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Foraging Activity of *Geniotrigona thoracica Smith* (*Apidae: Meliponinae*) and Its Feed Plants in the Universitas Syiah Kuala Campus Area, Banda Aceh

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Abstract

Geniotrigona thoracica plays an essential role in pollination and ecosystem sustainability, making the research of its foraging behavior crucial for understanding its ecological contributions. This research aims to analyze the foraging activity and food plants of *G. thoracica* to determine foraging behavior, food sources, and materials used for nest construction. The research was conducted from February to May 2024. The method employed direct observation of the foraging activities of three *G. thoracica* colonies. Data collection was carried out for 10 minutes every hour (five minutes observing bees leaving the nest and five minutes observing their return) from 06:00 to 18:00 WIB. Foraging activities were categorized into nest exit and entry behaviors. Additionally, food plant and nest material identification was conducted using the transect method along eight paths aligned with the cardinal directions, within a 500-meter radius from the colony. The results show that *G. thoracica* engages in foraging activities to collect pollen, nectar, a combination of pollen and nectar, and resin. Pollen was the most frequently transported resource by worker bees, followed by resin and nectar. In the campus area of Syiah Kuala University, a total of 131 plant species were identified as food sources and nesting materials, with eight species serving as resin sources. This research has implications for providing insight into the ecological role of G. thoracica and the diversity of plant resources that are important for its survival.

Keywords: Food Plants, Foraging Activity, *Geniotrigona Thoracica*, Syiah Kuala University.

INTRODUCTION

Geniotrigona thoracic is a type of kelulut from the genus Geniotrigona that is distributed in Southeast Asia and is most commonly found in Malaysia, Indonesia, and Thailand (Norowi et al., 2010); (Ng et al., 2021). *G. thoracica* is one of the most widely cultivated kelulut species in the community after Heterotrigona itama due to its high honey production (Herwina et al., 2021). In addition to producing honey, *G. thoracica* also produces propolis extract,, which is highly effective as an antimicrobial and a source of antioxidants that are useful in the medical world (Suhaini et al., 2023). Information on the daily activities of this kelulut is still not reported, especially in semi-natural environments.

Kelulut utilizes various plant species as food sources and nesting materials. The food collected by worker kelulut consists of nectar and pollen and resin as nest-building material (Salatnaya, Fuah, et al., 2020). The food source of kelulut is usually nectar and plant pollen. Nectar is a source of energy for kelulut, while pollen is a source of essential proteins, vitamins, fats, and minerals for developing kelulut larvae (Hidayatullah et al., 2021). Pollen is used as a source of protein, nec, tar is used as a source of carbohydrates,, and the collected resin is used to build, repair,, and protect the nest (Yustia et al., 2017).

The results of research (Putri, 2023) recorded as many as 74 species of pollen and nectar-producing plants, 6 of which produce pollen, nectar, and resin, namely Mangifera foetida, Shorea resinosa, Aleurites moluccanus, Macaranga denarius, Acacia auriculiformis, and Vitex pinnata. Based on several families obtained, Asteraceae is the family with the most types obtained and is favored by kelulut because it has a cup flower type (corymbs) and an open flower shape that makes it easier for kelulut to take pollen or nectar. Some plants that produce pollen, nectar, and resin can also be found around the campus of Syiah Kuala University (SKU), namely Mangifera indica and Aleurites moluccanus, and plants from the Asteraceae family are also widely planted, thus providing a variety of pollen and nectar as a food source for kelulut.

Kelulut can live in various types of habitats, especially in areas where there are many flowering plants, both in forests, plantations, housing and even in green campus areas. Syiah Kuala University is one of the universities in Banda Aceh City which has an area of ± 125 ha. The campus environment area of Syiah Kuala University is part of the green open space in Banda Aceh City. Syiah Kuala University puts forward the concept of green campus, which is to provide and utilize green open space in the campus environment by planting plants that are beneficial for environmental conservation, maintaining the beauty and beauty of the campus environment (Suciyani, 2018). One of the green open spaces at Syiah Kuala University is an experimental garden known as a biological garden. It is one of the facilities owned by the Department of Biology FMIPA Syiah Kuala University, which functions as an experimental garden for research lecturers and students and is open to the public. The experimental garden is prepared for learning media to develop and hone students' abilities in agriculture.

