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Inventory of Soil Insects in Solok Radjo Coffee Plantation, Solok Regency

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ABSTRAK

Serangga tanah memiliki peranan yang penting dalam menjaga keseimbangan ekosistem di lahan perkebunan, baik sebagai pengurai bahan organik, sebagai dan pengendali hayati. Keberadaannya dapat menjadi indikator kesehatan tanah serta kestabilan lingkungan pertanian. Disisi lain serangga tanah dapat merugikan yaitu sebagai hama pada tanaman Penelitian ini dilaksanakan dengan tujuan untuk menginventarisasi jenis-jenis serangga tanah yang terdapat pada perkebunan kopi (*Coffea* sp.) Koperasi Solok Radjo, Kabupaten Solok. Pengambilan sampel dilakukan mulai Bulan Juli sampai dengan Bulan September 2025 dengan menggunakan metode *pitfall trap* dengan pola transek diagonal sepanjang 100 meter. Identifikasi serangga tanah dilakukan di Laboratorium Pengelolaan Hama Terpadu Universitas Andalas Kampus Dharmasraya. Identifikasi berdasarkan ciri morfologi serangga tanah dengan bantuan menggunakan mikroskop dan kunci identifikasi serangga. Hasil berdasarkan penelitian yang telah dilaksanakan di perkebunan kopi Solok Radjo Kabupaten Solok diidentifikasi sebanyak 5 ordo serangga tanah yaitu Coleoptera, Hymenoptera, Blattodea, Dermaptera, dan Orthoptera. Ditemukan juga 8 famili serangga tanah diantaranya Scarabaeidae, Carabidae, Formicidae, Ectobiidae, Blattidae, Anisolabididae, Gryllidae, dan Gryllotalpidae. Dari hasil penelitian terdapat 8 genus yang ditemukan yaitu Onthophagus, Pheropsophus, Odontomachus, Blattella, Eurycotis, Euborellia, Lepidogryllus, dan Gryllotalpa. Serangga yang berperan sebagai predator yaitu Pheropsophus, Odontomachus, dan Euborellia, serangga yang berperan sebagai dekomposer yaitu Onthopghagus dan Eurycotis. Serangga yang berperan sebagai hama yaitu Blattella dan Gryllotalpa, serta Lepidogryllus.

***Kata kunci*:** Hama, Serangga predator, serangga dekomposer

ABSTRACT

Soil insects play an important role in maintaining the balance of the ecosystem in plantation areas, both as decomposers of organic matter and as biological control agents. Their presence can be an indicator of soil health and the stability of the agricultural environment. On the other hand, soil insects can be detrimental, namely as pests on plants. This study was conducted with the aim of inventorying the types of soil insects found in coffee plantations (Coffea sp.) Solok Radjo Cooperative, Solok Regency. Sampling was carried out from July to September 2025 using the pitfall trap method with a diagonal transect pattern of 100 meters. Identification of soil insects was carried out at the Integrated Pest Management Laboratory, Andalas University, Dharmasraya Campus. Identification based on morphological characteristics of soil insects with the help of a microscope and insect identification keys. The results based on research conducted in the Solok Radjo coffee plantation, Solok Regency, identified consist of 5 orders of soil insects, namely Coleoptera, Hymenoptera, Blattodea, Dermaptera, and Orthoptera. Also found 8 families of soil insects including Scarabaeidae, Carabidae, Formicidae, Ectobiidae, Blattidae, Anisolabididae, Gryllidae, and Gryllotalpidae. From the results of the study, there were 8 genera found, namely Onthophagus, Pheropsophus, Odontomachus, Blattella, Eurycotis, Euborellia, Lepidogryllus, and Gryllotalpa. Insects that act as predators are Pheropsophus, Odontomachus, and Euborellia, insects that act as decomposers are Onthopghagus and Eurycotis. Insects that act as pests are Blattella and Gryllotalpa, and Lepidogryllus.

