USDA Agricultural Research Service
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Research Brief

Temperature and Humidity Affect Bumble Bees

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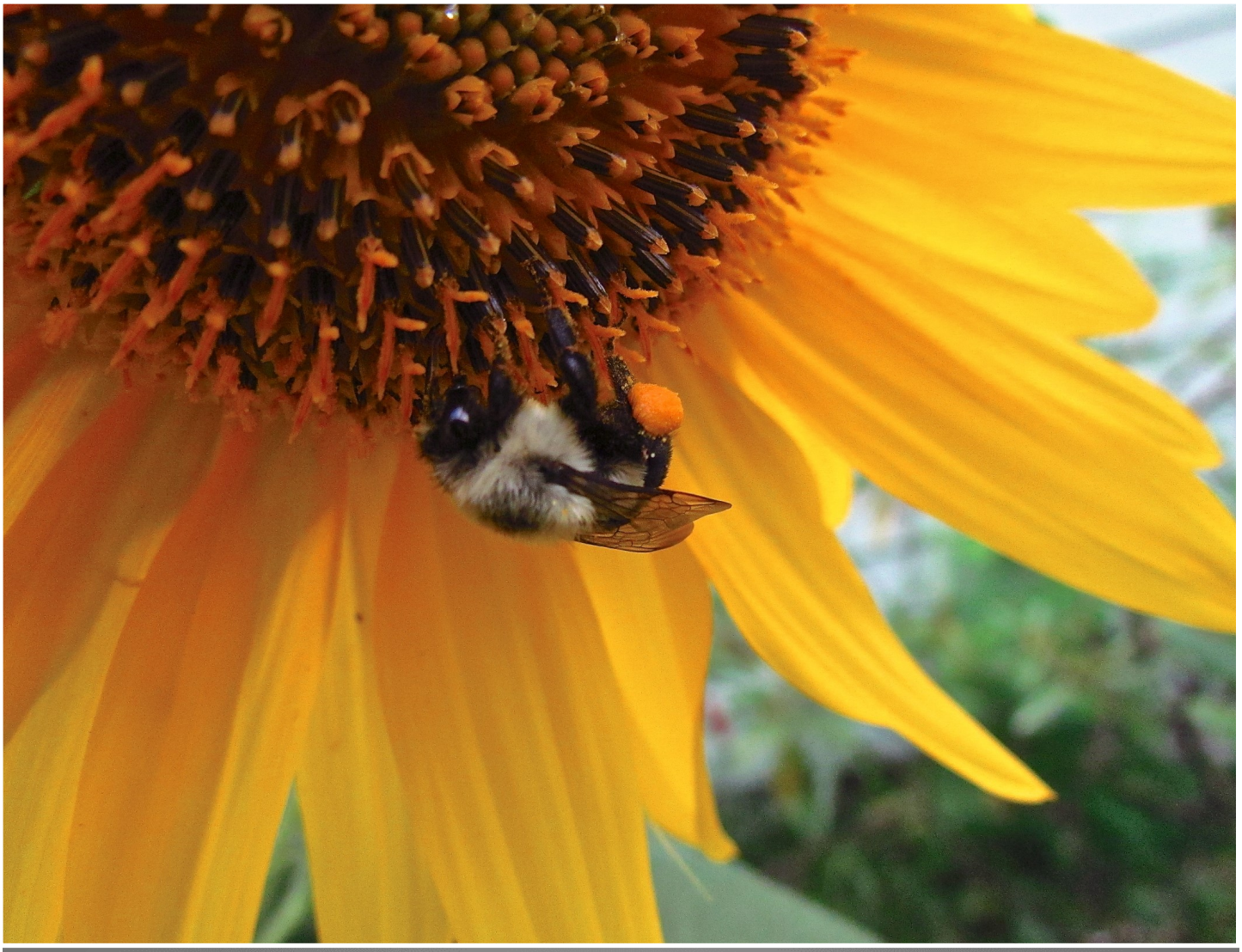

Key Findings:

- Bumble bees became dehydrated faster at warmer or drier conditions.
- Warmer, but not drier, air resulted in earlier mortality for bees without access to nectar.
- Larger individual bees could withstand more stressful conditions.
- Colonies varied in their water balance traits.

