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## Distribution of Endangered Dipterocarps in the Freshwater Swamp Forest of Parit Forest Reserve, Perak

Mohd Nazip Suratman<sup>1,2\*</sup>, Siti Maisarah Che Abdulah<sup>1</sup>, Judith Gisip<sup>1</sup>

\*Corresponding Author

<sup>1</sup> Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Malaysia

<sup>2</sup> Institute for Biodiversity and Sustainable Development, Universiti Teknologi MARA, 40450 Shah Alam, Malaysia

nazip@uitm.edu.my, saracheabdullah@gmail, judith@uitm.edu.my  
Tel \*0193653412

### Abstract

Many endangered tree species suffered reductions in their population sizes due to forest fragmentation. A field survey was conducted to study the demographic structure of five threatened Dipterocarps species and to map their spatial distribution in freshwater swamp forests at Parit Forest Reserve, Perak, Malaysia. Of five species recorded, *Shorea hemsleyana* exhibited the highest number of individuals (i.e., 198), followed by *Dipterocarpus semivestitus* (35), *S. macrantha* (24), *Hopea apiculata* (14) and *Vatica flavida* (6). While the spatial distribution of *D. semivestitus*, *S. macrantha*, *H. apiculata* and *V. flavida* are appeared to be spatially dispersed, *S. hemsleyana*'s appears to be more localized.

Keywords: Freshwater swamp forest; Dipterocarpaceae; Endangered species; *Dipterocarpus semivestitus*

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### 1.0 Introduction

In Peninsular Malaysia, Dipterocarpaceae comprises 165 taxa, 155 species and nine genera (Suhaida & Chua, 2012). The family dominates the rainforest of Malaysia, and is distributed within the lowland, hill and upper hill dipterocarp forests (Suratman et al., 2015). It is listed as one of the most threatened tree families with a total of 92 taxa listed in various levels of threats (i.e., 15 taxa critically endangered, 35 taxa endangered and 42 taxa vulnerable). According to Saw et al. (2010), 34 of the species are endemic to Peninsular Malaysia and 39 species have narrow distribution. They are often characterized by small population sizes, limited geographic distribution and specific habitat requirements. The rarest threatened species of this family (i.e., 29 species) are found in the coastal hills (Saw et al., 2010). *Dipterocarpus semivestitus* (Keruing padi) is one of critically endangered species of Dipterocarpaceae that has a restricted distribution and endemic to the freshwater swamp forests of Parit Forest Reserve, Perak (Suratman et al., 2014). This species can only be found in Parit Forest Reserve, Perak in which only 53 individuals remain intact in the swamp forests (Chua et al., 2010).

As one of twelfth megadiversity country, Malaysia is home to the most endangered species in the world. The list of threatened species of Dipterocarpaceae has been initiated for Malaysia with a publication of the Malaysia Plant Red List (Chua et al., 2010). The list is the most comprehensive national threatened tree species under this family thus far, and the first of such prepared by the Malaysian botanists working together. This Red List is used to classify Peninsular Malaysian Dipterocarpaceae species at high risk of extinction for assessment at the national level. It covers dipterocarp taxa that are indigenous to Peninsular and taxa that are common to the peninsula, Sabah and Sarawak. *Vatica flavida* (Resak padi), *Hopea apiculata* (Resak melukut), *Shorea hemsleyana* (Cengal pasir daun besar) and *S. macrantha* (Meranti kepong hantu) are the other endangered species in the family of Dipterocarpaceae that have been reported to have restricted distribution in the said area. These species have suffered reductions in their population sizes due to land use changes that disrupt their habitats. Much of the area of their habitats has been developed into urban sites leaving very small fragments of isolated swamps. This has caused a very little is known about the biological requirement of the species so far. Therefore, this work aimed at

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studying the demographic structure of endangered dipterocarps and mapping their spatial distribution in the freshwater swamp forest remnants at Parit Forest Reserve, Perak, Malaysia.

