

PLANT CONSERVATION STATUS AND SPECIES DIVERSITY OF HUTAN LIPUR JERAM LINANG, KELANTAN

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Abstract: A study to determine plant species diversity and the conservation status of a hilly lowland forest of Hutan Lipur Jeram Linang in Kelantan was carried out within 0.1 ha plot. All vascular plants (except lianas and epiphytes) were enumerated and identified. A total of 255 taxa representing 121 species belonging to 87 genera in 47 families were identified. Among these were 24 species endemic to Peninsular Malaysia and 47 species with medicinal values. Plants were categorized according to growth forms as follows: 67% trees, 17% shrubs, 7% palms, 6% herbs, and 3% ferns. Based on Important value index (IVI), *Elateriospermum tapos*, *Goniothalamus umbrosus*, and *Monocarpia marginalis* were the most dominant species whilst Rubiaceae, Arecaceae and Fabaceae were the three most diverse families. Species diversity was high based on the Shannon-Weiner index with the value of 4.38. In this study, two species from Dipterocarpaceae, which were *Dipterocarpus grandiflorus* and *Shorea collina*, were listed as Endangered (E) and Critically Endangered (CE) species respectively according to IUCN Red List. Information gained from this study showed that the forest harbored high plant diversity and endemism, so proper management is needed to protect and conserve this forest for sustainability and development.

Keywords: Plant diversity, hilly lowland forest, medicinal plant, endemism, conservation status.

Introduction

Malaysia is rich in plant biodiversity with over 2,800 species of trees documented in The Tree Flora of Malaya (Whitmore, 1972; 1973 & Ng, 1978; 1989). However, it is estimated that there are about 15,000 species of flowering plants (Bidin & Latiff, 1995) and more than 1,170 species of ferns (Parris & Latiff, 1997) in Malaysia. For Peninsular Malaysia alone, more than 8,500 species of seed plants have been catalogued (Turner, 1995) so far. However, the documentation of floral diversity in Malaysia is far from complete as the areas in Sabah and Sarawak have not been actively surveyed botanically yet.

As a global hotspot, plant biodiversity and conservation of these unique life forms in Malaysia merit special attentions to avoid becoming endangered plants. But nowadays, Malaysian tropical rainforests are highly exposed to the globalization development for human purposes. Consequently, Malaysia has been losing much of its natural resources including plants and animal species through habitat degradation, forest fragmentation,

commercial logging, introduction of exotic species and local climate change. IUCN-World Conservation Union Biodiversity Report indicates that Malaysia has more endangered plant species than any other countries in the world (IUCN 2010). The report suggests that, in the last 50 years, about two per cent or about 170 of the estimated 12,500 species of flowering plants in Peninsular Malaysia have become extinct. For Peninsular Malaysia, there are more than 2830 tree species, but 400 tree species have been exploited for timber and other forest products (Latiff, 2011).

In Peninsular Malaysia, forest inventories at the macro-level were conducted to collect and generate some information on the forest resources (Masran & Samsudin, 1996). In view of Malaysia's vast biological diversity, it is a heavy task to document and conserve all plant species present. However, investigations into plant diversity and conservation value of forests play vital roles in providing information on species richness of the plants and the changes that they undergo that can potentially be useful for management purposes and assist

in understanding forest ecology and ecosystem functions. With urban development putting pressures on tropical forests, there is urgency to document the plant diversity of Malaysian forest.

Hutan Lipur Jeram Linang is one of the most well-known recreational forests located in Ulu Sat Forest Reserved, Machang Kelantan. This virgin forest comprising 1, 026 ha has been developed since 1983 with 10 ha development equipped with infrastructure to attract visitors. To date, no plant diversity and conservation studies have been conducted at this area. Therefore, this study was carried out to document the plant diversity and serve as a stepping stone towards conservation and sustainable development of the forest.

Materials and Methods

Study Site

Hutan Lipur Jeram Linang (Figure 1) is located in Machang district, in the state of Kelantan (N 05° 44.52' E 102° 22.54'). The forest protects a watershed area supported by huge numbers of flora and fauna, with an average elevation of 153 meters above sea level. The climate is classified as a tropical wet, with a tropical moist forest bio-zone. The minimum and maximum temperature throughout Hutan Lipur Jeram Linang are 24 °C and 32 °C respectively, while the daily average temperature is 27 °C. The minimum and maximum relative humidity are 52% and 92% respectively, while the average relative humidity is recorded at 78% (JPSM, 2010). This forest falls under the jurisdiction of State Forest Department of Kelantan for its restoration and maintenance activities.



Figure 1: Sampling area at Hutan Lipur Jeram Linang, Kelantan (Source: Google Maps)

Data collection

A 0.1 hectare (50 m x 20 m) of belt transect plot was established systematically at the study site. The plot was then divided into ten subplots. The plant sampling focused only on certain life form of plants, which were trees, shrubs, ferns and herbaceous plants. Climbers and epiphytes were excluded in this study. The sampled species were divided into four main categories:

- i. All tree species with Diameter Breast Height (DBH) above 5 cm
- ii. Saplings and small shrubs with DBH below 5 cm
- iii. Seedlings below 1.3 m in height
- iv. Herbaceous plants and ferns

In each plot, the plants were counted for their number of individuals. For each plant species, the tree diameter and height were measured and the number of individuals of each species was recorded in all plots, except for seedlings, ferns and herbs, where only the number of individuals

per species and basal diameter were calculated and recorded. Two samples of each species were collected for species identification, and voucher specimens were kept in the laboratory for future references.

