Journal of Research in Forestry, Wildlife & Environment Vol. 13(1) March, 2021
E-mail: jrfwe2019@gmail.com; jfewr@yahoo.com
http://www.ajol.info/index.php/jrfwe

ISBN: 2141 – 1778
Akomolafe et al., 2021

DIVERSITY AND DISTRIBUTION PATTERN OF FERNS AT BUKIT LARUT, TAIPING, MALAYSIA

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ABSTRACT

In this preliminary study, the ferns diversity and richness were assessed at Bukit Larut, Taiping, Malaysia. This was done to understand the pattern of distribution of the ferns and their conservation statuses. Plots of size 10 x 10 m were established at different elevations along the hill using a preferential Random Sampling method and ensuring a minimum distance of 20 m between each plot. Although there were variations in the ferns diversity and richness with regards to the different elevations studied, the base of the hill was still more diverse in ferns (Shannon index = 1.28 and Margelef index = 1.27). Fifteen ferns belonging to 10 families were identified in all the sampled plots. Dicranopteris linearis was observed to be weedy and more abundant. Terrestrial ferns were reported to be the most common and abundant in this hill forest. This is an indication of less-disturbed nature of the forest.

Keywords: *Dicranopteris linearis,* elevation, Peninsular Malaysia, Taiping

INTRODUCTION

Ferns are regarded as the second largest group of vascular plants having more than 11,000 species globally (PPG and Shmakov, 2016). They are important components of tropical ecosystems where they occupy more than 20 % of the entire plant cover (Linares-Palomino *et al.*, 2008; Salazar *et al.*, 2015). A lot of studies have reported the correlations between ferns diversity and some environmental factors such as water, light intensity, and topography in tropical forests. The results have revealed that ferns richness is higher at mid-elevations where there is usually moderate temperature and highest amount of humidity (Hemp, 2001; Kessler, 2000; Kessler *et al.*, 2011; Krömer *et al.*, 2013). However, the underlying mechanisms of this fern-environment relationship are still known to be complex (Kessler *et al.*, 2014).

The differentiation in the habits of ferns (i.e. terrestrial and epiphytic) has also been regarded as very important in considering the diversity of ferns along elevation gradients in tropical forest ecosystems. Studies have shown that ferns are more diverse at mid-elevations (Kessler *et al.*, 2011; Kluge and Kessler, 2006). Similarly, epiphytic ferns are more abundant at mid-elevations than at higher elevations (Kessler, 2000). This differentiation pattern is dependent on a number of factors such as the moisture availability and some features of the host plants which all constitute the niche complexity of the hosts (Krömer *et al.*, 2007). Although there are many studies on ferns diversity, there are still lots of gaps in understanding the ferns diversity along elevation gradients in some tropical montane forests in Malaysia. This study thereby

investigates the diversity pattern of ferns at Bukit Larut, Taiping, Malaysia.

MATERIALS AND METHODS

Study Area

This study was carried out at the Bukit Larut (Maxwell hill), Taiping, Malaysia (Figure 1). It is located at the northwestern part of the Peninsular Malaysia. Bukit Larut which was founded in 1870 is regarded as the first and oldest hill resort in Peninsular Malaysia. It was named after George Maxwell who was the first British resident assistant in Perak State. This hill is known to be very rich in biodiversity as it houses about 621 plants, and 319 animals. Taiping is a city that receives the highest annual rainfall of about 5800 mm in Malaysia. The daily temperature in Taiping ranges between 10 – 25 ^{o}C.

