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New Locality Record of *Platyceps najadum* (Eichwald, 1831) With Ecological Niche Modeling in Turkey

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ABSTARCT: In this study, one death *Platyceps najadum* was found on road in Aşağıyanlar Village/Çankırı in Northern Turkey. The distribution range of the species has been extended 88 km from known localities. The specimen was evaluated in terms of morphology and colour-pattern characteristics. The climatic preference of *P. najadum* was analyzed. The average AUC value was 0.771 and the most effected bioclimatic variable of *P. najadum* distribution range is precipitation of wettest month (bio13) (47.5%). Under the distribution model, coast of Aegea, Northern Black Sea and Mediterranean is seen more suitable places for the species.

Keywords: *Platyceps najadum*, Dahl's Whip Snake, distribution model, new locality, Turkey

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INTRODUCTION

Platyceps najadum (Eichwald, 1831) firstly described from Baku in Azerbaijan as *Tyria najadum*. Dahl's Whip Snake is distributed in Crotia, Bosnia and Herzegovina, Albania, Montenegro, Serbia, North Macedonia, Greece, Bulgaria, Russia, Turkey, Cyprus, Lebanon, Syria, Iran, Iraq, Georgia, Azerbaijan, Armenia and Turkmenistan (Leviton et al., 1992; Hraoui-Bloquet et al., 2002; Beshkov and Nanev, 2006; Baier et al., 2009; Baran et al., 2012; Rajabizadeh, 2017). Six subspecies are known; *P. n. najadum* (Eichwald, 1831) Caucasus and Northeastern Anatolia; *P. n. dahlii* Schinz, 1832 Balkans, Cyprus, West, South and Southwest Turkey, Lebanon, Syria and Iraq; *P. n. kalymnensis* Schneider, 1979 is endemic to island of Kalimnos; *P. n. atayevi* Tuniev and Shammakov, 1993 southeastern Turkmenistan and northern Iran; *P. n. albitemporalis* Darevsky and Orlov, 1994 southeastern Azerbaijan; *P. n. schmidtleri* (Schatti and McCarthy, 2001) Zagros Mountain, Iran (Schatti and McCarthy, 2001; Schatti et al., 2005; Anonymus, 2019a) .

Dumeril et al., (1854) was cited to *Platyceps najadum* in *Zamenis* manuscript. After, many authors evaluated this species as *Zamenis dahlii* in their studies. Mertens and Müller (1928) placed this species to *Coluber* (Linnaeus, 1758) as *Coluber najadum*. Baran (1976) compared the *Coluber najadum* and *Coluber dahlii* specimens with morphological aspects and reported that this species were synonymus and they must be evaluated as *Coluber najadum* in terms of the priorite rules.

Schatti and McCarthy (2001) considered *Tyria najadum* as *Zamenis dahlii* var *collaris* (Müller, 1878). Schatti and Utiger (2001) reported that the *najadum* group is a distinct evolutionary lineage within the genus *Platyceps* Blyth, 1860, in terms of morphology. The most comprehensive study of the *Platyceps najadum* was conducted by Schatti et al., (2005). They focused on morphology, distribution and systematics of the species, and the *Platyceps najadum* differs from the congeneric taxa in number of apical pits and molecular analysis.

In this study, the distribution of *Platyceps najadum* was expanded to north Anatolia and morphological detail of the specimen from the new locality was presented. In addition to this, potential distribution of the species in Turkey was determined.

MATERIALS AND METHODS

Description of new locality sample

One death male *Platyceps najadum* was found on the road from Aşağıyanlar Village, Çankırı in northern Anatolia on 28 June 2019. The specimen was closest to non-evergreen woodland and stony area. The specimen fixed with a 96% ethanol injection and deposited in %80 ethanol in Eldivan Vocational School of Health Service, Çankırı Karatekin University. Metric and meristic characteristics are determined according to the literature (Baran, 1976; Başoğlu and Baran, 1980; Darevsky and Orlov, 1994; Schatti et al., 2005). Meristic characteristics were counted under the Olympus brand binocular. Metric characteristics were measured with 0.05 mm caliper.

The following metric measurements were taken: SVL (snout-vent length), tip of snout to anal cleft; TL (tail length), anal cleft to the tip of tail; TBL (total body length), tip of snout to the tip of tail; PW (pileus width), at widest point between parietal plates; PL (pileus length), tip of snout to the posterior margins of parietals, PH (pileus height), FW (frontale width), at widest point frontale plate, FL (frontale length), from anterior to posterior of frontale.

