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A NEW RECORD OF THE KURDISTAN NEWT (*Neurergus derjugini*) IN IRAN AND POTENTIAL DISTRIBUTION MODELING FOR THE SPECIES

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The Kurdistan newt (*Neurergus derjugini*) is distributed in the Zagros Mountains in north-eastern Iraq and western Iran. We described a new record of the species in the vicinity of Baneh town (Kurdistan Province, Iran). We developed a Species Distribution Model based on environmental data for identification of suitable habitats of the species. Four climatic variables associated with temperature and precipitation accounted for 92.1% of the predicted range. The species was recorded in mountains in altitudes from 700 to 2100 m above sea level. The model for *N. derjugini* demonstrated some niche overlaps with models for neighboring species, *N. crocatus* and *N. microspilotus*.

Keywords: Amphibia; Salamandridae; distribution model; Maxent modeling; ecological niche overlap.

INTRODUCTION

The mountain newts of the genus *Neurergus* Cope, 1862 consist of four – five species which inhabit the Southeastern Taurus, Hakkari and Zagros mountains (Schmidtler and Schmidtler, 1975; Schneider and Schneider, 2011; Hendrix et al., 2014). *Neurergus strauchii* (Steindacher 1887) is distributed in south-eastern Turkey, *N. crocatus* Cope, 1862 in northern Iraq and adjacent territories of Turkey and Iran, *N. microspilotus* (Nesterov, 1916) in the Zagros Mountains in eastern Iraq and western Iran, and *N. kaiseri* Schmidt, 1952 in the Southern Zagros Mountains of western Iran (Schmidt, 1955; Sharifi and Assadian, 2004; Pasmans et al., 2006; Schneider and Schneider, 2010, 2011; Najafi-Majd and Kaya, 2013).

A taxonomic status of *N. derjugini* (Nesterov, 1916) is still under discussion. Long time it has been synonymized with *N. crocatus* (Wolterstorff, 1926; Schmidtler and Schmidtler, 1975), because these taxa has very similar coloration pattern. Recently, based on morphological data Schneider and Schneider (2011) proposed to constitute a valid name for *N. derjugini*. However, Fleck (2011) considered that this taxon could be conspecific with *N. microspilotus* and singled them as two subspecies, *N. d. derjugini* and *N. d. microspilotus*. The last survey (Hendrix et al., 2014) revealed weak genetic differences between *N. derjugini* and *N. microspilotus* by mitochondrial DNA and good differences by a nuclear marker. As a result, these authors considered that *N. microspilotus* and *N. derjugini* could be conspecific. Nonetheless, the dissimilarity of these results could be explained by influence of historical or recent asymmetric introgression of mitochondrial DNA. For example, such process caused to total or partial mitochondrial DNA replacement in several amphibian species (e.g., Liu et al., 2010; Sequeira et al., 2011; Wielstra and Arntzen, 2012; Litvinchuk et al., 2013; Zielinski et al., 2013). Therefore, we continue to consider *N. derjugini* and *N. microspilotus* as separate species before more detailed study.

The distribution of *N. derjugini* is poor studied. Long time it was assumed that range of the species is limited by two localities (Germav in Iran and Siyah Guvez in Iraq), which were pointed out in original description of the species (Nesterov, 1916). However, recently it was revealed several new localities of the species in Iran and Iraq (Schneider and Schneider, 2011; Bozorgi et al., 2015).

The aim of our paper was to describe a new record of *N. derjugini* in Iran. Additionally, using maximum entropy modeling, we tried to fill in the knowledge gap that exists in the distribution pattern of the species.

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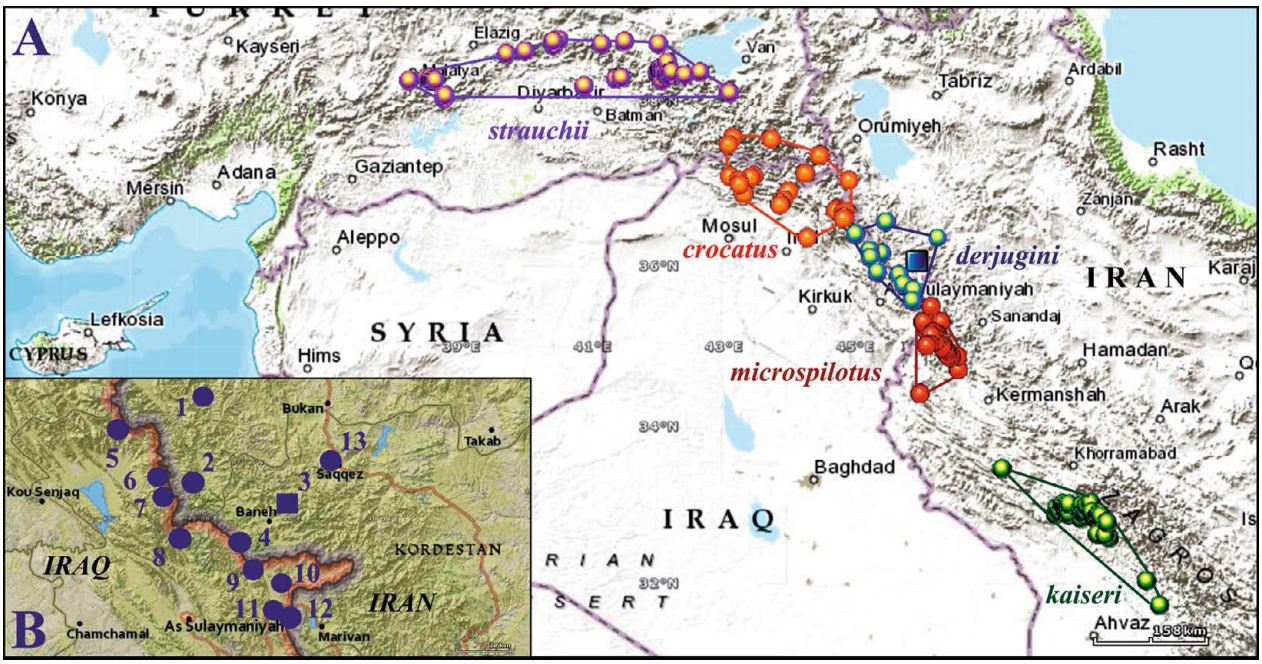

