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Soil Arthropod Community Structure Across Three Traditional Land-Use Sites in Baduy Customary Land

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Abstract

This study compared soil arthropod communities across three traditional land-use sites, namely Reuma, Jami, and Huma, which are located within Baduy customary land, with soil arthropods serving as indicators of soil health and ecosystem stability. This study investigated the activity density, diversity, dominance, and ecological roles of soil arthropods across these three land-use types, along with their relationship with key environmental variables. Soil arthropod communities were sampled using pitfall traps set along 100 m transects (ten sampling points per land-use type) and identified to the class and order levels. Measured environmental variables included soil pH, organic carbon, organic matter, total nitrogen, soil temperature, and light intensity. The data collected were analyzed using calculations of activity density, dominance index, Shannon–Wiener diversity index, and Pearson correlation analysis. A total of 537 individuals, representing two classes and ten orders, were recorded. Jami exhibited the highest activity density (241 individuals), followed by Huma (154 individuals) and Reuma (142 individuals). The Shannon–Wiener index (H′) ranged from 0.86 to 1.03, indicating low taxonomic diversity at the order level, while the dominance index ranged from 0.45 to 0.57, indicating moderate dominance by Hymenoptera. Predatory fauna dominated the community, comprising an estimated 93.66% to 97.93% of all collected individuals based on ordinal-level functional guild assignment. Soil organic matter levels (3.93%–5.88%) indicated naturally fertile soil conditions. Exploratory Pearson correlation analysis showed positive associations of soil pH, organic carbon, total nitrogen, and soil temperature with several soil arthropod orders, whereas light intensity showed negative associations. Overall, the three sampled land-use sites differed in soil arthropod community composition and activity density, with Jami showing the highest activity density.

INTRODUCTION

Indonesia is an archipelagic country with a high diversity of ethnicity and culturae. One of the major ethnic groups is the Sundanese, who inhabit the western part of Java Island. Among the Sundanese people, there is the indigenous Baduy community located in Lebak Regency, Banten Province. The Baduy community is known for maintaining a traditional way of life and adhering firmly to the customs of their ancestors in everyday life. The life of the Baduy community is based on the principle of balance between humans and nature as a form of carrying out the mandate of their ancestors to maintain environmental harmony (Chairuman, 2024). These ecological values are reflected in various community activities, including traditional agriculture systems and sustainable management of forest areas.

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According to Tamimi (2021), the Baduy community has the view that preserving nature is an important part of maintaining the continuity of life and ecosystem balance.

The spatial arrangement of the Baduy customary area reflects a clear ecological conservation system through the division of residential zones, agricultural lands, communal spaces, and protected forest areas. The culture and belief system of the Baduy community impose the obligation on every Baduy family to cultivate rice on dry fields (ngahuma). The whole cultivation process until harvest and post-harvest preservation must strictly avoid any use of chemicals, either as a fertilizer or pesticide, to ensure the quality required for long-term storage is maintained (Habiyaremye & Korina, 2021).

The main activities of the Baduy community consist of managing agricultural land (ngahuma) and maintaining forest areas as a form of environmental protection. Based on its use, land in the Baduy area can be distinguished into Huma, Jami, and Reuma. Huma is traditional agricultural land used for cultivating food crops, especially upland rice. Jami is a mixed field located around residential areas with relatively high human activity. Meanwhile, Reuma is former Huma land that has been abandoned and undergone natural succession, so it is covered with secondary vegetation. The differences in land use lead to variations in soil environmental conditions, such as organic matter content, moisture, soil pH, and nutrient distribution, which in turn affect the presence of soil arthropods (Aulia, 2019).

Biodiversity is one of the important indicators of ecosystem stability because it reflects the balance of biotic components within an environment. Soil fauna play an important role indecomposition, nutrient cycling, soil structure formation, and biological control of other organisms within the soil ecosystem (Sulistyorini, 2021). Soil arthropods also function in various ecological activities such as predation, herbivory, decomposition, and pollination, which support the sustainability of agroecosystems. Some previous studies have shown that soil arthropod communities can be used as indicators of soil health and environmental quality. Soil macrofauna in agroforestry systems play significant roles, such as improving the physical, chemical, and biological properties of the soil through immobilization and humification processes providing nutrients through the decomposition of soil organic matter. Therefore, soil macrofauna can be used to predict land quality, as it is the most sensitive indicator of changes in land use (Pribadi et al., 2026).

Although various studies on the Baduy community have been conducted, most of the research still focuses on cultural aspects, environmental conservation, traditional spatial planning, and agricultural practices based on local wisdom (Krisnawaty et al., 2025). Studies on soil arthropod communities as biological indicators of soil health across different types of traditional Baduy land use are still very limited. Furthermore, only a few studies compare the composition of soil arthropod populations in the Huma, Jami, and Reuma sites according to their ecological role in preserving ecosystem balance. The study on the potential of the traditional Baduy agricultural system as a model of sustainable agroecosystems based on soil biodiversity is also minimally reported. Despite these ecological differences between Huma, Jami, and Reuma, little is known about how soil arthropod communities respond to each land-use type under the traditional Baduy management system. Comparative information on the activity density, diversity, dominance, and ecological roles of soil arthropods across these land-use sites, as well as their relationships with soil environmental characteristics, remains limited. Addressing this knowledge gap is important for understanding how traditional indigenous land-use systems contribute to soil biodiversity and ecosystem stability (Schofield et al., 2026)

Based on these conditions, this study aimed to analyze the structure of surface-active soil arthropod communities in land-use types in the Baduy customary land (Huma, Jami, and Reuma). Specifically, this study compared the activity density, diversity, dominance, and ecological roles of surface-active soil arthropods between the three land-use types and examined their relationships with selected environmental variables. This study is expected to provide scientific information regarding the relationship between traditional land use and the structure of soil arthropod communities as indicators of soil health and ecosystem stability. The results of this study are also expected to serve as a basis for developing sustainable agricultural systems through the utilization of soil biodiversity and reducing dependence on inorganic fertilizers and synthetic pesticides.

MATERIALS AND METHODS

This study was an observational field study with a descriptive-quantitative approach. The selection of research locations used a purposive sampling method because they represent the dominant traditional land-use systems in customary land of Baduy Luar, Kanekes Village, Leuwidamar District, Lebak, Banten, Jawa Barat (Figure 1). The coordinates of each research location are: Reuma (young Shrub/secondary forest >5 years) at -6°36'09"S 106°13'47"E, Jami (mixed field) at -6°36'07"S 106°13'46"E, and Huma (dryland rice field) at -6°36'04"S 106°13'44"E.

