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On Additional Samples of *Vipera berus barani* Böhme and Joger, 1983 (Reptilia: Ophidia: Viperidae)

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ABSTRACT: Four samples of *Vipera berus barani* are recorded from Alaçam Village, Kestel/Bursa and Gölcüğez Village, Ünye/Ordu. The meristic and metric characteristics and the color-pattern features of the samples captured from additional localities are given in detail and compared with the specimens from other localities with regard to literature. A database of 30 distribution records of *V. b. barani* was provided and the climatic preference was analyzed. The average AUC value was 0.955 and the most effected bioclimatic variable of *V. b. barani* distribution range is precipitation of driest month (bio14) (55.2%). Under the distribution model, Black Sea borders of Turkey and southeast of Marmara Sea are seen more suitable places for the species.

Keywords: *Vipera berus barani*, Baran's Adder, distribution, morphology, climate, Turkey

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INTRODUCTION

The genus *Vipera* Laurenti, 1768 comprises 21 species. *Vipera* is the most diverse. In Eurasia the genus includes three subclades: 1. *Pelias,* comprising *V. berus, V. altaica, V. anatolica, V. darevskii, V. dinniki, V. eriwanensis, V. graeca, V. kaznakovi, V. lotievi, V. nikolskii, V. orlovi, V. renardi, V. sakoi, V. seoanei, V. ursinii and V. walser.* 2. *Vipera* 1 comprising, *V. aspis* and the *V. latastei-monticola* complex; and 3. *Vipera* 2 including, the *Vipera ammodytes-transcaucasiana* complex (Freitas et al., 2020).

Baran's Adder, *V. b. barani* is an endemic species for Anatolia. It was described as *Vipera barani* from approximately 60 km North of Adapazarı based on a female specimen (Böhme and Joger, 1983). Afterwards, new localities records were reported from the northwestern and the northeastern Anatolia (Baran et al., 1997; Franzen and Heckes, 2000; Baran et al., 2001; Avcı et al., 2004; Baran et al., 2005; Kumlutaş et al., 2013; Gül, 2015; Göçmen et al., 2015; Gül et al., 2016).

V. b. barani is different from other subspecies in *V. berus* in having higher numbers of ventrals and subcaudals for females, fragmented loreals and head plates and unique coloration. The species has melanistic and patterned forms (Böhme and Joger, 1983; Franzen and Heckes, 2000; Baran et al. 2001, 2005; Kumlutaş et al., 2013; Tuniyev et al., 2019).

Several studies were carried out to reveal the taxonomic status of *Vipera berus. barani* and phylogenetic relationship with related taxa. Joger et al. (1997) studied the phylogeny of the *V. berus* group using a partial sequence of the mitochondrial cyt b gene. They studied also the position of *V. barani* and *V. nikolskii* within the group using external morphologic and hemipenial comparisons. Based on mtDNA information, they found that *V. barani* might be a subspecies of *V. berus*. But according to morphology and hemipenis structure *V. barani* represent a distinct species within the *V. berus* "superspecies" group. Joger et al. (2003) worked on subgenus *Pelias* is consisted basically of two lineages covering *V. berus* and *V. ursinii-kaznakovi* group and identified *V. barani* as one of five haplotype groups of the *V. berus* group. Later, Kalyabina-Hauf et al. (2004) analyzed the phylogeny of *V. berus* group based on mitochondrial gene sequences (cyt b, 12S and 16S RNA). They found that *V. bosniensis* and *V. barani* are to be different species because they were morphologically different from *V. berus*. They also reported that if that *V. barani* would be recognized a separate species, *V. barani* was supported as paraphyletic, with *V. berus*. But Freitas et al., (2020) studied on Eurasian Vipers and found that the range of divergence time between *berus* and *barani* is 1.38 Mya. They suggested that despite the obvious geographic isolation; the status of *barani* should be more suitable as subspecies of *V. berus* due to its low genetic divergence (2%).

