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INSIDE JEB

Forest protects *Heliconius* butterflies from climate extremes

A female *Heliconius erato lativitta* in captivity. Photo credit: Gabriela Montejo-Kovacevich.

For many species, mountains aren't just physical barriers. As the altitude increases, the air temperature falls and humidity can change, preventing cold-blooded species (ectotherms) from crossing into adjacent valleys. And the situation is even more intricate for insects that make their homes in tropical mountain forests. Gabriela Montejo-Kovacevich from the University of Cambridge, UK, explains that the climate beneath the forest canopy rarely resembles the measurements made by local weather stations. 'The forest understoreey is often more than 2°C cooler than the canopy and can span an 11% difference in humidity', says Montejo-Kovacevich. In addition, tropical species are also more vulnerable to climbing temperatures, as they never experience the drastic seasonal changes that make temperate species more hardy. Knowing that tropical species are likely to be more susceptible to climate change, thanks to seasonal stability, Montejo-Kovacevich and colleagues from the Universities of Cambridge and Sheffield, and the Universidad Regional Amazónica de Ikiam, Ecuador, decided to get a handle on just how the climate within mountain forests differs from meteorologists' climate predictions.

Travelling to high (∼1200 m) and low (∼450 m) locations on the eastern and western flanks of the Ecuadorian Andes, Montejo-Kovacevich, Simon Martin, Chris Jiggins and Nicola Nadeau suspended temperature loggers and humidity detectors in the forest canopy (∼11 m) and nearer the ground (∼1 m). 'We used fishing weights attached to a line and threw them up into the canopy, hoping they would go over our chosen branches', says Montejo-Kovacevich. And, when they returned 12 months later, she recalls that the forest had reclaimed all 56 data loggers: 'there were ants' and wasps' nests, fungus, moss and all sorts of things growing on them', she chuckles. Then the team compared the forest climate with weather predictions and it was clear that the forest had a major effect on the temperature within. Near to the ground at low altitudes, the vegetation offered relief (temperatures of ∼25°C) from the predicted temperatures of 27–29°C, while the temperatures edged up around 30°C in the canopy. However, the effects of the forest seemed to be less dramatic at high altitude, with a temperature difference of ∼1°C between the canopy and ground cover.

But how much of an effect would these differences have on the insects that dwell within? Montejo-Kovacevich and her colleagues armed themselves with butterfly nets and went hunting for *Heliconius* butterflies in the Ecuadorian Andes at low (∼500 m) and high (∼1400 m) altitudes. Having collected 11 members of the family, Montejo-Kovacevich set up impromptu laboratories, sometimes in the bathrooms of remote hostels, to warm the insects while recording how long it took for them to topple over, to find out how resilient they were. Not surprisingly, the butterflies from the foothills coped better, managing to stay upright for ∼18 min, in contrast to the butterflies from high altitude, which succumbed after ∼5 min. But were these differences hardwired into the populations, or were the butterflies becoming acclimatised to their individual environments and could they cope better if reared in a different location?

Collecting fertilised *Heliconius erato lativitta* females from high and low locations, the team reared the offspring at the Universidad Regional Amazónica Ikaim to find out how the youngsters coped with high temperatures. Remarkably, the offspring of the vulnerable high-altitude insects were significantly more robust than their parents, almost matching the tolerance of the low-altitude descendants. It seems that temperatures experienced by insects beneath the canopy may be less extreme than meteorologists' climate predictions, and insects may have the ability to cope as climate change takes grip.

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