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Distribution and Conservation Status of *Neurergus microspilotus* (Caudata: Salamandridae) in Western Iran

Mozafar Sharifi* and Somayeh Assadian

Department of Biology, Faculty of Science, Razi University, Kermanshah, Iran.
**E-mail: sharifimozafar@hotmail.com*

Abstract. - Field and laboratory observations of the Yellow Spotted Newt, *Neurergus microspilotus* (Nestrov, 1917), in western Iran have yielded preliminary data on conservation biology and distribution of this species. New distributional ranges have been determined for *Neurergus microspilotus* in its Iranian range in the mid-Zagros Mountains. In streams occupied by *Neurergus microspilotus,* dissolved oxygen, temperature, discharge, NO_3, and PO_4 were measured. Land use practices, adjacent riparian habitats and channel substrate were also determined. Four new stream habitats were identified. On the basis of interviews with local inhabitants, three other streams were identified as likely habitat for *Neurergus microspilotus*. Measurements of relative abundance of *N. microsphilotus* indicate that this animal is likely to occur in higher numbers in cold and first order streams located at high altitudes in the western edge of the Iranian plateau on the mid-Zagros Range. The limiting factor for the yellow spotted newts in western Iran appears to be human disturbance. In the last four years, one of the five known streams with *N. microspilotus,* in the area of Ghorighala, has virtually lost its entire population due to pollution by a tourist facility and local sewage effluence.

Key words. - *Neurergus microspilotus*, salamander, first order stream, distribution, conservation.

Introduction

Available information on the conservation biology of the western Iranian salamanders is scarce. Investigations made in the 1970s (Schmidtler and Schmidtler, 1975) indicated that three of four species of salamanders belonging to the genus *Neurergus* (*N. crocatus*, *N. microspilotus* and *N. kaiseri*) occur in Iran. There is no recent information on distribution and abundance of these species for assessment of conservation. However, a world-wide concern over declines in amphibian populations (Wake, 1991; Gardner, 2001) is equally pertinent in remote areas of western Iran. Amphibians are sensitive to land-use alteration (Wilkins and Peterson, 2000) and there is widespread concern that environmental pollution and land deterioration are responsible for their decline (Richardson, et al 2000). Several factors are known to have contributed to the declines, including habitat destruction (Sala et al, 2000), fragmentation of habitat (Sjogren, 1991, Marsh and Trenham, 2000), and alteration of species composition of communities through the introduction of exotic predators and pathogens (Beebee, 1977). In addition, acidification and other chemical pollution, alteration of climate (Pounds and Crump, 1994), disease and road kill (Carey, 1993, 2000) are candidates for the amphibian decline.

Relatively few caudate species occur in Iran. These include seven species of the genera *Triturus*, *Batrachuperus*, *Neurergus,* and *Salamandra* (Balutch and Kami, 1995). Newts of the genus *Neurergus* have a relatively wide geographic distribution, ranging from western Iran (Zagros Mountains) and extending into Iraq and southern Turkey (Balutch and Kami, 1995). There is no sufficient information regarding the geographic distribution of the three species of newts that occur in western Iran. Previous investigations indicate that the primary distribution range of *Neurergus microspilotus* is in the mid-Zagros range at the border of Iran and Iraq (Nesterov, 1917; Schmidtler and Schmidtler, 1975). This information also indicates that *Neurergus kaiseri* and *Neurergus crocatus* are expected to occur in southern and northern parts of the Zagros Range, respectively. Recent investigations on *N. microspilotus* confirms that this newt occurs in highland streams in the mid-Zagros region (Assadian and Sharifi, 2002; Rastegar Pouyani and Assadian, 2002).

The aims of the present study are to determine the geographic distribution and conservation biology of *Neurergus microspilotus*. To improve conservation efforts related to this species, information is needed on physico-chemical characters of the habitat. For this reason, we measured some variables in the aquatic environment and adjacent terrestrial habitats.

