

## CHAPTER 5

### RESULTS

#### Seedling establishment

A total of 78 tree seedling species (1,156 individuals) had established in the studied plots (Appendix B). Most seedlings, 57 tree species (64.2% of individuals) were dispersed by animals (birds and small mammals), whilst 21 tree species were dispersed seeds by wind (Table 2). Plots beneath tree crowns supported more tree seedling species and individuals (72 species, 648 seedlings) than control plots (60 species, 508 individuals).

Table 2 Number of seedlings and number of seedling species divided by dispersal means in all plots

Dispersal means	Under tree crown		Control		Total	
	no.of seedlings	no.of species	no.of seedlings	no.of species	No.of seedlings	no.of species
wind	215 (33.2%)	19 (26.4%)	200 (39.4%)	19 (31.7%)	415 (35.9%)	21 (26.9%)
birds and wind	22 (3.4%)	3 (4.2%)	10 (1.9%)	2 (3.3%)	32 (2.8%)	3 (3.8%)
birds	73 (11.3%)	5 (6.9%)	53 (10.4%)	5 (8.3%)	126 (10.9%)	6 (7.7%)
birds and small mammals	216 (33.3%)	22 (30.6%)	157 (30.9%)	20 (33.3%)	373 (32.3%)	25 (32.1%)
small mammals	122 (18.8%)	23 (31.9%)	88 (17.3%)	14 (23.3%)	210 (18.2%)	23 (29.5%)
Total	648	72	508	60	1156	78

The most abundant seedling species in all plots combined were *Dalbergia ovata* Grah. ex Bth. (Leguminosae, Papilionoideae) (127 seedlings, 11.0%), *Schima wallichii* (DC.) Korth. (Theaceae) (83 seedlings, 7.2%), *Litsea cubeba* (Lour.) Pers. var. *cubeba* (Lauraceae) (76 seedlings, 6.6%), *Rhus chinensis* Mill. (Anacardiaceae) (64 seedlings, 5.5%) and *Litsea monopetala* (Roxb.) Pers. (Lauraceae) (55 seedlings, 4.8%). In plots underneath tree crowns, the most abundant species were *Dalbergia ovata* Grah. ex Bth. (Leguminosae, Papilionoideae) (80 seedlings, 12.3%), *Litsea cubeba* (Lour.) Pers. var. *cubeba* (Lauraceae) (43 seedlings, 6.6%) and *Litsea monopetala* (Roxb.) Pers. (Lauraceae) (42 seedlings, 6.5%). In the control plots, the most abundant species were *Schima wallichii* (DC.) Korth. (Theaceae) (58 seedlings, 11.4%), *Dalbergia ovata* Grah. ex Bth. (Leguminosae, Papilionoideae) (47 seedlings, 9.2%) and *Litsea cubeba* (Lour.) Pers. var. *cubeba* (Lauraceae) (33 seedlings, 6.5%) (Table 3).

Table 3 Number of seedlings found in each species from all isolated tree species combined

no.	Botanical name	Family name	Seed dispersal mechanism	Under tree crowns	Controls	Total
1	<i>Glochidion acuminatum</i> M.-A. var. <i>siamense</i> A.S.	Euphorbiaceae	wind, animal	3	2	5
2	<i>Glochidion kerrii</i> Craib	Euphorbiaceae	wind, animal	1	0	1
3	<i>Glochidion sphaerogynum</i> (M.-A.) Kurz	Euphorbiaceae	wind, animal	18	8	26
4	<i>Albizia chinensis</i> (Osb.) Merr.	Leguminosae, Mimosoideae	wind	10	5	15
5	<i>Albizia odoratissima</i> (L. f.) Bth.	Leguminosae, Mimosoideae	wind	4	5	9
6	<i>Archidendron clypearia</i> (Jack) Niels. ssp. <i>clypearia</i> var. <i>clypearia</i>	Leguminosae, Mimosoideae	wind	2	3	5
7	<i>Bauhinia variegata</i> L.	Leguminosae, Caesalpinoideae	wind	20	19	39
8	<i>Cratogeomum cochinchinense</i> (Lour.) Bl.	Guttiferae, Hypericaceae	wind	0	2	2
9	<i>Dalbergia cultrata</i> Grah. ex Bth.	Leguminosae, Papilionoideae	wind	6	8	14
10	<i>Dalbergia ovata</i> Grah. ex Bth.	Leguminosae, Papilionoideae	wind	80	47	127
11	<i>Engelhardia spicata</i> Lechen. ex Bl. var. <i>spicata</i>	Juglandaceae	wind	3	2	5
12	<i>Erythrina stricta</i> Roxb.	Leguminosae, Papilionoideae	wind	8	1	9
13	<i>Firmiana colorata</i> (Roxb.) R. Br.	Sterculiaceae	wind	2	0	2
14	<i>Ilex umbellulata</i> (Wall.) Loesn.	Aquifoliaceae	wind	0	1	1
15	<i>Kydia calycina</i> Roxb.	Malvaceae	wind	4	4	8
16	<i>Mallotus philippensis</i> (Lmk.) M.-A.	Euphorbiaceae	wind	1	7	8
17	<i>Markhamia stipulata</i> (Wall.) Seem. ex K. Sch. var. <i>kerrii</i> Sprague	Bignoniaceae	wind	7	4	11
18	<i>Melochia umbellata</i> (Houtt.) Stapf	Sterculiaceae	wind	2	0	2
19	<i>Oroxylum indicum</i> (L.) Kurz	Bignoniaceae	wind	5	4	9
20	<i>Schinus molle</i> (L.) Korth.	Theaceae	wind	25	58	83

Table 3 (continued)

no.	Botanical name	Family name	Seed dispersal mechanism	Under tree crowns	Controls	Total
21	<i>Stereospermum colais</i> (B.-H. ex Dillw.) Mabb.	Bignoniaceae	wind	15	5	20
22	<i>Toona ciliata</i> M. Roem.	Meliaceae	wind	4	4	8
23	<i>Vernonia volkamerifolia</i> DC. var. <i>volkamerifolia</i>	Compositae	wind	5	3	8
24	<i>Wendlandia tinctoria</i> (Roxb.) DC. ssp. <i>floribunda</i> (Craib) Cowan	Rubiaceae	wind	12	18	30
25	<i>Alangium kurzii</i> Craib	Alangiaceae	animal	2	0	2
26	<i>Alseodaphne andersonii</i> (King ex Hk. f.) Kosterm.	Lauraceae	animal	1	1	2
27	<i>Anneslea fragrans</i> Wall.	Theaceae	animal	9	2	11
28	<i>Antidesma acidum</i> Retz.	Euphorbiaceae	animal	24	27	51
29	<i>Antidesma bunius</i> (L.) Spreng. var. <i>bunius</i>	Euphorbiaceae	animal	8	5	13
30	<i>Aporosa villosa</i> (Wall. ex Lindl.) Baill.	Euphorbiaceae	animal	31	18	49
31	<i>Artocarpus lakoocha</i> Roxb.	Moraceae	animal	6	10	16
32	<i>Artocarpus lanceolata</i> Trec.	Moraceae	animal	3	3	6
33	<i>Baccaurea ramiflora</i> Lour.	Euphorbiaceae	animal	1	1	2
34	<i>Beilschmiedia</i> aff. <i>intermedia</i> Allen	Lauraceae	animal	1	0	1
35	<i>Callicarpa arborea</i> Roxb. var. <i>arborea</i>	Verbenaceae	animal	1	0	1
36	<i>Canarium subulatum</i> Guill.	Burseraceae	animal	1	0	1
37	<i>Canthium parvifolium</i> Roxb.	Rubiaceae	animal	10	14	24
38	<i>Castanopsis acuminatissima</i> (Bl.) A. DC.	Fagaceae	animal	8	1	9
39	<i>Castanopsis argyrophylla</i> King ex Hk. f.	Fagaceae	animal	4	0	4
40	<i>Castanopsis diversifolia</i> (Kurz) King ex Hk. f.	Fagaceae	animal	12	9	21