Based on the above background, the purpose of this research is to analyze the foraging activities of Geniotrigona thoracica and identify the types of plants that become food sources and nesting materials in the campus environment of Syiah Kuala University. This research is expected to provide an overview of the daily activity patterns of G. thoracica in foraging and its contribution to local ecosystems, especially in the context of semi-natural ecosystems found in the campus environment.

The benefit of this research is to provide scientific information about the diversity of plants that become food sources and nesting materials for G. thoracica, which can be used as a basis for conservation efforts and kelulut-based environmental management. In addition, the results of this research can also be a reference for kelulut farmers in determining the appropriate location for cultivation and in selecting plant species that can support the productivity of kelulut colonies. Thus, this research contributes to the development of a sustainable agroecological system as well as increasing awareness of the importance of biodiversity in urban areas.

RESEARCH METHOD

Place and Time of Research

The research was conducted from February to May 2024. Observations of kelulut foraging activities were carried out in the Experimental Garden of the Department of Biology FMIPA USK and Nino Park ARC. Data processing and identification of food plants were carried out at the Herbarium Acehense Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Syiah Kuala University.

Tools and Materials

The tools used were three colonies of *Geniotrigona thoracic*, a counter, an insect net, stationery, a timer, and photographic equipment. The materials used in this research are log books.

Research Design

The method used in this research was direct observation of the foraging activities of three *G. thoracica* colonies. Observations were made every hour for 10 minutes (five minutes out and five minutes into the nest) by observing and counting the number of workers who left and entered the nest, starting at 06.00-18.00 WIB (Suwarno et al., 2023). Observations of foraging activities of kelulut workers leaving and entering the nest were made for 15 observations for each colony. Meanwhile, observations of food plants and nesting materials used the transect method with eight lanes following the cardinal directions within a radius of 500 m from the center of the nest (colony). Observations of physical environmental factors (temperature, light intensity, and relative humidity of the air) were conducted simultaneously with observations of foraging activities and nesting materials.

Work Procedure

Colony Preparation of G. thoracica

G. thoracica colonies were obtained from a kelulut farm in Jantho, Aceh Besar. Colony transfer can only be done at night in a closed entrance. Colony strips are placed on wood with a height of 40 cm from the ground to avoid being submerged by water when it rains and also by predators such as frogs. Colonies that are successfully moved will be opened during the day and acclimatized (adaptation to the new environment) for 3-7 days before observation. Data collection on kelulut foraging activities can be done after acclimatization.

Foraging Activity of G. thoracica

Data collection on foraging activity was carried out for 10 minutes every hour (five minutes out and five minutes into the nest) starting from 06.00-18.00 WIB. Observations of foraging activity were divided into two, namely nest exit activity and nest entry activity. The activity of leaving the nest is divided into three categories referring to the method (Yustia et al., 2017) and (Suwarno et al., 2023), namely foraging activities and nest materials (resin), nest cleaning activities, and nest guarding activities. Foraging and nest material activities were observed in kelulut that flew out of the entrance of the nest. The activity of cleaning the nest was observed on the kelulut that left the nest and carried material in the mandibles. Nest guarding activity was observed on kelulut that exited the nest entrance at low speed and flew around the nest and then back to the nest entrance (entering or landing on top of the nest entrance). Nest exit activity was observed for 5 minutes.