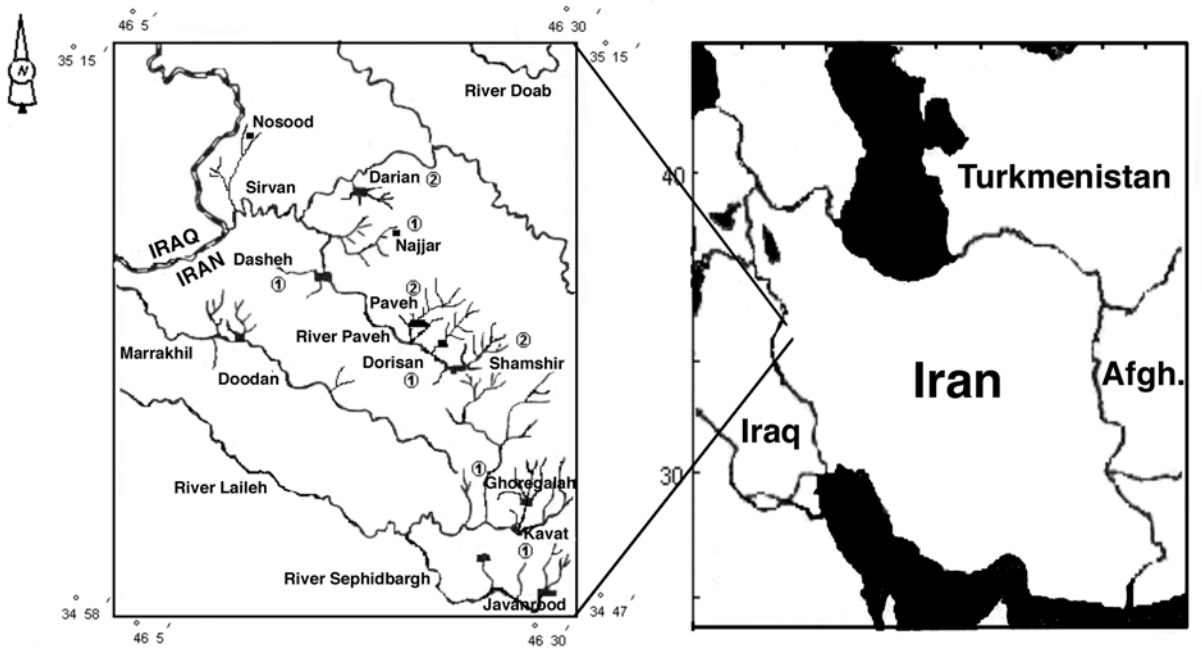

Figure 1. Geographic distribution of *Neurergus microspilotus* in streams of the mid-Zagros Range in western Iran. Those streams with the species have been shown by **(1)**. Those streams that expected to have the animal are shown by **(2)**.

Study Areas

The Iranian basin is a large triangular depression flanked by Elbourz Mountains in the north and the Zagros Mountains in the west. The Zagros Mountains extend diagonally from eastern Turkey to the north of the Persian Gulf and Pakistan border. This range is part of a greater geographic unit arising from the east of the Anatolian Plateau of Turkey and expanding southward to include Iran, Afghanistan, Pakistan and further east to the western edge of the Tibetan Plateau. The Zagros Mountains act as barriers to the incoming air parcels from the west and receive precipitation according to their height and longitude. In general, the northern and western portions of the range receive considerably more rainfall than those in the south and east. The average annual precipitation in the northern Zagros ranges from 400 to 800 mm. per year. Most of the central and southern Zagros receive between 300 and 500 mm (Ghobadian, 1990).

The western Zagros Range meets the northern Mesopotamian Plain, a low land with a hot and dry climate. In some parts of the Zagros Range, where this meeting takes place over a relatively short distance a steep environmental gradient is encountered where high altitude and cold climate from the Iranian Plateau diffuse into the low altitude and warm Mesopotamian Plain in just few kilometers. The weather condition in the western edge of the Iranian Plateau in the mid-Zagros Range is characterized by a pronounced seasonal variation including a long freezing period in winter and a mild summer. Although the average annual precipitation in this area is around 500 mm, most of this comes as snow. As a result, many seasonal and permanent streams at the western side of the Zagros Range are nourished by heavy snow accumulated on the high mountains. In the lowlands of the northern Mesopotamian Plain, which in some parts lie only 20 or 30 km from cold uplands, summers are hot and dry and winters are free of frost. Precipitation in this area approaches 400 mm per annum, rarely appearing as snow. Information obtained from Ravansar Synoptic Station (20 km from Kavat Stream in the highlands) and Sarepolezahab on the northern Mesopotamian Plain (40 km away from Kavat Stream) summarizes the annual climatological data for these two contrasting environments.