Table 3 (continued)

no.	Botanical name	Family name	Seed dispersal mechanism	Under tree crowns	Controls	Total
41	<i>Cinnamomum longipetiolatum</i> H.W. Li	Lauraceae	animal	3	2	5
42	<i>Dillenia parviflora</i> Griff. var. <i>kerrii</i> (Craib) Hoogl.	Dilleniaceae	animal	4	2	6
43	<i>Dimocarpus longan</i> Lour. ssp. <i>longan</i> var. <i>longan</i>	Sapindaceae	animal	2	0	2
44	<i>Diospyros glandulosa</i> Lace	Ebenaceae	animal	9	7	16
45	<i>Elaeocarpus lanceifolius</i> Roxb.	Elaeocarpaceae	animal	3	2	5
46	<i>Eugenia claviflora</i> Roxb.	Myrtaceae	animal	11	18	29
47	<i>Eugenia fruticosa</i> (DC.) Roxb.	Myrtaceae	animal	8	7	15
48	<i>Eurya acuminata</i> DC. var. <i>wallichiana</i> Dyer	Theaceae	animal	3	2	5
49	<i>Ficus fistulosa</i> Reinw. ex Bl. var. <i>fistulosa</i>	Moraceae	animal	0	1	1
50	<i>Ficus hispida</i> L. f. var. <i>hispida</i>	Moraceae	animal	1	1	2
51	<i>Ficus semicordata</i> B.-H. ex J.E. Sm. var. <i>semicordata</i>	Moraceae	animal	1	0	1
52	<i>Ficus subulata</i> Bl. var. <i>subulata</i>	Moraceae	animal	1	0	1
53	<i>Garuga pinnata</i> Roxb.	Bursaceae	animal	2	2	4
54	<i>Gluta obovata</i> Craib	Anacardiaceae	animal	1	2	3
55	<i>Gmelina arborea</i> Roxb.	Verbenaceae	animal	3	6	9
56	<i>Grewia eriocarpa</i> Juss.	Tiliaceae	animal	0	1	1
57	<i>Helicia nilagirica</i> Bedd.	Proteaceae	animal	6	3	9
58	<i>Horsfieldia thorelii</i> Lec.	Myristicaceae	animal	1	0	1
59	<i>Lithocarpus fenestratus</i> (Roxb.) Rehd.	Fagaceae	animal	1	0	1
60	<i>Litsea cubeba</i> (Lour.) Pers. var. <i>cubeba</i>	Lauraceae	animal	43	33	76

Table 3 (continued)

no.	Botanical name	Family name	Seed dispersal mechanism	Under tree crowns	Controls	Total
61	<i>Litsea glutinosa</i> (Lour.) C.B. Rob. var. <i>glutinosa</i>	Lauraceae	animal	1	1	2
62	<i>Litsea monopetala</i> (Roxb.) Pers.	Lauraceae	animal	42	13	55
63	<i>Litsea salicifolia</i> Nees ex Roxb.	Lauraceae	animal	1	0	1
64	<i>Machilus bombycina</i> King ex Hk. f.	Lauraceae	animal	12	11	23
65	<i>Maesa ramentacea</i> (Roxb.) A. DC.	Myrsinaceae	animal	0	3	3
66	<i>Michelia baillonii</i> Pierre	Magnoliaceae	animal	1	1	2
67	<i>Phoebe lanceolata</i> (Wall. ex Nees) Nees	Lauraceae	animal	4	6	10
68	<i>Phyllanthus emblica</i> L.	Euphorbiaceae	animal	20	11	31
69	<i>Planchonella punctata</i> Flet.	Sapotaceae	animal	1	0	1
70	<i>Protium serratum</i> (Wall. ex Colebr.) Engl.	Bursaceae	animal	1	0	1
71	<i>Rhus chinensis</i> Mill.	Anacardiaceae	animal	37	27	64
72	<i>Sapindus rarak</i> DC.	Sapindaceae	animal	1	0	1
73	<i>Saurauia roxburghii</i> Wall.	Saurauiaceae	animal	5	1	6
74	<i>Fluggea virosa</i> (Roxb. ex Willd.) Voigt	Euphorbiaceae	animal	1	0	1
75	<i>Sterculia villosa</i> Roxb.	Sterculiaceae	animal	27	26	53
76	<i>Styrax benzoides</i> Craib	Styracaceae	animal	9	5	14
77	<i>Trema orientalis</i> (L.) Bl.	Ulmaceae	animal	0	1	1
78	<i>Turpinia pomifera</i> (Roxb.) Wall. ex DC.	Staphyleaceae	animal	23	12	35
Total				648	508	1,156

### Comparison between recruitment beneath tree crown and control

A comparison of tree seedling recruitment beneath tree crowns and in control plots was carried out by using *t*-tests on seedling density and species richness.

Although mean seedling density and species richness beneath tree crowns were higher than in control plots for all tree species (except *Albizia chinensis*) the differences were statistical significant ( $P < 0.05$ ) only for seedling density in the *Schima wallichii*-plots ( $P = 0.02$ ) and for species richness in the *Eucalyptus camaldulensis*-plots ( $P = 0.01$ ).

Table 4 Average density (no./m<sup>2</sup>) and species richness (no.species/m<sup>2</sup>) of total seedlings in each studied tree plots

Species	n	Density				Species richness			
		Beneath tree		Control		Beneath tree		Control	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
<i>Albizia chinensis</i>	6	0.153	0.061	0.155	0.122	0.108	0.032	0.074	0.054
<i>Callicarpa arborea</i>	7	0.209	0.131	0.206	0.168	0.154	0.092	0.152	0.136
<i>Castanopsis diversifolia</i>	8	0.224	0.165	0.170	0.076	0.122	0.099	0.098	0.036
<i>Erythrina stricta</i>	6	0.399	0.157	0.369	0.216	0.247	0.091	0.212	0.134
<i>Eucalyptus camaldulensis</i>	8	0.268	0.121	0.198	0.245	0.097 *	0.041	0.057 *	0.047
<i>Pinus kesiya</i>	8	0.156	0.139	0.135	0.165	0.116	0.087	0.089	0.085
<i>Schima wallichii</i>	8	0.372 *	0.210	0.199 *	0.123	0.161	0.042	0.133	0.074

Remark: \* significant differences ( $P < 0.05$ )

Considering only wind-dispersed seedling species (Table 5) seedling density beneath tree crowns was higher than in control plots for the *Castanopsis diversifolia*, *Erythrina stricta* and *Schima wallichii*-plots, but the difference was significant ( $P < 0.05$ ) only in the *Erythrina stricta*-plots ( $P=0.04$ ). Mean seedling density beneath the tree crowns was lower than in the control plots for all other tree species plots, but not significantly so. Mean seedling species richness was high beneath the crowns of most remnant tree species (except for only *Pinus kesiya* and *Schima wallichii*). However, the differences between tree crown plots and control plots were not statistically significant.

