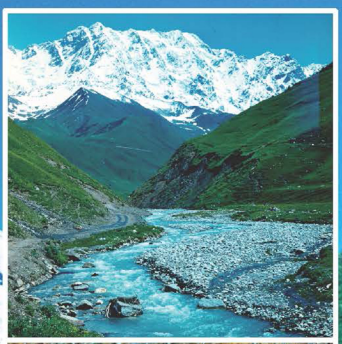
Arnold Gegechkori



Caucasus and Central Asia Political, Social and Economic Issues

Biomes of the Caucasus

A Comprehensive Review

NOVA

CAUCASUS AND CENTRAL ASIA POLITICAL, SOCIAL AND ECONOMIC ISSUES

BIOMES OF THE CAUCASUS

A COMPREHENSIVE REVIEW

CAUCASUS AND CENTRAL ASIA POLITICAL, SOCIAL AND ECONOMIC ISSUES

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This book is dedicated to my teachers, colleagues, friends and internationally renowned biologists Prof. Dr. Alexander F. Emelyanov

and

(to the memory of) Prof. Dr. Izyaslav M. Kerzhner,

Zoological Institute of the Russian Academy of Sciences (RAS)

CAUCASUS AND CENTRAL ASIA POLITICAL, SOCIAL AND ECONOMIC ISSUES

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A COMPREHENSIVE REVIEW

ARNOLD GEGECHKORI

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CONTENTS

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INTRODUCTION

The Caucasus is a geopolitical region which encompasses four independent countries. The North Caucasus includes the following republics of the Russian Federation: Adygeya, Karachayevo–Cherkessia, Kabardino–Balkaria, Northern Ossetia, Ingushetia, Chechnya, Dagestan, and parts of the Krasnodar and Stavropol Provinces. The area to the South of the Greater Caucasus Range, i.e., the South Caucasus, includes all of Armenia, Azerbaijan, and Georgia (Gvozdetsky 1963).

The area is situated between the Black Sea (west) and the Caspian Sea (east) in a triangle of three massive mountain peaks; the Elbrus (5,642 m a. s. l., the highest summit) in Kabardino-Balkaria, the Kazbek (5,033 m a.s.l.) in Georgia, and the Ararat (5,165 m a.s.l.) found in Turkey, close to the Armenian border (Gvozdetsky 1954, 1963).

The beauty of the Caucasus is much celebrated in Russian literature, most notably in Pushkin's poem 'Captive of the Caucasus', Lermontov's novel 'A Hero of Our Time' and Tolstoy's novels 'The Cossacks and Hadji Murad'

The Caucasus is not only the natural bridge between Europe and Asia. Throughout its history, the region was the permanent battle-ground between two continents of several dominant imperial powers, namely the Greeks, Romans, Persians, Turkish Ottomans and Mongolians, before the region, over the course of 200 years, was finally incorporated into the Russian Empire (Longuet-Marx (Ed.) 1998). This region is still under the threat of post-Soviet wars and interethnic conflicts at different levels (O'Loughlin *et al.* 2007; Coene 2010).

The region covers about 441,000 km^2 (Gvozdetsky 1954; Dumitrashko 1966, 1977). It should be stressed that the definitions of 'Caucasus Biodiversity Hotspot' and 'Caucasus Ecoregion' concepts also includes parts of northeastern Turkey (the Black Sea coastal area) and part of northwestern Iran (the Caspian Sea coastal region), covering a total area of 580.000 km^2 (Williams *et al.* (Eds.) 2006).

The word 'Kavkaz' is very old though the origin of the word has not been determined exactly. Pliny the Elder's *Natural History* (AD 77-79) derives the name of the Caucasus from the Scythian *kroy-khasis* ('ice-shining, white with snow') (*https://en.wikipedia.org/wiki/Caucasus*). According to the other version it may be connected with the Hittite *Kaz-kaz*, the name of the people who lived on the southern coast of the Black Sea. For the first time it was mentioned (as Káukanoç) in the Greek tragedy Prometheus is bound by Aeschylus, the ancient Greek dramatist (*c. 525 BC/524 BC – c. 456 BC/455 BC*) in which Prometheus is bound to a rock as punishment from Zeus for providing fire to the mortal humans (*encyclopedia2.thefreedictionary.com/Kavkaz*).

According to the 11th century Georgian chronicler Leonti Mroveli, Kavkas was a son of Togarmah and grandson of biblical Noah's third son Japheth. After the fall of the Tower of Babel and the division of humanity into different languages Togarmah settled with his sons Kartlos, Haik, Movakos, Lekos, Heros, Kavkas, and Egros between two inaccessible mountains, presumably Mount Ararat and Mount Elbrus (Qoranashvili 1996).

The Czech linguist and archaeologist Betrich Hrozny suggested that Kavkaz comes from the word 'Kash' or 'Kuoh', the name of the land of an early Indian civilization, which has not left any written documents (Hollubek & Krikva 2006).

Scientific names of vascular plants follow Czerepanov (2007), for mammals Wilson & Reeder (2005) and for birds Beaman (1994). The geological time scale of the Earth's history (terminology), sequence and time of geological periodization during the last 600 mya follow Eicher and McAlester (1980). Consulted dictionaries of biological and a more general scientific nature include Grebenshikov (1965); Reimers (1990); IUCN multilingual dictionary of conservation terms (1976); Afanasjeva *et al.* (1979); Menabde (1983); Makashvili (1995) and Maruashvili (1985).

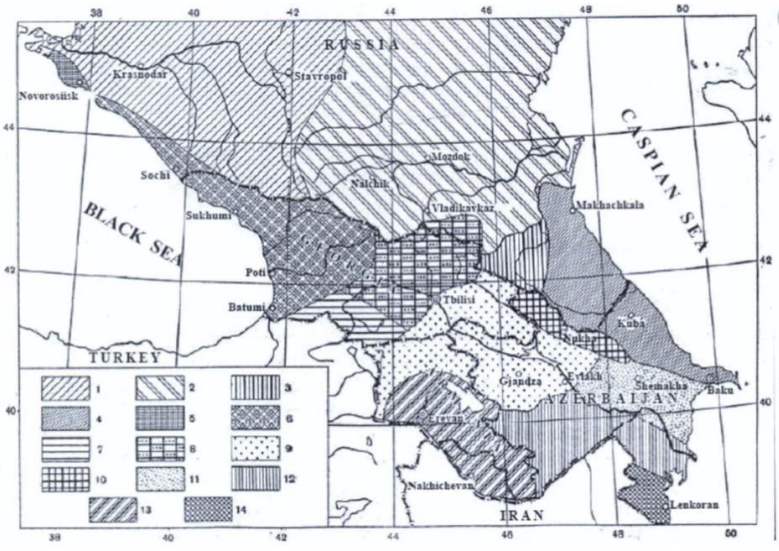

Figure 1. Schematic map of the natural-historical regions of the Caucasus. 1. Western part of the North Caucasus; 2. Central part of the North Caucasus; 3. Inner Dagestan; 4. Eastern part of the North Caucasus; 5. Novorossiiskaya Oblast (Region); 6. West Caucasus; 7. Meskhet-Javakheti; 8. Upper Kartalinia (Kartli); 9. Central Transcaucasia; 10. Alazani-Avtorani Region; 11. Shirvani Region; 12. Zangezur-Karabakh region; 13. Southern Transcaucasia (middle reaches of the Aras); 14. Talysh (Gulisashvili 1964).

Georgian terms (ancient, classical, modern, biological and other natural sciences) were translated into English using Rayfield (Ed-in-chief) (2006).

Globally threatened species are indicated using the IUCN criteria with the following abbreviations: EX-extinct, EW-extinct in the wild, CR-critically endangered, EN-endangered, VU-vulnerable, NT-near threatened, LC-least concern, DD-data deficient, NE-not evaluated.

Basically, only current publications that involved references to older literature are included because inclusion of all of the primary literature would have resulted in an excessively long bibliography.

Terms and concepts may differ between English and Russian. Examples include the usage of the terms Middle Asia and Central Asia, Arcto-Tertiary Flora and Turgai Flora, and finally soil classification. As far as is relevant these differences are explained in the text.

PSYLLIDS (HEMIPTERA, PSYLLOIDEA) AS A KEY INDICATOR GROUP FOR UNDERSTANDING OF THE CAUCASIAN BIOTA

The overview of biomes is first and foremost the result of my long-term comprehensive (faunistic, floristic, biogeographical) studies of the wildlife of the Caucasus proper and Caucasus Ecoregion in general. In this study I focused first of all on the psyllids or jumping plant-lice (Insecta: Hemiptera, Psylloidea).

Psyllids are small (1-5mm) phloem feeding insects that are typically monophagous (feed on a single plant species) or narrowly oligophagous (feed on a few related species). In their nymphal stages in particular, they inhabit almost exclusively perennial dicotyledonous plants (Gegechkori 1968; Loginova 1968; Hodkinson 1974; 2009, Burckhardt 1989). There are about 4000 described species distributed world-wide in all biogeographical regions (Li 2011; Burckhardt, pers. comment). Together with aphids, scales and white-flies they form the monophyletic group, Sternorrhyncha (Homoptera), which was until recently considered basal within the true bugs (Hemiptera) (*Percy: www.psyllids.org/*). Psyllids have recently been considered as vectors of serious plant diseases, as economically important pests in agriculture and forestry and as potential control organisms of exotic invasive plants (Burckhardt & Ouvrard 2012). The current taxonomy of Psylloidea is provided by Burckhardt and Ouvrard (2012) based on a cladistic and phenic study of larval and adult morphological characters of the world fauna by White and Hodkinson (1985). The superfamily Psylloidea in the former Soviet Union contains about 520 species (Gegechkori & Loginova 1990) and in the Caucasus – about 210 species (Gegechkori 1984a) (Figure 2).

Figure 2. Gall-inducing psylloid *Trichochermes walkeri* feeds on *Rhamnus cathartica*.

The data were gathered during almost thirty years (1962-1990) of field work in all biomes and altitudinal zones of the 14 natural-historical regions of the Caucasus and in all vegetation seasons (early spring – late autumn). During the years 1990-2018 similar excursions were made but with a lower intensity. Field excursions involved all Strict Natural Reserves, National parks and Biosphere Reserves of the Caucasus. Data for interregional comparison were collected in the Caucasus Ecoregion (Turkish Caucasus, Iranian part of Hyrcanian refugium), Middle (Central) Asia, Siberia and the Russian Far East (1981-1991), in Asia Minor (Turkey, 1995-1998, 2006), Asia Interior (Iran, 2012) and in other parts of the world (1986, 1989, 2000-2003), involving all biomes of the world (Gegechkori 2008) and almost all 'Biodiversity hotspots' (CEPF 2000). The results are presented in various monographs (Gegechkori 1975a, 1978, 1984a, 1985, 2007, 2008; Gegechkori & Jibladze 1976; Gegechkori & Loginova 1990), and numerous articles.

Low mobilty of psyllids and, therefore, poor powers of dispersal allows them to be used successfully as a highly indicative (bio-indicator) group for environmental research (Hodkinson 1974, 2009; Loginova 1968; Gegechkori 1984a, b).

In the Caucasus and other mountainous countries psyllids display a well expressed altitudinal distribution with their host plants (Gegechkori 1984a; Conci *et al.* 1996).

Psyllids have an almost worldwide distribution (on all major land masses, except Antarctica). They occur in all terrestrial biomes from the tropics up to both of the subpolar regions, the Antarctic and tundra where suitable host plants are found (Hodkinson 1980, 2009).

All these and other ecological characteristics make Psylloidea a very useful group of invertebrate animals for studies of ecological biogeography in different biomes and habitats including the habitat-rich Caucasus region (Ecoregion) (e.g., *Some aspects of the ecology of Psylloidea of the Caucasus*) (Gegechkori 1984a: pp.70-132).

They are rather well fossilized (Loginova 1968). For example, in Dominican amber (Miocene) all extant families are represented except for Carsidaridae and Homotomidae (Burckhardt & Ouvrard 2012). From the Caucasus the single well-known fossil psyllid fauna (almost 32 species) is known from mid-Miocene deposits of the North Caucasus (the area of Stavropol and its surrounding). They belong mainly to species of two genera *Psylla* Geoffroy and *Trioza* Förster (*sensu lato*). The insect fauna looks rather modern, close to or congeneric with extant genera (Bekker-Migdisova 1964).