Plant Identification

All the collected plant species were preserved and dried before the identification process started. The books “Tree Flora of Malaya” (Whitmore, 1972; 1973 & Ng, 1978; 1989) and “Flora of Peninsula” (Ridley, 1922; 1923; 1924; 1925) were used as references for the plant identification. All plants were identified to the lowest taxonomic level according to their morphological characteristics.

Data Analysis

For species diversity, Shannon-Weiner index (H'), (as in Magurran, 1988), was calculated. Relative density, relative frequency, relative dominance and importance value index (IVI) were calculated according to Cottam and Curtis (1956). For this study, the conservation value of the sampled plants only included two main portions, which were their conservation status and endemism. The conservation status for each species was identified using IUCN Red List whilst endemic species was referred to Ng et al. (1990). Plants species with potential medicinal values were identified using the “Economic Products of Malay Peninsula” (Burkill, 1935) and Compendium of Medicinal and Aromatic Plants Asia (Volume 2) (Handa et al. 2006).

The Importance Value index (IVI) is calculated as shown below:

- 1) Importance Value = Relative Density + Relative Dominance + Relative Frequency
- 2) Diversity index is used to determine species abundance in one particular area. This index is calculated as shown below:

$$H' = - \sum p_i \log_e p_i$$

Results and Discussion

Floristic Composition

A total of 349 vascular plants representing 121 species belonging to 87 genera in 47 families were identified within 0.1 ha of Hutan Lipur Jeram Linang (Table 1). These plants comprised 4.2% species, 16% genera and 44% families of the total taxa found in Peninsular Malaysia. Plants were categorized according to growth forms as follows: 67% of all species were trees (232 individuals), 17% shrubs (59 individuals), 7% palms (25 individuals), 6% herbs (21 individuals), and 3% ferns (12 individuals) (Figure 2). The three highest families collected across all categories were Rubiaceae with 11 species, followed by Arecaceae (9 species), Fabaceae (7 species) and Euphorbiaceae (6 species) (Fig 2). Euphorbiaceae was the most abundant family with the largest number of individuals per hectare (11.7% of plants), followed by Annonaceae (8.3%), and Arecaceae (6.9%) (Figure 3). In terms of individual's composition, the study area was dominated by three most abundant tree species, namely *Elateriospermum tapos* (Euphorbiaceae), *Goniothalamus umbrosus* (Annonaceae) and *Monocarpia marginalis* (Annonaceae). For herbaceous, the three most abundant species were *Ardisia foliosa* (Myrsinaceae), *Iguanura wallichiana* (Arecaceae) and *Homalomena sagittifolia* (Araceae) (Fig 4).

This study showed that the study area had a high plant species diversity despite the smaller size of plot (0.1 ha) compared to other previous studies at Bukit Belata Forest Reserve, Selangor (0.2 ha) that recorded 127 species belonging to 82 genera and 37 families (Nizam et al. 2008) and 173 species belonging to 100 genera and 44 families of 0.24 ha at Panti Forest Reserve, Johor (Nizam et al. 2009). Meanwhile, Juliana et al. (2005) recorded 45 and 65 species in two study plots of 0.2 ha at Ulu Muda Forest Reserve, Kedah. Euphorbiaceae was the dominant family based on the number of individuals in this study which was consistent with studies of lowland forest at Pasoh Forest Reserve (Kochumen et al. 1990), Gunung Stong Forest Reserve (Nizam et al. 2008) and Panti Forest Reserve (Nizam et al. 2009).

Table 1: Total list of species found within 0.1 ha at Hutan Lipur Jeram Linang.

No	Family	Species	Local Name	Life form
ANGIOSPERMS				
Monocotyledonous				
1	Araceae	<i>Homalomena sagittifolia</i>	Keladi Kemoyang	Herb
2	Arecaceae	<i>Arenga hookeriana</i>	Sugar Palm	Palm
3	Arecaceae	<i>Arenga pinnata</i>	Kabong	Palm
4	Arecaceae	<i>Calamus</i> sp. 1	Rotan	Palm
5	Arecaceae	<i>Calamus</i> sp. 2	Rotan	Palm
6	Arecaceae	<i>Iguanura</i> sp. 1	Mapau Kalui	Palm
7	Arecaceae	<i>Iguanura</i> sp. 2	Tronok	Palm
8	Arecaceae	<i>Iguanura wallichiana</i>	Tronok	Palm
9	Arecaceae	<i>Licuala sallehana</i>	-	Palm
10	Arecaceae	<i>Pinanga scortechinii</i>	Pinang	Palm
11	Aristolochiaceae	<i>Thottea dependens</i>	Telinga Kelawar	Herb
12	Cyperaceae	<i>Mapania cuspidata</i>	Serapat	Herb
13	Hypoxidaceae	<i>Molineria capitulata</i>	Lemba	Palm
14	Maranthaceae	<i>Stachyphrynium cylindricum</i>	Tong Sat	Herb
15	Musaceae	<i>Musa gracilis</i>	Pisang Hutan	Herb
16	Taccaceae	<i>Tacca integrifolia</i>	Janggut Adam	Herb
17	Taccaceae	<i>Tacca palmata</i>	Keladi Murai	Herb
Dicotyledonous				
18	Anacardiaceae	<i>Mangifera gracilipes</i>	Medang	Tree
19	Anacardiaceae	<i>Melanochyla caesia</i>	Rengas Hitam	Tree
20	Anacardiaceae	<i>Swintonia robinsonii</i>	Merpauh	Tree
21	Anisophylleaceae	<i>Anisophyllea disticha</i>	Kayu Pacat	Tree
22	Annonaceae	<i>Cyathocalyx pruniferus</i>	-	Tree
23	Annonaceae	<i>Goniothalamus macrophyllus</i>	Selayak Hitam	Tree
24	Annonaceae	<i>Goniothalamus</i> sp.	Kenerak	Tree
25	Annonaceae	<i>Goniothalamus sumbrosus</i>	Kenerak	Tree
26	Annonaceae	<i>Monocarpia marginalis</i>	Mempisang	Tree
27	Aralidiaceae	<i>Aralidium pinnatifidum</i>	Hempedu Buaya	Shrub
28	Burseraceae	<i>Canarium littorale</i>	Asam	Tree
29	Burseraceae	<i>Dacryodes longifolia</i>	-	Tree
30	Burseraceae	<i>Triomma malaccensis</i>	-	Tree
31	Cannabaceae	<i>Gironniera hirta</i>	Hampas Tebu	Tree
32	Cannabaceae	<i>Gironniera nervosa</i>	Medang Kasap	Tree
33	Cannabaceae	<i>Gironniera parvifolia</i>	-	Tree

