JPBIO (Jurnal Pendidikan Biologi)
Vol. 10, No. 1, April 2025, 59 – 68 //e-ISSN 2540-802X
http://jurnal.stkippersada.ac.id/jurnal/index.php/JBIO/index

Identification of weaver ant behavior patterns (oechophylla smaragdina)

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Article Info

Article History:
Received 02 February 2025
Revised 17 March 2025
Accepted 17 April 2025
Published 30 April 2025

Keywords:
Weaver Ants
Weaver Ant Behavior Patterns
Ad-libitum Sampling Method
Scan Sampling Method
Behavior Sampling Method

ABSTRACT

Ants are insects that are widely distributed on land throughout the world and are known as eusocial insects that live in colonies and are very dependent on the presence of trees. This study aims to determine the behavior of weaver ants that are seen using the *Ad-libitum Sampling* method, to determine the behavior of weaver ants and their frequency using the *Scan Sampling* method, and to determine interesting weaver ant behavior patterns using the *Behavior Sampling* method. Observations of weaver ant behavior were carried out at PPST Bahjaturroghibin for a period of two months between October - November 2024. From the results of the observations, it was found that the behavior of weaver ants that were observed was moving activities with a percentage of 57%, looking for food with a percentage of 10%, grooming or cleaning themselves with a percentage of 5%, resting with a percentage of 7%, defense or horse stance before fighting with a percentage of 4%, fighting with a percentage of 4%, communication between ants with a percentage of 9%, and eating with a percentage of 4%. The most frequently observed activity is the activity of moving from one place to another.

Citation: Zulfa, P.I., Muta'allimah, Azzahra, A.F.D.N., Nafi'ah, N.I., & Hayya, A.W. (2025). Identification of weaver ant behavior patterns (oechophylla smaragdina). *JPBIO (Jurnal Pendidikan Biologi), 10*(1), 59-68. DOI: https://doi.org/10.31932/jpbio.v10i1.4458

INTRODUCTION

Ants are an important component of the ecosystem, where they belong to the species of insects that have social habitats and live together in organized colonies. Ants are found all over the world and are the most numerous (Castillo & Santibáñez, 2023). Ants can be found in tropical and subtropical regions. Ants are an important species in the ecosystems where they live, and some species even function and have a very large impact on their ecological communities. Some ants are considered pests to humans, but ants can also protect plants from pests. One type of ant used for pest control is the weaver ant (Oechophylla smaragdina) (Putriana et al., 2022).

According to Putriana et al. (2022), Weaver ants (Oechophylla smaragdina) are known as eusocial or true social insects that live in colonies and are highly dependent on the presence of trees. Each ant has clear tasks and functions in each colony. Ants are usually found in shady trees, bearing sweet fruit and with broad and thin leaves, such as mango, orange, guava, rambutan, and so on. Weaver ants form nests in the crown of trees or in young leaves because they are easily attacked by pests so they become a source of food (Mariod, Mirghani, & Hussein, 2017). The nests are polydomous, which means that one colony inhabits many nests in one tree or in different trees. In one nest, hundreds to thousands of worker ants can be found. In each colony, there are three castes, namely queen ants, male ants, and worker ants (Ellis et al., 2017).

Weaver ants (*Oechophylla smaragdina*) are ants that live in colonies, so they have many benefits. According to Offenberg (2015), weaver ants have a major role as biological controllers in the agricultural world. Weaver ants also help plants spread seeds for pollination, loosen agricultural soil through their movement in the soil, and can be predators for plant pests. Because of their predatory nature, weaver ants can be suitable agents in integrated pest control (IPM).

Behavior is an animal's response to stimuli in the form of motor activity. Ant behavior is all the activities carried out by ants in their lives. Ants usually carry out various activities such as colonizing, foraging, fighting behavior in their colonies, carrying food, communicating behavior, quiet or resting behavior, moving behavior, and gromming behavior (ant self-cleaning behavior) (Rezki et al., 2023). Colonial behavior in ants is the behavior of ants getting to know each other and their extended family in the nest. Quiet or resting activity is a condition where ants do nothing in their place for a long time. The activity or behavior of moving places is related to the ant's foraging activity. Fighting behavior is the behavior of ants in defending themselves from threats (Ningrum et al., 2023).