Fig. 1. A, Distribution of *Neurergus* species. The square is new record of *N. derjugini*; B, Previously known (circles) and new (square) localities of *N. derjugini*: 1, Bengun; 2, Sardasht; 3, Baneh; 4, Germap; 5, Qara and Abubakra; 6, Halsho; 7, Hero; 8, Mawat-Isawa; 9, Siya Güz; 10, Penjwin-1; 11, Penjwin-2; 12, Penjwin-3; 13, Saqqez (for details see *Appendix*).

MATERIAL AND METHODS

Morphological characters were measured using dial calipers. For comparison we used a larva of *N. derjugini* from Germav (Iran) described by Nesterov (1916; Pl. 1: 4 – 5) and stored in herpetological collections of the Zoological Institute of Russian Academy of Science (ZISP 4834). The number of trunk vertebrae was estimated by counting of costal grooves using methodology described by Litvinchuk and Borkin (2003, 2009).

For the contemporary niche prediction, we used all 13 known localities of *N. derjugini* (see Appendix). Additionally, to study presumed niche overlaps with other *Neurergus* species, we made models for *N. strauchii* (41 localities), *N. crocatus* (24), *N. microspilotus* (30), and *N. kaiseri* (36). The layers were extracted from the WorldClim (http://www.worldclim.org), the GlobCover 2009 (due.esrin.esa.int/globcover), the Global Aridity and PET (http://www.cgiar-csi.org), the Percent tree coverage (http://www.iscgm.org/gm/ptc.html) databases. The altitude, land cover, tree cover percentage, aridity index, and 19 bioclimatic variables (30″ resolution) were used for the models which were generated by Maxent (ver. 3.3.3k; Phillips et al., 2006; Phillips and Dudik, 2008). This is an algorithm that uses environmental parameters in combination with geographical coordinates that produces high quality predictions of species distribution, often more reliable when evaluated and compared with other predictive models (Hernandez et al., 2006; Jiménez-Valverde et al., 2008; Giovanelli et al., 2010). Maxent was used with default settings. We used 70% of the occurrence localities as training data, and the remaining 30% were reserved for testing the resulting models. We evaluated our predicted models using Area Under the Curve (AUC) derived from the Receiver Operating Characteristic plots. The plots represent a model's ability to discriminate species locations from pseudo-absences by plotting sensitivity against 1 — specificity (Fielding and Bell, 1997). Area under curve values range from 0.5 to 1.0, with 0.5 indicating no greater fit than expected by chance and 1.0 indicating perfect model fit (Hosmer and Lemeshow, 2000). Models with test AUC values above 0.75 are considered useful and above 0.90 very good (Swets, 1988; Elith, 2002).

Following methodology from Hijmans et al. (2005) and Waltari et al. (2007) and to avoid highly-correlated and redundant variables, correlations between pairs of altitude and bioclimatic variables were assessed using the Pearson correlation coefficient by ENMTools for the analysis of predicted potential geographic distributions of each taxa. Two variables sharing a correlation coefficient of 0.8 or higher were considered highly correlated. Previous knowledge on biology and requirements of the

Fig. 2. A pool in the vicinity of Baneh town (Kurdistan Province, Iran), where was found a larva of *Neurergus derjugini*.