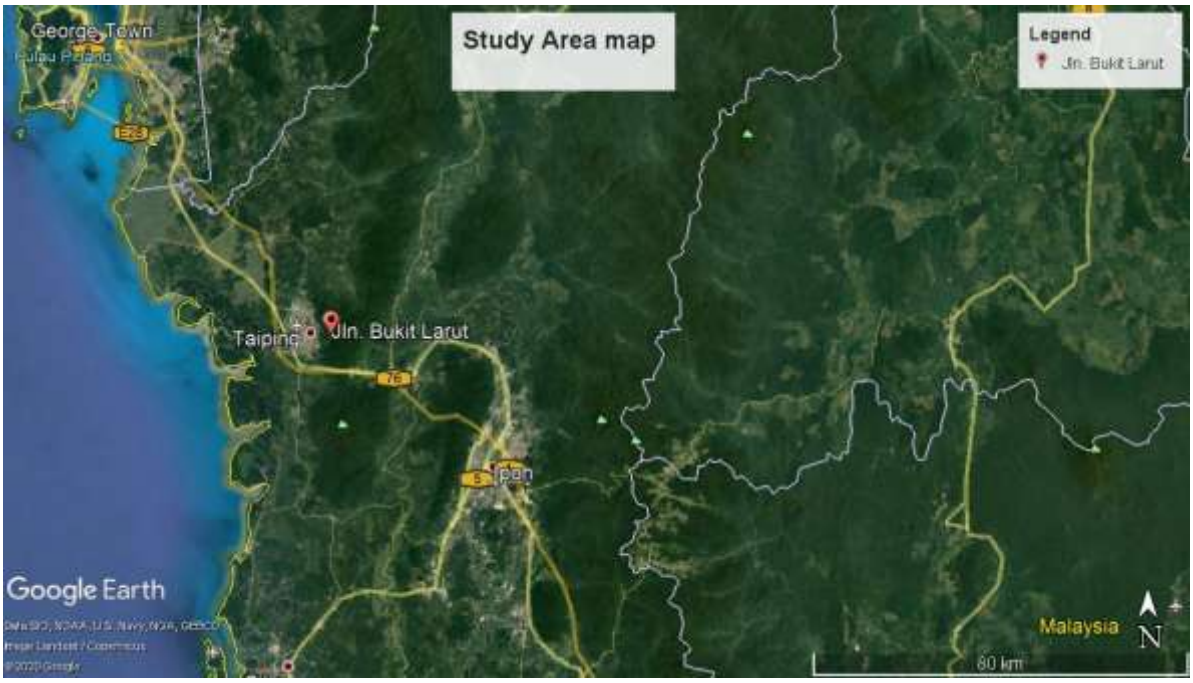

Figure 1: Google earth image showing Bukit Larut, Taiping, Malaysia

Sampling Method and Analysis

A simple preferential Random Sampling was adopted for the study. The diversity and abundance of ferns found along the elevation of the hill were accounted for by laying a 10 m x 10 m plot at any spot where ferns were found along the hill. Each plot was separated from each other by a minimum distance of 20 m. A total of 15 plots were laid along the hill. The geographical coordinates and the elevation of each plot were recorded using a Global Positioning System (GPS) device (Table 1).

The identity of each fern was confirmed using the International Plant Names Index (IPNI) and a flora (Piggott, 1988). The conservation status of each fern was also confirmed using the International Union for Conservation of Nature and Natural Resources (IUCN) redlist assessment and Malaysia biodiversity information system (MyBIS). The differences in the ferns diversity indices between the plots were estimated using pairwise permutation test with 1000 bootstrap replicates in PAST 3 software. A rarefaction analysis was done to estimate the species richness of the ferns in all the sites using a Biodiversity Pro software (McAleece *et al.*, 1997). Also, the similarity between the study plots in terms of the ferns species was established using a single linkage Bray-Curtis cluster analysis in Biodiversity Pro software.

