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Anomalies of the Smooth Newt *Lissotriton vulgaris* (L., 1758) in the Gradient of Urbanization

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Abstract

The paper addresses the influence of environmental transformation and water pollution on the number and frequency of abnormalities. Comparative analysis shows that the range and frequency of morphological anomalies of juveniles was significantly poorer than adult. Also, difference in the anomalies spectra mentioned in populations of the smooth newt in European and Asian parts of the area were found. Overall cases of morphological abnormalities of mature and adult animals are discussed.

Keywords: Caudata, amphibians, anomalies, urbanization, water chemistry, *Lissotriton vulgaris*.

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1. Introduction

The smooth newt is a widespread species of tailed amphibian [1], which is adapts relatively easily to anthropogenic changes in the environment [2–4]. However, despite a certain tolerance to various anthropogenic factors, the common newt has a number of features that allow you to use it as a kind of environmental indicator.

Tailed amphibians are sensitive to chemical pollution (the specifics of the geochemical background). The smooth newt is an official species bioindicator. The indication is based on the high sensitivity of the newt's smooth skin to pollutants. A special 'newt test; reflects the degree of contamination by carcinogens [5].

Information on the specific spectra and frequency of the morphological anomalies is an essential signaling characteristic of local geochemical specifics and environmental health [6]. The main objective of this study was a comparative analysis of the morphological abnormalities in juvenile and adult populations of *L. vulgaris* on the territory of a large urban agglomeration (Yekaterinburg). One of the tasks of the research was

to assess the impact of geochemistry on the persistence of deviant forms in post-metamorphic and adult *L. vulgaris* along with a gradient of urbanization, as well as to evaluate the uniqueness of the spectrum of anomalies for smooth newt populations living in the European and Asian part of the area. The research also sought to assess the range and frequency of the occurrence of anomalies with the help of biodiversity indices.

2. Methods

This work was completed between 2010 and 2015 in the city of Yekaterinburg and its suburbs. 39 amphibian habitats in the city were studied, and the common newt was found in 10 of them. The total number of animals under investigation was 1345 smooth newts, including 982 adults and 363 juveniles. The degree of the anthropogenic transformation of habitats was assessed on the basis of landscape typification [7]: this was confirmed annually by means of the hydrochemistry of spawning ponds (analyses were performed in the Laboratory of Physical and Chemical Analyses of the Ural State Mining University). The urban territory was subdivided into four zones depending on the degree of land use: zone I - the central part of the city with multi-storey buildings, bodies of water with heavy pollution, small rivers (in this area there are no amphibians); zone II - multi-storey buildings; zone III - low-storey buildings; zone IV – forest-park zone. As a control (K), a population living 30 km from Yekaterinburg (near Mramorskoye village of Sysert district) was used.

The amphibians were collected manually in aquatic and terrestrial habitats: juveniles were caught shortly after metamorphosis. All the animals were researched for the presence of morphological abnormalities. An analysis of the spectrum and frequency of anomalies was performed using a classification of external morphological abnormalities [7–9]. After analysis and measurement, all the adults were released in the same places. Analyses of variance were conducted in the program Statistica for Windows 7.0. Biodiversity indices were calculated in the PAST program.

3. Results

The distribution of the smooth newt is related to the degree of water acidity. So, common newts inhabit ponds with pH 6.0 – 9.0, while none were observed at pH <6.0, although some specimens were occasionally encountered in pH 5.8 [1, 4]. When there are values of pH <3.9, common newts disappear [11]. In city ponds in the multistory

building area with a level of pH=7.9, the most diversity in and frequency of deviant forms were observed.

High concentrations of pollutants in the ponds of the residential part of the city (zones II - III) are an explanation for increases in abnormalities and the abnormal regeneration frequency. The widest range of variants and a high percentage of morphological abnormalities were found in habitats with high water mineralization, which represents the integral parameter of pollutant accumulation. In the city and suburbs, the mineralization range of newt spawning ponds was 81-962 mg/dm^3, but for the multistorey building area it was 324-666 mg/dm^3, with an average of 443.6 mg/dm^3 (from 2010 to 2015).