Meristic characteristics considered here included the following counts: preocularia (left-right), loralia (left-right), postocularia (left-right), temporalia (left-right), supralabialia (left-right), ventralia, subcaudalia and dorsalia between 75 and 85th ventral plates.

Distribution Model

For the distribution model, 119 literature records and one new locality record (Table 1) of *Platyceps najadum* 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 *Platyceps najadum* used in this study

Locality Name and Literature	Latitude	Longitude
Meles Çayı/İzmir (Bird, 1936)	38.403199	27.100648
Bodrum/Muğla (Bird, 1936)	37.040566	27.430907
Haymana/Ankara (Bird, 1936)	39.434250	32.495670
Ankara (Bird, 1936)	39.933363	32.859742
Bolkar/Mersin (Bird, 1936)	37.249934	34.333444
Mersin (Bird, 1936)	36.832454	34.621796
Gülek/Mersin (Bird, 1936)	37.257263	34.768923
Tarsus/Mersin (Bird, 1936)	36.916599	34.895196
Adana (Bird, 1936)	36.991435	35.330741
Amanos/Hatay (Bird, 1936)	36.750063	36.332811
Kaypak/Osmaniye (Bird, 1936)	37.110565	36.452668
Gaziantep (Bird, 1936)	37.065972	37.377795
Malatya (Bird, 1936)	38.353716	38.330617
Trabzon (Bird, 1936)	41.002693	39.716747
10 km east of Anamur/Mersin (Clark and Clark, 1973)	36.077298	32.832919
20 km north of Kırıkhan/Hatay (Clark and Clark, 1973)	36.496724	36.360656
Yakacık/Gaziantep (Clark and Clark, 1973)	36.902367	37.534309
Kaz Dağı/Balıkesir (Baran, 1976)	39.699987	26.833381
Aliağa/İzmir (Baran, 1976)	38.799352	26.970898
Gaziemir/İzmir (Baran, 1976)	38.323122	27.138240
Bornova/İzmir (Baran, 1976)	38.470981	27.217715
Yatağan/Muğla (Baran, 1976)	37.387202	28.159223
Kayaköy/Muğla (Baran, 1976)	36.574984	29.091093
Xanthos/Antalya (Baran, 1976)	36.352776	29.321437
Geyikdere/Kocaeli (Baran, 1976)	40.659000	29.467489
Çığlıkara/Elmalı/Antalya (Baran, 1976) (Kumlutaş et al., 2004)	36.482181	29.910853
Karapınar/Konya (Baran, 1976)	37.711692	33.655848
Aksaray (Baran, 1976)	38.368670	34.029948
Fındıkpınarı/Mersin (Baran, 1976)	36.922911	34.368095
Sebil/Mersin (Baran, 1976)	37.129631	34.562629
Madenköy/Niğde (Baran, 1976)	37.449037	34.624373
Kıranardı/Kayseri (Baran, 1976)	38.633859	35.524220
Kadirli/Osmaniye (Baran, 1976)	37.374022	36.097300
Zincirli Höyük/Gaziantep (Baran, 1976)	37.103884	36.676336
Nemrut/Adıyaman (Baran, 1976)	37.980779	38.740800
Burmageçit/Tunceli (Baran, 1976)	38.966843	39.539269
Karacadağ/Diyarbakır (Baran, 1976)	37.735021	39.640723
Erciş/Van (Baran, 1976)	39.028729	43.358162
Artvin (Başoğlu and Baran, 1980)	41.180937	41.820819
Van (Başoğlu and Baran, 1980)	38.501146	43.372192

Table 1. All available distribution records of the *Platyceps najadum* used in this study (continued)