Table 1: Geographical coordinates and elevations of the sampling plots

Plot Number	Latitude (N)	Longitude (E)	Elevation (m)
1	4° 51′ 33″	100° 45′ 28″	73
2	4° 51′ 36″	100° 45′ 42″	79
3	4° 51′ 36″	100° 45′ 43″	85
4	4° 51′ 35″	100° 45′ 44″	87
5	4° 51′ 34″	100° 45′ 47″	102
6	4° 51′ 34″	100° 45′ 51″	136
7	4° 51′ 35″	100° 45′ 51″	147
8	4° 51′ 34″	100° 45′ 54″	160
9	4° 51′ 35″	100° 45′ 54″	174
10	4° 51′ 31″	100° 45′ 58″	179
11	4° 51′ 34″	100° 45′ 58″	199
12	4° 51′ 33″	100° 45′ 59″	201
13	4° 51′ 37″	100° 45′ 55″	207
14	4° 51′ 36″	100° 45′ 57″	212
15	4° 51′ 37″	100° 45′ 56″	219

RESULTS

Fifteen (15) fern species belonging to ten (10) families were identified in all the sampling plots along the elevation gradient at this Bukit Larut. Eleven of these ferns are terrestrial while there are two epiphytes and two lithophytes. The families Asplenaceae, Dryopteridaceae, Gleicheniaceae Pteridaceae, and Hymenophyllaceae are represented by two species each while the remaining families are represented by only one species each. The conservation status of the ferns in Peninsular Malaysia revealed that only *Angiopteris evecta*, *Asplenium nidus*, *Asplenium scortechinii* and *Nephrolepis biserrata* are categorized as least concern (i.e. stable), while the remaining ones have not been evaluated (NE). These four stable ferns represent only 26.67% of the total ferns observed at this hill.

Although there were variations in the number of individuals of ferns species at each plot as the elevation increased, plot 11, 12 and 15 had the highest number of individuals (i.e. 660, 892, and 1133 respectively) (Table 3). These high numbers of individual ferns at these plots were mostly dominated by the monospecific populations of *Dicranopteris linearis*. Furthermore, the most common fern species found in almost all the plots as elevation increased include *Dicranopteris linearis*, *Angiopteris evecta*, and *Trichomanes bilabiatum*. It is also worthy to note that the lowest elevation (plot 1) at this hill had the highest Shannon index and Margalef index (Table 3).

The rarefaction analysis revealed that plots 1 and 10 have the highest species richness while plots 6, 7 and 14 have the lowest (Figure 2). The Bray-Curtis cluster analysis revealed the highest similarity (80%) between plot 15 and 12 while plot 13 has the lowest similarity (12%) with the other plots in terms of the fern species (Figure 3).

Table 2: Checklist of the ferns identified at the Bukit Larut, Taiping, Malaysia.

S/No	Name	Family	Habit	IUCN Status	Malaysia Status	Native or non-native
1	*Angiopteris evecta* (G. Forst.) Hoffm.	Marattiaceae	Terrestrial	NE	LC	Native
2	*Asplenium nidus* L.	Aspleniaceae	Epiphyte	NE	LC	Native
3	*Asplenium scortechinii* Bedd.	Aspleniaceae	Epiphyte	NE	LC	Native
4	*Blechnum orientale* L.	Blechnaceae	Terrestrial	NE	NE	Native
5	*Cyclosorus megaphyllus* (Mett.) Ching	Thelypteridaceae	Terrestrial	NE	NE	Non-native
6	*Dicranopteris linearis* (Burm.) Underwood	Gleicheniaceae	Terrestrial	LC	NE	Native
7	*Dryopteris sparsa* (Don) O. Kunze	Dryopteridaceae	Terrestrial	NE	NE	Native
8	*Sticherus truncatus* (Willd.) Nakai.	Gleicheniaceae	Terrestrial	NE	NE	Native
9	*Lindsaea cultrata* (Willd) Sw.	Dennstaedtiaceae	Terrestrial	NE	NE	Native
10	*Nephrolepis biserrata* (Sw.) Schott	Nephrolepidaceae	Terrestrial	NE	LC	Native
11	*Polystichopsis hasseltii* (Bl.) Holtt.	Dryopteridaceae	Terrestrial	NE	NE	Non-native
12	*Pteris semipinnata* L.	Pteridaceae	Terrestrial	NE	NE	Native
13	*Pteris vittata* L.	Pteridaceae	Terrestrial	LC	NE	Native
14	*Trichomanes bilabiatum* Nees & Bl.	Hymenophyllaceae	Lithophyte	NE	NE	Non-native
15	*Trichomanes bipunctatum* Poir.	Hymenophyllaceae	Lithophyte	NE	NE	Native

