RESULTS

ECOLOGICAL ROLE OF PTERIDOPHYTES

Extensive Qualitative Survey

A total of 61 Pteridophyte species from 20 families were recorded in all sampling areas (Appendix A). EGF had the highest Pteridophyte species richness, having 17 families, with a total of 36 species, followed by the riverine site with 14 families, BB/DF with 9 families, and DOF with 6 families, having a total of 24, 10 and 12 species, respectively (Figure 14 and Appendix B). The family Thelypteridaceae had the highest number of species both in the EGF and RR sites, while Parkeriaceae and Selaginellaceae had the highest species numbers in the DOF and BB/DF sites (Figure 15).

Intensive Quantitative Survey

Species Area Curves

In order to determine whether the number of sample units was enough to represent the whole study area, species area curves were calculated using frequency of occurrence. Figure 16A shows how the number of Pteridophyte species increases with area in the DOF site. The species area curves in the three subsites reached the upper asymptote and leveled off as the number of quadrats increased. For the BB/DF site, the area curves of BB/DFX and BB/DFL also leveled off, except the BB/DFM which was still increasing (Figure 16B). For EGF, curves of the two disturbed subsites were approaching the upper asymptote and started to level off (Figure 16C). RR/BDF and RR/VL curves for the RR site also leveled off, whereas the RR/WF was still

Figure 14. Abundance of Pteridophytes in all sampling areas by qualitative survey.