Soil arthropod sampling was carried out using pitfall traps. Pitfall traps have been widely used to sample litter- and surface-dwelling macro-arthropods. This method collects arthropods that fall into cups filled with preservative (e.g., antifreeze), with the rim of the container positioned flush with the soil surface (Coleman et al., 2024). However, this approach only characterizes the surface-active arthropod community rather than the entire soil fauna community, as pitfall traps tend to capture highly mobile organisms moving across the soil surface. Each land-use type was represented with a single 100-m transect. Along each transect, ten pitfall traps were installed at 10-m intervals and operated for 24 hours (Suhardjono et al., 2012), as illustrated in Figure 2. The ten traps were intended to increase sampling coverage within each land-use type and to capture spatial variation in surface-active soil arthropods. However, these traps were considered subsamples within a single transect and were not treated as independent replicates for the land-use treatment. Each trap was fitted with a cover measuring approximately 15 x 15 cm to prevent rainwater or leaf litter from entering the container, as shown in Figure 3.

Soil samples were taken at a depth of 0-5 cm from the soil surface. The top layer of soil generally contains the greatest number of organic materials and living organisms (Erhunmwunse et al., 2026). The trapped soil arthropods were then identified to the class and order levels using a stereo microscope with 10x-40x magnification and the taxonomic identification key of Borror et al. (1996). Online identification resources used include BugGuide (https://bugguide.net) and the Picture Insect application. According to Manfield (2022), Picture Insect has a high usefulness level of up to 94%. Environmental parameters observed include soil physicochemical properties, namely soil pH, soil organic carbon (SOC), and total nitrogen (total N), as well as climatic variables consisting of soil temperature and light intensity. Soil samples collected from each land-use type were composited prior to laboratory analysis. Soil pH was determined using a pH meter in a soil–water suspension (1:2.5, w/v). Soil organic carbon was determined using the Walkley–Black method, and total nitrogen was analyzed using the Kjeldahl method. Soil temperature

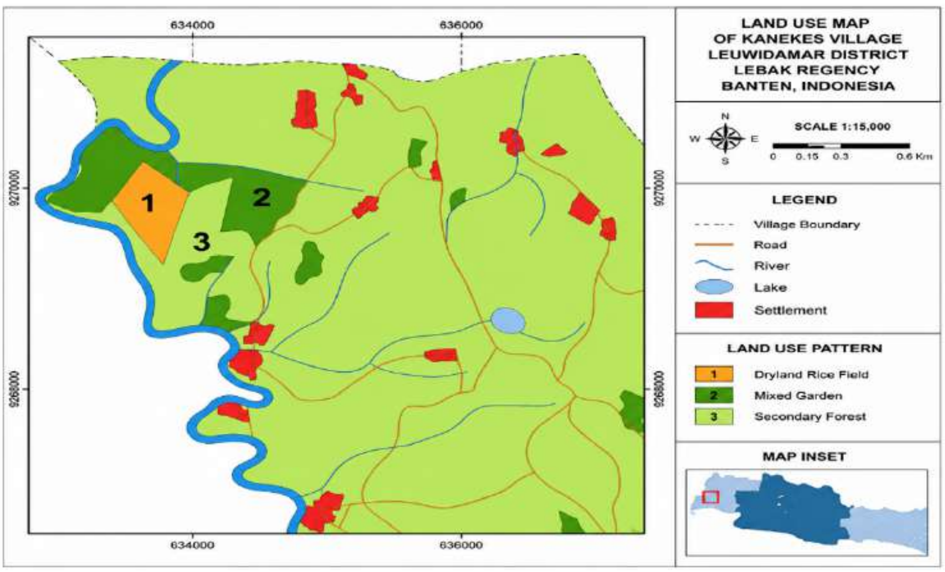

Figure 1. Location of the study area

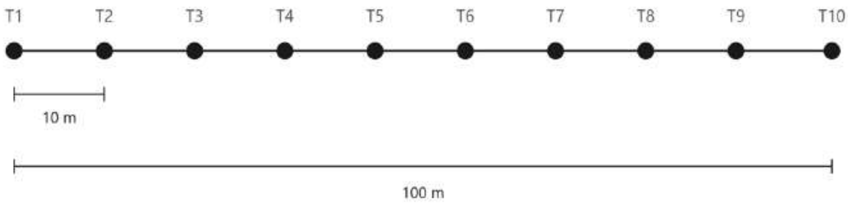

Figure 2. Layout of pitfall trap points

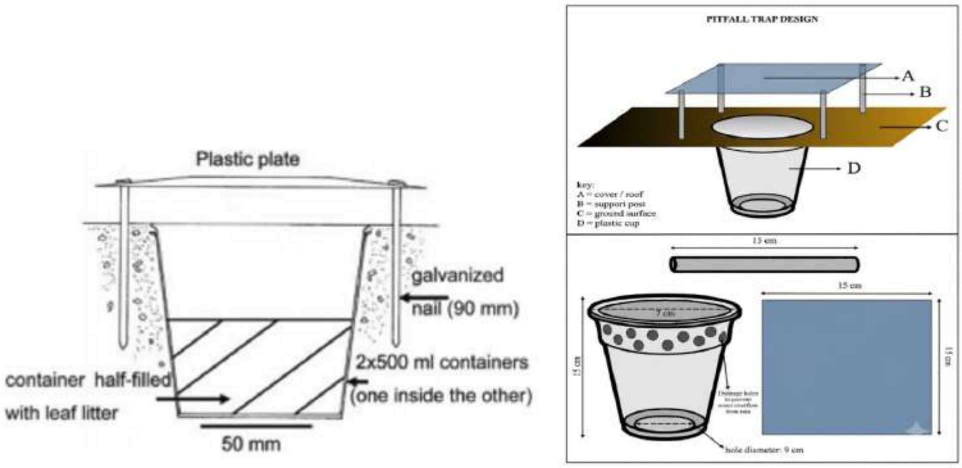

Figure 3. Pitfall trap design used for sampling surface-active soil arthropods
a. Cendan et al.,2024 b. Fityan, et al.,2025

was measured in situ using a digital soil thermometer, whereas light intensity was measured using a digital lux meter. Soil chemical properties analysis was conducted at the ICBB-PT Biodiversity Biotechnology Indonesia Laboratory, West Java. Data analysis and observations or calculations of surface-active soil arthropods using the pitfall traps in this study were as follows:

1. Pitfall-trap-based activity density

The number of individuals captured by pitfall traps at each sampling point within each land-use site was recorded to estimate pitfall-trap-based activity density, following Fachrul (2012) and Suin (2003):

$$K \text{ type A} = \frac{\text{Number of type A individuals}}{\text{Number of sample units}}$$

