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Population size estimates of *Lissotriton vulgaris* (L., 1758) and *Triturus ivanbureschi* Arntzen & Wielstra 2013 (Caudata: Salamandridae) from Edirne, European part of Turkey

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Abstract. Here we provide data on adult population size in the breeding period of *Lissotriton vulgaris* (Smooth newt) and *Triturus ivanbureschi* (Balkan-Anatolian crested newt) from Edirne, Turkey. The population sizes of the syntopic newts were estimated in three ponds (58m², 27m², 122m²) using a removal method. According to our data, the population sizes were calculated as 228 (range= 204 - 285), 19 (14 – 68), 162 (92 -507) for *L. vulgaris* and 11 (11 - 21), 34 (24 - 103), 52 (35 - 160) for *T. ivanbureschi*, respectively. A female-biased sex ratio was observed for *L. vulgaris*, whereas a balanced sex ratio was observed for *T. ivanbureschi*.

Keywords: population size, sex ratio, *Lissotriton vulgaris*, *Triturus ivanbureschi*, Turkey.

The Smooth newt, *Lissotriton vulgaris*, ranges from Ireland and Great Britain, through west and central Europe and Scandinavia, south to Italy, the Balkans and northern and western Turkey, and east through much of the steppes of Ukraine and Russia, from sea level up to 2,700m a.s.l. (Başoğlu et al. 1994, Tarkhnishvili & Gokhelashvili 1999, Arntzen et al. 2009a). *Triturus karelinii* s.l. is distributed on the Balkan Peninsula, western and northern Turkey, Crimea, the Caucasus and northern Iran up to 2134 m a.s.l. (Başoğlu et al. 1994, Tarkhnishvili & Gokhelashvili 1999, Arntzen 2003, Arntzen et al. 2009b). The *Triturus karelinii* group has been split recently into four populations due to genetic differences (Wielstra et al. 2013a, b). Balkan-Anatolian crested newt, *T.ivanbureschi*, has been separated recently from the *T. karelinii* group and is distributed from the south-eastern Balkan Peninsula through Thrace and western Turkey (Wielstra et al. 2013b).

Lissotriton vulgaris is listed in the least concern category of IUCN Red List and included in the Bern Convention and Annex IV EU Natural Habitat Directives. The recently divided *T. ivanbureschi* also deserves the same status. The potential threats to both newt species are habitat loss and fragmentation, chemical pollution, eutrophication and early desiccation of their breeding sites, deforestation, agricultural development, urbanization, introduced fishes and pet trade (Tarkhnishvili & Gokhelashvili 1999, Arntzen et al. 2009a, 2009b, AmphibiaWeb 2014).

The ecology of the Smooth newt and the Crested newts group has been studied well in European (e.g. Bell 1977, Verrell & Halliday 1985, Arntzen & Teunis 1993, Beebee & Griffiths 2000, Arntzen 2003, Schmidtler & Franzen 2004) and Asian parts of their distribution (reviewed by Tarkhnishvili & Gokhelashvili 1999). However, there have been a limited number of studies conducted in Turkey (e.g. Mermer et al. 2008, Çiçek & Ayaz 2011, Çiçek 2011).

Previous work on amphibians from the Thrace region, (e.g. Yılmaz 1983, 1984, 1989) has only focused on distribution and systematic status of species. During our herpetofaunal trips conducted in the Thrace region, we observed *L. vulgaris* and *T. ivanbureschi* inhabiting some ponds syntopically. The aim of the present study was to obtain preliminary data on habitats, population size and structure of *L. vulgaris* and *T. ivanbureschi* from Edirne, Thrace, Turkey.