## 2.0 Materials and Methods

This study was conducted in the 12.4-ha freshwater swamp forests within the Universiti Teknologi MARA (UiTM) Perak branch, Seri Iskandar campus ground. The forest is part of Parit Forest Reserve, Perak, Malaysia (Fig.1). The area lies between the latitude of 4° 21' 21" N and longitude of 100° 57' 14" E with the topographical ranges from 20-45 m above sea level. The climate is characterized by warm temperatures range from 20-35°C. The weather is dry and warm from January till March with the lowest rainfall occurs in January (60-100 mm of rainfall). The highest rainfall occurs in October to November (i.e., 230-350 mm). Historically, the vicinity of the areas has experienced land use and land cover changes as a result from land development for townships, residential areas and university campuses. Some information about the study area was obtained from the field inventory conducted by the Forest Research Institute Malaysia (FRIM) in 2006. Based on this data, five endangered species of Dipterocarpaceae (i.e., *D. semivestitus*, *V. flavida*, *H. apiculata*, *S. hemsleyana* and *S. macrantha*) occur in the area were traced and relocated (Figs. 2a-e). All trees from these species with the diameter at breast height (DBH)  $\geq$  one cm were enumerated and recorded. Demographic structure is used by previous researchers to determine tree population characteristics for many purposes. One of the them is to study the trends of regeneration of tree population. In this study, field measured DBH were classified into nine size classes (i.e., 1 – 4.9 cm, 5 – 9.9 cm, 10 – 14.9 cm, 15 – 19.9 cm, 20 – 24.9 cm, 25 – 29.9 cm, 30 – 34.9 cm, 35 – 39.9 cm and > 40 cm) and plotted against the tree frequency. The spatial data of trees were recorded using Global Positioning System (GPS) receiver.

