



REPRODUCTION OF *Helopeltis theivora* Waterhouse (HEMIPTERA: MIRIDAE) AND EGG PARASITOID CHARACTERISTICS OF *Helopeltis* spp. INFESTING *Eucalyptus* IN PT TOBA PULP LESTARI AND PT RIAU ANDALAN PULP AND PAPER, SUMATRA

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**STUDY PROGRAM OF ENTOMOLOGY
FACULTY OF AGRICULTURE
IPB UNIVERSITY
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2026**



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RINGKASAN

WILDATUR ROHMAH. Reproduksi *Helopeltis theivora* Waterhouse (Hemiptera: Miridae) dan Karakteristik Parasitoid Telur *Helopeltis* spp. pada Tanaman *Eucalyptus* di PT Toba Pulp Lestari dan PT Riau Andalan Pulp and Paper, Sumatra. Dibimbing oleh PURNAMA HIDAYAT, DAMAYANTI, dan KODAK KADAN SRIKUMAR

Serangga mirid *Helopeltis* spp. (Hemiptera: Miridae) merupakan hama penting pada tanaman *Eucalyptus* di Indonesia. Serangga ini menyerang pucuk dan daun muda yang menyebabkan bercak tusukan, lesi nekrotik, pengeringan pucuk, pertumbuhan tanaman terhambat, hingga kematian tanaman muda. Parasitoid telur berpotensi dimanfaatkan sebagai agens pengendali hayati, namun informasi mengenai jenis, karakter biologis, dan perannya pada ekosistem *Eucalyptus* di Indonesia masih terbatas. Selain itu, pemahaman mengenai kapasitas reproduksi *Helopeltis theivora* pada inang yang berbeda diperlukan untuk mendukung pemeliharaan serangga dan penyediaan telur inang dalam penelitian parasitoid. Penelitian ini bertujuan untuk (1) membandingkan kapasitas reproduksi *H. theivora* pada dua jenis tanaman inang, (2) mengidentifikasi parasitoid telur yang berasosiasi dengan telur *Helopeltis* spp. pada *Eucalyptus* di PT Toba Pulp Lestari (TPL) dan PT Riau Andalan Pulp and Paper (RAPP), (3) mendeskripsikan kelimpahan dan karakter biologis parasitoid telur, serta (4) menganalisis faktor-faktor ekologis utama yang secara kondisional memengaruhi tingkat parasitisasi pada telur *Helopeltis* spp.

Penelitian dilaksanakan pada Mei 2024–Januari 2025. Uji reproduksi *H. theivora* dilakukan pada 20 pasang imago berumur satu hari yang berasal dari generasi pertama (F1) hasil pemeliharaan induk lapangan. Pengujian dilakukan pada dua jenis tanaman inang, yaitu pucuk *Eucalyptus* dan buah mentimun, dengan penggantian inang setiap hari hingga betina mati. Variabel yang diamati meliputi masa oviposisi, keperidian, produksi telur harian, dan lama hidup betina. Sampel telur *Helopeltis* spp. pada tanaman *Eucalyptus* dikoleksi secara *purposive* dari pohon bergejala serangan di tiga perkebunan TPL dan tiga Perkebunan RAPP, kemudian dipelihara hingga parasitoid muncul. Parasitoid diidentifikasi berdasarkan karakter morfologi dan disusun kunci dikotomi. Variabel parasitoid yang diamati meliputi komposisi jenis, tingkat parasitisasi, masa inkubasi, tingkat pemunculan parasitoid, rasio jenis kelamin, dan kepadatan telur per ranting.

Data dianalisis menggunakan Microsoft Excel 365 dan RStudio (Version 2024.9.01+94). Data reproduksi *H. theivora* pada dua tanaman inang dianalisis menggunakan uji dua sampel (uji t, uji t Welch, atau uji Wilcoxon) berdasarkan hasil uji normalitas dan homogenitas ragam. Data kepadatan telur per ranting dianalisis menggunakan Welch ANOVA yang dilanjutkan dengan uji Games–Howell pada taraf signifikansi 5%. Data jumlah parasitoid telur dianalisis menggunakan ANOVA satu arah yang dilanjutkan dengan uji Tukey HSD. Selain itu, analisis *Conditional Inference Tree* (CIT) digunakan untuk mengidentifikasi faktor ekologis utama yang memengaruhi tingkat parasitisasi berdasarkan uji independensi berbasis permutasi ($\alpha = 0,05$).

