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THRIPS POLLEN-CARRYING CAPABILITY OF SOME SELECTED ORNAMENTAL PLANTS

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ABSTRACT

Thrips are generally considered pests because they feed on plant tissue and can transmit viral diseases to their host plants. However, their vast numbers and capacity to travel both short and long distances may also make them effective pollinators. A study was conducted at the Penang Botanical Garden, Malaysia during the flowering season from March to April 2022 to investigate the pollen-carrying potential of thrips on selected ornamental plants, including *Thunbergia erecta*, *Couroupita guianensis, Tabernaemontana corymbosa* 'Flore Pleno', *T. divaricata*, and *Beaumontia murtonii*. A total of 149 thrips from the family Thripidae, comprising six species namely *Thrips hawaiiensis, T. florum, T. levatus, T. parvispinus, T. vitticornis,* and *Ceratothripoides brunneus* were collected. Of these, 51 individuals (34.23%) were recorded as pollinators of ornamental plants, including *T. hawaiiensis* (49.02%), *T. florum* (13.73%), *T. vitticornis* (1.96%), and *C. brunneus* (36.30%). The mean (±SD) number of pollen grains carried by these thrips pollinators ranged from 6.83 (±2.79) to 12.61 (±2.55). This study aims to provide useful insights for future research, particularly regarding thrips pollination at the Penang Botanical Garden.

Keywords: Thrips; pollinator; pollen; ornamental plants

ABSTRAK

Serangga trips secara umumnya dianggap sebagai perosak kerana kecenderungannya untuk memakan tisu tumbuhan dan keupayaannya untuk memindahkan penyakit virus kepada tumbuhan perumah. Namun begitu, jumlah populasi yang tinggi serta keupayaannya untuk bergerak dalam jarak dekat dan jauh juga berpotensi menjadikan ia sebagai agen pendebungaan yang berkesan. Kajian ke atas keupayaan thrips pada debunga tumbuhan hiasan melibatkan *Thunbergia erecta, Couroupita guianensis, Tabernaemontana corymbosa* 'Flore Pleno', *T. divaricata* dan *Beaumontia murtonii* telah dijalankan di Taman Botani Pulau Pinang, Malaysia

pada musim berbunga antara Mac dan April 2022. Sejumlah 149 individu Thysanoptera terdiri daripada satu famili Thripidae dan enam spesies iaitu *Thrips hawaiiensis, T. florum, T. levatus, T. parvispinus, T. vitticornis* dan *Ceratothripoides brunneus* telah dikumpulkan. Sejumlah 51 (34.23%) trip daripada 149 individu Thysanoptera berjaya direkodkan sebagai pendebunga kepada tumbuhan hiasan terdiri daripada *T. hawaiiensis* (49.02%), *T. florum* (13.73%), *T. vitticornis* (1.96%) dan *C. brunneus* (36.30%). Butiran debunga yang dibawa oleh thrips pendebunga di atas mempunyai min (±SD) julat antara 6.83 (±2.79) to 12.61 (±2.55). Kajian ini diharapkan dapat memberi maklumat kepada penyelidik pada masa akan datang terutamanya melibatkan kajian pendebungaan thrips di Taman Botani Pulau Pinang.

Kata kunci: Pendebunga; thrips; tumbuhan hiasan; debunga

INTRODUCTION

Pollination is essential for food production and the survival of flowering plants. Pollinators are rewarded with pollen and nectar from flowering plants (Arenas & Farina 2012; Bezzi et al. 2010; Ng & Ain 2021; Pop et al. 2025), while flowering plants need pollinators to regenerate and proliferate plant diversity. Hymenoptera and Lepidoptera are typically primary insect pollinators. However, as early as the 1900s, scientists concluded that some flowering plant species were pollinated by thrips, based on several important factors: their ability to fly, abundance, active movement within flowers, and their capacity to transfer pollen between plants. In 1914, Shaw detected the presence of thrips with pollen flying across the sugar beet, proving the involvement of thrips in pollination. Since then, many researchers have investigated thrips association in pollination (Hagerup & Hagerup 1953; Kondo et al. 2016; Penalver et al. 2012; Rust 1980; Sakai 2001). Thrips feed on nectar, pollen, plant tissues, and fungi (Kondo et al. 2016). *Thrips hawaiiensis* had been reported as a native pollinator of oil palm in Malaysia, before oil palm weevil*, Elaeidobius kamerunicus* was introduced (Wahid & Kamarudin 1997). Besides, *Neoheegeria* sp. was the main thrips pollinator of *Macaranga hullettii* in Malaysia's rainforest (Moog et al. 2002). Ng and Ain (2021) conducted a study on the species composition of thrips pollinators in *Callerya atropurpurea* (Fabaceae) flowers and found that thrips were the sole pollinators**.**