According to fossil materials and present distribution patterns of psylloids on the former Laurasian (Klimaszewski 1973; Hodkinson 1980, 1983, 1986, 1988; Gegechkori & Loginova 1990; Burckhardt & Basset 2000; Li, 2011) and Gondvanian continents (Hollis 1976, 1984, 2004; Hodkinson 1983, 1989; Burckhardt 1987, 1988a; Taylor 1990), they are obviously well affected by vicariant events. Psyllids are a very useful group in testing hypotheses about the reconstruction of the history of ancestral biotas in response to the changing geography of the Earth (e.g., *Distributional patterns of some psyllid taxa in southern countries in relation to plate tectonic theory* (Gegechkori 1985: pp.31-43) and *The origin and evolution of Psylloidea of different biomes of the Earth* (Gegechkori 1985: pp.46-233).

Psyllids, as mentioned, are generally highly host specific − monophagous or narrowly oligophagous, being restricted to just one or a few closely related host plants. Such close relationships between the hosts and consumers are hypothesized as a mechanism of a close corespondence between the phylogenies of the insects (psyllids) and their host plants (vascular, largely dicotyledonous) (Hodkinson 1984: 327pp.; Gegechkori 1985: pp. 187-194, pp. 251-275; Brown & Hodkinson 1988: pp. 280-284).

These and other materials help to determine the history of the formation of regional fauna, the biogeographic aspects, etc. (e.g., *The principal stages of formation of the Psylloidea of the Caucasus* (Gegechkori 1984a: pp. 269-278).

The present research and review have the aim to increase our knowledge about the set of some organisms inhabiting the Caucasus with particular reference to their habitats. The data presented here are meant to supply a database for nowadays, the presence and distribution of some species, particularly the keystone species. It is highly likely that these factors will be changed in species composition and their range and correlated with either climatic changes (e.g. global warming) or direct impacts (agriculture, tourism, pollution, poaching, etc.).

Figure 3. Field excursions of Dr. Arnold Gegechkori across the Caucasus (1962-2018).

Figure 4. The zoological expedition of a team of scholars of the Georgian National Museum, crossing the lower reaches of the river Aras (1972).

A BRIEF HISTORY OF BOTANICAL AND ZOOLOGICAL STUDY IN THE CAUCASUS

The Caucasus has attracted the attention of geologists, geographers, archaeologists, and anthropologists for years. For 300 years, this region has already been of great interest to naturalists, especially botanists. From the beginning the initiative and guidance was in the hands of explorers, mainly from Western Europe, with Joseph de Tournefort (1656-1706) being the pioneer student of the Caucasus flora (1702-1703). Peter Simon Pallas (1741-1811), Samuel Gottlieb Gmelin (1744-1774), Johann Anton Güldenstädt (1745-1781), Friedrich August Marschall von Beberstein (1768-1826), Christian von Steven (1781-1863), Carl Anton von Meyer (1795-1855), Fridriech Hohenacker (1798-1874), Alexander Davidovič von Nordmann (1803-1866), Karl Koch (1809-1876), Ernest Rudolf Trautvetter (1809-1889), Pierre Edmond Boissier (1810-1885), Franz Ruprecht (1814-1870), Jakov Sergejevič Medvedev (1847-1923), Vladimir Ipolitovič Lipskij (1863-1937), Martin Rikli (1868-1951), Nikolaj Adolfovič Bush (1869-1941), and Eduard August Rübel (1876-1960) were among the first researchers. The first description of the vegetation zonation in the mountains of Georgia was provided in 1742 by the outstanding Georgian geographer Vakhushti Bagrationi (1696-1757).

An important impetus to the study of fauna and vegetation of the Caucasus was the establishment of the Caucasian Museum in Tbilisi[1] (1852), which, since 1866, has consisted of separate departments, for geology, botany and zoology. The Department of Zoology was headed by the incomparable naturalist Gustav Radde (1831-1903), who was also the director of the entire Museum (1866-1903).

Apart from the Caucasus, Radde organized field expeditions to adjacent countries and regions, including Iran, Turkey, Middle Asia, the Crimea and the Balkan Peninsula (1881-1901). Famous zoologists like Johan Karl Edward Ivanovich von Eichwald (1795-1876), Konstantin Ljudvigoviėc Bramson (1842-1909), Nikolai Yakovlevich Dinnik (1847-1917), Julius Lederer (1821-1870), Otto Staudinger (1830-1900), Hugo Feodorovič Khristof (1831-1894), Nicholas (Nicolay) Mikhailovič Romanov (1859-1919)[2], Ludwik Frantiszek Mlokosievich (1831-1909), Boris Petrovič Uvarov (1888-1970) and others contributed to the rich faunal collections of the Museum (Gegechkori & Joosten (Eds.) 2009).

N. M. Albov, F. Bayern, N. Kuznetsow, J. Medwedew, A. Schelkownikow, B. Shishkin, D. Sosnovsky, K. Steven, G. Woronow, and partially also the above-mentioned zoologists, especially Gustav Radde, participated in collecting the plants of the Caucasus (Gegechkori & Joosten (Eds.) 2009).

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[1] Tbilisi (Georgian თბილისი) formerly (until 1936) known as Tiflis. Tblisi it is the capital of Georgia (in 1922-1936), the Imperial administration of the Caucausus during the Russian rule from 1801-1917, as well as the Transcaucasian Socialist Federative Soviet Republic from 1922 to 1936, etc. (*https://en.wikipedia.org/wiki/Tbilisi*)

[2] Grand duke Aleksander Mikhailovich of Russia (in Russian Александр Михайлович), was a branch of the Romanov dynasty. He was three years old when, in 1862, the family moved from Russia to Tiflis (Georgia) where his father, Grand Duke Michael Nikolaevich of Russia, was named Viceroy of the Caucasus. Nicholas spent his childhood and youth in Georgia, where his family (parents, brothers) lived for twenty years. From his youth in the Caucasus, Nicholas, a scholar and an eminent historian, developed an interest in wildlife (botany, entomology). He had rich collections of rare butterflies (part of his collections are deposited in the Georgian National Museum – A.G.). He published a ten-volume work entitled 'Discussions on the Lepidoptera' (*https://en.wikipedia.org/.../Grand_Duke_Nicholas_Mikhailovi...*).

As we see most of the eighteenth century investigations of natural history in the Caucasus were carried out by Western Europe's scholars (mainly Germans) via St. Petersburg's Academy of Sciences (founded in 1724 by order of Czar Peter the First. Researchers of European and then Russian origin prevailed in it for about 150 years.

According to Maharramova (2015), the first publication on the flora of the region was written by M. von Bieberstein in *Flora Taurico-Caucasica* (1808) who described about 2,000 Caucasian plant species. During the 19th century, Caucasian species were included in *Prodromus* of de Candolle (1824-1873), *Flora Rossiaca* of Ledebour (1841-1853, about 3,000 species), *Flora Orientalis* of Boissier (1867-1884) and *Flora of the Caucasus* of V.I. Lipskiy (1899, about 4,500 species). In 1901, N. Kuznetsov, N. Bush and A. Fomin began to publish *Flora Caucasica Critica*, but publication was interrupted during World War I and the Russian Revolution. A great contribution to the flora of the region was made by outstanding A.A. Grossheim, who published, among other titles, the comprehensive *Flora of the Caucasus* (1928-1967), *The analysis of the Caucasian Flora* (1936), *Manual of the Caucasian Plants* (1949), and the first *Flora of Azerbaijan (*1934-1936). The next major work describing Caucasian species was *Flora of the USSR* (V.L. Komarov (Ed.) 1934-1960). During the 20th century, many works on the flora of different regions of the Caucasus were published. By the 21st century, old publications were out-of-date and a new *Caucasian Flora Conspectus* was edited by the outstanding A.L. Takhtajan (2003-2008). First data on the endemic species of all the regions belonging to the Caucasus Ecoregion were given in the *Red list of the Endemic Plants of the Caucasus* (Solomon *et al.* 2014).

The first study of the fauna of the Caucasus was published by entomologist E. Ménétriés: *Catalogue raisonné des objets de zoologie recueillis dans une voyage au Caucase et jascu'aux frontiĕres actualles de la Perse* (St. Petersbourg 1832). This work was published on the basis of a field expedition (1829-1830) in the eastern Caucasus. Further reports on the richness and diversity of the animal kingdom of the Caucasus can be found on the basis of travel notes during the 19th century by K. E. von Eichwald: *Fauna Caspio-Caucasica* (1841). The next publication *Meletemata entomologica* (1845-1846) by F.A. Kolenati contains extensive taxonomic studies in entomology (Coleoptera, Dermatoptera, Lepidoptera, Neuroptera, Aphaniptera, Anoplura), arachnology and, extensively, Chiropterology. In connection with a faunistical study one must refer with profound gratitude to the A. Nordmann – *Die in Gabiete der Fauna Taurico-Caucasica* (1851); as a result of expeditions to the Caucasus the species of butterflies have been listed by E.F. Eversmann (1851), and other entomologists, J. Lederer (1852, 1860, 1864) and O. Staudinger (1871), etc. A significant role in the development of Lepidoptera was played by N.M. Romanov (1884-1887) in *Les Lépidoptéres de la Transcaucasie* (in Romanoff, *Mem. Lépid*). He greatly expanded the list of species of butterflies of the South Caucasus (Didmanidze 2005).

As already mentioned, the most famous explorer and traveller during the late 19th and early 20th centuries was G. Radde – one of the most many-sided, encyclopedically educated scholars. He pioneered complex and multiple field expeditions across the Caucasus, excursion routes (over 35 years) covering hundreds of kilometers, included the most remote places of the region from the 'jungles' of Colchis and Hircan forests up to the towering snowcapped mountain of the Greater Caucasus. Scientific interests consisted of both natural (geography, botany, zoology) and cultural (ethnography) heritages of the North- and South Caucasus. These most complete and comprehensive investigations are cited in numerous monographs (volumes) and articles. For example, *Ornis Caucasica* (1884), *Die Sammlungen des Kaukasischen Museums*

(alternative text in Russian: *Kollektsii Kavkazskogo Muzeia*). Actually, it was descriptions of the collections of the Caucasian Museum and his own biography in six volumes. The first volume was dedicated to a zoological study of the region (two volumes from six were not finished during his life). If we take into account the fact that he set up the Caucasus Museum in 1867 (founded in 1852) and Public Library (founded in 1846) in Tiflis, his contribution to the development of natural history in this region is priceless (Gegechkori 2012b) (Figure 5).

Figure 5. Gustav Radde (1831-1903).

The next list of major works dedicated to the Caucasian animal kingdom include: *Beasts of the Caucasus* by N.J. Dinnik (1910), *Mammals of the Caucasus region*, vol. 1-2 by K. A. Satunin (1915-1920) (Gegechkori 2012b).

Traditions of elaborated research on fauna were continued among the academic expeditions of the beginning of twentieth century. During the period following the political changes in Russia and the Caucasus, field expeditions and collecting of faunistical materials in this region increased significantly. This increase was mainly through the Zoological Institute of the Academy of Science of the USSR (Leningrad) and similar institutions within the Republics of the North - and South Caucasus. It should be pointed out a series of publications *Animal kingdom of the USSR* (in Russian) in five volumes of which vol. five is dedicated to various groups of animals of the Caucasus. A great contribution to the mammalian fauna of the Caucasus was made by N.K. Vereshchagin (*The mammals of the Caucasus; a history of the evolution of the fauna* (1959), translated from Russian into English 1967) (Gegechkori 2002).

The 20th century can be considered as the heyday of the study of Caucasian nature with the activities of two outstanding scientists A. A. Grossheim (1888-1948) and A. L. Takhtajan (1910-2009). Their direct and indirect pupils from Armenia, Azerbaijan and Georgia have also made a valuable contribution to botanical science. Worth mentioning are, among others, I. S. Abashidze, S. D. Agadjanov, A. G. Dolukhanov, R. I. Gagnidze, V. Z. Gulisashvili, L. M. Kemularia-Natadze, N. N. Ketskhoveli, A. L. Kharadze, A. A. Kolakovski, A. K. Magakjan, L. B. Makhatadze, G. S. Nakhutsrishvili, L. I. Prilipko, I. S. Safarov, M. E. Sakhokia, I. I. Tumadjanov and others (Maharramova 2015).