The aim of this study is to define the climatic patterns and potential distribution of this species with description of pholidotical characteristics, morphometric measurements and the color-pattern characteristics of four *Vipera berus barani* samples collected from two additional localities.

MATERIALS AND METHODS

This study was carried out with the permission of Aydın Adnan Menderes University Animal Experiments Local Ethic Committee dated 27.08.2020 and numbered 64583101/2020/064. This study is based on three samples from Alaçam Village, Kestel/Bursa and one specimen from Gölcüğez Village, Ünye/Ordu, Turkey which were found between the 2012 and 2019. The materials are currently deposited in the Zoology Museums of the Department of Biology at the Science and Arts Faculty, Aydın Adnan Menderes University, Aydın and Uludağ University, Bursa.

Material Examined: n: 4 ♀♀: ♀ Patterned, Alaçam Village, Kestel/Bursa, 1905 m. a.s.l., 15.09.2012, K. Olgun, A. Avcı; ♀ Patterned, Alaçam Village, Kestel/Bursa, 1843 m. a.s.l., 10.09.2013,

A. Akkaya; ♀ Melanistic, Alaçam Village, Kestel/Bursa, 1920 m. a.s.l., 09.09.2019, İ. Şentürk; ♀ Patterned, Gölcüğez Village, Ünye/Ordu, 128 m. a.s.l., 20.08.2019, Y. E. Gümüş.

When the samples were still alive, color-pattern characteristics were determined. The samples were fixed and kept in ethanol 96% and 70 % respectively (Başoğlu and Baran, 1980). Meristic characteristics and the interrelation between them were counted and recorded manually. The number ventral plates were determined by using Dowling system (1951). A dial caliper (± 0.01 mm) was used to taking the metric measurements.

For the distribution model, 26 literature records and four new localities records (Table 1) of *V. b. barani* from Turkey were collected and determined the coordinates from Google Earth Pro vers. 7.3.2. All records are georeferenced into WGS-84 coordinate system and checked with ArcGIS vers. 10.3.1.

Table 1. All available distribution records of the *Vipera berus barani* used in this study.

Locality Name and Literature	Latitude	Longitude
Anadoluhisarı/İstanbul (Bodenheimer, 1944)	41.076582	29.086539
60 km north of Adapazarı/Sakarya (Böhme and Joger, 1983)	41.172167	30.227777
Duygulu-Çamlıhemşin/Rize (Baran et al., 1997)	41.105277	41.044452
Gökdağ-Sapanca/Sakarya (Franzen and Heckes, 2000)	40.667584	30.258639
Hoşdere-Ardeşen/Rize (Franzen and Heckes, 2000)	41.119112	41.038878
Alancık-Dereli/Giresun (Franzen and Heckes, 2000)	40.662072	38.408022
Fırtına Valley-Ardeşen/Rize (Franzen and Heckes, 2000)	41.048711	41.007611
Arpagözü-Çaykara/Trabzon (Baran et al., 2001)	40.584711	40.410233
Ballıca-Of/Trabzon (Kutrup, 2003)	40.893645	40.287497
Sugeldi-Hayrat/Trabzon (Kutrup, 2003)	40.892985	40.327575
Çınarlı-Yomra/Trabzon (Kutrup, 2003)	40.940146	39.822572
Çamlık-Vakfıkebir/Trabzon (Kutrup, 2003)	41.034256	39.251648
İkizce/Ordu (Avcı et al., 2004)	41.046227	37.043309
Göktepe-Geyve/Sakarya (Baran et al., 2005)	40.609096	30.556471
Gölyazı-Terme/Samsun (David and Vogel, 2010)	41.263124	36.956332
Kozlu/Zonguldak (Kumlutaş et al., 2013)	41.412995	31.750258
Köprüköy-Ardeşen/Rize (Mebert et al., 2015)	41.118465	41.051197
Çayyaka-İnegöl/Bursa (Göçmen et al., 2015)	40.002411	29.473170
Durabey-Domaniç/Kütahya (Göçmen et al., 2015)	39.819488	29.628569
Camiliyayla-Bozüyük/Bilecik (Göçmen et al., 2015)	39.808681	29.790152
Koru-Geyve/Sakarya (Göçmen et al., 2015)	40.514787	30.438268
Altındere-Maçka/Trabzon (Göçmen et al., 2015)	40.678663	39.663631
Ömerler/Bolu (Göçmen et al., 2015)	40.694616	31.455846
Yaylacık-Dereli/Giresun (Göçmen et al., 2015)	40.739712	38.461506
Büyükköy-Çayeli/Rize (Gül, 2015)	40.994275	40.691457
Tektaş-Pazar/Rize (Gül et al., 2016)	41.106715	40.814288
Alaçam Village, Kestel/Bursa (In this study)	40.088306	29.295311
Alaçam Village, Kestel/Bursa (In this study)	40.101969	29.240336
Alaçam Village, Kestel/Bursa (In this study)	40.060366	29.312187
Gölcüğez-Ünye/Ordu (In this study)	41.065278	37.381111

