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The Distribution of Palms and *Pandans* in Teluk Bahang Permanent Forest Reserve, Penang

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ABSTRACT

Woody species of the coastal forest of Penang island have received substantial focus in term of their diversity, composition and spatial distribution. In comparison, comprehensive data on the non-woody plant species component, specifically the palms and *pandans*, are relatively lacking. The objective of this study was to provide baseline data on the non-woody component of Penang coastal forest flora which would become a platform for more extensive research on their population dynamic. In order to provide these baseline data, an assessment of the diversity and distribution of two non-woody families, namely palms and *pandans*, was conducted in Teluk Bahang Permanent Forest Reserve (TBPFR) located in Penang, from February 2005 to January 2008. One ha plot (100 metre x 100 metre) was established in the TBFR and all palms and *pandans* were enumerated and individual positions were recorded. A total of seven species of palms and two species of *pandans* (i.e. *Pandanus ovatus* and *Pandanus penangiensis*) were recorded. The most abundant palm species is *Eugeisona tristis*, with a total count of 551 individuals, whilst a total of 312 *P. ovatus* were also enumerated. Based upon the Morisita Standardized Modified Index of Dispersion, the distribution of the two monocots ranged from random to clumped distribution.

Keywords: Coastal forest, clumped distribution, non-woody species, Penang Island

INTRODUCTION

Arecaceae of palm family is a common sight in Malaysian forest (Turner, 1989; Gong & Ong, 1983; Manokaran, 1992). Studies have shown that *Eugeissona tristis* is one of the common palm species growing wild in most types of Malaysian forests, particularly under the canopy of giant Dipterocarpaceae (e.g. Aiken & Leigh, 1992; Fuller, 2000; Gavin *et al*., 1996). The plant also occupies the spaces immediately after the formation of tree gap (LaFrankie & Saw, 2005). In certain cases, *E. tristis* is able to form monospecific stands, which are at time impenetrable, under tropical forest canopy (Baker *et al*., 1998). Even though this species has no commercial value, a recent study has suggested that this species does play a role in protecting the soil surface from direct contact with rainfall and it also can suppress seedling growth (Montgomery & Chazdon, 2001).

Another common monocots that thrive on the forest floor is the member of Pandanaceae. Early studies have suggested the importance of Pandanaceae in terms of its biodiversity and phylogenetic study (see for example the early work by van Steenis, 1954; Kam, 1971; Stone, 1972). Among the locally known uses of pandan (e.g. *Pandanus odoratisimus* and *P. ovatus*) are such as in the traditional mat making industry, whereas they ecologically form a protective place for small mammals in the tropical forest (Whitmore, 1985). Nonetheless, studies on its

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exclusive impacts on the ecosystem and dynamic of forest are rather limited.

The distribution of *Arecaceae* in the tropical forest has been described by many authors (Uhl & Dransfield, 1987; Dransfield, 1992), but a more specific study of the Penang forest reserves is particularly lacking, especially for *pandans*. Many species of these plants occupy a small area and can be found on almost all soil types. Some studies have shown that many populations of animals and plants are aggregated in nature, and a few are spaced out in a regular pattern (e.g. Krebs, 2002). One reason for knowing these patterns is that they affect decisions about what method to use for estimating population density. However, the second reason for determining the pattern is to describe it objectively and explain it biologically (Krebs, 2002).

The objectives of this study were to describe the distribution pattern of these common species and to determine whether the pattern was related to soil condition, availability of light on the forest floor or a combination of these factors.

MATERIAL AND METHODS

Study Site

Teluk Bahang Permanent Forest Reserve (TBPFR) in Pulau Pinang (latitude 100° 12' 55.79" U and longitude 5° 15' 56.88" T) has been designated as an educational and recreational forest. This particular forest is bordered by bukit Laksamana Permanent Forest Reserve on the west side and Bukit Kerajaan Permanent Forest Reserve on the east. A preliminary survey of the TBPFR shows that both palm and *pandan* species are concentrated within the boundary recreational forest of the TBPFR (A. Mansor & R. Zakaria, pers. obs.). Thus, in order to assess palm and *pandan* diversity, only one ha plot was decided to be established. The one ha study plot within the TBPFR was a coastal hill lowland forest (*Fig. 1*) which is dominated by Anacardiaceae, Clusiaceae and Myrtaceae (Zakaria *et al.,* 2009).

