4				
Litter mass (g dry weight/m^2)	482.4				
pH	7.6				
Surface cover (%):					
Bare soil	0	2	0	5	0
Stones	3	2	0	10	4
Litter	10	3	10	10	6
Dead wood	5	3	10	5	0
Cryptogams	10	2	10	10	2
Plants	72	88	70	60	88
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	25				
Pinus sylvestris var. *hamata*	3				
Betula litwinowii	2				
Sorbus caucasigena	1				

Releve No. 13	**1**	**2**	**3**	**4**	**5**
Fagus orientalis	1				
Acer trautvetteri	1				
Quercus macranthera	R				
Abies nordmanniana	R				
Picea orientalis	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.2	1.5	1.5	1.2	1
Vaccinium arctostaphylos	5	4	5	4	5
Vaccinium myrtillus	2	1		2	1
Rhododendron luteum	3	2		1	R
Corylus avellana		2	R		1
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	50	40	45	30	
Asperula odorata		1	2	1	1
Clinopodium vulgare		+	+	+	
Festuca drymeja	1	1	1		2
Luzula sylvatica	2	2		1	
Oxalis acetosella	1			1	
Pachyphragma macrophyllum	1	1	1		2

6.5 Racha

Six forest types were studied in Racha: Riparian forest (of alder), oak, hornbeam, dark coniferous and mixed, and pine forests.

Riparian forest

6.5.1 Alnetum festucosum

The riparian forest community was studied in the middle montane forest belt, at the village Ghebi, on gentle slope. In the first layer (9 m), along with the dominant *Alnus incana, Pyrus caucasica* and *Quercus iberica* are recorded in low abundance; in the second one (5-7 m) *Malus orientalis* dominates; in the third layer of shrubs (0.9-1 m) *Crataegus pentagyna*, *Rosa canina*, as well as vine *Smilax excelsa* are recorded. The herb cover is very diverse with 17 species listed. Among them are typical forest species: *Festuca drymeja, Fragaria vesca, Geum urbanum, Primula vulgaris, P. macrocalyx, Geranium robertianum, Valeriana alliariifolia, Serratula quinquefolia*, as well as much lower number of subalpine meadow plants: *Agrostis tenuis, Leontodon hispidus*.

Table 1. *Relevés of Alnetum festucosum*

Releve No. 1	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.748675 Lat; 43.543467 Long				
Ghebi					
Landscape type:	2				
Elevation, m a. s. l.:	1250				
Cardinal point exposure (°):	142				
Slope angle/Inclination (°)	2				
Litter depth (cm):	2				
Litter mass (g dry weight/m^2)	1280.64				
pH	7.6				
Surface cover (%):					
Bare soil	5	8	10	5	1
Stones	5	7	10	7	7
Litter	11	7	3	13	12
Dead wood	5	5	5	5	5
Cryptogams	2	2	2	5	2
Plants	80	71	70	65	73
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	9				
Alnus incana	4				
Pyrus caucasica	+				
Malus orientalis	+				
Quercus iberica	+				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1	1.2	1	0.9	1.2
Crataegus pentagyna	1	1		1	1
Rosa canina	1				1
Smilax excelsa	++	++	++	1	
Swida australis		++	1		++
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	50	50	55	50	45
Agrostis capillaris	+		+	+	+
Equisetum hyemale	+		+	1	1
Eupatorium cannabinum	+	+		+	+

Releve No. 1	**1**	**2**	**3**	**4**	**5**
Euphorbia sp.	+	+	+		+
Festuca drymeja	3	3	2	3	3
Fragaria vesca	2	2	2	2	2
Gentiana cruciata		+		+	+
Geranium robertianum	1		1	1	1
Geum urbanum	1		1	1	1
Lapsana grandiflora	+	+		+	+
Lathyrus roseus	+	+		+	+
Leontodon hispidus	+	+		+	+
Primula macrocalyx	+	+	+		
Primula vulgaris	1	1	1		1
Sambucus ebulus	+	+	+		+
Serratula quinquefolia	++		++	1	++
Stenactis annua	+	+	+		
Valeriana alliariifolia	+		+		+
Viola alba	2	2	1		+

Oak forest

6.5.2 Quercetum ibericae

Quercus iberica often dominates the driest and most eroded slopes. From the point of view of soil protection, its role is enormous. Floristic composition of the oak forest is diverse. We studied Querceta iberici in the Tugi valley, in the middle montane forest belt, on a rather inclined S slope. Litter cover, as expected, is not as big as that of cryptogams. Plant cover does not exceed 55%. The first layer (12 m) is dominated by *Quercus iberica, Acer laetum*, and *Carpinus caucasica*. The second layer (8-10 m) consists of *Pyrus caucasica, Sorbus torminalis, Populus tremula*. The second layer (0.6-1 m) includes shrubs: *Ligustrum vulgare, Cytisus hirsutissimus, Swida australis, Daphne pontica, Euonymus europaeus*. All of them are widespread plants in Colchis. The layer of herbaceous plants (20-25 cm) is well formed and quite diverse (12-14 species per 25 m2). Typical forest components are found here: *Poa nemoralis, Luzula sylvatica, Sanicula europaea, Peucedanum caucasicum, Pteridium tauricum* as well as scree meadow plants such as *Campanula alliariifolia* and subalpine and alpine meadow plants such as *Leontodon hispidus, Bupleurum polyphyllum*.

Table 2. *Relevés of Quercetum ibericae*

Releve No. 2	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.4361 Lat; 43.14435 Long				
Tlughi					
Landscape type:	5				
Elevation, m a. s. l.:	1220				
Cardinal point exposure (°):	171				
Slope angle/Inclination (°)	25				
Litter depth (cm):	2				
Litter mass (g dry weight/m^2)	836.76				
pH	6.8				
Surface cover (%):					
Bare soil	5	5	3	10	5
Stones	0	1	0	0	5
Litter	35	35	35	25	30
Dead wood	7	7	7	15	2
Cryptogams	3	7	5	3	3
Plants	50	50	50	47	55
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	12				
Quercus iberica	4				
Acer laetum	1				
Sorbus torminalis	1				
Populus tremula	1				
Carpinus caucasica	R				
Pyrus caucasica	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.7	0.7	0.8	0.6	0.7
Ligustrum vulgare	1	1		1	1
Cytisus hirsutissimus	1	1	1	1	1
Swida australis	1	1	1		1
Daphne pontica	+		+	+	
Euonymus europaeus	+			+	
Euonymus latifolius		+	+		
Crataegus pentagyna		++	++	++	++
Rosa canina		+	+	+	+
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	20	25	25	20	20
Bupleurum polyphyllum	1			++	
Calamintha grandiflora	++	++	++	++	++
Campanula alliariifolia	+			+	+

Releve No. 2	**1**	**2**	**3**	**4**	**5**
Campanula cordifolia		+	+	+	+
Helleborus caucasicus		+		+	+
Lathyrus roseus	+	+	+	+	+
Leontodon hispidus	1	1	++		
Luzula sylvatica	1	1	1	1	1
Orobanche alba		R			R
Orobus aureus	1		1		1
Peucedanum caucasicum	++	++	++		++
Poa nemoralis	1	1	1	1	1
Primula vulgaris		1	1		1
Primula woronowii		1	+		1
Pteridium tauricum	+	+		+	
Sanicula europaea	1		1	1	1
Veronica peduncularis	++	++	++		++
Viola alba		1	1		1

6.5.3 Querceto-Carpinetum orientalis

One of the most xerophilous forest types is Querceto -Carpinetum orientalis. The community grows on the S slope. Plant cover is very low (25%). Quercus iberica occupies the dominant position in the first layer (6 m); in the second layer (3-4 m) *Carpinus orientalis* and *Acer campestre* are the dominant species. In the shrub layer (0.5–1.5 m) there are two Colchis species present: *Daphne pontica*, liana *Hedera colchica* and common species of the Caucasian forests: *Ligustrum vulgare, Euonymus latifolia, Crataegus kyrtostyla*. The third layer (30-50 cm) contains herbaceous plants characteristic to the Colchis forests: *Luzula sylvatica, Festuca drymeja, Geranium robertianum, Viola alba* and ferns: *Athyrium filix-femina, Dryopteris filix-mas, Asplenium trichomanes.*

Table 3. *Relevés of Querceto-Carpinetum orientalis*

Releve No. 3	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.60683 Lat; 43.46714 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1130				
Cardinal point exposure (°):	237				
Slope angle/Inclination (°)	15				
Litter depth (cm):	2				
Litter mass (g dry weight/m^2)	1920.64				
pH	7.1				
Surface cover (%):					
Bare soil	5	13	16	19	22
Stones	10	18	9	11	8
Litter	40	39	8	21	12

Releve No. 3	**1**	**2**	**3**	**4**	**5**
Dead wood	10	10	19	5	19
Cryptogams	10	6	18	15	11
Plants	25	14	30	29	28
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	6				
Quercus iberica	3				
Carpinus orientalis	4				
Acer campestre	1				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.5	1	0.7	0.5	0.8
Ligustrum vulgare	1	1			1
Hedera colchica	1	1		1	
Daphne pontica	1	1	1	1	1
Euonymus latifolius	1	1	1		
Crataegus kyrtostyla	1		1	1	1
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	40	42	39	42	41
Asplenium trichomanes	1	1		1	1
Athyrium filix-femina	+		+		
Dryopteris filix-mas	++		++	++	
Festuca drymeja	1	1		1	
Geranium robertianum	R	R	R	R	R
Luzula sylvatica	2	2	2	2	2
Viola alba	1		1		1

Hornbeam forest

6.5.4 Carpinetum caucasici

Carpinus caucasica forests are widespread in Racha. The community was studied near the village Lagvanta, on a gentle NW slope in the middle montane forest belt, at 1150 m a.s.l. The substrate is more or less stony, the plant cover is low (40-50%), the amount of cryptogams is 6-9%, there are abundant deadwood (4-18%) and litter (13-26%).). In this type of forest there are six species of trees, seven species of shrubs, five species of herbaceous plants recorded.

The first layer (15 m) is dominated by *Carpinus caucasica, Tilia begoniifolia, Castanea sativa*, in places *Cerasus avium* is admixed. In the second layer (8-10 m) is made up of *Acer campestre, Carpinus orientalis*. The third layer (3-5 m) consists of the shrubs: *Daphne pontica, Ilex colchica*, and liana *Hedera colchica*. All are Colchic elements. There are also non-Colchic shrubs recorded: *Corylus avellana, Swida australis, Rhododendron luteum, Crataegus pentagyna*. The fourth layer (20-25 cm) contains herbaceous plants: *Sanicula europaea, Primula woronowii, Festuca drymeja, Luzula sylvatica, Viola alba*, typical forest species, some of which are typical of Colchis.

Table 4. *Relevés of Carpinetum caucasici*

Releve No. 4	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.60649 Lat; 43.47109 Long				
Lagvanta					
Landscape type:	5				
Elevation, m a. s. l.:	1150				
Cardinal point exposure (°):	271				
Slope angle/Inclination (°)	15				
Litter depth (cm):	3				
Litter mass (g dry weight/m^2)	4110.4				
pH	6.6				
Surface cover (%):					
Bare soil	5	15	15	6	19
Stones	9	6	8	5	8
Litter	15	13	26	14	18
Dead wood	13	9	4	18	9
Cryptogams	8	8	7	9	6
Plants	50	49	40	48	40
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	15				
Carpinus caucasica	4				
Tilia begoniifolia	2				
Castanea sativa	1				
Cerasus avium	R				
Acer campestre	+				
Carpinus orientalis	1				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	2.5	2	3	2.7	2.5
Hedera colchica	2	2	2	2	2
Rhododendron luteum	1		1	1	
Crataegus pentagyna	1		1		1
Corylus avellana	1	1	1		
Daphne pontica	1	1			
Ilex colchica	2	2	2	2	2
Swida australis	1	1		1	1

Releve No. 4	1	2	3	4	5
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	20	22	21	24	24
Festuca drymeja	2	2	2	2	2
Luzula sylvatica	1		1	1	
Primula woronowii	1	1	1		
Sanicula europaea	2	2	2	2	2
Violi alba	++		++		

Dark coniferous and mixed forest

6.5.5 Piceetum orientalis

Spruce forest was studied in Shovi vicinity, at1450 m a.s.l., on almost plain terrain. Vegetation cover is variable and ranges from 24% to 65%, cryptogams are quite abundant (7-19%). The forest is dominated by *Picea orientalis* forming the first layer (25 m). The layer also includes *Fagus orientalis*. The second layer is made up of *Acer laetum*. The third layer of shrubs (60-80 cm) mainly consists of Colchic elements such as: *Ilex colchica, Vaccinium arctostaphylos, Rubus anatolicus*, *Rhododendron luteum*, *Corylus avellana*. The herbaceous cover is quite well developed and contains up to ten species, all of which are typical species of the Colchic forest.

Table 5. *Relevés of Piceetum orientalis*

Releve No. 5	1	2	3	4	5
GPS coordinates:	42.70616 Lat; 43.58184 Long				
Shovi					
Landscape type:	3				
Elevation, m a. s. l.:	1450				
Cardinal point exposure (°):	172				
Slope angle/Inclination (°)	5				
Litter depth (cm):	6				
Litter mass (g dry weight/m^2)	2507.2				
pH	4.9				
Surface cover (%):					
Bare soil	3	8	8	3	5
Stones	7	15	4	7	9
Litter	14	28	10	14	26
Dead wood	9	4	6	9	15
Cryptogams	10	19	7	10	9
Plants	57	24	65	57	36

Releve No. 5	**1**	**2**	**3**	**4**	**5**
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	25				
Picea orientalis	5				
Abies nordmanniana	+				
Acer laetum	+				
Fagus orientalis	1				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.6	0.8	0.7	0.5	0.6
Ilex colchica	3	3	3	3	3
Rhododendron luteum	1		1	1	
Vaccinium arctostaphylos	1		1	1	1
Rubus anatolicus	1	1		1	1
Corylus avellana	++	++	++	++	
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	12	11	14	15	15
Athyrium filix-femina	+	+	+		+
Asperula odorata	+	+	+	+	+
Calamintha grandiflora	+	+		+	
Dryopteris filix-mas	++	++	++	++	
Festuca drymeja	+	+	+	+	+
Luzula sylvatica	++	++		++	++
Oxalis acetosella	2	2	2	2	2
Sanicula europaea	1		1	1	1
Viola alba	++	++	++	++	++

6.5.6 Piceeto-Abietum

The typical Colchic plant community was studied in the Shovi vicinity, in the upper montane forest belt, at 1580 m a.s.l. on a gentle (7°) slope, with significant litter (28-55%) and deadwood (18-32%) cover. Plant cover is low (10-15%), cryptogams are abundant (13-20%). The first layer (27 m) consists of two codominant trees: *Abies nordmanniana* and *Picea orientalis*. It is worth noting that fir often outgrows spruce in height and remains in the first layer, while spruce is consequently left in the second one. The shrub layer (0.2-0.3 m) contains three species, two of which (*Ilex colchica, Rubus anatolicus*) are typical Colchic elements. The herbaceous third layer (10 cm) is quite well formed. All species are typical forest plants while *Oxalis acetosella*, a constant species of coniferous forests, dominates among them.

Table 6. *Relevés of Piceeto-Abietum*

Releve No. 6	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.69719 Lat; 43.68773 Long				
Shovi					
Landscape type:	5				
Elevation, m a. s. l.:	1580				
Cardinal point exposure (°):	251				
Slope angle/Inclination (°)	7				
Litter depth (cm):	6				
Litter mass (g dry weight/m^2)	1580.0				
pH	5.0				
Surface cover (%):					
Bare soil	5	2	10	5	7
Stones	5	2	0	5	0
Litter	28	53	30	40	55
Dead wood	32	18	30	20	10
Cryptogams	20	15	20	20	13
Plants	10	10	10	10	15
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	27				
Abies nordmanniana	4				
Picea orientalis	3				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.2	0.2	0.25	0.2	0.3
Ilex colchica	++	1	++		++
Rubus anatolicus	++	++		1	
Euonymus latifolius	++	++		++	++
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	10	10	10	10	10
Athyrium filix-femina	+	+	+		1
Cardamine parviflora	+	++			+
Gentiana schistocalyx		+	+	+	+
Oxalis acetosella	2	1	2	1	2
Poa nemoralis	1		++	1	1
Orthilia secunda	+		+	+	
Sanicula europaea	+	+		+	+
Viola alba		+	+		+

6.5.7 Abieto-Fagetum orientalis

This is a characteristic forest type to Colchis and especially to Racha. Abieto-Fagetum orientalis was studied in the middle montane forest belt, on a moderately inclined NE slope. Litter cover is very high (77-86%).

Cryptogam and stone cover is insignificant. Forest closeness is moderate. The height of trees reaches 28 m, and that of shrubs does not exceed 0.2-0.5 m. This community can be classified as bi-dominant with three layer. The first layer is made up of almost equal-height *Abies nordmanniana* and *Fagus orientalis*, and the second layer of shrubs of almost equal-height *Rubus anatolicus* and *Ilex colchica*. It is known that natural regeneration of beech in this forests community occurs quite well, and sometimes even better than in a pure beech forest (Dolukhanov, 2010).

Table 7. *Relevés of Abieto-Fagetum orientalis*

Releve No. 7	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.40354 Lat; 43.03771 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1215				
Cardinal point exposure (°):	E42				
Slope angle/Inclination (°)	15				
Litter depth (cm):	3				
Litter mass (g dry weight/m^2)	995.2				
pH	5.8				
Surface cover (%):					
Bare soil	2	4	5	0	3
Stones	2	0	5	0	2
Litter	81	86	78	77	85
Dead wood	10	5	5	15	2
Cryptogams	3	3	5	5	4
Plants	2	2	2	3	4
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	28				
Fagus orientalis	4				
Abies nordmanniana	3				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.2	0.3	0.4	0.5	0.3
Rubus anatolicus	++		++	++	++
Ilex colchica	+	+		++	+
Hedera colchica		+			+
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	-	-	-	-	-
-	-	-	-	-	-

6.5.8 Abieto-Fagetum lauroserasosum

This forest type was studied in the middle montane forest belt, on a moderately inclined N slope. Four Colchic tree species were recorded. Two of the four species are co-dominant and have a larger cover: *Fagus*

orientalis and *Abies nordmanniana*. *Tilia begoniifolia* and *Castanea sativa* are present in relatively low abundances. The tree height in the first layer reaches 30 m. All shrubs of the second layer (1 m) are Colchic elements. The herbaceous cover is absent.

Table 8. *Relevés of Abieto-Fagetum lauroserasosum*

Releve No. 8	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.41027 Lat; 43.01589 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1210				
Cardinal point exposure (°):	N350				
Slope angle/Inclination (°)	20				
Litter depth (cm):	4				
Litter mass (g dry weight/m^2)	1392.0				
pH	5.0				
Surface cover (%):					
Bare soil	0	0	5	2	3
Stones	0	1	5	3	0
Litter	18	25	12	25	12
Dead wood	7	2	3	10	5
Cryptogams	5	2	2	5	5
Plants	70	70	73	55	75
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	30				
Fagus orientalis	4				
Abies nordmanniana	3				
Tilia begoniifolia	+				
Castanea sativa	+				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.2	1	1.3	1.2	1.1
Laurocerasus officinalis	4	3	4	3	5
Hedera colchica	2	1	1	1	
Ilex colchica	1	1			1
Rubus anatolicus		+		1	+
Vaccinium arctostaphylos		+	1		+
Viburnum opulus	+				
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	-	-	-	-	-
-	-	-	-	-	-

6.5.9 Abietum herbae mixta

The typical Colchic forest community with Colchic undergrowth was studied in the middle montane forest belt, on a moderately inclined N slope. The cryptogams cover is quite large (60–65%). Forest canopy closeness is 0.7. The trees height is up to 30 m. *Abies nordmanniana* forms the first layer. The abundance of *Rubus anatolicus*, widespread in Colchis, slightly exceeds that of the other shrubs of the undergrowth (0.2-0.4 m). This plant community may rarely occur below 500 m and above 2000 m a.s.l. in conditions of high humidity (Dolukhanov, 2010).

Table 9. *Relevés of Abieta herbae mixta*

Releve No. 9	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.42794 Lat; 43.14554 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1437				
Cardinal point exposure (°):	N350				
Slope angle/Inclination (°)	15				
Litter depth (cm):	2				
Litter mass (g dry weight/m^2)	2017.92				
pH	6.0				
Surface cover (%):					
Bare soil	5	5	5	5	5
Stones	0	0	0	5	2
Litter	3	3	3	3	3
Dead wood	7	7	7	7	5
Cryptogams	65	65	65	60	60
Plants	20	20	20	20	25
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	30				
Abies nordmanniana	25				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.2	0.2	0.2	0.3	0.4
Rubus anatolicus	++			++	++
Vaccinium arctostaphylos	+				
Rhododendron luteum	+	+	+	+	
Hedera colchica		+	+	+	+
Viburnum opulus		+	+	+	+
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	15	10	15	15	15
Aruncus vulgaris	+		+		+
Dryopteris filix-mas	+	+	+	+	+

Releve No. 9	**1**	**2**	**3**	**4**	**5**
Festuca drymeja	+	+	+	+	+
Fragaria vesca	+	+	+	+	
Galium rotundifolium	+	+	+	+	+
Lapsana grandiflora	+		+		+
Lathyrus vernus	+	+	+	+	+
Mycelis muralis	1	1	1	1	
Primula woronowii	+	+	+	+	+
Prunella vulgaris	1	1	1		1
orthilia secunda	+	+	+	+	
Sanicula europaea	1		1	1	1
Viola alba	1		1	1	

6.5.10 Abietum rubosum

The typical Colchic forest type, widespread in Racha, was studied in the upper montane forest belt, on a gentle NW slope. Plant cover is quite high (75-82%), terricolous cryptogams are scanty. The two co-dominant species: *Abies nordmanniana* and *Fagus orientalis* make up the first layer (25 m). The second layer (17-20 m) contains *Cerasus avium*. The shrub layer (1.5-2 m) is represented by several species, of which *Rubus anatolicus* dominates. Colchic elements are represented by the evergreen vine *Hedera colchica* and shrubs: deciduous *Vaccinium arctostaphylos* and evergreen vine *Laurocerasus officinalis*. Of deciduous shrubs, in addition to blackberries and blueberries, *Viburnum opulus*, *Rhododendron luteum* and *Sorbus caucasigena* widespread in Georgia and, in particular, Colchis, are noteworthy. The herbaceous layer (80-100 cm) is well developed, and includes the common dominant grass species of Georgia's forests, relict *Festuca drymeja*, as well as: *Fragaria vesca, Sanicula europaea, Viola alba, Orthilia secunda*.