LC: Least Concern, NE: Not Evaluated

Table 3: Ferns diversity indices of the study plots

Diversity Indices	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12	Plot 13	Plot 14	Plot 15
Number of species	7	3	5	4	3	2	2	5	5	7	5	3	5	2	3
Number of Individuals	112	35	71	175	25	94	187	509	85	382	660	892	84	328	1133
Simpson index	0.579	0.532	0.496	0.443	0.627	0.119	0.317	0.438	0.489	0.537	0.256	0.247	0.513	0.205	0.233
Shannon index	1.28	0.91	1.02	0.83	1.04	0.24	0.49	0.75	0.96	0.99	0.59	0.49	1.07	0.36	0.47
Species Evenness	0.514	0.826	0.556	0.575	0.942	0.634	0.822	0.425	0.52	0.387	0.361	0.545	0.582	0.716	0.535
Margalef index	1.27	0.56	0.94	0.58	0.62	0.22	0.19	0.64	0.90	1.01	0.62	0.29	0.90	0.17	0.28

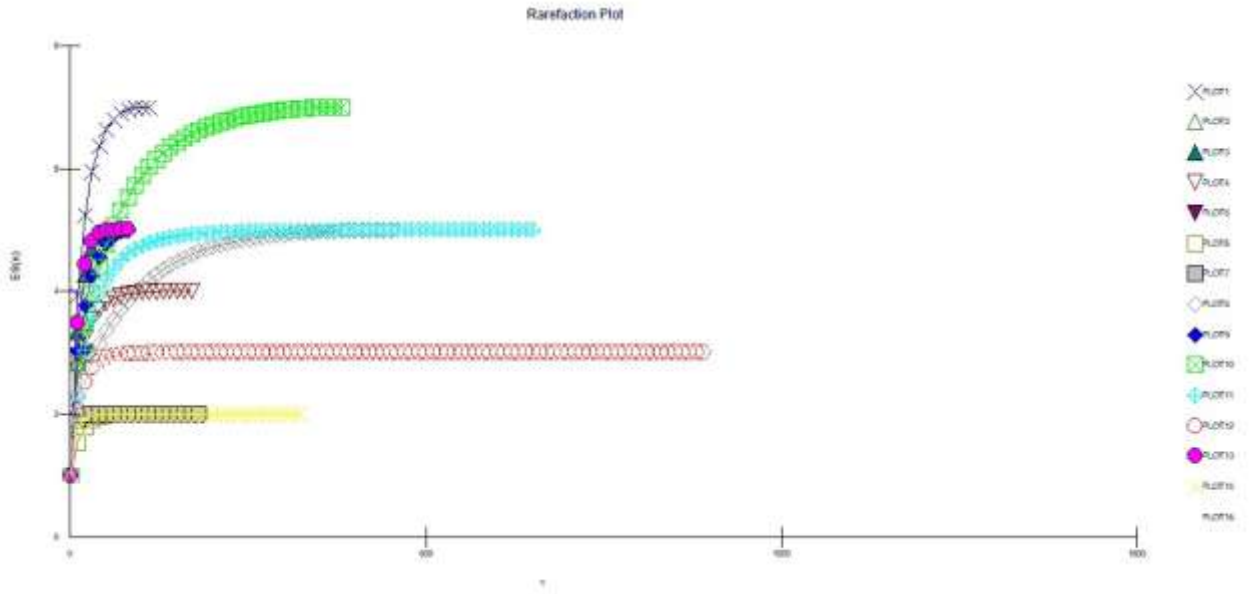

Figure 2: Rarefaction curves for the species richness of all the sample plots.

