Fieldnotes on the ecology and distribution of Neurergus crocatus COPE, 1862 and Neurergus strauchii strauchii (STEINDACHNER, 1887) in Turkey
( Amphibia: Caudata: Salamandridae)

Beobachtungen zur Ökologie und Verbreitung von Neurergus crocatus COPE, 1862 und Neurergus strauchii strauchii (STEINDACHNER, 1887) in der Türkei
( Amphibia: Caudata: Salamandridae)

CHRISTOPH SCHNEIDER & WILLI SCHNEIDER

ABSTRACT

Observations on the ecology and distribution of the little known mountain brook newts, Neurergus strauchii strauchii (STEINDACHNER, 1887) and Neurergus crocatus COPE, 1862 made during two herpetological trips to east Turkey in spring 2008 and 2009 are presented. The authors discuss ecological parameters of inhabited streams, which cause differences in the seasonal use of brooks by N. strauchii strauchii. The duration of the aquatic period of N. strauchii and the general suitability of brooks for this newt seemed to be dependent on the water temperature. The surrounding vegetation, especially its shading effect directly along the brookside played an essential role. Furthermore a new locality for N. crocatus close to the city of Semdinli, district of Hakkari, is presented. Besides the population’s habitat and the animals appearance, a sexual dimorphism in the tail coloration of adult N. crocatus is described for the first time.

KEY WORDS

Amphibia: Caudata: Salamandridae: Neurergus strauchii strauchii, Neurergus crocatus, ecology, habitat requirements, distribution, new records, color-pattern, sexual dimorphism, Hakkari and Bitlis districts, SE Turkey

INTRODUCTION

The geographic distribution of the four mountain brook newt species of the genus Neurergus extends from the mountains of southeast Turkey and the Turkey-Iraq and Iraq-Iran borders, into the southern Zagros Mountains of Iran (STEINFARTZ et al. 2002). It includes parts of east Turkey, northern Iraq and western Iran. Neurergus strauchii (STEINDACHNER, 1887), comprising two subspecies, is autochthonous to Turkey. The western subspecies N. strauchii barani Oz, 1994 inhabits a small distribution area west of the River Euphrates, at the Kubbe Mountain (PASMAINS et al. 2006). The nominate form N. strauchii strauchii, has a significantly larger distribution range, extending from the Euphrates River in the west, to Lake Van in the east, and is the most studied species of the genus (BOGAERTS et al. 2006). Nevertheless, information about its natural history is limited. Neurergus crocatus COPE, 1862 inhabits parts of Turkey, Iran and Iraq. It is assumed that N. crocatus has one of the largest distribution ranges among all Neurerg-
Streams were selected using Google Earth® and on-site decision based upon size and flowing conditions. The presence of newts was verified by walking along the brookside during the day and visually detecting adult animals or by finding spawn under rocks. Between half an hour to three hours were spent searching each stream. Seventeen streams were visited one to three times each. Local people were asked about the presence of newts in these streams. Images of Neurergus were shown to the local newspaper, mentions only vaguely where they were found, at the Sümbül Mountains south of Hakkari (ANONYMOUS 2008; BIRICIK 2009), whereas an article from 2009 deals with animals collected close to Beytüşseba at the village Başaran (ÖZDEMIR et al. 2009).

Our aim was to extend the knowledge of both species in the area south east of Bitlis and south of Lake Van. We focused on searching for brooks and small streams to find adults, larvae or eggs of Neurergus. The investigation took place during two trips to the southeastern Turkish provinces Hakkari and Bitlis at the end of May, beginning of June in 2008 (05.25. - 06.05.) and 2009 (05.31. - 06.10.).

MATERIALS AND METHODS

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MATERIALS AND METHODS

Fig. 1: Map of southeastern Turkey. Numbers 1-4 southwest of Lake Van refer to record localities of Neurergus strauchii (STEINDACHNER, 1887) characterized in Table 1.

Table 1: Ten streams southwest of Lake Van, east Turkey, were investigated for the presence of *Neurergus strauchii* (Steindachner, 1887). Selected characteristics of the streams are detailed. Stream numbers (No.) 1 through 4 refer to corresponding numbers in the map Figure 1.