34	Clusiaceae	<i>Calophyllum macrocarpum</i>	Bintangor Bunut	Tree
35	Clusiaceae	<i>Garcina eugeniifolia</i>	Manggis Hutan	Tree
36	Clusiaceae	<i>Mesua ferrea</i>	Penaga Lilin	Tree
37	Clusiaceae	<i>Mesua grandis</i>	Penaga Bayan	Tree
38	Clusiaceae	<i>Mesua lepidota</i>	Penaga Tikus	Tree
39	Combretaceae	<i>Terminalia phellocarpa</i>	-	Tree
40	Dilleniaceae	<i>Dillenia reticulata</i>	Simpoh	Tree
41	Dipterocarpaceae	<i>Dipterocarpus cornutus</i>	Keruing Gombang	Tree
42	Dipterocarpaceae	<i>Dipterocarpus grandiflorus</i>	Keruing Belimbing	Tree
43	Dipterocarpaceae	<i>Shorea collina</i>	Red Balau	Tree
44	Ebenaceae	<i>Diospyros lanceifolia</i>	Kayu Arang	Tree
45	Ebenaceae	<i>Diospyros sumatrana</i>	Kayu Malam	Tree
46	Ebenaceae	<i>Diospyros trengganuensis</i>	Kayu Arang	Tree
47	Euphorbiaceae	<i>Aporosa arborea</i>	-	Tree
48	Euphorbiaceae	<i>Baccaurea parviflora</i>	Semambun	Tree
49	Euphorbiaceae	<i>Croton caudatus</i>	Alimpai	Shrub
50	Euphorbiaceae	<i>Croton oblongus</i>	Randang Jagong	Tree
51	Euphorbiaceae	<i>Drypetes longifolia</i>	Mintulang	Tree
52	Euphorbiaceae	<i>Elateriospermum tapos</i>	Perah	Tree
53	Fabaceae	<i>Archidendron jiringa</i>	Niang	Tree
54	Fabaceae	<i>Callerya atropurpurea</i>	Purple Milletia	Tree
55	Fabaceae	<i>Cynometra malaccensis</i>	Kekatong	Tree
56	Fabaceae	<i>Fordia albiflora</i>	-	Tree
57	Fabaceae	<i>Pithecellobium bubalinum</i>	Buah Kerdas	Tree
58	Fabaceae	<i>Saraca thaipingensis</i>	Gapis	Tree
59	Fabaceae	<i>Sindora</i> sp.	Sepetir	Tree
60	Fagaceae	<i>Lithocarpus rassa</i>	Berangan Babi	Tree
61	Icacinaceae	<i>Gomphandra qudrafida</i>	Bakok	Shrub
62	Ixonanthaceae	<i>Ixonanthes icosandra</i>	Pagar Anak	Tree
63	Lauraceae	<i>Alseodaphne</i> sp.	Nethane	Tree
64	Lauraceae	<i>Cinnamomum mollissimum</i>	Pokok Teja	Tree
65	Lauraceae	<i>Dehaasia longipetiolata</i>	-	Tree
66	Lecythidaceae	<i>Barringtonia racemosa</i>	Putat	Tree
67	Malvaceae	<i>Scaphium macropodum</i>	Kembang Semangkuk	Tree
68	Malvaceae	<i>Scaphium scaphigerum</i>	Kapas-kapas	Tree
69	Melastomataceae	<i>Pternandra echinata</i>	Sial Menahun	Tree
70	Meliaceae	<i>Aglai exstipulata</i>	-	Tree
71	Meliaceae	<i>Sandoricum koetjape</i>	Kelampu Bukit	Tree
72	Moraceae	<i>Artocarpus elasticus</i>	Terap Nasi	Tree
73	Moraceae	<i>Artocarpus scortechinii</i>	Merawan	Tree