Acar Köyü/Kilis (Baran, 1982)	36.744811	37.194107
3 km east of Akçaova/Kocaeli (Teynie, 1987)	41.037446	29.949944
Elvanlı/Mersin (Teynie, 1987)	36.702837	34.372210
Çatalan/Adana (Teynie, 1987)	37.201680	35.297030
Kağızman/Kars (Teynie, 1987)	40.140648	43.119118
Akdam/Adana (Schmidtler, 1988)	37.550956	35.618423
Kozan/Adana (Schmidtler, 1988)	37.452519	35.819267
Kızılada/Muğla (Baran, 1990)	37.128328	27.297788
Kiliseliceada/Kaş/Antalya (Baran, 1990)	36.729509	28.055200
Sarıoda Adası/Kaş/Antalya (Baran, 1990)	36.133889	29.658333
Söğüt/Antalya (Baran, 1990)	37.077954	29.915682
Eskipazar/Karabük (Teynie, 1991)	40.944204	32.532524
Kastabala/Osmaniye (Teynie, 1991)	37.176527	36.186915
Baykan/Siirt (Teynie, 1991)	38.162650	41.785194
Digor/Kars (Teynie, 1991)	40.375076	43.414150
Kuşadası/Aydın (Manteuffel, 1993)	37.857897	27.261072
Karaisalı/Adana (Schmidtler, 1993)	37.257347	35.058197
Selçuk/İzmir (Mulder, 1995)	37.950879	27.370032
Sağırin/Antalya (Mulder, 1995)	37.010261	31.231775
Uğurlu/Konya (Mulder, 1995)	37.410036	31.685341
Hadim/Konya (Mulder, 1995)	36.986063	32.455878
Kargıcak/Mersin (Mulder, 1995)	36.622696	34.323213
Emirler/Niğde (Mulder, 1995)	37.473687	34.512439
Süngütepe/Kilis (Mulder, 1995)	36.792517	36.948846
Uzundere/Erzurum (Mulder, 1995)	40.611413	41.628441
Civan/Artvin (Mulder, 1995)	41.344500	41.661900
Iğdır (Mulder, 1995)	39.920057	44.043567
Bakırdağı/Kayseri (Schmidtler, 1997)	38.216621	35.807480
Hanyeri/Adana (Schmidtler, 1997)	38.212500	36.022778
15 N of Saimbeyli/Adana (Schmidtler, 1997)	37.986090	36.089587
Reyhanlı/Hatay (Uğurtaş et al., 2000)	36.268697	36.567545
Yamansaz/Antalya (Erdoğan et al., 2002)	36.873642	30.853291
Arapsuyu/Antalya (Kumlutaş et al., 2004)	36.876524	30.650189
Kovada/Eğirdir/Isparta (Kumlutaş et al., 2004)	37.634351	30.870993
Boğazak/Serik/Antalya (Kumlutaş et al., 2004)	36.855079	31.163516
Kızılot/Manavgat/Antalya (Kumlutaş et al., 2004)	36.718215	31.567918
15 km SW of Karakurt/Kars (Baran et al., 2004)	40.166882	42.606777
Akarkuyu/Milas/Muğla (Kete et al., 2005)	37.416495	27.485401
Gölyaka/Milas/Muğla (Kete et al., 2005)	37.486544	27.544783
Danışment/Milas/Muğla (Kete et al., 2005)	37.417162	27.579775
Edirne (Schatti et al., 2005)	41.676992	26.556024
Borçka/Artvin (Schatti et al., 2005)	41.363700	41.679100
Ardanuç/Artvin (Schatti et al., 2005)	41.117212	42.064817
Çanakkale (Tok et al., 2006)	40.146720	26.408730
Küplüce/Kilis (Göçmen et al., 2009)	36.753186	37.242727
Kolludere/Karacadağ/Diyarbakır (Akelma and Coşkun, 2013)	37.863547	40.056675
Eğil/Diyarbakır (Akelma and Coşkun, 2013)	38.257900	40.081151
Kırca/Sultandağı/Afyonkarahisar (Cihan and Tok, 2014)	38.512165	31.235528
Dereçine/Sultandağı/Afyonkarahisar (Cihan and Tok, 2014)	38.487355	31.257273
Gölçayır/Akşehir/Konya (Cihan and Tok, 2014)	38.465148	31.323354
Tınaztepe/Afyonkarahisar (Eser and Erişmiş, 2014)	38.728464	30.378473
Kavşit/Çine/Aydın (Özcan and Üzüm, 2014)	37.657608	28.122666

Table 1. All available distribution records of the *Platyceps najadum* used in this study (continued)

