Fern diversity and distribution in the UBD campus

Daniele Cicuzza[1], Muhammad Adib Hidayatullah Ahmad[1], Ahmad Rafi'uddin Bin Jipli[1], Dk Noorul Suhailah Binti Pg Sapudin[1], Nor Syukriah Akmal Bte Awg Hj Ismail[1]*

[1]Environmental and Life Sciences, Faculty of Science, Universiti Brunei Darussalam, Jalan Tungku Link, BE 1410, Brunei Darussalam

**corresponding author email: dcicuzza@gmail.com*

Abstract

Green areas and parks are important for maintaining local biodiversity in urbanised habitats. Recent studies have demonstrated that the biodiversity retained in these areas is also important for engaging citizen scientists in conservation projects. Most of the documentation on biodiversity is from temperate regions, whereas in the tropics this field is still in its infancy. This study documented the fern and fern allies richness and abundance within the Universiti Brunei Darussalam (UBD) campus, Brunei Darussalam. We found 39 species in total, belonging to 20 families and 28 genera. Although the total richness did not differ between forest and open plots, ordination showed that forested areas retained a different species composition. Although none of the identified species were IUCN listed, nearly half of the species were recorded once or twice, indicating small population sizes and the biological value of small forest fragments. Our study contributes to understanding the flora diversity of the UBD campus. These results can be used to minimise environmental degradation during infrastructure development on the UBD campus.

Index Terms: ferns, diversity, Brunei Darussalam, urban ecology, conservation

1. Introduction

Studies in urban ecology have underlined the importance of green areas and parks within cities for species biodiversity protection and ecosystem services.[1] Moreover, green areas can also be used to engage citizens, students and tourists in understanding local biodiversity and its importance for the urban environment.[2] Cities can harbour a high biodiversity due to the fragmented original landscape and the mosaic of habitats that are created within it. Even in densely populated cities the species richness can be surprisingly high.[3] At the same time degradation of the original habitat, during urbanisation, creates areas where most of the native species have disappeared.[4] These sites are generally colonised by more disturbance-tolerant or alien species, which can modify the local environment.[5]

Ferns and fern allies (hereafter called "ferns") comprise the second richest vascular plant group, after angiosperms, with approximately 11,000 species, with most of them found in the tropics.[6,7] Fern life form includes terrestrial herbs, climbers, epiphytes, and rooted and free-floating aquatic forms.[8] Some of the species are also commonly used as vegetables in local diets. Despite their ecological importance and diversity, our knowledge of fern distribution and diversity within urban landscapes is still poor. To increase our knowledge of ferns within urban environments we surveyed the richness and distribution of ferns within the UBD campus in Brunei Darussalam. The study aimed to a) provide a complete checklist of ferns and fern allies in the UBD campus, b) generate fern distribution maps of the campus, c) highlight the species richness and abundance within the UBD campus and the conservation values of the remaining forest patches, and d) to highlight the species which are endangered and require special conservation attention.

2. Experimental approach

2.1 Study site

The study was conducted within the campus of Universiti Brunei Darussalam, 4.97646^{o}N and 114.895^{o}E. The campus is located in the district of Brunei Muara, in a typical coastal heath forest vegetation, locally known as Kerangas forest. The campus has a hilly orography with small valleys distributed within the area. Small, partially disturbed forest patches with trees up to 15 meter high remain within the campus. This mosaic provides a wide range of natural, semi-natural or entirely urbanised habitats and ecological niches for fern species (see ***Figure 1***).

The Heath Forest (HF) is formed on infertile, acidic and predominantly sandy soils. The trees are generally shorter and smaller than those of the wider distributed Borneo Mixed Dipterocarp forest. The leaves of the HF trees are typically thick, leathery and small, characteristics correlated with nutrient deficiency on very acid soils and an adaptation to minimize water loss and reduce heat load during periods of drought. Despite the low species richness compared with the Mixed Dipterocarp forest, the HF retains several endangered and vulnerable species related to soil traits.[9]

Figure 1. Map of UBD campus with the grid of plots superimposed. Plots have side lengths of 100m. The plots at the edge of UBD campus with reduced surface areas were not included in the assessment.

2.2 Data collection and species identification

The UDB campus map was downloaded from Google Earth. Subsequently a grid of 100 x 100 meters was imposed over the map (see ***Figure 1***). The plots surveyed covered 80 to 100% of the area within UBD campus because incomplete plots at the edge of the UBD campus were not included. In total 128 1-ha plots were surveyed. The grid was developed using Adobe Photoshop software (2017). The surveys were conducted during 2017 and 2018.

Plots were established using four poles, one at each quadrat corner. Distances were measured with a 50-meter measuring tape. The location of the plots was established with the use of multiple techniques. A hard copy map was used to locate buildings and other human artefacts so as to quickly locate the approximate location of plot corners. The plot position was confirmed by comparing the Google Map application with the hard copy map.

The area of each plot was carefully inspected, and the fern species present were noted. The fern species were categorized by their growth habit as either terrestrial, epiphyte, or climber. The fern species assessment was done in both forest and open areas, such as grass meadows. Buildings and other constructions were carefully checked for epiphytic species. The presence or absence of each fern species was noted in each plot. The fern species abundances were estimated based on their cover per plot, with the cover intervals being <5%; 5-10%; 11-50% and >50%. For the most common and abundant species on the UBD campus, the total area covered was estimated by multiplying the percentage cover level (using the lower limits of the intervals) by their frequency over the campus. Although this type of estimation is sometimes considered to be coarse, it nonetheless has potential and interesting implications for ecological understanding. In order to categorise the plots based on their forest cover, they were visually assessed as open plots (OP) or forest plots (FP). The assessment was conducted first based on the map (see ***Figure 1***). If the forest cover was clearly over half of the plot (50%), it was confirmed as a forest plot, and if the area was open with buildings and grassland on more than half (50%) of the plot, it was classified as an open plot. Each plot classification was confirmed in the field as soon as the four poles were visible on the ground. This allowed a clearer view to confirm the classification previously assessed from the map.

Species were collected from the field and identified at the UBD herbarium (UBDH). Identification was based on available references such as *Flora Malesiana*,[10,11,12] *Flora of Malay*a,[13] and the website "Ferns of Thailand, Laos and Cambodia".[14] Furthermore, a comparison was conducted with the herbarium vouchers available in the UBD Herbarium; the specimens collected were not used for herbarium vouchers.

2.3 Data analysis

To assess the fern diversity in the UBD campus we ran a sampling completeness analysis, using the Chao2 species richness estimator. The calculation was conducted using the sample-based incidence (presence-absence) of fern species, with plots as replicated sampling units. Diversity of forest (Forest Plot FP) and anthropogenic (Open Plot OP) plots were compared using a one-way ANOVA. Fern compositional patterns within the campus were assessed using Non-Metric Multidimensional Scaling (NMDS) analysis of the presence/absence dataset. The sampling completeness was calculated using the programme EstimateS, whereas the species accumulation, ANOVA and NMDS analyses were performed using the software R,[15] and in particular the R package Vegan.[16]

3. Results and Discussion

3.1 Richness

A total of 39 species of ferns and fern allies were found, belonging to 16 families and 29 genera. The most abundant family was Polypodiaceae with 8 species, representing 21% of total richness, followed by the Pteridaceae with 7 species and 18% of the entire richness (see ***Table 1***). Over half of the species (56%) were terrestrial

ferns, followed by epiphytic ferns (32%), and climbing ferns (12%) (see ***Table 1***).

Chao2 estimates a total of 42.9±3.9 ferns species for the entire study area, indicating that 4 undetected fern species are expected to be present within the campus. Confidence that the sample size was sufficient is confirmed by a sample completeness greater than 50%. Chao 2 requires that the proportion of unique species should be less than 50% of the total number of species, and in this study, it was 41%. Based on the Chao2 analysis, our 'sampling completeness' corresponded to ~95% of species. We are therefore confident we have assessed nearly all of the fern species in the UBD campus (see ***Figure 2***).

