

Diversity and distribution of amphibians in the Greater Caucasus Natural Area (Azerbaijan)

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Abstract. The diversity and distribution of amphibian species in the natural area of the Greater Caucasus, which covers the north-eastern part of Azerbaijan and has great biodiversity, have not yet been fully studied. The article is based on materials obtained during field studies. Maps of the distribution of amphibians in the natural area are given. As a result of the inventory in the region, 1 species of tailed (*Triturus karelinii*) and 7 species of tailless (*Pelobates syriacus*, *Pelodytes caucasicus*, *Bufo verrucosissimus*, *Bufo variabilis*, *Hyla orientalis*, *Rana macrocnemis*, *Pelophylax ridibundus*) amphibians were recorded. Of these, two species (*P. caucasicus*, *B. verrucosissimus*) were found in Azerbaijan only in a small natural area of the Greater Caucasus. Based on the cluster analysis of the species composition of amphibians, it was found that among the 5 natural regions of Azerbaijan, the natural region of the Greater Caucasus has the least similarity with other regions (Lesser Caucasus, Kura-Araz, Lankaran, and Nakhchivan).

Key words: Amphibians, biodiversity, mapping, Natural area of the Greater Caucasus, Azerbaijan.

Introduction

The natural area of the Greater Caucasus is one of the five natural areas of Azerbaijan, bordering with the Ganikh-Ayrichay valley, the Shirvan and southeastern Shirvan plains in the south, the Russian Federation in the north, the Caspian Sea in the east, and Georgia in the west. Altitude ranges from 27 m (Caspian Sea level) up to 4466 m (Mt. Bazarduzu). From plains to high mountains of the natural area of the Greater Caucasus, all types of climate are widespread in the Greater Caucasus natural area, from semi-desert and arid steppe to the climate of nival mountain belt. The average annual temperature in the natural area ranges from 10-14°C to below 0°C, and the annual amount of precipitation varies from 200-300 mm to 1400-1600 mm. There are 2,078 rivers of different lengths in the Greater Caucasus natural area (Tanriverdiyev et al. 2015, Museyibov 1998). In Azerbaijan, 48.7% of the forested areas are located in the Greater Caucasus. At the same time, according to the richness of species of trees and shrubs in different botanical-geographical regions, the north-eastern slope region of the Greater Caucasus ranks first (45 tree species and 122 shrub species) (Dolkhanov et al. 2012).

In general, the Caucasus ecoregion is one of the regions with high biodiversity, distinguished by its unique fauna and flora. This ecoregion, which involves Azerbaijan, was included in the Conservation International's 2011 list of 35 hotspots for endangered biodiversity (Mittermeier et al. 2011).

The Government of the Azerbaijan Republic established the policy environment and legal framework for the conservation and use of biodiversity. One of the first challenges for the conservation and sustainable use of biodiversity is to conduct an inventory of animals using advanced monitoring methods to establish the current and to predict the future status of biodiversity (E-qanun.az 2016).

Although the study of amphibians in Azerbaijan began in the middle of the 18th century, many issues related to the species diversity and bioecology have not been studied. In recent years, a number of works on the batrachofauna of Azerbaijan have been published (Aleperov 1978, Ganiyev

2006, Ganiyev & Nuriyev 2004), however, there is no general literature source containing information on the distribution and current status of amphibians in the Greater Caucasus natural area. Taking all this into account, a species inventory of amphibians in the Greater Caucasus natural area was conducted and a map of the distribution of the species found was prepared by us.

The information obtained on the distribution of species as a result of our research can be used as a basis for future research in the field of ecology, taxonomy, biogeography, and biodiversity conservation measures in the region.