Gökçeada (Tok and Çiçek, 2014)	40.163952	25.842486
Bozcaada (Tok and Çiçek, 2014)	39.819762	26.031783
Gelibolu/Çanakkale (Tok and Çiçek, 2014)	40.413959	26.670076
Biga/Çanakkale (Tok and Çiçek, 2014)	40.226527	27.243625
Güllük/Muğla (Cumhuriyet and Ayaz, 2015)	37.235031	27.606183
Alara Kalesi/Antalya (Kucharzewski, 2015)	36.697909	31.728644
Küçüklü/Antalya (Kucharzewki, 2016)	36.965338	29.781810
Avsallar/Antalya (Kucharzewki, 2016)	36.622558	31.767257
Öznurtepe/Antalya (Kucharzewki, 2016)	36.358360	32.376091
Dağdibi/Pozantı/Adana (Sarıkaya et al., 2017)	37.643627	35.001699
Çamlıbel/Aladağ/Adana (Sarıkaya et al., 2017)	37.491239	35.066825
Kapı/Karataş/Adana (Sarıkaya et al., 2017)	36.647911	35.196543
Kabasakal/Seyhan/Adana (Sarıkaya et al., 2017)	37.039548	35.332525
Dutluca/Sarıçam/Adana (Sarıkaya et al., 2017)	37.150334	35.437964
Vayvaylı/Yüreğir/Adana (Sarıkaya et al., 2017)	36.901974	35.632755
Kurtkulağı/Ceyhan/Adana (Sarıkaya et al., 2017)	36.923867	35.885852
Çatalçam/Tufanbeyli/Adana (Sarıkaya et al., 2017)	38.194722	36.079722
Mutki/Bitlis (Akman et al., 2018)	38.408588	41.922320
Dilburnu/Ahlat/Bitlis (Akman et al., 2018)	38.837977	42.263409
Küçüksu/Tatvan/Bitlis (Akman et al., 2018)	38.441687	42.320308
Çökekyazı/Hizan/Bitlis (Akman et al., 2018)	38.270557	42.375541
Sağırkaya/Hizan/Bitlis (Akman et al., 2018)	37.989747	42.570998
Karşıyaka/Adilcevaz/Bitlis (Akman et al., 2018)	38.804757	42.956803
1 km east of Gözlüçayır/Çemişgezek/Tunceli (Avcı et al., 2018)	39.118006	38.974942
16 km north of Pülümür/Tunceli (Avcı et al., 2018)	39.486815	39.896072
Olympos/Antalya (Mermer, 2018)	36.386568	30.443708
Derecik/Patnos/Ağrı (Yıldız et al., 2018)	39.157600	43.01425
Aşağıyanlar/Çankırı (In this study)	40.566038	33.556442

Nineteen bioclimatic data were obtained from Worldclim ver. 1.4 data set (Hijmans et al. 2005; Anonymus, 2019b) with the spatial resolution for past climate variables was 2.5 arc-minutes (approximately 5 km^2). Many of these 19 bioclimatic variables appeared redundant (Gül et al., 2015) and the correlation matrix was calculated for these variables with SDM toolbox vers. 1.1. (Brown, 2014). A Pearson correlation coefficients higher than 0.75 accepted as correlated variables and these variables were eliminated from the analysis. Six enviromental 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 conducted with using the Maxent 3.3.3k (Phillips et al., 2006; Phillips and Dudik, 2008). The Maxent algorithm predicts the potential distributions of species from locality point data by finding the probability distribution of the maximum entropy subject to the limitation that the expected value of each of a set of features (environmental variables or functions) under this estimated distribution closely matches its empirical average (Phillips et al. 2004; Phillips et al., 2006). Maxent logistic outputs represent the habitat suitability ranging from unsuitable to suitable. The 10 percentile training presence logistic threshold approach was performed as recommended by Liu et al. (2005), and the logistic output was transformed into a continuous map of the presence-absence distribution. The area under the receiver operating characteristic curve (AUC) estimates the significance of the model. Predicted distribution maps imported and visualized with ArcGIS vers. 10.3.1.

RESULT and DISCUSSION

The new locality is far from approximately 92 southeast of Eskipazar, Karabük and 88 km northeast of Ankara. The morphometric measurements of our specimen are as follows: PL, 14.7 cm; PW, 8.3 cm; PH, 6.6 cm; FW, 4.6 cm; FL, 5.5 cm; SVL, 71.0 cm; TL, 22.5 cm; TBL, 93.5 cm. The numbers of the supralabial plates are 8-8; preocular plates 2-2; loreal plates 1-1; postocular plates 2-2; temporal plates 2-2; ventral plates 229; dorsal plates 19 and subcaudal plates 110.

The colour of head is brownish. The ground colours of anterior and posterior of eyes are white. Dorsum colour of anterior of body is greyish with dark greyish spots on flanks. The rest of the dorsum is ligth brownish. Colour of the ventralia is yellowish (Figure 1).

Figure 1. General view of the *Platyceps najadum* from Aşağıyanlar Village-Çankırı.

A database of 200 distribution records of *Platyceps najadum* in Anatolia is provided in Table 1. The mean AUC value of the current distribution model (Figure 2) is high (0.771). According to the model, the primary factor affecting the distribution of the *P. najadum* in Anatolia precipitation of wettest month (bio13) (47.5%). The contributions of the other variables are given in Table 2. The distribution model shows Mediterranean, Aegean and Eastern Black Sea borders as more suitable places, whereas Southeast Anatolia and East Anatolia is not suitable for distribution of the species. Moreover, the distribution model is covering wider area than known locality records.