Table 10. *Relevés of Abietum rubosum*

Releve No. 10	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.42939 Lat; 43.1606 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1550				
Cardinal point exposure (°):	340				
Slope angle/Inclination (°)	10				
Litter depth (cm):	2				
Litter mass (g dry weight/m^2)	1691.68				
pH	6.6				
Surface cover (%):					
Bare soil	0	0	0	4	5
Stones	0	0	3	4	0
Litter	7	5	7	7	5

Releve No. 10	**1**	**2**	**3**	**4**	**5**
Dead wood	10	15	10	2	5
Cryptogams	3	5	5	3	3
Plants	80	75	75	80	82
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	25				
Abies nordmanniana	4				
Fagus orientalis	3				
Cerasus avium	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.5	1.5	1.5	1.7	1.5
Rubus anatolicus	4	4	4	4	4
Hedera colchica	1	1		1	
Viburnum opulus	+	+		+	
Vaccinium arctostaphylos	+	+	+	+	
Rhododendron luteum	+	+	+	+	+
Sorbus caucasigena	+	+	+	+	+
Laurocerasus officinalis	+	+	+		+
Ilex colchica			+		+
Euonymus europaeus			+		+
Tamus communis		+		+	+
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	100	80	100	70	100
Festuca drymeja	2	2	2	2	2
Fragaria vesca	1				1
Orthilia secunda		+	1	+	
Sanicula europaea	1	1	1		1
Viola alba	+			+	

6.5.11 Pinetum

The pine forest was studied near Gomi, Ambrolauri, in the middle montane forest belt at 1010 m a.s.l. on a S slope. Litter cover is unevenly distributed on the ground surface (2-25%), as well as with terricolous cryptogams (2-15%); plant cover is also unevenly distributed (27-85%) and a significant portion of the ground surface is bare soil (3-12%). Pine is the only woody plant and is present in high abundance. Its height reaches 18 m. There are seven species of shrubs and one liana recorded in the second layer. Of particular note is the diversity of herbaceous plants with 15 species recorded.

Table 11. *Relevés of Pinetum*

Releve No. 11	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	42.51229 Lat; 43.16275 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1010				
Cardinal point exposure (°):	215				
Slope angle/Inclination (°)	15				
Litter depth (cm):	3				
Litter mass (g dry weight/m^2)	1055.04				
pH	7.8				
Surface cover (%):					
Bare soil	5	12	11	8	3
Stones	0	9	0	27	7
Litter	5	2	11	5	25
Dead wood	3	4	4	23	30
Cryptogams	2	15	5	7	8
Plants	85	58	69	30	27
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	18				
Pinus hamata	5				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	1.8	1.9	1.5	1.4	1.6
Pyracantha coccinea	3	3	3	3	3
Smilax excelsa	2	2	2	2	2
Crataegus kyrtostyla	2	2	2	2	2
Ligustrum vulgare	2	2	2	2	2
Rosa canina	1			1	1
Rubus sp.	1			1	
Cotinus coggygria	1	1	1		
Clematis vitalba	1		1		1
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	40	43	41	42	44
Campanula alliariifolia	+		+	+	+
Dorycnium graecum	+		+	+	+
Festuca drymeja	1	++		1	
Lapsana grandiflora	++	++			+
Lathyrus roseus	+	++			+
Lithospermum purpureocaeruleum	+	+	+		
Luzula sylvatica	1	++		++	
Medicago minima	+	+	+		

Releve No. 11	**1**	**2**	**3**	**4**	**5**
Origanum vulgare	+	+		+	
Pimpinella saxifraga	+		+	+	+
Primula vulgaris	+	+			
Primula woronowii	++		++	++	++
Scabiosa colchica	+	+			+
Veronica peduncularis	+		+		+
Viola alba	+	+	+		

6.6 Samtskhe-Javakheti

In Samtskhe-Javakheti, the following forest types were studied: dark coniferous forest (of spruce) and two variants of mixed forest: spruce-beech forest with evergreen Colchic undergrowth and beech-fir forest with evergreen Colchic undergrowth, subalpine forest of birch and coniferous species.

Dark coniferous and mixed forest

6.6.1 Piceetum

Coniferous forests form the montane forest belt in the Caucasus from 1100-1500 m to 2000-2200 m a.s.l. Depending on the environmental conditions, these forests form either an entire strip (in the North Caucasus) or occupy only the northern, wetter, shaded slopes (in Apkhazeti). This type of forest is the habitat to five Caucasian endemic species. Of these, three are herbaceous plants. Of them, a very rare orchid *Goodyera repens* is noteworthy.

Table 1. *Relevés of Piceetum*

Releve No. 1	1	2	3	4	5
GPS coordinates: Bakuriani	41.76099 Lat; 43.51793 Long				
Landscape type:	5				
Elevation, m a.s.l.:	1700				
Cardinal point exposure,°:	S				
Slope angle/Inclination,°:	5				
Litter depth, cm:	3				
Litter mass (g dry weight/m^2)	1445.12				
pH	6.4				
Surface cover, %:					
Bare soil	0	0	0	3	0
Stones	0	0	0	0	0
Litter	30	80	70	20	40
Dead wood	5	10	5	7	10
Cryptogams	50	4	0	50	30

Plants	15	6	25	20	20
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	32				
Picea orientalis	4				
Fagus orientalis	+				
Sorbus caucasigena	1				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	0.5		1.0	1.0	1.5
Rosa sp.	+				
Lonicera caucasica			+	+	
Euonymus latifolius					R
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	30	30	22	100	20
Asperula odorata				+	
Campanula stevenii	R				
Carex divulsa	1	R			
Carex sp.	+	2	2		
Corallorhiza trifida	R				
Descurainia sophia				+	
Dryopteris filix-mas				+	
Festuca drymeja				2	2
Fragaria vesca	+			+	
Fragaria viridis	1			1	+
Galega orientalis				+	+
Galium uliginosum	+		+		
Geranium gracile			+		
Geranium robertianum				1	
Goodyera repens				+	
Hieracium pilosella	+				+
Lactuca muralis				1	+
Lapsana communis					R
Listera cordata					1
Luzula sp.	+				
Orobus aureus	1				1
Orobus cyaneus	+	R		1	

Oxalis acetosella	1			1	2
Poa nemoralis	++			+	
Primula macrocalyx				+	+
Ranunculus sp.	R				
Sanicula europaea			+		
Scrophularia umbrosa			+		
Securigera orientalis	R				
Sedum oppositifolium	R				
Trifolium aureum	++				
Veronica peduncularis	1				
Viola odorata	++	R	+	+	+

6.6.2 Piceeto-Fagetum rhododendrosum

A spruce-beech forest with evergreen Colchic undergrowth was studied in the Banishkevi gorge, the Borjomi-Kharagauli National Park. Despite the fact that the study area is located outside of Colchis, its natural conditions support the Colchic evergreen undergrowth. The first layer (26-28 m) is made up of tall trees: *Fagus orientalis, Picea orientalis* and *Tilia begoniifolia*; in the second layer (18-20 m) there are relatively small trees: *Acer laetum, Crataegus microphylla, Mespilus germanica*; in the third layer (0.45-0.80 m) there are shrubs and vines: *Rhamnus imeretina, Ilex colchica, Rubus caucasicus, Viburnum opulus* and *Hedera pastuchovii*; the lowest, fifth layer consists of herbaceous plants and ferns: *Festuca drymeja, Dryopteris filix-mas*, etc. It should be noted that in this ecosystem there are five endemic species of the Caucasus, and three of them are shrubs, which means that 60% of shrubs are endemic.

Table 2. *Relevés of Piceeto-Fagetum rhododendrosum*

Releve No. 2	1	2	3	4	5
GPS coordinates:	41.875624 Lat; 43.370429 Long				
Landscape type:	5				
Elevation, m a.s.l.:	960				
Cardinal point exposure,°:	NE				
Slope angle/Inclination,°:	27				
Litter depth, cm:	5				
Litter mass (g dry weight/m^2)	1364.0				
pH	6.3				
Surface cover, %:					
Bare soil	10	12	5	10	10
Stones	8	5	5	0	5
Litter	20	40	45	55	55
Dead wood	7	8	5	5	5
Cryptogams	15	5	5	5	5

Plants	45	30	35	25	20
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	28				
Fagus orientalis	3	3	3	3	3
Picea orientalis	1	1	1	1	1
Acer laetum	1	1	1	1	1
Tilia begoniifolia	1	1	1	1	1
Crataegus microphylla	R	R	R	R	R
Mespilus germanica	R	R	R	R	R
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	0.80	0.70	0.45	0.65	0.6
Hedera pastuchovii	1	1	2	1	2
Rhamnus imeretina	+				
Ilex colchica	+	+	1		
Rubus caucasicus	1	1		1	1
Viburnum opulus		R		++	
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	50	60	50	55	40
Festuca drymeja	1	1		+	1
Dryopteris filix-mas	++	+	1	1	
Cyclamen vernum	+			+	
Oxalis acetosella	+				+
Phyllitis scolopendrium		1			
Luzula forsteri	R			+	
Polystichum aculeatum			1		
Primula macrocalyx				+	
Orobanche alba					+

6.6.3 Fageto-Piceetum rhododendrosum

This ecosystem, as the one discussed above, was studied in the in Banishkevi gorge, the Borjomi-Kharagauli National Park, where Colchic forests are well developed due to very high humidity. The study site is located at 915 m a.s.l.; the slope is rather steep (32°) and north-facing. Plant cover is 50-60%, and litter cover is 10-20%. In the first layer (25-27 m) thee species of trees grow: *Picea orientalis, Fagus orientalis, Tilia begoniifolia*; the second layer (18-20 m) consists only of *Acer laetum*; the third layer (1.5-1.9 m) is made up of several evergreen and deciduous shrubs and vines: *Rhododendron ponticum, Hedera pastuchovii, Rhamnus imeretina, Ilex colchica, Rubus caucasicus, Viburnum opulus, Laurocerasus officinalis, Euonymus europaeus*; the fourth layer (50-90 cm) is herbaceous: *Asperula odorata, Calamagrostis epigeios, Festuca drymeja, Dryopteris filix-mas, Phyllitis scolopendrium* and others.

Table 3. *Relevés of Fageto-Piceetum rhododendrosum*

Releve No. 3	1	2	3	4	5
GPS coordinates:	41.87612 Lat; 43.37465 Long				
Landscape type:	5				
Elevation, m a.s.l.:	915				
Cardinal point exposure,°:	NE				
Slope angle/Inclination,°:	32				
Litter depth, cm:	4				
Litter mass (g dry weight/m^2)	838.56				
pH	6.7				
Surface cover, %:					
Bare soil	10	15	13	15	10
Stones	5	1	0	2	0
Litter	10	20	15	13	15
Dead wood	5	7	7	5	5
Cryptogams	15	2	15	15	10
Plants	55	55	50	50	60
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	27				
Picea orientalis	3				
Fagus orientalis	2				
Acer laetum	++				
Tilia begoniifolia	++				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	1.50	1.50	1.80	1.90	1.80
Rhododendron ponticum	3	4	3	3	2
Hedera pastuchovii	3	2	3	3	3
Rhamnus imeretina	+				
Ilex colchica	1		1		1
Rubus caucasicus	++			1	1
Viburnum opulus		1	1	1	
Laurocerasus officinalis		1		1	
Euonymus europaeus				R	
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	90	60	60	50	60
Asperula odorata	+			+	+

Releve No. 3	1	2	3	4	5
Calamagrostis epigeios		++		1	1
Cyclamen vernum	++				
Dryopteris filix-mas	2	2		2	
Festuca drymeja	1	1	1	++	1
Luzula forsteri	+	+		+	
Oxalis acetosella	+	+	+		1
Phyllitis scolopendrium	++	1	++	+	+
Polystichum aculeatum	1		1		1

Subalpine forest of birch

6.6.4 Betuletum

Subalpine birch forest was studied on Mt. Kodiana, the Lesser Caucasus, on a gentle (7°) NE slope slope. Plant cover ranges from 60-85%. The litter cover is very uneven (5-30%). High species richness of trees and the absence of shrub species are noteworthy. The first layer (16-18 m) consists of *Betula litwinowii* and *Acer trautvetteri*; in the second layer (10-15 m) *Salix caprea* and in lower abundance *Quercus macranthera* and *Pinus sylvestris* var. *hamata* are recorded; the third layer (3-5 m) is represented by *Sorbus caucasigena*; in the fourth, herbaceous layer (130-190 cm), elements of subalpine tall herb communities: *Aconitum orientale, Anthriscus sylvestris, Cephalaria gigantea* are found along with other species.

Table 4. *Relevés of Betuletum*

Releve No.	1	2	3	4	5
GPS coordinates: Kodiana	41.712840 Lat; 43.342975 Long				
Landscape type:	5				
Elevation, m a.s.l.:	1970				
Cardinal point exposure,°:	NE				
Slope angle/Inclination,°:	7				
Litter depth, cm:	3				
Litter mass (g dry weight/m^2)	2007.2				
pH	6.4				
Surface cover (%)					
Bare soil	1	0	0	3	0
Stones	0	0	0	0	0
Litter	5	5	20	15	30
Dead wood	2	5	5	5	5
Cryptogams	7	10	5	2	5
Plants	85	80	70	75	60
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	18				

Betula litwinowii	3				
Acer trautvetteri	2				
Sorbus caucasigena	1				
Salix caprea	2				
Quercus macranthera	R				
Pinus sylvestris var. *hamata*	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:					
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	190	190	190	130	160
Aconitum orientale					+
Agrostis planifolia				1	
Alchemilla pycnotricha		+	1		
Anthriscus sylvestris	1	2	1		1
Asperula orientalis	1	1	1		2
Astrantia maxima	2	R			1
Betonica macrantha	1	2	2		2
Brachypodium sylvaticum				+	
Calamagrostis arundinacea	3	4	4		4
Carduus adpressus				1	1
Carex sylvatica			R		
Centaurea cheiranthifolia			+		
Cephalaria gigantea	1				
Cirsium arvense					+
Cirsium obvallatum		+	+		
Clinopodium vulgare				+	
Cruciata laevipes		1	1		
Dactylis glomerata	1	+	1	1	1
Delphinium sp.			+		
Deschampsia cespitosa	2		4		
Festuca montana		3			3
Gadellia lactiflora		1			
Galega orientalis	4	1	1	3	3
Galium odoratum	1				
Geranium robertianum					+
Grossheimia macrocephala			+		
Heracleum sosnowskyi		+			+
Knautia montana				1	
Lapsana communis	1	2	1		1

Marrubium catariifolium				2	1
Mentha arvensis				1	
Poa nemoralis				2	
Poa pratensis	1				
Polygonatum verticillatum				r	
Polypodium vulgare					+
Ranunculus oreophilus		+			
Rumex sp.		R			
Silene italica	1		+	1	
Veronica beccabunga			+		
Vicia sepium		+	1		

6.6.5 Piceeto-Abietum

This ecosystem was studied in the Borjomi-Kharagauli National Park, near Abastumani, the Lesser Caucasus. The study area is located in the upper montane forest belt, at 1850 m a.s.l., on a N slope 20°. Litter is contained in a 5-centimeter layer of topsoil and its cover is 25-40%. Plant cover is 25-40%. The total height of the forest is up to 25-30 m and its canopy closure is 0.7-0.8. The forest is dominated by *Abies nordmanniana* and *Picea orientalis*. The layer structure is as follows: the first layer (25-30 m) is made up of: *Abies nordmanniana, Picea orientalis*, *Pinus sylvestris* var. *hamata*; the second layer (10-15 m) consists of smaller trees: *Acer laetum, Pyrus caucasica, Populus tremula*; the third layer (5-7 m) of shrubs contains: *Corylus avellana, Rubus idaeus*; the fourth layer (30-90 cm) is composed of the following species: *Festuca drymeja, Asperula odorata, Sanicula europaea, Oxalis acetosella* and others.

At this site, almost all the recorded plant species are typical representatives of the Eastern Euxinian dark-coniferous forests.

Table 5. *Relevés of Piceeto-Abietum*

Releve № 5	**1**	**2**	**3**	**4**	**5**
GPS coordinates: Abastumani	41.80482 Lat; 42.84440 Long				
Landscape type:	4				
Elevation, m a.s.l.:	1850				
Cardinal point exposure,°:	N				
Slope angle/Inclination,°	20				
Litter depth, cm:	5				
Litter mass (g dry weight/m^2)	1600.0				
pH	7.3				
Surface cover, %:					
Bare soil	0	5	0	0	0

Releve № 5	**1**	**2**	**3**	**4**	**5**
Stones	0	0	0	0	0
Litter	25	25	40	30	40
Dead wood	15	10	10	15	10
Cryptogams	25	20	25	15	25
Plants	35	40	25	40	25
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	30				
Abies nordmanniana	5				
Picea orientalis	3				
Pinus sylvestris var *hamata*	1				
Pyrus communis	1				
Acer laetum	+				
Populus tremula	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	3.0	0.7	0.5	0.5	0.5
Corylus avellana	++				
Rubus idaeus	++	++	++	++	++
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	80	60	30	60	90
Calamagrostis arundinacea		+			
Dactylis glomerata		+			2
Deschampsia cespitosa	R				
Elymus spicatus		+	+		
Festuca drymeja		3		2	+
Festuca pratensis	1		1		
Fragaria vesca	+	+	++	1	
Galium uliginosum	++	++		+	+
Lathyrus cyaneus	++	1	+	1	+
Luzula spicata				+	
Omalotheca supina	R				+
Oxalis acetosella	2	1	++	1	1
Prunella vulgaris	++		+		

Releve № 5	1	2	3	4	5
Sanicula europaea	3	2	+	2	2
Viola reichenbachiana	+	+		+	+

6.7 Kartli

In Kartli, the following forest types were studied: oak forest, beech forest.

6.7.1 Quercetum ibericae

Forests of *Quercus iberica* are spread in the South Caucasus and eastern part of the North Caucasus (Dagestan, partly Chechnia-Ingushetia). One of the major co-dominants in these forests is *Carpinus caucasica*. None of the forests are modified by human intrusions as oak forests and especially the forest of *Quercus iberica.* Of the Caucasus deciduous forests, the oak forests thrive in the driest climatic conditions. The lower limit of its distribution passes at 350-500 m, and the upper at 1400-1500 m, rarely rising above 1700 m a.s.l.

Querceuma ibericae was studied in Tbilisi National Park, near Saguramo, at 815 m a.s.l. on a steep southern slope of 25° with litter depth of about 5 cm and cover 50-75%. Plant cover is 10-40%. The tree height reaches 17 m. The first layer is dominated by oak, with a lower abundance of *Fraxinus exccelsior* and an even lower of *Acer campestre*. In the second layer of shrubs the following are most abundant: *Swida australis, Lonicera caucasica, Cornus mas, Viburnum ortientale*; all the recorded species are characteristic to deciduous forests of eastern Georgia; only *Ruscus ponticus* present in Saguramo forest, at eastern border of its distribution in the Caucasus, represent a group of species constituting evergreen undergrowth of Colchic temperate rainforests. The herbaceous synousia is represented by the trivial hemixerophilic species of eastern Georgian's forests.

Table 1. *Relevés of Quercetum ibericae*

Releve No. 1	1	2	3	4	5
GPS coordinates: Saguramo	41.86453 Lat; 44.75691 Long				
Landscape type:	5				
Elevation, m a.s.l.:	815				
Cardinal point exposure,°:	S				
Slope angle/Inclination,°:	25				
Litter depth, cm:	4				
Litter mass (g dry weight/m^2)	2958.08				
pH	7.8				
Surface cover, %:					
Bare soil	5	5	5	5	5
Stones	0	0	0	0	0
Litter	60	65	65	50	75
Dead wood	10	10	10	5	5
Cryptogams	5	5	5	0	5
Plants	20	15	15	40	10

Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	17				
Quercus petraea subsp. *iberica*	4				
Carpinus orientalis	3				
Fraxinus excelsior	2				
Acer campestre	+				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	2.0	0.4	1.0		0.4
Swida australis	2				
Lonicera caucasica	2				
Cornus mas	R				
Crataegus microphylla	R				
Ruscus ponticus		R			1
Viburnum orientale			R		
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	50	30	120	120	100
Achillea ptarmicifolia			R		
Aegonychon purpurocaeruleum	2	2	4	4	1
Anthriscus nemorosa		1	1	1	1
Carduus acanthoides		+			
Serratula quinquefolia	R				
Lithospermum officinale	1				
Melica uniflora				R	+
Paeonia caucasica			R		
Silene multifida					+
Viola odorata	1	1			
Viola reichenbachiana					2

6.7.2 Fagetum rubosum

Fagetum rubosum (with *Rubus hirtus*) are mainly confined to moderately humid conditions. And grow above 1400-1500 m a. s. l., mostly on northern slopes of 10-25°. In the studied Sabaduri forest (in Tbilisi National Park) trees are quite tall (32-35 m), litter depth is small (3-5 cm) indicating intense decomposition the organic material in the ecosystem. The forest has three layers: the tree layer (30-33 m) of *Fagus orientalis, Carpinus betulus, Pyrus caucasica*; the layer of shrubs (0.5-2 m) of *Rubus hirtus, Sambucus nigra*; the layer of herbs (35-60 cm) containing *Anemone caucasica, Arum albispathum, Galanthus alpinus, Pachyphragma macrophyllum.* The floristic list of the forest shows that in the studied ecosystem the major species of shrub and herb layers are typical forest plants; *Rubus hirtus* is interesting as an indicator species of natural / close to natural forests (Dolukhanov, 2010). Age classes of woody plants are observed to be diverse with good representation of the regeneration phase; deadwood is present. Such endemic species of Georgia's flora as

Ilex colchica, Pachyphragma macrophyllum, Anemone caucasica, Euphorbia macroceras, Galanthus alpinus, Primula woronowii and others grow here. A few words about *Pachyphragma macrophyllum*: this plant is a relict, endemic plant of the monotypic genus of the Colchic origin, which prefers moderately moist, often heavily stony, humus-rich habitats. Early spring plant synousia, including geophytes is specifically diverse with *Galanthus alpinus, G. kemulariae, Anemone caucasica, Corydalis marschalliana, Prymula macrcalyx, P. woronowii, Viola odorata, Arum albispathum*. Of summer-flowering herbs, *Asperula odorata* is distinguished by the highest frequency. Abundance of ferns is noteworthy, namely of: *Athyrium filix-femina, Dryopteris filix-mas*. Grasses and sedges are represented by a small number of species and individuals.