2. Diversity index

Soil arthropod diversity was analyzed using the following formula by Shannon Wiener (1949):

$$H' = -\Sigma\left(\frac{ni}{N}\ ln\ \frac{ni}{N}\right)$$

ni : Number of individuals captured for each recorded order

N : Total number of individuals captured across all recorded orders

3. Dominance of soil arthropod

Soil arthropod dominance is one of the indices in ecology that describes the level of dominance of a certain number of soil arthropod in an ecosystem. The dominance index was calculated using the formula by Odum (1991):

$$D = \Sigma\left(\frac{ni}{N}\right)^2 \quad \text{or} \quad D = \Sigma\,(pi)^2$$

ni : Number of individuals captured for each recorded order

N : Total number of individuals captured across all recorded orders

pi : Proportion of individuals captured for each recorded order relative to the total sample

4. Pearson correlation test

Pearson correlation analysis was used to descriptively examine the direction and strength of associations between soil arthropod activity density and environmental variables. The analysis is regarded as exploratory and essentially descriptive, as it was carried out on three sampled land-use sites (n = 3). As a result, this correlation analysis did not involve any statistical inference or significance evaluation. The Pearson correlation coefficient (r) ranges from −1 to +1, where a positive value indicates a direct relationship between variables, a negative value indicates an inverse relationship, and values closer to +1 or −1 indicate stronger associations. The Pearson correlation coefficient was determined using the equation by Sugiyono (2016):

$$r = \frac{n\,\Sigma\, xy - (\Sigma x)(\Sigma y\,)}{\sqrt{\{n\Sigma x^2 - (\Sigma \mathrm{x})^2\}}\{n\Sigma\, y^2 - (\Sigma\, y)^2\}}$$

Where
rxy : correlation coefficient
n : number of samples
x : independent variable (soil arthropod)
ky : dependent variable (environmental factors)

The observation data are presented in tabular form and categorized by the type of soil arthropod based on their ecological roles (predator, herbivore, decomposer, or pollinator), assigned at the ordinal level according to the dominant feeding behavior reported for each order in the literature, and then interpreted according to the observed parameters to see the trends of each parameter.

RESULTS AND DISCUSSION

Activity Density, Diversity, and Dominance of Soil Arthropods

Table 1 shows variations in activity density, diversity index, and dominance of trapped soil arthropods. The high activity density of surface-active soil arthropods at the Jami site is likely linked to the increased complexity of its mixed-field ecosystem. Jami was reported to have the highest activity density with 241 individuals, surpassing Huma (154 individuals) and Reuma (142 individuals). Additionally, Jami showed the highest levels of soil organic carbon(3.38%), organic matter (5.88%), and total nitrogen (0.44%). The mixed-field layout likely offers a wider array of plant life and microhabitats, which could enhance the food and shelter options for surface-active arthropods. This idea aligns with the findings of Campera et al. (2024), who observed that invertebrate abundance and diversity increased alongside greater canopy cover and richer plant and tree diversity within agroforestry systems. Their results bolster the habitat heterogeneity hypothesis, suggesting that more intricate habitats can offer a broader range of resources and conditions for invertebrate populations. Hence, the relatively diverse conditions present in Jami might explain the increased activity density seen at this location.

The soil arthropod community on the three land-use types in customary land consists of two classes, namely Arachnida of the subphylum Chelicerata and Insecta of the subphylum Hexapoda, both of which belong to the phylum Arthropoda. The phylum Arthropoda is the largest animal phylum and comprises several major classes, five of which are significant to human existence. These key classes are Crustacea, Diplopoda, Chilopoda, Insecta, and Arachnida, which play essential roles in sustaining ecosystem functions that directly and indirectly support human well-being (Potapov et al., 2022). Soil organisms play a vital role in benefiting humans by speeding up the breakdown of organic materials, boosting nutrient cycling, enriching soil quality, controlling harmful plant microorganisms, and facilitating primary production. Collectively, these factors contribute to increased agricultural yields and food security. Furthermore, soil organisms help preserve soil biodiversity, strengthen ecosystem resilience, support carbon sequestration, and promote the One Health approach by focusing on the sustainability of terrestrial ecosystem functions (Delgado-Baquerizo et al., 2025). Soil arthropod numbers and distribution vary as a result of climate, vegetation cover, soil pH, moisture levels, and organic matter content (Lewthwaite et al., 2024).

Based on their function in agricultural ecosystems, arthropods can be categorized into herbivores, decomposers, predators, and pollinators. Herbivorous arthropods play a crucial role in sustaining ecological balance. However, when their feeding reduces the economic worth of crops, they are termed pests. Decomposer arthropods contribute to the decomposition process of dead plants and animals into nutrients. This decomposition process involves breaking down

Table 1. The activity-density, diversity, and dominance of surface-active arthropods differed among the three sampled land-use sites

Kelas	Ordo	Reuma	Jami	Huma
Arachnida	Araneae	11	24	13
	Acari	2	1	1
Insecta	Hymenoptera	106	177	97
	Orthoptera	6	33	33
	Lepidoptera	1	1	0
	Blattodea	2	0	1
	Coleoptera	2	1	0
	Diptera	4	2	6
	Hemiptera	8	1	1
	Thysanoptera	0	1	0
	Dermaptera	0	0	2
Total activity density		142	241	154
D (Dominance index)		0.57	0.57	0.45
H' (Diversity index)		1.03	0.86	1.02

complex organic compounds into simpler molecular forms, thereby enabling plants to absorb them efficiently. Another function of arthropods is as natural enemies, which can be categorized into predators and parasitoids. Predators are arthropods that directly consume part or all of their prey's body. Meanwhile, parasitoids are arthropods that live inside or on the bodies of other insects, ultimately leading to their death (Leksono, 2017). Predatory arthropods comprise dragonflies, beetles, wasps, ants, scorpions, centipedes, and spiders (Robinson, 2005).

The Shannon–Wiener diversity index (H') was used to evaluate the diversity of surface-active soil arthropods based on the number of documented taxa and their activity density. Community diversity reflects how the individuals are distributed across identified taxa and their proportional representation in the community. Soil is the most heterogeneous component of the ecosystem, serving as a habitat for more than ¼ of the Earth's biodiversity (Lindo et al., 2023). This study produced a low diversity index, specifically 1.03 for Reuma, 1.02 for Huma, and 0.86 for Jami, indicating the dominance of certain groups, especially Hymenoptera. The pitfall trap method also affected soil arthropod diversity index values. According to Ruiz-Lupion et al. (2019), pitfall traps can catch 1.5 times more actively moving predators on the soil surface, such as ants (Hymenoptera) and crickets (Orthoptera), compared to the cul-de-sac method and basket traps, which can only catch detritivores and herbivores. Thus, the proportion of predators in the sample may appear more dominant compared to the actual community conditions in the field (Table 1).

