

# Arthropods Diversity on Sugar Palm Plantation with Vegetation Addition Refugia Flowering Plants

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## Abstract

Arthropods abundance is one of the factors that affect the growth of sugar palm plants. This study aims to examine the diversity of arthropods in sugar palm plantations that include several types of refugia plants, such as *Zinnia elegans* and *Ruellia tuberosa*. This research was conducted from June to September 2024 in the Wak Uban sugar palm plantation in Ulak Segelung Village, Ogan Ilir Regency, South Sumatra. Arthropod identification and analysis activities were conducted in the Department of Plant Pests and Diseases laboratory, Faculty of Agriculture, Sriwijaya University. Traps were set to obtain arthropods species using the Yellow Sticky Trap, Sweep Net, Pitfall Trap and Light Trap. The method used in this research is Purposive Random Sampling using five refugia flowers per plot, and consists of 7 plots. Several arthropods that have a positive impact, such as *Eurema hecabe*, *Apis cerana*, *Ceriatrigon auranticum*, *Trigona sp.*, *Trigosa anexa*, *Collembola*, *Cleon dipterum*, and several other arthropods, are found in sugar palm plantations. Based on the data obtained, the diversity index (H') of arthropods in medium criteria ( $1 < H' < 3$ ). The value of the Evenness Index (E) is more than 0,6 ( $e \geq 0,6$ ), which means that the evenness of arthropods in sugar palm plantations is high. The arthropod dominance index is low ( $C > 0.5$ ), suggesting no single species dominates the community. The presence of diverse distributed arthropod populations with low dominance indicates a stable and balanced ecological environment in the sugar palm plantation.

Keywords: Arthropods, refugia, sugar palm, diversity

## Introduction

Plantations are one of the sectors that support national economic growth (S Yarifah *et al.*, 2018). This is because Indonesia has a tropical climate supporting the growth and development of plantation crops (Lukas, 2016). The sugar palm (*Arenga pinnata* Merr.) is a potential plantation crop that can thrive in various climates, from lowlands to 1400 meters above sea level (Harahap, 2017). Every year, sugar palm plantations in Indonesia have grown by 2% with an area of 61,924 ha. In addition, the growth rate of palm production increased by 1.9% (Ulfa & Asmarahman, 2023). Based on 2018 agricultural statistics, the area of sugar palm plantations in South Sumatra reached 1,095 ha and produced 297 tons of palm sugar.



Arthropods, which can serve as pollinators, pests, natural enemies, or decomposers, significantly influence the growth of sugar palm plants in plantations (Mulyanie & Romandi, 2018). Withanigsih *et al.* (2021) found that several arthropods from Apidae (*Apis cerana*, *Apis dorsata*, *Trigona* sp.) and Drosophilidae (*Drosophila* sp.) frequently surround sugar palm plants and flowers in sugar palm plantations. Furthermore, Herlin *et al.* (2024) research indicates that sugar palm plantations frequently host arthropods from Lepidoptera, Hymenoptera, Coleoptera, and Diptera. Environmental factors and the surrounding vegetation undoubtedly influence the diversity of arthropods in the plantation area. Arthropods will occupy a habitat where diverse plant species are present, thereby increasing the diversity of arthropods (Herni *et al.*, 2016).

