

NEOTENY IN THE ALPINE NEWT POPULATION FROM
THE SUBMEDITERRANEAN AREA OF YUGOSLAVIA

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ABSTRACT. - In the Dinarid karst field, Nevesinjsko Polje, we found Alpine newt neotenic individuals. The environmental conditions of the aquatic habitat of the population in question appeared to be quite different from other neotenic populations of this species known to now. Neoteny has probably evolved and been maintained here under conditions of both unfavourable aquatic and terrestrial habitats.

INTRODUCTION

In most habitats and throughout the majority of its range, the Alpine newt (*Triturus alpestris*) exhibits a typical Amphibian life history: aquatic larvae and essentially terrestrial adults. But, especially in the mountainous regions of Yugoslavia, a number of populations have been recorded in which neoteny occurs to varying degrees. A comparison of known instances of neoteny in this newt suggested that there is a correlation between the occurrence of neotenic individuals and a certain type of environment. Such specimens are almost invariably confined to high-altitude, deep glacial lakes or tarns. Here we report the unexpected discovery of neotenic individuals in an Alpine newt population from the Submediterranean region of Yugoslavia which inhabit a rather different type of habitat. They were found in the relatively small shallow water bodies lying along a lost river in the

Nevesinjsko Polje.

LOCALITY DESCRIPTION, MATERIAL AND METHODS

Nevesinjsko Polje is a typical Dinarid karst field. It is among the largest (around 180 km²) and its altitude ranges from 830 to 900 m above sea level. The soil is composed mainly of floodplain alluvium materials: clay, sand and gravel in varying proportions. The climate of this field is a mixture of moderate continental and mediterranean climate types, that is, rather hot and dry summers and rainy, rather mild autumns and winters (average precipitation ranges from 60 mm to 170 mm per month, respectively; data for the town of Nevesinje; DJERKOVIĆ, 1966). The hydrography of this field is characterized by numerous temporary water currents which are active only during the rainy season. There are only a few permanent streams and small rivers which meander along the field and invariably end in swallow-holes. During the summer months these currents may have a drastically decreased water level, while during the rainy season they usually broadly flood the surrounding areas. The vegetation of this field is mainly steppe-like, with willow trees along the river banks only.

In May 1983, we found a population of the Alpine newt with neotenic specimens in the western part of Nevesinjsko Polje, toward Mount Velež. Newts were collected from the relatively small water bodies (abandoned river branches and a few dug holes) lying along the Alagovac river. Most of these permanently contain water, up to 1.5 m in depth, and are fed by river overflows and underground water. The bottoms are mainly overgrown with scanty stands of *Equisetum* and *Typha*.

In such a habitat we collected a total of 41 Alpine newt individuals of which 28 were neotenic specimens with well-developed gills, 8 were adult metamorphosed females and 15 were juveniles and older larvae (individuals were recognized by gonads inspections). The neotenic females conspicuously outnumbered the neotenic males: 19 females and 9 males were collected. Besides the Alpine newt we found a quite numerous population of the smooth newt *Triturus vulgaris dalmaticus* in this locality which is probably marginal for this subspecies. The Dalmatian smooth newt is confined to the Mediterranean and Submediterranean area of Dalmatia, Herzegovina and Montenegro and is a distinctive member of the batrachofauna of this region. Other

Vertebrates that we found living here include: the Dalmatian barbel gudgeon (*Aulopyge hugeli*), the agile frog (*Rana dalmatina*), the marsh frog (*Rana ridibunda*), the common tree frog (*Hyla arborea*), the grass snake (*Natrix natrix persa*), the ground vole (*Arvicola terrestris*), and otter (*Lutra lutra*). Some of these species (e.g. *R. ridibunda* and *N. natrix*) are effective predators of the newts.

The neotenic specimens of the Alpine newt from Nevesinjsko Polje were conserved in 70 % ethanol and measured for the following nine morphometric characters: L = total length; L_{sv} = snout-vent length (measured from the snout to the posterior edge of cloaca basis); L_{cd} = tail length (measured from the anterior edge of the cloaca basis to the tip of the tail); L_{tc} = head width; L_c = head length (measured from the snout to the corner of the mouth); L_{cl} = head length (measured from the snout to the skin fold of the throat); P_a = forelimb length; P_p = hindlimb length; D = distance between fore and hind limbs.

The coefficient of variation (CV) was used as a measure of morphometric variability. Weighted mean and weighted standard error of the CV values were calculated according to WOOLF (1968).