***Keywords*:** Pests, predatory insects, decomposer insects

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1. INTRODUCTION

Coffee (*Coffea* sp.) is a leading plantation commodity that plays a significant role in Indonesia's foreign exchange earnings. Over the past three years, Indonesian coffee exports have increased, contributing significantly to the country's foreign

exchange earnings. In 2022, the value of Indonesian coffee exports reached USD 1.15 billion, then increased to USD 1.49 billion in 2023, and again to USD 1.612 billion in 2024 (BPS, 2024).

The world's largest coffee producing countries in 2023 were Brazil, with total production reaching 3,172,562 tons, followed by Vietnam with 1,953,990 tons. Indonesia ranked third with 794,762 tons, and Colombia ranked fourth with 665,016 tons (FAO, 2024). Coffee productivity in Indonesia reached 807.25 kg/ha in 2024, projected to increase to 820 to 850 kg/ha in 2025. Coffee production centers in Indonesia are South Sumatra, Lampung, North Sumatra, Aceh, Bengkulu, and West Sumatra (BPS, 2023).

One of the areas in West Sumatra known for its coffee production is Solok Regency. In 2022, coffee productivity in Solok Regency reached 513 kg/ha, increasing to 1,150 kg/ha in 2023. Several key factors contributed to this increase in productivity, including the implementation of modern technology and more efficient cultivation practices, support from government programs and institutions, improved infrastructure and better market access, facilitating coffee distribution and increasing demand for Solok coffee, and ideal natural conditions. All of these factors contributed to this increase in productivity (BPS West Sumatra Province, 2022). In Solok Regency, there is a cooperative called the Solok Radjo Producer and Multipurpose Cooperative (KPSU), which serves as a forum for economic and business development for farmers, particularly in coffee production and marketing.

In efforts to increase coffee production, many factors influence it, including the presence of soil insects in the coffee plantation, which can have different impacts. Utari *et al.* (2024) stated that soil insects on coffee plants can have both detrimental and beneficial impacts. Some beneficial insects include predators or natural enemies such as crazy ants (*Anoplolepis* sp.), fire ants (*Tetramorium* sp.), and black ants (*Odontoponera* sp.) which play a role in controlling pest populations in coffee plantations. In addition, decomposer insects from the Lauxaniidae family also help in the decomposition of organic matter, increasing soil fertility, and supporting the growth of coffee plants. Meanwhile, there are also harmful insects, such as termites (*Coptotermes* sp. and *Macrotermes* sp.) which attack the roots and base of coffee stems, reducing yields. Although fire ants (*Tetramorium* sp.) function as predators of other pests, they can also become pests by making nests in the soil that disturb the roots of coffee plants (Directorate General of Plantation Production Development, 2002). To manage pests properly without disturbing beneficial insects such as predators or decomposers, it is important to conduct an inventory of soil insects on the KPSU Solok Radjo coffee plantation.

A soil insect inventory is necessary to identify the types of soil insects present in coffee plantations and their roles, whether as pests, natural enemies, decomposers of organic matter, converting plant debris into humus that can improve soil fertility, or providing nutrients for coffee plants (Ayu *et al.,* 2020). Therefore, conducting a soil insect inventory in coffee fields is not only beneficial for understanding soil ecosystem dynamics but also supports sustainable and environmentally friendly agricultural practices.

The soil insect inventory in the KPSU Solok Radjo coffee plantation is expected to identify the types of soil insects and their roles and can be used as a reference in controlling soil insects that are pests of coffee plants. Therefore, researchers need to conduct this research.

2. METHODOLOGY

This research was conducted in the field by directly collecting soil insects using pitfall traps with purposive sampling to collect soil insects at the sampling location in the coffee plants. The purposive sampling technique was used with the criteria of productive coffee land in KPSU Solok Radjo at an altitude of ± 1600 meters above sea level. Sampling points were determined diagonally along 100 m with a distance of 5 m between traps, resulting in 20 pitfall trap points. The samples collected were active soil insects on the soil surface. The procedures carried out for this study were as follows:

2.1. Preliminary Study

The preliminary study was conducted through several activities: direct field observations to assess general land conditions, interviews with farmers or land managers to obtain practical information related to cultivation and the surrounding environment, and reviewing secondary data such as land maps, crop types, and agroecosystem conditions to support the selection of representative research sites.