In terms of the threats caused by global warming, the disappearance of snow-associated plants (*Galanthus alpinus, Corydalis marschalliana*) and mesophytes (*Anemone caucasica, Arum albispathum*), the damage to beech sprouts and, most importantly, the limitation of beech growth as a mesophilic relict species is noteworthy.

Table 2. *Relevés of Fagetum rubosum*

Releve No. 2	**1**	**2**	**3**	**4**	**5**
GPS coordinates: Sabaduri	41.90861 Lat; 44.91472 Long				
Landscape type:	5				
Elevation, m a.s.l.:	1400				
Cardinal point exposure,°:	N (008)				
Slope angle/Inclination,°:	16				
Litter depth, cm:	5				
Litter mass (g dry weight/m^2)	2880.96				
pH	5.7				
Surface cover, %:					
Bare soil	5	3	1	0	1
Stones	0	1	0	0	1
Litter	35	60	46	50	41
Dead wood	10	8	10	13	15
Cryptogams	5	0	2	0	0
Plants	45	28	41	37	42
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	33				
Fagus orientalis	4	4	4	4	4
Pyrus caucasica	1	1	1	1	1
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	0.5	1.7	2.0	1.2	1.3
Rubus hirtus	2	2	+	2	+
Sambucus nigra	R	+	R	2	
Ilex colchica		1			

Herbaceous plants 25 m^2 (5 X 5 m)	35	50	35	50	60
Grass canopy height, cm:					
Spring					
Anemone caucasica	3	2	2	2	3
Arum albispathum			2	1	
Arum megobrebi					1
Corydalis marschalliana	+		+		
Euphorbia macroceras	+				
Festuca drymeja	1	1			
Galanthus alpinus				1	
○ *Galanthus kemulariae*				1	
Galium mollugo		+			
Asperula odorata	+				
Geranium robertianum			R	R	
Orobanche cumana		+			
Pachyphragma macrophyllum	1	+	R	+	
Poa annua		R			
Primula woronowii	+				
Ranunculus meyerianus		+			
Scutellaria orientalis		R			
Viola odorata	+				
Summer					
Arum megobrebi		+			1(+)
Asperula odorata	1	+	1	3	2
Brachypodium sylvaticum		+			
Carex panicea	+		+	+	
Clinopodium vulgare			+		
Dryopteris carthusiana		1	3		
Dryopteris filix-mas	2			4	3
Euphorbia macroceras				+	++
Geranium robertianum	+				+
Pachyphragma macrophyllum	1	1	1		
Paris quadrifolia	+	+	+	+	+
Polygonatum glaberrimum		+			
Salvia glutinosa	1			+	

Trachystemon orientale			+	+	
Urtica dioica	+				+
Viola odorata		+	+	+	

6.8 Kvemo Kartli

In Kartli, the following forest types were studied: riparian forest, hornbeam forest.

Riparian forest

6.8.1 Querceto-Populetum

Riparian forest of the river Mtkvari was studied in the Gardabani Habitat Management Area, at 285 m a.s.l., on almost plain terrain. The proportion of litter (25-45%) and bare soil (10-20%) in the total cover is quite large. The riparian forest physiognomy is defined by trees and plants, abundantly covered with vines, and an almost impenetrable shrub layer formed by many species. The first layer (28-30 m) is made up of by *Populus hybrida* and *Quercus pedunculiflora*. The former grows on the first river terrace and the latter on the following terraces; in the second layer (16-18 m) there are lower trees: *Carpinus caucasica, Ulmus minor, Salix excelsa*, etc. *Salix excelsa* grows closest to the water. The third layer consists of small trees (6-8 m): *Cornus mas, Mespilus germanica*. The shrub layer (3-4 m) consists of 15 species of shrubs and vines. Of the vines, *Vitis vinifera* subsp. *sylvestris* is noteworthy.

Table 1. *Relevés of Querceto-Populetum*

Releve No. 1	**1**	**2**	**3**	**4**	**5**
GPS coordinates: Gardabani	41.38984 Lat; 45.06798 Long				
Landscape type:	1				
Elevation, m a.s.l.:	285				
Cardinal point:	SE				
Slope angle/Inclination○:	4				
Litter depth, cm:	5				
Litter mass (g dry weight/m^2)	733.92				
pH	7.7				
Surface cover, %:					
Bare soil	15	20	20	10	15
Stones	2	5	5	0	5
Litter	40	35	30	45	25
Dead wood	10	15	3	15	9
Cryptogams	5	1	2	1	1
Plants	28	24	40	29	45
Trees per 400 m^2 plot (20 X 20 m)					

Tree canopy height, m:	30				
Carpinus caucasica	1				
Celtis caucasica	R				
Populus hybrida	3				
Quercus pedunculiflora	3				
Robinia pseudoacacia	1				
Ulmus minor	1				
Salix excelsa	1				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	3	4	3	3	3
Amorpha fruticosa		1			
Clematis vitalba	1		1		1
Cornus mas	2	2	2	2	2
Crataegus meyeri	+				
Crataegus pentagyna					+
Hedera helix	1		2	2	
Hedera pastuchovii	2			2	
Ligustrum vulgare	1	1	1	2	1
Lonicera iberica		1		1	
Mespilus germanica	1				
Periploca graeca			+		
Rubus caucasicus				1	
Smilax excelsa	3	3	3	3	3
Swida australis		2			1
Vitis vinifera subsp. *sylvestris*				+	1
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	45	40	35	40	50
Aegonychon purpurocaeruleum	1	2	2	1	1
Asparagus officinalis	1		+		+
Euphorbia macroceras		1			1
Festuca drymeja				+	+
Fragaria vesca				+	
Glycyrrhiza glabra		1		1	
Orobanche alba			+		+
Poa palustris	1			1	
Setaria viridis	1	1	1	1	1
Viola odorata	+	+	+	+	+

Hornbeam forest

6.8.2 Carpinetum

Carpinus caucasica forest was studied in the vicinity of Dmanisi, at 1000 m a.s.l., on N slope of 15-20°. The forest contains *Carpinus orientalis* and other tree species in lower abundance: *Fagus orientalis, Quercus iberica, Acer laetum* and *A. campestre*. The first layer (24-26 m) consists of *Carpinus caucasica* and *Fagus orientalis*; the second layer (16-22 m) of *Quercus iberica*, *Acer laetum, A. campestre*; the third (10-15 m) of *Carpinus orientalis*; the fourth (up to 0.5 m) of shrubs, and the fifth (10-30 cm) of typical herbaceous plants of the forest: *Calamagrostis arundinacea, Fragaria vesca, Galium odoratum, Viola odorata*, etc. It is noteworthy that the litter makes the major portion of the ground cover (80-90%).

Table 2. *Relevés of Carpinetum*

Releve No. 2	**1**	**2**	**3**	**4**	**5**
GPS coordinates: Dmanisi	41.29471 Lat; 44.31426 Long				
Landscape type:	5				
Elevation, m a. s. l.:	1000				
Cardinal point exposure (°):	NE				
Slope angle/Inclination (°)	15-20				
Litter depth (cm):	6				
Litter mass (g dry weight/m^2)	829.92				
pH	5.9				
Surface cover (%):					
Bare soil	0	0	0	2	0
Stones	2	2	5	3	3
Litter	80	90	80	85	80
Dead wood	3	2	2	3	5
Cryptogams	5	2	8	1	2
Plants	10	4	5	7	5
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height (m):	26				
Carpinus caucasica	2				
Carpinus orientalis	1				
Fagus orientalis	++				
Acer laetum	++				
Acer campestre	++				
Quercus iberica	++				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height (m):	0.5			0.3	0.3
Swida australis	++			+	+
Cotinus coggygria	++			+	

Rubus sp.	+				+
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height (cm):	30	10	30	20	30
Calamagrostis arundinacea			++		
Carex divulsa	2				
Carex sylvatica			2	2	1
Carex vulpina		r			
Elymus spicatus	++			+	+
Fragaria vesca	++		+	+	+
Galium odoratum			+		
Sanicula europaea	+		+	+	
Urtica dioica	+				
Viola odorata	+	+	1	1	+

6.9 Khevi

In Khevi (Kazbegi region) three forest types were studied: subalpine birch forests (forests of Mt. Kuro, the Bashi ridge and the Lifu forest), including tiberline crook-stemmed birch forest, and pine forest.

Subalpine birch forests

6.9.1 Betuleta

One of the objects of our study was the subalpine birch forest in the Kazbegi region, the Central Great Caucasus. Birch forest is the most widespread forest type in the region and it grows in the montane forest (1000 – 1500 m a.s.l.), upper montane forest (1500 – 1700-1750 m a.s.l.), and subalpine (1700-1750 – 2450-2500 m a.s.l.) belts, on the north-facing slopes. Timberline passes at 2500 m a.s.l., where trees have crook-stemmed shape because of deep and long-lasting snow cover.

Mt. Kuro birch forest is spread throughout the upper belt of the mountain (above 1800 m). It is mainly represented on N and NW slopes of 25°. The forest is made up of by two species of birch: *Betula litwinowii* and *B. pendula*. There are three layers in the forest: the tree layer (8-10 m): *Betula litwinowii, Betula pendula*; the shrub layer (0.5-1.3 m): *Rubus idaeus, Vaccinium arctostaphylos, Rosa canina*; the herb layer (50-100 cm): *Festuca drymeja, Poa nemoralis, Heracleum asperum, Primula macrocalyx, Trollius ranunculinus, Lapsana communis, Alchemilla caucasica, Asperula odorata, Cirsium obvallatum, Campanula rapunculoides, Astrantia maxima, Athyrium filix-femina, Oxalis acetosella, Stachys sylvatica*. The floristic composition shows that the main components of the forest are species typical of subalpine forests. The stand is bi-dominant with trees of the same age group. The herb cover is represented by forbs, grasses and individual plants of tall herb communities.

The rhododendron birch forest of the Bashi Ridge is growing above 2200 m, on northwestern slopes of 22°. It is dominated by *Betula pendula* and *B. litwinowii* with admixture of *Sorbus caucasigena* and *Salix caprea*. There are three layers in the forest: the tree layer (10-12 m): *Betula pendula, Betula litwinowii, Sorbus caucasigena, Salix caprea*; the shrub layer (0.8-1.5 m): *Rhododendron caucasicum, Daphne glomerata, Vaccinium arctostaphylos, Rubus idaeus, Vaccinium vitis-idaea*; the herb layer (50-100 cm): *Festuca drymeja,*

Anthriscus nemorosa, Trifolium alpestre, Oxalis acetosella, Calamagrostis arundinacea, Cirsium obvallatum, Carex sylvatica, Senecio taraxacifolius, Pyrola minor, Chamaenerion angustifolium, Alchemilla caucasica, Ranunculus caucasicus. Most of the plants are species typical of subalpine forests. *Rhododendron caucasicum* dominates the undergrowth (60-75%). The herbaceous cover is represented by forbs and elements of subalpine tall heb communities.

Liphu forest grows above 2100 m on northern slopes of 27°. It is dominated by *Betula litwinowii* mixed with *Sorbus caucasigena* and *Salix caprea*. There are the following three layers in the forest: the tree layer (8-12 m): *Betula litwinowii, Sorbus caucasigena, Salix caprea*; the shrub layer (2-3 m): *Rubus saxatilis, Vaccinium myrtillus, Viburnum orientale*; the herb layer (140-180 cm): *Calamagrostis arundinacea, Ranunculus caucasicus, Fragaria vesca, Lapsana grandiflora, Asyneuma campanuloides, Senecio caucasigena, Betonica officinalis, Swertia iberica, Polygonatum verticillatum, Oxalis acetosella, Veratrum lobelianum, Alchemilla valdehirsuta, Viola odorata, Vicia crocea, Cephalaria gigantea, Paris quadrifolia, Sedum oppositifolium, Anemonastrum fasciculatum*. This is a monodominant forest of *Betula litwinowii* with admixture *Sorbus caucasigena*, *Salix caprea*, and in small number of endemic *Betula raddeana*. The herb cover is diverse with grasses and elements of subalpine tall herb communities.

Table 1. *Relevés of Betuleta*

Study region:	**Kazbegi, Kuro slope**					**Kazbegi, Liphu forest**					**Kazbegi, Bashi gorge**				
Releve No. 1	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
GPS coordinates:	42.643008 Lat; 44.643932 Long					42.6547 Lat; 4723907 Long					42.66055 Lat; 44.61265 Long				
Landscape type:	5					5					5				
Elevation, m a.s.l.:	1800					2100					2200				
Cardinal point exposure,°:	N					N					NW				
Slope angle/Inclination,°:	25					22					27				
Litter depth, cm:	5					4					5				
Litter mass (g dry weight/m^2)	1026.4					1677.76					452.8				
pH	5.7					5.8					5.4				
Surface cover, %:															
Bare soil	23	10	7	15	15	10	12	25	10	10	15	10	10	5	8
Stones	10	40	15	15	15	5	12	10	8	5	5	0	5	5	2
Litter	20	20	10	20	20	10	8	10	15	10	13	15	15	20	10
Dead wood	15	10	15	10	10	5	20	5	5	5	7	10	10	5	10
Cryptogams	2	5	3	5	5	10	18	8	7	10	10	5	5	5	5
Plants	30	15	50	35	35	60	40	42	55	60	50	60	55	60	65
Trees per 400 m^2 plot (20 X 20 m)															

Tree canopy height, m:	10					12				12					
Betula pendula	4	4	4	4	4						3	3	3	3	3
Betula litwinowii	2	2	2	2	2	4	4	4	4	4	2	2	2	2	2
Betula raddeana	++		++			++		+			+				++
Sorbus caucasigena				++		2	2	2	2	2	1	1	1	1	1
Salix caprea		++				1	1	1	1	1	+	+	+	+	+
Shrubs & lianas per 25 m^2 plot															
Shrub canopy height, m:	1.5	1.5	1.0	1.0	1.5	3.0	1.5	2.0	2.0	2.0	0.9	0.8	1.0	1.5	1.1
Rubus idaeus	3	1	2	3	3						1	1	+		1
Rosa canina		R													
Vaccinium arctostaphylos		R								+	+	+	+	+	+
Rubus saxatilis						1	1	1	+	1					
Viburnum orientale						+	+								
Rhododendron caucasicum									++		3	4	4	4	4
Daphne glomerata							+		+		++	++	+	++	
Vaccinium vitis-idaea											++			++	++
Lonicera caucasica														R	
Salix kazbekensis			++				+								
Empetrum nigrum									++						
Vaccinium myrtillus								++							
Herbaceous plants 25 m^2 (5 X 5 m)															
Grass canopy height, cm:	60	95	80	90	70	95	150	140	150	150	90	80	150	140	110
Festuca drymeja	1			+	1							+			+
Poa nemoralis	1	1	2	1	1									+	
Heracleum asperum	++	+	1	++	+										
Primula macrocalyx	++	+		++	++		+			+					
Trollius patulus	1														
Lapsana communis	R	1	1	R			+								
Alchemilla caucasica	+		R	1							1	+	1		1
Galium odoratum	+			+			+			+					
Galium palustre	R			R	+										
Cirsium obvallatum	+	R			+		+		+	+		R		R	
Campanula rapunculoides	+			+	+										

Thalictrum foetidum	R	+			R										
Galium verum		++													
Athyrium filix-femina		R		R											
Leontodon hispidus		+													
Geranium robertianum			1												
Astrantia maxima			+	1	+										
Oxalis acetosella				+	+				2	3	1	1	+		
Calamagrostis arundinacea						2	1	+			1	+	1	1	1
Fragaria vesca						R									
Asyneuma campanuloides						+									
Senecio caucasigena						+							R		
Betonica officinalis						1	+	+	1						
Swertia iberica						+	R	+	+	+					
Polygonatum verticillatum						+									
Heracleum leskovii						+									
Aconitum nasutum						1	1	2	+	+					
Pimpinella rhodantha						+				+					
Rumex acetosella						+				+					
Veratrum lobelianum						+			+						
Alchemilla valdehirsuta						+	2	1	+						
Viola odorata						R			+						
Vicia crocea						+		+	1	+					
Cephalaria gigantea						+				+					
Poa longifolia							+		1						
Geranium sylvaticum							1								
Sedum oppositifolium							+	+	+					R	
Poligonatum verticillatum							1								
Campanula oblongifolia							+								
Solidago virgaurea							+	+	+						
Aconitum orientale								+							
Cruciata glabra									+						
Campanula trautvetteri									+	+					
Ranunculus caucasicus									+	+	+		+		+

Lapsana grandiflora									+	+					
Myosotis sylvatica									+						
Aruncus sylvestris										1					
Aquilegia caucasica										+					
Urtica dioica										+					
Dryopteris oreades											+		+		+
Geranium columbinum											+		+		+
Anthoxanthum odoratum											+				
Valeriana alliariifolia											+		+		
Trifolium alpestre											1	1	+	1	1
Carex sylvatica												+			+
Anthriscus nemorosa												+	+	1	
Senecio taraxacifolius												R	R		
Pyrola minor												+		+	
Chamerion angustifolium												+		+	
Avenella flexuosa													+		
Cyclamen vernum														+	

6.9.2 Betuletum (Timberline)

Timberline vegetation of the subalpine belt includes crook-stemmed birch forest, subalpine tall herb communities, prostrate evergreen scrub and elements of alpine turf meadows. Open birch forest dominated by *Betula litwinowii* was studied at the timberline (2500 m a.s.l.), on the N slope of 20-30°. In the timberline forest, four layers are distinguished: the tree layer (2.5-3.5 m) of *Betula litwinowii*, *Sorbus caucasigena, Salix caprea*; the shrub layer (0.7-1.0 m) of *Rhododendron caucasicum, Vaccinium myrtillus, Empetrum nigrum, Salix kazbekensis*; the herb layer (40-70 cm) of *Deschampsia flexuosa, Festuca supina, Senecio taraxacifolius, Gymnadenia conopsea, Betonica macrantha, Oxalis acetosella, Gentiana cruciata, Chamaenerion angustifolium, Senecio taraxacifolius, Poa pratensis*. The crook-stemmed birch forest undergrowth is dominated by *Rhododendron caucasicum* and *Vaccinium myrtillus*. Birch regeneration and survival of juvenile plants largely depends on *Rhododendron caucasicum*, which creates favorable conditions (temperature and light) for germination of birch trees, which is a clear example of a positive relationship (facilitation) between birch and rhododendron (Akhalkatsi et al., 2006; Hughes et al., 2009). The species diversity of the herb cover is low, because of strong shading and soil acidification.

Table 2. *Relevés of Betuletum (Timberline)*

Releve No. 2	**16**	**17**	**18**	**19**	**20**
GPS coordinates:	42.667110 Lat; 44.497216 Long				
Landscape type:	5				
Elevation, m a.s.l.:	2500				
Cardinal point exposure,°:	N				

Slope angle/Inclination,°:	22				
Litter depth, cm:	5				
Litter mass (g dry weight/m^2)	783.04				
pH	5.95				
Surface cover, %:					
Bare soil	30	25	5	8	15
Stones	5	2	1	3	3
Litter	20	20	15	17	20
Dead wood	8	6	1	5	4
Cryptogams	7	5	2	6	5
Plants	55	42	75	58	50
Trees per 400 m2 plot (20 X 20 m)					
Tree canopy height, m:	3				
Betula litwinowii	3				
Betula raddeana	R				
Sorbus caucasigena	1				
Salix caprea	+				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	0.8	1.0	1.0	1.0	0.8
Vaccinium arctostaphylos		+			
Rubus saxatilis			+		
Rhododendron caucasicum	3	4	3	4	2
Daphne glomerata			+		
Salix kazbekensis	1	1	1	1	
Empetrum nigrum	+	+	1	1	1
Vaccinium myrtillus	2	1	2	2	2
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	50	50	60	40	70
Alchemilla caucasica				+	
Calamagrostis arundinacea	+			1	
Senecio caucasigena	+		+		
Veratrum lobelianum			+		
Viola odorata				+	
Senecio taraxacifolius					+
Pyrola minor					
Chamerion angustifolium	+	1	+	+	+
Avenella flexuosa	+	1	1	1	
Poa pratensis	1	+			
Luzula spicata		+	+		
Festuca supina		+			+
Pyrola rotundifolia				+	

Gymnadenia conopsea				+	+
Gentiana cruciata					+
Betonica macrantha					+

Pine forest

6.9.3 Pinetum oreadosum

6.9.4 Pinetum

Pine forest was studied on the northern macroslope of the Central Great Caucasus. Two variants were studied: a pine forest in the Khde gorge on rocky but relatively soft terrain with fern undergrowth and a pine forest on a very steep slope rocky at the confluence of the Daryali and Khde gorges.

