DISTRIBUTION AND CONSERVATION STATUS OF THE CAUCASIAN PARSLEY FROG, *PELODYTES CAUCASICUS* (AMPHIBIA: ANURA)

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Pelodytes caucasicus inhabits Turkey, Georgia, Abkhazia, South Ossetia, Azerbaijan, and six regions of Russia (226 localities). The forest cutting strongly threatens its populations. Therefore, the frog is listed in Red Data Books of Georgia, South Ossetia, Azerbaijan, and the Russian Federation. Additional factors influencing the decline of *P. caucasicus* populations are destruction and contamination of suitable water bodies, clearing of forests from fallen trees, destroying of litter, mortality on roads, and preying by the introduced North American raccoon. Using of MaxEnt, we developed a species distribution model based on climate, landscape and land cover data to estimate the potential distribution range, ecological preferences and conservation status of *P. caucasicus*. Two precipitation parameters, annual precipitation and precipitation seasonality, had the highest contribution percentage to the model (52% and 11% respectively). As a rule, suitable habitats for the species located in woodland mountain areas with annual precipitation ranged from 513 mm to 2376 mm. Drier regions to the north and south of the Caucasus limit its distribution.

Key words: Caucasus, GIS modelling, MaxEnt, Pelodytidae

Introduction

The Caucasian parsley frog, *Pelodytes caucasicus* Boulenger, 1896 (Fig. 1), is an endemic species of the Caucasian Isthmus, the region (about 580 000 km^2) delimiting Europe and Asia, and lying between the Black Sea in the west and the Caspian Sea in the east. The frog inhabits Turkey, Georgia, Abkhazia, South Ossetia, Azerbaijan, and Russia. On the territory of Russia, the species was found in six regions, namely in the autonomous republics of Adygea, Karachay-Cherkessia, Kabardino-Balkaria, North Ossetia-Alania, Chechnya, and Krasnodarsky Krai (Kuzmin, 2013). The occurrence of the species was assumed in the Dagestan Republic of Russia (Askenderov, 2017). *Pelodytes caucasicus* was listed as near-threatened by the IUCN (Kaya et al., 2009) and was included in the Appendix II of the Bern Convention, Red Data Books of Russia, Georgia, South Ossetia, Azerbaijan, the republics of Adygea, Karachay-Cherkessia, Kabardino-Balkaria, North Ossetia-Alania, Chechnya, and Krasnodarsky Krai of Russia (Kacharava, 1982; Udovkin & Lipkovich, 1999; Dzuev & Ivanov, 2000; Kuzmin, 2000; Lotiev, 2007; Tuniyev & Tuniyev, 2012, 2017; Doronin, 2013; Lotiev & Tuniyev, 2017).

The distribution of *Pelodytes caucasicus* is similar to other Caucasian forest amphibian species, which may suggest similar ecological requirements. However, the position of range boundaries for all these species is somewhat different. For example, the range of *Mertensiella caucasica* (Waga, 1876) in the Minor and Turkish Caucasus is basically coinciding with the distribution of *P. caucasicus*. However, the first species is absent in the Great Caucasus (Tarkhnishvili et al., 2008; Gül et al., 2018). *Ommatotriton ophryticus* (Berthold, 1846) occurs in North Armenia, but does not penetrate in Azerbaijan and the central part of the North Caucasus (Litvinchuk, 2017; Van Riemsdijk et al., 2017). *Lissotriton lantzi* (Wolterstorff, 1914) inhabits the Dagestan Republic of Russia, Armenia and the Lenkoran Lowland in Azerbaijan, but is lacking in the Black Sea coastal part of Turkey (Skorinov et al., 2014). *Triturus karelinii* (Strauch, 1870) occurs in the Dagestan Republic of Russia, the Crimea, Azerbaijan, Iran, but is absent in the Black Sea coastal part of Turkey (Litvinchuk & Borkin, 2009; Wielstra et al., 2013a,b). The Caucasian part of ranges of *Bufo verrucosissimus* (Pallas, 1814) and *Pelodytes caucasicus* are approximately the same. However, the first species probably inhabits western and southern Turkey, eastern Bulgaria, Lebanon and Syria (Litvinchuk et al., 2008; Garcia-Porta et al., 2012; Arntzen et al., 2013; our data). The Caucasian lineage of *Hyla orientalis* Bedriaga, 1890 (Dufresnes et al., 2016), which could be recognised as a separate subspecies, is also associated with the Caucasian forest belt. However, unlike *P. caucasicus* it is widely distributed in the eastern part of the Caucasus and is lacking in the Black Sea coastal part of Turkey.

Fig. 1. A male of *Pelodytes caucasicus* from Makopse River, Krasnodarsky Krai, Russia.

The GIS-based ecological niche modelling is a rapidly developing area of research. Recently, numerous studies were made by using this method (Tarkhnishvili et al., 2008; Garcia-Porta et al., 2012; Dufresnes et al., 2016). The obtained models of species distribution could be useful for study of many aspects of ecology and conservation, predicting of new localities for rare and threatened species, and invasive species spread (Bombi et al., 2009; Lyet et al., 2013; Vences et al., 2017). This approach appears a good and reliable tool for past and future climatic scenario studies, too (Brito et al., 2011; Tarkhnishvili et al., 2012; Litvinchuk et al., 2013; Duan et al., 2016; Iannella et al., 2017; Wetterings & Vetter, 2018). Therefore, the aim of this study was to apply the ecological niche modelling to predict potential distribution range, estimate ecological preferences and conservation status of *Pelodytes caucasicus*.