Refugia plants are plants that farmers often use to attract arthropods. Farmers typically plant refugia plants around their main crop to protect arthropods, particularly from natural enemies (Galih *et al.*, 2024). Generally, refugia plants have characteristics that attract arthropods, such as color, aroma, size, shape, flowering period, and pollen and nectar content (Sumini & Bahri, 2020). Planting refugia can improve the ecosystem balance in monoculture plantation crops (Saputra & Mujahidin, 2021). Refugia is a type of plant that possesses flowers and specific properties, enabling it to serve as a habitat, attract natural insects to the cultivation area, and reduce the population of pests that attack plants (Harahap *et al.*, 2022). Common refugia plants include sunflowers (*Helianthus annuus*), water henna flowers (*Impatiens balsamina* L.), marigold flowers (*Tagetes erecta*), cockscomb flowers (*Celosia cristata* L.), kenikir flowers (*Cosmos caudatus*), and zinnia paper flowers (*Zinnia elegans*). The paper flower, also known as the zinnia flower, is an annual plant in the genus *Zinnia*. This flower is native to Mexico, grows as an ornamental plant, and is commonly found in various parts of the world, including Indonesia. People frequently utilize this plant as a decorative, finding it effortless to cultivate. *Zinnias* are simple to grow with loose soil and plenty of sunlight (Triatmi & Akbar, 2021). One plant type that has the potential to serve as a refugium is the wild pettunian flower (*Reullia tuberosa* L.). Wild petunia flower is a plant from the Acanthaceae family and is generally considered a weed. This plant typically inhabits rice fields, bushes, and even the side of the road. This plant's blue-purple color and trumpet-like shape make it a unique attraction for arthropods (Hidayah *et al.*, 2022). The results of Wulandari and Tamam's research (2021) show that using flowers is very important. Using wild petunias as refugia can attract various arthropods, creating a microhabitat. In addition, according to Wati and Wakhidah (2023), planting wild petunias as refugia can increase the population of natural enemies, especially parasitoids. This plant can attract three families and 12 species of Hymenoptera, which act as parasitoids for plants (Hidayat *et al.*, 2018).

### **Research Method**

This research was carried out in the Wak Uban palm plantation in Ulak Segelung Village, Ogan Ilir Regency, South Sumatra Province. The collected specimens were identified and analyzed at the Laboratory of the Department of Plant Pests and Diseases, Faculty of Agriculture, Sriwijaya University. The entire research process was conducted over four months, from June to September 2024. A total of 35 refugia plants were selected as the observation units, comprising seven refugia plants, each containing five individual plants. These plants and plots were selected using the Purposive Random

Sampling method, which allowed researchers to target specific plant species likely to attract diverse arthropod populations.

Four trapping techniques were employed to collect arthropods from the refugia plants: sweep nets, pitfall traps, yellow sticky traps, and light traps. The application of sweep nets was standardized by ensuring that each plant plot received the same number of sweeping motions to maintain consistency in sampling effort. This technique was intended to directly observe and collect arthropods actively present around the plant canopy. Pitfall traps were installed at the base of each refugia plant to capture ground-dwelling arthropods, while yellow sticky traps were affixed near the foliage to attract flying insects. In addition, light traps were installed during nighttime hours to collect nocturnal arthropods, using yellow and white light sources to evaluate differences in attraction.

All collected arthropods from the various traps were carefully transferred into vials containing 70% ethanol to preserve their morphology and avoid specimen degradation. Each vial was labelled accurately with codes indicating the corresponding plant species or trap type and plot number, facilitating clear differentiation during subsequent identification and analysis. The primary parameters observed in this research were the type and number of arthropods found around the refugia plants and oil palm flowers, particularly after the introduction of wild *Petunia* (*Petunia integrifolia*) and *Zinnia elegans* as additional refugia flowering species.

To assess species diversity, evenness, and dominance within the arthropod community, the present research also employed standard ecological indices, including the Shannon-Wiener Diversity Index ( $H'$ ), Evenness Index ( $E$ ), and Dominance Index ( $D$ ). These indices were used to interpret the balance and structure of species distributions around the refugia plants. The combined data from all trapping methods were analyzed to determine the abundance of beneficial arthropods, including entomophages and pollinators, which were particularly concentrated in yellow light traps and *Zinnia* and wild *Petunia* flower plots.

Hence, using quantitative sampling methods, this research design aimed to produce a robust dataset reflecting the composition and ecological function of arthropods in oil palm plantations. The methodological approach ensured reliable, repeatable, and scientifically valid outcomes that contribute to understanding arthropod biodiversity and their potential role in integrated pest management (IPM) strategies in tropical agroecosystems.