According to Zhanna Reznikova (2021), in more than 14,000 ant species, their foraging styles vary, from individual foraging to cooperative arrangements, as most ants forage in colonies. Many studies consider differences in behavior between colonies on different axes, such as boldness, explorative nature, and even collective cognition and learning. How an ant colony behaves in different situations depends on the allocation of workers to different tasks. According to Anderson & McShea (2001), in other species, task specialization among workers can be shaped by size polymorphism, genetic background, experience, and social interactions, which are also partly influenced by age. The allocation of workers to different tasks can depend on external cues, such as interactions between ants and changes in the environment.

Many ant species exhibit convergent behavioral syndromes depending on the number of reproductive queens in the colony. Colonies with multiple queens (polygyny) produce smaller queens and workers than colonies with a single queen (monogyny). The two forms differ in important behavioral traits such as tolerance to conspecifics and dispersal methods. Behavioral syndromes are evident across populations (Zhanna Reznikova, 2021). Colonies from warmer environments appear to exhibit more active exploration and foraging and lower aggressiveness than colonies from cooler locations. Interestingly, some positive correlations between foraging, exploration, and aggression are more pronounced in the warmest locations, while negative associations are more common in cooler locations. In ants, foraging styles show a continuum from individual to cooperative behavior (Ningrum et al. 2023).

This research on weaver ants was conducted in the PPST Bahjaturroghibin boarding school environment because we wanted to know all the behavioral patterns of weaver ants and also the level of diversity of weaver ants in the boarding school environment, the benefits of weaver ants for the surrounding environment, and the role of weaver ants in the ecosystem in the boarding school environment.

RESEARCH METHODS

Research Design

This study is a qualitative descriptive study that aims to describe and analyze the phenomenon of animal behavior, especially ants, both social behavior and daily behavior. This study uses three observation methods, namely Ad-Libitum Sampling, Scan Sampling, and Behavior Sampling. Qualitative descriptive research was chosen because it can describe phenomena or conditions as a whole, both natural and human-engineered (Sukmadinata, 2017). This study was conducted for two months, from October - November 2024. The subjects of this study were the behavioral patterns of weaver ants observed using three methods associated with the behavior of organisms.

Population and Samples

The population in this study was a group of ants found in the observation area. Ant behavior samples were observed in a mapped area measuring 1 x 1 m². Each plot was divided into four parts, and each part was observed by one observer to ensure that all individuals were recorded properly. This research was conducted for two months, from October - November 2024. The research location was in the PPST Bahjaturroghibin boarding school environment. The subject of this research was the behavior pattern of weaver ants observed using three methods associated with the behavior of organisms.

Instruments

The instruments used in this study were: observation sheets for recording behavior, writing instruments for recording observation data, a timer or stopwatch for setting the observation time interval, a map of the observation area (1x1 m² grid) to help record the location of the ant positions, and a camera to document activities.

Procedures

Ad-Libitum Sampling

This method is carried out at the initial stage of observation. Researchers record all visible ant behavior, both social behavior and daily behavior, without any limitations on certain behavioral categories. Observations are carried out 3 times.

Scan Sampling

In this method, the observation area is mapped in a size of 1 x 1 m² and divided into four parts. Each part is observed by one observer. The observer records the behavior of all individual ants every 30-second interval during a total observation time of 120 minutes. This method is repeated 2 times.

Behavior Sampling

In this method, researchers record and observe interesting or specific ant behavior. The focus of observation is directed at certain behaviors, as well as recording the frequency or duration of behavior that occurs during the observation period.

Data Analysis

Data obtained from the observation results were analyzed descriptively and qualitatively. The recorded behavioral data will be categorized based on the type of behavior (eg: social behavior, foraging behavior, defense behavior, etc.). Then the data were analyzed by calculating the frequency and percentage of occurrence of each type of behavior. The results of the observations will be described narratively to describe the behavior patterns of ants in their natural environment.

RESULTS

In the *Ad-Libitum Sampling* method, observations were carried out on November 28, 2024 at 09.00 - 17.00 with 3 repetitions. There are several behaviors carried out by ants in (Table 1), move, communication, defense, fight, rest, eat, grooming, and steal food.

