Foraging behavior of *Dolichogenidea tasmanica*

&

patterns of parasitism in light brown apple moth

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Thesis submitted for degree of Doctor of Philosophy in the

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October 2014

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This thesis is dedicated

To the memory of my father,

I miss him every day, and I know he would be glad and proud to see me fulfilling this ambitious process to its completion.

To my Mom,

For dealing with me being world away, offering the support to make it possible, as well as plenty of friendly encouragement.

Abstract

Dolichogenidea tasmanica (Cameron) (Hymenoptera: Braconidae) is a solitary endoparasitoid that is native to Australia. I examined its response to a key pest, light brown apple moth (LBAM), *Epiphyas postvittana* (Lepidoptera: Tortricidae). LBAM is a native species in south-eastern Australia. *D. tasmanica* is known to parasitise larvae of several tortricid moths. The use of insecticides after flowering has been restricted in Australian vineyards to minimize the likelihood of pesticide residues in wine. Therefore biological control is crucial to the effective management of LBAM populations on grapes. With the long term aim of enhancing biological control in vineyards, factors that influence behaviour and population dynamics of the pest and their natural enemies must be taken into account. So in this thesis, I focused on the foraging behaviour and functional response of *D. tasmanica* to elucidate aspects of the biological control potential of this parasitic wasp.

An understanding of the host stage preference of *D. tasmanica* is crucial to elucidate its role in biological control. Therefore, the first objective of my study was to determine the larval stages of LBAM that are parasitised by *D. tasmanica*. This study was conducted in four identical wind tunnels, using choice and no-choice tests. Here I showed that *D. tasmanica* parasitises the 3rd instar of LBAM, however, it was previously reported as a parasitoid of only the 1st and 2nd instars. So, *D. tasmanica* is capable of parasitising early larval instars, which is important for minimising pest populations through biocontrol.

The searching behaviour of female *D. tasmanica* responding to plants infested with susceptible larval stages of LBAM was studied next. Behavior was continuously recorded with event-recorder software. The elapsed time before and after taking flight from the release point until landing on an infested leaf, and the mean duration,

frequency and proportion of time devoted to each type of behaviour on the leaf were analysed for each instar. These observations gave insight into how *D. tasmanica* interacts with hosts. I found that female *D. tasmanica* effectively responds to cues associated with all susceptible larval stages of LBAM to locate hosts. These experiments showed that first instar LBAM is more susceptible to parasitism by *D. tasmanica*.

Superparasitism is an important factor as it affects the stability of host-parasitoid interactions and the shape of the functional response curve. To assess the rate of superparasitism avoidance by *D. tasmanica,* female wasps were given choices between (i) unparasitised hosts versus freshly parasitised hosts, (ii) unparasitised hosts versus hosts at 24 h post-parasitisation, and (iii) freshly self-parasitised hosts versus hosts freshly parasitised by a conspecific female. So I investigated the frequency of superparasitism in order to evaluate whether *D. tasmanica* deposits its eggs in a random or non-random fashion. Experiments demonstrated that host discrimination frequently occurs in *D. tasmanica*. However, it appears that females are not able to discriminate the host parasitisation status prior to contacting a host. So *D. tasmanica* contacts hosts randomly but host acceptance is not random.

The functional response of a parasitoid influences its capacity to control pests. I conducted a study to determine the type of functional response of *D. tasmanica* to varying densities of larval LBAM. The results showed that *D. tasmanica* displays a Type III functional response to varying low densities of LBAM. This suggests that it should operate in a density-dependent manner in contributing to population regulation of LBAM. Subsequently experiments were conducted to determine how recent experience affects the functional response of *D. tasmanica*. Results showed that *D.*

tasmanica responds to its experience in a habitat, which influences the searching behaviour in the process of host location

Parasitoids do not always forage alone. Individuals of a given species have similar needs for survival, growth, and reproduction, and thus will often compete for similar resources (e.g., hosts, food, nests). This may lead to a flexible patch exploitation strategy compared to the situation of a solitary forager. The foraging behaviour of single and multiple female *D. tasmanica* in the presence of patchily-distributed hosts was observed and analysed. Results showed that females *D. tasmanica* assessed patch quality instantaneously while foraging. A searching female might deposit a marking pheromone on a visited patch, which inhibits further searching and contributes to mutual interference among competitors.

In this study key aspects of the individual and population behaviour of *D. tasmanica* were investigated. It seems that *D. tasmanica* can play a valuable role in the biocontrol of LBAM. The outcomes of my study should also provide insights into parasitism of other leafrollers that are susceptible to *D. tasmanica*. Finally the results of this research provide a foundation for understanding the biological control potential of *D. tasmanica* against LBAM in vineyards. Further research is needed to investigate how factors such as host plant preference, alternative host species, the availability of floral resources and interspecific competition influence patterns of parasitism by this species.

Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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Maryam Yazdani Date

Acknowledgment

A major research project like this is never the work of anyone alone. The contributions of many different people, in their different ways, have made this possible. I would like to extend my appreciation especially to the following people.

First and foremost I offer my sincerest gratitude to my supervisor, Associate Professor Mike Keller, who has supported me throughout my thesis with his patience and knowledge whilst allowing me the room to work in my own way. I attribute the level of my PhD degree to his encouragement and effort and without him this thesis, too, would not have been completed or written. You have been a tremendous mentor for me and your advice on both research, as well as on my career, have been priceless. Your kindness and extensive support have been ever present in this important time of my life, for which I am eternally grateful.

I would like to thank my co-supervisor Dr. Richard Glatz for encouraging and supporting me to grow as a research scientist. Special appreciation to Professor Eileen Scott, she has been always my support in the moments when there was no one else to answer my queries. I thank staff at SARDI (South Australian Research and Development Institute) for supplying information on rearing LBAM and also Latif Salehi and Cate Paull for their support during my project. I would also like to thank Dr. Farid Christo for his guidance and encouragement.

I would especially like to thank my officemates, Arthur Selwyn Mark, Feng Yi, Kala Bhandari, Mary Retallack, Kay Anantanawat, Ahmad Chatha and Tom Wang. In my daily work I have been blessed with a friendly and cheerful group of fellow students. I would like to thank you all for supporting me in writing, and encouraging me to strive towards my goal. All of you have been there whenever I needed you.

I would like to express my special appreciation and thanks to all of my friends in Adelaide for their unconditional support throughout my life here. In particular, the patience and understanding shown by them during the last three years is greatly appreciated.

A special thanks to my family. Words cannot express how grateful I am to my mother for all of the sacrifices that she has made on my behalf. Your prayer for me was what sustained me thus far.

Last but not least, I would like to thank The University of Adelaide which has provided the support and equipment I have needed to produce and complete my thesis and the ***Adelaide Scholarship International (ASI)*** has funded my studies and living allowance.

Preface

The research discussed in this thesis has led to the generation of five journal papers and three conference papers.

Journal papers

- **M. Yazdani**, F. Yi, R. Glatz & M.A. Keller. Host stage preference of *Dolichogenidea tasmanica* (Cameron) (Hymenoptera: Braconidae). *Austral Entomology*.

  DOI: 10.1111/aen.12130

- **M. Yazdani**, R. Glatz & M.A. Keller. "Searching behaviour of *Dolichogenidae tasmanica* in response to susceptible stages of *Epiphyas postvittana*". Submitted: *Australian Journal of Zoology.*

- **M. Yazdani**, R. Glatz & M.A. Keller. "Host discrimination by the solitary endoparasitoid *Dolichogenidea tasmanica* (Hymenopotera: Braconidae)*".* *Biocontrol Science and Technology.*

  DOI: http://dx.doi.org/10.1080/09583157.2014.964663

- **M. Yazdani** & M.A. Keller. "The sigmoid functional response of *Dolichogenidea tasmanica* (Hymenoptera: Braconidae) is affected by experience". Submitted: *Oecologia.*

- **M. Yazdani** & M.A. Keller. "Foraging for Patchily-Distributed Light Brown Apple Moth by *Dolichogenidea tasmanica* (Cameron) (Hym.: Braconidae)". Submitted: *Biological control.*

Conference papers

- **M. Yazdani**, M.A. Keller. Understanding the mechanisms that influence the response of the parasitic wasp *Dolichogenidea tasmanica* (Hym.: Braconidae) to the density of Light Brown Apple Moth. 61st Annual Meeting of the

Entomological Society of America (ESA). Austin, Texas, 10-13 November 2013.

- **M. Yazdani**, M.A. Keller. Host location and host stage preference of *Dolichogenidea tasmanica* (Cameron) (Hymenoptera: Braconidae). Australian Entomological Society (AES) 44th AGM & Scientific Conference Adelaide 29 September-2 October 2013.
- **M. Yazdani**, M.A. Keller, F. Yi. Searching behaviour of *Dolichogenidea tasmanica* in response to different larval instars of LBAM. Australian Society for the Study of Animal Behaviour (ASSAB). Deakin University, Geelong, 26-28 June 2012.
- **M. Yazdani**, M.A. Keller, How easy is for parasitoid wasp to locate and parasitise its host in vineyard? Postgraduate Symposium. School of Agriculture, Food & Wine, 19-20 September 2012.