However, little was known about the pollination ecology of thrips on specific flowering plants species in Malaysia. With a few studies focusing on its function as a pollinator, the majority of thrips ecology research has focused on agriculture and economics. Due to their small size and poor flying abilities, thrips have been overlooked by many researchers who should have recognised their significance in pollen transfer dynamics. Ornamental plants consist of flowering plants which can be found in several botanical gardens in Malaysia. Their existence is not just to beautify landscapes, but also to provide nourishment for animals that depend on them. Ornamental plants obtained were of *T. erecta, C. guianensis, T. corymbosa 'Flore Pleno', T. divaricata and B. murtonii*. Despite the presence of these ornamental plants in Peninsular Malaysia, research on thrips and other insects' pollination mechanisms has been very limited. This study was conducted to determine the species of thrips pollinator and its pollen-carrying capability of selected flowering ornamental plants.

MATERIALS AND METHODS

Study Area

This study was carried out in Penang Botanical Garden, Malaysia (5°26'13"N and 100°17'28"E). It is a well-known botanic garden situated on Jalan Air Terjun in George Town,

Pulau Pinang. Penang Botanical Garden has been designated as Malaysia's third Biosphere Reserve by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and is also listed in the World Network of Biosphere Reserve (WNBR). Penang Botanical Garden is divided into various areas, including a formal garden, a Japanese garden, an orchid house, a fern house, plant nurseries and herb gardens.

Sampling Method

Sampling was conducted during the flowering season from March to April 2022, on three specific dates: March 25, April 2, and April 17. Sampling was performed three times throughout the anthesis period: at the beginning, at peak anthesis, and at the end of the season. Collection of thrips took place between 9 a.m. and 2 p.m., during their active foraging period. Ornamental plants were selected for accessibility to obtain the thrips. A total of 90 flower buds were collected either by hand-searching on the ground or directly from the plants. The flowers, along with the thrips, were then placed in plastic bags. Ethyl acetate was applied to tissue paper and placed in the bags to gradually kill the thrips before dissection.

Specimens Preparation

Specimens of thrips were prepared in the following ways: pollen counting, maceration, washing, dehydration and microscopic slide preparation. For pollen counting, collected flower samples from the research plot were stored in plastic bags. Adult thrips collected on the flowers and the flowers were carefully examined under a microscope. Every flower was dissected to make sure every thrips was seen and counted for pollen on its body. During maceration, specimens were soaked into a weak NaOH (5%) solution for an appropriate period depending on the size of the thrips. The specimens then were transferred into 60% alcohol for about 12 hours for the washing process. Next, during the dehydration process, the specimens were soaked in different alcohol concentrations (70%, 80%, 90%, 100%) with different time duration. Last but not least, clove oil was used to soak the thrips after dehydration was completed. During microscopic slide preparation, thrips were transferred on slides containing sufficient Canada balsam. A 45°C hot plate was then used to dry the slide.

Species Identification

Thrips were identified to genus level using the keys by Mound & Ng (2009), and identification to species level using keys by Mound & Azidah (2009), Ng & Saiful (2018) under an Olympus compound microscope BX41.