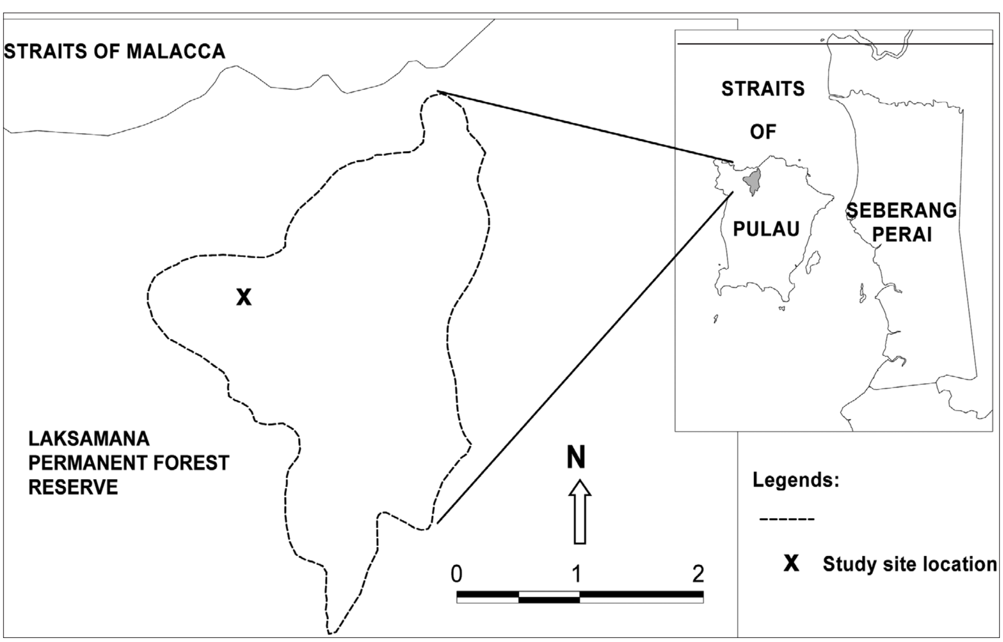

Fig. 1: Site location and the boundry of Teluk Bahang Permanent Forest Reserve, Penang, Malaysia.

Study Plot Design

This study was conducted between February 2005 to January 2008 at a one hectare plot (100 x 100 m) which had been randomly selected. The established study plot was divided into 100 quadrates with individual dimensions of 10 m x 10 m. Light illuminance was recorded using handheld digital Lux meter (Model: LX1010B), soil properties (i.e. soil type and soil pH) were tested using a method suggested by Bouyucos (1962), while temperature and humidity were recorded using HOBO® H8 Pro series Logger (Model: H08-031-08) from Onset Computer Corporation, USA. These parameters were recorded from four (4) randomly selected points within the study plot.

Species Assessment

All the palms with a height of 1 meter tall were recorded and mapped to the nearest 0.1 m in each quadrate. Using the Morisita Standardized Modified Index of Dispersion (MSMID; Krebs, 2002), the distribution pattern of the species was calculated. Meanwhile, the standardized Morisita Index of Dispersion (I_P) ranged from -1.0 to +1.0, with 95% confidence limits at +0.5 and -0.5. The random patterns gave I_P of zero, clumped patterns above zero, and uniform patterns below zero. The standardized Morisita Index is one of the best measures of dispersion because it is independent of population density and sample size. The recommended minimum sample size should be 50 quadrates, and that when the pattern is highly clumped, at least 200 quadrates are required (Krebs, 2002). The identification of the species was done based upon Whitmore (1972,1973) and Ng (1978, 1989).

RESULTS AND DISCUSSIONS

Limitation

There are two limitations on data interpretation and final outcome from this study. First, the study was designed to address the lack of data especially on non-woody component of TBPFR. Thus, the plot size was deliberately established as one ha plots with smaller size subplots and should be sufficient (see Putz & Chai, 1987; Appanah *et al.*, 1993). Second, the plot location was located within a hilly section of TBPFR and may contribute to low number of palm and *pandan* species.