2.2. Determining Sample Points

The sampling plot locations were determined systematically using a 100-meter diagonal transect pattern. Pitfall traps were placed every 5 meters along the transect line, resulting in a total of 20 sample traps.

2.3. Sampling

Sampling was conducted using pitfall traps (Southwood and Henderson, 2000). Pitfall traps are used to capture insects actively on the ground surface. The trap is buried in the soil, with the mouth parallel to the soil surface. The trap is filled with detergent diluted with water to half the height of the trap, and the trap is shaded with skewers to prevent rainwater or plant leaves from entering. Trapped insects are collected after 24 hours. Insects collected from the trap are then transferred to labeled collection bottles filled with 70% alcohol until fully submerged using tweezers and a strainer. Insect sampling was conducted three times at the research site, with weekly intervals.

2.4. Identification

Identification of soil insects was performed in the laboratory using a microscope and magnifying glass by placing the insects in a petri dish and observing them based on morphological characteristics.

Identification of soil insects was performed in the laboratory using a microscope and magnifying glass. The insects were placed in petridishes and observed based on morphological characteristics. Identification was conducted by referring to the Insect Identification Guide (Borror *et al*., 1992) and using the identification key available on the BugGuide.Net website.

2.5. Data Collection

The data obtained are descriptive data. These data are: 1) location conditions in coffee plantations using a hygrometer (air humidity), thermometer (temperature) and lux meter (light intensity). 2) insect classification from the level of order, family, genus as well as role and 3) their function based on morphological characteristics referring to the Insect Identification Guide (Borror et al., 1992).

3. RESULT AND DISCUSSION

3.1. General Conditions of Research Locations

This research was conducted in the Solok Radjo Coffee Plantation area in Solok Regency. This location is at an altitude of approximately 1,600 meters above sea level (masl). In general, the research area has a cool environment with a temperature of 20-21ºC, sufficient sunlight with a light intensity of 1,100-1,600 lux meters and the presence of coffee shade plants, for the topography of the land is slightly sloping ranging from 8-13%. The soil texture on the surface of the coffee plantation tends to be loose. The soil is dark brown to black, indicating a high and fertile organic matter content. In terms of acidity, this soil is relatively stable with a pH value of 7. The microclimate conditions in this location are very supportive of coffee plant growth.

The environment plays a crucial role in insect life. Each insect species adapts to different environments. One of the environmental factors that influences this is abiotic factors. Therefore, abiotic factors such as temperature and humidity significantly influence insect survival. The environmental conditions observed in this study can be seen in Table 1.

Based on observations, soil temperature ranges from 20-21ºC, humidity levels range from 56-58%, light intensity ranges from 1100-1337 lux, and soil pH is 7. This temperature range supports the physiological processes and reproduction of soil insects. Yulistia *et al*. in 2020 reported that the optimal temperature for soil insect activity in a coffee plantation ecosystem is between 20-25ºC.

Humidity, ranging from 56-58%, also plays a crucial role in supporting the existence of soil insects. Soil moisture is directly related to the availability of oxygen necessary for insect survival. Suheriyanto *et al.* (2023) stated that there is a positive relationship between soil moisture and the diversity of soil arthropods, particularly in mountainous ecosystems.

Different light intensities influence canopy cover and weather conditions in the field. Pebriani (2022) reported that moderate light, filtered by tree canopies, supports the existence of soil animals that tend to avoid light. The intensity of incoming light is also influenced by shade plants such as sengon, lamtoro, and eucalyptus.

Meanwhile, the observed soil pH was neutral, which is very favorable for the existence of soil insects. Neutral soil pH creates perfect conditions for the activity of microorganisms, which serve as a food source for several insect species, and does not disrupt their physiological processes. Research by Ari *et al.* (2021) showed that in a coffee agroforestry area on Mount Ungaran, neutral soil pH had a positive relationship with the soil insect diversity index, which serves as a bioindicator of soil fertility.