The diversity values of the three land-use types were not in the extremely low categories, indicating that the ecosystem is still in a balanced state. This condition is closely related to the Baduy community's agricultural system, which continues to adhere to natural principles without using synthetic chemical inputs. Based on Table 2, the organic matter content in the three land-use types falls into the moderate to high category, ranging from 3.93-5.88, while the total N content is in the moderate category, ranging from 0.25-0.44. These findings align with research by Widiawati (2025), reporting that organic farming systems implemented in the Dieng highland horticultural area positively affected soil health. Natural materials and management practices that avoid synthetic chemicals can improve soil fertility by increasing organic matter content and soil microorganism activity.

Land management patterns such as Reuma, Huma, and Jami create habitat heterogeneity that can support various fauna groups. Despite the dominance of certain group, such as Hymenoptera, this may reflect the organisms' ability to adapt to a stable, low-disturbance environments rather than indicating ecosystem damage (Kudureti et al., 2023). Thus, these results suggest a potential role of the natural agricultural system applied to Baduy customary land in supporting the stability of soil arthropod communities. These findings imply that traditional farming practices could help sustain soil ecological functions, possibly owing to the absence of synthetic inputs. This offers a valuable contrast to intensively managed agricultural systems, where soil-fauna biodiversity has been reported to be approximately 21% lower under glyphosate-based management than under less intensive management practices (El Jaouhari et al., 2023), and the composition of the macro-arthropod community was drastically altered when these herbicides were applied. Related to this result, we found in our study that there were significantly fewer earthworms in intensive tomato and yam crops where these herbicides were used (Lorenger-Mercires et al., 2025)

The dominance value in this study ranges from 0.45 to 0.57, indicating a moderate dominance value (Ludwig and Reynold, 1998). Simpson's index is expressed as 1 − D or 1/D because diversity decreases as D increases, and thus, it captures the variance of species abundance distribution (Tomy et al., 2021). Based on relative abundance, Hymenoptera was the numerically dominant order, accounting for 70.96% of the individuals captured, followed by Orthoptera (13.43%), Araneae (8.96%), Acari (0.75%), Blattodea and Coleoptera (0.56% each), and Dermaptera (0.37%). Lepidoptera and Thysanoptera had the lowest relative abundance, at 0.19% each (Figure 4). The order Hymenoptera has the highest relative abundance, in line with the results of Rosa et al. (2025), which found the order Hymenoptera at three research sites: Frederico Westphalen (FW; 27°23'50" S, 53°25'35" W), Santa Maria (SM; 29°43'27" S, 53°43'39" W), and São Vicente do Sul (SVS; 29°42'27" S, 54°41'28" W). The climate at all three land-use sites is classified as humid subtropical with hot summers (Cfa) according to Köppen’s classification (Alvares, Stape, Sentelhas, Gonçalves, & Sparovek, 2013), although the actual climatic conditions at the study sites are tropical wet with an average annual rainfall of 3,000 mm; this indicates that the order Hymenoptera has high adaptability and dominates terrestrial environments. Furthermore, the predatory potential of ants has been demonstrated, particularly in the biological control of invertebrate pests affecting cultivated crops. Pests potentially controlled by ants include mites, Coleoptera, fruit flies, true bugs, Lepidoptera, thrips, mollusks, and other ants. Scientific literature provides strong evidence of the potential of ants as biological control agents, especially against invertebrate pests (Lutinski et al., 2024).

The orders Lepidoptera, Thysanoptera, Dermaptera, Blattodea, Coleoptera, and Acari have relative abundances ranging from 0.19% to 0.75%. The relative abundance is low in the order Lepidoptera (larvae). The larval stage of Lepidoptera is more vulnerable to disturbances compared to the egg stage or adult individuals, which have high mobility. During the larval stage, they require relatively heterogeneous and abundant host plants

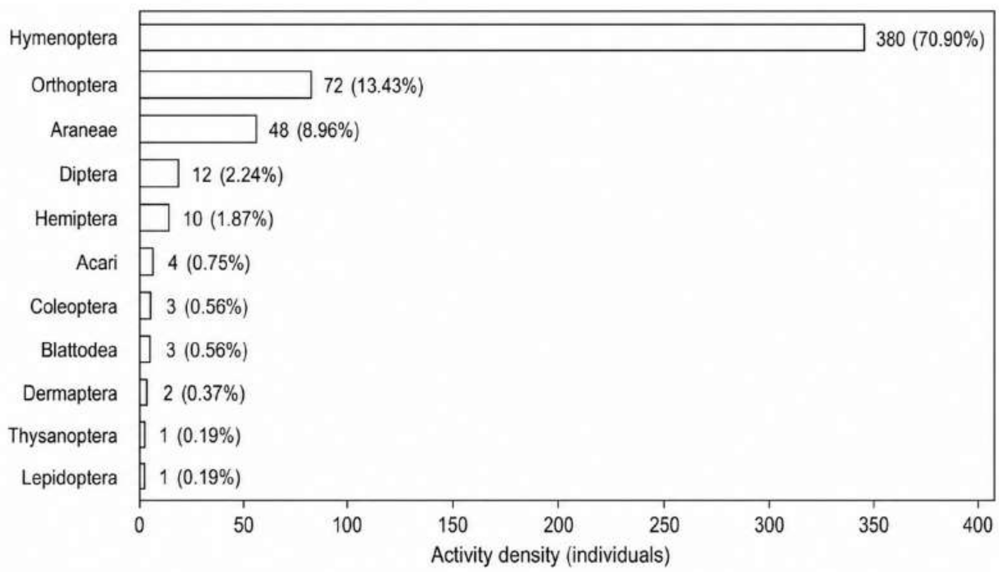

Figure 4. Relative Abundance of Soil Arthropods in Three Land-Use Types in the Baduy Customary Area

as a food source (Korosi et al., 2022). This explains why Lepidoptera were found only in Jami (mixed field) and Reuma (secondary forest), while no Lepidoptera were detected in Huma (dryland rice field), which has a monoculture system and habitats vulnerable to disturbance due to land processing (Table 1). Thysanoptera are small, inconspicuous insects (thrips) that share some morphological similarities with Lepidopteran larvae and inhabit specific plant types. Thrips species exhibit considerable diversity in their nutritional and habitat requirements (Menta & Remelli, 2020); consequently, this order was found in Jami but was absent from Huma and Reuma sites.

