

## Puffing up as a defensive reaction of the yellow-bellied toad *Bombina variegata*

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Amphibians have evolved a wide range of adaptations to minimise the risk of predator attack, including aposematic colouration. It is generally accepted that predators receive advance warning of apparent toxicity when potential prey items present bright and contrasting colours (Vitt & Caldwell, 2014). This is in line with the hypothesis of venom optimization (Wigger et al., 2002), according to which the successful deterrence of a predator may not require the use of venoms or poisons. These consist of hundreds of protein and non-proteinaceous compounds, and their production comes at a high metabolic cost. As a result, adaptations have evolved to minimise toxin expenditure, for example by behavioural control (Morgenstern & King, 2013).

A well-known way of displaying aposematic colouration is the unken reflex, first described in amphibians of the genus *Bombina*, but also demonstrated in other amphibians, including newts and salamanders (Löhner, 1919 as cited in Telea et al., 2021). This reflex involves arching the body, presenting the undersides of the brightly coloured limbs and partially exposing the ventral surface, while at the same time remaining still and closing the eyes. In addition to the full unken reflex, there may be a partial reflex, with markedly less flexion. Then, the limbs are detached from the ground so as to display the brightly coloured side, and the eyes are open. Both *Bombina bombina* and *Bombina variegata*, are found in Poland and both exhibit this reflex. Besides the unken reflex, *Bombina* toads may also react to a threat by immobilising, running away or inflating their bodies. The last of these reactions has apparently not been reported previously in *B. variegata* and has been suggested as a feature that distinguishes this species from *B. bombina* (Bajger, 1980).

On 15 August 2008 in the village of Makowa (southern Poland; GPS 49° 38'33.85" N, 22° 40'24.55" E), I approached a *B. variegata* standing on the flat edge of a small puddle, near the waterline of a shallow stream. As I approached the toad, it first became motionless (this lasted for about 30 seconds), then it jumped into the stream, at the same time turned over on to its back and inflated its body (Fig. 1). It remained perfectly still in this position for almost 5 minutes, after which it deflated, returned to its 'normal' shape and calmly moved away. The locality of this observation lies well to the south of the known distribution of *B. bombina* thus the individual observed must be *B. variegata*. The observation shows that, in exceptional situations, *B. variegata* may use the antipredator defensive strategy of flipping over onto its back and puffing up its body. This makes it visually larger and more difficult for predators to overpower and swallow. Also, the fact that the



Figure 1. Puffed up body of *Bombina variegata*

bright colouration of *Bombina* covers the entire underparts and not just the legs and body margins suggests that it plays an important role in defensive behaviour.

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