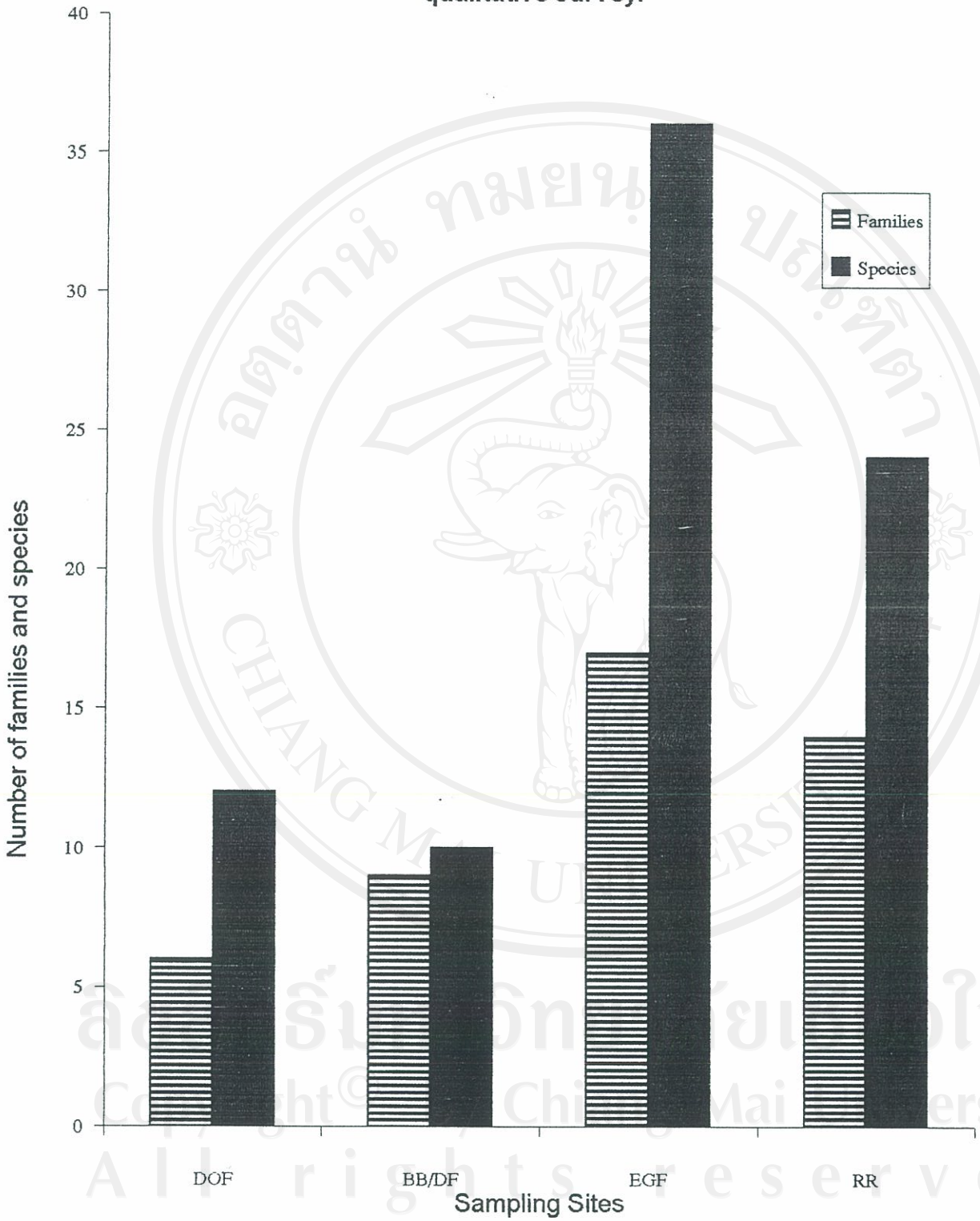
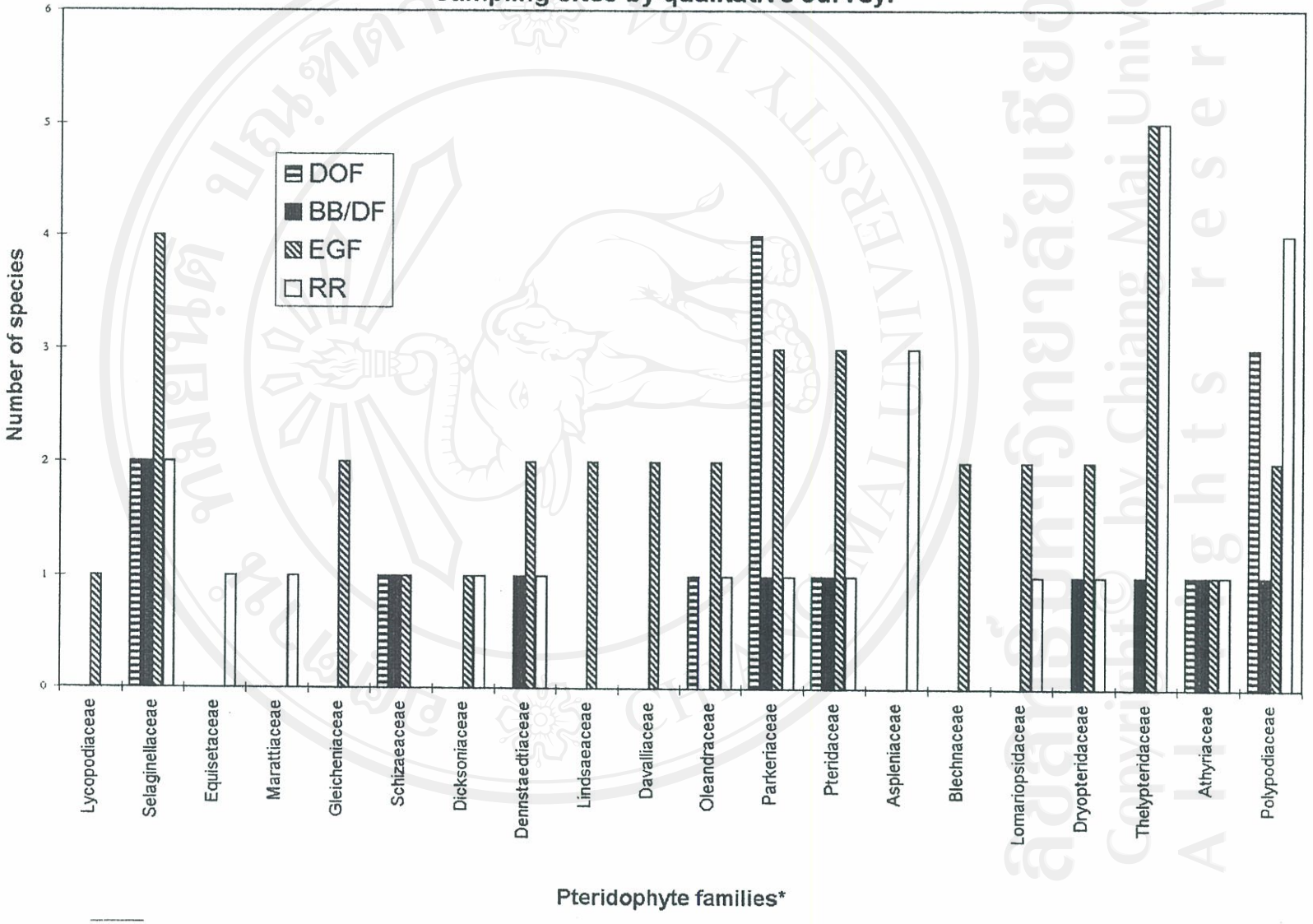