An intensive study of the fauna of the Caucasus was carried out by P.A. Zaitsev, a native scientist from Georgia, and the Russian naturalists G.Y. Bey-Bienko, N. S. Borchsenius, O.L.

Krizhanowski, L.A. Portenko, M. Ryabov, A.A. Stackelberg, M.E. Ter-Minasian, N.K. Vereshchagin, A.K. Zagulyaev and others (Gegechkori 2012b).

From 1970 onwards, the staff of the Department of Zoology of the Georgian National Museum (as the former Caucasian Museum was named since 1852), led by A.M. Gegechkori (1970-2005), resumed Radde's tradition to study biodiversity in all regions of the Caucasus and in adjacent countries. E.A. Didmanidze and I.A. Skhirtladze were the first women scientists who, for 20 years (1970-1989), collected invaluable entomological material from every natural zone of the North- and South Caucasus.

Today the Georgian National Museum holds about 160,000 herbarium specimens (including samples collected in the period 1805-1810 by Ch. Steven), about 480,000 animal specimens of which 295,000 are invertebrate and 33,000 vertebrates with many duplicates. It includes the unique specimens of butterflies presented to the Museum by the cousin of the Russian Tsar N. Romanov. Some collections belong to animal species that are today extinct in the Caucasus, e.g., the Turanian (Caspian) tiger and the Caucasian mountain bison. Many stuffed animals were prepared for the Museum by I. Chkhikvishvili with the assistance of the German naturalist K. Krell (1932) (Gegechkori 2002).

The flora and fauna of the Transcaucasian countries and Ciscaucasian republics of the Russian Federation are investigated by a large network of research institutions, mainly belonging to the National Academies of Sciences. Most institutions carry out research projects on the biodiversity of the Caucasus, as do the respective chairs of botany, zoology, ecology and forestry Faculties of Universities, and the scientific staff of botanical gardens, zoological parks, strict nature reserves (zapovedniks), and national parks.

The first ever national University in the Caucasus (*Alma Mater*) was opened on January 26 (new style February 8), 1918 in Tbilisi ('White Temple'), symbolically on the Memorial Day of King David Agmashenebeli (the Builder).

Recently, the 100th anniversary of Ivane Javakhishvili Tbilisi State University (TSU) was held during 2018 (with nationwide and international celebrations that took place throughout the year). Under the aegis of UNESCO the relevant decision was made at the 39th session of the UNESCO General Conference in Paris upon proposal by member states. The University laid the foundation for a European-type higher school in Georgia based on Georgian educational traditions. It should be remembered that one of the first higher educational institutions was the Fazisi Academy in Colchis (4th century) followed by the Gelati and Ikalto Academies in medieval Georgia (11th-12th). Now, TSU is the only University, not only in Georgia but also throughout the Caucasus region, which has been ranked among the top two percent of Universities in the world, according to U.S. News & World Report.

The chairs of Botany and Zoology of the State University of Georgia were founded in 1919 by the Russian botanist S. G. Navashin and zoologist (entomologist) B. P. Uvarov as the first chair-holders. In 1852 the Royal Garden of Tiflis was awarded the new status of 'Botanical Garden'. Consequently, with the foundations of the Caucasian Museum (1852) and the Botanical Gardens, Tiflis became the center of botanical investigations in the Caucasus.

The Caucasus possesses a very wide range of natural habitats and climatic regions. This has led to a similar richness in numbers and variety of plant and animal species (Gegechkori 2008).

The biodiversity of the Caucasus is exceptionally rich, conditioned by diverse climatic and topographic features and by a complex geological history. 'Almost all species of Europe and

Asia coming together in the Caucasus and live here side by side' (Anisimov 1916 cited in Gegechkori 2007).

Various global organizations have identified the Caucasus as one of the biodiversity hotspots of the world. Now this biodiversity is being lost at an alarming rate due to unsustainable logging, overgrazing, poaching, infrastructure development, and pollution. Conservation strategies in the Caucasus Ecoregion are supported by a range of scientific, governmental, and non-governmental organizations, including the Global Environmental Facility (GEF), the World Bank (WB), and the US Agency for International Development (USAID). Non-governmental, environmental organizations carrying out programs in the region include Greenpeace, IUCN, CNF and WWF. WWF has a Country Office in Georgia, Tbilisi (WWF – Caucasus), which has been active since 1990.

As well as these international and regional institutions, research centres in the four Caucasus countries are involved in biodiversity conservation. The Center for Biodiversity Conservation and Research (NACRES) was founded in 1989 (Tbilisi). Its conservation activities in the South Caucasus are based on scientific research (e.g., 'Conservation of *Capra* species in Georgia', 'Brown Bear Conservation in Georgia', the research programme also included the famous male leopard from Vashlovani National Park). Another non-governmental organization is the Georgian Centre for the Conservation of Wildlife (GCCW, Tbilisi 1994) with research into living nature and conservational and educational programmes as its main goals. It is also important to mention the Azerbaijan Ornithological Society (1986), the Armenian Society for the Protection of Birds (1999), and the Russian Bird Conservation Union (1993) (Gegechkori & Joosten (Eds.) 2008).

Box. 1. The Phenomenon of Blumenbach's 'Caucasian race'

The dawn and dusk of scientific anthropology focus on the Caucasian race. The systematization of race concept during the Enlightenment period did not receive much support. However, the idea received its influential theoretization in the writings of a colleague of Meiners from the University of Göttingen, Blumenbach. He proposed a new, polygonal and major hypothetical racial division.

Johann Friedrich Blumenbach (1752-1840), German physician, natural scientist, physiologist and comparative anatomist. He is often cited in the scholary literature as 'the father of anthropology'. In the historiography of physical anthropology, Blumenbach appears as a Founding Father of racial science and the classification of races (Painter 2003). His M.D. thesis – *De generis humani varietate nativa* (1775), later was translated in English ('On the natural variety of mankind').

Many historians of science believed that Blumenbach belongs with Buffon, Linnaeus, Kant, Lamark, and Cuvier as Enlightenment thinkers who all made significant 18th century contributions to the field of scientific anthropology. Blumenbach was the first to show the value of comparative anatomy in the study of man's history, and he is well known as being one of the first to propose a scientific classification of the races mankind (*http://www.blumenbach.info/-/Proposal_Pt_3.html*.).

Blumenbach's thesis was published in three editions. In 1775 the first edition discussed four geographically defined varieties of humans, while the second edition in 1781 outlined five geographically defined varieties. He developed this classification further in the third edition in 1795 (see below), which is the definitive volume, where he provided generic rather than geographical labels. He identified the major unique features of humans as: the large brain, speech,

erect posture, two free hands, naked skin and the hymen in women (Blumenbach 1865; Painter 2003, 2011).

Blumenbach underlined the unity of humanity - that all humans are one species – *Homo sapiens*. However, he saw gradations among humans, but no distinct species or subspecies. He attributed differences between five human types, such as variations in stature, color and even the shape of the skull to environmental factors, largely to climate which exerts its full influence, and produces its most deteriorating effects in a savage of society. Another factor, according to Blumenbach, is pure biotic, i.e., contemporary society, the level of civilization in which men are educated and the mode of life which is attracted to their general appearance, the form of expression of their emotion and their whole aspect. Blumenbach viewed mankind as an object of natural history, an animal as of one group and superior to another one. He surveyed characteristics of human races, mapped their distribution and invented comparative physiological anatomy. Unlike Mainers, Blumenbach based his anthropological classification primarily on craniology after deciding that there was more to racial differences than skin pigmentation (Baum 2006 and references therein).

In addition to the index of skin color, he focused on other bodily measurements, especially of skulls. His most important anthropological work – 'On the Natural Variety of Mankind' – was based on a collection of sixty human crania. Among them was the skull of a young, Georgian woman sent in 1772 from Russia (St.Petersburg) by a famous scientist, Ash. Blumenbach reduced a diversity of skulls to five main varieties. Unlike Camper's idea that only the measurement of facial angles was important, Blumenbach measured skulls along several lines, placing skulls from around the world in a horizontal line on a table and studying them from the rear view. This approach would allow the identification of various parts of the skulls – forehead, the size and angle of the jawbone, the angle of the teeth, Camper's facial angle in profile and so on – that formed the national character (Painter 2003, 2011; Teo 2009).

The physical traits of Caucasoid crania are still recognized as distinct within modern forensic anthropology in contrast to the Mongoloid and Negroid races.

In the first edition of his work (MD thesis, 1775) Blumenbach pointed out that climate and culture determine the outward appearance of various kinds of people, portraying brown skin as less beautiful than white. Having initially built upon the Linnaean scheme, Blumenbach in the 1780s and 1790s departed from Linnaeus's four-way classification of humans. The second edition of his work (1781) added Malays and introduced the five-fold racial division: Caucasian (white race), Mongolian (yellow race), Malayan (brown race), Ethiopian (black race) and American (red race) with the Caucasian example in the center. He wrote: 'The middle one is a very symmetrical and beautiful one of a Georgian female . . .' (Painter 2003, 2011 and references therein; Baum 2006).

He stressed that five races were more consonant to nature than Linnaeus's four-way racial classification of *Homo sapiens*. In the 1795 third edition of his work, Blumenbach improved the description of his five varieties of humankind and specifically in this edition described one of his races as the '**Caucasian variety**': color white, cheeks rosy; hair brown or chestnut-colored; head subglobular; face oval, straight, its parts moderately defined smooth, nose narrow, slightly hooked, mouth small. The primary teeth placed perpendicularly to each jaw; the lips (especially the lower one) moderately open, the chin full and rounded. In general, that kind of appearance which, according to our opinion of symmetry, we consider most handsome and becoming. To this first variety belong the inhabitants of Europe (except the Laps and the remaining descendants of the Finns) and those of Eastern Asia, as far as the river Obi, the Caspian Sea and the Ganges; and lastly, those of Northern Africa' (Blumenbach 1795, third edition).

With regard to the Caucasian race or *Varieties Caucasia*, the scientist named it after the Caucasian peoples from the southern Caucasus region, whom he considered to be the archetype for the grouping (Oxford English Dictionary: 'a name given by Blumenbach').

Another reason the Caucasus had such an attraction to Blumenbach was because of its proximity to Mount Ararat where according to the Biblical account Noah's ark eventually landed after the flood. The Caucasus was also the traditional site of Prometheus and the Golden Fleece – myths featured in the Caucasus (Schiebinger 2004 and references therein). According to Painter (2003) 'its very vagueness probably made it more attractive than the more precisely located 'Georgia, whose name lacked this Caucasus mythological and symbolic charm'.

Later anthropologists of the 19th and early 20th century (Pritchard, Broca, Morton, Dixon, etc.) came to recognize other Caucasian morphological features (Lieberman 2002).

Blumenbach was regarded by his contemporaries as one of Europe's greatest scientists; indeed, his scientific heritage has been largely influential in the thought of several generations of early anthropologists in Europe and the United States. A number of outstanding, rare theorists have taken up his racial theory making it the firm basis for scientific racism.

Despite the number of human races offered by racial taxonomists: three (Cuvier), four (Kant), four (Linnaeus), six (Buffon), eight (Agassit), twenty-two (Morton), etc., within their racialized systems, Blumenbach is generally regarded as being the first to develop a scientific concept of race as applied to humans.

The science of 'Craniology' was introduced by Blumenbach. The scientists use his method of studying skulls today. Those who are working in forensics still need to use his basic opinions to determine age, sex, race and other factors based on human skulls.

Though recognized as a significant figure during his life, unlike the founding 'fathers' in other scientific disciplines, Blumenbach's fame and influence waned in the latter half of the 19th century. He was largely forgotten by the turn of the 20th century, frequently appearing in studies on race and racism mainly in negative a sense (e.g., Gould 1994; Baum 2006; Rhopal 2007; Teo 2009; Painter 2011 and so on). On the other hand, some specialists take into account the fact that Blumenbach lived in an age when ideas of progress, and the cultural superiority of European ways, dominated political and social life. Despite all of this, he was 'largely, passively recording the social view of his time' and, convinced of the superficiality of racial variation, Blumenbach defended the mental and moral unity of all peoples (Gould 1994).