3.2. Classification and Description of Soil Insects at Order, Family, Genus and Role Levels

The results of the research indicate the presence of five orders of soil insects: Coleoptera, Hymenoptera, Blattodea, Dermaptera, and Orthoptera. Eight families of soil insects were also identified, including Scarabaeidae, Carabidae, Formicidae, Ectobiidae, Blattidae, Anisolabididae, Gryllidae, and Gryllotalpidae. Eight genera were also identified in this study: Onthophagus, Pheropsophus, Odontomachus, Blattella, Eurycotis, Euborellia, Lepidogryllus, and Gryllotalpa. The dominant role of insects in this study was as predators, as can be seen in Table 2.

In the coffee plantation ecosystem, soil insects play a crucial role in maintaining environmental balance, acting as decomposers, predators, and pests. One of these is the order Coleoptera, which consists of genus Onthophagus (Family Scarabaeidae) and Pheropsophus (Family Carabidae). Onthophagus is known as a decomposer that breaks down animal waste and other organic matter, contributing to soil structure and fertility. The presence of Onthophagus in coffee plantations indicates an ecological balance that supports soil quality. Research by Ranteallo (2024) in Tana Toraja found that Onthophagus was most commonly found in organic coffee plantations, due to the availability of litter and high organic matter. Research by Nichols *et al.* (2008) stated that decomposing beetles such as Onthophagus can increase water absorption and nutrient availability through the activity of digging and burying waste.

Table 1. Environmental Conditions of Abiotic Factors of the Research Area

Observation	Week		
	1	2	3
Soil temperature (ºC)	21	20	21
Humidity (%)	56	56	58
Light intensity (lux)	1337	1601	1100
pH	7	7	7

Table 2. Classification of Soil Insects at the Order, Family, Genus and Role Levels

Order	Family	Genus	Role Levels
Coleoptera	Scarabaeidae	*Onthophagus*	Dekomposer
	Carabidae	*Pheropsophus*	Predator
Hymenoptera	Formicidae	*Odontomachus*	Predator
Blattodea	Ectobiidae	*Blattella*	Hama
	Blattidae	*Eurycotis*	Dekomposer
Dermaptera	Anisolabididae	*Euborellia*	Predator
Orthoptera	Gryllidae	*Lepidogryllus*	Herbivora
	Gryllotalpidae	*Gryllotalpa*	Hama

From the order Hymenoptera, there is the Formicidae family which includes the genus Odontomachus. This insect is a predatory ant with very strong jaws and the ability to move quickly to prey on other insects. In coffee plantations, this ant plays a role in natural biological control agents that play a role in controlling the population of small insect pests, such as Lepidoptera larvae, Coleoptera, and even other insect eggs. Its speed and ability to catch slow-moving soil animals make it an important part of the natural biological control system. According to Richard *et al.* (2001), Odontomachus is a very efficient predator in protecting the soil ecosystem from pest population explosions.

The order Blattodea, which consists of two genera: Blattella (Family Ectobiidae) and Eurycotis (Family Blattidae). The genus Blattella, known as small cockroaches, acts as a pest often found in damp areas, where there is a lot of litter and near decaying organic matter. This makes these insects potential carriers of pathogenic microorganisms such as bacteria and fungi that can cause diseases in coffee plant roots. Rihan (2018) revealed that this type of cockroach is often found in damp coffee plantations and can exacerbate root disease attacks. On the other hand, Eurycotis functions as a decomposer of dry organic matter such as litter, as explained by Bell *et al.* (2007), who stated that tropical forest cockroaches have the ability to decompose lignocellulose, thereby accelerating the decomposition process and humus formation.

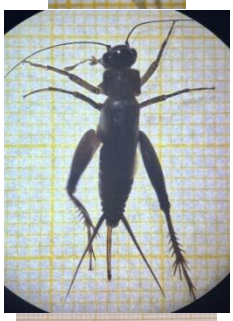
Soil insects that have been observed using a microscope in the laboratory and then identified based on morphological characteristics referring to the Introduction to Insects Textbook (Borror *et al.,* 1992). 8 types of soil insects were obtained with 5 different orders, 8 different families, and 8 different genera and each has its own role in coffee plantations including as predators (Pheropsophus, Odontomachus, and Euborellia), decomposers (Onthophagus and Eurycotis), pests (Blattella and Gryllotalpa) as well as herbivores (Lepidogryllus). And the following can be seen the morphology of the types of soil insects on coffee plants can be seen in Table 3.