Data Analysis

The results of thrips data obtained during the period of sampling were collected and analysed using Microsoft Excel. Mean number of pollen count and standard deviation were analysed using Past 5.2 (Hammer et al. 2001)

RESULTS AND DISCUSSION

Number of Thrips with Pollen

The research found that there were 51 individuals (34.23%) from a total of 149 Thysanoptera with pollen grains attached to their body parts. Table 1 shows several species of Thysanoptera individuals comprising *T. hawaiiensis, T. florum, T. vitticornis* and *C. brunneus* which possibly contributed to the pollination of ornamental plants. 13 individuals of *T. hawaiiensis* were adhered with pollen grain from flowers of *C. guianensis.* Along with their colourful petals, the stamen white hoods and yellow apices are known to reflect UV light, luring thrips and other pollinators. Eighteen individuals of *C. brunneus* had pollens attached from flowers of *T. erecta.*

The abundance and the ability to transport pollen between plants suggest that *C. brunneus* may be an effective pollinator. Many *T. erecta* plants were noticeable in different locations within Penang Botanical Garden.. The effectiveness of *C. brunneus* as the primary pollinator for this plant has not yet been documented, and further research is required to confirm. Whereas, in *B. murtonii*, five individuals of *T. hawaiiensis* were found with pollen on their bodies. The corolla, style, and filaments of *B. murtonii* are so long and open that they provide pollinators with a barrier-free entrance despite the anthers still being attached to the style head (Middleton 2007). The existing floral structure in this way has an impact on pollination that takes place by thrips.

Furthermore, *T. divaricata* had 6 individuals of *T. hawaiiensis* with pollen. Last but not least, *T. corymbosa* 'Flore Pleno' recorded three thrips species that carried pollen in particular *T. hawaiiensis* (1 individuals), *T. florum* (7 individuals) and *T. vitticornis* (1 individual). The primary tropical Apocynaceae are distinguished by an intricate pollination system that encourages cross-pollination. Additionally, functional dioecy has been recently reported in members of this family (Koch et al. 2002). These traits point to a specialised pollination mechanism in the genus that prevents self-pollination. Therefore, they depend on insect pollinators for pollination and reproduction. The thrips were covered with pollen grains which could be found near their abdomen, thorax, wings, mouth, and leg. The quantity and structure of the thrips' setae as well as how sticky the pollen grains are (Pacini & Hesse 2005) would all have an impact on how well they could transport pollen grains. Additionally, it is well known that fully winged species of thrips, like the four species found, are capable of travelling both short and long distances. Therefore, *T. hawaiiensis, T. vitticornis, T. florum* and *C. brunneus* are believed to become pollinators of these ornamental plants based on the collected numbers from the flowers**.**

Table 1. Number of Thysanoptera adhered with pollen grains

Thrips Species	**Selected Plants**				
	C. guianensis	***T. erecta***	***B. murtonii***	***T. divaricata***	***T. corymbosa 'Flore Pleno'***
Ceratothripoides brunneus	0	18	0	0	0
Thrips hawaiiensis	13	0	5	6	1
Thrips florum	0	0	0	0	7
Thrips vitticornis	0	0	0	0	1
Total (individual)	13	18	5	6	9

Pollen Carrying Capacity

The presence of fringed wings in many thrips species enables them to fly effectively which is the most common method to disperse with the help of winds. This helps them to scatter vastly and move quickly in close proximity to plants (Lewis 1973). In theory, these traits make it easier for thrips to transfer pollen. It has been estimated that a single species of thrips can carry between 15 and 30 pollen grains. The varying pollen loads carried by similar thrips species when they visit different species of flowers may be explained by the variation in pollen exine ornamentation as well as the level of pollen production in the various flowers. Thrips offer several advantages that other insects cannot provide, including: a) Thrips live and breed on flowers, allowing them to pollinate plants continuously, even at night. b) With their delicate bodies, thrips can access closed stigmas and anthers that other insects cannot reach. c) Thrips populations increase significantly during the mass-flowering season, enabling them to provide pollination services to a wide range of trees. d) Due to their small size, thrips can easily be

carried by the wind to distant locations. These advantages make thrips important and effective pollinators.

In terms pollen-carrying capacity differences could be observed not only between similar individual's body parts but also among species of thrips. Figure 1 illustrates *T. hawaiiensis* with pollen grain from one of the ornamental plants. Pollen grains may be seen clumped together or individually. The likelihood that a species will be an effective pollinator depends on a variety of factors, including how frequently it visits different flowers and brushes against the stigma and anther while consuming pollen or nectar. The amount of pollen that sticks to the body in this situation is obviously important, and this varies among particular plants. The range of pollen found on thrips pollinators from five ornamental plants was generally between four and 17 grains. The pollen load on an insect's body plays a crucial role in the reproduction of plants. The more pollen grains an insect carries, the higher the chances of flower fertilization. According to Norita et al. (2017), stingless bees have been observed carrying up to 30,000 pollen grains, and this amount is positively correlated with their body weight. Each insect has its own unique advantages when it comes to pollination. Although thrips carry a lower pollen load than bees and butterflies, they offer several unique benefits. Thrips are found in a wider variety of habitats, with nearly all flowers being inhabited by them. They are also present in flowers that open at night or have enclosed stigmas and anthers. In these situations, thrips have a distinct advantage for pollination.

