Introduction

Triturus karelinii and Triturus vittatus are in the least concern category of the World Conservation Union’s Red List of Threatened Species. Nevertheless, habitat loss and degeneration, agriculture, and pollution (stemming from agricultural, industrial, and domestic waste materials) are the main factors contributing to the decline in their populations, exposing the 2 species to the serious risk of extinction in the future (IUCN, 2006). Although the species are not protected in Turkey, Demirsoy (1996) has suggested that T. vittatus should be placed under protection. It is our opinion, however, that T. karelinii might have a weaker conservation position than T. vittatus. T. karelinii inhabits northern and western regions of Turkey, with a vertical distribution of 0-2100 m. T. vittatus inhabits northern Anatolia and southern Anatolia, with a vertical distribution of 0-2750 m (Baran and Atatür, 1998). Both species live in shallow, still or slow moving water bodies with a lot of vegetation; however, T. karelinii prefers relatively deeper waters (Baflo¤lu and Özeti, 1973; Tarknishvili and Gokhelashvili, 1999).

Abundance of Syntopic Newts, Triturus karelinii (Strauch, 1870) and Triturus vittatus (Gray, 1835), in Uludağ National Park (Bursa, Turkey)

Ahmet MERMER1, Dinçer AYAZ2, Kerim Ç‹ÇEK1,*

1Ege University, Faculty of Science, Biology Department, Zoology Section, TR-35100 Izmir - TURKEY
2Ege University, Faculty of Science, Biology Department, Hydrobiology Section, TR-35100 Izmir - TURKEY

Received: 07.11.2006

Abstract: The present study provides data on the abundance of syntopic southern crested newts, Triturus karelinii, and banded newts, Triturus vittatus, in Uludağ National Park. The population of T. karelinii was 275 ± 60.9 (95% CI = 138-413) in Kirazlıyayla and 424 ± 85.6 (95% CI = 212-636) in Saralan. The populations of T. vittatus in Kirazlıyayla and Saralan were 392 ± 85.6 (95% CI = 196-586) and 158 ± 37.9 (95% CI = 79-237), respectively. T. karelinii populations had an approximately balanced sex ratio in all ponds. In Kirazlıyayla 2 and Saralan ponds the sex ratio of T. vittatus was balanced, whereas it was female-biased in the Kirazlıyayla 1 pond.

Key Words: Triturus karelinii, T. vittatus, newt, abundance, sex ratio, Uludağ National Park, Turkey

Uludağ Milli Parkı'nda Sintopik Semenderler, Triturus karelinii (Strauch, 1870) ve Triturus vittatus (Gray, 1835)’un Bolluğu, (Bursa, Türkiye)


Anahtar Sözcükler: riturus karelinii, T. vittatus, semender, bolluk, cinsiyet oranı, Uludağ Milli Parkı, Türkiye

E-mail: kerim.cicek@ege.edu.tr
hand, although the taxonomical status and distribution of Triturus species have been studied in detail (Olgun and Baran, 1993a, 1993b; Olgun et al., 1997; Arntzen and Olgun, 2000; Olgun et al., 2001), there are not many studies related to their ecology (Olgun et al., 2005). Uludağ National Park is located about 22 km southwest of Bursa, on Mt. Uludağ, the highest mountain in west Anatolia, and covers an area of 12,762 ha. Parts of the Uludağ flora (e.g., Güleryüz, 2000) and fauna (e.g., Uğurtaş, 1989) have been investigated, but we still lack sufficient information as to the status and ecologies of amphibian populations living in this region. The objective of the present study was to provide data on the abundance, sex ratio, and body size of syntopic T. karelinii and T. vittatus inhabiting Uludağ National Park.

Materials and Methods

The study was conducted at 4 sites located in a fir forest (Abies bornmulleriana) in the Kirazlıyayla (lat 40°07′21″N, long 29°05′25″E, 1476 m a.s.l.) and Sarıalan (lat 40°07′96″N, long 29°06′75″E, 1617 m a.s.l.) areas of Uludağ National Park, Bursa (Table 1). The sites in Kirazlıyayla are 2 temporary ponds in the forest near Suçil Creek, flowing into the Nilüfer River. One of the sites in Sarıalan is a temporary pond near a picnic ground, formed as the result of overflow from Gülpınar Creek due to heavy snowfall, and the other is a permanent artificial pond connected to the creek in the forest. The vegetation within the ponds was mainly composed of meadow herbs on the shores (Juncus sp., Carex sp., Festuca sp., and Eleocharis sp.). Southern crested newts and banded newts share their breeding sites with the Uludağ frog (Rana macrocnemis).