Material and Methods

The materials used in this work were collected by the author during field research in March-October of 2010-2016. The coordinates of the areas where the amphibians were found were recorded using the Garmin eTrex GPS device. A map for each species was prepared using the ArcGIS 10.3 electronic mapping program on the basis of factual materials collected and the analysis of the literature data. The Latin and English names of the amphibian species in the article are given with reference to the Amphibian Species of the World website, and the conservation status of the species is given with reference to the IUCN Red List (Frost 2021, IUCN 2020). The similarity index was determined by conducting a cluster analysis (Bray-Curtis Cluster Analysis) of the species composition of the batrachofauna of the Greater Caucasus natural area and the Lesser Caucasus, Kur-Araz,

Table 1. The list of Amphibian species distributed in the Greater Caucasus natural area and their conservation status: the IUCN (International Union for the Conservation of Nature and Natural Resources) criteria (NT - Near Threatened; LC - Least Concern and DD - Data Deficient).

Order	Family	Species	IUCN value
Caudata	Salamandridae	<i>Triturus karelinii</i>	LC
	Pelobatidae	<i>Pelobates syriacus</i>	LC
	Pelodytidae	<i>Pelodytes caucasicus</i>	NT
	Bufo	<i>Bufo verrucosissimus</i>	NT
Anura		<i>Bufo variabilis</i>	DD
	Hylidae	<i>Hyla orientalis</i>	-
	Ranidae	<i>Rana macrocnemis</i>	LC
		<i>Pelophylax ridibundus</i>	LC



Figure 1. Amphibians of the Greater Caucasus natural area. A) Male of the *Triturus karelinii* on the bank of Duruja river of Gakh region; B) Juvenile individual of the genus *Pelobates syriacus* on the banks of the Girdimanchay, Ismayilli district; C) The tadpoles of the *Pelodytes caucasicus* in Gabizdere village, Zagatala district; D) The male and female of the *Bufo verrucosissimus* staying in amplexus on the banks of the Silban River, Jar village, Zagatala district; E) The female of the *Bufotes variabilis* in the forest glade, village Poshbina, Balakan district; F) The male of the *Hyla orientalis* in the forest, Lakid village, Gakh district; G) *Rana macrocnemis* in the cold waters of Laza waterfall of Gusar region; H) The male of the *Pelophylax ridibundus* in the Chanlibel lake, II Nugadi village, Guba district. Photos by Gulbaniz Gasimova.

Lankaran, and Nakhchivan natural areas using the BioDiversity Pro-2 program (McAleece et al. 1997).

Results

During the field research, we have recorded 8 species belonging to 8 genera (*Triturus*, *Pelobates*, *Pelodytes*, *Bufo*, *Pseudepidalea*, *Hyla*, *Rana*, *Pelophylax*), 6 families (*Salamandridae*, *Pelobatidae*, *Pelodytidae*, *Bufo* *naidae*, *Hylidae*, *Ranidae*), 2 orders (*Caudata*, *Anura*) in the Greater Caucasus natural area (Tab.1).

Salamanders - Salamandridae Goldfuss, 1820
Southern Crested Newt - *Triturus karelinii* (Strauch, 1870) (Fig. 1). During the field research, it was found at an altitude

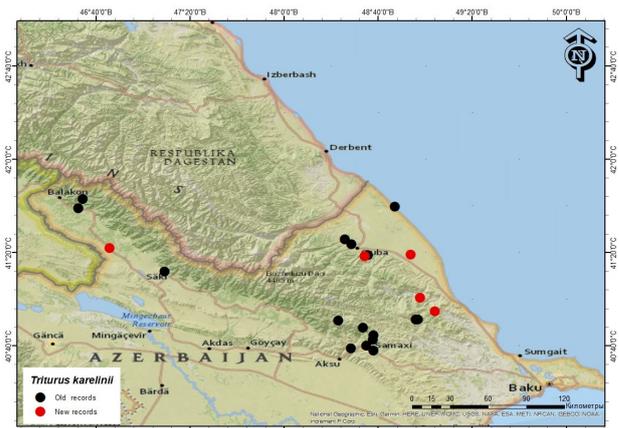


Figure 2. Points where the Southern Crested Newt was found in the Greater Caucasus natural area. Note: The black circles in the map show the previously known points of the species and the red circles show the newly recorded points.