Material and Methods

To predict the potential distribution of the Caucasian parsley frog, we modelled the species distribution using MaxEnt (ver. 3.3.3k; Phillips et al., 2006). This algorithm combines environmental parameters with geographic co-ordinates and produces high-quality predictions of species distribution, often more reliable when evaluated and compared with other predictive models (Hernandez et al., 2006). For the contemporary niche predictions, we used 226 localities, comprising own and previously published records (Tosonoğlu & Taskavak, 2004; Zinenko & Goncharenko, 2009; Iğci et al., 2013; Kuzmin, 2013; Gül, 2014; Tuniyev et al., 2017; Tuniyev, 2018). To avoid spatial autocorrelation of occurrence points, we filter them by ENMTools 1.3 (Warren et al., 2010).

The altitude and 19 bioclimatic layers representing climatic data for the past fifty years (~1950–2000) were extracted from the WorldClim 1.4 database (http://www.worldclim.org). Further, four layers (the aridity index, land cover, spatial homogeneity of global habitat, and global percent of tree coverage) were obtained from the following databases: Global Aridity and Potential Evapo-Transpiration (http://www.cgiar-csi.org/data/global-aridity-and-pet-database), GlobCover 2009 (Global Land Cover Map; due.esrin.esa.int/globcover/), EarthEnv (http://www.earthenv.org/texture.html), and Github (https://github.com/globalmaps/gm_ve_v1) respectively. To consider topography in the model, four landscape layers (aspect, exposition, slope, and terrain roughness index) were calculated with QGIS (http://www.qgis.org/). We applied a mask that extends from 39°N to 46°N and 35°E to 50°E. All analyses were conducted in the WGS 84 projection.

To eliminate predictor collinearity prior to generating the model, we calculated Pearsons's correlation coefficients for all pairs of bioclimatic variables using ENMTools. We excluded the variable of a correlated pair with $|r| > 0.7$ that we considered to be the less biologically important of the two based on known preferences of *Pelodytes caucasicus* (Tarkhnishvili & Gokhelashvili, 1999; Franzen, 2012; our data). The resulting dataset contained nine bioclimatic variables: Bio2 (mean diurnal range; °C × 10), Bio3 (isothermality; %), Bio5 (maximum temperature of warmest month; °C × 10), Bio6 (minimum temperature of coldest month; °C × 10), Bio7 (temperature annual range; °C × 10), Bio8 (mean temperature of wettest quarter; °C × 10), Bio9 (mean temperature of driest quarter; °C × 10), Bio 12 (annual precipitation; mm), and Bio15 (precipitation seasonality; CV).

We used layers with 30 arc seconds spatial resolution because *Pelodytes caucasicus* inhabits very heterogeneous mountain landscapes. Searching for new localities and for verification of previously published records, we visited Abkhazia, Georgia, South Ossetia, as well as Krasnodarsky Krai, Karachay-Cherkessia, Kabardino-Balkaria, North Ossetia-Alania, and Adygea republics of Russia in 2006–2014. Co-ordinates and altitude for previously published records (if they were not specified) were determined by use of Google Earth, taking into account known ecological preferences of the species.

A total of 18 variables were used (Table). Model performance was measured using the Area Under the Curve (AUC) derived from the Receiver Operating Characteristic (ROC) plots. AUC values range from 0.5 to 1.0, with 0.5 indicating no greater fit than expected by chance and 1.0 indicating a perfect model fit. AUC values above 0.75 are considered useful and above 0.90 very good (Swets, 1988; Elith, 2002). To properly parameterise the model, we evaluated the performance of various combinations of ten regularisation multipliers (from 0.5 to 5.0, in increments of 0.5; see details in Vences et al., 2017). The best-fit model was parameterised with a regularisation multiplier of 1.0 (30 replicates). We used default settings in MaxEnt, i.e. all feature classes, maximum iterations 500 and maximum number of background points 10000 (Phillips & Dudík, 2008). We applied a jackknife analysis for estimating the relative contributions of variables to the MaxEnt model.

Table. Results of jackknife analysis for estimation of relative contribution of variables to the MaxEnt model

Variable	Percent of contribution
Annual precipitation (Bio 12)	51.9
Precipitation seasonality (Bio 15)	11.2
Aridity index	9.1
Terrain roughness index	8.0
Altitude	5.8
Slope	3.8
Temperature annual range (Bio 7)	1.7
Mean diurnal range (Bio 2)	1.4
Isothermality (Bio 3)	1.3
Habitat homogenity	1.2
Mean temperature of wettest quarter (Bio 8)	1.1
Tree coverage percent	1.1
Land cover	1.1
Maximum temperature of warmest month (Bio 5)	0.6
Mean temperature of driest quarter (Bio 9)	0.4
Minimum temperature of coldest month (Bio 6)	0.2
Aspect	0.1
Exposition	0.0

Results

All defined records of *Pelodytes caucasicus* have been summarised in Fig. 2 and the Appendix. About half of the localities (n = 108) were found in the North Caucasus (Russia), where a majority was revealed in its westernmost part (98 localities in Krasnodarsky Krai and Adygea). In the eastern part of the North Caucasus, records of the species were single (10). In Transcaucasia, localities of *P. caucasicus* were numerous in Georgia (56), northeastern Turkey (25), Abkhazia (21), and South Ossetia (12 localities). Records of the species in northwestern Azerbaijan were few (4).