Table 5 Average density (no./m<sup>2</sup>) and species richness (no.species/m<sup>2</sup>) of wind-dispersed seedlings in each studied tree plots

Species	n	Density				Species richness			
		Beneath tree		Control		Beneath tree		Control	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
<i>Albizia chinensis</i>	6	0.069	0.064	0.086	0.113	0.041 *	0.032	0.026 *	0.025
<i>Callicarpa arborea</i>	7	0.065	0.037	0.070	0.049	0.052	0.032	0.049	0.037
<i>Castanopsis diversifolia</i>	8	0.072	0.053	0.058	0.041	0.044	0.035	0.036	0.019
<i>Erythrina stricta</i>	6	0.219 *	0.147	0.077 *	0.043	0.108 *	0.060	0.044 *	0.018
<i>Eucalyptus camaldulensis</i>	8	0.068	0.084	0.109	0.160	0.023	0.022	0.021	0.019
<i>Pinus kesiya</i>	8	0.031	0.036	0.044	0.049	0.031	0.036	0.035	0.027
<i>Schima wallichii</i>	8	0.143	0.170	0.079	0.054	0.037	0.019	0.038	0.021

Remark: \* significant differences ( $P < 0.05$ )

Considering only animal-dispersed seedling species (Table 6) seedling density beneath tree crowns was higher than in control plots for all of remnant tree species except for *Erythrina stricta*. However, the difference was significant ( $P < 0.05$ ) only for *Schima wallichii* ( $P = 0.008$ ). Mean seedling species richness beneath the tree crowns was higher than in the control plots, also except for only *Erythrina stricta*. For three species of remnant tree, this difference was statistically significant ( $P < 0.05$ ), *Eucalyptus camaldulensis* ( $P = 0.0006$ ), *Pinus kesiya* ( $P = 0.02$ ), and *Schima wallichii* ( $P = 0.04$ ).

Table 6 Average density (no./m<sup>2</sup>) and species richness (no.species/m<sup>2</sup>) of animal-dispersed seedlings in each studied tree plots

Species	n	Density				Species richness			
		Beneath tree		Control		Beneath tree		Control	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
<i>Albizia chinensis</i>	6	0.084	0.049	0.068	0.049	0.067	0.025	0.048	0.042
<i>Callicarpa arborea</i>	7	0.148	0.117	0.138	0.135	0.106	0.072	0.104	0.104
<i>Castanopsis diversifolia</i>	8	0.172	0.134	0.125	0.079	0.091	0.076	0.071	0.031
<i>Erythrina stricta</i>	6	0.197	0.119	0.292	0.225	0.156	0.072	0.168	0.121
<i>Eucalyptus camaldulensis</i>	8	0.202	0.137	0.089	0.111	0.075 *	0.024	0.036 *	0.033
<i>Pinus kesiya</i>	8	0.132	0.140	0.091	0.125	0.094 *	0.085	0.055 *	0.070
<i>Schima wallichii</i>	8	0.232 *	0.076	0.120 *	0.080	0.126 *	0.035	0.097 *	0.064

Remark: \* significant differences ( $P < 0.05$ )

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The mean ratios of animal / wind -dispersed seedling (Table 7) individuals were higher beneath tree crowns than in control plots for all remnant tree species studied except *Erythrina stricta*. However, the differences were insignificant ( $P \geq 0.05$ ). For seedling species richness, the ratios were higher beneath tree crowns than in control plots for all of remnant tree species, except *Erythrina stricta*. However, these differences were statistically significant ( $P < 0.05$ ) only for *Eucalyptus camaldulensis* ( $P = 0.03$ ).

Table 7 Mean ratios of animal / wind seedlings using number of individuals and number of species

Species	n	Individual				Species richness			
		Beneath tree		Control		Beneath tree		Control	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
<i>Albizia chinensis</i>	4	1.952	2.309	0.956	0.931	3.021	4.028	1.542	1.329
<i>Callicarpa arborea</i>	6	2.786	3.208	1.601	1.372	2.375	2.312	1.944	1.421
<i>Castanopsis diversifolia</i>	7	2.485	0.926	1.812	1.087	2.152	0.516	1.928	0.937
<i>Erythrina stricta</i>	6	1.506	1.611	4.889	3.908	2.212	2.436	3.750	1.475
<i>Eucalyptus camaldulensis</i>	4	2.088	2.048	1.684	1.664	2.875 *	1.315	1.625 *	0.478
<i>Pinus kesiya</i>	4	2.917	3.625	0.833	1.106	2.167	2.285	0.917	1.258
<i>Schima wallichii</i>	8	2.726	1.453	2.069	1.833	4.292	2.250	2.858	1.670

Remark: \* significant differences ( $P < 0.05$ )

### Ecological indices

Maximum species richness ( $N_0=17$ ) occurred beneath the crown of a *Castanopsis diversifolia* tree (7) (Table 8). Minimum species richness ( $N_0=0$ ) occurred underneath the crown of a *Pinus kesiya* (4) and one of the control plots of *Eucalyptus camaldulensis* (3). Mean species richness of tree seedlings, for each species of isolated tree was highest underneath *Castanopsis diversifolia* crowns ( $N=39$ ) and lowest in the control plots near to *Eucalyptus camaldulensis* trees ( $N_0=14$ ).

Species diversity was highest ( $N_1=25.16, N_2=29.62$ ) underneath *Castanopsis diversifolia* and *Albizia chinensis* crowns, while highest evenness ( $E_5=1.32$ ) occurred underneath *Albizia chinensis* and *Pinus kesiya* crowns. For the control plots, species diversity was highest in the *Callicarpa arborea*-control plots ( $N_1=26.75, N_2=40.83$ ), but evenness was highest in the *Pinus kesiya*-control plots ( $E_5=1.63$ ).

Table 8 Ecological indices of natural tree seedlings in each plots

Mature tree species	Under tree crown						Control						
	Richness		Diversity		Evenness		Richness		Diversity		Evenness		
	N0	N1	N2	E5	N0	N1	N2	E5	N0	N1	N2	E5	
<i>Albizia chinensis</i> (1)	3*												
<i>Albizia chinensis</i> (2)	11	10.02	22.75	2.41	2*								
<i>Albizia chinensis</i> (3)	4	3.36	4.00	1.27	4	3.59	5.25	1.64					
<i>Albizia chinensis</i> (4)	10	8.67	12.21	1.46	3	2.75	3.75	1.57					
<i>Albizia chinensis</i> (5)	2*				4	1.78	1.38	0.48					
<i>Albizia chinensis</i> (6)	8	7.58	22.50	3.27	1*								
<i>Albizia chinensis</i>	27	22.69	29.62	1.32	10	9.44	25.99	2.96					
<i>Callicarpa arborea</i> var. <i>arborea</i> (1)	6	4.86	6.00	1.29	19	8.48	4.27	0.44					
<i>Callicarpa arborea</i> var. <i>arborea</i> (2)	4*				8	7.58	22.50	3.27					
<i>Callicarpa arborea</i> var. <i>arborea</i> (3)	3	2.83	6.00	2.73	3*								
<i>Callicarpa arborea</i> var. <i>arborea</i> (4)	8	7.58	22.50	3.27	5	3.99	4.67	1.22					
<i>Callicarpa arborea</i> var. <i>arborea</i> (5)	6	5.29	9.34	1.94	8	7.19	13.75	2.06					
<i>Callicarpa arborea</i> var. <i>arborea</i> (6)	2	1.65	1.67	1.03	1*								
<i>Callicarpa arborea</i> var. <i>arborea</i> (7)	9	7.56	11.00	1.52	1*								
<i>Callicarpa arborea</i> var. <i>arborea</i>	26	19.52	20.09	1.03	9	8.48	22.00	2.80					
<i>Castanopsis diversifolia</i> (1)	12	9.82	12.16	1.26	31	26.75	40.83	1.55					
<i>Castanopsis diversifolia</i> (2)	11	7.84	6.99	0.88	9	4.99	3.39	0.59					
<i>Castanopsis diversifolia</i> (3)	9	5.65	4.48	0.75	14	9.01	6.92	0.74					
<i>Castanopsis diversifolia</i> (4)	8	7.54	18.33	2.65	5	2.29	1.71	0.55					
<i>Castanopsis diversifolia</i> (5)	6	5.34	7.33	1.46	8	7.24	13.19	1.96					
<i>Castanopsis diversifolia</i> (6)	10	7.67	8.00	1.05	7	6.73	27.99	4.71					
<i>Castanopsis diversifolia</i> (7)	17	12.68	11.81	0.92	7	6.34	11.00	1.87					
<i>Castanopsis diversifolia</i> (8)	3	2.83	6.00	2.73	8	7.72	36.00	5.21					
<i>Castanopsis diversifolia</i>	39	25.16	20.48	0.81	12	10.49	17.00	1.68					
					38	23.11	16.19	0.69					