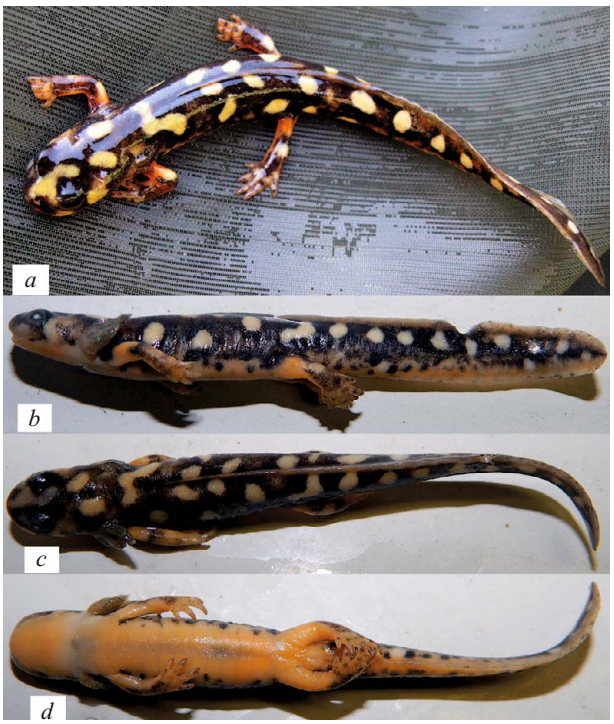

Fig. 3. A larva of *Neurergus derjugini*: *a*, dorsal view (alive); *b*, lateral view (after alcohol); *c*, dorsal view (after alcohol); *d*, ventral view (after alcohol).

studied species is crucial for optimal modeling (Sardà-Palomera and Vieites, 2011). We therefore selected variables based on known preferences of *Neurergus* species. After correcting for correlation among data layers, nine variables were retained: Alt (elevation, m a.s.l.), Bio2 (mean diurnal range, °C), Bio3 (isothermality), Bio4 (temperature seasonality), Bio5 (maximal temperature of warmest month; °C), Bio8 (mean temperature of wettest quarter, °C), Bio14 (precipitation of driest month, mm), Bio15 (precipitation seasonality, CV), and Bio19 (precipitation of coldest quarter, mm). We used a jackknife analysis for estimation of relative contribution of variables to Maxent models. Finally, the models were reclassified into binary maps for which the average ten-percentile threshold was used (Raes et al., 2009).

Niche overlaps between species were estimated using Schoener's (1968) *D* distance in ENMTools with niche similarity quantified statistically from 0 (no overlap) to 1 (identical niche models) based on potential niche models of the species.

RESULTS

In July 29, 2014, A. V. Barabanov found a larva of *N. derjugini* in a spring near Baneh town (36°04′29.9″ N 45°58′38.7″ E, altitude 2100 m a.s.l.), Kurdistan Province, Iran (Fig. 1). The larva was observed in a pool with diameter near a meter and depth about 20 cm, which was formed by a small waterfall (Fig. 2). The bottom of the pool was rocky with mud and willow leaves. Willows and other bushes were growing along this spring lying in a mountain steppe. Fishes were lacking. In the vicinities of the pool, *Pelophylax ridibundus* (Pallas, 1771), *Testudo graeca* Linnaeus, 1758, *Lacerta media* Lantz et Cyrén, 1920, and *Ophisops elegans* Ménétries, 1832 were found.

The total length of the larva was 66.0 mm, the body length (from the tip of snout to the end of cloaca) was 33.3 mm, the head length (from the tip of snout to the occipital opening) was 7.0 mm, the head width (at the commissure of the jaws) was 6.6 mm, and the maximum length of gills was 4.9 mm. The coloration of dorsal and lateral parts of body was black-brown with large yellow round spots (Fig. 3). The ventral surface was orange without dark spots. The number of costal grooves (excluding grooves, which touched margins of limb bases) was 8, which corresponds to 12 trunk vertebrae.

According to our and previously published data (see *Appendix*), *N. derjugini* inhabits the Zagros Mountains in altitudes from 700 to 2100 m a.s.l., between 36°33′ N latitude in the north and 35°35′ N in the south. The distributional model obtained for the species had very high (0.997) mean test AUC value and showed significance for the binomial omission test, indicating a good performance of the model. The predicted potential niche model under the current climate conditions are shown in Fig. 4. Four variables accounted for 92.1% of the predicted range (Table 1). The most important character was the