The study was carried out in three ponds located in agricultural areas of Bülbül Korusu, Kırkavak village, Uzunköprü (Edirne, Turkey). Pond 1 (Lat.: 41.208112, Long.: 26.730247, 86m a.s.l., surface area= 58m², depth= 0.7m) is a semi-marsh pond, surrounded by perennial plants belonging to aquatic Cyperaceae and Graminae families. There were also fruit trees of plantation origin belonging to the Rosaceae. The substrate of the pond was covered by Graminae and the middle of the upper surface of pond covered by several annual plants from the Brassicaceae. One is also likely to encounter *Populus* species, which are best adapted to such environments. Pond 2 (Lat.: 41.208388, Long.: 26.728006, 84m a.s.l., surface area= 27m², depth= 1.5m) and Pond 3 (Lat.: 41.207906, Long.: 26.726687, 83m a.s.l., surface area= 122m², depth= 2m) are

more suitable for aquatic plants and partly too deep for plants which favor semi-marsh environments. The shores of semi-marsh areas are covered by Cyperaceae, well adapted to these areas. In deep areas, it is common to see *Ranunculus peltatus*, an aquatic plant which is adapted to these areas, as well as *Juncus* species in places. All ponds are natural in origin, the 3rd one is permanent; the 1st and the 2nd ones are temporary. The newts share their breeding sites with *Pelophylax ridibundus*, *Hyla orientalis*, *Emys orbicularis*, *Mauremys rivulata*, and *Natrix natrix*.

Sampling was carried out with a dip net between 08.00 and 21.00 with intervals on April 05, 2014. The sampling period was the breeding season for both newts as shown by the nuptial dresses of the males. In the ponds, sampling was conducted by three people in the morning (08.00-10.00), at noon (12.00-14.00), in the afternoon (16.00-18.00) and evening (19.00-21.00). Captured newts were sexed and measured for snout-vent length (hereafter SVL) to the nearest 0.01mm with a dial caliper. Then, they were kept in plastic containers for a short time. Immediately after the study, they were released at points where they had been captured. Throughout the study, none of the newts were wounded or died during sampling or capture.

The removal model assumes every individual has an equal and constant probability of capture on all occasions (White et al. 1982). Population sizes were calculated using the removal estimator derived from M_{bh} (Otis et al. 1978, Pollock & Otto 1983) by Program CAPTURE (White et al. 1982, Rexstad & Burnham 1991). On the day of sampling, temperature was in the range of 14 to 17°C and water temperature was in the range of 8 to 19°C. The weather was fair without wind. SVL of sexes were tested by student t test and sex ratios were compared by X^2 test. All statistical analyses were performed by PAST statistical program (Hammer et al. 2001). Means are presented with their standard deviations (SD).

A total of 272 aquatic adult *L. vulgaris* (91 males, 181 females) and 64 adult *T. ivanbureschi* (33 males, 31 females) were captured from Bülbül Korusu on April 05, 2014 (Edirne, Turkey, Table 1). According to the data, the number of *L. vulgaris* in Pond 1 was rather high when comparing other ponds. Population size of *L. vulgaris* in this pond was estimated to be 228 individuals (204 – 285). The lowest number of *L. vulgaris* was observed in Pond 2 and the population size was 19 individuals (14 - 68). As shown in Table 2, number of the recapture was slightly increased for both newts in afternoon sampling especially on Pond 1. This could be caused by increased activity of individuals at night.

When sex ratios were compared, in general, *L. vulgaris* showed a female biased sex ratio (♂:♀, 0.5), while *T. ivanbureschi* showed a balanced sex ratio (1.1). However, differences were observed among the ponds (Table 2). *L. vulgaris* showed a female biased sex ratio in Ponds 1 and 3, whereas

Table 1. The capture history and population size of *L. vulgaris* and *T. ivanbureschi* from Edirne, European part of Turkey.

