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# MASS REARING OF *Platynopus melachantus* BOISDUVAL (HEMIPTERA: PENTATOMIDAE)

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## ABSTRACT

The mass rearing of predator insects for biological control in agricultural areas, such as oil palm has gained significant interest as a sustainable approach for pest management. This research focuses on evaluating the mass rearing system and biological characteristics of *Platynopus melachantus* Boisduval, a potential biological control agent for leaf-eating pests. Result of this study revealed that the *P. melachantus* has a high fecundity rate of 133.25±32.92 eggs/female, making it a promising candidate for mass-rearing programs. High percentage of egg hatching (84.81±2.45%) and moderate survival rate of nymphs to become an adult (56.08±3.64%) demonstrate the success of the rearing process. Results also documents the developmental stages and lifespan of *P. melachantus*, with a total lifecycle duration of 122.48±10.53 days and five instar stages. This study highlights the effectiveness of *T. molitor* larvae as a suitable diet for the mass rearing of predator insects. This study suggested the utilization of *Tenebrio molitor* larvae and pupae as the primary food source is possible in controlled laboratory environment.

**Keywords:** Asopine bug, mealworm, predator, biological control, nettle caterpillar

## ABSTRAK

Penternakan massa serangga pemangsa sebagai kawalan biologi dalam sektor pertanian, seperti ke atas kelapa sawit telah menarik minat besar sebagai pendekatan lestari dalam pengurusan serangga perosak. Kajian ini memberi tumpuan kepada penilaian sistem penternakan dan ciri-ciri biologi *Platynopus melachantus* Boisduval, agen kawalan biologi yang berpotensi untuk mengawal perosak pemakan daun. Kajian ini mendedahkan kadar keupayaan *P. melachantus* untuk menghasilkan telur yang tinggi pada 133.25±32.92 telur/betina, menjadikannya calon yang sesuai untuk program penternakan ini. Peratusan kematangan telur yang tinggi (84.81±2.45%) dan kadar kelangsungan hidup sederhana nimfa menjadi dewasa (56.08±3.64%) menunjukkan kejayaan dalam proses pembiakan. Kajian ini juga mendokumentasikan peringkat perkembangan dan jangka hayat *P. melachantus*, dengan jangka hayat keseluruhan selama 122.48±10.53 hari dan lima peringkat nimfa. Kajian ini menunjukkan keberkesanan larva *T. molitor* sebagai diet yang sesuai untuk pemeliharaan serangga pemangsa ini. Kajian ini khususnya mengkaji penggunaan larva dan pupa *Tenebrio molitor* berkemungkinan sebagai sumber makanan utama dalam persekitaran makmal yang terkawal.

**Katakunci:** Serangga Asopine, ulat tepung, pemangsa, kawalan biologi, Ulat Hama Api

## INTRODUCTION

In recent years, there has been a growing interest in mass-rearing predator insects for biological control purposes in agricultural areas, particularly oil palm plantations (Parra & Coelho Jr 2022). Mass release of predatory insects provides a means of ensuring the presence of numbers that are adequate to maintain pest populations at the desired level (Takahashi 2001). One reason for this is the increasing demand for sustainable pest management methods that do not rely on harmful chemicals or pesticides in adopting good agricultural practices (GAP) (Fuat et al. 2022; Kamarudin et al. 2019). Rearing of predatory insects in large quantities can be an economical and sustainable strategy to control pest populations and encourage healthy crop production. An assassin bug, *Sycanus dichotomus* mass-rearing was estimated to cost RM0.15 per individual by feeding reared prey, *Tenebrio molitor* in a simple laboratory setting (Ahmad et al. 2020a). Researchers have explored various methods for mass-rearing predatory insects, including artificial diets, controlling environmental variables like humidity and temperature, and optimizing rearing settings (Jamian et al. 2017; Nasir et al. 2018).