<table>
<thead>
<tr>
<th>Locality Coordinates</th>
<th>Altitude [m a.s.l.]</th>
<th>Water temperature [°C] (date of visit)</th>
<th>Estimated surface of water shaded by vegetation [%]</th>
<th>Average width of stream [m]</th>
<th>Further date of visit</th>
<th>Observation of Neurergus</th>
</tr>
</thead>
<tbody>
<tr>
<td>38°20'N, 42°14'E</td>
<td>(1) [1.5]</td>
<td>14.6 (28.05.09) 14.7 (11.06.09)</td>
<td>&gt; 50</td>
<td>1.5-2</td>
<td>23.05.08</td>
<td>Adults, fresh spawn, advanced larvae</td>
</tr>
<tr>
<td>38°18'N, 42°12'E</td>
<td>(2) [2.0]</td>
<td>19.3 (28.05.09) &lt; 10 lower reaches</td>
<td>&gt; 50 lower reaches &lt; 10 upper flow</td>
<td>2</td>
<td>11.06.09</td>
<td>Spawn and recently hatched clutch</td>
</tr>
<tr>
<td>38°15'N, 42°06'E</td>
<td>(3) [0.5]</td>
<td>18.6 (28.05.09) &lt; 10 (no shade at all)</td>
<td>&lt; 10</td>
<td>1.5</td>
<td>11.06.09</td>
<td>Spawn / Laich</td>
</tr>
<tr>
<td>38°23'N, 42°04'E</td>
<td>(4) [1.0]</td>
<td>9.8-19.0 (28.05.09)</td>
<td>&lt; 10 (no shade at all)</td>
<td>1.5</td>
<td>11.06.09</td>
<td>Spawn / Laich</td>
</tr>
<tr>
<td>38°20'N, 42°11'E</td>
<td>[-0.5]</td>
<td>21.5 (11.06.09) &lt; 10</td>
<td>&lt; 10</td>
<td>1-2</td>
<td>No record / kein Nachweis</td>
<td></td>
</tr>
<tr>
<td>38°20'N, 42°08'E</td>
<td>[-0.5]</td>
<td>20.4 (28.05.09) &lt; 10</td>
<td>&lt; 10</td>
<td>2-3</td>
<td>No record / kein Nachweis</td>
<td></td>
</tr>
<tr>
<td>38°21'N, 42°05'E</td>
<td>[-0.5]</td>
<td>21.9 (11.06.09) &lt; 10</td>
<td>&lt; 10</td>
<td>2-2.5</td>
<td>No record / kein Nachweis</td>
<td></td>
</tr>
<tr>
<td>38°21'N, 42°41'E</td>
<td>[-0.5]</td>
<td>Not measured (11.06.09)</td>
<td>&lt; 25</td>
<td>3-3.5</td>
<td>No record / kein Nachweis; strong water current / starke Wasserströmung</td>
<td></td>
</tr>
<tr>
<td>38°07'N, 43°07'E</td>
<td>[-0.5]</td>
<td>Not measured (04.06.08)</td>
<td>&lt; 10</td>
<td>2</td>
<td>No record / kein Nachweis; probably outside range / wahrscheinlich außerhalb des Verbreitungsgebietes</td>
<td></td>
</tr>
<tr>
<td>38°06'N, 43°08'E</td>
<td>[-0.5]</td>
<td>Not measured (04.06.08)</td>
<td>&lt; 10</td>
<td>3</td>
<td>No record / kein Nachweis; probably outside range wahrscheinlich außerhalb des Verbreitungsgebietes</td>
<td></td>
</tr>
</tbody>
</table>
locals to identify and verify the presence of newts. Water temperature was measured by utilizing a digital thermometer (Greisinger® GTH 175/MO, accuracy 0.1 °C). Moreover, water samples from streams inhabited by *N. crocatus* were analyzed for total hardness, carbonate hardness and pH, using standard test stripes (Sera Quick-test®). The streams and the surrounding land habitat were photographed and the proportion of the water surface shaded by vegetation of the streams inhabited by *Neurergus* was estimated. The length of the streams on the surface is indicated in Tables 1 and 2. Digital images of newts were taken and the geographical positions of the streams (in most cases the place where a street crossed or passed by) were determined by means of a Global Position Device. The total length (tip of snout to tip of tail) of ten randomly selected adult *N. crocatus* was measured with a caliper in order to gain size data of the animals.

