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# Occurrence of Amphibian Deformities along the Hungarian Section of the River Danube, Tisza and Ipoly

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**Summary:** Amphibian deformities were studied along the Hungarian section of the River Danube and two tributaries, the River Tisza and Ipoly, between 1994 and 2001. The health conditions of approximately 50,000 adults and juveniles were checked. Amphibian deformities have been recorded along all three investigated rivers. Altogether nine deformity types have been found, the highest diversity of amphibian deformities being recorded in the Danubian floodplain. Ectrodactyly and ectromely were the commonest malformations. Both *Caudata* and *Anura* species showed deformities. The most diverse deformity types were found in the fire-bellied toad, *Bombina bombina*. Mass deformity (*Bombina bombina*: 71%, *Rana esculenta* complex: 32%) also occurred along the investigated river stretches, on the Danubian floodplain in the Gemenc Region of the Danube Dráva National Park. Ninety-six per cent of the deformities were present on the hind legs, which points to environmental causes. The occurrence of multiple deformities was also very high in comparison with the literature. Mass deformities were only recorded when the Danube flooded the area.

**Zusammenfassung:** Zwischen den Jahren 1994 und 2001 haben wir im ungarischen Dunauabschnitt und an ihren Nebenflüssen, entlang der Theiss und der Eipel, um das Vorkommen der Entwicklungsanomalien der Amphibien feststellen zu können, entsprechende Forschungen durchgeführt. Wir haben den Gesundheitszustand von etwa 50 000 Amphibien kontrolliert. Entwicklungsanomalien sind bei den Amphibien entlang aller drei untersuchten Flüsse vorgekommen. Es konnten insgesamt neun Entwicklungsanomalientypen registriert werden. Die Zusammensetzung der Entwicklungsanomalien war im Inundationsgebiet der Donau mannigfalstigsten. Hier konnten wir sieben verschiedene Typen wahrnehmen. Die häufigsten Entwicklungsanomalien waren Ectrodactylia und Ectromelia. Die Caudata- und Anura-Arten haben ebenfalls Anomalien aufgewiesen. Die meisten Deformitätstypen konnten bei den rotbä

uchigen Unken (*Bombina bombina*) wahrgenommen werden. Wir haben auch das Vorkommen einer massenhaften Entwicklungsanomalien (*Bombina bombina*: 71%, *Rana esculenta*-Komplex: 32%) entlang der untersuchten Flussabschnitten, ferner im Inundationsgebiet der Donau in der Gemencer Aulandschaft des Donau-Drau-Nationalparkes registriert. 96% der Entwicklungsanomalien zeigte sich am hinteren Bein, was auf die Wirkung der Umweltfaktoren hinweist. Das Vorkommen der mehrfachen Anomalien war - im Vergleich der Fachliteratur beschriebenen Werte - ebenfals sehr hoch. Das Vorkommen der Anomalie über den Grenzwert konnte erst dann konstatiert werden, falls die Donau das Untersuchungsgebiet überschwommen hat.

Key words: amphibian deformity, River Danube, Tisza, Ipoly

## Introduction

Amphibians are good indicators of environmental changes (KHANGAROT, 1985) due to their bi-phasic life cycle, sophisticated development and moderate migration capacity. As their skin is semi-permeable, water-soluble substances, including pollutants, can easily enter their body (QUELLET et al., 1997). As a consequence, the occurrence of deformities is especially common in species, which lay their eggs in water, and the tadpoles develop in the same medium. Deformities decrease survival rate, affect swimming performance, foraging, and fleeing abilities. Only a very low proportion of deformed amphibians reach maturity as they are caught more frequently by predators than healthy ones (QUELLET, 1999), which leads to different frequency rates in different cohorts.

Amphibian deformities also occur naturally, but in the last two decades of the twentieth century mass deformity events, when the deformity rate was over 5%, were recorded more and more frequently. In most cases the causing agents were difficult to identify because of the time lag in the discovery of deformities, and the possibility of multiple causes (JOHNSON et al., 2001). However, the deformity rate of newly metamorphosed amphibians can be a useful tool in the evaluation of ecosystem health in general, and the detection of water-borne pollution events (QUELLET et al., 1997).

Amphibian decline is an international phenomenon and occurs in Europe (GRIFFITHS and BEEBEE, 1992), and has also been proved to occur in Hungary (SCHÁD et. al., 1999). The increased deformity frequency can be a

part of this process, as many deformities lead to the death of the amphibians at an early stage of development (QUELLET, 1999). It is especially important due to the internationally protected status of Hungarian amphibians (COUNCIL OF EUROPE, 1998; IUCN, 1996). However, the study of amphibian deformities is not in the focus of environmental research projects in Europe. In Hungary, for example, the earlier literature contains only one description of a deformed amphibian, a *Rana esculenta* individual with five legs (DELY, 1960). This paper summarises amphibian deformity types, the species involved and the deformity frequencies occurring along the River Danube, and two of its large tributaries; the Rivers Tisza and Ipoly, in Hungary.

