How do morphology and environmental factors predict flight capability of the mountain pine beetle?

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Background

The mountain pine beetle (*Dentroconus ponderosae;* MBP) is regarded as the most destructive pest of mature pine (*Pinaceae*) in western Canada[1]. Their recent expansion has caused great concern in the recent decades, yet because of the difficulty to study their flight behaviour, little is known regarding their dispersal capabilities[2].

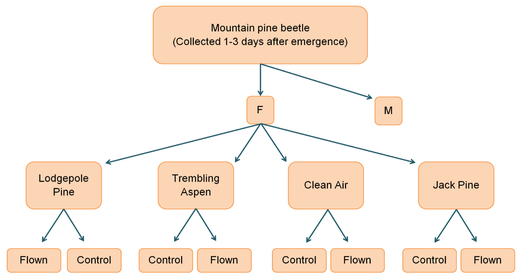
The purpose of this study was to identify the most influential MPB characteristics on various aspects of flight, primarily through the comparison of morphology and environmental factors.

Data was collected on weight, pronotum width, body length, wing area, wing loading, and aspect ratio. Beetles flown were exposed to four different treatments; phloem from jack pine, lodgepole pine, and trembling aspen, and clean air as a control.

Methods

Bolts were collected from Grande Prairie, AB and kept at 4°C until they were transferred to a controlled room. They were kept at 21°C, held under a schedule of 18 hours of light to every 6 hours of darkness.

Beetles were collected twice daily following emergence, then separated by sex and placed into a fridge at 5°C, until their use for the flight mills. Female beetles were used for the entirety of the flight experiments.



Beetles were randomly selected for flight and control groups, weighed, and then evenly distributed among the three volatile organic compound (VOC) treatments and the clean air treatment.

Beetles chosen for flight were then tethered onto flight mills and flown for 22 hours at room temperature while exposed to 1 gram of phloem. Mills were sealed off to reduce contamination.

Figure 1: Dissected MBP wing, used to calculate area, aspect ratio (length²/area; AR), and wing loading (weight/area).

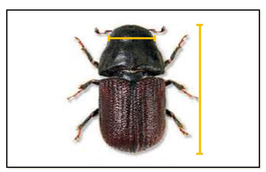


Figure 2: Diagram representing pronotum width and body length.

