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DIVERSITY OF THE INSECT VISITORS SPECIES ON LILY-LEAF ACRIOPSIS *Acriopsis liliifolia* (J. Koenig) Ormerod IN AYUNAN LANGIT, KALURAHAN PURWOSARI, GIRIMULYO, KULON PROGO

KEANEKARAGAMAN JENIS SERANGGA PENGUNJUNG ANGGREK BAWANG *Acriopsis liliifolia* (J. Koenig) Ormerod DI AYUNAN LANGIT, KALURAHAN PURWOSARI, GIRIMULYO, KULON PROGO

Lisna Nur Aini[1], Siti Sumarmi[2]*
[1]*Faculty of Biology, Universitas Gadjah Mada, Special Region of Yogyakarta 55281*
[2]*Entomology Laboratory, Faculty of Biology, Universitas Gadjah Mada, Special Region of Yogyakarta 55281*
**Corresponding author:* siti-sumarmi@ugm.ac.id

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Abstract

Besides being a microhabitat for insects, *Acriopsis liliifolia* orchid's economic value can be increased through cultivation techniques, but it is constrained because *A. liliifolia* flowers can't self-pollinate. Based on their flower structure, insects have the potential to become their pollinator. Insect visitors of *A. liliifolia* must be identified to know their species diversity and roles during visiting orchids. The research was conducted in Ayunan Langit, Sabrangkidul, Kalurahan Purwosari, Girimulyo, Kulon Progo from September to October 2023. Insect collection was done manually by brush and then put in a flask bottle containing 5 mL of 70% alcohol. The collected specimens were then carried out to the Entomology Laboratory, Faculty of Biology, Gadjah Mada University, and identified based on morphology characters. The results showed that there was one member of *Cicadellidae* and 14 species of insect visitors to the *A. liliifolia*. The majority of insect visitors acted as herbivores (73.33%), 20% as carnivores, and the rest is unknown. It is predicted that *the Braunsapis* genus is a pollinator because it has a tonguelike maxilla and labium used to suck nectar. In this study, we conclude that the diversity of insect visitor species in *A. liliifolia* is moderate (H'= 1.95) and *Braunsapis* has potential as a pollinators.

Keywords: *Acriopsis liliifolia*; *Braunsapis*; Insect visitor; Kulon Progo; Pollinator

Abstrak

Anggrek Acriopsis liliifolia, selain sebagai mikrohabitat serangga, juga berpotensi untuk ditingkatkan nilai ekonominya melalui teknik budi daya, tetapi terkendala karena bunga A. liliifolia tidak dapat melakukan penyerbukan sendiri. Berdasarkan struktur bunga, serangga memiliki potensi berperan sebagai polinator bagi A. liliifolia. Serangga pengunjung A. liliifolia perlu diidentifikasi untuk mengetahui keanekaragaman jenis dan perannya selama mengunjungi anggrek tersebut. Penelitian dilakukan di Ayunan Langit, Sabrangkidul, Kalurahan Purwosari, Girimulyo, Kulon Progo pada September sampai Oktober 2023. Koleksi serangga dilakukan secara manual menggunakan kuas kemudian dimasukkan ke dalam botol falkon berisi 5 mL alkohol 70%. Spesimen serangga hasil koleksi selanjutnya dibawa ke Laboratorium Entomologi, Fakultas Biologi, Universitas Gadjah Mada dan diidentifikasi berdasarkan karakter morfologi. Hasil penelitian menunjukkan terdapat satu anggota famili Cicadellidae dan 14 spesies serangga pengunjung anggrek A. liliifolia. Mayoritas serangga pengunjung berperan sebagai herbivora (73,33%), 20% berperan sebagai karnivora, dan sisanya belum diketahui perannya. Diprediksi genus Braunsapis adalah polinator karena memiliki maksila dan labium yang berbentuk lidah digunakan untuk menghisap nektar. Simpulan dari penelitian ini adalah keanekaragaman jenis serangga pengunjung A. liliifolia sedang (H'= 1,95) dan anggota genus Braunsapis berpotensi berperan sebagai polinator.

