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First observation of facultative paedomorphosis in the Danube crested newt (*Triturus dobrogicus* Kiritzescu, 1903) and the occurrence of facultative paedomorphosis in two newt species from soda pans of the Danube-Tisza Interfluve (Kiskunság National Park, Hungary)

Béla MESTER[1], Nastasia Julianna COZMA[1] and Miklós PUKY[2,*]

1. University of Debrecen, Department of Ecology, Conservation Ecology Research Group, 4032 Debrecen, Egyetem tér 1, Hungary
2. MTA Centre for Ecological Research, Danube Research Institute, 2131 Göd, Jávorka S. utca 14, Hungary
*Corresponding author: M. Puky, Email: puky.miklos@okologia.mta.hu

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Abstract. The first observation of paedomorphosis in *Triturus dobrogicus* and the occurrence of facultative paedomorphosis in two newt species (*T.dobrogicus* and *Lissotriton vulgaris*) from soda pans of the Danube-Tisza Interfluve, Hungary are reported in this paper. Facultative paedomorphosis in soda pans occurred in 2010, a year with extremely high precipitation. The favorable environmental conditions created enabled newt populations to extend their aquatic life stage in otherwise unsuitable (too saline), though fish-free habitats. As such, soda pans may provide a suitable aquatic environment for local newt populations in rainy years, and facultative paedomorphosis may be an important adaptation allowing early reproduction in the following year possible in an environment that frequently dries out.

Key words: paedomorphosis, *Triturus dobrogicus*, *Lissotriton vulgaris*, soda pans, Hungary.

Induced by the changing environment and genetic factors (Semlitsch 1987, Semlitsch et al. 1990, Whiteman 1994, Denoël et al. 2005b) paedomorphosis (neoteny sensu lato, Dubois 1985) is common in urodeles (Amphibia: Caudata). It is known in about 60 urodele species from nine families around the world (Denoël et al. 2005b, Kaya et al. 2008). It has been described in 17 European urodele species under natural conditions so far. In most cases it is a rare phenomenon but in five species (*Pleurodeles waltl*, *Lissotriton helveticus*, *Lissotriton vulgaris*, *Mesotriton alpestris*, *Triturus carnifex*) over 130 paedomorhic populations have been found (Ceacero et al. 2010, Covaciu-Marcov et al. 2011, Denoël & Andreone 2003, Denoël 2007, Denoël et al. 2009, Gabrion et al. 1977, 1978, Henle 1983). Before this article was published, five species from the *Triturus* genus (*T. cristatus*, *T. carnifex*, *T. marmoratus*, *T. pygmaeus*, *T. macedonicus*) were known to have paedomorphic individuals (Caetano-Castanet 1993, Ceacero et al. 2010, Covaciu-Marcov & Cicort-Lucaciu 2009, Cyrén 1945, Denoël et al. 2009b, Dolmen 1978, Fasola & Canova 1992, Fuentes et al. 2011, Kalezic et al. 1994, Piazzini et al. 2005, Zeller 1899). In our paper, we present the first observation of facultative paedomorphosis in a sixth species from the genus, the Danube crested newt (*Triturus dobrogicus*). We also provide the first description of paedomorphic newt species that developed in soda pans with high conductivity in 2010.

A survey was undertaken to monitor aquatic macroinvertebrates in five soda pans (Kelemen-szék, Zab-szék, Büdös-szék, Böddi-szék and Fehér-szék) in the Danube-Tisza Interfluve (Kiskunság National Park, Hungary) by using the 'monolith' method, a sampling method for the quantitative collection of aquatic macroinvertebrates.