Population	Species	Sampling	males	females	overall	N	SE	95%CI
Pond 1	*L. vulgaris*	morning	14	30	44	228	19.5	204 - 285
		noon	19	37	56			
		afternoon	22	51	73			
		evening	3	10	13			
	T. ivanbureschi	morning	-	-		11	1.6	11 - 21
		noon	3	2	5			
		afternoon	1	4	5			
		evening	1		1			
Pond 2	*L. vulgaris*	morning	3	2	5	19	9.5	14 - 68
		noon	1	1	2			
		afternoon	2	1	3			
		evening		3	3			
	T. ivanbureschi	morning	4	4	8	34	15.1	24 - 103
		noon	2	2	4			
		afternoon	6		6			
		evening	4		4			
Pond 3	*L. vulgaris*	morning	5	15	20	162	85.5	92 -507
		noon	5	14	19			
		afternoon	12	11	23			
		evening	5	6	11			
	T. ivanbureschi	morning	4	6	10	52	24.6	35 - 160
		noon	4	3	7			
		afternoon	3	6	9			
		evening	1	4	5			

its sex ratio for Pond 2 was balanced. The sex ratio of *T. ivanbureschi* was balanced in Pond 1, male biased in Pond 2 and female biased in Pond 3. The ratio of *L. vulgaris* to *T. ivanbureschi* (Lv:Ti) varied between the ponds. Calculated ratios were 17, 0.6, and 2.4 for pond 1, pond 2 and pond 3, respectively. Except Pond 2, the number of *L. vulgaris* in the ponds was high (Table 2).

Table 2. Comparison of the sexes and numbers between *L. vulgaris* and *T. ivanbureschi* (with X^2 test) from Edirne, European part of Turkey.

	Pond	♂	♀	♂:♀	X^2	P
Lv	P1	58	128	0.5	30.69	<0.01
	P2	6	7	0.9	0.09	0.76
	P3	27	46	0.6	4.94	0.03
	Total	91	181	0.5	29.78	<0.01
Ti	P 1	5	6	0.8	0.04	0.83
	P 2	16	6	2.7	4.54	0.03
	P3	12	19	0.6	1.58	0.21
	Total	33	31	1.1	0.06	0.80
Species	Pond	Lv	Ti	Lv:Ti		
	P1	186	11	16.9		
	P2	13	22	0.6		
	P3	73	31	2.4		
	Total	272	64	4.3		

In the *L. vulgaris* population, the average SVL was 35.1mm (SD= 1.88, 32 – 38), with 35.5mm (1.29) in males, and 34.4mm (2.5) in females. The average SVL of *T. ivanbureschi* was 65.8mm (SD= 4.49, range= 56 - 72), with 66.6 mm (3.43) in males, and 65.0 mm (5.66) in females. Although males were slightly longer in terms of SVL values for *L. vulgaris* (t= 0.16, P= 0.87) and *T. ivanbureschi* (t= 0.54, P= 0.61), there was no statistically significant difference between the sexes.

Smooth newts and Crested newts have syntopic distribution in many areas (Tarkhnishvili & Gokhelashvili 1999, Arntzen 2003, Schmidtler & Franzen 2004). For breeding, smooth newts prefer small, stagnant or slow-flowing permanent pools of less than 1000 m² of surface, with rich vegetation, close to a forest (Tarkhnishvili & Gokhelashvili 1999, Beebee & Griffiths 2000). Their habitats are usually more humid places in the forest zone, whereas Southern crested newts prefer more semi-xeric landscapes (Tarkhnishvili & Gokhelashvili 1999, Arntzen et al. 2009b). Tarkhnishvili & Gokhelashvili (1999) reported that the most suitable breeding places for *T. karelinii* in the Caucasus are ponds with a surface area of 0.5-2ha and a depth of 30-100cm in forest areas.

