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Composition of Soil Arthropods in the Urban Forest Area of Arboretum Cibubur, East Jakarta

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Abstract

The Cibubur Urban Forest, designated by the DKI Jakarta Regional Government as a conservation area, serves as a vital ecological patch supporting diverse plant vegetation and associated organisms. This study investigates the composition and diversity of soil arthropods within the forest, focusing on their ecological roles across different habitat types. Field research was conducted in March 2024 using pitfall traps (15 traps per habitat, filled with 70% alcohol) deployed for three days. Specimens were collected from four distinct habitats and classified taxonomically. Results identified six arthropod classes: Arachnida, Chilopoda, Collembola, Crustacea, Diplopoda, and Insecta, with Insecta being the most dominant. A total of 16 orders were recorded, with Collembola, Coleoptera, and Diptera exhibiting the highest abundance, while Mantodea and Isoptera were the least represented. Habitat 1 showed the highest arthropod diversity, whereas Plot 2 had the lowest. Ecological analysis revealed arthropod functions as predators, decomposers, scavengers, herbivores, and carnivores, underscoring their critical roles in maintaining forest ecosystem stability. These findings highlight the Cibubur Urban Forest's significance as a biodiversity hotspot and emphasize the need for habitat-specific conservation strategies to preserve soil arthropod communities and their ecological services.

Keywords: Soil arthropods, cibubur, urban forest, composition

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INTRODUCTION

The group of fauna that live in or on the surface of the soil is called soil arthropods which constitute 23% of the total living organisms in the world (Razzak et al., 2022). Soil arthropods can be categorized as part of the soil fauna that lives above and below the soil surface and then grouped based on their size into 3 groups, namely microfauna (20-200 microns), mesofauna (200 microns-1 cm) and macrofauna (>1 cm) (Wasis et al., 2024). It is known that there are several groups of soil arthropods such as Arachnida, Crustacea, Myriapoda, Collembola, and Insects (Wenying, 2000)

There are several well-known roles of soil arthropods, both beneficial and harmful to humans. Among them are predators, which are commonly found in certain

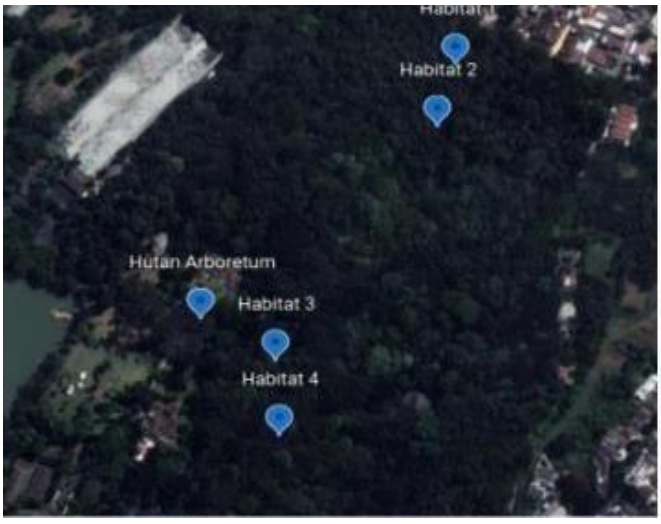
species belonging to the order Coleoptera, such as the Carabidae family, ants (Rohyani, 2020), and Arachnidae (Pereira et al., 2019). In addition to their role as predators, some soil arthropods also function as decomposers (detritivores) of organic matter, such as termites (Isoptera) and dung beetles (family Scarabaeidae) (Pradipta et al., 2020). Soil arthropods also have a detrimental role as pests in various agricultural products by damaging the skin/epidermis of agricultural products (Kurniawan et al., 2023).

The presence of soil arthropods is generally influenced by various abiotic climatic factors such as soil pH, temperature, humidity, light, and rainfall, which are conducive to the development and metamorphosis of soil insects (Rohyani & Sulistiani, 2022). The same publication also states that differences in soil microhabitats can affect the abundance of soil arthropod individuals. Microhabitat climate factors such as air, light, and temperature can influence the level of organic matter decomposition (Damayanti et al., 2023).

Research in the Arboretum Cibubur urban forest in Jakarta has previously been conducted on ants from the order Hymenoptera (Ruslan et al., 2023) and butterflies (Ruslan et al., 2020; Ruslan et al., 2022). However, studies on soil arthropods have been limited, with few publications available. This serves as the basis for conducting research in various habitat types within the Arboretum Cibubur urban forest, which represents a natural habitat patch surrounded by various anthropogenic disturbances.