Nineteen bioclimatic data were provided from Worldclim ver. 1.4 data set (Hijmans et al., 2005) with the spatial resolution for past climate variables was 2.5 arc-minutes (approximately 5 km^2). Many of these bioclimatic variables appeared unnecessary (Gül et al., 2015) and the correlation matrix was

calculated for these variables with SDM toolbox vers. 1.1. (Brown, 2014). The Pearson correlation coefficients higher than 0.75 accepted as correlated variables and these variables were eliminated from the analysis. Six environmental variables [bio7 = Temperature range (Bio5–Bio6); bio12 = Annual precipitation; bio13 = Precipitation of wettest month; bio14 = Precipitation of driest month; bio17 = Precipitation of wettest quarter; bio18 = Precipitation of warmest quarter] were chosen.

Species distribution models were performed with using the Maxent 3.3.3k (Phillips et al., 2006; Phillips and Dudik, 2008). The Maxent algorithm estimates the potential range of species from locality point data by finding the possibility distribution from the features like environmental variables or functions (Phillips et al. 2004, 2006). Maxent logistic outputs give the possible range as appropriate or not. The area under the receiver operating characteristic curve (AUC) predicts the importance of the model. Predicted distribution maps uploaded and visualized with ArcGIS vers. 10.3.1.

RESULTS AND DISCUSSION

The samples from Bursa were found during day excursions between 10:00 and 13:00 hours in different days, above the upper altitudinal limit of the forest at elevation of approximately 1900 m. The vegetation cover included *Juniperus sp*. The specimen from Ordu was found during day excursions between 13:00 and 15:00 hours, in the forest at elevation of approximately 128 m. The vegetation cover included *Phyllyrea latifolia, Campanula rapunculoides, Lathyrus laxiflorus, Filipendula vulgaris, Mercurialis annua, Coronilla varia, Smilax excels* and *Trachystemon orientalis* (Figure 1).

