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First record of the egg cannibalism in tadpoles of *Bufotes viridis* complex (Anura: Bufonidae) from Croatia

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Abstract. In the present paper we recorded the first observation of egg cannibalism of high developed tadpoles of *Bufotes viridis* complex from the island of Krk, Croatia. The main point of the food interests of observed tadpoles were the newly laid strings of eggs. As a main reason of the observed cannibalistic oophagy we discuss the type of the habitat and the high density of tadpoles.

Key words: cannibalism, the Green Toads complex, competition, ephemeral breeding sites, Balkan Peninsula.

Cannibalism (intraspecific predation) is widespread feeding strategy of many animal species, which influences the competitive interactions amongst individuals of the same species, population dynamics, density, demographic structure and life cycles of animals. Therefore, it becomes one of the most important factors in animal ecology (Polis & Myers 1985). As one of the possible long-lasting or short life strategy, the cannibalism was proved in more than 1300 animal species (Polis 1981), including more than 100 species of amphibians and reptiles (Polis & Myers 1985). As for autochthons amphibians species of western Palearctic, the cannibalistic behavior was observed e.g. in *Salamandra salamandra*, *Triturus cristatus*, *Bufo bufo*, *Hyla arborea*, *H. intermedia*, *Pelophylax ridibundus, P. lessonae*, *Rana arvalis*, *R. temporaria*, which devoured each other in various combinations of their ontogeny: it occurs in most cases in combinations of adult/juvenile, but also tadpole/tadpole or tadpole/egg are not the exception (Eibl-Eibesfeldt 1951, Juszczyk 1987, Baruš & Oliva 1992, Covaciu-Marcov et al. 2005, Çiçek & Mermer 2006, Grant & Halliday 2011). The advantages, resulting from the interactions amongst tadpole/tadpole or tadpole/egg of one species, can particularly occur if the population density of individuals is in the periodic breeding sites very high (cf. Crump 1983, Dayton & Wapo 2002). The cannibalistic oophagy is not thus a rare phenomenon amongst anurans (Crump 1992, Gunzburger & Travis 2005) and from the Bufonidae it was observed e.g. at species *Anaxyrus americanus* (Hamel 2009).

The species complex of the green toads is well known and widely distributed group of frogs to be found in Europe, Asia and Northern Africa [in the south-eastern part of Europe, two morphologically hardly recognizable species are found - *Bufotes viridis* (Laurenti, 1768) and *B. variabilis* (Pallas, 1769), whose exact borders of distribution still remain unknown; sensu Stöck et al. 2006]. It is also found on the majority of large Mediterranean islands, including numerous Croatian ones as well (Bruno 1980, Tóth et al. 2006). The trophic spectrum of juvenile and adult individuals of *B. viridis* complex is consisted particularly of small invertebrates. Tadpoles eat various organic materials (e.g. phytoplankton) and they are mostly omnivores (Opatrný 1992). In these frogs, the cannibalism is observed as well, as it is in relation to adult/juvenile (Freislin 1948, Chonjakina 1973). From the recent past there exists a record of cannibalistic behaviour of tadpoles from this species, bigger individuals eat smaller ones (Kovács & Sas 2009). Whether we are well informed, the egg cannibalism (oophagy) in tadpoles of these frogs has not been published.