METHOD

The research was conducted in March 2024 in the Arboretum City Forest area, Cibubur, East Jakarta. The equipment used during data collection included: a shovel, labels, chopsticks, plastic bottles with a diameter of 8.5 cm, 70% alcohol, Styrofoam, plastic bags, a measuring tape, a pH meter, a thermometer, a hygrometer, a lux meter, a Global Positioning System (GPS), an identification book, a ruler, and a smartphone camera. Laboratory equipment consisted of a stereo microscope, specimen bottles, tweezers, pipettes, and petri dishes.



The method used for collecting soil arthropod specimens in this study was the Pitfall

trap (Vincent and Hadrien, 2013). The traps were placed in each habitat, forming a circular arrangement with a radius of 15 m in a hole 15 cm deep. A plastic bottle with a diameter of 8.5 cm was placed inside the trap and filled with 70% alcohol to a depth of approximately ¾ of the bottle's height. The trap was covered at the top with a 15x15 cm (Length x Width) Styrofoam sheet. The distance between the bottle's opening and the Styrofoam cover was 15 cm. Each habitat contained 15 traps arranged in a circular pattern, with a distance of 5 meters between each trap. The traps were set for three days. Data collection was conducted on abiotic condition parameters at each trap point, including soil surface temperature, air temperature, soil moisture, air humidity, light penetration, and soil pH. Additionally, soil texture observations were carried out for each type of vegetation. Data analysis in this research used Frequency, and Important Value Index (INP).

Relative Abundance and Relative Frequency

Relative Abundance (KR) was determined using the following formula (Brower et al,.1990)

$$KR = \frac{\text{No. of Individual Species}}{\text{No. Of All Individuals}} \times 100\%$$

The Relative Frequency (FR) value was determined using the following formula::

$$FR = \frac{Frequency\ of\ a\ Species}{\text{Frequency of All Species}} \times 100\%$$

The Important Value Index (INP) of butterflies was determined using the following formula:

$$INP = KR + FR$$

RESULT

A. Description and Habitat Conditions

The Arboretum Urban Forest in Cibubur, Jakarta, is one of the important conservation areas. This area contains several habitats.

Habitat 1

It is an area with open vegetation lighting conditions (high intensity). This area is a homogeneous forest dominated by pine trees (Pinus merkusii). However, several other plant species can also be found, such as sugar palm (Arenga pinnata) and melinjo (Gnetum gnemon). Additionally, the ground surface is covered with litter, predominantly pine litter, and has a clayey and humus-rich soil texture. (Figure 2).

Habitat 2

It is an area with open vegetation lighting conditions (low intensity), which is a homogeneous forest area dominated by melinjo (Gnetum gnemon), with the ground surface thinly covered by litter. The soil texture in this area tends to be denser and harder compared to Vegetation Area 1 (Figure 3.)

Habitat 3

It is an area with closed vegetation lighting conditions (low intensity), classified as a heterogeneous forest area dominated by kapok (Ceiba pentandra) and melinjo (Gnetum gnemon). This area has a ground surface thinly covered by litter and a loose soil texture with humus (Figure 4)

Habitat 4

It is an area with closed vegetation lighting conditions (low intensity), classified as a heterogeneous forest area dominated by kapok (Ceiba pentandra). The ground surface is thickly covered by litter, with a loose soil texture and a thicker humus content (Figure 5).

B. Composition of Soil Arthropods in Various Habitats

The composition of soil arthropods in Habitat 1 (Figure 2.) includes 6 classes of arthropods and 14 orders, with a total of 305 individuals (Table 1).