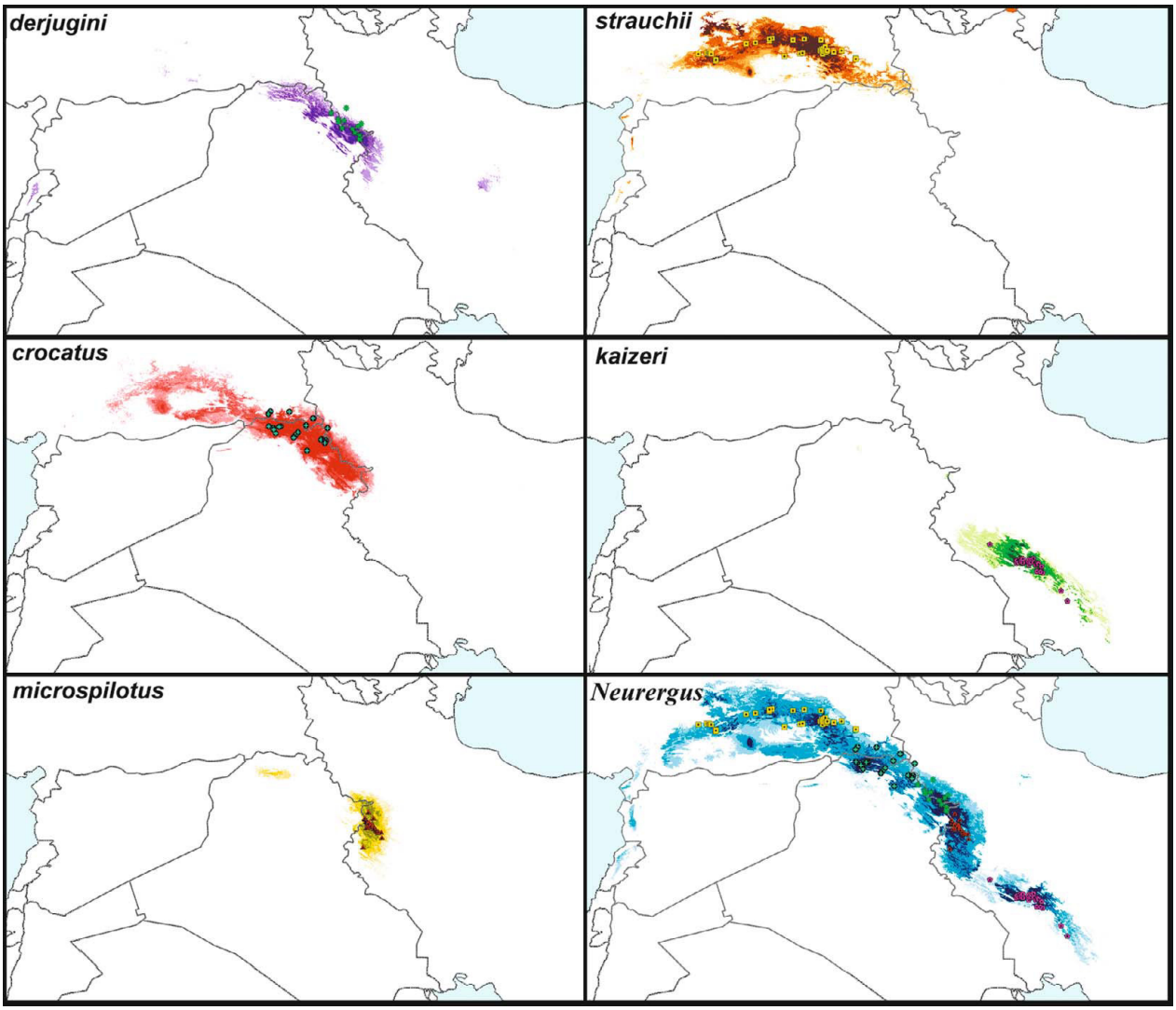

Fig. 4. Predicted potential geographic distribution for *Neurergus* species. The degree of habitat suitability was designated by color saturation (10 – 25% is light tone, 25 – 50% is middle, and more than 50% is dark).

precipitation of coldest quarter, which associated with snow depth in places of newt's wither hibernation and level of water in creeks which newts use for breeding. The results of associated jack-knife test for this variable was 37.8%. Three other characters were the mean temperature of wettest quarter (27.9%), the temperature seasonality (15.2%), and the precipitation of driest month (11.2%).

To study distributional peculiarities of the genus *Neurergus* as a whole, we made the Maxent model for all 144 known localities of the genera (see *Appendix*). The model of the genus had high mean test AUC value (0.977) and showed continual distribution without gaps for all species in exception of *N. kaiseri* (Fig. 4). To locate presumed range contacts between the Kurdistan newt and other species of the genera we made additional four models for other species of the genera (Fig. 4). All these models had very high (0.990 – 0.998) mean test AUC values (Table 1). The models had little overpredictions, meaning they did not predict broadly outside of the modeled species ranges. The precipitation of coldest quarter was one of the most important characters for all species studied (in exception of *N. crocatus*) and the genus as a whole (Table 1). The model for *N. derjugini* demonstrated some niche overlaps ($D = 0.33 – 0.47$) with models for two neighboring species, *N. crocatus* and *N. microspilotus* (Fig. 4, Table 2).

TABLE 1. AUCs and Results of Jackknife Analysis for Estimation of Relative Contribution of Variables (in %) to Maxent Models for *Neurergus* Species (variables with values less than 10% not shown)

Variable	*N. derjugini*	*N. crocatus*	*N. microspilotus*	*N. kaiseri*	*N. strauchii*	*Neurergus* as a whole
AUC	0.997	0.991	0.998	0.997	0.990	0.977
Altitude	—	—	12.7	—	—	23.3
Aridity index	—	46.8	23.0	—	—	—
Mean diurnal range	—	—	—	49.4	—	—
Isothermality	—	—	—	—	18.0	—
Temperature seasonality	15.2	29.7	—	—	—	11.8
Mean temperature of wettest quarter	27.9	—	—	—	12.1	—
Precipitation of driest month	11.2	15.3	18.5	—	31.2	—
Precipitation of coldest quarter	37.8	—	26.3	36.1	28.9	53.2

DISCUSSION

Nesterov (1916) was the first who described a record of *N. derjugini* in Iran. In July 10, 1914 (27.06.1914 in old style), he received a single larva of the species which was collected in the vicinities of village Germav (= Germap) in the Surkev Mountains near pass on the Iran/Iraq (Persian/Ottoman) border. This larva had a total length 71.5 mm.