74	Moraceae	<i>Streblus elongatus</i>	Tempinis	Tree
75	Myristicaceae	<i>Horsfieldia brachiata</i>	-	Tree
76	Myristicaceae	<i>Knema laurina</i>	-	Tree
77	Myrsinaceae	<i>Ardisia foliosa</i>	-	Shrub
78	Myrsinaceae	<i>Ardisia wrayi</i>	Mata Pelanduk	Shrub
79	Myrtaceae	<i>Syzygium claviflorum</i>	Gelam	Tree
80	Myrtaceae	<i>Syzygium grande</i>	Kelat	Tree
81	Myrtaceae	<i>Syzygium lineatum</i>	Kelat Putih	Tree
82	Olacaceae	<i>Ochanostachys amentacea</i>	Petaling	Tree
83	Olacaceae	<i>Scorodocarpus borneensis</i>	Kulim	Tree
84	Pandanaceae	<i>Pandanus</i> sp.	Pandan Hutan	Shrub
85	Phyllantaceae	<i>Antidesma cuspidatum</i>	Sebasah	Tree
86	Phyllantaceae	<i>Antidesma lycopodium</i>	Jarupis	Tree
87	Phyllantaceae	<i>Antidesma neurocarpum</i>	Kemuning	Tree
88	Phyllantaceae	<i>Antidesma orthogyne</i>	Beberas Pachat	Shrub
89	Phyllantaceae	<i>Antidesma</i> sp.	-	Tree
90	Polygalaceae	<i>Xanthophyllum bullatum</i>	Nyalin	Tree
91	Polygalaceae	<i>Xanthophyllum affine</i>	Minyak Beruk	Tree
92	Polygalaceae	<i>Xanthophyllum griffithii</i>	Nyalin	Tree
93	Polygalaceae	<i>Xanthophyllum rufum</i>	Kayu Ampang	Tree
94	Rhizophoraceae	<i>Gynothroces axillaris</i>	Mata Keli	Tree
95	Rhizophoraceae	<i>Pellacalyx saccardianus</i>	Membuluh	Tree
96	Rubiaceae	<i>Chassalia chartacea</i>	Jejarum	Shrub
97	Rubiaceae	<i>Chassalia curvifolia</i>	Beberas	Shrub
98	Rubiaceae	<i>Diplospora malaccensis</i>	Kahwa Hutan	Tree
99	Rubiaceae	<i>Gaertnera obesa</i>	-	Shrub
100	Rubiaceae	<i>Gaertnera oblanceolata</i>	Mengudu	Tree
101	Rubiaceae	<i>Ixora javanica</i>	Jejarum	Shrub
102	Rubiaceae	<i>Lasianthus griffithii</i>	-	Shrub
103	Rubiaceae	<i>Nauclea officinalis</i>	Bebangka	Tree
104	Rubiaceae	<i>Neonauclea lanceolata</i>	Bengkal Udang	Tree
105	Rubiaceae	<i>Urophyllum macrophyllum</i>	-	Shrub
106	Rubiaceae	<i>Urophyllum ferrugineum</i>	-	Shrub
107	Sapindaceae	<i>Xerospermum noronhianum</i>	Menmangas	Tree
108	Sapotaceae	<i>Madhuca malaccensis</i>	Basong	Tree
109	Sapotaceae	<i>Payena lanceolata</i>	Nyatoh ekor	Tree
110	Sapotaceae	<i>Payena lucida</i>	Baringin Jiput	Tree
111	Sapotaceae	<i>Payena obscura</i>	-	Tree
112	Symplocaceae	<i>Symplocos cerasifolia</i>	-	Tree
113	Theaceae	<i>Gordonia multinervis</i>	-	Tree

114	Tiliaceae	<i>Pentace floribunda</i>	-	Tree
115	Tiliaceae	<i>Pentace grandiflora</i>	-	Tree
116	Tiliaceae	<i>Schoutenia accrescens</i>	Bayur Bukit	Tree
117	Verbenaceae	<i>Vitex pinnata</i>	Leban	Tree
118	Violaceae	<i>Rinorea javanica</i>	-	Tree
119	Unknown	<i>Unknown sp.</i>	-	Tree

PTERIDOPHYTES

120	Dryopteridaceae	<i>Tectaria fissa</i>	-	Fern
121	Dryopteridaceae	<i>Tectaria singaporeana</i>	Singapore Fern	Fern

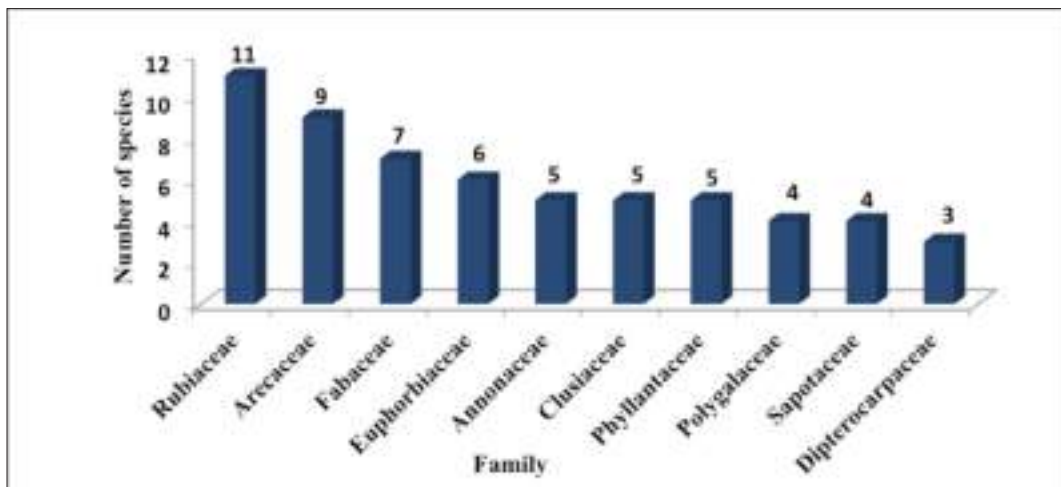


Figure 2: The highest families based on the number of species at Hutan Lipur Jeram Linang

