QuickNotes

Science summaries from fRI Research

Introducing: Assessment of eastern spread risk of Mountain Pine Beetle (MPB) through studies on beetle dispersal and host colonization

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Spread of MPB populations across the landscape occurs as a result of both beetle dispersal and establishment of the population in new environments (Bleiker 2019). Dispersal by flight is obligatory for MPB, as adults must leave the natal host and fly to seek new hosts for brood production. Mountain pine beetles exhibit flight polyphenisms that result in differences in dispersal across the landscape and impact subsequent range expansion (Jones et al. 2020). Some beetles will colonize adjacent trees within a stand and others will fly much further and attack hosts at a distance, resulting in spot growth or spot proliferation of attack on the landscape, respectively (Robertson et al. 2007). In Alberta, spot proliferation occurs mainly within 2 km from the parent population, but 20% of new infestations are more than 4 km from the natal tree (Carroll et al. 2017). Spread measured in the field correlates with estimates of flight capacity obtained using a computer-linked flight mill assay (Evenden et al. 2014). Long distance flight with assistance of the wind can also carry mountain pine beetle over the canopy for distances greater than would be physiologically possible using energy stores alone (Jackson et al., 2008). Beetle body condition affects host colonization behaviour in mountain pine beetle (Elkin and Reid, 2005) and recent work in the Evenden lab has shown that flight directly affects pheromone signaling and host entry behaviours involved in the colonization process (Jones et al. 2020). Mountain pine beetle flight is also modified due to pre-exposure to semiochemical cues before flight and during flight, as flight is significantly reduced in the presence of non-host volatiles (Jones and Evenden 2021). This might influence dispersal in the expanded range as beetles experience stands with lower host availability. It is not known,

Federal-Provincial MPB Research Partnership

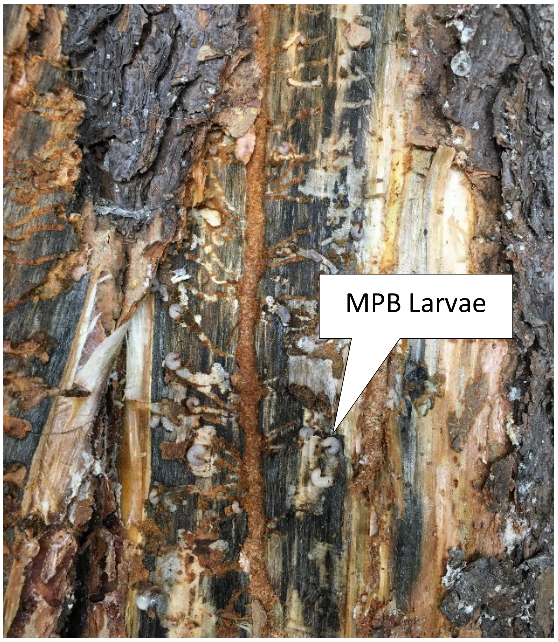
Mountain Pine Beetle remains a severe threat to Alberta's pine forests despite the province making positive progress in controlling its spread within the province and reducing the risk to the rest of Canada.

Natural Resources Canada and Alberta Agriculture and Forestry have provided funding to a suite of projects with the goals of limiting the spread of Mountain Pine Beetle and mitigating damages where it has already invaded.

Natural Resources Canada / Ressources naturelles Canada

Canada

Alberta Agriculture and Forestry



however, if energy use during dispersal is necessary for beetles to become acutely responsive to the semiochemical cues that are relevant to host colonization.

Dispersal capacity has implications for the spread of beetle populations and range expansion. Research on bark beetle flight generally has focussed on morphological characteristics of the beetle, energy consumption during flight and abiotic conditions that impact flight (Jones et al. 2019). In a few bark beetle species, the physiological state of beetles influences response to chemical cues that mediate host colonization (Jones et al. 2019). In the European spruce beetle, *Ips typographus*, only a small proportion of the population will orient to pheromone-baited traps upon eclosion from the natal tree. Instead, dispersal by flight seems necessary to enhance the response of *I. typographus* antennal receptors to volatile cues (Duelli et al. 1997) that results in host orientation and landing (Nêmec et al. 1993). Although flight exercise has been proposed as a necessary precursor for orientation to chemical cues in host colonization in MPB (Bleiker 2019), this has not been tested to date. The congeneric species, the Douglas-fir beetle, *Dendroctonus pseudotsugae*, on average need to fly for 90 minutes before becoming responsive to conspecific pheromone. It is possible that lipid oxidation that fuels flight provides an internal feedback mechanism that regulates beetle dispersal distance (Bennett and Borden 1971) to ensure enough fuel remains for the costly activity of host colonization (Reid et al. 2017). Recent work in the Evenden lab has illustrated that within population variation in flight phenotypes in epidemic phase beetles impacts subsequent pheromone production and host colonization processes (Jones et al. 2020), but it is not known if flight and lipid oxidation influences MPB response to semiochemical cues. Our approach is to test the effect of exercise by flight on subsequent electrophysiological and behavioural response to semiochemicals used in the host colonization process. We will attempt to compare our lab findings to field populations through assessment of the condition of beetles captured in semiochemical-baited traps at sites across the expanded range.

Our research will directly address the eastern spread of the mountain pine beetle (MPB) by tackling questions on dispersal and subsequent response to semiochemicals used in the host colonization process.

For more information on this project, contact Dr. Maya L. Evenden at mevenden@ualberta.ca; 780-492-1873.

Objectives

Our research aims to determine if energy use during flight is essential for MPB detection and response to semiochemical cues used in the host colonization process. Further, we will compare the condition of beetles captured in semiochemical-baited traps across the expanded range in AB.

Our Specific Objectives and hypotheses are:

1. To investigate whether flight impacts the electrophysiological response of antennal receptors to semiochemical cues.
   H_O: Flight of MPB does not impact electrophysiological response of antennal receptors to semiochemical cues.
   H_1: Flight of MPB does impact electrophysiological response of antennal receptors to semiochemical cues.

2. To investigate whether flight impacts the behavioural response of MPB to semiochemical cues.
   H_O: Flight of MPB does not impact behavioural response of MPB to semiochemical cues.
   H_1: Flight of MPB does impact behavioural response of MPB to semiochemical cues.

3. To compare morphology and fat content of beetles captured in pheromone-baited traps across the expanded range in AB.
   H_O: The size and fat content of MPB captured in pheromone-baited traps does not vary across its expanded range in AB.
   H_1: The size and fat content of MPB captured in pheromone-baited traps varies across its expanded range in AB.

Deliverables and Implications

1. This research will provide data to better understand the role of flight in the perception of semiochemical cues used in host colonization behaviour. Understanding this aspect of beetle dispersal biology will help us to interpret pheromone-baited trap catch and to predict host colonization success.
2. This research will provide data to better understand the condition of beetles as it relates to dispersal (fat content and body size) across the expanded range in Alberta. Our field sampling and subsequent beetle body measurements will help us to determine if morphological measurements can correlate with dispersal phenotypes in a field setting.
3. This research will provide training of HQP in entomology, integrated pest management, chemical ecology and forest ecology.

The research team will provide regular updates on our research to Forest Health Officers in Alberta and Saskatchewan, and the forest industry. Moreover, if conditions permit, we will participate in Annual Research Forums. Research manuscripts will also be an essential outcome of this research.

Expected Completion Date

September 30, 2023

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