Our larva was slightly smaller (66.08 mm) and morphologically very similar with larva described by Nesterov (1916). The single peculiarity was smaller amount of trunk vertebrae. Usually, the number of trunk vertebrae in *N. derjugini* and other species of the genus is 13 and rarely 14 (Herre, 1932; Haller-Probst and Schleich, 1994; Lanza et al., 2006, 2010; our data). Our larva was the first record of representatives of the genus with 12 vertebrae. However, such little variation is common in other salamandrids (Litvinchuk and Borkin, 2009; Lanza et al., 2010).

Apart of our and Nesterov's (1916) records, in Iran *N. derjugini* was recently recorded in the vicinities of town Saqqez (Bozorgi et al., 2015). Additionally, Najafi-Majd and Kaya (2010) described a record of "*N. microspilotus*" from western Iran. The specimen had coloration similar to the Kurdistan newt. In August 8, 2011, Behnam Ghorbani published in his Facebook page a picture of adult *N. derjugini* from the vicinity of Sardasht city. In Iraq, four localities of *N. derjugini* were previously known (Nesterov, 1916; Schneider and Schneider, 2011). Additional four records of "*N. microspilotus*" mentioned by Al-Sheikhly et al. (2013) could be belonging to *N. derjugini*. Thus, it is recently known eight localities of the species in north-eastern Iraq and five localities in western Iran.

Niche modeling could provide insight into the abiotic factors affecting the geographic limits of species (Graham et al., 2004; Kidd and Ritchie, 2006). According to our data, arid territories to the east and west of the South-eastern Taurus, Hakkari and Zagros mountains limit distribution of *Neurergus* species. The aridity index, precipitations of driest month and coldest quarter are strongly contributed to Maxent models for all *Neurergus* species (Table 1). Some thermal variables and the altitude influenced on the models as well. The vegetation type distribution did not sufficiently contribute to the models.

TABLE 2. Niche Overlaps (D) between *Neurergus* Species

Species	*crocatus*	*derjugini*	*microspilotus*	*kaiseri*
strauchii	0.28	0.09	0.02	0.00
crocatus	—	0.47	0.16	0.02
derjugini	—	—	0.33	0.07
microspilotus	—	—		0.10

Beside the climate impact, the boundaries of species ranges could be determined by interspecific competition, a mechanism that defines evolutionarily stable ranges among species that are not segregated in habitat use (Case et al., 2005). The models for all species of *Neurergus* demonstrated some niche overlaps with models of neighboring species (Table 2). Based on the models (Fig. 4), *N. derjugini* could be parapatric (or sympatric) with two neighboring species, *N. crocatus* in the north and *N. microspilotus* in the south.

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APPENDIX

Museum abbreviations: CAS, California Academy of Sciences, San-Francisco, CA, USA; FMNH, The Field Museum of Natural History, Chicago, IL, USA; MVZ, The Museum of Vertebrate Zoology, Berkeley, CA, USA.

Neurergus derjugini

Bengun, Iran, 36°33′ N 45°31′ E, 1833 m (Najafi-Majd and Kaya, 2010); **Sardasht**, Iran, 36°10′ N 45°27′ E, ~1545 m (http://www.facebook.com/groups/AmphConBreeding); **Baneh**, Iran, 36°04′ N 45°59′ E, 2100 m (present paper); **Saqqez**, Iran, 35°59′ N 45°53′ E, 1682 m (Bozorgi et al., 2015); **Germap**, Iran, 35°54′ N 45°43′ E, 1524 m (Nesterov, 1916); **Qara and Abubakra**, Iraq, 36°24′ N 45°03′ E, 1300 m (Al-Sheikhly et al., 2013); **Halsho**, Iraq, 36°12′ N 45°16′ E, ~1200 m (Al-Sheikhly et al., 2013); **Hero**, Iraq, 36°07′ N 45°17′ E, 1342 m (Al-Sheikhly et al., 2013); **Mawat-Isawa**, Iraq, 35°56′ N 45°23′ E, 700 – 1000 m (Al-Sheikhly et al., 2013); **Siya Güz**, Iraq, 35°47′ N 45°47′ E, 1352 m (Nesterov, 1916); **Penjwin-1**, Iraq, 35°43′ N 45°56′ E, 1287 m (Schneider and Schneider, 2011); **Penjwin-2**, Iraq, 35°35′ N 45°57′ E, 1443 m (Schneider and Schneider, 2011); **Penjwin-3**, Iraq, 35°35′ N 45°55′ E, 1263 m (Schneider and Schneider, 2011).

