JASSU
Journal of Agrosociology and Sustainability
JASSU 3(1): 57–74
ISSN 3025-1362

Institute for Advanced Science, Social and Sustainable Future
MORALITY BEFORE KNOWLEDGE

Assessment of soil mesofauna diversity, dominance, and environmental conditions in paddy field ecosystems with recommendations for sustainable agricultural practices

Alya Mahirotun Numa[1,*], Susanto[1]
[1] *Biology Education Study Program, Faculty of Teacher Training and Education, Universitas Muhammadiyah Purwokerto, Purwokerto, Central Java 53182, Indonesia.*
*Correspondence: alyamahirotun15@gmail.com

Received Date: May 5, 2025 Revised Date: June 30, 2025 Accepted Date: July 29, 2025

ABSTRACT

Background: The diversity and dominance of soil mesofauna are influenced by environmental factors such as soil temperature, pH, humidity, and texture. This study aims to analyze the soil mesofauna community, including species count, diversity, and dominance, and evaluate the environmental quality of rice fields in Pliken Village, Kembaran District, Banyumas Regency. **Methods:** The research was conducted using a survey method from January to June 2023. Soil samples were collected from three different locations (west, north, and south) with a one-month interval. Sampling was carried out twice a day, in the morning (06:0–008:00 Western Indonesia Time) and evening (18:00–20:00 Western Indonesia Time). **Findings:** A total of 820 individuals from 13 species, 11 families, and 9 orders of soil mesofauna were recorded. *Solenopsis invicta* (Red Ants) had the highest count (332 individuals), while *Cimex* sp. and *Pulex* sp. had the lowest (2 individuals each). The Shannon-Wiener diversity index ranged from 1.19 to 1.86, averaging 1.52, indicating moderate diversity. The Simpson dominance index ranged from 0.150 to 0.531, averaging 0.300, suggesting no species dominance. Environmental factors such as air temperature (22–28°C), soil temperature (23–28°C), and soil pH (6.1) were within optimal ranges for mesofauna life. However, humidity levels varied between 20–65%, with lower values in the dry season, potentially affecting mesofauna survival. **Conclusion:** The rice fields of Pliken Village support a moderately diverse soil mesofauna community with no dominant species. The environmental conditions are generally favorable, except for humidity fluctuations, which may impact mesofauna populations. Sustainable land management practices, such as reducing excessive pesticide use, are recommended to maintain soil fertility and biodiversity. **Novelty/Originality of this article:** This study provides a comprehensive assessment of soil mesofauna diversity and environmental quality in rice fields, offering valuable insights into the impact of agricultural practices on soil ecosystems. The findings highlight the need for sustainable land management to preserve soil biodiversity and fertility.

KEYWORDS: soil mesofauna; individual count; diversity; dominance; rice fields.

1. Introduction

Central Java Province possesses extensive rice fields, particularly within Banyumas Regency. Banyumas Regency itself contains significant areas of paddy land, notably in Pliken Village, Kembaran Subdistrict. The total area of rice fields in Pliken Village reaches 3.4 km^2. Macroscopically, Kembaran Subdistrict is situated on a fluvial plain at the foot of a volcano. This study is located in an area where the primary livelihood of the community is farming, with an annual growth rate of 1.2%.

Banyumas Regency has substantial areas of paddy land, one of which is located in Pliken Village, Kembaran Subdistrict. The community of Pliken Village utilizes a portion of

Cite This Article:
Numa, A. M., & Susanto. (2025). Assessment of soil mesofauna diversity, dominance, and environmental conditions in paddy field ecosystems with recommendations for sustainable agricultural practices. *Journal of Agrosociology and Sustainability, 3*(1), 57-74. https://doi.org/10.61511/jassu.v3i1.2025.1862

their land for rice cultivation. Cultivated crops include corn, rice, and legumes. The extensive paddy fields indicate the presence of a significant population of soil fauna inhabiting the area, including soil mesofauna. Soil fertility is indicated by the presence of soil mesofauna, serving as a bioindicator due to its population density and diversity. This is based on the reality that Indonesia is an agrarian nation where all agricultural activities remain fundamentally dependent on the soil, as land use fulfills the food requirements of the population (Faoziyah et al., 2024; Permadi & Azizi, 2024).

The soil alteration associated with conventional rice farming can adversely impact the diversity of soil fauna, a decline that may result in the extinction of dependent species. The role of soil fauna is crucial, as it contributes significantly to soil ecosystem functions including pore space formation, water retention, and organic residue decomposition (Peng et al., 2025; Quandahor et al., 2024; Peng et al., 2024).

Soil is an environment composed of two components: abiotic and biotic. The combination of these abiotic and biotic elements forms an environment suitable for soil organisms. Another definition of soil is the natural medium for plant growth, composed of minerals, living organisms, and organic matter (Li et al., 2024a). According to Li et al. (2025), the soil profile is structured into distinct horizons, each characterized by unique color, physical properties, and texture. Soil functions to regulate ecosystem balance and food chains within forest environments, analogous to the role of wildlife within an ecosystem (Ren et al., 2024; Vanolli et al., 2023).

Soil fauna plays a critical role in improving the biological, physical, and chemical properties of soil. Biologically, soil fauna creates environmental conditions that support other animal life. The physical role of soil fauna involves the breakdown of organic matter via decomposition. Its chemical role is to release and cycle vital nutrients within the soil, making them accessible to plants (Angst et al., 2024; Khan et al., 2025). The diversity of soil fauna in a given location depends on adequate energy sources and supportive environmental conditions, which allow for the proliferation of various taxa in high abundance. For instance, soil mesofauna, a key group of soil fauna, are commonly found in paddy fields (Angst et al., 2024). An ecological community consists of multiple species whose populations demonstrate positive or negative correlations across temporal and spatial gradients (Godoy et al., 2024; Davison et al., 2024).

Soil mesofauna refers to three groups of organisms sensitive to environmental changes caused by human activities. Soil mesofauna acts as decomposers, converting organic materials into inorganic compounds beneficial to plants. Furthermore, soil mesofauna plays a vital role in sustaining an environment's physical, chemical, and biological fertility (Gruss et al., 2025). Soil mesofauna (1–10 mm in size) decompose organic matter to release soil nutrients for plants (Hauer et al., 2025). Their distribution is governed by environmental conditions like soil pH, temperature, and moisture, making them sensitive bioindicators of soil quality. These same factors, especially temperature, also regulate microbial activity within the soil (Remelli et al., 2024).

Soil mesofauna is dependent on its environment, both biotic and abiotic. Its presence and diversity are influenced by food sources, such as organic matter. The availability of energy and nutrients for soil fauna indirectly exerts a positive impact on soil fertility. Given that soil mesofauna is highly sensitive, assessing soil quality in specific areas is essential. Based on these considerations, this research on the Soil Mesofauna Community in the Paddy Fields of Pliken Village, Kembaran Subdistrict, Banyumas Regency, was conducted in 2023.

2. Methods

This research was conducted in the rice fields of Pliken Village, Kembaran District, Banyumas Regency for six months, namely in January–June 2023. The determination of the time was based on the estimated effective time to carry out the research by considering the rainy season, namely January–March and the rainy season, namely April–June. Sampling was carried out 6 times with a sampling interval of one month. Soil sampling and soil mesofauna samples were taken during the day (06:00–08:00 Western Indonesia Time) and

in the afternoon (18:00–20:00 Western Indonesia Time). The method used in this study was purposive random sampling or random sampling that has a specific purpose. According to Ahmed (2024), the purposive random sampling technique is a technique for determining research samples with several specific considerations with the aim that the data obtained can be more representative. There are 3 sampling locations in the rice fields of Pliken Village and each location has 6 sampling points.

