

## Plant Diversity and Conservation Value of Ayer Hitam Forest, Selangor, Peninsular Malaysia

I. FARIDAH HANUM

Department of Forest Production

Faculty of Forestry, Universiti Putra Malaysia

43400 UPM Serdang, Selangor Darul Ehsan, Malaysia

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### ABSTRAK

Hutan Ayer Hitam dengan keluasan 1248 hektar terletak di Negeri Selangor dan merupakan hutan pamah dipterocarpa yang pernah dibalak. Ia merupakan satu daripada hutan yang baki di Lembah Klang selain Hutan Bukit Nenas di Kuala Lumpur. Hutan ini telah disewakan kepada Universiti Putra Malaysia (UPM) selama 80 tahun bermula tahun 1996 untuk tujuan pendidikan, penyelidikan dan pengembangan. Sejak itu berbagai usaha telah dijalankan untuk mengetahui kepelbagaian sumber yang terdapat di dalamnya. Dengan itu, satu pengkalan maklumat mengenai tumbuhan yang terdapat di hutan ini telah dimulakan pada tahun 1998. Maklumat ini diperolehi dari kajian pada beberapa plot dan pungutan tumbuhan dari masa ke semasa. Hasil awal dibentangkan di sini. Sebanyak 430 spesies tumbuhan berbiiji yang terangkum dalam 203 genus dan 72 famili terdapat di sini. 33 spesies paku-pakis dan sekutunya, 127 spesies balak, 29 spesies buah-buahan dan 98 spesies ubat telah direkodkan dari hutan ini. Daripada jumlah takson ini, sebanyak 20 spesies yang endemik kepada Semenanjung Malaysia terkandung di hutan ini. Lima daripada spesies endemik ini merupakan rekod baru bagi Negeri Selangor. Walaupun Hutan Ayer Hitam ini belum terpulih sepenuhnya, ia merupakan satu ekosistem terserpih yang kaya dengan kepelbagaian tumbuhan dan perlu dipulihara untuk generasi akan datang.

### ABSTRACT

The Ayer Hitam Forest, a logged-over lowland mixed-dipterocarp forest in the State of Selangor covers an area of 1248 hectares. It is one of the remaining forests left in the Klang Valley besides the Bukit Nenas Forest in Kuala Lumpur. This forest has been leased to Universiti Putra Malaysia (UPM) in 1996 for 80 years for the purpose of education, research and extension. Since then various efforts have been taken to know the biodiversity it houses. Thus, a database on the plants of Ayer Hitam Forest was started in 1998. Several plots have been established and plant collections were made to achieve this and is still progressing. Results presented here are still preliminary. A total of 430 species of seed plants in 203 genera and 72 families occur here. 33 species of ferns and fern-allies, 127 timber species, 29 fruit tree species and 98 species with medicinal values were recorded from this forest. Of these taxa, 20 species which are endemic to Peninsular Malaysia are found here, five being new records for Selangor. Although Ayer Hitam Forest is still regenerating, it is nevertheless a rich fragmented ecosystem that needs to be conserved for future generations to come.

### INTRODUCTION

The Ayer Hitam Forest is an important support facility of Universiti Putra Malaysia (UPM) for studies in forestry, environment, zoology, botany and related fields. This forest is classified as a disturbed Kelat - Kedondong - Mixed Dipterocarp type of lowland forest (Faridah Hanum and Zamri Rosli 1999). It is located 25

km away from the UPM main campus in Serdang. The Selangor State Government leased it to UPM in 1996 for 80 years and the Faculty of Forestry in UPM is trusted to manage the forest for teaching, research and extension activities. This lease involves Compartments 1, 2, 12, 13, 14 and 15. For the past three years, some works have been carried out to gather information on

the plant resources of Ayer Hitam and subsequently, a database on the plant diversity of Ayer Hitam was started. Information on a few related aspects of plant diversity studies in the Ayer Hitam Forest was earlier discussed in Faridah Hanum *et al.* (1997) and Faridah Hanum and Zamri Rosli (1999). In this paper, a summary of selected plant taxa will be presented to give a picture of the diversity of this forest. The significance of conserving Ayer Hitam Forest is also discussed.

### SITE DESCRIPTION AND METHODS

#### *Ayer Hitam Forest*

The Ayer Hitam Forest was much larger covering an area of about 3500 hectares prior to the lease to UPM in 1996. The size of this forest is now 1248 ha, after it was further excised for some socio-economic development projects such as housing estates, oil palm plantations, new townships, factories and highways. This lowland forest is thus surrounded by development,

making it an isolated patch of forest in the middle of modern infrastructures and society. Being strategically located within the Multimedia Super Corridor, that connects Kuala Lumpur with the new administrative city of Putrajaya and business city of Cyberjaya, it is one of the two remaining forests left in the Klang Valley; the other being Bukit Nenas in the city of Kuala Lumpur. Even more unique is the habitation of this forest by a group of indigenous people of the Temuan Tribe. This forest is also readily accessible by all kinds of vehicle up to the base camp.

