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Diversity of Predatory Arthropods In Two Cocoa (*Theobroma cacao* L.) Habitats In Pemepek Village, Central Lombok Regency

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ABSTRACT

This study aims to determine the diversity of predatory arthropods on cocoa plants (*Theobroma cacao* L.) as part of a sustainable biological control approach. The research was conducted at two smallholder farm locations in Pemepek Village, Central Lombok Regency, from May to June 2025. The methods used were field surveys and specimen collection using pitfall traps, beating trays, yellow pans, and brocap traps, followed by laboratory identification. The results showed a total of 704 predatory individuals, originating from 10 orders, 34 families, and 99 species. Location 2 had a higher number of predatory individuals (487) compared to Location 1 (217). The Shannon-Wiener diversity index (H') values were 3.31 for Location 1 and 2.64 for Location 2. The dominance index (C) values were 0.13 (low category) and 0.07 (low category) for Locations 1 and 2, respectively. The evenness index (E) values were 0.43 (low category) for Location I and 0.27 (low category) for Location 2.

INTRODUCTION

Cocoa (*Theobroma cacao* L.) is a plantation crop that is one of Indonesia's non-oil and gas export commodities. Cocoa plants play an important role in the national economy. Cocoa plantations provide employment opportunities and serve as a source of income for farmers. Furthermore, Indonesia ranks third as a cocoa-producing and exporting country in the world (Central Bureau of Statistics, 2021). Additionally, cocoa plants produce seeds that are used as the main raw material in the chocolate industry and its derivative products in the cosmetics, health or pharmaceutical, as well as food and beverage sectors (Central Bureau of Statistics 2019; Central Bureau of Statistics 2020).

West Nusa Tenggara Province is one of the main cocoa-producing regions. However, cocoa production in this province experienced fluctuations from 2016 to 2021. Annual cocoa production was recorded at 2,110.66 tons in 2016; in 2017, there was no cocoa production; then in 2018, cocoa production resumed at 2.00 tons. In 2019, production increased again to 2.52 tons, then dropped to 0.73 tons in 2020, and rose again to 2.22 tons in 2021 (BPS, 2024).

The development of cocoa plantation areas can be seen from its contribution as an export commodity that helps increase national income. In 2018, the area of cocoa plantations in Indonesia based on management status reached 1,610.9 hectares with a production of 767.4 tons. In 2019, the area decreased to 1,560.7 hectares with a production of 734.7 tons. Meanwhile, in 2020, the area of cocoa plantations was recorded at 1,528.4 hectares, with a production of 713.4 tons (Suci, 2022).

In a polyculture planting system, cocoa plants are grown together with other plants such as coffee, rambutan, banana, durian, langsat, and so on. These types of plants are soil-enriching, have tall trees, and bear economically valuable fruits. The polyculture planting system also has greater plant diversity, which helps maintain arthropod diversity and the balance of the ecosystem within it.

In West Nusa Tenggara itself, most people cultivate cocoa plants using a polyculture system, one example of which is in Pemepek Village, Central Lombok Regency. This is possible because the polyculture system has many benefits for the growth of cocoa plants, one of which is the presence of various predators that can help eliminate pests attacking the plants. Cocoa cultivation faces several obstacles that lead to low cocoa productivity, such as the main challenge, which is pest and disease attacks. There are pests that attack

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the plants, such as the cocoa pod borer (*Conomorpha cramella*), mirid bugs (*Helopeltis* spp.), leaf caterpillars (*Hyposidea infixaria*), stem/branch borers (*Zeuzera coffeae*), leaf-eating beetles (*Apogonia* sp.), and other insects, which can disrupt the growth and development of cocoa.

Therefore, farmers take various measures to control pests on cocoa plants, one of which is using chemical pesticides. However, the use of chemical pesticides needs to be reduced due to several negative impacts caused by improper use, such as the emergence of pest resistance, pest resurgence, secondary pest outbreaks, increased pesticide residues on plants, declining human health, and various other environmental problems. (Astuti et al., 2013). One approach that can be taken is through biological control.