Onthophagus has an oval-shaped, robust body, similar to other beetles from the Scarabaeidae family. However, this genus is known for the presence of horns in males visible on the head or pronotum, which is not found in other genera in the same family. Onthophagus's body size ranges from 5–15 mm, with a dark or metallic color. Its antennae are lamellae at the tips and arranged like a fan, which functions to detect the smell of animal waste as a food source. Scholtz *et al.* (2009) stated that Onthophagus is one of the most adaptive dung beetle genera, with special morphology such as forelegs that function as tools for digging and burying waste into the soil. According to research by Nichols *et al.* (2008), Onthophagus plays a role as an important decomposer agent in agricultural ecosystems, including in coffee plantations, because its efforts in burying animal waste can improve soil aeration and accelerate nutrient cycling.

Odontomachus has a distinctive body compared to other ant genera, with a larger size (8–15 mm), and is equipped with a pair of long, straight jaws that can open almost 180° and close very quickly. This ant has elbow-shaped antennae and a petiole consisting of two segments, which is a characteristic feature of the Formicidae family. These jaws are used both for hunting and defense against predators. According to Richard *et al.* (2001), this ant actively hunts and plays an important role in maintaining the balance of pest populations on the ground.

Table 3. Description of Types of Soil Insects on Coffee Plants

No	Morphology	Description
1		Onthophagus have a body size ranging from 5–15 mm. Their bodies are oval and hard, with a dark, shiny color (black or brown). Their antennae are short and have fan-like tips. Their forelegs are broad and short, which aid them in digging. In some species, males have small horns on their heads. The head appears slightly bowed and is partially covered by the pronotum.
2		Pheropsophus has a slender body, measuring about 10–20 mm in length. Its body is generally black, with two striking orange spots on its hard wings (elytra). Its antennae are long and filiform. Its hind legs are long and used for fast running. Its mandibles are large and powerful, used for preying on other insects on the ground.
3		Odontomachus varies in size between 8 and 15 mm. It has large jaws (mandibles) that can open up to 180° and close very quickly. Its body is jet black with a two-segmented waist with angled antennae, and a large, prominent head.
4		Blattella measures between 8–12 mm. Its body is elongated, flat, black or dark brown, and it has small wings. At the tip of its abdomen is a pair of forceps, which are curved in males. The antennae are long and multi-segmented. It is active in dark, damp places.
5		Eurycotis measures approximately 20–35 mm in length. The body is broad, flat, and shiny black. The antennae are very long and thin. The wings cover almost the entire body and are shiny. The head is covered by the pronotum from above. This species is capable of secreting a pungent fluid as a defense mechanism.

No	Morphology	Description
6		Euborellia insects measure approximately 8–12 mm in length. Their bodies are elongated, flat, black or dark brown, and they have small wings. At the tip of the abdomen are a pair of pincers, which are curved in males. Their antennae are long and segmented. These insects are active in dark, humid environments.
7		Lepidogryllus is 8–12 mm long, has a slender body, and is brown to black in color. Its antennae are very long, and its front wings cover part of its body. It is known to produce sounds by rubbing its wings together. Its hind legs are large and powerful for jumping.
8		Gryllotalpa, or mole crickets, are large, around 30–50 mm long. Their bodies are cylindrical and light brown. Their heads are large, while their front legs are flat and strong, used for digging. Their wings are located on their backs, but they are rarely used for flight. Their antennae are medium-sized, and their compound eyes are small.

Euborellia has an elongated, flattened body shape, dark brown to black in color, measuring between 8–12 mm in length. Unlike many other winged ground insects, this genus is wingless, particularly in species like Euborellia annulipes. One distinguishing characteristic of Euborellia is a pair of forceps on its back, which are curved in males but straight in females. These pincers serve for protection, capturing prey, and also in mating. Ranteallo (2024) found that Euborellia populations increased in organically managed coffee areas, where a thick layer of litter provides ideal microhabitat conditions for its activity.