In the 128 plots surveyed the species diversity ranged from 0 to 16 per plot. Based on the forest cover, 79 plots had less than 50% forest cover, whereas 49 plots had more than 50% forest cover. The average number of species per plot was 4.6, with 5.3 for the FP and 4.1 for the OP (see ***Figure 3***), a difference that was not significant (ANOVA, F=5.116, p=0.025) (see ***Figure 3***). Of the 39 species found in the UBD campus, 16 were recorded only once, comprising nine in open sites and seven in forested sites. The study reported 29 genera in total with an equal number, 21, in the two categories FP and OP, while 7 genera were unique to the OP and 7 to the FP.

3.2 Abundance and distribution

The most abundant species was *Dicranopsis linearis* (Burm.f.) Underw. This species bordered the edge of most forest fragments. Based on plot cover estimates and species frequency, *D. linearis* had a total estimated cover of approximately three hectares. The next two common species, *Nephrolepis biserrata* and *N. brownii*, are known to readily colonise anthropogenic sites. These last two species were recorded as either terrestrial or epiphytic, thus showing ecological adaptation. Species with low abundance and presence in only one or two plots were *Pyrrosia lanceolata* (L) Farw, *Schizaea digitata* (L.) Sw., *Ceratopteris thalictroides* (L.) Brongn, *Acrostichum aureum* L., *Pityrogramma calomelanos* (L.) Link, *Platycerium coronarium* (Koenig.) Desv, *Ophioglossum pendulum* L., *Lepisorus longifolium* (Bl.) Holtt. According to the IUCN redlist these species are not considered in danger of extinction or critically threatened.

The distribution of species, genera and families showed that the northern part of the UBD campus had a lower richness, while the southern border of the campus had a higher richness (see ***Plate 1*** and ***Plate 2***). At the family level (see ***Plate 1.A***) the whole campus ranged between one and four. Two areas had 5-9 families, namely the areas around the Faculty of Science (FOS), the Faculty of Arts and Social Sciences (FASS), the central library and the sports complex. These sites were also richest at the genus and species level. At the genus and species level the plots between the sports complex and the central area of UBD campus (FOS, FASS and the central library) had between 5 and 9 genera or species. At some of these sites this increased to 10-14 species, particularly the sites which had a mix of forest and open area. Most of these were concentrated in the southern part of the campus, bordering the provincial road. In some of these sites, rare and unique species were recorded, such as *Schizaea sp.* Most importantly, the site around the FOS building had an exceptional number of 19 species. The distribution of rare and unique species within the UBD campus (see ***Plate 2***) showed a rather random distribution and was not necessarily related to a specific habitat. Some of the epiphytic species were recorded on trees bordering parking areas, whereas species related to forest or water bodies were recorded inside forest patches or along drainages.

The ordination analysis, based on Euclidian distance, showed that most of the plots overlapped in ordination space. The OP were widely distributed, encompassing a broad and diverse species composition. The FP, by contrast and despite their overlap with the OP plots, were mostly concentrated in the negative area of the First Principal axis. This indicates that, despite no statistical difference in species richness between the open and forested sites, the species

composition in the FP was spatially separated, demonstrating a selected species composition that cannot be not identified from the species richness parameter (see ***Figure 4***).

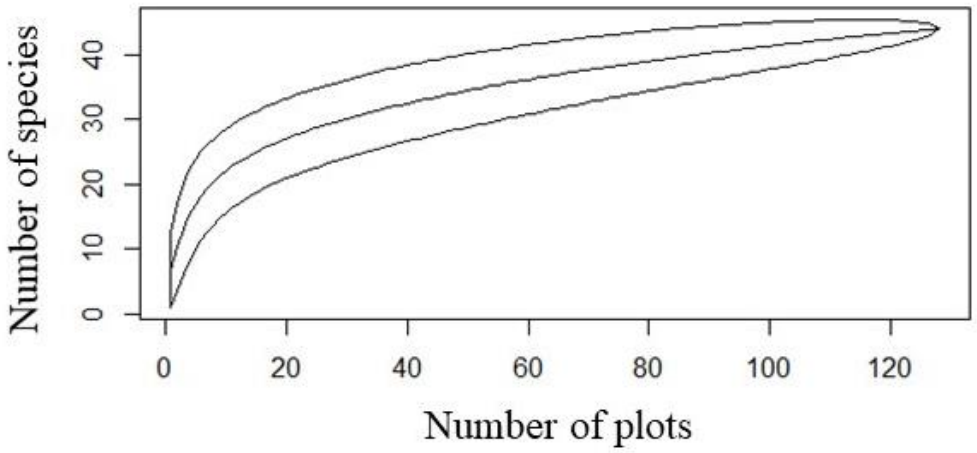

Figure 2. Species accumulation curve for the 128 plots within the UBD campus. The curve shows the accumulation of species as the number of sites increases, and the Chao2 richness parameter has been used to generate an estimate of the total species number. The central black line is the mean value, and the two side lines represent the upper and lower 95% CI. The plateau observed in the curve supports the claim that the total number of observed species is close to the actual number of species, with only a few unseen species.

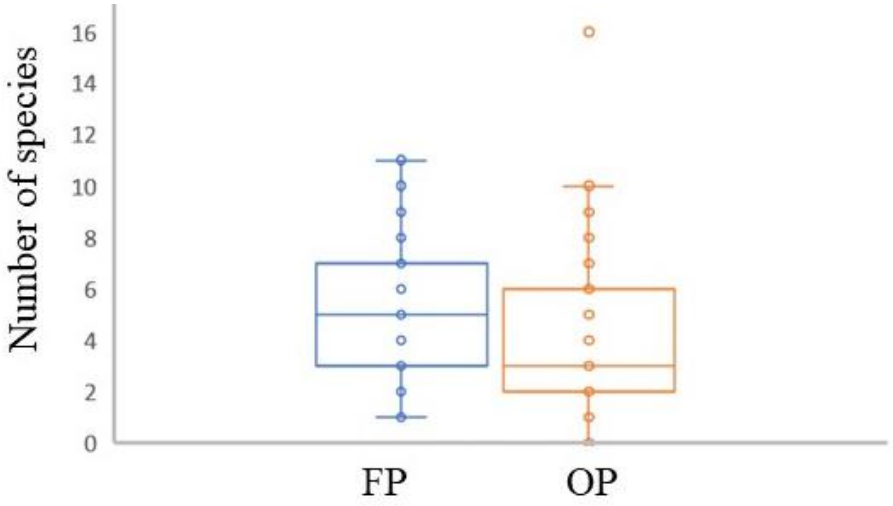

Figure 3. Fern species richness for the two categories, forested plot (FP) and open plot (OP). The figure shows the medians, the upper and lower quartiles and one outlier for the open sites plots. The ANOVA test between the two categories does not show a significant difference (F=5.116, p= 0.025).