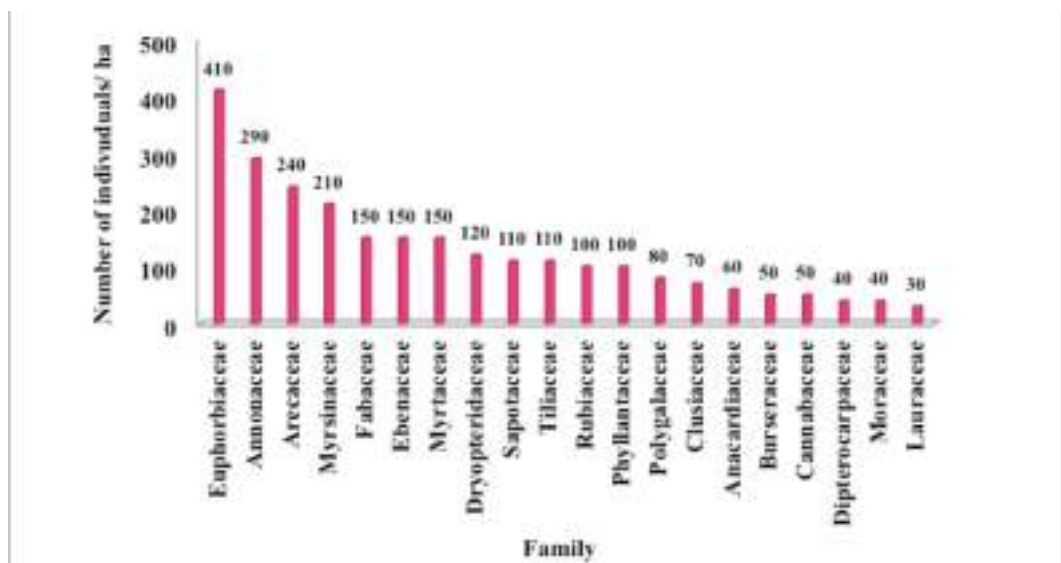


Figure 3: The most abundant families based on the number of individuals at Hutan Lipur Jeram Linang

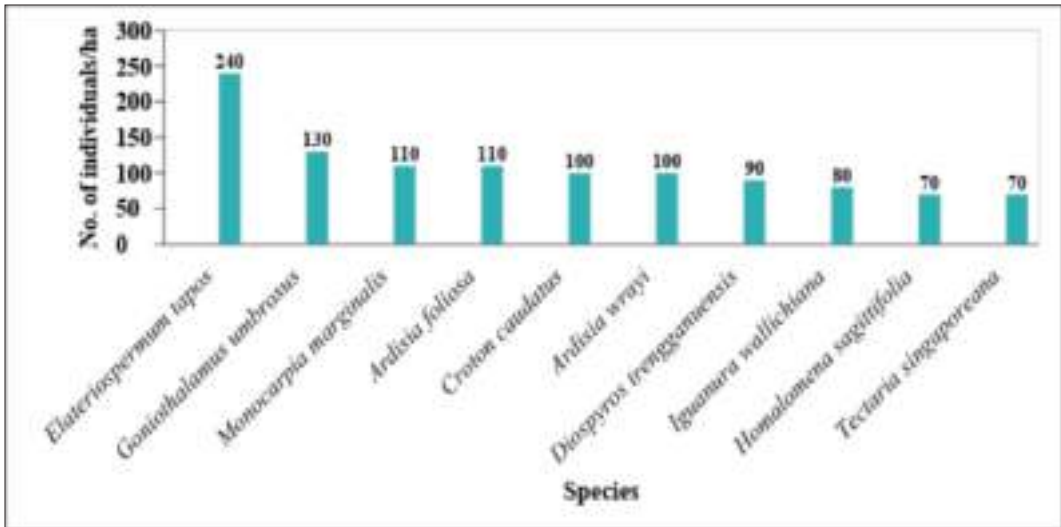


Figure 4: Ten most abundant species at Hutan Lipur Jeram Linang.

Community structure

Stem Diameter

The distribution of DBH classes showed reverse ‘J’ shape curve with 1800 ind/ha having DBH between 0.1-9.9 cm, 450 ind/ha or 15% of 10-19.9 cm dbh and 250 ind/ha of 20.0-29.9 cm DBH (Fig 5). Trees within class 0-9.9 cm DBH constituted an average of about 62% of individuals and the distribution for other classes declined dramatically in which 15%

of individuals belonged to the next higher range (10-19.9cm). However, several species i.e. *Cyathocalyx pruniferus*, *Dipterocarpus grandiflora*, and *Syzygium grandae* attained dbh > 60 cm represent 5% of the total individuals. The numbers of individual plants were decreasing with diameter size classes reflecting that this forest was high in regeneration as smaller dbh size tree dominated the forest more (Nizam *et al.* 2008).