***Kata Kunci**: Acriopsis liliifolia; Braunsapis; Kulon Progo; Polinator; Serangga pengunjung*

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INTRODUCTION

Insects live in environmental habitats that provide their living needs (Southwood, 1981). Insect habitats include agricultural land (Siregar et al., 2014), water/swamps (Teristiandi, 2020), forest trees (Putri et al., 2019), forest floor (Nuraeni & Mangesu, 2017), savanna (Moe et al., 2017), and deserts (Segoli et al., 2020). One of the insect microhabitats in the forest is the *Acriopsis liliifolia* orchid which is an epiphyte on forest trees. This orchid is attached to a rough-textured tree trunk so that the orchid's dorsiventral roots can attach perfectly and are able to obtain nutrients from the material around the roots. The *A. liliifolia* orchid has roots that dangle in the air which are called catch roots. Catch roots function to catch falling litter and use it as a food source. The flowers of *A. liliifolia* are cross-shaped, about 1 cm in size, and white with purple hues (Sofiyanti, 2014). Flowers have nectar which can attract pollinator insects. The unique part of the *A. liliifolia* flower is the column because it is shaped like an insect (Sofiyanti, 2014). Research by Yulia (2009) shows that the blooming time of *A. liliifolia* flowers is eight to 14 days in the Purwodadi Botanical Gardens, with flowering time being August to October.

Based on its ability to survive in wet tropical areas with high relative humidity, the *A. liliifolia* orchid can live in the Menoreh Hills, Kalurahan Purwosari, Girimulyo, Kulon Progo, Special Region of Yogyakarta. The Menoreh Hills were designated as a biosphere reserve by the United Nations Educational, Scientific, and Cultural (UNESCO) at the 32nd session of UNESCO's International Coordinating Council of the Man and the Biosphere (ICC-MAB) in 2020. The concept of the biosphere reserve is to manage areas designated to harmonize the need for sustainable biodiversity - social-economic conservation and adequate logistical support where conservation areas become core areas (Anonymous, 2020). Based on this concept, the biodiversity found in the Menoreh Hills must be preserved, for example, insects related to the life of the *A. liliifolia* orchid so that this orchid can continue to exist in nature.

The natural presence of insects can be detrimental or beneficial. Insects play a detrimental role when they become plant pests. Meanwhile, insects are said to be beneficial if they help pollinate flowers (Katumo et al., 2022), act as predators (Seni & Halder, 2022), and parasitoids (Godfray, 2007). The interaction of pollinators with plants is beneficial for food production and makes ecosystems play an important role in supporting biodiversity. As many as 87.5% of flowering plants are estimated to depend on pollinators (Katumo et al., 2022).

Research on insect visitors of orchid plants was studied by Henneresse and Tyteca (2016). The results of this research show that there are 49 species of insect visitors to the *Orchid militaris* orchid and are dominated by members of the order *Diptera* (50%) and *Hymenoptera* (32%). Members of the order *Diptera* only act as visitor insects because they don't carry pollen. Meanwhile, *Apis mellifera* (*Hymenoptera*) is reported to act as a potential pollinator of *O. militaris* orchid flowers (Henneresse & Tyteca, 2016). Members of the orders *Diptera* and *Hymenoptera* are also reported to be insect visitors to the *Dactylorhiza majalis* orchid in North-Eastern Poland. *Apis mellifera* was also found in the study and included the pollinator of *D. majalis*. This insect plays a role in the pollination process in several plants so it is not a specific pollinator for the *D. majalis* (Russo, 2016; Ostrowiecka et al., 2019).

The Menoreh Hills Biosphere Reserve must be preserved by preserving the diversity within it. The diversity of insect visitors of the *A. liliifolia* in Kalurahan Purwosari needs to be inventoried as initial data for further conservation efforts that can be carried out by the community. In this research, data were collected on the diversity of insect species visiting the *A. liliifolia* orchid and their role during visiting the orchid. It is hoped that this research will be able to obtain the names of insect visitor species and predictions of pollinators of the *A. liliifolia*.

MATERIALS AND METHODS

Site surveys were conducted on 24 September 2023 in the Ayunan Langit area, Sabrangkidul, Kalurahan Purwosari, Girimulyo, Kulon Progo, Special Region of Yogyakarta (Figure 1). The research location is agroforestry dominated by calliandra, snake fruit, cloves, and coffee. Data and specimen collection in the field was carried out four times when the orchids were flowering, between

September to October 2023. The orchids were attached to host plants called calliandra, clove, coffee, and sengon at a height of fewer than two meters above the ground. Identification of insect types was carried out at the Entomology Laboratory, Faculty of Biology, Gadjah Mada University.