The MaxEnt model for *Pelodytes caucasicus* had robust evaluation metrics. The average test AUC for the replicate runs was evaluated as 0.939 and the standard deviation was 0.031. The predicted potential distribution is shown in Fig. 3. Estimates of relative contributions of variables to the species are shown in the Table. Of the parameters included in the model, annual precipitation and precipitation seasonality were variables with the highest percentage contributions (52% and 11% respectively). Other parameters had no notable contribution (less than 10%). Suitable habitats for the species were located in areas with annual precipitation ranging from 513 mm in several localities in Turkey to 2376 mm in Batumi botanical garden in Georgia (mean 1068.7 mm; SD = 313.3; Fig. 4). As a rule, the species was revealed in mountain areas with an altitude ranging from sea level to about 2300 m a.s.l. in Tskhra-Tskharo Pass in Georgia (mean 842.3; SD = 588.9; Fig. 4), only occasionally penetrating to adjacent plains in the North Caucasus (Goryachiy Klyuch) and the Colchis lowland (Kulevi and Poti). Drier regions to the north and south of the Caucasus limit the species distribution.

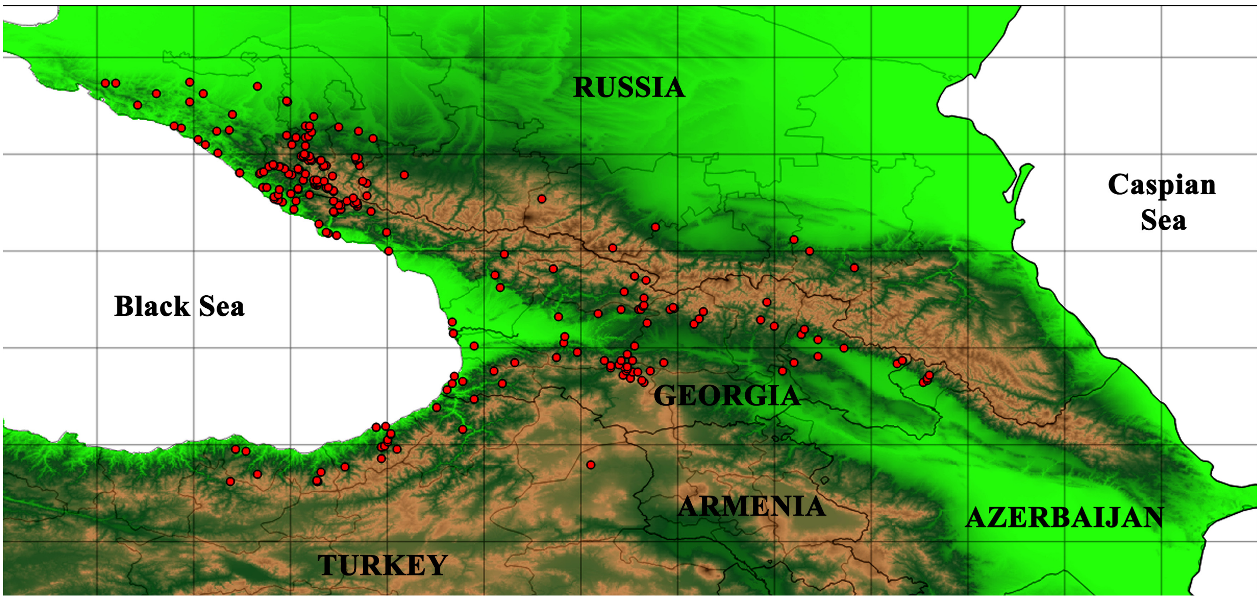

Fig. 2. The distribution map of *Pelodytes caucasicus* in the Caucasus. Localities of the species are given as red circles. Lowlands are marked in green and mountains are in brown.

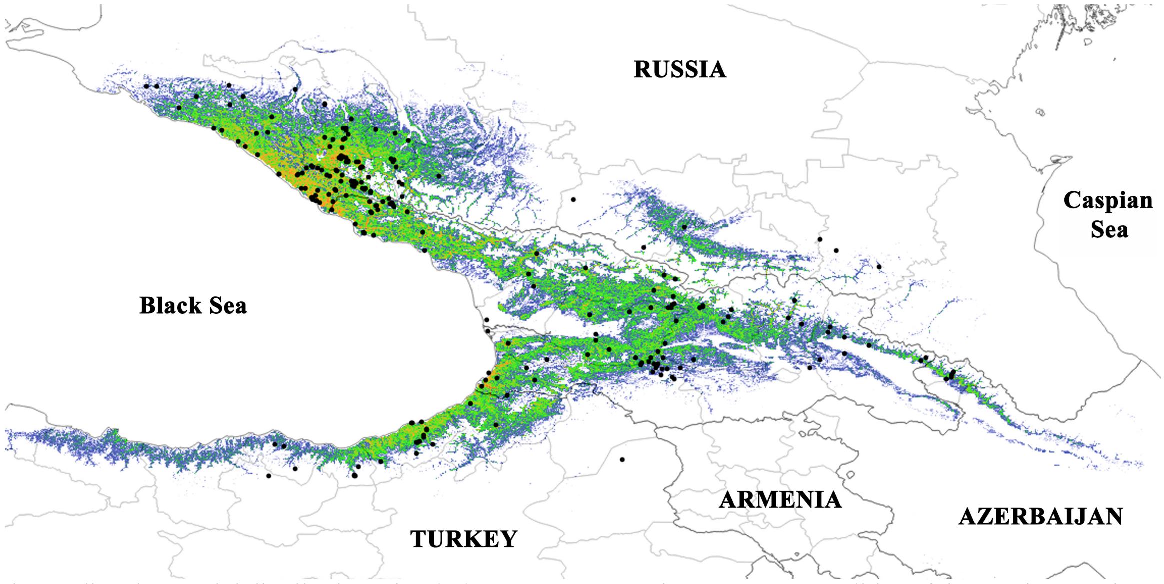

Fig. 3. The predicted potential distribution of *Pelodytes caucasicus* using MaxEnt. Localities of the species are given as black circles. Most suitable regions are designated by the orange colour (probability of occurrence of the species is 0.5–1.0); moderately suitable are in green and blue (0.1–0.5); and little or unsuitable are in white (0–0.1).