Table 1. Soil Arthropods Found in Habitat 1

Arthropoda Tanah	Ordo	Jumlah	FR	KR	INP
Arachnida	Araneae	30	0.14	0.10	0.34
Chilopoda	Scolopendromorpha	6	0.03	0.02	0.08
Collembola	**Poduromorpha**	**47**	**0.11**	**0.15**	**0.26**
	Entomobryomorpha	**47**	**0.07**	**0.15**	**0.22**
	Symphypleona	21	0.04	0.07	0.11
Crustacea	Isopoda	1	0.01	0	0.01
Diplopoda	Julida	2	0.01	0.01	0.03
Insekta	Blattodea	6	0.03	0.02	0.08
	Coleoptera	**50**	**0.16**	**0.16**	**0.47**
	Dermaptera	15	0.10	0.05	0.20
	Diptera	**67**	**0.20**	**0.22**	**0.61**
	Mantodea	1	0.01	0	0.01
	Orthoptera	10	0.07	0.03	0.14
	Psocoptera	2	0.01	0.01	0.03
		305	**1**	**1**	**2**

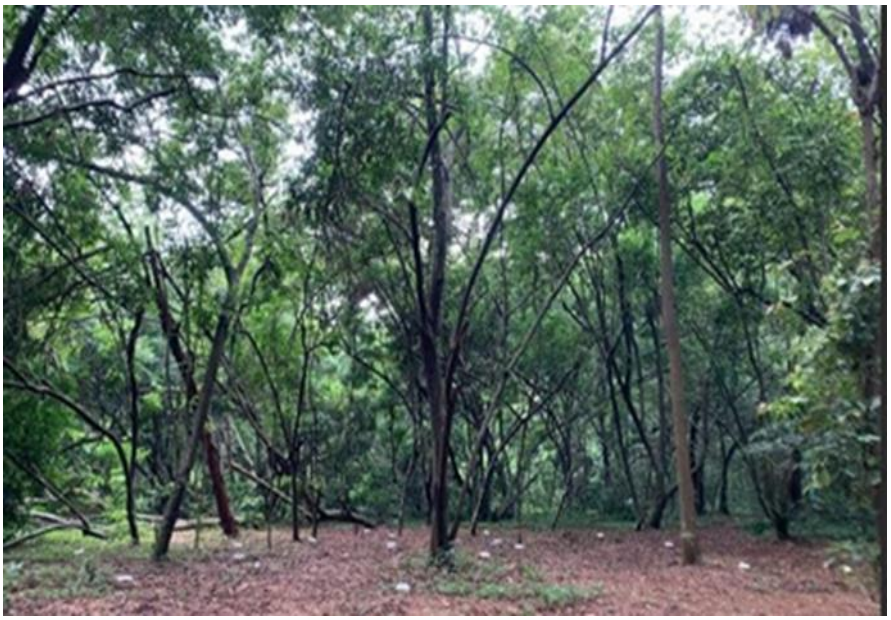


Figure 2. Habitat 1

In Habitat 2 (Figure 3), includes 5 classes of arthropods, 11 orders, and 69 **individuals were found (Table 2).**

Table 2. Soil Arthropods Found in Habitat 2

Soil Arthropoda	Ordo	Abundance	FR	KR	INP
Arachnida	Araneae	6	0.11	0.09	0.23
Chilopoda	Scolopendromorpha	4	0.06	0.06	0.13
Collembola	Poduromorpha	5	0.06	0.07	0.13
	Entomobryomorpha	6	0.04	0.09	0.12
Diplopoda	Julida	1	0.02	0.01	0.04
Insekta	Blatodea	1	0.02	0.01	0.04
	Coleoptera	**11**	**0.15**	**0.16**	**0.36**
	Dermaptera	8	0.13	0.12	0.28
	Diptera	**19**	**0.26**	**0.28**	**0.62**
	Hemiptera	5	0.09	0.07	0.19
	Orthoptera	3	0.06	0.04	0.11
		69	1	1	2

Figure 3. Habitat 2

The composition of soil arthropods in Habitat 3 (Figure 4) includes 6 classes of arthropods and 14 orders, totaling 197 individuals (Table 3).

Table 3. Soil Arthropods Found in Habitat 3.

Arthropoda Soil	Ordo	Abundance	FR	KR	INP
Arachnida	Araneae	17	0.15	0.09	0.30
Chilopoda	Scolopendromorpha	3	0.03	0.02	0.05
Collembola	Poduromorpha	20	0.11	0.10	0.21
	Entomobryomorpha	16	0.07	0.08	0.15
	Symphypleona	4	0.03	0.02	0.05
Crustacea	Isopoda	1	0.01	0.01	0.02
Diplopoda	Julida	3	0.02	0.02	0.04
Insekta	Blattodea	1	0.01	0.01	0.02
	Coleoptera	**39**	**0.11**	**0.20**	**0.39**
	Dermaptera	22	0.15	0.11	0.33
	Diptera	**56**	**0.24**	**0.28**	**0.66**
	Hemiptera	6	0.02	0.03	0.06
	Mantodea	1	0.01	0.01	0.02
	Orthoptera	8	0.05	0.04	0.12
		197	**1**	**1**	**2**