3.3. Comparison

In this study, 39 ferns species have been recorded and mapped within the UBD campus. The high diversity of families and genera shows that the phylogenetic diversity occurring within this small and highly urbanised tropical area is high. The non-parametric estimators pointed to the prevalence of different communities between the forest and open sites in this small and highly urbanised area, although the difference was not significant. The presence of species with forest related ecology and with a low frequency is a sign that the forest patches are still able to retain a certain number of species with a strict ecological niche. At the same time, some species with low frequencies were recorded in open sites around buildings. The 39 species found in the 120,000 square meters is relatively high compared with the 20 species recorded on the university campus of Indralaya (in Sumatra,

Indonesia; the species comprising 16 terrestrial, 3 epiphytic and 1 aquatic fern);[17] and with the 27 epiphytic fern species noted in an oil palm plantation near the university.[18] The species diversity in our study site included eighteen genera represented by a single species. A few of the representatives of these genera are common species, but others are rare and occur with low frequencies, such as *Ophioglossum*, *Psilotum* and the *Platicerium*. Surprisingly, some species that are generally common in urban sites were rare and recorded only twice on UBD campus, such as *Ceratopteris thalictroides* (L.) Brongn, *Acrostichum aureum* L. and *Pityrogramma calomelanos* (L.) Link.[14]

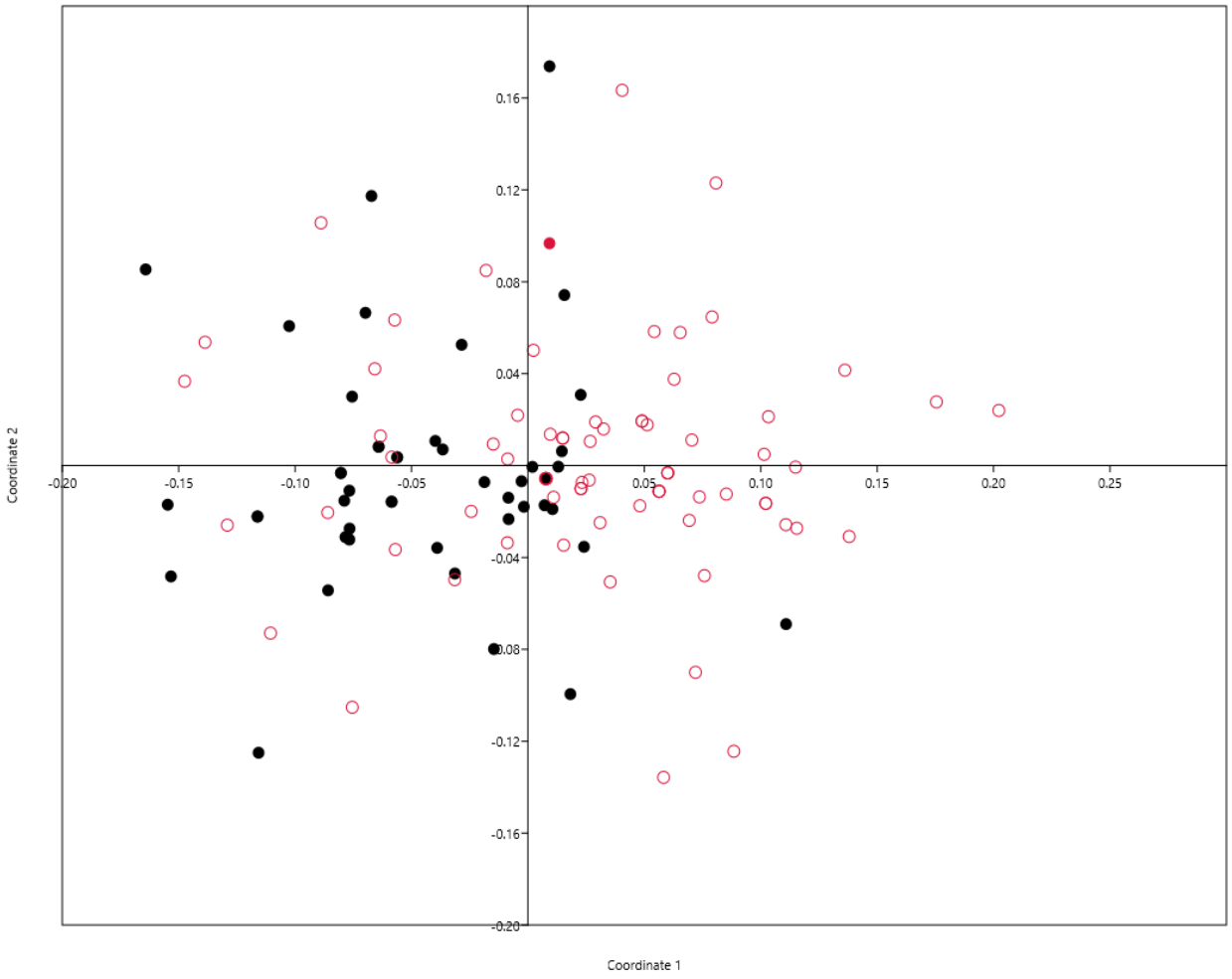

Figure 4. Ordination analysis (NMDS) using the fern species presence/absence dataset for the entire UBD campus. Black filled circles represent the plots from forested cites, while empty red circle are the open site plots. Although there is no statistically significant difference, the fern community in the forested plots is primarily distributed toward the negative site of the ordination analysis, showing a certain community composition occurring primarily in forest, while the open sites have a wide range of distribution.

3.4 Fern species and ecology

To our knowledge there are no available studies of fern species composition in heath forest in Brunei. Moreover, based on the published literature, some of the species recorded within the campus are ecologically related to disturbed southeast Asian habitats, and some have a forest-interior preference. In this study, none of the fern species assessed is considered alien or invasive, and so the floristic fern composition of UBD campus is represented by native South East Asian species. Although alien species have been documented as a common threat for native plant species,[19] there are no alien fern species among

those assessed in this study. Furthermore, even though in temperate cities of Europe and North America the flora in major cities show a high homogenization, combined with a strong differentiation between the flora within the urbanised area and the forest vegetation surrounding the city itself,[20] the forest patches within the UBD campus still retain a certain degree of typical heath forest fern species. Some of the species, such as *Dicranopteris linearis*, are particularly abundant throughout the campus. *D. linearis* is a common species in Southeast Asia, where it is especially abundant along the forest edge. Apparently, the fragmentation process in the UBD campus has facilitated the increase of cover of this species. Disturbance and fragmentation have also increased the abundance of other common species such as *Nephrolepis biserrata*, *Stenochlaena palustris* and *Lygodium circinnatum*. Their cover is strictly related to the fragmentation process and the disturbance; that is, they follow the expansion of human activities.

Heath forests have low species diversity;[21] however this habitat is unique with many species rare or restricted to the heath forest. There is no significant difference in total richness between the OP and the FP. The assessment of these two categories, open and forest, was based on the threshold of 50% forest cover, and so a few plots had small forest patches and were still considered OP, and vice versa. This is better explained by the ordination analysis, with species from the OP broadly distributed within the ordination graph. At the same time species from the FP were mainly concentrated on the negative side of the graph. This highlights the fact that, despite the threshold between the open and forest plots, it is possible to observe a difference in species composition between the two categories. It is important to highlight that the forest patches are also disturbed. Therefore, the species composition also includes species common to disturbed areas. This 'noise' in the species composition is difficult to isolate in the analysis. The distribution of forest patches is mainly concentrated on the southern part of the UBD campus, with a smaller proportion of forest on the northern site. The southern part with forest and edge sites had the highest number of fern families, genera and species. A few sites with a high number of species and genera are distributed either in the northern or the southern parts of the campus. This is probably due to local stochastic conditions that are difficult to discriminate at the level of the floristic analysis done in this study. Moreover, a peculiarity of this high rich plot is the presence of rare species recorded only once.

Sixteen species were recorded only once, of which seven were in the FP and 9 in the OP. From the distribution map (see ***Plate 1***), rare species are not concentrated in a given area or habitat, but rather are distributed randomly within the campus. In the forest patches, two important species, *Schizaea dicotoma* and *S. digitate*, were recorded once or twice. These two species are rare in heath forest and in the dry habitat of mixed dipterocarp forest. While the first can have populations consisting of several individuals, *S. digitata* has only a few individuals per population. Therefore, the presence of these species in the forest patches on the UBD campus highlights an importance example of conservation, as they have survived in a forest which is heavily disturbed along the coastline of Borneo. One species found in an open site, *Ophioglossum pendulum*, is not under threat in tropical regions, but was recorded only once in the present study. Another important species found in an open site is *Platicerium coronarium*, represented by a single individual on a tree near the FOS building. Fern species have few limitations on their dispersal, but populations with low frequencies separated in small forest patches, or impeded by human construction, have difficulty in maintaining the constant flux of spores needed to sustain or expand their populations. Therefore, more attention needs to be paid to these species.

