Turkish Journal of Zoology

Volume 32 | Number 1 Article 8

1-1-2008

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

AHMET MERMER

DİNÇER AYAZ

KERİM ÇİÇEK

Turk J Zool
32 (2008) 59-64

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

Ahmet MERMER[1], Dinçer AYAZ[2], Kerim ÇİÇEK[1,*]

[1]Ege University, Faculty of Science, Biology Department, Zoology Section, TR-35100 İzmir - TURKEY

[2]Ege University, Faculty of Science, Biology Department, Hydrobiology Section, TR-35100 İzmir - 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 Sarıalan. The populations of *T. vittatus* in Kirazlıyayla and Sarıalan were 392 ± 85.6 (95% CI = 196-588) 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 Sarıalan 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)

Özet: Bu çalışma, Uludağ Milli Parkı'nda sintopik Pürtüklü Semender, *Triturus karelinii* ve Şeritli Semender, *Triturus vittatus*'un bolluğu hakkında bilgi sağlamaktadır. *T. karelinii*'nin populasyon büyüklüğü, Kirazlıyayla'da 275 ± 60,9 (% 95 Güven Aralığı (GA) = 138-413), Sarıalan'da 424 ± 85,6 (% 95 GA = 212-636) bulunmuştur. *T. vittatus*'un populasyon büyüklüğü, Kirazlıyayla ve Sarıalan'da sırasıyla 392 ± 85.6 (% 95 GA = 196-588) ve 158 ± 37,9 (% 95 GA = 79-237) bulunmuştur. Tüm havuzlarda *T. karelinii*'nin populasyonlarında cinsiyet oranı yaklaşık olarak dengededir. Kirazlıyayla 2 ve Sarıalan havuzlarında, *T. vittatus*'un cinsiyet oranı dengededir. Kirazlıyayla 1'de ise bu değer dişi eğilimlidir.

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

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 (Başoğlu and Özeti, 1973; Tarknishvili and Gokhelashvili, 1999).

The population ecology of *Triturus* species has been extensively studied in several localities in Europe and other regions of the world where they are distributed (Verrell and Halliday, 1985; Arntzen and Teunis, 1993; Cooke, 1995; Baker, 1999). In Turkey, on the other

* 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°07'210''N, long 29°05'259''E, 1476 m a.s.l.) and Sarıalan (lat 40°07'964''N, long 29°06'753''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 (m^2); DM: maximum depth (m)].

Pond	SA	DM	Origin	Status	Setting
Kirazlıyayla 1	1.0	0.3-0.5	natural	temporary	fir forest
Kirazlıyayla 2	8.28	0.2-0.5	natural	temporary	fir forest
Sarıalan 1	0.45	0.4-0.9	natural	temporary	fir forest
Sarıalan 2	5.75	0.5-1.2	artificial	permanent	fir forest

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].

Species	Ponds	Kirazlıyayla 1	Kirazlıyayla 2	Sarıalan 1	Sarıalan 2
T. karelini	r	22	36	63	57
	n (m)	19 (5)	51 (9)	41 (12)	64 (17)
	N (± SE)	73 (± 25.6)	187 (± 40.7)	203 (± 59.9)	218 (± 37.)
	(CI)	(37.-110)	(94-281)	(103-305)	(109-327)
T. vittatus	r	26	46	19	24
	n (m)	33 (8)	53 (7)	27 56)	16 (5)
	N (± SE)	98 (± 22.6)	310 (± 88.0)	76 (± 18.3)	68 (± 27.2)
	(CI)	(49-147)	(155-465)	(38-114)	(34-102)

southern crested newts in Kirazlıyayla was calculated to be 275 ± 60.9 (95% CI = 138-413) and that of banded newts was 392 ± 85.6 (95% CI = 196-588). The corresponding figures in Sarıalan were 424 ± 85.6 (95% CI = 212-636) and 158 ± 37.9 (95% CI = 79-237), respectively. When comparing each pond, *T. vittatus* outnumbered *T. karelinii* in both Kirazlıyayla ponds. On the other hand, the number of *T. karelinii* was higher than that of *T. vittatus* in both Sarıalan ponds (Table 3).

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).

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. karelini* population and 79.36 ± 1.01 mm (range: 70.75-

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].