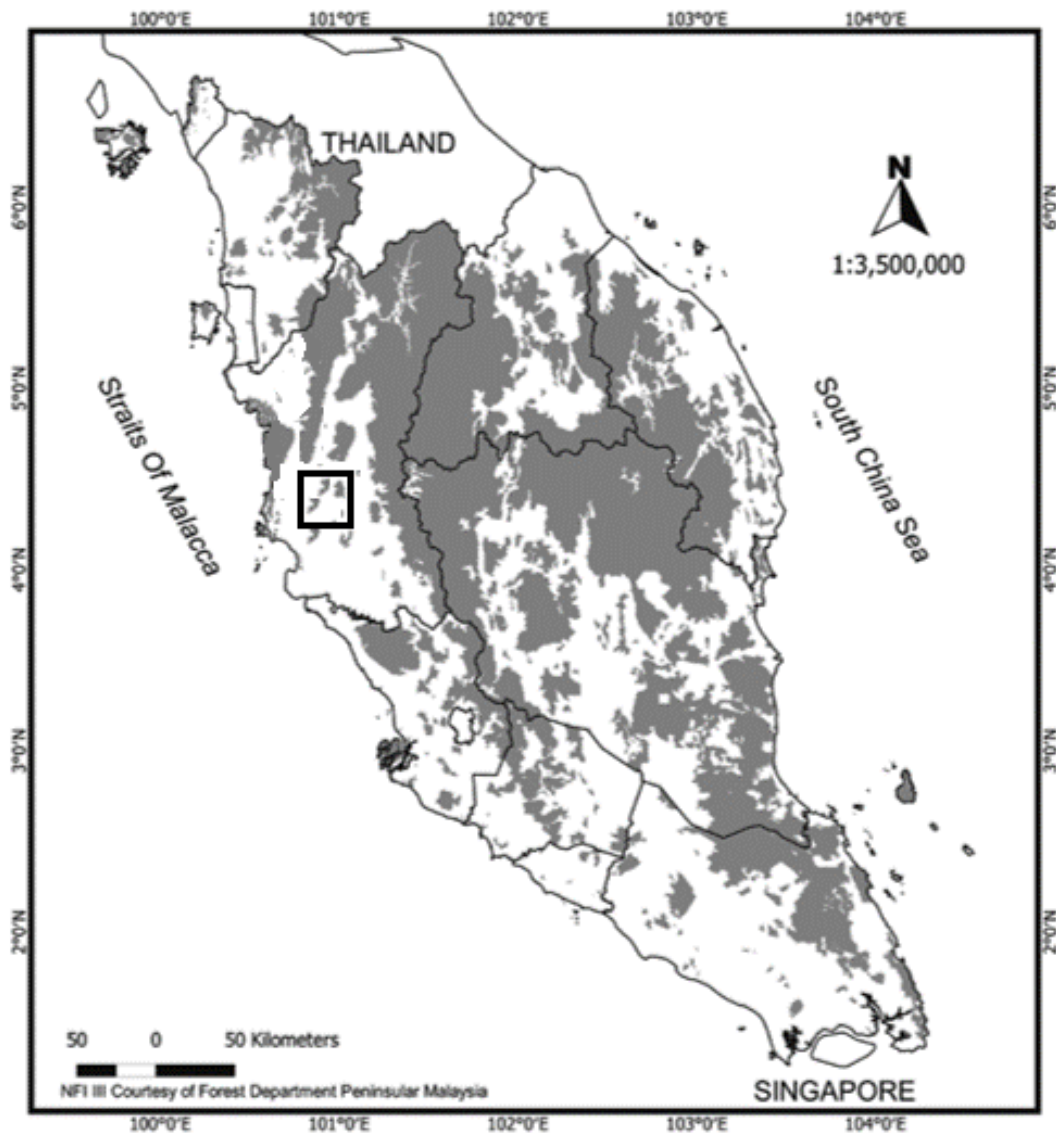


Fig. 1: Map of Peninsular Malaysia shows the location of a study area (in box) in Parit Forest Reserve, Perak, Malaysia (modified from Yong et al. 2021).

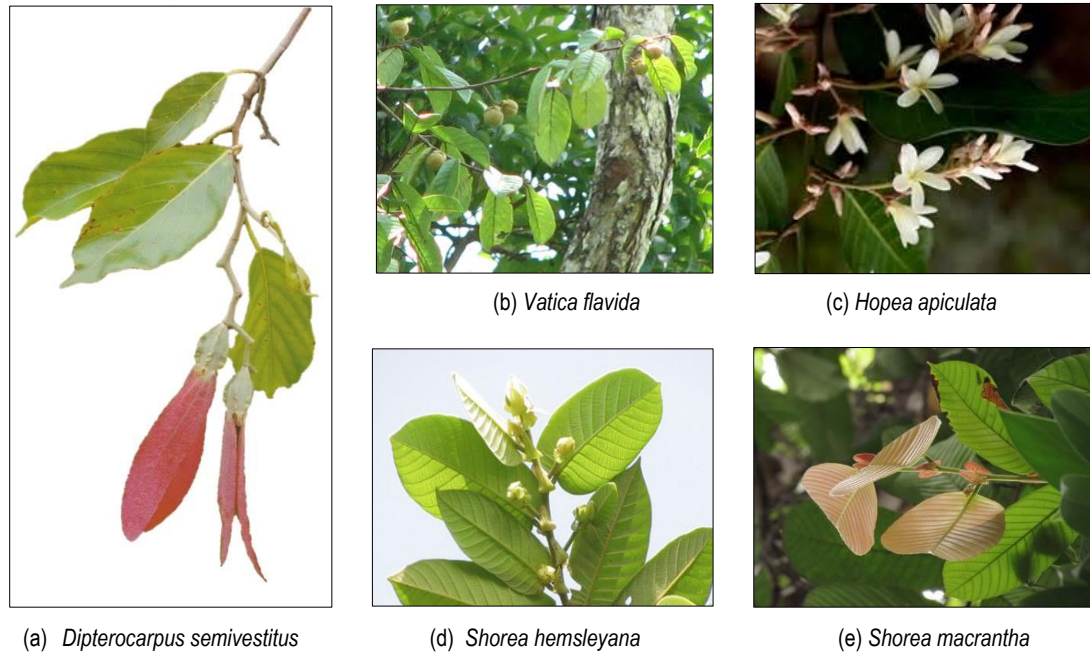


Fig. 2: Five endangered Dipterocarps species in Parit Forest Reserve, Perak, Malaysia.