Hasil penelitian menunjukkan bahwa kapasitas reproduksi *H. theivora* dipengaruhi oleh jenis tanaman inang. Individu yang dipelihara pada mentimun



memiliki keperidian (112,4 telur per betina) dan produksi telur harian (10,6 telur per hari) lebih tinggi dibandingkan pada pucuk *Eucalyptus*, sehingga mentimun lebih sesuai digunakan sebagai inang alternatif untuk pemeliharaan *H. theivora* di laboratorium. Kepadatan telur *Helopeltis* spp. berbeda nyata antara perkebunan di TPL dan RAPP. Pada penelitian ini ditemukan tiga parasitoid telur, yaitu *Chaetostricha* sp. (Hymenoptera: Trichogrammatidae), *Erythmelus helopeltidis* (Hymenoptera: Mymaridae), dan *Telenomus* sp. (Hymenoptera: Scelionidae). Kunci dikotomi parasitoid telur juga berhasil disusun untuk mendukung identifikasi. Komunitas parasitoid didominasi oleh *Telenomus* sp. dengan tingkat kelimpahan dan persentase parasitisasi tertinggi mencapai 37,3%. Secara biologis, *E. helopeltidis* memiliki masa inkubasi lebih singkat (8,27 hari) dan tingkat pemunculan (44%) lebih tinggi dibandingkan dua jenis parasitoid lainnya. Rasio jenis kelamin dari tiga jenis parasitoid cenderung bias betina. Hasil analisis CIT menunjukkan bahwa jumlah spesies parasitoid merupakan faktor ekologis utama yang memengaruhi tingkat parasitisasi telur *Helopeltis* spp. Hasil penelitian ini memberikan informasi dasar yang penting dalam pengembangan musuh alami sebagai agens pengendali hayati *Helopeltis* spp. pada perkebunan *Eucalyptus* di Indonesia.

Kata kunci: keperidian, pengendalian hayati, periode inkubasi, rasio jenis kelamin, tingkat parasitisasi

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SUMMARY

WILDATUR ROHMAH. Reproduction of *Helopeltis theivora* Waterhouse (Hemiptera: Miridae) and Egg Parasitoid Characteristics of *Helopeltis* spp. Infesting *Eucalyptus* in PT Toba Pulp Lestari and PT Riau Andalan Pulp and Paper, Sumatra. Supervised by PURNAMA HIDAYAT, DAMAYANTI, and KODAK KADAN SRIKUMAR

Mirid bugs of the genus *Helopeltis* spp. (Hemiptera: Miridae) are major pests of *Eucalyptus* in Indonesia. These insects attack young shoots and leaves, causing puncture marks, necrotic lesions, shoot dieback, stunted growth, and even mortality of young plants. Egg parasitoids have potential as biological control agents; however, information on their species composition, biological characteristics, and ecological roles in *Eucalyptus* ecosystems in Indonesia remains limited. In addition, understanding the reproductive performance of *Helopeltis theivora* on different host plants is essential to support insect rearing and the provision of host eggs for parasitoid studies. This study aimed to (1) compare the reproductive performance of *H. theivora* on two host plants, (2) identify egg parasitoids associated with *Helopeltis* spp. eggs on *Eucalyptus* in PT Toba Pulp Lestari (TPL) and PT Riau Andalan Pulp and Paper (RAPP), (3) describe the abundance, parasitism rate, and biological characteristics of egg parasitoids, and (4) analyze the main ecological factors influencing parasitism rates of *Helopeltis* spp. eggs.

The study was conducted from May 2024 to January 2025. Reproductive performance tests of *H. theivora* were conducted using 20 pairs of one-day-old adults derived from the first generation (F1) of field-collected populations. The experiments were carried out on two host plants, *Eucalyptus* shoots and cucumber, with daily replacement of host material until female death. Observed variables included oviposition period, fecundity, daily egg production, and female longevity. Egg samples of *Helopeltis* spp. on *Eucalyptus* were collected purposively from infested trees in three TPL estates and three RAPP estates, then reared until parasitoid emergence. Parasitoids were identified based on morphological characteristics, and a dichotomous key was constructed. Observed parasitoid variables included species composition, parasitism rate, incubation period, emergence rate, sex ratio, and egg density per branch.

Data were analyzed using Microsoft Excel 365 and RStudio (Version 2024.9.01+94). Reproductive performance data of *H. theivora* on the two host plants were analyzed using two-sample tests (t-test, Welch's t-test, or Wilcoxon test) based on data normality and variance homogeneity. Egg density per branch was analyzed using Welch ANOVA followed by the Games–Howell post hoc test at a 5% significance level. The number of egg parasitoids was analyzed using one-way ANOVA followed by Tukey's HSD test. In addition, Conditional Inference Tree (CIT) analysis was applied to identify the main ecological factors influencing parasitism rates based on permutation-based independence tests ($\alpha = 0.05$).

