Diversity of plant community at Gunung Ledang, Malaysia

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Abstract. Gunung Ledang National Park (GLNP) is one of national parks in Peninsular Malaysia. The forest in GLNP is rich in biodiversity which harboring various species as well as important for upstream water regulation and subsequent climate change mitigation. A rapid assessment of plant communities and diversity at the park was carried out in June 2014. Five sampling sites were identified based on elevation gradient. Overall, 68 plant species representing 58 genera and 35 families were recorded for all study sites. In each site, the plant species ranged from 15 to 32 species. The plant families with largest number of species in the studied sites were Euphorbiaceae (12 species) and Myrtaceae (5 species). The plant diversity in each site ranged from 2.7 to 3.5 based on Shannon diversity index. Three plant communities of the park separated out: lower (L1 and L2), middle (L3 and L6) and upper (L10) plant communities. Some exotic invasive species had been recorded and they were rated as natural vegetation. It is important to consider them as invasive species because of the obvious negative impacts on local biodiversity and ecosystem functioning of the pristine GLNP; and some actions are needed to remove them.

1. Introduction
Malaysia lies in the tropics region with the habitats variety leads to the species diversity and heterogeneity of an area [1] as part of Asian tropical region [2, 3]. Due to its significant species richness, most of the studies have been conducted at or near to the 1 ha level per plot for rain forest structure and diversity. The most abundant plant species forms the three dimensional structure of a plant community [3]. Plants evolution begins when there are competitions at the ground level for food and light. Plants will fight in the way of adaptation to its surrounding area by living on the branches of other plants or even strangle on large trees. Meanwhile, in the humid rainforest, the condition encourages plants with air roots to gather the nourishment from the air by itself.

Gunung Ledang also known as Mount Ophir, located in Ledang district is the highest peak in Johor State, with its highest point at 1,276 m above sea level (asl) and an area of 10,022 ha. This forest is included in the protected area of Johor noted as Gunung Ledang National Park established in 1997. It is mainly made up of granite (biotite-muscovite-granite); with Sagil Waterfall as the best developed and a very famous waterfall along the foothill of the Gunung Ledang [5]. There are two points of entry for this park, one is in Sagil, Johor and the other is in Asahan, Melaka. The major habitat types of this forest are hill Dipterocarp forest and mountain forest.

The former idea of gazetting this mountain as a National Park is to protect the catchment area, also the biodiversity richness across various types of flora and fauna, hence support the sites for education and research with the following increasing in the number of tourist from local and overseas [6].
most attractive orchid that could be found at Gunung Ledang is Lady’s Slipper Orchid (*Paphiopedilum callosum*). However, there is limited study related plant community at the national park through altitude. The objective of this study was to evaluate plant composition, distribution, richness and diversity at Gunung Ledang National Park, Malaysia based on elevation gradient.

2. Material and Method
A rapid assessment of plant distribution and communities at the Gunung Ledang in Johor was carried out during on June 2014. There were five sampling sites were observed at the Gunung Ledang were placed following the elevation gradient that estimated as an average at 100, 200, 300, 600 and 1,000 m asl which were L1, L2, L3, L6 and L10, respectively. The sampling sites are following the road before the Empangan Tangkak to the Gua Haji within the GLNP.

The identification of species was done based on upon Ridley [7], Whitmore [8], and plant database online, such as Plant of Southeast Asia [9] and the Malaysian flora database [10]. Plant diversity and community structure by hierarchical clustering performed using the MVSP program ver 13.3d by Kovach Computing Services [11] following UPGMA method [12].

3. Result and Discussion
A total of 68 plant species representing 58 genera and 35 families were recorded for all study areas. The plant families with largest number of species in the total studied sites were Euphorbiaceae (12 species or 17.6%), and Myrtaceae (5 species or 7.4%) (Table 1). The plant habits with largest number of species in all studied areas were tree (37 species or 54.4%), followed by shrub (12 species or 17.6%) and herb (9 species or 13.2%) (Table 2). The site with highest number of species was L10 (32 species), and followed by L3 (21 species) and L6 (19 species) (Table 2). The observation also indicated that the plant species and diversity increased with increasing altitude in the Gunung Ledang areas (Figure 1). The species richness in the park is higher than Ayer Hitam Forest Reserve, Selangor, Malaysia [13].

| No | Family               | # Genera | # Species | No | Family               | # Genera | # Species |
|----|----------------------|----------|-----------|----|----------------------|----------|-----------|
| 1  | Anacardiaceae        | 2        | 2         | 18 | Melastomataceae      | 2        | 2         |
| 2  | Apocynaceae          | 1        | 1         | 19 | Mimosaceae           | 1        | 1         |
| 3  | Araceae              | 1        | 1         | 20 | Moraceae             | 2        | 4         |
| 4  | Areaceae             | 3        | 3         | 21 | Musaceae             | 1        | 1         |
| 5  | Asteraceae           | 1        | 1         | 22 | Myrtaceae            | 3        | 5         |
| 6  | Asteraceae           | 1        | 1         | 23 | Nepenthaceae         | 1        | 2         |
| 7  | Bombacaceae          | 1        | 1         | 24 | Orchidaceae          | 2        | 2         |
| 8  | Cactaceae            | 1        | 1         | 25 | Pandanaceae          | 1        | 1         |
| 9  | Caricaceae           | 1        | 1         | 26 | Pinaceae             | 1        | 1         |
| 10 | Dileniaceae          | 1        | 1         | 27 | Poaceae              | 4        | 4         |
| 11 | Dipterocarpaceae     | 1        | 1         | 28 | Podocarpaceae        | 2        | 2         |
| 12 | Euphorbiaceae        | 7        | 12        | 29 | Rhamnaceae           | 1        | 1         |
| 13 | Fabaceae             | 4        | 4         | 30 | Rubiaceae            | 1        | 1         |
| 14 | Fabaceae             | 1        | 1         | 31 | Theaceae             | 2        | 2         |
| 15 | Gleicheniaceae       | 1        | 1         | 32 | Tiliaceae            | 1        | 1         |
| 16 | Loganiiaceae         | 1        | 1         | 33 | Verbenaceae          | 3        | 3         |
| 17 | Marattiaceae         | 1        | 1         | 34 | Zingiberaceae        | 1        | 1         |
|    | Grand Total          |          |           |    |                      | 58       | 68        |
Table 2. The plant habit composition in each study sites

