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Species Composition and Stand Structure of Myrtaceae Trees in a Lower Montane Forest at Fraser Hill, Selangor

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ABSTRACT. This research aimed to ascertain the species composition and stand structure of Myrtaceae trees in a lower montane forest at Fraser's Hill, Selangor. A total of nine species and two genera of Myrtaceae from 22 individuals for trees with diameter ≥ 5.0 cm DBH were recorded in the study plot of 0.2 ha. *Syzygium* is the most diverse genus, with eight species, whereas *Rhodamnia* consists of only one species. The tree's DBH range is between 5.0 and 32.0 cm. The density of Myrtaceae is 110 individuals/ha. *Syzygium* is also the densest genus, with 95 individuals/ha, whereas *Syzygium* sp. 12 has the densest species, with 45 individuals/ha. The total basal area for Myrtaceae is 1.74 m^2/ha, while *Syzygium* contributed 95.68 % of the basal area with 1.67 m^2/ha. *Syzygium* sp. 12 contributed the highest basal area of 1.13 m^2/ha (65.12%). *Syzygium oreophium* is an endemic species to Peninsular Malaysia. Another four species, namely *Syzygium griffithii*, *S. rugosum* var. *cordatum*, *S. syzygoides*, and *Syzygium* sp. 12, are considered new records for Fraser Hill.

Key words: Community structure, Fraser Hill, Lower montane forest, Myrtaceae

INTRODUCTION

The tropical rain forest of Peninsular Malaysia, including the upper hill dipterocarp and montane forest, is an important habitat that supports many species of flora, especially the seed plants. Fraser's Hill in Pahang, for example, had recorded more than 1,000 species of seed plants based on studies by Kiew (1998), Latiff et al. (2001) in the lower montane forest, and Ahmad Fitri et al. (2017a) in the upper hill dipterocarp forest. Although ecological studies had been conducted in the area (e.g., Perumal et al., 2001), the study focused on all the trees in the plot and not on certain important families such as Fagaceae, Lauraceae, Myrtaceae, and Theaceae. All these families are among the well-represented families in the montane forest in the Malesian region (van Steenis, 1962).

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Myrtaceae is among the ten largest families in Peninsular Malaysia, with ca. 210 species in nine genera, including 66 of uncertain status (Kochummen, 1978) and one new record of rheophytic species (Ahmad Fitri & Latiff 2016). From the coastal forest to the top of the ericaceous mountain, this family has a wide distribution (Kochummen, 1978; Corner, 1988). Previous studies also documented this family in peat swamps (Ng & Shamsuddin, 2001) and limestone hill forests (Chin, 1977). The genus *Syzygium* is among the biggest genera in the Malesian region (Whitmore, 1984). In addition, many studies in Peninsular Malaysia showed *Syzygium* as the top five biggest genus. For instance, in the primary lowland dipterocarp forests, such as in the 50-ha plot at Pasoh Forest Reserve, Ahmad Fitri et al. (2020a) found that *Syzygium* has recorded the highest number of species with 45 species. Meanwhile, in the upper-hill dipterocarp forest at Temengor Forest Reserve, Perak, Ahmad Fitri (2013) reported *Syzygium* as the most speciose genus with 23 species. Other studies, such as the logged-over lowland dipterocarp forest of Kluang Forest Reserve, Johor (Ahmad Fitri et al. 2019) and the riparian forest of Hulu Sungai Sedili Besar, Johor (part of Ulu Sedili Forest Reserve) (Ahmad Fitri et al. 2020b), also concluded that *Syzygium* is the most speciose genus in their study areas.

The objective of this study is to determine the species composition and stand structure of the Myrtaceae trees with a diameter of ≥ 5.0 cm DBH in a lower montane forest at Fraser's Hill, Selangor. These data are also important to determine the status of Myrtaceae species in the lower montane forest, especially the rare and endemic taxa. The data can also be used for management purposes in the future, especially for the Forestry Department of Selangor.

METHODOLOGY

The study was conducted in the lower montane forest at Fraser's Hill, Selangor. This forest is located about 100 km from Kuala Lumpur and classified as a lower montane forest at an altitude of 1200 m above sea level, following the classifications of Symington (2004), Saw (2010), and Wyatt-Smith (1995).