This forest was selectively logged several times between 1936 to 1965. There are three major rivers i.e. Sg. Rasau, Sg. Bohol and Sg. Biring flowing in this forest which is generally a low lying area with several steep slopes and many streams. Altitude ranges between 5 - 80 metres a.s.l. and the highest peak at Permatang Kuang is 213 metres a.s.l. (Fig. 1). A small patch of swamp is found in Compartment 15 and some sandy patches are also found along the major rivers.

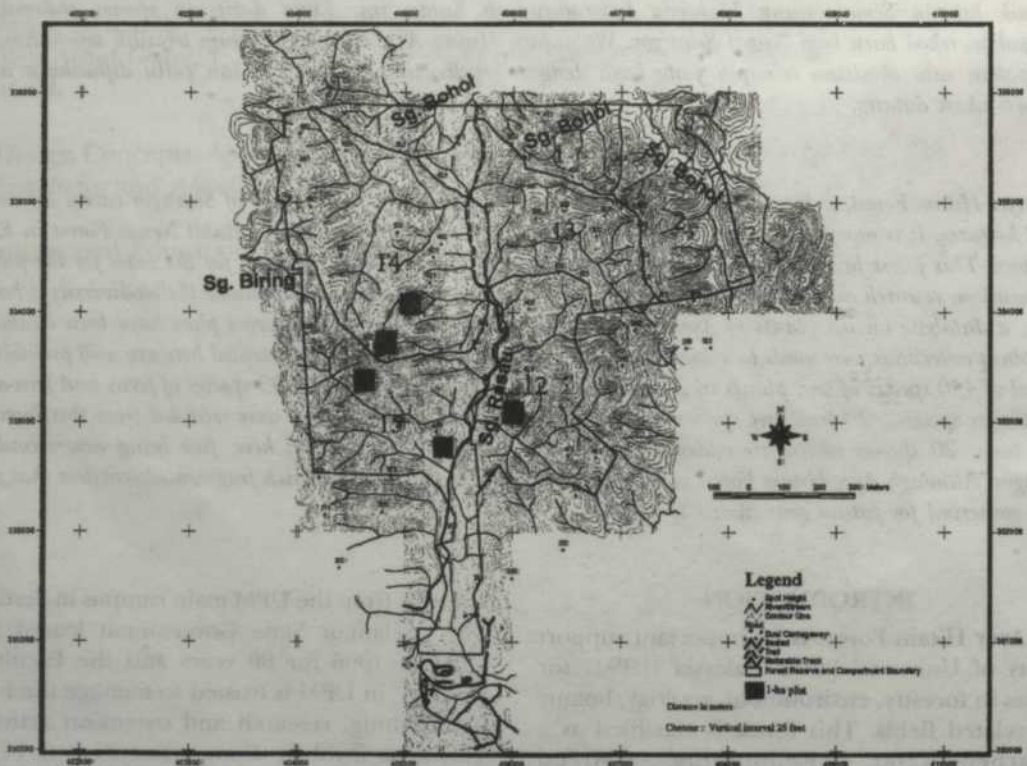


Fig. 1. Location of plots at Ayer Hitam Forest, Selangor

The soil is of the Serdang-Kedah Series and Durian Series, a combination of alluvium-colluvium silt which reshaped from metamorphic stones with sandy clay loam soil texture. Average yearly temperature is 25.3°C with the maximum temperature of 27.7°C and minimum at 22.9°C. The relative humidity averages at 87.6 % with a maximum at 97.8% and minimum of 77.4%. Average annual rainfall is 2178 mm (Ahmad Ainuddin Nuruddin, pers. comm.).

With the receding size of the forest, many of the larger mammals have disappeared or reduced in number. Of noteworthy attention is the tiger which have been sighted in this forest. Other mammals recorded include the wild boars and mousedeaders. Some 160 species of birds were also recorded from this forest, mainly frugivorous and insectivorous birds. Migratory birds such as the Siberian Blue Robins were also sighted here (Mohd. Zakaria Hussin, pers. comm.).

#### Methods

Plant specimens were collected over a period of three years and this was done either through five 1 - ha plots (100m x 100m) which were placed in several locations in the forest (Fig. 1) or regular collecting trips made to the forest. In either attempt, specimens were collected for the record and identification of uncertain taxa, in duplicates of three for flowering or fruiting specimens or one only for sterile specimens. Where plot studies are concerned, all trees greater than 5 cm in diameter breast height were measured, tagged and enumerated. The initial census of the five 1 - ha plots was carried out in 1998.

