

**UNIVERSITI TEKNOLOGI MARA**

**THE EMERGENCE BEHAVIOUR,  
LONGEVITY AND FLOWER  
UTILISATION OF *Blastophaga* spp.  
FIG WASPS FROM *Ficus deltoidea*  
AND THEIR PHYLOGENY**

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## ABSTRACT

*Ficus deltoidea* Jack (Moraceae), a dioecious fig tree with seven varieties can be found in Peninsular Malaysia. Their lives mutually depend on fig wasps, *Blastophaga* spp. (Agaonidae), to disperse pollen, which in turn supports the offspring's growth. *Blastophaga quadrupes* is the only described pollinator of this intriguing fig tree species. However, fig wasps of different varieties are known to differ in several entomophily traits. Yet to know how different they are in emergence behaviour, longevity outside figs, and offspring sex ratio, which are likely influenced by their identity. Molecular phylogeny is required to further clarify their relatedness, true identities, and genetic distances. *Blastophaga* spp. of var. *angustifolia*, var. *deltoidea*, and var. *trengganuensis* were collected in Banting, Batu Pahat, and Tembila oil palm plantations, respectively. Studies on fig wasps of var. *trengganuensis* were restricted and only managed to allow phylogeny due to different growth. Emergence and longevity were studied using 36–50 male figs, which resulted in approximately 800 and 1,300 female foundress individuals of var. *angustifolia* and var. *deltoidea*, respectively. *Blastophaga* spp. foundresses of both var. *angustifolia* and var. *deltoidea* mostly emerged between 9:00 a.m. and 13:00 p.m. (Class 2), with a high frequency of emergence occurring and rushing within the earliest cohorts (Cohort 1) of diurnal periods. From post-hoc Fisher's least significant difference (LSD), Cohort 1 was significantly different compared to other emergence cohorts (Cohort 2 to Cohort 8), and the same went for Class 2. Foundress females of var. *deltoidea* significantly lived longer (Median survival estimate: 16 hours) than females of var. *angustifolia* (Median survival estimate: 14 hours) (log-rank test,  $\chi^2 = 20.76$ ,  $df = 1$ ,  $p < 0.001$ ). Their short longevity could have influenced their rushed emergence. Flower utilisation that is reflected by their offspring sex ratios demonstrated female-biasedness with no significant difference between them (independent sample t-test,  $t = 0.12$ ,  $df = 1$ ,  $p > 0.05$ ). Incorporation of phylogenetic analyses has revealed relatively close relatedness among *Blastophaga* spp. from all three varieties based on mitochondrial DNA cytochrome *b* (cyt *b*) and nuclear 28S rRNA. Genetic distances based on cyt *b* ranged from 4.70% to 9.70% and from 0.40% to 1.90% based on 28S rRNA. When they were compared to *B. quadrupes*, the genetic distance ranged from 4.70% to 11.00% based on cyt *b*. This study suggests they were closely-related but not distinct, separate species. Further studies are needed to clarify their identity and species/subspecies status.

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# TABLE OF CONTENTS

	<b>Page</b>
<b>CONFIRMATION BY PANEL OF EXAMINERS</b>	<b>ii</b>
<b>AUTHOR'S DECLARATION</b>	<b>iii</b>
<b>ABSTRACT</b>	<b>iv</b>
<b>ACKNOWLEDGEMENT</b>	<b>v</b>
<b>TABLE OF CONTENTS</b>	<b>vi</b>
<b>LIST OF TABLES</b>	<b>ix</b>
<b>LIST OF FIGURES</b>	<b>x</b>
<b>LIST OF SYMBOLS</b>	<b>xiii</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xiv</b>
<b>CHAPTER ONE: INTRODUCTION</b>	<b>1</b>
1.1 Research Background	1
1.2 Problem Statement	3
1.3 Objectives	5
1.4 Significance of Study	6
1.5 Scope of Limitation	7
<b>CHAPTER TWO: LITERATURE REVIEW</b>	<b>9</b>
2.1 Epiphytic <i>Ficus deltoidea</i> and Its Varieties in Peninsular Malaysia	9
2.2 Obligatory Mutualism Relationship of Figs and Agaonid Fig Wasps	11
2.3 <i>Blastophaga</i> spp., agaonid fig wasps of <i>Ficus</i> fig trees	12
2.3.1 Life of Female and Male Agaonid Fig Wasps Within a Fig	13
2.3.2 Emergence and Life Span of Pollinator Fig Wasps Upon Emergence	16
2.3.3 Sex Ratio of Fig Wasp's Offspring	17
2.4 <i>Blastophaga</i> spp. Fig Wasps of <i>Ficus deltoidea</i> Varieties	19
2.5 Molecular Approaches in Entomology Study on Fig Wasps	20
2.5.1 Mitochondrial <i>cyt b</i> and Nuclear 28S rRNA as Molecular Markers	22
2.5.2 Molecular Phylogenetic Analyses	23

# CHAPTER ONE

## INTRODUCTION

### 1.1 Research Background

*Blastophaga* (Agaonidae) is a genus of fig wasps responsible for pollinating (dispersing pollen) and ovipositing (laying eggs) of fig trees under genus *Ficus* and subsection *Ficus* including *Ficus deltoidea* Jack complex (Moraceae) (Berg & Corner, 2005; Herre et al., 2008). In Malaysia, *Ficus deltoidea* or Mas Cotek (Malay local name) is a species of genus *Ficus*, subgenus *Ficus*, section *Ficus*, and subsection *Frutescentiae* Sata (Berg & Corner, 2005) and composed of many varieties (Kochummen, 1998). Seven varieties of *F. deltoidea* had been discerned in Peninsular Malaysia (Fatihah et al., 2014) and at least three of them thrived as epiphytes in Malaysian oil palm plantations, namely: *F. deltoidea* var. *angustifolia* (Miq.) Corner, *F. deltoidea* var. *deltoidea* Corner, *F. deltoidea* var. *trengganuensis* Corner (Berg & Corner, 2005; Mohd Hatta, 2019). To date, a number of *Blastophaga* fig wasps of *Ficus* spp. have remained unidentified (Weiblen, 2002) and compared to the fig trees, fig wasps, their mutual partners have not received equivalent attention. This leads to a lack of background knowledge either biologically, behaviourally or phylogeny of *Blastophaga* fig wasps which could assist in assessing the degree of strict relationship with their host fig tree species and their mutualistic interaction.

Long history of co-evolution of fig wasps developing and living within the enclosed figs could have majorly led to the adaptation of both their morphology but also behaviour. Only a few studies address the emergence behaviour and longevity of female pollinator fig wasps of *Ficus* spp. (e.g., Kjellberg et al., 1988, Dunn et al., 2008; Zachariades et al., 2010). Fig wasps' emergence behaviour is likely influenced by their ability to disperse and their longevity as soon as they emerge from their natal host figs. They are believed to emerge at a specific period of time (Chen et al., 2021) within a similar time frame when the volatile cues are released (Harrison, 2003) since they are known to have a limited lifespan (Harrison & Rasplus, 2006; Dunn et al., 2008; Sutton et al., 2018). As soon as fig wasps emerge, they do not forage for food and are required to find receptive figs available nearby quickly to give them enough time to oviposit their