

# *Syzygium myrtifolium* Walp. flowering stages and its visitor insects

DEDEN MUDIANA<sup>✉</sup>, ESTI E. ARIYANTI<sup>✉✉</sup>

Purwodadi Botanic Garden, Research Center of Plant Conservation and Botanical Gardens, Indonesian Institute of Sciences.  
Jl. Raya Surabaya-Malang Km 65, Purwodadi, Pasuruan 67163, East Java, Indonesia. ✉email: dmudiana@yahoo.com, ✉✉estimudiana@yahoo.com

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**Abstract.** Mudiana D, Ariyanti EE. 2021. *Syzygium myrtifolium* Walp. flowering stages and its visitor insects. *Biodiversitas* 22: 3489-3496. "Pucuk merah" or Red lip (*Syzygium myrtifolium* Walp.) is widely known as an ornamental plant used as garden components. This species belongs to the Myrtaceae family with the scientific name *Syzygium myrtifolium* Walp. This paper specifically aimed to observe the stages of flowering and visiting insects of *S. myrtifolium*, while the determination of insects as pollinators was not carried out in this study, and was intended merely to make a species list of visiting insects, without counting the number of individuals and the times of their visits. These are done by examining two individual trees of *S. myrtifolium* (which have flowered and fruited several times) during its flowering season, recording all visible flower developments and the visitor insects. The visitor insects were observed during flower bloom. The results showed ten stages of flowering process in *S. myrtifolium* starting from emerging flower buds until fruits ripened, which took 105-124 days. Twelve species of insects were recorded visiting flowers of *S. myrtifolium* during full blooming period, namely *Euploea core*, *Hypolimnas bolina*, *Telicota colon*, *Eurema hecabe*, *Rapala pheretima*, *Apis cerana*, *Apis mellifera*, *Trigona* sp., *Dysphania sagana*, *Amata trigonophora*, *Chrysomya megacephala*, *Lucilia caesar*. They belong to three orders, i.e. Diptera, Hymenoptera and Lepidoptera; and eight families, namely Calliphoridae, Apidae, Hesperidae, Nymphalidae, Lycaenidae, Geometridae, Erebidae, and Pieridae.

**Keywords:** Flowering stages, pollinators, pucuk merah, *Syzygium myrtifolium*

## INTRODUCTION

The genus *Syzygium* Gaertn. is considered to be one of the largest genera of flowering plants. This genus has a fairly wide distribution covering tropical and subtropical regions including South Africa, South America, Southeast Asia and Australia (Badou et al. 2020), whereas *S. myrtifolium* is native to Bangladesh, Borneo, Jawa, Malaya, Myanmar, Philippines, Sumatera, Thailand (POWO 2019).

*Syzygium myrtifolium* Walp. which is known as "pucuk merah" or red lip, kelat oil, is a species of the Myrtaceae family that is widely recognized as an ornamental plant. It has several synonyms, i.e.: *Eugenia oleina* Wight, *Eugenia parva* C.B.Rob., *Eugenia sinubanensis* Elmer, *Syzygium campanellum* Miq., *Syzygium campanulatum* Korth., *Syzygium campanulatum* var. *longistylum* Chantar. & J.Parn., *Syzygium sinubanense* (Elmer) Diels (POWO 2019). Generally, the *Syzygium* genus is used and known as a fruit-producing plant, medicinal raw material and essential oil plant. As fruit-producing plants, several *Syzygium* species are widely known such as wax apple or jambu Semarang (*Syzygium samarangense*), water apple or jambu air (*Syzygium aqueum*), kopo or kupa (*Syzygium polycephalum*) and Malay apple or jambu darsono/jambu bol (*Syzygium malaccense*); meanwhile, as a producer of medicinal raw materials and essential oils which are commonly known, such as cloves (*Syzygium aromaticum*), bay or salam leaves (*Syzygium polyanthum*), and java pulm or juwet/jamblang (*Syzygium cumini*). For use as an ornamental plant, the presence of "pucuk merah" (*Syzygium myrtifolium*) is an interesting phenomenon. Its