## Materials and Methods

Two sampling strategies were applied according to the age of the investigated animals. Adult amphibians were mainly examined during their peak activity period; the spring breeding season, when they migrated from land to water, but animals found later were also checked for deformities. The study of adult animals was especially important with newts, which have the ability to develop deformities which heal even after metamorphosis has finished (SCADDING, 1981). Juveniles were primarily studied in September, after they had finished their dispersal because of other considerations, e.g. abundance estimations. In addition to health conditions, the growth characteristics of common species were also recorded for further comparison between deformed and healthy individuals (PUKY, 2000). Length was measured with a spring balance, and weight with a KERN 462-41 digital scales.

Danubian sampling was mainly focussed on the Gemenc Region of the Danube - Dráva National Park, where amphibian monitoring has been carried out since autumn, 1997 (PUKY, 2000). Along the River Tisza, twenty-five sampling sites, primarily oxbow lakes, were selected for monitoring in 2000. Sampling along the River Ipoly was based on the fifteen-year data set on migrating amphibians of the Drégelypalánk - Hont floodplain section, which was started in 1987 (PUKY et al., 1990). Other data sets, e.g. the national amphibian and reptile database (PUKY et al. 2001), were also used to obtain further data. Altogether nearly 50,000 amphibians were checked for deformities along the three investigated rivers.

Data was collected on standardised questionnaires, the most important species and habitats were also documented by photography.

## Results and Discussion

Amphibian deformities have been recorded along all three investigated rivers. Deformity types, their description and geographical distribution can be seen in Table 1. In general, reductive malformations predominated. Ectrodactyly, ectromely and unilateral anophthalmia were also found along the River Danube, Tisza and Ipoly. These deformities can also be caused by traumatic events. Amphibian deformities were the most diverse in the Danubian floodplain, where seven types were recorded, while only three deformity types were found along the River Tisza.

Table 1. Occurrence of amphibian deformity types along the River Danube, Tisza and Ipoly.

| Type of deformity | Characterisation | River Danube | River Tisza | River Ipoly |
|---|---|---|---|---|
| Ectrodactyly | total or partial absence of toe(s) | X | X | X |
| Ectromely | total or partial absence of limb(s) | X | X | X |
| Unilateral anophthalmia | missing eye | X | X | X |
| Syndactyly | total or partial fusion of toes | X | | |
| Synmely | total or partial fusion of limbs | X | | |
| Clinomely | curvature of limb(s) | X | | |
| Polymely | supernumerary limb(s) | | | X |
| Polydactyly | supernumerary toes(s) | X | | |
| Tail deformity | reductive deformity of the tail | | | X |

Similarly to their geographical distribution, the same three deformity types were the most frequent when the number of species was taken into consideration (Table 2.). Ectromely was found in the highest number of species (7), followed by ectrodactyly (6), and unilateral anophthalmia (4).

The temporal analysis of the data based on the occurrence of the deformities in the years studied resulted in the same conclusions. Ectromely was continuously detected from 1995 to 2001, unilateral anophthalmia in six years, ectrodactyly in five years, while with the exception of clinomely, the other deformity types were restricted to one year.

Table 2. Detection year and species specificity of amphibian deformity types along the River Danube, Tisza and Ipoly.

| Type of deformity | Species | Year |
|---|---|---|
| Ectromely | *Triturus vulgaris, Bufo bufo, Bombina bombina, Pelobates fuscus, Rana arvalis, Rana dalmatina, Rana esculenta* complex | 1995, 1996, 1997, 1998, 1999, 2000, 2001 |
| Ectrodactyly | *Triturus vulgaris, Bufo bufo, Bombina bombina, Pelobates fuscus, Rana arvalis, Rana dalmatina, Rana esculenta* complex | 1997, 1998, 1999, 2000, 2001 |
| Unilateral anophthalmia | *Bufo bufo, Bombina bombina, Pelobates fuscus, Rana esculenta* complex | 1994, 1995, 1997, 1998, 1999, 2000, 2001 |
| Syndactyly | *Bombina bombina* | 1999 |
| Synmely | *Bombina bombina* | 1999 |
| Clinomely | *Bombina bombina, Rana esculenta* complex | 1999, 2000, 2001 |
| Polymely | *Rana esculenta* complex | 1997 |
| Polydactyly | *Bombina bombina* | 1999 |
| Tail deformity | *Triturus vulgaris* | 1997 |

Both *Caudata* and *Anura* species showed deformities. In most species, more than one deformity was detected. The most diverse deformity types were found in *Bombina bombina*, which is a cause of concern as it is listed in the International Red Data Book (IUCN, 1996). The high diversity of deformities in *Rana esculenta* complex is rather due to the fact that it is the commonest amphibian along the investigated floodplains.