Materials and Methods

Streams, ponds, and springs were searched for adults and larvae of *Neurergus microspilotus* in the mid-Zagros Range in Kermanshah and Kurdistan provinces in western Iran in the spring and summer 2001 and 2002. In streams where the salamander was found, channel substrate, channel width, adjacent riparian plant community type, and land use practice were determined. Where possible, relative abundance of *N. microspilotus* was deter-

Table 1. Altitude at head stream, approximate length of the streams and amount of discharge (l/s) in streams where *Neurergus microspilotus* was sighted.

Stream	Altitude (m)	Approximate Length (km)	Position (l/s)	Discharge
Kavat	1500	4	34° 53' N, 46° 31' E	625.7*
Dorisan	1600	3	35° 21' N, 46° 24' E	35**
Dareh Najar	1400	2	35° 06' N, 46° 19' E	-
Ghorighaleh	1600	0.1	34° 54' N, 46° 30' E	333.7*
Paveh rood	1100	2.3	35° 06' N, 46° 17' E	-
Darian	1000	2	35° 08' N, 46° 19' E	-
Shamshir	1800	1.5	34° 59' N, 46° 25' E	-
Marakhil	1600	2.5	35° 02' N, 46° 11' E	-

* Based on measurement made by department of water resource.
** - Discharge measured in field by determining the velocity of water and the extent of cross-section.

mined and expressed as individuals per every ten paces. In small streams where there was no routine hydrological measurement of water discharge, the water discharge was estimated by measuring velocity of water and extent of cross-section width of the channel. In Kavat Stream, where highest relative abundance of *N. microspilotus* was found, visual estimates were made of percent channel substrate composition (Wilkins and Peterson, 2000) by bedrock, boulder (>256mm diameter), cobble (64-256 mm diameter), gravel (16-64 mm diameter), pebble (2-16 mm diameter), fine sediment and coarse woody debris. In these streams several water characteristics were measured. These include dissolved oxygen (Winkler method), temperature (glass thermometer), electrical conductivity (conductivity meter), NO_3 and PO_4 (spectrophotometer).

Results

The geographic distribution of *Neurergus microspilotus* in its Iranian range is shown in Figure.1. These are Kavat Stream (34° 53′ N, 46° 31′ E), Dorisan Stream (35° 21′ N, 46° 24′ E), Ghorighaleh Stream (34° 54′ N, 46° 30′ E), Najar Stream (35° 06′ N, 46° 19′ E), and Paveh Rood Stream (35° 06′ N, 46° 17′ E). Apart from streams in which the newt has already been observed, there are three other streams where, on the basis of interviews with local inhabitants, the presence of this animal is likely. These streams are upstream of Marakhil River (35° 02' N, 46° 11' E), Shamshir Stream (34° 59' N, 46° 25' E) and Hajij Stream (35° 08' N, 46° 19' E). Altitude, approximate length of the streams in which *N. microspilotus* is expected to occur, geographic position, and water discharge are shown in Table 1.

Physico-chemical characteristics in streams with *N. microspilotus* are shown in Table 1. Water analysis has been carried out in upper and lower reaches of Ghorighala Stream in order to demonstrate the human impact on the water quality.

Occurrence of the yellow spotted newt in different aquatic microhabitats has been evaluated using the Wilkins and Peterson (2000) classification of channel substrate including bedrock, boulder, cobble, gravel, pebble and fine sand sediment. The yellow spotted newt occupies an assortment of aquatic microhabitats during the breeding season. Visual determination of substrate texture in Kavat Stream indicated that this newt tended to occupy substrates that are gravel or pebble (60%). Figure 3 demonstrate the frequency distribution of substrate classes used by this newt.

Table 2. Physico-chemical characteristics of water where *Neurergus microspilotus* was found.

Streams	DO	NO_3-N (mg/l)	PO_4-P (mg/l)	EC (micm /cm)	Temperature (°C)
Head stream in Ghorighala	8.15	0.38	N.D	323	11
Lower reach of Ghorigala	6.65	0.35	N.D	356	11
Dareh nagar	7.8	1.14	N.D	549	15
Kavat	-	-	-	-	11.5
Dorissan	-	-	-	-	11