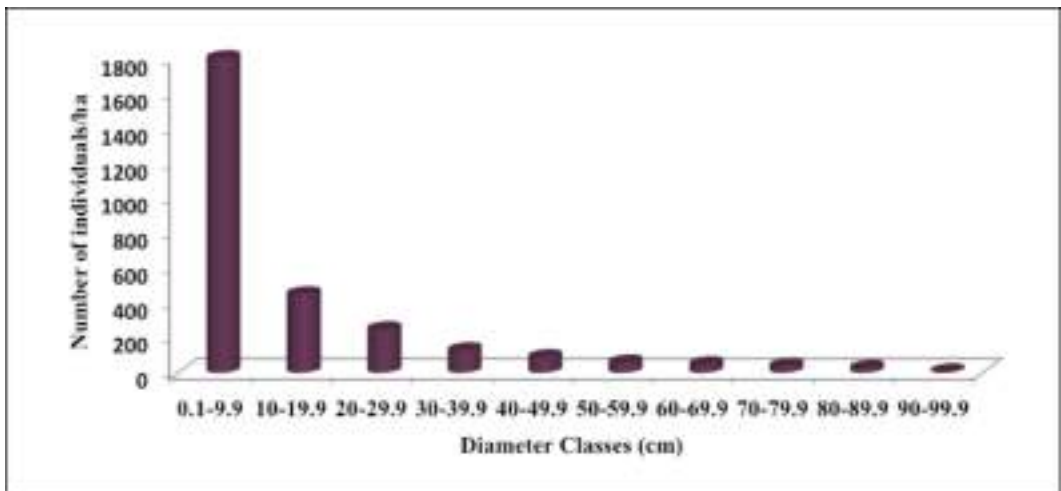


Figure 5: Distribution of trees per ha based on diameter size classes.

Importance Value Index (IVI)

The dominance of species present in Hutan Lipur Jeram Linang was determined by calculating the Importance Value Index (IVI) for each species. *Elateriospermum tapos*, *Goniothalamus umbrosus* and *Monocarpia marginalis* were the most dominant species based on IVI of 14, 8 and 6 respectively. *Ardisia foliosa*, *Iguanura wallichiana*, *Homolomena sagittifolia* and *Tectaria singaporeana* were the most dominant species for shrubs, palms herbs and fern based on IVI=6, 5, 4 and 4 respectively. *E. tapos* was also the most dominant species recorded at Pasoh Forest Reserve (Kochumen *et al.* 1990) and Pantl Forest Reserve (Nizam *et al.* 2009).

Species Diversity

In this study, the Shannon–Winner’s index (H') of species diversity was 4.38 (Table 3). This study showed that the diversity index of the forest was within the range of other studies such as H' = 4.94 at Pantl Forest Reserve, Johor (Nizam *et al.* 2009), H' = 4.31 Bukit Belata Forest Reserve (Nizam *et al.* 2008) and H' = 4.09 at Gunung Stong Forest Reserve (Nizam *et al.* 2008). However, the diversity index of the study area was higher than the study by Juliana *et al.* (2005) at Ulu Muda Forest Reserve (H' = 3.02).

Table 3: Diversity indices from different forest reserve

Location	Shannon Weiner diversity index H'
Ulu Muda Forest Reserve (Juliana <i>et al.</i> 2005)	3.02; 3.84
Bukit Belata Forest Reserve (Nizam <i>et al.</i> 2008)	4.31
Pantl Forest Reserve (Nizam <i>et al.</i> 2009)	4.94
This study	4.38

Conservation Status and Endemism

A total of 19 species from this study are listed in the IUCN Red List (Table 4). *Dipterocarpus cornitus* and *Shorea collina* fall under Critically Endangered category whilst *Dipterocarpus grandiflorus* is under endangered category. Species under these categories are facing high risk of extinction. *Goniothalamus umbrosus*, *Xantophyllum bullatum*, *Gordonia multineris* and *Sindora* sp. are listed as vulnerable species. There are a number of ecological reasons as to why *Dipterocarps* may be sensitive to habitat degradation and fragmentation. Many species of Dipterocarpaceae have a low density of reproductive adults as they are insect-pollinated with recalcitrant seeds, the traits of which are likely to reduce the resilience of *Dipterocarp* forest to fragmentation (Aguilar *et al.* 2006). Therefore, the reduction in forest cover is leading directly to the endangerment, and local extinction of many plant and animal species (Sodhi *et al.* 2010), which may include *Dipterocarp*. Urgent attention is needed on the species that face higher risk of extinction, to prevent further reduction in their number of individuals which may lead to the local extinction.

In terms of endemism, 24 species represented by 20% from total identified species in this study were endemic to Peninsular Malaysia (Table 5). Of all endemic species, 67% belong to trees (16 species), 21% shrubs (5 species), 8% palms (2 species) and 4% herbs (1 species). The investigation of endemism and the conservation status of the species are getting increasingly important with issues of plant conservation to be dealt under current forest management practices (Faridah Hanum, 1999).

Table 4: Total species red-listed based of IUCN Red List within 0.1 ha at Hutan Lipur Jeram Linang

