Endocrine disruption affects the physiological ontogeny of a wide-spread European anuran

Katharina Ruthsatz¹, Kathrin H. Dausmann¹, Myron A. Peck² and Julian Glos¹

⁠¹ Institute of Zoology, University of Hamburg, Martin Luther-King Platz 3, 20146 Hamburg, Germany
⁠² Institute of Hydrobiology and Fisheries Science, University of Hamburg, Olbersweg 24, 22767 Hamburg, Germany

Contact information
E-mail: katharina.ruthsatz@uni-hamburg.de
Homepage: www.katharinaruthsatz.com

Objectives
1. Do altered thyroid hormone (TH) levels as caused by the endocrine-disruptive effect of environmental stressors affect the ontogeny of physiological traits in *Rana temporaria*?
2. Do effects of endocrine disruption during larval stage persist across the metamorphic boundary?

Conclusions
1. Altered TH levels significantly affected age, size, and energetics at all developmental stages throughout ontogeny.
2. Endocrine disruption during larval stage leads to carry-over effects in metabolism and energy storages in froglets of *Rana temporaria*.

---

**Fig. 1:** Environmental stressors in the larval habitat of anuran larvae affecting metamorphosis and energetics by influencing endogenous thyroid hormones (TH). Blue symbols: stressors acting as endocrine disruptors inhibiting TH production pathways resulting in low endogenous TH levels. Green symbols: stressors increasing TH production by the activation of the neuroendocrine stress axis. A Household chemicals and pharmaceuticals: Artificial steroid hormones (testosterone) and hormonal contraceptives, analgetic agents (e.g., ibuprofen, diclofenac), chemicals from sunscreen, microplastics and bisphenol A (BPA) from packaging and clothes, phosphates from washing agents. B Byproducts of Industry (persistent organic products), aerospace, and fireworks. C Chemicals from agriculture: fertilizer (NO₃⁻), herbicides, pesticides (e.g., Atrazine, Glyphosate, Malathion). D Habitat fragmentation and road salt. E Biotic stressors: food availability, competition (i.e. crowding), predator pressure. F Climatic stressors: UV-radiation, temperature variation, precipitation and desiccation risk.

---

**-55%**

Significant differences in heart rate might reduce long-term survival due to heart failure or insufficient cardiac output.

**-51%**

Due to effects on developmental, growth, and metabolic rate, endocrine disruption leads to immense size differences.

**+147%**

Endocrine disruption during metamorphosis lead to carry-over effects on internal energy reserves.

**+54%**

An altered metabolic rate might affect the capacity for gaining energy reserves and thus, growth compensation.

**-39%**

FAT