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Warming homogenizes leaf surface temperatures: Implications for behavioural thermoregulation by arthropods

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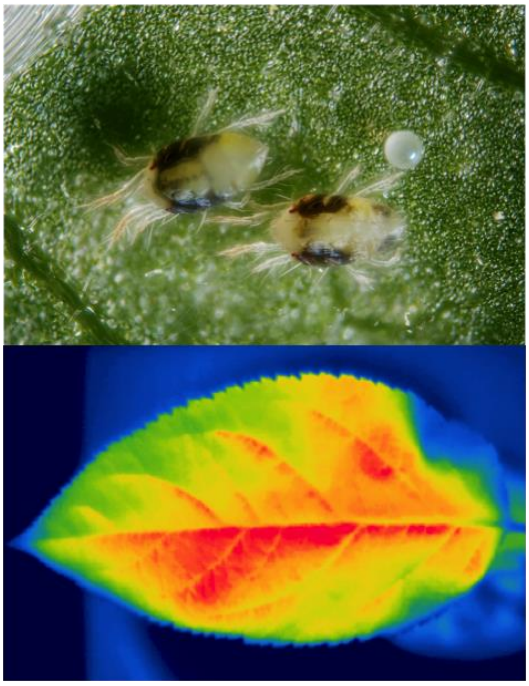
Many ectotherms move rapidly over short distances to keep their body at, or close to, optimal temperatures. Such behavioural thermoregulation can improve performance and allow individuals to avoid temperature extremes. However, opportunities for behavioural thermoregulation depend on the local spatial heterogeneity of available microhabitats. Highly heterogeneous thermal environments provide ample opportunities for animals to adjust their temperature by making relatively small movements, whereas homogeneous ones may allow little or none.

Global warming is expected to alter the spatial heterogeneity of environmental conditions in many habitats. However, despite the great diversity of organisms living on plant leaves, little is known about the impact of global warming on the spatial heterogeneity of microclimatic conditions on individual leaf surfaces (scales finer than 10 cm). We examined this question by comparing the thermal heterogeneity of individual apple leaf surfaces under moderate and high air temperatures, and we explored the consequences of that heterogeneity for behavioural thermoregulation by the two-spotted spider mite *Tetranychus urticae*.

Our results showed that ambient warming both decreased the range of temperatures available at the leaf surface and increased their spatial aggregation. Hence, warming homogenized the leaf microclimate, which prevented mites from thermoregulating behaviourally. These results suggest that climate warming



Primary organism, T. urticae *(top, photo credit: Gilles San Martin) and infrared image of an apple leaf surface (bottom, photo credit: Amélie Ezanic).*

may not only shift mean temperature at leaf surfaces, but also depress their thermal heterogeneity, with potentially critical implications for leaf dwelling arthropods. In particular, small arthropods may have reduced opportunities for behavioural thermoregulation at fine spatial scales. Such an effect may depress the performance of relatively immobile individuals, and may force more mobile individuals to thermoregulate by moving among habitat patches that are farther apart.