presence and widespread use show that the community accepts this species to meet the needs of ornamental plants. Efendi et al. (2017) stated that in Cibodas Botanical Garden, this species was introduced to the community as an ornamental plant in environmental education activities for botanical garden visitors. At present, this species is used in many places as a component in gardens and roadside plants (Agus et al. 2015). Some of the things that might cause this were: an attractive red color on young leaves, the size of the plant habit (short shrubs) therefore it was easy to prune and arrange, easy to propagate and provide seeds, and adaptive in various habitat conditions, moreover it has abundant flowers. This condition inadvertently also provides ecosystem services for pollinating insects that visit their flowers. These pollinating insects are very important for the survival of plants and will ultimately be useful for human life.

Therefore, information about the insect pollinator *Syzygium myrtifolium* is expected to be useful for the sustainable use of this plant. However, research on its pollinators and flowering development has never been done before. Most of the research on this species had been carried out regarding its potential as traditional medicine, including antimutagenic effect activities (Lingga et al. 2018), antioxidants (Santoni et al. 2013, Purnomo and Yuliati 2020, Angraini 2017), antidiabetic (Hasti et al. 2016), burn medication (Indriani et al. 2020), antibacterial (Haryati et al. 2015), anti-hyperuricemia (Juwita et al. 2017), potential as a natural hand sanitizer (Putri et al. 2020), and potential for food coloring agents (Syahri 2012).

Meanwhile, Sulisty (2017) examined this species as a noise reduction in horticultural plant systems.

Utilization of *S. myrtifolium* which is quite extensive as an ornamental plant and its potential to provide ecosystem services as a source of insect food can help maintain a mutually beneficial relationship between pollinators and plants. To support this, it is necessary to know the character of the *S. myrtifolium* flower and the species of pollinators. This paper specifically aimed to observe the stages of flowering and visiting insects of *S. myrtifolium*, while the determination of insects as pollinators was not carried out in this study.

## MATERIALS AND METHODS

### Study area

The research was conducted in May-June 2019 and March 2020 which coincided with the flowering season of *S. myrtifolium*. Two individual trees which were about 3 meters high and 1 m wide canopy and have flowered and fruited several times, were observed. The research location was in Lawang, Malang District, East Java, Indonesia. The used equipment included a camera to take pictures/photos of flowers and visitor insects; stationery, and the *S. myrtifolium* tree, which has been regularly flowering.

### Procedures

Observation of the morphology of flowers is carried out by observing, measuring and documenting the morphological characters of flowers. Flowering stages were observed started from the appearance of flower buds until the fruits were all ripe. Each change in flowering stage was documented and the duration of each stage was recorded. The flower samples were taken during the blooming phase, then the morphological characters were observed and recorded. The inflorescence that has the most complete condition (not falling) and can represent the overall characters of the inflorescence was taken and observed. The observed morphological characters of the flowers were i.e.: the number of flowers per inflorescence, the length of the pedicel (flower stalk), the number and the size of tepals (modification from Dewi et al. 2015), tepal color, stamen number and size, pistil number and size, fruit size and shape, seed number and size. The plant habit and the type of inflorescence were also examined.

Observations of insect visitors to the *S. myrtifolium* flower were carried out during the full blooming period. Observations were made in the morning at around 08.00-11.00 am, which was the time when the most insects visited. Photo documentation was carried out mainly for each different insect that visits the flower. This was intended merely to make a list of the insect species that visited flowers, without counting the number of individuals and the times of their visits. Each different species of insect that visited the flower was photographed and recorded and then the species was identified using various literature sources by comparing the images taken to the mixture of

documentation, identification key and insect photos from literature.