Blumenbach taught many students, such as the naturalist Alexander von Humboldt, Karl Ernst von Hoff. When he was appointed curator at the University of Göttingen, the collection of human skulls housed 85 specimens. When he died (1840), the collection had grown to 245 crania.

As we see, human diversity has long fascinated scientists, but unfortunately it also has led to discrimination. The dominant western cultural ethos, that whites were 'superior' and blacks 'inferior' (and even 'ape like'), was commonly reflected in science books published between 1880 and 1980. In the 1930s, most negative ideas of eugenics such as rankings of intelligence (IQ), racial segregation, racial hygiene (inferiority), sterilization, genocide, and contrary, racial superiority, thanks to proponents of eugenics among scientists (Ernst Rüdin, Eugen Fischer, Stuart Chamberlain) were used to correlate human physique with physiological traits (intelligence, criminality, etc.) as justification for the racial policies (pure 'Nordic' or 'Aryan') of Nazi Germany. This argument of pre-Nazi and Nazi ideology was strongly influenced by social Darwinism (with the appearance of Herbert Spencer's social Darwinism) (Hofstadter 1992).

What is race from today's viewpoint? George Gaylord Simpson stated that: 'Races of men have', or perhaps one should say 'had', exactly the same biological significance as the sub-

species of other species of mammals' (Simpson 1966), i.e., biological variation in keeping with general zoological practice (Keita et al. 2004 and references therein).

As late as the 2000s, anthropologist Hewson Smith concluded that race is more than just a biological fact (Stockwell 2002). Mayr (2002) considering that since every local population of *Homo sapiens* has its own genetic pool and a mutational history that is unique to the local environment. Despite this, difference between individuals on the planet may have less to do with genetics, but more to do with culture and social geography. Therefore, geographical and cultural factors are more significant than racial differences based on skin color or genetic differences. Hence, there is no innate superiority of 'whites' vs inferiority of 'blacks' and other skin-colored people. For Mayr, a superiority of a culture of race is thus not due to a set of innate characteristics, but rather due to favorable climate, and to the accident of history, being in the right place, first, at the right time (Smith 2002).

'. . . Skin color or facial features, according to Bamshad and Olson (2003), – traits influenced by natural selection – are routinely used to divide people into races. But groups with similar physical characteristics as a result of selection can be quoted as different genetically. Individuals from sub-Saharan Africa and Australian aborigines might have similar skin pigmentation, but genetically they are quite dissimilar. In contrast, 'two groups that are genetically similar to each other might be exposed to different selective forces'.

Based on the relationship between the patterns of biological and sociocultural variation in extant humans, some researchers continue to conceptualize the term in widely different ways. Another explanation of race involves the following definition: 'all living humans belong to the same species, *Homo sapiens*, and the latter itself includes one subspecies, *Homo sapiens sapiens*' (Keita *et al.* 2004).

Although still used in general contexts, race has often been replaced by other words which are less ambiguous, such as populations, people(s), ethnic groups (a group of people sharing the same culture, history, language, etc.), or communities, depending on context (Keita *et al.* 2004.)

Therefore, biological evolution has stopped but, according to the same author, cultural evolution continues. Despite arousing controversy, both in the past and today, many scientists categorized humans into four distinct races (white or Caucasian, black or African, yellow or Asian, and red or Native American), and within racial groups, as it was previously mentioned, some phenotypical sub-races.

The term Caucasian was largely introduced by Blumenbach and is still used today. For example, it is used in anthropology (Howells 1997), forensic anthropology (Eckert 1997), psychology (Teo 2009). The terms either 'Caucasian' or 'Caucasoid' is used in race genetics in relation to human population origination including the popular notion of an 'African (Real) Eve', woman. She lived in East Africa about 300,000 years ago, and all of us are descendants of this female in the global scale migrations of early members of the genus *Homo* from early Pleistocene until Last Glacial Maximum; the paths by which Neolithic pastoralists spread from the Middle East toward Europe, West Asia, and North Africa (Cavalli-Sforza *et al.* 1994).

'Caucasian' is broadly recognized in the craniology, epidemiology, forensic archaeology, especially in the USA (http.//an.wikipedia.org(wiki) Caucasian race). Among other races the white race, under the name 'Caucasian' is still exhibited in many museums of the world.

Time has shown that some of Blumenbach's views were wrong (e.g., 'scientific romanticism', which means that maximal beauty of people comes from the Caucasus, and the probability that humans were first created in this area). Despite the changes made in Blumenbach's theories with respect to advances in biology when evolution and natural selection became widely accepted, he is – one of the least racist thinkers of his day - still highly credited for his works within anthropology and comparative anatomy.

Chapter 1

GENERAL CHARACTERISTICS OF THE CAUCASUS

1.1. OROGRAPHY

The Caucasus region (N 47^0 15′ to N 38^0 25′, E 36^0 30′ to 50^0 20′) is mainly mountainous and, as mentioned, covers approximately 441,000 km^2 of which about 15% is above the treeline. It occupies the area between the Black Sea, the Sea of Azov in the west and the Caspian Sea in the east and is therefore also known as the Caucasus Isthmus (Gvozdetsky 1954) (Figure 6).

Figure 6. Caucasus Ecoregion (480,000 sq. km.) with the Caucasus proper (~441,000sq. km).

The northern border is formed by the Kuma-Manych depression, the southern border by Adjara (westward) and the Aras River in the South Caucasus (eastward); i.e., by the borders of

Turkey and Iran. The Kuma-Manych Depression is bounded by the Sea of Azov and Kerch Strait on the west, and the Caspian Sea on the east (Gvozdetski 1954; Prokhorov (Ed.-in-chief) 1973; Gabrielian (Ed.) 1986).

The Caucasus is a geographical hinge that connects Eastern Europe with the Asian Interior and has thus an extraordinary crossroad location between Europe and Asia. It is characterized by the complex and imposing mountain ranges (Gvozdetsky 1958).

Its position between two continents has long been and still is the source of controversy between geographers and politicians: does the region belong to Europe or to Asia? The opinion of the scientists is divided, some consider the Caucasus to be a part of Europe, whereas others suggest the region to be part of Asia. Similarly different political bodies have different opinions.

According to Coene (2010), the main viewpoints are the following:

- The Caucasus belongs entirely to Asia because the Europe-Asia border passes through the Kuma-Manych depression (see also *Coincide Atlas of the World, second edition* 2008).
- The Caucasus belongs entirely to Europe because the Europe-Asia border passes along the border between the South Caucasian countries, on the one side, and Turkey-Iran, on the other.
- The Northern Caucasus belongs to Europe and the Southern Caucasus to Asia, because the Europe-Asia border passes along the Greater Caucasus Range.
- The part of the Caucasus north of the rivers Rioni and Kura belongs to Europe and the part to the south to Asia, because these rivers form the Europe-Asia border.
- The main western part of the Caucasus belongs to Europe and a smaller part in the east (basically most of Azerbaijan and small parts of Georgia, Armenia and the Caspian Sea coast of the Russian Federation) to Asia, because the Europe-Asia border passes along the landscape borders. This last version - as Coene indicates, - is the most widely accepted one.

The Caucasus is often divided into two parts: the North Caucasus (Ciscaucasia) and the South Caucasus (Transcaucasia), separated by the Main Ridge of the Greater Caucasus. The North Caucasus thus comprises the northern macro slope of the Greater Caucasus Range and the adjacent foothills and lowlands, whereas the southern macro slope is part of Transcaucasia. The Greater Caucasus includes three provinces: the northern macro slope, the southern macro slope, and the central part. The area is further subdivided into western, central and eastern sectors with the borders between the sectors corresponding to the highest mountains, Mt Elbrus (5,642metres above sea level) and Mt Kazbek (5,033m) (Dumitrashko 1966, 1977; Khain & Koronovski 1998; Gabrielian (Ed.) 1986; Volodicheva 2003; Eppelbaum & Khesin 2012).

Geomorphologically the Caucasus contains the following main landforms (Table 1): (1) the North Caucasus lowlands; (2) the Greater (Great) Caucasus Range; (3) the Intermontane Depression (between the Greater Caucasus and the Lesser Caucasus) comprising: (3a) the Colchis Depression adjacent to the Black Sea in the west, and (3b) the Kura-Aras Depression adjacent to the Caspian Sea in the east; (4) the Transcaucasian Uplands consisting of three mountain systems: (4a) the Lesser Caucasus, (4b) the Talysh Mountains, and (4c) the South Caucasus (Armenian-Javakhetian) Volcanic Upland, which extends into Turkey and Iran.

There are three main lowlands in the South Caucasus: the Colchis, Kura, and Lenkoran (Gvozdetsky 1960; Mil'kov & Gvozdetsky 1976).

The Colchis Lowland (also known as Kolkhida or Rioni Lowland) and the Kura Lowland, divided by the transverse Surami Ridge, comprise the Rioni-Kura tectonic depression. The Colchis Lowland is a young accumulative plain formed during the Pliocene-Quaternary period when the whole region experienced uplift. The Miocene marine basin, which existed in its place, was filled by sediments, the thickness of which reaches 700m. However, a number of rivers, beginning in the Greater Caucasus Ridge and the mountains of Adjara and Imereti (West Georgia), drain the Colchis Lowland delivering and depositing a vast amount of alluvium at a rate exceeding 100 million m^3a^{-1} to the coast and beyond (Gvozdetsky 1960; Mil′kov & Gvozdetsky 1976).

The Colchis Lowland has a flat topography with altitudes gently increasing landwards. It comprises relict river deltas and river-mouth bars and ramps and also relict alluvial deposits. Originally, much of the lowland was swampy and, although extensive improvements have been made, swamps still occupy large areas. The warm and moist climate of the Colchis Lowland preconditions the development of lush vegetation containing many relict species which have survived from the Tertiary; the vegetation in the foothills is especially rich floristically while on the lowland itself, plant communities are less diverse because of the lowland's young age. Little of the climax vegetation survived on the Colchis Lowland with the exception of riparian forests because it is a major agricultural region growing tea, grapes, and citrus fruits. These and many other species were introduced in the 19th century and at present agricultural ecosystems dominate. Of introduced plants, eucalyptus, used in amelioration projects, is particularly widespread (Gulisashvili 1964; Gegechkori 2008).

The Kura (or Kura-Aras) Lowland extends between the Surami Ridge and the Caspian Sea. Absolute altitudes decline from the west (450m above sea level) to the east where the delta of the Kura is located 27m below mean sea level. The lowland is composed of marine sediments in the east, deposited during the Quaternary transgressions of the Caspian, and alluvium delivered by the Kura and the Aras. Protected by the Greater Caucasus from the north and the Likhi or Surami Range from the west, the Kura Lowland has a dry climate with 200-400mm precipitation per annum. Desert and semi-desert and sparse, arid woodlands represent the zonal vegetation. The ground water table is close to the surface and topographic depressions are often swampy. Wetland vegetation communities developing in such habitats are represented largely by *Phragmites australis* and *Bolboschoenus maritimus* while riparian forests develop along the Kura and the Aras Rivers (Gvozdetsky 1960).

Bordering on the Kura-Aras Lowland are southern Kobustan, the Absheron Peninsula with its hills and mud volcanoes, the Iori-Adzhinouri highland region and the Kura sloping plain (in the foothills of the Lesser Caucasus). Also belonging to this territory are the Shida Kartli (Gori) plain and the Alazani-Agrichai longitudinal valley (the Alazani-Avtoran intermountain area) (Grossheim 1932b; Gvozdetsky 1960).

The folded Talysh Mountains (with heights up to 2,477m) and the coastal Lenkoran Lowland are located south of the Kura Lowland, extending between the eastern foothills of the Talysh and the Caspian. This region has a very warm and moist climate with annual precipitation totals exceeding 1,200mm. Climax vegetation communities comprise many Tertiary species but natural forests have been largely destroyed and replaced by agricultural

ecosystems. Natural ecosystems are preserved in coastal wetlands, which are widespread in Lenkoran, and in nature reserve (Hyrcan [or Hyrkan] National Park) (Grossheim 1926, 1948).