## **Results and Discussion**

### **Result**

The research conducted in the sugar palm plantation of Ulak Segelung Village revealed the presence of up to 40 different species of arthropods. The arthropod species found were divided into 11 orders, namely Araneae, Coleoptera, Diptera, Ephemeroptera, Entomobryomorpha, Hemiptera, Hymenoptera, Isoptera, Lepidoptera, Odonata and Orthoptera. The most common arthropods found were from the arthropod class, namely the Hemiptera order, with 181 arthropods. The Araneae order, comprising seven families and 13 species, is the arthropod with the highest species diversity. The Ephemeroptera, Odonata, Entomobryomorpha, Isoptera, and Hemiptera, each comprising one family and one species, exhibit the least diversity. There are 1945 arthropods found from the zinnia and wild pettunian flower combined. Based on the

results of the calculations carried out, a total of 690 arthropods were found from the wild Pettunian flower, and 1255 arthropods were found from the Zinnia. Entomobryomorpha order throughout each observation week. The highest percentage was in week 9, 86%, or 30 individuals in wild Pettunian flower and week 5 in zinnia flower. In addition, the pollinator arthropods found had a reasonably high abundance, especially from the Hymenoptera and Lepidoptera orders.

Tabel 1. Arthropods found on refugia plants

| No                               | Refugia Plant  | Species                         | Number                | H                     | D    | E    |
|----------------------------------|----------------|---------------------------------|-----------------------|-----------------------|------|------|
| 1.                               | Wild pettunian | <i>Trigosa anexa</i>            | 9                     |                       |      |      |
|                                  |                | <i>Oxyopes macilentus</i>       | 4                     |                       |      |      |
|                                  |                | <i>Oxyopes salticus</i>         | 3                     |                       |      |      |
|                                  |                | <i>Condyslostylus</i> sp.       | 10                    |                       |      |      |
|                                  |                | <i>Neotephritis finalis</i>     | 5                     |                       |      |      |
|                                  |                | <i>Collembola</i>               | 324                   |                       |      |      |
|                                  |                | <i>Cloeon dipterum</i>          | 35                    |                       |      |      |
|                                  |                | <i>Aphis gosypii</i>            | 181                   |                       |      |      |
|                                  |                | <i>Apis cerana</i>              | 4                     | 1,53                  | 0,64 | 0,32 |
|                                  |                | <i>Trigona</i> sp.              | 7                     |                       |      |      |
|                                  |                | <i>Paratrechina longicornis</i> | 3                     |                       |      |      |
|                                  |                | <i>Odontoponera denticulata</i> | 14                    |                       |      |      |
|                                  |                | <i>Eurema Hecabe</i>            | 25                    |                       |      |      |
|                                  |                | <i>Leptophobia aripa</i>        | 10                    |                       |      |      |
|                                  |                | <i>Ceriagrion auranticum</i>    | 21                    |                       |      |      |
|                                  |                | Other Arthropods                | 35                    |                       |      |      |
|                                  |                | 2.                              | <i>Zinnia Elegans</i> | <i>Trigosa annexa</i> | 61   |      |
| <i>Aectosa littoralis</i>        | 4              |                                 |                       |                       |      |      |
| <i>Oxyopidae</i> Sp.             | 13             |                                 |                       |                       |      |      |
| <i>Colembolla</i>                | 919            |                                 |                       |                       |      |      |
| <i>Amphimallon soltitiale</i>    | 23             |                                 |                       |                       |      |      |
| <i>Camponotus pennsylvanicus</i> | 27             |                                 |                       |                       |      |      |
| <i>Trigona</i> sp.               | 10             |                                 |                       | 2,66                  | 1,12 | 0,55 |
| <i>Ceriagrion</i> Sp.            | 26             |                                 |                       |                       |      |      |
| <i>Pseudagrion pilidorsum</i>    | 10             |                                 |                       |                       |      |      |
| <i>Pezotettix giornae</i>        | 6              |                                 |                       |                       |      |      |
| <i>Acheta domesticus</i>         | 19             |                                 |                       |                       |      |      |
| <i>Paratettix meridionalis</i>   | 10             |                                 |                       |                       |      |      |
| Other arthropods                 | 127            |                                 |                       |                       |      |      |
| <b>Total</b>                     |                |                                 | <b>1945</b>           |                       |      |      |