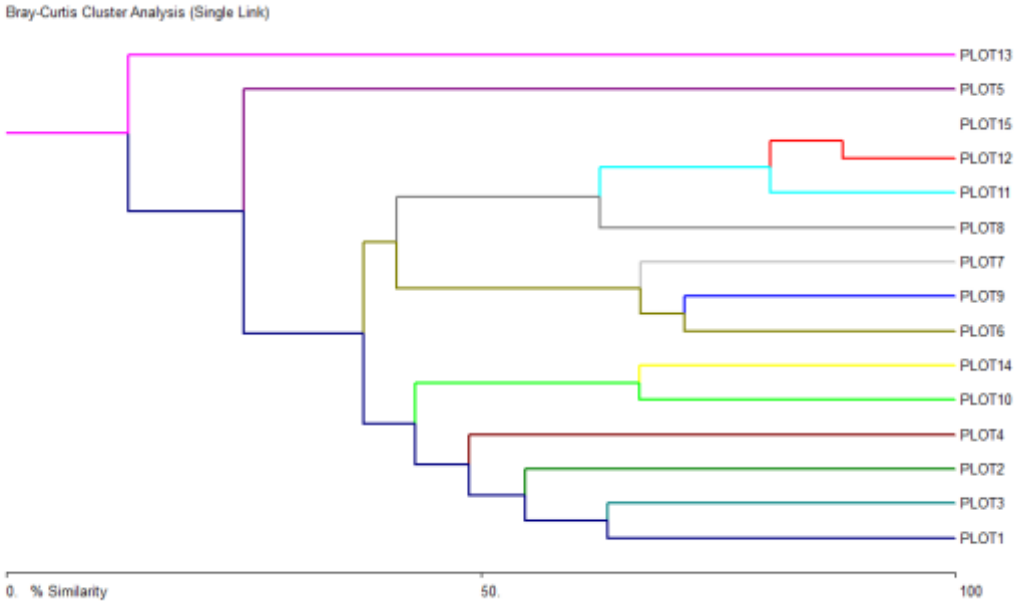

Figure 3: Dendogram showing the relatedness of the study plots

DISCUSSION

The higher proportion of the terrestrial ferns in this forest could indicate that the forest is less disturbed, despite being a recreational hill forest. This is because terrestrial ferns are known to be more common in less disturbed forests (Rahmad and Akomolafe, 2018; Sathapattayanon and Boonkerd, 2006). According to the Malaysian biodiversity information system, only *Cyclosorus*

megaphyllus, *Polystichopsis hasseltii*, and *Trichomanes bilabiatum* have not been naturalized to Malaysia, the others were identified as natives. The paucity of information on the conservation status of the identified ferns in in this study further confirms previous researches that there are lots of gaps in the assessment of the conservation statuses of ferns in Malaysia by both IUCN and MyBIS (Akomolafe and Rahmad, 2019; Rahmad and Akomolafe, 2018).

The higher number of individuals of *Dicranopteris linearis* observed in this forest shows that the fern has the tendency to be an aggressive invasive fern in Malaysia in the future. A few studies have reported it to be a weedy native fern in forest floors and disturbed sites in Malaysia and Indonesia (Ooi, 1992; Wahyuni and Sulistijorini, 2015; Wong *et al.*, 2010). The higher diversity indices observed at the base of the hill indicated that it is more diverse and richer as compared with the other plots. Our preliminary survey did not reach the topmost elevation of the hill, perhaps there might be a different trend in the diversity and richness of the ferns.

CONCLUSION

This preliminary study has revealed that the ferns diversity and richness vary with respect to the different elevations. The base of the Bukit Larut hill was found to be diverse and richer in ferns species. The conservation statuses of a higher percentage of the identified ferns have not been assessed in this region and worldwide. This is a call to the conservation experts and ecologists to focus on documenting the conservation statuses of these ferns in Malaysia and the entire world. *Dicranopteris linearis* has also been observed as a potential weedy fern in this hill forest.

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