Table 1. Main Geomorphological Landforms of the Caucasus (Gvozdetsky 1960)

North Caucasus Lowlands	Western North Caucasus Lowland	
	Stavropol Elevation	
	Eastern North Caucasus Lowland	
Greater Caucasus Range		
Intermontane Depression	Colchis Depression	
	Kura-Aras Depression	
	Lesser Caucasus	Adjara-Trialeti mountain system
		Lokh-Karabakh mountain system
		North Armenian mountain system
	South Caucasus (Armenian-Javakhetian) Volcanic Upland	

The North Caucasus Lowlands are composed of three parts: the Western North Caucasus Lowland, the Stavropol Elevation and the Eastern North Caucasus Lowland.

The Caucasus region is dominated by the massive Caucasus mountain range. This range is sometimes called the Main, Major or Greater Caucasus to distinguish it from another range, for example further south is the orographic unit called the Lesser (or Minor) Caucasus.

The Greater Caucasus is Europe's largest and highest mountain system. It runs from west to east for approximately 1100 km extending from the vicinity of the Taman Peninsula on the Black Sea to the Absheron Peninsula in the Caspian Sea, on an axis oriented west-northwest to east-southeast. Its total area is about 145,000km^2. The Greater Caucasus (Figure 7) with its complex of branching and parallel ridges is generally about 100 km wide, but narrows to 60 km in the Terek River Valley and widens to 135 km in Dagestan. The northern slopes are generally rather gentle and full of terraces and inclined plateaus, whereas the southern slopes are generally steeper and partly fractured. The highest summit of the Greater Caucasus (and therefore of the entire Caucasus) is the already mentioned Mt Elbrus (Figure 8). The highest peak in the South Caucasus is Mt Shkhara (5,068 m) (Figure 9). The ridge between Mt Elbrus and Mt Kazbek is called the Central Caucasus, where most peaks reach heights of between 4,000 and 5,200m. Mt Shkhara and Mt Dykh Tau (5,203 m) in the middle of the Greater Caucasus are very close to each other and represent the highest point of the main watershed ridge of the Caucasus. This is the land of permanent snow and glaciers. The ridge west of Mt Elbrus is called the West Caucasus. The frontal ranges and ridges on the northern side of the western and central Caucasus have a cuesta character. In places, karst is strongly developed in limestone (Gvozdetsky 1958; Geresimov (Ed.) 1966; Gvozdetsky & Mil'kov 1976; Volodicheva 2003; Eppelbaum & Khesin 2012).

The Greater and the Lesser Caucasus are separated by the river valleys of the Rioni (Colchis, in the west) and the Kura (in the east) and connected by the 102 km long Likhi (Surami) Range (900-2,471 m a.s.l.) which has originated by submeridian tectonic faulting and divides Georgia into western and eastern parts. On the other hand, it separates the Colchian Lowlands from the Kura-Aras Basin. Both of these lowland areas are deep depressions partly filled by enormous deposits of Tertiary sediment (several kilometers thick) and Pliocene and Quaternary alluvia (Gvozdetsky & Mil'kov 1976).

Figure 7. The Greater Caucasus Range (GCR), geographical backbone of the Caucasus, the highest landform in Europe. Panoramic view from the Lagodekhi Reserve, E. Georgia. In the foreground: growth of *Acer trautvetteri* (1972).

Figure 8. Mount Elbrus, 5,642 m a.s.l. (1976).

Figure 9. Mount Shkhara, 5,068 m a.s.l. (1983).

The Lesser Caucasus 'with its arcuate N-convex shape is a most heterogenous structure' (Eppelbaum & Khesin 2012). It extends from the Black Sea to the Aras River Valley. The Lesser Caucasus in western Georgia links to the easternward to the Pontic Mountains of northeastern Turkey, and the Talysh Mountains of South-eastern Azerbaijan link to the Alborz (Elburz) mountain range of northern Iran.

The Lesser Caucasus consists of three highlands: 1) the Adjara-Trialeti, (Figure 10), 2) the Lokh-Karabakh, and 3) the North Armenian mountain systems. The highest peaks of Transcaucasia are Mt Giamish (3,724m) on the Murovdagh ridge (the Lesser Caucasus), Mt Gomorgoi (Kijmurkei, 2,477 m) in the Talysh Mountains, and Mt Aragats (4,090m) on the South Caucasus Volcanic Upland. Characteristic features of the Volcanic Upland (Armenian Highland) (Figure 11) are extinct volcanoes, lava plateaux and plains, uplifts formed by lava and tufa, and in the south folded ranges (Aiotsdzor) and large intrusive massifs, for example, the southern part of the Zangezur Range with Mt Kaputdzhukh (3,904m). A tectonic depression, the Middle Aras extends along the Azerbaijan and Armenia border. There are no glaciers in the Lesser Caucasus (Gvozdetski 1960; Maruashvili 1975; Khain & Koronovski 1997; Eppelbaum & Khesin 2012).

The mountains, particularly those of the Greater Caucasus, determine distinct climatic and biotic gradients, both vertical and horizontal, provide a large variety of habitats and form natural barriers that limit the migration of species (Volodicheva 2003).

Figure 10. Western Lesser Caucasus (WLC), striking area of relict and endemic arboreal plants found nowhere else. Part of the Lesser Caucasus, scenic view from Zemo (Upper) Adjara, W. Georgia (1970).

Figure 11. View encompasses Javakheti volcanic plateau. Surface of highland remnant of lava that covered Javakheti since prehistoric time (1998).

1.2. GEOLOGY

According to L.V. Eppelbaum & B. E. Khesin (2012), many outstanding geologists have studied the Caucasus. Here should be mentioned G.V. Abich, I.M. Gubkin, V.E. Khain, K.N. Paffenholtz and others.

Geologic terms and the length of geologic time follow Eicher and McAlester (1980).

The origin of the Caucasus Isthmus is considered on the basis of a modern understanding of Wegener's theory (e.g., Khain & Ryabukhin 2002 cited in Eppelbaum & Khesin 2012); concerning the geology of the Earth through its plate tectonics (e.g., Le Pichon 1968; Dietz & Holden 1970; Lilienberg & Shirinov 1977; Oreskes (Ed.) 2003; van Thienen *et al.* 2004; Keary *et al.* 2009).

The geology and evolution of the Caucasus, particularly the Greater Caucasus range has been studied for at least 150 years (Saintot *et al.* 2006).

The Caucasus (the Caucasian-Arabian belt) is a central part of the huge Late Cenozoic, Alpine-Hymalaian, orogenic belt and its complex structure and landscape of high mountain ranges, intermontane depression and volcanic highlands is a result of the continuous collision (convergence) of continental, that is the Eurasian and the African-Arabian, plates (Adamia *et al.* 2011a; Sharkov *et al.* 2015).

The Greater Caucasus – the backbone of the Caucasus mountain systems, as already mentioned, is Europe's largest and highest mountain belt (Bochud 2011). Saintot *et al.* (2006 and references cited in) comment: 'The Greater Caucasus is located in the Black Sea-Caspian Sea region, which is regarded as a mosaic of terraines, of Gondwanan, Tethyan and Eurasian affinity that are sometimes controversial in origin'.

The Caucasus region in the Late Proterozoic, Paleozoic, Mesozoic and the Early Cenozoic eras located in the now-transgrassed Tethys Ocean (Prototethys, Palaeotethys, Tethys, Paratethys) and its Eurasian and Gondwanian (Africa-Arabian) margins. Within this ocean-continent convergence zone, there existed a system of island arcas (Adamia *et al.* 2011b). 'The structure and geological history of the Caucasus, - as Adamia *et al.* (2011b) indicate, - are largely determined by its position between the still-converging Eurasian and Africa-Arabian lithosphere plates, within a wide zone of continental collision'.

The convergence of the Arabian Plate and Eurasia created the Lesser Caucasus, which is being pushed to the north by the Arabian Plate, stamped against the continental crust and this initiated the development of the Greater Caucasus (Gamkrelidze 1986, 1997; Volodicheva 2003; Philip *et al.* 2009). The Greater Caucasus uplifted simultaneously with the circum-Mediterranean alpine mountain belt: the Alps, the Balkans, the Carpatians, and the Atlas with the Alpine folding from the Oligocene (Vincent *et al.* 2007) till the Pliocene (Adveev & Niemi 2011).

In the course of a few million years the Caucasus thus experienced a dramatic transformation from a marine basin and lowlands to mountain ranges exceeding 4,000 m in altitude.

In the Mesozoic and Early Cenozoic, the Greater Caucasus and South Caucasus represented the North tethyan realm - the southern active margin of the Eurasian lithospheric plate (Adamia *et al.* 2011b).

The Caucasian mountain system belongs to the middle sector of the Apline-Himalayan mountainous belt that was created 28.5-23.8 million years ago by continental collision between

the above mentioned plates (Gamkrelidze 1986, 1997; Golonka 2004). The northward motion of Arabia during the Oligocene and Miocene Epochs, and, therefore, collision between the Afro-Arabian and stable Eurasian lithospheric plates caused neotectonic faulting in the Caucasus (Tutberidze 2012). The folded structure of the Alpine system, coinciding with the Alpine orogeny (Alpide orogeny) started to form in the above mentioned Alpine belt. Among others these mountain systems include the Caucasus Mountains (Moores & Fairbridge (Eds.) 1998).

So, the orogenic processes, due to plates colliding, led to the present mountain chains starting in the Early Tertiary, accelerated during the Plio-Pleistocene, and they are still active nowadays (Adamia *et al.* 2011b). Today the rate of convergence is estimated at approximately up to 30 mm per year (Eppelbaum & Khesin 2012).

The largest part of the Caucasus is overlain by Jurassic and Cretaceous rocks (Figure 12). The section west of Mt Elbrus is predominantly limestone. Sediments of the Jurassic Period (mostly slates) are from the main ridge of the East Caucasus, Inner Dagestan and the Skalisty Khrebet (Ruban 2006). Cretaceous rocks are represented by marl, sandstone, claystone and limestone. Limestone is found in north Dagestan and in the east and west ends of the Greater Caucasus. Kartli and Kakheti (East Georgia) are composed of Tertiary rocks (Saintot *et al.* 2006; Mosar *et al.* 2010). Mt Elbrus and Mt Kazbek are volcanoes and stand aside of the main ridge.

Figure 12. Dinosaur track site from Sataplia site (Imereti province, W. Georgia), GCR. Such ichnological remains are exclusively rare in the Caucasus.

The Lesser Caucasus is formed of volcanic and sedimentary rocks. The northern part contains stratified limestone of the Cretaceous Period, covered by Tertiary sediments, slates, andesites, tufas, sandstones and marls. The south-eastern part of the Lesser Caucasus consists of Jurassic and Cretaceous rocks such as limestone and sandstone. Volcanic plateaus, ridges and massifs reach to the north-east Armenian highlands (Gamkrelidze 1949; Adamia *et al.* 1992, 2010; Gamkrelidze 1997; Sosson 2010).

At present, sedimentary rocks are overlined by lava flows whereas valleys are filled with alluvial-deluvial sediments. The largest volcanic highlands are Samarski, Ketchutski, Armyanski, Goktschinski, Bezobdalski and Mischanski. Individual mountains can reach high altitudes such as Mt Abul (3,300 m), Mt Akhdag (3,570 m) and Mt Aragats (4,090m) (Milanovsky & Khain 1963).

The tectonics and geology of the Caucasus have been extensively studied and many papers on the subject have been published in English (Khain 1975; Khain & Koronovski 1977; Skhirtladze *et al.* 1977; Adamia *et al.* 1981, 1991, 1992, 2010, 2011a; Gamkrelidze *et al.* 1977; Gamkrelidze 1986, 1977; Zonenshine *et al.* 1990; Volodicheva 2003; Golonka 2004; Saintot *et al.* 2006; Philip *et al.* 2009; Mosar *et al.* 2010) and in Russian (Gamkrelidze 1949, 1960; Gvozdetski 1958, 1960; Paffengolts 1959; Milanovski 1968, 1977; Milanovsky & Khain 1963).

1.3. THE MODERN CLIMATE

Almost the entire territory of the Caucasus is located within the temperate climate zone of Eurasia. According to another definition the Caucasus Isthmus is located on the border of the temperate and subtropical climatic zones (Gvozdetsky 1954; Chubukov 1966). Its large orographic heterogeneity, however, provides the region with a unique combination of a very diverse climate from the humid, almost subtropical areas of the West Caucasus and the arid, desert and semi-desert climate of the East Caucasus, to the alpine and nival zone with glaciers and eternal snow.

