Long-term changes in the clutch number of a *Rana dalmatina* population at the Danubian floodplain at Göd, north of Budapest, Hungary

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Introduction

Floodplains are vital habitats and corridors for many species, such as amphibians (ROBINSON et al. 2002, VADINEANU et al. 1998). However, little is known on the survival and stability of such populations and the effect of hydrological changes even if there is a clear need for such information from an ecological as well as a conservational viewpoint, due to the overall importance of this landscape element. Amphibian species richness in floodplains can vary according to levels of disturbance induced by flood events (MORAND & JOLY, 1995). Man-made water bodies near floodplains providing stable breeding sites might be important to maintain populations if the floodplain has good quality terrestrial habitats and offers opportunities to spread over other areas during floods.

Amphibian decline is a world-wide phenomenon currently including at least 32% of all species according to IUCN estimates (IUCN et al., 2004). *Rana dalmatina* is a European species listed in the Bern Convention and the Habitat Directive as well as in different national legislations. It is especially vulnerable to threats at its breeding sites caused by e.g. pesticides and fertilisers (WEDERKINCH, 1988) and is known to be more sensitive to water chemistry changes e.g. to lowering of the pH than are the closely related *Rana arvalis* and *Rana temporaria* (ANDRÉN & NILSON, 1988). In Hungary its presence is highly connected to both deciduous and mixed forests or, in some areas such as the eastern, lowland part of Hungary, to riparian corridors, so the latter are important habitats for the survival and spread of this species. Along the middle section of the Danube it is present as a concomitant species (PUKY, 2000).

The dynamics of a *Rana dalmatina* population in a locally protected but anthropogenically influenced habitat at the floodplain of the River Danube at Göd was followed since 1992. The possible effects of water level fluctuations and water chemistry on the dynamics of this population and its management implications are discussed in this article.

Site and methods

The sampling site included five cascading ponds next to the floodplain of the Danube, with the source approximately 60 metres from the main arm situated at the Hungarian Danube Research Station in a locally protected reserve, 20 km north of Budapest, surrounded by the floodplain to the west and a town called Göd on the three other sides. As such, it is isolated from other *Rana dalmatina* breeding sites apart from those that might develop under favourable hydrological conditions in the neighbouring floodplain. The ponds are fed by subterranean seepage from gravel terraces situated above the level of the Danube. In earlier investigations, it was established that their total salt content was higher than in the Danube, and dominated by Ca^{2+} and HCO^{3-} ions; the pH variation was 7.6 - 8.4 over three years (DVIHALLY & KOZMA, 1966). There is a slight but negligible current in the ponds because most of their water originates from a spring. General pollution sources reaching the ponds (e.g. from households) cannot be excluded. Parallel with the recording of the number and

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distribution of *Rana dalmatina* egg clutches as an indicator of the number of females reproducing in the given year, water level fluctuations of the River Danube were expressed as the number of days with water cover on the neighbouring floodplain and the highest water level in the 1.5 months preceeding spawning over more than a decade. Water chemistry measurements were also carried out in 2005 and 2006. Temperature, dissolved oxygen concentration, conductivity and pH were measured with a portable WTW Multiline P4 meter. Nitrate, phosphate and ammonia content of the filtered water (pore size 0,45 μm) were determined with an Anthelie spectrophotometer. Nitrate was measured by the salicylate method, phosphate by the ammonium molybdate method according to FELFÖLDY (1987), ammonia according to ISO 7150-1. Chlorophyll-a was extracted from the sample retained on glass fiber filters, using hot methanol. The chlorophyll-a concentration was calculated from the absorbance values at 747, 666 and 653 nm. Because the test of normality (Kolmogorov-Smirnov test) of the hydrological data was negative at p=0.05, Spearman rank order correlation was used to statistically evaluate the results.

Results

The analysis of the individual number of egg clutches indicating the number of reproducing *Rana dalmatina* females breeding in the pond system was not significantly affected by hydrological changes of the River Danube. No significant difference was found related to either the maximal water level (df= 9, r= 0.491, p= 0.149 or the length of water cover (df= 9, r= 0.603, p= 0.064) in the floodplain during the preceeding 1.5 months and the number of egg clutches during the period of study, i.e. eleven years (Figure 1. and 2.).

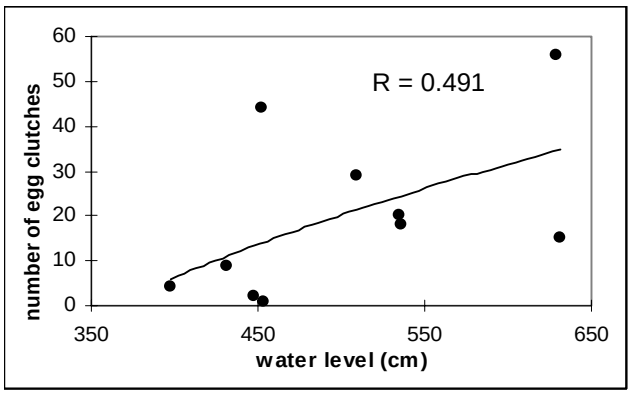

Figure 1. Relationship between the number of *Rana dalmatina* egg clutches and the maximal water level at Göd during 1.5 months preceeding spawning