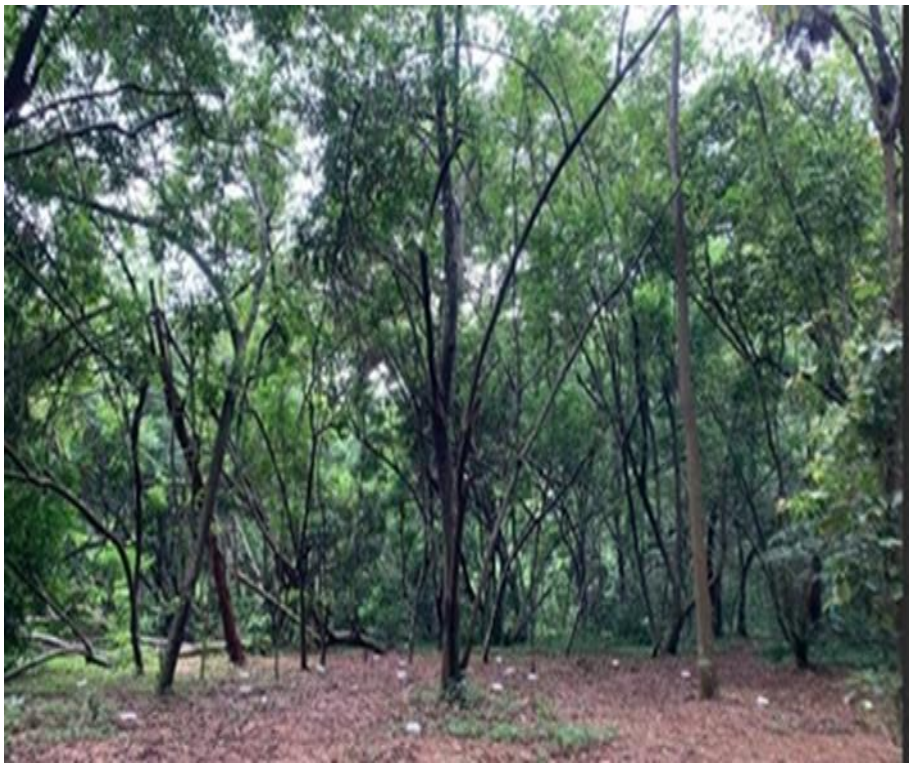


Figure 4. Habitas 3

In Habitat 4 (Figure 5), includes 4 classes of arthropods, 9 orders, and 181 individuals were found (Table 4).

Table 4. Soil Arthropods Found in Habitat 4

Soil Arthropoda	Ordo	Abudance	FR	KR	INP
Arachnida	Araneae	15	0.14	0.08	0.23
Collembola	Poduromorpha	4	0.03	0.02	0.05
	Entomobryomorpha	3	0.01	0.02	0.03
Crustacea	Isopoda	2	0.02	0.01	0.03
Insekta	**Coleoptera**	**79**	**0.22**	**0.44**	**0.69**
	Dermaptera	**30**	**0.24**	**0.17**	**0.43**
	Diptera	**22**	**0.17**	**0.12**	**0.30**
	Isoptera	4	0.03	0.02	0.06
	Orthoptera	19	0.10	0.10	0.21
		181	1	1	2