During the past glacial periods, the range of the European reptiles is limited in Central and Northern Europe, and they expanded their range in the inter-glacial periods (Gasc et al., 1997; Araújo et al., 2006). Reptiles are react to the global climate change in two ways; extinction (Stuart et al. 2004) and expand their distribution (Gasc et al., 1997; Araújo et al., 2006). Anatolia was a refugium during the Quaternary ice ages and it is a played a bridge role for migration of species during the interglacial periods to Europe and the Caucasus (Hewitt, 2001).

The species prefers a variety of lowlands, low montanes, rocky hillsides, river valleys, abandoned buildings, forest edges and scrublands (O'Shea, 2018). The new locality of the species is shown the similarity to habitat preference of the species, in terms of rocky hillside and river valley. The prediction of the distributions of species has an important place in the applications about ecology, evolution, and

conservation biology (Guisan and Thuiller 2005; Elith et al., 2006). In this study, we found precipitation of wettest month (bio13, 47.5%) as the most important ecological variable for habitat preference of species.

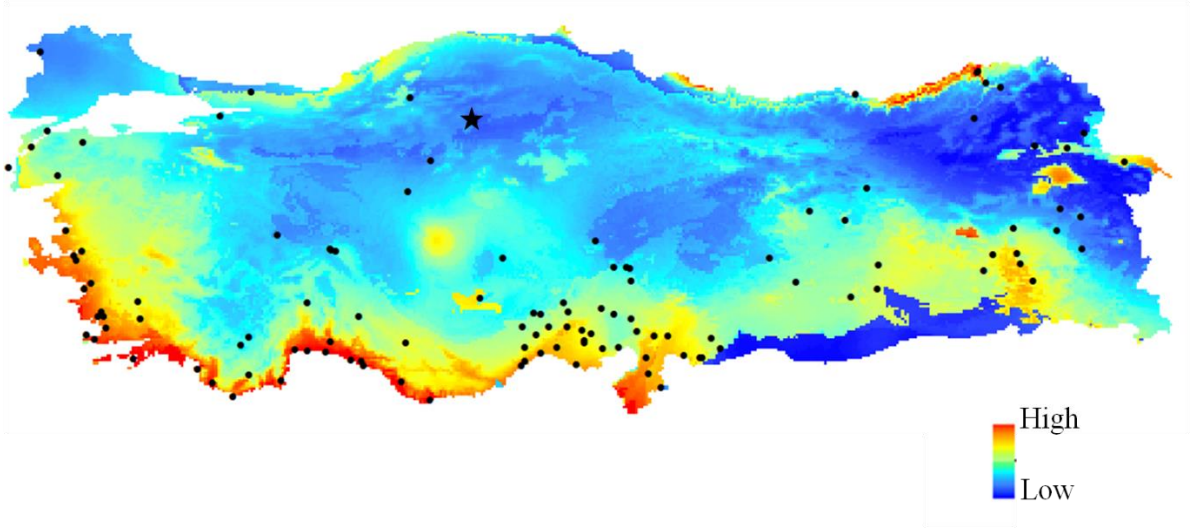

Figure 2. The potential distribution of the *Platyceps najadum* in Turkey. The circles show the known literature records and the star shows the new locality record.

Table 2. The contributions of the environmental variables for *Platyceps najadum* in Turkey.

Variables	Description	Percent Contribution
Bio7	Temperature range (Bio5–Bio6)	12.4
Bio12	Annual precipitation	13.9
Bio13	Precipitation of wettest month	47.5
Bio14	Precipitation of driest month	14.2
Bio17	Precipitation of wettest quarter	9.6
Bio18	Precipitation of warmest quarter	2.5

CONCLUSION

Regarding all morphological measurement and colour pattern, our specimen agrees with the given for *P. najadum* in the literature (Baran, 1976; Başoğlu and Baran, 1980; Schatti et al., 2005). Moreover, the distribution range of the species in Anatolia was extended by 88 km of air distance from known localities. Schatti (2004) reported that the elevation range of the *P. najadum* is varied from 400 to 2000 m. The elevation of the new locality is 570 m, but seasides of Turkey are shown the more suitable places by distribution model. According to distribution model, a large part of Anatolia is seen as more suitable area for distribution of *P. najadum*, but known locality records is not comprise the distribution model. Therefore, there is limited number of the publications about the *P. najadum* and these locality records are mainly depends of the herpetofaunal reports.

According to the this study, the distribution model of the *P. najadum* mainly covered the coast of Northern Black Sea, Aegea and Mediterranean in Turkey, and known locality records are shown similarity with the distribution model. But also, the distribution model shows suitable places for the species without any records. And, the distribution range of the *P. najadum* was extended by 88 km in Northern Anatolia.

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