A Geographic Information Systems (GIS) was used to analyse the geographical distribution of endangered species. This was done by overlying the spatial location of endangered species onto the image of habitat areas. The purpose was to visualize and analyze how the trees are spatially distributed in the landscape.

### 3.0 Results and Discussion

Analysis of diameter distribution of trees can be used to indicate whether the density of smaller trees in a stand is sufficient to replace the current population of larger trees to help potential forest regeneration. Information of the regeneration status of the stands has been an intrinsic part of forest conservation and management planning. The structure of diameter distribution within a stand is dependent on several factors namely the growth habit of the tree species (i.e., whether they are shade tolerance), ecological condition and the history of disturbance of management of the forest area.

#### 3.1 Diameter class frequency distribution

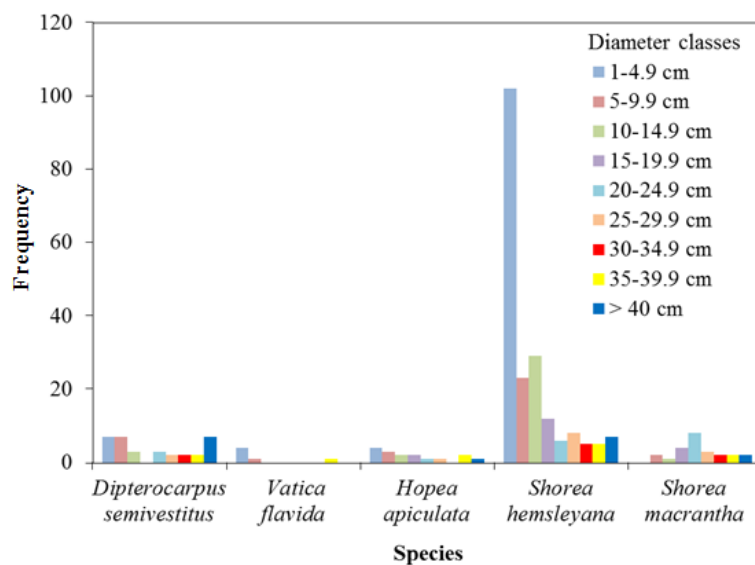


Fig. 3: Diameter class frequency distribution of five endangered Dipterocarps species in Parit Forest Reserve, Perak, for trees with > 1 cm.

For an uneven-aged stand, the frequency distribution typically displays the characteristic of De iocourt's factor procedure or inverse J-shaped distribution. However, small areas may normally be normally or bimodally distributed, but when small patches are added together, the overall effect may appear reverse-J distribution. In this study, only *S. hemsleyana* has the diameter class distribution of clear inverse J-shaped, where stems frequencies decrease with the increase in DBH (Fig. 3). For this species, stands appear to be developing with the presence of natural regeneration which may dependent on the availability of mother trees, fruiting patterns and favorable conditions (Suratman 2012). For *H. flavida* and *H. apiculata*, the diameter distribution appeared to be approximated inverse-J-shaped. However, the diameter distributions for *D. semivestitus* and *S. macrantha* appeared to be bimodal (i.e., two peaks in the curve) and normally distributed (bell-shaped), respectively. The lack of an inverse J-shaped diameter class distribution may be interpreted the risk to sustain regeneration. However, the inconsistency between diameter distributions of all species could also be artifact of a small size of populations which tend to reduce the observed frequency of trees in the smaller diameter-classes. This in turn results in bimodal- and bell-shaped rather than an inverse J-shaped frequency distribution.

As shown in Fig. 4, collectively the trees formed an inverse-J-shaped diameter distribution considered characteristics of many uneven-aged stands, as did the species in the freshwater swamp forest of Parit Forest Reserve. Below the 5-cm DBH class and majority of classes after that, *S. hemsleyana* are more abundant than the other four species. It is evident that the diameter structure of the curve is largely driven by this species. Overall, *S. hemsleyana* accounted for 71.5% (198 trees) of trees in terms of total number of individuals (i.e., 277 trees). However, for 20 – 24.5 cm diameter classes, *S. macrantha* is more abundant than the rest of the species. *S. hemsleyana* and *D. semivestitus* dominate trees with diameter classes greater than 40 cm.