## RESULTS AND DISCUSSION

### PLANT DIVERSITY

#### *Taxonomic Composition of Seed Plants*

430 species of seed plant taxa in 203 genera and 72 families were recorded from Ayer Hitam Forest (Table 1). Detailed species composition of seed plants of Ayer Hitam is not included in this paper as it will be presented in another companion manuscript in the very near future. For tree taxa alone, this forest contains almost half the total number of tree families, one-sixth and one-third the total number of genera and species respectively in Peninsular Malaysia (Table 2). Comparisons cannot be made with other

TABLE 1  
Composition of seed plant taxa at  
Ayer Hitam Forest, Selangor

Family	No. Genera	No. Species
Euphorbiaceae	18	39
Myrtaceae	4	26
Lauraceae	5	23
Moraceae	7	21
Myristicaceae	4	20
Rubiaceae	13	17
Bursaceae	3	16
Guttiferae	3	15
Piperaceae	1	15
Leguminosae	12	14
Anacardiaceae	6	14
Annonaceae	7	13
Dipterocarpaceae	5	12
Zingiberaceae	7	10
Melastomataceae	6	8
Elaeocarpaceae	1	8
Sapotaceae	4	8
Meliaceae	5	7
Polygalaceae	2	7
Fagaceae	2	6
Sapindaceae	2	6
Apocynaceae	4	5
Rhizophoraceae	2	5
Thymelaeaceae	2	5
Myrsinaceae	2	5
Celastraceae	3	5
Ulmaceae	1	5
Sterculiaceae	4	5
Rutaceae	3	4
Acanthaceae	4	4
Compositae	4	4
Ebenaceae	1	4
Marantaceae	3	4
Tiliaceae	1	4
Palmae	4	4
Flacourtiaceae	4	8
Dilleniaceae	2	3
Dioscoreaceae	1	3
Bombacaceae	2	3
Olacaceae	2	3
Verbenaceae	2	3
Proteaceae	1	3
Graminae	3	3
Menispermaceae	2	2
Linaceae	2	2
Gnetaceae	1	2
Combretaceae	1	2
Araliaceae	1	1
Lecythidaceae	1	1
Ochnaceae	1	1

Table 1 (Continued)

Crypteroniaceae	1	1
Opiliaceae	1	1
Hypericaceae	1	1
Sonneratiaceae	1	1
Orchidaceae	1	1
Simaroubaceae	1	1
Icacinaceae	1	1
Theaceae	1	1
Podocarpaceae	1	1
Rosaceae	1	1
Vitaceae	1	1
Oxalidaceae	1	1
Scrophulariaceae	1	1
Taccaceae	1	1
Asclepiadaceae	1	1
Aristolochiaceae	1	1
Malvaceae	1	1
Araceae	1	1
Labiatae	1	1
Cyperaceae	1	1
Cornaceae	1	1
Solanaceae	1	1
Total	72	203
		430

TABLE 2  
Comparison of tree taxa at Ayer  
Hitam Forest, Selangor

	Ayer Hitam	Peninsular* Malaysia
No. Family	56	100
No. Genus	160	532
No. Species	400	2830

\* Source: Ng *et al.* (1990)

lowland forests if we limit to trees of 5cm dbh and above because many past plot studies enumerated trees of 10cm dbh and above. Thus, when the diversity of Ayer Hitam was compared for trees of 10 cm dbh and above, this forest was about 35% lower in diversity than Pasoh Forest with 210 species per ha (Kochummen *et al.* 1990) and about 25% lower in diversity than Bangi Forest with 167 species per ha (Rashidah Johar 1993). The mean diversity per hectare at Ayer Hitam Forest for trees greater than 10 cm dbh was about 60 species per ha (Faridah Hanum and Zamri Rosli 1999).

