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PAST, CURRENT AND FUTURE STATES OF GREEN LIZARD (*LACERTA VIRIDIS*) POPULATIONS IN EASTERN EUROPE

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INTRODUCTION

The green lizard (*Lacerta viridis* Laurenti 1768) is one of the species of big-sized reptiles (Reptilia) of a total length of up to 400 mm with natural range occupying territories from Italy to Turkey. This species requires special protection being included in Appendix II of the Bern Convention (1979), Annex IV of the Habitats Directive (1992) and IUCN protection lists (category Least Concern (LC)). It is also included in the 4th edition of the Red Data Book of Ukraine (category «Vulnerable»).

Over the last decades, climate change and various anthropogenic pressures have been reported to have greatest impacts on reptile populations worldwide. Moreover, thermophilic species such as *L. viridis* are protected due to their dramatic population trends specially in Eastern Europe.

MATERIALS AND METHODS

To study the prospects for the 2050 of green lizard in Europe, we used the GBIF database (n=1031), literature sources and personal observations. We used species distribution bioclimatic modeling Maxent software (25 replicates, test 25%) using the 35 ClMond and 19 PaleoClim bioclimatic variables. To account for sampling bias, we used the nearest neighbor distance ('nbox' package in R; Osorio-Olivera et al., 2020) method for thinning the data. Occurrence points that were ≤ 0.1 units away from each other were removed to avoid errors due to spatial autocorrelation. Modeling and calculations were carried out using Maxent v3.3.3 software with 25 replicates (Phillips, 2005). Additional processed material from Ukrainian populations was included into the study in order to illustrate modern problems and trends face by the lizards, includes museum specimens from the 1960s (n = 50) and modern records (2012-2017, n=97).

PAST

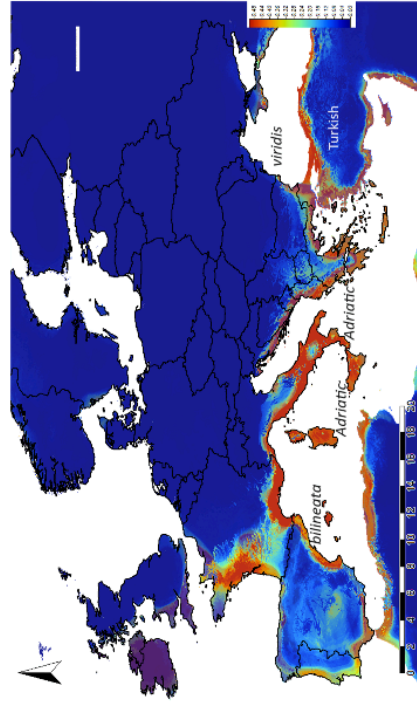


Figure 1. GIS-model of the Early Holocene location of glacial refuges (red) of *L. viridis* complex

CURRENT



Figure 2. «Mediterranean morphotypes» and «leopard morphotype» (photo by V. Golub) of *L. viridis* from southern and central Ukraine respectively.

By studying the morphology of both museum specimens from the 1960s (n = 50) and comparing with modern populations (2012-2017, n=97), we noticed an increase in number of anomalies of head foldiosis in the most recent specimens (21.1%). Recent field censuses and observations in our field sites throughout Ukraine also revealed an increase in the occurrence of rare or so-called abnormal morphs - melanized forms, "mediterranean morphotype" (Odesa and Mykolaiv regions) and "leopard morphotype" (Cherkasy region), with visible signs of viral (Reoviridae) papillomas in the populations of southern Ukraine.



Figure 3. Viral papillomas (Reoviridae) from *L. viridis* of southern populations in Ukraine. In a population of Sukhyi Lyman, Odesa, up to 15% of the detected lizards are have visual evidence of these viral papillomas.

FUTURE

Finally, by implementing bioclimatic models based in GIS, Maxent and WorldClim, we could predict a northward shift of the range of the species in Europe up to the Baltic countries by 2050. Consistently there is already almost a 2-fold decrease in the number of populations in the south of its range (Black Sea region). All these records collected in the recent decades indicate that green lizard populations require creation of local and international conservation programs for the protection of the species.

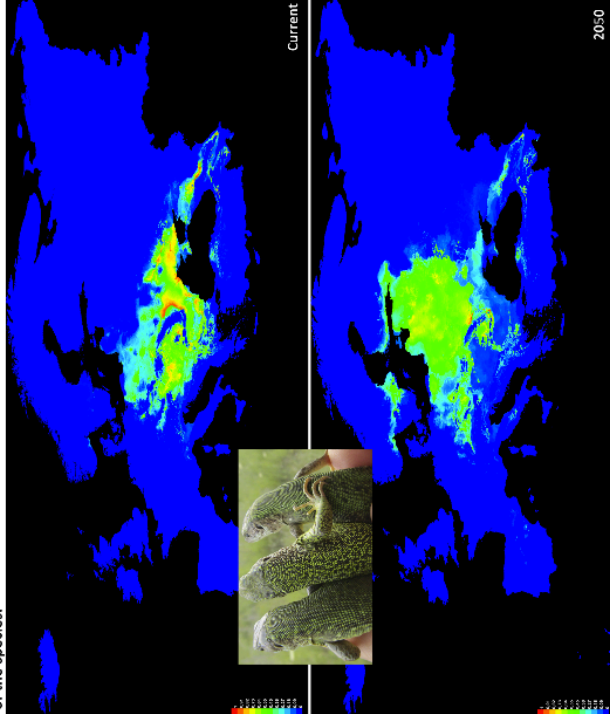


Figure 4. Modelled current distribution of *L. viridis* in Europe based on the used bioclimatic variables for current situation (2000) and taking into account future climate changes (2050).



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