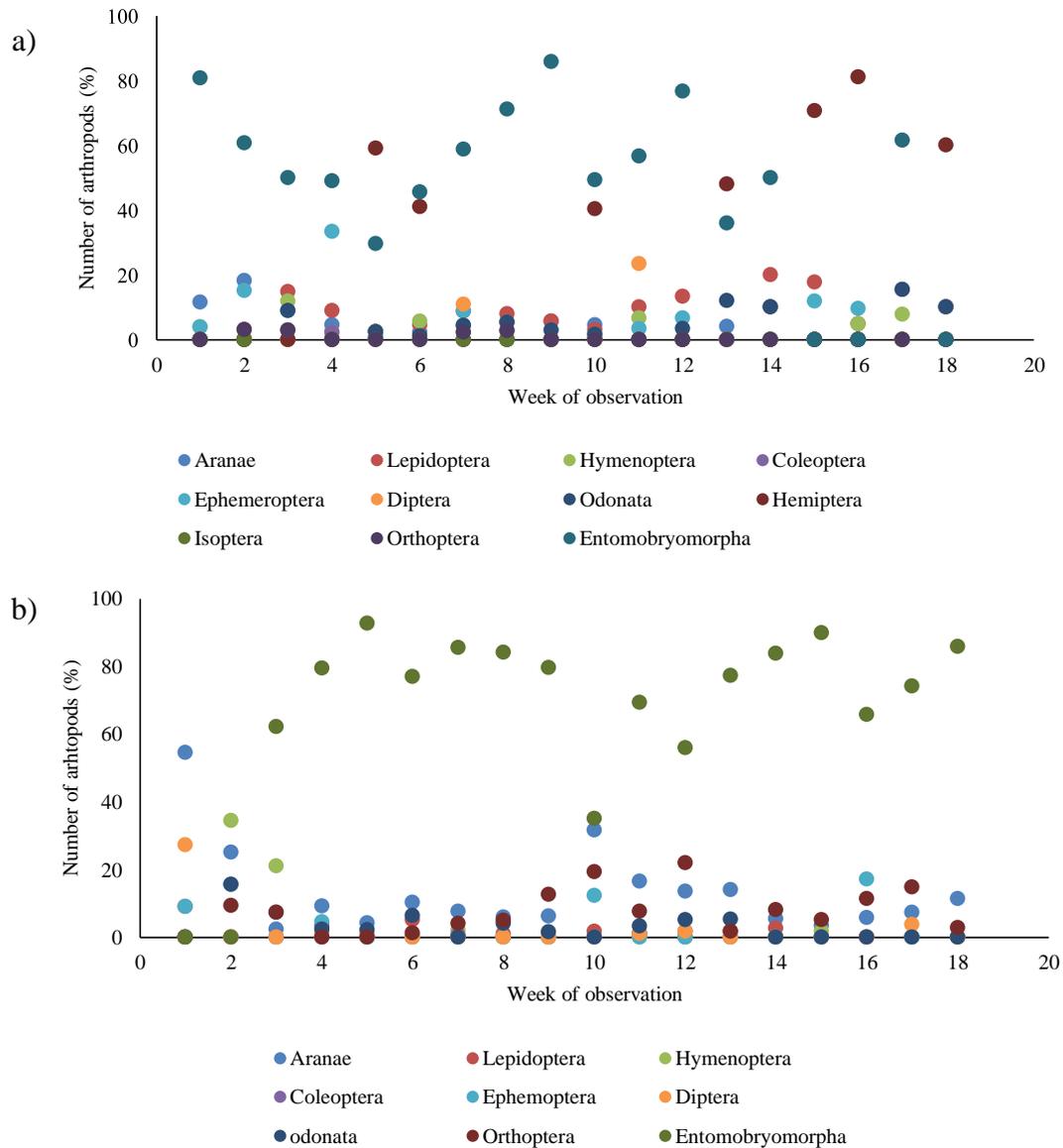


Figure 1. Observations of the number of arthropods by order on refugia plants: a) Wild Pettunian plant, b) *Zinnia elegans*

After testing with three indices, namely the evenness index, the Shannon-Wiener diversity index, and the dominance index, each index value was obtained to see the evenness, diversity, and dominance of the species obtained from the field.

Tabel 2. Arthropods index value

|                          |      |
|--------------------------|------|
| Diversity Index ( $H'$ ) | 1,63 |
| Evennes Index (E)        | 0,68 |
| Dominance Index (D)      | 0,28 |

This research used three traps for field sampling on refugia plants: pitfall traps, sweep nets and yellow sticky traps. The number of arthropods found using these three traps amounted to 476 individuals. Pitfall traps were the most common