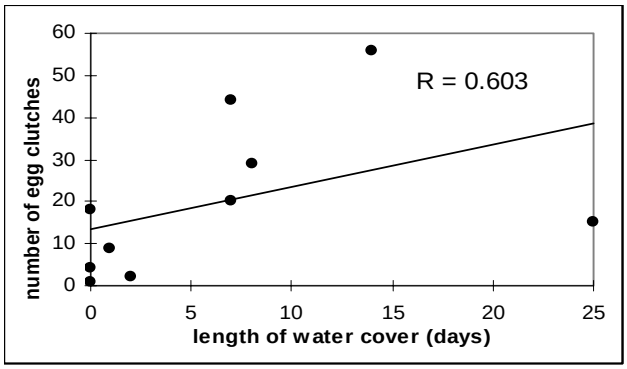

Figure 2. Relationship between the number of *Rana dalmatina* egg clutches and the number of days with water cover over the floodplain at Göd during 1.5 months preceeding spawning

There was a characteristic difference between the water quality of the River Danube and the investigated pond series (Table 1.). From among the investigated parameters the oxygen content considerably varied between the ponds. Ponds with the highest oxygen content had the highest number of egg clutches.

Table 1. Characteristic water chemistry parameters of the investigated ponds and the River Danube at Göd at the time of *Rana dalmatina* spawning in 2006

	T	Conductivity	DO	O_2 saturation	PO_4-P	NH_4-N	NO_3-N	Chlorophyll-a	pH
	^{0}C	mS/cm	mg/l	%	mg/m^3	mg/l	mg/l	mg/m^3	
Pond No. 1.	8.5	1521	17.83	155	13.77	0.59	25.8	14.9	7.66
Pond No. 2.	7.7-8.3	1474-1498	8.5-10.7	72-92	13.0-15.5	0.05-0.15	20.1-23.7	3.8-12.6	7.66-7.74
Pond No. 3.	7.2-7.7	1476-1506	9.7-12.5	82-105	10.3-32.8	0.05-0.08	18.0-19.0	3.6-95.8	7.71-7.73
Pond No. 4.	6.3-7.5	1424-1481	16.4-19.3	138-159	7.8-14.0	0.05-0.09	15.9-16.5	4.4-32.0	7.83-8.03
Pond No. 5.	7.0-8.6	1424-1431	14.3-17.7	120-154	8.7-9.0	0.05-0.07	14.7-15.4	17.4-144.9	7.95-8.08
River Danube	7.2	410	10.4	80.3	63.32	0.11	2.86	16.56	8.5

Discussion

Rana dalmatina is known to have an opportunistic breeding strategy and lays its egg clutches into diverse water bodies (ARNOLD, 2002). However, at the site studied neither the water cover over the floodplain nor the availability of alternative water bodies significantly influenced the number of egg clutches laid either in a positive (when there is a flood more females spawn in the ponds usually unaffected by the water level fluctuation of the Danube) or in a negative (when there is a flood females leave the ponds and spawn in water bodies available in the floodplain) way. This is in harmony with the conclusions of PAVIGNANO et al. (1990) stating that breeding success is influenced by four factors, the age of the water, its macrophyte cover, the quality of the surrounding terrestrial habitats and human disturbance. In these respects the ponds studied provide a stable environment with relatively moderate human disturbance. *Rana dalmatina* is known to lay its eggs on different substrates but if there is an opportunity, it prefers the stems and leaves of *Glyceria maxima* (KECSKÉS & PUKY, 1992). However, in the ponds studied, reeds and different weeds, also branches fallen into the water, were used for such purposes. Another important factor for this species is the presence of forests, and the number of its eggs exponentially decreases with distance (WEDERKINCH, 1988) and most egg clutches are within 300 metres of the nearest forested patch even under floodplain conditions (PONSERO & JOLY, 1998). In this respect there was no difference between the (forested) floodplain and the park around the ponds.

Similarly to other studies, where e.g. the nitrogen and phosphorus forms affect the presence of Ranid species (HOULAHAN & FINDLAY, 2003), the water chemical parameters of the breeding ponds, particularly the oxygen content of the water slightly influenced the distribution of the clutches within the pond system but the population size remained stable and no decline has been recorded. Consequently, such small-scale aquatic systems can be beneficial for floodplain amphibians long-term even if due to their size their buffer capacity is limited and thus, they can play a role in the maintenance and restoration of floodplain fauna. Just as in other regions such as North America (STEVENS et al., 2002), small wetland restoration projects may be beneficial for the biodiversity and conservation of anurans such as *Rana dalmatina* also in the Danubian floodplain especially as drought, a primary factor of low juvenile production (PETRANKA et al., 2003) can be avoided at such sites. Besides, at a regional level, such ponds may contribute significantly to biodiversity, supporting considerably more species, more unique species and more scarce species than other waterbody types from several groups such as macrophytes and macroinvertebrates (WILLIAMS

et al., 2003). As several studies have shown (e.g. JANSEN & HEALEY, 2003) there were clear relationships between frog communities and riverine wetland conditions, thus studying amphibians in them also gives an indication of the overall status of these habitats.

Summary

The dynamics of a *Rana dalmatina* population in a locally protected but anthropogenically influenced habitat at the floodplain of the Danube at Göd was followed since 1992. The sampling site included five cascading ponds fed by seepage next to the floodplain of the Danube, approximately 60 metres from the main arm. The individual number of reproducing *Rana dalmatina* females was not significantly affected by either the maximal water level or the duration of water cover in the floodplain during the preceding 1.5 months. Water chemical parameters of the breeding ponds, namely the oxygen content of the water, slightly influenced the distribution of the clutches within the pond system but the population size remained stable. Consequently, such small-scale aquatic systems can be beneficial for floodplain amphibians long-term and thus, they can play a role in the maintenance and restoration of floodplain fauna.

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