

New data on facultative paedomorphism of the smooth newt, *Lissotriton vulgaris*, in Western Anatolia, Turkey

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(Received 1 September 2010; final version received 25 October 2010)

During a monitoring survey of the amphibians and reptiles in Lake Sülüklü (Manisa, Turkey) in the spring of 2010, we found that the smooth newt (*Lissotriton vulgaris*) population was composed of partially paedomorphic individuals. During the study, 146 aquatic individuals (56 males, 90 females) were captured and marked. Of these individuals, 27 (seven males, 20 females) were paedomorphic. The population size in Lake Sülüklü was calculated as 305 (SE = 20.72, range = 270–351). According to these data, it was calculated that about 18.5% (56 individuals) of the population consisted of paedomorphic individuals.

Keywords: *Lissotriton vulgaris*; facultative paedomorphosis; Lake Sülüklü; Turkey

Introduction

Facultative paedomorphosis is a conspicuous environmentally based polymorphism in tailed amphibians (Whiteman 1994; Denoël et al. 2005a; Denoël and Lehmann 2006). The phenomenon is very common and has been observed in 57 species of newts and salamanders (Denoël et al. 2005a). Paedomorphosis has been reported in numerous European and Caucasian newts, such as *Mesotriton alpestris* (Radovanovic 1961; Henle 1983; Kalezić et al. 1990; Andreone and Dore 1991), *Ommatotriton ophryticus* (Kaya et al. 2008; Skorinov et al. 2009), *Triturus carnifex* (Kalezić et al. 1994), *Triturus helveticus* (Denoël 2005) and *Triturus macedonicus* (Denoël et al. 2009).

Previous studies considered facultative paedomorphosis to be a metamorphic failure caused by detrimental effects of various environmental factors (Snyder 1956; Sprules 1974). However, paedomorphosis occurs in such contrasting habitats as permanent mountain lakes surrounded by arid grounds and lowland temporary ponds surrounded by wet forests (Denoël et al. 2005a). Numerous environmental factors affect the expression of facultative paedomorphosis (Semlitsch 1987; Semlitsch et al. 1990; Ryan and Semlitsch 2003). Paedomorphs are encountered in different regions and at different latitudes, dependent on environmental and habitat conditions (Whiteman 1994; Denoël et al. 2001; Denoël et al. 2005a; Denoël et al. 2009). This indicates that phenotypic plasticity occurs through the cooperation of genotype and environmental variables (Semlitsch 1987; Denoël et al. 2005a).

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Lissotriton vulgaris has a high tendency to be paedomorphic (Beebee and Griffiths 2000). Paedomorphism in the species was reported in Turkey (western Anatolia) (Çevik et al. 1997), the Ukraine (Litvinchuk 2001), Russia (the vicinity of St. Petersburg) (Litvinchuk et al. 1996), Abkhazia (western Caucasus) (Litvinchuk et al. 1996; Skorinov et al. 2009) and Romania (Fuhn 1960, 1963; Covaciu-Marcov and Cicort-Lucaciu 2007). We have observed paedomorphosis in the population of *L. vulgaris* in Lake Sülüklü (Manisa, Turkey) and herein provide information about the population structure.

Materials and methods

Lake Sülüklü is situated on the northeastern slope of Mt. Spil (38.565035° N, 27.532617° E, 612 m a.s.l.) and is surrounded by a pine forest (*Pinus brutia*). The surface area of the lake is nearly 1.6 ha and its depth is 2–4 m. The lake is nourished by ground water, snow melt and rain. The water level drops drastically in summer, especially in July and August, because of a decrease in spring waters and monthly rainfall. We have observed that four amphibians (*Pseudopidalea variabilis*, *Pelophylax bedriagae*, *L. vulgaris* and *Triturus karelinii*), the European pond turtle (*Emys orbicularis*) and the grass snake (*Natrix natrix*) inhabit the lake. Moreover, introduced common carp (*Cyprinus carpio*) is also present.

During a monitoring survey of the amphibians and the turtle between 23 April and 21 May 2010, some individuals in the smooth newt population in the lake were observed to be paedomorphic. Subsequently, a capture–recapture study was conducted to determine the population size of smooth newt and to find the metamorph–paedomorph ratio. Sampling was performed four times (23 April and 4, 10 and 21 May). These dates are the beginning of the reproductive period, and eggs are laid at the beginning of May. Sampling was conducted by dip net. The sex of the captured individuals was determined, snout-vent length (SVL) and total length (TL) were measured with digital calipers, and specimens were weighed. The individuals were marked by belly pattern photographing. Then, the individuals were released again into their places of capture.