The tool used in collecting soil mesofauna is using a soil drill with a depth of 15–30 cm. The soil samples obtained were taken to be incubated for 7 days using a Turgen Funnel tool or turgen tunnel using a solution of 4% formalin and 70% alcohol. Soil mesofauna samples were identified using the Borror key An Introduction to the study of insects conducted at the Zoology Laboratory, Biology Education Study Program, Faculty of Teacher Training and Education, Muhammadiyah University of Purwokerto. Environmental quality measurements were carried out at each research location including air temperature, soil temperature, acidity, humidity and soil texture.

3. Results and Discussion

3.1 Mesofauna community structure

Soil is an environment consisting of two components, namely abiotic and biotic. The composition of abiotic and biotic soil that forms the environment can be used as a place for soil organisms. Another definition of soil is as a natural medium used for plant growth composed of minerals, living organisms and organic materials (Li et al., 2024a). Soil provides a good habitat for microorganisms and a wide habitat for: fungi, algae, protozoa and arthropods (Ogedegbe & Edwuonwu, 2014). Soil as one of the abiotic components in an ecosystem is a natural resource that greatly affects life. The results suggest that the structure and function of mesofauna communities are greatly influenced by habitat type and local environmental conditions, which is important for coastal ecosystem conservation (Ortiz-Ramírez et al., 2024). Soil fauna significantly influences soil organic matter content (Sofo et al., 2020).

According to Li et al. (2025) soil is composed and formed from various layers formed from various layers of soil. Soil layers are grouped based on: color, physical and texture Based on the layers, soil is divided into 3 parts, namely: top layer, which is the layer that extends to a depth of 30 cm, is often referred to as top soil. This layer is the most fertile layer because it contains a lot of organic matter. Therefore, this layer is the optimal part of plant life. Layer, located just below the top soil and has a thickness ranging from 50 cm to 1 meter. Formed by a mixture of weathered material from the lower layer and topsoil material that has been transported by water and then deposited. This soil layer is characterized by its lighter color compared to the layer above it and has a denser texture. It is often referred to as clay. Bottom layer consists of weathered rocks that have begun to mix with the soil deposited on the layer above it, or clay. The parent material of the soil is found in the bottom layer and consists of inorganic material from fractured rocks originating from the layer below. It does not contain humus.

Soil is said to be a system that has three functions. The three functions are chemical, physical and biological functions (Pedrinho et al., 2024). Chemical function, soil chemically functions as a warehouse and supplier of nutrients, both organic and inorganic, and main elements such as N, P, K, Ca, Mg, S, Cu, Zn, Fe, Mn, B, and Cl. Physical function, soil physically as a place for roots to grow and develop. Roots provide water and nutrient needs to plant roots and function as a support for the upright growth of plants biological function, the function of soil is used as a habitat for active organisms in providing additives and nutrients for plants.

Organisms that live on the surface of the earth or in the soil are soil animals or often referred to as land animals. Soil organisms are organisms that are responsible for the destruction and synthesis of organic matter. Most soil fauna are buried more than 10 cm

above the soil mineral layer. Some or all of the life cycle of soil fauna occurs in the soil and can be related to the soil environment (Pedrinho et al., 2024).

Soil fauna encompasses a wide range of taxa, including rotifers, protozoa, nematodes, annelids, mollusks, arthropods, and even vertebrates (Boyce & Nelsen, 2025; Blakemore, 2025). Soil fauna is grouped based on its presence in the soil, the habitat chosen, feeding activities and body size. Fauna based on its presence is divided into temporary, periodic, transient and permanent groups. Classification based on presence: Transient, animals that are located in the soil during winter, these animals live and are active in the plant layer during the sleep phase (rest/hibernation). For example, *Hippodamea* sp., or ladybird beetle. Temporary resident, this animal is located in the soil from the egg phase to the juvenile phase or young phase, and lives above the soil surface when it is an adult. For example, *Tipula* sp. (*Diptera*) which obtains food by decomposing the remaining litter in the soil. Periodic, their life is spent in the soil. Lives above the soil surface in the adult phase. For example, *Forticula* sp. (*Dermaptera*). Permanent, animals that live in the soil permanently and are able to adapt to various soil depths. For example, *Batrisodes* sp. (Pedrinho et al., 2024).

The presence of soil fauna is important in the balance of a soil system. There are two different components in the soil, namely abiotic components and biotic components. Biotic components include fauna, flora and abiotic components such as climate (temperature, humidity, rainfall) air and water. The presence of soil fauna is very important for the balance of an ecosystem. Soil has a function to regulate the balance of the ecosystem and the food chain in the forest so that it can be analogized as wild animals that live in an ecosystem (Ren et al., 2024; Vanolli et al., 2023). Soil fauna is very important for soil formation, litter decomposition, nutrient cycling, biotic regulation, and to enhance plant growth (Briones, 2018). Climate change on soil fauna suggests that frequent summer droughts can reduce the abundance and diversity of forest soil fauna. More humid conditions can lead to changes in community structure (Lindberg, 2003).

Soil fauna classified into soil macrofauna and soil mesofauna, play an important role in improving the physical, chemical and biological properties of the soil and increasing soil fertility. Based on the importance of the role of soil fauna in maintaining ecosystem balance and the limited information available about soil fauna, especially in Indonesia, it is necessary to conduct research on the role of soil fauna in soil processes (Ren et al., 2024; Vanolli et al., 2023). Soil fauna uses soil as a natural habitat to survive. Soil fauna plays an important role in regulating ecosystem balance, nutrient production, organic matter breakdown and recycling, and soil structure maintenance and soil formation processes. Examples of soil fauna included in it are Insecta, Crustaceae, Chilopoda, Diplopoda, Mollusca and small vertebrates (Harrison et al., 2024).

Soil mesofauna can be used as bioindicators of soil fertility, and their population and diversity in the soil can be used to see how much or how little environmental influence affects the population and diversity of soil mesofauna. Environmental factors, including air temperature, soil temperature, and soil pH, influence the existence of soil mesofauna. These factors are often a direct result of land processing and cultivation techniques (Gruss et al., 2025; Wang et al., 2025). There are 3 soil organisms that are sensitive to environmental changes caused by humans (Chen et al., 2024). Soil fauna plays a very important role in improving the biological, physical and chemical properties of the soil. Biologically, soil fauna creates environmental conditions that support the lives of other animals. Physically, soil fauna facilitates the fragmentation of organic matter through the process of decomposition. Chemically, it enhances soil fertility by converting this matter into essential plant-available nutrients (Khan et al., 2025).

3.1.1 Individual count

The number of soil mesofauna individuals obtained during the study (January–June 2023) in the Rice Fields of Pliken Village, Kembaran District, Banyumas Regency was 820 individuals belonging to 13 species, 11 families and 9 orders. In this study, the soil

mesofauna obtained were the orders Hymenoptera, Diplura, Collembola, Coleoptera, Diptera, Araneae, Acarina, Hemiptera, and Siphonaptera. The largest number of soil mesofauna individuals found in the rice fields of Pliken Village was the species *Solenopsis invicta* (Red Ants) totaling 332 individuals, while the second largest acquisition is the species *Temothorax* sp., (Winged Ant) with a total of 177 individuals. Furthermore, for soil mesofauna with the smallest number of individuals, there are several species, namely *Cimex* sp., and *Pulex* sp., with a total of two individuals. While for other species obtained, the number of individuals varies between 5-17 individuals.

