

Rediscovery of the Lake Urmia newt, *Neurergus crocatus* Cope, 1862 (Caudata: Salamandridae) in northwestern Iran after 150 years

¹Elnaz Najafi-Majd and ²Uğur Kaya

Ege University, Faculty of Science, Department of Biology, Section of Zoology, Bornova, Izmir/ 35100, TURKEY

Abstract.—We report on the rediscovery of the Lake Urmia newt, *Neurergus crocatus* in Iran, 150 years after its original description and last report by Cope 1862. The Lake Urmia newt is classified as Vulnerable by the IUCN Red List of Threatened Species. Some specimens, both adult and larvae, of *N. crocatus* were found in Iran during two field surveys near the Iran-Iraq border (south west of West Azerbaijan Province, surrounding the type locality “Urmia,” at 1786-1823 m above sea level [a.s.l.] elevation). Water samples were taken from two breeding habitats, as preliminary data, and were analyzed for 13 chemical variables to determine the characteristics of water chemistry. The morphological comparison of the new specimens with the original description and data from Schmidtler and Schmidtler (1975) did not reveal any distinct morphological differences. Previous to our study there was no information regarding the exact locality of *N. crocatus* and its population status in Iran. Our confirmation of *N. crocatus* in northwestern Iran indicates that protection is needed if this species is to persist in Iran. In addition, water chemistry analysis of the two new habitat records showed that in this area *N. crocatus* inhabits two streams with good water quality.

Key words. *Neurergus crocatus*, rediscovery, conservation, Iran

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Introduction

Newts of the genus *Neurergus* (Salamandridae) are confined to Turkey, Iran, and Iraq. *Neurergus* was originally categorized as a member of the family Salamandridae and the subfamily Tritoninae, subsequently it was changed to Pleurodelinae (Cope, 1862). Four species of *Neurergus* have been described (Schmidtler 1975; Leviton et al. 1992; Sparreboom et al. 2000): *Neurergus crocatus* Cope, 1862 from northwest of Iran, northern Iraq, and southeast of Turkey; *Neurergus strauchii* (Steindachner 1887) from the western side of Van Lake to Malatya in eastern (Anatolian) Turkey; *Neurergus microspilotus* (Nesterov 1916) from the west and northwest of Iran and east of Iraq; and *Neurergus kaiseri* Schmidt 1952 from the surroundings of Shah-Bazan of Luristan Province, Iran. All known species of *Neurergus* can easily be distinguished by their morphological characters (Schmidtler and Schmidtler 1970, 1975; Schmidtler 1994; Najafimajd and Kaya 2010; Schneider and Schneider 2011). At present, the taxonomic relations of the closely related taxa *N. microspilotus* and *N. derjugini* (Nesterov 1916) from the Iraq and Iran borders are still debatable (Schneider and Schneider 2011).

The genus *Neurergus* is represented by three species in Iran, *N. crocatus* Cope, 1862, *N. microspilotus* (Nesterov 1916), and *N. kaiseri* Schmidt, 1952 (Balouch and Kami 1995). According to IUCN, *N. crocatus* has one of the largest distribution ranges among all *Neurergus* species; though there is almost no data about its biology and exact distribution (Steinfartz et al. 2008). As stated by Sparreboom (2009) this insufficient data may be ascribed primarily to geographic inaccessibility, as well as long term ethnic tensions, and a long and continuing history of military conflicts. *Neurergus crocatus* has been known from several localities in Turkey since 1986 (Baran and Öz 1986; Baran and Atatur 1997; Özdemir et al. 2009). This striking coloration of these *N. crocatus* attracted the attention of local people and non-herpetologists subsequently misidentified them as *N. strauchii* (Kemal 2008). Very recently in 2010 a new locality for *N. crocatus*, including two neighboring streams close to the Şemdinli, Turkey, was published (Schneider and Schneider 2010).

Neurergus crocatus has been reported from eight localities in Iraq: Agrah (Schmidt 1939), Shiwolak and Tajeka villages in the northeastern (Khalaf 1961; Nader 1969), and five recent localities from Barzan, Girbish, Roste, Smilan, and Nawanda in 2010 (Schneider and Schneider 2011).

Correspondence. Email: ²ugur.kaya@ege.edu.tr (corresponding author); ¹elnaz.najafi.majd@gmail.com

There is limited information regarding the exact locality and the distribution of *N. crocatus* and its population status in Iran. Only one historic record by Cope (1862) is noted from northwestern Iran but the exact type locality is unknown, however Fowler and Dunn (1917) reported the type locality as “Ooremiah, Persia.”

