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A Preliminary Study on Floristic Composition of Trees in Pelangai Forest Reserve, Kuala Pilah, Negeri Sembilan

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ABSTRACT. A preliminary study was conducted to determine the floristic composition and community structure of trees in Pelangai Forest Reserve, Kuala Pilah, Negeri Sembilan. Two temporary ecological plots with the dimension of 25 m x 20 m (0.1 ha in total) had been established. The census was carried out for all trees with a diameter at breast height (DBH) of 5.0 cm and above. The floristic composition consisted of 135 individuals from 78 species, 67 genera, and 28 families. The most speciose family was Dipterocarpaceae with eight species, followed by Fabaceae with seven species. The main canopy and understorey species groups recorded the highest number of species and individuals, with 28 and 22 species and 51 and 44 individuals, respectively. *Pentace strychnoidea* represented the highest total number of individuals for DBH classes of ≥ 5.0 cm, ≥ 10.0 cm and ≥ 15.0 cm. This preliminary study contributed the additional data for logged-over forests in Negeri Sembilan. A detailed study needs to be carried out in the future to obtain more information on tree species in this forest with a large-sized plot and lower measurement of diameter.

Key words: floristic composition, Pelangai Forest Reserve, species group

1. INTRODUCTION

The lowland dipterocarp forest, mostly in the regenerating phase, is the main forest type in Peninsular Malaysia that can be classified as a biotic climax forest (Saw, 2010). This forest is up to 300 m above sea level, which includes all the well-drained primary forests, undulating land, and foothills, as well as those already overexploited (Symington, 2004). Most of the lowland dipterocarp forests have been felled for the planting of rubber and oil palm, the two most important economic crops. Besides that, the forestry sector has been one of the most important sectors in the Malaysian economy since independence (Latiff 1994; Ooi 1993; Raj 1986). In 1991, Malaysia was the largest supplier of hardwood timber in the world (Sharifah, 2006). The total timber production increased by 0.06% in 1992 (43.5 million m³) relative to 1990 (41 million m³) (Sharifah, 2006). More timber extracted from the forest meant many

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forests were logged, and the forested areas decreased all the time.

Lowland dipterocarp forests are globally recognised as critical hotspots of biodiversity, yet they are increasingly threatened by land-use change and climate variability. While numerous ecological studies have characterised the floristic composition of this type of forest across Peninsular Malaysia, significant geographical knowledge gaps persist, particularly in lesser-explored, smaller reserves. Specifically, the Pelangai Forest Reserve, a critical but unstudied tract of protected forest, lacks any foundational, recent data on its tree species composition and community structure. This research gap is critical, as a baseline floristic inventory is essential for effective, science-based conservation and management planning. Therefore, during a scientific expedition in 2023, we established two temporary ecological plots in Pelangai Forest Reserve. The focus of this study was to determine the current species composition of this specific, undocumented lowland dipterocarp forest, providing a high-level baseline reference crucial for informing Pelangai Forest Reserve conservation status, guiding future ecological research, and supporting sustainable forest management strategies.

2. METHODOLOGY

2.1. Study Site

Pelangai Forest Reserve was gazetted as a forest reserve on 1st December 1936 and is located in the district of Kuala Pilah, Negeri Sembilan (Figure 1). This forest covers an area of 6,630 ha (Anon. 2017). About 400 ha were designated for UiTM, with some areas developed to accommodate infrastructure for the UiTM Kuala Pilah Campus facilities. This forest has been logged with the presence of skid trails, and the big trees are scarce. This forest is classified as the regenerating lowland dipterocarp forest and is still rich with dipterocarp species, especially from *Dipterocarpus*, *Richetia* and *Rubroshorea*. For undergrowths, the common species are the stemless palms of *Eugeissona tristis* and *Johannesteijsmannia altifrons*.

2.2. Methods

In this study, two temporary ecological plots with the dimension of 25 m x 20 m each (0.05 ha) were established in Pelangai Forest Reserve, covering an area of 0.1 ha. All trees with a diameter of ≥ 5.0 cm were marked and measured using DBH tape. Specimens (fruit and flowers if present) for each tree were collected for identification. Then, the specimens were curated and processed by the methods of Bridson and Forman (1992) and kept in the oven for one week at the temperature of 60°C. Species identification was done by using the keys in the books of the local flora (Corner, 1988; Kiew et al., 2010, 2011, 2012, 2013, 2015, 2017, 2018; Ng, 1978, 1989; Symington, 2004; Whitmore, 1972a, 1973a) and compared with herbarium specimens at Herbarium of Universiti Kebangsaan Malaysia (UKMB) and Herbarium of Forest Research Institute Malaysia (KEP). For the classification of species, those proposed by Wyatt-Smith (1966), Manokaran and Swaine (1994), Kochummen et al. (1990), Ahmad Fitri (2013) and Ahmad Fitri et al. (2014, 2017, 2018, 2020, 2023) were used in this study.