Biological control is control carried out by utilizing natural enemies such as predators. Predators are organisms that live independently and actively hunt prey to meet their nutritional needs; they usually require more than one prey to complete their life cycle. Information about the diversity of arthropod predators on cacao plants is still limited. Therefore, a study titled "Diversity of Arthropod Predators in Two Cacao (*Theobroma cacao* L.) Habitats in Pemepek Village, Central Lombok Regency" was conducted to determine the diversity and abundance of arthropod predators.

MATERIALS AND METHODS

This research was conducted from May to June 2025 in Pemepek Village, Central Lombok Regency, West Nusa Tenggara. The study was carried out using field survey techniques and specimen collection. Observation areas were determined using the selected random sampling method (systematic random sampling) at two research locations. Five samples were taken at each location with a distance of 10 meters between samples from a population of 50 cocoa trees. The plot area measured 40x50 meters. The experiment used pitfall traps, brocap traps, yellow pans, and beating trays.

The tools used in this study included bamboo, Styrofoam, clear plastic cups, umbrellas, white cloth, koptan pheromone traps (brocap traps), yellow bowls, raffia strings, tape measures, collection bottles, stationery, mobile phone cameras, label sheets, tweezers, sprayers, and observation tables. The materials used included detergent, water, 70% alcohol, and koptan pheromones. Data analysis of predatory arthropods was carried out by calculating the number of predator species, the number of predator individuals, the Shannon-Wiener diversity index (H'), the Abundance Index (K), the Dominance Index (D), and the Evenness Index (Evenness = E).

1. Shannon-Wiener Diversity Index (H')

Species diversity was calculated using the Shannon-Wiener diversity index (Mujalipah et al., 2019), with the following formula:

$$H' = -\sum_{i=1}^{s} \left\{ \left(\frac{ni}{N}\right) Ln \left(\frac{ni}{N}\right) \right\}$$

Explanation:
H' = Shannon-Wiener Index (H')
ni = number of individuals of the observed species
N = Total number of individuals

The criteria for calculating the diversity index (H') are as follows: H' < 1, the diversity is low. H' = 1 or 1 < H' < 3, the diversity is medium. H' > 3, the diversity is high.

2. Abundance Index (K)

The abundance index of predatory arthropods can be calculated using the following formula (Micheal, 1995).

$$\frac{jumlah\ individu\ spesies\ ke{-}i}{jumlah\ individu\ seluruh\ spesies} \text{ x } 100\%$$

3. Evenness Index (Evenness = E)

The evenness of predatory arthropods can be calculated using the formula according to Pielou in Odum (1996) as follows:

$$E = H'/Ln\ S$$

Explanation:
H' = Shannon-Wiener Index
S = Number of species
E = Evenness Index

The criteria for the evenness index value of a population range from 0-1 with the following criteria: 0.00 < E < 0.50 = Low evenness, the community is uneven. 0.50 < E < 0.75 = Moderate evenness, the community is even. 0.75 < E < 1.00 = High evenness, the community is very even.

4. Dominance Index (D)

The dominance index of each insect group is calculated using Simpson's formula (Ludwig and Reynold, 1998 in Supriadi et al., 2015)

$$C = \sum_{i=1}^{s} \left(\frac{ni}{N}\right)^2$$

Explanation:
C = Dominance index
ni = Number of individuals of one species
N = Total number of individuals of all species

The criteria for the Simpson dominance index are as follows: C < 0.5 = Low dominance. 0.5 < C < 0.75 = Moderate dominance. C > 1.0 = High dominance.

RESULTS AND DISCUSSION

1. Shannon-Wiener Diversity Index (H')

Based on field research and the identification of predatory arthropods, two classes of predatory arthropods were found, namely Arachnida and Insecta. The class Insecta consists of 8 orders, namely Hymenoptera, Coleoptera, Diptera, Neuroptera, Dermaptera, Hemiptera, Psocodea, and Orthoptera. Meanwhile, the class Arachnida consists of 2 orders, namely Araneae and Pseudoscorpiones. A total of 99 predator species were found.

Table 1. Number of Species and Individuals of Each Predator on Cocoa Plants (*Theobroma cacao* L.)