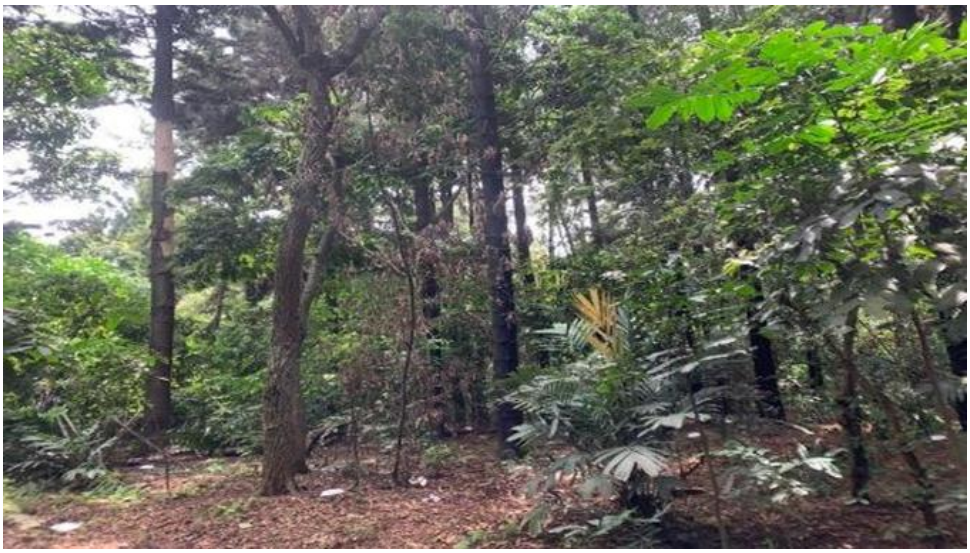


Figure 5. Habitat 4

DISCUSSION

A. Composition of Soil Arthropods in Various Habitats

In Habitat 1, six groups were found: Arachnida, Chilopoda, Collembola, Crustacea, Diplopoda, and Insecta. These groups are commonly found in terrestrial insect habitats on the soil surface. This habitat supports a higher diversity of arthropods due to its open-canopy forest structure and the presence of litter, which facilitates the reproduction of many soil arthropods. Litter is known to influence the food sources of soil arthropods, while plant canopies are associated with soil climatic conditions that also affect the presence and abundance of soil arthropods beneath them (Wildermuth, B., et al., 2024). The life of soil arthropods depends on the habitat environment, which consists of both abiotic and biotic factors (Suin, 2003)

Based on individual abundance, the highest number of individuals was found in Collembola, Diptera, and Coleoptera. Collembola and Coleoptera are groups of terrestrial insects that prefer habitats with a substantial and thick layer of litter (Damayanti et al., 2023). On the other hand, the lowest number of arthropods was found in Mantodea and Isopoda. Mantodea is a predatory order commonly found in various habitats, including open forests, and is known for its solitary nature (Marchiori, 2024), which may explain its low occurrence in this observation. Meanwhile, the low abundance of Isopoda may be because some members of this order have specific reproductive periods (Boeraeve et al., 2021)

In Habitat 2, five groups of soil arthropods were found, including Arachnida, Chilopoda, Collembola, Diplopoda, and Insecta. The number of individuals found was lower compared to other habitats. This may be due to the absence of litter covering the soil surface and the presence of an open canopy. An open canopy allows for high exposure to sunlight, which can affect the soil microclimate and, in turn, indirectly influence the abundance and diversity of arthropods (Wildermuth, B., et al., 2024)

Based on individual abundance, the highest number of individuals found in Habitat 2 belonged to Coleoptera and Diptera, while the lowest number was found in Blattodea and Diplopoda. Collembola and Coleoptera are common soil arthropods typically found

on the soil surface; however, in this habitat, they were found in limited numbers due to habitat characteristics that appear less conducive for these groups.

Diptera, from Habitat 1 to Habitat 4, consists mainly of non-terrestrial insects but was found in large numbers, likely because the sample collection or trap placement coincided with the breeding period of Diptera. This resulted in a significantly higher number of individuals during that time. Fikri and Arrufitasari (2024) stated that the presence of Diptera (Culicidae) in pitfall traps was due to trap placement occurring during the wet season, which is the breeding period for these insects.

Diplopoda was found in limited numbers, possibly due to the absence of litter in this habitat, which serves as a food source for Diplopoda. Diplopoda rely on litter or organic material as an energy source, influencing their presence and population size in a given area (Darmi et al., 2023)

In Habitat 3, six diverse groups of soil arthropods were found, with a total of 197 individuals. The number of individuals in this habitat was higher compared to Habitat 2 due to the more favorable conditions for soil arthropods, including an abundant layer of litter and a partially closed canopy. A closed canopy helps maintain climatic factors beneath the trees, such as temperature and humidity, which are suitable for the development of many soil arthropod species (Damayanti et al., 2023).