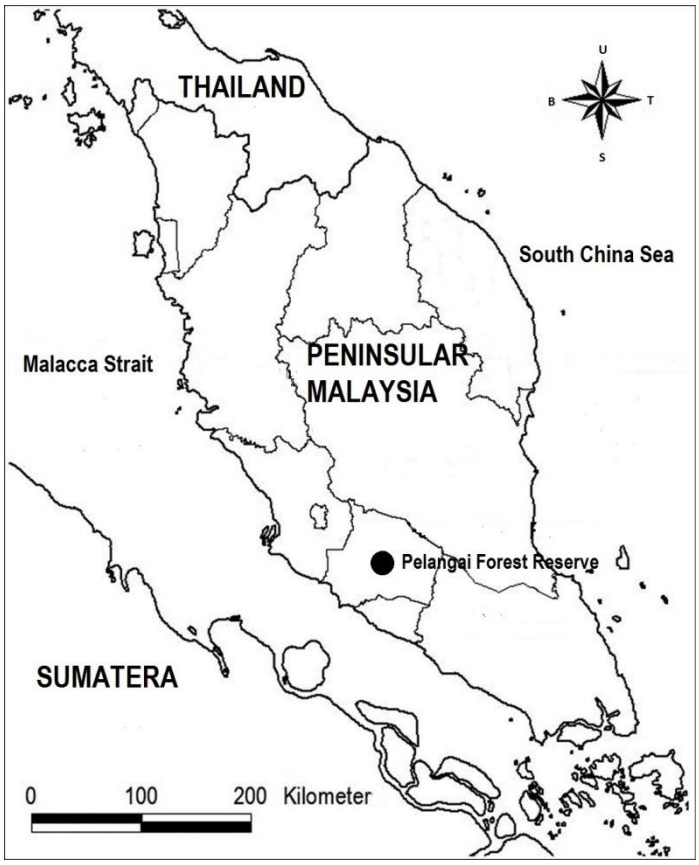

Figure 1. Location of Pelangai Forest Reserve, Kuala Pilah, Negeri Sembilan

Emergent group is a long-lived group that needs light in the mature phase and can grow up on the top of the main canopy of primary forest up to 30 m high (Kochummen et at., 1990; Manokaran & Swaine, 1994). The main canopy species group is also relatively long-lived and requires light during its mature phase, forming the main canopy in primary rainforest at altitudes between 20 m and 30 m (Kochummen et al., 1990; Manokaran & Swaine, 1994). Understorey is a group of shade-tolerant species in the mature phase that forms the lower stratum in primary rainforest and has a maximum height of 20 m (Kochummen et al., 1990; Manokaran & Swaine, 1994). Treelet is a group of shade-tolerant species that forms the lower stratum, either alone or in conjunction with another group under the canopy and has a maximum height of up to 10 m and a diameter (DBH) of up to 10 cm (Kochummen et al., 1990). Pioneer is a group of plants that need high exposure to sunlight and will die if the tree is shaded from sunlight or if there is not enough sunlight exposure (Manokaran & Swaine, 1994; Ahmad Fitri et al. 2017). In the successional group, the species require relatively more light than those in the pioneer group; however, despite having dormant seeds, they do not germinate in response to the light-temperature changes that occur during gap formation (Ahmad Fitri, 2013; Ahmad Fitri et al., 2017). For species whose species group cannot be determined, the species group was separated from other species and put under the undetermined group.

3. RESULTS AND DISCUSSION

3.1. Floristic Composition

A total of 78 species in 67 genera and 28 families were represented by 135 individuals in the 0.1 ha plot recorded in Pelangai Forest Reserve, Negeri Sembilan. The most speciose family was Dipterocarpaceae with eight species,

followed by Fabaceae with seven species and Euphorbiaceae with six species. Two families, namely, Annonaceae and Phyllanthaceae, have recorded five taxa each. Table 1 showed the details of the rank of every family with the highest total number of species and percentage. Malvaceae has the highest total number of individuals, with 15 individuals, followed by Fabaceae and Phyllanthaceae, with 14 individuals each.

Table 1. Species composition and total individual for all families in 0.1 ha plot at Pelangai Forest Reserve, Kuala Pilah, Negeri Sembilan.

Family	Rank	Total number of species	%	Rank	Total number of individuals	%
Dipterocarpaceae	1	8	10.26	4	12	8.89
Fabaceae	2	7	8.97	2	14	10.37
Euphorbiaceae	3	6	7.69	5	11	8.15
Annonaceae	4	5	6.41	10	5	3.70
Phyllanthaceae	5	5	6.41	3	14	10.37
Burseraceae	6	4	5.13	6	6	4.44
Ebenaceae	7	4	5.13	14	4	2.96
Melastomataceae	8	4	5.13	7	6	4.44
Anacardiaceae	9	3	3.85	13	4	2.96
Lauraceae	10	3	3.85	17	3	2.22
Malvaceae	11	3	3.85	1	15	11.11
Myristicaceae	12	3	3.85	15	4	2.96
Sapindaceae	13	3	3.85	12	5	3.70
Calophyllaceae	14	2	2.56	16	3	2.22
Clusiaceae	15	2	2.56	18	2	1.48
Meliaceae	16	2	2.56	19	2	1.48
Moraceae	17	2	2.56	11	5	3.70
Rubiaceae	18	2	2.56	8	6	4.44
Anisophylleaceae	19	1	1.28	9	5	3.70
Fagaceae	20	1	1.28	20	1	0.74
Ixonanthaceae	21	1	1.28	21	1	0.74
Lamiaceae	22	1	1.28	22	1	0.74
Loganiaceae	23	1	1.28	23	1	0.74
Myrtaceae	24	1	1.28	24	1	0.74
Passifloraceae	25	1	1.28	25	1	0.74
Pentaphylacaceae	26	1	1.28	26	1	0.74
Putranjivaceae	27	1	1.28	27	1	0.74
Sapotaceae	28	1	1.28	28	1	0.74
Total		78	100		135	100