Order	Family	Species	Location	
			1	2
Araneae	Tinomisidae	*Xysticus funestus*	4	0
	Lycosidae	*Lycosa pseudoannulata*	1	0
		Lycosa sp.	1	0
		Trochosa sp.	0	1
		Pardosa sp.	0	1
	Salticidae	*Heliophanus flavipes*	1	0
		Epeus sp.	22	14
		Chalcoscirtus sp.	3	0
		Myrmaracne sp.	2	0
		Erigone sp.	2	0
		Metaphidippus sp.	1	2
		Saitis sp.	1	0
		Xenocytae sp.	1	0
		Cylistella sp.	1	1
		Phintella sp.	1	4
		Prostheclina sp.	1	0
		Phintelloides sp.	0	2
		Hypaeus sp.	0	1

Order	Family	Species	Location	
			1	2
		Bianor sp.	0	1
		Myrmarachne formicaria	0	1
		Colyttus sp.	0	1
	Clubionidae	*Clubiona subtilis*	1	1
		Clubiona sp.	1	0
	Oxyopidae	*Oxyopes* sp.	1	2
		Oxyopes matiensis	1	0
	Araneida	*Mangora* sp.	1	0
		Araneilla sp.	1	0
		Araneus inustus	1	0
		Larinia sp.	0	2
		Argiope sp.	0	1
		Anepsion sp.	0	3
		Pristidia sp.	0	1
		Hypsosinga sp.	0	1
		Araneus sp.	0	2
	Oecobiidae	*Oecobius* sp.	1	0
	Philodromidae	*Philodromus* sp.	1	0
	Liocranidae	*Apostenus* sp.	0	8
	Helicidae	*Agelenopsis* sp.	0	2
	Linyphidae	*Agyneta* sp.	4	1
		Tenuiphantes sp.	1	0
		Walckenaeria sp.	1	0
		Bathyphantes sp.	1	0
	Theridiidae	*Cryptachaea* sp.	1	2
		Steatoda sp.	2	0
		Chrysso sp.	0	1
		Rhomphaea sp.	0	1
	Tetragnathididae	*Tetragnatha caudata*	2	0
		Tetragnatha pallescent	1	0
		Pachygnatha sp.	0	1
	Ghaphosidae	*Zelotes* sp.	0	1
	Cybaeidae	*Blabomma* sp.	0	5
Hymenoptera	Formicidae	*Solenopsis invicta*	1	0
		Camponotus aethiops	1	0
		Leptogenys sp.	45	4
		Tapinoma melanocephalum	1	0
		Solenopsis geminate	4	0
		Oecophylla smaragdina	10	10
		Myrmica americana	1	0
		Anaplolepis gracilipes	12	0
		Polyrachis dives	1	0
		Camponotus inaequalis	1	1
		Solenopsis molesta	1	75
		Paratrechina longicornis	1	0
		Monomorium sp.	4	129
		Dolichoderus thoracicus	1	0
		Nylanderia sp.	4	1
		Themnothorax sp.	3	0
		Polyrhachis sp.	1	49
		Crematogaster Pilosa	2	0
		Oodontomachus brunneus	1	0
		Leptogenys luederwaldti	2	7

Order	Family	Species	Location	
			1	2
		Pheidole sp.	10	0
		Aphaenogaster sp.	4	0
		Monomorium floricola	1	0
		Brachynopera chinensis	1	0
		Monomorium captator	0	19
		Temnothorax affinis	0	23
		Tapinoma sp.	0	58
		Acropyga acutiventris	0	26
		Lophomyrmex sp.	0	3
Coleoptera	Pyrochroidae	*Binburum* sp.	3	0
	Staphylinidae	*Bisnius sp.*	14	0
	Carabidae	*Neocollyris Benelli*	1	0
	Cantharidae	*Cantharis* sp.	0	3
Diptera	Ceratopogonidae	*Palpomyia tibialis*	1	0
	Hybotidae	*Oedalea* sp.	1	0
	Chloropidae	*Rhodesiella* sp.	16	0
	Muscidae	*Coenosia distingues*	0	1
	Syrphidae	*Baccha elongate*	0	1
	Neriidae	*Telestylinus lineolatus*	0	2
	Dolichopodidae	*Dolichopus* sp.	0	5
		Gymnopternus sp.	0	2
Neuroptera	Sisyiridae	*Sisyiridae* sp.	1	0
Dermaptera	Anisolabididae	*Euborellia* sp.	1	0
Hemiptera	Herbridae	*Hebrus* sp.	0	1
	Veliidae	*Microvellia* sp.	0	1
Pseudoscorpiones	Neobisiidae	Neobisium sp.	0	1
Psocodea	Psyliipsocidae	*Psyllipsocus* sp.	0	1
Orthoptera	Gryllidae	*Anaxipha* sp.	2	0
Total			217	487