Within the Salamandridae, newts of the genus *Neurergus* are basically known as stream inhabiting species that leave streams during dry periods or during winter (Schmidtler and Schmidtler 1970, 1975; Schmidtler 1994). The Lake Urmia newt, *N. crocatus* is quite closely related in an ecological aspect to *Calotriton* species which have similar habitats (Steinfartz et al. 2002). *Neurergus crocatus* is a montane species and lives in cool and well-oxygenated streams (Özeti and Yilmaz 1994; Baran and Atatür 1998), where it breeds. There is no published information about the terrestrial component of their life history. It is presumed that the adults hibernate under rocks and other cover during the winter (Papenfuss et al. 2009). There is almost no information on its life cycle, but eggs and larvae of different lengths were observed at the end of May and June. The seasonality of the breeding season is dependent upon elevation (Özeti and Yilmaz 1994).

According to the IUCN, there is a continuing decline in the extent and quality of the habitat of *N. crocatus* in Turkey, Iran, and Iraq (Papenfuss et al. 2009). However, there is no published information about the size and rate of this decline. *Neurergus crocatus* is categorized as a Vulnerable species [VU B2ab (iii)] in the IUCN Red List of Threatened Animals. Despite the significance of its conservation, nothing is known about the life history of *N. crocatus*, e.g., individual growth, longevity, and other demographic parameters, or its ecology including critical habitat components such as water quality and temperature, breeding, oviposition, or hibernation sites.

One hundred and fifty years after the original description of *N. crocatus* (Cope 1862) we verify the existence of *N. crocatus* in northwest Iran. We also provide information on the characteristics of water chemistry in the aquatic breeding habitat of *N. crocatus*.

Materials and methods

To assess the presence of *N. crocatus* in north-west Iran, we conducted two surveys during the field seasons of 2009 and 2010 of the northern Zagros Mountains in the west of Lake Urmia, from Sero (the area between Lake

Table 1. Morphological characteristics of the closely related species *Neurergus microspilotus* and *N. crocatus* (Schmidtler and Schmidtler 1975) in comparison with our specimens from Oshnaviyeh.

Characteristics	<i>Neurergus crocatus</i>	<i>Neurergus microspilotus</i>	Specimens from Oshnaviyeh
Adult			
1. Maximum total length of ♀/♂	16 / 18 cm	15 / 17 cm	16.8 cm ♀ (Mean)
2. The form of cloacae in mating season in ♀	Lips approximately 1-2 mm protruding	Not sharp conical, lips 3 mm protruding	Lips approximately 1-2 mm protruding
3. Design of backside (spots small 0.2 mm, large 0.4 mm)	Large and small yellow spots	Small yellow spots	Large and small yellow spots
4. Design of throat	Unicolored orange	Orange, mostly with black spots	Unicolored orange
5. Design of belly	Unicolored yellow to reddish orange	Lateral black coloration confines orange middle parts	Unicolored yellow to reddish orange
6. Design of underside of extremities	Unicolored orange	Orange, mostly black spotted	Unicolored orange
7. Design of tail laterals	Large yellow spots	Small yellow spots	Large yellow spots
Larvae			
8. Total length	35-70 mm	35-70 mm	58 mm
9. Relation dorsal fin-length / interaxial length	1.0-1.1 Protrudes from the back center significantly	0.7-0.9 Protrudes from the back center	1.0-1.1 Protrudes from the back center significantly
10. Dorsal design of older larvae (about 50 mm total length)	Bright spots irregularly and big; partly fused	Clearly long bright stains toward two lines along center of the back	Big, irregular bright spots; partly fused
11. Design of belly of older larvae (about 50 mm total length)	Almost unicolored bright	Two imperfect dark spot lines along edges of belly	Almost unicolored bright
12. Design of tail sides	More or less clearly dark pigmented	Clearly blackish brown "clouded"	More or less clearly dark pigmented

Urmia and Iran-Turkey border) and continued the search to the south up to Piranshahr, in the West Azerbaijan Province near the Iran-Iraq border (between 37° 42' 36" and 36° 40' 33" latitudes).

We investigated all potential and accessible habitats of *N. crocatus* in this area, including streams, springs, and ponds. Searches were undertaken between 9.30 am and 6.30 pm. Local people were interviewed in order to obtain more information on *N. crocatus*.