type of trap that collected arthropods, totalling 1500 individuals from refugia or about 77.12%, and the dominant order was from Entomobryomorpha. There are 70 individuals of arthropods found from a yellow sticky trap, or about 4.7%, and from the sweep net, there are a total of 172 arthropods or 18.18%.

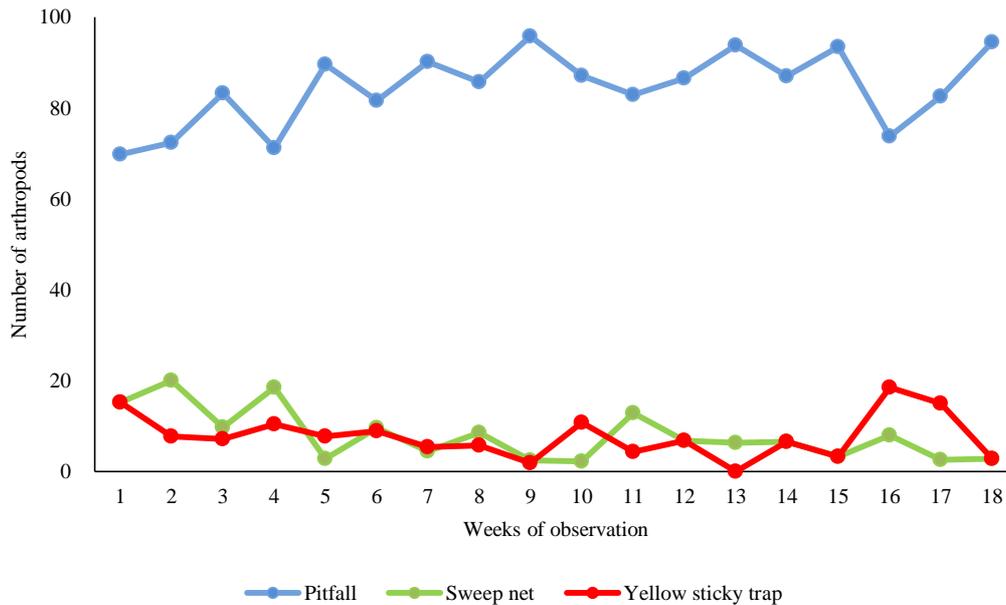


Figure 2. Observation of the number of arthropods based on the type of trap used on refugia plants.

This study also used light traps to capture nocturnal arthropods. The light trap used consisted of yellow and white colors. The total number of arthropods obtained from this trap was 1651 individuals. The yellow light trap had the highest catch of 953 individuals. Arthropods that act as Entomophages are the dominant species in yellow light traps, which amounted to 85% or 819 of the total arthropods obtained.