Bell (1977) observed *L. vulgaris* populations in 44 ponds in the vicinity of Oxford (southeastern England), and reported that the size of the population varied between 0 and 1000 by years and the mean population was 70 individuals. In southwestern Sweden, Hagström (1979) observed 300 *L. vulgaris* individuals in a pond of 300m² and 70 individuals in a pond of 6m². In Mid-Wales, it was observed that every year, 350 to 640 smooth newts migrated in a natural pond (Griffiths et al. 1986). Schmidtler & Franzen (2004) summarized studies on *L. vulgaris* and indicated that in Germany, the population size of this species varied between 287 and 2616 individuals in ponds of 20000 - 25000m² and between 2085 and 200 individuals in ponds of 25 - 50 m², resulting in a density of 42 – 0.01 indiv./m². It was reported by Tarkhnishvili & Gokhelashvili (1999) that in Satovle ridge (Georgia), the abundance of *L. vulgaris* may vary between 100 and 1000 individuals, with 80-220 males and 50-280 females living in ponds of 20-50m². The calculated size of *L. vulgaris* population in Lake Sülüklü (1.6 ha, Manisa, Turkey) was 305 individuals (Çiçek & Ayaz 2011). In northwest France, the colonized population of adult *T. cristatus* ranged from 16 to 335 between 1977 and 1992 and the cause of fluctuations was mostly related to the variation in juvenile recruitment (Arntzen & Teunis 1993). In Uludağ (Bursa, Turkey), the calculated population size of *T. ivanbureschi* was 73 – 187 individuals in ponds of 100m² - 828m² and 203 – 218 in ponds of 450m² - 575m² (Mermer et al. 2008). The number of *T. karelinii* varied in the range of 50 to 800 individuals in five ponds in the vicinity of Tbilisi (Georgia) and 600 to 700 individuals in Lake Tsodoreti (Georgia) (Tarkhnishvili & Gokhelashvili 1999).

In the Caucasus, if *T. karelinii* coexists with *L. vulgaris* or *Ommatotriton ophryticus*, the number of *T. karelinii* individuals will be less (Tarkhnishvili & Gokhelashvili 1999). In Western Anatolia, (Lake Sülüklü, Manisa), *T. ivanbureschi* and *L. vulgaris* coexist (Çiçek & Ayaz 2011) and the number of *L. vulgaris* individuals is rather high (K.Ç. unpublished data). Similarly, *T. ivanbureschi* and *O. ophryticus* live together in Uludağ (Bursa, Turkey), and the number of *O. ophryticus* is higher in ponds at an altitude of 1476m and the number of *T. ivanbureschi* is higher in ponds at an altitude of 1617m (Mermer et al. 2008). The authors attributed this difference to harsher climate conditions depending on altitude. In ponds investigated in the Thrace region, the number of *L. vulgaris* is usually higher than *T. ivanbureschi*. The difference between *L. vulgaris* and *T. ivanbureschi* is probably associ-

ated with habitat preferences.

The population sizes of *L. vulgaris* and *T. karelinii* s.l. vary considerably, depending on the region, climatic conditions, and biotope structures (e.g. Arntzen & Teunis 1993, Tarkhnishvili & Gokhelashvili 1999; Beebee & Griffiths 2000, Kupfer & Kneitz 2000, Arntzen 2003, Schmidtler & Franzen 2004). Moreover, study methods of aquatic newts (e.g. dip netting, funnel traps, drift fences, pitfall traps and mark-recapture methods) may produce varying ratios of bias in determining the population size and sex ratio (Arntzen 2002b, Weddeling et al. 2004). Although it suffers from the disadvantage of disturbing newts, the dip netting method is also used by many authors (Cooke & Frazer 1976; Arntzen 2002a, 2002b, Mermer et al. 2008). Arntzen (2002b) indicated that dip net sampling generally represents *Triturus* s.l. populations as a whole and that the technique is appropriate for quantitative surveying, provided sampling takes place in all sections of a pond.

In populations studied in Thrace, although sex ratio varied by ponds, the sex ratio was female biased for *L. vulgaris* and balanced for *T. ivanbureschi*. In the Caucasus, the sex ratio was balanced or biased in favor of females for *L. vulgaris*, and was balanced for *T. karelinii* (Tarkhnishvili & Gokhelashvili 1999). For newts, male-biased (Hagström 1979; Griffiths 1984, Arntzen 2002a), female-biased (Bell 1977, Arntzen 2002a) and balanced (Hagström 1979; Verrell & Halliday 1985; Mermer et al. 2008) sex ratios have been reported by numerous studies. In general, males arrive at breeding grounds earlier than females and females stay longer (Verrell & Halliday 1985, Arntzen 2002a). Variations in sex ratios of both newts in the studied ponds can be due to differences in timing of breeding periods and habitat conditions.