RESULTS

Statistical parameters of nine morphometric characters of the Alpine newt neotenic specimens from Nevesinjsko Polje are presented in Table I. The total body length of the females ranges from 63 to 84 mm, and of the males from 63 to 79 mm, with mean values of 73.7 ± 1.2 and 71.4 ± 1.7 , respectively. Another character, head width, which is of special interest for neotenic Alpine newt specimens, ranges from 6.7 to 10.1 mm in the females and from 6.2 to 8.3 mm in the males, with mean values of 7.9 ± 0.2 and 7.5 ± 0.2 , respectively. For both characters the neotenic specimens from Nevesinjsko Polje appeared to be considerably smaller in size than neotenic specimens from some other populations for which comparable data are available (Jezero, SELIŠKAR & PEHANI, 1935; Prokoško Jezero, WOLTERSTORFF & RADOVANOVIĆ, 1938; Zminičko Jezero, DŽUKIĆ & KALEZIĆ, unpublished data).

The head width and limbs lengths are the most variable characters in both sexes (Table I). The weighted means of the coefficient of variation

Table I. - Statistical parameters of the morphometric characters of the Alpine newt neotenic specimens from Nevesinjsko Polje. N, sample size; Min-Max, range; M, mean; SE, standard error of mean; CV, coefficient of variation; S_{cv} , standard error of CV.

Character	Females (N = 19)			Males (N = 9)		
	Min-Max	M \pm SE	CV \pm S_{cv}	Min-Max	M \pm SE	CV \pm S_{cv}
L	63-84	73.7 \pm 1.2	7.1 \pm 1.1	63-79	71.4 \pm 1.7	7.2 \pm 1.7
L _{sv}	34.8-46.5	40.6 \pm 0.7	7.5 \pm 1.2	36.9-43.9	40.2 \pm 0.9	6.6 \pm 1.5
L _{ed}	31.1-42.6	36.7 \pm 0.7	7.8 \pm 1.3	30.5-39.9	35.5 \pm 1.0	8.6 \pm 2.0
L _{tc}	6.7-10.1	7.9 \pm 0.2	11.2 \pm 1.8	6.2-8.3	7.5 \pm 0.2	8.7 \pm 2.0
L _c	5.0-6.7	5.5 \pm 0.1	7.4 \pm 1.2	5.1-5.9	5.5 \pm 0.1	5.7 \pm 1.3
L _{cl}	8.2-10.1	9.2 \pm 0.2	8.6 \pm 1.4	7.7-10.8	9.0 \pm 0.4	11.9 \pm 2.8
P _a	11.5-16.9	13.8 \pm 0.3	10.7 \pm 1.7	12.5-16.4	13.9 \pm 0.4	9.8 \pm 2.3
P _p	9.8-16.5	13.9 \pm 0.3	10.5 \pm 1.7	12.1-16.0	14.1 \pm 0.4	8.1 \pm 1.9
D	17.8-24.6	20.9 \pm 0.4	7.9 \pm 1.3	18.5-22.4	20.6 \pm 0.4	6.2 \pm 1.5

over all nine characters for females and males are 8.3 ± 0.5 and 7.4 ± 0.6 , respectively. Although not significantly different, females appeared to be somewhat more variable in these characters than males, as has also been observed for some other *Triturus* species (*T. cristatus*, KALEZIĆ & STEVANOVIĆ, 1980; *T. vulgaris*, TUCIĆ & KALEZIĆ, in preparation).

It has been suggested that the head size, as well as some coloring features, differentiate some Alpine newt populations, especially those with neotenic specimens, even to the subspecies level. In this way, WERNER (1902) described a population from Prokoško Jezero as *T. alpestris reiseri*, RADOVANOVIĆ (1951) a population from Bukumirsko Jezero as *T. alpestris montenegrimus*. RADOVANOVIĆ (1961) designated populations from Kapetanovo and Manito Jezero as *T. alpestris piperianus*, and a population from Zminičko Jezero as *T. alpestris serdarus*. The individuals from all these populations were said to have larger and wider heads in comparison with the nominative form, besides some differences in colouring. However, the separate taxonomic position

of some of these taxa has become uncertain (ROČEK, 1974 a-b; POČRNIĆ et al., 1980; BREUIL & GUILLAUME, 1984). Though the aim of this paper is not to evaluate taxonomical relations among Yugoslav neotenic populations since we do not have adequate sample sizes and some other relevant information, it seems worthwhile to give the relative width of head of the specimens from Nevesinjsko Polje expressed by the L/L_{tc} and L_{sv}/L_{tc} indices.