Sampling was carried out with a dip net and a mark-recapture method between 1000-1100 and 1400-1500 on 2 days (May 20 and 22, 2006). Adult individuals were sexed and measured for snout-vent length (hereafter SVL) to the nearest 0.01 mm with a dial caliper. The newts were group marked by toe-clipping, according to the Donnelly system (Donnelly et al., 1994). Sterile surgical scissors were used for toe clipping and Isosol solution was applied to the parts that were cut in order to prevent any contamination. The clipped toes regrow within ca. 8 months of terrestrial life (Arntzen et al., 1999). We assumed that the population was closed (no births, deaths, or migration), acknowledging the brief study period. We used a simple Petersen estimate formula, modified by Bailey (1951), to calculate the population sizes. Confidence intervals of 95% were calculated according to Robson and Regier (1964). The one-way ANOVA (LDS) test was applied for the comparison of the SVL values of the sexes, and the chi-squared test was applied for the comparison of sex ratios and population size between species. Humidity and water temperature were measured with a Testo 435-2 data logger and sensors. The air temperature was 21 °C on day 1 and 22 °C on day 2.

Results

The population of adult T. karelinii was 73 ± 25.6 (± SE) in Kirazlıyayla 1 and 187 ± 4.7 in Kirazlıyayla 2. The corresponding figures were 203 ± 59.9 in Sarıalan 1 and 218 ± 37.0 in Sarıalan 2. The population of adult T. vittatus was estimated as 98 ± 22.6 in Kirazlıyayla 1 and 310 ± 88.0 in Kirazlıyayla 2. The corresponding figures were 76 ± 18.3 in Sarıalan 1 and 68 ± 27.2 in Sarıalan 2 (Table 2). Based on the data obtained, the number of

Table 1. Characteristics of the ponds during the study period [SA: surface area (m²); DM: maximum depth (m)].

<table>
<thead>
<tr>
<th>Pond</th>
<th>SA</th>
<th>DM</th>
<th>Origin</th>
<th>Status</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kirazlıyayla 1</td>
<td>1.0</td>
<td>0.3-0.5</td>
<td>natural</td>
<td>temporary</td>
<td>fir forest</td>
</tr>
<tr>
<td>Kirazlıyayla 2</td>
<td>8.28</td>
<td>0.2-0.5</td>
<td>natural</td>
<td>temporary</td>
<td>fir forest</td>
</tr>
<tr>
<td>Sarıalan 1</td>
<td>0.45</td>
<td>0.4-0.9</td>
<td>natural</td>
<td>temporary</td>
<td>fir forest</td>
</tr>
<tr>
<td>Sarıalan 2</td>
<td>5.75</td>
<td>0.5-1.2</td>
<td>artificial</td>
<td>permanent</td>
<td>fir forest</td>
</tr>
</tbody>
</table>
The sex ratio of the *T. vittatus* population was 0.64 in Kirazlıyayla 1 and 1.02 in Kirazlıyayla 2, the ratio being slightly in favor of females in Kirazlıyayla 1 and approximately balanced in Kirazlıyayla 2. The sex ratios of the *T. vittatus* populations in Sarıalan 1 and Sarıalan 2 were 1.19 and 1.35, respectively (Table 3). The sex ratio of the southern crested newt population in Kirazlıyayla was 1 and that of the banded newt 0.86, whereas in Sarıalan, the sex ratio of the southern crested newt population was 0.99 and that of the banded newt 1.26.

In the *Triturus karelinii* population in Kirazlıyayla, the average SVL of males was 72.65 ± 3.46 mm (mean ± SE) (range: 64.11-80.74) versus 81.77 ± 3.66 mm (range: 74.42-89.96) for females. The average SVL was 74.61 ± 1.22 mm (range: 67.57-85.61) in males of the Sarıalan *T. karelinii* population and 79.36 ± 1.01 mm (range: 70.75-84.93) in females. The average SVL of males in Kirazlıyayla 1 and 2 was 72.65 ± 3.46 mm (mean ± SE) (range: 64.11-80.74) versus 81.77 ± 3.66 mm (range: 74.42-89.96) for females. The average SVL was 74.61 ± 1.22 mm (range: 67.57-85.61) in males of the Sarıalan *T. karelinii* population and 79.36 ± 1.01 mm (range: 70.75-84.93) in females.