The first variant was studied in Dariali canyon at 1560 m a.s.l. on a SE slope of 30°. The vertical stratigraphy of a forest is as follows: the ground is covered with litter and deadwood. The deadwood cover is small (5-10%), while the litter cover is high on average (27%) but uneven ranging from 8% to 48%. Stones also have a significant ratio in the ground cover (8-20%). Plant cover is quite low and uneven (10-42%). As expected, large number of shrubs are present including junipers characteristic of arid habitats (*Juniperus communis* and *J. foetidissima*). The tree abundance is low and only pine has relatively large cover. The forest layers are distinguished as follows: the tree layer (8-18 m): *Pinus sylvestris* var*. hamata, Betula pendula, Carpinus betulus, Quercus iberica, Sorbus caucasigena, Acer pseudoplatanus*; the shrub layer (2-3 m): *Juniperus* spp*., Rosa canina, Rubus idaeus, Berberis vulgaris*; the herb layer (0.5-1.5 m): *Festuca drymeja, Calamagrostis arundinacea, Dryopteris oreades, Geranium sylvaticum.*

The second gigantic pine forest ecosystem is developed on inaccessible, almost vertical basalt cliffs in the Daryali gorge. Despite the high level of knowledge of the flora and vegetation of the Kazbegi region, this forest was completely unexplored and the first survey was conducted in 2019. The study site is located on the right bank of the river Tergi, at 1400 m a.s.l., on a NW slope of of 75°. The litter depth is only 2 cm. The ground cover is quite high but uneven (57-85%) as well as that of the plant cover (20-68%). Of the trees *Pinus sylvestris* var. *hamata* predominates, followed by typical forest components: *Betula pendula, Sorbus caucasigena, Carpinus caucasica, Quercus iberica, Acer platanoides*. Of the shrubs, oroxerophytes deserve attention such as species of *Juniperus, Spiraea hypericifolia*. The herb cover include typical representatives of subalpine forests and forest edges: *Geranium sylvaticum, Betonica macrantha, Poa nemoralis, Valeriana officinalis, Thalictrum foetidum*.

Table 3 and 4. *Relevés of Pinetum oreadosum and Pinetum (Rock pine forest)*

Forest type	**Pinetum oreadosum**					**Pinetum on rocks**				
Study region:	**Kazbegi, Khde gorge**					**Kazbegi, Dariali gorge**				
Releve No. 3 & 4	1	2	3	4	5	1	2	3	4	5
GPS coordinates:	42.736339 Lat; 44.640661 Long					42,736361 Lat; 44,639268 Long				
Landscape type:	5					8				
Elevation, m a.s.l.:	1560					1400				
Cardinal point exposure,°:	SE (154)					NW (310)				
Slope angle/Inclination,°:	30					75				

Litter depth, cm:	10					2				
Litter mass (g dry weight/m^2)	3714.08					1156.48				
pH	7.4					7.2				
Surface cover, %:										
Bare soil	2	2	7	2	6	3	5	5	2	10
Stones	16	20	8	20	15	40	15	10	20	25
Litter	16	48	35	30	8	12	30	30	5	25
Dead wood	10	10	5	5	10	5	12	10	2	10
Cryptogams	10	10	3	3	6	10	7	5	3	5
Plants	42	10	34	18	34	30	31	40	68	20
Trees per 400 m^2 plot (20 X 20 m)										
Tree canopy height, m:	11	8	10	12	13	7	6.5	8	7.5	6.8
Pinus sylvestris var. *hamata*	5	5	5	5	5	4	4	4	4	4
Carpinus caucasica	1	1	1	1	1		R	R	R	R
Quercus iberica	3	R	R	R	R	R	R	R	R	R
Acer pseudoplatanus						R	R	R	R	R
Sorbus caucasigena	1	1	1	1	1	++	++	++	++	++
Betula litwinowii						+	+	+	+	+
Betula pendula						3	3	3	3	3
Shrubs & lianas per 25 m^2 plot										
Shrub canopy height, m:	3	2	3	3	3.5	3	2.5	1.0	1.5	1.2
Lonicera caucasica										+
Juniperus communis	+	1	1	2	1	+	+	1	3	1
Juniperus foetidissima			+	2		+	+			
Rosa canina	1			1	+	+	+			1
Rubus caucasicus								+		+
Rubus idaeus	+	+	+	1						
Spiraea hypericifolia		1		+	1	+	+		1	1
Ribes biebersteinii				+	R	+	+			
Berberis vulgaris		+								1
Daphne glomerata									1	
Dryas caucasica									1	
Salix kazbekensis									+	
Herbaceous plants 25 m^2 (5 X 5 m)										
Grass canopy height, cm:	70	50	50	100	50	50	160	150	130	70
Aconitum nasutum							1			
Alchemilla caucasica									+	
Allium saxatile										+
Allium victorialis	1	1	1	1	1					

Anemone fasciculata									+	
Anemone caucasica									+	
Artemisia vulgaris						+			+	
Aruncus vulgaris		+								
Asplenium septentrionale	+			+						
Asplenium trichomanes	+									
Aster alpinus										+
Aster amelloides			+							
Betonica macrantha									++	
Polygonum carneum									2	
Calamagrostis arundinacea	1			1	+	+		+	2	
Campanula collina									+	
Campanula hohenackeri			+		R					
Campanula latifolia						+			2	
Carex tristis									1	
Carex sylvatica	+	+								
Carum caucasicum									1	
Chamerion angustifolium		+		+	R					
Cirsium obvallatum							R		+	
Cryptogramma crispa					+					
Dryopteris oreades	3		+	3	2	+		+		+
Festuca drymeja	1	2	+	2	2					+
Festuca supina						+				
Festuca varia						1				
Festuca varia subsp. woronowii							1		4	
Fragaria vesca	1	1			+				+	
Galium album						+	1	1	+	+
Asperula odorata	+	+								
Geranium columbinum			+	+						
Geranium robertianum	1			+		+				
Geranium sylvaticum		+		+			+	+	+	
Hypericum perforatum	+			+		+				
Lactuca seriola	+									
Lapsana grandiflora						+				
Leontodon hispidus									++	
Minuartia circassica						+	+			
Orobanche alba					R					
Orobanche lutea							R			
Oxalis acetosella						+				

Phleum pratense									+	
Platanthera chlorantha		+								
Poa longifolia				1						
Poa nemoralis		+	+		1	1	3	4	1	+
Polygonatum glaberrimum				+	3					
Polygonatum orientale	R		+							
Polypodium vulgare				+	1	+				
Primula amoena									+	
Salvia glutinosa		+		+	+					
Saxifraga juniperifolia									+	
Saxifraga kolenatiana						+				
Sedum caucasicum							R			
Sedum oppositifolium	+	+		+			1	+	+	
Senecio sosnovskyi		+		+						
Teucrium nuchense	+	+	+							
Thalictrum buschianum	+									
Thalictrum foetidum						+	+	1	+	+
Thymus collinus						+				
Trifolium alpestre									+	
Valeriana alliariifolia	+									
Valeriana officinalis							2	2	+	
Vicia alpestris									+	
Vicia angustifolia							+	+		
Vicia crocea		+								
Vicia grossheimii						+				
Vinca herbacea		+		+						
Viola odorata		+		+						

6.10 Kakheti

Six forest types were studied in Kakheti: riparian forests (of poplar and pterocarya), hornbeam forest, zelkova forest, pine forest, beech forest, arid open forest (of junipers and pistachio-tree).

Riparian forest

6.10.1 Populetum

Iori floodplain forests were explored in Kiziki, in Chachuna Habitat Management Area in Dedoplistskaro municipality, adjacent to the tiver Iori. The study site is located at 250 m a. s. l. on SW gentle slope of 5-7° with shallow litter covering 10 to 45% of the ground surface. Plant cover ranges from 25 to 53%. Tree height reaches 28 m. The forest has the following layers: trees (20-28 m): *Populus canescens, P. hybrida, Quercus pedunculiflora, Salix alba, Ulmus minor, Morus alba.* In the area the river Iori flows through the zone of semi-

desert and arid open forest, for which reason on the third terrace of the river *Pistacia mutica* is recorded. The second layer of shrubs (6-7 m) contains: *Elaeagnus angustifolia, Rubus caucasicus, Tamarix ramosissima, Smilax excelsa, Vitis vinifera* subsp*. sylvestris, Ligustrum vulgare, Periploca graeca.* The third layer of herbs (70-380 cm) is composed of *Arundo donax, Asparagus verticillatus, Dactylis glomerata, Glycyrrhiza glabra, Rubia tinctorum. Arundo donax* is noteworthy with its height reaching 4 m.

Table 1. *Relevés of Populetum*

Releve No. 1	**1**	**2**	**3**	**4**	**5**
GPS coordinates: Dedofliswyaro	41.232435 Lat; 45.938116 Long				
Landscape type:	1				
Elevation, m a.s.l.:	250				
Cardinal point exposure,°:	SW (210)				
Slope angle/Inclination,°:	7				
Litter depth, cm:	4				
Litter mass (g dry weight/m^2)	1191.04				
pH	7.2				
Surface cover, %:					
Bare soil	15	30	15	20	5
Stones	0	0	0	0	0
Litter	30	10	30	40	45
Dead wood	2	10	2	15	20
Cryptogams	0	0	0	0	0
Plants	53	50	53	25	30
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	28				
Morus alba	+				
Pistacia mutica	R				
Populus canescens	2				
Prunus cerasifera	R				
Quercus pedunculiflora	+				
Salix alba	R				
Ulmus minor	1				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	6.0	7.0	6.0	8.0	6.0
Amorpha fruticosa				+	
Berberis vulgaris	R			R	R
Clematis vitalba	+		1.0	+	
Crataegus kyrtostyla	1		1	R	
Elaeagnus angustifolia	1	1			+

Ligustrum vulgare		+			1.0
Paliurus spina-christi	1				
Periploca graeca		+	+		+
Rosa canina	2				
Rubus caucasicus	2	3	3		2
Smilax excelsa	+	1			+
Tamarix ramosissima	R	2	2	R	
Vitis sylvestris	+			R	
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	90	250	250	380	70
Anchusa azurea			R		
Arundo donax	1			3	1
Asparagus verticillatus	R	+	+	R	
Dactylis glomerata	2	R	1		1
Euphorbia seguieriana		+	1		
Festuca rupicola	R			+	
Glycyrrhiza glabra		1	3		3
Lactuca serriola				R	
Rubia tinctorum	+	1		R	
Trifolium arvense		R	R	R	
Vicia angustifolia		3			

6.10.2 Pterocaryetum

Relatively large stands of Pterocaryeta, separated by a considerable distance from each other, can be found in the South Caucasus: on the Colchis lowland in the western part and on the Alazani valley in the eastern part. In Colchic part of their distribution range the climate is humid subtropical, and and in the eastrern part the climate is moderately humid subtropical with dry winter (Sakhokia, 1980). These forests are dominated by Colchic-Hyrkanian species such as *Alnus barbata* and *Pterocarya pterocarpa*.

The forest community was studied in one of the gorges in Lagodekhi National Park. The forest stand is worth considering as a natural monument. It occurs as at 620 m a. s. l. on SE slope of 5-10°. The forest grows along stony riverbank with numerous large boulders. Stone and bare soil cover is considerable, 5-20% and 25-30%, respectively. Pterocarya tree height reaches 35 m. Almost pure stand of *Pterocarya pterocarpa* occupies the first river terrace and 3-5 m away from the river the species is substituted by other deciduous tree species: *Alnus barbata, Quercus pedunculiflora, Carpinus caucasica, Cerasus silvestris, Acer pseudoplatanus.* In the woody undergrowth *Corylus avellana, Sambucus nigra* are common, and the herb cover is mainly composed of *Poa nemoralis, Fragaria vesca, Viola odorata. Hedera pastuchovii* is noteworthy of the lianas.

Table 2. *Relevés of Pterocaryetum*

Releve No. 2	**1**	**2**	**3**	**4**	**5**
GPS coordinates: Lagodekhi	41.87522 Lat; 46.23972 Long				
Landscape type:	2				
Elevation, m a.s.l.:	620				
Cardinal point exposure,°:	SE (120)				
Slope angle/Inclination,°:	6				
Litter depth, cm:	10				
Surface cover, %:	60				
Litter mass (g dry weight/m2)	1466.72				
pH	7.6				
Surface cover, %:					
Bare soil	30	30	30	25	28
Stones	20	10	12	12	5
Litter	20	30	15	12	51
Dead wood	5	5	8	5	10
Cryptogams	10	10	7	7	10
Plants	15	13	12	13	19
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	35				
Pterocarya pterocarpa	4				
Carpinus betulus	2				
Acer pseudoplatanus	1				
Cerasus silvestris	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	3.0	3.0	3.0	3.0	3.0
Corylus avellana	+	+	+	+	+
Sambucus nigra	+	+	+	+	+
Lonicera iberica	+	+	+	+	+
Rubus caucasicus	++	++	++	++	++
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	60	60	60	50	60
Poa nemoralis	+	1	+		++
Dryopteris filix-mas	+			+	+
Viola odorata	R		R	+	+
Asperula odorata		++	R	+	+
Fragaria vesca		+			+

Hornbeam forest

6.10.3 Carpinetum

Hornbeam forest was studied in the Lagodekhi National Park, at 610 m a.s.l., on a SE gentle slope (11°). The litter depth ranges from 3-7 cm, and its cover from 10-20%. Deadwood cover is 5-15% and plant cover 30-70%. Terricolous cryptogam cover does not exceed 5% and therefore cannot be considered as a characteristic independent layer. The first layer (9-12 m) consists of *Carpinus caucasica, Fagus orientalis* and *Acer campestre*; the second layer (<0.8 m) of *Hedera helix, Rubus canescens*; the third layer (85-150 cm) of *Festuca drymeja, Asperula odorata, Poa nemoralis*.

Table 3. *Relevés of Carpinetum*

Releve No. 3	**1**	**2**	**3**	**4**	**5**
GPS coordinates: Matsimi gorge, Lagodekhi	41.81583 Lat; 46.34018 Long				
Landscape type:	3				
Elevation, m a.s.l.:	610				
Cardinal point exposure,°	SE				
Slope angle/Inclination,°	11				
Litter depth, cm:	3-7				
Litter mass (g dry weight/m^2)	4110.4				
pH	6.7				
Surface cover, %:					
Bare soil	23	22	5	5	2
Stones	10	8	5	0	0
Litter	20	20	10	15	15
Dead wood	15	12	10	5	10
Cryptogams	2	5	5	5	3
Plants	30	33	65	70	70
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	12				
Carpinus betulus	4				
Acer campestre	1				
Fagus orientalis	1				
Mespilus germanica	1				
Cerasus silvestris	R				
Tilia begoniifolia	1				
Acer pseudoplatanus	R				
Fraxinus excelsior	+				
Diospyros lotus	R				
Populus canescens	R				

Releve No. 3	**1**	**2**	**3**	**4**	**5**
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	0.00	0.80	0.75	0.00	0.70
Hedera helix	3	3	3	3	3
Rubus canescens		2	2		1
Smilax excelsa					1
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	150	100	110	85	100
Asperula odorata		1	1	1	1
Athyrium filix-femina		+	+		
Euphorbia macroceras	+	+	+	1	
Festuca drymeja	3	3	2	2	2
Galega orientalis	2	1			
Lapsana communis	+	+			
Orobanche alba	+		+	+	+
Poa nemoralis		1	1	2	1
Primula macrocalyx	1	+	+		+
Primula woronowii			+		+
Ranunculus muricatus			+	+	+
Rumex acetosella			+		+
Viola alba		+	+	+	+
Digitalis ferruginea					+

Zelkova forest

6.10.4 Zelkovetum

Zelkoveta, a xerothermic relict forest of the Tertiary, was studied in Babaneuri Nature Reserve at 445 m a. s. l. on SW slope of 20°. The forest has the following layers: trees (25-32 m): *Zelkova carpinifolia, Quercus iberica, Carpinus caucasica*; the second layer of shrubs (0.5-2.0 m): *Carpinus orientalis, Crataegus pentagyna, Lygustrum vulgare, Lonicera iberica, Ruscus ponticus*; the third layer of herbs (20-60 m) is made up of *Helleborus caucasicus, Primula* spp., *Viola odorata, Festuca drymeja, F. ovina, Brachypodium sylvaticum*, etc.

Zelkova carpinifolia, unlike all other relicts of the Tertiary period, has a more xerothermic character. *Quercus iberica*, the companion tree species, shrubs *Carpinus orientalis, Crataegus pentagyna, Lonicera iberica*, and herbs: *Festuca ovina, Brachypodium sylvaticum* are also by xero- and xeromesophilic species. In more general view, in the foothills of the South Caucasus and partly in the lower montane belt, zelkova makes up mixed forest with oaks (*Quercus iberica, Q. imeretina, Q. hartwissiana*).

Table 4. *Relevés of Zelkovetum*

Releve No. 4	1	2	3	4	5
GPS coordinates:	42.07805 Lat; 45.38416 Long				
Landscape type:	5				
Elevation, m a.s.l.:	445				
Cardinal point exposure,°:	SW (211)				
Slope angle/Inclination,°:	20				
Litter depth, cm:	3				
Litter mass (g dry weight/m^2)	979.36				
pH	6.8				
Surface cover, %:					
Bare soil	8	6	7	5	6
Stones	1	1	7	5	4
Litter	70	68	43	45	50
Dead wood	2	4	3	5	5
Cryptogams	1	1	5	3	3
Plants	18	20	28	32	28
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	27				
Zelkova carpinifolia	4				
Carpinus orientalis	2				
Quercus iberica	+				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	0.5	2.0	_	4.0	2.0
Crataegus pentagyna	1				
Ruscus ponticus		+			
Hedera helix		1		+	
Lonicera iberica				+	
Ligustrum vulgare				1	+
Herbaceous plants 25 m^2 (5 X 5 m)	22	45	55	40	35
Grass canopy height, cm:					
Brachypodium sylvaticum				1	
Carex sylvatica	1		2	1	+
Cyclamen coum		+			
Avenella flexuosa		1	2		
Festuca drymeja	1	1		1	1
Festuca ovina	2	1			
Geum urbanum		+			

Helleborus caucasicus	+				
Poa nemoralis		+			
Viola odorata	1	1			+

Pine forest

6.10.5 Pinetum

Pine forest was studied in Mariamjvari Nature Reserve, Sagaredjo, on the 40th km from Tbilisi along the Kakheti highway. The described forest grows at about 1140 m a. s. l. on S to SW slope of about 5° with stony substrate developed on alluvial deposits. The gound cover is mostly made up of litter but because of surface microtopography and position of deciduous and coniferous trees, it is unevenly distributed on the area (10-75%). Litter depth is also considerable (12 cm). The big amount and uneven distribution of the litter is the reson for the uneven pattern of the herbaceous cover (5-80%).

Pine is dominant tree and is accompanied by *Fagus orientalis, Carpinus caucasica, Quercus iberica, Sorbus torminalis, Carpinus orientalis, Acer laetum*. Layers are not readily distinguishable. The following shrubs (0.5–2 m) are present in highest abundance: *Cotynus coggygria, Lonicera caucasica.* Herb layer also consists of a few species: *Festuca gigantea, Lathyrus roseus, Polygonatum verticillatum*. All the species are typical forest plants.

Table 5. *Relevés of Pinetum*

Releve No. 5	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.759575 Lat; 45.373023 Long				
Landscape type:	5				
Elevation, m a.s.l.:	1130				
Cardinal point exposure,°:	SW				
Slope angle/Inclination,°:	4				
Litter depth, cm:	12				
Litter mass (g dry weight/m^2)	4732.16				
pH	7.7				
Surface cover, %:					
Bare soil	5	5	1	2	1
Stones	3	3	1	5	2
Litter	70	70	75	30	10
Dead wood	8	8	2	4	5
Cryptogams	9	9	2	2	1
Plants	5	5	20	57	80
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	17				
Pinus sylvestris var. *hamata*	3				
Carpinus caucasica	1				

Carpinus orientalis	2				
Fagus orientalis	2				
Quercus iberica	+				
Acer laetum	1				
Sorbus torminalis	1				
Shrubs & lianas per 25 m2 plot					
Shrub canopy height, m:	1.50	2.00	2.00	0.50	2.00
Cotinus coggygria	3	1	3	2	2
Pyracantha coccinea	1	+			
Cornus mas	+		+		
Lonicera caucasica	1	1	2	+	
Rosa sp.		R			
Rubia tinctorum	2				
Vitis vinifera	R				
Herbaceous plants 25 m2 (5 X 5 m)					
Grass canopy height, cm:	30	150	110	110	100 (30)
Festuca gigantea	2	2	2	2	5
Lathyrus roseus			2	1	2
Laser trilobum					2
Polygonatum verticillatum					1

Beech forest

6.10.6. Fagetum nudum

Fageta nuda, i.e. beech forests lacking shrub and herb layers occur only on the slopes of the Great Caucasus in Georgia from 500(600) to 1200(1400) m a.s.l. in conditions with annual precipitation above 800 mm.

We have studied these forests in Lagodekhi State Reserve, within 840-860 m on northwestern slopes of 12-28° with litter cover 75-90% and its depth 3.5-5 cm. The plant cover is only 2-5%, although it is almost completely made up of young and mature individuals of *Fagus orientalis*. Dwarfish individual trees of *Acer laetum* and *Tilia begoniifolia*, shrub *Rubus hirtus* and grass *Festuca drymeja* are recorded. The phenomenon of Fageta nuda in not yet well studied.

Table 6. *Relevés of Fagetum nudum*

Releve No. 6	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.83081 Lat; 46.322534 Long				
Landscape type:	5				
Elevation, m a.s.l.:	839				
Cardinal point exposure,°:	NW				
Slope angle/Inclination,°:	20				

Litter depth, cm:	5				
Litter mass (g dry weight/m^2)	4286.6				
pH	7.83				
Surface cover, %:					
Bare soil	7	2	2	5	5
Stones	7	4	4	3	1
Litter	75	90	90	85	85
Dead wood	6	1	1	5	7
Cryptogams	0	0	0	0	0
Plants	5	3	3	2	2
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	28				
Fagus orientalis	5				
Acer laetum	R				
Tilia begoniifolia	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	0.2				
Rubus hirtus	1	R	+		
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:				30	
Festuca drymeja				R	

6.10.7 Fagetum festucosum

Fageta festucosa, beech forest with *Festuca drymeja*, is a widespread community found almost all over Georgia. In Lagodekhi National Park, we studied Fageta festucosa at 655 m a.s.l., on S slopes of 15° with litter depth of 6 cm and its cover 10-15%,the deadwood cover 10%, and cryptogam cover 5%. The forest layer structure is quite complex represented by four layers: the first layer of tall trees (25-35 m) is made up of *Fagus orientalis, Tilia begoniifolia, Carpinus caucasica, Cerasus silvestris*; the second layer of small trees (10-15 m) of *Quercus iberica, Acer campestre, A. laetum, Sorbus torminalis*; the third layer of shrubs (0.5-4 m): *Mespilus germanica, Rubus hirtus, Lonicera caucasica, Rhododendron luteum*; the fourth layer of herbs (100-130 cm): *Festuca drymeja, Galega orientalis, Primula macrocalyx, P. woronowii, Asperula odorata, Aquilegia olympica, Athyrium filix-femina, Geranium robertianum, Euphorbia macroceras.* All the herbaceous plants except for the dominant *Festuca drymeja* are present in low abundance.