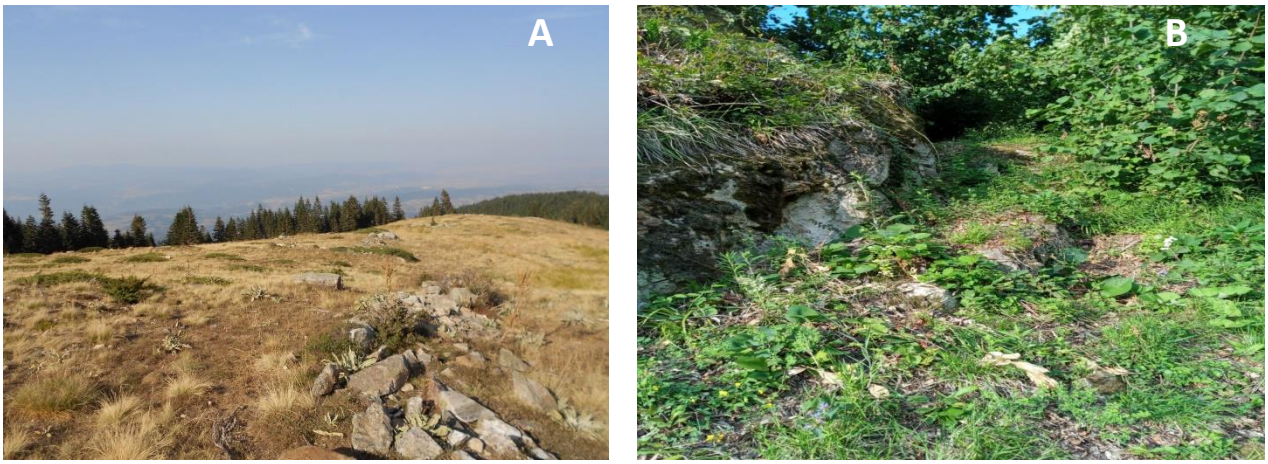

Figure 1. The habitat of *Vipera berus barani* at Alaçam Village, Kestel/Bursa (A) and Gölcüğez Village, Ünye/Ordu (B).

While the snout-vent and tail lengths of the samples from Bursa ranged from 433.96 to 538.44 mm and from 64.23 to 68.47 mm; Ünye/Ordu specimen is 616.03 and 88.65 mm, respectively.

All samples had two apicals in contact with rostral and also they had two canthals on each side of the head. Supralabialia ranged from 9 to 11 on the left and 9 to 10 at right site. Sublabialia ranged from 10 to 12 on the left and 10 to 11 at right site. 21 Dorsal scales in one row at mid-body and they strongly keeled except those on the rows adjoining the ventrals. Ventral plates were found between 142 and 149 while subcaudals were ranged between 33 and 35 pairs. The significant pholidotic features and morphometric measurements of the new samples of *V. b. barani* are given in Table 2.

Table 2. Morphometric measurements and pholidotical characteristics of examined samples of *Vipera berus barani*.

Characteristics	15.09.2012 Kestel/Bursa ♀ Patterned	10.09.2013 Kestel/Bursa ♀ Patterned	09.09.2019 Kestel/Bursa ♀ Melanistic	20.08.2019 Ünye/Ordu ♀ Patterned
Circumocularia (L/R)	11-11	10-10	12-10	10-12
Supralabialia (L/R)	10-9	9-9	9-9	11-10
Sublabialia (L/R)	11-10	10-11	11-11	12-11
Apicalia	2	2	2	2
Canthalia (L/R)	2-2	2-2	2-2	2-2
Intercanthals and Intersupraoculars	28	28	25	25
Lorealia (L/R)	5-5	5-4	2-3	5-4
Dorsalia (mid-body)	21	21	21	21
Subcaudalia (L/R)	33/33+1	34/34+1	33/33+1	35/35+1
Ventralia	1+149	1+148	2+142	1+147
Scales between Supraocularia	5	6	5	4
Gularia	4-4	4-5	3-3	5-5
Rostral height (mm)	2.84	3.77	3.67	4.32
Rostral width (mm)	2.68	3.16	3.64	3.52
Distance between the nostrils (mm)	4.02	4.75	4.87	5.78
Eye diameter (mm)	2.49	3.11	2.97	3.60
Head length (mm)	20.46	21.24	20.60	22.42
Head width (mm)	13.02	16.33	13.17	19.62
Head depth (mm)	7.80	8.35	6.12	8.69
SVL (mm)	433.96	538.44	458.41	616.03
TL (mm)	64.23	67.89	68.47	88.65
Zig-zag Bants (body)	54	68	---	52
Zig-zag Bants (tail)	10	7	---	7

The body color of the melanistic specimen is completely black (Figure 2). But supralabials on each site are yellowish-white with black edges. The white spots present on sublabials but not as remarkable as present in the supralabials. The whitish spots on supra- and sublabials form a fine line where the ventrals contact with the first row of dorsal scales and becoming sparse towards the posterior. Whitish spots of different sizes present on the underside of the head. The ground color of the ventral side is lighter than the deep black dorsal scales and covered with dense white spots, which disappear toward the anus. The color of 1/3 of ventral tip of the tail is yellowish.