No.	Family	Species	Conservation status
1	Dipterocarpaceae	<i>Dipterocarpus cornutus</i>	Critically Endangered
2	Dipterocarpaceae	<i>Dipterocarpus grandiflorus</i>	Endangered
3	Dipterocarpaceae	<i>Shorea collina</i>	Critically Endangered
4	Meliaceae	<i>Aglaia exstipulata</i>	Near Threatened
5	Annonaceae	<i>Goniothalamus</i> sp.	Vulnerable
6	Annonaceae	<i>Goniothalamus umbrosus</i>	Vulnerable
7	Fabaceae	<i>Sindora</i> sp.	Vulnerable
8	Polygalaceae	<i>Xanthophyllum bullatum</i>	Vulnerable
9	Theaceae	<i>Gordonia multinervis</i>	Vulnerable
10	Anacardiaceae	<i>Mangifera gracilipes</i>	Least Concern
11	Anacardiaceae	<i>Swintonia robinsonii</i>	Least Concern
12	Anisophylleaceae	<i>Anisophyllea disticha</i>	Least Concern
13	Annonaceae	<i>Cyathocalyx pruniferus</i>	Least Concern
14	Burseraceae	<i>Canarium littorale</i>	Least Concern
15	Ebenaceae	<i>Diospyros trengganuensis</i>	Least Concern
16	Lauraceae	<i>Cinnamomum mollissimum</i>	Least Concern
17	Malvaceae	<i>Scaphium macropodum</i>	Least Concern
18	Rhizophoraceae	<i>Pellacalyx saccardianus</i>	Least Concern
19	Tiliaceae	<i>Pentace grandiflora</i>	Least Concern

Table 5: List of endemic species in 0.1 ha of Hutan Lipur Jeram Linang

No.	Family	Species	Endemic place
1	Anacardiaceae	<i>Mangifera gracilipes</i>	Peninsular Malaysia
2	Anacardiaceae	<i>Swintonia robinsonii</i>	Kelantan, Terengganu, Pahang
3	Annonaceae	<i>Cyathocalyx pruniferus</i>	Peninsular Malaysia
4	Annonaceae	<i>Goniothalamus umbrosus</i>	Penang, Kelantan, Terengganu
5	Arecaceae	<i>Licuala sallehana</i>	Terengganu
6	Arecaceae	<i>Pinanga scortechinii</i>	Peninsular Malaysia
7	Aristolochiaceae	<i>Thottea dependens</i>	Peninsular Malaysia
8	Burseraceae	<i>Dacryodes longifolia</i>	Peninsular Malaysia
9	Clusiaceae	<i>Mesua lepidota</i>	Peninsular Malaysia
10	Dilleniaceae	<i>Dillenia reticulata</i>	Malacca
11	Dipterocarpaceae	<i>Shorea collina</i>	Malaysia
12	Ebenaceae	<i>Diospyros trengganuensis</i>	Terengganu
13	Fabaceae	<i>Fordia albiflora</i>	Peninsular Malaysia
14	Lauraceae	<i>Alseodaphne</i> sp.	Peninsular Malaysia
15	Lauraceae	<i>Cinnamomum mollissimum</i>	Peninsular Malaysia
16	Myrsinaceae	<i>Ardisia foliosa</i>	Johor, Perak, Kelantan

17	Myrsinaceae	<i>Ardisia wrayi</i>	Peninsular Malaysia
18	Polygalaceae	<i>Xanthophyllum bullatum</i>	Terengganu, Perak, Selangor
19	Rhizophoraceae	<i>Pellacalyx saccardianus</i>	Peninsular Malaysia
20	Rubiaceae	<i>Gaertnera obesa</i>	Peninsular Malaysia
21	Rubiaceae	<i>Ixora javanica</i>	Peninsular Malaysia
22	Rubiaceae	<i>Urophyllum ferrugineum</i>	Pahang, Johor
23	Theaceae	<i>Gordonia multinervis</i>	Peninsular Malaysia
24	Tiliaceae	<i>Pentace grandiflora</i>	Terengganu

Medicinal Value

Hutan Lipur Jeram Linang harbours high richness of medicinal species. 47 out of 120 species from 30 families recorded at Hutan Lipur Jeram Linang possessed medicinal properties (Table 6). The three most diverse medicinal families collected across all categories were Rubiaceae,

followed by Euphorbiaceae and Fabaceae. Of all the medicinal plants, 68% belong to trees (26 species), 16% shrubs (16 species), 8% palms (3 species), 5% herbs (2 species) and 3% fern (species).

Table 6: List of plants with medicinal values at Hutan Lipur Jeram Linang and their uses

Species	Uses
<i>Anisophyllea disticha</i>	Used for gastrointestinal problems
<i>Antidesma orthogyne</i>	Used as an antiseptic
<i>Aralidium pinnatifidum</i>	Used traditionally to treat fever
<i>Archidendron jiringa</i>	Used as poultice for skin problems and chest pains
<i>Arenga pinnata</i>	Used for Sore throat and cold sores
<i>Artocarpus elasticus</i>	Used in anticancer activity
<i>Artocarpus scortechinii</i>	Used to cure stomach-ache.
<i>Baccaurea parviflora</i>	Used to ease urinating
<i>Barringtonia racemosa</i>	Used for skin itches, chicken pox, alone or with bark or root
<i>Chassalia chartacea</i>	Malaria, coughs, childbirth, cuts, wounds and ulcers.
<i>Chassalia curviflora</i>	Used for antibacterial activity
<i>Cinnamomum mollissimum</i>	Used for antifungal activity
<i>Croton caudatus</i>	Applied as poultice in sprains, diuretic
<i>Diospyros lanceifolia</i>	Cure ill waist.
<i>Diospyros sumatrana</i>	Used as a protective medicine after childbirth
<i>Elaterospermum tapos</i>	Use the latex to heal crack wounds
<i>Girroniera hirta</i>	After childbirth as a protective medicine

Conclusion

This study showed that Hutan Lipur Jeram Linang has a diverse population of vascular plants. A total of 121 species comprising 87 genera and 47 families were found within the study site. Our results indicated that this forest comprises plant species with high conservation status, high plant endemism and plants with medicinal properties. Therefore, proper management is important to maintain and preserve the forest from exploitation and destruction.