During that survey, a fully-grown and fully developed, facultative paedomorphic female Danube crested newt (*Triturus dobrogicus*) with characteristic adult morphology (head size and shape, colouration of the belly, back and tail) was caught in the northern part of Zab-szék (N 46°50'32.74", E 19°10'33.15") on 30th July, 2010 (Fig. 1.). It had an estimated total length of over 120 mm. *Triturus dobrogicus* is a typical newt species of the Great Hungarian Plain (Puky et al. 2005). In addition to the paedomorphic specimen, a metamorphic female *T. dobrogicus* was also found nearby in the same lake (N 46°49'48.52", E 19°10'52.05"). During the autumn survey of the same area a facultative paedomorphic female smooth newt (*Lissotriton vulgaris*) was also found at another site, a freshwater spillage near Kelemen-szék soda pan (N 46°47'59.81", E 19°10'19.56") on 5th October, 2010. Its total and snout-vent length were 65 and 35 mm, respectively and its weight was 1.3 grams. Because

Table 1. Mean water depth, mean conductivity and total annual precipitation of the Zab-szék soda pan in the summer of 1999-2001 and 2010 (water depth and conductivity were calculated from data of six to sixteen sampling sites collected four times from June to the beginning of August).

Year	Mean water depth (cm)	Mean conductivity (µS/cm at 25°C)	Total annual precipitation (mm)
1999	23.6	5,920	790
2000	19.5	8,900	405
2001	15.8	10,830	610
2010	46.7	3,330	959

Figure 1. Facultative paedomorphic female Danube crested newt (*Triturus dobrogicus*) caught on 30th July, 2010, at Zab-szék soda pan (Photo: Vivien Blanka Viski).

of the significant seasonal water level fluctuation, the salinity of both investigated alkali waters shows hyposaline (3-20gL^{-1}) and mesosaline (>20gL^{-1}) values. These lakes are characterized by the dominance of Na^+, HCO_3^-,CO_3^{2-}, and Cl^- ions and a pH ranging between 9 and 10 (Schmidt 2003). Both alkali waters have volatile chemical systems consisting of four components, of which Na_2CO_3, $NaHCO_3$, $Ca(HCO_3)_2$ are in dissociation and $CaCO_3$ is in an undissolved condition (Boros 1999). The water level of the soda pans fluctuates greatly over the years (Table 1.). This affects the fauna that they support. During a similar monitoring survey in 1999-2001, for example, no amphibians were found in the same habitats (Lengyel & Kiss, Debrecen, pers. comm. 2012). This can be linked to salt concentration, and thus, conductivity changes of the water (Table 1.), which was within the range amphibians can tolerate only in 2010. This difference was caused by the 959 mm of annual precipitation in 2010, the highest precipitation level since 1901 in Hungary. The 100 year average is only 560 mm (OMSZ 2012). The development of paedomorphosis was described several times in waters with pH over 7 and is therefore likely to be more common than previously thought (Denoël et al. 2009a). However, the successful larval development of amphibians is an unlikely event in soda pans with high conductivity. This is because even moderate levels of salinity are sufficient to significantly reduce survival and delay the development of amphibian larvae (Chinathamby et al. 2006). Smith et al. (2007), for example, reported 6,000 μScm^{-1} at 25 °C as a threshold for largely excluding amphibian larvae from saline wetlands in Australia with no effect below 3,000 μScm^{-1}. This is comparable to our findings. Similarly to what we found, high precipitation was also suspected to help the development of paedomorphosis in *L. vulgaris* (Ghergel et al. 2010) described from 2007 in waters with moderate salinity in Romania (Covaciu-Marcov & Cicort-Lucaciu 2007, 2009). This effect was also recognised in soda pans, such as the Zab-szék, of the Danube-Tisza Interfluve. In 2010, these pans did not dry out by late-summer as they usually do in years with low or average total precipitation (e.g. 2000 and 2001, respectively). In wet years, soda pans may have an advantage for newts over nearby permanent potential breeding sites due to the absence of fish predators. A paedomorphic life strategy (Denoël et al. 2005a) enables earlier reproduction in the following year; a vital phenomenon in an environment that frequently dries out (Denoël 2003). Thus, according to our findings, in rainy years soda pans may provide a suitable, in some respects even favourable, aquatic environment for local newt populations. In wet years, the conductivity of their water is lower than usual and facultative paedomorphosis may be an important adaptation to the changing environment under such conditions.

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