Description for the general public

Opposite to mammals and birds cold-blooded vertebrates, like for example reptiles, are not able to physiologically maintain body temperature at optimal level, instead their body temperature is determined by ambient conditions. In consequence, such a thermal dependence of cold-blooded animals (ectotherms) is ubiquitous for many biological features, like growth rate, food intake, metabolism, digestion, all of which increase with higher temperature. So far, research has mainly addressed this temperature dependence by oversimplification and performing experiments at constant temperatures that do not reflect the natural variation found in nature. Likewise, complex daily temperature profiles are generally oversimplified and many scientific conclusions are based on crude daily averages not taking into account thresholds in in terms of temperatures or exposure length. This research aims at investigating temperature as a resource that limits animal performance through both, threshold temperatures and time of exposure to the optimal temperature above such threshold by employing the **thermal window concept**. In other words, we determined in pilot studies and based on literature optimal temperatures for our species of interest, the grass snake (*Natrix natrix*), and within the here proposed research will now manipulate the duration of exposure to the pre-determined optimal temperature. **This thermal window approach will enable us to investigate how ectothermic organisms adjust their physiology to manipulated length of time the temperature is optimal and biological processes are most efficient**.

This novel thermal window manipulation is employed to provide cutting-edge insights on the overall whole animal energy budget in terms of its costs and benefits. Oxygen uptake is necessary to produce energy, yet oxygen-based metabolism also entails a cost, namely the production of free radicals. Such free radicals are an unavoidable by-products of oxidative metabolism - the main pathway to generate biochemical energy – and they cause damages to virtual all biological structures including DNA. In our project we will study how the length of the thermal window in a day-to-day and also in a seasonal context (determined by hibernation duration) determine the use of energy and the associated oxidative costs. We will investigate how snakes adjust their energy use within and outside the thermal window and also over a 24-hour period and whether the employed strategy of energy use causes shifts in generation of oxidative damage in dependence of thermal window length (Experiment I). On the annual scale, we will investigate if the length of hibernation affects energy use of dormant snakes and the increase of metabolism during „awakening" from hibernation (Experiment II a). Subsequently, we will determine if snakes show compensation processes in the amount of energy used and the associated oxidative costs between the hibernation and the post-hibernation period, again in response to the length of the thermal window and here determining the dormant state (Experiment II b).

Our study is of special importance in the light of global climatic change. The climatic conditions shape species distribution and viability of populations existing at the edge of species range. At present, the exact causes of distribution range dynamics are poorly understood and our novel thermal window approach will provide novel understanding not only for grass snakes, but rather for all animals that depend on ambient conditions to regulate their body temperature and thus activity windows for reproduction, growth and other activities. Specifically the length of hibernation has so far been largely neglected and provides many unanswered questions and even more questions that have not even been asked.