**RESULTS**

**Province of Bitlis**

*Neurergus strauchii*

Southwest of Lake Van, ten streams were investigated (Fig. 1, Table 1). In six of them neither newts nor their spawn were observed. In three more brooks (Nos. 2, 3, 4 in Table 1) spawn in different stages of development was found. Adult animals were no longer present. The water temperature was between 8.9 °C (spring outlet No. 4) and 19.3 °C (stream No. 2). In all three streams the spawn was already in an advanced stage of development. Generally, the spawn was attached to the underside of rocks or boulders in deeper pools of the streams. The clutches consisted of 15 to 120 (probably from several clutches) eggs on individual rocks; about 35 eggs represented a common clutch size. The number of clutches found was four (stream No. 1), three (stream No. 2), one (stream No. 3), and 10 (stream No. 4) but cannot be taken as representative of the abundance of newts since rocks and boulders were not inspected in a systematic way. On the 11th of June 2009, we found a clutch in stream No. 2 with all larvae but one already hatched. The stream was situated in a deep valley with trees and bushes at its waterside and slopes, only the first few hundred meters running through an open area of meadow. Brook No. 3, close to the village of Çeltikli in the southern Bitlis province, was surrounded by steep hills covered by scattered oak trees on rocky ground. It drained into a larger river valley in which rice was grown. Stream No. 4 was the only water body the surrounding hills of which were completely devoid of forest. Exclusively in the lower reaches, large trees nearby houses provided some shadow.

Only one stream (No. 1, Fig. 5) was detected in which adult *N. strauchii strauchii* were still present. Two adult newts were found on 23.05.08 when further research was not possible because of village guards preventing our activity in that area, 25 adults and one clutch were found on 28.05.09 and 12 adult animals, three clutches and three larvae on 11.06.09. In summary, during three visits of the stream and a total of 3.5 hours spent searching for newts, 39 animals (10 males, 29 females) were found. All adults were in reproductive condition. Beside the adults, four clutches in their first third of development (maybe originating from more than four females) as well as three large larvae were present. The maximum number of adults observed was 1.7 animals per 100 meters (28.05.09). The water temperature along the course of the stream was relatively constant at 14.7 °C (11.06. 2009). In Table 1 the collected data on the characteristics of the streams are presented.

**Province of Hakkari**

*Neurergus crocatus*

In the Hakkari province, seven streams were studied (Fig. 1, Table 2). Five streams in the surrounding of the city of Hakkari were investigated without finding any *Neurergus*. Locals were not familiar with the animals shown on photographs.

However, *N. crocatus* was found in the southeastern part of the province bordering
Iraq and Iran. Here, newts were observed close to the city of Şemdinli in two neighboring streams located at a distance of about five km from each other. The animals were called “Kaşkaduk” by the local Kurds. The breeding streams of *N. crocatus* were visited on the 2nd of June 2008 and 10th of June 2009. In 2008 an average of two to three animals was detected in each larger pool (Fig. 4) and within two hours, we observed 25 animals. They were resting at the bottom of pools mainly in the shade. According to the corpulence of the females, they were still carrying eggs. Fresh spawn (six clutches, but stones were turned only randomly) was found on the underside of rocks. The size of the clutches varied between 20-40 eggs.

Two animals were detected on land between the roots of trees stabilizing the brookside. For the latter two streams the observed abundance of newts was 2.5 newts per 100 m in 2008 (2nd of June) and 0.7 per 100 m in 2009 (10th of June). Water temperature was almost equal in both streams measuring 14.0 and 13.2 °C, respectively. It did not vary significantly along their courses. The streams were located in steep valleys facing northwest. Surrounding slopes were covered by dense oak forest, growing on sandy soil with only a few rocks scattered in between. In the lower reaches of the streams grew large walnut trees. Most parts of the brooks were shaded by ash and oak trees, dog rose, willow, stinging nettle, blackberry and diverse herbage. This vegetation provided the stream with plenty of shade. In a few sections horsetail and algae grew within the stream, and stones directly along its run were covered by moss. Sand sediment, pebble, cobbles and boulders alternated as substrates of the stream bed. The altitude was about 1600 m a.s.l. See Table 2 for all collected data on characteristics of the streams.