Table 1 shows the number of predator species at each location. At location 1, there are 64 species (7 orders and 25 families). Meanwhile, at location 2, there are 51 predator species (7 orders and 22 families). The total number of predator individuals at both locations is 704. At location 1, there are 217 individuals, and at location 2, there are 487 individuals. The total number of predator arthropod individuals at location 2 is higher than at location 1.

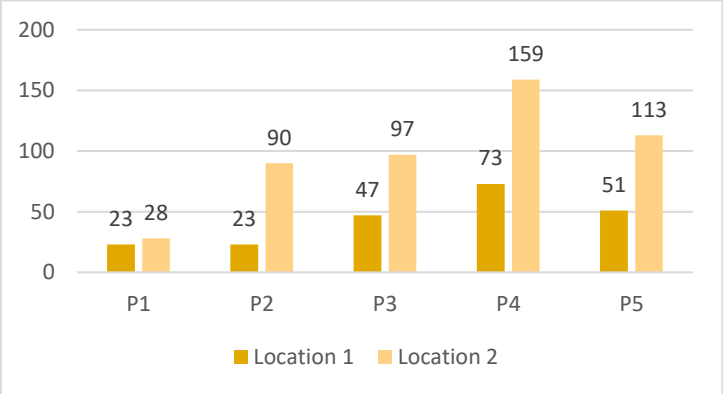

Figure 1. Number of Predator Individuals per Observation

The image above shows the results of observations of the number of predator individuals in each observation at both locations over five observations. In the first observation (P1), Location 1 had 23 individuals and Location 2 had 28 individuals. In the second observation (P2), Location 1 had 23 individuals and Location 2 had 90 individuals. The third observation showed an increase, with Location 1 having 47 individuals and Location 2, 97 individuals. In the fourth observation, there was another increase, with Location 1 having 73 individuals and Location 2, 159 individuals. Meanwhile, in the fifth observation, there was a decrease, with

Location 1 having 51 individuals and Location 2, 113 individuals. This may be caused by the availability of food sources for the survival of predators. Melhanah et al. (2020) stated that a relatively high number of predators is closely related to the presence of neutral insect populations that serve as a food source or alternative prey.

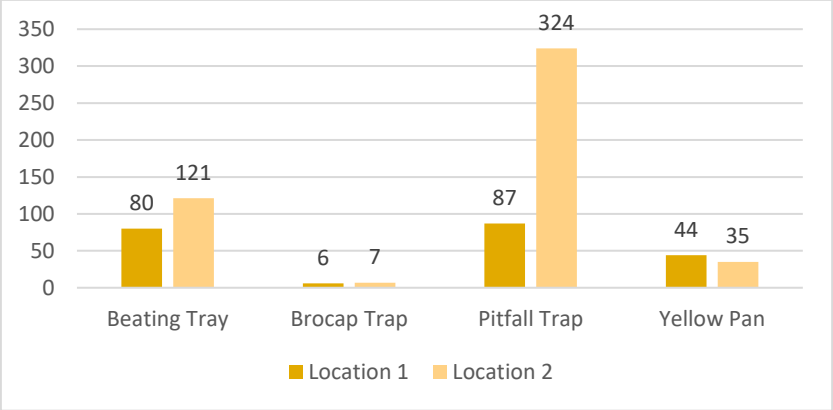

Figure 2. Number of Predator Individuals per Trap during Observation

Figure 2 shows the number of predatory arthropod individuals per trap. At location 1, the trap with the highest number was the pitfall trap, with 87 predator individuals, the majority belonging to the order Hymenoptera, family Formicidae. Meanwhile, at location 2, the results were similar to location 1, with the trap having the highest number being the pitfall trap with 324 predators, the majority also belonging to the order Hymenoptera, family Formicidae.

In the beating tray trap, the number of predator individuals at location 1 was 80, with the highest number of individuals in the order Hymenoptera, family Formicidae, while at location 2, the number of predator individuals was 121, also with the highest number in the order Hymenoptera, family Formicidae.