Figure 2. General view of *Vipera berus barani* samples: A- ♀ Patterned, Alaçam Village, Kestel/Bursa, 15.09.2012; B- ♀ Patterned, Alaçam Village, Kestel/Bursa, 10.09.2013; C- ♀ Melanistic, Alaçam Village, Kestel/Bursa, 09.09.2019; D- ♀ Patterned, Gölcüğez Village, Ünye/Ordu, 20.08.2019.

The dorsal color of the patterned samples is almost greyish brown with a blackish zig-zag band in a longitudinal row (Figure 2). This zig-zag band shrinks towards the rear and extends up the tip of the tail. The number of zig-zag bands on the body varies between 52-68 while on the tail is between 7-10. The whitish spots on supralabials, sublabials and undersite of the head are similar to the melanistic specimen. The base color of the ventral side is black with rare white spots. The 1/3 of ventral tip of the tail is yellowish like melanistic specimen.

In their morphology and color-pattern features of the new samples correspond well with the other known individuals as mentioned before by Böhme and Joger, 1983; Baran et al., 1997; Franzen and Heckes, 2000; Baran et al., 2001; Avcı et al., 2004; Baran et al., 2005; Kumlutaş et al., 2013; Gül, 2015; Mebert et al., 2015; Göçmen et al., 2015; Gül et al., 2016.

Furthermore, the specimen from Gölcüğez Village, Ünye/Ordu observed in this study had total body length was 704.68 mm. Up to now, the total size of *V. b. barani* generally reaches 55–60 cm (Baran et al., 2012). Our record is the largest total body length for *V. b. barani*, recorded to date.

A database of 30 distribution records of *Vipera b. barani* is provided in Table 1. The mean AUC value of the current distribution model is high (0.955 ± 0.036) (Figure 3). According to the model, the primary factor affecting the distribution of the *V. b. barani* in Anatolia precipitation of driest month (bio14) (55.2%). This species is ranged from Marmara Region to Eastern Black Sea Region. And we know that this region is also rainy in summer than other regions of Turkey.

All this last glacial maksimum, current climatic conditions (Gül, 2015) and field observations are supported this scenario which is affected the distribution of this species by precipitaion in driest month. The contributions of the other variables are given in Table 3. The distribution model shows Black Sea borders of Turkey and southeast of Marmara Sea as more suitable places for distribution of

the species. Gül (2015) reported that precipitation in driest month (Bio14) is also determined as highest gain of the distribution of *Vipera berus barani* under the current climatic conditions and northwest and northeast of Turkey showed better adaptation of the distribution of the species. As in Gül (2015), we also found that Bio14 was the highest gain under last glacial maximum conditions and Black Sea and Marmara Regions are the most suitable locations for the distribution of the species.

Table 3. The contributions of the environmental variables for *Vipera berus barani* in Turkey.

Variables	Description	Percent Contribution
Bio7	Temperature range (Bio5–Bio6)	22.5
Bio12	Annual precipitation	3.4
Bio13	Precipitation of wettest month	8.1
Bio14	Precipitation of driest month	55.2
Bio17	Precipitation of wettest quarter	8.1
Bio18	Precipitation of warmest quarter	2.7

