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

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**ABSTRACT:** 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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Geliş tarihi / Received: 25-12-2019
Kabul tarihi / Accepted: 09-02-2020
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 prioretie 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 Çay/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  |
| Boğaz/Mersin (Bird, 1936)   | 37.249934 | 34.333444  |
| Mersin (Bird, 1936)          | 36.832454 | 34.621796  |
| Gülük/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  |
| Yakaköy/Gaziantep (Clark and Clark, 1973) | 36.902367 | 37.534309  |
| Kaz Dağı/Balikesir (Baran, 1976) | 39.699987 | 26.833831  |
| Aliağ/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  |
| Çiğlikara/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  |
| Fundıkpınar/Mersin (Baran, 1976) | 36.922911 | 34.368095  |
| Sebil/Mersin (Baran, 1976)   | 37.129631 | 34.562629  |
| Madenköy/Niğde (Baran, 1976) | 37.449037 | 34.624373  |
| Kiranard/Kayseri (Baran, 1976) | 38.633859 | 35.524220  |
| Kadirli/Osmaniye (Baran, 1976) | 37.374022 | 36.973000  |
| Zinciri Höyük/Gaziantep (Baran, 1976) | 37.103884 | 36.676336  |
| Nemrut/Adıyaman (Baran, 1976) | 37.980779 | 38.740800  |
| Burmageçit/Tunceli (Baran, 1976) | 38.966843 | 39.539269  |
| Karacada/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)

| Location                                      | Latitude  | Longitude |
|-----------------------------------------------|-----------|-----------|
| 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 |
| Kağrızman/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 |
| Sarroda Adas/Kaş/Antalya (Baran, 1990)      | 36.133889 | 29.658333 |
| Süğüt/Antalya (Baran, 1990)                 | 37.077954 | 29.915682 |
| Eskipazar/Karabük (Teynie, 1991)            | 40.944204 | 32.532524 |
| Kastabala/Osmaniye (Teynie, 1991)           | 37.176527 | 36.186915 |
| Baykan/Sürt (Teynie, 1991)                  | 38.162650 | 41.785194 |
| Digor/Kars (Teynie, 1991)                   | 40.375076 | 43.414150 |
| Kuşadası/Aydın (Manteuffel, 1993)           | 38.578979 | 27.261072 |
| Karaisalı/Adana (Schmidtler, 1993)           | 37.253747 | 35.058197 |
| Selçuk/İzmir (Mulder, 1995)                 | 37.905879 | 27.370032 |
| Sağırın/Antalya (Mulder, 1995)              | 37.010261 | 31.231775 |
| Uğurlu/Konya (Mulder, 1995)                 | 37.410036 | 31.685341 |
| Hadim/Konya (Mulder, 1995)                  | 36.986063 | 32.455878 |
| Kargıçak/Mersin (Mulder, 1995)              | 36.622696 | 34.323213 |
| Eminler/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 |
| Bakırdağ/Kayseri (Schmidtler, 1997)         | 38.216621 | 35.807480 |
| Hanyer/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 (Kumlatuş et al., 2004)   | 36.876524 | 30.650189 |
| Kovada/Edir/Isparta (Kumlatuş et al., 2004) | 36.734351 | 30.870993 |
| Boğazak/Serik/Antalya (Kumlatuş et al., 2004) | 36.855079 | 31.163516 |
| Kızıloğlu/Manavgat/Antalya (Kumlatuş 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 |
| Danışman/Muğla/Muğla (Kete et al., 2005)   | 37.417162 | 27.579775 |
| Edirne (Schatti et al., 2005)               | 41.676992 | 26.550264 |
| Borçka/Artvin (Schatti et al., 2005)        | 41.363700 | 41.679100 |
| Ardahan/Artvin (Schatti et al., 2005)       | 41.117212 | 42.064817 |
| Çanakkale (Tok et al., 2006)                | 40.146720 | 26.408730 |
| Küplice/Kilis (Göçmen et al., 2009)        | 36.753186 | 37.242727 |
| Kolludere/Karacadag/Diyarbakır (Akelma and Coşkun, 2013) | 37.863547 | 40.056675 |
| Eğil/Diyarbakır (Akelma and Coşkun, 2013)  | 38.257900 | 40.081151 |
| Kırka/Sultandağı/Afyonkarahisar (Cihan and Tok, 2014) | 38.512165 | 31.235528 |
| Derecine/Sultandağı/Afyonkarahisar (Cihan and Tok, 2014) | 38.487355 | 31.257273 |
| Gölçayır/Akşehir/Konya (Cihan and Tok, 2014) | 38.465148 | 31.323354 |
| Tinaztepe/Afyonkarahisar (Eser and Erişmiş, 2014) | 38.728464 | 30.378473 |
| Kavşit/Cine/Aydın (Özcan and Üzüm, 2014)   | 37.657608 | 28.122666 |
Table 1. All available distribution records of the *Platyceps najadum* used in this study (continued)

| Location                          | Latitude          | Longitude         |
|-----------------------------------|-------------------|-------------------|
| 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) | 36.965338    | 29.781810         |
| Kıcıkülü/Antalya (Kucharzewski, 2016) | 36.622558    | 31.767257         |
| Avsallar/Antalya (Kucharzewski, 2016) | 36.358360    | 32.376091         |
| Öznurtepe/Antalya (Kucharzewski, 2016) | 39.491239    | 35.066825         |
| 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/Sarçam/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         |
| Çatalçaş/Tufanbeyli/Adana (Sarıkaya et al., 2017) | 38.194722   | 36.079722         |
| Mutkı/Bitlis (Akman et al., 2018) | 38.408588     | 41.922320         |
| Dilburnu/Ahlat/Bitlis (Akman et al., 2018) | 38.837977   | 42.263409         |
| Kıcıküştu/Tatvan/Bitlis (Akman et al., 2018) | 38.441687   | 42.320308         |
| Côkekyazı/Hızan/Bitlis (Akman et al., 2018) | 38.270557   | 42.375541         |
| Sağırkaya/Hızan/Bitlis (Akman et al., 2018) | 37.989747   | 42.570998         |
| Karşıyaka/Adılcevaz/Bitlis (Akman et al., 2018) | 38.804757   | 42.956803         |
| 1 km east of Gözlüçayır/Çemişgezek/Tunceli (Avcı et al., 2018) | 39.118006   | 39.879492         |
| 16 km north of Pülümür/Tunceli (Avcı et al., 2018) | 39.486815   | 39.896072         |
| Olympos/Antalya (Mermer, 2018)    | 36.386568      | 30.443708         |
| Dereçik/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 km²). 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 using with 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 colour 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 ligh brownish. Colour of the ventralia is yellowish (Figure 1).

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](image)

**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; Baçoğlu 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 seashores 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.

**ACKNOWLEDGEMENTS**

The author would like to thank Aziz Avci for their valuable contributions.
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