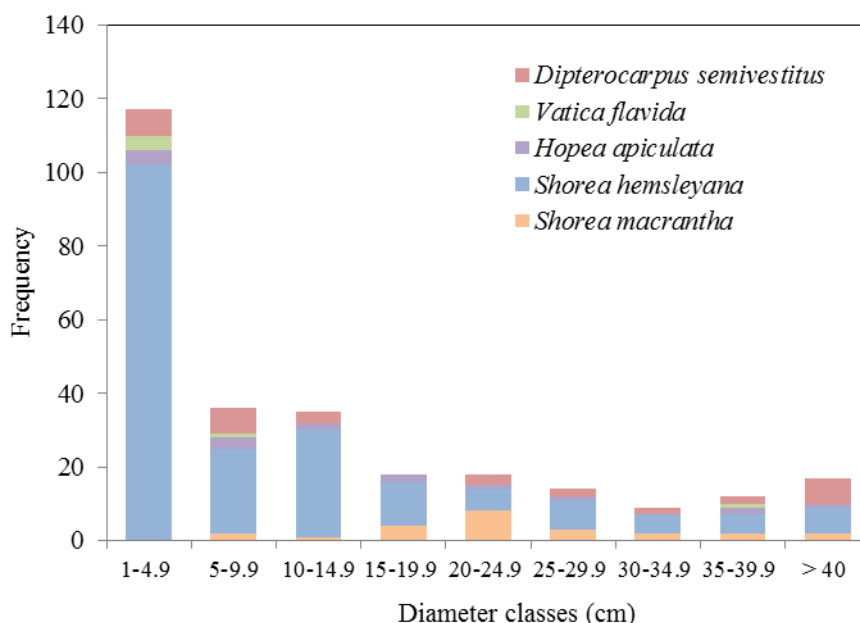


Fig. 4: Diameter classes vs. frequency distribution of species in the study area.

### 3.2 Conservation status

The conservation status of all species were assessed following the Malaysia Red List (Yong et al. 2021) and the IUCN Red List for Threatened Species (IUCN, 2022). In this study, of five species, *D. semivestitus*, *V. flavida* and *S. hemsleyana* are categorized as Critically Endangered (CR) and *H. apiculata* and *S. macantha* are classified as endangered based on Endangered (EN) based on the Malaysia Red List (Table 1). A similar conservation status categories for all species was obtained from IUCN assessment except for *S. macantha* which is categorized as CR. As mentioned aerlier, *S. hemsleyana* recorded the highest number of individuals discovered in the study area (i.e., 198), followed by *D. semivestitus* (35), *S. macrantha* (24), *H. apiculata* (14) and *V. flavida* (6). For *D. semivestitus*, the number of individuals found has reduced from what was previously reported. Chua *et al.* (2010) reported that 53 trees were located in this area. The lost 18 individuals of *D. semivestitus* was due to an illegal logging in the area in which took placed in 2012 and lightning strike in May 2014. Historical records reported that the species occurs in two locations, the current study location and Murabahan district, Central Kalimantan, Indonesia (Ashton, 1982). However, the population in Kalimantan was reported to have gone extinct due to forest conversion to oil palm plantations. Therefore, the freshwater swamp forests in Hutan Simpan Parit, Perak is likely the last population in the world.

Table 1. Conservation status assessment for five endangered species in the study area.

Latin and local name	Number of individuals	Conservation status	
		Malaysia Red List	IUCN
<i>D. semivestitus</i> (Keruing padi)	35	CR	CR



<i>V. flavida</i> (Resak padi)	6	CR	CR
<i>H. apiculata</i> (Resak melukut)	14	EN	EN
<i>S. hemsleyana</i> (Cengal pasir daun besar)	198	CR	CR
<i>S. macrantha</i> (Meranti kepong hantu)	24	EN	CR

