Habitat suitability prediction of *Tenuidactylus caspius* (Eichwald, 1831) (Reptilia: Gekkonidae) in Iran

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Abstract

Tenuidactylus caspius is one of the Gekkonid lizards in northern Iran. In the present study, habitat suitability of the species has been examined and the most important abiotic factors for its presence were determined. Based on the result, precipitation of warmest season (summer) is the most important factor for species presence. The species is known as house gecko in northern Iran and dispersed to distant regions by human. According to the predicted map, northeastern, northern and northwestern Iran is the high suitable regions for the species.

Introduction

Species distribution modeling (SDM) is a useful tool for prediction habitat suitability and estimating the most important environmental variables for species presence during recent years (Gogol-Prokurat, 2011). The SDM models will be used for different goals as conservation biology, climate change (Wiens et al., 2010) and taxonomic decision (Carvalho et al., 2011).

Reptiles like other animals need to conservation and recently many species of reptiles faced to several threats (Todd et al., 2010; Yousefkhani, 2019). Using SDM can help conservationists to know about abiotic ecological factors that effect on the species presence. Geckos are a group of lizards that are most at extinction risk (Jenkins et al., 2014). *Tenuidactylus caspius* (Eichwald, 1831) is one of the gekkonid lizards in Iran that dwells in rocky habitats, but recent years the species mostly adapted with humanization and mostly appears around human communities. The species distribution range is eastern, northeastern, northern and northwestern Iran (Smid et al., 2014). *Tenuidactylus caspius* (Eichwald, 1831) is a ground dwell lizard that found among rocks and borrows of mammals and turtles during the day and nights (Anderson, 1999). Type locality of the species is Baku, Azerbaijan at coastal region of Caspian Sea (Anderson, 1999), but the species was recorded from various habitats and regions in western and central Asia (Szczerbak and Golubev, 1996). These various occupied habitats and dwelling near to the human houses indicated that the species has strong adaptations to different conditions, whether in urban or natural regions.

Then, I decided to do species distribution modeling on the species and found the most important environmental variables that contributed on the species presence. Also predict the suitable area for species presence.