The population size (N), capture probability rate (p) and standard errors (SEs) were calculated using the program CAPTURE (Otis et al. 1978; White et al. 1982) according to Model (h) because of the short sampling time during which the recaptures were made.

Results and discussion

During the study, 146 aquatic individuals (56 males and 90 females) were captured and marked. Of these individuals, 37 (12 males and 25 females) were recaptured. Of the captured individuals, 27 (7 males and 20 females) were paedomorphic (Figure 1). The population size was calculated as 305 individuals (SE = 20.72, range = 270–351), and capture probability was 15% in Lake Sülüklü. According to these calculations, out of 305 individuals in the population, 56 (18.5%) were paedomorphic.

In metamorphic individuals, the mean SVL was 37.1 mm (31.7–41.0) and TL was 66.7 mm (58.9–82.5). On the other hand, in paedomorphic individuals, SVL was 34.8 mm (32.7–36.9) and TL was 61.9 mm (56.6–69.9), respectively (Table 1). Olgun et al. (1999) reported that in the metamorphic individuals of the western Anatolian



Figure 1. A paedomorphic *L. vulgaris* female from Lake Sülüklü.

Table 1. Summary statistics of the smooth newts from Lake Sülüklü.

	TL (mm)		SVL (mm)		Weight (g)		GL (mm)	
	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
Number	40	51	56	65	56	65		
Mean	66.9	66.5	37.7	36.6	0.8	0.8		
Standard deviation	6.9	4.7	2.3	2.3	0.19	0.1		
<i>Paedomorphs</i>								
Number	6	16	7	18	7	18	7	18
Mean	62.2	61.8	35.0	34.8	1.2	1.2	5.9	5.9
Standard deviation	5.1	4.7	1.5	1.4	0.2	0.2	1.8	1.7

population, the SVL ranged from 28.8 to 35.4 mm in males and from 30.5 to 36.4 mm in females and that TL ranged from 54.6 to 65.9 mm in males and from 56.1 to 66.8 mm in females. Baçoğlu and Özeti (1973) reported that when larvae completed their metamorphosis, their TL could be 35 to 40 mm and that adults could be 70 to 80 mm in TL and males could be up to 110 mm in TL. The exterior gills (GLs; gill lengths) of paedomorphs were measured to be 5.88 mm (3.30–7.90). Covaciu-Marcov and Cicort-Lucaciu (2007) measured GL as 6.7 mm, while Litvinchuk (2001) measured it as 1.5 mm. Covaciu-Marcov and Cicort-Lucaciu (2007) reported that TL and SVL of the female paedomorph were 50.9 and 30 mm, respectively.

The absences of predators and rich food are known to favour the delay of metamorphosis and the appearance of paedomorphs (Denoël and Poncin 2001; Denoël et al. 2001). Despite the presence of predators in Lake Sülüklü, abundant sources of food are available (e.g., abundant odonate and hemipteran nymphs). The lake water ebbs around 4 to 5 m, due to irrigation for agricultural purposes and aridity in summer months (July and August). Furthermore, the introduced common carp population is quite dense, and many individuals are 40–50 cm in length. The food content of the European pond turtle population was also examined within the

scope of our ongoing study, and it was found that smooth newts constituted 3% of the food of individuals between April and June 2010 (Çiçek and Ayaz, unpublished data). These factors may also negatively affect paedomorphosis.

Habitat is an essential key in the persistence of facultative paedomorphosis in natural populations of newts (Denoël 2005). Due to the scarcity of suitable lake habitat, paedomorphic individuals will use areas around the lake (terrestrial forms) as shelter even though they might prefer to remain in water under more homogeneous conditions. It is reported that paedomorphic individuals generally use the deeper sections of water (Denoël and Joly 2001; Denoël and Schabetsberger 2003; Denoël 2005). However, almost all paedomorphic individuals that we captured were in regions with depths of 30–90 cm. This is possibly due to the fish population in the lake. This indicates that the pressure of predators might have some effect on habitat sharing. The paedomorphic newt populations in Europe are also under pressure due to introduced exotic fish species (Denoël et al. 2005b). The facultative paedomorphosis is triggered by certain factors from the environment, possibly because of the plasticity and the possibility of the distinct evolution of the newts (Denoël et al. 2005a). Although Lake Sülüklü is a suitable habitat for the paedomorphic smooth newt population, it is also under the pressure of *C. carpio*, *E. orbicularis* and *T. karelinii* populations in particular.

Acknowledgements

The authors thank Mathieu Denoël for his help with an earlier version of the manuscript.

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