Dermaptera, Blattodea, and Coleoptera are groups within the class Insecta. Dermaptera are often difficult to observe due to their nocturnal nature, secretive habits, and tendency to hide in small crevices. Nevertheless, this taxonomic group is widely distributed; approximately 1,900 species have been identified, found on every continent except Antarctica. Dermaptera were recorded only at the Huma site; members of this order can play diverse ecological roles in agroecosystems, although some species are recognized as agricultural pests that may damage vegetative tissues, flowers, grains, and fruits. Other species have proven to be biological control agents against many insect pests, such as leafhoppers, caterpillars, aphids, and flies (Menier 2024). Coleoptera exhibit widespread abundance, making them rapid indicators of environmental changes. This is proven in Huma (dryland rice field), which has undergone changes due to land clearing, such as shrub clearing, and a monoculture planting system that caused Coleoptera to be absent. Blattodea, Lepidoptera, and Orthoptera play crucial roles in ecosystem functioning; they contribute to decomposition processes, the incorporation of organic residues into the soil, nutrient mineralization, and the formation of biopores (Bartz et al., 2013), thereby improving soil quality. The Acari order was found in Reuma (2 individuals), Jami (1 individual), and Huma (1 individual), with a relative abundance of 0.75%, which is categorized as low. The Acari order was found in Reuma land (2 individuals), Jami (1 individual), and Huma (1 individual), with a relative abundance of 0.75%, which is categorized as low. This is attributed to the sampling methods that focused more on surface-active soil arthropods, meaning groups inhabiting plant canopies, plant tissues, or soil microhabitats were not optimally detected. The dominance of certain orders also reduced the relative proportion of these groups.

Effects of environmental parameters on soil arthropod communities

Environmental parameters are factors that influence soil arthropod communities; these factors consist of abiotic and biotic factors. The results of measuring environmental parameters, including organic C, total N, soil pH, soil temperature, and light intensity are presented in Table 2.

Based on Table 2, Jami had higher values of soil organic carbon, organic matter, total nitrogen, and soil temperature than Reuma and Huma. These site-level differences describe the environmental characteristics of the three sampled land-use sites and provide ecological context for the observed variation in soil arthropod activity density. Jami also had the highest number of individuals captured by

Table 2. Environmental parameters in three types of land use on Ulayat Baduy land

Environmental Parameters	Reuma	Jami	Huma	Correlation Value
Organic C (%)	2.57 (M)	3.38 (H)	2.26 (M)	0.93
Organic material (%)	4.47 (H)	5.88 (H)	3.93 (M)	0.93
Total N (%)	0.32 (M)	0.44 (M)	0.25 (M)	0.89
C/N ratio	8.00 (L)	8.00 (L)	9.00 (L)	-0.4
pH H_2O	5.52	5.63	5.57	0.94
pH KCl	3.79	4.56	3.82	0.99
Soil Temperature (^0C)	26.00	29.00	27.00	0.97
Light intensity (lux)	7,903.8	11,117	23,117	-0.209

Remarks: M: medium, H: high, L: low

pitfall traps (241 individuals), followed by Huma (154 individuals) and Reuma (142 individuals). The higher levels of organic carbon and organic matter at Jami likely enhance microbial growth and activity by ensuring a constant supply of energy and nutrients. This is crucial because microorganisms, particularly fungi and bacteria, serve as a primary nutrient source for various soil-dwelling organisms, and creatures consuming litter or soil organic matter may inadvertently ingest these microorganisms. Consequently, greater microbial availability can foster a larger population of soil arthropods. In turn, grazing activities, whether targeted or incidental, by soil organisms can modify microbial biomass, community structure, and function; this impacts the decomposition and stability of soil organic matter, including the proportions of particulate organic matter and mineral-associated organic matter, both of which play vital roles in long-term soil carbon management (Angst, 2024). In general, soil fauna abundance varies depending on environmental conditions, soil pH, and organic matter content (Lewthwaite et al., 2024). Soil fauna play a pivotal role in soil ecosystems, contributing to organic matter decomposition and nutrient release through their feeding activities (Potapov et al., 2022).

Differences in microclimate and soil conditions across the three sites are closely linked to their respective land-use histories and vegetation structures. Reuma, a former cultivation site undergoing secondary succession, exhibits higher structural vegetation complexity, low light intensity (7,903.8 lux), and minimal human disturbance, providing an accumulation of leaf litter that stabilizes microhabitats. Conversely, Huma represents an actively cultivated dryland rice field with high canopy openness and light exposure (23,117 lux) resulting from periodic clearing and agricultural activities. Meanwhile, Jami represents a mixed-garden system characterized by moderate canopy openness (11,117 lux), intermediate human activity, and the highest organic carbon (3.38%) and total nitrogen (0.44%) inputs. Together, these measurable habitat contrasts influence the observed variation in soil arthropod activity-density and community composition.

The Pearson correlation analysis presented in Table 3 reveals variations in the relationships between soil-fauna orders and the environmental variables measured across the three sampled land-use types. In general, higher soil pH, total organic carbon, total nitrogen, and soil temperature were associated with relatively greater abundance of several soil-fauna orders, including Araneae, Hymenoptera, Orthoptera, and Thysanoptera. In contrast, light intensity showed negative correlation coefficients for most orders, indicating that higher abundances were found at more shaded sampling sites. Correlation coefficients with the C/N ratio varied among orders, indicating potential differences in ecological responses related to habitat conditions and food resources. These patterns are consistent with Kurniawan et al. (2023), who reported that soil organic carbon, soil moisture, and pH are among the environmental variables most strongly associated with Arthropod assemblages.

Table 3. The exploration of Pearson correlation between environmental parameters and order activity density in 3 land types

Order	Total abundance	pH	C total (%)	N total (%)	C/N	Soil temperature (°C)	Light intensity (Lux)
Araneae	48	0.94	0.91	0.87	-0.37	0.98	-0.85
Acari	4	-0.84	-0.25	-0.15	-0.50	-0.75	-0.85
Hymenoptera	380	0.84	0.98	0.96	-0.59	0.91	-0.85
Orthoptera	72	0.84	0.25	0.15	0.50	0.76	-0.85
Lepidoptera	2	0.05	0.71	0.78	-1.00	0.19	-0.85
Blattodea	3	-0.90	-0.70	-0.62	0	-0.99	-0.85
Coleoptera	3	-0.40	0.27	0.36	-0.89	-0.65	-0.85
Diptera	12	-0.50	-0.97	-0.99	0.87	-0.65	-0.85
Hemiptera	10	-0.84	-0.25	-0.15	0.50	-0.75	-0.85
Thysanoptera	1	0.89	0.91	0.93	-0.50	0.94	-0.85
Dermaptera	2	-0.05	-0.71	-0.78	1.00	-0.12	-0.85

Ecological Function of Soil Arthropods

According to Figure 5, soil arthropods that serve as ecological predators predominate on Baduy customary land (about 93.66–97.93%), whereas herbivores and pollinators make up the smallest percentages. The activity density of these predators is influenced by characteristics such as community structure and activity density, which vary across the three types of Baduy customary land. In the traditional Baduy shifting cultivation system, Reuma refers to former cultivation field plots that have been abandoned and undergone natural succession, so that the vegetation is beginning to be dominated by shrubs and wild plants. Jami refers to land around residential areas that are generally planted with mixed crops and experience higher human activity. Meanwhile, Huma is the main agricultural land of the Baduy people used for cultivating food crops, especially upland rice, with traditional management without the use of synthetic chemicals. High activity density was observed particularly in the orders Hymenoptera and Araneae (Table 1); both taxa include predatory members, such as ants and spiders, known to play an important role in maintaining predation stability and natural control of herbivorous organisms. Jami recorded the highest activity density across the sampled sites, with Hymenoptera (177 individuals) and Araneae (24 individuals) as the most abundant taxa. Although Hymenoptera also comprises non-predatory groups such as parasitoid wasps and pollinating bees, its ecological function in this study is classified as predominantly predatory at the ordinal level; this aligns with extensive reports regarding the dominance of predatory taxa (e.g., ants) within this order (Robinson, 2005).