The Greater Caucasus mountain system with its lofty peaks sharply delimits the boundary between two climatic zones by protection from the excesses of the northern continental climate, i.e., by impeding the flow of cold air masses from north to south into Transcaucasia and warm air masses from south to north into Ciscaucasia. The mountain barrier formed by the Greater Caucasus is particularly appreciable in winter when Ciscaucasia is filled with cold air masses arriving from the north and northeast, while Transcaucasia is protected from their intrusion. The average temperatures for January are -2^0 to -5^0C in Ciscaucasia; 4.5^0C to 6^0C in Western Transcaucaisa (Colchis Lowland), and 1^0C to 3.3^0C in eastern Transcaucasia (Kura-Aras and Lenkoran Lowlands). In summer the temperature differences between the northern and southern parts of the Caucasus diminish. The disparity is more noticable between the temperatures of the western (with a more maritime climate) and the eastern (continental) parts of the Caucasus. The average July temperatures are 23^0C-24^0C in the west and 25^0C-29^0C in the east (Gerasimov (Ed.) 1966; Volodicheva 2003).

The Caucasus is influenced by wet oceanic air masses from the Atlantic Ocean and the Mediterranean Basin from the west and by dry continental air masses from Asia Interior, Central Asia and Siberia. The Black Sea increases the moisture of the Western Atlantic winds. In Transcaucasia the most frequent air movement is from the west bringing moisture from the

Atlantic Ocean and the Mediterranean Sea. On the other hand, the Caspian Sea is not large enough to moisten the dry air from Central Asia sufficiently, so it brings moisture only to the easternmost ridges, i.e., to the Talysh in Azerbaijan and the eastern slopes of the Greater Caucasus. A high pressure above the North Caucasus as an effect of the Siberian anticyclone causes the North Caucasus winter to be mostly frosty and dry. In spring the influence of the Siberian anticyclone slowly decreases in favour of the Azores cyclones that bring wet weather. In summer, continental hot dry air from the steppe zone of Asia moves westwards and facilitates the occurrence of steppe vegetation in the North-East Caucasus (Gerasimov (Ed.) 1966; Volodicheva 2003).

The climate of the high mountains results from the interaction of the free atmosphere and the topography. Altitude controls isolation and temperature, whereas the overall dimension and the orientation of the ridges in relation to the western winds are important for the distribution of precipitation and the accumulation of snow and ice. Relative elevation, terrain shape and slope angles result in strikingly different regional and local climates (Volodicheva 2003).

The barrier effect of the Caucasus is reinforced by two mountain ranges: the Stavropol elevation in the North Caucasus and Likhi (Surami) Range in Transcaucasia. They decrease the influence of western winds and therefore contribute to the creation of a dry climate in Dagestan, desert conditions along the Caspian Sea coast and a similar dry climate in the eastern part of the South Caucasus (annual average precipitation in Yerevan 304 mm, in Baku 206 mm). As a result, desert and semi-desert vegetation prevails in the lowlands and savanna-like arid open woodland in the foothills. The orographic conditions are very diverse and cause many regional differences in climate and irregularities in vegetation zonation (Gvozdetsky 1963).

Both temperature and precipitation vary strongly across the Caucasus, mainly as a function of relief. The temperature-altitude gradient is different in various parts of the Caucasus. In the western Caucasus, under the influence of the Black Sea, the temperature gradient is 0.50/100m. Annual precipitation varies from less than 2,000 mm to over 4,500 mm. Precipitation is influenced by altitude in each locality, but not in a uniform manner across the entire Caucasus. For instance, along the main ridge maximum precipitation occurs around 2,500m, whereas in the Adjara-Imeretian (Meskhetian) part of the Lesser Caucasus the maximum precipitation is at a lower elevation (Gvozdetsky 1963).

Most precipitation falls in the West Caucasus (Batumi 2,465mm, Sochi 1,410mm, Sokhumi 1,370mm). This high amount results in the prevalence of lush mesophytic forest in the lowlands and at lower altitudes, particularly in south-western Colchis. Two South Caucasus regions, Colchis and Talysh, have to be highlighted because they are characterized by an almost humid subtropical climate. This climate must have existed over a long time, because both regions are refugia of flora and fauna elements of the Tertiary. Their special character within the moderate climate zone of the Northern Hemisphere can be explained by the warming effect of the Black and Caspian Seas, especially in winter, and the barrier role of the mountain ridges. The combination of the Caspian Sea and the arid Central (Middle) Asian Kopet-Dagh and Alborz (Elburz) Mountains in Iran is essential for the existence of the Talysh (Hyrcania in general) refugium, whereas the Black Sea and the Greater Caucasus play a similar role for the Colchis refugium. The Greater Caucasus prevents the penetration of cold air masses from the north Boreal (Euro-Siberian) centre into Colchis, whereas the above-mentioned Asian mountains perform the barrier role against penetration of hot air masses in the Talysh refugium. In this way, natural greenhouse conditions maintained two famous shelters for ancient organisms in the South Caucasus. The exceptional climatic position is particularly clear in the

Colchis refugium. The average temperature in January, the coldest month of the year, varies from -20 C to $+5^0$ to 7^0C, average annual precipitation equals 2,000 mm, with a maximum of 4,500 mm at Mt Mtirala (Adjara). Both values constitute record data for the territory of the former USSR (Alpaidze & Shengelia 1989).

The highest degree of continentality is found on the landlocked Armenian-Javakethian Volcanic Plateau. Under a clear sky, a local high pressure cell develops over Armenia in winter and radiation cooling brings about temperatures that are very low for this latitude. The plains and foothills of the eastern Caucasus foreland are characterized by a dry climate and frequent droughts with dry winds and dust storms. Dry summer climates are typical of the Kura-Aras Depression (Gerasimov (Ed.) 1966).

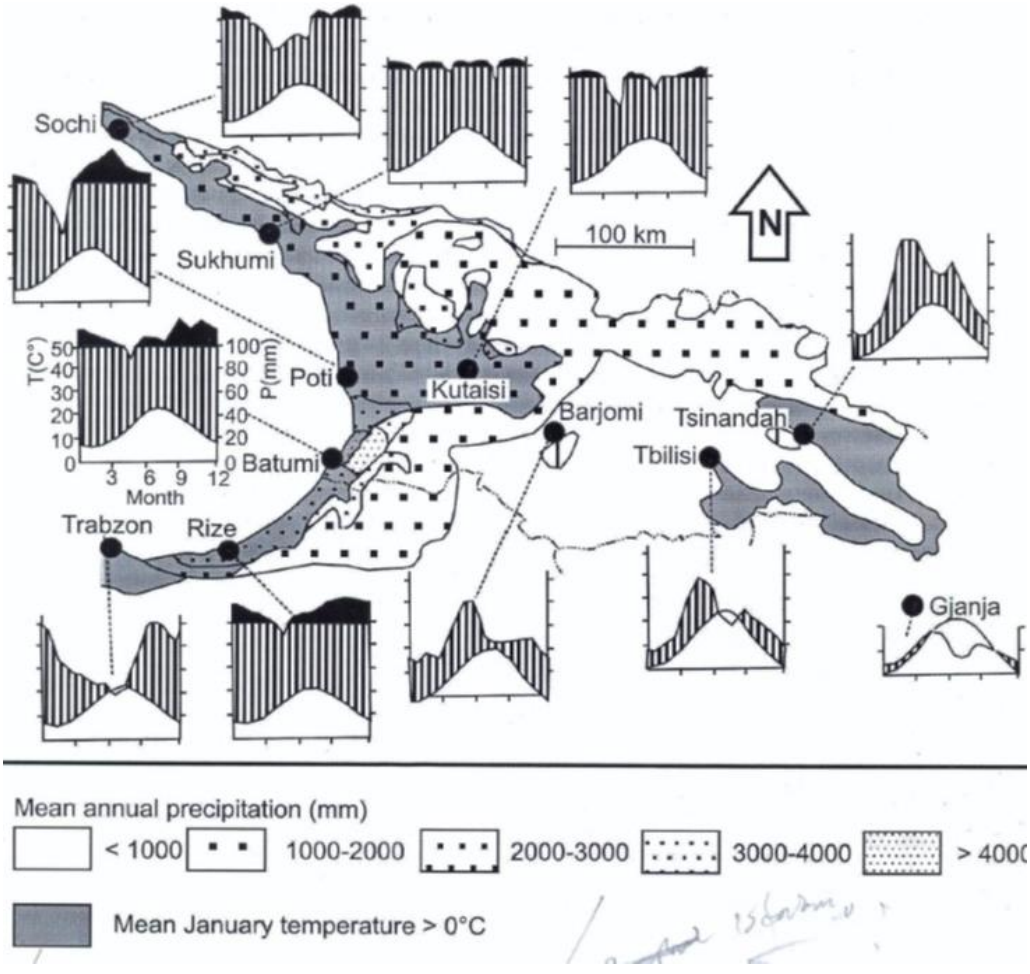

Figure 13. Climate characteristics of the Caucasus (Walter & Lieght 1960-1967).

Thus, the western part of the North Caucasus is characterized by a moderate continental (steppe) climate; the eastern part of the North Caucasus by a drier (desert - semi-desert) climate; a small part of the Black Sea coastal zone (north and northeasternward of Sochi) in the western part of Transcaucasia by a sub-mediterranean type climate; the area south of Sochi, including Batumi, and in general the Colchis Lowland by an (moist) almost subtropical climate; the Kura-

Aras Lowland in the eastern South Caucasus by a dry steppe, semi-desert and desert climate; the Lenkoran Lowland again by a moist almost subtropical climate with mild winters and an abundance of solar heat in summer; the middle part of the Aras River Valley by a dry subtropical climate; and finally the Armenian-Javakhetian Plateau by a dry climate with mainly low moisture and low temperatures in winter (Gerasimov (Ed.) 1966).

1.3.1. Current Glacial Fluctuations of the Greater Caucasus

Glaciers are located mainly in the Greater Caucasus where there are 1,521 of them (Penov et al. 2008) with a combined area in excess of 1,780 km^2. Most glaciers are located in the central sector, which is the highest, in the Glavny and Bokovoy Ridges (Kotlyakov 1966).

The north-facing slopes of the Greater Caucasus develop more glaciers than the southern slopes. The high altitudes and humid climate predetermine the wide-spread development of contemporary glaciation (Kotlyakov 1966).

Extensive plateau, intermontane depressions, and valleys, associated with the ancient drainage network, occur between 2,700 and 3,900m providing ideal conditions for the accumulation of snow and ice and the development of large glaciers of a branching mountain valley type. The north-facing slopes of the Greater Caucasus develop more glaciers than the southern slopes (Kotlyakov 1966).

Out of 215 mountain valley glaciers, known in the Caucasus, 130 occur in this region. Seven glaciers, whose terminations descend to 1,800-2,000m, exceed 20-30 km in length and 20-30 km^2 in area, accounting for 40 percent of the glaciated area of this region. However, the largest glaciers develop on the volcanic cones of the Elbrus (123km^2) and Kazbek (71km^2). Cirque and hanging glaciers are numerous in the central Greater Caucasus. There are also a few surging glaciers. The most dramatic surges were registered at the Kolka glacier, located on the northern slope of the Kazbek massif (Rototaev *et al.* 1983 cited in Volodicheva 2003).

Current knowledge of the dynamics, structure, thermal regime, and mass balance of glaciers is mainly limited to a number that have been selected as representative ones, and have been monitored in the course of national and international research programs. These include the Maruh glacier in the western Greater Caucasus, the Bashkara, Shkhelda, Dzhankuat, Bezengi, and the glaciers of the Elbrus and Kazbek in the central Greater Caucasus. With regard to the thickness of ice, radiosounding has shown that the thickness of typical mountain-valley glaciers of average size (e.g., the Dzhankuat and Maruh) is about 100m while the depth of the Bezengi, the largest in the Caucasus reaches 350m (Tushinsky 1968; Macheret & Luchininov 1973 cited in Volodicheva 2003) (Figure 14).

The later stage of glacial advance resulted from the combination of colder and wetter weather. Evidence of a warm interval (e.g. 'Arkhyz break in glaciation') preceding the Little Ice Age in this region is based on geochemical, pedological, palynological, tree-ring-based summer temperature reconstruction and archaeological data (Kotlyakov 1966).

