

# **Ambassador Story**

## It is Getting Hot in Here



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#### It is Getting Hot in Here

When I disembarked the Twin Otter in Zackenberg during one slightly snowy and cold day in June, heatwaves were the furthest from what I expected to experience. But on July 15-17, 2025, above average temperatures were logged on three consecutive days at the Zackenberg Research Station. As a human, I could still thermoregulate internally, and still went on "business as usual". However, this may not have been the case for our **insect friends**, especially those with narrow thermal limits. Heavy emphasis on the "may".

This summer, a few colleagues and I were attempting to have more confident answers to questions on how warming trends in the arctic are affecting insects and how they do their "business".

To make our goal of unravelling temperature-dependence of ecological interactions more doable, our team (TEMPNET) headed up to Greenland, where ecological networks are not too complex.

#### Our first stop: Nuuk (Figure 1).

When we arrived, the weather was uncooperative, and not conducive for sample collection.

However, thanks to our intrepid on-site collaborator and Tomas Roslin' PhD student, Viktor Gårdman, we managed to get a head start on our work.



**Figure 1**. View of the Greenland Institute of Greenland Institute of Natural Resources in Nuuk in mid-June 2025.

He graciously collected samples for us prior to our arrival, allowing us to conduct some ecophysiological experiments focused on characterizing the temperature-dependence of several performance traits of various arctic insects.

From these measurements, we constructed thermal performance curves that tells us things like: at which temperature ranges can we expect species A and B to be in their best conditions, and consequently, able to interact?



In these experiments, we measure a few things: 1) the speed at which insects move in temperatures ranging from 0 °C to 45 °C (locomotion-based thermal assays), 2) the time it takes for insects to "wake up" after being submerged in ice cold water (**chill coma recovery time or CCRT**), 3) at which elevated temperature do physiological processes break down to the point when insects can no longer control their movement (critical thermal maximum or CTmax, which we used to inform the last experiment), 4) the time it takes for insects to become incapacitated after being warmed up in a heat plate (heat knockdown time or HKDT) at a temperature close to their CTmax. These experiments are ideally conducted under controlled lab settings. However, with us being in a remote base, this required our team to be doused with **resourcefulness and creativity.** 



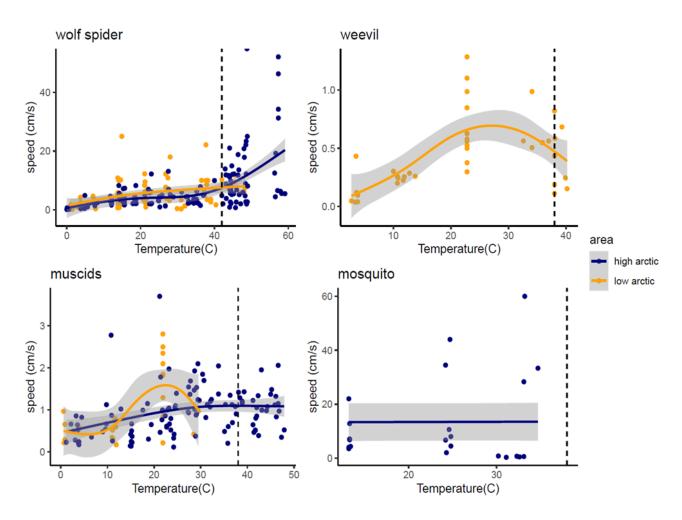
**Figure 2**. Multiple ways to test locomotor performance in remote settings. (From left to right) Henrika happily showing off our vertical walkway for flies. Henrika and I testing another version of our vertical walkway with a small plastic tub filled with snow. Set-up of a thermal assay on spiders with a view of Kobbefjord.

With Henrika Bosua as our lead creative director, we crafted make-shift arenas for different kinds of insects to walk across, and designed portable "freezers" to simulate below freezing conditions (**Figure 2**). Did these work? We think so!

#### How do we know?



Well, for starters, almost all of the well-sampled taxa, including wolf spiders, flies, and weevils, walked at a relatively slower pace at lower temperatures (< 5°C, Fig. 3). While this is expected, what we found mind-boggling were their responses at extremely high temperatures; by this I mean temperatures above their CTmax. This anomalous response is most obvious in wolf spiders (**Figure** 3). We would often see them bolt through the arenas when it gets above 42°C.