3.5 Extinct species, conservation and recommendations

None of the species found in the UBD campus are at risk of extinction or considered to be critically endangered according to the IUCN pteridophytes assessment. At the same time, some of the species typical of heath forest

vegetation have very low frequencies and therefore they need special attention, particularly in the light of future campus development. The species that have low frequencies either in the campus and in forest patches with low disturbance are *Schizaea digitata* (L.) Sw., *Pyrrosia lanceolata* (L) Farw, *Platycerium coronarium* (Koenig.) Desv, *Lepisorus longifolium* (Bl.) Holtt. Except for *Schizaea digitate*, which is a terrestrial species, the remaining three have an epiphytic life cycle. The three epiphytic species are rare also in the heath forests of Brunei Darussalam, and so their presence in the campus needs to be considered with attention. Particular attention should be paid to *Ophioglossum pendulum* and *Platycerium coronarium*, which were both represented by a single individual. The species *Ophioglossum nudicaul*e, which was collected by the UBD Herbarium in 1994, can no longer be found. The voucher label describes the species as present in 'cultivated grassland in light shade between buildings.' But despite efforts to retrieve this species it was not found; therefore, we have now declared it to be locally extinct.

4. Conclusion

This study is the first assessment of fern species richness, distribution and abundance in the UBD campus. The results can be used for future reassessment and to document the change in species richness in an anthropogenic tropical area. Despite the fact that none of the species appears in the IUCN redlist categories, a few species have very low frequencies, and some cases are represented by only one individual. This must be borne in mind when potential development is planned. We strongly recommend that, in the case of future development, large trees hosting epiphytic species should be pruned, and the Botanical Research Centre should be consulted so as to assess the environmental impact, and perhaps to eventually proceed with a translocation (*ex-situ* conservation) to the botanic garden area of those species with low frequencies.

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Plate 1. Distribution map of richness at Species, Genus and Family level in the UBD campus.
A: Family, B: Genus and C: Species. Colour scale: 0: Red, 1-4: Orange, 5-9: Yellow, 10-14: Blue, 15-19: Green.

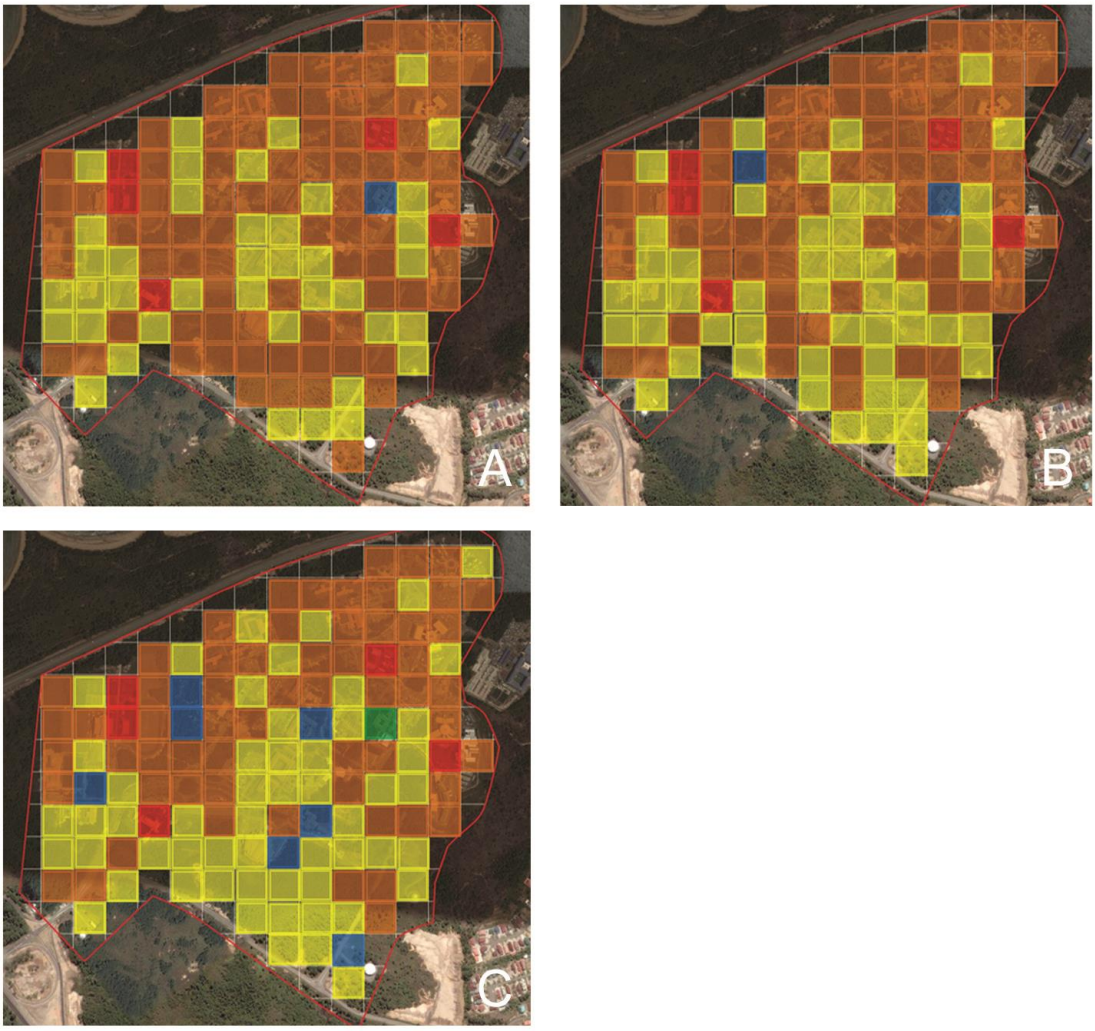
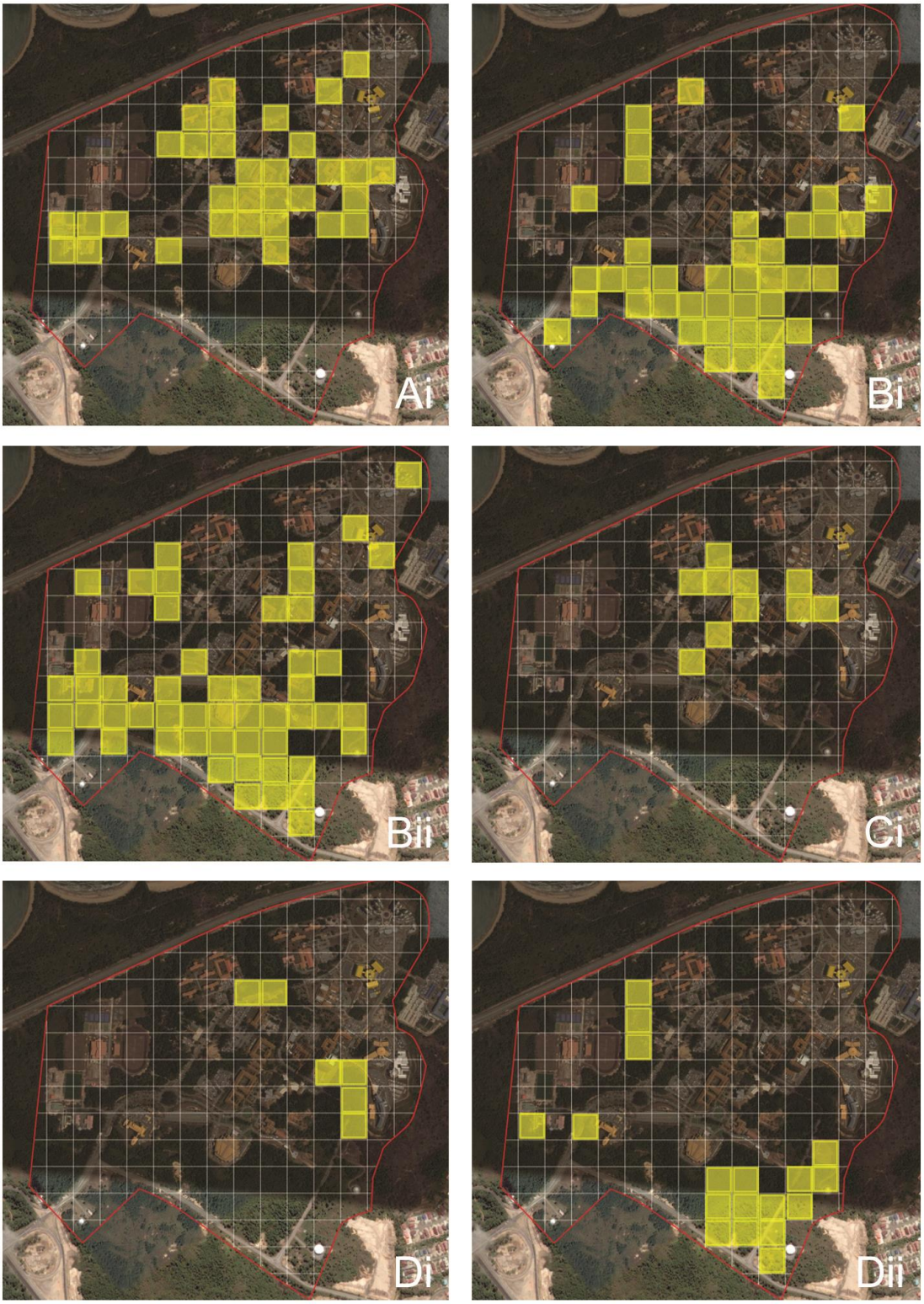
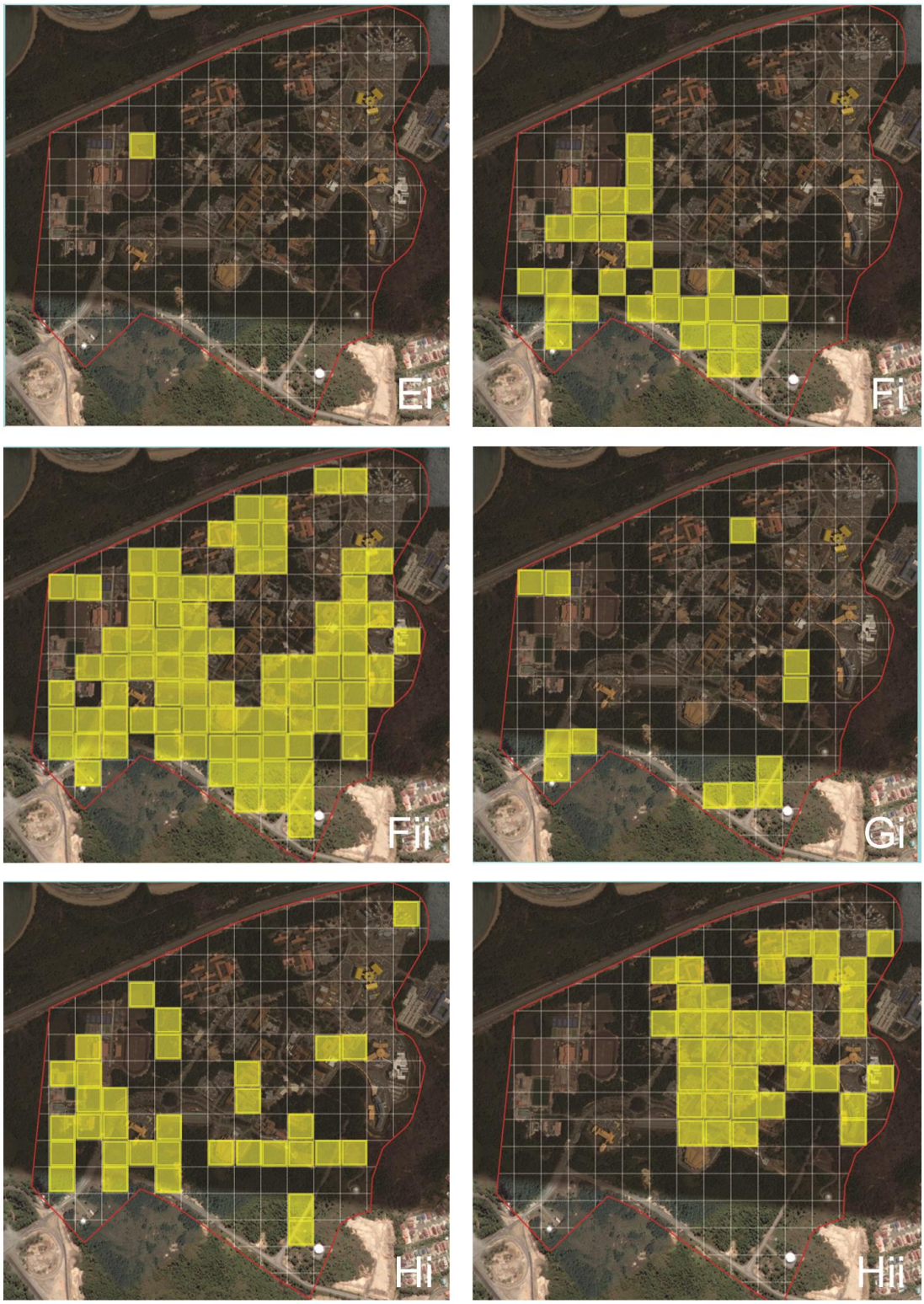