Next, on the yellow pan trap, the number of predator individuals at location 1 was 44 predators, with the highest number of predator individuals in the order Hymenoptera, family Formicidae. At location 2, the number of predator individuals was 35, with the highest number of predator individuals also in the order Hymenoptera, family Formicidae.

Meanwhile, in the brocap trap, the number of predator individuals at location I was 6 individuals, with 4 individuals from the order Hymenoptera, family Formicidae, and 2 individuals from the order Araneae, family Linyphidae. At location 2, the number of predator individuals was 7, with 4 individuals from the order Hymenoptera, 2 individuals from the order Diptera, family Dolichopodidae, and 1 individual from the order Araneae, family Araneida.

On each trap, there are Hymenoptera of the family Formicidae. According to Agus and Septianjaya (2021), ants are insects that live on the ground surface, in the soil, or in trees. Ants are known as predators of other insects and small invertebrates (Putro et al., 2021). According to Tillberg et al. (2007), Formicidae live in colonies and adapt easily to various ecosystems. According to Poerwitasari (2013) in Fatimah et al. (2017), Formicidae are generalist predators, so their abundance usually dominates the predator population. Ikbal et al. (2014) stated that Dolichoderus sp., Pheidole sp., and Anoplolepis sp. are ant species that are aggressive in foraging. Therefore, the most effective traps based on this study are pitfall traps and beating trays.

2. Abundance (K), Evenness (E), and Dominance (D) Indices

Table 2. Diversity Index (H'), Dominance (D), Evenness (E), and Predatory Arthropods

Locations	Diversity (H')	Evenness (E)	Dominance (D)
1	3.31	0.43	0.07
2	2.64	0.27	0.13

Based on Table 2, it shows that the predator diversity index (H') at location 1 is 3.31 (high category), indicating that location 1 has relatively high diversity. Whereas at location 2 it is 2.64 (medium category), which has moderate diversity. This is in accordance with the opinion of Wangge & Mago (2021) that one of the factors affecting the diversity index to be categorized as medium is because some arthropod species found have a high number of individuals, while other species have uneven numbers of individuals. The evenness index value at location 1 is 0.43, indicating low evenness or an uneven community, while at location 2 it is 0.27, which also indicates low evenness or an uneven community. According to Annam et al. (2017), a low evenness (E) value indicates that the distribution of each individual is uneven and there is a tendency for a certain species to dominate the plantation area. The dominance index value at location 1 is 0.07, which indicates low dominance,

while at location 2, the dominance index is 0.13, also indicating low dominance. According to Amirul & Haryono (2007), in a highly diverse community, no single species can dominate, whereas in a community with low diversity, one or two species may become dominant.

The abundance index of arthropods in cocoa plantations was highest at location 1, namely in the species *Leptogenys* sp. from the order Hymenoptera, family Formicidae, with a value of 0.207. *Leptogenys* sp. is an aggressive predatory ant that actively hunts prey. *Leptogenys* sp. is classified as an opportunistic predator (exploiting available opportunities) that uses direct hunting behavior to catch small insects and other arthropods that are pests of cocoa plants. *Leptogenys* sp. can be found abundantly in several areas, usually in moist places or in locations with a high presence of isopods as their food (Lattke, 2011 in Putra, 2017). Meanwhile, the highest abundance was found at location 2, which is *Monomorium* sp. from the order Hymenoptera, family Formicidae, with a value of (0.26). *Monomorium* sp. is known to exhibit opportunistic behavior and can prey on various types of crop pests, such as eggs, larvae, and small adult insects. They also nest in the soil or under leaves and actively move around plants, resulting in continuous predatory activity.

CONCLUSIONS

Based on the results of the research that has been conducted, it can be concluded that there is a diversity of predatory arthropods on cocoa plants (*Theobroma cacao* L.) in Pemepek Village, Central Lombok Regency. The predator diversity found consists of 10 orders, 34 families, and 99 species. The total number of predator individuals is 704. Location 2 shows a higher total number of predator individuals (487 individuals) compared to location 1 (217 individuals). The Shannon-Wiener diversity index (H') value at location 1 (3.31, high category) and location 2 (2.64, medium category) indicates that the distribution of predator individuals is more diverse. The dominance index (C) value at location 2 (0.13, low category) and location 1 (0.07, low category) shows that both locations fall into the low dominance category, indicating relatively stable ecosystem conditions. The evenness index (E) is higher at location 1 (0.43, low category) compared to location 2 (0.27, low category). Thus, both locations show a moderate ecological level, reflecting an ecosystem with fairly high productivity and ecological stability that supports the role of predators as biological control agents in a sustainable agricultural system.