Table 7. *Relevés of Fagetum festucosum*

Releve No. 7	**1**	**2**	**3**	**4**	**5**
GPS coordinates:	41.85019 Lat; 46.264845 Long				
Landscape type:	4				
Elevation, m a.s.l.:	655				

Cardinal point exposure,°:	S				
Slope angle/Inclination,°:	15				
Litter depth, cm:	6				
Litter mass (g dry weight)	6134.08				
pH	6.15				
Surface cover, %:					
Bare soil	0	5	10	5	5
Stones	0	15	0	0	0
Litter	10	15	10	10	15
Dead wood	10	10	10	10	10
Cryptogams	5	5	5	5	5
Plants	75	70	65	70	70
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	35				
Fagus orientalis	4				
Acer campestre	R				
Carpinus caucasica	R				
Cerasus silvestris	+				
Mespilus germanica	+				
Quercus iberica	+				
Sorbus torminalis	+				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	0.5	4	2	1	1
Hedera helix	1	1	1	1	1
Rubus canescens	1	1	1	1	1
Lonicera caprifolium		1			x
Rhododendron luteum			1		
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	130	100	120	130	100
Aquilegia caucasica			+	+	
Asperula odorata					+
Athyrium filix-femina	R		R	R	R
Dianthus armeria		R			
Euphorbia macroceras					1
Festuca drymeja	5	5	5	5	5
Galega orientalis		+			1
Geranium pyrenaicum		+			
Geranium robertianum			+		
Juncus effusus			+	+	

Lapsana communis	+		+	+	+
Primula macrocalyx	+	+		+	+
Viola alba			+		

6.10.8 Carpineto-Fagetum rubosum

Carpineto-Fageta rubosa is one of the noteworthy natural forest communities. It consists of the following trees: *Fagus orientalis, Carpinus caucasica, Acer laetum, Tilia begoniifolia, Cerasus silvestris,* shrubs: *Rubus caucasicus*, *Corylus avellana, Staphylea pinnata.* The herb cover in the dense forest is poor. The major portion on the ground surface is covered wih litter. The layer structure is as follows: big trees (30-35 m): *Fagus orientalis, Carpinus caucasica, Tilia begoniifolia*; small trees (18-20 m): *Acer laetum*; shrubs (2-3 m): *Rubus caucasicus*, *Corylus avellana, Staphylea pinnata*; herbs (25-50 cm) including herbs: *Athyrium filix-femina, Dryopteris filix-mas, Phyllits scolopendrium.*

Table 8. *Relevés of Carpineto-Fagetum rubosum*

Releve No. 8	1	2	3	4	5
GPS coordinates:	41.81497 Lat; 46.34041 Long				
Landscape type:	4				
Elevation, m a.s.l.:	610				
Cardinal point exposure,°:	SW (220)				
Slope angle/Inclination,°:	4				
Litter depth, cm:	9				
Litter mass (g dry weight/m^2)	1666.4				
pH	5.86				
Surface cover, %:					
Bare soil	5	3	5	5	6
Stones	7	1	1	3	5
Litter	63	74	70	66	57
Dead wood	5	5	7	6	7
Cryptogams	5	2	2	4	7
Plants	15	15	15	16	16
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	35				
Fagus orientalis	5				
Acer laetum	3				
Carpinus caucasica	4				
Cerasus silvestris	+				
Tilia begoniifolia	1				
Shrubs & lianas per 25 m^2 plot					

Shrub canopy height, m:	3.0	2.0	3.0	3.0	2.0
Corylus avellana	3	3	3	3	3
Rubus caucasicus	5	5	5	5	5
Staphylea pinnata	+	+	+	+	+
Herbaceous plants 25 m2 (5 X 5 m)					
Grass canopy height, cm:	45	45	25	40	50
Athyrium filix-femina				1	+
Corallorhiza trifida				+	
Orobanche cumana			1	+	
Phyllitis scolopendrium	+	+		+	
Pyrola rotundifolia	+	+	+		
Viola odorata				+	

Open arid forest

6.10.9 Juniperetum

Junipereta, a type of arid open forest, was stidued in the Vashlovani Protected Areas, at 500 m a. s. l. on a SW slope of 12°. The forest has open canopy. As expected, litter is shallow (2 cm) in the semi-arid community. Ration of the bare ground in the ground cover is remarkable (10-30%) as well as abundance of terricolous cryptogams. Juniper height does not exceed 5-6 m and that of the shrubs 3 m. The tallest is *Pistacia mutica* (6-7 m). Of junipers *Juniperus foetidissima* is the most and *J. oxycedrus* is the least abundant, while *J. polycarpos* is the tallest of the juniper species present. The following shrubs are also recorded: *Carpinus orientalis, Cottinus coggygria, Jasminum fruticans, Ephedra procera, E. distachya*. Presence of 47 species in the herb layer is noteworthy as well. All the species are typical of arid and semi-arid habitats. This vegetation borders such of semi-arid and arid vegetation types as desert, semi-desert, steppe, riparian forests, xerophilous scrub. Despite such intersections, there are almost no plants not typical for this community in the studied stand.

Table 9. *Relevés of Juniperetum*

Releve No. 9	1	2	3	4	5
GPS coordinates:	41.212992 Lat; 46.439233 Long				
Landscape type:	3				
Elevation, m a.s.l.:	500				
Cardinal point exposure,°:	SW (210)				
Slope angle/Inclination,°:	12				
Litter depth, cm:	2				
Litter mass (g dry weight/m^2)	804.0				
pH	4.49				
Surface cover, %:					
Bare soil	10	30	30	10	30
Stones	20	10	15	1	0

Litter	2	2	3	2	15
Dead wood	3	0	3	5	3
Cryptogams	10	5	5	25	20
Plants	55	53	44	57	32
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	7				
Juniperus oxycedrus	1				
Juniperus foetidissima	2				
Pistacia mutica	R				
Juniperus polycarpos	1				
Carpinus orientalis	R				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	3.0	3.0	3.0	3.5	2.5
Cotinus coggygria	1			1	
Paliurus spina-christi	+	R	+	+	
Jasminum fruticans	1	1	1	1	1
Ephedra distachya	2			2	+
Ephedra procera			2		2
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	50	80	50	65	50
Achillea biebersteinii	1		1	1	1
Agropyron pectinatum			1		
Allium atroviolaceum	+				
Anthemis candidissima			+		
Arenaria serpyllifolia			+		
Artemisia lerchiana	R		1		
Asparagus verticillatus		R			1
Astragalus brachycarpus		+		R	
Astrodaucus orientalis				+	
Avena barbata	3	3	1	1	
Bromus japonicus		1			
Buglossoides arvensis				R	
Bupleurum rotundifolium	+				
Campanula hohenackeri		+	+		
Carduus hamulosus					+
Carex liparocarpos	1		R		
Catabrosella humilis	R				
Dactylis glomerata	+		1	R	
Festuca valesiaca			2	2	2

Galium verum		1			1
Glycyrrhiza glabra		2	3	2	2
Hypericum perforatum			1	1	1
Lagoseris sancta				R	
Linum tenuifolium	3				
Medicago orbicularis		1			
Melica taurica	1				
Minuartia wiesneri	1		+		
Nonea lutea					+
Onobrychis radiata			R		
Phleum phleoides	1	+			
Rubia tinctorum					R
Salvia nemorosa		+			
Silene chlorifolia				R	
Stipa capillata					1
Stipa tirsa	2	2		1	
Teucrium nuchense	1	R			
Teucrium polium	1			R	
Thalictrum minus					1
Thymus tiflisiensis		1			
Tragopogon pusillus				R	
Trifolium arvense			R		
Trifolium pratense	1		1	1	
Trigonella monspeliaca	1				
Trisetum rigidum			R	+	+
Valeriana officinalis		R			
Velezia rigida			+		
Vicia angustifolia	R				

6.10.10 Pistacietum

Pistacietum is the major type of arid open forests. The forest was studied in the Vashlovani Protected Areas at 450 m a. s. l. Litter is rather shallow (2-5 cm). Plant cover ranges from 35-75%. A remarkable portion of the ground surface is bare ground (10-40%). *Pistacia mutica* is the dominant species. Its individuals reach 8 m as well as individuals of another tree species *Celtis caucasica*. The shrub layer consists of *Salsola dendrioides, Ephedra procera, Rhamnus pallasii, Jasminum fruticans, Paliurus spina-christi.* The two last mentioned species are the most abundant. Of herbaceous synousia (50-130 cm) the most abundant are *Elytrigia elongatiformis, Stipa capillata, Melica taurica, Poa bulbosa, Achillea biebersteinii.* The majority is typical semi-arid community plants and are widespread in the Vashlovani Protected Areas (Lachashvili et al., 2010).

Table 10. *Relevés of Pistacietum*

Releve No. 10	1	2	3	4	5
GPS coordinates	41.209041 Lat; 46.439341 Long				
Landscape type:	3				
Elevation, m a.s.l.:	450				
Cardinal point exposure,°:	S-SW (182)				
Slope angle/Inclination,°:	8				
Litter depth, cm:	2				
Litter mass (g dry weight/m^2)	1029.28				
pH	6.34				
Surface cover, %:					
Bare soil	10	10	20	30	40
Stones	2	30	5	5	5
Litter	3	2	2	2	5
Dead wood	5	3	3	4	10
Cryptogams	5	8	5	7	5
Plants	75	47	65	52	35
Trees per 400 m^2 plot (20 X 20 m)					
Tree canopy height, m:	8				
Pistacia mutica	4				
Celtis caucasica	1				
Shrubs & lianas per 25 m^2 plot					
Shrub canopy height, m:	3.5	3.0	2.0	2.0	3.0
Rhamnus pallasii	2			2	2
Jasminum fruticans	1	1	1	1	1
Paliurus spina-christi	+				
Ephedra procera	2	2	2	2	2
Herbaceous plants 25 m^2 (5 X 5 m)					
Grass canopy height, cm:	70	50	50	50	130
Achillea biebersteinii	+	+	+	+	+
Allium atroviolaceum					1
Avena barbata	1	1	1		1
Bothriochloa caucasica					1
Carduus hamulosus				+	
Dactylis glomerata	+				

Consolida paniculata		R	R		
Elytrigia elongatiformis	2	2	2	2	2
Erysimum repandum		+	+	+	+
Euphorbia seguieriana					1
Fragaria vesca	R	R	R		
Galium verum				+	+
Medicago minima	1				
Silene latifolia		R	R		
Melica taurica	2			2	
Meniocus linifolius		1	1		
Minuartia wiesneri	+	+	+	+	+
Papaver arenarium	R	R	R		
Phleum phleoides	1				
Plantago lanceolata				1	
Poa bulbosa	+	+	+	+	
Podospermum canum				R	
Potentilla adenophylla	+	+	+	+	
Salsola dendroides					2
Scabiosa micrantha					R
Securigera varia					+
Stachys fruticulosa				+	+
Stipa capillata					1
Stipa tirsa	2				
Teucrium polium					+
Trifolium ambiguum	+	+	+	+	
Trisetum rigidum		2	2		2
Vicia angustifolia	R	R	R		

CHAPTER 7. TAXONOMIC SURVEY OF NATURAL FORESTS OF GEORGIA

7.1 Diversity

According to the results of the National Forest Inventory, the vast majority of Georgia's forests (98.5%) are of natural origin. Only 1.5% are artificially planted groves (mostly pine), which are scattered throughout almost all regions.

More than 60% of the total forest area is located at 1000 m a.s.l. and above. More than 49% of forests are located on slopes with a steepness of more than 25°. A significant area of forest (39.4%) is present on the slopes of northern aspect.

The tree species that make up the forest are diverse, the number reaches 190. Among the widespread species noteworthy are: *Fagus orientalis, Carpinus caucasica, Alnus barbata, Quercus iberica, Picea orientalis, Castanea sativa*, and some others.

Habitat tree is an important element of the forest in terms of biodiversity. Because it is home to a variety of small animals, a number of epiphytic and epixylic organisms, and numerous microorganisms, it contributes to the maintenance of high levels of biodiversity and sustainable functioning of the ecosystem. It has been established that the concentration of habitat trees in the forests of Georgia is high: 175 trees/ha, that is, 25% of trees have one or more characteristics that ensure the coexistence and sustainable functioning of many organisms.

The great diversity of Georgia's forests is also confirmed by their structural complexity and diversity, which is reflected in the abundance of forest types (>80) and the pronounced heterogeneity (mosaic) of their spatial distribution.

7.2 Forest indicators

The wood supply in the forest, the volume of tree trunks, is one of the important and basic variables, the availability of information about which is a decisive factor for ensuring sustainable forest management. Analysis of timber stock/volume (m^3) and long-term monitoring of this indicator provide the information necessary to assess the quality of sustainable forest management. This parameter provides information about the available wood reserves and allows assessment of the possibility of its use. In model areas, knowledge of timber stock thresholds provides an additional opportunity for effective assessment, planning and implementation of forest management activities.

In modern forestry, the preservation of deadwood in forests and the integration of this indicator into the methods and regulations necessary for forestry management are becoming increasingly relevant as a valuable element of biodiversity and one of the sources where the main carbon reserves accumulate. Deadwood, both standing and fallen, also provides important habitat (food, shelter, breeding environmrnt, etc.) for rare and endangered species.

Studying the diameters of woody plants is largely informative. It provides information on the spatial distribution of trees and changes in tree size. This is considered one of the main indicators of the naturalness of the forest and is necessary for analyzing the diverse forest structure.

7.2.1 Wood volume

An important indicator of the sustainability of a forest ecosystem is a sufficient amount of deadwood (standing, fallen). Based on field studies in western and eastern Georgia, it was established that in Georgia's

forests of this figure is 28.96 m^3/ha and is close to the threshold value necessary for the sustainable functioning of the ecosystem.

As a part of the research, timber reserves were determined for the main and typical forest types of Georgia (Fig. 5). It turns out that in all types of forests the wood reserve rate is high. An analysis of average taxation characteristics in Georgia (National Forestry Inventory 2023 – A Preliminary Report) indicates possible growth potential for timber reserves. Wood supply rates vary among forest types, depending largely on habitat type and dominant species.

When setting threshold values for timber reserves in different forest types as model areas, one should consider the fact that target values (in terms of timber reserves) for degraded and regenerating areas, the location of which corresponds to the ecology of the forest types under study, have also been determined.

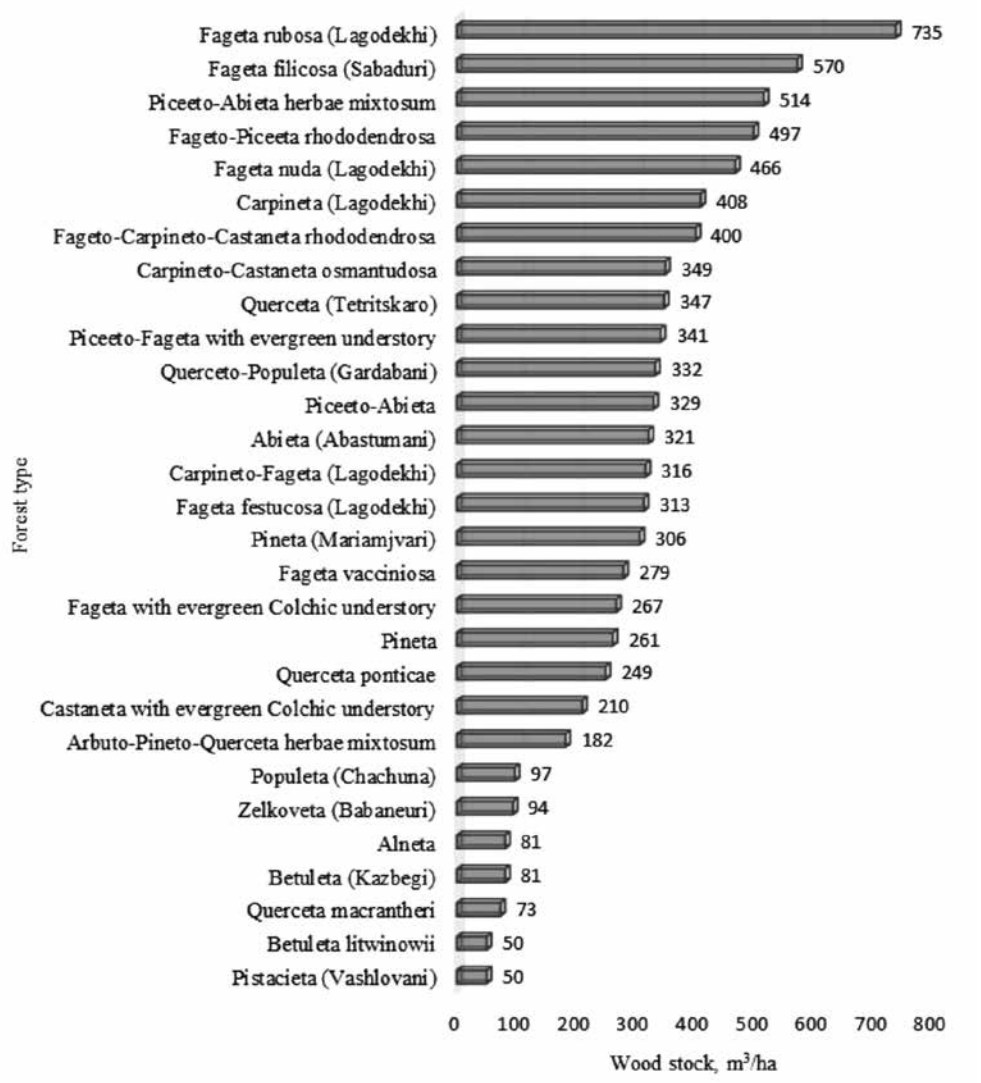


Fig. *5. Wood stock in different forest types.*

7.2.2 Volume of deadwood

As a part of the study, stocks of deadwood were determined for different types of forest (Fig. 6), including threshold indicators characterizing natural forests by the concentration of deadwood. The results show that all major forest types have a large amount of deadwood resources that should be assessed positively and sufficiently in the context of fulfilling their functional purpose. This idea is supported by data from European forests, a review of which found thresholds ranging from 10 to 150 m^3/ha for mixed montane forests, with optimal values of 30-40 m^3/ha (Müller and Bütler, 2010).

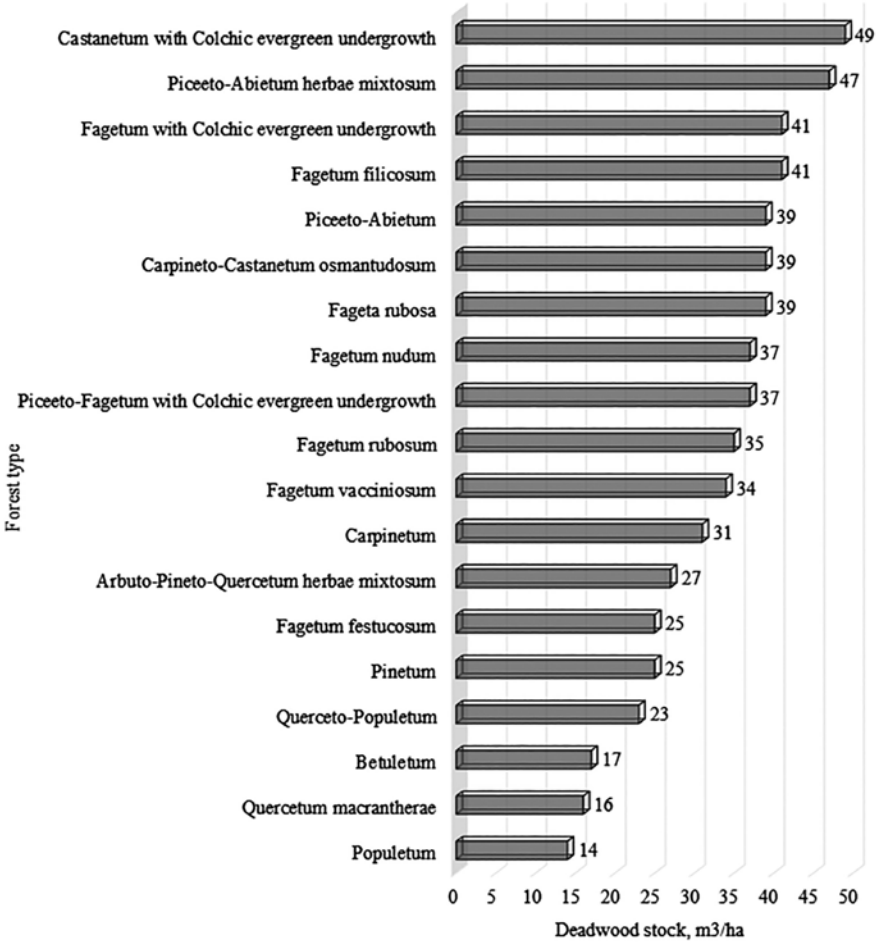


Fig. 6. *Deadwood stock in various forest types.*

7.2.3 Stem diameter and shoot location

Natural forests are characterized by a significant number of large trees (with big diameter). It is also an informative indicator of the full functioning of the ecosystem and speaks about the processes of self-healing of the forest. Therefore, the diameter of a tree trunk is considered an important forest indicator. The ratio of large diameter trees to seedlings and saplings is also important.

The number of tree shoots and saplings in the forest indicates the restoration potential of a particular species or the forest as a whole. Data on the age structure of the population and its spatial distribution are necessary to predict the recovery of forest ecosystems. The dependence of species on biotic and abiotic factors and their interaction are the determining factors of their regeneration. For optimal growth and renewal processes, there must be a certain balance between mature and old trees, on the one hand, and saplings and their shoots, on the other hand. Successful forest restoration depends on several specific factors, namely: (1) the ability to produce a sufficient number of shoots; (2) their resilience and survival potential; (3) on the development of a sufficient number of adolescents and their competitiveness. All this directly depends on the regeneration of the species under natural conditions (Odum, 1971; Taylor, Zisheng, 1988; Manral et al., 2018). In addition, the age structure of tree species and the diameter of their trunks are of particular importance (Bargali et al., 1989; Bhuyan, 2003).