Species Diversity and Composition

Seven species of palms and two species of *pandans* were recorded within the study plot (Table 1). Highest individual count was recorded for *Eugeissona tristis* (551 individuals) and only one individual plant was recorded for *Oncosperma tigillarium*. In terms of individual occurrences for *pandan*, *Pandanus ovatus* is the most abundant (312 clump count) compared to *Pandanus penangensis* (62 clump count). Statistical analysis shows that *E. tristis* and *P. ovatus* are the two most common palm and *pandan* found in this study site (Table 1). The distribution pattern calculated for palm and *pandan* shows that, at 95 % confident level, both families are distributed randomly toward clumping with the index reading of between 0 to 1 (Table 2). From the observation of the surrounding habitat, *O. tigillarium* adapt well in damp and wet habitats but less likely to establish on a higher ground. In addition, Putz & Chai (1987) stated that climbing palm (rattan) were more abundant on ridges than valleys. This could also explain the low number of palm species recorded in this study especially *Calamus exilis*.

Distribution

The finding in MSID shows that, all major species are distributed randomly to clump (Table 2; *Fig. 2*). According to Baker *et al*. (1998) and Tomlison (1979), the distribution of this type of plant is influenced by light availability. Monocotyledons are random-clumply distributed whereas large main dicotyledon are randomly distributed (Index near to 0). This type of dispersion is largely light oriented which reflected by the *pandans* and palms composition. These two families are commonly thrived under low light intensity (Baker *et al*., 1998; Tomlison, 1979).

TABLE 1
The statistical information of all Arecaceae and Pandanaceae found in the Teluk Bahang Forest Reserve study site.

Family	Species	Count	Mean	Std. Dev
Arecaceae	*Calamus exilis*	9	0.36	0.86
	Eugeissona tristis	551	22.04	13.15
	Licuala longipes	55	2.2	2.43
	Myrialepis scortechinii	58	2.32	2.72
	Oncosperma tigillarium	1	0.04	0.20
	Pinanga malaiana	67	2.68	2.69
	Plectocomia griffithii	36	1.44	1.85
Pandanaceae	*Pandanus ovatus*	312	12.48	1.40
	Pandanus penangensis	62	2.48	2.45

TABLE 2
Arecaceae and *Pandan*aceae dispersion in TBFR based on Morisita's Modified Index.

Parameters	*E. tritis*	*L. longipes*	*P. penangensis*	*M. scortechinii*	*P. ovatus*
Sample size (number of plots)	100	100	100	100	100
Frequency	545	59	62	58	309
Mean	5.45	0.59	0.62	0.58	3.09
Variance	21.08	1.13	1.35	1.30	20.16
Ratio of variance/mean	3.87	1.92	2.18	2.24	6.52
Chi-square	382.89	190.15	215.42	221.31	646.02
Morisita's index	1.52	2.57	2.91	3.15	2.78
Modified Morisita's Index	0.50	0.51	0.51	0.51	0.51
Type of distribution	*	*	*	*	*

Notes: * = clumping dispersion. Other Arecaceae found are not included in this analysis due to their low number of frequency detected in TBFR, thus their dispersion pattern need wider study plots.

Other possible explanation is palm is probably clumped together as water surface flowing on the forest floor is likely to wash away the seeds. However, we cannot confirm this particular event and suggested for a more in-depth study to be conducted in future.

Forest Ecology

The forest canopy in most part of the study site are continuous with only a few small gap (Mansor & Zakaria, pers. obs.), therefore the light illuminance recorded for 12 month on the forest floor never exceeded 2000 Lux at 1200 H as most of the light are captured by the upper forest canopy and less than 5 % of light penetrate to the ground (Montgomery & Chazdon, 2001; Table 3). This phenomenon has been described by Dorothy *et al*., (2001) which stated that light is very unlikely to penetrate to the forest floor during early morning and late evening. In addition, at times only 1% of sunlight ever reached the forest floor while mean temperature ranged from 24.9^{o}C to 29.5^{o}C and humidity from 85% to 95% (MSTEM, 1997).

Importance and implication for conservation

Palm family can be a primary target for conservation, due to their richness and abundance of taxa, their occurrences in all strata of forest as well as their importance as source of food