Background

Alongside warming temperatures, climate change alters precipitation patterns. Because of their small size, terrestrial insects often struggle to maintain proper water levels. As the air becomes drier, as predicted for some parts of the country, insects are more susceptible to dehydration. The effect this has on a population of insects depends on the biology of the organism, because insects have several adaptations that help them slow water loss or tolerate higher levels of dehydration. While it is known that temperature and humidity may interact in ways that may affect insects' water balance, few studies have evaluated the effect of this interaction.

Bumble bees are an economically and ecologically important insect pollinator. Because they are capable of buzz pollination, bumble bees play an important role in the production of some crop species, including tomatoes, peppers, and blueberries. However, very little is known about their sensitivity to humidity and temperature conditions. Understanding their physiological capacity to survive and prevent water loss in hot and dry conditions provides an important first step in developing management practices that support and enhance native and managed pollination in agricultural systems, especially as the climate changes.

Common eastern bumble bee (*Bombus impatiens*)
Photo: Sam Droege, USGS BIML

Objective

We measured the ability of the common eastern bumble bee (*Bombus impatiens*) to resist and tolerate water loss across a range of temperature and humidity conditions. This species is both found unmanaged in the wild and is sold commercially for pollination services. No study prior to this work has evaluated their sensitivity to water loss under different temperature and humidity conditions.

Figure 1. Chambers holding individual bees at different humidities were placed in larger controlled environment chambers.

Methods

We placed 540 individual bumble bee workers in small chambers (Fig. 1) that either had low (<5% relative humidity, RH), moderate (50% RH), or high humidity (>90% RH). We achieved these treatments by including a desiccant to draw down the humidity in the low humidity treatment and a wet cotton ball in the high humidity treatment. We placed these into controlled environment chambers that regulate the air temperature. We had three temperature treatments, which span the range of temperatures we observe these bees foraging at in South Dakota (20, 25, and 30 °C or 68, 77, 86 °F). Inside these chambers, bees did not have access to nectar. The bees came from six source colonies, so that we could account for genetic variation.

We then checked bees every 2-4 hours until the bees were no longer responsive. We also measured the rate at which the bees lost water and total water content, by recording their weight before placing them into the chambers, after mortality, and after drying the bees to remove any of the remaining water.

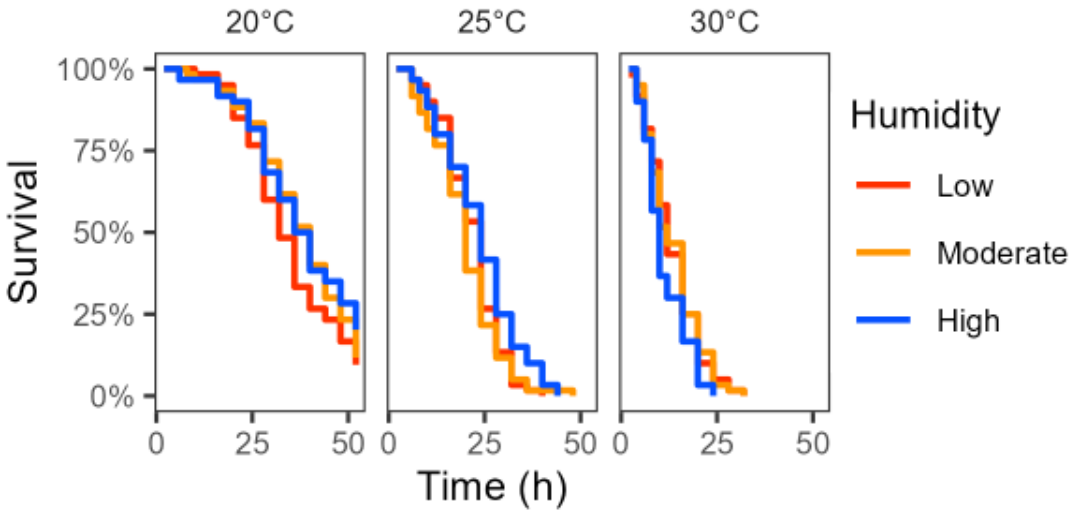

Figure 2. Survival curves for the bees in the experiment. Each line shows the percentage of bees surviving at a given time. The colors represent the different humidity treatments and the panels show different temperature treatments. Survival was shortest at high temperatures and longest at low temperatures, with little effect of humidity on survival.