Figure 3. Areas where the Syrian Spadefoot was found in the Greater Caucasus natural area.

of 200 m to 2000 m a.s.l. in the natural area, in forests, forest-steppe and mountain-steppe regions rich in water basins, mainly in forest edges and open areas. It was recorded in small artificial lakes with a depth of 0.5-0.7 m and large ones with a depth of 25-35 m, the coast of which is rich in *Phragmites communis* Trin., the surface covered with *Potamogeton*, the bottom is rich in such aquatic plants as *Juncus inflexus*, *J. compressus*, *J. gerardii*, *Sparganium erectum*, *S. neglectum*, *S. microcarpum* and *Mentha aquatica*. (Fig. 2). The status of the species was assessed as Least Concern in the Red List of the IUCN (Arntzen et al. 2009).

Spadefoots - Pelobatidae Bonaparte, 1850
Syrian Spadefoot - *Pelobates syriacus* (Boettger, 1889) (Fig. 1). The species was recorded by us in rocky, semi-desert areas in the river banks and in the saline, sandy areas with sparse vegetation along the Caspian coast. Distribution boundaries in the territory of the natural area are 27-1900 m a.s.l. (Fig. 3). The status of the species was assessed as Least Concern in the Red List of the IUCN (Agasyan et al. 2009).

Parsley frogs - Pelodytidae Bonaparte, 1850
Caucasian Parsley Frog - *Pelodytes caucasicus* (Boulenger, 1896) (Fig. 1) - We did not record adults of this species



Figure 4. Areas where the Caucasian Parsley Frog was found in the Greater Caucasus natural area.



Figure 5. Areas where the Caucasian Toad was found in the Greater Caucasus natural area.

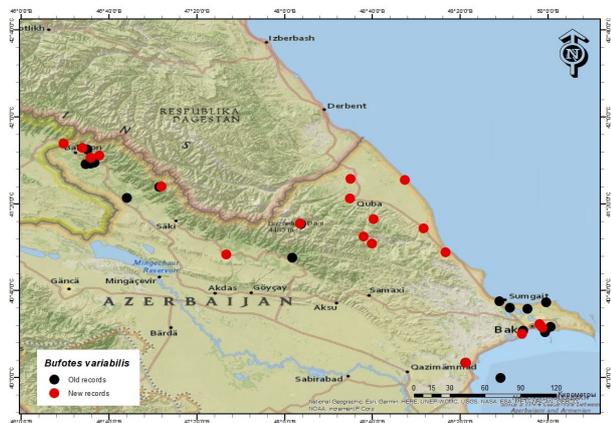


Figure 6. Areas where the Variable Toad was found in the Greater Caucasus natural area.

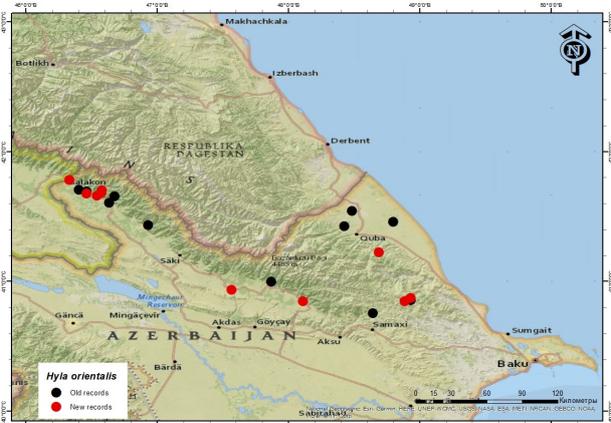


Figure 7. Areas where the Oriental Tree Frog was found in the Greater Caucasus natural area.

during our research. The tadpoles have been recorded in a large forest massif (up to 500-1200 m a.s.l.) consisting of broad-leaved trees, at least 5-7 km away from human settlements, which is less affected by anthropogenic factors (Fig. 4). The vegetation of the habitats consists of plants such as *Rhododendron luteum*, *Carpinus orientalis*, *Quercus iberica*, *Fagus orientalis*, *Alnus barbata*, *Diospyros lotus* and *Smilax excelsa* (Ganiev & Gasimova 2012). This species is endemic to the Caucasus and has only a small area in Azerbaijan situated in the Greater Caucasus natural area (Ganiev 2013b). It is included in the Red List of the IUCN with Near Threatened status (Kaya et al. 2009, Iskenderov 2009).