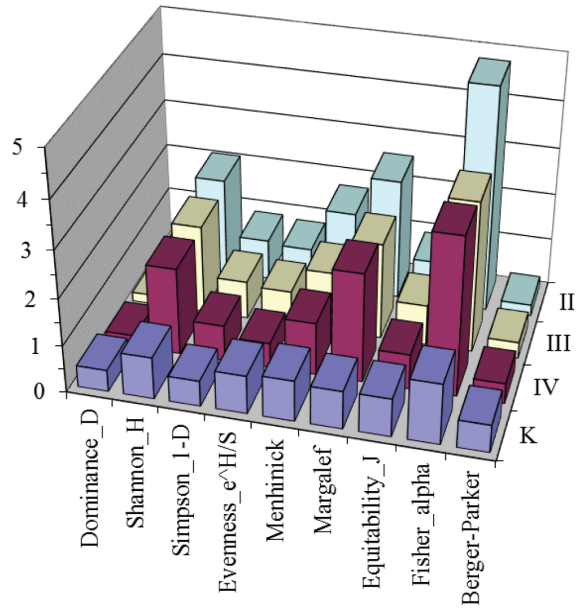
In the urban area, the widest range and frequency of morphological anomalies were noted. The range and frequency of morphological anomalies in juveniles was significantly poorer than in adult newts. However, the range and deviant form frequency in residential areas increases. In adults, the range and frequency of morphological anomalies compared with juveniles increases: urban areas also have the highest deviation rate in juveniles and the richest spectrum of anomalies. This pattern clearly reflects in changes in the biodiversity indices (Figure 1).

Some of the specimens can simultaneously carry joint abnormalities, like syndactyly and polydactyly, pigment deviation and tumors. Acting as a traumatic factor, the bivalve mollusc *Sphaerium sp*. can accidentally injure the fingers of adult newts during feeding (the injury can lead to abnormal regeneration with the presence of pollution; Figure 2).

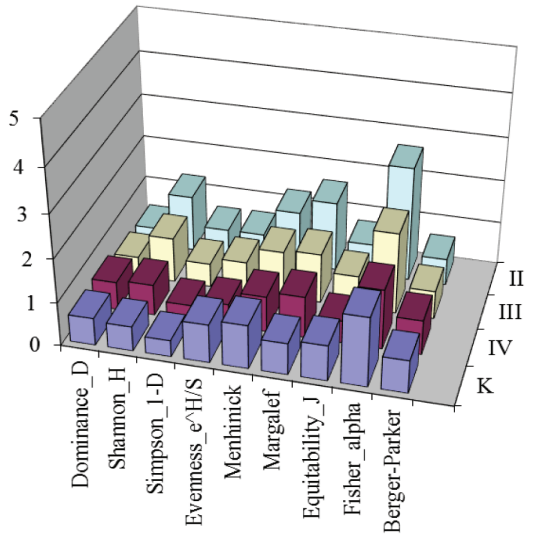
The spectra of morphological abnormalities in the European and Asian parts of the area are close to 42.8% - 9 abnormalities are common. In the European populations observed, 11 abnormalities are present which are not found in populations of *L. vulgaris* in Asia: depigmentation of the iris, skull deformation, albinism, melanism, polimely, amely, skinfold finger, thickening of phalanges, brachydactyly, bifurcation of the tail and neoteny. In turn, in Asian populations six abnormalities not mentioned in the literature on Europe were found: ceratobranhyale, hernia, tumors, ectromely, taumely and oligodactily.

4. Conclusion

The high rate of anomaly variants in adult smooth newts compared with juveniles may be caused by abnormal regeneration and the accumulation of the results of this



a



b

Figure 1: Assessment of the spectrum and frequency of anomalies by biodiversity indexes (II – multi-storey building, III – low-storey building, IV – forest park, K – forest; a - juveniles, b – adults).

in the presence of environmental pollution. The distribution and frequency of external morphological abnormalities increase along a gradient of urbanization due to the accumulation of developmental abnormalities and regeneration caused by pollution

Figure 2: Smooth newt injured by *Sphaerium* sp.

and urban environment destabilization. A number of unique morphological abnormalities were discovered in the Asian habitats of *L. vulgaris*. The deviation spectra in the European part is considerably higher than in the Asian part (11 unique variants versus 6, respectively).

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