Table 1. Results of individual soil mesofauna counts obtained during the study (January – June 2023)

No	Order	Family	Species	Local name	Number of individuals
1	Hymenoptera	Formicideae	*Dolichoderus thoracicus*	Black Ants	117
2			*Solenopsis invicta*	Red Ants	332
3			*Temothorax* sp.	Winged Ants	177
4	Diplura	Japydideae	*Japyx* sp .		36
5	Collembola	Hypogastruridae	*Hypogastrura purpurescens*		60
6		Entomobrydeae	*Entomobrya sicia*		24
7	Coleoptera	Staphylinidae	*Paederus fuscipes*	Tomcat Beetle	12
8		Carabidae	*Amblytelus* sp.	Bee	5
9	Diptera	Drosophilidae	*Drosophila* sp.	Fruit Fly	13
10	Araneae	Araneidae	*Araneus* sp.	Spider	6
11	Acarina	Ascidians	*Asca vulgaris*	Predatory Mites	34
12	Hemiptera	Cimidae	*Cimex* sp.	Bedbug	2
13	Siphonaptera	Pulicideae	*Pulex* sp.		2
Qty	9	11	13		820

Based on the results of the acquisition of the number of individual counts in the rainy and dry seasons, there are more individual counts in the rainy season. This is because the greater number of total individual counts in the rainy season occurs because the rainy season guarantees the availability of water which is important in supporting the life of soil fauna. Li et al. (2024b) that the abundance of soil fauna will decrease drastically during the dry season, so that the higher the air temperature, the lower the population level of soil fauna. Ants, a family often prevalent in diverse research areas, possess a greater tolerance for direct sunlight compared to other soil fauna. This resilience explains their common presence in sunlit environments (Nagy et al., 2025). According to Liu et al. (2024a) research indicates an inverse relationship between incoming light intensity and soil mesofauna population size.

Table 2. Results of obtaining the total number of individual soil mesofauna obtained in the rainy and dry seasons

Rainy season	Total individual count	Dry season	Total individual count
January	159	April	105
February	239	May	71
March	154	June	92
Amount	552		268

Based on the results of the individual counts in the rainy and dry seasons, there are more individual counts in the rainy season. Water will evaporate more in the dry season. This is because the water content in a habitat will decrease. Lack of water in the body of soil fauna can cause dehydration and death which will reduce the population of soil mesofauna in the habitat. In accordance with Li et al. (2024b) that the abundance of soil fauna will

decrease drastically during the dry season, so that the higher the air temperature, the lower the population level of soil fauna.

During the study, the most abundant individual count was from the Hymenoptera Order in the Formicidae Family found in the rainy and dry seasons. The highest member of *the* Formicideae Family was *Soleonopsis invicta* (Red Ants) with a total of 332 (39.5%). In the number of individuals in the Formicideae Family, *Soleonopsis invicta* was greater because it was a very large group of organisms and was colonial. According to Azhar et al. (2024), ants often exhibit the highest individual abundance due to their extensive foraging area. They function as scavenger predators, preying on various fauna within the litter and canopy. Furthermore, the ample availability of litter is a key factor supporting this high species abundance. Due to their higher tolerance for direct sunlight relative to other soil fauna, ants are a family frequently observed in sun-exposed locations and are thus common subjects in various field studies (Nagy et al., 2025).

3.1.2 Species

In the rainy season, during the day there are 10 species variations, while at night there are 7 species variations. In the dry season, during the day there are 11 species variations, while at night there are 12 species variations.

Table 3. Number of species variations based on the rainy season and dry season during the study

Season	Time	
	Afternoon	Evening
Rain	10	7
Drought	11	12

In the number of species variations obtained in the previous year, 26 species were obtained, while the variations obtained in this study were 13 species. This is because the use of pesticides in rice fields in Pliken Village has caused fewer species. Soil organic matter significantly influences soil fauna population density; increased organic content is associated with greater ecosystem diversity among soil fauna (Mamabolo et al., 2024; Qiu et al., 2025) taxa such as Isotomidae, Entomobryidae, Onychiuridae, and Armadillidiidae can function as bioindicators for land use types such as agricultural land, artificial vegetation, and wetlands (Zheng et al., 2022). The composition and type of leaf litter determine the types of soil fauna found in the area and the amount of litter available determines the density of soil fauna. Excessive use of pesticides can cause various problems. The problems caused by the decline in the types of soil fauna to extinction. The lack of diversity of soil fauna in the ecosystem.

3.1.3 Diversity index

The diversity index of soil mesofauna in the rice fields of Pliken Village can be calculated using the Shannon-Winner index (H'). The diversity index value aims to determine the number of species present at a time in the community. The average results of the diversity index measurement range from 1.19 to 1.86 with an average of 1.52. The diversity index in the rainy season, namely January-March 2023, ranged from 0.96 to 1.47 with an average of 1.19. While the diversity of soil mesofauna in the dry season, namely April-March 2023, ranged from 1.72 to 2.07 with an average of 1.86.

The diversity index value with moderate criteria in the study was due to the presence of dominant animals from the Formacidae family, namely *Soleonopsi invicta* (Red Ants), *Dolichoderus thoracicus* (Black Ants) and *Temnothorax* sp., (Winged Ants). According to Waheed et al. (2024), moderate diversity was due to changes in land and soil texture, so that the soil fauna was not very diverse.

Based on the sampling time, it shows that in June, both during the day and night, it has the highest diversity index when compared to other months. Based on the sampling

location, location three has the highest mesofauna diversity index. Litter at location three causes soil mesofauna to live in that environment. According to Wang et al. (2024), both the type and amount of leaf litter are critical factors; the former influences the diversity of soil fauna species present, and the latter controls their overall density.

Table 4. Average results of diversity index measurements from January–June 2023

Season	Month	Diversity index	Average
Rain	January	0.96	1.19
	February	1.13	
	March	1.47	
Drought	April	1.72	1.86
	May	1.80	
	June	2.07	

Based on the analysis of the diversity index calculation (H') in the rice fields of Pliken Village at the time and location of sampling, it is included in the criteria for a moderate diversity index because H' is greater than 1 and less than 3. According to Waheed et al. (2024), the Shannon-Winner decreasing species diversity formula is used to determine species diversity in a community. The Shannon-Winner diversity index shows that there is a relationship between the number of species and the number of individuals that make up a community based on the criteria if H' is less than 1 then the diversity is low, while if 1 is less than H' is less than 3 then the diversity is moderate and if H is more than 3 then the diversity is high.

The diversity index value with moderate criteria in the study was due to the presence of dominant animals from the Formacidae family, namely *Soleonopsi invicta* (Red Ants), *Dolichoderus thoracicus* (Black Ants) and *Temnothorax* sp., (Winged Ants). According to Waheed et al. (2024), moderate diversity was due to changes in land and soil texture, so that the soil fauna was not very diverse. The diversity of organisms will tend to be low in a controlled ecosystem or get pressure from the environment. Then diversity is said to be high if an area has an optimum environment.