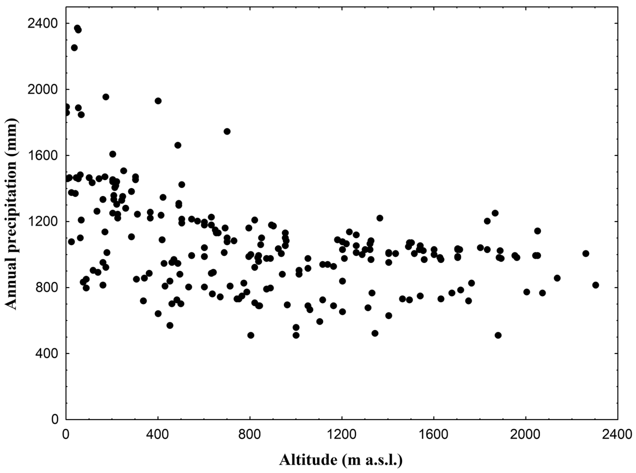

Fig. 4. Distribution of altitude and annual precipitation among localities of *Pelodytes caucasicus*.

Fig. 5. The breeding habitat of *Pelodytes caucasicus* in River Makopse, Krasnodarsky Krai, Russia (May 2012).

Discussion

The annual precipitation, which had the highest contribution to the MaxEnt model obtained, plays a very important role for the species survival. According to our and previously published data (Golubev, 1980; Gül, 2014), *Pelodytes caucasicus* inhabits very wet terrestrial biotopes (Fig. 5), such as shores and banks of ponds and streams with a completely shaded, dense vegetation (trees, bushes and grasses). Usually, the frog was found in dark humid broad-leaved and mixed coniferous-deciduous forests, and it was only sometimes found in more open coniferous forests, as well as subalpine and alpine zones (Golubev, 1985; Dzuev & Ivanov, 2000; Tuniyev & Tuniyev, 2012; Lotiev & Tuniyev, 2017; Tuniyev, 2018). *Pelodytes caucasicus* breeds in pools along river banks, backwaters and creeks located deep in the forests, far from its boundaries (Golubev, 1980; Kuzmin, 2013).

We have compared the ecological preferences of *Pelodytes caucasicus* with other Caucasian forest amphibian species studied with MaxEnt. The precipitation parameter has the greatest influence on the range of *Lissotriton lantzi* only (Skorinov et al., 2014). The precipitation of the warmest quarter strongly influences (58.2%) the distributional pattern of the species. A notable contribution of the precipitation of the driest month (20%) was revealed for *Ommatotriton ophryticus* as well (Litvinchuk, 2017). In contrast, only the thermal parameter (isothermality) has the highest percentage contribution for *Mertensiella caucasica* (Gül et al., 2018).

The distributional range of *Pelodytes caucasicus* is precisely restricted, being limited to woodland areas (Tarkhnishvili & Gokhelashvili, 1999). For example, Tuniyev (1990) noted that populations from Lagodekhi and Zakataly regions in eastern Georgia and western Azerbaijan are isolated from the main range. However, our results of the MaxEnt modelling (Fig. 3) shows that these populations are connected with the main range. On the other hand, we have found that populations which inhabit the central part of the North Caucasus (Kabardino-Balkaria, North Ossetia-Alania and Chechnya republics of Russia) could be isolated. Moreover, some of the local records (Khabaz in Kabardino-Balkaria, Martanka and Gekhi rivers in Chechnya) are placed in regions with little suitable habitats (probability of occurrence is 0.02–0.07).

It is important to note that a locality from the vicinities of Kars City in eastern Turkey (number 220 in the Appendix) seems to be wrong, being located under unsuitable environmental conditions (probability of occurrence is 0.01), which confirms the opinion previously expressed by Franzen (1999).

Pelodytes caucasicus is relatively common in the West Caucasus and rarer in eastern peripheral populations (Tarkhnishvili & Gokhelashvili, 1999). As with other Caucasian amphibians, the most important factor limiting the abundance of the species is a lack of appropriate breeding sites. The forest cutting is the main threat, causing a fragmentation of the range and, potentially, an extinction of local populations (Golubev, 1980; Tuniyev, 1985; Tarkhnishvili & Gokhelashvili, 1999). Destruction and contamination of water bodies by pesticides, mineral fertilisers and cattle, clearing of forests from fallen trees, destroying of litter and mortality on roads also strongly threatens the species (Golubev, 1980, 1981, 1985; Bozhanskiy & Semenov, 1981; Franzen, 1999, 2012; Dzuev & Ivanov, 2000; Lotiev, 2007; Kaya et al., 2009). Predatory fishes, adult newts (*Ommatotriton ophryticus*), larvae of salamanders (*Mertensiella caucasica*), snakes (*Natrix*), crabs (*Potamon potamios* (Olivier, 1804)), beetles (*Dytiscus marginalis* Linnaeus, 1758), shrews (*Neomys fodiens* (Pennant, 1771)), and tadpoles of coexisting anurans can consume eggs, larvae and adults of *P. caucasicus* (Tarkhnishvili & Gokhelashvili, 1999). However, the introduced North American raccoon (*Procyon lotor* (Linnaeus, 1758)) has the greatest impact on populations of *P. caucasicus*. In shallow water bodies, it can prey most spawning frogs (Lotiev, 2007; Tuniyev & Tuniyev, 2012).