## RESULTS AND DISCUSSION

### Morphological characters

*Syzygium myrtifolium* is a shrub or small tree, leaves narrowly lanceolate to ovate-lanceolate, base narrowed into petiole, apex acuminate, young leaves are red later turn into reddish-green then green. Flower perianths were white and indistinguishable between the sepals and the petals so they were called tepals, forming a calyptra with 2 mm wide, slightly flat in shape. In this study, all observed morphological characters were shown in Table 1, while the appearance of habit, flowers, inflorescence diagrams, fruit, and seeds was shown in Figure 1. These morphological characters are features of *S. myrtifolium* which are easy to observe and recognize in the field, considering the small size of the flowers. One of the characters that can be used for identification is the flower.

### Flower development of *S. myrtifolium*

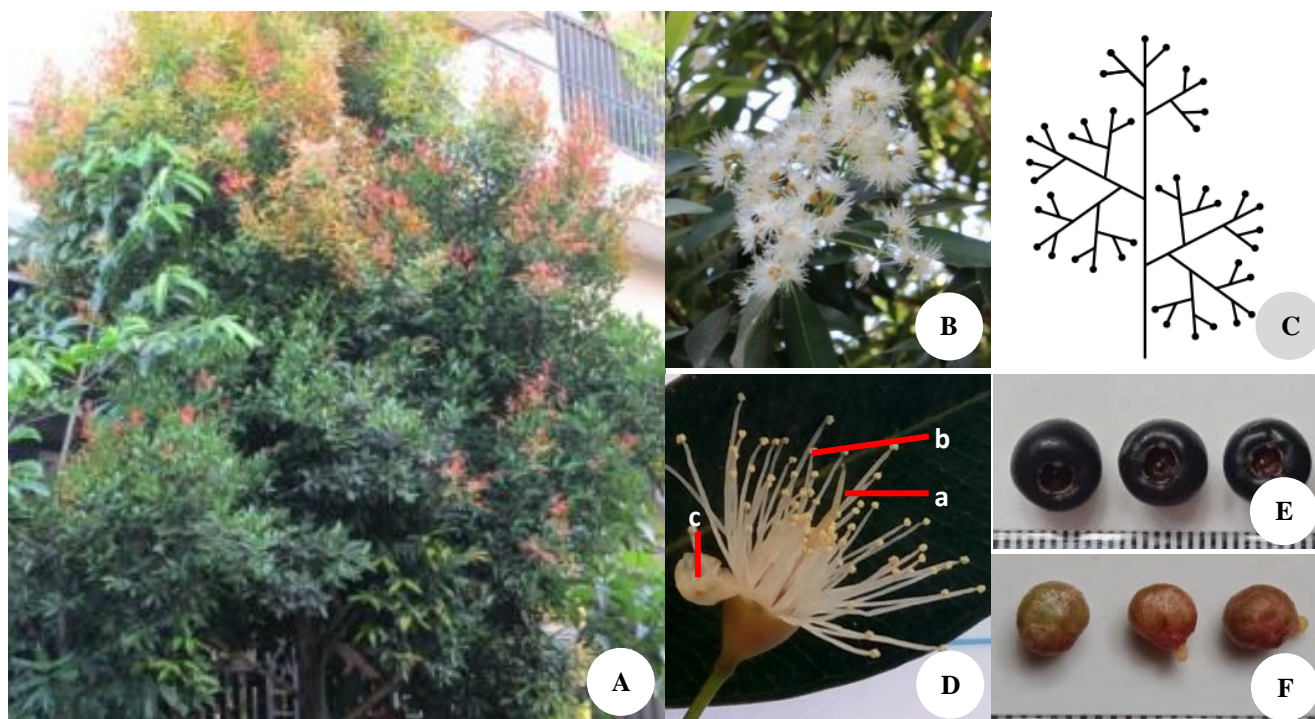
As many as ten flowering stages of *S. myrtifolium* were noted and presented in Table 2.

### Visitor insects of *S. myrtifolium*

Twelve species of insects were recorded visiting flowers of *S. myrtifolium* during full blooming period, they were shown in Table 3 and Figure 2.