Observations of nest entry activity were divided into five categories, namely kelulut that entered carrying pollen, nectar, pollen-nectar, nest material (resin), and kelulut that entered carrying nothing (Yustia et al., 2017) . Observations of these five activities were also made for five minutes. The entrance hole is closed for five minutes, and all kelulut flying towards the entrance will be captured using an insect net. Ants carrying pollen can be identified by observing the presence of pollen powder attached to the corbicula on the hind tibia, which has general characteristics of yellow or white color that is not shiny and has a round shape with a smooth surface. Ants carrying nectar are characterized by swelling and shiny abdomen. Ants carrying pollen-nectar are characterized by the presence of pollen powder on the corbicula and swelling of the abdomen. Ants carrying resin can be identified by observing the presence of resin attached to the hind tibia, usually white, clear, or brown in color and irregularly shaped, shiny, and sticky. An ant that is not carrying anything is characterized by the absence of material attached to the corbicula and an abdomen that is not enlarged and shiny.

Forage Plant Inventory

The inventory of food plants is carried out by observing flowering plants that have the potential to become a source of food and nesting material based on literature within a radius of 500 m from the center of the colony. The plants will be recorded for their characteristics and documented in the form of photographs. Identification is done by referring to books or literature, including local names and scientific names of plants. References or literature references used in the identification of kelulut food plants include the book Flora of Peninsular Malaysia. Series II: Seed plants, Volume 1 (Kiew et al., 2010), Tropical flowering plants: A guide to identification and cultivation and other identification books.

Research Parameters

The parameters observed in this research were the activities of leaving and entering the kelulut nest and the food plants for kelulut. Parameters were recorded for the activity of the kelulut nest exit, including the number of kelulut leaving the nest: looking for food, cleaning the nest, and guarding the nest. Furthermore, the activity of kelulut entering the nest, in the form of the number of kelulut that enter the nest carrying nectar, pollen, resin, pollen and nectar, and kelulut that do not carry anything. The observed food plant parameters include plant species.

Data Analysis

Data on the foraging activities of *G. thoracica* kelulut in the form of nest exit activities (foraging, littering, and drone) and nest entry activities (carrying pollen, carrying nectar, carrying pollen and nectar, carrying resin, and not carrying anything) were analyzed using Microsoft Excel. Furthermore, descriptive analysis was carried out on the inventory of kelulut food plants, including local names and scientific names of plants and images.

RESULT AND DISCUSSION

G. Thoracica Foraging Activity

Nest exit activity

Observations of *Geniotrigona thoracica* nest exit activity showed that nest exit activity consisted of foraging, littering, and drones guarding the nest. Foraging activities are characterized by workers leaving the nest flying quickly and not carrying any material, while littering activities are characterized by the presence of material carried by workers in the mouth (mandible). This material is in the form of pots of chicks that have left to become adults, kelulut that died in the nest, or the rest of the nest material. Meanwhile, the drone kelulut (male) is the kelulut in charge of guarding the nest. (Hidayati et al., 2020) , said that in one colony or kelulut nest, there is a queen (quin), male bees (drones), and worker bees (workers). Drones are male bees that have the second largest number after worker bees in the hive; the task of drones, in addition to fertilizing the queen, is also in charge of protecting the nest from disturbances. Most of the activity is about leaving the nest for foraging and disposing of garbage and drones (Table 1).

Table 1. Nest exit activity

Colonies	Nest Exit Activity		
	Foraging	***Drones***	**Dumping Garbage**
Colony 1	76%	10%	14%
Colony 2	75%	11%	14%
Colony 3	74%	13%	13%

Nest Entry Activity

The activity of kelulut entering the nest consists of carrying pollen, nectar, resin, pollen-nectar, and carrying nothing (empty). *G. thoracica* is a pollinator insect. The small body size of the kelulut makes it easy to forage on small flowers without causing damage and can also take food from hidden parts of the flower that are not visible to other larger bees (Salatnaya, Widodo, et al., 2020). Pollen is the material most commonly carried by *G. thoracica* in nest entry activities, followed by resin and nectar (Table 2). This is because the observed *G. thoracica* colonies are new colonies and still in the developmental period. (Haneda et al., 2022) Explains the daily activities of foraging kelulut, which, when returning to the nest, will carry pollen, nectar, resin, water, mud, and soil particles.