This study is considered to have a moderate total number of species compared to previous studies in the lowland dipterocarp forest in Peninsular Malaysia. For instance, there were 171 species represented by 113 genera and 43 families of trees with a diameter ≥ 5.0 cm DBH in one hectare plot at Bangi Forest Reserve, a twice-logged forest (Lajuni & Latiff 2013). Meanwhile, a study by Ahmad Fitri et al. (2019) in logged-over lowland dipterocarp forest at

Kluang and Remen Cereh Forest Reserve revealed the higher total number of floristic compositions. In Kluang Forest Reserve, a total of 238 individuals from 142 species, 96 genera, and 47 families were enumerated, while in Remen Cereh Forest Reserve, a total of 33 families, 85 genera, and 122 species were recorded for 283 individuals.

3.2. Species Groups

In the study area, tree species were classified into eight groups: emergent, main canopy, late seral, understory, treelet, pioneer, successional, and undetermined. The main canopy group represented the largest total number of species with 28 species (35.90%), followed by the understorey group (22 species; 28.21%), emergent group (11 species; 14.10%) and treelet group (10 species; 12.82%). The detailed information of all species groups is shown in Table 2.

Table 2. Total numbers of trees species, stems and density in different species groups in the study plot at Pelangai Forest Reserve, Kuala Pilah, Negeri Sembilan.

Species group	Total number of species	% of species	Total number of stems	% of total stems	Density (tree/ha)
Emergent	11	14.10	15	11.11	150
Late seral	1	1.28	1	0.74	10
Main canopy	28	35.90	51	37.78	510
Understorey	22	28.21	44	32.59	440
Treelet	10	12.82	14	10.37	140
Pioneer	2	2.56	5	3.70	50
Successional	2	2.56	3	2.22	30
Undetermined	2	2.56	2	1.48	20
Total	78	100	135	100	1350

It is apparent that the main canopy group recorded the highest number of stems with 51 stems and a density of 510 trees/ha (37.78%); the understorey group had the second highest number of stems of 44 stems (440 trees/ha; 32.59%), followed by the emergent group that was represented by 15 stems (150 trees/ha; 11.39%) and the treelet group of 14 stems (140 trees/ha; 10.37%) (Table 2).

For comparison, a study by Ahmad Fitri et al. (2020) in the logged-over riparian forest at Hulu Sungai Sedili Besar, Johor, reported that the main canopy group recorded the highest density with 720 trees/ha, followed by the understorey group (400 trees/ha) and the treelet group (385 trees/ha). The main canopy group was dominated by Myrtaceae, Fagaceae and Euphorbiaceae. *Tristaniopsis whiteana* (main canopy group) was represented by 32 individuals. For the understorey group, it was represented by the medium- and small-sized trees from Euphorbiaceae, Sapotaceae, Flacourtiaceae and Sapindaceae. *Croton laevifolius* recorded the highest total number of stems (14 individuals). The emergent group was dominated by Dipterocarpaceae, especially from *Dryobalanops* and *Shorea*; Leguminosae, which includes *Dialium* and *Koompassia*. *Dryobalanops oblongifolia* ssp. *occidentalis* recorded the highest total number of stems with 24 individuals.

A study by Manokaran and Swaine (1994) in three primary forests of Peninsular Malaysia, namely Bukit Lagong

Forest Reserve (hill dipterocarp forest), Sungai Menyala Forest Reserve (lowland dipterocarp forest) and Pasoh Forest Reserve (lowland dipterocarp forest), they had determined that the main canopy group contributed a higher proportion of total species number compared to other ecological groups. In Bukit Lagong Forest Reserve, the main canopy group contained 47.4% of the total species number; the main canopy group at the Sungai Menyala Forest Reserve comprised half, or 50.4%, of the total species, whilst the main canopy group at the Pasoh Forest Reserve had 46.2% of the total number of species.

In terms of density, Manokaran and Swaine (1994) have reported that the main canopy group was dominated by the number of stems with the highest density at the Bukit Lagong and Sungei Menyala Forest Reserve, whilst the understorey group showed the highest density at the Pasoh Forest Reserve. Meanwhile, Ahmad Fitri et al. (2017), in their study in the primary upper hill dipterocarp forest at Temengor Forest Reserve, Perak, have determined the understorey group with the highest total number of stems (320 ind/ha), followed by the main canopy group with 306 ind/ha.