Table 8 (continued)

Mature tree species	Under tree crown				Control			
	Richness N0	Diversity		Evenness E5	Richness N0	Diversity		Evenness E5
		NI	N2			NI	N2	
<i>Erythrina stricta</i> (1)	11	9.72	17.14	1.85	5	4.17	5.14	1.31
<i>Erythrina stricta</i> (2)	13	11.08	15.33	1.42	5	3.67	3.43	0.91
<i>Erythrina stricta</i> (3)	4*				13	9.57	9.24	0.96
<i>Erythrina stricta</i> (4)	8	7.19	13.75	2.06	5	4.76	14.99	3.72
<i>Erythrina stricta</i> (5)	3	2.38	2.50	1.09	5	4.46	6.99	1.74
<i>Erythrina stricta</i> (6)	10	7.07	6.13	0.84	4	3.58	5.25	1.64
<b><i>Erythrina stricta</i></b>	<b>28</b>	<b>21.41</b>	<b>22.19</b>	<b>1.04</b>	<b>22</b>	<b>14.89</b>	<b>13.72</b>	<b>0.92</b>
<i>Eucalyptus camaldulensis</i> (1)	5	4.17	5.14	1.31	2	1.65	1.67	1.03
<i>Eucalyptus camaldulensis</i> (2)	1*				1*			
<i>Eucalyptus camaldulensis</i> (3)	2	1.29	1.67	0.57	0**			
<i>Eucalyptus camaldulensis</i> (4)	6	4.36	4.12	0.93	2	1.89	3.00	2.25
<i>Eucalyptus camaldulensis</i> (5)	5	4.76	14.99	3.72	6	3.83	3.25	0.79
<i>Eucalyptus camaldulensis</i> (6)	2	1.75	2.00	1.32	1*			
<i>Eucalyptus camaldulensis</i> (7)	5	2.84	2.17	0.63	3	1.59	1.32	0.54
<i>Eucalyptus camaldulensis</i> (8)	8	5.26	4.42	0.80	5	4.14	4.62	1.15
<b><i>Eucalyptus camaldulensis</i></b>	<b>15</b>	<b>7.92</b>	<b>6.06</b>	<b>0.73</b>	<b>14</b>	<b>6.96</b>	<b>5.36</b>	<b>0.73</b>
<i>Pinus kesiya</i> (1)	5	3.99	4.67	1.22	5	4.46	6.99	1.74
<i>Pinus kesiya</i> (2)	11	10.11	19.43	2.02	11	9.49	13.57	1.48
<i>Pinus kesiya</i> (3)	3*				2	1.89	3.00	2.25
<i>Pinus kesiya</i> (4)	0**				2*			
<i>Pinus kesiya</i> (5)	4*				2*			
<i>Pinus kesiya</i> (6)	1*				1*			
<i>Pinus kesiya</i> (7)	5	4.76	9.33	2.22	2	1.89	3.00	2.25
<i>Pinus kesiya</i> (8)	4*				2*			
<b><i>Pinus kesiya</i></b>	<b>24</b>	<b>19.97</b>	<b>26.05</b>	<b>1.32</b>	<b>23</b>	<b>20.49</b>	<b>32.79</b>	<b>1.63</b>

Table 8 (continued)

Mature tree species	Richness			Under tree crown						Control		
	N0	Diversity		Evenness E5	Richness N0	Diversity		Evenness E5	Diversity		Evenness E5	
		N1	N2			N1	N2		N1	N2		
<i>Schima wallichii</i> (1)	9	3.68	2.25	0.47	8	5.34	4.77	0.87				
<i>Schima wallichii</i> (2)	4	3.78	7.49	2.34	4*							
<i>Schima wallichii</i> (3)	13	10.81	13.80	1.30	10	8.85	13.59	1.60				
<i>Schima wallichii</i> (4)	8	7.72	36.00	5.21	10	8.14	10.00	1.26				
<i>Schima wallichii</i> (5)	15	12.46	15.16	1.24	5	4.71	10.50	2.56				
<i>Schima wallichii</i> (6)	8	5.85	5.25	0.88	5	3.99	4.67	1.22				
<i>Schima wallichii</i> (7)	12	8.48	7.88	0.92	5	4.76	14.99	3.72				
<i>Schima wallichii</i> (8)	6	5.45	9.00	1.79	6*							
<b>Total</b>	<b>36</b>	<b>17.18</b>	<b>9.51</b>	<b>0.53</b>	<b>33</b>	<b>21.69</b>	<b>17.16</b>	<b>0.78</b>				
	<b>72</b>	<b>36.61</b>	<b>24.39</b>	<b>0.66</b>	<b>60</b>	<b>32.88</b>	<b>23.02</b>	<b>0.69</b>				

\* one seedling per one species, therefore can't calculate diversity and evenness

\*\* no seedlings

### Species/area curves

Species/area curves were used to compare the expected number of seedling species beneath tree crowns and in control plots. The species/area curves for wind-dispersed, animal-dispersed, and total seedlings are shown in Figures 14-34. Most species/area curves beneath tree crowns indicate higher numbers of species than in control plots, except all charts of *Callicarpa arborea*-plots and charts of wind-dispersed seedling species in the *Castanopsis diversifolia* and *Pinus kesiya*-plots, for which the species/area curves are higher in control. However, all differences between the curves are very small.

Figure 14 Species/area curves of wind-dispersed seedlings  
in *Albizia chinensis* plots

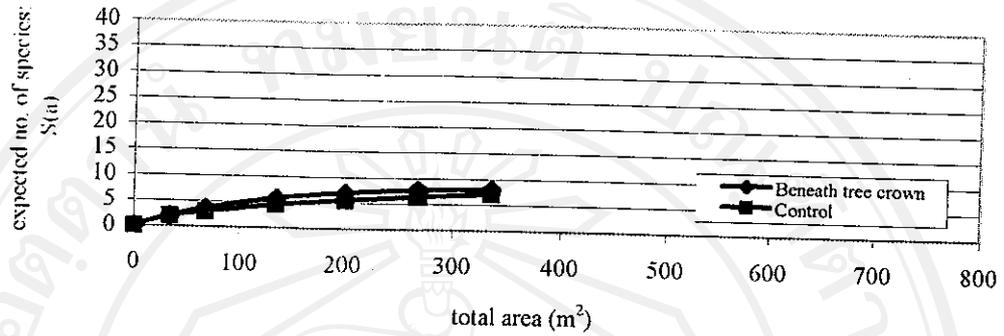


Figure 15 Species/area curves of animal-dispersed seedlings  
in *Albizia chinensis* plots

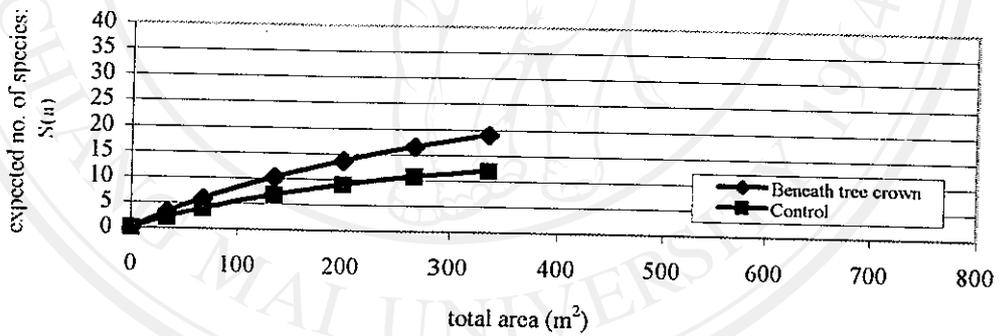
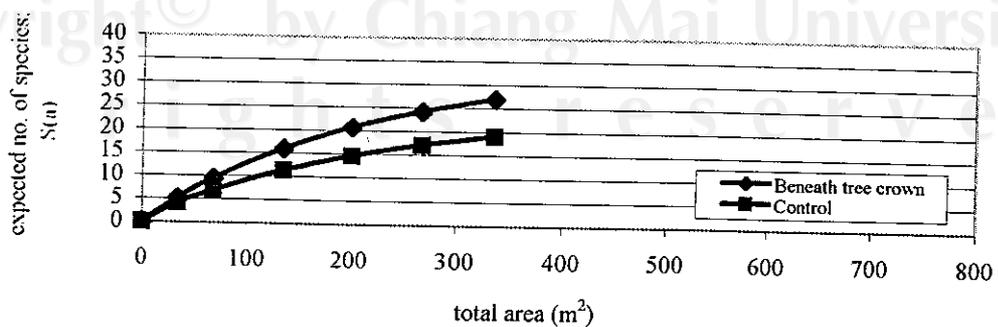