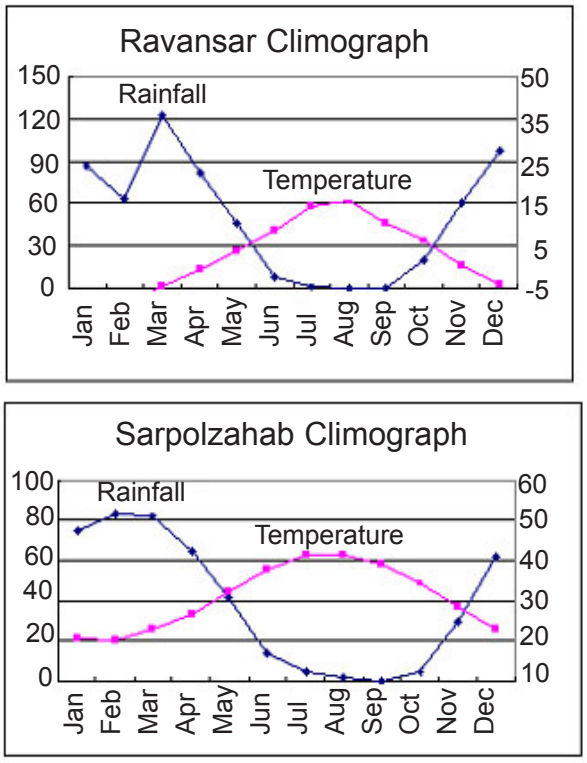

Figure 2. Climographs representing the pattern of precipitation and temperature in Ravansar at the western edge of the Iranian Plateau and Sarepolezahab in the northern Mesopotamian Plain. Data are 20 years mean monthly temperature and rainfall collected at the synoptic stations in these two cities.

Discussion

The presence of *Neurergus microspilotus* in Ghorighaleh Stream has also been reported in previous studies (Nesterov, 1917; Schmidtler and Schmidtler, 1975). Assadian and Sharifi (2002) and Rastegar Pouyani and Assadian (2002) have reported *Neurergus microspilotus* in this stream. Papenfuss and Sharifi also collected several salamanders from this stream in Spring 2000. No information is available regarding the occurrence of *Neurergus microspilotus* in other streams, therefore, the other four streams are new records for *N. microspilotus* in its Iranian range.

All *Neurergus* streams reported in this study with originated from the western edge of the Iranian Plateau (Figure 2) and join to the Dez-Karkheh watershed system in the northern Mesopotamian Plain and finally enter into the Persian Gulf. All these stream are first order streams located at relatively high altitude (1100-1600 m) and join to the main rivers in the lowland (300-600 m) of the catchments (Table 1).

Neurergus microspilotus is a medium size salamander with a slender body. Adults reach a length (snout to vent) of 60-70 mm (mean=65.6, sd=4.63, n=20). Adults are black dorsally and laterally, with greenish yellow blotches. The spots are distributed on the salamander's body without an obvious pattern. *Neurergus microspilotus* characteristically possess broad heads with blunt, rounded snout. *N. microspilotus* is also structured for swimming using their laterally compressed tails for propulsion and steering during swimming.

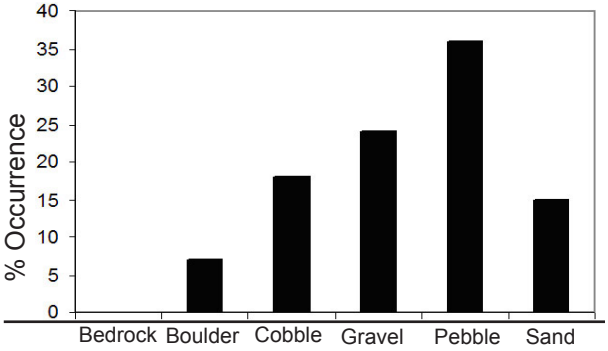

Figure 3. Percent occurrence of *Neurergus microspilotus* in various substrate size group in Kavat Stream (n=42).

The prevailing climatic conditions are distinctly different between and within streams. Since these streams are located at the western edge of the Iranian Plateau, the climatic conditions may vary considerably at the upper reaches compared with lower reaches of the same streams. At the same time it appears that streams closer to the Mesopotamian Plain are experiencing climatic conditions that are different with those that are located at the western edge of the Iranian Plateau. Because of the steep environmental gradient the streams occupied by *Neurergus microspilotus* can be conveniently divided into two groups. Those located in the high altitude and cold weather regions on the western Iranian Plateau (Kavat, Ghorighaleh, Dorisan and Shamshir streams) and those in the north and north eastern part of the range which because of lower elevation experience warmer climate (Marakhil River, Dareh Najar and Darian streams). In Dareh Najar Stream where very few *Neurergus microspilotus* were located, and also in Marakhil and Darian streams where the animal is reportedly seen, it is possible that the animal drifted by the action of water currents. It is also possible that the lower relative abundance in *N. microspilotus* in Dareh Najar and possibly in the other two streams is due to the lower altitude and the vicinity to the northern Mesopotamian Plain.