REFERENCES

Annam AC, and N Khasanah. (2017). Keanekaragaman arthropoda pada pertanaman kubis (Brassica oleracea L.) yang diaplikasi pestisida kimia dan nabati. *E- Jurnal Agroteknis.* 5 (3): 308-314.

Amirul, H & Haryono, H. (2007). *Metodologi Penelitian Pendidikan*. Bandung: Pustaka Setia

Astuti, R., dan Utami, S. (2023). Keanekaragaman Serangga di Hutan Hekunder dan Perkebunan Sawit di Kalimantan Tengah. *Jurnal Penelitian Hutan Tanaman*, 14(1): 1-12.

Badan Pusat Statistik. (2019). *Statistik Kakao Indonesia 2018*. Sub Direktorat Statistik Tanaman Perkebunan, Editor. Sub Direktorat Statistik Tanaman Perkebunan.

Badan Pusat Statistik. (2020). *Statistik Kakao Indonesia 2019*. Sub Direktorat Statistik Tanaman Perkebunan, Editor. Sub Direktorat Statistik Tanaman Perkebunan

Badan Pusat Statistik. (2021). *Statistik Kakao Indonesia 2020*. Direktorat Statistik Tanaman Pangan, Hortikultura Dan Perkebunan, Jakarta.

Badan Pusat Statistik, Lombok Tengah. (2024). *Lombok Tengah dalam Angka 2024*. B.P. Tengah.

Lombok Tengah: BPS Lombok Tengah

Ikbal, M., Putra, N. S., & Martono, E. (2014). Keragaman semut pada ekosistem tanaman kakao di Desa Banjaroya Kecamatan Kalibawang Yogyakarta. *Jurnal Perlindungan Tanaman Indonesia*, *18*(2), 79-88.

Melhanah, Supriati, L., & Saraswati, D. (2020). Struktur komunitas Arthropoda nokturnal pada jagung manis dan kacang panjang organik dan konvensional di lahan gambut. *Jurnal Daun,* 7(1), 11-22

Mujalipah., Rosa, H. O., & Yusriadi. (2019). Keanekaragaman Serangga Hama dan Musuh Alami pada Fase Pertumbuhan Tanaman Padi (*Oryza sativa* L.) di Lahan Irigasi. [Skripsi, *unpublished*]. Lampung: Universitas Lambung Mangkurat.

Odum, E. P. (1996). *Dasar-Dasar Ekologi. Edisi ke-3*. Yogyakarta: Gajah Mada University Press.

Putra, I. M., Hadi, M., & Rahadian, R. (2017). Struktur komunitas semut (Hymenoptera: Formicidae) di lahan pertanian organik dan anorganik desa Batur, kecamatan Getasan, kabupaten Semarang. *Bioma: Berkala Ilmiah Biologi*, *19*(2), 170-176.

Suci, F. A. (2022). *Eksplorasi Dan Karakterisasi Morfologi Tanaman Kakao (Theobroma cacao L.) Rakyat Di Kecamatan Pulau Punjung Dan Ix Koto Kabupaten Dharmasraya* (Doctoral Dissertation, Universitas Andalas).

Supriadi, Romadhon, A., & Farid, A. (2015). Struktur Komunitas Mangrove di Desa Martajasah kabupaten Bangkalan. *Jurnal Kelautan*, *8*(1).

Wanggae, M. M. N., & Mago, O. Y. T. (2021). Keanekaragaman Arthropoda Musuh Alami Hama Tanaman Kakao (*Theobroma cacao* L.) Pada Perkebunan Polikultur Di Desa Hokeng Jaya Kecamatan Wulanggitang Kabupaten Flores Timur. *Spizaetus: Jurnal Biologi dan Pendidikan Biologi*, *2*(1).