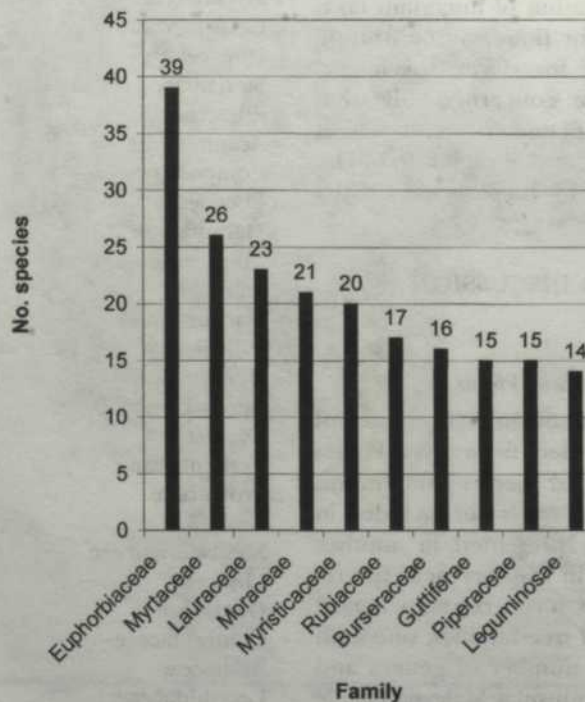


Fig. 2. Species diversity of 10 largest families in Ayer Hitam Forest, Selangor

Fig. 2 shows the species diversity of 10 largest families in Ayer Hitam Forest. So far, Euphorbiaceae was found to be the most diverse family with 39 species. Most Euphorbiaceae as well as other families such as Ulmaceae, Rubiaceae and Melastomataceae are commonly found in disturbed forest. *Gironiera parvifolia* (Ulmaceae) for instance was found to be the most frequent occurring species in a 1-ha plot at Ayer Hitam Forest (Faridah Hanum and Zamri Rosli 1999).

Eight species of monocots were recorded this far. Examples worth mentioning include *Schizostachyum latifolium*, a bamboo commonly seen at forest fringes and streams, and *Cyrtostachys renda*, a beautiful palm frequently occurring in swampy places. *Podocarpus teysmanii* was the only conifer collected from this forest.

**Timber Trees**

127 tree species that occur in Ayer Hitam Forest thus far, are classified as timber trees and this constitutes about 30% of the total number of tree species existing in this forest (Table 3). Of

TABLE 3  
List of timber species in Ayer Hitam Forest, Selangor

Family	Species
Anacardiaceae	<i>Bouea oppositifolia</i> <i>Buchanania sessifolia</i> <i>Camposperma auriculatum</i> <i>Gluta elegans</i> <i>Melanochyla angustifolia</i>
Annonaceae	<i>Alphonsea elliptica</i> <i>Cyathocalyx pruniferus</i> <i>Goniothalamus malayanus</i> <i>Polyalthia rumphii</i> <i>Xylopi ferruginea</i>
Bombacaceae	<i>Durio lowianus</i> <i>Durio griffithii</i>
Burseraceae	<i>Canarium apertum</i> <i>Canarium littorale</i> <i>Canarium patentinervium</i> <i>Dacryodes laxa</i> <i>Santiria apiculata</i> <i>Santiria laevigata</i> <i>Santiria oblongifolia</i>
Combretaceae	<i>Terminalia subspathulata</i>
Compositae	<i>Vernonia arborea</i>
Celastraceae	<i>Bhesa robusta</i> <i>Kokoona ochracea</i> <i>Lophopetalum pachyphyllum</i>

Crypteroniaceae	<i>Crypteronia griffithii</i>
Ctenolophonaceae	<i>Ctenolophon parvifolius</i>
Dipterocarpaceae	<i>Anisoptera costata</i> <i>Anisoptera curtisii</i> <i>Dipterocarpus crinitus</i> <i>Dipterocarpus verrucosus</i> <i>Hopea beccariana</i> <i>Shorea bracteaolata</i> <i>Shorea dasyphylla</i> <i>Shorea leprosula</i> <i>Shorea macroptera</i> <i>Shorea parvifolia</i> <i>Shorea platycarpa</i> <i>Vatica lobata</i>
Elaeocarpaceae	<i>Elaeocarpus ferrugineus</i> <i>Elaeocarpus robustus</i>
Euphorbiaceae	<i>Antidesma cuspidatum</i> <i>Aporusa aurea</i> <i>Aporusa confusa</i> <i>Aporusa stellifera</i> <i>Baccaurea macrophylla</i> <i>Blumeodendron tokbrai</i> <i>Drypetes pendula</i> <i>Elateriospermum tapos</i> <i>Endospermum diadenum</i> <i>Paracroton pendulus</i> <i>Sapium baccatum</i> <i>Sapium discolor</i>
Fagaceae	<i>Lithocarpus cantleyanus</i> <i>Lithocarpus gracilis</i> <i>Lithocarpus rassa</i> <i>Lithocarpus sundaicus</i>
Flacourtiaceae	<i>Hydnocarpus filipes</i> <i>Hydnocarpus kunstleri</i>
Guttiferae	<i>Calophyllum ferrugineum</i> <i>Calophyllum pulcherrimum</i> <i>Calophyllum rubiginosum</i> <i>Calophyllum macrocarpum</i> <i>Calophyllum wallichianum</i> <i>Garcinia cuspidata</i> <i>Mesua ferrea</i> <i>Mesua lepidota</i>
Ixonanthaceae	<i>Ixonanthes icosandra</i>
Lauraceae	<i>Actinodaphne macrophylla</i> <i>Actinodaphne pruinosa</i> <i>Actinodaphne sphaerocarpa</i> <i>Litsea firma</i> <i>Litsea gracilipes</i> <i>Litsea grandis</i>
Leguminosae	<i>Archidendron splendens</i> <i>Callerya atropurpurea</i> <i>Sindora coriacea</i>
Meliaceae	<i>Chisocheton patens</i> <i>Dysoxylum cauliflorum</i> <i>Walsura pinnata</i>
Moraceae	<i>Artocarpus dadah</i>