Table 2: Seven streams in the Hakkari province, southeast Turkey, investigated for the presence of *Neurergus crocatus* Cope, 1862. Selected characteristics of the streams are detailed. ‘Stream length’ means investigated stream length.

<table>
<thead>
<tr>
<th>Locality Coordinates</th>
<th>Altitude [m a.s.l.]</th>
<th>Water temperature [°C]</th>
<th>Estimated surface of water shaded by vegetation [%]</th>
<th>Average width [m]</th>
<th>Carbonate hardness [°dH]</th>
<th>Total hardness [°dH]</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>37°31'N, 44°31'E</td>
<td>1510 (~0.5)</td>
<td>13.2 (10.06.09)</td>
<td>&gt; 50</td>
<td>2</td>
<td>15.4</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>37°31'N, 44°30'E</td>
<td>1560 (~0.5)</td>
<td>14.0 (10.06.09)</td>
<td>&gt; 50</td>
<td>1.5-2</td>
<td>8</td>
<td>8.5</td>
<td>7.5</td>
</tr>
<tr>
<td>37°30'N, 44°33'E</td>
<td>(01.06.08)</td>
<td></td>
<td>No evidence or indication for the occurrence</td>
<td></td>
<td></td>
<td>No evidence or indication for the occurrence</td>
<td></td>
</tr>
<tr>
<td>37°35'N, 44°42'E</td>
<td>(01.06.08)</td>
<td></td>
<td>No evidence or indication for the occurrence</td>
<td></td>
<td></td>
<td>No evidence or indication for the occurrence</td>
<td></td>
</tr>
<tr>
<td>37°35'N, 44°48'E</td>
<td>(03.06.08)</td>
<td></td>
<td>No evidence or indication for the occurrence</td>
<td></td>
<td></td>
<td>No evidence or indication for the occurrence</td>
<td></td>
</tr>
<tr>
<td>37°41'N, 44°49'E</td>
<td>(01.06.08)</td>
<td></td>
<td>No evidence or indication for the occurrence</td>
<td></td>
<td></td>
<td>No evidence or indication for the occurrence</td>
<td></td>
</tr>
<tr>
<td>37°42'N, 44°01'E</td>
<td>(03.06.08)</td>
<td></td>
<td>No evidence or indication for the occurrence</td>
<td></td>
<td></td>
<td>No evidence or indication for the occurrence</td>
<td></td>
</tr>
</tbody>
</table>

Aquatic adults or larvae may potentially feed on *Gammarus* species, larvae of *Neurergus* species or *Hydropsyche* species.
Fig. 2: Pair of *Neurergus crocatus* Cope, 1862 from a stream near the city of Şemdinli, SE Turkey. The male is on the left side.

Abb. 2. Ein Pärchen von *Neurergus crocatus* Cope, 1862 aus einem Bach nahe der Stadt Şemdinli, Südosttürkei; Männchen links.

Fig. 3: Ventral aspect of a male *Neurergus crocatus* Cope, 1862 from a stream near the city of Şemdinli, SE Turkey.

Abb. 3: Bauchseite eines männlichen *Neurergus crocatus* Cope, 1862 aus einem Bach nahe der Stadt Şemdinli, Südosttürkei.
Fig. 4: *Neurergus crocatus* Cope, 1862 within its breeding stream near the city of Şemdinli, SE Turkey.

Abb. 4: *Neurergus crocatus* Cope, 1862 in seinen Laichgewässer nahe der Stadt Şemdinli, Südosttürkei.

Fig. 5: Stream No. 1, southwest of Lake Van, east Turkey, in which numerous *Neurergus strauchii* (Steindachner, 1887) were found.

Abb. 5: Bach Nr. 1, südwestlich des Wansees, Osttürkei, in welchem zahlreiche *Neurergus strauchii* (Steindachner, 1887) gefangen wurden.
Neurergus strauchii strauchii. The species which had been known from the south-western area of Lake Van only, was recently found to have a far more widespread distribution range (BOGAERTS et al. 2006). The present investigation was conducted in the eastern part of the distribution area bordering Lake Van.