Table 1. Observation Results of the Ad-libitum Sampling Method

Activity	Description of Behavior
Move	Ants move from one place to another
Communication	Ants communicate with other ants by touching each other's antennae.
Defense	Ants move by lifting their abdomen upwards.
Fight	Ants make physical contact against other animals by pecking and biting other opponents using their mandibles.
Rest	Ants stay in place
Eat	Ants will peck and bite other dead insects
Grooming	Ants perform self-cleaning movements using their front legs.
Steal food	Ants carry food using their front legs and bite it using their mandibles, then place it in the nest to be eaten later.

The *scan sampling* method, it was carried out at 11:00 to 13:00 with 2 repetitions. In the scan sampling method, the method of data collection is by making 4 maps, and each map is observed by one person. The data obtained in the scan sampling method and the results of the percentage diagram are in Figure 1.

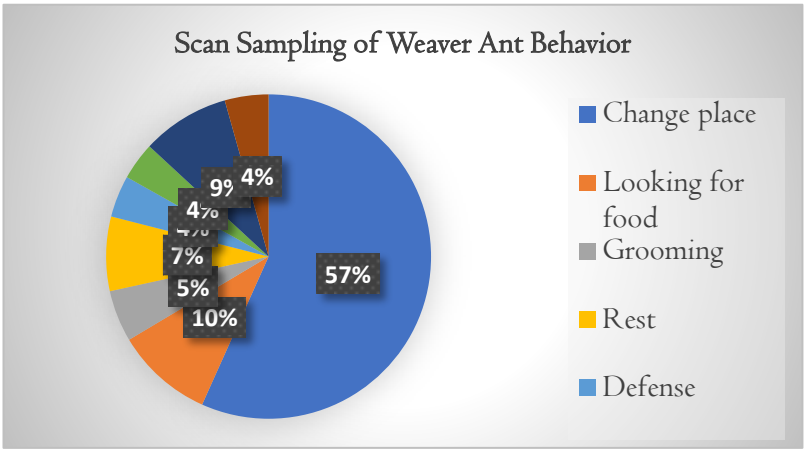
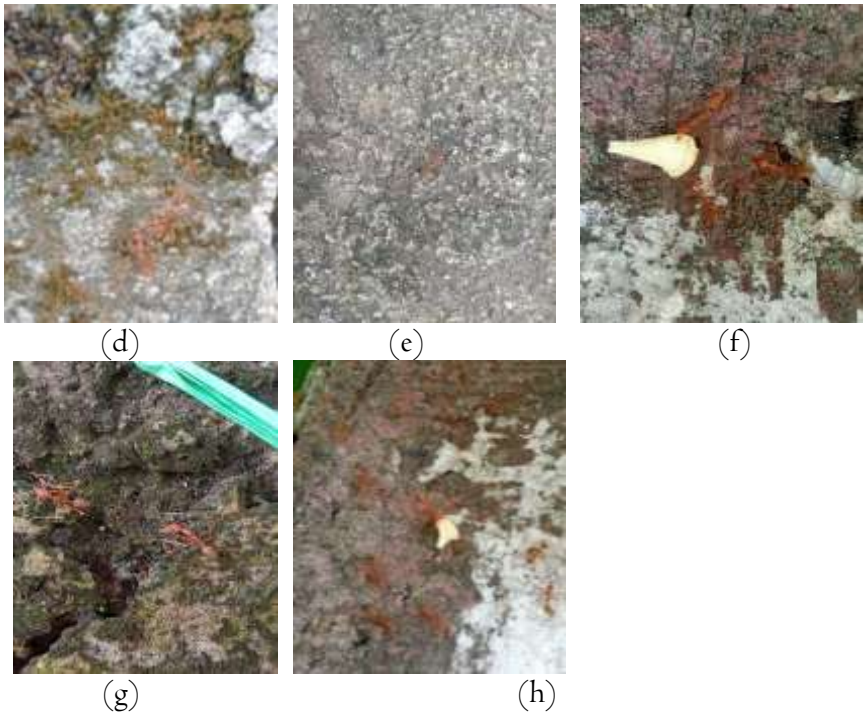


Figure 1. Diagram of scan sampling observation results

(a) (b) (c)



(d) (e) (f)

(g) (h)

Figure 2. Observed behavior in the Ad Libitum Sampling method a. Moving behavior, b. Communication behavior c. Defense behavior, d. Fighting behavior, e. Resting behavior, f. Eating behavior, g. Grooming behavior, h. Steal food behavior.