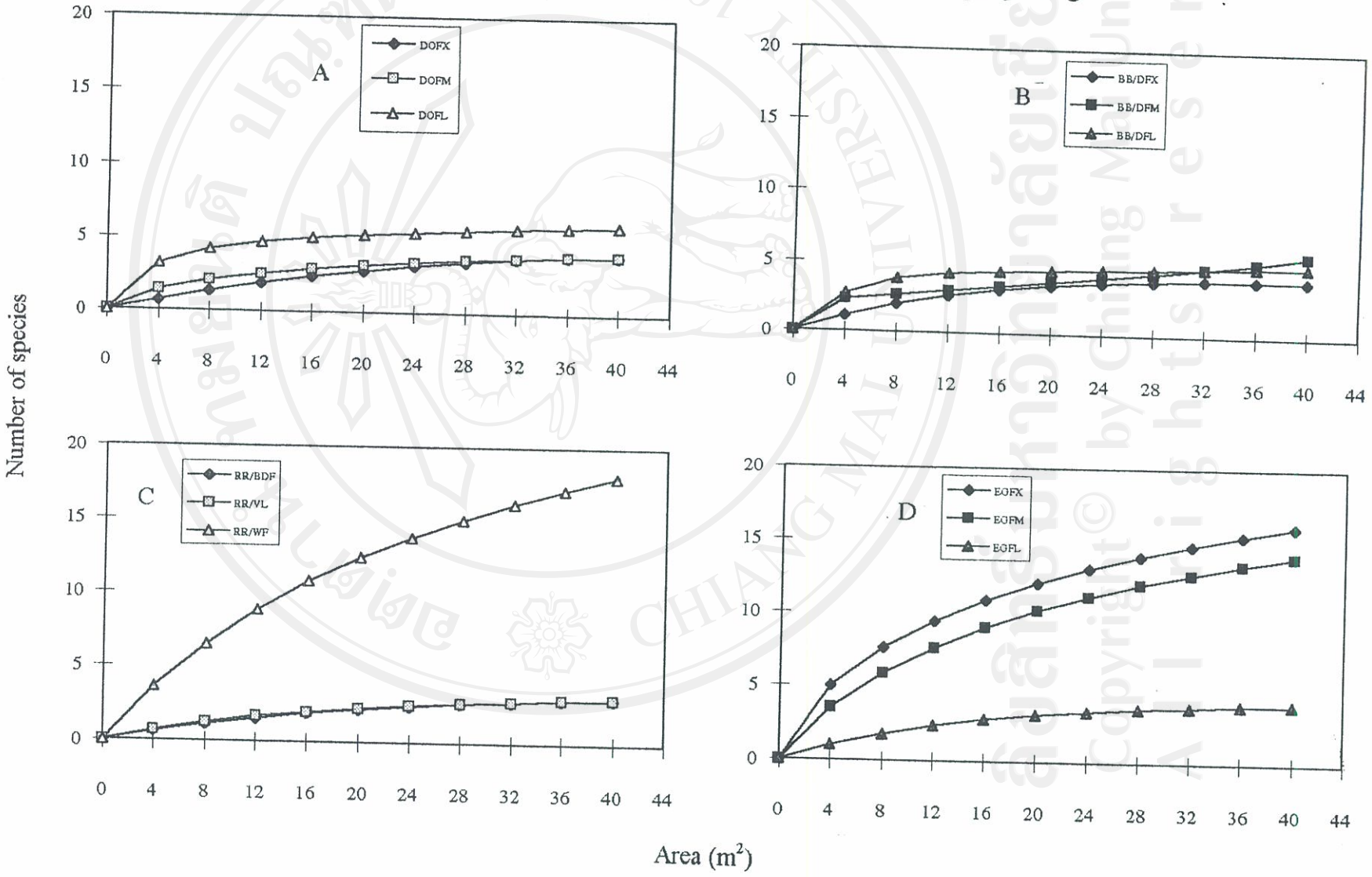