The adult asopine bug, *Platynopus melachantus*, has been identified as a potential biological control agent for leaf-eating pests such as nettle caterpillars and bagworms (Khoo & Chan 2000). *Platynopus melachantus* Boisduval (Hemiptera: Pentatomidae) is one of the seven hemipteran predator species found in the Beluran district, along with *Eochanthecona furcellata* (Hemiptera: Pentatomidae), *Sycanus annulicornis, S. affinis, Cosmolestes picticeps*, *Velinus nigrigenu* and *Campsolomus nr.* sp. (Hemiptera: Reduviidae) (Harris Nasir et al. 2023). To sustain the predator insect population and reduce the impact of leaf-eating pests, some of these species have been studied as potential biological control agents to be mass-reared and released into the plantations. Among these species, *Sycanus* sp. (Poopat & Maneerat 2021; Sahid & Natawigena 2018; Syari et al. 2011), *C. picticeps* (Azlina & Tey 2011), *V. negrigenu* (Azhari et al. 2024) and *Eocanthecona furcellata* (Rustam & Gani 2019) are particularly promising due to their ability to survive and grow in a simple laboratory setting and easy to be handle.

However, there is no recorded publication detailing the status and information regarding the mass rearing of *P. melachantus* in a simple laboratory system.

Leaf-eating pests are major concerns in oil palm plantations, as they can cause extensive damage to the crop resulting in significant economic losses. Among the most common leaf-eating pests in oil palm plantations are the nettle caterpillar (*Setora nitens* and *Setothosea asigna*) (Darus et al. 2000) and bagworm (such as *Metisa plana* and *Pteroma pendula*) (Wood & Kamarudin 2019). In addition to predator insects, the application of entomopathogenic fungi, such as *Beauveria bassiana*, *Metarhizium anisopliae* and *Cordyceps militaris*, as biological control agents have demonstrated encouraging outcomes in managing pests such as *Oryctes* larvae, *S. asigna,* and *D. trima* larvae (Priwiratama & Susanto 2014). However, the effectiveness of these methods can be influenced by the surrounding vegetation, with non-oil palm habitats showing higher predation rates (Nurdiansyah et al. 2016). Severe damage can be caused by nettle caterpillar infestations, with yield losses of up to 70% in the first year after defoliation and up to 90% if the attack persists in subsequent years (Sudharto et al. 2003). Additionally, Norman and Basri (2007) reported that bagworm infestations caused damage to 49,151.63 hectares of oil palm plantations in Malaysia between 2000 and 2005. These pests are challenging to control using conventional methods, such as pesticides, due to their resistance to chemicals and the potential harm they pose to the environment and non-targeted organisms.

Integrated Pest Management (IPM) has been proposed as a sustainable approach to controlling leaf-eating pests in oil palm plantations. This approach involves the use of a combination of strategies, including biological, mechanical and chemical methods, to manage pest populations (Sulaiman 2021). In oil palm plantations, insect's pest can be effectively managed through both mechanical methods, including manual removal, pruning, destruction of breeding sites (Bedford 2014; Mazmira et al. 2011) and pheromone trapping (Santi et al. 2022) and chemical methods, employing insecticides such as carbofuran and cypermethrin alongside biopesticides like *Bacillus thuringiensis* and *Beauveria bassiana* for targeted action with reduced environmental impact (Ali et al. 2011). Biological control, which involves the use of natural enemies, such as predatory insects, to suppress pest populations, has been identified as a crucial component of IPM. To reduce the reliance on synthetic pesticides and promote a more sustainable approach to pest management, mass rearing of predatory insects in the laboratory has been discussed as a viable method for their large-scale deployment in the field (Sørensen et al. 2012). The aim of this study is to determine the mass-rearing technique and biological characteristics of *P. melachantus* in laboratory.

## MATERIALS & METHODS

### Environmental Conditions and Insects Sampling

The research was conducted at theIOI Research Centre Sabah Insectary in Sandakan, Sabah, Malaysia The laboratory had a good ventilation system with average temperature of (28.55±0.1°C), a photoperiod of 12:12 (L:D) hours, and a humidity of (78.15±0.3 RH) which was monitored by a digital hygrometer (Ahmad et al. 2020b). The parent population of 15 pairs of *P. melachantus* was sourced from five IOI oil palm plantations in the Beluran district, Sandakan, and the Sime Darby Plantation Research Sdn Bhd in the Tawau region.