Plate 2. Distribution of all the 39 species assessed in this study:

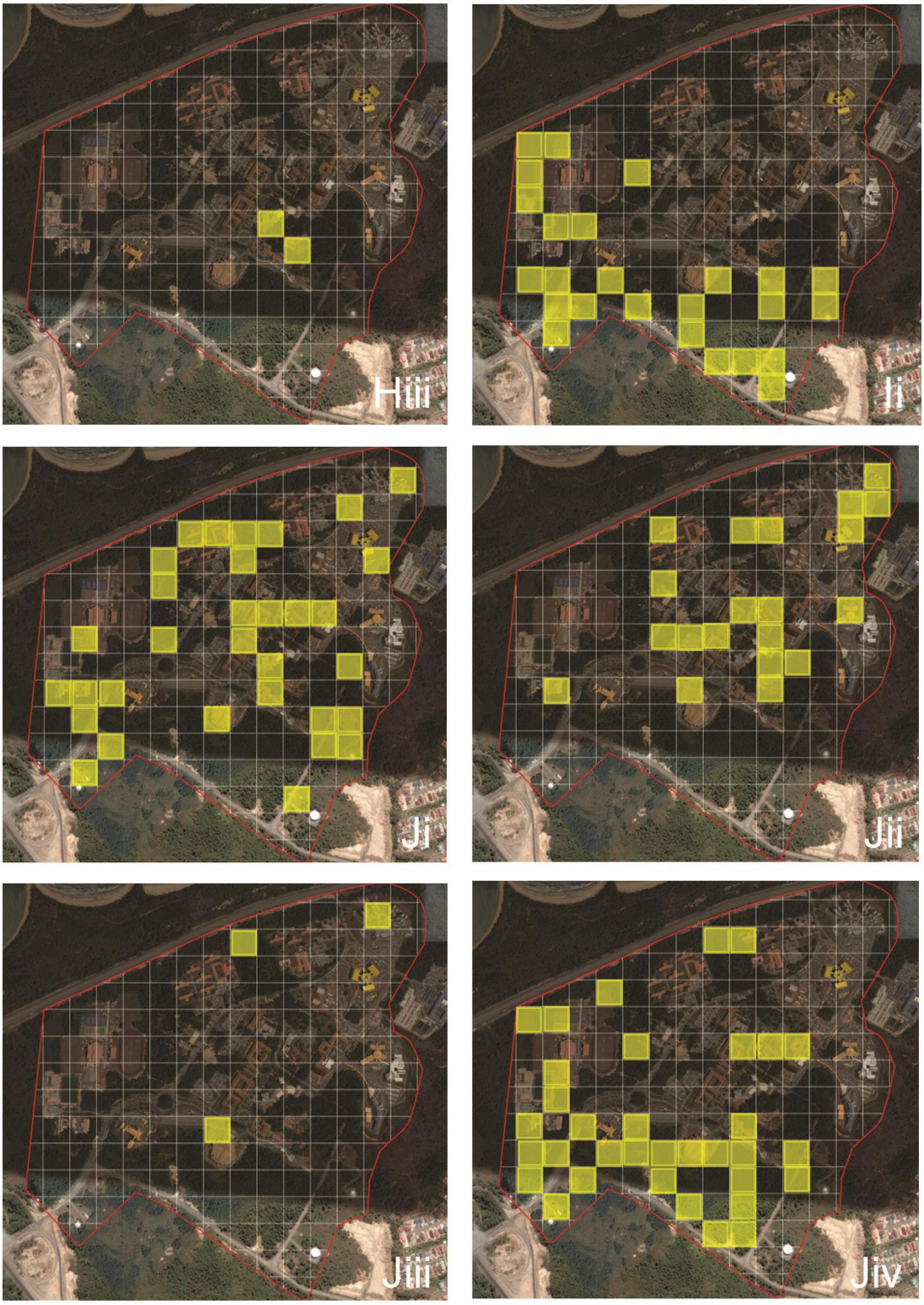
Ai - Dii
Ai: *Aspenium nidus*; Bi: *Blechnum orientale*; Bii: *Stenochlaena palustris*;
Ci: *Davallia denticula*; Di: *Pteridium aquilinum*; Dii: *Pteridium caudatum*