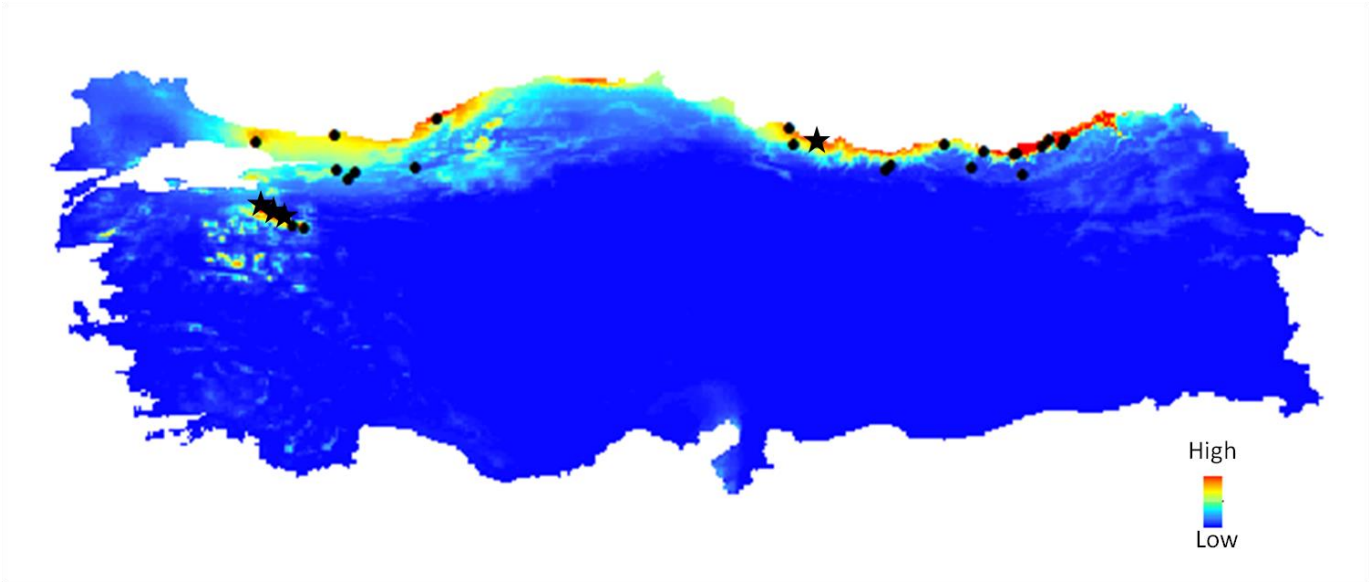

Figure 3. The potential distribution of the *Vipera berus barani* in Turkey. The circles show the known literature records and the stars show the new localities records.

During the past glacial periods, the range of the reptiles is limited in Central and Northern Europe, and in the inter-glacial periods they enlarged their distribution range (Gasc et al., 1997; Araújo et al., 2006). The global climate changes are affected to reptiles in two ways; extinction (Stuart et al., 2004) and expand their distribution (Gasc et al., 1997; Araújo et al., 2006). In the Quaternary ice ages, Anatolia was a refugium, and it is a played a bridge role for migration of species during the interglacial periods to Europe and the Caucasus (Hewitt, 2001). The estimation of the distributions of species has an important place in the practice about ecology, evolution, and conservation biology (Guisan and Thuiller, 2005; Elith et al., 2006).

CONCLUSION

In this study, we examined four samples of *Vipera b. barani* from two new locality which are named Alaçam Village, Kestel/Bursa and Gölcüğez Village, Ünye/Ordu. Also, length of the sample obtained from Gölcüğez Village, Ünye/Ordu is 704.68 mm and it is the largest sample belonging to the

species mentioned in the literature so far. Moreover, we found precipitation of driest month (bio14, 55.2%) as the most important ecological variable for habitat preference of species.

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Conflict of Interest

The authors declare that they have contributed equally to the article.

Author's Contributions

The article authors declare that there is no conflict of interest between them.

KAYNAKLAR

Araújo MB, Thuiller W, Pearson RG, 2006. Climate warming and the decline of amphibians and reptiles in Europe. Journal of Biogeography, 33 (10): 1712-1728.

Avcı A, Üzüm N, Olgun K, 2004. A new record of *Vipera barani* Böhme & Joger, 1983 (Reptilia, Viperidae) from north-eastern Anatolia, Turkey. Russian Journal of Herpetology, 11: 77–79.