Figure 15. List of Pteridophyte families with their corresponding number of species in all sampling sites by qualitative survey.



* arranged according to the order found in the CMU Herbarium

Figure 16 A-D. Species area curves for the Pteridophytes at 4 habitats in Mae Kampong Village.



increasing, but was approaching the upper asymptote (Figure 16D). These results implied that the number of quadrats used in all subsites except at the BB/DFM were enough to represent the whole area.

Abundance of Pteridophytes

A total of 48 Pteridophyte species from 18 families were recorded in all sampling sites during the intensive quantitative survey (Appendix C). This was lower than the qualitative survey. The EGF site had the highest Pteridophyte diversity, followed by the RR site, then by the BB/DF and DOF sites with numbers of families and species of 16 & 27; 12 & 20; 8 & 8 and 3 & 6, respectively (Figure 17 and Appendix D). The family Pteridaceae had the highest species number in EGF site, Polypodiaceae in the riverine, and Parkeriaceae in DOF. All families found in BB/DF site had equal numbers of species (Figure 18).

Among the subsites of the four sampling areas, the degree of disturbance did not have a consistent effect on the species richness (Figures 16A-16D). However, selection of these different subsites was very rough and subjective because estimation of tree density was the only basis for the categorization of the degree of disturbance. Slope and aspect were not considered as factors in the selection process since the area had similar vegetation. However, the less disturbed subsites for all habitats were consistently located at higher elevations compared to the two disturbed subsites. In the DOF and BB/DF sites, the lowest number of species were found in the most disturbed subsites (Figures 16A and 16B), where agricultural activities are going on . However, in EGF, the most disturbed subsite (the area where a dirt road cuts through the tea plantation, resulting in a large forest gap) had the highest number of species (Figure 16 C). In the RR, species richness increased with elevation and as the degree of disturbance decreased (Figure 16D).

Figure 17. Abundance of Pteridophytes in the four sampling areas by quantitative survey.