| Habit  | L1 | L2 | L3 | L6 | L10 | All Plots |
|--------|----|----|----|----|-----|-----------|
| Fern   | 0  | 0  | 1  | 1  | 2   | 2         |
| Grass  | 2  | 0  | 0  | 0  | 3   | 4         |
| Herb   | 5  | 1  | 1  | 0  | 3   | 9         |
| Palm   | 2  | 1  | 2  | 1  | 0   | 2         |
| Pandan | 0  | 0  | 0  | 0  | 1   | 1         |
| Shrub  | 3  | 1  | 0  | 0  | 8   | 12        |
| Tree   | 6  | 12 | 17 | 16 | 14  | 37        |
| Vein   | 0  | 0  | 0  | 1  | 1   | 1         |
| Grand Total | 18 | 15 | 21 | 19 | 32  | 68        |

Figure 1. The correlation between species number ($S$) and Shannon diversity index ($H'$) in all study sites.

The *Alstonia scholaris* had the widest distribution. This species was found in all study sites from lowland to high land. The following species with wide distribution were *Gluta renghas* and *Elaeis guenensis* (each of them had 80%) as shown at Figure 2. Based on observation, the forests in study sites at the Gunung Ledang were indicated as *Alstonia scholaris-Gluta renghas* communities. The two species were constantly found in all elevations between 200 to 1,000 m asl at the GNLP. Species in genus *Macaranga* occupied the disturbed areas where forest had been developed for roads. This genus is known as pioneer species similar to the fern species *Dicranopteris linearis*. The *Elaeis guenensis* and *Hevea brasiliensis* were allegedly spread by animals into sites L2 and upwards. Nevertheless the species were planted by human at site L1.

Based on cluster analysis, there were three groups from seven study sites. The groups are (A) L1+L2, (B) L3+L6 and (C) L10 as shown at Figure 3. Some species were only found within a group as indicator of the group in cluster analysis based on present and absent of the species. For example, there are three species found only in group A, i.e. *Leucaena leucocephala*, *Zingiber officinale*, and *Durio* sp. The species of *Eucalyptus camaldulensis*, *Shorea* sp., *Macaranga triloba*, *Acacia mangium*, and *Porterandia anisophylla* are found only at group B. Subsequently, the 23 species are only found at group C. According to some publications [12-16], plant communities represent environment and social relationship between plant communities in the site.

Based on observation, most of the forests in the park have good condition (Figure 4) as well as some unique plants were growing at highland areas of the park (Figure 5). The mountain forests have important role for watershed and water regulation and the functions are depend on the condition of the forests [4, 17-18]. The forests have also important role in nutrient cycle [19]. Therefore, the mountain forests in the part need to maintain and manage very well. In addition, the disturbances need to be anticipated continually.
The exotic invasive species *Mimosa pigra* (woody shrub), *Acacia mangium* (tree) and the commercial *Elaeis guenensis* (palm) were rated as natural vegetation in the GLNP. Mansor and Crawley [20-21] suggested that repeated defoliation combined with total removal of leaves can strongly restrict the ability of *Mimosa* seedlings to compete with other vegetation. They stated this treatment may be used to enhance the effect of other control methods.

Figure 2. Distribution (%) of top ten species in all study sites. Note: A.s. is *Alstonia scholaris*, M.g. is *Macaranga gigantean*, G.r. is *Gluta renghas*, E.g. is *Elaeis guenensis*, H.b. is *Hevea brasiliensis*, M.d. is *Macaranga denticulate*, M.i. is *Macaranga indica*, D.l. is *Dicranopteris linearis*, E.c. is *Eucalyptus camaldulensis*, S.c. is *Schima wallichii*, and V.b. is *Vitex pubescens*.

Figure 3. Dendrogram of 3 clusters grouping of the study site. Cluster analysis was performed using Jaccard’s coefficient of similarity based on plant species occurred.
Figure 4. The good forest conditions as viewed from the Empangan Tangkak to foot of the mountain. At foot of mountain mostly are covered by oil palm plantation and other farming land (leaf). Then, the fern *Dicranopteris linearis* and the tree *Alstonia scholaris* were seen growing on limestone at highland areas. The slope of the rock is showing an association between fern and *Alstonia scholaris* (right).

Figure 5. The exotic species of orchid: *Paphiopedilum callosum* (left) and pitcher plant: *Nepenthes* (right) covered the hillside at highland areas.
4. Conclusion and Recommendation

GLNP is rich in plant diversity and based on Shannon diversity index, the diversity ranged from 2.7 to 3.5 in each site. Subsequently, based on cluster analysis, there were three plant communities in the park which are lower (L1 and L2), middle (L3 and L6) and upper (L10) plant communities. The mountain forests in GLNP have important role for watershed and water regulation as well as nutrient cycle.

It should be noted that some exotic invasive species were invaded the GLNP areas and they were rated as natural vegetation in the area. Therefore, some actions are needed to remove the exotic invasive plants because it is important to be considered invasive species due to obvious impact of this species on biodiversity and ecosystem functioning in the pristine GLNP.

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