**Table 1.** The results of observations of the morphological characters of *Syzygium myrtifolium*.

Morphological character	Observation result
Plant height	0.75-3 m
Inflorescence type	panicle
Inflorescence length	3.5-8 cm
Number of flowers on each inflorescence	5-24
Pedicel length	4 mm
The number tepal	1
Tepal color	white
Tepal size	± 4 mm
The number of stamens	numerous
Stamen length	4-5 mm
The number of pistils	1
Pistil length	± 4 mm
Fruit shape	globose
Fruit diameter	6-8 mm
The number of seeds	1
Seed diameter	3-4 mm
Fruit color when young	green
Fruit color when ripe	dark purple to black



**Figure 1.** Morphology of *Syzygium myrtifolium*: A. Habit-a small tree with red young leaves, B. Inflorescence, C. Sketch of inflorescence type panicle (Endress 2010), D. Flower: a. Stamen, b. Pistil, c. Tepal, E. Fruits, F. Seeds










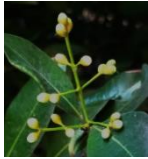










## Discussion

The common name of *S. myrtifolium* in Indonesia is "pucuk merah" which means red shoots referred to the red young leaves (Figure 1.A). In general, the flower parts of *S. myrtifolium* consist of stamens, pistils, and tepals, as shown in Figure 1.D. Tepal is actually a flower perianth that cannot be distinguished between calyx and corolla (Meyer 2005). Therefore, the flower characters, namely inflorescence type, flower size, the color of the flowers and the shape of perianths, can be used to identify this species. In addition, the character of the fruit, especially the size, shape, color and number of seeds in the fruit are also character traits (Figure 1.E-F). The type of inflorescences on *S. myrtifolium* is panicle, which is an inflorescence in which the main peduncle is branched and the branches branch again; the whole often looks like a pyramid or cone shape (Figure 1.B-C). The sketch of inflorescence type was taken from Endress (2010) who worked on inflorescence morphology.

The flowering phase in *S. myrtifolium* as shown in Table 2, can be divided at least into 10 stages which lasted for 105-124 days, starting from the emergence of flower buds, extending peduncles, elongated inflorescences, enlarging flower buds, showy perianths, flowers started blooming, flowers perfectly blooming, enlarging ovules, fruit formation and fruit ripening. Stage 1 began with the emergence of potential flower buds on the twigs (no. 1). It

took about 14 days to enter the second stage, when the stalk began to elongate and showed a second branching (no. 2). This second stage required 13 days roughly. The next stage was when the inflorescences were longer with more flower buds and the fourth branches were visible (no. 3). This third stage needed around 12 days until the fourth stage happened that was indicated by the enlargement of the flower buds and the peduncles stop elongating (no. 4). This stage took approximately 8 to 12 days. The fifth stage started when the perianths were showy and the flower buds had ovoid shape; this indicated the flower buds were about ready to bloom (no. 5). It took roughly 8 to 17 days. Subsequently, the stage at which several tepals opened, the stamens and pistils became visible, then the flowers started blooming (no. 6), was stage 6 which took 1-3 days. The next was stage 7, marked by the full bloom of flowers, white in color, the stamens and pistils appearing together with the open tepals (no. 7). This stage took about 3 to 4 days. Stage 8 was marked by enlarging ovules, falling stamens and tepals off, and the basic shape of the flowers becoming visible (no. 8). It took around 16-18 days. Stage 9 was indicated by enlarging the flower base and starting to form fruits until young fruits had purplish-green in color as ripened (stage no. 9). This stage occupied 13-14 days. In the last stage, the fruits were completely ripe, black and had round-shape and were already contained seeds (no. 10); this process required 15-17 days.