Table 2. Nest entry activities carrying food and nesting materials

Colonies	Feed Carrying Activity			
	Pollen (%)	**Nectar (%)**	**Resin (%)**	**Pollen-Nectar (%)**
Colony 1	62%	7%	28%	3%
Colony 2	62%	8%	27%	3%
Colony 3	56%	7%	33%	4%

Peak nest entry activity occurs in the morning due to the availability of abundant food and favorable environmental conditions. (AF et al., 2019) convey insect activity, most of which occurs in the morning. Another research said pollinating insects such as kelulut generally visit in the morning, which coincides with the blooming of flowers. The volume of nectar and the amount of pollen in flowers is high in the morning and continues to decline until the afternoon, which affects the visit of pollinator insects to flowering plants. Based on Table 2, it can be seen that the activity of collecting food and nest materials in *G. thoracica* is dominated by collecting pollen, followed by carrying resin, nectar, and pollen + nectar. (Suwarno et al., 2023) Found that the activity of collecting food and nest materials in H. Saitama is carrying nectar (44.66%), resin (23.41%), pollen (21.17%), and not carrying anything (10.74%).

G. thoracica utilizes resin as a nest building material, in addition *G. thoracica* has the behavior of using various resins to protect the nest which makes it difficult for predators to enter the nest. Resin around the entrance is used to repel and make it difficult for intruding insects. The type of these protective resins varies depending on the environment in which the colony originates. Wallacetrigona incisa in the Sulawesi highlands has an entrance coated with a hard, thick resin that protects the nest entrance from forest rats (Suhri et al., 2022). Kelulut usually deposits a sticky and elastic resin, which is used to bury the bodies of intruders or predators that enter the nest.

Food Source Plants and Nesting Materials

Geniotrigona thoracica typically has foraging ranges that vary based on environmental conditions and resource availability. (Benedick et al., 2021) explains, *G. thoracica* generally chooses to forage from a variety of resources available within a 500 meter radius of the nest, particularly where food resources are diverse and closer to the nest. Based on this distance, the kelulut can access a wide variety of floral resources while maintaining energy efficiency. The foraging behavior of *G. thoracica* is influenced by factors such as food resource availability, season, and habitat type. For example, at times when floral resources are scarce, keluluts may travel longer distances in search of food. Conversely, when resources are abundant and close to the nest, their foraging range may be more limited. The availability of abundant food resources may increase worker kelulut activity. *G. thoracica* collects a variety of materials, both for food in the form of nectar and pollen and nest building materials in the form of resin collected from plants around the nest.

The types of plants used as food sources and nest-making materials by *G. thoracic* can be seen in Table 3 below.

Table 3. Food source plants and nesting materials of G. thoracica

No.	Family	Latin Name	Local Name
1	Acanthaceae	*Asystasia gangetica* (L.) T. Anders.	Israeli grass
2		*Ruellia tuberosa* L.	Wild purple badge
3		*Ruelllia prostrata* Poir.	
4	Amaranthaceae	*Aerva lanata* (L.) A. L. Juss. ex Schultes	Upasan Upas Grass
5		*Alternanthera caracasana* Kunth.	
6		*Celosia cristata* L.	Cockscomb
7	Anacardiaceae	*Mangifera indica* L.*	Mango
8		*Spondias dulcis* Parkinson*	Kedondong
9	Annonaceae	*Annona muricata* L.	Srikaya
10		*Cananga odorata* (Lamk.) Hook.	Kenanga
11	Apocynaceae	*Adenium obesum* (Forssk.) Roem. & Schult.	Cambodia Japan
12	Arecaceae	*Areca catechu* L.	Pinang
13		*Cocos nucifera* L.	Green Coconut