Neurergus strauchii

Kokpinar, Turkey, 38°15′ N 38°15′ E, ~1770 m (MVZ. 236781 – 236783); **Kubbe Mt.-1**, Turkey, 38°17′ N 38°31′ E, ~1050 m (Lanza et al., 2010); **Kubbe Mt.-2**, Turkey, 38°15′ N 38°35′ E, ~1690 m (Hendrix et al., 2014); **Kubbe Mt.-3**, Turkey, 38°15′ N 38°37′ E, 1715 m (Bogaerts et al., 2006); **Kubbe Mt.-4**, Turkey, 38°15′ N 38°38′E, 1618 – 1966 m (Öz, 1994); **Kubbe Mt.-5**, Turkey, 38°15′ N 38°39′ E, 1550 – 1580 m (Bogaerts et al., 2006); **Pütürge-1**, Turkey, 38°17′ N 38°35′ E, 1223 m (Pasmans et al., 2006); **Pütürge-2**, Turkey, 38°15′ N 38°36′ E, 1880 m (Pasmans et al., 2006); **Yandere-1**, Turkey, 38°04′ N 38°48′E, 1100 m (MVZ 236784 – 236787); **Yandere-2**, Turkey, 38°02′ N 38°47′ E, 1050 m (http://calphotos.berkeley.edu/cgi); **Tepehan**, Turkey, 38°05′ N 38°47′ E, 1213 m (Özdemir et al., 2009); **Kuşhane**, Turkey, 38°34′ N 39°44′E, 977 m (Pasmans et al., 2006); **Tarhana**, Turkey, 38°36′ N 40°01′ E, 1353 m (Pasmans et al., 2006); **Karci**, Turkey, 38°40′ N 40°27′ E, 1073 m (Pasmans et al., 2006); **Soğukpinar**, Turkey, 38°43′ N 40°27′ E, 1328 m (Koyun et al., 2013); **Genç**, Turkey, 38°44′ N 40°32′ E, 1088 m (Pasmans et al., 2006); **Ağaçlı**, Turkey, 38°11′ N 40°55′ E, ~1150 m (Coşkun et al., 2013); **Kayalisu**, Turkey, 38°41′ N 41°11′ E, 1459 m (Pasmans et al., 2006); **Gümüşörgü**, Turkey, 38°16′ N 41°24′E, ~1080 m (Coşkun et al., 2013); **Kozluk Geçitaltı**, Turkey, 38°17′ N 41°29′ E, ~1270 m (Coşkun et al., 2013); **Muş**, Turkey, 38°43′ N 41°32′ E, 1500 m (Steindacher, 1887); **Deliktaş**, Turkey, 38°21′ N 42°02′ E, 1400 m (Schmidtler, 1994); **Sürüm**, Turkey, 38°41′ N 42°03′ E, 1450 – 1500 m (Schmidtler and Schmidtler, 1970); **Yolyazi**, Turkey, 38°23′ N 42°04′E, 1675 m (Schneider and Schneider, 2010); **Yolyazi-1**, Turkey, 38°21′ N 42°05′ E, 1520 m (Schneider and Schneider, 2010); **Yolyazi-2**, Turkey, 38°23′ N 42°05′ E, 1483 – 1550 m (Baran and Öz, 1986); **Muhti**, Turkey, 38°24′ N 42°05′ E, 1550 – 1627 m (Pasmans et al., 2006); **Çeltikli**, Turkey, 38°15′ N 42°06′ E, 1205 m (Schneider and Schneider, 2010); **Bitlis-1**, Turkey, 38°22′ N 42°06′ E, 1450 – 1510 m (Ragghianti et al., 1987); **Bitlis-2**, Turkey, 38°25′ N 42°08′ E, 1710 m (MVZ 236765, 236767); **Bayramalan**, Turkey, 38°20′ N 42°08′ E, 1490 m (Schneider and Schneider, 2010); **Bölükyazi**, Turkey, 38°20′ N 42°11′ E, 1670 m (Schneider and Schneider, 2010); **Yalnızçamlar**, Turkey, 38°28′ N 42°11′ E, 1777 m (Özdemir et al., 2009); **Cayirbasi-1**, Turkey, 38°18′ N 42°12′ E, 1565 m (Schneider and Schneider, 2010); **Cayirbasi-2**, Turkey, 38°20′ N 42°14′ E, 1695 m (Schneider and Schneider, 2010); **Cayirbasi-3**, Turkey, 38°21′ N 42°14′ E, ~1740 m (Hendrix et al., 2014); **Kuşlu**, Turkey, 38°21′ N 42°15′ E, 1765 m (Pasmans et al., 2006); **Küçüksu**, Turkey, 38°27′ N 42°19′ E, 1750 m (Schmidtler and Schmidtler, 1970); **Kağanli**, Turkey, 38°21′ N 42°41′ E, 1840 m (Schneider and Schneider, 2010); **Aşağirnalica-1**, Turkey, 38°07′ N 43°07′ E, 2110 m (Schneider and Schneider, 2010); **Aşağirnalica-2**, Turkey, 38°06′ N 43°08′ E, 2020 m (Schneider and Schneider, 2010).