Glaciers reached their maximum extent in the 1680s, 1750s, and 1850s. Currently, glaciers are in a state of retreat which began at the end of the 19th century. For example, the Dzhankuat glacier has been estimated that between the 1880s and the 1970s, the glaciated area has declined by 600km^2 (or 29 percent) and 25 percent of the ice has been lost. The number of glaciers has increased by 31 percent as a result of disintegration of large glaciers. Deglaciation is more

intense in those regions where precipitation is less abundant and glaciers have been retreating faster on the northern macroslope. The intensity of deglaciation also increases from west to east: while in the western Greater Caucasus the glaciated area had declined by 21 percent. In the central and eastern sectors larger reductions of 30 percent and 40 percent have occurred.

The contemporary glacial retreat is not unique. Extensive degradation of glaciers occurred in the Greater Caucasus between the 3rd and the 13th centuries. The retreat of glaciers was so strong that this period is often referred to as 'the Arkhyz termination' (although it can be argued that 'termination' is not a valid term as glaciers declined but did not disappear altogether). In many regions the tree line was positioned higher than now by 200-300 m and many mountainous passes were free of snow and ice (Kotlyakov 1966; Tushinsky (Ed.) 1968; Volodicheva 2003 and references therein; Gobejishvili & Kotlyakov 2006; *www.rusnature.info/reg/15-4.htm*).

Figure 14. Weichselien glacier lowering from Bezengi Wall (Balkaria, S. Russia). It is one of the largest snowdrifts of the region (length 17 km, depth – 350m) (1976).

In the Northern Caucasus a wide scale glacier retreat occurred in the late 1840s, with four to five minor readvances in the 1860-1880s and three readvances or steady states in the 20th century (1910s, 1920s and 1970s-1980s) (Solomonia *et al.* 2016).

Khromova *et al.* (2014) found that glaciers lost 4.9% of the area between 2001 and 2010. Glacier wastage was higher in the southern slopes at 5.6% vs 4.3% in the northern slopes glaciers. To compare to the European Alps, glacier reduction in the Caucasus Mountains appears to be slower. For example, Fischer *et al.* (2014) reported 33% and 11% reduction for the eastern Swiss Alps for the 1973-2003 and 2003-2009 periods, respectively (Tielidze 2016).

In the Lesser Caucasus (Zangezur Range, Aragats Mts), due to a more continental climate, glaciers are only found on high mountain peaks (Ivankov 1959b cited in Kotlyakov 1966).

During the Late Pleistocene (115-10 ka), some of the largest glaciers in the Central Greater Caucasus descended to 600-750 m a.s.l. It means that the foothills and lowlands of any regions of the Caucasus were ice free. Glaciers on the Lesser Caucasus and the Armenian Highland were insignificant and the lower altitudes reached by glaciers in the Lesser Caucasus were about 2,500-2,700 m a.s.l. In Alborz, the snowline was about 600-1,100m lower than the present level and no traces of the Pleistocene glaciers have been found in the Talysh Mountains (Shcherbakova 1973; Milanovsky 2008; Gobejishvili & Kotlyakov 2006).

1.4. HYDROLOGY AND MAIN WATER BODIES

1.4.1. The Black Sea

The hydrology of the Caucasus and especially its two seas, the Black Sea and the Caspian Sea, historically have a decisive importance in formation of the region's biota, first of all its two outstanding refugia – Colchis and Talysh.

The modern name of the Black Sea goes back only to the 13th century but the appellation is actually much older. It is generally accepted that the primary Greek name *Pontos Axeinos* (*Axenos*), i.e., etymology to á – xeinos – 'inhospitable'. This ominous name was later (after AD) changed to the euphemism *euxeinos* (*Euxinus*), i.e., Eú-xeinos – 'hospitable' (*Encyclopedia Iranica: www.iranicaonline.org/articles/black-sea*).

The Black Sea, like the Caspian Sea, Aral Sea, and Lake Urmia, is a remnant of the ancient Paratethys Sea.

The Black Sea biogeographical region consists of two coastal bands encompassing the southern half of the Black Sea. The longest east-west extent is about 1,175 km. The western part stretches from the delta of the Danube extending east towards the Bosphorus outlet. This stretch is 530 km long and its width varies between 20 and 60 km. The other part – 1,400 km long and between 10 and 160 km wide – streches from east of the Bosphorus over the various mountain ranges along the southern coast of the Black Sea and as far as the Caucasus mountain in the East (Liamine (Ed.) 1961) (Figure 15).

The Black Sea is the most isolated sea in the World. It is connected to the World Oceans via the Mediterranean Sea through the Bosphorus, Dardanelle and Gibraltar straits and with the Sea of Azov in the northeast through the Kerch Strait.

The maximum depth of the Black Sea is 2,212m., the surface area is 432,000 km^2 with a total volume of 547,000 km^2 (State of the Environmental of the Black Sea 2002). The replenishment of the bottom waters of the Black Sea with new seawater from the Mediterranean takes hundreds of years. This very slow rate of replenishment and the large input of freshwater have led to a stratification of the Black Sea. The thin upper layer of marine water (up to 150 m)

supports a unique ecosystem. The deeper and denser water layers are saturated with hydrogen sulfide (H_2S), that has been accumulated from decaying organic matter. The slow replenishment and bad mixing of waters does not provide enough oxygen for the process of decomposition and the bacteria in the lower layers use it up entirely. Consequently, the Black Sea is virtually dead below a depth of about 180m and this boundary is being pushed upwards. Moreover the metabolism of some bacteria generates hydrogen sulfide, a soluble, poisonous gas associated with the small of rotten eggs. Hydrogen sulfide is present in the entire layer of seawater in the Black Sea (Black Sea NGO Network 2004).

Figure 15. The Black Sea. Panoramic view from Cape Bichvinta, Abkhazeti province, NW Georgia. In foreground: Pinus brutia var. *pityusa* (1975).

The catchment drainage area of the Black Sea is 2,000,000km^2 with the total river inflow 340.6 km^3. The Rioni, Kodori, Inguri, Chorokhi (Gorukh), Kyzyl-Irmak, Sakarya, Southern Bug, Dnister, the Danube, Dnieper and Don via the Sea of Azov are the main rivers that flow into the Black Sea.

The Geography and macro-circulation processes existing in the Mediterranean Basin influence the climate of the Black Sea Basin which, in the majority of the sea, is similar to the Mediterranean climate (warm humid winters and hot dry summers). The south-eastern part, surrounded by the mountains is characterized by a humid, almost subtropical climate – abundance of precipitation, warm winter, hot summer. Total amount of precipitation from the Bosphorus to Varne is about 500-700mm per year, in the north near Odessa – 300-400mm in the southern coast of Crimea – 586mm, the amount of annual precipitation increases eastward – 1,600mm between Novorossiysk and Sokhumi to 2,465mm in Batumi (State of Environment of the Black Sea 2002).

The Black Sea is now the largest natural anoxic water basin in the world. This means that 87% of its volume is practically devoid of marine life, except for some forms of bacteria. However, the sea is comparatively rich in living resources. Also, the Black Sea shelf and river

deltas are important spawning grounds for sturgeon and other fish species, and the coastal wetlands are migration and breeding grounds for numerous rare and endangered European birds (Black Sea NGO Network 2004).

The thin upper layer of marine water supports the unique biological life in the Black Sea ecosystem. The deeper and more dense area is (450-2,250 m) inhabited by more specific organisms, basically, as was pointed out, at the level of bacteria, protozoa and some multicellular invertebrates (Ciliate, Foraminifera, Nematoda, Kinorhyncha, Ostracoda and others). There are six species of seagrasses in the Black Sea (State of the Environment of the Black Sea 2002) (Hsü *et al.* 1978; Hsü & Bernoulli 1978).

The Black Sea, along with the Caspian Sea and Aral Sea, in a broad sense is a remnant of the Paratethys (Hsü & Giovanoli 1979; Rögl 1999).

Due to a large catchment area compared to surface area the Black Sea is very vulnerable to pressure from land based human activity and its health is equally dependent on the coastal and non-coastal states of its basin.

Eutrophication, pollution and irresponsible fishing resulted in an overall decline of biological resources, the diversity of special and the recreational values of the Black Sea.

The Bucharest 'Convention on the Protection of the Black Sea Against Pollution' was signed in 1992 and ratified by Bulgaria, Romania, the Russian Federation, Ukraine, Georgia and Turkey in 1994. It was designed to initiate a regional approach for nature conservation of the Black Sea. The Black Sea Environmental Programme was officially established in 1933 by UNDP/GEP (Bucharest Convention). The programme is funded by GEP with additional cost sharing contributions from GEC's PHARE and TACIS programmes as well as bilateral contributions from Canada, the Netherlands, Switzerland and France.

The strategic Action Plan for the Rehabilitation and Protection of the Black Sea was adopted in Istambul, Turkey (1996).

1.4.2. The Caspian Sea

The Caspian Sea is the world's largest lake of inner drainage, with no outlet to the ocean (Figure 16). The word Caspian is derived from the name Caspi, an ancient people who lived to the southwest of the sea in Transcaucasia and has now disappeared. In classical antiquity among Greeks and Persians it was called the Hyrcanian Ocean (*https://en.wikipedia.org/wiki/Caspian_Sea*). The sea extends over 1,200km from the north to the south. The sea has a surface area of 371,000 km^2 and a volume of 78,200 km^3, maximum depth 1.015m. The Caspian drainage basin covers more than 3 million sq km, and included the Volga, Europe's largest river, which contributes more than 80% of the total river inflow, as well as several smaller rivers. The brackish water of the Caspian Sea contains three times less salt than that of the World Oceans. Presently the sea-level stands at 27m below the ocean's level, but the peculiarity of the Caspian Sea consists of repeatedly occuring oscillations of its level (Nikolaeva 1966, in: Gerasimov (Ed.) 1966).

The Caspian Sea, is a landlocked basin, which became landlocked about 5.5 mya due to tectonic uplift and a fall in sealevel. It is more sensitive to environmental changes compared to the world's oceans. As the Caspian is an inland water body, man-caused impact on the catchment area (about 3.5 million km^2) is accumulated here.

Figure 16. The Caspian Sea (schematic map).

The north Caspian is the shallowest portion of the sea, with an average depth of 4 to 6 meters, the Middle part has an average depth of 190 m and the South Caspian Sea contains a depression reaching a maximum depth of 1.025 meters (Voropaev (Ed.-in-chief) 1986).

The biodiversity of the Caspian Sea is 2.5 times poorer than that of the Black Sea (Zenkevich 1963). The main reason of this is probably its variable salinity. According to Mordukhai-Boltovskoy (1979), for the freshwater fauna and flora the Caspian water salinity is too high, and for the current marine species it is low. So, the contemporary Caspian Sea has an ideal environment for brackish water species originating both from marine and from freshwater bodies. Hence, due to their very good osmoregulatory abilities, fishes and crustaceans have the greatest diversity in the Caspian (63% of the total number of species) (Zenkevich 1963). Therefore, the modern biodiversity of the Caspian Sea reflects a complicated history of paleo-Caspian transgressions and regressions, desalinization and salinization (Abramova, 1972; Aladin & Plotnikov 2004).

Environmental problems of the Caspian Sea are multiple and characterized by heterogenity of their origin. From anthropogenic activity should be marked out the artificial regulation of Caspian rivers' discharges. Man-built dams have reduced water input into the Caspian, huge water reservoirs (e.g., the Volga River) prevent a high amount of river fresh waters flowing into the sea. Regulation of rivers that flow into the Caspian is one of the most significant human impacts on the biodiversity of the water body (man-made canals that were built to link the Volga and then the Caspian with other rivers and with other seas via the rivers). Accidents on oil tankers, a high amount of pollutants which are carried by Caspian rivers etc., make significant damage to the biological diversity of the aquatic community. Overfishing and illegal fishing with other factors mentioned earlier resulted in the reduction of populations or the complete loss of some species of fish and other groups of organisms. About 90% of world sturgeon reserves occur in the Caspian Sea therefore it can be considered a global, genetic fund

for these species. Nowadays the catch of sturgeon in the Caspian Sea has reduced from 25,000 tonnes per year to 1, 000 tonnes.