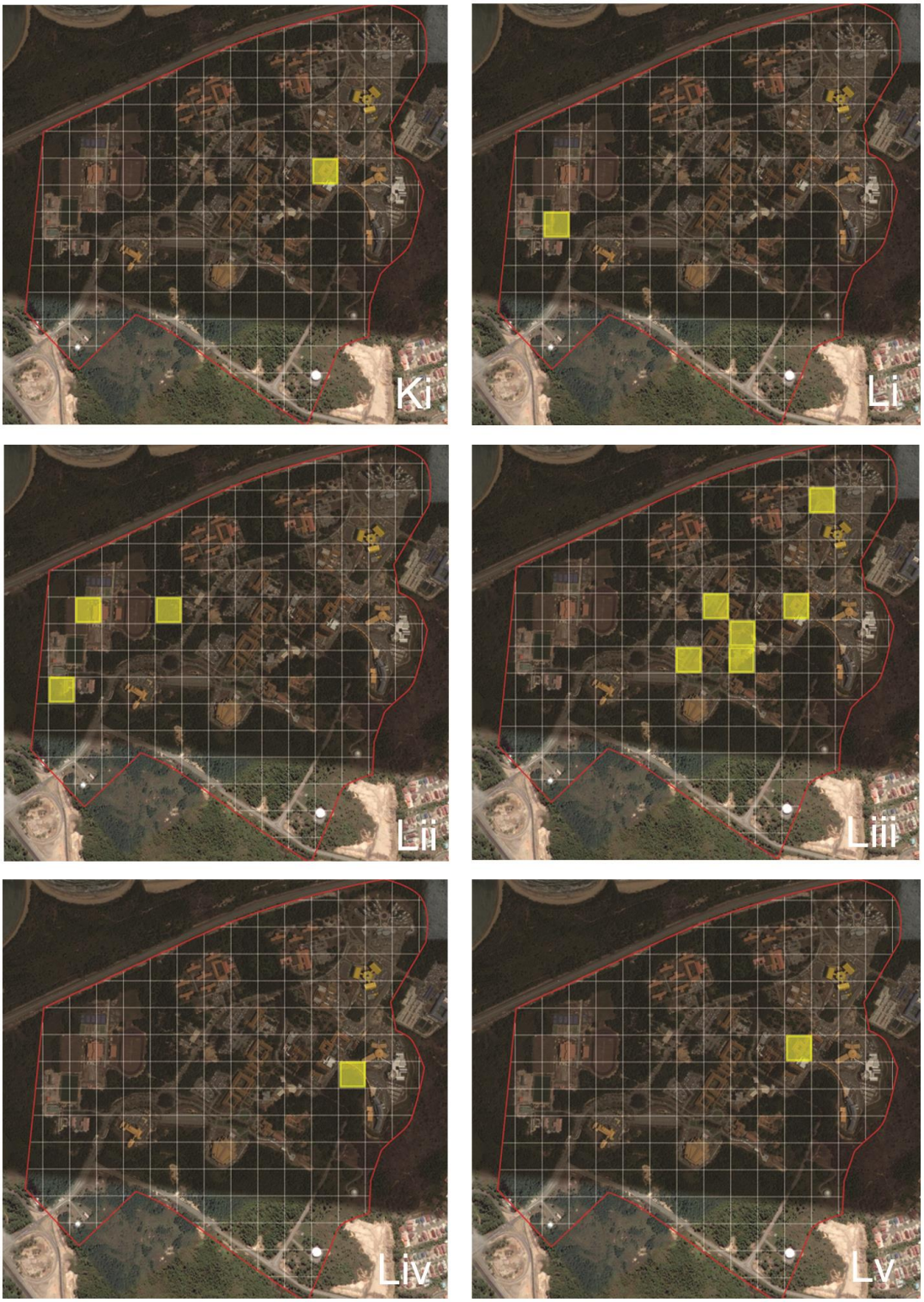
Ei - Hii
Ei: *Leucostegia sp.*; Fi: *Dicranopteris curranii*; Fii: *Dicranopteris linearis*;
Gi: *Lindsaea ensifolia*; Hi: *Nephrolepis biserrata*; Hii: *Nephrolepis multiflora*



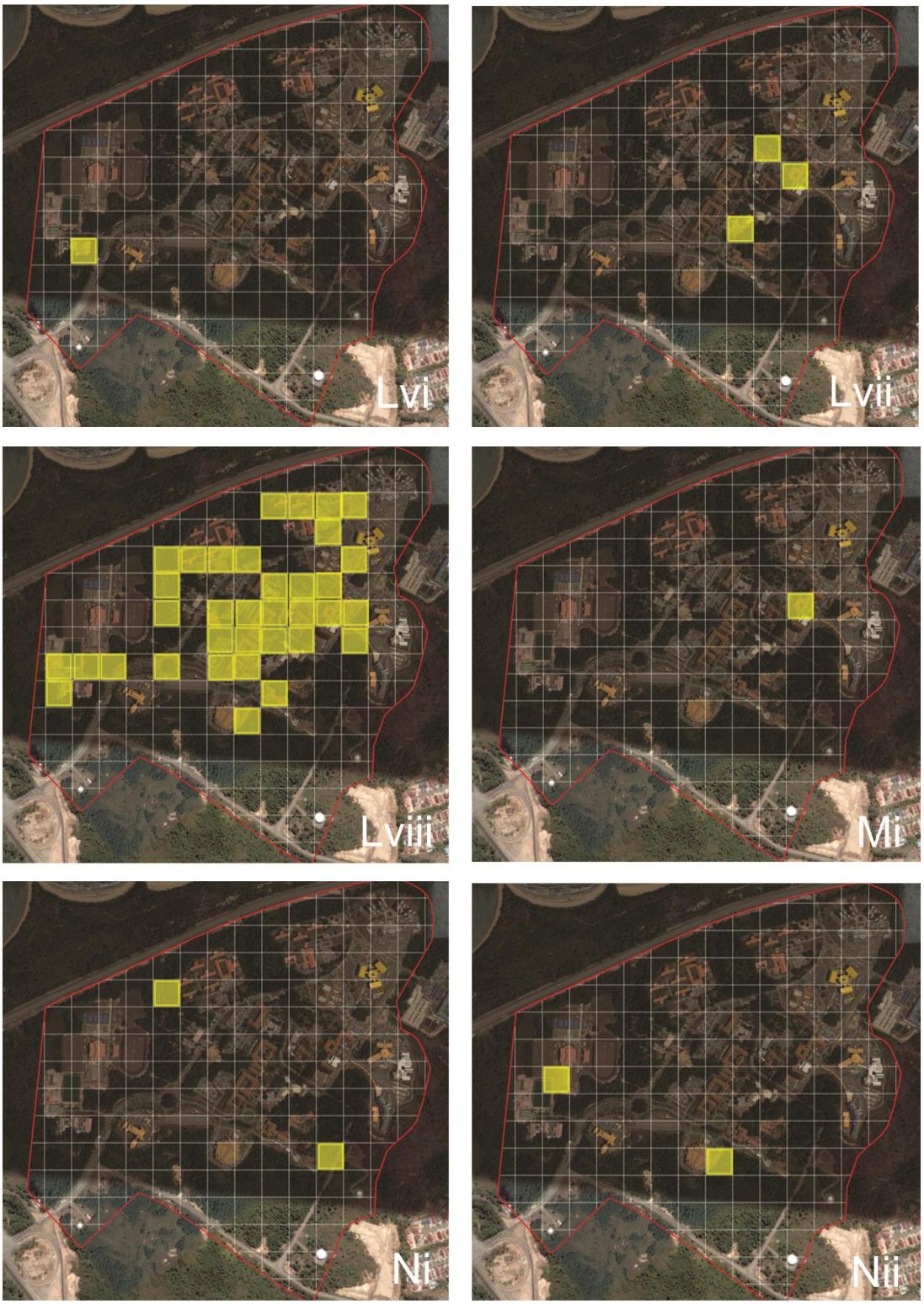
Hiii - Jiv
Hiii: *Nephrolepis radicans*; Ii: *Lycopodium cernuum*; Ji: *Lygodium circinnatum*;
Jii: *Lygodium flexuosum*; Jiii: *Lygodium longifolium*; Jiv: *Lygodium microphyllum*