**Figure 3.** Locomotion-based performance of various taxa occurring in the low (i.e. Kobbefjord) and high (i.e. Zackenberg) arctic regions of Greenland under different thermal conditions. Each panel illustrates taxon-specific responses, with each dot representing individual measurements of speed at each temperature. Blue dots indicate responses of individuals captured in the high arctic while gold dots indicate responses of individuals captured in the low arctic. Dashed lines indicate the taxon-specific critical thermal maximum ( $CT_{max}$ ) determined either through thermolimit respirometry or by controlled thermal ramping until coordinated muscle movement is lost.



Why? We're not quite sure yet, but a study on social spiders shows that they employ these behavioral thermoregulation strategies or escape responses to avoid stressful temperatures (Malmos et al. 2021). Our results seem to align with their findings because even though wolf spiders ran very quickly (sometimes tiptoeing) at such high temperatures, more often than not, they ended up dead or passed out soon after. Many other studies on ectotherms suggest that locomotor performance, and even functional responses such as feeding, should decline steeply beyond an optimal temperature (Huey and Stevenson 1979, DeLong et al. 2023). This makes sense, ecologically speaking, because if we were to expect an ever increasing probability of interactions, such as predation at warmer temperatures, it can lead to increased instability in the system through the overexploitation of resources (i.e., prey items).

Knowing this, and the fact that the Arctic is warming rapidly, it is prudent to ask questions such as: do predator-prey interactions, specifically of wolf spiders and their prey items, occur more frequently at higher temperatures? Are the wolf spiders' prey items in danger with their predators running amuck with warming trends in the Arctic?

We pilot tested a semi-natural experiment in Zackenberg to explore this (**Figure 4**). We set up **24 mesocosm boxes** and varied the thermal conditions and the community types in each. Half of these boxes were made out of acrylic glass to simulate warmed environments, and the other half were lined with mesh to keep the insects inside. To simulate different community types, a subset of these boxes were housing a few wolf spiders with flies in, another subset with just flies, and another subset were left empty. We've fitted half of these mesocosms with Raspberry Pi camera systems to monitor all types of insect activity (e.g., wolf spider and fly predation, plant-pollinator interaction, etc.) for 5 days.





**Figure 4.** Mesocosm boxes installed in Zackenberg Research Station to explore changes in species interactions under different thermal conditions.



Figure 5. Team members in action in Zackenberg. (Left) Tomas fiddling with the electrical connections of our raspberry pi camera systems, and (Right) Pat sealing the gaps in our mesocosms.

If we had to put an ad to find someone to run this experiment, it would say something like: "Ideal candidate has adequate knowledge of electrical connections, shell scripting, keen eye for catching flies, sturdy knees for catching spiders, can spend days on end drilling holes and sticking things together using all types of adhesives" (Figure 5).

Although setting up this experiment was an arduous task, we were able to accomplish it with the **help of the staff at Zackenberg**. Needless to say, we would not have been able to implement this ambitious-given-logistical-and-time-constraints experiment without their guidance and assistance.

So what do we have to show for with this experiment? Well, to be honest, not much at the moment. We have almost 500 gb of imagery (photos and 1-minute videos) data to go through before we can say more. However, once we have distilled it into numbers -such as the frequency and duration of interactions at different thermal conditions- we can then combine it with results from the ecophysiological experiments to validate our expectations about species interactions under warming trends, using individual thermal response functions.

Once we have done that, we can (hopefully) more confidently say that: it is not business as usual for the local buzzers and creepers in the arctic when it gets too warm. We can probably expect more or less predation (and/or pollination). But what does that mean? Will it bode well for all or for just some of them? Nonetheless, if more interactions are in the cards, we have some unusual yet scientifically exciting dynamics on the horizon. And our team is here for it.

TEMPNET is a research project that develops and applies a mathematical framework to understand how temperature influences ecological interaction networks, using Arctic ecosystems as a model to predict how climate warming may reshape species interactions and community structures. TEMPNET was funded by POLARIN through its first call for Transnational Access to polar research infrastructures. The project conducted a research visit to the Greenland Institute of Natural Resources and Zackenberg Research Station from 16–20 June 2025.



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