Meanwhile, the yellow light trap captured the fewest arthropods that act as pollinators, with just 16 individuals. White light traps revealed 698 individuals of arthropods. Arthropods that function as Entomophages are the most commonly found in white light traps, accounting for 71% or 499 individuals. Arthropods that function as decomposers are the least common, with only 33 individuals being found. Arthropods were found to be Entomophages, dominating every day of observation in yellow and white light traps.

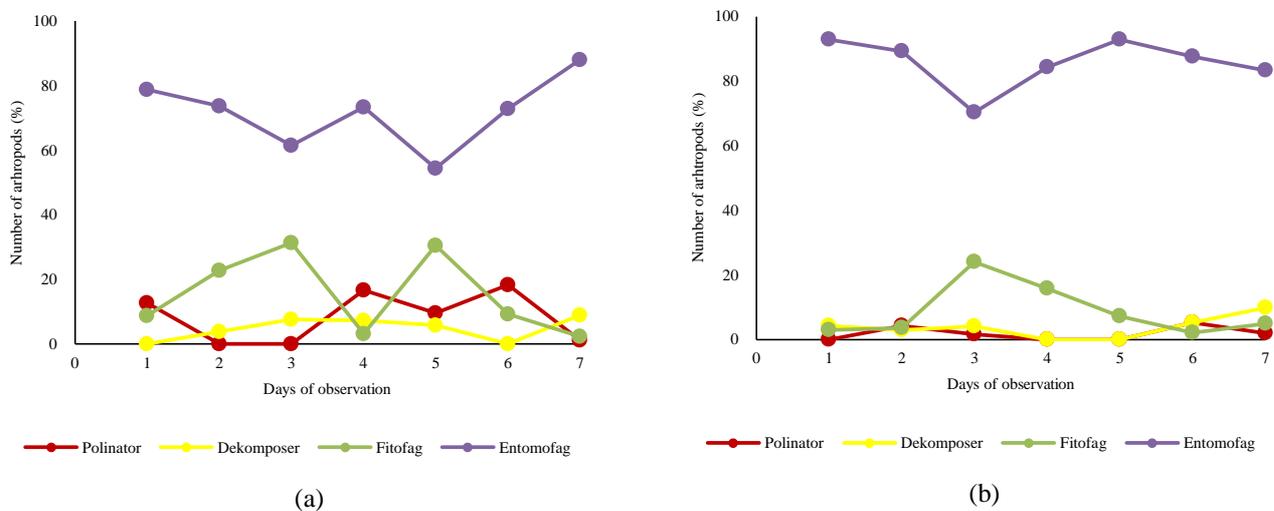


Figure 3. Number of arthropods using light trap: (a) white light trap, (b) yellow light trap

## Discussion

Three types of traps, namely pitfall traps, yellow sticky traps, and sweep nets, capture arthropods on refugia plants in sugar palm plantations. Based on observations, the pitfall trap consistently yields the highest number of catches. This is due to the high vegetation surrounding the palm trees, which provides a habitat for numerous arthropods. Collembola is the dominant arthropod in pitfall traps. The large number of Collembola in this plantation can be attributed to the abundance of organic matter from plant residues, which serves as their food source. Furthermore, because abiotic factors influence their life activities, the high abundance of soil organisms like Collembola can indicate the ecosystem's stability. Furthermore, we can use the high and low populations of soil organisms as an accurate indicator to gauge the level of soil toxicity in the environment (Joimel *et al.*, 2022).

During the 18 weeks of observations on refugia plants, week 5 yielded the highest number of arthropods. However, there was an erratic increase in the number of arthropods, with a few being obtained in some weeks of observation, increasing in the following week, and then decreasing in the last few weeks. Abiotic influences on palm plantations, such as temperature, humidity, and weather, cause this erratic increase, which varies with each observation. In addition, another factor that can affect the number of arthropods in the field is the availability of food, such as pollen, nectar, protein sources, or the number of preys, which is the main factor causing the abundance of arthropods in the field (Windriyanti, 2023).