Neurergus crocatus

Başaran, Turkey, 37°29′ N 43°07′ E, 1135 m (Schneider and Schneider, 2010); **Beytüşşebap**, Turkey, 37°34′ N 43°11′ E, ~1650 m (Baran and Öz, 1986); **Sümbül Mt.**, Turkey, 37°33′ N 43°46′ E, 1500 m (Biricik, 2009); **Derecik**, Turkey, 37°08′ N 44°17′ E, 1510 m (Uğurtaş et al., 2015); **Şemdinli-1**, Turkey, 37°21′ N 44°30′ E, 1560 m (Schneider and Schneider, 2010); **Şemdinli-2**, Turkey, 37°21′ N 44°31′ E, 1510 m (Schneider and Schneider, 2010); **Arabe spring**, Iran, 37°03′ N 44°57′ E, 1786 – 1823 m (Najafi-Majd and Kaya, 2013); **Mangesh**, Iraq, 37°06′ N 43°08′ E, ~690 m (http://www.gbif.org/occurrence); **Al Amadiyah**, Iraq, 37°06′ N 43°30′ E, ~1220 m (Gorgees et al., 1977); **Amedi**, Iraq, 37°05′ N 43°27′ E, 1400 – 1500 m (Al-Sheikhly et al., 2013); **Tajika**, Iraq, 37°01′ N 43°18′ E, ~1600 m (Nader, 1969); **Ashawa-Sarsank**, Iraq, 37°00′ N 43°17′ E, 1206 m (Al-Sheikhly et al., 2013); **Barzan**, Iraq, 36°55′ N 44°02′ E, 708 m (Schneider and Schneider, 2011); **Balkaif**, Iraq, 36°53′ N 43°21′ E, ~860 m (Al-Adhami and Hameed, 1988); **Girbish**, Iraq, 36°49′ N 43°57′ E, 807 m (Schneider and Schneider, 2011); **Kani Zarg spring**, Iraq, 36°46′ N 43°54′ E, 500 – 900 m (Nader, 1969); **Akrah**, Iraq, 36°45′ N 43°54′ E, 763 m (Villwock, 1961); **Roste**, Iraq, 36°42′ N 44°46′ E, 1483 m (Schneider and Schneider, 2011); **Smilan**, Iraq, 36°41′ N 44°45′ E, 1085 m (Schneider and Schneider, 2011); **Grtk Mts.**, Iraq, 36°40′ N 44°52′ E, 1400 m (Al-Sheikhly et al., 2013); **Nawanda**, Iraq, 36°40′ N 44°54′ E, 1283 m (Schneider and Schneider, 2011); **Shiwalok-1**, Iraq, 36°36′ N 44°53′ E, 1283 m (Schneider and Schneider, 2011); **Shiwalok-2**, Iraq, 36°35′ N 44°52′ E, ~1620 m (Nader, 1969); **Doli Smaquli**, Iraq, 36°21′ N 44°19′ E, 1200 m (Al-Sheikhly et al., 2013).

Neurergus microspilotus

Ahmad Awa, Iraq, 35°18′ N 46°05′ E, 1400 m (Al-Sheikhly et al., 2013); **Khurmal**, Iraq, 35°19′ N 46°05′ E, ~850 m (CAS 157131); **Sargate**, Iraq, 35°17′ N 46°06′ E, 1254 m (Al-Sheikhly et al., 2013); **Byara**, Iraq, 35°13′ N 46°07′ E, ~1080 (Al-Sheikhly et al., 2013); **Balcha**, Iraq, 35°12′ N 46°09′ E, 1513 m (Nesterov, 1916); **Tawale**, Iraq, 35°11′ N 46°11′ E, 1390 – 1400 m (Nesterov, 1916); **Ravansar**, Iran, 34°43′ N 46°37′ E, ~1400 m (CAS 210913 – 210922); **Kavat stream-1**, Iran, 34°53′ N 46°36′ E, ~1500 m (Parto et al., 2013); **Kavat stream-2**, Iran, 34°53′ N 46°31′ E, 1500 m (Sharifi and Assadian, 2004); **Kavat stream-3**, Iran, 34°52′ N 46°30′ E, ~1500 m (Sharifi et al., 2014); **Ghorghaleh stream**, Iran, 34°54′ N 46°30′ E, 1600 m (Sharifi and Assadian, 2004); **Quri Qaleh**, Iran, 34°21′ N 46°30′ E, 1400 m (Schmidtler and Schmidtler, 1975); **Qholani**, Iran, 34°54′ N 46°27′ E, ~1400 m (Rastegar-Pouyani et al., 2013a); **Shaban-**

kareh, Iran, 34°57′ N 46°26′ E, ~1765 m (http://calphotos.berkeley.edu/cgi); **Shamshir stream**, Iran, 34°59′ N 46°25′ E, 1800 m (Sharifi and Assadian, 2004); **Dorisan stream**, Iran, 35°01′ N 46°23′ E, 1600 m (Schmidtler and Schmidtler, 1975); **Paveh**, Iran, 35°03′ N 46°22′ E, ~1560 m (Lanza et al., 2010); **Noseme**, Iran, 35°00′ N 46°22′ E, ~1640 m (Rastegar-Pouyani et al., 2013a); **Sarvabad**, Iran, 35°19′ N 46°21′ E, 1300 – 1400 m (Bahmani et al., 2014); **Hajij**, Iran, 35°09′ N 46°19′ E, ~730 m (Rastegar-Pouyani et al., 2013a); **Daryan**, Iran, 35°08′ N 46°19′ E, 1000 m (Sharifi and Assadian, 2004); **Dareh Najar stream**, Iran, 35°06′ N 46°19′ E, 1400 m (Sharifi and Assadian, 2004); **Paveh rood stream**, Iran, 35°06′ N 46°17′ E, 1100 m (Schmidtler and Schmidtler, 1975); **Deshe**, Iran, 35°04′ N 46°16′ E, ~1400 m (Rastegar-Pouyani et al., 2013a); **Nodeshe**, Iran, 35°11′ N 46°14′ E, ~1580 m (Rastegar-Pouyani et al., 2013a); **Nilan and Nowsood**, Iran, 35°09′ N 46°12′ E, ~960 m (Rastegar-Pouyani et al., 2013a, 2013b); **Marivan**, Iran, 35°30′ N 46°12′ E, 1300 – 1400 m (Bahmani et al., 2014); **Marakhil river**, Iran, 35°02′ N 46°11′ E, 1600 m (Sharifi and Assadian, 2004); **Lashgargah**, Iran, 35°01′ N 46°08′ E, ~750 m (Rastegar-Pouyani et al., 2013a); **Mar Ab canyon**, Iran, 34°25′ N 46°02′ E, ~1180 m (FMNH 170931).