3.1.4 Dominance

Simpson's dominance index (C) shows the magnitude of the role of organism types in the relationship with the community as a whole. The results of the calculation of the dominance index of all sampling locations in the rainy season (January–March 2023) with an average of 0.419 while in the dry season (April–June 2023) with an average dominance index of 0.199.

Table 5. Average results of soil mesofauna dominance index calculations from January-June 2023

Season	Month	Dominance index	Average
Rain	January	0.531	0.419
	February	0.419	
	March	0.308	
Drought	April	0.243	0.199
	May	0.204	
	June	0.150	

The results of the Simpson dominance index criteria for the results of dominance identification in the rainy and dry seasons show that there are no dominant species, because D is less than 0.5, namely the rainy season is 0.419 and the dry season is 0.199. According to Waheed et al. (2024) states that if 0 is less than D less than 0.5 means there is no dominant species and if 0.5 is more than D more than 1 then there is a dominant species.

According to Waheed et al. (2024) stated that habitats that have relatively unchanged environmental conditions have high species types with a small number of species. When environmental conditions provide everything needed by organisms, the diversity of species

will be more abundant or have many variations but with a smaller number of species due to competition with others. However, on the contrary, when environmental conditions change, only certain organisms can survive so that they have many members because they have no competitors but with less diverse species diversity.

3.2 Environmental quality

Both abiotic and biotic environmental factors have an influence on the life of soil fauna, including soil mesofauna. Biotic environmental factors are other organisms that are in the same habitat as plants and microflora. While abiotic environmental factors are factors that influence the existence of soil fauna. Among them are soil pH, soil temperature, and available water content (Pedrinho et al., 2024). Abiotic components consist of elements such as temperature, light, soil, air, and water. Biotic components include all animals, plants, and microorganisms (Azal, 2022).

Research in Colombia shows that soil fauna including mesofauna and microfauna play a crucial role as indicators of soil environmental quality. Significant correlations between reported mesofauna and organic matter (OM) and phosphorus (P) content, as well as soil pH, reflecting the level of fertility and the main functions of the soil ecosystem. Biological activities such as organic matter fragmentation, biogenic structure formation (galleries, aggregates), and element accumulation (e.g. P) confirm that soil fauna create positive feedbacks on the physical, chemical, and biological quality of the soil. Thus, the presence of soil fauna, especially oribatids and collembola, can be used as effective ecological indicators to integrate soil quality degradation or recovery (Chamorro-Martínez et al., 2022).

The environment is an external factor that plays an important role in the condition of a community of living things, one of which is soil mesofauna. There are several factors that affect the life of soil mesofauna, namely air temperature, soil temperature, soil pH and humidity. Measurements were carried out during the study, namely in January–June 2023 based on the time, season, and location of sampling, including:

3.2.1 Air temperature

Measurement of air temperature in the rice fields of Pliken Village using an air thermometer. The results of the analysis of air temperature based on the season, namely the rainy season (January-March) and the dry season (April–June 2023) range from 22–28°C with an average of 25°C. Bicho et al. (2025) Temperature critically influences the survival of soil fauna, as these organisms possess specific thermal tolerance limits. The effective air temperature for soil fauna in the development of life is around the optimum breeding temperature of 25°C.

Table 6. Air temperature measurement results based on sampling time

Month	Research time	Temperature (°C)		Average (°C)
		Lowest	Highest	
January	Morning	24	26	25
	Evening	22	24	23
February	Morning	25	27	26
	Evening	24	25	24.5
March	Morning	26	27	26.5
	Evening	23	24	23.5
April	Morning	26	28	27
	Evening	25	27	26
May	Morning	26	27	26.5
	Evening	24	25	24.5
June	Morning	23	27	25
	Evening	22	25	23.5

The survival of good soil fauna is in the range of 18–20°C. At high and low temperatures related to the intensity of sunlight. The more sunlight that shines on the rice fields, the higher the temperature will be and the less intensity of sunlight that shines on the land, the lower the temperature will be. According to Ferreira et al. (2013) air temperature can affect the life of soil mesofauna. The abundance of soil mesofauna will decrease drastically during the dry season so that the higher the air temperature, the lower the population level of soil mesofauna.

Table 7. Air temperature measurement results based on sampling time

Location	Research time	Temperature (°C)		Average (°C)
		Lowest	Highest	
Location 1	Morning	23	25	24
	Evening	24	26	25
Location 2	Morning	24	27	25.5
	Evening	22	24	23
Location 3	Morning	25	28	26.5
	Evening	24	25	24.5

3.2.2 Soil temperature

Soil temperature is a soil physical factor that can determine the level of soil fauna diversity, soil temperature has an influence on the process of decomposition of soil organic matter (Suin, 2012). The average soil temperature from the rainy season and the dry season ranged from 23–28°C with an average of 25.5° C. According to Emmerling et al. (2025) soil temperature is a critical factor that influences whether a soil organism can survive and how abundant its population can become. This is because the temperature factor affects the activity of soil fauna, especially in metabolism and reproduction. The optimum soil temperature is 20°C and the maximum temperature range is 38–45°C.

High soil temperature will cause population density and diversity in soil fauna. Increasing soil temperature can reduce the diversity of soil fauna. High soil temperature affects the physiological processes of soil fauna such as disrupting the reproduction process, metabolism and respiration. Soil temperature will greatly affect the diversity and richness of soil fauna (Wuri & Aji, 2020).

Table 8. Results of soil temperature measurements based on sampling locations during the study

Location	Research time	Temperature (°C)		Average (°C)
		Lowest	Highest	
Location 1	Morning	23	26	24.5
	Evening	23	25	24
Location 2	Morning	24	27	25.5
	Evening	23	26	24.5
Location 3	Morning	24	27	25.5
	Evening	24	25	24.5

3.2.3 Degree of acidity

One of the chemical properties of soil is acidity and pH (potential of hydrogen). pH is a value on a scale of 0-14 that describes the relative amount of H^+ ions to OH^- ions in the soil solution. The soil solution is said to react acidically if the pH value is in the range of 0–6, this means that the soil solution contains more H^+ ions than OH^- ions, conversely if the amount of H^+ ions in the soil solution is smaller than the OH^- ions the soil solution is said to react alkaline or have a pH of 8–14. Soil acidity (pH) greatly affects the life and activities of soil animals (Pedrinho et al., 2024).

Soil acidity or pH is very important in the ecology of soil fauna because the existence and density of soil fauna is very dependent on soil pH. At the research location, the average pH was found to be 5-6, where the pH is not suitable for soil macrofauna life. Measuring soil

pH is very important in soil animal ecology because the presence and density of soil animals is very dependent on soil pH (Rasmusson et al., 2025). According to Rasmusson et al. (2025), there are soil fauna that can live in acidic pH conditions and can also be found in wet pH conditions.

Based on the results of the average acidity level (pH) in the rice fields of Pliken Village, the pH value is 6.1, which indicates that the soil is acidic. Meanwhile, research in Pliken Village, Kembaran District conducted by Devi & Jahan (2024) had a soil pH of 7. According to Antonangelo et al. (2025), the optimal pH range for most soil fauna is between 6 and 7, as this promotes high nutrient availability. pH levels that are either too acidic or alkaline are detrimental to their survival. Therefore, assessing soil pH is essential for understanding soil animal ecology, given its significant influence on their presence and abundance.