TABLE 3 (Continued)

	<i>Artocarpus lowii</i>
	<i>Artocarpus maingayi</i>
	<i>Artocarpus scortechinii</i>
Myristicaceae	<i>Horsfieldia fulva</i>
	<i>Horsfieldia irya</i>
	<i>Horsfieldia sucosa</i>
	<i>Knema curtisii</i>
	<i>Knema furfuracea</i>
	<i>Knema intermedia</i>
	<i>Knema kunstleri</i>
	<i>Knema laurina</i>
	<i>Myristica iners</i>
Myrtaceae	<i>Syzygium conglomeratum</i>
	<i>Syzygium fastigiatum</i>
	<i>Syzygium filiforme</i>
	<i>Syzygium lineatum</i>
	<i>Syzygium papillosum</i>
	<i>Rhodamnia cinerea</i>
Ochnaceae	<i>Brackenridgea hookeri</i>
Olacaceae	<i>Ochanostachys amantacea</i>
Podocarpaceae	<i>Podocarpus teysmanii</i>
Polygalaceae	<i>Xanthophyllum affine</i>
	<i>Xanthophyllum amoenum</i>
	<i>Xanthophyllum eurhynchum</i>
	<i>Xanthophyllum griffithii</i>
Rhizophoraceae	<i>Carallia brachiata</i>
	<i>Pellacalyx saccardianus</i>
Rosaceae	<i>Prunus arborea</i>
Rubiaceae	<i>Neolamarckia cadamba</i>
	<i>Nauclea officinalis</i>
	<i>Porterandia anisophyllea</i>
	<i>Timonius wallichianus</i>
	<i>Urophyllum blumeanum</i>
Rutaceae	<i>Acronychia pedunculata</i>
	<i>Melicope glabra</i>
Sapotaceae	<i>Palaquium rostratum</i>
	<i>Palaquium stellatum</i>
	<i>Pouteria malaccensis</i>
Sonneratiaceae	<i>Duabanga grandiflora</i>
Sterculiaceae	<i>Scaphium macropodium</i>
	<i>Sterculia parviflora</i>
Thymelaeaceae	<i>Gonystylus affinis</i>
	<i>Gonystylus confusus</i>
Ulmaceae	<i>Gironniera parvifolia</i>
	<i>Gironniera subaequalis</i>
	<i>Gironniera nervosa</i>
Verbenaceae	<i>Teijsmanniodendron coriaceum</i>

this percentage, approximately 3% are dipterocarps (Faridah Hanum and Zamri Rosli 1999). 12 species from the family Dipterocarpaceae are represented in 5 genera viz., *Anisoptera*, *Dipterocarpus*, *Hopea*, *Shorea* and

*Vatica* constituting about half the total number of genera that are found in Peninsular Malaysia (Table 3). Their diversity could be due to remnants of extensive logging of once a lowland dipterocarp forest here in the past. The Dipterocarpaceae is the dominant family among upper canopy trees in this forest. Five dipterocarp species that most commonly occur in the swampy areas of this forest are *Shorea platycarpa*, *S. bracteolata*, *S. leprosula*, *S. parvifolia* and *Vatica lobata*. The remaining timber genera from the non-dipterocarp families that are diverse and worth mentioning include *Lithocarpus* (4 spp.), *Xanthophyllum* (4 spp.), *Artocarpus* (4 spp.), *Knema* (5 spp.), *Syzygium* (5 spp.) and *Calophyllum* (5 spp.).

#### Fruit Trees

An estimated 100 species of native fruit trees are found in the Malaysian forests (Soepadmo 1973). Composition of fruit trees in a primary forest is moderate in diversity and low abundance (Soepadmo 1979; Whitmore 1971). 29 species that are found in the wilderness of Ayer Hitam Forest are edible fruits as categorized by Jansen *et al.* (1991). Especially diverse are the wild species of tampoi (*Baccaurea*, 5 spp.) and terap (*Artocarpus*, 4 spp.). Other wild fruit species as shown in Table 4 would be of economic potential or for selection and breeding. Based on observations made by the author, 14 species (Table 5) are considered to have potential as edible fruits because they were seen eaten by birds and animals.