In addition to individual cases, mass deformities also occurred along the investigated river stretches on the Danubian floodplain in the Gemenc Region of the Danube Dráva National Park (PUKY, 2000). Indeed, the ratio of deformed amphibians was strikingly high at one site (*Bombina bombina*: 71%, *Rana esculenta* complex: 32%), and also above the 1-2% background value (VERSHININ, 1989; HOPPE, 1999) at other sites in 1999, to a lesser extent it was also higher in the following two years. Ninety-six per cent of the deformities were present on the hind legs (Figure 1), which points to environmental causes because the front legs develop in the branchial chamber, which protects them until the last stages of their development (GOSNER, 1960). It also correlates with the fact that clinomely was present in the area from 1999 to 2001, as this deformity was always described as the result of altering normal developmental pathways (GARDINER and HOPPE, 1999). Deformities were found in similar numbers on the both sides of the body, but the occurrence of multiple deformities was very high in comparison to the literature, as so far only one or two such cases have been reported (QUELLET et al., 1997; SESSION and RUTH, 1990).

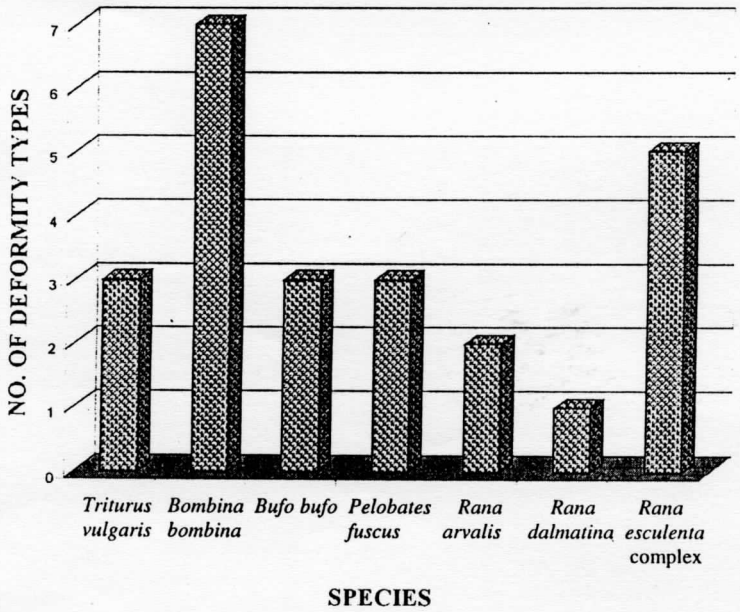


Figure 1. Number of recorded deformity types at different amphibian species.

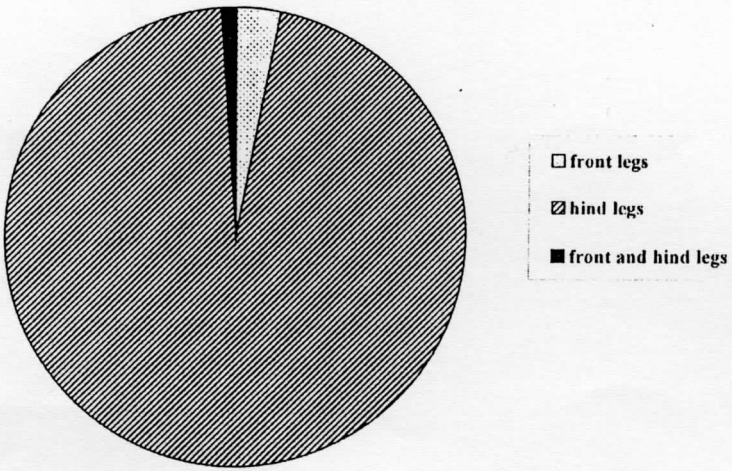


Figure 2. Distribution of *Bombina bombina* leg deformities at Bundá s Hókony, Gemenc, Hungary.

The analysis of the deformity types, species included, and habitat characteristics revealed four possible causes (extremely high tadpole density, high water temperature, pesticides, and bacterial infection). Average monthly temperatures, however, did not differ significantly between 1997 and 2001, and several other factors (e.g. industrial pollution, and increased UV-B radiation) cannot completely be excluded. Deformities were only recorded when the Danube flooded the area, which emphasises the importance of the medium in the process. It also stresses the importance of further studies on amphibian deformities in floodplains.

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