Undoubtedly, *Pelodytes caucasicus* should be included in Red Data Books of all regions which it inhabits (including Abkhazia and Turkey). The species needs protection in several nature reserves within all regions where it was found (Darevsky, 1987; Kaya et al., 2009; Kuzmin, 2013). For conservation of the species, it is necessary to identify spawning water bodies and organise micro-reserves (Tarkhnishvili & Gokhelashvili, 1999; Tuniyev & Tuniyev, 2017). Puddles and ditches along poorly exploited forest roads are often used by the Caucasian parsley frog as breeding sites (Golubev, 1980). Therefore, to enlarge the population of this species, the best solution would be digging of new water bodies in such places. Additionally, it is necessary to create shelters from fallen cripples and trees near breeding sites and, perhaps, organise protection of spawning sites against raccoons with use of mesh fences.

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Appendix. GIS-referenced list of localities of *Pelodytes caucasicus*.

Abkhazia (21 localities)

1: Salme, ~40.038°E, 43.426°N, ~100 m; 2: Gagra, ~40.290°E, 43.282°N, ~500 m; 3: Pitsunda-Myussers-kiy Nature Reserve, ~40.371°E, 43.191°N, ~41 m; 4: Pitsunda, ~40.385°E, 43.178°N, ~13 m; 5: Myussera, ~40.478°E, 43.160°N, ~50 m; 6: Patara (= Malaya) Ritsa Lake, ~40.502°E, 43.476°N, ~1260 m; 7: Avadkhara (= Auadkhara) River, ~40.658°E, 43.500°N, 1500 m; 8: Pskhu Nature Reserve, ~40.833°E, 43.412°N, ~890 m; 9: Gumistinskiy Nature Reserve, ~40.996°E, 43.190°N, ~245 m; 10: Sukhumi, ~41.017°E, 43.000°N, ~6 m; 11: Gega River canion, ~40.447°E, 43.410°N, ~490 m; 12: Agepsta Mt., ~40.443°E, 43.521°N, ~1700 m; 13: Bzyp' River canion, ~40.459°E, 43.393°N, ~220 m; 14: Yupshara River canion, ~40.520°E, 43.425°N, ~500 m; 15: Audkhara resort, ~40.662°E, 43.498°N, ~1490 m; 16: Lashipse Ridge, ~40.676°E, 43.511°N, ~1540 m; 17: Mzym Lake, ~40.579°E, 43.521°N, ~2050 m; 18: Pyv Pass, ~40.687°E, 43.488°N, ~1885 m; 19: Chkhy Lake, ~40.692°E, 43.465°N, ~2260 m; 20: Between Bol'shaya Ritsa and Patara Ritsa lakes, ~40.515°E, 43.475°N, ~1230 m; 21: Kutikhug Ridge, ~40.646°E, 43.546°N, ~1950 m.

Azerbaijan (4 localities)

22: Katex, ~46.536°E, 41.643°N, ~335 m; 23: Gabizdara, ~46.584°E, 41.688°N, ~530 m; 24: Zagatala State Reserve, Gumukh-Dere River, ~46.604°E, 41.714°N, ~600 m; 25: Mazix, ~46.585°E, 41.668°N, ~430 m.

Georgia (56 localities)