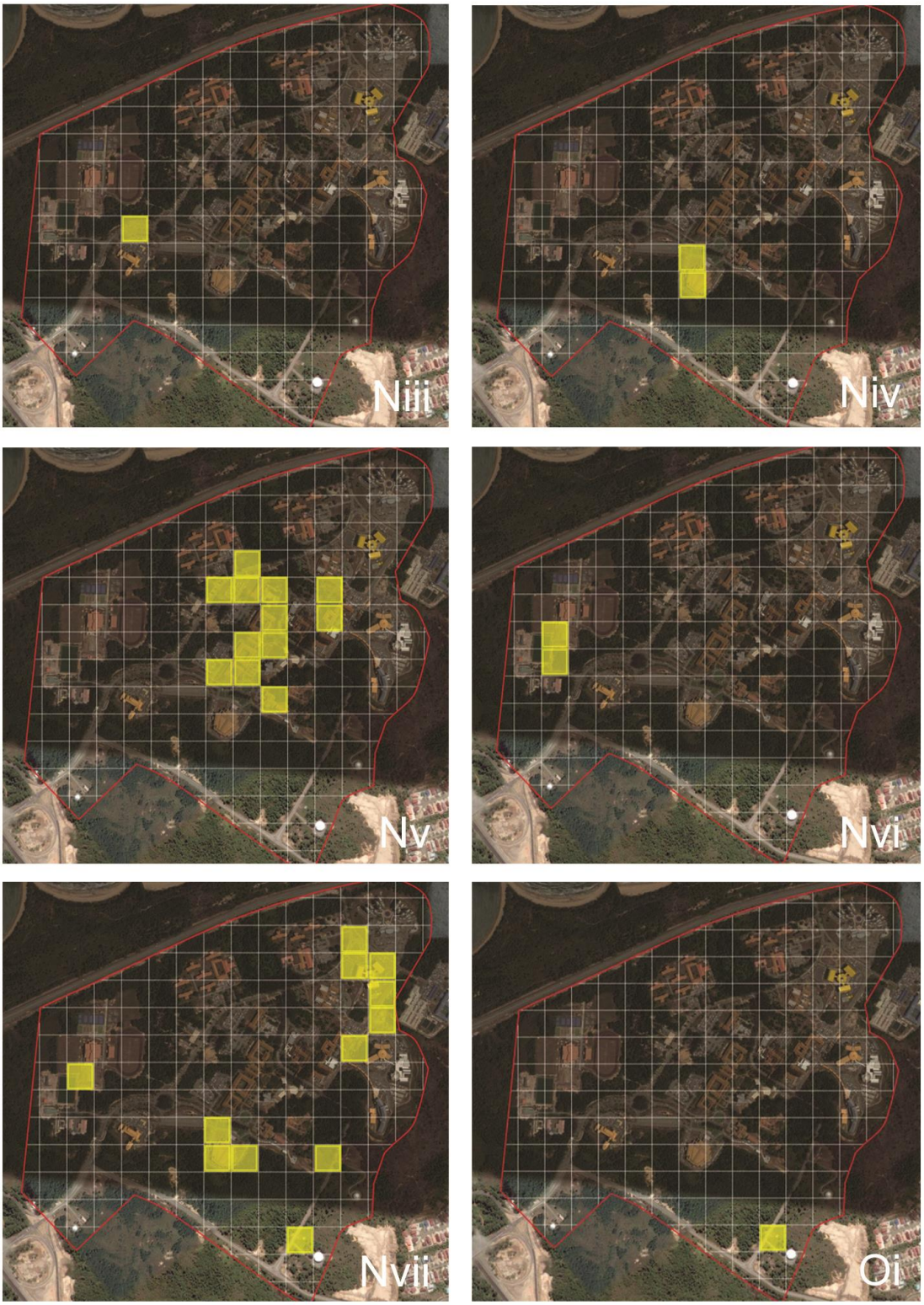
Ki - Lv
Ki: *Ophioglossum pendulum*; Li: *Aglaomorpha heraclea*; Lii: *Drynaria quercifolia*; Liii: *Drynaria sparsisora*; Liv: *Lepisorus sinensis*; Lv: *Platicerium coronarium*



Lvi – Nii
Lvi: *Pyrrosia lanceolata*; Lvii: *Pyrrosia longifolia*; Lviii: *Pyrrosia piloselloides*;
Mi: *Psilotum nudum*; Ni: *Taenitis blechnoides*; Nii: *Acrosticum aureum*



Niii – Oi
Niii: *Ceratophteris thalictroides*; Niv: *Cheilantes farinose*; Nv: *Haplopteris angustifolia*;
Nvi: *Pityrogramma calomelanos*; Nvii: *Pteris vittata*; Oi: *Schizaea dicotoma*



Oii – Qi
Oii: *Schizaea digitata*; Pi: *Selaginella sp.*; Qi: *Cyclosorus parasiticus*