Five countries (Azerbaijan, Iran, Kazakhstan, Russia and Turkmenistan) share the natural heritage of the Caspian Sea. Today the Caspian faces significant environmental problems, many of a transboundary nature, that arise from both anthropogenic and natural causes. The Caspian Environmental programme (CEP) is a regional umbrella programme established by the Caspian littoral states and aided by the international agencies. Due to the necessity for regional cooperation, expressed through a number of regional agreements including the Almaty Declaration of Environmental Cooperation (1994), the CEP is involved in a joint mission with the World Bank, UNEP, UNDP (1995, 1998), where UNDP plays a central role in inplementation of the CEP.

1.4.3. A Brief Review of Freshwater Bodies of the Caucasus (Rivers and Lakes)

An exceptionally large diversity of landscapes is typical of the Caucasus because of the complexity of its orography and its climatic contrasts, as well as the individual features of the history of the formation of the different parts of the Caucasus and the influence of the neighbouring territories.

The rivers of the Caucasus belong to the basins of the Caspian Sea (The Volga River, the Kura and Aras, Sulak, Terek, Kuma and others), the Black Sea (Rioni, Enguri and their tributaries), and the Sea of Azov (the Kuban and its tributaries) (Ioganson *et al.* 1966 in Gerasimov (Ed.) 1966) (Figure 17).

Among lakes should be noted numerous glacial lakes dammed by glaciers and marine ridges (Afkhazava 1969; Tatashidze 2000; Eppelbaum & Khesin 2012).

At present there are nearly 1,900 lakes with a total area of 95.8 km^2 in the Caucasus. As it is usually known the chemical composition of the water of lakes is controlled by geology, precipitation, vegetation, and drainage type (Rosssolimo et al. 1966 cited in Gerasimov (Ed.) 1966; Efremov 1988). Lakes appear in all altitudinal zones of the region. Some of the lowlands are represented by a number of coastal lagoons and limans (e.g., the brackish lake of Paleostomi, remnant of the Black Sea), mountain lakes (e.g., lake Sevan, the largest lake in the Caucasus (Armenia) and one of the largest (total surface is about 5.0 km^2 freshwater high-altitude (1,900 m a.s.l.); lake Ritsa (Abkhazeti (Georgia), located in the Greater Caucasus at a height of 950 m a.s.l. and known as 'the Pearl of the Western Caucasus'. Most of the high mountain lakes have a glacial moraine or karst genesis (Figure 18). Mainly they are small water-bodies. Today, as glaciers retreat, hundreds of new periglacial lakes have appeared in the Caucasus. Among karst lakes should be mentioned the blue lake of Arkhyz, lake Badukskoe (Western Caucasus, Karachay-Cherkessy Republic in southern Russia). The largest net of volcanic lakes occurs in the volcanic plateau of Samtskhe-Javakheti region (1800-2000 m a.s.l.) (the Lesser Caucasus) of southern Georgia.

Figure 17. River Rioni (Guria province, W. Georgia), named Phasis by the Ancient Greeks. Rioni is the major water catchment area for the SW Caucasus (2006).

Figure 18. The Green Lake in the Arsiani Range, WLC, Adjara, W. Georgia, 2,058 m a.s.l. In the background: *Picea orientalis* mixed with *Fagus orientalis* (1981).

According to ECPC (2012), freshwater habitats cover 8.5% of the Caucasus Ecoregion and are crucial for water conservation, spawning of fish and for breeding and migratory birds.

1.5. PEDOLOGY

The founder of the Russian school of genetic soil science, Dokuchaev, appropriately called the Caucasus a natural soil museum (Dokuchaev 1898, 1899, 1900 in Gerasimov 1949). As a result of complex bioclimatic, lithological and geomorphological conditions more than 50 soil types have been identified on its territory (Fridland 1966). The diverse natural conditions of soil formation are furthermore modified by human activity, e.g., by transforming natural into arable lands. In some regions of the Caucasus the cultivation of soil with the frequent use of irrigation has a history of thousands of years, whereas in other regions soil cultivation has only been conducted in the last few centuries. Closely connected with the climatic regime, the soil has a considerable importance for the development of vegetation.

The study of soils of the Caucasus has been instrumental in the formulation of a number of main principles of modern soil science, including the vertical zonality of soils, the theory of provinciality (Zakharov, 1914, 1934, 1938 in Sabashvili 1948), and the distinction of some new types of soils (Gerasimov 1949; Rosanov 1954). Various fundamental monographs were dedicated to the soils of the Caucasus, including in Georgia those of Sabashvili (1936, 1948, 1965), Talakhadze (1964), Urushadze (1987), Urushadze & Blum (2013), in Azerbaijan - Aliyev *et al.(*1953) and Salaev (1966), in Armenia - Galstian (1930), and in Ciscaucasia - Gavriljuk (1947); Zonn (1950) and Fridland (1950).

Figure 19. Red soils, Colchis (Guria province, W. Georgia) (1969).

The soils of the Caucasus are extremely diverse and patchy, as local processes overlay the general vertical zonality (Gegechkori & Joosten (Eds.) 2009).

Different types of chernozems occupy a large territory of lowlands, foothills and plateaux of the North Caucasus, the South Caucasus Upland, the plateau of the Shekino-Adjinouri low-mountains and the Shiraki-Garedji steppe in the South Caucasus.

The eastern slopes of the Stavropol Elevation are covered by dark-chestnut soils and further eastward by light-chestnut soils. The same type of soils occurs in the foothills of the Greater and Lesser Caucasus surrounding the Kura-Aras Lowland. The mountain-chestnut soils in the Armenian Upland that co-occur with mountain-chernozem soils are strongly developed. The coastal zone of the Caspian Sea and the Kura-Aras Lowland are covered by grey semi-desert soils, frequently with saline soils and true solonchaks, alternating with sandy grounds. Grey soils have developed in the lower parts of the Aras Lowland.

Forest soils of moderate climate are found over the extensive north slopes of Ciscaucasia and in the forest zone of the South Caucasus, where mixed deciduous forests prevail under colder climatic conditions. Depending on the dominant species in the forest stand, these forests have grey forest or dark-grey forest soils, whereas at the same altitudes long-fallowed mountain podzol forest soils have developed.

Various types of cinnamonic and mountain-cinnamonic soils occur in areas with a Mediterranean climate. In the Caucasus such soils are present in the south-western Caucasus and in the mid-Aras Depression, small areas are also found in the north-western Caucasus and in the warmest places of south-eastern Ciscaucasia. The limestone ranges of the mid- and high altitude areas have humid-carbonate soils. In the high mountain areas of the Greater and Lesser Caucasus mountain-meadow soils occur. The most conspicuous soil types are present in the most humid regions of the South Caucasus, i.e., red soils and yellow soils in Colchis (Figure 19) and yellow soils in Talysh (usually characterized by a red or yellow color, clayed and a well-developed profile). Meadow, wetland and floodplain soils are confined to water saturated areas and mainly consist of organic soils with undifferentiated profile, strong decomposition and sometimes signs of glaciation (Fridland 1966, in: Gerasimov (Ed.) 1949).

1.6. BIODIVERSITY OF THE CAUCASUS ECOREGION HOTSPOT

‘To prevent language extinction, we must redouble our efforts to prevent biodiversity hotspots and wilderness areas from being converted for short-term gain’ (Mittermeier 2012).

The Caucasus as a whole is isolated from other mountains by seas and plains. This high degree of isolation - transit position of the Caucasus between two climatic zones, its extraordinary geographic range location that connects Asia to Europe and at the same time the region’s extraordinary position among far more large biogeographical regions (Irano-Turanian, Euro-Siberian and Mediterranean) from east to west and from north and south and *vice versa* - creates favorable conditions for the successful evolution of a wide spectrum of flora and fauna with an extremely high percentage of endemism. No temperate climate zone has more biodiversity per square kilometer than the Caucasus (Caucasus Nature Fund 2013). The richness of biodiversity of the region increases within the boundary of the Caucasus Ecoregion.

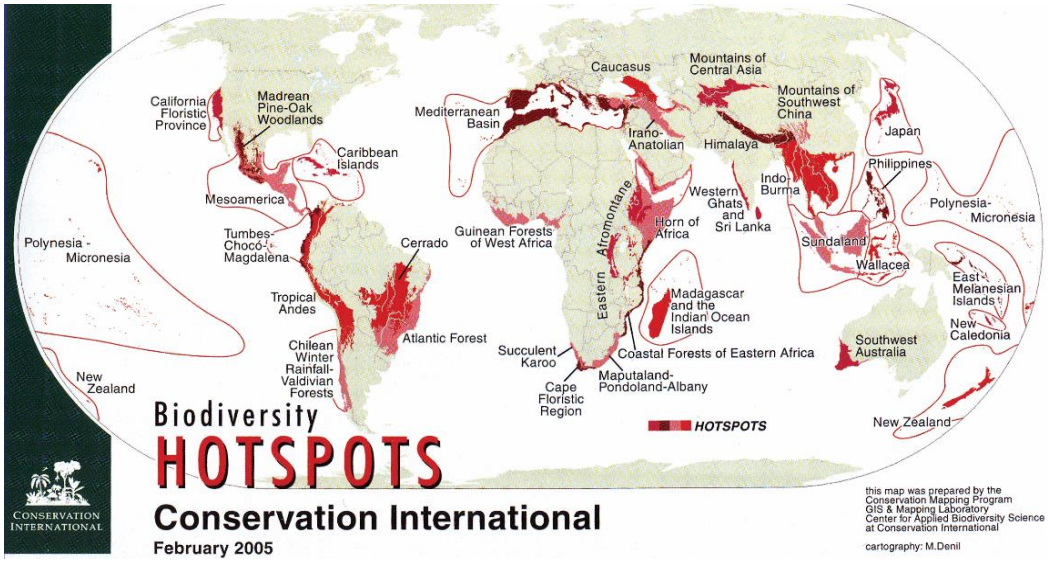

Figure 20. Biodiversity Hotspots of the Earth (Conservation International 2005).

The Caucasus is one of the most important biodiversity hotspots in the Northern Hemisphere (Myers *et al.* 2000). This fact, that the Caucasus biota raises special interest of scholars, here it is worth mentioning the following opinion of Myers *et al*. (2000): 'The hotspots' boundaries have been determined by 'biological communities'. Each of the areas features a separate biota or community of species that fits together as a biogeographic unit. This is apparent in the case of islands or island groups such as New Caledonia, New Zealand, the Caribbean, Polynesia/Micronesia, Madagascar and the Philippines. Much the same applies to 'ecological islands' in clearly defined continental units such as the Cape Floristic province, the eastern Arc and Coastal Forests of Tanzania/Kenya (hereafter abbreviated to 'Eastern Arc'), southwestern Australia and Caucasus'.

The Caucasus Ecoregion covers 580,000 km^2 in six countries: Armenia, Azerbaijan, Georgia, the North Caucasus part of Russia, northeastern Turkey, and part of northwestern Iran (Zazanashvili & Mallon (Eds.) 2009). As one of the biologically richest areas on the Earth, the Caucasus is included in WWF's list of Global 200 Ecoregions, ranked among the planet's 35 most diverse and endangered hotspots by Conservation International (Meyers *et al*. 2000), and one of the world's 15 'Biodiversity Hotspots' of the Critical Ecosystems Partnership Fund (CEPF) (Krever *et al.* (Eds.) 2001; Williams *et al.* (Eds.) 2006) (Figure 20). For a non-tropical region, the Caucasus has a high species diversity and endemism (Tarkhnishvili & Kikodze (Eds.) 1996; Zazanashvili & Molles (Eds.) 2009). Only 10% of its primary vegetation cover remains from the 500,000 km^2 it once occupied (Myers *et al.* 2000). No temperate climate zone has more biodiversity per square kilometer than the Caucasus. Despite some threats, about a quarter of the territory remains in environmentally good condition, and as much as 12 percent of the original vegetation, including forests, is considered (almost) pristine, compared to less than one percent in Europe (CNE 2012). Review works on the nature of the Caucasus include 'The Caucasus' (Gerasimov (Ed.) 1966; Schmidt 2005a, b; Sokolov & Syroechovski (Eds.) (1990); Khain & Koronovski (1997); Volodicheva (2003); and the South Caucasus Republics: Biodiversity analysis Updates for Armenia (2009), for Azebaijan (2010) and for Georgia (2009). Potential analysis for further nature conservation in Azerbaijan (2009), especially