### Table 2. Number of newts calculated in the study sites [r = number of animals caught, marked, and released on day 1; n = total number of animals caught on day 2; m = total number of marked animals caught on day 2; N = population size; SE = standard error; CI = 95% confidence intervals].

<table>
<thead>
<tr>
<th>Species</th>
<th>Ponds</th>
<th>Kirazlıyayla 1</th>
<th>Kirazlıyayla 2</th>
<th>Sarıalan 1</th>
<th>Sarıalan 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>T. karelinii</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r</td>
<td></td>
<td>22</td>
<td>36</td>
<td>63</td>
<td>57</td>
</tr>
<tr>
<td>n (m)</td>
<td></td>
<td>19 (5)</td>
<td>51 (9)</td>
<td>41 (12)</td>
<td>64 (17)</td>
</tr>
<tr>
<td>N (± SE)</td>
<td></td>
<td>73 (± 25.6)</td>
<td>187 (± 40.7)</td>
<td>203 (± 59.9)</td>
<td>218 (± 37.3)</td>
</tr>
<tr>
<td>(CI)</td>
<td></td>
<td>(37-110)</td>
<td>(94-281)</td>
<td>(103-305)</td>
<td>(109-327)</td>
</tr>
<tr>
<td><em>T. vittatus</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>r</td>
<td></td>
<td>26</td>
<td>46</td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>n (m)</td>
<td></td>
<td>33 (8)</td>
<td>53 (7)</td>
<td>27 (96)</td>
<td>16 (5)</td>
</tr>
<tr>
<td>N (± SE)</td>
<td></td>
<td>98 (± 22.6)</td>
<td>310 (± 88.0)</td>
<td>76 (± 18.3)</td>
<td>68 (± 27.2)</td>
</tr>
<tr>
<td>(CI)</td>
<td></td>
<td>(49-147)</td>
<td>(155-465)</td>
<td>(38-114)</td>
<td>(34-102)</td>
</tr>
</tbody>
</table>

### Table 3. Comparison of the sexes and population sizes between species and among ponds according to the chi-squared test [Tk: *Triturus karelinii*; Tv: *T. vittatus*; M: males; F: females; P = significance level].

<table>
<thead>
<tr>
<th>Ponds</th>
<th>Kirazlıyayla 1</th>
<th>Kirazlıyayla 2</th>
<th>Sarıalan 1</th>
<th>Sarıalan 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tk M vs. Tk F</td>
<td>Tk M vs. Tk F</td>
<td>Tk M vs. Tk F</td>
<td>Tk M vs. Tk F</td>
</tr>
<tr>
<td>χ²</td>
<td>0.03</td>
<td>0.02</td>
<td>0.35</td>
<td>0.21</td>
</tr>
<tr>
<td>P</td>
<td>0.88</td>
<td>0.91</td>
<td>0.56</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>Tv M vs. Tv F</td>
<td>Tv M vs. Tv F</td>
<td>Tv M vs. Tv F</td>
<td>Tv M vs. Tv F</td>
</tr>
<tr>
<td>χ²</td>
<td>33.17</td>
<td>0.01</td>
<td>0.35</td>
<td>0.90</td>
</tr>
<tr>
<td>P</td>
<td>0.00</td>
<td>0.92</td>
<td>0.56</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>Tk vs. Tv</td>
<td>Tk vs. Tv</td>
<td>Tk vs. Tv</td>
<td>Tk vs. Tv</td>
</tr>
<tr>
<td>χ²</td>
<td>3.65</td>
<td>30.44</td>
<td>57.81</td>
<td>78.67</td>
</tr>
<tr>
<td>P</td>
<td>0.05</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