Baran İ, Tosunoğlu M, Kaya M, Kumlutaş Y, 1997. On the herpetofauna of the vicinity of Çamlıhemşin. Turkish Journal Zoology, 21: 409–416.

Baran İ, Joger U, Kutrup B, Türkozan O, 2001. On new specimens of *Vipera barani* Böhme and Joger, 1983 from northeastern Anatolia, and implications for the validity of *Vipera pontica* Billing, Nilson and Sattler, 1990 (Reptilia, Viperidae). Zoology in the Midddle East, 19: 33–36.

Baran İ, Kumlutaş Y, Ilgaz Ç, İret F, 2005. Geographical distributions and taxonomical states of *Telescopus fallax* (Fleischman, 1831) and *Vipera barani* Böhme and Joger, 1983. Turkish Journal of Zoology, 29: 217–224.

Baran İ, Ilgaz Ç, Avcı A, Kumlutaş Y, Olgun K, 2012. Türkiye Amfibi ve Sürüngenleri. TÜBİTAK Popüler Bilim Kitapları, s. 179, Ankara-Türkiye.

Başoğlu M, Baran İ, 1980. Türkiye Sürüngenleri. Kısım II. Yılanlar. Ege Üniv. Fen Fak. Kitaplar Serisi, pp. 272, İzmir-Turkey.

Bodenheimer FS, 1944. Introduction into the knowledge of the amphibia and reptilia of Turkey. İstanbul Üniversitesi Fen Fakültesi Mecmuası, 9: 1-93.

Böhme W, Joger U, 1983. Eine neue Art des *Vipera berus*-Komplexes aus der Turkei. Amphibia–Reptilia, 4: 265–271.

Brown JL, 2014. SDMtoolbox: a python- based GIS toolkit for landscape genetic, biogeographic and species distribution model analyses. Methods in Ecology and Evolution, 5: 694-700.

David P, Vogel G, 2010. Terralog - Giftschlangen Europas, Nord- Zentral- und Westasiens. Edition Chimaira, pp. 160, Frankfurt-Germany.

Dowling HG, 1951. A proposed standard of counting ventrals in snakes. British Journal of Herpetology, 1: 97-99.

Elith J, Graham CH, Anderson RP, Dudík M, Ferrier S, Guisan A, Hijmans RJ, Huettmann F, Leathwick J, Lehmann A, Li J, Lohmann LG, Loiselle BA, Manion G, Moritz C, Nakamura M, Nakazawa Y, Overton JMcCM, Peterson AT, Philips SJ, Richardson K, Scacchetti-Pereira R, SchapireRE, Soberon J, Williams S, Wisz MS, Zimmermann NE, 2006. Novel methods improve prediction of species' distributions from occurrence data. Ecography, 29: 129-151.

Franzen M, Heckes U, 2000. *Vipera barani* Böhme and Joger, 1983 aus demöstlichen Pontus-Gebirge, Türkei: Differentialmerkmale, Verbreitung, Habitate. Spixiana, 23: 61–70.

Freitas I, Ursenbacher S, Mebert K, Zinenko O, Schweiger S, Wüster W, Brito JC, Crnobrnja-Isailovic J, Halpern B, Fahd S, Santos X, Pleguezuelos JM, Joger U, Orlov N, Mizsei E, Lourdais O, Zuffi MAL, Strugariu A, Zamfirescu ŞR, Martinez-Solano I, Velo-Anton G, Kaliontzopoulou A, Martinez-Freiria F, 2020. Evaluating taxonomic inflation: towards evidence-based species delimitation in Eurasian vipers (Serpentes: Viperinae). Amphibia–Reptilia, 41: 285–311.

Gasc JP, Cabela A, Crnobrnja-Isailovic J, Dolmen D, Grossenbacher K, Haffner P, Lescure J, Martens H, Martinez-Rica JP, Maurin H, Olivera ME, Sofianidou TU, Veith M, Zuiderwijk A, 1997. Atlas of amphibians and reptiles in Europe. Societas Europaea Herpetologica and Muséum national d'Histoire naturelle, pp. 516, Paris-France.