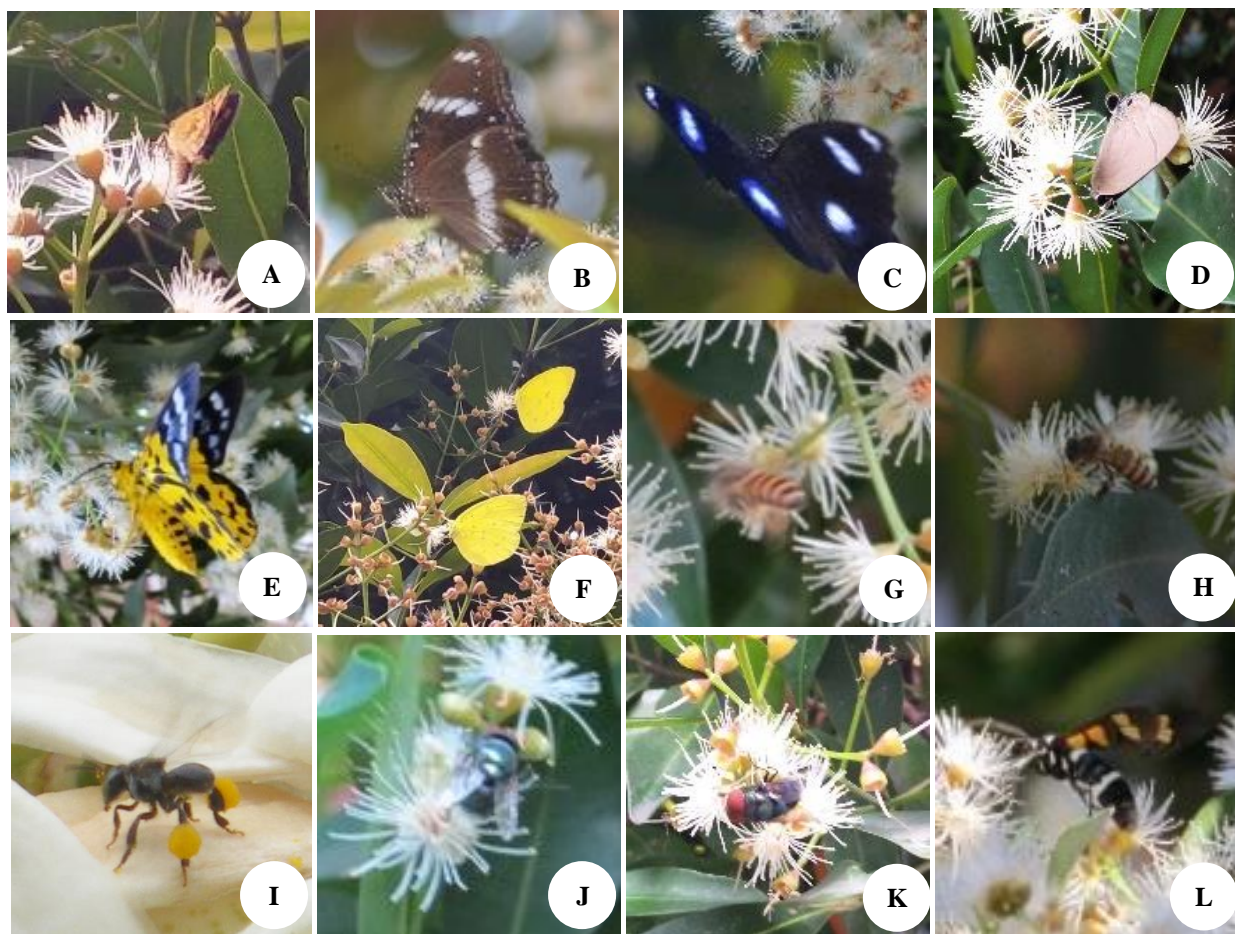
**Table 2.** The flowering stages of *S. myrtifolium*.