The high dominance of predators across the three land-use types in Baduy results in a high dominance value (D = 0.57) and a lower diversity index (H' = 0.86), indicating the dominance of certain predator groups. This condition is suspected to be influenced by high human activity on Jami as well as the abundant availability of food sources around the yard, which supports the development of certain predator groups, particularly ants. On Huma, the predator community tends to be more balanced compared to Jami. Although the total number of predators is lower, the relatively high diversity value (H' = 1.02) indicates a more even distribution of individuals among orders. This site maintained several soil-fauna orders representing different ecological functions, including predators, decomposers, and herbivores. The traditional farming system on Huma, which involves minimal chemical disturbance, allows various arthropod groups to persist and form a more stable community.

Meanwhile, Reuma has a lower predation intensity compared to Jami because the total number of predators is smaller, although the community diversity value is relatively high (H' = 1.03). Reuma, which has undergone natural succession, provides a more heterogeneous habitat, thereby supporting

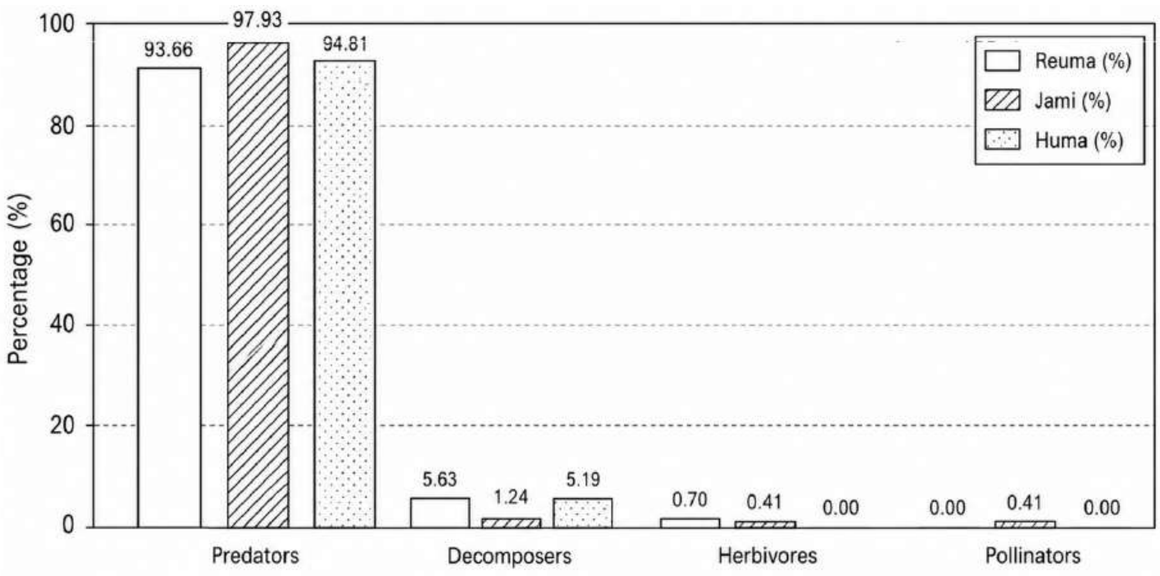

Figure 5. Ecological function of Soil Arthropod on land types in Baduy Customary Land

arthropod diversity. According to Lami et al. (2019), abundant and diverse predator communities are beneficial for the intensity and stability of predation. Soil disturbance itself does not affect the overall composition of predator communities and predation, but it alters their spatial patterns within the land. At the edges of traditionally cultivated land, predation is lower and more fragmented compared to the edges of conservationally cultivated land. However, predation increases more sharply towards the center of traditionally cultivated land. The findings of Lami et al. (2019) can be applied to sustainable weed management through biological control, as well as to a better understanding of the role of functional diversity in regulating ecosystem services.

The order Hymenoptera, particularly the family Formicidae (ants), is a dominant group that serves as a natural predator in corn farming ecosystems and is crucial in pest control (Ahmad et al., 2021). Another study by Iswara (2022) stated that collection methods such as pitfall traps and sweep nets are effective for detecting insect diversity, particularly among arthropod groups. Hymenoptera is among the orders most frequently captured. Besides Hymenoptera, the presence of the orders Araneae and Coleoptera is also important in biological control in organic farming, particularly in larval pest populations. Thus, the diversity of soil arthropods found not only indicates the presence of different arthropod groups but also reflects their diverse ecological roles, such as pollination, decomposition, and herbivory. These varied groups support a sustainable organic farming system through natural interactions among organisms without dependence on synthetic pesticides.

In summary, the three traditional land-use types (Reuma, Jami, and Huma) represent interconnected components of the Baduy customary land-use system rather than separate management units. Differences in vegetation cover, soil organic carbon, and soil-fauna composition reflect the Baduy community's traditional management practices, which maintain soil productivity while supporting natural ecological processes. These findings highlight the ecological wisdom of the Baduy land-use system, demonstrating that traditional management can sustain soil biodiversity and contribute to sustainable land management.

CONCLUSIONS

The three land-use sites (Reuma, Jami, and Huma) in Baduy customary land (Tanah Ulayat) showed variations in activity density, diversity level, and the dominance of surface-active soil arthropods. Jami had the highest activity density with 241 individuals, followed by Huma with 154 individuals and Reuma with 142 individuals. The Shannon-Wiener diversity index was the highest in Reuma (1.03), followed by Huma (1.02) and Jami (0.86). The dominance index values were recorded at 0.57 for Jami and Reuma, whereas Huma had a value of 0.45. Hymenoptera contributed significantly to the observed community structure. The notable presence of predatory soil arthropods indicates their important ecological role in regulating prey populations and facilitating natural biological control within traditional agricultural environments. Other groups of arthropods recorded might also play roles in ecological processes such as organic matter breakdown and nutrient cycling, based on their established ecological functions. Nonetheless, these processes were not directly assessed in this research. In summary, the results reveal variations in the community structure of surface-active soil arthropods across the three studied land-use sites and provide foundational information for understanding soil arthropod diversity in the context of the Baduy community’s traditional land-use methods. Importantly, all three sampling sites maintained soil organic matter contents above 2%, a notable condition considering that agricultural soils in Indonesia are generally reported to have low organic matter contents, often below 2%. This relatively high organic matter status may reflect the traditional land-management practices in the Baduy customary land and provides an important basis for maintaining soil quality and biological activity.