Aquatic period.— After their hibernation in early spring, during or after the snow melting, *N. strauchii strauchii* migrate into the brooks in order to mate and lay their eggs. Later, after spawning the adults leave the water to return to the land. Information about the duration of the aquatic phase is contradictory. SCHWEIGER (2009) claims only a few days, whereas SCHMIDTLER & SCHMIDTLER (1970) reported that locals observed adult newts in the water until September. Remarkably, in the present study, adult *N. strauchii strauchii* were detected only in one stream (stream No. 1) out of ten at the end of May / beginning of June; they obviously had already left three other ones at that time. According to the advanced developmental status of the spawn in these three streams (streams nos. 2-4), the egg laying period must have ended several weeks before. This estimate was roughly derived from an embryonic developmental period of about three weeks at cool captive conditions (SCHULTSCHIK 2010) that is certainly prolonged at significantly lower temperatures. On the contrary, in stream No. 1 where adult newts and larvae were found, the spawn had been laid recently, and the spawning period had not been over yet. The detected large larvae had certainly hibernated in the brook (comp. SCHMIDTLER & SCHMIDTLER 1970; SCHMIDTLER 1994).

Habitat requirements.— This latter stream (No. 1, Fig. 5) lay at an altitude similar to stream No. 4 (1695 vs. 1675 m a.s.l.), and its structure is comparable to the lower reaches of stream No. 2 (2 m wide; > 50% of water surface shaded). The substrate consisted of rocks, large stones, rubble and sand sediment as in all of these streams. But the low and constant water temperature of 14.6 °C clearly distinguished stream No. 1

<p>| Table 3: Total length (cm) of four male (m) and six female (f) <em>Neurergus crocatus</em> COPE, 1862 from streams near the city of Şemdinli, SE Turkey (comp. Fig. 1, Table 2). |
|---|---|---|---|---|---|---|---|---|---|</p>
<table>
<thead>
<tr>
<th>Sex</th>
<th>Total length</th>
<th>m</th>
<th>m</th>
<th>m</th>
<th>f</th>
<th>f</th>
<th>f</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males / Männchen</td>
<td>n = 4, range: 12.0-15.7, mean: 13.9, standard deviation: 1.51</td>
<td>14.0</td>
<td>14.0</td>
<td>15.7</td>
<td>12</td>
<td>15.5</td>
<td>13.5</td>
<td>16.5</td>
</tr>
<tr>
<td>Females / Weibchen</td>
<td>n = 6, range: 13.5-16.5, mean: 15.4, standard deviation: 1.05</td>
<td>14.0</td>
<td>15.5</td>
<td>16.1</td>
<td>15.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

stone flies, ephemera and caddis flies which were present in the stream. Total length [in cm] of four adult males was 12.0-15.7 (mean: 13.9, standard deviation: 1.51) and 13.5-16.5 (mean: 15.4, standard deviation: 1.05) of six adult females (Table 3). Males appeared to be smaller and more slender.

### DISCUSSION

*Neurergus strauchii strauchii*. The species which had been known from the south-western area of Lake Van only, was recently found to have a far more widespread distribution range (BOGAERTS et al. 2006). The present investigation was conducted in the eastern part of the distribution area bordering Lake Van.

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Habitat requirements.— This latter stream (No. 1, Fig. 5) lay at an altitude similar to stream No. 4 (1695 vs. 1675 m a.s.l.), and its structure is comparable to the lower reaches of stream No. 2 (2 m wide; > 50% of water surface shaded). The substrate consisted of rocks, large stones, rubble and sand sediment as in all of these streams. But the low and constant water temperature of 14.6 °C clearly distinguished stream No. 1
from all others investigated. Neither the altitude nor the proportion of shade in general, but the shade by vegetation in the headwater region seems to be essential for low water temperatures. Moreover, stream No. 1 was relatively untouched, in particular the brookside. In addition stream No. 1 was characterized by a variety of deep pools, fast flowing and calmer sections. These structures were created by rocks, dammed up branches and roots growing into the stream bed. All along its length, the temperature was constant due to the shade cast by the trees growing along its banks. In contrast, the other brooks, heavily marked by human impact, had deforested riverbanks and hills surrounding it.