The Shannon-Wiener Diversity Index is used to measure species diversity in the community. This study yielded a diversity index ( $H'$ ) value of 1.52. This indicates that the species diversity in this community falls into the moderate category, with a value of  $H'$  exceeding one and falling below 3. Herlin *et al.* (2024) previous research on sugar palm plantations aligns with our findings. The Shannon-Wiener Diversity Index's value without adding refugia plants is 1.93. This indicates that the Diversity Index ( $H'$ ) in previous studies, both with and without refugia plants, falls into the medium category. According to SchianoLomoriello *et al.* (2024), in the Shannon diversity index, if a community shows a diversity value close to 3, it means that the community has a high number of species and a balanced abundance of existing species. According

to Ross and Sam (2014), there are several categories that can be used to measure the value of diversity ( $H'$ ), such as behavior, feeding movements, and several other categories that show the diversity of a species in the community.

NCSS software was used to look at the effect of arthropods and observation week, arthropods and traps, and arthropods and plants on the observation of refugia plants. In addition, this software is also used to see the effect between light traps and arthropods and arthropods and observation week. The analysis revealed a significant influence between arthropods and observation week, arthropods and traps, and arthropods and light traps. This is attributed to the significant difference in the number of arthropods found in each observation. In the observation of refugia and light traps, the relationship between arthropods and plants did not show a significant effect, as indicated by the  $P$ -value  $> 0.01$  obtained. This is likely because each observation has similar arthropods.

In the sugar palm plantation, two types of light trap colors were used, namely white and yellow. Observations reveal that the yellow light trap captures the highest number of arthropods, totalling 953 individuals. Only 698 individual arthropods were captured by the white light trap. This is because arthropods are more attracted to white light traps with a yellow color. After all, yellow is considered a food source or ripe fruit, so they are more interested in approaching them. In addition, arthropods have a longer wavelength of light than humans, ranging from 300-650 nm, whereas yellow is between 560-590 nm (Rahman & Aphrodyanti, 2018).

### Conclusion

The diversity of arthropods found in sugar palm plantations with the addition of wild petunia and *Zinnia elegans* shows a level of diversity ( $H'$ ) in the medium category. This is proven by the Diversity Index value of 1.63. The positive arthropods found acted as predators, parasitoids, pollinators, and decomposers. The highest positive arthropods were found to act as predators. Compared to previous research at the same place, the Diversity Index ( $H'$ ) value of 1.93 was obtained, which is classified into the medium category. In addition, in the previous study, the most positive aptropods were found to act as pollinators.

In the three traps used, namely sweep net, yellow sticky trap and pitfall trap, the most effective traps used to capture arthropods are sweep net and pitfall trap. The use of yellow sticky traps around refugia plants was not effective enough to capture arthropods.

### References

- Galih E. F., Nanang, D. W., and Winsah, S. (2024). Jenis Tanaman Refugia Yang Berpotensi Menarik Musuh Alami Pada Lahan Pertanian Padi Di Global Village, Sumbawa, Ntb, Jurnal TAMBORA, 8(1), pp. 19–24.
- Harahap, D. E. (2017). Kajian Produktivitas Tanaman Aren Berdasarkan Sifat Morfologi Tanaman Pada Skuen Tinggi Tempat Di Kabupaten Tapanuli Selatan, *Jurnal Pertanian Tropik*, 4(2), pp. 161–170.