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REFERENCES

Ahmad, S. C., Aprilia, D., Djulian, D., Azzahra, H. E., Ayuningtias, K., Azzahra, L. P., and Arsi, A. (2021). Inventarisasi Arthropoda Predator, Agens Pengendali Serangga Spodoptera frugiperda (Lepidoptera: Noctuidae) pada Pertanaman Jagung (*Zea mays*). Prosiding Seminar Nasional Lahan Suboptimal, 1(1), 329–337.

Alvares, C. A., Stape, J. L., Sentelhas, P. C., Gonçalves, J. L. M., and Sparovek, G. (2013). Koppen's climate classification map for Brazil. Meteorologische Zeitschrift, 22(6), 711–728. https://doi.org/10.1127/0941-2948/2013/0507

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

Aulia, R. (2019). Respon mikrob dan fauna tanah terhadap perbedaan penggunaan lahan di Kecamatan Kaduhejo, Pandeglang, Banten. Skripsi. Departemen Sumber Daya Lahan, IPB University, Bogor.

Bartz, M. L. C., Pasini, A., and Brown, G. G. (2013). Earthworms as soil quality indicators in Brazilian no-tillage systems. Applied Soil Ecology, 69, 39–48. https://doi.org/10.1016/j.apsoil.2013.01.011

Borror, D. J., Triplehorn, C. A., and Johnson, N. F. (1996). Pengenalan Pelajaran Serangga. Edisi Keenam. Diterjemahkan oleh Partosoedjono, S.; disunting oleh Brotowidjoyo, M. D. Yogyakarta: Gadjah Mada University Press.

Campera, M., Balestri, M., Solihati, N., Hedger, M., Adi, D., Esguerra, S., and Nekaris, K. A. I. (2024). Impact of cropland management on invertebrate richness and abundance in agroforestry systems in Bali, Indonesia. Land, 13(4), 493. https://doi.org/10.3390/land13040493

Cendan, L., Perez, A. M., Cottiere, S., and Maul, P. (2024). Arthropod diversity in an urban forest from Miami Dade County, Florida, US. Journal of Urban Ecology, 3(1), 1–5.

Chairuman, M. (2024). Konservasi sebagai landasan perencanaan lansekap berbasis tempat pada masyarakat Baduy Dalam di Kabupaten Lebak Provinsi Banten. Jurnal Lanskap Indonesia, 8(1), 67–77.

Coleman, D. C., Geisen, S., and Wall, D. H. (2024). Soil fauna: occurrence, biodiversity, and roles in ecosystem function. In: Soil Microbiology, Ecology and Biochemistry. Amsterdam: Elsevier. https://doi.org/10.1016/B978-0-12-822941-5.00005-3

Delgado-Baquerizo, M., Eldridge, D. J., Liu, Y.-R., Liu, Z.-W., Coleine, C., and Trivedi, P. (2025). Soil biodiversity and function under global change. PLOS Biology, 23(3), e3003093. https://doi.org/10.1371/journal.pbio.3003093

Edo, M., Herzog, F., Moreno, G., Olave, R., Ripamonti, A., Rösch, V., Simonson, W., Gabriele, L., Olivier, T., and Martin, V. (2025). The potential of agroforestry and small fields to enhance ground-dwelling spiders. Agroforestry Systems, 99(8), 1–18. https://doi.org/10.1007/s10457-025-01373-8

El Jaouhari, M., Damour, G., Tixier, P., and Coulis, M. (2023). Glyphosate reduces the biodiversity of soil macrofauna and benefits exotic over native species in a tropical agroecosystem. Basic and Applied Ecology, 73, 18–26.

Erhunmwunse, A. S., Dawson, E., and Strauss, S. L. (2026). Topsoil sampling depth impacts on soil microbial communities in cover-cropped perennial tree systems. Applied Soil Ecology, 222, 107016. https://doi.org/10.1016/j.apsoil.2026.107016

Habiburrahman, F. (2025). Keanekaragaman Fauna Tanah pada Tiga Tipe Penggunaan Lahan di Tanah Ulayat Baduy, Desa Kanekes. Skripsi. Program Studi Agroekoteknologi, Fakultas Pertanian, Universitas Sultan Ageng Tirtayasa, Serang.

Habiyaremye, A., and Korina, L. (2021). Indigenous knowledge systems in ecological pest control and post-harvest rice conservation techniques: Sustainability lessons from Baduy communities. Sustainability, 13, 9148. https://doi.org/10.3390/su13169148

Hohbein, R. R., and Conway, C. J. (2018). Pitfall traps: A review of methods for estimating arthropod abundance. Wildlife Society Bulletin, 42, 597–606. https://doi.org/10.1002/wsb.928.

Iswara, D. (2022). Kelimpahan serangga pada berbagai perangkap dengan beberapa teknik pengendalian berbeda pada pertanaman jagung Pioneer 36. Jurnal Agroplasma, 9(2), 213–224.

Kőrösi, Á., Dolek, M., Nunner, A., Lang, A., and Theves, F. (2022). Pace of life and mobility as key factors to survive in farmland: Relationships between functional traits of diurnal Lepidoptera and landscape structure. Agriculture, Ecosystems &

Environment, 334, 107978. https://doi.org/10.1016/j.agee.2022.107978

Krisnawaty, F., Gojali, M. M., Arfandi, A. M., Mahipal, and Asrun, A. M. (2025). Mengenal keunikan masyarakat adat Suku Baduy dalam menjaga kelestarian alam pada konteks hukum lingkungan. Jurnal Sosial dan Sains (SOSAINS), 5(6), 1715–1722.