For six species groups, at least one listed species with the highest number of individuals was shown in Table 3. For the main canopy group, *Pentace strychnoidea* was recorded with the highest total number of individuals, with 11 individuals, followed by *Anisophyllea corneri* and *Adinobotrys atropurpureus* with five stems each. *Richetia multiflora* was represented by four individuals, while *Artocarpus lanceifolius* had three.

In the understorey group, *Cleistanthus ellipticus* was recorded as the highest number of individuals, with seven individuals, followed by *Aidia densiflora*, with five individuals (Table 3). Another four species, namely, *Canarium patentinervium*, *Microcos fibrocarpa*, *Pternandra echinata* and *Lepisanthes senegalensis*, were represented by three individuals each.

In the treelet group, *Baccaurea parviflora* was represented by three individuals, followed by both *Knema stenophylla* and *Trigonostemon malaccanus*, which are represented by two individuals each. For the emergent group, *Sindora coriacea* was recorded as the highest number of individuals in the group, with three individuals. Another two species, viz. *Neobalanocarpus heimii* and *Parartocarpus bracteatus*, were represented by two individuals each.

As a comparison, Kochummen et al. (1990) found that the 10 most abundant species were dominated by the dipterocarps, including *Shorea leprosula*, *S. acuminata*, *S. parvifolia* and *S. macroptera*, in the 50-ha plot at Pasoh Forest Reserve. Manokaran and Swaine (1994) reported that in the Sungai Menyala Forest Reserve, the emergent group comprised 14 dipterocarp species and some species of Fabaceae, such as *Dialium platysepalum*, *Koompassia malaccensis*, *Sindora coriacea* and *S. echinocalyx*.

Table 3. List of at least one species with the highest number of individuals for six major species groups in the 0.1 ha plot at Pelangai Forest Reserve, Kuala Pilah, Negeri Sembilan.

Species group	Species	Family	Total number of individuals
Emergent	*Sindora coriacea* (Baker) Maingay ex Prain	Fabaceae	3
	Neobalanocarpus heimii (King) P.S. Ashton	Dipterocarpaceae	2
	Parartocarpus bracteatus (King) Becc.	Moraceae	2
Main canopy	*Pentace strychnoidea* King	Malvaceae	11
	Anisophyllea corneri Ding Hou	Anisophylleaceae	5
	Adinobotrys atropurpureus (Wall.) Dunn	Fabaceae	5
	Richetia multiflora (Burck) P.S.Ashton & J.Heck.	Dipterocarpaceae	4
	Artocarpus lanceifolius Roxb.	Moraceae	3
Pioneer	*Endospermum diadenum* (Miq.) Airy Shaw	Euphorbiaceae	4
Successional	*Buchanania sessifolia* Blume	Anacardiaceae	2
Treelet	*Baccaurea parviflora* (Müll.Arg.) Müll.Arg.	Phyllanthaceae	3
	Knema stenophylla (Warb.) J. Sinclair	Myristicaceae	2
	Trigonostemon malaccanus Müll.Arg.	Euphorbiaceae	2
Understorey	*Cleistanthus ellipticus* Hook.f.	Phyllanthaceae	7
	Aidia densiflora (Wall.) Masam.	Rubiaceae	5
	Canarium patentinervium Miq.	Burseraceae	3
	Microcos fibrocarpa (Mast.) Burret	Malvaceae	3
	Pternandra echinata Jack	Melastomataceae	3
	Lepisanthes senegalensis (Poir.) Leenh.	Sapindaceae	3
	Kayea lepidota (T.Anderson) Pierre	Calophyllaceae	2
	Macaranga lowii King ex Hook.f.	Euphorbiaceae	2
	Archidendron bubalinum (Jack) I.C. Nielsen	Fabaceae	2
	Aporosa aurea Hook.f.	Phyllanthaceae	2

For the pioneer group, only two species were recorded and represented by *Balakata baccata* and *Endospermum diadenum*. Only *E. diadenum* was listed in Table 3, while *B. baccata* was represented by a single stem. According to Whitmore (1973b) and Esser (1999), *Endospermum diadenum* is common in the secondary and primary forests of lowland and hill dipterocarp forests in Peninsular Malaysia, especially in the disturbed forest (van Welzen, 2020) and forest gaps. This species is also associated with *Balakata baccata* in lowland dipterocarp forests in Peninsular Malaysia that are poor in dipterocarp species (Wyatt-Smith, 1963, 1999).

For the successional group, this group was represented only by *Buchanania sessifolia* (Anacardiaceae) with a single individual. This species of successional group is common in the lowland and hill forests of Peninsular Malaysia (Kochummen, 1989).

3.3. Species Composition Based DBH Classes

For the DBH class of ≥ 5.0 cm, *Pentace strychnoidea* has recorded the highest number of stems (11 individuals), followed by *Cleistanthus ellipticus* (seven individuals). Three species, viz. *Adinobotrys atropurpureus*, *Aidia densiflora* and *Anisophyllea corneri*, were represented by five individuals each. Meanwhile, for the DBH class of ≥ 10.0 cm, *Pentace strychnoidea* has recorded the highest number of stems with eight individuals, followed by *Anisophyllea corneri* with five individuals and *Endospermum diadenum* with four individuals. Further, for class DBH of ≥ 15.0 cm, *Pentace strychnoidea* has recorded the highest number of stems (five individuals), followed by *Endospermum diadenum* and *Sindora coriacea* with three individuals each. Table 4 shows a list of tree species, which recorded the highest number of individuals for three different DBH classes.