Figure 1. Sampling point of the orchid. Al= *Acriopsis liliifolia* location

In this study, the equipment used was an HTC-1 thermohygrometer, Canon EOS M50 camera, 10 mL flask, Olympus stereo microscope, OptiLab, brush, petri dish, pin, styrofoam, simple oven, and buffalo paper. The materials used were the insect visitor of *A. liliifolia* orchid, the *A. liliifolia* orchid, and 70% alcohol.

Insect Data and Specimen Collection

At this step, data on insect visitors and the temperature and humidity at the research location were collected. The HTC-1 thermohygrometer was installed on a tree at a height of about one meter from the ground. Insect collection was carried out directly with manual technique. Collection using a brush was done by sweeping the brush over the insects to put them in a flask bottle containing 5 mL of 70% alcohol. Observations and collections of insect visitors were carried out in the morning (08:00–10:00 WIB), noon (12:00–14:00 WIB), and afternoon (15:00–16:00 WIB). The number of *A. liliifolia* orchid clusters was 10 clusters scattered over calliandra, clove, coffee, and sengon plants.

Preservation and Insect Species Identification

The collected insect visitors were then taken to the Entomology Laboratory, Faculty of Biology, Gadjah Mada University for preservation and identification. Insects were brought to the laboratory by storing them wet in 70% alcohol (Sukmawati et al., 2019). Before being identified, the insect specimens collected were preserved and stored in the insectarium. Insects were pinned to styrofoam using a needle and triangular-shaped buffalo paper measuring 8 mm long and 3 mm wide at the base. Then the insect was glued to the top end of the paper (Triplehorn et al., 2005). Next, the insect specimens were dried in a simple oven for 3 days at a temperature of 30.4 °C. The identification process was done by photographing insect specimens using a microscope and OptiLab. Identification was based on the morphological characteristics of visiting insects up to the species level or at least the family level. Pollinator insects were defined based on body modifications to carry pollen and nectar (Triplehorn et al., 2005). The identification step was carried out referring to the insect identification book Borror and Delong's *Introduction to the Study of Insects* (Triplehorn et al., 2005) up to the family level and identification journals up to the species level.

Data Analysis

Data analysis of morphological characteristics of insect species was carried out descriptively with key determinations following Triplehorn et al. (2005) and identification journals. Typical morphological parts of insects were described to determine the name of the insect species. The parts of the *A. liliifolia* orchid that were visited by insects were also described as the organs and insects based on references. Analysis of determining pollinator insects based on body modifications to carry pollen and nectar, and insect behavior when visiting orchids (Triplehorn et al., 2005). The results of the morphological character analysis were presented in the form of a table of insect species diversity. Data on humidity and temperature at the study location were presented in the form of a Table of average temperature and humidity.

The diversity of insects is calculated by the Shannon-Wiener Index (H') (Fachrul, 2012). $H' = -\sum pi \ln pi$, where H'= Shannon-Wiener diversity index; pi= ni/N; ni= number of individuals within species; N= total number of individuals within species found. Shannon-Wiener diversity index was defined as: $H'<1$= low diversity; $1<H'<3$= moderate diversity; $H'>3$= high diversity.

RESULTS

In this study, 15 species of insect visitors to the *A. liliifolia* orchid were obtained in the Ayunan Langit area, Sabrangkidul, Kalurahan Purwosari, Girimulyo, Kulon Progo. They belong to 5 families, 3 orders which detail information about this insect can be read below.

Order Member's Composition and Identification of Collected Insects

The pie diagram in Figure 2 shows that 86.67% of insect visitors belong to the order *Hymenoptera*, 6.67% of *Hemiptera*, and 6.67% of *Diptera*. Insect visitors are dominated by the order *Hymenoptera*.