The number of adult shoots in different types of natural forests in Georgia is presented in Fig. 7.

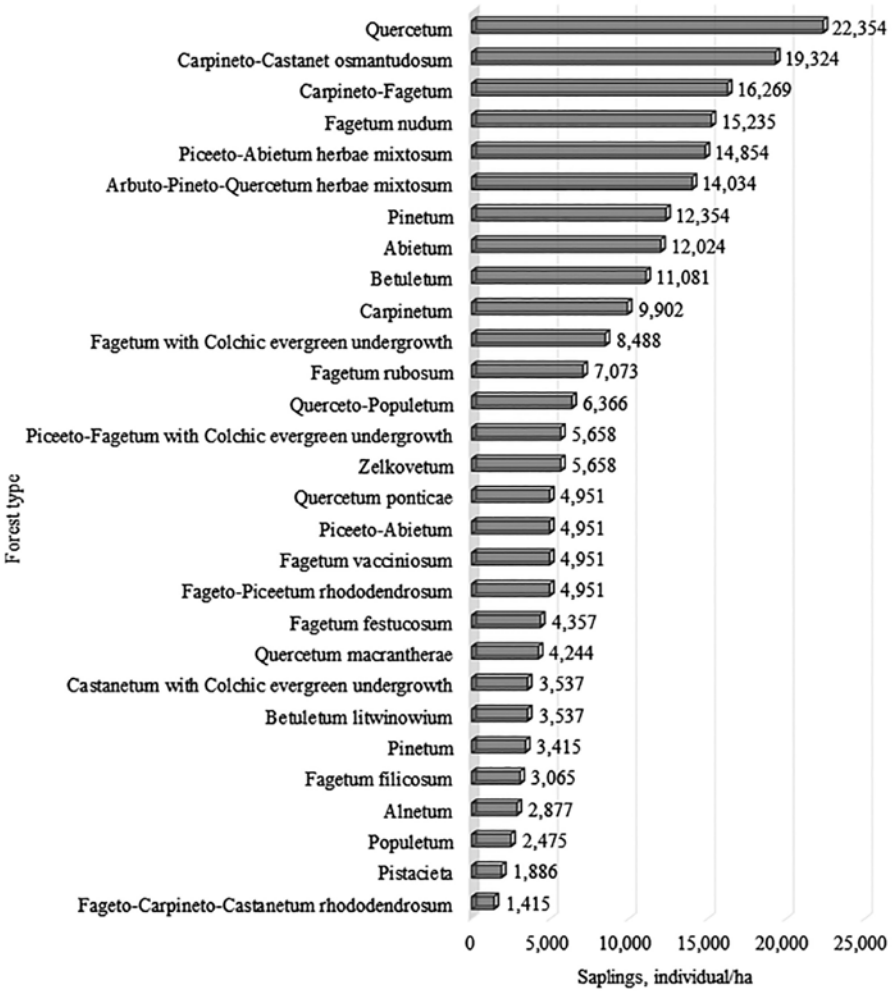


Fig. 7. *Number of saplings in different forest types.*

BIBLIOGRAPHY

1. Begalishvili N. (Chief ed.) (2003): Climate of Georgia (1. Adjara). Georgian Academy of Sciences, Proceedings of the Institute of Hydrometeorology, #110, Tbilisi, 134 p. (in Georgian)
2. Elizbarashvili E. (2007): Climatic resources of Georgia. Institute of Hydrometeorology, Tbilisi, 428 p. (in Georgian)
3. Elizbarashvili E. (2017): Climate of Georgia. Institute of Hydrometeorology of Tech. Univ. of Georgia, Tbilisi, 360 p. (in Georgian)
4. Flora of Georgia. N. Ketskhoveli (ed.) (1971-2013): I-XV vols., "Metsniereba", Tbilisi. (in Georgian)
5. Key of plants of Georgia. Ketskhoveli N. (ed.) I vol. (1964): 458 p., II vol. (1969): 508 p. Tbilisi, "Science". (in Georgian)
6. Gobejishvili R. (2011): Topography of Georgia. "Universali", Tbilisi, 260 p. (in Georgian)
7. Javakhishvili A. (1926): Geography of Georgia, vol. 1, Geomorphology. Tbilisi Univ. Ed., Tbilisi. (in Georgian)
8. Javakhishvili Sh. (1981): Atmospheric precipitation on the territory of Georgia. Tbilisi.
9. Ketskhoveli N. (1935): The main vegetation types of Georgia. Tbilisi house Univ. Publisher, Tbilisi, 445 p. (in Georgian)
10. Ketskhoveli N. (1959): The vegetation of Georgia. "Metsniereba", Tbilisi, 441 p. (in Georgian)
11. Kordzakhia M. (1961): Climate of Georgia. Acad. Scienced of Georgia, Tbilisi, 174 p. (in Georgian)
12. Kordzakhia M., Javakhishvili Sh. (1971): Climate of Georgia. "Ganatleba", Tbilisi, 86 p. (in Georgian)
13. Lachashvili I., Lachashvili N., Khachidze M. (2010): Flora and vegetation of Georgia's deserts. Tbilisi, "Universali", 319 p. (in Georgian)
14. Makashvili A. (1991): Botanical dictionary, the 3rd edition, "Metsniereba", Tbilisi, 246 p. (in Georgian)
15. Makashvili A. (1995): Trees and shrubs of Georgia. World Wildlife Fund (WWF), Tbilisi. (in Georgian)
16. Maruashvili L. (1969): Physical geography of Georgia. I vol., Tbilisi State University, Tbilisi, 170 p. (in Georgian)
17. Maruashvili L. (1975): Physical geography of the Caucasus. I vol., "Metsniereba", Tbilisi. (in Georgian)
18. Nakhutsrishvili G. (2000): The main biomes of Georgia. – in the book: Beruchashvili N., Kushlin A., Zazanashvili N. (ed.). Biological and Landscape Diversity of Georgia (Tbilisi, Proceedings of the 1st National Conference, May 28-29, 1999), pp. 43-68. (in Georgian)
19. Nomenclature list of the flora of Georgia (2018): G. Nakhutsrishvili, M. Churadze (ed). Institute of Botany of Ilia State University, "Universali", Tbilisi, 295 p. (in Georgian)
20. Sabashvili M. (1965): Soils of the Georgian SSR. "Metsniereba", Tbilisi, 552 p. (in Georgian)
21. Shatilova I., Mchedlishvili N., Rukhadze L., Kvavadze E. (2012): History of flora and vegetation of Georgia. Georgian National Academy of Sciences, Tbilisi, 193 p. (in Georgian)
22. Urushadze T. (1997): Basic soils of Georgia. "Science", Tbilisi, 268 p. (in Georgian)
23. Vakhushti Batonishvili (1941): Description of the Kingdom of Georgia (Geography of Georgia). Tbilisi State University, Tbilisi, 439 p. (in Georgian)
24. Akhalkatsi M., Abdaladze O., Nakhutsrishvili G., Smith W. K. (2006): Facilitation of seedling microsites by *Rhododendron caucasicum* extends the *Betula litwinowii* alpine treeline, Caucasus Mountains, Republic of Georgia. – Arctic, Antarctic & Alpine Research vol. 38, № 4, pp. 481-488.
25. Alexander K., Smith M., Stiven R., Sanderson N. (2003): Defining „Old growth" in the UK context. English Nature Research Reports. Northminster House, Peterborough PE1 1UA, 55p.

26. Bargali S.S., Rana B.S., Rikhari H.C., Singh R.P. (1989): Population structure of Central Himalayan blue pine (*Pinus wallichiana*) forest. Environment and Ecology, 7: 431-436.
27. Batsatsashvili K., Nersesyan A., Mehdiyeva N., Murtazaliev R., Emina ğaoğlu Ö., Kavousi K. (2020): Flora and vegetation of the Caucasus. pp 106-118 in Zazanashvili N., Gaforth M., Bitsadze M. (eds) Ecoregional Conservation Plan for the Caucasus, 2020 Edition: Supplementary Reports. WWF, KfW, Tbilisi.
28. Bhuyan P., Khan, M. L., Tripathi, R.S. (2003): Tree diversity and population structure in undisturbed and human-impacted stands of tropical wet evergreen forest in Arunachal Pradesh, Eastern Himalaya. India. Biodiversity and Conservation, 12: 1753-1773.
29. Birks H. H., Birks H. J. B., Kaland P. E., Moe D. (eds.) (1988): The cultural landscape. past, present and future. Cambridge: Cambridge University Press.
30. Bohn U., Neuhäusl R., Gollub G., Hettwer C., Neuhäuslova Z., Raus T., Schluter H., Weber H. (2003): Karte der natürlichen Vegetation Europas/Map of the natural vegetation of Europe. Maβstab/Scale 1:2 500 000. Teil 3/part 3: Karten/Maps. Landwirtschaftsverlag, Münster.
31. Bohn U., Zazanashvili N., Nakhutsrishvili G. (2007): The map of the natural vegetation of Europe and its application in the Caucasus Ecoregion. Bull. Georg. Nat. Acad. Scien., 175: 112-121.
32. Box O., Fujiwara K., Nakhutsrishvili G., Zazanashvili N., Libermann R., Miawaki A. (2000): vegetation and landscapes of Georgia (Caucasus), as a basis for landscape restoration. Bull. Inst. Environ. Sci. Technol. Yokohama Nath. Univ. 26: 69-102.
33. Box, E. O. (2015): Warm-Temperate Deciduous Forests of Eastern North America. In: Warm-Temperate Deciduous Forests around the Northern Hemisphere. Cham: Springer, pp. 225-255.
34. Butler J., E., Rose F., Green E. E. (2001): Ancient trees – icons of our most important wooded landscapes in Europe. In: Read, H., Forfang, A.S., Marciau, R., Paltto, H., Andersson, L., & Tardy, B., eds, Tools for preserving woodland biodiversity. EU: Naconex, pp 20-26.
35. Coker P., Kent M. (1992): Vegetation Description and Analysis. A Practical Approach.
36. Denk T., Frotzler N., Davitashvili N. (2001): Vegetational patterns and distribution of relict taxa in humid temperate forests and wetlands of Georgia (Transcaucasia). Biological Journal of the Linnean Society, 72: 287-332.
37. Diaci J. (ed.) (1999): Virgin forests and forest reserves in Central and east European countries history: Present status and future development. Ljubljana, 25-28 April, 1998. Ljubljana, 172 p.
38. Different Forests of Central Himalaya. Current World Environment, Vol. 13, No. (1): 113-123.
39. Dolukhanov A. G. (1978): Timberline and subalpine belt in Caucasus Mountains, USSR. Arct. Alp. Res. 10(2): 409–422.
40. Dolukhanov A. G., Nakhutsrishvili, G. (2003): Die natürlichen Vegetationsformationen Europas und ihre Untergliederung. Hygrophile thermophytische Laubmischwälder. – Pp. 384-388 in: Bohn, U., Gollub G. Hettwer C., Weber H., Neuhäuslová Z., Raus T., Schlüter H. (Eds.), Karte der natürlichen Vegetation Europas. Maßshtab 1:2 500 000. Bonn.
41. Ekhvaia Zh., Simeone M. C., Silakadze N., Abdaladze O. (2018): Morphological diversity and phylogeography of the Georgian durmast oak (*Quercus petraea* subsp. *iberica*) and related Caucasian oak species in Georgia (South Caucasus). Tree Genetics & Genomes 14 (2), 17.
42. Ellenberg H. (1988): Vegetation Ecology of Central Europe. 4 ed. Cambridge: Cambridge University Press.
43. European Forest Types (2007): Categories and types for sustainable forest management reporting and policy. EEA Technical Report No 9/2006, EEA, Copenhagen, 2007, 114 p.
44. FAO (2020): Global Forest Resources Assessment, Terms and Definitions (FRA). Forest Resources

Assessment Working Paper, 32 p. (www.fao.org/3/I8661EN/i8661en.pdf).
45. FAO Forest Resource Assessment 2015, Terms and Definitions (FRA) (2012): Forest Resources Assessment Working Paper 180. Rome: Food and Agriculture Organization of the United Nations: 30-41.
46. Fujiwara, K. (1987): Aims and methods of phytosociology or "vegetation science". Plant ecology and taxonomy to the memory of Dr. Satoshi Nakanishi.
47. GBIF – Global Biodiversity Information Facility. https://www.gbif.org/
48. Güldenstädt J.A. (1787-1791): Reisen durch Russland und im Caucasischen Gebürge / Auf Befehl der Russisch-Kayserlichen Akademie der Wissenschaften herausgegeben von P.S. Pallas. St. Petersburg: Russisch-Kayserlichen Akademie der Wissenschaften. St. Petersburg: Russisch-Kayserlichen Akademie der Wissenschaften. Bd 1. (1787), Bd 2. (1791).
49. Güldenstädt J.A. (1815): Reisen durch Georgien und Imerethi / Aus seinen Papieren gänzlich umgearbeitet und herausgegeben von J. von Klaproth. Berlin, 305 p.
50. Hughes N.M., Johnson D.M., Akhalkatsi M., Abdaladze O. (2009): Characterizing *Betula litwinowii* Seedling Microsites at the Alpine-Treeline Ecotone, Central Great Caucasus Mountains, Georgia. – Arctic, Antarctic & Alpine Research, vol. 41, № 1, pp. 112-118.
51. IUCN (2009): IUCN red list of threatened species. Version 2009.
52. Ji, C.J., Yang, Y.H., Han, W.X., He, Y.F., Smith, J., Smith, P. (2014): Climatic and edaphic controls on soil pH in alpine grasslands on the Tibetan Plateau, China: a quantitative analysis. Pedosphere 24 (1), pp. 39–44.
53. Kent M. (2011): Vegetation description and data analysis: a practical approach. John Wiley & Sons, New York.
54. Kirby K. J., Watkins C. (eds.) (1998): The ecological history of European forests. Wallingford: CABI.
55. Knapp H. D., Klaus S., Fahser L. (2021): Der Holzweg – Wald im Widersteit der Interessen. Sucoff Stiftung.
56. Koch K. (1850): Karte von dem Kaukasischen Istmus und von Armenien. Berlin.
57. Kormos C.F., Mackey B., DellaSala D. A., Kumpe N., Jaeger T., Mittermeier R.A. and Filardi C. (2018): Primary Forests: Definition, Status and Future Prospects for Global Conservation. In: Dominick A. DellaSala, and Michael I. Goldstein (eds.) The Encyclopedia of the Anthropocene. Oxford, Elsevier, vol. 2, p. 31-41.
58. Körner Ch. (2021): Alpine Plant Life: Functional Plant Ecology of High Mountain Ecosystems. 3rd edition, Springer Nature, Switzerland AG, 500 p.
59. Körner Ch. (2021): Alpine Treelines, Sprimger, Basel.
60. Larcher W. (2003): Physiological Plant Ecology. Springer, Berlin-New York.
61. Lund G. K. (2001): home.att.net/~gklund/pristine.html
62. Mackey B., DellaSala D.A., Kormos C., Lindenmayer D., Kumpel N., Zimmerman B., Hugh S., Young V., Foley S., Arsenis K., Watson J.E.M. (2014): Policy options for the world's primary forests in multilateral environmental agreements. Conservation Letters 8: 139–147.
63. Makadze M., Tutberidze B., Akhalkatsishvili M., Kobakhidze N. (2019): New Species of the Fossil Flora in the Tuffs of the Goderdzi Suite (Goderdzi Pass Area). Bull. of the Georgian Nat. Acad. of Scien., vol. 13, no. 3: 103-109.
64. Manral V., Padalia K., Karki H. (2018): Plant Diversity and Regeneration Potential of Three
65. Morales-Hidalgo D., Oswalt S. N., Somanathan E. (2015): Status and trends in global primary forest, protected areas, and areas designated for conservation of biodiversity from the Global Forest Resources Assessment 2015. Forest Ecology and Management 352: 68–77.
66. Müller J., Bütler R., 2010. A review of habitat thresholds for dead wood: A baseline for management

recommendations in European forests
67. Nakhutsrishvili G, Abdaladze O, Kikodze A. (2005): Khevi kazbegi region. Tbilisi, 54 p.
68. Nakhutsrishvili G. (1999): The vegetation of Georgia (Caucasus), vol. 15, Braun-Blanquetia, Camerino, pp 5–74.
69. Nakhutsrishvili G. (2013): The Vegetation of Georgia (South Caucasus). Springer, Heidelberg-London, 235 p.
70. Nakhutsrishvili G., Abdaladze O. (2017): Plant diversity of the Central Great Caucasus. In: Nakhutsrishvili G., Abdaladze O., Batsatsashvili K. Spehn E., Körner Ch. (eds) Plant Diversity in the Central Great Caucasus: A Quantitative Assessment. Springer International Publishing AG, Switzerland Basel), pp. 17-111.
71. Nakhutsrishvili G., Abdaladze O., Akhalkatsi M. (2006): Biotope Types of the Treeline of the Central Great Caucasus. – In: D. Gafta, J. Akeroyd (eds.): Nature Conservation: Concepts and Practice, Springer-Verlag Berlin Heidelberg, pp. 211-225.
72. Nakhutsrishvili G., Zazanashvili N., K. Batsatsashvili K., Montalvo Mancheno S. (2015): Colchic and Hyrcanian forests of the Caucasus: similarities, differences and conservation status. Flora Mediterranea, 25 (Special Issue): 185-191.
73. Nakhutsrishvili G., Zazanashvili, N. & Batsatsashvili, K. 2011: Regional profile: Colchic and Hyrcanic Temperate Reinforest of the Western Eurasian Caucasus. – Pp. 214-221 in: DellaSala, D. A. (Ed.), Temperate and boreal rainforests of the world: Ecology and conservation. – Washington, Covelo, London.
74. Nakhutsrishvili, G. Abdaladze, O., Akhalkatsi, M. (2006): Biotope types of the treeline of the Central Great Caucasus. In: Nature conservation: Concepts and practice: 211 – 224. Berlin.
75. Novák P., Zukal D., Harásek M., Vlčková P., Abdaladze O., Willner W. (2021): Ecology and syntaxonomy of oak-hornbeam and ravine forests of the Eastern Great Caucasus in Georgia. Folia Geobotanica, 55.
76. Odum E. P. (1971): Fundamentals of Ecology (III ed.) W.B. Saunders Co., Philadelphia, U.S.A. 574 p.
77. Olson D. M., Dinerstein E. (2002): The Global 200: Priority ecoregions for global conservation. Annals of the Missouri Botanical Garden 89(2):199-224.
78. Parviainen J. (2005): Virgin and natural forests in the temperate zone of Europe. For. Snow Landsc. Res. 79, 1/2: 9–18.
79. Radde, G. 1899. Grundzüge der Pflanzenverbreitung in den Kaukasusländern. Die Vegetation der Erde, Vol. 3. Wilhem Engelmann Verlag, Leipzig, 500 pp.
80. Rübel E. (1932): Die Buchenwalder Europas. Bern-Berlin, Verlag Hans Huber, pp. 63-167.
81. Salbitano F. (ed.) (1988): Human influence on forest ecosystems development in Europe. Bologna: Pitagora.
82. SDG indicator metadata (Last updated: 2023-05-15) (2023): https://unstats.un.org/sdgs/metadata/files/Metadata-15-01-01.pdf 8 p.
83. Slavíková J. (1958): Einfluss der Buche (*Fagus silvatica* L.) als Edifikator auf die Entwicklung der Krautschicht in den Buchenphytozönosen. – Preslia 30: 19–42.
84. Solomon J., Schatz G., Shulkina T., (2014): Red List of Endemic Plants of the Caucasus Region, Saint Louis, MO, USA, Missouri Botanical Garden Press, Saint Louis, 451 p.
85. Taylor A.H., Zisheng, Q. (1988): Regeneration pattern in old growth Abies-Betula forests in the Wolony Natural Reserve, Sichuan, China. Journal of Ecology, 76: 1204-1218.
86. Tielidze L. (2017): Glaciers of Georgia (Geography of the Physical Environment). Springer, Book series, 1st ed., 167 p.
87. Tournefort J. P. (1717): Relation d'un Voyage du Levant. Vol. XXX, 1, 2. Paris.