Table 4. List of trees species with highest number of total individuals for trees with diameter of ≥ 5.0 cm, ≥ 10.0 cm and ≥ 15.0 cm in 0.1 ha plot in Pelangai Forest Reserve, Kuala Pilah, Negeri Sembilan.

DBH	Species	Family	Total number of individuals
≥ 5.0 cm	*Pentace strychnoidea* King	Malvaceae	11
	Cleistanthus ellipticus Hook.f.	Phyllanthaceae	7
	Adinobotrys atropurpureus (Wall.) Dunn	Fabaceae	5
	Aidia densiflora (Wall.) Masam.	Rubiaceae	5
	Anisophyllea corneri Ding Hou	Anisophylleaceae	5
	Endospermum diadenum (Miq.) Airy Shaw	Euphorbiaceae	4
	Richetia multiflora (Burck) P.S.Ashton & J.Heck.	Dipterocarpaceae	4
	Artocarpus lanceifolius Roxb.	Moraceae	3
	Baccaurea parviflora (Müll.Arg.) Müll.Arg.	Phyllanthaceae	3
	Canarium patentinervium Miq.	Burseraceae	3
	Lepisanthes senegalensis (Poir.) Leenh.	Sapindaceae	3
	Microcos fibrocarpa (Mast.) Burret	Malvaceae	3
	Pternandra echinata Jack	Melastomataceae	3
	Sindora coriacea (Baker) Maingay ex Prain	Fabaceae	3
≥ 10.0 cm	*Pentace strychnoidea* King	Malvaceae	8
	Anisophyllea corneri Ding Hou	Anisophylleaceae	5
	Endospermum diadenum (Miq.) Airy Shaw	Euphorbiaceae	4
	Cleistanthus ellipticus Hook.f.	Phyllanthaceae	3
	Sindora coriacea (Baker) Maingay ex Prain	Fabaceae	3
≥ 15.0 cm	*Pentace strychnoidea* King	Malvaceae	5
	Endospermum diadenum (Miq.) Airy Shaw	Euphorbiaceae	3
	Sindora coriacea (Baker) Maingay ex Prain	Fabaceae	3

3.4. Stand Structure

Stand structure of trees in Pelangai Forest Reserve is described based on the size of DBH classes with the interval of 10 cm. The classes consist of Class I: 5.0-14.9 cm; Class II: 15.0-24.9; Class III: 25.0-34.9; Class IV: 35.0-44.9 cm; and Class V: > 45.0 cm (Figure 2). Almost two-thirds, or 73.33% (99 stems), of the total number of individuals were

recorded in Class I (5.0–14.9 cm), followed by Class II (15.0–24.9 cm) with 19 stems (14.07%), and Class III (25.0–34.9 cm) with eight stems (5.93%), while Class IV (35.0–44.9 cm) had five stems (3.70%). The last class of DBH classes of 45.0 cm and above (Class V) consisted of four stems (2.96%). Figure 2 clearly shows a pattern of inverse "J"-shape distribution where the number of trees declines as the diameter class increases. The high percentage of individuals in Class I and the decline of tree number with increasing DBH are common scenarios that have been reported in many inland forests in Peninsular Malaysia, including primary and logged-over forests.

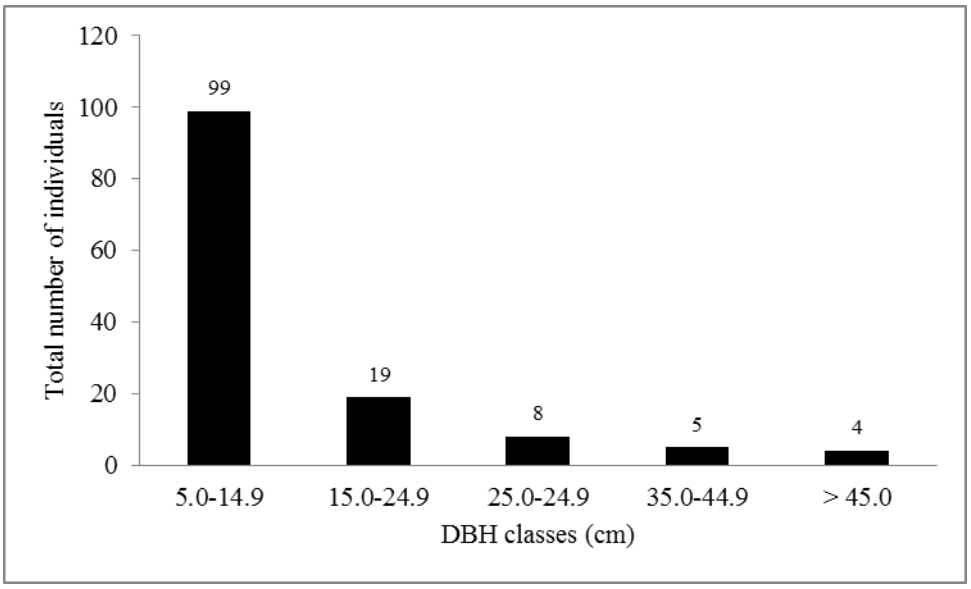

Figure 2. Stand structure based on DBH classes in study plot Pelangai Forest Reserve, Kuala Pilah, Negeri Sembilan.