Pheropsophus has a long, slender body shape, predominantly black, with two striking orange spots on its hard wings. This characteristic distinguishes it from other Carabidae genera, such as Harpalus and Calosoma. They range in length from 12–20 mm, with long, filiform antennae and mandibles, which are their primary preying tools. Members of the Carabidae family are generally nocturnal and move quickly using their long legs. Pheropsophus, in particular, is known to possess a chemical defense mechanism, releasing a hot fluid from its anal glands, similar to Pheropsophus verticalis. According to Eisner *et al.* (2000), this mechanism is very effective in repelling predators and ensuring survival in open habitats. In coffee fields, Pheropsophus can be found in leaf piles and soil crevices to prey on root and stem-infesting insect larvae.

Blattella is a genus of small to medium-sized cockroaches (approximately 10–15 mm), flat and oval in shape, with a body color ranging from light brown to dark brown. This genus is recognizable by its long, delicate antennae and the pronotum that covers the head from above. Its wings are quite long and generally cover the entire body, and although most species can fly, it rarely does so. One of the best-known species of this genus is Blattella germanica, which is often found in human environments. Within agroecosystem contexts, Blattella tends to be opportunistic and generally lives among litter and decaying organic matter. Rihan (2018) noted that this genus can be found in coffee fields with high humidity levels and is often associated with manure residues or piles of leaves. Although not a major pest of coffee plants, its presence can indicate a high accumulation of undecomposed organic matter and can act as a secondary vector for pathogenic microorganisms.

Eurycotis has a large body (approximately 25–35 mm), dark brown to jet black, with a glossy surface. One of its distinctive characteristics is the large, shield-like pronotum that covers the head. It has wings that cover the abdomen but are rarely used for flight. According to Borror *et al.* (1992), Eurycotis antennae are long, composed of many segments, and have the unique ability to produce a pungent fluid as a defense against predators. Species such as Eurycotis floridana are known to secrete an acidic fluid that acts

as a repellent to insects and other predators. In coffee ecosystems, Eurycotis is found under piles of litter, rotting wood, and other damp spaces, where it acts as a decomposer, helping accelerate the decomposition of coarse organic matter. Ranteallo (2024) noted the presence of Eurycotis in coffee fields as an indicator of an active organic matter recycling system and indicates a balanced soil ecosystem.

Gryllotalpa, also known as the mole cricket, has a unique morphology that distinguishes it from other Orthoptera. Its body is large (30–50 mm), cylindrical, with strong, flat forelegs specially adapted for digging. The head is small but powerful, with small compound eyes and medium-sized antennae. Borror *et al.* (1992) noted that the forewings cover the upper body and can produce sounds through stridulation, while the hind legs remain strong for jumping. Gryllotalpa has a burrowing habit, lives underground, and is active at night. This species is often a root pest of plants, including young coffee, by digging in the soil and eating the lower stems and fine roots. Rihan (2018) found that Gryllotalpa infestations can damage the early growth of coffee seedlings if left uncontrolled.

Lepidogryllus is a genus of crickets with a medium-sized body (8–12 mm), dark or brown color, and very long antennae that exceed the length of their bodies. Crickets in the Gryllidae family have narrow forewings, which are used to produce sounds (stridulation), especially in males to attract females. The hind legs of Lepidogryllus are large and powerful, used for jumping. This genus can usually be found under litter, in soil crevices, or in shaded areas near the ground surface. According to Ranteallo (2024), the presence of Lepidogryllus increases in coffee plantations that are not significantly disturbed by human activity and pesticide use. Although not a major pest, these crickets play a role in the soil food chain, helping to maintain the stability of predator communities such as ants and ground beetles.

Of all the soil insects found, some are closely associated with the soil environment. According to Erwinda *et al.* (2016) in Budiaman *et al*. (2023), extreme changes in humidity and rainfall can reduce the abundance of some soil insects.

4. CONCLUSION

Based on the insect inventory conducted at the Solok Radjo Coffee Plantation in Solok Regency, the insects found fall into the categories of predators and decomposers; these are highly beneficial for maintaining the coffee plantation ecosystem, as they are capable of naturally controlling soil organisms and decomposing organic matter.

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