University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Science

of

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BSc (University of Victoria, 2012)

"Interaction Between the Seed-Chalcid Wasp, *Megastigmus spermotrophus* and its Host, Douglas-fir (*Pseudotsuga menziesii)*"

Department of Biology

Thursday, September 3, 2015
2:00 P.M.
Engineering and Computer Science Building
Room 130

Supervisory Committee:
Dr. Patrick von Aderkas, Department of Biology, University of Victoria (Co-Supervisor)
Dr. Juergen Ehlting, Department of Biology, UVic (Co-Supervisor)
Dr. Steve Perlman, Department of Biology, UVic (Member)

External Examiner:
Dr. Terry Pearson, Department of Biochemistry and Microbiology, UVic

Chair of Oral Examination:
Dr. Terry Prowse, Department of Geography, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

Megastigmus spermotrophus is a parasitic chalcid wasp that spends most of its life in the seed of its host, Douglas-fir (*Pseudotsuga menziesii*). The adult female wasp lays its eggs into the megagametophyte deep within the ovule; the larva prevents an unpollinated ovule from aborting, redirecting resources to feed itself. Host-site selection pressures that influence female oviposition depend on a number of factors. Morphological characteristics of Douglas-fir cones including seed size, seed location, and scale thickness were measured for every ovuliferous scale. Seeds infested by *M. spermotrophus* as well as seeds galled by a competing conophyte, *Contarinia oregonensis* were noted. Using a generalized linear mixed effects model, I found that seed position, and the presence of *C. oregonensis*, were strong predictors of *Megastigmus* infestation. The percent of *M. spermotrophus* infested seed was higher in the apical and basal regions of the cone where seeds were smaller, scales were thinner and *C. oregonensis* were less frequently found. *M. spermotrophus* was also found to exploit seeds in regions of the cone, where seeds rarely complete development. This data suggests that competitors may not be the only factor influencing infestation; factors of cone morphology are also important.

Douglas-fir seed does not show any anatomically detectable defense response to *Megastigmus* attack. To study mechanisms of host manipulation and defense response of the seed I took a genomics approach. Four types of ovules/seeds were studied: 1. pollinated & uninfested, 2. pollinated & infested, 3. unpollinated & uninfested, and 4. unpollinated and infested. A *de novo* reference transcriptome was assembled in Trinity. Expression values were estimated based on the alignment of the original reads back onto the reference transciptome using RSEM. Transcripts were annotated based on sequence similarity to genes of *Pinus taeda, Arabidopsis thaliana, Nasonia vitripennis*, and the UniProt database. Differentially expressed transcripts were identified. Oviposition of *M. spermotrophus* caused substantial changes to expression of Douglas-fir transcripts. Functional classification of differentially expressed transcripts between infested and uninfested seed revealed genes with roles in wounding, but none specific to herbivory. Infested treatments had more transcripts similarly expressed to pollinated than unpollinated seeds suggesting that *M. spermotrophus* is capable of manipulating gene expression. These transcripts had functional roles related to seed storage, cell division and growth, solute transport, hormone signaling, and programmed cell death among others. Overall, this study reveals genes involved in stress response to wounding and also genes important for seed development and maturation.