**Insect Rearing**

These adult specimens were accommodated in 15 separate collapsible insect cages, each measuring 40 cm x 40 cm x 60 cm and were provided with fresh *Antigonon leptopus* plants as a substrate for egg-laying and as hiding spots to simulate their natural environment. The study employed an observation method, monitoring the growth and development of these pairs and their offspring, feeding them with mealworm larvae (*T. molitor*). Adult *P. melachantus* preyed on these larvae, whereas nymphs in instars 1 to 3 were given pupae (to reduce prey movement and better suit the early nymph stages) and tissues soaked in a 10% honey solution. Nymphs in instars 4 to 5 were provided with larvae as their food source. Food was provided daily to the insects, and the containers they were housed in were cleaned every day to maintain a controlled and sanitary environment.

**Life Cycle Study**

Observed eggs were carefully transferred to transparent, round, disposable plastic containers (3000 ml) equipped with wire mesh lids and lined with tissue layers to simulate a conducive habitat for development. The lifespan of *P. melachantus* individuals was determined by tracking the period from their emergence (instar 1) through to the adult stage until death, offering a comprehensive view of their life cycle within the study's parameters.

**Statistical Analysis**

Photographic documentation was done using a RaxVision stereomicroscope with DinoCapture 2.0 software. Collective data including the average size of the *P. melachantus* at each stage, the number of eggs laid, fecundity rates, hatching percentages, survival rates, and the lifespan of each developmental stage were analysed using Minitab 19.0 software (Minitab 2021).

## RESULTS & DISCUSSION

The study evaluated the mass rearing of *P. melachantus*, a predatory insect for bagworm and nettle caterpillar (Figure 1) using *T. molitor* larvae and pupae as their primary diets. Table 1 shows the results of the observations made in the insectary regarding the number of eggs/clusters, fecundity, hatch percentage, and survival rate of *P. melachantus.* The female adults started ovipositing on the 16.34±2.74 days after they were paired with male imago. The study's findings revealed that the average number of eggs/clusters was 26.47±2.74, with an average fecundity of 133.25±32.92 eggs/female. The eggs of *P. melachantus* are bright black in colour with a surface of shiny silver in colour in the shape of cylinder with a hemisphere on the top. The percentage of egg hatch was 84.81±2.45 %, and the survival rate was 56.08±3.64%. These results suggest that the rearing process of *P. melachantus* was successful, with a relatively high percentage of egg hatch and a moderate survival rate. The high fecundity of *P. melachantus* indicates that it is a prolific breeder, which makes it a promising candidate for mass rearing programs.

Table 1**.** Mean number of eggs collected, fecundity, percentage of egg hatched and survival rate of *P. melachantus* in the insectary

| **Observation** | Number of Eggs/Clusters | Fecundity (Egg/Female) | Hatch Percentage (%) | Survival Rate (%) |
|---|---|---|---|---|
| **Average±SE** | 26.47±2.74 | 133.25±32.92 | 84.81±2.45 | 56.08±3.64 |


Figure 1. The *P. melachantus* nymphs feed on *S. nitens* using its long proboscis