Table 9. Results of soil pH measurements based on sampling time during research

Month	Research time	Ph		Average
		Lowest	Highest	
January	Afternoon	6.2	6.5	6.35
	Evening	6.2	6.5	6.35
February	Afternoon	6	6.3	6.15
	Evening	6	6.5	6.25
March	Afternoon	5.4	6.1	5.75
	Evening	5.4	6.2	5.8
April	Afternoon	6.2	6.3	6.25
	Evening	6	6.3	6.15
May	Afternoon	6.2	6.2	6.2
	Evening	5.2	6	5.6
June	Afternoon	6	6.2	6.1
	Evening	5.8	6	5.9

3.2.4 Soil moisture

Soil moisture can be affected by the diversity of soil fauna. This humidity is related to the existence of soil fauna populations. Humidity is one of the main parameters in chemical and biological processes because it determines the presence or absence of water which is a supporting factor for the sustainability of life. Dry soil has an impact on increasing the rate of organisms losing water in their bodies. If the situation continues, it will affect the small chance of organism survival, because organic matter accumulates more easily in soil that has higher humidity compared to lower humidity. In addition, the bodies of soil animals that contain water are the cause of dry soil conditions (Pedrinho et al., 2024).

Soil moisture is the environmental variable that most influences the structure and function of mesofauna communities, including Collembola and mites: density and biomass of both decrease significantly under drought, while temperature changes alone have little effect unless accompanied by a decrease in humidity; for example, increasing temperature without humidity does not increase mesofauna populations, but under sufficiently wet conditions high temperatures can actually increase mesofauna numbers (Xu et al., 2012).

Humidity measurement has a factor that influences the presence of soil mesofauna. The tool for measuring humidity is a soil tester. Humidity measurements were carried out during research in Pliken Village from January–June 2023. The study was divided into two seasons, namely the rainy season (January–March) and the dry season (April-June). Based on the results of humidity measurements in the study which have a range of 20–65%. In the rainy season it has a humidity of 32% while the dry season is 45%.

Humidity is a critical factor in terrestrial ecosystems, primarily due to its significant influence on climate. It directly affects soil processes such as nitrification and is generally more favorable for soil fauna at higher levels than at lower ones. Furthermore, a decline in one type of soil fauna can lead to the dominance of another within a given area. Consequently, measuring humidity is essential, as its effects on soil fauna communities are

more pronounced and ecologically critical at higher levels (Ludwiczak et al., 2024; Qin et al., 2024).

Table 10. Soil moisture measurement results based on sampling time

Month	Research time	Humidity		Average %
		Lowest %	Highest %	
January	Afternoon	20	30	25
	Evening	30	50	40
February	Afternoon	20	40	30
	Evening	15	30	23
March	Afternoon	20	40	30
	Evening	20	40	30
April	Afternoon	30	40	35
	Evening	40	50	45
May	Afternoon	20	30	25
	Evening	30	50	40
June	Afternoon	30	50	40
	Evening	25	40	33

3.2.5 Soil texture

Soil texture is a factor that affects the life of soil mesofauna. The results of soil texture analysis at the Zoology Laboratory of Muhammadiyah University of Purwokerto. The soil texture at the research site in Pliken Village was identified manually via the hand feel method, as described by Rabot et al. (2024). Analysis of samples from locations 1, 2, and 3 revealed an average texture of clay and sandy clay. The clay was characterized by its smooth, sticky, and cohesive properties, in contrast to the sandy clay, which felt rough and gritty.

According to Adhikari et al. (2024), the earth's crust is soil which consists of organic and mineral materials. Soil texturing is taking half a handful of soil samples and removing foreign objects from the soil, leaving fine soil fragments. Then add a little water (if the soil is dry) and let it be absorbed by the soil, make a fist and knead with your index finger and thumb until it is wet and evenly distributed and crushed into individual pieces of soil. Subsequently, a soil or water sample is added. If the soil is too wet or too dry, it must be manipulated until it reaches its field capacity the ideal moisture level where soil just begins to stick to the fingers without being overly wet or dry (Rabot et al., 2024). Soil texture is one of the main determining factors: fine-textured soil (clay) supports different densities than coarse-textured soil (sandy) (Vanolli et al., 2023).

Soil structure occurs because of high temperatures in the dry season, increasing the process of water evaporation in the soil which causes the water content to decrease so that the soil density begins to decrease so that the soil density begins to decrease which is marked by the formation of soil cracks. While dry land has a sandy clay soil texture. Soil that has a clay texture and is dark in color is a characteristic of soil with a high organic matter content and soil that is good for the life of soil fauna.

According to Franzluebbers (2025) shows that soil texture has fine or coarse soil grains, more typical texture is determined by the balance of sand, clay and slit contained in the soil. Soil texture is used to indicate the particles contained in the soil, especially in the relative comparison of various soil groups. The number of individual counts obtained in this study was less when compared to the study conducted by Devi & Jahan (2024). The study conducted by Devi & Jahan (2024) on the Diversity of Soil Mesofauna in Rice Fields in Pliken Village, Kembaran District, Banyumas Regency, Central Java in 2022 obtained 612 individual counts including 26 species, 20 families and 13 orders. The decrease in the number of species was due to environmental factors in the rice fields of Pliken Village. This is because the use of pesticides in rice fields in Pliken Village has resulted in fewer species. According to Liu et al. (2024b), soil organic content is a primary determinant of soil fauna population density, with higher organic matter levels correlating to greater faunal diversity within an ecosystem. Furthermore, the composition and type of leaf litter influence the

specific taxa present, while the quantity of available litter directly affects overall fauna density (Bian et al., 2025). Conversely, the excessive application of pesticides poses significant ecological risks, including the reduction of soil fauna species diversity and, in severe cases, local extinction. This decline threatens ecosystem functioning due to the resultant loss of faunal diversity (Mazumdar & Mandal, 2025).

Table 11. of soil texture conditions at the research location

Location	Station	Soil texture
Location 1	Station 1	Clay
	Station 2	Clay
	Station 3	Sandy loam
Location 2	Station 4	Clay
	Station 5	Clay
	Station 6	Clay
Location 3	Station 7	Clay
	Station 8	Sandy loam
	Station 9	Sandy loam

The diversity index obtained was 1.52 indicating that the diversity index was moderate, because H' was more than 1 but less than 3. Devi & Jahan's (2024) diversity index ranged from 1.84–2.21 with an average of 2.03. Based on the Shannon-Winer criteria, it explains that the diversity index is moderate. According to Waheed et al. (2024), moderate diversity is due to changes in land and soil texture, so that soil fauna is not very diverse. The diversity of organisms will tend to be low in a controlled ecosystem or under pressure from the environment. Then diversity is said to be high if an area has an optimum environment.

The dominance index in this study was 0.30 based on the Simpsons criteria that the dominance index is low because D <0.5. Devi & Jahan's research (2024) obtained a dominance index of 0.13 - 0.26 with an average of 0.1. Based on the Simpsons criteria that the dominance index is low because D <0.5. Devi & Jahan's research (2024) obtained the results of environmental quality in rice fields in Pliken Village, Kembaran District in 2022 optimally supported the life of soil mesofauna. The results of environmental quality measurements in this study obtained the results that environmental quality optimally supported the life of soil mesofauna. According to Waheed et al. (2024) stated that habitats that have relatively unchanged environmental conditions have high species types with a small number of species. When environmental conditions provide everything needed by organisms, the diversity of species will be more abundant or have many variations but with a smaller number of species due to competition with others. However, on the other hand, when environmental conditions change, only certain organisms can survive and thus have many members because they have no competitors but with less species diversity.