In this study, a total of two study plots with a size of 50 m x 20 m each with a total area of 0.2 ha were established randomly in Fraser's Hill (Figure 1). All Myrtaceae trees with a diameter of ≥ 5.0 cm DBH were tagged, measured, and identified up to the species level where possible. For individuals that are easily identified up to species level, identification was carried out directly in the field, while for individuals that cannot be identified, voucher specimens were collected and processed for further identification in Herbarium, Universiti Kebangsaan Malaysia (UKMB), and Herbarium, Forest Research Institute Malaysia (KEP). Identification is also done using the keys and descriptions of Kochummen (1978), Corner (1988), and Wyatt-Smith (1999).

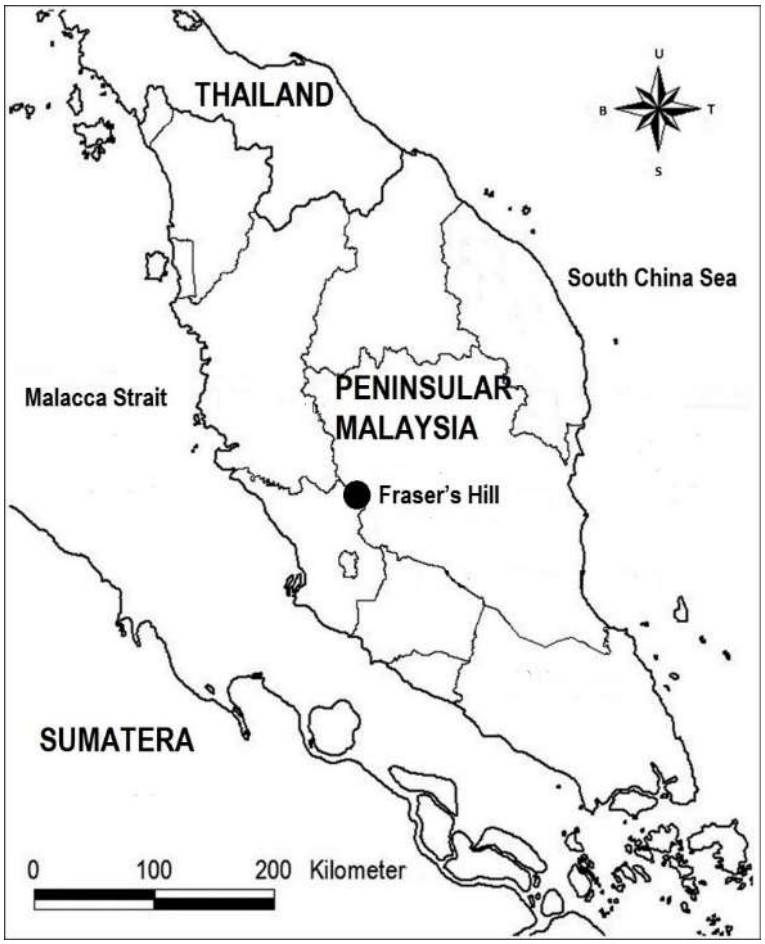

Figure 1. Location of Fraser's Hill, Selangor.

The floristic composition of Myrtaceae comprising the genus and species in this forest is calculated. The abundance parameters such as density, stand structure, and basal area were calculated. The status of endemic taxa was referred to Kochummen (1978), Turner (1995), and Kiew (1998).

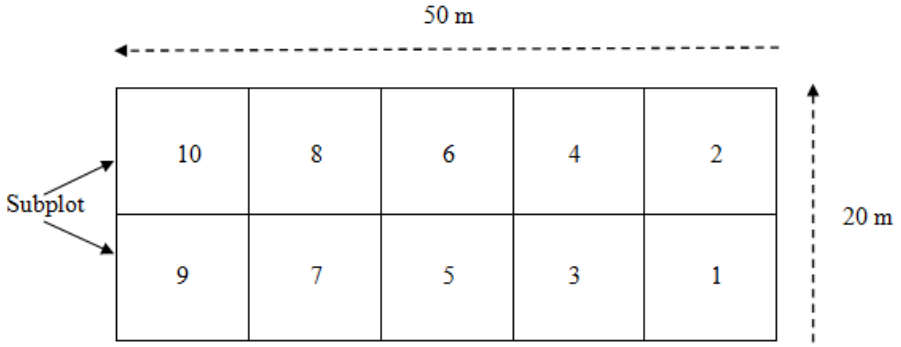

Figure 2. Design of plot study (50 m x 20 m) in Fraser's Hill, Selangor.