Terrestrial habitats occupied by *N. microspilotus* include diverse community types including oak-pistachio open woodlands dominated by *Quersus branti* and *Pistachio* spp. This woodland grows on various soil

types, including deep sandy loam soils at the bottom of valleys or gravelly soils on the slopes of steep valleys. In warmer parts of its range, riparian vegetation may also contain willow (*Salix* spp.) or shrubs such as *Cerrasus* and Amygdale (*Amygdalus* spp.). In colder parts of the range the riparian vegetation may be characterized by more hydrophobic plants such as sedges (*Carex* spp.) and sphagnum moss (*Sphagnum* spp.).

Neurergus microspilotus moves from its wintering site to the breeding streams as soon as the spring melt occurs, from late January through early March. Within its range, in high altitude-cold weather regions, egg-laying was observed in early May. However, it appears that the reproductive pattern of *N. microspilotus* is not tightly synchronized because unhatched eggs have been observed as late as mid-June. No breeding activity, eggs, or juveniles of *N. microspilotus* have been observed in the low altitude warm climate part of the range. Eggs of *N. microspilotus* are laid singly or in small clumps on vegetation or on rocks. The number of oocytes in a female dissected in laboratory was 108. Laboratory observations of larval growth and development indicate that larvae complete the metamorphosis in the first year. In early autumn they still possess their gills. Larvae with large heads, well developed dorsal fins, and bushy gills have the ability to react suddenly with a whole body reaction to external stimulus.

Although no information is available regarding wintering activity of *Neurergus microspilotus* in its Iranian range, the appearance of the animal in early spring and disappearance in summer implies that this newt requires both upland and wetland habitat that contain suitable aquatic environment during the breeding season and subterranean burrows appropriate for wintering. These normally include an aquatic environment for breeding and a terrestrial habitat where juveniles and adults spend most of their time.

Habitat loss through divergence of streams for irrigation of cultivated lands is probably the single most important factor that threatens *Neurergus microspilotus* in its Iranian range. Traditionally, due to the lack of land in steep valleys in the mid-Zagros Range, extensive attempts have been made to construct a complex of reinforced terraces of land, which is cultivated for walnut and other orchard trees. Water is diverted from its natural channel to irrigate these lands. Although no harm is directed toward *N. microspilotus* in these orchards, the impact of land use alteration especially in dry periods causes many of these creatures to be deprived of a healthy aquatic environment.

Although human settlement in the mid-Zagros area is characteristically less developed compared with other localities in western Iran, *Neurergus microspilotus* is experiencing an environmental impact similar to that found in more urbanized areas in the country. For example, Ghorighaleh Stream originates from a cave that has been developed by a reclamation project for visitors. Since the construction of this unit the stream is suffering from gross pollution caused by thousands of visitors. Changes in water characteristics in the upper and lower reaches of the stream are shown in Table 2. Although in 2000 and 2001 numerous Yellow Spotted Newts were reported (Assadian and Sharifi, 2002; Rastegar Pouyani and Assadian, 2002) no newts were seen in 2002. The absence of *Neurergus microspilotus* is presumably due to the human impacts resulting from an ecotourism center developed in 1999 at the Ghorighaleh Cave where the source of the stream is located. Massive solid waste disposed by thousands of visitors together with raw sewage released to the stream by residents of Ghorighaleh Village can be observed in the upper reaches of this stream although only changes in dissolved oxygen are evident in physico-chemical characteristics measured in this study.

Conclusions

Although *Neurergus microspilotus* has been virtually extirpated from one of five known breeding streams in its Iranian range, it does not appear to be in immediate danger of extinction because one is likely to find this newt occur in other streams in the area. However, the situation for *N. microspilotus* is not promising as the major threatening factors such as habitat destruction and water pollution are operating. Robust populations occur in at least in one of its habitats (Kavat Stream). However, the lack of information essential to estimate population size and population trends makes it difficult to assess conservation status of this salamander. Future work should examine the long-term effects of anthropomorphic impacts associated with land use alteration and pollution.

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