Too hot to reproduce? The impact of heatwaves on pollinator fertility

Global warming has significantly increased average temperatures and the frequency of extreme weather events, such as heatwaves, droughts, floods, cyclones, and wildfires. Heatwaves—prolonged periods of excessively high temperatures that exceed the typical climate patterns of a region—pose a serious threat to ecological communities. These climatic shifts destabilize ecosystems, making them more vulnerable to additional environmental stressors and accelerating biodiversity loss worldwide.

Extreme weather events are particularly concerning when they impact organisms that are crucial for ecosystem functioning, such as insect pollinators. Pollinators provide essential ecosystem services that sustain agriculture, as well as, the human health and economy. The decline in pollinator populations threatens food security by reducing crop yields, which in turn imposes significant economic pressure on agricultural systems.

To understand how extremely climatic events affect pollinators, we need to move beyond traditional thermal stress measurements, like "*critical thermal limits*", which only capture the temperatures that cause immediate physiological failure. Relying solely on critical thermal limits can therefore provide an incomplete picture, potentially overestimating species' resilience to climatic change. A new concept, the "*thermal fertility limit*", offers a more precise approach. Thermal fertility limit identifies the temperature at which fertility is lost, often occurring at lower temperatures than those causing survival failure. Fertility, which is critical for long-term population persistence, provides a clearer indication of how pollinators respond to heat stress, offering deeper insights into their vulnerability and the broader implications for ecosystem services in a warming world.

This project investigates the impact of extreme temperatures, particularly heatwaves, on pollinator fertility, with a focus on the red mason bee (*Osmia bicornis*), a common and ecologically significant pollinator in Central Europe. The study aims to identify the thermal fertility limit for *O. bicornis* by examining both current and projected heatwave scenarios. Bees will be exposed to simulated heatwaves in controlled lab conditions during both their larval and adult stages. Key reproductive traits, such as sperm viability in males, ovary size and progeny numbers in females, and mating behaviors, will be analyzed to understand the full impact of heat stress on reproduction.

In addition to groundbreaking research on pollinator fertility, the project will establish an open-access global database documenting the relationship between temperature and reproduction across diverse insect species and populations under real-world thermal stress conditions. This database will aggregate standardized data, support future research, enable comparative studies, and improve predictive models for insect responses to climate change. By focusing on fertility and integrating real-world scenarios, the project will contribute significantly to conservation strategies and mitigating the effects of climate change on pollinators.