26: Mtirala Mt., ~41.783°E, 41.650°N, ~900 m; 27: Borjomi, 10 km SSE, ~43.479°E, 41.780°N, ~1492 m; 28: Charnali River, ~41.621°E, 41.569°N, ~35 m; 29: Batumi, ~41.667°E, 41.633°N, ~50 m; 30: Kulevi, ~41.674°E, 42.270°N, ~0 m; 31: Poti, ~41.683°E, 42.150°N, ~2 m; 32: Batumi botanical garden, ~41.695°E, 41.707°N, ~47 m; 33: Kolkhida Nature Reserve, ~41.900°E, 42.017°N, ~170 m; 34: Kintrishskiy Nature Reserve, ~42.098°E, 41.766°N, ~1830 m; 35: Kvira, ~42.117°E, 42.750°N, ~1365 m; 36: Mukhuri, ~42.168°E, 42.624°N, ~250 m; 37: Shuakhevi, ~42.183°E, 41.633°N, ~885 m; 38: Inguri River, ~42.207°E, 42.968°N, ~660 m; 39: Bakhmaro, ~42.317°E, 41.850°N, ~1866 m; 40: Lentekhi, ~42.717°E, 42.817°N, ~1177 m; 41: Sairme, ~42.743°E, 41.904°N, ~938 m; 42: Kurusebi, ~42.767°E, 42.317°N, ~363 m; 43: Mayakovskiy, ~42.827°E, 42.054°N, ~222 m; 44: Bagdadi, ~42.833°E, 42.117°N, ~200 m; 45: Khani, ~42.967°E, 41.950°N, ~886 m; 46: Khreiti, ~43.183°E, 42.350°N, ~868 m; 47: Chitakhevi, ~43.303°E, 41.791°N, ~838 m; 48: Green Monastery, ~43.310°E, 41.811°N, ~960 m; 49: Borjomi, 43.393°E, 41.826°N, 837 m; 50: Kvereti, ~43.411°E, 42.392°N, ~818 m; 51: Rveli, Baniskhevi River, ~43.412°E, 41.873°N, ~818 m; 52: Tsikhisdzvari, ~43.433°E, 41.717°N, ~1627 m; 53: Oni, ~43.443°E, 42.579°N, ~837 m; 54: Tba, ~43.444°E, 41.800°N, ~1160 m; 55: Sakochavi, ~43.464°E, 41.765°N, ~1463 m; 56: Tsagveri, ~43.483°E, 41.800°N, ~1050 m; 57: Lomis-Mta Mt., ~43.246°E, 41.868°N, 2134 m; 58: Akhaldaba, ~43.412°E, 41.873°N, ~750 m; 59: Tskhra-Tskharo Pass, ~43.515°E, 41.689°N, ~2300 m; 60: Bakuriani, ~43.533°E, 41.750°N, ~1676 m; 61: Nedzura River, ~43.539°E, 41.865°N, ~1115 m; 62: Saglolo, ~43.555°E, 42.736°N, ~1286 m; 63: Mutarchi, ~43.583°E, 41.750°N, ~1540 m; 64: Tabatskuri Lake, ~43.633°E, 41.667°N, 2000 m; 65: Nariani, ~43.655°E, 41.640°N, ~2069 m; 66: Shovi, ~43.671°E, 42.703°N, ~1488 m; 67: Gudzhareti River, ~43.717°E, 41.767°N, ~1715 m; 68: Surami, ~43.558°E, 42.020°N, ~765 m; 69: Kvelantubani, ~43.858°E, 41.846°N, ~1330 m; 70: Magaroskari, ~44.863°E, 42.287°N, ~956 m; 71: Barisakho, ~44.927°E, 42.472°N, ~1323 m; 72: Zemo-Artani, ~45.000°E, 42.227°N, ~1260 m; 73: Akhalsopeli, ~45.084°E, 41.764°N, ~840 m; 74: Gombori, ~45.200°E, 41.850°N, ~1200 m; 75: Pankisi, ~45.278°E, 42.143°N, ~633 m; 76: Birkiani, ~45.305°E, 42.190°N, ~710 m; 77: Pshaveli, ~45.450°E, 42.083°N, ~460 m; 78: Telavi, ~45.454°E, 41.916°N, ~785 m; 79: Shilda, ~45.717°E, 42.000°N, ~496 m; 80: Lagodekhi, ~46.267°E, 41.833°N, ~480 m; 81: Lagodekhi Nature Reserve, ~46.317°E, 41.867°N, ~870 m.

Adygea Republic, Russia (25 localities)

82: Mirnyi, ~39.961°E, 44.546°N, ~337 m; 83: Maykop, ~39.970°E, 44.544°N, ~305 m; 84: Lagonaki, ~40.016°E, 44.096°N, ~1627 m; 85: Goreloe site, ~40.112°E, 43.981°N, ~730 m; 86: Suvorovskiy check point of Kavkazskiy Nature Reserve, ~40.133°E, 43.967°N, ~1400 m; 87: Zabrookennykh ravine, ~40.136°E, 43.983°N, ~843 m; 88: Guzeripl check point, ~40.138°E, 43.996°N, 700 m; 89: Khamyshki, Lipovaya River, ~40.150°E, 44.092°N, ~600 m; 90: Nikel, Syuk River, ~40.154°E, 44.174°N, 800 m; 91: Guzeripl, 3 km to Abago pastury, ~40.154°E, 43.987°N, ~844 m; 92: Aminovka River, ~40.154°E, 44.293°N, ~483 m; 93: Gruzinka River, ~40.183°E, 44.183°N, ~544 m; 94: Rufabgo waterfalls, ~40.187°E, 44.269°N, ~460 m; 95: Kamennomostskiy, ~40.192°E, 44.296°N, ~423 m; 96: Dakhovskaya, ~40.213°E, 44.227°N, ~468 m; 97: Abadzekhskaya, ~40.243°E, 44.389°N, ~360 m; 98: Turovaya River mouth, ~40.188°E, 43.934°N, 950 m; 99: Guzeripl, 7 km to Abago pastury, ~40.193°E, 43.977°N, ~1430 m; 100: Abago pastury, ~40.211°E, 43.950°N, 1700 m; 101: Ekspeditsiya Mt., ~40.216°E, 43.940°N, ~1880 m; 102: Tyaginya point, ~40.300°E, 43.933°N, ~1624 m; 103: Gefo Mt., ~40.317°E, 43.933°N, ~1888 m; 104: Grustnaya River mouth, ~40.341°E, 43.874°N, ~1200 m; 105: Sennaya glade, ~40.348°E, 43.884°N, 1300 m; 106: Dzugu stream, ~40.367°E, 43.883°N, ~1400 m.

Chechnya Republic, Russia (3 localities)

107: Martanka (= Fortanga) River, ~45.199°E, 43.119°N, ~400 m; 108: Gekhi River, ~45.367°E, 43.000°N, ~670 m; 109: Sharo-Argun River, ~45.823°E, 42.828°N, ~740 m.

Kabardino-Balkaria Republic, Russia (2 localities). 110: Khabaz, Malka River, ~42.595°E, 43.541°N, ~1760 m; 111: Verkhnyaya Balkariya, 15 km upper, ~43.330°E, 43.035°N, ~1555 m.

Karachaevo-Cherkessia Republic, Russia (4 localities)

112. Damkhurts Mt., ~40.748°E, 43.720°N, 1700 m; 113: Zakan, ~40.786°E, 43.699°N, ~1322 m; 114: Damkhurts River source, ~40.788°E, 43.575°N, ~1535 m; 115: Cheremukhovskiy Nature Rezerve, Urup River, ~41.171°E, 43.783°N, ~1050 m.