#### Ferns and Fern-allies

Ferns are usually considered to be plants of shady damp places. But with disturbance, species preferring more open places with lots of sunlight and less humid conditions have spread and become more common. Some species have stringent requirements and grow only when all these are met, but where they do, the species is often abundant (Piggott 1988). Only a small collection of fern and fern-allies were made from this forest, with a total of 33 species (Table 6). The most common occurring species in Ayer Hitam Forest is the terrestrial thicket sun-fern, *Dicranopteris linearis*. This could be due to Ayer Hitam Forest having many areas that have been disturbed at various degrees in the past. Known locally as resam, *Dicranopteris linearis* grows long fronds that cannot support themselves in erect

TABLE 4

Wild fruit species in Ayer Hitam Forest, Selangor

Family	Species
Anacardiaceae	<i>Bouea oppositifolia</i>
Bombacaceae	<i>Durio lowianus</i>
Burseraceae	<i>Canarium pilosum</i> <i>Dacryodes rugosa</i>
Euphorbiaceae	<i>Baccaurea brevipes</i> <i>Baccaurea kunstleri</i> <i>Baccaurea parviflora</i> <i>Baccaurea motleyana</i> <i>Baccaurea racemosa</i> <i>Pimelodendron griffithianum</i> <i>Ptychopyxis caput-medusae</i>
Gnetaceae	<i>Gnetum gnemon</i>
Guttiferae	<i>Garcinia atroviridis</i> <i>Garcinia mangostana</i>
Leguminosae	<i>Archidendron bubalinum</i> <i>Parkia speciosa</i>
Moraceae	<i>Artocarpus elasticus</i> <i>Artocarpus integer</i> <i>Artocarpus lanceifolius</i> <i>Artocarpus nitidus</i> <i>Ficus variegata</i>
Myrtaceae	<i>Rhodamnia cinerea</i>
Oxalidaceae	<i>Sarcotheca monophylla</i>
Passifloraceae	<i>Paropsia variciformis</i>
Sapidaeae	<i>Nephelium ramboutan-ake</i> <i>Xerospermum laevigatum</i> <i>Xerospermum noronhianum</i>
Sterculiaceae	<i>Sterculia macrophylla</i>
Tiliaceae	<i>Grewia laevigata</i>

TABLE 5

Potential edible fruit species in Ayer Hitam Forest, Selangor

Species	Notes
<i>Aidia densiflora</i>	Ripe fruit red, eaten by birds
<i>Champerea manillana</i>	Fruit eaten by birds
<i>Elaeocarpus petiolatus</i>	Fruit eaten by animals
<i>Elaeocarpus stipularis</i>	Fruit eaten by birds
<i>Endospermum diadenum</i>	Fruit yellowish, eaten by birds
<i>Ficus grossularioides</i>	Fruit eaten by birds
<i>Knema curtisii</i>	Fruit eaten by animals
<i>Lithocarpus gracilis</i>	Fruit eaten by animals
<i>Litsea grandis</i>	Fruit eaten by animals
<i>Mallotus paniculatus</i>	Fruit eaten by birds
<i>Monocarpia marginalis</i>	Fruit eaten by animals
<i>Polyalthia hypoleuca</i>	Fruit eaten by animals
<i>Porterandia anisophyllea</i>	Fruit eaten by animals
<i>Xanthophyllum affine</i>	Fruit eaten by animals

position, thus forming a tangled thicket and thrives well in forest gaps and fringe. Another fern which is commonly found in open areas is the terrestrial solitary sun-fern, *Blechnum orientale*. *Cyathea latebrosa* is more specific in requirements and was observed to occur beside streams. Other species found in the Ayer Hitam Forest that require more specific requirements include *Mesophlebion chylamydophorum* and *Tectaria singaporeana* which were found in shady wet places of the forest, *Diplazium riparium* on banks of streams and swampy areas of the forest. A common epiphytic fern observed was *Asplenium nidus* or commonly known as bird's nest fern. Woodsiaceae (*Diplazium*, 4 spp.) is the most diverse fern family present in this forest.