Neurergus kaiseri

Shadab-Kuh, Iran, 33°28′ N 47°17′ E, ~1000 m (Safaei and Mahrou, 2012); **Veroun Nargeseh**, Iran, 32°53′ N 48°06′ E, ~900 m (Mobaraki et al., 2013); **Dar-Khorma**, Iran, 32°58′ N 48°07′ E, ~1000 m (Mobaraki et al., 2013); **Kool chap fall**, Iran, 32°55′ N 48°10′ E, ~900 m (Mobaraki et al., 2013); **Kerser**, Iran, 33°01′ N 48°12′ E, 995 m (Sharifi et al., 2013); **Mordastan**, Iran, 33°01′ N 48°13′ E, ~1000 m (Mobaraki et al., 2013); **Tafo**, Iran, 32°59′ N 48°14′ E, 1387 m (Sharifi et al., 2013); **Chovah**, Iran, 32°59′ N 48°15′ E, ~1300 m (Mobaraki et al., 2013); **Ahoo-Bourard**, Iran, 32°55′ N 48°15′ E, 1330 m (MVZ 26952); **Ab-Anar spring**, Iran, 32°56′ N 48°15′ E, 1300 – 1430 m (MVZ 234198 – 216); **Darehgol**, Iran, 32°59′ N 48°16′ E, 1227 m (Sharifi et al., 2013); **Mongere**, Iran, 32°53′ N 48°18′ E, ~900 m (Torki, 2012); **Shaikhon**, Iran, 32°54′ N 48°18′ E, 960 m (Sharifi et al., 2013); **Choobeh**, Iran, 33°01′ N 48°18′ E, 1395 m (Sharifi et al., 2013); **Hajibarikab stream**, Iran, 32°51′ N 48°23′ E, 1004 m (Torki, 2012); **Bozorgab stream**, Iran, 32°56′ N 48°28′ E, 1381 m (Vaissi et al., 2012); **Dodut spring**, Iran, 32°57′ N 48°28′ E, ~1300 m (Mobaraki et al., 2013); **Pifeh**, Iran, 33°00′ N 48°30′ E, 1381 m (Sharifi et al., 2013); **Moolik spring**, Iran, 32°54′ N 48°31′ E, ~1200 m (Mobaraki et al., 2013); **Shahzadehahmad**, Iran, 32°55′ N 48°33′ E, 1262 m (Torki, 2012); **Vojen-Ab fall-1**, Iran, 33°00′ N 48°34′ E, ~1000 m (Torki, 2012); **Vojen-Ab fall-2**, Iran, 33°02′ N 48°38′ E, 1000 – 1400 m (Torki, 2012); **Mazoo**, Iran, 32°55′ N 48°39′ E, ~1000 m (Mobaraki et al., 2013); **Sar gach**, Iran, 31°43′ N 49°41′ E, ~800 m (Mobaraki et al., 2013); **Tove stream**, Iran, 32°50′ N 48°42′ E, 1000 m (Torki, 2012); **Darreh dioni**, Iran, 32°38′ N 48°44′ E, ~1270 m (Mobaraki et al., 2013); **Kul-e Sat fall**, Iran, 32°52′ N 48°44′ E, 607 – 1050 m (Torki, 2012); **Ab Moindjah**, Iran, 32°53′ N 48°45′ E, 1000 m (Schmidt, 1955); **Shahbazan stream**, Iran, 32°54′ N 48°45′ E, 1200 m (Schmidt, 1952); **Tuba**, Iran, 32°53′ N 48°46′ E, 750 m (Schmidt, 1955); **Mansu-Abad cave**, Iran, 32°52′ N 48°47′ E, 990 m (Schmidt, 1955); **Emamzadeh haft tanan**, Iran, 32°37′ N 48°51′ E, ~900 m (Mobaraki et al., 2013); **Shevi fall**, Iran, 32°47′ N 48°52′ E, 991 – 2000 m (Sharifi et al., 2008); **Taleh-Zang fall**, Iran, 32°47′ N 48°53′ E, 850 m (Torki, 2012); **Dej-e Mohamad Ali Khan**, Iran, 32°35′ N 48°55′ E, ~920 m (Safaei and Mahrou, 2012); **Shovalander** (= Olad), Iran, 32°02′ N 49°29′ E, ~700 m (Safaei and Mahrou, 2012).

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