During field work (25th May 2012) on the Krk island (Kvarner Gulf, North Adriatic Sea, Croatia) we observed the biotope of periodic, artificially created, oligotrophic water reservoir of round shape (overall diameter approx. 4 m), which had served as an occasional watering place for local cattle (Fig. 1). The locality is 800 m far from the south-eastern direction from the Stara Baška village (44.9501° N 14.7005° E, 25 m a.s.l.). The slowly drying reservoir consisted particularly of dense vegetation of *Batrachium* sp., where the clutches of *B. viridis* complex had been laid. The observed density of tadpoles in the reservoir was relatively high (exact quantity of tadpoles had not been investigated), with a size variety from just hatched individuals to the others to be close to the metamorphosis (stage 21-40 according to Gosner 1960). We also recorded metamorphosed juvenile individuals and in the same time a few pairs of these toads in amplexus during egg laying. These newly laid strings of eggs were of specific food interest of observed tadpoles (see Fig. 2AB). We observed the tadpoles eating both eggs and exterior gelatinous layers. They did not make any groups, but were observed individually. As for these individuals, they were in the stage of the high develop (before metamorphosis) with already developed rudiments of their lower limbs in a total body length of about 35 mm. Regarding smaller individuals, we also observed the round injuries on the dorsal part of their body. Nonetheless we cannot prove the intraspecific predation of tadpoles, as their reciprocal interactions amongst active tadpoles had not been observed. The other potential predators such as an individual of Odonata, *Dytiscus* spp., an introduced fish *Gambusia affinis*, which can be the significant predator of eggs and tadpoles of amphibians (cf. e.g. Komak & Crossland 2000, Baber & Babbitt 2003, Zeiber et al. 2008), were not observed. Also some species of amphibians (e.g. *P. ridibundus*) can also be considered a predator, but none of them were observed on the locality as well.

As a main reason of the observed cannibalistic oophagy we can consider the type of the habitat (the periodically drying water reservoir) and the high density of tadpoles from a *B. viridis* complex. Therefore, the strategy at these conditions

Figure 1. Breeding site of observed *Bufotes viridis* complex. Photograph by Petr Vlček.

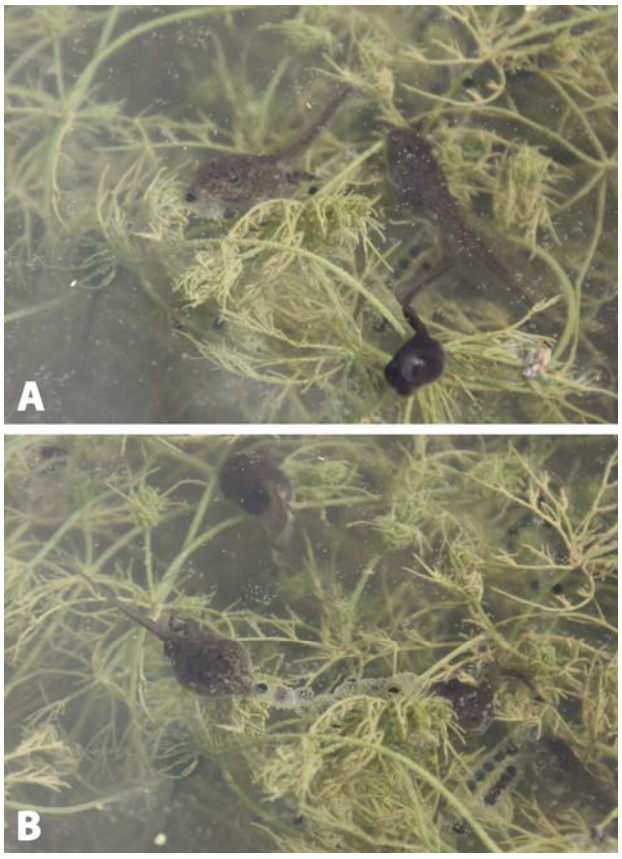

Figure 2AB. Cannibalistic oophagy in tadpoles of *B. viridis* complex. Photograph by Petr Vlček.

can be very profitable, because: (i) it decreases the competition amongst individuals, (ii) it facilitates the access to source and increases the amount of potential food, (iii) it increases chances to survive by shortening time to the metamorphosis in the environs with limited period of existence (e.g. ephemeral breeding sites; Heinen & Abdella 2005). The similar conclusions of observation based on the drying breeding sites/cannibalism were proven by any other authors as well (see e.g. Kovács & Sas 2009, Grant & Halliday 2011, Jablonski & Vlček 2012). Our piece of knowledge thus supports an assumption that various cannibalistic interactions of amphibians are broadly extended in nature (Polis & Myers 1985) and also increases the knowledge concerning feeding biology of these frogs.

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