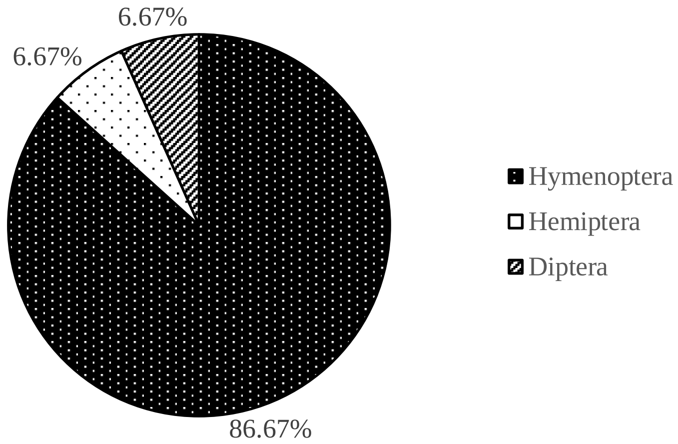

Figure 2. Members composition of insect visitors order to the *Acriopsis liliifolia*

The results of identifying collected insect species on morphological characters are presented in Table 2. There were 13 species of *Hymenoptera*, one species of *Diptera*, and one species of *Hemiptera*. The family *Formicidae* is the family with the most members visiting *A. liliifolia*. Identification of pollinators was based on insect morphology and behavior when visiting orchids. *Brausapis* has a tonguelike for sucking nectar. *Braunsapis* entered the orchid flower and searched for nectar in it. When came out, *Braunsapis* brought pollen on the head as in Figure 3.

Table 2. Insect visitors of *Acriopsis liliifolia* in Ayunan Langit, Sabrangkidul, Kalurahan Purwosari

Order	Family	Species	Character	Number
Diptera	*Celyphidae*	*Spaniocelyphus* sp.	Convex scutellum covers the abdomen. Antennal arista is setaceous or flattened like a leaf at its base (Kirk-Spriggs & Sinclair, 2021).	1
Hemiptera	*Cicadellidae*	-	The hind tibia has one or more rows of small spines (Triplehorn et al., 2005).	1

Order	Family	Species	Character	Number
Hymenoptera	*Apidae*	*Braunsapis hewitti*	Clypeus has a yellow marking shape and the mandible is black with a yellow stain (Reyes, 1991; Reyes & Michener, 1990).	2
		Braunsapis mixta	Clypeus has a yellow marking shape (the central curve of the pattern is not too deep and the lower part of the pattern has relatively flat/straight edges) (Reyes, 1991).	2
		Braunsapis picitarsis	The anterior part of the head (clypeus and paraocular) has an ivory-shaped marked. The mandible is yellow (Reyes, 1991).	2
	Eurytomidae	*Eurytoma imminuta*	The antennal scape is black with yellow at the base or anterior surface. Metasome is small and oval. The ovipositor is parallel to the horizontal axis (Zhang et al., 2017).	1
	Formicidae	*Crematogaster* sp1	Postpetiole attached to the upper surface of the gaster. Gaster is heart-shaped when viewed from above (Nazarreta et al., 2021). The leg is black with a lighter trochanter.	4
		Crematogaster sp2	Postpetiole attached to the upper surface of the gaster. Gaster is heart-shaped when viewed from above (Nazarreta et al., 2021). The leg is brown with a lighter trochanter. The mesosome is brown and the same as the leg color.	2
		Crematogaster sp3	Postpetiole attached to the upper surface of the gaster. Gaster is heart-shaped when viewed from above (Nazarreta et al., 2021). The leg is paler/lighter than the mesosoma.	9
		Crematogaster sp4	Postpetiole attached to the upper surface of the gaster. Gaster is heart-shaped when viewed from above (Nazarreta et al., 2021). The leg is brown with a lighter trochanter. The mesosome is darker than the leg.	1
		Crematogaster sp5	Postpetiole attached to the upper surface of the gaster. Gaster is heart-shaped when viewed from above (Nazarreta et al., 2021). The leg is brown with a lighter trochanter.	24
		Myrmicaria arachnoides	Antennae consist of 7 segments. No antennal scribe below the eyes. The first funicular segment of the antenna is longer than the length of the eye. The propodeum is elevated to form a dome (Nazarreta et al., 2021; Yahya et al., 2009).	1
		Paraparatrechina dichroa	The pronotum has two pairs of setae, one pair of mesonotum setae, and one pair of propodeum erect setae. The head, mesosome, and metasome are brown on the dorsal side and white on the ventral side (Nazarreta et al., 2021; Williams & Lapolla, 2016).	1
		Paraparatrechina glabra	The pronotum has two pairs of setae, one pair of mesonotum setae, and one pair of propodeum erect setae. Mesosome elongated with a length of 0.4–0.6 mm. Propodeum short-angled. Scape length is <0.6 mm (Lapolla et al., 2010; Nazarreta et al., 2021; Williams & Lapolla, 2016).	1
		Tetramorium insolens	There is an antennal scribe above the eye. Antennae consist of 12 segments. Dorsal mesosomal hairs are sparse. Gaster is lighter in color than the head and mesosome (Bolton, 1979; Nazarreta et al., 2021).	1
Total				53