The observed sex ratio (male:female) of *T. karelinii* was 1.05 in Kirazlıyayla 1 and 0.98 in Kirazlıyayla 2. The sex ratio was 0.89 in Sarıalan 1 and 1.09 in Sarıalan 2. Hence, *T. karelinii* males slightly outnumbered females in Kirazlıyayla 1 and Sarıalan 2, whereas females slightly outnumbered males in Kirazlıyayla 2 and Sarıalan 1 (Table 3).
89.80) in females. The average SVL was 74.45 ± 1.83 mm (range: 71.91-78.38) in males of the Kirazlıyayla T. vittatus population and 66.41 ± 1.56 mm (range: 58.18-75.93) in females. The average SVL was 74.45 ± 1.83 mm (range: 70.75-78.38) in males of the Sarıalan T. vittatus population and 62.01 ± 3.21 mm (range: 56.53-67.48) in females. With respect to SVL values, a statistically significant difference was noted between males and females of T. karelinii ($F_{74} = 26.09, P = 0.00$) and T. vittatus ($F_{74} = 37.69, P = 0.00$). Among T. karelinii, females were slightly larger than males, whereas, among T. vittatus, males were slightly larger than females.

**Discussion**

According to literature reviews (Griffiths, 1984; Arntzen and Teunis, 1993; Tarknishvili and Gokhelashvili, 1999; Kupfer and Kneitz, 2000; Arntzen, 2003), the population size of Triturus species vary considerably, depending on the region, climatic conditions, and biotope structures. Methods for studying populations of aquatic newts (Triturus spp.) have primarily employed netting, torch-survey, or trapping techniques. Funnel traps (Bell, 1977; Griffiths, 1985), drift fences (Baker, 1999), and torch-survey (Beebee, 1979; Griffiths, 1984) are generally used. Although it suffers from the disadvantage of disturbing animals and vegetation, the dip netting method is also used by many authors (Cooke and Frazer, 1976; Arntzen, 2002b). Arntzen (2002b) demonstrated that dip net sampling generally produces data that are representative of Triturus populations as a whole and that the technique is appropriate for quantitative surveying, provided sampling takes place in all sections of a pond. Moreover, the estimates based on mark-recapture techniques (Petersen method) do not vary substantially between the 2 modes of recapture applied (funnel traps and drift fences with pitfall traps) (Weddeling et al., 2004).

The number of individuals in the Caucasian population of T. vittatus varies between several hundred and several thousand. For instance, about 20-80 male and 15-55 female individuals were found in a water body of 20-50 m² on Satovle ridges (Abashis Raioni, Georgia) and the total population exceeded 1500. On the other hand, the number of individuals did not exceed 1000 in the entire Caucasian Nature Reserve (northwestern Caucasus) (Tarknishvili and Gokhelashvili, 1999). The Saralan and Kirazlıyayla populations of T. vittatus presently studied are similar to those in the northwestern Caucasus, with respect to population size.

The southern England population of adult T. cristatus was reported to be 264 ± 123 by Verrell and Halliday (1985), and in central England the population varied between 67 and 242 individuals (Baker, 1999). In northwest France, the population of adult T. cristatus ranged from 16 to 335 individuals (Arntzen and Teunis, 1993), whereas the variation in the adult population among years largely followed the variation in juvenile recruitment. The size of the Kirazlıyayla and Saralan populations of T. karelinii we recorded resemble those in northwest France, and southern and central England.

The number of T. karelinii populations is nearly always lower than that of the coexisting newt species. For instance, 600-700 adult T. karelinii individuals were found in Lake Tsodoreti located near Tbilisi (Georgia), whereas the number of adult T. vittatus individuals was 6000-7000 (Tarknishvili and Gokhelashvili, 1999). At both sites in Kirazlıyayla, the number of southern crested newts was less than that of banded newts; however, the situation was the opposite at the sites in Saralan. This difference is thought to be associated with the fact that Kirazlıyayla is a more humid (humidity was 54.5%-42.8% during the study period) biotope compared to Saralan (35.7%-31.7% during the study period). T. karelinii populations living in dry biotopes like Saralan can be 10 times as large as other newt populations. For example, a large population of this species, which numbered several thousand adults (with an even higher density than that of T. vittatus), inhabited Lake Pitsesi in the Trialeti ridge (dry hornbeam forest) (Tarknishvili and Gokhelashvili, 1999). Furthermore, southern crested newts prefer relatively deeper waters (100-150 cm), for breeding, compared to other newt species. Banded newts are less sensitive to the depth of a water body compared to southern crested newts. The fact that T. karelinii outnumbered T. vittatus at the site in Saralan could be attributed to the depth of the water and volume of the ponds.