The results of our study indicate the successful rearing of *P. melachantus*, with a high percentage of egg hatch and a moderate survival rate. This fecundity pattern is in line with findings from *E. furcellata*, another closely related species in the Pentatomidae family. For instance, Rustam & Gani (2019), reported an average fecundity of 134.88 eggs per female adult in laboratory conditions, which is comparable to our findings. However, Ibrahim et al. (2011), found that continuous feeding of *Cantheconidea furcellata* with mealworms resulted in the highest number of eggs laid, with 1013 eggs per female. In comparison, the combination of rice moth larvae rice moth larvae, *Corcyra cephalonica* (Lepidoptera: Pyralidae) and mealworm with banana leaf rollers, *Erionota thrax* (Lepidoptera: Hesperiidae) produce 349 and 901 eggs, respectively. These findings demonstrate the influence of diet on the fecundity of the predator *E. furcellata*. In addition, the fecundity of *E. furcellata* reared on two major crucifer pests, *Spodoptera litura* (Lepidoptera: Noctuidae) and *Plutella xylostella* (Lepidoptera: Plutellidae) recorded a total number of eggs of 829.1 and 725.6, respectively (Tuan et al. 2016). They also reported a high percentage of viable eggs (≥80%), which aligns with the data presented in our study. Similar to *E. furcellata*, *P. melachantus* can also benefit from specific dietary provisions to optimize fecundity and viability, indicating the potential for targeted diet strategies to enhance mass rearing efforts. In this study, where *P. melachantus* was fed primarily with *T. molitor* larvae and pupae, and observed an average fecundity of 133.25±32.92 eggs per female. Although not reaching the peak fecundity observed in the previous study, this findings suggest that diet remains a significant factor in reproductive success.

The mean lifespan of *P. melachantus* at different developmental stages is presented in Table 2. The species undergoes incomplete metamorphosis, with five nymph stages that resemble the adults but with smaller body size and lack of wings (Figure 2). The nymphs have a smaller body size compared to adults. The head and body of the nymphs are dark black in colour, while their abdomen is bright red or orange, with a black strip running along the edge and middle of their abdomen (Figure 3). As for the adults, they have a brown coloration with a large scutellum. The eggs took 6.47±0.24 days to hatch, and the nymphal stages ranged from mean of 3.47±26 to 4.15±0.28 days. The first instar nymph lasts for mean of 3.65±0.25 days, followed by the second, third, fourth, and fifth instar nymphs, which last for 3.79±0.16, 3.85±0.21, 4.15±0.28, and 3.47±0.26 days, respectively. The adult stage had the longest lifespan with an average of 97.09±9.12 days and the total life cycle lasts for an average of 122.48±10.53 days.

Table 2. Mean Lifespan (days) of the *P. melachantus* fed with *T. molitor* larvae and pupae

| **Stages** | **Life Cycle (Days)±SE** |
|---|---|
| Egg incubation period | 6.47±0.24 |
| 1st Instar nymph | 3.65±0.25 |
| 2nd Instar nymph | 3.79±0.16 |
| 3rd Instar nymph | 3.85±0.21 |
| 4th Instar nymph | 4.15±0.28 |
| 5th Instar nymph | 3.47±0.26 |
| Adult | 97.09±9.12 |
| Total Life cycle | 122.48± 0.53 |