Materials and methods

All species presence records were obtained from literature and direct observations (field work). Totally, 77 records for the species were gathered and used in this study (Anderson, 1999; Ahmadzadeh et al., 2010; Smid et al., 2014). Nineteen Bioclimate layers (Table 1) were downloaded for current timescale (Hijmans et al., 2005; www.worldclim.org) for 30 sec degree resolution. All bioclimate layers were clipped using ArcGIS 10.3 (ESRI) for Iran. Autocorrelation between all layers was calculated by Openmodeller 1.1.0 (de Souza Muñoz et al., 2011) and SPSS 16.0 to avoid any effects of correlations on the models. Correlated variables more than 0.7 not considered for analyses. SDM for the species were done using MaxEnt 3.3.3e (Phillips et al., 2006). By these analyses, the most important variables for species presence can be distinguished. One of the important criteria for model accuracy is Area under the receiver operating characteristic curve (AUC) that will be reached after analyses. The AUC ranges between 0.5 (the predicted model not better than random prediction) to 1 (the best predicted model) (Manel et al., 2001).
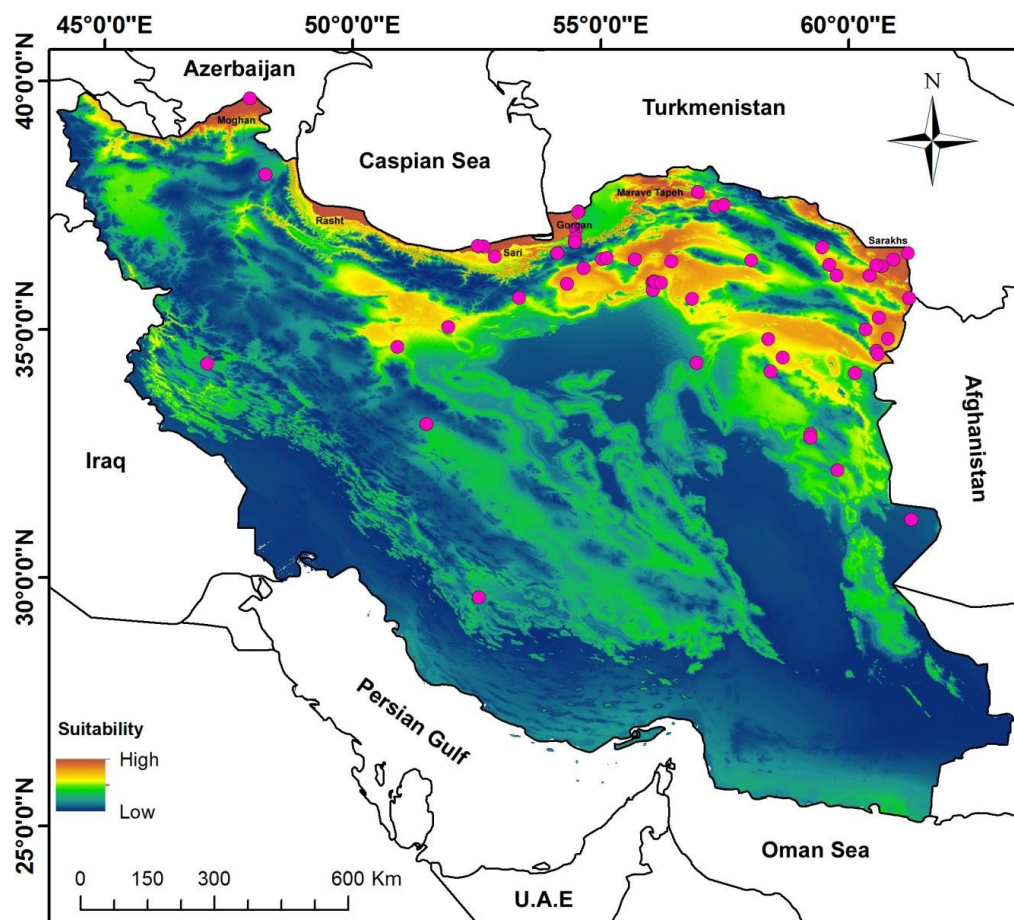

Figure 1. habitat suitability of *T. caspius* in Iran. Warmer colors refer the most suitable regions. Dots presented the occurrence records of the species that used in this study.

Results

By calculating correlation between variables, finally four bioclimate variables were selected to do SDM as: BIO 5 (Maximum Temperature of Warmest Month), BIO 6 (Minimum Temperature of Coldest Month), BIO 18 (Precipitation of Warmest Quarter) and BIO 19 (Precipitation of Coldest Quarter). According to the result, the most suitable area for the species presence was predicted in northeastern, northern and northwestern Iran (Figure 1). As you can see the warmest color refers to the most suitable are. Occurrence records of the species were from literature and most of the presented in NE Iran. The predicted map has good AUC value (AUC: 0.843; Figure 2), but some records are out of the suitable range of the species. As in the previous it has been referred, the species are known as house gecko in northern Iran, and then it is usual to transfer by human to other localities. Those records in Kermanshah, Shiraz and Zabol probably show transferring by human. All selected variables were employed on the model preparation, but their percentage contributions are variable as: BIO 18: 44%, BIO 6: 41.1%, BIO 5: 10% and BIO 19: 4.9%.
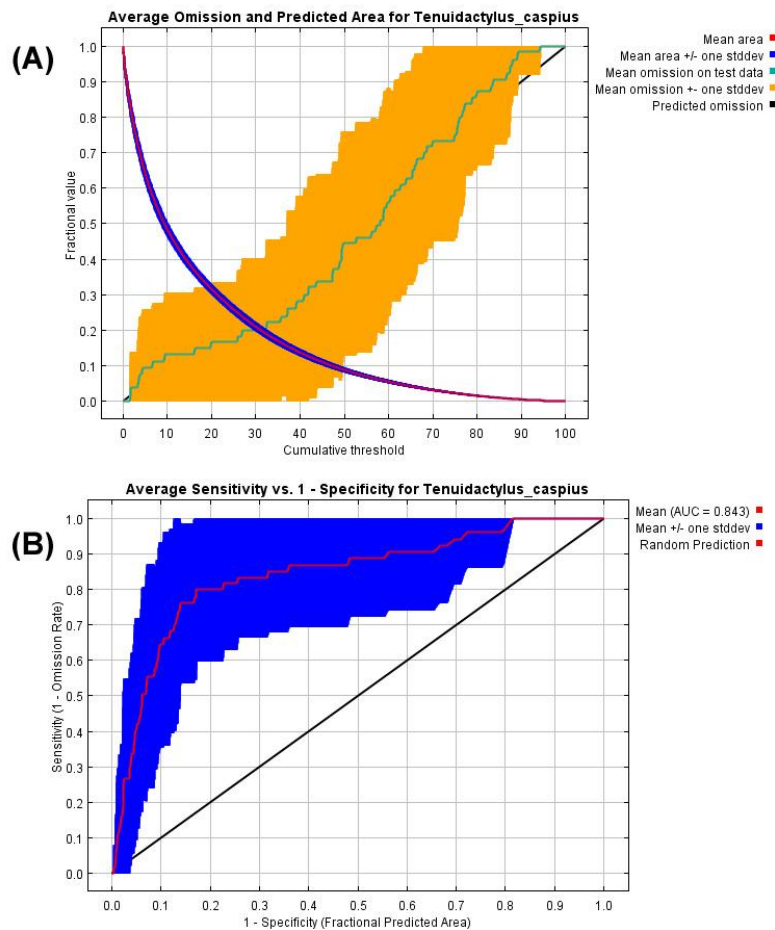