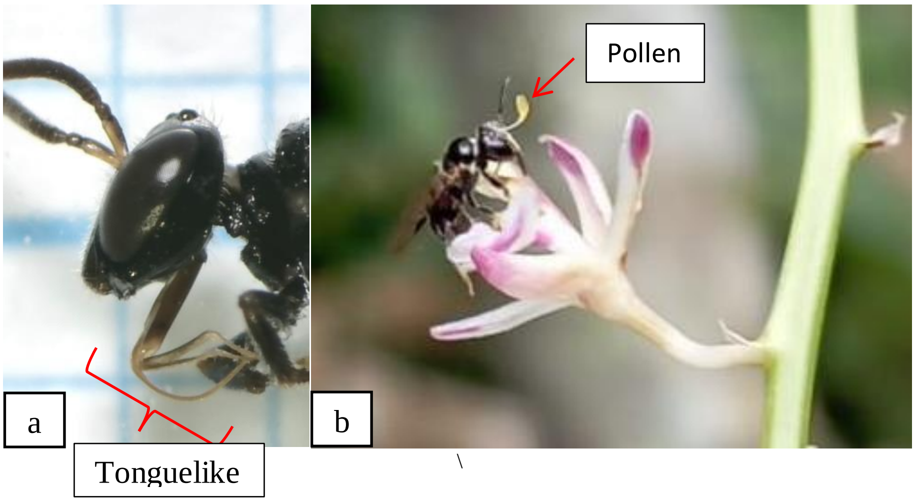

Figure 3. *Braunsapis* as a predicted pollinator of *Acriopsis liliifolia*. Mouthpart of *Braunsapis* (Apidae) (a) and *Braunsapis* visiting *A. liliifolia* with bringing pollen (b)

Parts of the *Acriopsis liliifolia* and the Role of Insects

Parts of orchid flowers, including the inner flowers and flower stalks, are plant parts often visited by insects. Table 3 shows the role of insects based on the literature. It was found that 73.33% of the total insect species act as herbivores, 20% act as carnivores, and the role of the rest is unknown. The pollinator role of *A. liliifolia* is determined based on the insect's behavior and morphological characteristics. Insects visiting the inner flowers are members of the order *Hymenoptera*, namely *Braunsapis*. *Braunsapis* has a maxilla and labium shaped tonguelike which is used to suck nectar. Based on this behavior and character (Figure 3), *Braunsapis picitarsis*, *Braunsapis hewitti*, and *Braunsapis mixta* are predicted to be pollinators of the *A. liliifolia* orchid.

Table 3. Parts of orchid plants and the role of insects based on research (orchid plant part) and literature (role)

Species/family	Orchid plant part	Role	References
Braunsapis picitarsis	Inner flower	Cashew pollinator	Vanitha and Raviprasad (2019)
Braunsapis hewitti	Inner flower	Mango pollinators in Southern Taiwan	Sung et al. (2006)
Braunsapis mixta	Inner flower	Cashew important pollinator	Vanitha et al. (2023)
Crematogaster sp1	Flower stalk, leaf	Thrips or mites predators on cashew, nectar forager	Nair (2010) and Sanfiorenzo et al. (2018)
Crematogaster sp2	Flower stalk	Thrips or mites predators on cashew, nectar forager	Nair (2010) and Sanfiorenzo et al. (2018)
Crematogaster sp3	Pseudobulb, leaf, root, flower stalk	Thrips or mites predators on cashew, nectar forager	Nair (2010) and Sanfiorenzo et al. (2018)
Crematogaster sp4	Leaf	Thrips or mites predators on cashew, nectar forager	Nair (2010) and Sanfiorenzo et al. (2018)
Crematogaster sp5	Flower stalk	Thrips or mites predators on cashew, nectar forager	Nair (2010) and Sanfiorenzo et al. (2018)
Myrmicaria arachnoides	Pseudobulb	Predator of other insects	Gathalkar and Barsagade (2018)
Eurytoma immunity	Flower stalk	Gall-forming insect parasitoid on plants	Earley et al. (2023)
Paraparatrechina glabra	Leaf	Predator of small invertebrate	Lampasona (2015)
Paraparatrechina dichroa	Pseudobulb, leaf, root, flower stalk	Generalist feeder	Kreider et al. (2021)
Tetramorium insolens	Pseudobulb	*Aeranthes arachnites* nectar forager	Roberts and McGlynn (2004)
Spaniocelyphus sp.	Leaf	Not yet unknown	-
Cicadellidae	Leaf	Herbivore	Triplehorn et al. (2005)