Göçmen B, Mebert K, Karış M, 2015. New distributional data on *Vipera* (*berus*) *barani* from Western and Northeastern Anatolia. Herpetology Notes, 8: 609–615.

Guisan A, Thuiller W, 2005. Predicting species distribution: offering more than simple habitat models. Ecology Letters, 8: 993-1009.

Gül S, 2015. Potential distribution modeling and morphology of *Pelias barani* (Böhme and Joger, 1983) in Turkey. Asiatic Herpetological Research, 6: 206–212.

Gül S, Kumlutaş Y, Ilgaz Ç, 2015. Climatic preferences and distribution of 6 evolutionary lineages of *Typhlops vermicularis* Merrem, 1820 in Turkey using ecological niche modeling. Turkish Journal of Zoology, 39: 235-243.

Gül S, Kumlutaş Y, Ilgaz, Ç, 2016. A new locality record of *Pelias barani* (Böhme et Joger, 1983) from the northeastern Anatolia. Russian Journal of Herpetology, 23: 319-322.

Hewitt GM, 2001. Speciation, hybrid zones and phylogeography- or seeing genes in space and time. Molecular Ecology, 10: 537-549.

Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology, 25: 1965-1978.

Joger U, Lenk P, Baran İ, Böhme W, Heidrich P, Wink M, 1997. The phylogenetic position of *Vipera barani* and of *Vipera nikolskii* within the *Vipera berus* complex. Herpetologia Bonnensis, 1997: 185-194.

Joger U, Kalyabina-Hauf S, Schweiger S, Mayer W, Orlov NL, Wink M, 2003. Phylogeny of the Eurasian *Vipera* (*Subgenius Pelias*). 12th Ordinary General Meeting Societas Europaea Herpetologica (SEH), St. Petersburg, August 12-13, 2003, pp. 77.

Kalyabina-Hauf S, Schweiger S, Joger U, Mayer W, Orlov NL, Wink M, 2004. Phylogeny and systematics of adders (*Vipera berus complex*). Mertensiella, 15: 7-15.

Kumlutaş Y, Sözen M, Ilgaz Ç, 2013. New record of the rare *Vipera barani* Böhme and Joger, 1983. Herpetozoa, 25: 183–188.

Kutrup B, 2003. The identification of new specimens of *Vipera* from Trabzon, Turkey with affinities to *Vipera barani* and *V. pontica*. Herpetological Review, 43: 28–31.

Mebert K, Göçmen B, İğci N, Oğuz MA, Karış M, Ursenbacher S, 2015. New records and search for contact zones among parapatric vipers in the genus *Vipera* (*barani, kaznakovi, darevskii, eriwanensis*), *Montivipera* (*wagneri, raddei*), and *Macrovipera* (*lebetina*) in northeastern Anatolia. The Herpetological Bulletin, 133: 13–22.

Phillips SJ, Dudik M, Schapire RE, 2004. A maximum entropy approach to species distribution modeling. Proceedings of the Twenty-First International Conference on Machine Learning, Alberta, July 4-8, 2004, pp. 655-662.

Phillips SJ, Anderson RP, Schapire RE, 2006. Maximum entropy modeling of species geographic distributions. Ecological Modelling, 190: 231-259.

Phillips SJ, Dudik M, 2008. Modeling of species distributions with MaxEnt: new extensions and a comprehensive evaluation. Ecography, 31: 161-175.

Stuart S, Chanson JS, Cox NA, Young BE, Rodrigues ASL, Fischman DL, Waller RW, 2004. Status and trends of amphibian declines and extinctions worldwide. Science, 306: 1783-1786.

Tuniyev BS, Orlov NL, Ananjeva NB, Aghasyan AL, 2019. Snakes of the Caucasus: taxonomic diversity, distribution, conservation. KMK ScientificPress, pp. 276, St. Petersburg-Russia.