88. Tüxen R. (1981): Querco-Fagetea. Bibliografia Phytosociologica syntaxonomica 35:1–1118.
89. Wagner M. (1848): Reise nach dem Ararat und dem Hochland Armenien (vol. 10). Cotta.
90. White D., Lloyd T. (1994): Defining Old Growth: Implications For Management. The Eighth Biennial Southern Silvicultural Research Conference, Auburn, al, Nov. L-3, 1994.
91. WWF, 2001. Insight into Europe's forest protection. Gland, Switzerland: World Wide Fund for Nature.
92. Zazanashvili N., Gagnidze R., Nakhutsrishvili G. (2000): Main types of vegetation zonation on the mountains of the Caucasus. Acta Phytogeogr. Suec. 85: 7-16.
93. Albov N. (1892): Forests of Apkhazeti. From the "Notes of the Imperial Society of Agriculture of Southern Russia." Odessa, st. 1-19. (in Russian)
94. Bondev I., Borhidi A., Goffman G., Gribova S. A., Dolukhanov A. G., Donitsa N., Isachenko T. I., Karamysheva Z. V., Lavrenko E. M., Lipatova V. V. ., Mateshkevich V., Michalko J., Moravec J., Nakhutsrishvili G. Sh., Neuheisl R., Rybnichek K., Safronova I. N., Shelyag-Sosonko Yu. R., Schlüter H., Yurkovskaya T. K. (1985): Map of vegetation of European countries – members of the CMEA: general provisions, legend. Geobotanicheskoye kartografirovaniye, art. 1-34. (in Russian)
95. Bush N. A. (1935): Botanical and geographical studies of the Caucasus. Ed. USSR Academy of Sciences, M.-L. (in Russian)
96. Golitsin S.V. (1939): Shkeriani – shrubby phytocenoses of the humid wooded mountains of Adjara. Tr. Voronezh. Gos. Univ., vol. 11, Bot. dept., No. 2. (in Russian)
97. Grossheim A. A. (1948): Vegetation cover of the Caucasus. MOIP, M. (in Russian)
98. Grossheim A. A., Prilipko L. I. (1939): Geobotanical sketch of the Karabakh steppe. Baku. (in Russian)
99. Gulisashvili V.Z. (1940): Some ecological features of eastern spruce (*Picea orientalis*) and Caucasian fir (*Abies nordmanniana*) and climatic boundaries of their distribution. Soobshch. Gruz. Fil. AN SSSR, vol. 1, no. 1. (in Russian)
100. Gulisashvili V.Z. (1950): Chestnut and its distribution in Transcaucasia in connection with soil and climatic conditions. Vest. Tbil. Bot. Sada. Vol. 59. (in Russian)
101. Gulisashvili V.Z. (1955): Patterns of distribution of forest vegetation and main tree species in Transcaucasia. Bot. zhurn., vol. 40, no. 8. (in Russian)
102. Gulisashvili V.Z. (1966): Forests of the Georgian SSR. Forests of the USSR. M, vol.3: 359-411. (in Russian)
103. Gulisashvili V.Z., Makhatadze L.B., Prilipko L.I. (1975): Vegetation of the Caucasus. M. Art. 234. (in Russian)
104. Dolukhanov A.G. (1938): Essay on the forest vegetation of the Tala-Chay river basin of the Zagatala region. Tr. Bot. in-ta Azerb. Fil. ANSSR, vol. 4, Baku. (in Russian)
105. Dolukhanov A.G. (1940): On the issue of the relationship between dark-coniferous and pine forests of the Caucasus. Bot. zhurn., vol. 25, no. 4-5. (in Russian)
106. Dolukhanov A.G. (1966): Vegetation. In the book: Caucasus, M. Art. 223-251. (in Russian)
107. Dolukhanov A.G. (1980): Colchis undergrowth (Modern positions in the Caucasus Mountains, botanical-geographical connections and questions of origin). "Metsniereba", Tbilisi, 262 st. (in Russian)
108. Dolukhanov A. G. (2010): Forest vegetation of Georgia. Tbil. Bot. Garden and Ins. Bot., "Universal", Tbilisi, 532 st. (in Russian)
109. Isachenko T.I. (1980): Eastern Euxinian dark coniferous forests. In the book: Vegetation of the European part of the USSR. L. (in Russian)
110. Isachenko T.I. (1980): Eastern Euxinian dark coniferous forests. Vegetation of the European part of the USSR and Transcaucasia. L., 59 art. (in Russian)

111. Kakhadze J. (1947): Georgia in Jurassic time. Bulletin Georgian Academy of Sciences, 8, Tbilisi. (in Russian)
112. Ketskhoveli N.N. (1980): Xerophytic woodlands. In the book S. A. Gribova et al (ed.): Vegetation of the European part of the USSR. V. L. Komarova Bot. Institut USSR Academy of Sciences, "Science", L. (in Russian)
113. Kolakovsky A. A. (1961): Flora of Colchis. Ed. Moscow State Univ., M., 522 p. (in Russian)
114. Kolakovsky A. A. (1964): Pliocene flora of the Kodori Gorge. "Metsniereba", Sokhumi. (in Russian)
115. Kolakovsky A. A. (1974): Vertical belts of Colchis forest vegetation in the Quaternary period. Tr. Tbil. In-ta Lesa, 21: 98-116. (in Russian)
116. Kolakovsky A. A., Shakril A. K. (1976): Sarmatian flora of Apkhazeti. Tr. Sukhumsk. Bot. Sada, 22: 22-98. (in Russian)
117. Medvedev Y. S. (1919): Trees and shrubs of the Caucasus. 3rd ed., Tiflis. (in Russian)
118. Nakhutsrishvili Sh. G. (1966): Main features of the vegetation cover of the southern highlands of Georgia. Problemy Bot. "Nauka", M.-L., 8:106-111. (in Russian)
119. Povarnitsyn V. A. (1931): Types of beech forests of the Dzhalabetsky forest massif of South Ossetia. Tr. SOPSAN USSR, ser. Transcaucasus, vol. 2. (in Russian)
120. Sakharov M.I. (1939): Some materials on the study of the variability of beech (*Fagus orientalis* Lipsky) in the Caucasus Nature Reserve. Scientific and methodological notes of the Committee on Nature Reserves. Vol. 3, Tbilisi. (in Russian)
121. Sahokia M. F. (1958): Botanical description of the surrounding mountains. Tbilisi and along the mountain route. Tbilisi – Shiraki plateau. Botanical excursions in Georgia. Vol. 1, Tbilisi. (in Russian)
122. Sahokia M.F. (1959): Genus *Juniperus* L. Dendroflora of the Caucasus. T. 1, Tbilisi. (in Russian)
123. Sahokia M. F. (1980): Euxine broadleaf forests; Eastern euxinian broad-leaved forests. Vegetation of the European part of the USSR. L. (in Russian)
124. Svanidze T. (1972): Jurassic flora of Georgia. Author's abstract. doc. diss., Tbilisi.
125. Sokolov S. Ya. (1936): Ecological and coenotic classification of tree and shrub species of Apkhazeti. Tr. SOPSAN USSR, ser. Transcaucasus, vol. 19. (in Russian)
126. Sokolov S. Ya. (1952): Some valuable tree and shrub species of the northern part of the Black Sea coast of the Caucasus. Tr. Bot. Inst. AN SSSR, ser. V, no. 3. (in Russian)
127. Sosnovsky D.I. (1915): Sketches of the vegetation of Upper Svaneti. Bull. Ross. (in Russian)
128. Sochava V.B. (1946): Questions of florogenesis and phylocenogenesis of the Manchurian mixed forest // Materials on the history of flora and vegetation of the USSR. Vol. 1.
129. Tumajanov I.I. (1938): Forests of Mountain Tusheti. Tr. Tbil. Bot. Institute, vol. 5, art. 105-248. (in Russian)
130. Tumajanov I.I. (1955): On the post-Pliocene history of forest vegetation in the North Caucasus. Tr. Tbil. Bot. In-ta, 17: 161-219. (in Russian)
131. Tumajanov I. I. (1980): Eastern Mediterranean pine forests. Vegetation of the European part of the USSR and Transcaucasia. L., 59 art. Flor. 1(3): 119-144. (in Russian)
132. Sharashidze R.V. (1967): Zelkovaniks of Georgia. Author. Cand. Diss., Tbilisi. (in Russian).

APPENDIX 1
SPECIES LIST

The list contains species mentioned in the relevés of natural forests included in this book. The nomenclature in the main list follows the Global Biodiversity Information Facility (GBIF) and the names in the parentheses are given according to The Flora of Georgia (1971-2013) and Nomenclature checklist of the flora of Georgia (2018).

Abies nordmanniana
Acer campestre
Acer cappadocicum
Acer cappadocicum subsp. cappadocicum (A. laetum)
Acer heldreichii subsp. trautvetteri (A. trautvetteri)
Acer monspessulanum subsp. ibericum (A. ibericum)
Acer platanoides
Acer pseudoplatanus
Acer sosnowskyi
Acer velutinum
Achillea arabica (A. biebersteinii)
Achillea millefolium
Achillea ptarmicifolia
Aconitum orientale
Aconitum variegatum subsp. nasutum (A. nasutum)
Actaea spicata
Aegonychon purpurocaeruleum
Agropyron cristatum (A. pectinatum)
Agrostis capillaris (A.tenuis)
Agrostis gigantea
Agrostis vinealis (A. planifolia)
Alchemilla caucasica
Alchemilla dura
Alchemilla oxysepala
Alchemilla pycnotricha
Alchemilla valdehirsuta
Allium atroviolaceum
Allium kunthianum
Allium saxatile
Allium victorialis
Alnus glutinosa subsp. barbata (A. barbata)
Alnus incana
Ambrosia artemisiifolia
Amorpha fruticosa
Amphoricarpos elegans (Alboviodoxa elegans)
Anchusa azurea
Anemonastrum narcissiflorum subsp. fasciculatum (Anemone fasciculata)
Anemone caucasica
Anthemis candidissima

Anthoxanthum nipponicum (A. alpinum)
Anthoxanthum odoratum
Anthriscus sylvestris
Anthriscus sylvestris subsp. sylvestris (A. nemorosa)
Aquilegia olympica (A. caucasica)
Arbutus andrachne
Arenaria serpyllifolia
Aria graeca (Sorbus migarica)Aristolochia iberica
Artemisia lerchiana
Artemisia vulgaris
Arum italicum subsp. albispathum (A. albispathum)
Arum megobrebi
Aruncus dioicus (A. sylvestris; A. vulgaris)
Arundo donax
Asarum europaeum subsp. caucasicum (A. caucasicum)
Asparagus officinalis
Asparagus verticillatus
Asperula orientalis
Asplenium adiantum-nigrum
Asplenium adiantum-nigrum subsp. adiantum-nigrum (A. nigrum)
Asplenium scolopendrium
Asplenium scolopendrium subsp. scolopendrium (Phyllitis scolopendrium)
Asplenium septentrionale
Asplenium trichomanes
Aster alpinus
Aster amellus subsp. bessarabicus (A. amelloides)
Astragalus brachycarpus
Astrantia maxima
Astrodaucus orientalis
Asyneuma campanuloides
Atadinus imeretinus (Rhamnus imeretina)
Athyrium filix-femina
Avena barbata
Avenella flexuosa
Berberis vulgaris
Betonica macrantha
Betonica officinalis
Betula medwediewii
Betula megrelica
Betula pendula
Betula pubescens var. litwinowii (B. litwinowii)
Betula raddeana
Bidens tripartita
Bistorta amplexicaulis (Polygonum petiolatum)
Bothriochloa bladhii (B. caucasica)
Brachypodium sylvaticum

Brachypodium pinnatum (B. rupestre)
Bromus japonicus subsp. japonicus (B.japonicus)
Buglossoides arvensis
Bupleurum polyphyllum
Bupleurum rotundifolium
Buxus sempervirens (B. colchica)
Calamagrostis arundinacea
Calamagrostis epigejos
Calystegia silvatica
Calystegia silvatica subsp. silvatica (C. sylvestris)
Campanula alliariifolia
Campanula collina
Campanula glomerata subsp. caucasica (C. trautvetteri)
Campanula glomerata subsp. oblongifolia (C. oblongifolia)
Campanula lactiflora (Gadellia lactiflora)
Campanula latifolia
Campanula rapunculoides
Campanula rapunculoides subsp. cordifolia (C. cordifolia)
Campanula sibirica (C. hohenackeri)
Campanula stevenii
Cardamine bulbifera (Dentaria bulbifera)
Cardamine impatiens (C. pectinata)
Cardamine parviflora
Carduus acanthoides
Carduus adpressus
Carduus hamulosus
Carex caucasica
Carex buschiorum
Carex digitata
Carex divulsa
Carex liparocarpos
Carex oreophila
Carex panicea
Carex pendula
Carex sp.
Carex spp.
Carex sylvatica
Carex tristis
Carex vulpina
Carpinus betulus (C. caucasica)
Carpinus orientalis
Carum caucasicum
Castanea sativa
Catabrosella humilis
Caucasalia macrophylla (Senecio rhombifolius)
Caucasalia pontica (Senecio platyphylloides)

Celtis caucasica
Centaurea cheiranthifolia
Centaurea phrygia subsp. salicifolia (C. salicifolia)
Cephalaria gigantea
Cerastium polymorphum
Chaerophyllum aureum (C.maculatum)
Chamaecytisus ruthenicus(C.caucasicus)
Chamaecytisus triflorus subsp. triflorus (C. hirsutissimus; Cytisus hirsutissimus)
Chamaenerion angustifolium
Chamaenerion angustifolium subsp. angustifolium (Chamerion angustifolium)
Chamaenerion dodonaei (Chamerion dodonaei)
Cherleria circassica (Minuartia circassica)
Chrysojasminum fruticans (Jasminum fruticans)
Cicerbita petiolata
Circaea alpina
Cirsium arvense
Cirsium obvallatum
Cirsium pugnax
Cirsium svaneticum
Cirsium vulgare
Cistus creticus
Cistus salviifolius
Clematis orientalis
Clematis vitalba
Clinopodium grandiflorum (Calamintha grandiflora)
Clinopodium umbrosum
Clinopodium vulgare
Commelina communis
Convolvulus arvensis
Corallorhiza trifida
Cornus mas
Cornus sanguinea subsp. australis (Swida australis)
Coronilla coronata
Coronilla orientalis (Securigera orientalis)
Coronilla varia (Securigera varia)
Corydalis cava (C. marschalliana)
Corylus avellana
Corylus colchica
Cota macroglossa (Anthemis macroglossa)
Cotinus coggygria
Crataegus ×kyrtostyla
Crataegus meyeri
Crataegus microphylla
Crataegus pentagyna
Crepis sancta subsp. sancta (Lagoseris sancta; Pterotheca sancta)
Cruciata glabra

Cruciata laevipes
Cryphonectria parasitica (Endothia parasitica)
Cryptogramma crispa
Cyclamen colchicum
Cyclamen coum
Cyclamen coum subsp. caucasicum (C. vernum)
Dactylis glomerata
Dactylorhiza euxina
Dactylorhiza sp.
Dactylorhiza urvilleana (Orchis triphylla)
Daphne caucasica
Daphne glomerata
Daphne pontica
Daphne pontica subsp. haematocarpa (D. albowiana)
Delphinium consolida subsp. paniculatum (Consolida paniculata)
Delphinium sp.
Delphinium speciosum
Deschampsia cespitosa
Descurainia sophia
Dianthus armeria
Dianthus nudiflorus (Velezia rigida)
Dichoropetalum caucasicum (Peucedanum caucasicum)
Dicranum scoparium
Digitalis ferruginea
Digitalis ferruginea subsp. schischkinii (D. schischkinii)
Dioscorea communis (Tamus communis)
Diospyros lotus
Doronicum macrophyllum
Dryas octopetala (D. caucasica)
Dryopteris borreri
Dryopteris carthusiana
Dryopteris dilatata subsp. dilatata (D. alexeenkoana)
Dryopteris filix-mas
Dryopteris oreades
Elaeagnus angustifolia
Elsholtzia ciliata
Elymus repens subsp. elongatiformis (Elytrigia elongatiformis)
Empetrum nigrum
Ephedra distachya
Ephedra procera
Epigaea asiatica
Epigaea gaultherioides
Epigaea repens
Epilobium algidum
Epilobium montanum
Epimedium pinnatum subsp. colchicum (E. colchicum)

Epimedium pubigerum
Equisetum hyemale
Erigeron annuus (Stenactis annua)
Erysimum repandum
Euonymus europaeus
Euonymus latifolius
Euonymus leiophloeus
Eupatorium cannabinum
Euphorbia macroceras
Euphorbia myrsinites subsp. myrsinites (E. pontica)
Euphorbia seguieriana
Euphrasia pectinata subsp. pectinata (E.caucasica)
Eurhynchium striatum
Fagus orientalis
Festuca airoides (F. supina)
Festuca drymeja (Drymochloa drymeja; Festuca montana)
Festuca ovina (F. pratensis)
Festuca rupicola
Festuca valesiaca
Festuca varia (F. varia subsp. woronowii)
Ficus carica
Ficus carica subsp. carica (F. colchica)
Fragaria sp.
Fragaria vesca
Fragaria viridis
Frangula alnus
Fraxinus excelsior
Galanthus alpinus
Galanthus lagodechianus (G. kemulariae)
Galega orientalis
Galeopsis bifida
Galium album
Galium mollugo
Galium odoratum (Asperula odorata)
Galium palustre
Galium rotundifolium
Galium uliginosum
Galium verum
Gelasia ketzkhowelii (Scorzonera ketzkhowelii)
Guneria dzhawakhetica (Scorzonera dzhawakhetica)
Genista suanica
Gentiana asclepiadea(G. schistocalyx)
Gentiana cruciata
Gentiana septemfida
Gentiana spp.
Geranium columbinum

Geranium gracile
Geranium gymnocaulon
Geranium platypetalum
Geranium psilostemon
Geranium pyrenaicum
Geranium renardii
Geranium robertianum
Geranium sylvaticum
Geum speciosum (Woronowia speciosa)
Geum urbanum
Glycyrrhiza glabra
Goodyera repens
Grossheimia macrocephala
Gymnadenia conopsea
Gymnocarpium dryopteris
Hedera colchica
Hedera helix
Hedera pastuchovii
Helianthemum nummularium
Helianthemum nummularium subsp. obscurum (H. hirsutum)
Helleborus orientalis subsp. orientalis (H. caucasicus)
Heracleum asperum
Heracleum leskovii
Heracleum mantegazzianum (H. grossheimii)
Heracleum sosnowskyi
Hesperis matronalis
Hieracium umbellatum
Hippophae rhamnoides
Humulus lupulus
Hydrocotyle ramiflora
Hylocomium splendens
Hylotelephium maximum subsp. ruprechtii (Sedum caucasicum)
Hymenophyllum tunbridgense
Hypericum androsaemum
Hypericum bithynicum (H. caucasicum)
Hypericum perforatum
Hypericum xylosteifolium (H. inodorum)
Ilex colchica
Impatiens noli-tangere
Inula magnifica
Juncus atratus
Juncus effusus
Juniperus communis
Juniperus communis var. communis (J. depressa)
Juniperus communis var. saxatilis (J.oblonga)
Juniperus excelsa subsp. polycarpos (J. polycarpos)

Juniperus foetidissima
Juniperus oxycedrus
Juniperus oxycedrus (J. rufescens)
Juniperus spp.
Kemulariella caucasica
Klasea quinquefolia (Serratula quinquefolia)
Knautia tatarica (K. montana)
Lactuca muralis
Lactuca serriola
Lapsana communis
Lapsana communis subsp. grandiflora (L. grandiflora)
Lapsana communis subsp. intermedia (L. intermedia)
Laser trilobum
Lathyrus aureus (Orobus aureus)
Lathyrus cyaneus (Orobus cyaneus)
Lathyrus roseus
Lathyrus vernus
Laurus nobilis
Laurus officinale
Leontodon hispidus
Ligustrum vulgare
Lilium szovitsianum
Linum tenuifolium
Lithodora fruticosa (Lithospermum purpureocaeruleum)
Lithospermum officinale
Lolium giganteum (Festuca gigantea)
Lolium pratense (Festuca pratensis)
Lomelosia micrantha (Scabiosa micrantha)
Lonicera caprifolium
Lonicera caucasica
Lonicera iberica
Lonicera xylosteum
Lophiolepis horrida (Cirsium pugnax)
Lotus corniculatus
Lotus graecus (Dorycnium graecum)
Luzula forsteri
Luzula sp.
Luzula spicata
Luzula sylvatica
Lythrum salicaria
Malus orientalis
Marrubium catariifolium
Matteuccia struthiopteris (Struthiopteris filicastrum)
Medicago lupulina
Medicago minima
Medicago monspeliaca (Trigonella monspeliaca)

Medicago orbicularis
Melampyrum arvense
Melica ciliata (M. taurica)
Melica uniflora
Meniocus linifolius
Mentha arvensis
Mespilus germanica
Minuartia montana subsp. wiesneri (M. wiesneri)
Morus alba
Morus nigra
Mycelis muralis
Myosotis sylvatica
Neottia cordata (Listera cordata)
Nepeta grandiflora
Nepeta supina
Nitrosalsola dendroides (Salsola dendroides)
Nonea lutea
Omalotheca supina
Onobrychis radiata
Oplismenus undulatifolius
Origanum vulgare
Orobanche alba
Orobanche cumana
Orobanche lutea
Orthilia secunda (Ramischia secunda)
Osmanthus decorus
Osmunda regalis
Ostrya carpinifolia
Oxalis acetosella
Pachyphragma macrophyllum
Paeonia caucasica
Paeonia macrophylla
Paliurus spina-christi
Papaver arenarium
Paris incompleta
Paris quadrifolia
Periploca graeca
Persicaria hydropiper (Polygonum hydropiper)
Persicaria nepalensis (Polygonum alatum)
Petasites albus
Petrorhagia saxifraga subsp. saxifraga (Tunica saxifraga)
Phedimus spurius subsp. oppositifolius (Sedum oppositifolium)
Phedimus stolonifer (Sedum stoloniferum)
Philadelphus coronaries (P. caucasicus)
Phillyrea medwedewii
Phleum alpinum

Phleum phleoides
Phleum pretense
Phytolacca americana
Phytophthora cambivora (Blepharospora cambivora)
Picea orientalis
Pilosella officinarum (Hieracium pilosella)
Pimpinella rhodantha
Pimpinella saxifraga
Pinus brutia var. pityusa (P. brutia subsp. pityusa)
Pinus sylvestris
Pinus sylvestris var. hamata (P. hamata; P. kochiana; P. sosnowskyi; P. sylvestris subsp. hamata)
Pistacia mutica
Plantago lanceolata
Platanthera chlorantha
Pleurozium schreberi
Poa annua
Poa bulbosa
Poa longifolia
Poa nemoralis
Poa palustris
Poa pratensis
Polygonatum glaberrimum
Polygonatum orientale (P. polyanthemum)
Polygonatum verticillatum
Polygonum carneum
Polypodium cambricum (P. serratum)
Polypodium vulgare
Polystichum aculeatum
Polystichum braunii
Polystichum setiferum
Populus × canescens (P.canescens; P. hybrida)
Populus nigra
Populus tremula
Potentilla divina
Potentilla elatior
Potentilla erecta
Potentilla humifusa (P. adenophylla)
Potentilla lazica
Potentilla micrantha
Potentilla recta
Prenanthes purpurea
Primula amoena
Primula veris subsp. macrocalyx (P. macrocalyx)
Primula vulgaris
Primula vulgaris subsp. vulgaris (P. sibthorpii)
Primula woronowii