Based on the results of environmental quality measurements including air temperature, soil temperature, acidity, soil moisture and soil texture. the results of air temperature measurements in this study are the same as the results obtained by Devi & Jahan (2024), which ranges from 23–28°C. This temperature is optimum for the life of soil mesofauna. The optimum rate of survival of soil fauna is at a temperature of 18–30 ° C. The results of soil temperature measurements are also no different from previous studies. Soil temperature ranges from 23–28°C which indicates the optimum for the life of soil mesofauna. According to Dong et al. (2025) the existence and population density of a soil organism are determined by soil temperature.This is because the temperature factor affects the activity of soil fauna, especially in metabolism and reproduction.

The degree of acidity or pH in previous studies from 2022 to 2023 ranged from 6 to 7 or acidic to neutral. According to Pearson et al. (2024), most soil fauna thrive within a pH range of 6–7, as this level supports high nutrient availability. Conversely, soil conditions that are either too acidic or too alkaline can adversely affect soil fauna viability. In this study, soil moisture levels increased compared to previous research, which recorded values of 37.5% during the rainy season and 30% in the dry season. This discrepancy is likely due to unusually high rainfall between January and March 2023, as well as unexpected rain during

April to June 2023 a period that is typically dry. Furthermore, the clay soil texture observed in the rice fields of Pliken Village is highly favorable for soil mesofauna, as it is rich in organic matter (Fatah et al., 2025).

4. Conclusions

Based on the discussion of the research results, it can be concluded that the soil mesofauna community in the rice fields of Pliken Village, Kembaran District in 2023. The individual count during January-June 2023 in Pliken Village, Kembaran District, Banyumas Regency obtained 820 individuals belonging to 13 species, 11 families and 9 Orders. The highest number of mesofauna is *Solenopsi invicta* (Red Ants), while for the soil mesofauna with the lowest number of individuals, namely *Cimex* sp., *Pulex* sp., with a total of two individuals. The soil mesofauna diversity index in the rice fields of Pliken Village, Kembaran District has a range of 1.19 - 1.86 with an average of 1.52. Based on the Shanon Winner criteria, it shows a moderate level of diversity because 1 < H '< 3. According to Waheed et al. (2024) the diversity index criteria are as follows: H '< 1 low diversity; 1 < H '< 3 = moderate diversity; H '> 3 = high diversity. The soil mesofauna dominance index in the rice fields of Pliken Village, Kembaran District has a range of 0.150 - 0.531 with an average of 0.300. Based on the Simpsons criteria, it shows low dominance, meaning that there are no dominant species because D < 0.5. According to Waheed et al. (2024) the dominance index criteria are as follows: 0 < D < 0.5 = no dominant species; 0.5 < D < 1 there is a dominant species.

Environmental quality in rice fields in Pliken Village, Kembaran District, Banyumas Regency 2023, which includes air temperature. Soil temperature, soil pH, humidity and soil texture have provided optimal support for soil mesofauna life. Air temperature measurements show that the research location has a range of between 22–28^{o}C, indicating that the air temperature is good for soil mesofauna life. The soil temperature in the study was in the range of 23–28°C, indicating that the soil temperature is good for soil mesofauna life. The degree of acidity (pH) in the study was 6.1, indicating that it is good for soil mesofauna life. Humidity in research has a range of 20–65%. In the rainy season the humidity is 32% while in the dry season it is 45%, indicating that humidity is not good for soil mesofauna life. The soil texture at the research location is clay which has a dark color, indicating that the soil texture is good for soil mesofauna life. Based on the research conducted, the author suggests that rice field managers in Pliken Village, Kembaran District, Banyumas Regency maintain soil quality in order to have fertile soil by not using excessive pesticides that have an impact on the environment. This aims to maintain sustainability and biodiversity including me SSofauna which have a role in improving soil fertility.

Acknowledgement
We would like to thank all parties who supported this research, especially the local farmers in Pliken Village and our respective institutions, for their assistance, facilities, and encouragement throughout the study.

Author Contribution
Both authors contributed equally to the conception, design, data collection, analysis, and writing of the manuscript, and approved the final version for publication.

Funding
This research received no external funding.

Ethical Review Board Statement
Not available.

Informed Consent Statement
Not available.

Data Availability Statement
Not available.

Conflicts of Interest
The authors declare no conflict of interest.

Open Access

References
Adhikari, K., Lalitha, M., Dharumarajan, S., Kaliraj, S., Chakraborty, R., & Kumar, N. (2024). Introduction to soils: Soil formation, composition, and its spatial distribution. In *Remote sensing of soils* (pp. 3-11). Elsevier. https://doi.org/10.1016/B978-0-443-18773-5.00015-6

Ahmed, S. K. (2024). How to choose a sampling technique and determine sample size for research: A simplified guide for researchers. *Oral Oncology Reports, 12*, 100662. https://doi.org/10.1016/j.oor.2024.100662

Angst, G., Potapov, A., Joly, F. X., Angst, Š., Frouz, J., Ganault, P., & Eisenhauer, N. (2024). Conceptualizing soil fauna effects on labile and stabilized soil organic matter. *Nature Communications*, *15*(1), 5005. https://doi.org/10.1038/s41467-024-49240-x

Antonangelo, J. A., Sun, X., & Eufrade-Junior, H. D. J. (2025). Biochar impact on soil health and tree-based crops: a review. *Biochar, 7*(1), 51. https://link.springer.com/article/10.1007/s42773-025-00450-6

Azal, B. (2022). The role of biotic and abiotic components in biodiversity. *Global Science Research Journal, 1*(1), 1–002. https://doi.org/10.15651/JBCR.22.1.1

Azhar, B., Razi, N., Sanusi, R., Lechner, A., Ashraf, M., Zaki, W. M. W., & Jafni, F. (2024). Vegetation structure and relative humidity drive the diurnal foraging activity of Malaysian giant ant workers in urban fragmented forests. *Insect Conservation and Diversity, 17*(2), 334-344. https://doi.org/10.1111/icad.12724

Bian, Z., Liu, L., Li, Y., Li, Y., & Ding, S. (2025). Effects of different fertilization treatments on ground-dwelling arthropods and their functional groups in agricultural landscapes. *Frontiers in Ecology and Evolution, 13,* 1437742. https://doi.org/10.3389/fevo.2025.1437742

Bicho, R. C., Chidiamassamba, S. B., Scott-Fordsmand, J. J., & Amorim, M. J. (2025). Impact of climate change on terrestrial invertebrates-temperature variations in laboratory conditions-from cool to heat waves. *Pedosphere.* https://doi.org/10.1016/j.pedsph.2025.09.004

Blakemore, R. J. (2025). Biodiversity restated: >99.9% of global species in Soil Biota. *ZooKeys, 1224*, 283–316. https://doi.org/10.3897/zookeys.1224.131153

Boyce, C. K., & Nelsen, M. P. (2025). Terrestrialization: toward a shared framework for ecosystem evolution. *Paleobiology, 51*(1), 174–194. https://doi.org/10.1017/pab.2024.15

Briones, M. J. I. (2018). The serendipitous value of soil fauna in ecosystem functioning: The unexplained explained. *Frontiers in Environmental Science*, *6*(DEC). https://doi.org/10.3389/fenvs.2018.00149