Conclusions.— Our observations of *N. strauchii strauchii* indicate that the duration of the aquatic phase is strongly influenced by environmental factors. Natural vegetation like oak forest or willows along the streams was depleted by human land-use practices. Water temperature alternates seasonally but this is amplified by activities such as grazing or deforestation, additionally water temperature increases rapidly along the course of the brook. Human adverse impact results in the destruction of vegetation which would otherwise provide shade along the stream, thereby maintaining a lower temperature. The most extreme example is stream No. 4. At the very spring outlet the water temperature was only 8.9 °C but flowing through a completely deforested and heavily grazed valley, the temperature rose about two degrees per 100 meter altitude. The outlet the water temperature was only 8.9 °C but flowing through a completely deforested valley, the temperature rose about two degrees per 100 meter altitude nor the proportion of shade in general. It seems that the critical water temperature for *N. strauchii* was approximately 19.5 °C but flowing through a completely deforested valley, the temperature rose about two degrees per 100 meter altitude.

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Sexual dimorphism in color-pattern.— Sexual dimorphism occurs in *N. strauchii* in the form of a silver-blue coloration on the lateral side of the tail in males (Steinfartz 1995; Sparreboom et al. 2000) but was not known for *N. crocatus*. Strikingly, adult males had few, intensively white and shiny large dots on the tail, which were arranged in a single line. The females in comparison had several irregularly arranged dots, colored as yellow as the dots on the rest of the body. Thus there was a clearly distinguishable coloration pattern for both sexes in the *N. crocatus* population studied (Fig. 2). These observations are in contrast to the presumption of a missing distinctive sexual coloration pattern in *N. crocatus* (Schmidtler & Schmidtler 1975).

Aquatic period.— At Beytüsşebap *N. crocatus* were observed in their aquatic habitats as early as at the end of April (Baran & Öz 1986). Nader (1969) found Iraqi specimens in March as well as May, and...
stated that the reproductive period began in the second half of May. In 2008, the authors found numerous aquatic newts on June 2nd 2008 near Şemdinli, southeast Turkey, at about 1500 m a.s.l. Due to the low number of seven adult *N. crocatus* in the water and the obviously declined breeding facilities observed on June 10th, 2009, we conclude that the end of the aquatic phase had approached. Nevertheless, the spawn was at an early developmental stage at that time. In the previous year, the animals had been right within the spawning period one week earlier. On the top of the surrounding mountains snow was visible at both visits, and along the streams signs of a previous flood, most likely from melting snow, were seen. According to the region’s locals, snow is often still present in April. It is difficult to back-calculate or estimate the date when the animals entered the water, but it seems unlikely that they can inhabit a rapidly flowing stream during snowmelt.

Habitat requirements.– The streams where the authors found aquatic *N. crocatus* as well as the stream in which *N. strauchii* were observed are characterized by dense riparian vegetation, reflecting low human adverse impact. The general situation of the aquatic habitat as well as the breeding patterns seem to be very similar in both species.

Systematic implications.– *Neurergus crocatus* from Beytüşşebap, southeastern Turkey, illustrated and described by Băran & Öz (1986) bear numerous small spots. One of these animals clearly resembles *N. crocatus* from our new locality. The other published illustrations of *N. crocatus* represent animals from Aqrah, Iraq (Freytag 1957; Nader 1969; Steinfartz 1995; Steinfartz & Schultschik 1997) and depict animals with large blotches. The same pattern is seen in the paratype originating from the type locality west of Lake Urmia (Orumiyeh), Iran (Freytag 1957). Both, Aqrah and the area west of Lake Urmia (Orumiyeh) lie within a radius of less than 100 km from the new locality near Şemdinli. A clear geographical barrier between those regions is not recognizable. It still has to be investigated if the morphological differences within *N. crocatus* are of systematic relevance (comp. Özdemir et al. 2009).

ACKNOWLEDGMENTS

We are grateful to Sergé Boogaerts (Nijmegen) for valuable comments on a previous version of the paper.

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Papenfuss, T. & Sporbooom, M. & Ugurtas, I. & Rastegar-Pouyani, N. & Kuzmin, S. & Ander-
Fieldnotes on ecology and distribution of *Neurergus crocatus* and *N. strauchii* in Turkey


SUBMITTED: May 6, 2010

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