Figure 16 Species/area curves of natural tree seedlings  
in *Albizia chinensis* plots



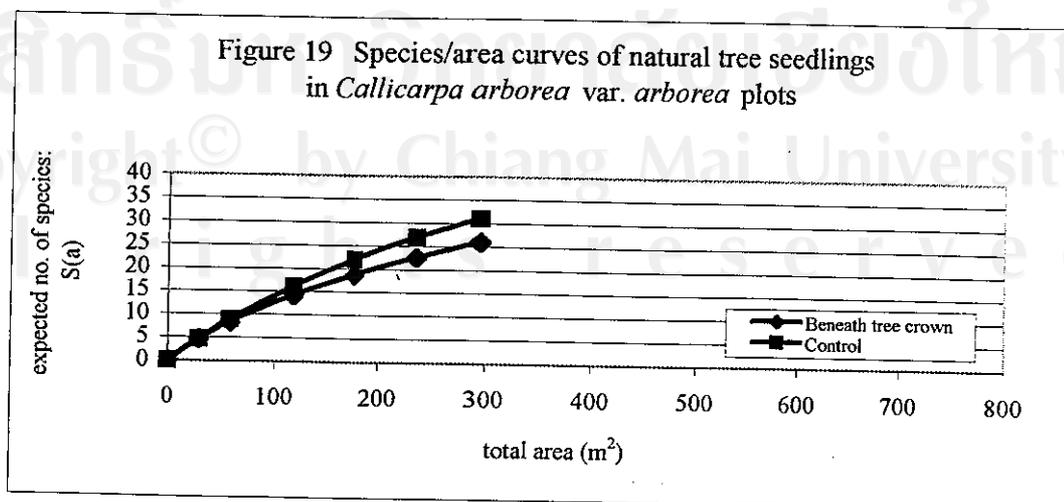
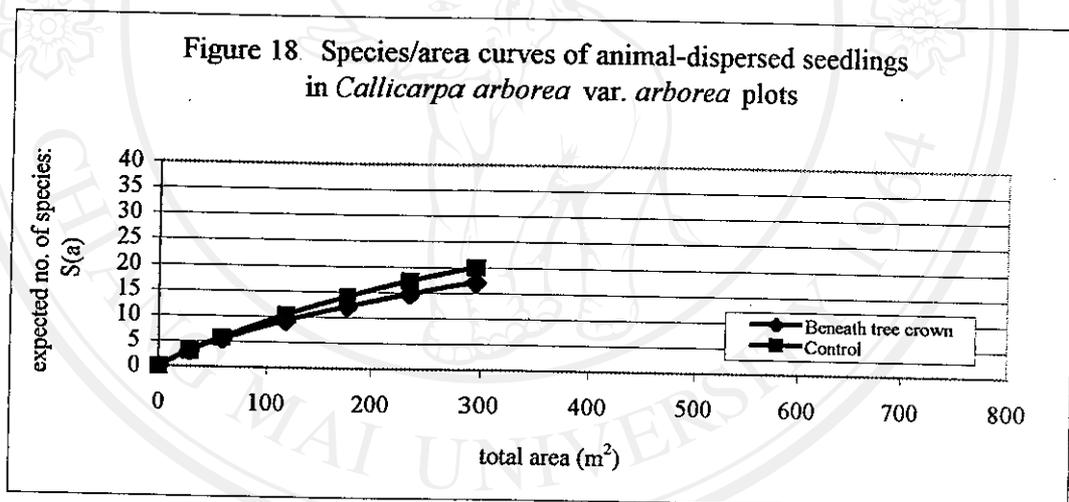
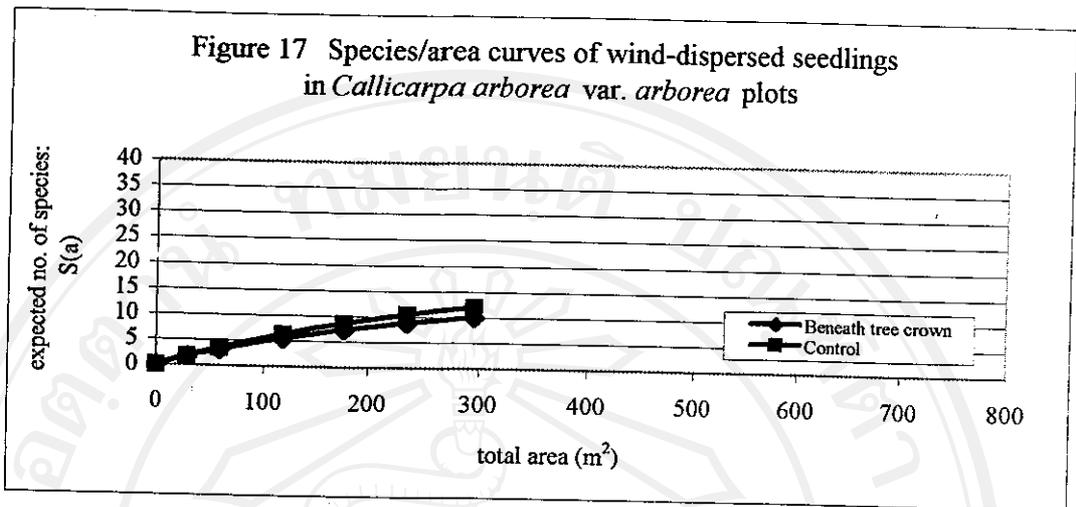


Figure 20 Species/area curves of wind-dispersed seedlings in *Castanopsis diversifolia* plots

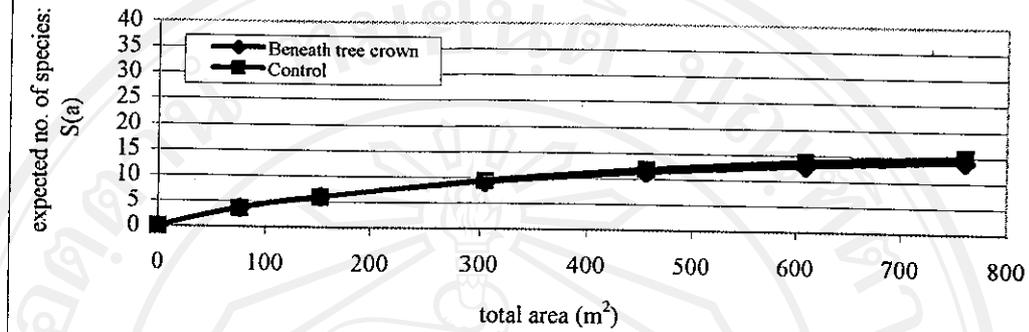


Figure 21 Species/area curves of animal-dispersed seedlings in *Castanopsis diversifolia* plots