Table 2. Observation Results of Scan Sampling Method

Activity	Frequency
Change place	612
Looking for food	105
Grooming	55.5
Rest	80
Defense	45
Fight	40.5
Communication	94.5
Eat	47

In the observation using the Behavior Sampling method, this observation was carried out by recording all the behavior of weaver ants in 4 plots and recording the behavior that was observed a lot and that was interesting according to the observer. This observation was carried out for 2 hours with a time interval of 5 minutes. With the Behavior Sampling method, the data results were obtained as in Table 3.

Table 3. Behavior Sampling Observation Results Table

Time	Behavioral Element 1	Behavioral Element 2	Behavioral Element 3	Behavioral Element 4
10.05	Change place	Defense	Rest	Communication
10.10	Change place	Change place	Change place	Change place
10.15	Rest	Rest	Change place	Change place
10.20	Grooming	Fight	Defense	Defense
10.25	Communication	Rest	Rest	Fight

10.30	Bringing food	Colonize	Bringing food	Change place
10.35	Rest	Fight	Communication	Communication
10.40	Change place	Communication	Communication	Change place
10.45	Grooming	Defense	Defense	Change place
10.50	Rest	Rest	Change place	Communication
10.55	Change place	Rest	Defense	Change place
11.00	Change place	Grooming	Change place	Change place
11.05	Change place	Rest	Change place	Communication
11.10	Defense	Fight	Eating behavior	Eating behavior
11.15	Communication	Bringing food	Grooming	Change place
11.20	Change place	Change place	Change place	Rest
11.25	Fight	Communication	Change place	Change place
11.30	Defense	Defense	Grooming	Rest
11.35	Change place	Rest	Rest	Move places
11.40	Communication	Communication	Change place	Rest
11.45	Fight	Communication	Change place	Change place
11.50	Grooming	Rest	Change place	Communication
11.55	Rest	Communication	Rest	Rest
12.00	Change place	Rest	Communication	Defense

Information : (a.) Element 1 : Square 1, (b). Element 2 : Square 2, (c). Element 3 : Square 3, (d). Element 4 : Square 4

DISCUSSION

In the observation results, there is a behavior of moving places (Figure 1a), ants will move from one place to another to find food sources by detecting their environment and then leaving pheromones on the route they take to return to their nest. Worker ants that find food will release pheromones in a certain capacity through small pores in their tails called gasters, the source of the pheromones released will be received by other ants as food coordinates (Ariska, 2018).

According to Putriana et, al. (2022) Worker ants that have found food will release pheromone fluid located in a small pore on their tail or called gaster. The gaster released by the ant will be received by other ants as a signal that it has found food. This pheromone legacy process is known as stigmergy, a process of modifying the environment that not only aims to remember the way back to the nest, but also allows the ants to communicate with their colony. Over time, however, the pheromone trail will evaporate and will reduce its attractive power. The longer an ant travels back and forth through the path, the longer the pheromone will evaporate (Suhara, 2009).

In communication behavior (figure 1b), the ant antennae will touch each other. Weaver ants have a chemical communication system to communicate with fellow colony members, in the form of chemical compounds called pheromones (Elsa et, al. 2023). Based on observations, the behavior of weaver ants in communicating is seen by touching each other's antennae and sometimes biting the abdomen of fellow members. Weaver ants will open their mandibles when they meet weaver ants from other colonies. The behavior of opening the mandibles is an aggressive behavior of ants towards other ants that are not in their colony (Ariska, 2018).

According to Raj et al. (2017), weaver ants appear to open their mandibles when they meet weaver ants from other colonies. The behavior of ants touching their antennae to each other is an important form of communication. The behavior of biting each other's abdomen is used to differentiate and recognize between colonies which is marked by the release of CHC (Cuticular hydrocarbons) compounds from the insect's cuticle. CHC is a mixture of n-alkanes, monomethyl alkanes, and dimethyl alkanes found in the ant's body.