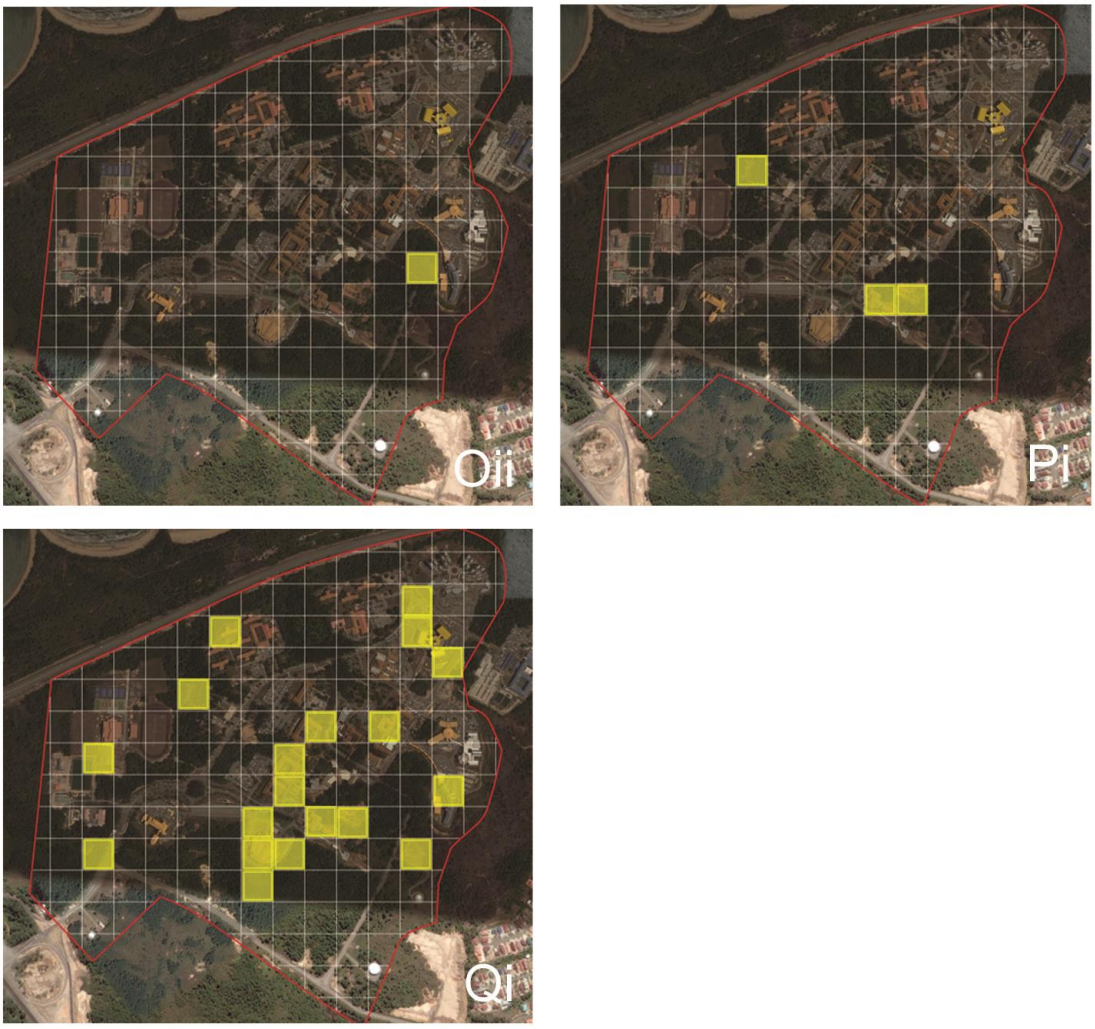


Table 1. Inventory list of ferns and fern allies, their habit as terrestrial, epiphytic and climber. The last column shows the frequency for each species among the 128 quadrats of the UBD campus map. The percentage of frequency for each species is in parentheses.

No.	Family	Genus	Species	Habitat	Frequency
1	Aspleniaceae	Asplenium	*Asplenium nidus* L.	Epiphyte	32 (25)
2	Blechnaceae	Blechnum	*Blechnum orientale* L.	Terrestrial	40 (31)
3	Blechnaceae	Stenochlaena	*Stenochlaena palustris* (Burm.) Bedd	Terrestrial	49 (38)
4	Davalliaceae	Davallia	*Davallia denticula* (Burm.) Mett. ex Kunn	Epiphyte	10 (8)
5	Dennstaedtiaceae	Pteridium	*Pteridium aquilinum* (L.) Kuhn	Terrestrial	6 (5)
6	Dennstaedtiaceae	Pteridium	*Pteridium caudatum* (L.) Maxon	Terrestrial	18 (14)
7	Dryopteridaceae	Leucostegia	Leucostegia sp.	Terrestrial	1 (1)
8	Gleicheniaceae	Dicranopteris	*Dicranopteris curranii* Copel.	Terrestrial	27 (21)

No.	Family	Genus	Species	Habitat	Frequency
9	Gleicheniaceae	Dicranopteris	*Dicranopteris linearis* (Burm. f.) Underw.	Terrestrial	78 (61)
10	Lindsaeaceae	Lindsaea	*Lindsaea ensifolia* Sw	Terrestrial	12 (9)
11	Lygodiaceae	Lygodium	*Lygodium circinnatum* (Burm. f.) Sw.	Climber	32 (25)
12	Lygodiaceae	Lygodium	*Lygodium flexuosum* (L.) Sw.	Climber	20 (16)
13	Lygodiaceae	Lygodium	*Lygodium longifolium* (Willd.) Sw.	Climber	2 (2)
14	Lygodiaceae	Lygodium	*Lygodium microphyllum* (Cav.) R. Br.	Climber	34 (27)
15	Lycopodiaceae	Lycopodium	*Lycopodiella cernua* L. Pic.Serm.	Terrestrial	25 (20)
16	Lomariopsidaceae	Nephrolepis	*Nephrolepis biserrata* (Sw.) Schott	Terrestrial	33 (26)
17	Lomariopsidaceae	Nephrolepis	*Nephrolepis brownii* (Desv.) Hovenkamp & Miyam.	Terrestrial	39 (31)
18	Lomariopsidaceae	Nephrolepis	*Nephrolepis radicans* (Burm.f.) Kuhn	Terrestrial	2 (2)
19	Ophioglossaceae	Ophioglossum	*Ophioglossum pendulum* L.	Epiphyte	1 (1)
20	Polypodiaceae	Aglaomorpha	*Aglaomorpha heraclea* (Kunze) Copel.	Epiphyte	1 (1)
21	Polypodiaceae	Drynaria	*Drynaria quercifolia* (L.) J.Sm.	Epiphyte	3 (2)
22	Polypodiaceae	Drynaria	*Drynaria sparsisora* (Desv.) Moore	Epiphyte	6 (5)
23	Polypodiaceae	Lepisorus	*Lepisorus sinensis* (Christ.) Ching	Epiphyte	1 (1)
24	Polypodiaceae	Platycerium	*Platycerium coronarium* (Koenig.) Desv	Epiphyte	1 (1)
25	Polypodiaceae	Pyrrosia	*Pyrrosia longifolia* (Burm.) Morton	Epiphyte	3 (2)
26	Polypodiaceae	Pyrrosia	*Pyrrosia piloselloides* (L.) M.G. Price	Epiphyte	35 (27)
27	Polypodiaceae	Pyrrosia	*Pyrrosia lanceolata* (L.) Farw.	Epiphyte	1 (1)
28	Psilotaceae	Psilotum	*Psilotum nudum* (L.) P.Beauv.	Epiphyte	1 (1)
29	Pteridaceae	Acrostichum	*Acrostichum aureum* L.	Terrestrial	2 (2)
30	Pteridaceae	Ceratopteris	*Ceratopteris thalictroides* (L.) Brongn	Terrestrial	3 (2)

No.	Family	Genus	Species	Habitat	Frequency
31	Pteridaceae	Cheilanthes	*Cheilanthes farinosa* (Forssk.) Kaulf	Terrestrial	2 (2)
32	Pteridaceaea	Haplopteris	*Haplopteris angustifolia* (Blume) E.H. Crane	Epiphyte	12 (9)
33	Pteridaceae	Pityrogramma	*Pityrogramma calomelanos* (L.) Link	Terrestrial	2 (2)
34	Pteridaceae	Taenitis	*Taenitis blechnoides* (Willd.) Sw.	Terrestrial	2 (2)
35	Pteridaceae	Pteris	*Pteris vittata* L.	Terrestrial	12 (9)
36	Schizaeaceae	Schizaea	*Schizaea digitata* (L.) Sw.	Terrestrial	1 (1)
37	Schizaeaceae	Schizaea	*Schizaea dicotoma* (L.) J.Sm.	Terrestrial	1 (1)
38	Selaginellaceae	Selaginella	Selaginella sp.	Terrestrial	3 (2)
39	Thelypteridaceae	Cyclosorus	*Cyclosorus parasiticus* (L.) Farw.	Terrestrial	19 (15)