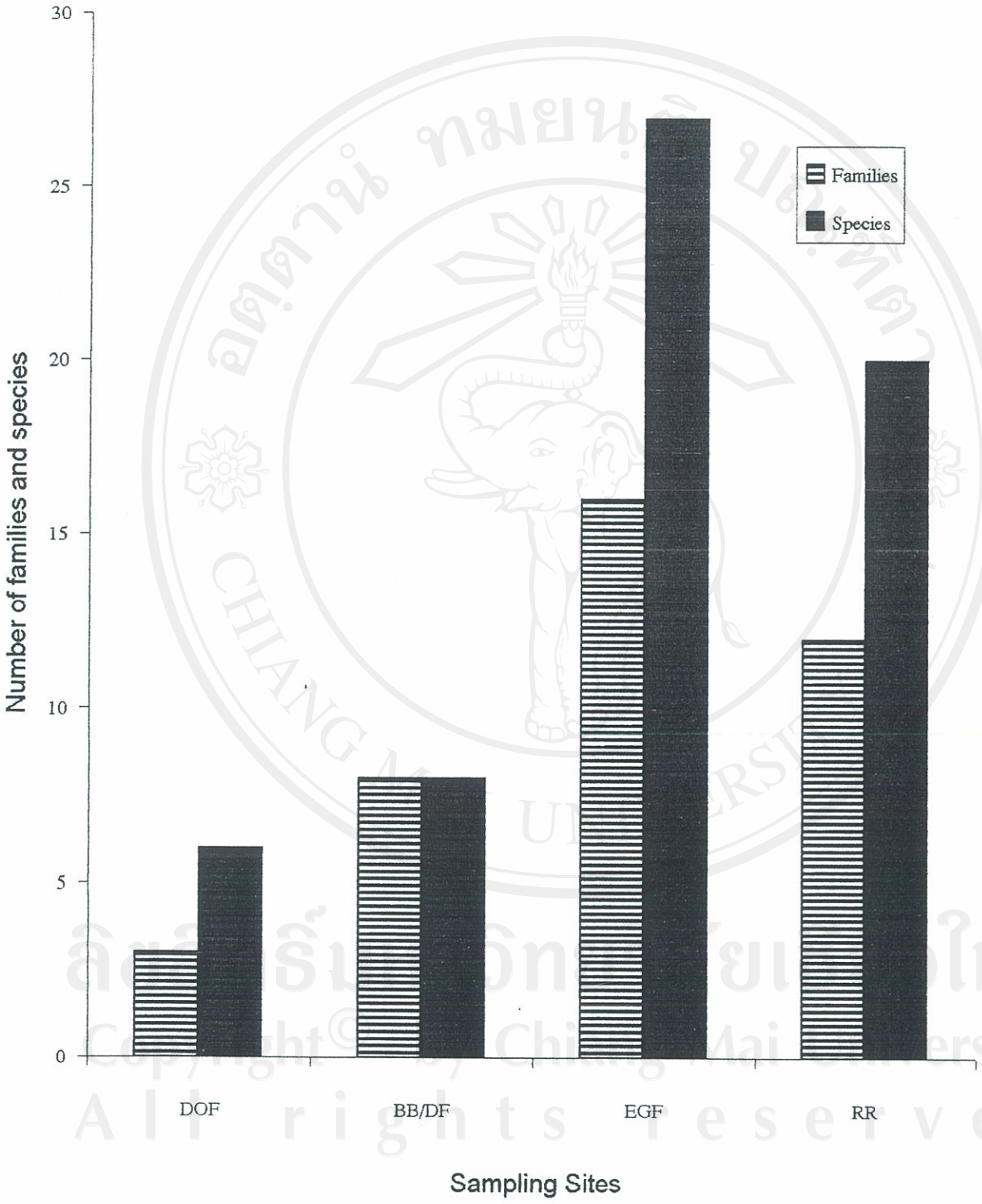
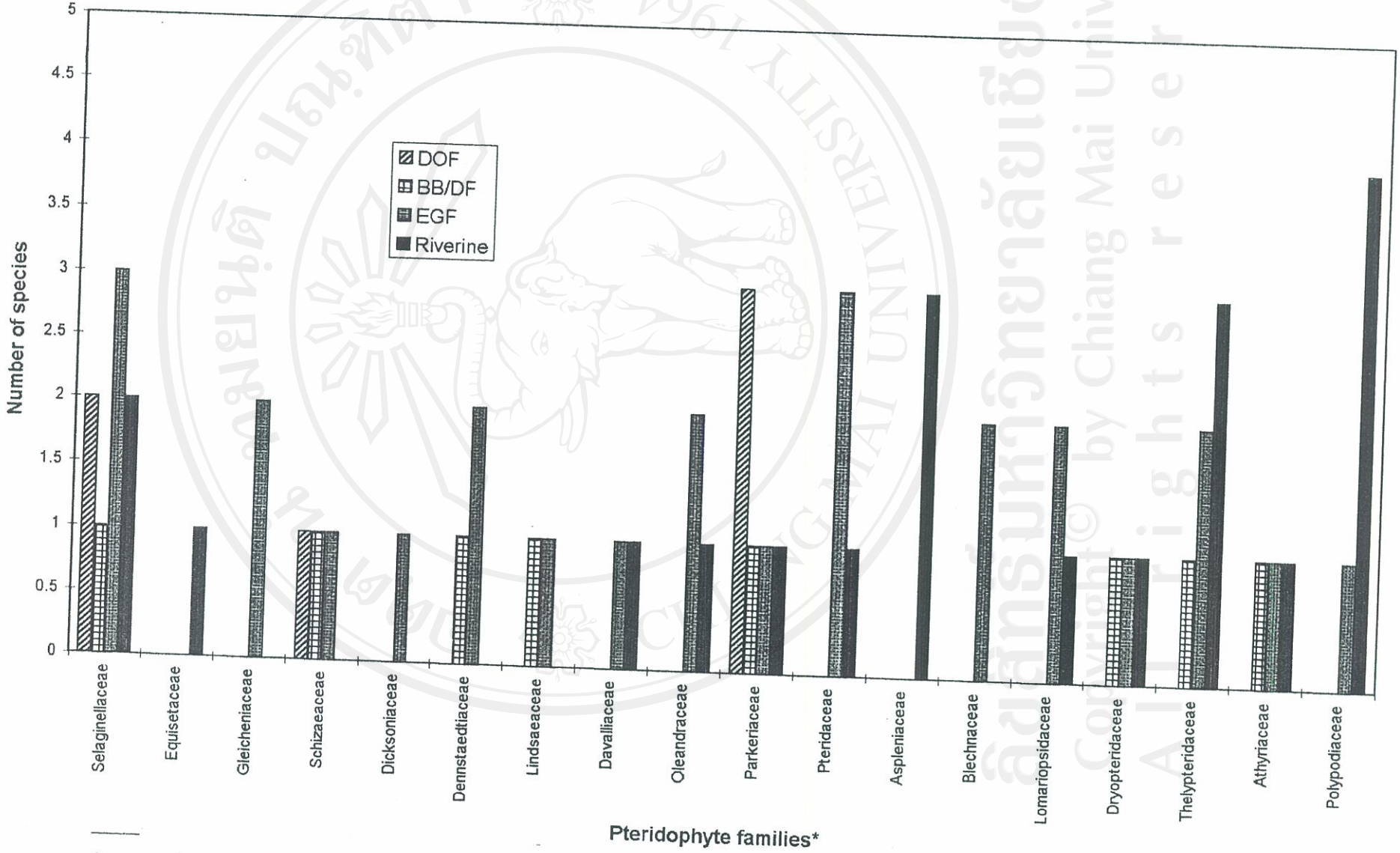