The presence of insects in a habitat is influenced by air temperature and humidity. The study result in Table 4 shows that the air temperature ranges between 24.4–37.1 °C and humidity 46.0–84.0%. This temperature range is by the literature that insects have a tolerance range for environmental temperature between 15–45 °C with an optimum temperature of 25 °C. The environmental temperature at the research location has an average of 27.5 °C so the insects can grow normally. Air humidity is also an important factor in insect life. Insects grow optimum in the range of 70–100%. In this study, the air humidity has an average of 71.2% indicating insect life optimally.

Table 4. Air temperature and humidity average at the research location

Day	Time (WIB)	Air temperature average (°C)	Air humidity average (%)
1	08:00–10:00	27.9 ± 0.8	61.0 ± 3.6
	12:00–14:00	27.6 ± 0.5	67.3 ± 1.9
	15:00–16:00	27.0 ± 1.6	64.5 ± 3.5
2	08:00–10:00	26.3 ± 2.0	78.0 ± 7.7
	12:00–14:00	27.3 ± 0.6	76.5 ± 7.0
	15:00–16:00	25.2 ± 0.5	80.4 ± 1.5
3	08:00–10:00	24.4 ± 0.0	84.0 ± 0.0
	12:00–14:00	26.1 ± 0.6	79.5 ± 3.5
	15:00–16:00	24.5 ± 0.0	81.0 ± 0.0
4	08:00–10:00	28.6 ± 0.6	62.0 ± 2.9
	12:00–14:00	37.1 ± 0.0	46.0 ± 0.0
	15:00–16:00	27.3 ± 0.0	74.0 ± 0.0

DISCUSSION

Order Member's Composition and Identification of Collected Insects

The research was conducted in the Ayunan Langit area, Sabrangkidul, Kalurahan Purwosari, Girimulyo, Kulon Progo at the location where orchids attached to host plants called calliandra, cloves, coffee, and sengon. Based on the research results, one family member and 14 species of insect visitors were obtained on the natural orchid *A. liliifolia* (Table 2). Insect diversity in Ayunan Langit is 1.95. The diversity index is considered moderate diversity as 1<H'<3. These insect visitors belong to the order *Hymenoptera*, *Hemiptera*, and *Diptera*. *Hymenoptera* is the largest number of insect visitors to the *A. liliifolia* orchid compared to other orders. This is because *Hymenoptera* has diverse behaviors and roles in the ecosystems (Triplehorn et al., 2005). This diverse role causes *Hymenoptera* members to occupy different food-based niches in the *A. liliifolia*, as seen from the diversity of the insect's mouthparts.

Table 2 shows that the family *Formicidae* has the greatest diversity of types and numbers. This is because the *Formicidae* is the most abundant and diverse insect living on earth (Holldobler & Wilson, 1990). Apart from that, the diversity of plants at the study location also supports the diversity of ants at that location (Li et al., 2017). The plants at the research location are diverse because the research location is agroforestry where the forest is processed by residents into agricultural land, for example, to grow snake fruit, calliandra, and coffee. This diversity of plants is likely to make the ant population tend to be stable or increase because of the many and varied food sources. Ants function as bioindicators of environmental conditions, which means the environment in Ayunan Langit is still relatively good and optimally used as a habitat for living creatures (Ariani et al., 2021). The Genus *Crematogaster* is the genus with the most species diversity. Members of this genus often visit the base of the flower to search for nectar there. *Crematogaster*'s behavior causes this genus to frequently visit *A. liliifolia*. No thrips or mites were found either on the orchid or in the surrounding environment, so it is predicted that *Crematogaster* only looks for nectar in the orchid.