The mean values of the L/L_{tc} and L_{sv}/L_{tc} indices are 9.4 ± 0.2 and 5.2 ± 0.1 for the females, respectively, and 9.5 ± 0.1 and 5.4 ± 0.3 for the males, respectively. These values appear to be well within the range of variation both for non-neotenic Alpine newt populations from Central, Eastern and Southern Europe (ROČEK, 1974 a), and for some neotenic Yugoslav populations (Manito Jezero, ROČEK, 1974 b; Zminičko Jezero, DŽUKIĆ & KALEZIĆ, unpublished data).

DISCUSSION

In most Tailed Amphibian species with facultative neoteny, the ease and frequency of metamorphosis can be correlated with geographical and ecological gradients (GOULD, 1977). Neotenic individuals are mostly encountered in a certain type of environment: high altitude, glacial, unproductive lakes or tarns. BREUIL & THUOT (1984) stated that neoteny could be a consequence of the life in the deep zone of such oligotrophic biotopes. WILBUR & COLLINS (1973) and SPRULES (1974 a) have viewed neoteny as an evolutionary adaptive response to highly predictable aquatic habitat surrounded by a hostile terrestrial habitat. If the land environment is characterized by unusually harsh conditions, such as severe temperature fluctuations, lack of suitable cover or food and low humidity, then neotenic individuals will have an adaptive advantage over those that metamorphose and become primarily terrestrial.

Up to now, known instances of neoteny in Alpine newt populations of Yugoslavia are restricted to localities situated in high altitude mountains, from 1300 m to almost 1800 m above sea level (fig. 1). These populations are polymorphic, containing both neotenic and metamorphosed individuals living apparently under the same environmental conditions. The possibility of microhabitat specialization of these two groups still remains to be tested. The neotenic specimens seem to outnumber the transformed ones in

