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Effects of a glyphosate-based herbicide on the development of Common toads (Bufo bufo L.; Amphibia) at different temperatures

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Herbicides based on the active ingredient glyphosate are frequently applied in agriculture, horticulture and private gardens all over the world. Recently, leaching of glyphosate or its metabolite (AMPA) into water bodies inhabited by amphibians has been reported. However, very little is known about non-target effects of these herbicides on amphibians and even less is known to what extent different temperatures might alter these effects. Using climate chambers, we investigated the effects of the glyphosate-based herbicide Roundup PowerFlex® (480 g L-1 glyphosate, formulated as 588 g L-1 potassium salt) on the larval development of Common toads (Bufo bufo L.; Amphibia: Anura) under different temperature regimes (15°C vs. 20°C). We established five herbicide concentrations: 0, 1.5, 3, 4 mg acid equivalent L-1 and a 4 mg a.e. L-1 pulse treatment (totally three applications of 1.5, 1.5 and another 1 mg a.e. L-1) at each temperature in a full-factorial design. Each treatment combination was replicated five times, the experiment ran for 24 days. Results showed a highly significant effect of temperature on body length and body width but no effect of herbicide concentration on these growth parameters. Moreover, highly significant interactions between herbicide and temperature on body length and body width were observed suggesting that herbicides had different effects on different temperatures. In conclusion, although Roundup PowerFlex® at the tested concentrations appeared to have no acute toxicity to larvae of Common toads, the observed effects on tadpole morphology will potentially affect competitive interactions in spawning ponds of amphibia. Our findings of herbicide x temperature interactions might become more prevalent when human-induced climate change will lead to more extreme temperatures.