Based on Henneresse and Tyteca (2016), the majority of insect visitors of the *Orchis militaris* orchid come from the order *Diptera* (50%) and *Hymenoptera* (32%). Meanwhile, in this study, order *Diptera* member was only found in one species of insect, namely *Spaniocelyphus* sp. This is because *Diptera*'s food preference is liquid and not parts of the *A. liliifolia* orchid. *Spaniocelyphus* has a lapping mouthpart and probably only visited orchids without looking for food there. Member of the order *Hemiptera* (*Cicadellidae*) was also found in only one species on orchid leaves, possibly because their food is not *A. liliifolia*. Hemiptera were found in the snake fruit gardens with the distance between the orchids and the ground being 1 meter. Predicted that *Hemiptera* only visited the orchid temporary time.

In this study, no members of the order *Coleoptera* and *Lepidoptera* were found, which are also reported to be insect visitors to orchids; members of order *Diptera* visited the *Catasetum integerrimum* (Rosas-Mejía et al., 2020) and members of order *Lepidoptera* visited the *Dendrophylax lindenii* (Houlihan et al., 2019). This is because the flower color tendency that is attractive to the two members of this order is not shared by *A. liliifolia*. Members of the order *Coleoptera* are attracted to the color of white-yellow flowers, while members of the order *Lepidoptera* are attracted to the pink color (Reverté et al., 2016). This interest is why members of these two orders do not visit the white and purple *A. liliifolia* orchid. Apart from that, *Lepidoptera* has a relatively long proboscis that is not suitable to suck nectar from *A. liliifolia* in shallow places.

Parts of the *Acriopsis liliifolia* and the Role of Insects

Based on the result in Table 3, insect visitors of *A. liliifolia* are divided into herbivores (73.33%), carnivores (20%), and unknown roles (6.67%). Herbivores have the highest diversity because their food source can be obtained from *A. liliifolia*, both from the vegetative and generative parts. The order *Hymenoptera* (Genus *Braunsapis*) visited the interior of flowers. It was reported that *Braunsapis* also visited members of the family *Asteraceae*, namely *Helianthus annuus*. While collecting pollen and/or nectar, *Braunsapis* sp. made contact with the stigma and anther thereby increasing the possibility of pollination (Esaie et al., 2018). *Braunsapis* in this study was probably looking for nectar because it entered the flower and stuck out its tongue. Apart from that, this genus is predicted to act as a pollinator of *A. liliifolia* because it can take pollen from these flowers.

According to Anonymous (2023), *A. liliifolia* flowers can last for two to four days and are pollinated by small bees. This pollination is carried out by moving pollinia measuring 0.07 × 0.02–0.03 cm into the elliptical stigma cavity (Huda et al., 2022). Based on the structure of orchid flowers where the pollinia and stigma cavity are blocked by the rostellum and the small size of the pollinia and stigma cavity, the process of pollination by humans or wind is difficult to occur, so it is predicted that the insect is a pollinator of the *A. liliifolia*. In this study, *Braunsapis* is probably a pollinator of *A. liliifolia*. *Braunsapis* took nectar from pseudospura, then accidentally hit the sticky viscidium so that the pollinaria stuck to the anterior part of the insect's head. Next, *Braunsapis* visited another *A. liliifolia* flower to collect nectar, but the pollinia got stuck in the stigma cavity. Other parts of the pollinaria, namely viscidium, and stipe, were still left on *Braunsapis*' head. Therefore, it is possible that pollination of *A. liliifolia* by *Braunsapis* insects occurred due to an accident.

Genus *Crematogaster* often visited the base of the flowers. *Crematogaster* is a generalist insect whose dominant food is sweet liquid (Moumite et al., 2022). This genus is also reported to be a predator of thrips or mites on cashew plants (Nair, 2010). Genus *Crematogaster* was predicted to act as herbivores, possibly looking for sweet liquids (nectar) at the base of the orchid flowers observed (Sanfiorenzo et al., 2018). *Myrmicaria arachnoides* was found in the pseudobulb and was probably looking for food from other insects (acting as a predator) and protecting the orchid from herbivores (Gathalkar & Barsagade, 2018). *Paraparatrechina glabra* was found on the leaves and was probably looking for food in the form of small invertebrates in this area (Lampasona, 2015). *Paraparatrechina dichroa* was found while walking in all parts of the orchid and was probably looking for food in the form of nectar or other insects because it was a generalist forager (Kreider et al., 2021). *Tetramorium insolens* was found in the pseudobulb and may be traveling toward flowers to search for nectar (Roberts & McGlynn, 2004). *Eurytoma imminuta* were collected from the flower stalks of *A. liliifolia*. Based on Earley et al. (2023), this insect acts as a parasitoid of gall-forming insects on plants. When collected, *E. imminuta* probably only visited the orchids without carrying out this role. The role of *Spaniocelyphus* sp. in leaves, when collected, was unknown due to limited supporting literature. *Cicadellidae* was found on the leaves and may act as herbivores, which can be seen from the piercing-sucking mouthpart type for sucking plant fluids (Triplehorn et al., 2005).