According to Yahya (2014), the form of colony recognition in ants is a way for ants to communicate with each other. The form of communication can be in the form of signals for recognition, warnings, invitations, cooperation, division of labor, to social gatherings between ants. They are also often tasked with finding new nest reserves if the old nest is no longer considered safe (Kurniawan, (2017).

In defense behavior (Figure 2c) or self-defense behavior, ants move by lifting their abdomen upwards. This is a form of self-defense from enemy interference. Weaver ants will bite and spray chemical fluids from their bodies to attack opponents. The self-defense behavior carried out by weaver ants in facing enemies is attacking behavior, biting, to using defensive weapons (spraying formic acid), then running away from potential predators, if it is felt that the defense can no longer be controlled (Zebua, 2022).

According to Gottwald, (1982) the cooperation of weaver ants in defending themselves and their colonies also comes from the smell they have, namely, Pheromones. Pheromones make all members of the colony continue to work together and protect each other, and recognize each other's colony members. Pheromones are also used by workers to mark food search paths so that they are easy for other workers to follow. Each colony has a different smell from other colonies, and all members of the same colony have the same smell (Zebua, 2022).

Weaver ants can act as predators and are aggressive, which are used as biocontrol agents for pest control in tropical plantations to increase crop production. Weaver ants will disturb, hinder, and even prey on other insects, such as aphids, caterpillars, green ladybugs, fruit flies, larvae, and other fruit-eating insects that approach their nest area (Dianing et al. 2017).

In fighting behavior (Figure 1d), the behavior seen is the ant raising its two front legs above the opponent's head. Fighting behavior is the behavior of ants in defending themselves from threats. Weaver ants will monitor prey from a distance, which is indicated by the raising of the gaster. Furthermore, weaver ants will move towards the prey by biting and directing formic acid at the prey (indicated by a raised and forward-curved gaster) (Ningrum et al. 2023).

According to Dianing et al. (2017) weaver ants will disturb, hinder, and even prey on other insects, such as aphids, caterpillars, green ladybugs, fruit flies, larvae, and other fruit-eating insects that approach their territory, let alone their nests. Ants bite the bodies of foreign ants using strong jaws and make foreign ants helpless, in their jaws contain formic acid, citronellal, and other toxic substances that they secrete (Desy et al. 2022).

In visible resting behavior, ants will be quiet or rest for a moment (Figure 2e). According to Ningrum et al. (2023) quiet activity is an activity when weaver ants do nothing in the same place for a long time. This activity is a non-social activity that occurs in a population in the form of sitting, standing, lying down, and looking around.

In feeding behavior (figure 1f) ants will spy/observe food from a distance. When eating, ants are above their food and lower their heads then bite the food with their mandibles. According to Desy et al. (2022) Ants are included in the category of opportunistic eaters or eat many things depending on what is available around them, starting from eating other ants, dead insects, vegetables, fruits, to rotting wood or meat.

Ant feeding strategies are obligate or can change due to environmental influences faced by the animal (Agosti et al. 2000). Weaver ants (Oecophylla smaragdina) are carnivorous insects and only search for food in their territory (Holldobler, 1983).

Grooming (figure 1g) is the behavior of ants in cleaning themselves. Grooming occurs in between the activities of ants walking, usually, ants will stop for a moment to do this activity and then return to their original activity. Grooming carried out by ants functions to clean the outer surface of the body using sensory signal antennas. In addition to keeping the body surface clean, in

some species this behavior has various functions such as thermoregulation, communication and social relations (Qiao et al. 2018)

According to Putriana et al. (2022), the behavior of weaver ants during grooming begins by pulling their antennae with their legs from the base of the antenna to the tip of the antenna, then touching both legs in turn using their mandibles. The front legs of ants function to clean the antennae, while the front legs of ants clean dirt particles because they have a cleaning structure, namely bristles, combs and brushes (Desy et, al. 2022).

Food carrying behavior (Figure 1h) is an ant's activity to try to take/grab food from other ant members to bring back to the nest. Worker ants will scatter to look for food, when they have found food, the ants will gather to lift the food and carry it together to be brought back to the nest. The front of the ant's head has a pair of jaws or mandibles which are used to carry food, manipulate objects, build nests, and for defense. Ants show a threat posture to other ants with their jaws widened and their gasters raised, then bite weaver ants or small black ants that approach them. Diagnostic behavior is competition to win food, mates, and shelter (Putriana et al. 2022).