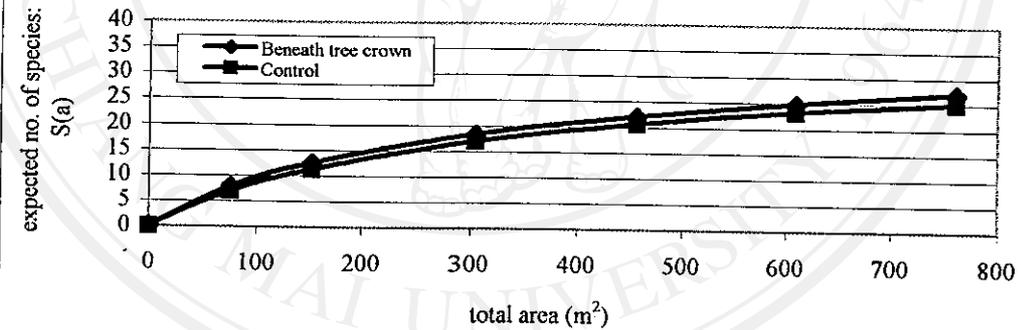


Figure 22 Species/area curves of natural tree seedlings in *Castanopsis diversifolia* plots

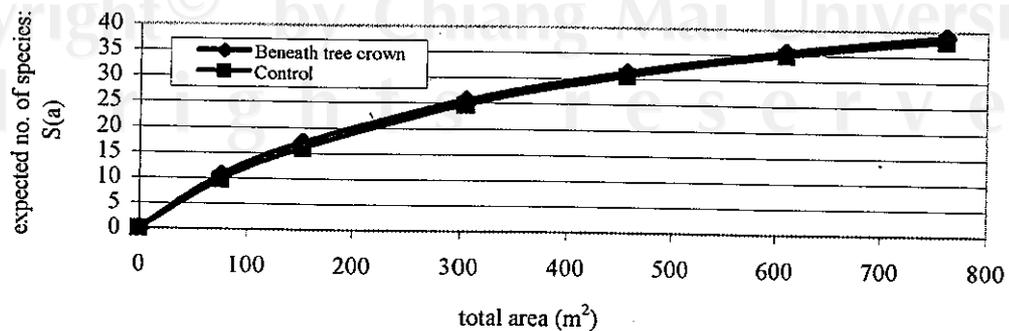


Figure 23 Species/area curves of wind-dispersed seedlings in *Erythrina stricta* plots

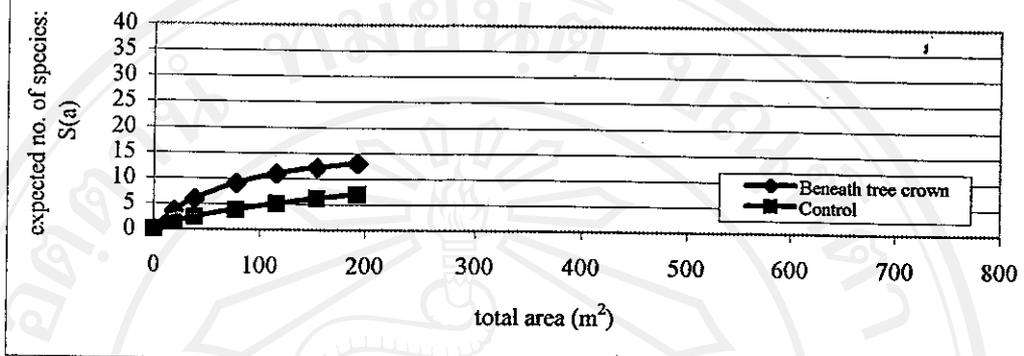


Figure 24 Species/area curves of animal-dispersed seedlings in *Erythrina stricta* plots