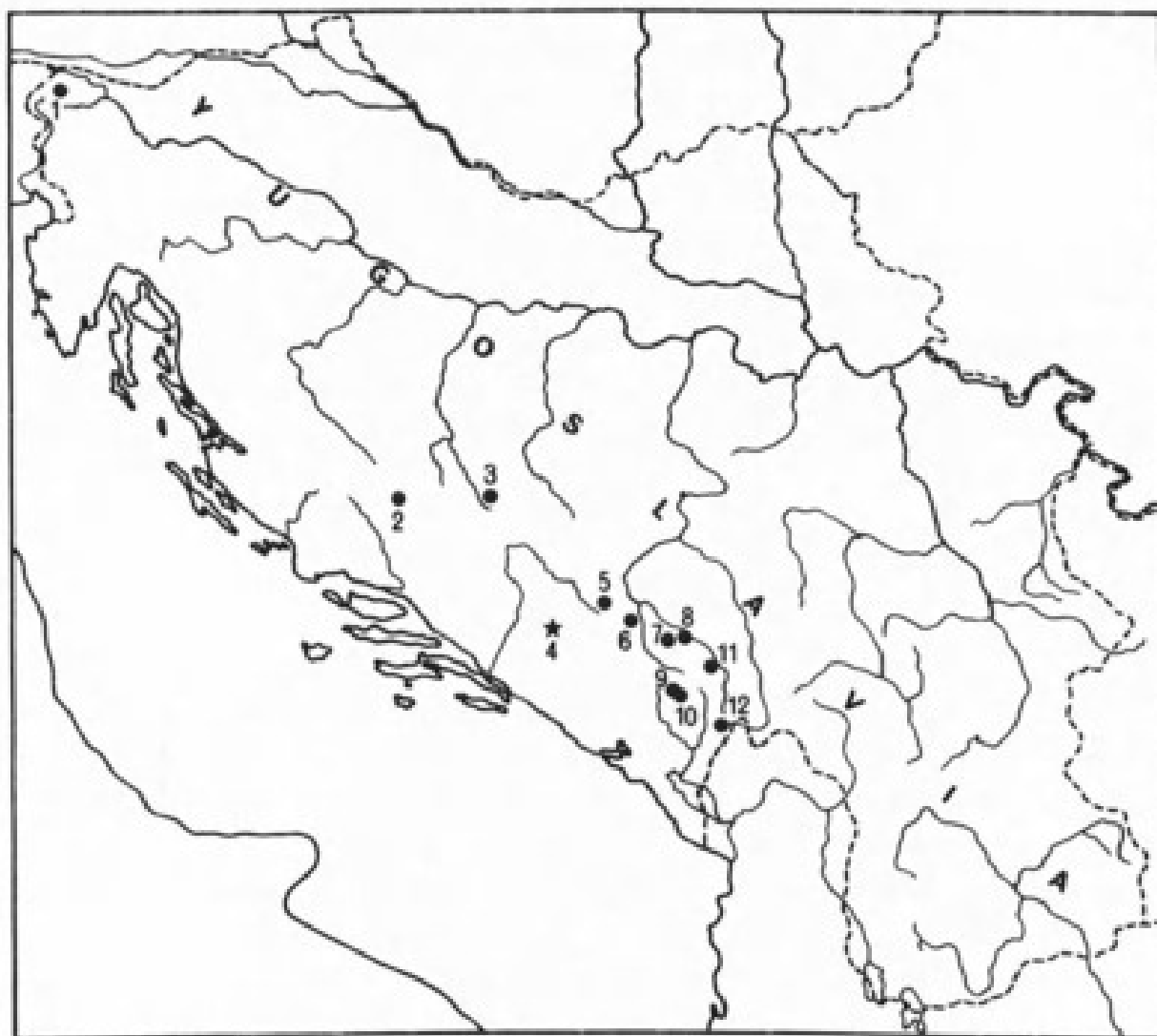


Fig. 1. - Known localities of the Alpine newt neotenic populations in Yugoslavia. 1: Jezero, 1428 m above sea level; 2: Šatorsko Jezero, 1488 m; 3: Prokoško Jezero, 1640 m; 4: Nevesinjsko Polje, 840 m; 5: Kladopoljsko Jezero, 1380 m; 6: Trnovačko Jezero, 1520 m; 7: Vražje Jezero, 1420 m; 8: Zminičko Jezero, 1285 m; 9: Kapetanovo Jezero, 1678 m; 10: Manito Jezero, 1773 m; 11: Zabojsko Jezero, 1477 m; 12: Bukumirsko Jezero, 1430 m.

most populations, with an extreme case in Bukumirsko Jezero where only three to four per cent of the newts were fully developed (RADOVANOVIĆ, 1951; BREUIL & THUOT, 1984). However, it is still not known whether these populations are as complex as populations of *Ambystoma gracile* (SPRULES, 1974 b) comprising both obligate and facultative neotenes in the group of neotenic individuals.

The localities of all Alpine newt neotenic populations in Yugoslavia were originally free of fish which certainly appears to be of considerable importance for the maintenance of neotenic individuals. Unfortunately, during the last ten years, in some of the lakes, i.e. in Prokoško, Kladopoljsko, Trnovačko, Zminičko and Kapetanovo Jezero, trouts have been introduced. This apparently causes a great reduction or probably the complete disappearance of neotenic and/or transformed newts from these localities, due to predatory and/or some type of competitive interaction between newts and fish (personal observations; closer inspection is in progress).

The environmental conditions of the aquatic habitat of the Nevesinjsko Polje population appear to be quite different from the others. Instead of deep, large water bodies of glacial lakes, the Alpine newt in Nevesinjsko Polje lives in shallow, much warmer water bodies with changeable levels. These are spread out along the lost river and are among the rare surface waters in this karst field. For such reasons, this aquatic environment can be hardly referred to as a stable, predictable habitat. The terrestrial habitat in this Submediterranean area is also hostile to the Alpine newt due to its relatively dry conditions.

The pertinent findings of this study are that neoteny in the Alpine newt population from Nevesinjsko Polje has probably evolved and been maintained under conditions of unfavourable aquatic and terrestrial environments. Similar environments promote conditions under which all individuals of *Eurycea neotenes* populations stay permanently larval in morphology (BRUCE, 1976). BRUCE invoked selection that favoured early maturity but not a lowering metamorphic body size. We do not have relevant data to make any statement as to whether such a selection operated in the Alpine newt population in question or not. Nevertheless, it seems that such an approach which takes into consideration both environmental and demographic population characteristics is promising in our case as well.

ACKNOWLEDGMENTS

We thank N. TUCIĆ for his comments on an earlier draft of this paper, and M. BREUIL, referee of *Alytes*, for helpful suggestions.

RESUME

Une nouvelle population de Tritons alpestres comportant des individus néoténiques a été découverte dans le karst dinarique à Nevesinjsko Polje (Yougoslavie). Les conditions ambiantes du milieu aquatique où vit cette population sont bien différentes de celles des autres populations néoténiques de ce triton connues jusqu'à présent. La néoténie s'y est probablement développée et maintenue en raison des conditions défavorables à la fois du milieu aquatique et du milieu terrestre.

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