Results

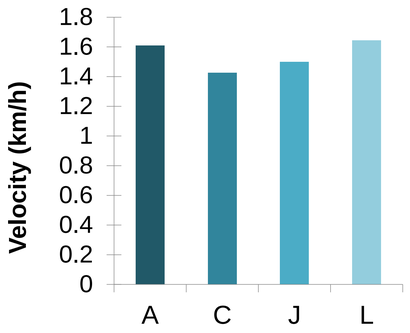


Figure 3: Average velocity of beetles compared by exposure

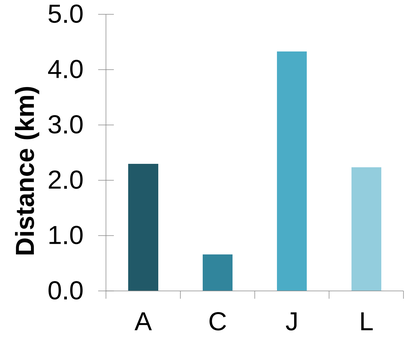


Figure 4: Average distance flown by beetles compared by exposure

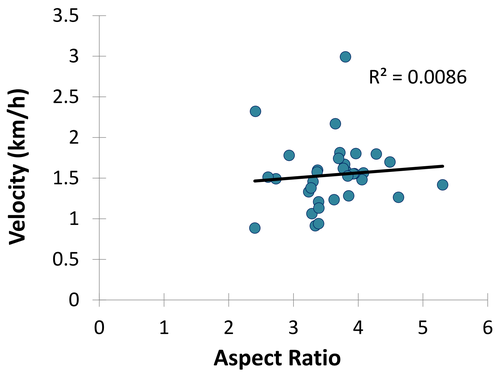


Figure 5: Average velocity compared to aspect ratio

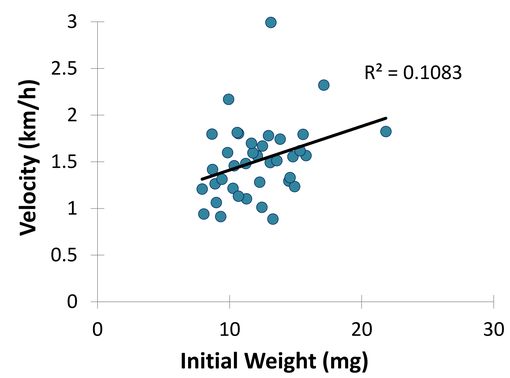


Figure 6: Average velocity compared to initial weight

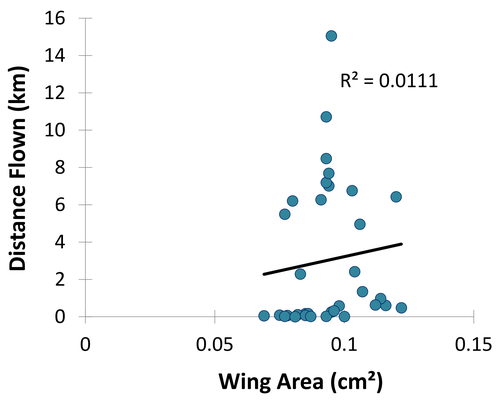


Figure 7: Average distance flown compared to wing area

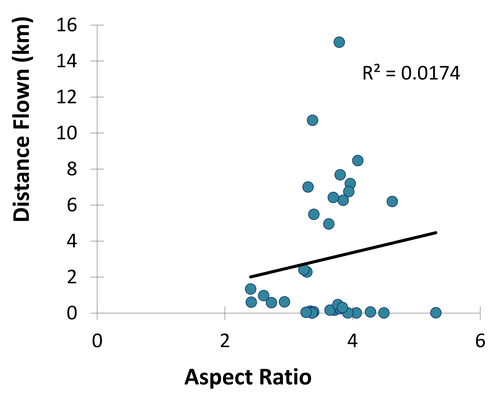


Figure 8: Average distance flow compared to aspect ratio

Discussion

In summary, the conclusions drawn from these graphs state that the average velocity was most strongly predicted with the combined factors of exposure and aspect ratio (AIC=-43.610, linear model in R). Isolating both factors resulted in less accurate readings, with exposure having an AIC=-68.022, and AR with an AIC=-46.832, the lowest individual AIC value for velocity.

The exposure group with the highest velocity was the lodgepole pine, a host tree, however, those exposed to jack pine, also a host, flew a greater average distance.

Average distance flown correlated most strongly with the combined factors of exposure and wing area (AIC=661.224). Alone, exposure resulted in an AIC=899.732, and wing area with an AIC=663.004. However, individually, aspect ratio resulted in the lowest AIC value (AIC=662.788).

Readings for both velocity and distance confirm that the best predictors, in terms of AIC values, resulted from combining factors, all of which including exposure.

This research, along with present ongoing studies, will serve to further understand MBP dispersal patterns and help predict future spread.

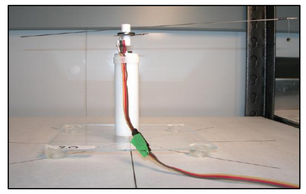


Figure 9: Flight mill apparatus

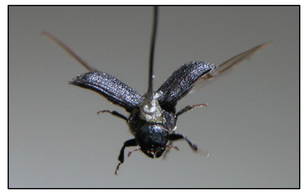


Figure 10: Tethered MPB

References & Acknowledgements

1. Evenden et al., 2014. *Environmental Ecology.*
2. Safranyik et al., 1992. *Journal of Applied Entomology.*

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