Krasnodarsky Krai, Russia (73 localities)

116: Shapsugskiy, ~38.085°E, 44.736°N, ~86 m; 117: Erivanskaya, ~38.191°E, 44.732°N, ~160 m; 118: Pshada, ~38.424°E, 44.510°N, ~172 m; 119: Plancheskaya Shchel', ~38.613°E, 44.630°N, ~137 m; 120: Zolotoy Bereg resort, ~38.795°E, 44.287°N, ~22 m; 121: Novomikhailovskiy, ~38.873°E, 44.275°N, ~60 m; 122: Kaluzhskaya, ~38.957°E, 44.742°N, ~87 m; 123: Khrebtovoe, ~38.962°E, 44.542°N, ~160 m; 124: Agoy, ~39.048°E, 44.154°N, ~65 m; 125: Goryachiy Klyuch, ~39.099°E, 44.620°N, ~114 m; 126: Tuapse, ~39.123°E, 44.097°N, ~223 m; 127: Chelipsi River mouth, ~39.243°E, 44.240°N, ~167 m; 128: Makopse River, 39.253°E, 44.017°N, 135 m; 129: Goitkh, ~39.364°E, 44.251°N, ~285 m; 130: Kurinskaya, ~39.400°E, 44.414°N, ~175 m; 131: Golovinskiy Nature Reserve, ~39.475°E, 43.811°N, ~38 m; 132: Shakhe, ~39.479°E, 43.805°N, ~23 m; 133: Chernigovskaya, ~39.655°E, 44.704°N, ~71 m; 134: Shakhe River, ~39.677°E, 43.799°N, ~160 m; 135: Solokh-Aul check point, ~39.685°E, 43.806°N, ~207 m; 136: Sergey-Pole, ~39.716°E, 43.654°N, 200 m; 137: Bzych stream, ~39.724°E, 43.820°N, ~204 m; 138: Sochi, ~39.758°E, 43.660°N, ~140 m; 139: Azhu River mouth, ~39.774°E, 43.869°N, ~310 m; 140: Babuk-Aul check point, ~39.822°E, 43.896°N, 630 m; 141: Agurchik stream, Bol'shoy Akhun Mt., ~39.831°E, 43.561°N, ~217 m; 142: Bushuyka River mouth, ~39.831°E, 43.882°N, ~410 m; 143: Malyi Akhun River, ~39.834°E, 43.538°N, 300 m; 144: Khosta, ~39.868°E, 43.528°N, ~203 m; 145: Malaya Khosta River, ~39.873°E, 43.583°N, ~112 m; 146: Tiso-Samshitovaya grove, 39.876°E, 43.528°N, 58 m; 147: Bushiy (= Bushchego) River mouth, ~39.884°E, 43.872°N, ~500 m; 148: Belyi stream, ~39.888°E, 43.637°N, ~490 m; 149: Kashtany, ~39.911°E, 43.509°N, ~166 m; 150: Shakhe River, ~39.933°E, 43.855°N, ~645 m; 151: Mezmay, ~39.963°E, 44.190°N, ~685 m; 152: Chernye osypi, ~39.983°E, 43.800°N, ~1710 m; 153: Troitse-Georgievskiy monastery, ~40.006°E, 43.590°N, ~285 m; 154: Bol'shaya Chura Mt., ~40.017°E, 43.783°N, 1800 m; 155: Ermolovka, ~40.051°E, 43.515°N, ~208 m; 156: Kamyshanova Polyana, ~40.051°E, 44.169°N, 1210 m; 157: Chvezhipse check point, ~40.073°E, 43.644°N, ~256 m; 158: Malaya Chura River, ~40.079°E, 43.847°N, 700 m; 159: Medvezhiy Ugol, ~40.083°E, 43.634°N, ~240 m; 160: Beryozovaya River, ~40.094°E, 43.845°N, ~950 m; 161: Achishkho Mt., ~40.133°E, 43.733°N, ~2040 m; 162: Chugush Ridge, ~40.150°E, 43.800°N, 1600 m; 163: Aibga Mt., ~40.195°E, 43.586°N, ~820 m; 164: Assara River mouth, ~40.243°E, 43.728°N, ~688 m; 165: Esto-Sadok, ~40.253°E, 43.692°N, ~630 m; 166: Laura River, apiary, ~40.264°E, 43.701°N, 600 m; 167: Achipse River mouth, ~40.264°E, 43.707°N, ~600 m; 168: Rudovaya River, ~40.266°E, 43.727°N, 850 m; 169: Laura and Achipse check points, ~40.269°E, 43.698°N, 570 m; 170: Psekhako Ridge, ~40.272°E, 43.737°N, ~1260 m; 171: Slantsevyi Rudnik, ~40.276°E, 43.681°N, ~545 m; 172: Bzerpiya River mouth, ~40.296°E, 43.716°N, ~650 m; 173: Pslukh River, ~40.364°E, 43.657°N, ~795 m; 174: Semikolenka Mt., ~40.383°E, 43.650°N, ~1322 m; 175: Between Krasnaya Polyana and Pseashkho Pass, ~40.348°E, 43.725°N, 1219 m; 176: Pslukh check point, ~40.390°E, 43.661°N, 950 m; 177: Urushten River, ~40.431°E, 43.778°N, 1600 m; 178: Between Aishkha Mt. and Engelmanovy glades, ~40.444°E, 43.627°N, 1700 m; 179: Engelmanovy glades, ~40.448°E, 43.618°N, 1200 m; 180: Barakaevskaya, ~40.502°E, 44.283°N, ~640 m; 181: Bambak Ridge, ~40.667°E, 43.971°N, ~1400 m; 182: Chernorech'e check point, ~40.683°E, 43.933°N, ~836 m; 183: Kirovskiy, ~40.685°E, 43.945°N, ~833 m; 184: Nikitino, ~40.700°E, 43.963°N, ~793 m; 185: Besleneevskaya, ~40.704°E, 44.235°N, ~492 m; 186: Tretya Rota check point, ~40.717°E, 43.885°N, ~936 m; 187: Psebay, ~40.851°E, 44.163°N, ~630 m; 188: Agura waterfalls, ~39.827°E, 43.559°N, ~215 m.