Chamorro-Martínez, Y., Torregroza-Espinosa, A., Morenopallares, M., Osorio, D., Paternina, A., & Echeverría-González, A. (2022). Soil macrofauna, mesofauna and microfauna and their relationship with soil quality in agricultural areas in northern Colombia: Ecological implications. *Revista Brasileira de Ciencia Do Solo, 46,* 1–15. https://doi.org/10.36783/18069657rbcs20210132

Chen, Q., Song, Y., An, Y., Lu, Y., & Zhong, G. (2024). Soil Microorganisms: Their Role in Enhancing Crop Nutrition and Health. *Diversity, 16*(12), 734. https://doi.org/10.3390/d16120734

Davison, C. W., Rahbek, C., & Morueta-Holme, N. (2024). Changes in Danish bird communities over four decades of climate and land-use change. *Oikos, 2024*(12), e10697. https://doi.org/10.1111/oik.10697

Devi, K. P., & Jahan, S. (2024). Diversity, Richness, Evenness and Dominance Index Fishes in Ami River Water, Gorakhpur, Uttar Pradesh, India. *Journal of Current Research and Studies*, *1*(2), 9-15. https://journalcurrentresearch.com/pub/jcr/article/view/8

Dong, Z., Wan, S., Ma, Y., Wang, J., Feng, L., Zhai, Y., ... & Chen, G. (2025). Productivity of water and heat resources and cotton yield response to cropping pattern and planting density in cotton fields in arid area. *Agricultural Water Management, 307,* 109197. https://doi.org/10.1016/j.agwat.2024.109197

Emmerling, C., Herzog, M., Hoffmann, C., & Schieber, B. (2025). Operational soil warming by underground transmission lines impacts on soil microorganisms and related metabolic activities. *Journal of Plant Nutrition and Soil Science.* https://doi.org/10.1002/jpln.202400554

Faoziyah, U., Rosyaridho, M. F., & Panggabean, R. (2024). Unearthing agricultural land use dynamics in indonesia: Between food security and policy interventions. *Land, 13*(12), 2030. https://doi.org/10.3390/land13122030

Fatah, A. M. A., Elbanna, S. M., Gamal, M. M., Alharbi, J. S., & Zalat, S. (2025). The influence of agricultural residues and horse manure on chemical and biological properties of soil. *Assiut University Journal of Multidisciplinary Scientific Research, 54*(1), 181-208. https://doi.org/10.21608/aunj.2024.334814.1103

Franzluebbers, A. J. (2025). Sand is the unifying textural component influencing surface-soil carbon and nitrogen fractions across undisturbed land uses in North Carolina. *Soil Science Society of America Journal, 89*(1), e70011. https://doi.org/10.1002/saj2.70011

Ferreira, A. S., Bellini, B. C., & Vasconcellos, A. (2013). Temporal variations of Collembola (Arthropoda: Hexapoda) in the semiarid Caatinga in Northeastern Brazil. *Zoologia, 30*(6), 639–644. https://www.scielo.br/j/zool/a/hpppf6tjYDfKSYdDGmnkTcT/?lang=en

Godoy, O., Soler-Toscano, F., Portillo, J. R., & Langa, J. A. (2024). The assembly and dynamics of ecological communities in an ever-changing world. *Ecological Monographs, 94*(4), e1633. https://doi.org/10.1002/ecm.1633

Gruss, I., Czarniecka-Wiera, M., Świerszcz, S., Szymura, M., Szymura, T., & Raduła, M. W. (2025). Responses of grassland soil mesofauna to induced climate change. *Scientific Reports*, *15*(1), 16532. https://doi.org/10.1038/s41598-025-01445-w

Harrison, G. T., Dunleavy, H. P., Vasquez-Valverde, L. F., Del Pozo-Valdivia, A. I., Ivanov, K., & Marek, P. E. (2024). Arthropod diversity in shallow subterranean habitats of the Appalachian Mountains. *Subterranean Biology*, *49*, 75-95. https://doi.org/10.3897/subtbiol.49.128521

Hauer, A., Zuev, A., Chatzinotas, A., Jurburg, S., Kümmel, S., & Potapov, A. (2025). Tracking assimilation of microbial biomass, leaf litter and artificially created soil organic matter by soil fauna using multi-resource stable isotope labelling. *European Journal of Soil Biology, 126,* 103752. https://doi.org/10.1016/j.ejsobi.2025.103752

Khan, M. T., Supronienė, S., Žvirdauskienė, R., & Aleinikovienė, J. (2025). Climate, Soil, and Microbes: Interactions Shaping Organic Matter Decomposition in Croplands. *Agronomy, 15*(8), 1928. https://doi.org/10.3390/agronomy15081928

Li, J. P., Jiang, S. H., Ma, G. T., Rezania, M., Nezhad, M. M., & Wan, J. H. (2025). Probabilistic evaluation of landslide influence zones considering stratigraphic dips and nonstationarity of soil properties. *Computers and Geotechnics, 177*, 106815. https://doi.org/10.1016/j.compgeo.2024.106815

Li, Y., Tu, Q., Liu, S., Ding, W., Min, X., Zhou, S., ... & Yuan, C. (2024a). Effects of the combined compost of grape branches and sheep manure on a soil-microorganism-chardonnay (Vitis vinifera L.) plant ecosystem. *Scientia Horticulturae, 336*, 113430. https://doi.org/10.1016/j.scienta.2024.113430

Li, Z., Yang, X., Long, W., Song, R., Zhu, X., Li, T., Shao, M., Chen, M., & Gan, M. (2024b). Temperature Mainly Determined the Seasonal Variations in Soil Faunal Communities in Semiarid Areas. *Land, 13*(4), 505. https://doi.org/10.3390/land13040505

Lindberg, N. (2003). Soil fauna and global change. *Acta Universitatis Agriculturae Sueciae. Silvestria*, (270).

Liu, C., Cheng, H., Wu, Y., Chen, T., Deng, L., Zhang, L., ... & Li, H. (2024a). Evaluation of soil fauna biodiversity in restored farmland for protection of wetland ecology by planting different crops. O*cean & Coastal Management, 247*, 106945. https://doi.org/10.1016/j.ocecoaman.2023.106945

Liu, X., Zang, J., Fu, Y., Pan, X., Meng, D., Zhu, Y., & Sun, T. (2024b). Influences of conservation tillage on soil macrofaunal biodiversity and trophic structure in the Mollisol region of Northeast China. *Catena, 236,* 107750. https://doi.org/10.1016/j.catena.2023.107750

Ludwiczak, E., Topa, E., Nietupski, M., Kosewska, A., & Rozwałka, R. (2024). The influence of humidity gradient in a forest on ground spider assemblages: a preliminary study. *The European Zoological Journal, 91*(2), 1104-1119. https://doi.org/10.1080/24750263.2024.2403537

Mamabolo, E., Pryke, J. S., & Gaigher, R. (2024). Soil fauna diversity is enhanced by vegetation complexity and no-till planting in regenerative agroecosystems. *Agriculture, Ecosystems & Environment, 367*, 108973. https://doi.org/10.1016/j.agee.2024.108973

Mazumdar, S., & Mandal, G. P. (2025). Effect of Soil Edaphic Factors on Collembola Diversity: A Case Study. *Records of the Zoological Survey of India, 125*(2S), 497–508. https://doi.org/10.26515/rzsi/v125/i2S/2025/173004

Nagy, M., Moneim, A. A., & El-Gohary, M. (2025). Biodegradation and weathering of merit-amun statue induced by insects and environmental factors. *International Journal of Conservation Science, 16*(2), 855-870. https://doi.org/10.36868/IJCS.2025.02.07