Stage no.	Flowering stages	Pictures of developmental stages		Duration (days)
1	Emerging buds: flower buds started to emerge			14
2	Extending peduncles: the peduncles started to extend until showing a second branching			13
3	Elongated inflorescences: The inflorescence was longer with more flower buds. Extension of the peduncle until the fourth branching was visible.			12
4	Enlarging flower buds: the peduncle was not growing longer along the flower buds were enlarged.			8-12
5	Showy perianths: the flower buds began to develop until they were perfectly ovoid in shape, which shows the perianths/tepals; flower buds were ready to bloom.			8-17
6	Flower started blooming: some of the flower buds have bloomed, marked by the opening of some tepals and the appearance of stamens and pistils.			1-3
7	Flower perfectly blooming: The flowers were perfectly blooming and completely open, white, the stamens and pistil appear simultaneously with the open tepals.			3-4
8	Enlarging ovules: tepals and stamens fell off, showing the flower's basic shape, which contained the ovule and pistil at the end part; ovules were started to enlarge.			16-18
9	Fruit formation: the base of the flowers was enlarge more, fruits were starting to form, young fruits had round shape, green, and gradually changed to purplish-green as they ripened.			13-14
10	Fruit ripening: The fruits were completely ripe, black and had round-shape and were already contained seeds.			15-17
Total time needed				105-124



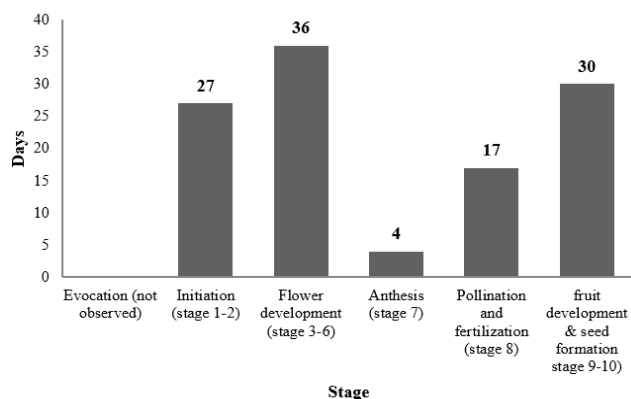
**Table 3.** Visitor insects of *S. myrtifolium* and their classification

Order	Family	Genus	Species	Common name
Diptera	Calliphoridae	<i>Chrysomya</i>	<i>Chrysomya megacephala</i>	Oriental latrine fly
Diptera	Calliphoridae	<i>Lucilia</i>	<i>Lucilia caesar</i>	Blowfly
Hymenoptera	Apidae	<i>Apis</i>	<i>Apis cerana</i>	Eastern honey bee
Hymenoptera	Apidae	<i>Apis</i>	<i>Apis mellifera</i>	Western honey bee
Hymenoptera	Apidae	<i>Trigona</i>	<i>Trigona</i> sp.	Stingless bee
Lepidoptera	Hesperiidae	<i>Telicota</i>	<i>Telicota colon</i>	Common palm-dart butterfly
Lepidoptera	Nymphalidae	<i>Euploea</i>	<i>Euploea core</i>	Common crow butterfly
Lepidoptera	Nymphalidae	<i>Hypolimnas</i>	<i>Hypolimnas bolina</i>	Common egg fly butterfly
Lepidoptera	Lycaenidae	<i>Rapala</i>	<i>Rapala pheretima</i>	Copper flash butterfly
Lepidoptera	Pieridae	<i>Eurema</i>	<i>Eurema hecabe</i>	Common grass yellow butterfly
Lepidoptera	Geometridae	<i>Dysphania</i>	<i>Dysphania sagana</i>	Yellow tiger moth
Lepidoptera	Erebidae	<i>Amata</i>	<i>Amata trigonophora</i>	Tiger moth

**Figure 2.** Visitor insects of *S. myrtifolium*: A. *Telicota colon*; B. *Euploea core*; C. *Hypolimnas bolina*; D. *Rapala pheretima*; E. *Dysphania sagana*; F. *Eurema hecabe*; G. *Apis cerana*; H. *Apis mellifera*; I. *Trigona* sp.; J. *Lucilia caesar*; K. *Chrysomya megacephala*; L. *Amata trigonophora*

The division of this flowering process into 10 stages was made based on the changes that appeared to occur gradually in the flowering process of *S. myrtifolium* during the observations in this study. However, in general, there are six stages of flowering process, namely: (i) evocation or flower induction, whereby events in a shoot meristem was altered in such a way as to produce flowers instead of leaves (Erwin 2005); (ii) flower initiation, was the

formation of flower buds after induction (Erwin 2005); (iii) flower development was the process after flower initiation until anthesis (Erwin 2005); (iv) anthesis, which referred to the release of pollen by the stamen (Erwin 2005); (v) pollination and fertilization. Pollination is the process of transferring pollen to the stigma. Next will be followed by the fertilization process that occurs in the ovary; (vi) fruit development and seed formation.