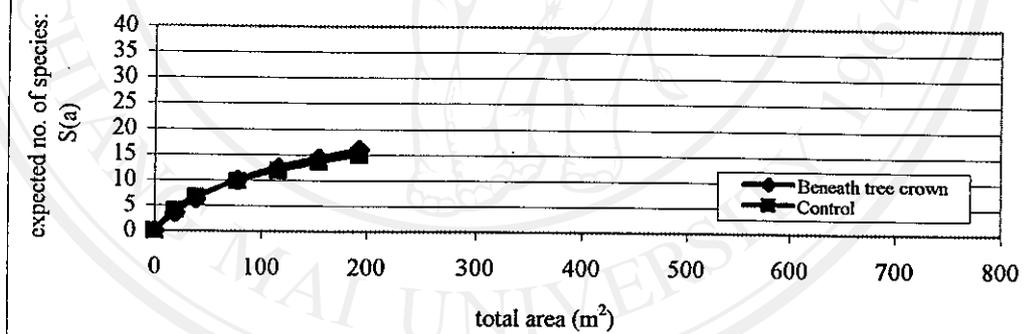
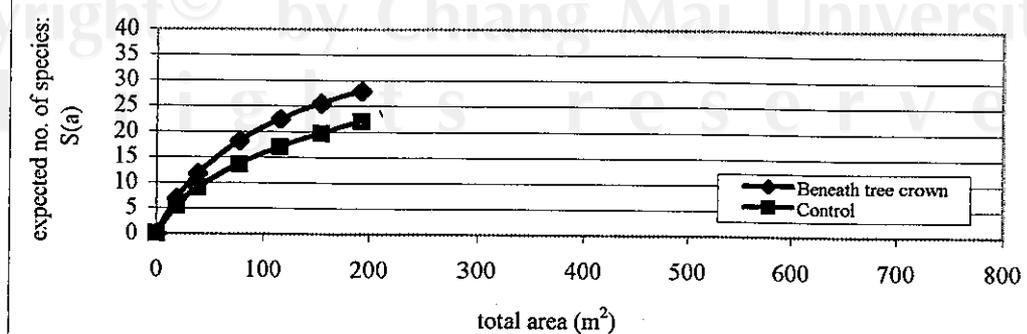
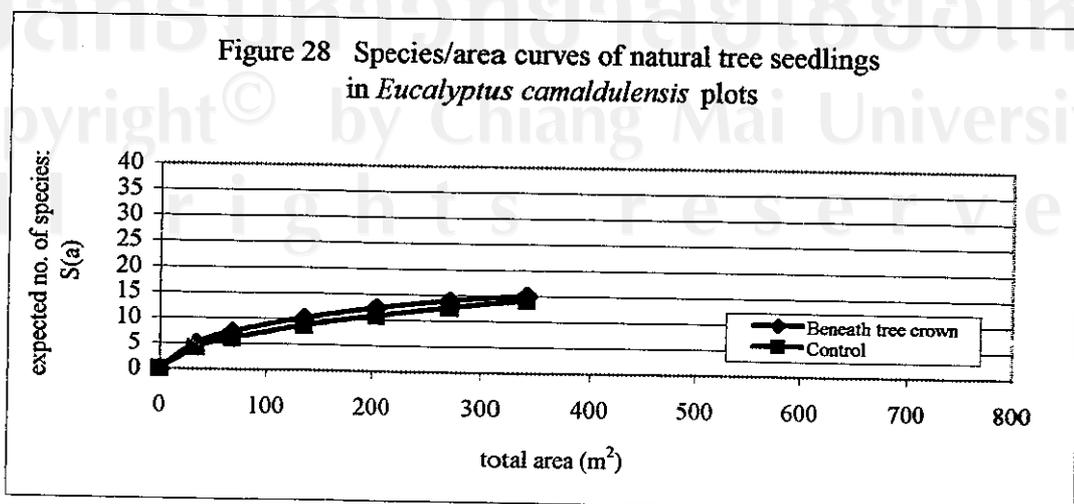
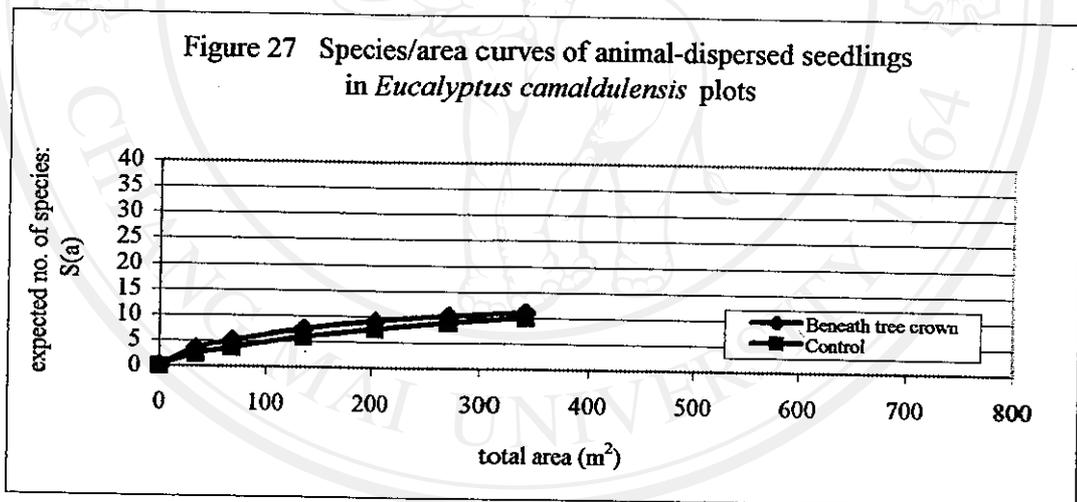
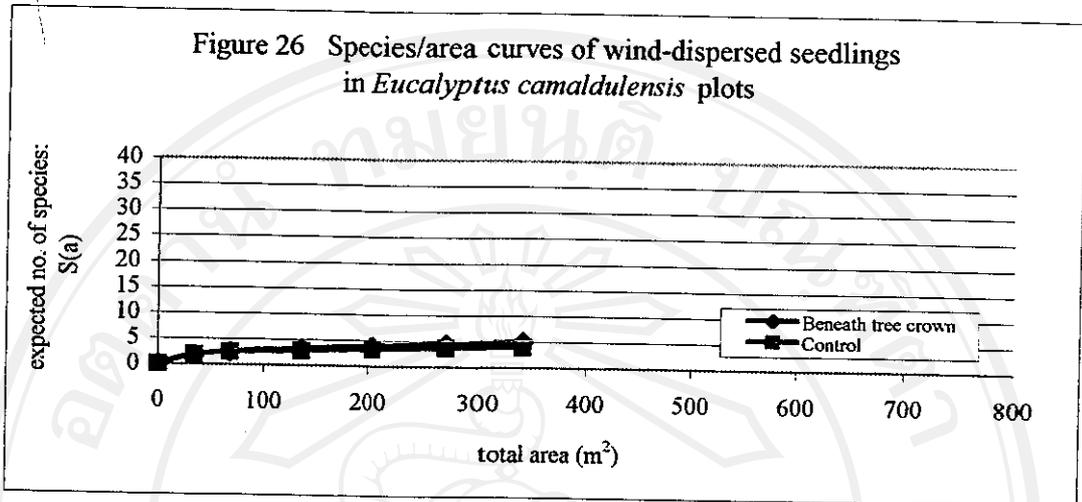
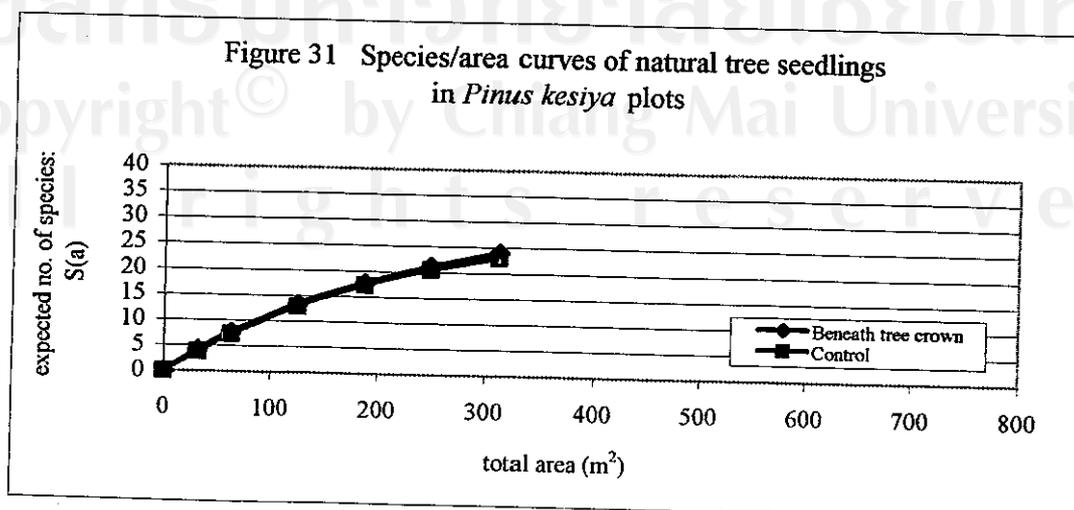
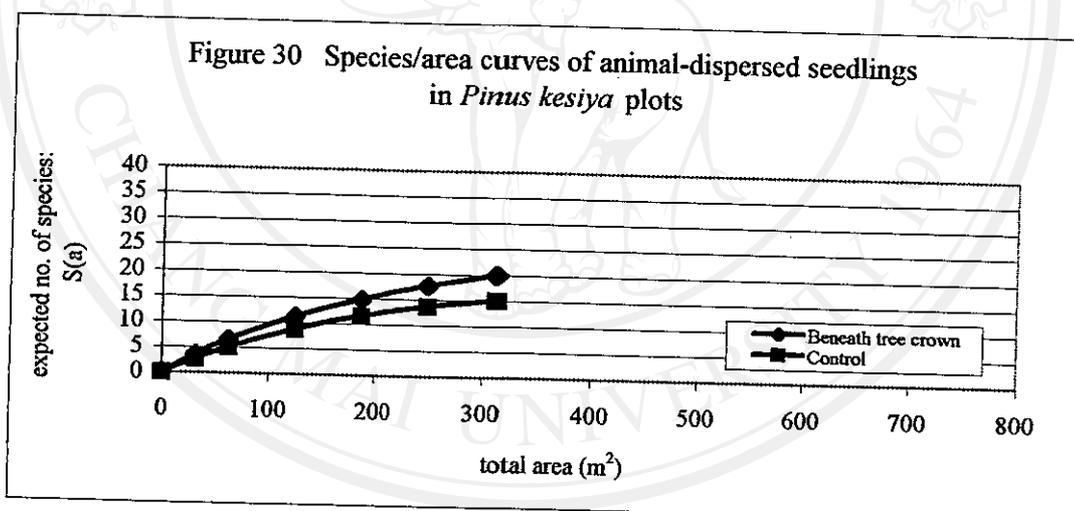
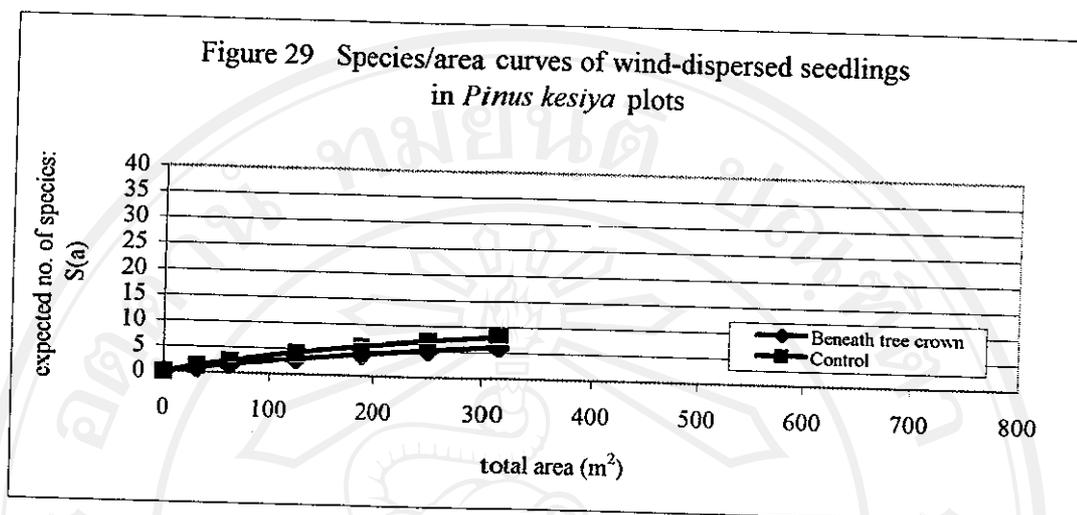
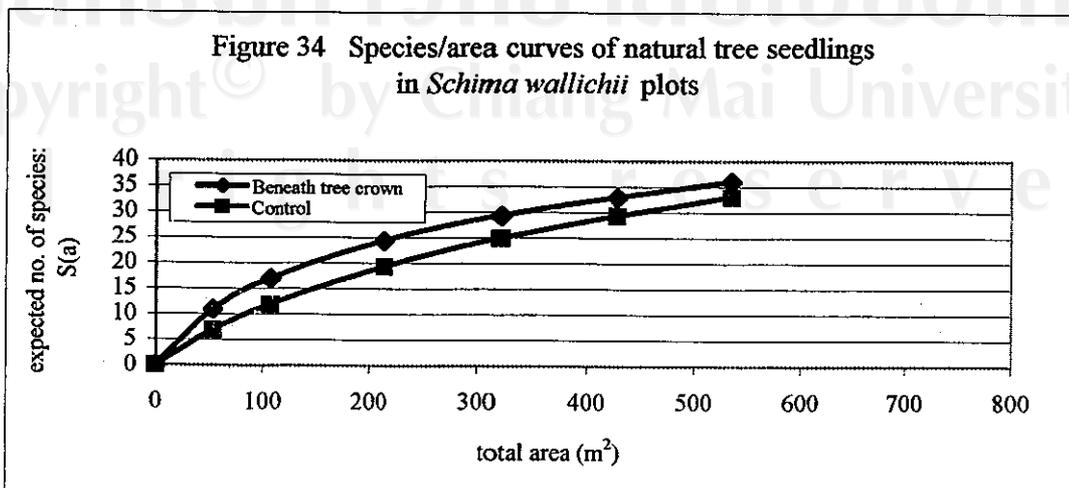
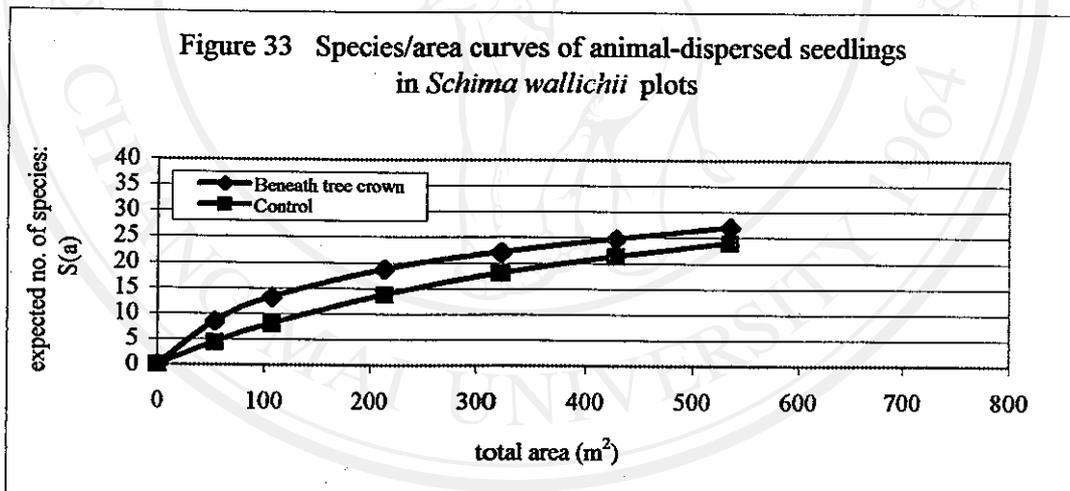
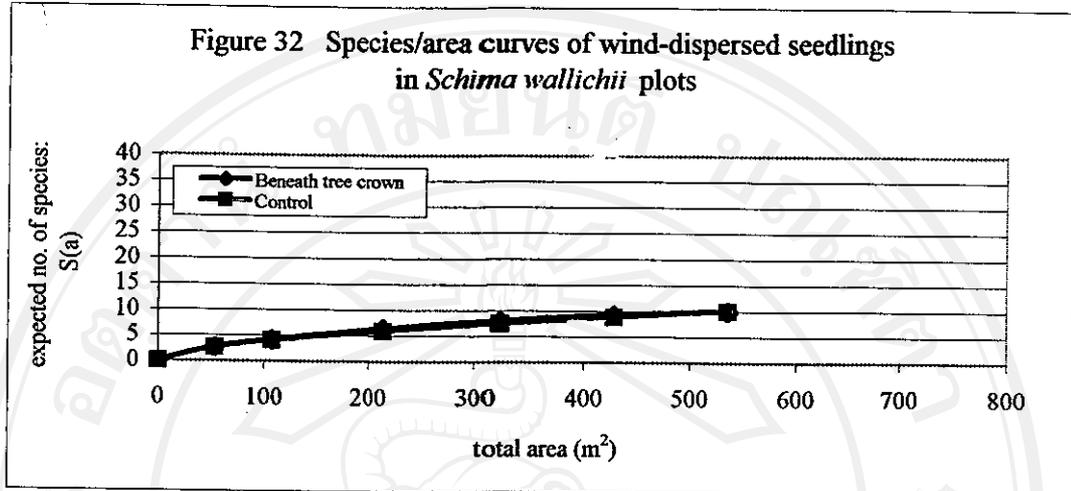