Ogedegbe, A., & Edwuonwu, I. C. (2014). Biodiversity of soil arthropods in Nigerian Institute for Oil Palm Research (NIFOR) Nigeria. *Journal of Applied Sciences and Environmental Management, 18*(3), 377–385. https://www.ajol.info/index.php/jasem/article/view/109849

Ortiz-Ramírez, G., Hernández, E., Pinto-Pacheco, S., & Cuevas, E. (2024). The Dynamics of Soil Mesofauna Communities in a Tropical Urban Coastal Wetland: Responses to Spatiotemporal Fluctuations in Phreatic Level and Salinity. *Arthropoda, 2*(1), 1–27. https://doi.org/10.3390/arthropoda2010001

Pearson, B. M., Minor, M. A., Robertson, A. W., & Clavijo McCormick, A. L. (2024). Plant invasion down under: exploring the below-ground impact of invasive plant species on soil properties and invertebrate communities in the Central Plateau of New Zealand. *Biological Invasions*, *26*(12), 4215-4228. https://doi.org/10.1007/s10530-024-03441-z

Pedrinho, A., Mendes, L. W., de Araujo Pereira, A. P., Araujo, A. S. F., Vaishnav, A., Karpouzas, D. G., & Singh, B. K. (2024). Soil microbial diversity plays an important role in resisting and restoring degraded ecosystems. *Plant and Soil*, *500*(1), 325-349. https://doi.org/10.1007/s11104-024-06489-x

Peng, Z., Qian, X., Liu, Y., Li, X., Gao, H., An, Y., ... & Jiao, S. (2024). Land conversion to agriculture induces taxonomic homogenization of soil microbial communities

globally. *Nature Communications*, *15*(1), 3624. https://doi.org/10.1038/s41467-024-47348-8

Peng, Z., Wei, G., & Jiao, S. (2025). Agriculture breaks down traditional biogeographic barriers of soil fungi. *One Earth*. https://www.cell.com/one-earth/abstract/S2590-3322(25)00252-0

Permadi, I., & Azizi, I. (2024). Agrarian Reform: Implementation and Exploration of Land Conflicts in Several Countries (A Bibliometric and Content Analysis of International Research on the Agrarian Reform Concept). *WSEAS Transactions on Environment and Development, 20*, 820-834. https://doi.org/10.37394/232015.2024.20.77

Qin, H., Shang, J., Qi, Q., Cao, B., Kong, Y., Li, Y., Chen, J., & Yi, X. (2024). Soil Moisture and Litter Coverage Drive the Altitude Gradient Pattern of Soil Arthropods in a Low-Elevation Mountain. *Diversity, 16*(5), 263. https://doi.org/10.3390/d16050263

Qiu, Y., Tang, R., Liu, Y., Chen, Y., Shen, Y., Zhuo, S., ... & Chang, S. X. (2025). Field experiment reveals varied earthworm densities boost soil organic carbon more than they increase carbon dioxide emissions. *Geoderma, 456,* 117251. https://doi.org/10.1016/j.geoderma.2025.117251

Quandahor, P., Kim, L., Kim, M., Lee, K., Kusi, F., & Jeong, I. H. (2024). Effects of agricultural pesticides on decline in insect species and individual numbers. *Environments, 11*(8), 182. https://doi.org/10.3390/environments11080182

Rabot, E., Saby, N. P., Martin, M. P., Barré, P., Chenu, C., Cousin, I., ... & Bispo, A. (2024). Relevance of the organic carbon to clay ratio as a national soil health indicator. *Geoderma, 443*, 116829. https://doi.org/10.1016/j.geoderma.2024.116829

Rasmusson, L. M., Strokirk, N., Tedengren, M., & Giese, M. (2025). Acid Sulfate Soils and Their Pathways of Impact: A Swedish Case Study. *Ecology and Evolution, 15*(7), e71732. https://doi.org/10.1002/ece3.71732

Remelli, S., Danise, T., Galli, L., & Menta, C. (2024). Soil arthropods in bioindication and ecotoxicological approach: The case of the extreme environment Mefite (Ansanto Valley, Southern Italy). *Heliyon, 10*(16). https://www.cell.com/heliyon/fulltext/S2405-8440(24)12373-0

Ren, H., Lv, H., Xu, Q., Yao, Z., Yao, P., Zhao, N., ... & Zhang, D. (2024). Green manure provides growth benefits for soil mesofauna by promoting soil fertility in agroecosystems. *Soil and tillage research, 238,* 106006. https://doi.org/10.1016/j.still.2024.106006

Sofo, A., Mininni, A. N., & Ricciuti, P. (2020). Soil macrofauna: A key factor for increasing soil fertility and promoting sustainable soil use in fruit orchard agrosystems. *Agronomy*, *10*(4). https://doi.org/10.3390/agronomy10040456

Vanolli, B. S., de Andrade, N., Canisares, L. P., Franco, A. L. C., Pereira, A. P. A., & Cherubin, M. R. (2023). Edaphic mesofauna responses to land use change for sugarcane cultivation: insights from contrasting soil textures. *Frontiers in Ecology and Evolution, 11*(January), 1–14. https://doi.org/10.3389/fevo.2023.1305115

Waheed, M., Haq, S. M., Arshad, F., Bussmann, R. W., Hashem, A., & Abd_Allah, E. F. (2024). Plant distribution, ecological traits and diversity patterns of vegetation in subtropical managed forests as guidelines for forest management policy. *Frontiers in Forests and Global Change, 7,* 1406075. https://doi.org/10.3389/ffgc.2024.1406075

Wang, D., Yuan, F., Xie, W., Zuo, J., & Zhou, H. (2024). Effects of leaf size and defensive traits on the contribution of soil fauna to litter decomposition. *Forests, 15*(3), 481. https://doi.org/10.3390/f15030481

Wang, T., Wang, Y., Wang, Y., Dong, J., & Yu, S. (2025). Temperature effects on forest soil greenhouse gas emissions: Mechanisms. *Ecosystem Responses, and Future Directions. Forests, 16*(9), 1371. https://doi.org/10.3390/f16091371

Xu, G. L., Kuster, T. M., Günthardt-Goerg, M. S., Dobbertin, M., & Li, M. H. (2012). Seasonal exposure to drought and air warming affects soil collembola and mites. *PLoS ONE, 7*(8), 23–27. https://doi.org/10.1371/journal.pone.0043102

Zheng, X., Tao, Y., Wang, Z., Kou, X., Wang, H., Wang, S., & Wu, D. (2022). Land-use types influence the community composition of soil mesofauna in the coastal zones of Bohai Bay, China. *Diversity, 14*(12). https://doi.org/10.3390/d14121035

Biographies of Authors

Alya Mahirotun Numa, Biology Education Study Program, Faculty of Teacher Training and Education, Universitas Muhammadiyah Purwokerto, Purwokerto, Central Java 53182, Indonesia.

- Email: alyamahirotun15@gmail.com
- ORCID: N/A
- Web of Science ResearcherID: N/A
- Scopus Author ID: N/A
- Homepage: N/A

Susanto, Biology Education Study Program, Faculty of Teacher Training and Education, Universitas Muhammadiyah Purwokerto, Purwokerto, Central Java 53182, Indonesia.

- Email: susanto280266@gmail.com
- ORCID: N/A
- Web of Science ResearcherID: N/A
- Scopus Author ID: N/A
- Homepage: N/A