Figure 18. List of Pteridophyte families with their corresponding number of species in all sampling sites by quantitative survey.



* arranged according to the order found in the CMU Herbarium

Species Richness, Diversity, and Evenness

Table 1 shows the species richness (which was statistically analyzed for any significant differences), diversity, and evenness of Pteridophytes in the four sampling areas. Species richness in the DOF was not significantly different from the BB/DF, but the two sites were significantly different from the EGF and RR sites. In the BB/DF sites, the abundance was more or less shared by all species as indicated by the highest evenness value (0.90) thus, the Pteridophyte community in this type of forest is the most even.

Table 1. Diversity indices of the four sampling areas. [1]

Sites	Indices			
	Richness [2]	Diversity		Evenness
	N0	N1	N2	E5
DOF	6 (a)	4.31	3.52	.76
BB/DF	8 (a)	5.08	4.69	.90
EGF	27 (b)	12.65	6.83	.50
RR	20 (b)	9.87	5.99	.56

[1] total number of species and cover for 30 quadrats

[2] values having the same letters are not significantly different from each other at 95% confidence level

Results of the same indices between subsites of the different sampling areas are shown in Tables 2-5. The number of species in all subsites in DOF and BB/DF areas was not significantly different from each other (Tables 2 and 3). Also, the species composition in these communitties was more or less similar with no dominating species because these subsites have the same ecological conditions. In the EGF site, the number of species in the EGFL was significantly lower than that in the EGFX and

Table 2. Diversity indices at DOF sampling site. [1]

	Indices			
	Richness [2]	Diversity		Evenness
Sites	N0	N1	N2	E5
DOFX	4 (a)	2.73	2.47	.85
DOFM	4 (a)	2.24	1.96	.77
DOFL	6 (a)	5.52	5.20	.93