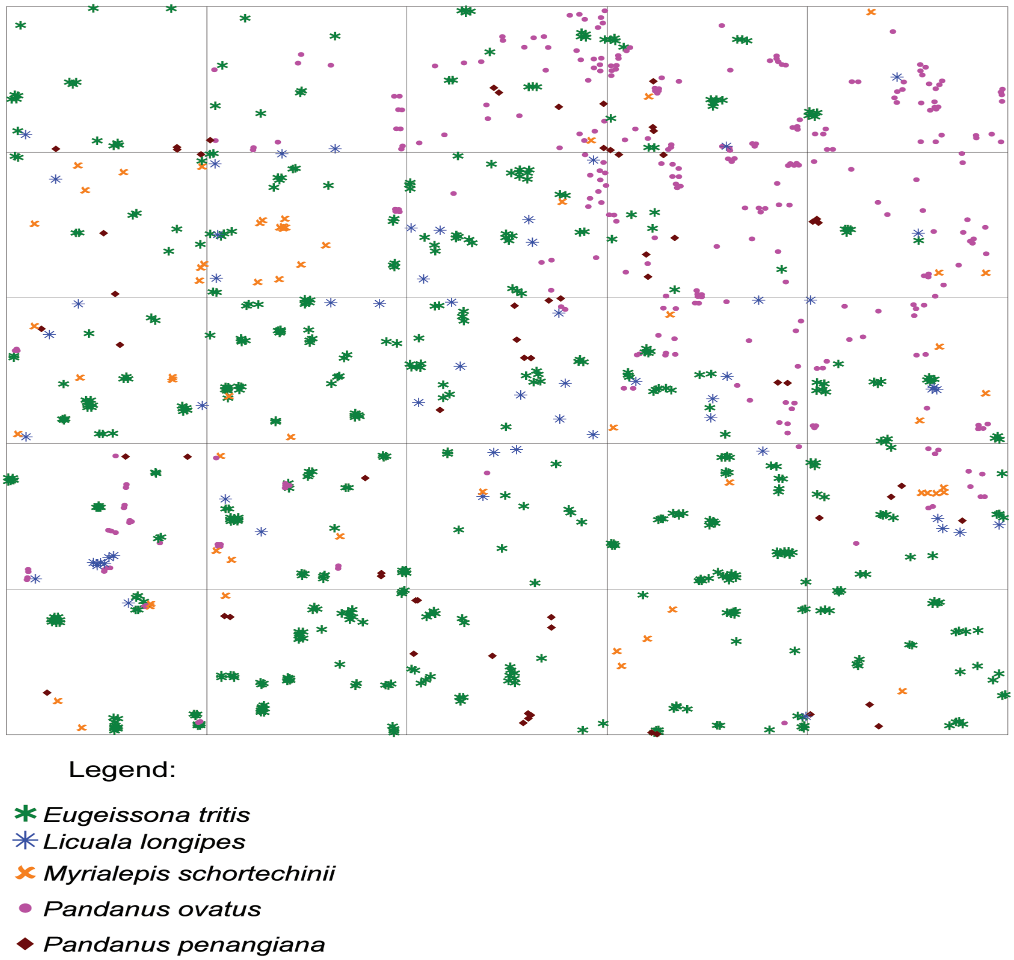

Fig. 2: Distribution of Arecaceae and Pandanaceae within the one ha study plot. Other Arecaceae found are not included in this because their number detected in TBFR is very low, thus their dispersion pattern is non-detectable.

for wild life (Terborgh, 1986). This may also applicable to the *pandan* family. According to a recent finding, *pandans* can also play an important part in providing shelter for small gecko (*Phelsuma cepediana*), which in turn act as a pollinator of another rare endemic plant, *Trochetia blackburniana* of Mauritius island growing nearby (see Hansen *et al.*, 2007). It is important to note that this particular information on plant-animal interaction is still lacking especially for coastal forest ecosystem (e.g. Penang Island), thus more research on this aspect is highly recommended. In general for non-woody species exclusively in Penang, the information on their population dynamics and how the biotic and abiotic components regulate their propagule distribution is still a big gap and would necessitate further investigation.

CONCLUSION

The composition and distribution of these two non-woody group of plant, namely palm (Arecaceae) and *pandan* (Pandanaceae) are regulated by light hence the regulated distribution pattern. In addition, the runoff water on the forest

TABLE 3
Average values for soil pH, air temperature, relative humidity, light illumination and soil type, recorded *in-situ*.

Parameter	Value (mean ± sd)
Soil pH	4.42 ± 0.16
Daily temperature at 1200H	28.167 ± 0.363 (n=12 reading)
Relative Humidity at 1200H	85.392 ± 2.849 (n=12 reading)
Light at 1200H	1341.7 ± 155.00 Lux (Highest around 1200 H to 1300 H, n=12 reading)
Soil type	Sandy loam

floor in addition to the location of study plot (i.e. hilly) are a probable cause for the clumped distribution observed for some palms and *pandans*, as seeds (or propagule) were washed and deposited at certain location. However, more experimental data is needed to further confirm this claim and future research is on its way.

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