No.	Family	Latin Name	Local Name
14		*Elaeis guineensis* Jacq.	Oil Palm
15	Asteraceae	*Ageratum conyzoides* L.	Babandotan
16		*Chromolaena odorata* (L.) King & H.E. Robins.	Mijangan
17		*Cosmos sulphureus* Cav.	Sulfur Kenikir
18		*Cyanthillium cinereum* (L.) HE Robins.	
19		*Eclipta alba* (L.) Hassk.	Urang Aring
20		*Elephantopus scaber* L.	
21		*Heliantus annuus* L.	Sunflower
22		*Melampodium divaricatum* (L.C. Rich.) DC.	Flower of a Thousand Stars
23		*Sonchus arvensis* L.	Tempuyung
24		*Sphagneticola trilobata* (L.) Pruski	Wedelia
25		*Symphyotrichum laeve* (L.) A. & D. Löve	Aster
26		*Syndrella nodiflora* (L.) Gaertn	Jotang kuda
27		*Tagetes erecta* L.	Chicken Mole Flower
28		*Tridax procumbens* L.	Gletang
29		*Zinnia elegans* Jacq.	Zinia
30	Balsaminaceae	*Impatiens balsamina* L.	Water Boyfriend
31	Bignoniaceae	*Spathodea campanulata* Beauv.	African Tulips
32		*Tabebuia aurea* (Silva Manso) Benth. & Hook.f. ex S.Moore	Yellow Tabebuya
33		*Tabebuia elliptica* (DC.) Sandwith	White Tabebuya
34		*Tabebuia pallida* (Lindl.) Miers	Pink Tabebuya
35		*Tecoma stans* (L.) Juss. ex Kunth	Yellow Trumpet Flower
36	Boraginaceae	*Ehretia microphylla* Lam.	
37	Campanulaceae	*Campanulata* Beauv.	
38		*Hippobroma longiflora* (L.) G. Don	Kitolod
39	Caricaceae	*Carica papaya* L.	Papaya
40	Cleomaceae	*Cleome rutidosperma* DC.	Maman Ungu
41		*Cleome viscosa* L.	
42	Combretaceae	*Terminalia mantaly* H. Perrier	Ketapang Kencana
43	Commelinaceae	*Tradescantia pallida* (Rose) D.R. Hunt	Purple Heart
44	Convolvulaceae	*Evolvulus nummularius* (L.)L.	
45		*Ipomoea cairica* L.	Sri pagi or Ubi Kates
46		*Ipomoea obscura* L.	
47	Cucurbitaceae	*Cucurbita moschata* Duchesne	Yellow Pumpkin
48		*Luffa acutangula* (Linn.) Roxb.	Gambas
49	Euphorbiaceae	*Acalypha siamensis* Oliv. ex Gage.	Tea-tehan
50		*Acalypha wilkesiana* Muell. Arg.	Akalipa or sablo plant
51		*Aleurites moluccanus* (L.) Willd.*	Candlenut
52		*Cnidoscolus aconitifolius* (P. Mill.) IM Johnston	Japanese papaya
53		*Euphorbia heterophylla* L.	
54		*Euphorbia hirta* L.	
55		*Euphorbia milii* Des Moul.	Crown of thorns
56		*Jatropha gossypiifolia* L.	Red Distance
57		*Jatropha multifida* L.	Betadin or Castor plant