RESULTS AND DISCUSSION

Genus and species composition

A total of nine species from two genera and 22 individuals of Myrtaceae were recorded in the 0.2 ha plot at Fraser's Hill, Selangor (Table 1). *Syzygium* has recorded the highest number of species, with eight species, while *Rhodamnia* is only comprised of a single species. The total number of genera and species in this study represent 12.5% and 4.2% of Myrtaceae in Peninsular Malaysia, respectively.

Table 1. List of genera and total number of species and individuals of Myrtaceae in 0.2 ha plot at Fraser's Hill, Selangor.

No.	Genus	Total number of species	Total number of individuals
1	*Rhodamnia*	1	3
2	*Syzygium*	8	19
	Total	9	22

Four species, namely *Rhodamnia cinerea*, *Syzygium dyerianum*, *S. napiforme*, and *S. oreophilum*, were also reported by Kiew (1998) out of 21 taxa of Myrtaceae in Fraser Hill, Pahang. Another four species, namely *Syzygium griffithii*, *S. rugosum* var. *cordatum*, *S. syzygoides*, and *Syzygium* sp. 12, are considered new records for Fraser Hill. *Rhodamnia cinerea*, *Syzygium dyerianum*, *S. griffithii*, *S. napiforme*, and *S. syzygoides* are distributed in lowland and hill dipterocarp forests and can be reached to montane forests (Kochummen, 1978; Turner, 1995). *Syzygium oreophilum* is distributed in the hill dipterocarp forest and montane forests, while *S. rugosum* var. *cordatum* is restricted to montane forests (Kochummen, 1978; Turner, 1995).

Endemic species

Syzygium oreophilum is an endemic species found in the study plots. This species is only recorded on ridges in the hill dipterocarp forest and montane forest at ca. 1300 m a.s.l. in Perak, Pahang and Selangor (Kochummen, 1978; Turner, 1995; Kiew, 1998).

Stand structure

The DBH range of Myrtaceae trees in a 0.2 ha plot on Fraser's Hill is from 5.0 to 32.0 cm. The largest tree in the study plot is *Syzygium* sp. 12, measuring 32.0 cm in DBH, followed by *Syzygium syzygioides* at 23.0 cm. The first DBH class of 5.0-9.9 cm has recorded the highest number of individuals, totaling 13 stems, representing 59.1% of the total Myrtacaceae trees that have been censused (Figure 3). The second highest number of individuals was recorded by DBH class 15.0-19.9 cm with five stems (22.7%). Only a single individual (4.5%) represented the largest DBH class of >25.0 cm. Mature trees (≥ 20 cm DBH) were only represented by three individuals.

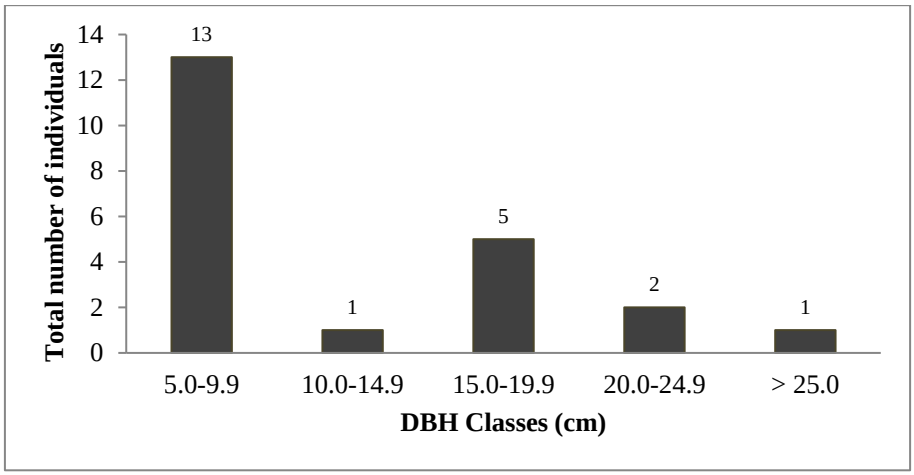

Figure 3. Distribution of DBH classes for Myrtaceae in 0.12 ha plot at Fraser's Hill, Selangor.

Density of genera and species

The density of Myrtaceae in the 0.2 ha study plot at Fraser's Hill is 110 individuals/ha. *Syzygium* is the densest, totaling 95 individuals/ha, while *Rhodamnia* has 15 individuals/ha (Table 2). A further study is needed to determine the density of trees with a DBH of ≥ 1.0 cm as reported in a study by Ahmad Fitri et al. (2017b) for Myrtaceae trees in Hulu Sungai Sedili Besar, Johor.