Figure 2. A) Average omission of the predicted model; B) ROC curve and the area under the curve that shows model accuracy.

Table 1. Bioclimatic variables used in this study to elaborate the models.

Variable	Definition
BIO1	Annual Mean Temperature
BIO2	Mean Diurnal Range [Mean of monthly (max temp - min temp)]
BIO3	Isothermality [(var2 / var7) * 100]
BIO4	Temperature Seasonality (standard deviation * 100)
BIO5	Maximum Temperature of Warmest Month
BIO6	Minimum Temperature of Coldest Month
BIO7	Temperature Annual Range (var5 - var6)
BIO8	Mean Temperature of Wettest Quarter
BIO9	Mean Temperature of Driest Quarter
BIO10	Mean Temperature of Warmest Quarter
BIO11	Mean Temperature of Coldest Quarter
BIO12	Annual Precipitation
BIO13	Precipitation of Wettest Month
BIO14	Precipitation of Driest Month
BIO15	Precipitation Seasonality (standard deviation / mean)
BIO16	Precipitation of Wettest Quarter
BIO17	Precipitation of Driest Quarter
BIO18	Precipitation of Warmest Quarter
BIO19	Precipitation of Coldest Quarter

Discussion

Climate condition is an abiotic factor for species presence in the wild, but there are other important biotic factors that influence on the species distribution range (Boulangeat et al., 2012). Gekkonids are sensitive reptiles and nocturnal (Bauer et al., 2013) and live in arid regions of Iranian Plateau. Due to habitat conditions, the species need suitable moisture then percent of precipitation is the most important variable for species. Our result confirms this scenario and BIO18 (precipitation in warmest quarter) is the most contributed variable. Some records of the species are outside of the suitable regions in Iran (Figure 1), but it can be assumed that species distribution partially due by human traveling.

Moghan, Sarakhs, Rasht, Sari, Gorgan and Maraveh Tape regions are the most suitable predicted areas for species presence (Figure 1). These regions have moderate climate in winter and summers (Ghobadi et al., 2012), however the species completely adapted to these conditions. Rainfall is varied in all distribution range (more than 2000 mm in northern Iran and less than 250 mm in Khorasan province). In high precipitation regions, the species is mostly natural, but in arid regions, the species nests near to human and their buildings. On the other hand, elevation has direct influence on species distribution, as it represented the most favorite regions are situated in the regions with elevation up to 500 m above sea level (Anderson, 1999). Mountainous regions are unsuitable for the species, but the species can be found in high elevation regions. These occurrences in high elevation areas are artificial and their presence dependent on humans.

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