All trees in the study plots at this forest reserve have a DBH range from 5.0 cm to 105.0 cm. *Xerospermum laevigatum* (Sapindaceae) was the largest tree in the study plots, with a DBH of 105.0 cm. This was followed by *Heritiera simplicifolia* (Malvaceae) with a DBH of 60.0 cm and *Sindora coriacea* (Fabaceae) with a DBH of 50.5 cm (Figure 3). Two species of dipterocarps, namely *Neobalanocarpus heimii* and *Anthoshorea bracteolata*, were on the fifth and sixth ranks with 43.9 cm and 42.2 cm DBH, respectively. The pioneer species, *Endospermum diadenum*, was in the seventh rank with a DBH of 38.3 cm.

Pelangai Forest Reserve, although likely a tract with a history of disturbance, displays a remarkable floristic structure that differentiates it from pristine old-growth stands, highlighting its role as a successfully regenerating secondary forest. The presence of multiple large trees across the study plots demonstrates a high recovery trajectory. Critically, these large individuals represent a mix of both highly valued dipterocarp and non-dipterocarp species. This successful regeneration makes this forest an ecologically significant example of how once-disturbed lowland dipterocarp forests can recover and retain high conservation values. Therefore, the current floristic composition of this forest is special not only for the size of its trees but also as a living case study of effective forest resilience in Peninsular Malaysia.

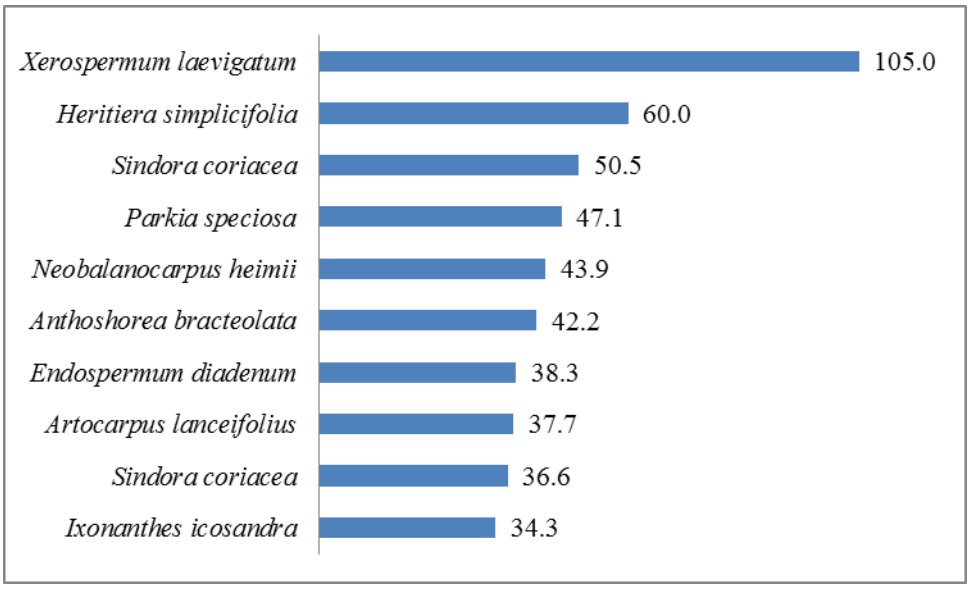

Figure 3. Ten largest tree in study plot at Pelangai Forest Reserve, Kuala Pilah, Negeri Sembilan.

4. CONCLUSION

This study indicated that the logged-over forest in Pelangai Forest Reserve still harboured many tree species, with more than 70 species in the relatively very small plots of 0.1 ha. The occurrence of Dipterocarpaceae as the most speciose families was common and also reported in other lowland dipterocarp forests in Peninsular Malaysia. For the species group, the main canopy and understorey groups were recorded as the highest number of species, with 28 and 22 species, respectively. The present study provided preliminary data on tree species in the logged-over lowland dipterocarp forests of Negeri Sembilan, specifically for trees with diameters of 5.0 cm and above. A large-scale plot with a minimum size of 1.0 ha and a lower measurement of ≥ 1.0 cm DBH is needed in the future to obtain more valuable floristic data.

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AUTHOR CONTRIBUTIONS

Ahmad Fitri Zohari – conceptualisation, data curation, supervision, writing – review & editing; Mohamad Sobre Zohari – data collection; Nik Hazlan Nik Hashim – supervision, writing – review & editing; Nik Norafida Nik Ali – conceptualisation, data curation; Nur 'Aqilah Mustafa Bakray – writing – review & editing; Mohamad Khairul Faizi Zulkifli – data collection; Khairunnisaa Abd Rasid - writing – review & editing; Wan Norilani Wan Ismail – conceptualisation, data curation; Mazlin Kusin – data collection; Engku Azlin Rahayu Engku Ariff – writing – review & editing & A. Latiff – supervision, writing – review & editing.