Figure 1. *Thrips hawaiiensis* with pollen grains

Thysanoptera did not always visit *C. guianensis, T. erecta, B. murtonii, T. divaricata,* and *T. corymbosa* 'Flore Pleno' to transfer pollen, but they accidentally deposited pollen from another flower while visiting a flower when they brushed against its reproductive parts. After

that, the plant yields a fruit or seed using the pollen. The thrips which potentially pollinate the selected plants presented different number of pollen loads that adhered to their body as shown in Figure 2. In *C. guianensis*, the average amount of pollen adhered to the thrips pollinator (*T. hawaiiensis*) was 10 grains. The pollen load on the thrips pollinator (*C. brunneus*) in *T. erecta* was 13 grains. The average pollen load of the thrips (*T. hawaiiensis*) that pollinate *B. murtonii* was 12 grains. *T. divaricata* showed an average of pollen load of 7 grains on the thrips pollinator (*T. hawaiiensis*) body and lastly, thrips pollinators (*T. hawaiiensis, T. florum* and *T. vitticornis*) on *T. corymbosa* 'Flore Pleno' displayed average pollen of 9 grains.

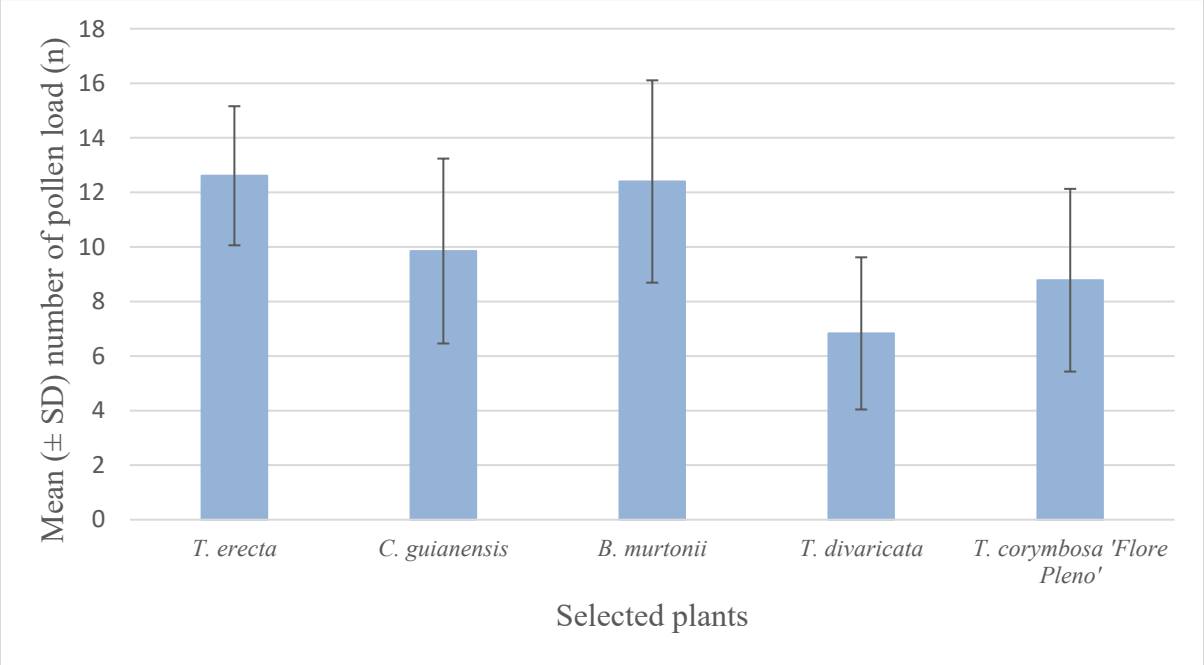

Figure 2. Mean pollen loads capacity for five ornamental plants

Standard deviation (SD) values ranged from 2.55, 3.39, 3.71, 2.79 and 3.35 for five ornamental plants, all of which could be classified as having low SD (Figure 2). The five ornamental plants, there was little difference in the amount of pollen carried by thrips pollinators. This showed that the pollen grains observed adhering to thrips were clustered around the mean pollen load on thrips pollinators. Additionally, in terms of variation, there was little variation in the pollen loads carried by the thrips from the five ornamental plants. Behaviour and foraging habits of insect pollinators are significantly influenced by temperature. Rainfall is one aspect of the environment that might affect how plant-pollinators interact. This is because, in addition to causing a disruption in the time frame of pollinator visit, rain may also have a direct physical impact on flowers and the pollinators that visit them (Lawson & Rands 2019). For example, not all Thysanoptera species had pollen grains adhered to their bodies, although some individuals did.

The morphology of pollen on the selected plants was not studied in depth. The characteristics of the pollen grains on these ornamental plants were described based on prior research. Thrips can carry detectable amounts of pollen more easily because of the pollen's ornamentation and sticky surface. In *C. guianensis*, two different types of stamens produced two different types of pollen. Pollen from the staminal ring appeared as monads while pollen from the hood staminode remained in tetrads. According to observation, thrips carrying pollen

