Environment affects life of living organisms. This statement is widely known from the basic ecology courses. It also constitutes a base for any ecological research worldwide. Yet, studying and understanding of what is this effect about, or how do the organisms sense and react to environmental changes, is extremely difficult. This is why, quite recently, this scientific issue was invoked one of the five greatest challenges of modern science by the leading American scientific journal.

Referring to the specific case study, we still do not understand the mechanisms and the evolutionary causes of existence of the so called **temperature-size rule (TSR)**. According to this very common rule in nature, organisms grow smaller at higher (more favorable) temperature, than in lower (less favorable) temperature. This pattern is puzzling from the evolutionary point of view, because one should expect that in more favorable conditions organisms will grow larger to have more progeny. Unless… there is another, accompanying factor, driving the TSR. Currently, it is suggested that the most promising candidate for this factor is **oxygen availability**. It naturally decreases with increasing temperature, lowering the efficiency of oxygen transport into the **mitochondria**. Body size is supposed to be a simple consequence of decreasing of cell size; the simplest solution enhancing this effectiveness.

Within the presented proposal, I will continue my own studies on this subject. I will focus on (i) determining the conditions, under which organisms react on the changes in thermo-oxygenic conditions through this simplest, plastic mechanism of body size decrease, and (ii) understanding and describing the physiological mechanisms launched beyond this "comfort thermal range". Physiological mechanisms will be studied on the level of mitochondrial response. Mitochondria constitute a unique structure in this context – they have a dual role of sensing the oxygen availability in the environment, and responding to the possible changes to prevent the negative effects of oxygen deficiency. Additionally, all the results will be referred to fitness. It will enable an evolutionary context by informing whether the mechanisms launched by a given organism positively affect the number of future progeny, or they constitute the so-called developmental noise, not bringing the direct evolutionary reward.

In the scientific attitude I apply in this proposal I will for the first time link all the stages of the organismal response to thermo-oxygenic stress, from phenotypic, through physiological, to fitness response. Such an approach enables an exhaustive answer on the mechanisms and evolutionary significance of TSR, and also on the alternative, physiological processes. This knowledge will make it possible to understand the effect of temperature and oxygen on living organisms, making us closer to answering the big question I mentioned at the beginning. It is worth adding that this knowledge will also be necessary to correctly predict the consequences of global warming effects on organisms, populations, and ecosystems.