- Harahap, D. E. (2021). Tanaman aren sebagai tanaman multi guna dalam upaya peningkatan pendapatan keluarga petani Di Desa Sialaman Kabupaten Tapanuli Selatan. *J-ABDI: Jurnal Pengabdian kepada Masyarakat*, 1(1), 69-74.
- Herlin, W., Fitriyani, D., Akbario, R., Aziz, M., Nurfalida, Y., Muhammad, G., and Rizkawati, V. (2024). Pollinator insects on sugar palm (*Arenga pinnata* Merr.) in South Sumatera, Indonesia, *IOP Conference Series: Earth and Environmental Science*, 1346(1).
- Herlin, W., Fitriyani, D., Akbario, R., Aziz, M., Nurfalida, Y., Muhammad, G., and Rizkawati, V. 2024. Pollinator insects on sugar palm (*Arenga pinnata* Merr.) in South Sumatera, Indonesia, *IOP Conference Series: Earth and Environmental Science*, 1346(1).
- Herni DP, N Maryana and W I Wayan. (2016). Keanekaragaman Parasitoid and Artropoda Predator Pada Pertanaman Kelapa Sawit and Pada Sawah di Cindali, Kabupaten Bogor. *J. HPT Tropika*. ISSN 1411-7525 Vol. 16, No. 2: 138 – 146.
- Hidayah, N., Syamwil, R., dan Nurrohmah, S. (2022). Pemanfaatan Gulma Kencana Ungu (*Ruellia Tuberosa* L.) Sebagai Pewarna Alami Kain Sutera Menggunakan Proses Post Mordanting, *Fashion and Fashion Education Journal*, 11(1), pp. 27–29.
- Hidayat, R., Irsan, C., and Setiawan, A. (2018). The Existence Species of Passion Flower (*Turnera subulata* J.E SM and *Turnera ulmifolia* L.) on Palm Oil Plant (*Elaeis guineensis* Jaqc.) Againts to The Diversity of Entomofag and Phytophage Insects. *Biological Research*, 4(1): 1-8.
- Joimel, S., Chassain, J., Artru, M., Faburé, J. 2022. Collembola are Among the Most Pesticide-Sensitive Soil Fauna Groups: A Meta-Analysis, *Environmental Toxicology and Chemistry*, 41(10), pp. 2333–2341.
- Lukas, S. (2016). Keragaan Eksisting Tanaman Aren (*Arenga pinnata* Merr) di Sumatera Utara (Peluang and Potensi Pengembangannya), *Jurnal Pertanian Tropik*, 3(2), pp. 133–138.
- Mulyanie, E., and Romandi, A. (2018). Pohon Aren sebagai Tanaman Fungsi Konservasi, *Jurnal Geografi*, 14(2), pp. 11–17.
- Saputra, S., and Mujahiddin, M. 2021. Stimulus Agrosociopreneur Melalui Pengembangan Sistem Refugia and Lebah Madu Berbasis Pertanian Jeruk di Desa Sekoci Kabupaten Langkat. *JMM (Jurnal Masyarakat Mandiri)*, 5(4), 1689-1700.
- Sumini, S., and Bahri, S. (2020). Keanekaragaman And Kelimpahan Musuh Alami Di Tanaman Padi Berdasarkan Jarak Dengan Tanaman Refugia, *Jurnal Agrotek Tropika*, 8(1), p. 177.
- Syarifah, M. R., and Baharuddin, I. T. (2018). Potensi and Pemanfaatan Tanaman Aren (*Arenga pinnata* ) Dengan Pola, *Perennial*, 14(1), pp. 24–27.
- Triatmi, N., and Akbar, M. 2021. Sistem Pakar Diagnosa Penyakit Tanaman Bunga Kertas *Zinnia* Menggunakan Metode Certainty Factor. *Journal Of Information System And Artificial Intelligence*, 2(1), 31-37.
- Ulfa, M., and Asmarahman, C. (2023). Regenerasi Tanaman Aren Pada Berbagai Kondisi ( Regeneration of Sugar Palm In Various Ecological Conditions Where It Grows In The Arrangement, *Jurnal Kehutanan Indonesia* 4.
- Wati, S. S., dan Wakhidah, A. Z. (2023). Kencana Ungu (*Ruellia tuberosa* L.): Botani, Fitokimia Dan Pemanfaatannya Di Indonesia, *Indobiosains*, 5(1), pp. 33–42.



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