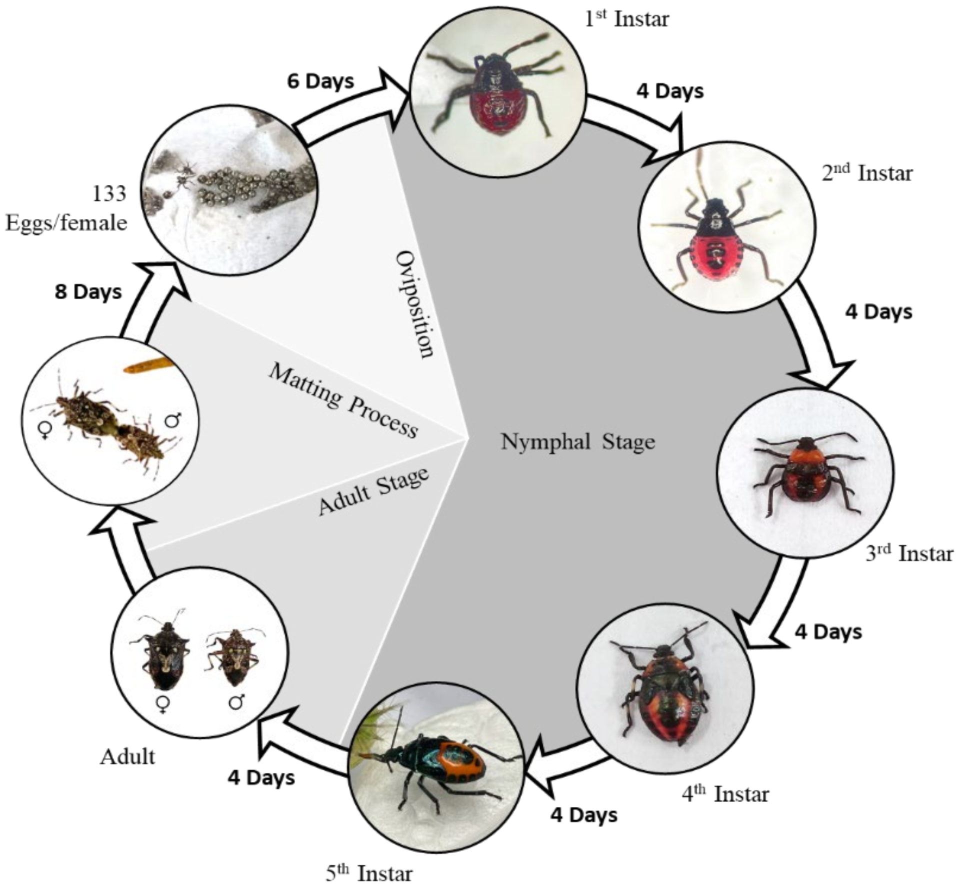


Figure 2. Life cycle of predator, *P. melachantus* fed *T. molitor* in a laboratory condition

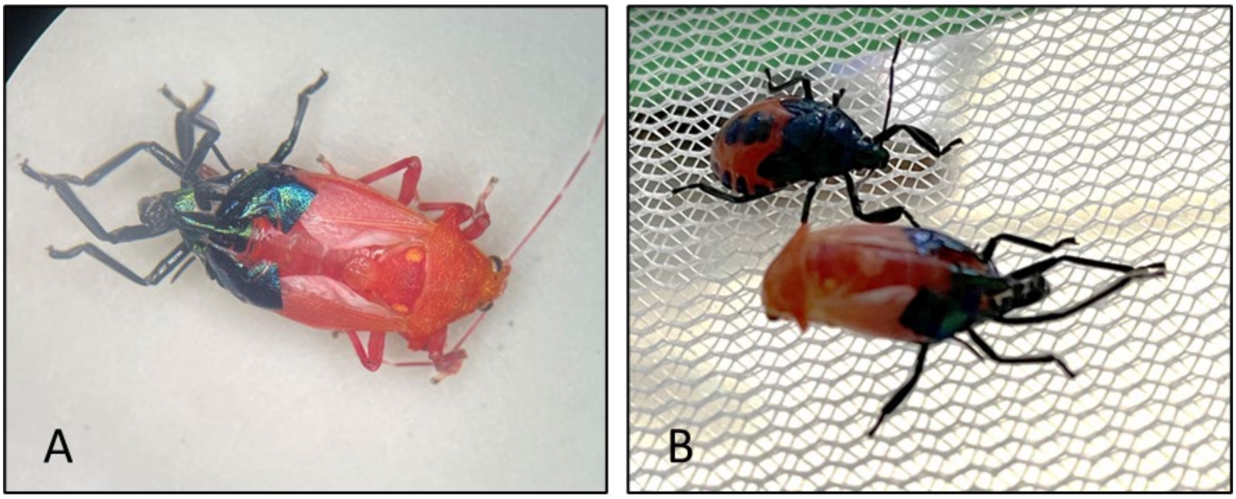


Figure 3. A) *P. melachantus* nymphs moulting into adults. B) Instar 4 nymphs moulted into instar 5 nymphs