Kudureti, A., Zhao, S., and Zhakyp, D. (2023). Responses of soil fauna community under changing environmental conditions. Journal of Arid Land, 15, 620–636. https://doi.org/10.1007/s40333-023-0009-4

Kurniawan, I. D., Kinasih, I., Akbar, R. T. M., Chaidir, L., Iqbal, S., Pamungkas, B., and Imanudin, Z. (2023). Arthropod community structure indicating soil quality recovery in the organic agroecosystem of Mount Ciremai National Park's buffer zone. Caraka Tani: Journal of Sustainable Agriculture, 38(2), 229–243. https://doi.org/10.20961/carakatani.v38i2.69384

Lami, F., Boscutti, F., Masin, R., Sigura, M., and Marini, L. (2019). Seed predation intensity and stability in agro-ecosystems: Role of predator diversity and soil disturbance. Agriculture, Ecosystems & Environment, 288, 106720. https://doi.org/10.1016/j.agee.2019.106720

Leksono, A. (2017). Ekologi Arthropoda. Malang: UB Press.

Lewthwaite, J. M. M., Baiotto, T. M., and Brown, B. V. (2024). Drivers of arthropod biodiversity in an urban ecosystem. Scientific Reports, 14, 390. https://doi.org/10.1038/s41598-023-50675-3

Lindo, Z., Bolger, T., and Caruso, T. (2023). Stochastic processes in the structure and functioning of soil biodiversity. Frontiers in Ecology and Evolution, 11, 1055336. https://doi.org/10.3389/fevo.2023.1055336

Loranger-Merciris, G., Jean-Pierre, A., Angeon, V, and Ozier-Lafontaine, H. (2025). Effects of agricultural practices and crops on soil fauna and soil properties in tropical agroecosystems. Pedobiologia, 112, 150978. https://doi.org/10.1016/j.pedobi.2025.150978

Lutinski, J. A., Lutinski, C. J., Ortiz, A., Zembruski, F. S., Ripke, M. O., and Garcia, F. R. M. (2024). Biological control using ants: Status, opportunities, and limitations. Agronomy, 14, 1558. https://doi.org/10.3390/agronomy14071558

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

Manderfield, M. (2022). Seek, Picture Insect, Google Lens: An analysis of popular insect identification apps using photos of realistic quality. Master's project. Department of Entomology, University of Nebraska-Lincoln, Lincoln, NE, United States. Available at: https://digitalcommons.unl.edu/entodistmasters/91/

Maria, A., Sorisi, H., Mambo, C. D., Esther, M., Moningka, W., Andrew, J., and Sapulete, M. (2023). Spider (Ordo Araneae) as a predator arthropoda. Scholars Journal of Agriculture and Veterinary Sciences, 10(7), 67–71. https://doi.org/10.36347/sjavs.2023.v10i07.001

Menta, C., and Remelli, S. (2020). Soil arthropods as bioindicators of soil quality. Insects, 11(1), 54. https://doi.org/10.3390/insects11010054

Meunier, J. (2024). The biology and social life of earwigs (Dermaptera). Annual Review of Entomology, 69, 259–276. https://doi.org/10.1146/annurev-ento-013023-015632

Odum, E. P. (1971). Fundamentals of Ecology. 3rd ed. Philadelphia, London: W. B. Saunders Company.

Potapov, A. M., Beaulieu, F., Birkhofer, K., Bluhm, S. L., Degtyarev, M. I., Devetter, M., Goncharov, A. A., Gongalsky, K. B., Klarner, B., and Korobushkin, D. I. (2022). Feeding habits and multifunctional classification of soil-associated consumers from protists to vertebrates. Biological Reviews, 97(3), 1057–1117. https://doi.org/10.1111/brv.12832

Prasad, K. H. (2022). Insect Ecology: Concepts to Management. Singapore: Springer.

Pribadi, A., and Purwadi. (2026). Study of the level of diversity of soil fauna macro in several agroforestry patterns in Puspo District, Pasuruan District, East Java. Jurnal Agrotek Tropika, 14(1), 301–314. https://doi.org/10.23960/jat.v14i1.8941

Robinson, W. H. (2005). Urban Insects and Arachnids: A Handbook of Urban Entomology. New York: Cambridge University Press.

Rosa, G. B. da, Follmann, D. N., Lúcio, A. D., Jacques, R. J. S., Portela, V. O., and Marchioro, V. S. (2025). Applying soil fauna diversity indices to relate maize residue decomposition and grain yield. Acta Scientiarum. Agronomy, 47, e69432.

Ruiz-Lupión, D., Pascual, J., Melguizo-Ruiz, N., Verdeny Vilalta, O., and Moya-Laraño, J. (2019). Pitfall traps are biased against small and sedentary arthropods: New alternatives for measuring activity-density of soil litter fauna. Insects, 10(5), 147. https://doi.org/10.3390/insects10050147

Schofield, L., Stratford, E., and Davison, A. (2026). Indigenous peoples and nature conservation: Lessons from 25 years of Australian biodiversity strategy. Geoforum, 170, 104518. https://doi.org/10.1016/j.geoforum.2025.104518

Shannon, C. E., and Wiener, W. (1963). The Mathematical Theory of Communication. Urbana: University of Illinois Press.

Sugiyono. (2016). Statistika untuk Penelitian. Bandung: Alfabeta.

Suhardjono, Y. R., Deharveng, L., and Bedos, A. (2012). Biology-Ecology-Collembola Classification (Spring Tail). Bogor: Vegamedia. (in Indonesian).

Suin, N. M. (2003). Ekologi Hewan Tanah. Jakarta: Bumi Aksara, Pusat Antar Universitas Ilmu Hayati ITB.

Sulistyorini, E., Rahayu, W., and Sugeng, S. (2021). Kelimpahan fauna tanah pada ekosistem pascabakar Kecamatan Mentebah, Kabupaten Kapuas Hulu, Kalimantan Barat, Indonesia. Agrobali: Agricultural Journal, 4(3), 362–369. https://doi.org/10.37637/ab.v4i3.745

Tamimi, H. (2021). Adat dan tradisi Baduy dalam novel Baiat Cinta. Gerbang Etam, 1(1). https://doi.org/10.24014/gjbs.v1i1.13013

Tomy, L., Chesneau, C., and Madhav, A. K. (2021). Statistical techniques for environmental sciences: A review. Mathematical and Computational Applications, 26(4), 74. https://doi.org/10.3390/mca26040074

Whitfield, J. B. (1998). Phylogeny and evolution of host-parasitoid interactions in Hymenoptera. Annual Review of Entomology, 43, 129–151. https://doi.org/10.1146/annurev.ento.43.1.129

Widiawati, Y. (2025). Pengaruh sistem pertanian organik terhadap kesehatan tanah dan keanekaragaman hayati di lahan hortikultura dataran tinggi Dieng. Jurnal Armada, 3(6), 194–200. https://doi.org/10.55681/armada.v2i6.1668

Yaherwandi, Manuwoto, S., Buchori, D., Hidayat, P., and Budiprasetyo, L. (2006). Analisis spasial lanskap pertanian dan keanekaragaman Hymenoptera di daerah aliran sungai Cianjur. Jurnal Hayati, 13(4), 137–144.