Ponds	Kirazlıyayla 1	Kirazlıyayla 2	Sarıalan 1	Sarıalan 2
	Tk M vs. Tk F	Tk M vs. Tk F	Tk M vs. Tk F	Tk M vs. Tk F
χ^2	0.03	0.02	0.35	0.21
P	0.88	0.91	0.56	0.65
	Tv M vs. Tv F	Tv M vs. Tv F	Tv M vs. Tv F	Tv M vs. Tv F
χ^2	33.17	0.01	0.35	0.90
P	0.00	0.92	0.56	0.34
	Tk vs. Tv	Tk vs. Tv	Tk vs. Tv	Tk vs. Tv
χ^2	3.65	30.44	57.81	78.67
P	0.05	0.00	0.00	0.00

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 m^2 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 Sarıalan 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 Sarıalan 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 Sarıalan. 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 Sarıalan (35.7%-31.7% during the study period). *T. karelinii* populations living in dry biotopes like Sarıalan 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 Sarıalan could be attributed to the depth of the water and volume of the ponds.

Both the Kirazlıyayla and Sarıalan 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 İçel 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). Diaz-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 was 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 Büyükçekmece, 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 urodeles (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

Arntzen, J.W. 2002a. Seasonal variation in sex ratio and asynchronous presence at ponds of male and female *Triturus* newts. J. Herpetol. 36: 30-35.

Arntzen, J.W. 2002b. Testing for equal catchability of *Triturus* newts by dip netting. J. Herpetol. 36: 272-276.

Arntzen, J.W. 2003. *Triturus cristatus* Superspezies – Kammolch Artenkreis [*Triturus cristatus* (Laurenti, 1768) – Nördlicher Kommolch, *Triturus carnifex* (Laurenti, 1768) – Italienisher Kommolch, *Triturus dobrogicus* (Kiritzescu, 1903) – Donau-Kommolch, *Triturus karelinii* (Strauch, 1870) – Südlicher Kommolch] In: Handbuch der reptilien und amphibien Europas, band 4/IIA:Schwanzlurche (Urodela) IIA. (eds. K. Gossenbacher and B. Thiesmeier), AULA-Verlag, Wiebelsheim.

Arntzen, J.W. and Olgun, K. 2000. Taxonomy of the Banded Newt, *Triturus vittatus*: morphological and allozyme data. Amphibia-Reptilia 21: 155-168.

Arntzen, J.W. and Teunis, S.F.M. 1993. A six year study on the population dynamics of the Crested Newt (*Triturus cristatus*) following the colonization of a newly created pond. Herpetol. J. 3: 99-110.

Arntzen, J.W., Smithson, A. and Oldham, R.S. 1999. Marking and tissue sampling effects on body condition and survival in the newt *Triturus cristatus*. J. Herpetol. 33: 567-576.

Bailey, N.T.J. 1951. On estimating the size of mobile populations from recapture data. Biometrika 38: 293-306.

Baker, J.M.R. 1999. Abundance and survival rates of Great Crested Newt (*Triturus cristatus*) at a pond in central England: monitoring individuals. Herpetol. J. 9: 1-8.

Baran, İ. and Atatür, M.K. 1998. Türkiye herpetofaunası (kurbağa ve sürüngenler), Çevre Bakanlığı Yayınları, Ankara.

Başoğlu, M. and Özeti, N. 1973. Türkiye Amfibileri (The Amphibians of Turkey; Taxonomic List, Distribution, Key for Identification pp. 127-138), Ege Üniv. Fen Fak. Kitaplar Serisi No. 50, Bornova-İzmir.

Beebee, T.J.C. 1979. Habitats of the British amphibians (2): suburban parks and gardens. Biol. Conserv. 15: 241-257.

Bell, G. 1977. The life of the Smooth Newt (*Triturus vulgaris*) after metamorphosis. Ecol. Monogr. 47: 279-299.

Cooke, A.S. 1995. A comparison of survey methods for Crested Newts (*Triturus cristatus*) and night counts at a secure site, 1983-1993. Herpetol. J. 5: 221-228.

Cooke A.S. and Frazer J.F.D. 1976. Characteristics of newt breeding sites. Journal of Zoology 178: 223-236.

Demirsoy, A. 1996. Türkiye Omurgalıları, Türkiye Omurgalı Faunasının Sistematik ve Biyolojik Özelliklerinin Araştırılması ve Koruma Önlemlerinin Saptanması, Amfibiler, Çevre Bakanlığı Yayınları, Ankara.

