Metabolic flexibility and tracheal morphology impacts on newly invasive insect thermal limits under oxygen limitation

Marion Javal*[1], Philipp Lehmann[2,1], Saskia Thomas[1], Madeleine G Barton[1], Desmond E Conlong[3], and John S Terblanche[1]

[1]Centre for Invasion Biology, Department of Conservation Ecology Entomology, Faculty of AgriSciences, Stellenbosch University – Victoria Street, Stellenbosch, 7600 Stellenbosch, Cap occidental, South Africa

[2]Department of Zoology, Stockholm University, Stockholm, Sweden – Sweden

[3]South African Sugarcane Research Institute – P/Bag X02, Mount Edgecombe, 4300, South Africa, South Africa

Abstract

The recent host shift of the indigenous longhorn beetle *Cacosceles newmannii* (Coleoptera: Cerambycidae) from indigenous vegetation onto sugarcane in the KwaZulu-Natal Province of South Africa has resulted in widespread concern surrounding its pest status due to severe crop damage and significant economic losses for growers.
This dramatic host shift can be attributed to several potential mechanisms that include both abiotic and biotic factors. Since temperature is a key environmental driver of insect population dynamics and distribution, it is important to characterize the thermal tolerance of this emerging pest.

Here we tested a predominant hypothesis about the mechanistic cause of death at high temperature (i.e. oxygen- and capacity-limited thermal tolerance theory). To understand the scope of support for this hypothesis, we used insect life stages variations as a model system (larva vs adult). We first examined the upper critical thermal limits (CTmax) to activity and survival of insects in a set of respirometry experiments using two different gas mixtures (normoxia and hypoxia). This study shows that despite a supposedly less constrained environment, adults have a much greater flexibility than larvae. Although similar in their thermal maxima at normoxia, larvae have a more pronounced hypoxia-induced reduction in CTmax than adults, but seem to be able to maintain a similar maximum metabolism under both gas mixtures. Further, we investigated the scaling relationship between tracheal structures and thermal resistance under hypoxic conditions. These results were linked with preliminary measurements of total tracheal volume using high-resolution micro-CT scans of adults and larvae.
Part of the ongoing research is now to investigate the physiological mechanisms behind hypoxia tolerance using several molecular techniques such as metabolomics or RNAseq.

*Speaker