North Ossetia-Alania Republic, Russia (1 locality)

189: Lesken, ~43.769°E, 43.244°N, ~770 m.

South Ossetia (12 localities)

190: Nyfsykau, 43.680°E, 42.258°N, 1010 m; 191: Sinagur, 43.620°E, 42.392°N, 1010 m; 192: Sinagur, 43.597°E, 42.402°N, 1050 m; 193: Perevikokhita point, 43.641°E, 42.424°N, 1512 m; 194: Nakatodari point, 43.654°E, 42.436°N, 2050 m; 195: Kvaysa Mt., 43.650°E, 42.517°N, 1831 m; 196: Dzau, 43.926°E, 42.400°N, 1160 m; 197: Kvemo-Khvtse, ~43.954°E, 42.413°N, ~1115 m; 198: Gudusidon River, 43.962°E, 42.411°N, 1134 m; 199: Orbodzala Mt., 44.171°E, 42.248°N, 1957 m; 200: Atsritskheu, 44.224°E, 42.297°N, 1325 m; 201: South-Ossetia (= Liakhva) Nature Reserve, Malaya Liakhve River, ~44.265°E, 42.379°N, ~1550 m.

Turkey (25 localities)

202: Zigana Pass, ~39.373°E, 40.621°N, ~1340 m; 203: Akçaabat, ~39.537°E, 40.930°N, 1060 m; 204: Meryemana, ~39.653°E, 40.700°N, 1000 m; 205: Çaykara, 7 km S, ~40.274°E, 40.625°N, 800 m; 206: Uzun Lake (=Uzungöl), 40.285°E, 40.622°N, 1100 m; 207: İkizdere, ~40.557°E, 40.772°N, 600 m; 208: Tezi-ha, ~40.885°E, 41.175°N, 400 m; 209: Çat, ~40.935°E, 40.860°N, 1200 m; 210: Ülkü, 40.938°E, 40.975°N, 450 m; 211: Meydanköy, ~40.940°E, 40.980°N, 920 m; 212: Şenyuva, 40.970°E, 40.990°N, ~415 m; 213: Ardeşen, 8 km S, ~40.987°E, 41.188°N, 50 m; 214: Çamlihemsin, ~41.005°E, 41.049°N, ~300 m; 215: Duygulu, 41.040°E, 41.110°N, ~486 m; 216: Hoşdere, 41.040°E, 41.120°N, ~200 m; 217: Cankurtaran pass, ~41.505°E, 41.386°N, 700 m; 218: Kafkasör, ~41.774°E, 41.164°N, ~1750 m; 219: Camili Biosphere Reserve, ~41.896°E, 41.475°N, ~420 m; 220: Kars, 20 km NW, ~43.107°E, 40.795°N, ~1875 m; 221: Hidirnebi, ~39.433°E, 40.954°N, 1400 m; 222: Pazar, ~40.884°E, 41.177°N, ~65 m; 223: Zi-kale, ~41.004°E, 41.029°N, ~363 m; 224: Ayder Yay-lasi, ~41.101°E, 40.954°N, ~1311 m; 225: Uzun Lake, 2 km N, ~40.276°E, 40.635°N, ~1000 m; 226: Çaykara, 40.317°E, 40.717°N, 450 m.

РАСПРОСТРАНЕНИЕ И ПРИРОДООХРАННЫЙ СТАТУС КАВКАЗСКОЙ КРЕСТОВКИ *PELODYTES CAUCASICUS* (AMPHIBIA: ANURA)

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Pelodytes caucasicus населяет Турцию, Грузию, Абхазию, Южную Осетию, Азербайджан и шесть регионов России (226 местонахождений). Вырубка лесов создает серьезную угрозу ее популяциям. Поэтому этот вид включен в Красные книги Грузии, Южной Осетии, Азербайджана, России. Среди прочих факторов, вызывающих сокращение популяций *P. caucasicus*, являются разрушение и загрязнение подходящих вододоемов, санитарная рубка леса, уничтожение подстилки, смертность на дорогах и уничтожение чужеродным видом *Procyon lotor*. Используя программу MaxEnt, мы разработали модель распространения вида, основанную на данных по климату, ландшафту и растительному покрову, чтобы оценить область потенциального распространения, экологические предпочтения и природоохранный статус *P. caucasicus*. Два параметра (количество осадков за год и сезонность осадков) имели наибольший процентный вклад в эту модель (52% и 11% соответственно). Как правило, подходящие места обитания для вида располагались в областях распространения горных лесов с годовым количеством осадков от 513 до 2376 мм. Более сухие районы на севере и юге Кавказа являются границей распространения *P. caucasicus*.

Ключевые слова: MaxEnt, Pelodytidae, ГИС-моделирование, Кавказ