According to Ningrum et al. (2023) weaver ants start looking for food when the air temperature is 23-30°C. Cloud and rain conditions also affect the search for food. When it rains, there is no foraging activity. In addition, the availability of food around the nest, humidity, and colony growth rate also affect foraging activity.

From the scan sampling observation, it was found that weaver ants carried out the activities of moving with a percentage of 57%, looking for food with a percentage of 10%, grooming or cleaning themselves with a percentage of 5%, resting with a percentage of 7%, defense or horse stance before fighting with a percentage of 4%, fighting with a percentage of 4%, communication between ants with a percentage of 9%, and eating with a percentage of 4%.

From the results of scan sampling observations in table 2, it has been identified that the most frequent activity carried out by weaver ants is moving. And the least frequent activity or the least percentage is defense, fighting, and eating behavior. According toRezki et al (2023), defense activities, fighting, and eating behavior in ants have unique characteristics that are rarely seen as individual activities. This is because ants live in very complex colonies. In the life of an ant colony, defense is not carried out by each individual separately, but through a very sophisticated collective defense system.

Some species of ants even have special soldiers whose job is to protect the colony, so that worker ants do not have to get involved in the fight. When it comes to foraging, ants use a very efficient pheromone communication strategy. Some worker ants who are tasked with foraging will leave a trail to direct other ants to the food source, so that it does not require massive participation from all members of the colony. This sophisticated task-sharing system allows the ant colony to save energy and optimize the function of each individual in the nest ecosystem.

The primary focus of ants is the survival of the colony through highly organized cooperation. Each individual has a specific and interdependent role, so that fighting, defense, and communication activities are of secondary importance compared to the efficient coordination and division of labor within the ant community.

Based on the results of observations of the Behavior Sampling method above, the most interesting behavior of ants found is moving, this is because ants are very active social creatures. According to Ningrum et al. (2023), ants are colonial animals. They have very specific tasks in their colonies, such as looking for food, making nests, guarding nests, and caring for the queen ant. To carry out their duties, ants must move a lot. This ant migration occurs when the surrounding environmental conditions no longer support the survival of the colony, such as depletion of food sources, damage to the nest, or the threat of predators. Ants move in an organized and systematic manner, where the queen ant and colony members move together to find a new location that is

safer and more profitable. Ants will always move by following the pheromone trails left by other ants.

Ad Libitum Sampling, Scan Sampling, and Behavior Sampling each have their own advantages. In the Ad Libitum Sampling method, researchers observe various behaviors without time constraints or specific events, so that they can capture behavior that occurs naturally (Altmann, 1974). On the other hand, the Scan Sampling method is effective for obtaining an overview of the condition of a group or individual at a certain time by recording the behavior of a number of individuals simultaneously at predetermined intervals, thus allowing for more efficient statistical analysis (Martin & Bateson, 2007). Meanwhile, the Behavior Sampling method is useful for focusing observations on certain behaviors that are considered important or rare, thus providing more in-depth data on the type of behavior (Lehner, 1996). Each of these methods has advantages in certain research contexts, depending on the purpose of the study and the type of behavior to be observed.

CONCLUSION

Based on the research of weaver ants above, it can be concluded that the observed behavior of weaver ants is moving, communicating, lifting the abdomen up, fighting, resting, eating, cleaning themselves, and carrying food. The behavior of weaver ants with the highest percentage that has been observed and analyzed is moving behavior, with a percentage of 57%. And the least activity or the lowest percentage is defense with a percentage of 4%, fighting with a percentage of 4%, and eating behavior with a percentage of 4%. The implications of the results of this study indicate that weaver ants spend more time moving, which may indicate high mobility in searching for food sources or exploring their nest area. This activity is very important in maintaining the sustainability of the colony because it is directly related to the search for resources. Conversely, the low frequency of activities such as fighting, defense, and eating indicates that at the time of observation, the colony was in a relatively safe and well-fed condition, so it did not require a lot of aggressive behavior or high food consumption.

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