The information provided in Table 2 is useful for predicting the timing of key developmental events in the life cycle of *P. melachantus*, which can be used to optimize rearing conditions and maximize the production of viable adults. It has been observed that when compared to insects fed with alternative diets like *C. cephalonica* larvae, the development time of *S. annulicornis* (Sahid & Natawigena 2018) and *S. dichotomus* (Ahmad & Kamarudin 2016) in laboratory setting has resulting in a longer development time from the first instar to adulthood. The total development period of *S. dichotomus* nymph take around 115.1 days with *T. molitor,* whereas it reduces to 97.6 days when fed with *C. cephalonica*. In our study, the total life cycle and development of *P. melachantus* nymphs was approximately 18.91±0.11 days, although no comparison with other diet sources was made. However, *S. dichotomus* nymphs fed with *T. molitor* larvae exhibit a higher survival rate of 81% to reach adulthood, while only 76% of the nymphs fed with *C. cephalonica* successfully develop into adults (Syari et al. 2011). These findings underscore the effectiveness of *T. molitor* larvae as an optimal diet for the mass rearing of biological control insects.

The width and length, indicating the growth and development for each staged is showed in Table 3. The 1st instar nymphs have the smallest size, with an average width of 1.70±0.81 mm and length of 1.80±0.81 mm, while the 5th instar nymphs exhibit a substantial increase in size, with an average width of 5.70±0.21 mm and length of 10.90±0.18 mm. The measurements for adult males and females show further growth and larger body size compared to the final nymphal stage. Adult males have an average width of 5.82±0.12 mm and length of 11.00±0.38 mm, while adult females have an average width of 6.46±0.29 mm and length of 12.25±0.35 mm. This sexual dimorphism in size is a common characteristic in many insect species, where females tend to be larger than males (Sahid & Natawigena 2018: Yuliadhi et al. 2015).

Table 3. Measurements of the length and width of *P. melachantus* life stages

| **Stages** | **Width(mm)** | **Length(mm)** |
|---|---|---|
| 1st Instar nymph | 1.70±0.81 | 1.80±0.81 |
| 2nd Instar nymph | 1.85±0.06 | 2.80±0.10 |
| 3rd Instar nymph | 3.27±0.18 | 5.27±0.20 |
| 4th Instar nymph | 4.55±0.16 | 6.82±0.23 |
| 5th Instar nymph | 5.70±0.21 | 10.90±0.18 |
| Male | 5.82±0.12 | 11.00±0.38 |
| Female | 6.46±0.29 | 12.25±0.35 |

## CONCLUSION

In conclusion, the study successfully reared *P. melachantus* using *T. molitor* larvae and pupae as their primary diets. The results showed a high percentage of egg hatch (84.81±2.45%) and a moderate survival rate (56.08±3.64%), indicating the success of the rearing process. The species exhibited a high fecundity with an average of 133.25±32.92 eggs/female, suggesting its potential for mass rearing programs. The study also provided insights into the developmental stages and lifespan of *P. melachantus*, with the total lifecycle lasting for an average of 122.48±10.53 days. Additionally, the findings highlighted the importance of diet in influencing fecundity and development time, with *T. molitor* larvae proving to be an effective diet for the mass rearing of this biological control insect. The information on size measurements revealed sexual dimorphism, with adult females being larger than males, a common characteristic in many insect species. This study highlighted the potential of *P. melachantus* as an additional predator insect to the successful mass rearing of other beneficial species such as *Sycanus* sp.

and *E. furcellata* presents promising opportunities for integrated pest management strategies as a sustainable approach to controlling bagworm populations in oil palm plantations.

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**Conflict of Interest**

The authors declare that they have no conflict of interest.

**Ethics Declarations**

No ethical issue required for this research.

**Data Availability Statement**

My manuscript has no associated data.

**Authors' Contributions**

The conceptualization of this study was carried out by Mohamad Harris Nasir (MHN), Mohanaraj Sithampalanadanarajah (MS), Muhammad Hafiz Aiman (MHA), and Joshua Mathew (JM). The methodology was developed by MHN and MHA. MHN and MHA also conducted the formal analysis and investigation. MHN prepared the original draft of the manuscript, while the writing, review, and editing process involved contributions from MHN, MS, MHA, LW, and JM. The resources for the study were provided by MHN, MS, MHA, LW, and JM. All authors read and approved the final manuscript.

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