#### Medicinal Plants

Well over 1000 species in Malaysia have been claimed to have uses or used by the multiethnic groups of Malaysia for generations (Latiff *et al.* 1980). About one-tenth of these species are recorded from Ayer Hitam Forest. A total of 98 species in 83 genera and 53 families are found in this forest. 140 different uses were recorded from informants and grouped into 7 methods of application i.e. drink, eat, chew rub, poultice, bath and shampoo. Examples of medicinal plant species that are both used by the forest dwelling indigenous community, the Temuans and fringing Malay community of Ayer Hitam Forest are shown in Table 7. Details on the composition and uses of medicinal plants in the Ayer Hitam Forest were discussed at length in a companion paper (Faridah Hanum and Nurulhuda Hamzah 1999).

#### Other Plants of Ethnobotanical Interests

Besides timber, medicinal and fruit species diversity that are found in the Ayer Hitam Forest, there are a number of ethnobotanically useful species enumerated here. Secondary products such as resin from *Dipterocarpus crinitus* are still tapped by the Temuans to be sold, while leaves of *Licuala spinosa* (palas) are rather commonly sold in the market as a local cake wrapper. There are also beautiful flowering trees, young flushes or desirable architecture such as *Pometia pinnata*, *Mesua ferrea* and *Callerya atropurpurea* from this forest that are ornamental. The rattans (*Calamus manan*) are still collected by the Temuans for a substantial income together with *Parkia speciosa* (petai).

TABLE 6  
Fern and fern-allies in Ayer Hitam Forest, Selangor

Adiantaceae	<i>Cheilanthes tenuifolia</i> <i>Taenitis blechnoides</i>	Polyodiaceae	<i>Platynerium coronarium</i> <i>Pyrrhosia nummularifolia</i> <i>P. piloselloides</i>
Aspleniaceae	<i>Asplenium nidus</i>	Schizaeaceae	<i>Lygodium circinnatum</i> <i>L. flexuosum</i> <i>L. longifolium</i> <i>L. microphyllum</i> <i>Schizaea dichotoma</i> <i>S. digitata</i>
Blechnaceae	<i>Blechnum orientale</i>	Selaginellaceae*	<i>Selaginella ascenden</i> <i>S. ciliaris</i> <i>S. intermedia</i> <i>S. stipulata</i> <i>S. willdenowii</i> <i>S. wallichii</i>
Cyatheaceae	<i>Cyathea latebrosa</i> <i>C. moluccana</i>	Thelypteridaceae	<i>Mesophlebion chylamydophorum</i>
Dryopteridaceae	<i>Tectaria singaporeana</i> <i>T. crenata</i>	Woodsiaceae	<i>Diplazium riparium</i> <i>D. tomentosum</i> <i>D. crenatoserratum</i> <i>D. allantoideum</i>
Gleicheniaceae	<i>Dicranopteris linearis</i>		
Lycopodiaceae*	<i>Lycopodium cernuum</i>		
Oleandraceae	<i>Nephrolepis auriculata</i>		
Ophioglossaceae	<i>Helminthostachys zeylanica</i> <i>Ophioglossum pendulum</i>		

\* Fern-allies

TABLE 7  
Some medicinal plants and uses at Ayer Hitam Forest, Selangor

Scientific names	Local names	Uses and parts used
<i>Goniothalamus macrophyllus</i>	Gajah beranak	Decoction of root to eliminate excessive gas in body
<i>Homalomena sagittifolia</i>	Keladi kemoyang	Decoction of root and leaves for fever
<i>Elephantopus scaber</i>	Tapak Sulaiman	Leaf and root decoction as supplement after childbirth, tonic, deworming, venereal disease and cough
<i>Tetracera indica</i>	Mempelas	Root decoction to treat high blood pressure and high fever
<i>Donax grandis</i>	Bemban	Poultice of leaf or stem for eye refreshment
<i>Vitex pinnata</i>	Halban	Decoction of bark and leaf for stomach-ache and given after childbirth
<i>Costus speciosus</i>	Setawar hutan	Decoction of roots to reduce high body temperature, decoction of rhizome as tonic



## CONSERVATION VALUE

Plant and animal species require a certain range or size of population in order to persist. This means if the area of the Ayer Hitam Forest is further excised, there will be a failure in their breeding systems such as pollination mechanisms or food will not be substantial enough to support certain populations of animals. Certain populations of species will thus not only be vulnerable, but also threatened. There will not only be habitat loss, but also inevitable species loss. The remaining four tigers in the forest will probably be threatening the safety of users of Ayer Hitam if the forest size is reduced, more critically diminished with time. A whole cycle of growth, maturity and decomposition is necessary to provide a sustainable and ecologically biodiverse habitats within the Ayer Hitam Forest for the animals to live in. Unlike human that can be expected to be temporarily squattered, the diverse animals of this forest will cease to exist. Especially of scientific interest are the endemics, which are species that grow in a specific area and have a restricted distribution. There are 746 endemic tree species in Peninsular Malaysia (Ng *et al.* 1990). To date Ayer Hitam Forest houses 20 endemic plant species. Of these endemics, one species is with the status uncommon (*Ptychopyxis caput-medusae*) while five species are new records for Selangor (Table 8). Forest fragmentation has severe implications on the survival of these endemic species. Endemics may exist due to natural extinction throughout much of their range (termed paleo-endemics or relicts) or due to actively evolving groups giving rise to localized distinct species (termed neo-endemics). Thus, conservation considerations should also include conserving as much evolutionary functions that give rise to these endemics, besides conserving particular sites of inferred rich biodiversity such as the Ayer Hitam Forest. There is no better way than protecting a habitat or ecosystem where all natural requirements are met if plants and animals in the Ayer Hitam Forest are to be protected.