Table 2. Density of two genera of Myrtaceae in 0.2 ha plot at Fraser's Hill, Selangor.

Genus	Total number of individuals	Density (ind/ha)
Rhodamnia	3	15
Syzygium	19	95
Total	22	110

At the species level, *Syzygium* sp. 12 shows the highest density of 45 individuals/ha followed by *Rhodamnia cinerea* and *Syzygium dyerianum* with 15 individuals/ha each. The detailed density for all species of Myrtaceae in Fraser's Hill is shown in Table 3.

Table 3. Density of all species of Myrtaceae in 0.2 ha plot at Fraser's Hill, Selangor.

Species	Total number of individuals	Density (ind/ha)
Rhodamnia cinerea	3	15
Syzygium sp. 12	9	45
Syzygium dyerianum	3	15
Syzygium oreophilum	2	10
Syzygium griffithii	1	5
Syzygium napiforme	1	5
Syzygium rugosum var. *cordatum*	1	5
Syzygium sp.	1	5
Syzygium syzygioides	1	5
Total	22	110

Basal area

In this study, the basal area for Myrtaceae is 1.74 m^2/ha. The genus *Syzygium* demonstrated the largest amount of basal area, as much as 1.67 m^2/ha (95.68%), while *Rhodamnia* only contributed 0.08 m^2/ ha (4.38%) (Table 4). At the species level, *Syzygium* sp. 12 contributes the highest basal area of 1.13 m^2/ha (65.12%), followed by *S. syzygioides* with 0.21 m^2/ha (11.94%) and *S. rugosum* var. *cordatum* with 0.11 m^2/ha (6.52%). Table 5 displays the basal area for all species in the Myrtaceae in a 0.2 ha plot at Fraser Hill.

As a comparison, Hulu Sungai Sedili Besar, Johor, Ahmad Fitri et al. (2017b) reported that the total basal area for Myrtaceae in the study plots was 2.19 m^2/ha, whereby *Tristaniopsis* contributed two-thirds of the basal area with 1.57 m^2/ha (71.48%). Species-wise, *Tristaniopsis whiteana* contributed the highest basal area, viz., 1.57 m^2/ha (71.48%).

Table 4. Basal area and percentage of genera of Myrtaceae in 0.2 ha plot at Fraser's Hill, Selangor.

Genus	Basal area per hectare (m^2/ha)	%
Rhodamnia	0.08	4.38
Syzygium	1.67	95.68
Total	1.74	100

Table 5. Basal area and percentage of all species of Myrtaceae in 0.2 ha plot at Fraser's Hill, Selangor.

Species	Basal area per hectare (m^2/ha)	%
Rhodamnia cinerea	0.08	4.38
Syzygium dyerianum	0.04	2.19
Syzygium griffithii	0.03	1.83
Syzygium napiforme	0.03	1.44
Syzygium oreophilum	0.09	5.24
Syzygium rugosum var. *cordatum*	0.11	6.52
Syzygium sp.	0.03	1.44
Syzygium sp. 12	1.13	65.12
Syzygium syzygioides	0.21	11.94
Total	1.74	100

CONCLUSION

The research indicated that almost all Myrtaceae trees are in the sapling stage, with merely three specimens (> 20.0 cm DBH) constituting the parent trees inside the study plots. Further research is required, especially on trees with a diameter at breast height (DBH) of less than 1.0 cm, to acquire additional data on the floristic composition, including endemic taxa.

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AUTHOR CONTRIBUTIONS

Writing original draft: Ahmad Fitri Zohari, Nik Hazlan Nik Hashim; Data curation: Nik Norafida Nik Ali, Nur 'Aqilah Mustafa Bakery, Wan Norilani Wan Ismail, Mazlin Kusin; Formal analysis: Mohammad Khairul Faizi Zulkifli, Mohd Nizam Mohd Said, Ahmad Firdaus Zainuddin; Writing review & editing: Khairunnisaa Abd Rasid, Norazlinda Mohamad, Engku Azlin Rahayu Engku Ariff; Project administration: Abdul Latiff.

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DATA AVAILABILITY

Not applicable.

COMPETING INTEREST

The authors declare that they have known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

COMPLIANCE OF ETHICAL STANDARDS

Not applicable.

SUPPLEMENTARY MATERIAL

Not applicable.

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