In the Thrace region, both newts are under threat, particularly due to destruction of their breeding ponds and terrestrial habitats. The main factors threatening populations in the region include insensible use of water for agriculture, discharge of industrial and municipal waste water and unplanned urbanization. Furthermore, newts are illegally collected and sold as pets in big cities, including Istanbul, Ankara, etc. According to our field observations, aquatic and terrestrial key habitats require immediate protection for the sustainability of amphibian populations living in Thrace. Also, it is inevitable that a conservation action plan will be required for both species at national level in the near future.

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References

AmphibiaWeb (2014): Information on amphibian biology and conservation [web application]. 2024. Berkeley, California: AmphibiaWeb. <http://amphibiaweb.org., accessed at: 2014.08.28.>

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

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

Arntzen, J.W. (2003): *Triturus cristatus* Superspezies – Kammolch Artenkreis (*Triturus cristatus* (Laurenti, 1768) – Nördlicher Kammolch, *Triturus carnifex* (Laurenti, 1768) – Italienischer Kammolch, *Triturus dobrogicus* (Kiritzescu, 1903) – Donau-Kammolch, *Triturus karelinii* (Strauch, 1870) – Südlicher Kammolch). pp. 421-514. In: Grossenbacher, K., Thiesmeier, B. (eds.), Handbuch der Reptilien und Amphibien Europas 4 (IIA), AULA Verlag, Wiebelsheim. [in German]

Arntzen, J.W., Kuzmin, S., Beebee, T., Papenfuss, T., Sparreboom, M., Uğurtaş, İ.H., Anderson, S., Anthony, B., Andreone, F., Tarkhnishvili, D., Ishchenko, V., Ananjeva, N., Orlov, N., Tuniyev, B. (2009a): *Lissotriton vulgaris*. The IUCN Red List of Threatened Species. Version 2014.2. <www.iucnredlist.org>, accessed at: 2014.08.21.

Arntzen, J.W., Papenfuss, T., Kuzmin, S., Tarkhnishvili, D., Ishchenko, V., Tuniyev, B., Sparreboom, M., Rastegar-Pouyani, N., Uğurtaş, İ.H., Anderson, S., Babik, W., Miaud, C., Isailovic J-C. (2009b): *Triturus karelinii*. The IUCN Red List of Threatened Species. Version 2014.2. <www.iucnredlist.org>, accessed at: 2014.08.25.

Arntzen, J.W., 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. Herpetological Journal 3: 99-110.

Arntzen, J.W., Wielstra, B. (2010): Where to draw the line? A nuclear genetic perspective on proposed range boundaries of the crested newts *Triturus karelinii* and *T. arntzeni*. Amphibia-Reptilia 31: 311–322.

Başoğlu, M, Özeti, N., Yılmaz, İ. (1994): Türkiye Amfibileri (The amphibians of Turkey); taxonomic list, distribution, key for identification. Ege Üniversitesi Fen Fakültesi Kitaplar Serisi No. 50, Bornova-İzmir. [in Turkish]

Beebee, T.J.C., Griffiths, R.A. (2000): Amphibians and reptiles. A natural history of the British herpetofauna. Harper Collins Publishers, London.

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

Çiçek, K. (2011): Morph switching in *Lissotriton vulgaris* (Caudata, Salamandridae). Biharean Biologist 5(2): 157-158.

Çiçek, K., Ayaz, D. (2011): New data on facultative paedomorphism of the smooth newt, *Lissotriton vulgaris*, in Western Anatolia, Turkey. Journal of Freshwater Ecology 26(1): 99-103.

