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**Reproductive behaviour of *Aphidius ervi*
Haliday (Hymenoptera: Aphidiidae)**

**a thesis presented in partial fulfilment of the requirements
for the degree of**

**Doctor of Philosophy in Plant Science
(Entomology)**

at

**Massey University
Palmerston North
New Zealand**

**Xiong Zhao He
2008**



CERTIFICATION OF REGULATORY COMPLIANCE

This is to certify that the research carried out in the Doctoral thesis entitled “Reproductive behaviour of *Aphidius ervi* Haliday (Hymenoptera: Aphidiidae)” in the Institute of Natural Resources at Massey University, New Zealand:

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CANDIDATE'S DECLARATION

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SUPERVISOR'S DECLARATION

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Prof. Qiao Wang

28 August 2008

Abstract

Aphidius ervi Haliday is a cosmopolitan parasitoid species of several major aphid pests on economically important crops. Prior to this research, little information was available on its reproductive behaviour. Emergence of *A. ervi* peaks during the first few hours of the photophase with males being protandrous. Females become sexually mature earlier than males and oviposit primarily in the photophase. Aphids parasitised in their early instars die before reproduction but those parasitised in later instars produce a limited number of progeny. Females prefer aphids of 3- to 5-d-old over the younger and older aphids for oviposition. Females ovipositing in 4- to 7-d-old aphids have more fitness gains in terms of progeny body size and egg load at emergence. Fertilised eggs are more likely deposited in large hosts and unfertilised eggs in small ones. Large individuals have greater longevity, large males father more progeny, and large females have higher fecundity, parasitism and greater ability in host searching. However, with increasing body size females gain more than males in longevity and fecundity but males gain more than females in the number of female progeny. Males can inseminate up to nine females and they carry about 82% effective sperm at emergence and replenish about 18% sperm during their adult life. Females adjust the oviposition and sex allocation strategies in response to increasing host density with higher number of aphids parasitised at higher host densities and lower proportion of female progeny produced at lower host densities. Males play an active role in mating behaviour. Males having mating experience, and being large or younger, respond to females more quickly and perform better courtships resulting in higher mating success. Males prefer larger and younger females for mating probably because the latter have greater reproductive potential. Males optimize the use of their sperm based on the availability of their sperm and the reproductive status (age) of females. The switching-off of female receptivity of male mating attempt after the mating is a gradual process. Some females accept the second males within 1 minute since the termination of the first mating. The shorter mating period in the second mating suggests that females remate probably due to the gradual process of switching-off of female receptivity rather than the insufficient sperm transformation during the first mating. Males prolong their mating duration in male-biased operational sex ratio to reduce the probability of female remating.

Acknowledgements

I am extremely grateful to my supervisor, Professor Qiao Wang, for his invaluable time, effort and support provided throughout this research. Qiao always fed me with more scientific questions, challenged my explanations, encouraged me to publish and present my results, and had an open-door policy with kind smile on his face.

My gratitudes are also towards my co-supervisor, Dr. David A. J. Teulon (Crop and Food Research, Christchurch, New Zealand), for his time in discussing the results and making valuable comments on the thesis and manuscript papers. I am also thankful for his financial support in the earlier stage of this project.

I appreciated very much Drs. G. P. Walker and N. Martin (Crop and Food Research, Auckland) for their valuable advice and comments on an early draft of the project. I am thankful for the excellent academic and technical support from Ms.L. K. Davis and staff of INR, Massey University. I also thank the staff of the Plant Growth Unit, Massey University, for providing me with materials and their technical assistance.

I am grateful to Drs. D. Hedderley, A. Noble and A. Jiménez-Pérez for statistical assistance and advice throughout the research, and to the staff of Massey University Library and the IT service (INR) for their help with information access.

I am very thankful to my family, especially my wife Dong Xiao Feng and my two daughters Joanna and Ivy for their unconditional support during my studies. My wife always does her best to take care of our daughters and our family so that I can concentrate on my studies. I am also grateful to my brother and sister for taking care of our parents after we migrated to New Zealand.

This thesis is dedicated

to my *loving parents* who showed me the way to succeed in my life

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- 2 He X.Z. and Wang Q. 2006. Asymmetric size effect of sexes on reproductive fitness in an aphid parasitoid *Aphidius ervi* (Hymenoptera: Aphidiidae). *Biological Control* 36: 293-298. 161
- 3 He X.Z. and Wang Q. 2006. Host age preference in *Aphidius ervi* (Hymenoptera: Aphidiidae). *New Zealand Plant Protection* 59: 190-194. 172
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- 6 He X.Z., Wang Q. and Teulon D.A.J. 2005. Host stage preference and reproductive fitness of *Aphidius eadyi* (Hymenoptera: Aphidiidae) on *Acyrtosiphon pisum* (Hemiptera: Aphididae). *New Zealand Journal of Agricultural Research* 48: 157-163. 190
- 7 He X.Z., Wang Q. and Teulon D.A.J. 2004. Emergence, sexual maturation and oviposition of *Aphidius ervi* (Hymenoptera: Aphidiidae). *New Zealand Plant Protection* 57: 214-220. 197
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APPENDIX II: Conference Presentations From PhD Study

- 1 He X.Z. and Wang Q. 2008. Operational sex ratio and population density influence partial local mating behaviour in *Aphidius ervi* (Hymenoptera Aphidiidae). Australia and New Zealand Biocontrol Conference, February, Sydney, Australia. 209
- 2 He X.Z. and Wang Q. 2006. Mate age at mating and male mating history affect mate choice and reproduction in *Aphidius ervi* Haliday (Hymenoptera: Aphidiidae). Australian and New Zealand Entomological Societies Conference, September, University of Adelaide, South Australia. 210
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- 6 He X.Z., Wang Q. and Teulon D.A.J. 2003. Effect of aphid life stage and parasitoid adult age on parasitism and sex ratio of *Aphidius eadyi* (Hymenoptera: Aphidiidae). XV International Plant Protection Congress, July, Beijing, China. 214
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- Figure 5.5** Interactions of male (χ_m) and female (χ_f) densities affecting mate competition in *A. ervi*: (A) number of mate competition events performed by males in combinations of different male and female densities ($y = \exp(-2.1592 + 0.4421\chi_m - 0.0173\chi_m^2 + 0.2742\chi_f - 0.0208\chi_f^2)$); (B) predicted number of mate competition events affected by male and female densities 112
- Figure 5.6** Interactions of male (χ_m) and female (χ_f) densities affecting mating success in *A. ervi*: (A) number of mating success in combinations of different male and female densities (CCD: $y = \exp(-1.5704 + 0.2042\chi_m - 0.0092\chi_m^2 + 0.3159\chi_f - 0.0126\chi_f^2)$; $F = 38.40$, $df = 4,201$, $P < 0.0001$, $R^2 = 0.4332$); (B) predicted number of mating success affected by male and female densities 113
- Figure 5.7** Interactions of male (χ_m) and female (χ_f) densities affecting mating period in *A. ervi*: (A) mating period in combinations of different male and female densities ($y = \exp(3.9891 + 0.0155\chi_m)$); (B) predicted mating period affected by male and female densities 115