were discovered in the staminal disc and androecial hood of *C. guianensis* flowers. A small amount of a sticky secretion exists on the stigma of *C. guianensis,* aiding in the adhesion of pollen to the surface of the thrips' bodies. According to Ormond et al. (1981), hood pollen, which is nutrient-rich due to its living protoplasm, serves only as food for the pollinators and is essential to the pollination process. There are approximately 450 viable pollen grains per anther in the staminal ring and each one is capable of germination. The pollen grains in stamens that are attached to the androecial hood, on the other hand, can reach a maximum of 3000 per anther and are not viable. In this study, some *T. hawaiiensis* adhered with viable pollen from staminal discs, supporting the pollination.

Next, pollen grains of *T. erecta* are dry, non-sticky, yellowish-white along with spheroidal and spiral-shaped apertures. The exine ornamentations are psilate, granulate, or rarely baculate (Hong-Pin & Chia Chi 2005). These pollen grains' characteristics allow them to adhere to *C. brunneus*, where they unintentionally spread pollen to other plants as they forage inside the flowers. Moreover, *T. divaricata* species were endowed with pollen grains that were small in size and spheroidal (Hanan et al. 2020). In the matter of *B. murtonii,* its pollen grains typically exhibit four or five stephanoporate. However, the pollen characteristics of *T. corymbosa* 'Flore Pleno' remain unknown. The evidence of pollen load captured in the body of the thrips could suggest that the thrips may be pollinators for these ornamental plants, but the extent of their pollination's effectiveness could not be determined.

CONCLUSIONS

A total of four species of thrips pollinators, including *T. hawaiiensis, T. vitticornis, T. florum,* and *C. brunneus* were successfully identified based on the number of individuals and pollen carried by the thrips. These four species carried between 4 to 17 grains of pollen. The discovery of the pollen indicated these thrips were the pollinators of the ornamental plants, but further studies need to be accomplished to observe the frequency of thrips visitations to the flowers. Although thrips are small insects, they are equipped with setae and wings that assist in pollen transfer and contribute to the successful pollination process. Future improvements to this study could include longer sampling periods and dynamic monitoring of thrips population density and flower preferences over time. Additionally, identifying pollen species and observing thrips' active pollination behavior at stigmas and anthers would strengthen the research.

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AUTHORS DECLARATIONS

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Conflict of Interest
No conflict of interest

Ethics Declarations
No ethical violations

Data Availability Statements
The data from this study were obtained from a master's thesis research project entitled 'Pollen Loading Capacity of Thrips on Several Ornamental Plants'

Author's Contributions
Nurul Hanani Ahmad (NHA) collected thrips samples, prepared slides, analyzed the data, and drafted the initial version of the manuscript.Ng Yong Foo (NYF) identified the all thrips species, rewrite and revised the manuscript.

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