Prunella vulgaris
Prunus avium (Cerasus avium; C. silvestris)
Prunus cerasifera
Prunus laurocerasus (Laurocerasus officinalis)
Psephellus caucasicus (Aetheopappus caucasicus)
Pseudoroegneria spicata (Elymus spicatus)
Pteridium tauricum
Pteris cretica
Pterocarya fraxinifolia (P. pterocarpa)
Pyracantha coccinea
Pyrola minor
Pyrola rotundifolia
Pyrola spp.
Pyrus communis
Pyrus communis subsp. caucasica (P. caucasica)
Pyrus salicifolia
Quercus hartwissiana
Quercus macranthera
Quercus petraea
Quercus petraea subsp. polycarpa (Q. dshorochensis; Q. iberica; Q. petraea subsp. iberica)
Quercus pontica
Quercus robur subsp. imeretina (Q. imeretina)
Quercus robur subsp. pedunculiflora (Q. pedunculiflora)
Quercus spp.
Ranunculus breyninus (R. oreophilus)
Ranunculus cappadocicus (R. ampelophyllus)
Ranunculus caucasicus
Ranunculus muricatus
Ranunculus polyanthemos subsp. meyerianus (R. meyerianus)
Ranunculus sp.
Rhamnus imeretina
Rhamnus pallasii
Rhinanthus minor
Rhododendron caucasicum
Rhododendron luteum
Rhododendron ponticum
Rhododendron smirnowii
Rhododendron ungernii
Rhus coriaria
Ribes biebersteinii
Robinia pseudoacacia
Rosa canina
Rosa sp.
Rubia tinctorum
Rubus anatolicus
Rubus canescens

Rubus caucasicus
Rubus hirtus
Rubus idaeus
Rubus platyphyllus
Rubus saxatilis
Rubus serpens
Rubus sp.
Rumex sp.
Rumex acetosella
Ruscus aculeatus (R. ponticus; R.aculeatus subsp. ponticus)
Ruscus colchicus
Ruscus hypophyllum
Salix excelsa
Salix × fragilis (S. excelsior)
Salix alba
Salix alba subsp. micans
Salix apoda
Salix caprea
Salix caucasica
Salix kazbekensis
Salix kuznetzowii
Salix pantosericea
Salix viminalis
Salvia glutinosa
Salvia nemorosa
Sambucus ebulus
Sambucus nigra
Sanicula europaea
Satureja spicigera
Saxifraga juniperifolia
Saxifraga kolenatiana
Saxifraga repanda
Scabiosa colchica
Scorzonera cana (Podospermum canum)
Scrophularia alata
Scrophularia umbrosa
Scutellaria orientalis
Sedum album
Sedum gracile
Senecio germanicus subsp. germanicus (S. jacquinianus)
Senecio kolenatiaunus
Senecio leucanthemifolius subsp. caucasicus (S. sosnovskyi)
Senecio propinquus
Sesleria alba (S. anatolica)
Setaria viridis
Sibbaldia parviflora (S. semiglabra)

Silene balansae (Melandrium balansae)
Silene chlorifolia
Silene dioica subsp. dioica(Silene latifolia)
Silene italica
Silene suaveolens (S. multifida)
Smilax excelsa
Solidago virgaurea
Sorbus aucuparia (S. caucasigena)
Sorbus aucuparia subsp. aucuparia (S. boissieri)
Sorbus subfusca
Spiraea hypericifolia
Spiranthes spiralis
Stachys fruticulosa
Stachys sylvatica
Staphylea colchica
Staphylea pinnata
Stellaria nemorum
Stipa capillata
Stipa tirsa
Struthiopteris castanea (Blechnum spicant)
Swertia iberica
Symphytum asperum
Symphytum grandiflorum
Tamarix ramosissima
Tanacetum partheniifolium (Pyrethrum partheniifolium)
Taxus baccata
Telekia speciosa
Tephroseris cladobotrys subsp. cladobotrys (Senecio cladobotrys)
Tephroseris integrifolia subsp. caucasigena (Senecio caucasigenus)
Teucrium chamaedrys subsp. nuchense (T. nuchense)
Teucrium polium
Thalictrum foetidum
Thalictrum minus
Thalictrum minus subsp. maxwellii (T. buschianum)
Thalictrum minus subsp. minus (T. collinum)
Thymus collinus
Thymus praecox subsp. caucasicus (T. caucasicus)
Thymus praecox subsp. grossheimii (T. grossheimii)
Thymus tiflisiensis
Tilia begoniifolia
Tilia cordata
Tilia dasystyla subsp. caucasica (T. caucasica)
Tilia sp.
Torminalis glaberrima (Sorbus torminalis)
Trachystemon orientale (T. orientalis)
Tragopogon pusillus

Trifolium alpestre
Trifolium ambiguum
Trifolium arvense
Trifolium aureum
Trifolium pratense
Trisetum rigidum
Trollius patulus
Trollius ranunculinus
Turanecio taraxacifolius (Senecio taraxacifolius)
Tussilago farfara
Ulmus carpinifolia
Ulmus elliptica
Ulmus foliacea
Ulmus glabra
Ulmus minor
Ulmus minor subsp. minor (U. foliacea; U. suberosa)
Urtica dioica
Vaccinium arctostaphylos
Vaccinium myrtillus
Vaccinium vitis-idaea
Valeriana alliariifolia
Valeriana officinalis
Veratrum lobelianum
Veronica beccabunga
Veronica filiformis
Veronica peduncularis
Viburnum lantana
Viburnum opulus
Viburnum orientale
Vicia alpestris
Vicia cracca (V. grossheimii)
Vicia crocea
Vicia sativa subsp. nigra (V. angustifolia)
Vicia sepium
Vinca herbacea
Viola alba
Viola alba var. scotophylla (V. scotophylla)
Viola odorata
Viola reichenbachiana
Viola sieheana
Viola sp.
Vitis gmelinii (V. vinifera subsp. sylvestris)
Vitis vinifera(V. silvestris)
Zelkova carpinifolia

APPENDIX 2

LIST OF STUDIED FOREST TYPES AND THEIR ASSOCIATIONS BY REGIONS OF GEORGIA

Region	Forest type	Association
Adjara	Temperate humid thermophilic Colchic rainforest, namely, Mixed deciduous / polydominant Colchic forest	Castaneto-Carpinetum • Fageto-Carpineto-Castanetum rhododendrosum pontici • Fageto-Castaneto-Carpinetum rhododendrosum pontici • Piceeto-Querceto-Castanetum • Arbuto-Pineto-Quercetum herbae mixtosum • Arbuto-Pineto-Quercetum herbae cistosum • Fagetum vacciniosum arctostaphyli
	Dark coniferous / mixed forest	• Piceetum rhododendrosum pontici • Piceeto-Abietum herbae mixtosum • Piceeto-Abietum vacciniosum arctostaphyli • Piceeto-Abietum laurocerasosum officinalis
Guria	Wetland forest	• Alnetum • Alnetum matteucciosum struthiopteris • Alnetum with Colchic evergreen undergrowth • Fageto-Alnetum with Colchic evergreen undergrowth
	Beech forest	• Fagetum rhododendrosum luteum • Fagetum filicosum • Fagetum rubosum anatolicus • Fagetum asperulosum odorati • Fagetum rhododendrosum pontici
	Chestnut forest	• Castanetum
	Hornbeam forest	• Carpinetum rhododendrosum lutei
	Dark coniferous forest	• Piceeto-Abietum rhododendrosum pontici • Piceeto-Abietum festucosum drymejae
	Mixed forest	• Abieto-Fagetum
	Subalpine forest	• Betuletum vacciniosum arctostaphyli • Betuletum rhododendrosum ungernii • Quercetum ponticae • Fageto-Quercetum ponticae

Samegrelo	Riparian forest	• Alnetum
	Temperate humid thermophilic Colchic rainforest, namely, Mixed deciduous / polydominant Colchic forest	• Fagetum with evergreen Colchic undergrowth • Fagetum vacciniosum arctostaphyli
	Chestnut forest	• Castanetum
	Colchic subalpine forest (of birch, of hazel, of Pontic oak)	• Coryletum colchicae • Betuletum megrelicae • Quercetum ponticae
Svaneti	Oak forest	• Quercetum ibericae
	Alder forest	• Alnetum barbatae • Alnetum incanae
	Dark coniferous and mixed forest	• Fageto-Abieto-Piceetum • Piceeto-Abietum • Abietum nordmannianae • Piceetum rhododendrosum lutei
	Subalpine forest (of birch, of montane oak)	• Betuletum pendulae rhododendrosum caucasici • Betuletum litwinowiae rhododendrosum caucasici (1) • Betuletum litwinowiae rhododendrosum caucasici (2) • Quercetum macrantherae
	Pine forest	• Pinetum • Pinetum vacciniosum arctostaphyli
Racha-Lechkhumi	Riparian forest	• Alnetum festucosum drymeae
	Oak forest	• Quercetum ibericae • Querceto-Carpinetum orientalis
	Hornbeam forest	• Carpinetum caucasici
	Dark coniferous and mixed forest	• Piceetum orientalis • Piceeto-Abietum • Abieto-Fagetum orientalis • Abieto-Fagetum laurocerasosum officinalis • Abietum herbae mixtosum • Abietum rubosum anatolici
	Pine forest	• Pinetum
Samtskhe-Javakheti	Dark coniferous and mixed forest	• Piceetum • Piceeto-Fagetum rhododendrosum pontici • Fageto-Piceetum rhododendrosum pontici
	Subalpine forest (of birch, of spruce-fir)	• Betuletum • Piceeto-Abietum
Kartli	Oak forest	• Quercetum ibericze
	Beech forest	• Fagetum rubosum

Kvemo Kartli	Riparian forest	• Querceto-Populetum
	Hornbeam forest	• Carpinetum
Khevi	Subalpine forest (of birch, of pine)	• Betuletum (1) • Betuletum (2) • Betuletum (3) • Betuletum (treeline) • Pinetum oreadosum • Pinetum (rock pine forest) (1) • Pinetum (rock pine forest) (2)
Kakheti	Riparian forest	• Populetum • Pterocaryetum
	Hornbeam forest	• Carpinetum
	Zelkova forest	• Zelkovetum
	Pine forest	• Pinetum
	Beech forest	• Fagetum nudum • Fagetum festucosum drymejae • Carpineto-Fagetum rubosum caucasici
	Juniper forest	• Juniperetum
	Pistachio-tree forest	• Pistacietum

1 a – Querceto-Populeta, riv. Mtkvari riparian forest, Gardabani Protected Area, Kvemo Kartli; b – Populeta, riv. Iori riparian forest, Chachuna Protected Area, Kakheti; c – Populeta, riv. Alazani riparian forest, Kakheti.

2 a – Pterocaryeta, Lagodekhi Protected Area, Kakheti; b – Alnetae barbati, Samegrelo; c – Alnetae barbati, Wetland forest, Bank of Paliastomi lake & riv. Pichori, Kolkheti Protected Area, Guria & Samegrelo.

3 a – Polydominant Colchic costal forest, Mtsvane Kontskhi, Ajara; b – Polydominant Colchic forest, riv. Chakvistskali gorge, Ajara; c – Polydominant Colchic forest, Marisi gorge, Ajara.

4 a & b – Dark coniferous & foliage mixed Colchic polydominant forest, riv. Ajaristskali gorge, Ajara

5 a & b – Castaneta, riv. Ajaristskali gorge, Ajara; c – Castaneta, riv. Tekhuri gorge, Samegrelo

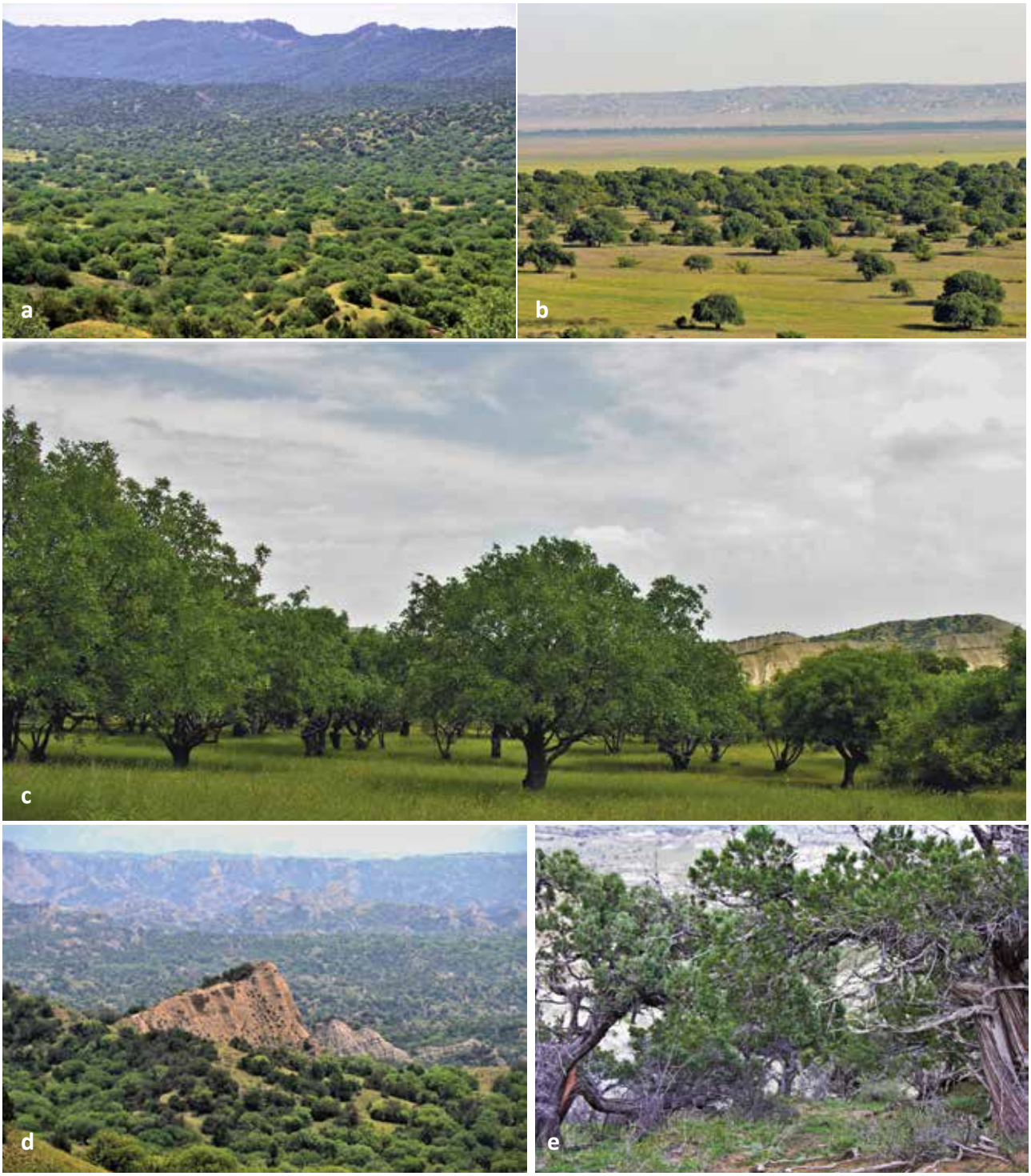
6 a – *Quercus pontica*, Bakhmaro, Guria; b – Querceta ponticae, Marisi, gorge, Ajara; c – Abieto-Fageto-Querceta ponticae, Marisi gorge, Ajara.

7 a – Coryleta colchicae, Migaria, Samegrelo; b – *Corylus colchica*, Migaria, Samegrelo; c – *Sorbus migarica*, Migaria, Samegrelo; d – *Rhamnus imeretina*, Migaria, Samegrelo; e & f – Betuleta megrelicae, Migaria, Samegrelo; g – *Betula megrelica*, samegrelo.

8 a – Piceeta rhododendrosa pontici, Marisi gorge, Ajara; b – Piceeta, Bakuriani, The Lesser Caucasus, Samtskhe-Javakheti; c – Piceeto-Abieta festucosa drymejae, Guria; d – Piceeto-Abieta rhododendrosa pontici, Bakhmaro, Guria

9 a & b – Abieta, The Central Great Caucasus, Svaneti; c – Piceeta, Bakuriani, The Lesser Caucasus, Samtskhe-Javakheti

10 a – Fageto-Piceeta rhododendrosa pontici, Baniskhevi, Samtskhe-Javakheti; b – Piceeto-Abieta laurocerasosa officinalis, Khulo, Ajara; c – Piceeta, Bakuriani, The Lesser Caucasus, Samtskhe-Javakheti; d – Abieta, Ajara



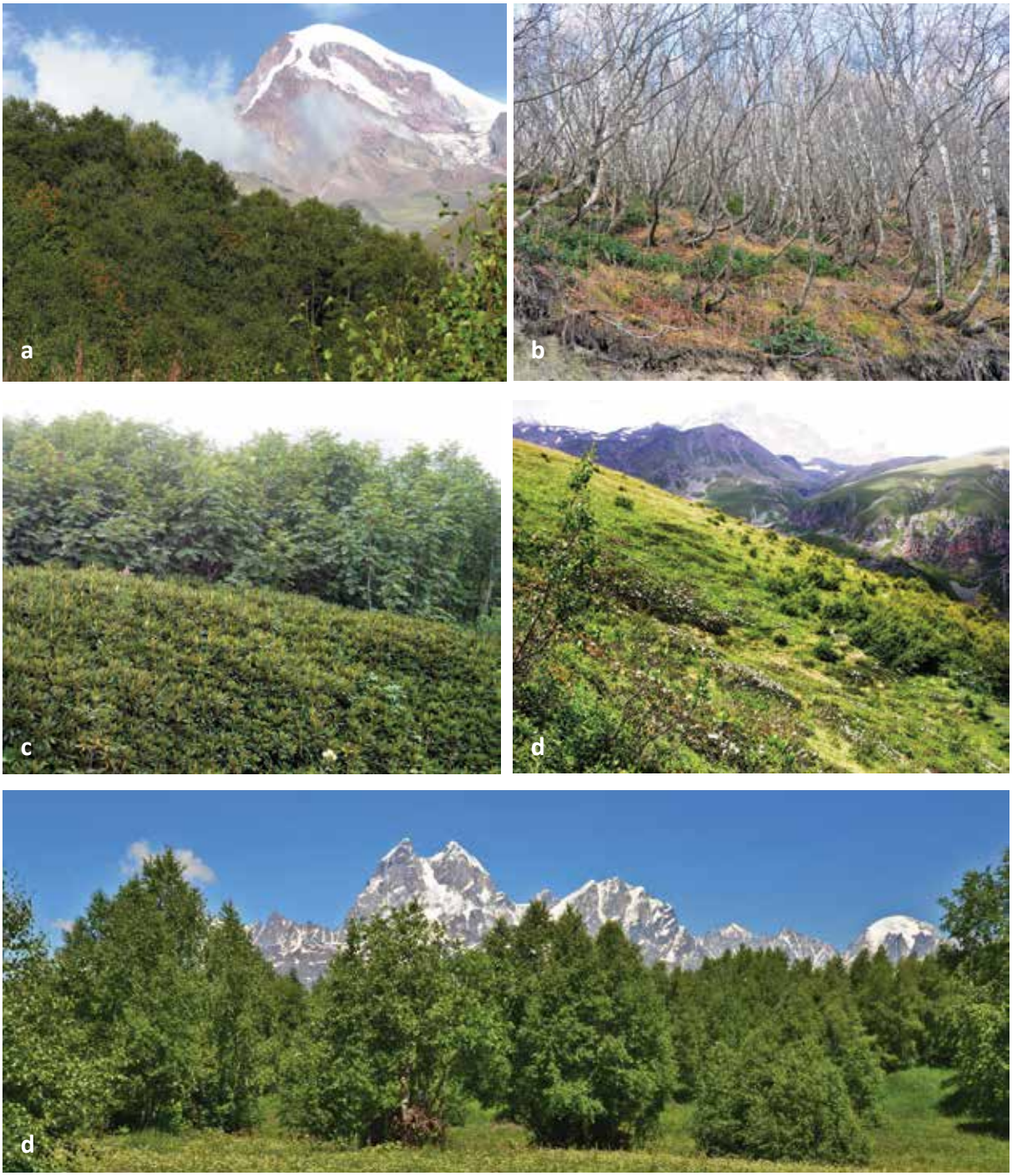
11 a, b & c – Pistacieta, Vashlovani Protected Area, Kakheti; d – Pistacieto-Junipereta, Vashlovani Protected Area, Kakheti; e – Junipereta, Chachuna Protected Area, Kakheti.

12 a & b – Zelkoveta & *Zelkova carpinifolia*, Babaneuri Protected Area, Kakheti; c – Querceta ibericae, Enguri gorge, Svaneti; d – *Quercus macranthera*, Bakuriani, The Lesser Caucasus, Samtskhe-Javakheti.

13 a – Pineta, Chalaati gorge, The Central Great Caucasus, Svaneti; b – Pineta, Mariamjvari Protected Area, Kakheti; c – Pineta, Borjomi gorge, Samtskhe-Javakheti.

14 a & b – Pineta oreadosa, Khde gorge, The Central Great Caucasus, Khevi (Kazbegi region).

15 a, b & c – Pineta, Rock pine forest in the Dariali canyon, The Central Great Caucasus, Khevi (Kazbegi region)



16 a & b – Betuleta litwinowiae rhododendrosum caucasici, The Central Great Caucasus, Khevi (Kazbegi region); c – Sorbeto-Betuleta rhododendrosum caucasici, The Lesser Caucasus, Bakuriani, Samtskhe-Javakheti; d – Crooked stem Betuleta litwinowiae (Treeline), Khevi (Kazbegi region); e – Betuleta pendulae rhododendrosum caucasici, The Central Great Caucasus, Svaneti.

17 a – Fageta vacciniosum arctostaphyli, Migaria, Samegrelo; b – Fageta filocosa, Bakhmaro, Guria; c – Fageta rhododendrosa lutei, Mt. Muchuta, Guria; d – Fageto-Alneta, Guria; e – Fageta rubosa anatolici, Sabaduri forest, Tbilisi Protected Area, Kartli; f – Fageto-Alneta, Guria.

18 a – Carpineta, Lagodekhi Protected Area, Kakheti; b – Carpineta rhododendrosa lutei, Guria; c – Fageto-Carpineta, Lagodekhi Protected Area, Kakheti; d – Fageto-Carpineta, Gombori Pass, Kakheti; e – Carpineto-Fageta rubosa, Ajara; f – Fageto-Castaneto-Carpineta rhododendrosa pontici, Ajara.

19 a & b – Abieto-Fageta, Guria.

20 a – Fageta asperulosa odorati, Bakhmaro, Guria; b – Fageta nuda, Gombori Pass, Kakheti