Toads – Bufonidae Gray, 1825

Caucasian Toad – *Bufo verrucosissimus* (Pallas, 1814) (Fig. 1) - It was recorded in gardens, meadows, and melon plantations, often near settlements. The plants predominated in the biotope of the Caucasian Toad are: *Tilia caucasica*, *Alnus barbata*, *Hedera pastuchowii*, *Ulmus elliptica*, *Salvia glutinosa*, *Arum megobrebi*, and *Dryopteris filix-mas*. It was recorded at an altitude of about 500-1000 m a.s.l. (Fig. 5). This species is widespread in the republic only in a limited part of its natural area (Ganiev 2013a). Registration of the Caucasian Toad at a new point in addition to the known range determined a wider range of the distribution of this species. Thus, the north-eastern boundaries of the total area of the species

have been updated. It is included in the Red List of the IUCN with Near Threatened status (Tuniyev et al. 2009).

Variable Toad – *Bufotes variabilis* (Pallas, 1769) (Fig. 1) - During the study, it was found in forest, forest-steppe, semi-desert, and desert zones, steppes, and forest roads. It was found to rise to the subalpine meadow. The vertical range of the distribution of this species, which distributed widely in the natural area, was 85-2100 m a.s.l. (Fig. 6). It was included in the Red List of the IUCN with Data Deficient status (Avci et al. 2015).

Tree frogs – Hylidae Gray, 1825

Oriental Tree Frog – *Hyla orientalis* (Bedriaga, 1890) (Fig. 1) - During our study, it was found in dense broadleaf forests (Gasimova 2014). The *Alnus barbata*, *Rubus* sp., and *Dryopteris* Adans. are predominated in the biotopes of this species. It lives at a height of 400-1000 m a.s.l. in the territory of the natural area (Fig. 7). It was not included in the Red List of the IUCN.

True frogs (brown frogs) – Ranidae Gray, 1825

Caucasian Brown Frog – *Rana macrocnemis* (Boulenger, 1885) (Fig. 1) - During the study, this species was observed in mountain forests, mountain and foothill steppes, subalpine meadows, especially in cold springs and water-

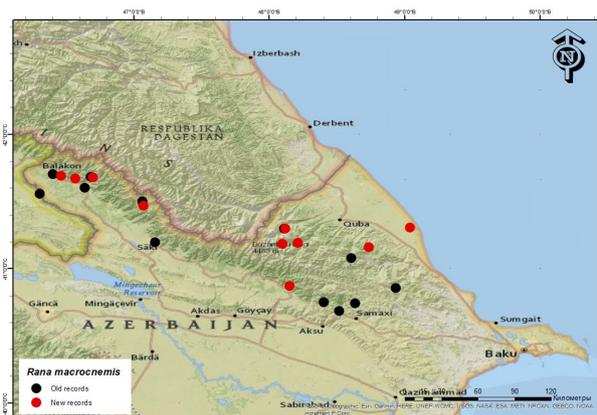


Figure 8. Areas where the Caucasian Brown Frog was found in the Greater Caucasus natural area.

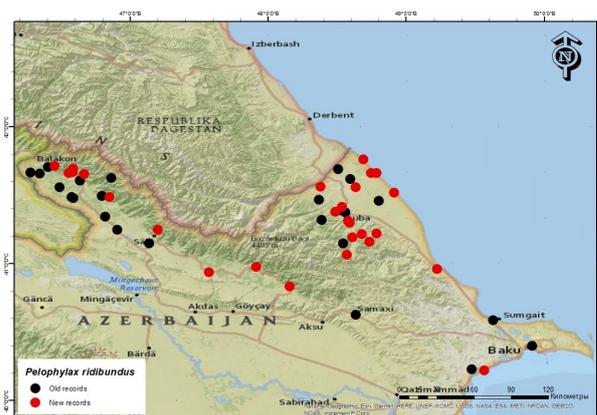


Figure 9. Areas where the Eurasian Marsh Frog was found in the Greater Caucasus natural area.