Both the Kirazlıyayla and Saralan populations of T. karelinii had approximately balanced sex ratios. In fact, the T. karelinii populations are generally referred to as balanced with respect to sex ratio (Tarknishvili and Gokhelashvili, 1999). Olgun et al. (2001) reported that the sex ratios in Bozdağ, İzmir (1.8) and Büyükçekmece, İstanbul (1.5) populations were in favor of males, while
the Koyulhisar, Sivas (1) population was balanced. Arntzen (2002a) found that adult Triturus newts show spatial and temporal variation in sex ratio at aquatic breeding sites. He studied 5 western European species and found approximately equal numbers of males and females.

For Triturus vittatus, on the other hand, the sex ratio was in favor of females in Kirazlıyayla 1 and was slightly in favor of males in Kirazlıyayla 2, and Sarıalan. T. vittatus males outnumbered females, which could be explained by a proportion of females skipping annual breeding opportunities. Nevertheless, the difference is not a great one statistically and the ratio can be said to be balanced. Olgun et al. (1997) reported that the sex ratio in the Çel population (1.28) of the species was in favor of males, whereas it was in favor of females in the Antakya population (0.8). In Tsodoreti Lake near Tbilisi, it was observed that the sex ratio of this population was 1.0 (Tarknishvili and Gokhelashvili, 1999). Males mostly arrive and leave breeding sites ahead of females (Arntzen, 2002a). Arntzen (2000a) reported that T. helveticus was female biased probably because there were too many samplings performed and that they were performed when females were active. T. cristatus × T. marmoratus hybrids are also female biased, which may have a genetic basis (Arntzen, 2002a). A wide range of variation in sex ratios has been observed for other Triturus populations during the aquatic season, with an excess of males (Hagström, 1979; Griffiths, 1984), equality (Verrell and Halliday, 1985, Arntzen, 2002a), and an excess of females (Bell, 1977). The skewed sex ratios in T. vulgaris were explained by a higher mortality rate of one sex (male or female) due to their greater reproductive effort (Bell, 1977; Harrison et al., 1983). Díaz-Paniagua (1998) reported that in the T. marmoratus pygmeus population of southwestern Spain equality was observed in most years, but in those seasons of lower autumnal rainfall males were twice as abundant as females.

The SVL in the Caucasian population of T. karelinii varies between 65 and 72 mm in males and between 64 and 80 mm in females, while the SVL in the Caucasian population of T. vittatus was between 58 and 82 mm in males and between 52 and 75 mm in females (Tarknishvili and Gokhelashvili, 1999). It was reported that newts from northwestern Turkey are much smaller than Caucasian specimens, but the SVL values display some resemblance with Caucasian populations. In Bozdağ, the SVL of T. karelinii was 69.5-89.0 mm in males and 70.4-79.5 mm in females; in Büyükköyceöme, 61.1-74.0 mm in males and 67.4-81.0 mm in females; and in Koyulhisar, 65.1-76.3 mm in males, 69.8-82.0 mm in females (Olgun et al., 2001). In the present study, a statistically significant difference was observed between sexes with respect to SVL. Sexual size dimorphism, with larger females than males, is generally seen in amphibians, but is lower in urodèles (61%) compared to anurans (90%). Many Triturus newts exhibit sexual dimorphism (Shine, 1979). This may be related to the age of populations.

Kılıç and Eken (2004) reported that poorly planned tourism and pollution posed the greatest threat to biodiversity in Uludağ. Indeed, it was seen that the fauna and flora of the Kirazlıyayla and Sarıalan areas suffered considerable damage stemming from winter tourism and picnics during the course of the present study. Despite all these unfavorable conditions, the area, which enjoys great biodiversity, still offers a number of biotopes suitable for the survival of amphibian populations. These studies are expected to continue until 2009, within the framework of the current project, which will help provide more detailed data on this particular issue.

Acknowledgments

We thank biologist S.K. Arserim for significant help in the field studies and Dr. J.W. Arntzen for his invaluable comments on an earlier version of the manuscript. This study constitutes part of a project [Project No: TBAG-105T336] supported by TÜBİTAK (The Scientific and Technological Research Council of Turkey). We are indebted to TÜBİTAK for the financial support it has provided.

References


Abundance of Syntopic Newts, Triturus karelinii (Strauch, 1870) and Triturus vittatus (Gray, 1835), in Uludağ National Park (Bursa, Turkey)