[1] total number of species and cover for 10 quadrats
[2] values having the same letters are not significantly different from each other at 95% confidence level

Table 3. Diversity indices at BB/DF site.[1]

	Indices			
	Richness [2]	Diversity		Evenness
Sites	N0	N1	N2	E5
BB/DFX	4 (a)	3.59	3.43	0.94
BB/DFM	6 (a)	3.53	3.19	0.87
BB/DFL	5 (a)	3.92	3.77	0.95

[1] total number of species and cover for 10 quadrats
[2] values having the same letters are not significantly different from each other at 95% confidence level

EGFM, while the latter were not significantly different from each other (Table 4). Similarly, the number of species in RR/WF was significantly higher than in the RR/BDF and RR/VL, while the latter were not significantly different from each other (Table 5).

Table 4. Diversity indices in EGF.[1]

	Indices			
	Richness [2]	Diversity		Evenness
Sites	N0	N1	N2	E5
EGFX	16 (b)	8.46	5.29	.57
EGFM	14 (b)	8.74	6.98	.77
EGFL	4 (a)	3.28	3.09	.92

[1] total number of species and cover for 10 quadrats
[2] values having the same letters are not significantly different from each other at 95% confidence level

Table 5. Diversity indices in the RR area.[1]

	Indices			
	Richness[2]	Diversity		Evenness
Sites	N0	N1	N2	E5
RR/BDF	3 (a)	2.60	2.38	.86
RR/VL	3 (a)	1.21	1.09	.42
RR/WF	18 (b)	12.06	10.18	.83

[1] total number of species and cover for 10 quadrats
[2] values having the same letters are not significantly different from each other at 95% confidence level

Similarity and Difference Indices

Each site had very different Pteridophyte communities as indicated by very low values of Sorensen's Index (SI) of similarity and high values of Chord Distance (CRD) coefficient of difference (Table 6). However, DOF and BB/DF sites had the most similar species composition of all the communities compared, even though the SI value

Table 6. Similarity and difference indices of Pteridophytes between the four study areas using SI of similarity and CRD of difference.

Sites Comapared	Indices	
	SI	CRD
DOF and BB/DF	0.43	1.06
DOF and EGF	0.12	1.40
DOF and RR	0	1.41
BB/DF and EGF	0.23	1.38
BB/DF and RR	0	1.41
EGF and RR	0.21	1.40

of similarity was only 0.43. SI values vary from 1 for exactly similar communities to 0 for communities with no species in common. For CRD, the nearer the value to 1.41, the more different are the communities being compared, while 0 indicates that the two communities have exactly the same species composition.

Tables 7-10 show the SI of similarity and the CRD values of difference between the subsites in each sampling area. Pteridophyte species composition between the subsites in DOF was more or less similar as indicated by the higher SI value of similarity and lower CRD value of difference, except between DOFX and DOFM (Table 7).

Table 7. Similarity and difference indices between the three subsites in DOF.

Sites Compared	Indices	
	SI	CRD
DOFX and DOFM	0.5	1.12
DOFX and DOFL	0.8	0.57
DOM and DOFL	0.8	0.86

In the BB/DF site, the Pteridophyte species composition between the subsites were also similar as represented by the higher SI value of similarity and lower CRD value of difference (Table 8).

Table 8. Similarity and difference indices between the three subsites in BB/DF.

Sites Compared	Indices	
	SI	CRD
BB/DFX and BB/DFM	0.6	1.18
BB/DFX and BBDFL	0.67	0.67
BB/DFM and BB/DFL	0.73	0.77

For the EGF and RR sites, the Pteridophyte composition between subsites were really different as shown by the very low SI value of similarity and higher CRD value of difference (Tables 9-10).

Table 9. Similarity and difference indices between the three subsites in EGF.

Sites Compared	Indices	
	SI	CRD
EGFX and EGFM	0.4	1.05
EGFX and EGFL	0.1	0.84
EGFM and EGFL	0.1	1.17

Table 10. Similarity and difference indices between the three subsites in the RR areas.