Diaz-Paniagua, C. 1998. Reproductive dynamics of a population of Small Marbled Newts (*Triturus marmoratus pygmaeus*) in south-western Spain. Herpetol. J. 8: 93-98

Donnelly, M.A., Guyer, C., Juterbock, J.E. and Alford, R. 1994. Techniques for marking amphibians. In: Measuring and Monitoring Biological Diversity, Standard Methods for Amphibians (eds. W.R. Heyer, M.A. Donnelly, R.W. McDiarmid, L.C. Hayek and M.S. Foster), Smithsonian Institution Press, Washington DC, pp. 277-284.

Griffiths, R. A. 1985. A simple funnel trap for studying newt populations and an evaluation of trap behaviour in Smooth and Palmate Newts, *Triturus vulgaris* and *T. helveticus*. Herpetol. J. 1: 5-10.

Griffiths, R.A. 1984. Seasonal behaviour and intrahabitat movements in an urban population of Smooth Newts, *Triturus vulgaris* (Amphibia: Salamanridae). J. Zool. 203: 241-251.

Güleryüz, G. 2000. Uludağ Alpin Çiçekleri, Dönence Basım ve Yayın Hizmetleri, İstanbul.

Hagström, T. 1979. Population ecology of *Triturus cristatus* and *Triturus vulgaris* (Urodela) in SW Sweden. Holoarctic Ecol. 2: 108-114.

Harrison, J.D., Gittins, S.P. and Slater, F. 1983. The breeding migrations of Smooth and Palmate Newts (*Triturus vulgaris* and *T. helveticus*) at a pond in mid Wales. J. Zool. 199: 249-258.

IUCN, 2006. IUCN Red list of threatened species. On line, URL: www.redlist.org/search/details.php?species=7717 (Last access: October, 18 2006).

Kılıç, D.T. and Eken, G. 2004. Türkiye'nin önemli kuş alanları - 2004 güncellemesi, Doğa Derneği, Ankara.

Kupfer, A. and Kneitz, S. 2000. Population ecology of the Great Crested Newt (*Triturus cristatus*) in an agricultural landscape: dynamics, pond fidelity and dispersal. Herpetol. J. 10: 165-171

Olgun, K. and Baran, İ. 1993a. Orta Karadeniz Bölgesi'nin iç kesiminde yaşayan *Triturus cristatus* (Laurenti, 1768) (Urodela: Amphibia) populasyonları üzerinde sistematik araştırma. Tr. J. of Zoology. 17: 457-470.

Olgun, K. and Baran, İ. 1993b. Orta Karadeniz Bölgesi'nin iç kesiminde yaşayan *Triturus vittatus* (Gray, 1835) (Urodela: Amphibia) populasyonları üzerinde sistematik araştırma. Tr. J. of Zoology. 17: 445-456.

Olgun, K., Baran, İ. and Tok, C.V. 2001. Comparative morphology of *Triturus karelinii* populations from western and central Turkey (Amphibia: Urodela). Zoology in the Middle East 22: 46-57.

Olgun, K., Taşkın, N., Avcı, A. and Claude, M. 2005. Age, size and growth of the Southern Crested Newt *Triturus karelinii* (Strauch, 1870) in a population from Bozdağ (western Turkey). Amphibia-Reptilia. 26: 223-230.

Olgun, K., Tok, C.V., Arntzen, J.W. and Türkozan, O. 1997. The taxonomic status of the Banded Newt (*Triturus vittatus*) in southern Turkey. Herpetol. J. 7: 169-171.

Robson, D.S. and Regier, H.A. 1964. Sample size in Petersen mark recapture experiments. Trans. Amer. Fish. Soc. 93: 215-226.

Shine, R. 1979. Sexual selection and sexual dimorphism in the Amphibia. Copeia 297-306.

Tarkhnishvili, D.N. and Gokhelashvili, R.K. 1999. The Amphibians of the Caucasus, Pensoft Publications, Sofia.

Uğurtaş, İ.H. 1989. Bursa-Uludağ Bölgesi'nin herpetofaunası. DOĞA TU. Zooloji D. 13: 241-248.

Verrell, P. and Halliday, T. 1985. The population dynamics of the Crested Newt *Triturus cristatus* at a pond in southern England. Ecography 8: 151-156.

Weddeling, K., Hachtel, M., Sander, U. and Tarkhnishvili, D. 2004. Bias in estimation of newt population size: a field study at five ponds using drift fences, pitfalls and funnel traps. Herpetol. J. 14: 17-23.