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

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

Griffiths, R.A., Harrison, J.D., Gittins, S.P. (1986): The breeding migrations of amphibians at Llysdinam pond, Wales: 1981-1985. pp 543-546. In: Rocek, Z. (eds.), Studies in Herpetology. Prague.

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

Hammer, Ø., Harper, D.A.T., Ryan, P.D. (2001): PAST: Paleontological Statistics Software Package for Education and Data Analysis. Palaeontologia Electronica 4(1): 1-9.

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

Mermer, A., Ayaz, D., Çiçek, K. (2008): Abundance of Syntopic Newts, *Triturus karelinii* (Strauch, 1870) and *Triturus vittatus* (Gray, 1835), in Uludağ National Park (Bursa, Turkey). Turkish Journal of Zoology 32: 59-64.

Otis, D.L., Burnham, K.P., White, G.C., Anderson, D.R. (1978): Statistical inference from capture data on closed animal populations. Wildlife Monographs. Allen Press, Lawrence, Kansas.

Pollock, K.H., Otto, M.C. (1983): Robust estimation of population size in closed animal populations from capture-recapture experiments. Biometrics 39: 1035-1049.

Rexstad, E., Burnham, K.P. (1991): Users Guide for Interactive Program CAPTURE. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Fort Collins, Colorado.

Schmidtler, J.F., Franzen, M. (2004): *Triturus vulgaris* (Linnaeus, 1758) – Teichmolch. pp. 847-967. In: Grossenbacher, K., Thiesmeier, B. (eds.), Handbuch der Reptilien und Amphibien Europas. Band 4/IIb. Schwanzlurche (Urodela) IIb, Salamandridae III: *Triturus* 2, Salamandra. Aula Verlag. [in German]

Tarkhnishvili, D.N., Gokhelashvili, R.K. (1999): The amphibians of the Caucasus. Advances in Amphibian Research in the Former Soviet Union. Pentsoft Publications, Sofia.

Verrell, P., 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., Tarkhnishvili, D. (2004): Bias in estimation of newt population size: a field study at five ponds using drift fences, pitfalls and funnel traps. Herpetological Journal 14: 17-23.

White, G.C., Anderson, D.R., Burnham, K.P., Otis, D.L. (1982): Capture-recapture and removal methods for sampling closed populations. Los Alamos National Laboratory LA-8787-NERP, Los Alamos, New Mexico.

Wielstra, B., Crnobrnja-Isailović, J., Litvinchuk, S.N., Reijnen, B.T., Skidmore, A.K., Sotiropoulis, K., Toxopeus, A.G., Tzankov, N.,Vukov, T., Arntzen, J.W. (2013a): Tracing glacial refugia of *Triturus* newts based on mitochondrial DNA phylogeography and species distribution modeling. Frontiers in Zoology 10: 13.

Wielstra, B., Litvinchuk, S., Naumov, B., Tzankov, N., Arntzen, J.W. (2013b): A revised taxonomy of crested newts in the *Triturus karelinii* group (Amphibia: Caudata: Salamandridae), with the description of a new species. Zootaxa 3682: 441-453

Yılmaz, İ. (1983): Trakya kuyruklu kurbağaları üzerine morfolojik ve taksonomik bir araştırma (Urodela: Salamandridae). Turkish Journal of Zoology 7: 119-130. [in Turkish]

Yılmaz, İ. (1984): Trakya kuyruksuz kurbağaları üzerine morfolojik ve taksonomik bir araştırma (Anura: Discoglossidae, Pelobatidae, Bufonidae, Hylidae, Ranidae). TUBİTAK Doğa Bilim Dergisi 8(2): 244-264. [in Turkish]

Yılmaz, İ. (1989): Kuzey Anadolu amfibilerinin yayılışı üzerine bir çalışma (Amphibia: Urodela, Anura). TUBİTAK Doğa Bilim Dergisi C13(2): 130-140. [in Turkish]