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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.

REFERENCES

Ahmad Fitri, Z. (2013). Community structure, species diversity and relationship of tree communities with soil factors in upper hill dipterocarp forest of Perak state, Peninsular Malaysia. M.Sc. Thesis. Universiti Kebangsaan Malaysia, Bangi (unpublished).

Ahmad Fitri, Z. Nik Hazlan, N.H., Khairil, M., Mohamad Murshidi, Z., Mohamad Sobre, Z. & Latiff, A. (2014). Komposisi spesies pokok di Hutan Simpan Gunung Tebu, Terengganu. In Abd Rahman, A.R., Mohs Nasir, A.H., Azmi, N., Nor Hasliza, M.B. & Latiff, A. (eds.). *Hutan Simpan Gunung Tebu, Terengganu: Pengurusan Hutan, Persekitaran Fizikal dan Kepelbagaian Biologi*, *Siri Kepelbagaian Biologi Hutan No*. 22, Jabatan Perhutanan Semenanjung Malaysia, Kuala Lumpur: pp. 271–284.

Ahmad Fitri, Z. Nizam, M.S., Latiff, A., Abd. Rahman, K., Serafina Christine, F. & Shamsudin, I. (2017). Floristic composition and biomass of trees in Temengor Forest Reserve, Perak, Peninsular Malaysia. *The Malaysian Forester 80*(2), 178–197.

Ahmad Fitri, Z., Wan Norilani, W. I., Wan Juliana, W. A., Mohamad Ruzi, A. R. & Mohd Nizam, M. S. (2018). Species composition and community structure of trees in a lowland dipterocarp forest. In Haja Maideen Kader Maideen, Wan Juliana Wan Ahmad & Mohamad Ruzi Abdul Rahman (eds.). *A Natural Heritage: The Flora and Fauna of Universiti Kebangsaan Malaysia*, Penerbit UKM, Bangi: pp. 44–56.

Ahmad Fitri, Z., Mohamad Sobre, Z., Mohamad Murshidi, Z., Nik Hazlan, N. H. Nik Norafida, N. A., Norazlinda, M., Nurhanim, M. N., Nizam, M. S., Noraini, T., Mohd. Ros, A. H., Ahmad Firdaus, Z.& Latiff, A. (2019). Floristic

composition, community structure and diversity of trees species in two logged-over lowland dipterocarp forests in Peninsular Malaysia. *Malayan Nature Journal*, *71*(4), 475–491.

Ahmad Fitri, Z., Muhamad Firdaus, A. S., Norazlinda, M., Nizam, M.S., Muhammad Rasul, A. H., Muhamad Ridwan, H., Nik Norafida, N. A., Nik Hazlan, N. H. Mohamad Sobre, Z., Mohamad Murshidi, Ahmad Firdaus Z. & Latiff, A. (2020). Species composition, community structure and diversity of trees in a logged-over riparian forest at Hulu Sungai Sedili Besar, Johor, Malaysia. *Malayan Nature Journal*, 72(3), 295–309.

Ahmad Fitri, Z., Nur 'Aqilah, M. B., Mohamad Khairul Faizi, Z., Nizam, M. S., Nik Hazlan, N. H., Nik Norafida, N. A., Wan Norilani, W.I., Noraini, T. & A. Latiff. (2023). Floristic composition of trees with diameter at breast height 1 cm and above in Plot 102 at Sungai Menyala Forest Reserve, Port Dickson, Negeri Sembilan. In Hamidi Abd. Halim, Nuazri Sedik, Umikalsum Nan, Siti Norhayati Mohamad Mastar, Noor Izianti Ishak & A. Latiff (eds.). *Hutan Simpan Sungai Menyala, Port Dickson, Negeri Sembilan: Persekitaran Fizikal dan Kepelbagaian Biologi*. *Siri Kepelbagaian Biologi Hutan. No*. 28, Jabatan Perhutanan Negeri Sembilan, Seremban: pp. 83-96.

Anon. (2017). *Laporan tahunan*. Seremban, Forestry Department of Negeri Sembilan.

Bridson, D. & Forman, L. (1992). *The herbarium handbook*. Boston, WCB/McGraw-Hill.

Corner, E. J. H. (1988). *Wayside trees of Malaya*. Volumes 1 & 2. Third Edition. Kuala Lumpur, The Malayan Nature Society.

Esser, H.-J. (1999). A partial revision of the Hippomaneae (Euphorbiaceae) in Malesia. *Blumea*, *44*, 149–215.

Kiew, R., Chung, R.C.K., Saw, L.G., Soepadmo, E. & Boyce, P. (2010). Flora of Peninsular Malaysia. Volume 1. Series II: Seed Plant. Kepong, Forest Research Institute Malaysia.

Kiew, R., Chung, R.C.K., Saw, L.G., Soepadmo, E. & Boyce, P. (2011). Flora of Peninsular Malaysia. Volume 2. Series II: Seed Plant. Kepong, Forest Research Institute Malaysia.

Kiew, R., Chung, R.C.K., Saw, L.G. & Soepadmo, E. (2012). Flora of Peninsular Malaysia. Volume 3. Series II: Seed Plant. Kepong, Forest Research Institute Malaysia.