During their life and carrying out their roles, insects are influenced by environmental factors, for example air temperature and humidity. Insects are poikilothermic organisms so body temperature is influenced by environmental temperature (Hasyimuddin et al., 2021). If the environmental temperature decreases, the insect's body temperature will decrease and physiological processes will slow down, and vice versa (Triplehorn et al., 2005). An increase in air temperature causes an increase in the rate of water loss from the bee's body at the same humidity (Li et al., 2019). This is a form of adaptation to the environment so that the insect's physiological is maintained. The research results in Table 4 show that changes in air temperature and humidity do not occur significantly with an average air temperature of 27.2 °C and air humidity of 71.1% so temperature adjustments by insects may not occur significantly and tend to be stable. During their activities, insects have a tolerance range for environmental temperature, namely 15–45 °C with an optimum temperature of 25 °C (Jumar, 2000).

Several studies have shown the temperature tolerance of insect species belonging to members of the family *Apidae*, *Formicidae*, and *Cicadellidae*, while references for temperature-tolerant members of the family *Celyphidae* have not been found. *Apidae* members forage at an average temperature range of 25.8–32.3 °C for *Bombus terrestris* L. (Kwon & Saeed, 2003), temperature of 17–24 °C for *Melipona subnitida* Ducke, and temperature of 12–24 °C for *Melipona quadrifasciata* (Maia-Silva et al., 2014). Members of *Formicidae* (*Solenopsis invicta*) forage at an average temperature of 19.57–41.05 °C (Lei et al., 2021). In this study, *Formicidae* members were found at a temperature range of 24.4–28.0 °C. Members of the *Cicadellidae* (*Dalbulus maids*) are tolerant of living at temperatures of 17.5–35 °C (Nieuwenhove et al., 2016). Members of *Cicadellidae* (*Matsumuratettix hieroglyphics*) grow optimally at a temperature of 27 °C (Kobori & Hanboonsong, 2017). This tolerant temperature shows that the temperature range at the research location supports the life of insects belonging to the *Apidae*, *Formicidae*, and *Cicadellidae*. Temperature is not the main determinant of insect diversity because based on temperature references for several members of the family, the temperature tolerances overlap and are not specific to certain family members. The temperature at the study location is suitable for insect growth.

Apart from temperature, air humidity is also an important factor in insect life. Insects can grow optimum in the humidity range of 70–100% (Wardani, 2015). Research by Li et al. (2019) showed that the survival rate of *Apis mellifera* and *Apis cerana* bees was more influenced by temperature than air humidity. The research data in Table 4 provides information on the relationship between air humidity and temperature. If the temperature decreases, air humidity increases, and vice versa. High air humidity may be related to high temperatures. At relatively high temperatures, high humidity can suppress water loss in bees. This causes the bee's body temperature to not be reduced effectively, resulting in a risk to its body (Li et al., 2019). The average air humidity at the research location is 71.2% and the temperature is 27.5 °C. The air temperature and humidity are considered optimum so that the relationship between the two parameters does not cause damage to the insect's body which has negative impacts. Based on the result of Li et al. (2019) and related to this study result, when the temperature increases, the air humidity decreases so that the insects can lower their body temperature effectively and not cause damage to their bodies.

CONCLUSION

This research concludes that 15 species of insect visitors of the *A. liliifolia* orchid have been identified based on morphology and references. The diversity of insect visitor species is quite large. As many as 73.33% of insect species act as herbivores, 20% act as carnivores, and the role of 6.67% is unknown. Genus *Braunsapis* is predicted to be the pollinator of *A. liliifolia* based on behavior, mouthpart shape, and literature. This study should be continued to ensure that *Braunsapis* as pollinators of the *A. liliifolia* so then we can conserve them optimally.

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