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References

- Aguilar, R., Ashworth, L., Galetto, L. & Aizen, M.A. (2006) Plant reproductive susceptibility to habitat fragmentation: review and synthesis through a meta-analysis. *Ecological Letter*, 9:968–980.
- Bidin, A. A & Latiff, A. (1995) The status of terrestrial biodiversity in Malaysia. In: Zakri, A. H. Eds. *Prospects in biodiversity prospecting*. Bangi: Genetic Society of Malaysia and Universiti Kebangsaan Malaysia. pp. 59-76.
- Burkill, I.H. (1935) *Economic Products of Malay Peninsula*. London: Crown Agent for the Colonies. 2.
- Cottam, G. and Curtis. J. T. (1956) The use of distance measures in phytosociological sampling. *Ecology*, 37: 451-460.
- Handa, S.S., Rakesh, D.D. and Vasisht, K. (2006) *Compendium of Medicinal and Aromatic Plants Asia*. United Nations Industrial Development Organization and the International Centre for Science and High Technology, 2006.
- IUCN. (2010) IUCN Red List of threatened species. Version 2010.3. Available at: <http://www.iucnredlist.org> (accessed 2 April 2012).
- JPSM, 2010. <http://www.forestry.gov.my/index.php/ms.html>. (09 March 2012).
- Juliana, W.A., M.S. Nizam, A.Raffae & S.B. Siti Najmi. (2005) Komposisi dan Kepelbagaian spesies pokok dalam dua habitat berbeza di Hutan Simpan Ulu Muda. In: Shahrudin, Ml et al. (Eds). *Hutan Simpan Ulu Muda, Kedah: Pengurusan, Persekitaran Fizikal dan Biologi Hutan*. Siri Kepelbagaian Biologi Hutan 3: 292-305.
- Kochumen, K. M., LaFrankie, J. V. & Manokaran, N. (1990). Floristic composition of Pasoh Forest Reserve, a lowland rain forest in floristic composition of Pasoh Forest Reserve, a lowland rain forest in peninsular. *Journal of Tropical Forest Science*. 3(1): 1-13.
- Latiff, A. (2011) Loss of Biodiversity And Resources due to Forest Exploitation and Degradation. *Rehabilitation of Tropical Rainforest Ecosystems*. Kuala Lumpur: Mitsubishi Corporation. pp. 137-144.
- Magurran A. E. (1988) *Ecological Diversity and Its Measurement*. Chapman and Hall, London. 179 pp.
- Masran M.S. & Samsudin M. (1996) Issues on the inventory and management of tropical forests in Malaysia. In : Haron A. H., Chin Y. M. and Nasaruddin R. Eds. *Multiple Resource Inventory And Monitoring Of Tropical Forests*. ASEAN Institute of Forest Management, 83-96 pp.

- Ng, F.S.P. (ed.) 1978. Tree Flora of Malaya. Volume 3. Malayan Forest Records No. 26. Longman Malaysia Sdn. Bhd., Kuala Lumpur. 339 pp.
- Ng, F.S.P. (ed.) 1989. Tree Flora of Malaya. Volume 4. Malayan Forest Records No. 26. Longman Malaysia Sdn. Bhd., Petaling Jaya. 549 pp.
- Ng F. S. P., Low C. M. & Mat Asri N. S. 1990. Endemic trees of the Malay Peninsula. Research Pamphlet 106, Forest Research Institute Malaysia, Kuala Lumpur.
- Nizam, M.S., Nur Maisarah, J., Jildred, J & W.A. Wan Juliana. (2008) Komposisi, Kepelbagaian dan Biojisim Komuniti Pokok di hutan Simpan Bukit Belata. In: Azahar Muda *et al.* (Eds). Bukit Belata, Selangor: Pengurusan, Persekitaran Fizikal, Kepelbagaian biologi dan Sosioekonomi. Siri Kepelbagaian Biologi Hutan 9: 134-151.
- Nizam, M.S., A., Azyela, K.Shamsul & W.A. Wan Juliana. (2009) Struktur komuniti dan biojisim pokok di Hutan Simpan Panti. In: Razani Ujang *et al.* (Eds). Hutan Simpan Panti, Johor: Pengurusan Hutan, Persekitaran Fizikal & Kepelbagaian Biologi. Siri Kepelbagaian Biologi Hutan 11: 150-163.
- Parris, B.S. & Latiff. A. (1997) Towards a pteridophyte flora of Malaysia: A provisional checklist of taxa. *Malaysians Nature Journal* 50 (4): 12 – 45.
- Ridley, H.N. 1922-1925. *Flora of Malay Peninsular*. (1-5). London: L. Reeve & Co. Ltd. 918 pp.
- Sodhi, N. S., Posa, M. R. C., Lee, T. M., Bickford, D., Koh, L. P. & Brook. B. W. (2010) The state and conservation of Southeast Asian. Biodiversity. *Biodiversity Conservation* 19: 317–328.
- Turner. I. M. (1995) A catalogue of vascular plants of Malaya. *Gardens Bulletin of Singapore*, 47 (1 & 2): 1-757.
- Whitmore, T.C. (ed.) 1972. Tree Flora of Malaya. Volume 1. Malayan Forest Records No. 26. Longman Malaysia Sdn. Bhd., Kuala Lumpur. 471 pp.
- Whitmore, T.C. (ed.) 1973. Tree Flora of Malaya. Volume 2. Malayan Forest Records No. 26. Longman Malaysia Sdn. Bhd., Kuala Lumpur. 444 pp.