No.	Family	Latin Name	Local Name
58	Fabaceae	*Acacia auriculiformis* A. Cunn. ex Benth.*	Acacia
59		*Alysicarpus vaginalis* (L.) DC.	
60		*Caesalpinia pulcherrima (*L.) Sw.	Peacock Flower
61		*Cajanus scarabaeoides* (L.) Thouars	
62		*Calliandra houstoniana* (Mill.) Standl.	Kaliandra
63		*Cassia leptophylla* Vogel	
64		*Delonix regia* (Bojer ex Hook.) Raf.	Flamboyant
65		*Desmanthus* sp.	
66		*Mimosa pudica* Linn.	Princess Shame
67		*Pterocarpus indicus* Willd.*	Angsana
68		*Samanea saman;* Merr	Trembesi
69		*Tamarindus indica* L.	Tamarind
70	Lamiaceae	*Clerodendrum splendens* G. Don	
71		*Clerodendrum thomsoniae* Balf.	Miss eating betel nut
72		*Hyptis capitata* Jacq.	Knop grass
73		*Ocimum x africanum* Lour.	Basil
74		*Tectona grandis* L. f.	Teak
75		*Vitex pinnata* L.*	Laban*
76		*Vitex trifolia* L.	Legundi
77	Linderniaceae	*Torenia fournieri* Linden ex E. Fourn	Cat's Eye Flower
78	Loranthaceae	*Dendrophthoe pentandra* (L.) Miq.	Mango balu
79	Lythraceae	*Lagerstroemia speciosa* (L.) Pers.	Bungur or local sakura
80		*Lawsonia inermis* L.	Plant Inai or Pacar Kuku
81		*Punica granatum* L.	Pomegranate
82	Malpighiaceae	*Malpighia glabra* L.	
83	Malvaceae	*Durio zibethinus* Murray	Durian
84		*Hibiscus rosa-sinensis* L.	Hibiscus
85		*Malvastrum coromandelianum* (L.) Garcke	
86		*Sida acuta* Burm. f.	Jruen Flower
87	Melastomataceae	*Melastoma malabathricum* L.	Senduduk
88	Moraceae	*Artocarpus heterophyllus* Lam.*	Jackfruit
89		*Ficus benjamina* L.	Banyan
90		*Morus alba* L.	Mulberry
91	Moringaceae	*Moringa oleifera* Lam.	Moringa
92	Muntingiaceae	*Muntingia calabura* L.	Kersen
93	Musaceae	*Musa paradisiaca* L.	Bananas
94	Myrtaceae	*Psidium guajava* L.	Guava
95		*Syzygium aqueum* (Burman f.) Alston	Water Guava
96		*Syzygium cumini* L.	Jamblang
97		*Syzygium malaccense* (L.) Merr. & Perry	Guava Bol
98		*Syzygium myrtifolium* Walp.	Red Paw Flower
99	Nyctaginaceae	*Boerhavia diffusa* L.	
100	Ochnaceae	*Ochna thomasiana* Engl. & Gilg	
101	Oxalidaceae	*Averrhoa bilimbi* L.	Vegetable Starfruit
102		*Averrhoa carambola* L.	Sweet Starfruit

No.	Family	Latin Name	Local Name
103		*Oxalis barrelieri* L.	Calincing Soil
104	Passifloraceae	*Passiflora foetida* L.	Rambusa or Wild Passion Fruit
105	Phytolaccaceae	*Rivina humilis* L.	Getih Getihan
106	Polygalaceae	*Polygala paniculata* L.	Balm Grass
10	Polygonaceae	*Antigonon leptopus* Hook. & Arn.	Bridal Tears
108	Rosaceae	*Rosa* sp.	Roses
109	Rubiaceae	*Gardenia jasminoides* J. Ellis	Perfumed Plate Glass
110		*Ixora coccinea* L.	Asoka
111		*Morinda citrifolia* L.	Noni
112		*Mussaenda erythrophylla* Schumach. & Thonn.	Nusa Indah Flower
113		*Oldenlandia corymbosa* L.	Pearl Grass
114		*Spermacoce remota* Lam.	False Button Weed
115	Rutaceae	*Citrus Aurantifolia* (L.) Swingle	Lime
116		*Murraya koenigii* (L.) Spreng.	Curry Leaf or Koja Salam
117		*Murraya paniculata* (L.) Spreng.	Kemuning
118	Sapindaceae	*Cardiospermum halicacabum* L.	Mountain Paria
119		*Dimocarpus longan* Lour.*	Longan
120		*Pometia pinnata* J.R. & G.Forst	Matoa
121	Sapotaceae	*Mimusops elengi* L.	Cape
122	Scrophulariaceae	*Scoparia dulcis* L.	Jaka Tuwa
123	Solanaceae	*Capsicum annum* L.	Curly Chili
124		*Capsicum frutescens* L.	Cayenne Pepper
125		*Solanum torvum* Sw.	Rimbang
126	Theaceae	*Camellia japonica* L.	Japanese Camellias
127	Verbenaceae	*Duranta erecta* L.	
128		*Lantana camara* L.	Lantana
129		*Stachytarpheta jamaicensis* (L.) Vahl	Horse Whip
130	Vitaceae	*Cayratia trifolia* (L.) Domin	Lakum or galing
131		*Cissus verticillata* (L.) Nicolson & C.E.Jarvis	Hanging Roots