Bray-Curtis Cluster Analysis (Single Link)

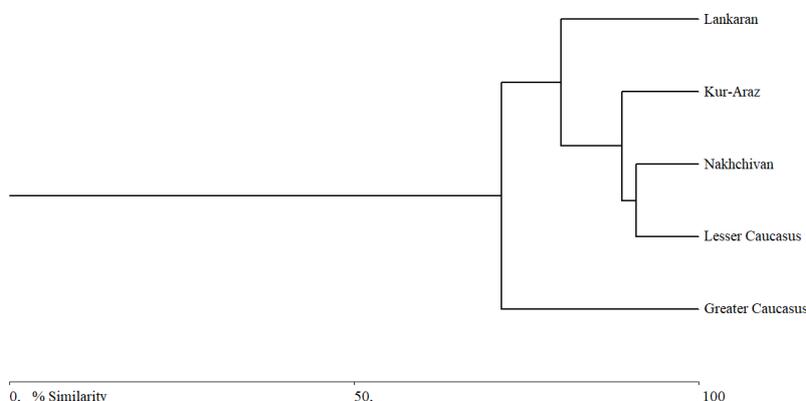


Figure 10. Dendrogram of similarity according to species composition of amphibians found in 5 natural areas of Azerbaijan.

Table 2. Similarity index for comparison of the species composition between batrachofauna of the Greater Caucasus natural area and other natural areas.

Natural Areas	Greater Caucasus	Lesser Caucasus	Kur-Araz	Lankaran	Nakhchivan
Greater Caucasus	*	61,53	50	70,59	71,42
Lesser Caucasus	*	*	88,89	71,42	90,90
Kur-Araz	*	*	*	61,53	80
Lankaran	*	*	*	*	80
Nakhchivan	*	*	*	*	*

waterfalls. In addition, it was recorded in the port area, where it was not seen before. Its biotope includes such plants as *Castanea Mill.*, *Alnus barbata*, *Crataegus rhipidophylla*, *Prunus spp.*, *Calamintha nepeta*, *Campanula glomerata*, *Androsace barbulate*, *Myosotis spp.* It is a widely distributed species living at a height of 25 -2400 m a.s.l. (Fig. 8). The status of the species was assessed as Least Concern in the Red List of the IUCN (Kuzmin et al. 2009a).

Eurasian Marsh Frog - *Pelophylax ridibundus* (Pallas, 1771) (Fig. 1) - This is one of the most widespread amphibian species in the natural area. In addition to densely forested areas, it has been recorded in stagnant and flowing water bodies such as arches, rivers, canals, ponds, reservoirs, and lakes, ranging from semi-desert and steppe zones to high mountain meadows. We also found it in the low-sulfur waters. During the research period, we recorded it at altitudes between 32 and 777 m a.s.l. (Fig. 9). The status of the species

was assessed as Least Concern in the Red List of the IUCN (Kuzmin et al. 2009b).

Discussion

According to the results of researches conducted in recent years on collections and living individuals by traditional (anatomical-morphological) and new (molecular-genetic) methods and according to changes in systematics, the Azerbaijani batrachofauna includes 11 species of amphibians belonging to 2 orders, 6 families, and 9 genera (Gasimova & Ganiyev 2011). Considering that only 0.14% of the world's amphibians live in the country, Azerbaijan's bathracofauna is not very rich. Within the republic, the Greater Caucasus natural area can be considered relatively rich in species diversity (8 species).

The data collected by us on the bathracofauna of the

natural region of the Greater Caucasus were compared to the literature data on the species composition of other natural regions (Lesser Caucasus, Kura-Araz, Lankaran, and Nakhchivan). According to the Brey-Curtis analysis carried out to assess the similarity and diversity of the amphibian fauna of these territories, the greatest similarity was recorded between the amphibian fauna of Nakhchivan and the Lesser Caucasus. According to the cluster analysis, the similarity rate of the amphibian fauna of these two natural regions is 90% (Tab.2). As can be seen in the dendrogram, the least similarity was observed as a result of cluster analysis of the species composition of the natural region of the Greater Caucasus and the other 4 natural regions mentioned above (Fig. 10).

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