Kiew, R., Chung, R.C.K., Saw, L.G. & Soepadmo, E. (2013). Flora of Peninsular Malaysia. Volume 4. Series II: Seed Plant. Kepong, Forest Research Institute Malaysia.

Kiew, R., Chung, R.C.K., Saw, L.G. & Soepadmo, E. (2015). Flora of Peninsular Malaysia. Volume 5. Series II: Seed Plant. Kepong, Forest Research Institute Malaysia.

Kiew, R., Chung, R.C.K., Saw, L.G. & Soepadmo, E. (2017). Flora of Peninsular Malaysia. Volume 6. Series II: Seed Plant. Kepong, Forest Research Institute Malaysia.

Kiew, R., Chung, R.C.K., Saw, L.G. & Soepadmo, E. (2018). Flora of Peninsular Malaysia. Volume 7. Series II: Seed Plant. Kepong, Forest Research Institute Malaysia.

Kochummen, K.M. (1989). Anacardiaceae. In: Ng, F.S.P. (ed.). *Tree flora of Malaya*. Volume 4, Longman Malaysia Sdn. Berhad, Petaling Jaya: pp. 9–57.

Kochummen, K, M., La Frankie, J. V. & Manokaran, (1990). Floristic composition of Pasoh Forest Reserve, a lowland rain Forest in Peninsular Malaysia. *Journal of Tropical Forest Science*, *3*(1), 1–13.

Lajuni, J. J. & Latiff, A. 2013. Biomass and floristic composition of Bangi Permanent Forest Reserve, a twice-logged lowland dipterocarp forest in Peninsular Malaysia. *Sains Malaysiana*, *42*(10), 1517–1521.

Latiff, A. (1994). *Kepelbagaian tumbuhan*: *status tumbuhan alam Malaysia*. Syarahan Perdana Universiti Kebangsaan Malaysia. Penerbit Universiti Kebangsaan Malaysia, Bangi.

Manokaran, N. & Swaine, M. D. (1994). *Population dynamics of trees in dipterocarp forests of Peninsular Malaysia*. Forest Research Institute Malaysia, Kepong.

Ng, F. S. P. (ed.). (1978). *Tree flora of Malaya*. Volume 3. Longman Malaysia Sdn. Berhad, Kuala Lumpur.

Ng, F. S. P. (ed.). (1989). *Tree flora of Malaya*. Volume 4. Longman Malaysia Sdn. Berhad, Petaling Jaya.

Ooi, J. B. (1993). *Tropical deforestation: the tyranny of time*. National Singapore University Press, Singapore.

Raj, K. (1986). *The forest resources of Malaysia: their economies and development. natural resources of South-East Asia*. Oxford University Press, Oxford.

Saw, L.G. (2010). Vegetation of Peninsular Malaysia. In Kiew, R., Chung, R.C.K., Saw, L.G., Soepadmo, E. & Boyce, P.C. (eds.). *Flora of Peninsular Malaysia*. Volume 1. Series II: Seed Plant, Kepong: Forest Research Institute Malaysia: pp. 21–45.

Sharifah, M. S. A. (2006). *Penyahhutanan hutan tropika dan cabaran persekitaran*. Syarahan Perdana Universiti Kebangsaan Malaysia. Penerbit Universiti Kebangsaan Malaysia, Bangi.

Symington, C. F. (2004). *Foresters' manual of dipterocarps*. Second edition revised by Ashton, P.S. & Appanah, S. (2004). Malayan Forest Record No. 16. Kepong, Forest Research Institute Malaysia.

van Welzen, P. C. (ed.). 2020. Flora Malesiana - Euphorbiaceae. Naturalis Biodiversity Centre, Leiden, available from www. Nationaalherbarium.nl/euphobrs.

Whitmore, T. C. (ed.). (1972). *Tree flora of Malaya*. Volume 1. Longman Malaysia Sdn. Berhad, Kuala Lumpur.

Whitmore, T. C. (ed). (1973a). *Tree flora of Malaya*. Volume 2. Longman Malaysia Sdn. Berhad, Kuala Lumpur.

Whitmore, T. C. (1973b). Euphorbiaceae. In Whitmore, T.C. (ed). *Tree flora of Malaya*. Volume 2, Longman Malaysia Sdn. Berhad, Kuala Lumpur: pp. 34-136.

Wyatt-Smith, J. (1963). *Manual of Malayan silviculture for inland forest*. Second Edition. Volume 1 & 2. Malayan Forest Records No. 23. Kepong, Forest Research Institute Malaysia.

Wyatt-Smith, J. (1966). Ecological studies on Malayan forests. I. Composition and dynamic studies in lowland evergreen rain forest in two 5-acre plots in Bukit Lagong and Sungei Menyala Forest Reserves and in two half-acre plots in Sungei Menyala Forest Reserve, 1947-1959. Research Pamplet No. 52. Forest Research Institute, Kepong.

Wyatt-Smith, J. (1999). *Pocket check list of timber trees*. Third revision by Kochummen, K.M. Malayan Forest Records. No. 17. Forest Research Institute Malaysia, Kepong.