*Resin-producing plants

Based on the results of collecting data on plants used by *G. thoracica* as a source of food and nest-making material, 131 plant species from 48 families were obtained as a source of food and nesting material for *G. thoracica*. The plants recorded are within a radius of 500 m from the center of the colony. Plant families and their types can be seen in Table 4.3. Eight resin-producing plants were found, namely *Acacia auriculiformis* A. Cunn. ex Benth., *Aleurites moluccanus* (L.) Willd., *Artocarpus heterophyllus* Lam., *Dimocarpus longan* Lour., *Mangifera indica* L., *Pterocarpus indicus* Willd.., *Spondias dulcis* Parkinson, and *Vitex pinnata* L. Families that are the most common source of food and nesting material are Asteraceae 15 species, Euphorbiaceae 9 species, Fabaceae 15 species, Lamiaceae 7 species, Myrtaceae 5 species and Rubiaceae 6 species. This is because these plants are easily adapted and the distribution of seeds is very wide (Rahmawati & Sulistiyowati, 2021). In general, these plants have a type of inflorescence with a relatively small size and position of pollen and nectar that is easily collected by kelulut. The cup flower type has an open flower shape that is favored by kelulut because it makes it easier for kelulut to land on the flower and makes it easier for kelulut to take pollen or nectar (Fauzia et al., 2019). This is in accordance with the statement of Kamilya et al. (2024), kelulut have a habit of visiting flowers that are small and flat, with unprotected nectar and pollen positions. Ants usually visit flowers of various sizes, but more on flowers that have small and long corollas. In addition, the visit of kelulut to flowers is influenced by morphological characteristics of flowers that are attractive such as visual appeal in the form of colors and patterns, as well as aroma clues (Nuraini et al., 2020).

The types of flowers frequented by kelulut other than the Asterceae family are fragrant plate glass (*Gardenia jasminoides*) and bridal tears (*Antigonon leptopus*). A. leptopus, this is because the plant has a sweet aroma and is also rich in pollen and nectar. In addition, this plant is not far from the kelulut nest, so the kelulut tends to visit the flower closest to the nest. Flowers have different characters in shape, aroma, color, nectar production and so on. (Tahir et al., 2021) , states that almost all flowering plants can be used as a source of food for keluluts. However, the important thing in choosing food plants for keluluts is the distance of the flower from the nest. This is related to flight distance and energy efficiency for kelulut (Hasan et al., 2024).

CONCLUSION

The conclusion of this research shows that foraging activities of *Geniotrigona thoracica* are divided into two main categories: nest exit and nest entry. The highest nest-exit activity was foraging, followed by litter removal and drone flying. During nest-entry activities, *G. thoracica* carries the most pollen, followed by resin and nectar. In the campus area of Syiah Kuala University, 131 plant species from 48 families were identified as food sources and nesting materials for G. thoracica. Among these, eight species serve as resin sources, including *Acacia auriculiformis, Aleurites moluccanus, Artocarpus heterophyllus, Dimocarpus longan, Mangifera indica, Pterocarpus indicus, Spondias dulcis*, and *Vitex pinnata*. These plants play an important role in supporting the feeding and nesting requirements of *G. thoracica*, indicating the ecological importance of plant diversity in maintaining kelulut bee populations.

This research provides valuable insights into the foraging behavior and plant resource utilization of *G. thoracica*, contributing to a broader understanding of kelulut bee ecology. Future research should explore seasonal variations in foraging activity, the influence of environmental factors on resource availability, and the potential role of *G. thoracica* in pollination services in urban green spaces. In addition, these findings can serve as a reference for conservation strategies, sustainable beekeeping practices, and the development of urban ecosystems that support pollinators. By integrating pollinator-friendly plants into landscape planning, this research can help increase biodiversity and promote ecological resilience in urban environments.

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