**Figure 3.** Average time (days) for each flowering stage observed in *S. myrtifolium*

Compared to these general stages, the ten stages of *S. myrtifolium* flowering process can be simplified into at least five stages. Figure 3 showed the average time on each stage of flowering process in *S. myrtifolium* which was simplified based on general flowering development. The first stage was evocation or flower induction, alas this stage was not observed in this study, so it could not be compared. The second stage was flower initiation, in this research showed stage 1 and stage 2, where took around 27 days. The flower development stage was the longest process and was represented by stage 3-6, which needed 36 days on average. Anthesis was denoted by stage 7, was the shortest among the other processes and required only 4 days on average. Pollination and fertilization began at stage 8, which needed more or less 17 days. The last process, fruit development and seed formation, was at stage 9-10, which took about 30 days.

One of the limitations of this study, the flower induction stage was not observed because the timing of this stage cannot be predicted with certainty. It should be observed months before flower buds appear. As Syamsuwida et al. (2012) observed flowering stages of *Melia azedarach* L., they discovered that the flowering induction occurred several months before flower buds appeared. Moreover, flower induction occurred in the cells, so it was necessary to observe by making microscopic preparations.

Several similar studies had been conducted on the same genus, namely *S. pycnanthum* (Mudiana and Ariyanti 2010), *S. guineense* subsp. *macrocarpum* (Badou et al. 2017), *S. hirtum* (Astuti et al. 2021), *S. cumini* (Bajpai et al. 2012), and *S. caryophyllatum* (Gethika and Sabu 2017). They showed different results, *S. pycnanthum* needed 80-89 days to experience the whole process of flowering, *S. guineense* subsp. *macrocarpum* needed 116-128 days, whereas *S. hirtum* needed 95-105 days, *S. cumini* required 186-196 days and *S. caryophyllatum* needed 63-78 days. These differences can be explained by some opinions and research that has been done. In addition to different species (even though in the same genus), flowering is influenced by other factors that are quite complex. The pattern of flowering and all of its processes were considered of combination of all genetic, physiological and morphological characters of certain species. Flowering

performance parameters among others consisted of the process of the emergence of the first flower buds, the process of the first flower appearing, the process until the appearance of 50% flowering, a continuous single flower period, etc; furthermore the factors of time, duration and frequency of flowering established the pattern of flowering (Jain 2011). Additionally, the flowering process is also influenced by external factors such as light, temperature, water, nutrients, microbes, pollinators, etc. (Cho et al. 2017).

The role of pollinators is important for this species since it is propagated one of which by seeds. To produce seeds, it is necessary to have a pollination process carried out by pollinators. Parnell (2003) suggested that most of the stamens in Myrtaceae (including *Syzygium*) had a dual function, namely as a pollen producer and as an attraction for pollinators to help spread and pollinate. Several studies had been conducted to study pollinators in *Syzygium* species, among others were Raju et al. (2014) which studied on *S. alternifolium*, Kuriakose et al. (2018) studied on *S. occidentale*, Hopper (1980) looked on *S. tierneyanum*, Boulter et al. (2005) observed on *S. sayeri*, Djonwangwe et al. (2011) looked on *S. guineense* var. *guineense* specifically, Tarwojto et al. (2019) studied on *S. aqueum* Merah Delima, Hashifah and Lazuardi (2016) studied on visitor insects of *S. samarangense*, Geethika and Sabu (2017) examined pollination of *S. caryophyllatum*, Lack and Kevan (1984) studied on reproductive biology of *S. syzygioides*. Based on those previous researches, some of the known pollinators of *Syzygium* were not only insects but also included: possums, bats and birds. However, this study only looked at visiting insects specifically and it has not been confirmed as pollinators yet since not all flower-visiting insects are pollinators. This can be considered as the other limitation of this study. Boulter et al. (2006) and Komamura et al. (2021) stated that some visitors even when they obtained pollen or nectar from flowers may not contribute as pollinators for some plant species. In other words, research on determining which flower visitors are pollinators requires more detailed observations at least like Komamura et al. (2021) did which were observing visiting frequency, counting the number of pollen grains per body surface, calculating fruit set, and investigating the mean number of seeds per fruit produced after a single visit of each visiting species. Another work also did by Boulter et al. (2006) on determining any animals as pollinators, among others by using trapping methods and video surveillance.