Results

We found that bees were sensitive to temperature and humidity. Bees survived three times as long in the coolest temperatures as they did in the warmest temperatures, with no effect of humidity on survival time (Fig. 2). However, they lost water much faster in warmer and drier environments (Fig. 3).

These results highlight the importance of bees' access to nectar, their primary water source, and nesting environments that allow them to avoid stressful environmental conditions.

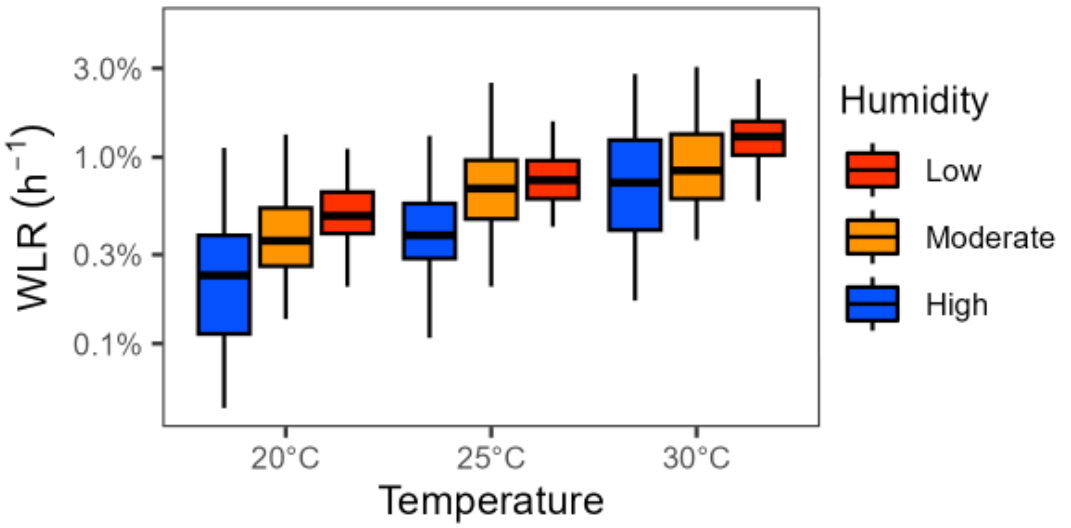

Figure 3. Water loss rates (% water lost per hour) increase in drier or hotter environments. The boxes are colored by the humidity treatment. The colored boxes show where 25-75% of the data fall, with the central black line showing the middle value. The vertical lines show the upper and lower range of the data. As both temperature increases and humidity decreases, bees lost water faster.

Findings and Next Steps

- In this study, we measured the ability for bumble bees to prevent and tolerate dehydration.
- We found that bumble bees are sensitive to temperature and humidity, suggesting that access to nectar is important for supporting bumble bees.
- Currently, we are evaluating the sensitivity of three other economically important bee species (honey bees, alfalfa leafcutter bees, and blue orchard mason bees) to humidity.
- We are also studying how these managed bee species compare to native bee species in their ability to prevent water loss.

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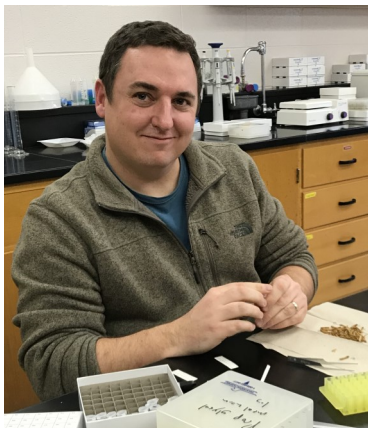
Research Entomologist



Questions or comments?
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About NCARL

The North Central Agricultural Research Laboratory (NCARL) is a USDA-Agricultural Research Service laboratory located in Brookings, SD. The goal of NCARL is to develop, document, and promote soil, crop, and pest management practices that are ecologically sustainable while maintaining producer profitability.