Sites Compared	Indices	
	SI	CRD
RR/BDF and RR/VL	0.33	0.51
RR/BDF and RR/WF	0.09	1.24
RR/VL and RR/WF	0.28	1.20

Soil and Other Physical Parameters in the Different Sampling Areas

EGF and RR had significantly higher soil moisture contents than the DOF and BB/DF areas using LSD test (Table 11 and Appendices Ea-d). Results of the general physical conditions of the four areas using the same test are shown in Table 12. The canopy cover in BB/DF and EGF was significantly higher than in the DOF and RR areas. Other parameters, e.g. soil temperature and relative humidity, were not significantly different between the areas. Although light intensity data was not statistically analyzed due to the problem with the light meter, it is clear from my own observations that EGF had the lowest light intensity while DOF and RR had the highest.

Table 11. Mean monthly soil moisture content in the different subsites of all sampling areas.[1]

Subsites	Sampling Sites[2]			
	DOF	BB/DF	EGF	RR
X	24.91 (a)	25.58 (a)	31.61 (a)	31.48 (ab)
M	17.90 (a)	26.79 (a)	37.80 (ab)	25.61 (a)
L	21.18 (a)	28.69 (a)	38.73 (b)	39.70 (b)

[1] mean of 5- months sampling period

[2] values having the same letters are not significantly different from each other at 95% confidence level

Table 12. The physical conditions of the four sampling sites.[1]

Sites	Parameters [2]			
	Canopy cover[3] (%)	Light intensity[4] (Lux)	Relative humidity[5] (%)	Soil temperature[5] (^{0}C)
DOF	3.44 (a)	31550.00	4.38 (a)	3.24 (a)
BB/DF	4.15 (b)	20370.43	4.32 (a)	3.20 (a)
EGF	4.18 (b)	12288.16	4.44 (a)	3.12 (a)
RR	3.75 (a)	31280.31	4.36 (a)	3.33 (a)

[1] mean of 30 samples
[2] values having the same letters are not significantly different from each other at 95% confidence level
[3] original values were transformed to square root to do ANOVA and LSD test
[4] parameter not subjected to any statistical test because there was something wrong with the light meter during data collection
[5] original values were transformed to log normal to do ANOVA and LSD test; time during the measurement was varied due to manpower limitations

Pteridophytes as Habitat Indicators

Since species richness is not a good indicator of disturbance, indicator species of Pteridophytes were selected, based on their abundance, since it is hypothesized that they have special mechanisms to tolerate certain conditions, e.g. fire, shade, elevation, soil, water, etc., hence their abundance. Table 13 shows the most abundant Pteridophyte species in the different sampling areas.

Table 13. Three most abundant Pteridophytes in the different sampling areas.

Sites	Pteridophyte Species	Σ % Cover	Frond Phenology[1]
DOF[2]	*Selaginella repanda* (Desv.) Spring	140.5	d
	Cheilanthes tenuifolia (Burm. f.) Sw.	37.5	d
	Selaginella ostenfeldii Hieron.	31	d
BB/DF[2]	*Selaginella repanda* (Desv.) Spring	150	d
	Dryopteris cochleata (D. Don) C. Chr.	140	d
	Anisocampium cumingianum Presl	15	d
EGFX[3]	*Dicranopteris linearis* (Burm. f.) Underw. var. *linearis*	95	e
	Blechnum orientale L.	90	e
	Pteridium aquilinum (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try.	58	e
EGFL[3]	*Brainea insignis* (Hk.) J. Smith	40	e
	Thelypteris hirtisora (C. Chr.) K. Iwats.	32	e
	Bolbitis virens (Wall. ex Hk. & Grev.) Schott var. *virens*	5	e
RR/BDF[3]	*Equisetum debile* Roxb. ex Vauch.	20	e
	Thelypteris nudata (Roxb.) Morton	10	e
RR/WF[3]	*Colysis pothifolia* (D. Don) Presl	20	e
	Leptochillus decurrens Bl.	16.5	e
	Thelypteris ciliata (Wall. ex Benth.) Ching	13	e

[1] d= deciduous
e= evergreen

[2] total from 30 quadrats

[3] total from 10 quadrats