Notes: CR=critically endangered, EN=endangered

### 3.3 Spatial distribution

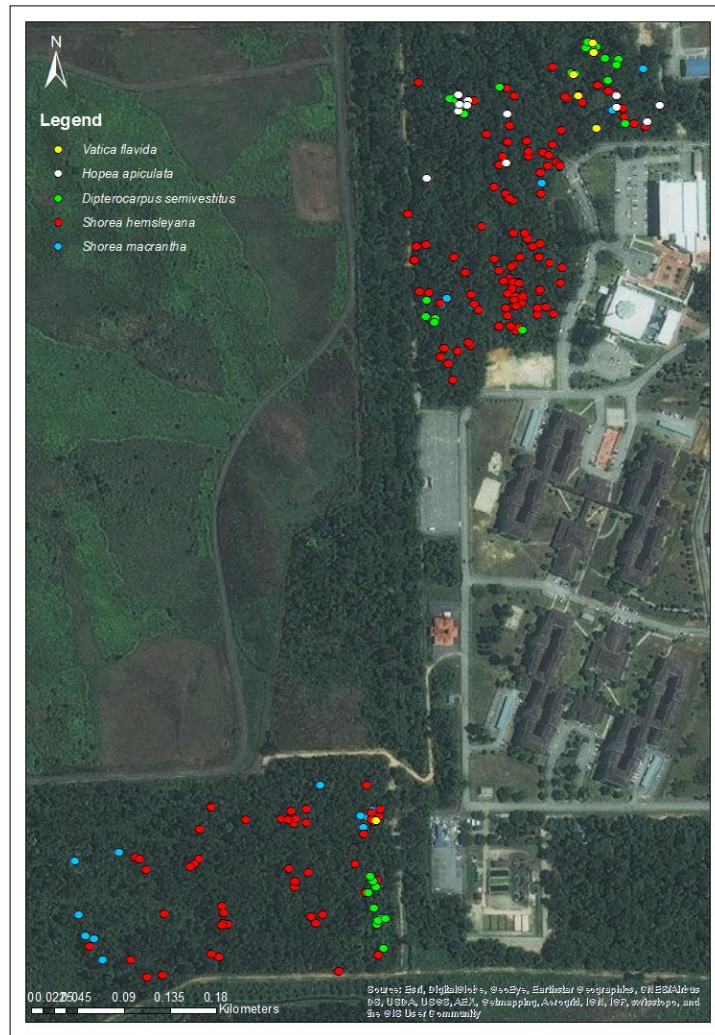


Fig. 5: Spatial distribution of five endangered species of Dipterocarpaceae in the freshwater swamp forests of Parit Forest Reserve, Perak, Malaysia.

The spatial distribution of five endangered species is shown in Fig. 5. From the map, distribution of four species i.e., *D. semivestitus*, *S. macrantha*, *H. apiculata* and *V. flavida* are appeared to be spatially dispersed. However, the spatial distribution of *S. hemsleyana* appears to be more localized compared to other species.

It can be observed from Fig. 5 that a great number of the individuals from *S. hemsleyana* and *D. semivestitus* are located at the forest edges. Forest edges prone to disturbance and experience more dramatic environmental changes. For instances, wind and sun dry out the forest edges which results in elimination of water sources for this sensitive habitat of freshwater swamp forest. Forest edges are also more exposed to vegetation clearing and urban development. Therefore, to address the further decline of biodiversity of tree species, it is essential that conservation plan be incorporated in the campus development plan and more efforts be undertaken to conserve these threatened species.

### 4.0 Conclusion

The findings of the study shows an alarming trend of Dipterocarps species in the study area with three species are listed as CR and two as EN. With the continuing threats and population declining to *D. semivestitus* in particular, conservation measures for this species is urgently needed. Factors that influence the reproductive phenology of Dipterocarps in the study area should be understood. At the

national level, forest management and protected area framework should incorporate habitat management and protection measures for threatened species. In addition, more High Conservation Value (HRV) areas should be established for threatened species. Involving stakeholders and local communities in biodiversity conservation can be the key success of a project. This can be achieved by raising awareness of the public and policy makers and enhancing engagement through institutional capacity building. The commitments and efforts of stakeholders to support the maintenance of *ex situ* collection is particularly crucial for species that occur on the private land. Furthermore, biodiversity conservation should be included as one of the key issues of sustainable development. In addition, the national priorities which include the conservation of natural heritage should be defined.

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