Yet another limitation of this study is the observation time of visiting insects during a day was limited and it maybe gives more results when the time of observation was extended. The reason for the selected time of observation done in this study was that this time was when most insects visited. Actually, there were also random observations during other times and the insects that appeared to visit were relatively the same and not too many in number or variety of species. The time stated here (8-11 am) was the effective observation time which was routinely carried out during the full blooming period.

Myrtaceae species do not have a specific pollination mechanism, but they magnetize a wide variety of flower visitors. Myrtaceae most common visitors are bees, nevertheless, several species of flies have also been reported to visit some Myrtaceae species (Gethika and Sabu 2017). Visitors insects of *S. myrtifolium* in this study is shown in Table 3 and Figure 2. This study recorded twelve insect species visiting *S. myrtifolium* during flowering season, three of them were bees, namely *Apis cerana*, *Apis mellifera* and *Trigona* sp., and two of them were flies, i.e. *Chrysomya megacephala* and *Lucilia caesar*.

Nevertheless, the flower-visiting insects of *S. myrtifolium* are mostly members of the order Lepidoptera (Table 3). Members of Lepidoptera consist of butterflies and moths. In this study, there were five species of butterflies (*Euploea core*, *Hypolimnas bolina*, *Telicota colon*, *Eurema hecabe*, *Rapala pheretima*) and two species of moths (*Dysphania sagana*, *Amata trigonophora*) found visiting flower of *S. myrtifolium* (Table 3, Figure 2). Hooks and Espindola (2020) believed that Lepidoptera was considered as important pollinator of various flowering plants, mainly in the wild as well as managed lands such as parks and yards.

Among 12 species, five of them (i.e. *Apis cerana*, *Apis mellifera*, *Chrysomya megacephala*, *Euploea core* and *Eurema hecabe*) were also noted visiting other *Syzygium*. *Apis cerana* was also noted visiting three other species i.e. *S. caryophyllatum* (Gethika and Sabu 2017), *S. alternifolium* (Raju et al. 2014), and *S. occidentale* (Kuriakose et al. 2018); *Apis mellifera* was also recorded coming to see *S. tierneyanum* (Hopper 1980), *S. guineense* var. *guineense* (Djongwangwe et al. 2011), and *S. sayeri* (Boulter et al. 2005); *Chrysomya megacephala* was also observed visiting *S. alternifolium* (Raju et al. 2014); *Euploea core* was also recorded visiting *S. caryophyllatum* (Gethika and Sabu 2017) and *S. alternifolium* (Raju et al. 2014); whereas *Eurema hecabe* was also noted visiting *S. caryophyllatum* (Gethika and Sabu 2017).

This is influenced by several factors, including the shape of the flowers, color, aroma or the content of compounds such as nectar which attracts visitors, as mentioned by Boulter et al. (2006) that the type of flower display and interesting stimulant affects the type of visitors that may be appealed to perch on the flowers. Furthermore, they added that several research have shown that plant flowering patterns were generally an adaptive response to the availability of proper pollinators.

Finally, the results of this study are expected to fill the information gap for *S. myrtifolium* regarding the development of flowers and insect visitors, so as to be able to develop this species for other potentials (other than as ornamental plants) for example as a service provider for the environment (as a source of feed for pollinating animals, etc.), although the further better approaches in the characterization and identification of this plant and its insect visitors should be conducted.

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