Based on individual abundance, the highest number of individuals found in Habitat 3 belonged to Diptera and Coleoptera, while the lowest number was found in Isopoda, Mantodea, and Blattodea. Diptera and Coleoptera had a higher number of individuals compared to other orders, whereas Isopoda, Mantodea, and Blattodea were found in low numbers. This is likely due to the biotic and abiotic factors in this habitat, which support the survival of these orders. Coleoptera and Diptera are among the largest insect orders (Triplehorn & Johnson, 2005)

In Habitat 4, arthropods were found in a lower number of groups compared to other habitats; however, the total number of individuals was nearly the same as in Habitat 3. The low number of arthropod classes found may be due to the placement position or technical aspects of the pitfall trap, which may not have been optimal due to the thick litter layer in this habitat. Environmental conditions, trap placement position, and the components of the pitfall trap significantly affect its efficiency (Litavsky & Prokop, 2024)

Based on the number of individuals, the highest abundance found in Habitat 4 belonged to Coleoptera, Diptera, and Dermaptera. Dermaptera was found in high numbers due to the habitat's closed canopy characteristics. Dermaptera is known to prefer moist and dark environments (Emiliyamma et al., 2024).

B. Ecological Role of Soil Arthropods

In habitats 1, 2, 3, and 4, there are several ecological roles held by soil arthropods found in these habitats which are attached in Table 5 as follows.

Table 5. Ecological Role of Arthropods in Habitats 1,2,3 and 4

Arthropoda	Ordo	The Role of Ecology	Reff
Arachnida	Araneae	Predators	Jasmi et al, 2021
Insekta	Blattodea	Omnivores and Detritivores	Natanaela et al., 2022
	Coleoptera	Predators, Decomposers Scavenger, Herbivore	Pravitarani dan Ichsan, 2022
	Dermaptera	Predators	Meunier, 2024

Arthropoda	Ordo	The Role of Ecology	Reff
	Diptera	Predators, pollinators, Decomposers	Nizam et al., 2021
	Orthoptera	Herbivore	Setiawan et al., 2023
	Hemiptera	Herbivore, Carnivore	Ruslan & Tobing, (2021); Diratika et al., 2020
	Isoptera	Decomposers	Bezerra et al., 2021
	Mantodea	Predators	Saha dan Chanda, (2023), Marchiori (2024)
	Psocodea	Decomposers and herbivore	Parra et al., 2022
Collembola	Poduromorpha	Decomposers/ detritivores	Hanisch et al., 2022
	Entomobryomorpha	Bioindicators	Estevam et al., 2022
	Symphypleona		
Crustacea	Isopoda	Decomposer /detritivores	Darwati et al., 2023
Chilopoda	Scolopendromorpha	Predators	Marchiori (2024a)
Diplopoda	Julida	Predators and mushroom eater	Kicaj (2023)

Based on previous publications, the role of soil arthropods found in habitats 1 to 4 is dominated by decomposers and predators, while other arthropods act as pollinators and herbivores. The group of arthropods that act as decomposers are known to have the largest number and types found on the soil surface due to the availability of organic media such as leaf litter, twigs, or dead tree trunks, and the presence of a humid microclimate that causes the emergence of many fungi which are food resources for some soil arthropods. Based on Arunachalam et al., (2022), soil insect diversity is beneficial for nutrient cycling in the soil surface habitat and maintaining the stability of soil structure (pores and particles) which is influenced by the presence of resources contained in the habitat. The presence of litter in habitats 1 and 3 and habitats 2 and 4 affect the high presence of soil arthropods that play the role of decomposers and fungal eaters (detritivores). The presence of soil arthropod communities is strongly influenced by the physical and chemical characteristics of the soil, which in turn is related to the stability of the soil community (Kurniawan et al., 2023). The presence of predators with high numbers in the four habitats is thought to be influenced by the richness of organisms found on the soil surface. The high number of predatory soil arthropods in a habitat is influenced by high prey availability and life skills such as aggressiveness in searching for prey (Nisa et al., 2024).

CONCLUSION

From the results of the study in 4 different habitats, it was found that the composition of the Arthropod Phylum was different. Six classes of arthropod phylum were found: Arachnida, Chilopoda, Collembola, Crustacea, Diplopoda, and Insect. The Insect class was the most dominant. There were 16 orders of soil arthropods found in 4 habitats in Cibubur City Forest. The order Colembola, the order Coleoptera, and the order Diptera had a high number of individuals found in all habitats, and the order Mantodea, and the order Isoptera had a low number of individuals found. In Habitat 1, the highest

number of individuals of soil arthropods was found, and the lowest number of soil arthropods was found in Plot 2. The ecological role of soil arthropods act as predators, decomposers, scavengers, herbivores, and carnivores.

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