As with the case of Ayer Hitam Forest, it is the only sanctuary for migratory birds and tigers in the Klang Valley. It is also one of the only two natural green lungs left in the Klang Valley for now and the generations to come. More importantly, there are still indigenous people of the Temuan Tribe dwelling this forest and relying on forest resources to support their life. Being

TABLE 8  
Peninsular Malaysia endemics in Ayer Hitam Forest, Selangor

Species	Status
<i>Actinodaphne pruinosa</i>	Common*
<i>Actinodaphne sphaerocarpa</i>	New record for Selangor
<i>Anisophyllea griffithii</i>	Common
<i>Calophyllum ferrugineum</i>	Common
<i>Calophyllum pulcherrimum</i>	New record for Selangor
<i>Cyathocalyx pruniferus</i>	Common
<i>Diospyros foxworthyi</i>	New record for Selangor
<i>Eleocarpus ferrugineus</i>	Common
<i>Gardenia costata</i>	New record for Selangor
<i>Gardenia griffithii</i>	Common
<i>Hydnocarpus filipes</i>	Common
<i>Mallotus kingii</i>	New record for Selangor
<i>Memecylon cinereum</i>	Common
<i>Palaquium maingayi</i>	Common
<i>Pellacalyx saccardianus</i>	Common
<i>Ptychopyxis caput-medusae</i>	Uncommon**
<i>Sarcotheca monophylla</i>	Common
<i>Syzygium conglomeratum</i>	Common
<i>Thottea dependens</i>	Common
<i>Vatica lobata</i>	Common

\* Common - more than 10 collections

\*\* Uncommon - (6-10) collections

strategically located in the midst of development in the Klang Valley, it is just fair that the public also enjoys this place, with a limited carrying capacity - for educating the public about forest, its environment and why we need to conserve it. This way, UPM not only enjoys this forest as an important support facility for education, research and extension but more importantly, the public gets a share of both the tangible and non-tangible benefits of what this forest has to offer.

It takes to know what this remaining fragmented forest contains in order to develop a sound management and conservation plan for the very near future. It is thus encouraged that other research efforts in related disciplines in UPM or other institutions be concentrated at the Ayer Hitam Forest to call for more information on the biodiversity it houses, be it at the species, genetic or ecosystem level. A policy

should also be formulated by UPM to designate the permanence of Ayer Hitam Forest as a research and education forest in the near future, so that it does not have to be mismanaged by the future decision makers. The author would like to suggest to the relevant authority in UPM to pipe out some development fund in demarcating the forest boundary by fencing, and enforcing the UPM security in preventing encroachment especially at the northern end of the forest. These suggestions are especially crucial to prevent unauthorized exploitation of the forest resources, especially medicinal plants and unlawful cutting if we are to conserve the Ayer Hitam Forest in entirety and for the coming generations. A certain hectareage of this forest should also be formally designated as Permanent Ecological Plot for long-term studies.

### CONCLUSION

Although the database is still in its infancy, the diversity captured this far, certainly is reputable for a fragmented ecosystem like the Ayer Hitam Forest. With work still progressing in Ayer Hitam Forest, a greater plant diversity information is expected. The database on the plants of Ayer Hitam will be updated with the completion of a 10-ha permanent plot in the near future.

Each ecosystem is idiosyncratic and has a continuum of ecological complexity, thus requires a specific study. Species rarely occur in isolation in nature, so understanding the interactions between species is equally important as understanding the interactions within species for survival. A more vigorous research programme to be considered for this forest that the author thinks relevant would include the effects of fragmentation on species interaction and community structure, ecosystem processes, single species (especially rare and endangered species), population dispersal and genetics and traits of rare species; employment of ecologically significant species for management and monitoring (eg. indicator species, keystone species) of the forest ecosystem, population genetics in relation to inbreeding depression, fitness, heterozygosity and bottlenecks, reproductive biology, population ecology and viability, and ethnobiology.

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