Geographic positions of study sites were recorded with a GPS receiver (Garmin eTrex® 30). Total lengths of adult females were measured with calipers in the field and given in millimeters (mm). Collected specimens were compared morphologically with the description given in Cope (1863) and Schmidtler and Schmidtler's (1975) table (Table 1).

Water samples were collected from the breeding habitat to determine parameters of the salamander's breeding water conditions. Water conductivity, pH, dissolved oxygen (DO), and salinity were measured in the field using a Hach Portable pH/conductivity/dissolved oxygen meter, and water temperature was measured with a thermometer. Some water chemistry parameters such as iron, manganese, chloride, ammonium, sulfide, potassium, nitrate, ammonia, and hardness (calcium and magnesium) were measured in the laboratory using a DR 2800 VIS Spectrophotometer, following the manufacturer's procedures.

Results and discussion

There was no evidence of the species in the 2009 field survey but in 2010, on June 4th, seven adult specimens (♀) were discovered and collected from a Margo Ziyarat Region spring near Oshnaviye, at the border in the west of West Azerbaijan Province, north-Zagros Mountains. In the last conducted survey of the same locality on July 30, 2010 morning, two adults in the spring and eight larvae were found in a small stream and six larvae were collected from the stream; elevation of the location was 1786-1823 m a.s.l.

Neurergus crocatus was previously known from 11 locations in Iran, Iraq, and Turkey (Cope 1863; Schmidt 1939; Khalaf 1961; Nader 1969; Baran and Öz 1986; Schneider and Schneider 2010, 2011). This species is present in the vicinity of Beytüşşebap and Şemdinli, south-east Anatolia, Turkey and in eight localities in the northeastern region of northern Iraq. For the Iranian record, Cope (1862) did not designate the exact type locality of *N. crocatus*; however subsequently Flower and Dunn (1917) determined the type locality as "Ooremiah, Persia" which corresponds to Lake Urmia. Freytag (1956: pl. 4) has at first depicted the type specimen with the labels. We discovered *N. crocatus* in the west of West Azerbaijan Province near the Iran-Iraq border in a natural spring and a small stream. The investigated locality and previously known localities are shown in Fig. 1.

In the north west of Iran in the Mergo Ziyarat region near Oshnaviyeh, we found a total of 17 newts (nine adult females and eight larvae); adults from a spring and larvae from a stream. Adult specimens were discovered in Arabe Spring (37° 2.59' N; 44° 56.72' E), west of Oshnaviyeh. Six larvae were collected from Gurgu Stream (37° 2.78' N, 44° 56.80' E), approximately 100 m north of the spring at 1786-1799 m a.s.l. (Fig 2: A, B). Females were hiding between vegetation in the spring and larvae were found in streams with fast running water, in a small puddle behind stones.

Morphological characters

Collected specimens were compared morphologically as well as in coloration with the description of Cope 1862 and Table 1 in Schmidtler and Schmidtler (1975). *Neurergus crocatus* is characterized and readily identified by yellowish color spots on their flattened black body. Dorsal blotches are yellow and small in midline and larger with light yellow coloration in the lateral position; ventral surface orange-red in males, yellowish in females; limbs overlap when laid against the body, broadly. Males have white colored spots along the tail (Schneider and Schneider 2010). Tail fins on dorsal and ventral sides developed; dorsal tail fin a little higher, especially in the breeding season (Fig 2: C, D).

Our specimens represent the typical characteristics of *N. crocatus* given in the literature (Table 1; Schmidtler and Schmidtler 1975). The species dorsal coloration varies from dark brown to black with numerous yellow round or elongated spots. The yellow spots were a little smaller than in the type specimen (Freytag 1956: pl. 4). The coloration of trunk and tail venter is yellowish orange with infrequent small black spots overlaying the abdomen.

Ecological habitat characteristics

Generally, salamanders are found only in or near running water such as mountain brooks and streams and their survival and distribution can be strongly limited by water quality (Sayim et al. 2009). Moreover, salamanders have highly permeable skin and their larvae may be particularly susceptible to water quality parameters (Duellman and Trueb 1994). Some chemicals such as nitrates and chlorides could influence salamander distribution, abundance, and the selection of breeding sites (Odum and Zippel 2008).

