

# **Thermal adaptation in Lepidoptera under shifting environments: mechanisms, patterns, and consequences**

Reyard Mutamiswa, Abongile Mbande, Casper Nyamukondiwa & Frank Chidawanyika

## **Abstract**

Thermal adaptation is a key facet safeguarding organismal function among ectothermic organisms. In this era of rapidly changing environments, understanding the diverse mechanisms mediating organismal climate stress resistance have become a priority given contrasting effects on organisms, vis declines in keystone species and an increase in invasive pest species. Here, we review mechanisms and patterns of thermal adaptation among shifting climates, specifically focusing on Lepidoptera, an economically significant insect order owing to its importance in agriculture and conservation. Lepidoptera are highly distinct, comprising species of diverse and unique morphology, ontogenetic development, habitat types and diets. Similarly, the diversity of adaptive responses ensuring survival under diverse thermal niches is equally remarkable. We therefore outline the mechanisms underpinning the success of Lepidoptera, mainly focusing on the important families and species which have quite attracted research attention in that order. We conclude by highlighting future studies for better understanding of lepidopteran species thermal adaptation under climate change. Understanding such adaptation will assist in accurate predictions and management of pest insect species and help conservation efforts in keystone species of the order Lepidoptera.

**Key Words:** Behavioural thermoregulation, Climate change, Insect conservation, Morphology phenotypic plasticity, Thermal stress