The results showed that the reproductive performance of *H. theivora* was influenced by host plant species. Individuals reared on cucumber exhibited higher fecundity (112.4 eggs/female) and daily egg production (10.6 eggs/day) than those reared on *Eucalyptus* shoots, indicating that cucumber is a more suitable alternative host plant for laboratory rearing of *H. theivora*. Egg density of *Helopeltis* spp.

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differed significantly between TPL and RAPP estates. Three egg parasitoids were recorded in this study: *Chaetostricha* sp. (Hymenoptera: Trichogrammatidae), *Erythmelus helopeltidis* (Hymenoptera: Mymaridae), and *Telenomus* sp. (Hymenoptera: Scelionidae). A dichotomous key was successfully developed to support identification. The parasitoid community was dominated by *Telenomus* sp., with the highest abundance and parasitism rate reaching 37.3%. Biologically, *E. helopeltidis* exhibited a shorter incubation period (8.27 days) and a higher emergence rate (44%) than the other parasitoid species. Parasitoid sex ratios were generally female-biased. CIT analysis identified parasitoid species richness as the main ecological factor influencing parasitism rates of *Helopeltis* spp. eggs. These findings provide important baseline information for the development of natural enemies as biological control agents against *Helopeltis* spp. in *Eucalyptus* plantations in Indonesia.

Keywords: biological control, fecundity, incubation period, parasitism rate, sex ratio

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WILDATUR ROHMAH

Thesis
as one of the requirements to obtain
a Master of Science degree in
Entomology Study Program

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FOREWORD

All praise and gratitude are due to Allah *Subhanahu Wa Ta'ala* for His boundless mercy and guidance, through which this work has been successfully completed. This research examines egg parasitoids as natural enemies of other insects, emphasizing their vital role in maintaining ecological balance. Within the vast universe created by Allah—encompassing galaxies, oceans, and mountains—every creature, no matter how small, including the egg parasitoids studied herein, exists in perfect harmony, each fulfilling its unique function as ordained by Allah. A profound reminder of this divine order is found in the Qur'an:

وَخَلَقَ كُلَّ شَيْءٍ فَقَدَرَهُ تَقْدِيرًا

“...it is He who created everything (all things) and ordered them in due proportions’ (Al-Furqan 25:2).

This verse affirms the wisdom inherent in Allah’s precise creation, in which every element of nature, including microscopic insects, holds an essential role in sustaining ecological balance. Accordingly, the author selected this research theme out of a deep interest in exploring the potential of insects to preserve the harmony of natural ecosystems, while simultaneously reducing reliance on synthetic pesticides that cause persistent environmental degradation.

The author extends sincere and profound gratitude to the supervisors, Prof. Dr. Ir. Purnama Hidayat, M.Sc., Prof. Dr. Ir. Damayanti, M.Sc., and Dr. Kodak Kadan Srikumar, B.Sc., M.Sc., for their patience and guidance, invaluable advice, and insightful contributions throughout the preparation of this thesis. The author also expresses appreciation to the seminar moderator and the external examiners for their thorough and constructive evaluations. Sincere appreciation is extended to the Ministry of Education, Culture, Research, and Technology for its full support through the *Beasiswa Unggulan* Program, which enabled the author to pursue and complete the master’s degree. The author also expresses profound gratitude to PT Toba Pulp Lestari and PT Riau Andalan Pulp and Paper for providing opportunities for research collaboration, as well as to all laboratory staff and field teams whose dedicated assistance was invaluable during data collection in both field and laboratory settings.

Throughout the process of completing this thesis, the author encountered numerous challenges, all of which were overcome through the unwavering support of her beloved parents, Abuya Muhammad Hayatul Ikhsan and Ummi Nur Mahmudah. With great patience, they accompanied her on her journey, offering continuous encouragement and consistently placing their trust in every step their daughter took. The author expresses her deepest gratitude for their boundless love and prayers. Deep appreciation is also extended to the family of YPP Miftahul Ulum Bengkak for their sincere prayers and support, which contributed greatly to the smooth completion of this work. Finally, the author acknowledges that this thesis may still contain certain limitations and imperfections. May this thesis benefit those in need and contribute to the advancement of knowledge

Bogor, May 2026

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