Neurergus crocatus is a montane species that lives and breeds in cool and continuously flowing streams and springs in hillsides and mountainous areas. Habitat substrate is composed of small stones and sands. Typical of the environment of *N. crocatus* are Water cress (*Nasturtium officinale*), Oregano (*Origanum vulgare*), and



Figure 1. A new locality, Oshnaviyeh (11) and other known localities of *Neurergus crocatus*: 1) Beytüşşebap, 2) Şemdinli, 3) Agrah, 4) Shiwolak, 5) Tajeka, 6) Barzan, 7) Girbish, 8) Roste, 9) Smilan, 10) Nawanda. The hatched part shows our studied area, which also covers the unknown exact location of Cope’s original “terra typica.”



Figure 2. A) Arabe Spring. B) Gurgu Stream. C and D) *Neurergus crocatus* adult female.

Table 2. Values of some water chemistry variables in breeding habitats of *Neurergus crocatus*.

Habitat	TEM (C°)	pH	DO mg/l	CON µs/cm	SAL %	Fe mg/l	Mn mg/l	Cl mg/l	K mg/l	NO ₃ mg/l	NH ₃ mg/l	Hardness Mg(mg/l)	Hardness Ca (mg/l)
Arabeh	10	7.69	6.78	228	0.11	0.03	0.2	0.9	0.7	1.2	0.01	2.43	0.01
Gurgu	15	8.45	7.64	301	0.14	0.00	0.2	0.9	0.5	1.2	0.02	2.00	0.13

Stinging nettle (*Urtica dioica*). According to Baran and Atatür (1998) *N. crocatus* spend the winter months on land under stones or in burrows.

Analysis results of some water chemistry parameters in breeding habitats such as iron, manganese, chloride, potassium, nitrate, ammonia, and hardness (calcium and magnesium) are given in Table 2.

Mean values of some water chemistry parameters of breeding habitats was found to be as follows: Fe = 0.015 mg/l, Mn = 0.2 mg/l, Cl = 0.9 mg/l, K = 0.6 mg/L, NO₃ = 1.2 mg/L, NH₃ = 0.015 mg/L, hardness Ca = 0.07 mg/L, and hardness Mg = 2.215 mg/L. Therefore, in these inhabited waters toxic parameters (chloride, nitrate, and ammonia), hardness (Mg and Ca), dissolved oxygen, and pH are all in acceptable range (Odum and Zippel 2008).

Amphibians, especially salamanders, are excellent indicators of local conditions because they have permeable skins and fairly limited home ranges (Blaustein and Wake 1995). After obtaining similar information from known breeding habitats and comparing these with habitats that are not used for breeding, it will be possible to assess the water quality requirements for breeding of *N. crocatus*. This information can be combined with information of other habitat variables to assess the broader habitat requirements of *N. crocatus*.

Threats and conservation of *N. crocatus*

Currently, *N. crocatus* is considered Vulnerable by the IUCN Red List due to its restricted range and potential habitat destruction. *Neurergus crocatus* has not been observed since its original description from Iran by Cope in 1862. Our new record verifies its existence after 150 years from its original description and adds to the broader distributional knowledge of the species. The species is susceptible to habitat change, habitat losses, pollution, drought, and over harvesting (Papenfuss et al. 2009), but these factors have not been determined.

There is a continuing decline in the extent and quality of its habitat. The distribution of this species in Turkey is expected to undergo significant change due to various human activities such as the construction of several dams within the range of *N. crocatus* over the next 10 years (Papenfuss et al. 2009). During summer and fall over grazing and pollution of streams by sheep and goats damage the habitat of *N. crocatus*. Some *N. crocatus* were reported killed by local people that use these springs as drinking water resource, as they think these newts are poisonous.

To assure the sustainable management of *N. crocatus* it is imperative to assess its habitat needs and conservation status over its range and distribution surveys. Of particular importance are how aquatic habitat variables influence the choice and success of breeding sites.

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Elnaz Najafi-Majd is originally from the Islamic Republic of Iran. She is currently a Ph.D. student at the Zoology Section, Biology Department at Ege University in Turkey. She focuses her studies on the conservation, ecology, and distribution of the Lake Urmia newt (Azerbaijan newt; *Neurergus crocatus*) and the Kurdistan newt (*Neurergus microspilotus*).



Uğur Kaya is professor at Ege University and curator of the zoology department Ege University (ZDEU) collection. His main research fields are taxonomy, ecology, and bioacoustics behavior of amphibians. Recently, his main research interests have focused on the conservation and ecology of amphibians. To help protect amphibians species, he monitors various endangered populations and also uses bioacoustics to monitor other anuran populations.