Figure 25 Species/area curves of natural tree seedlings in *Erythrina stricta* plots







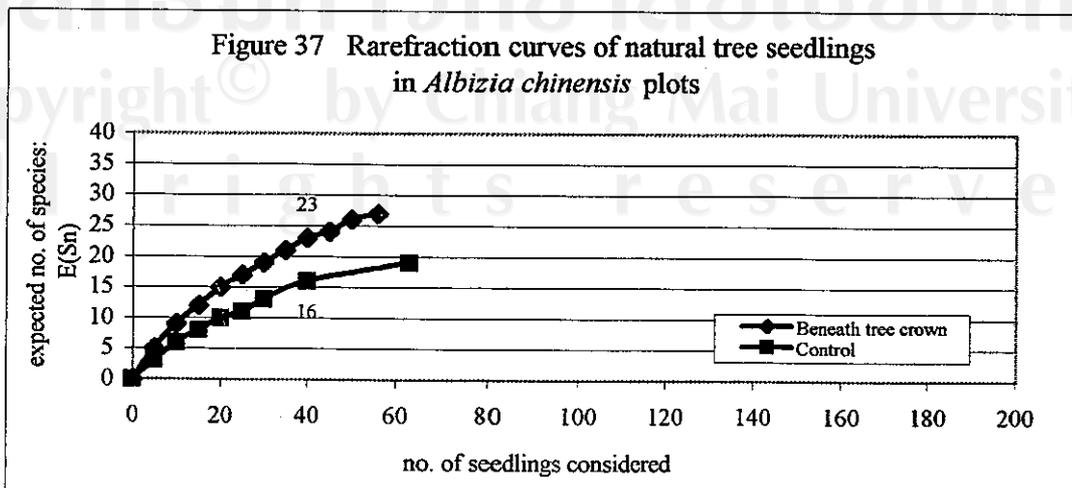
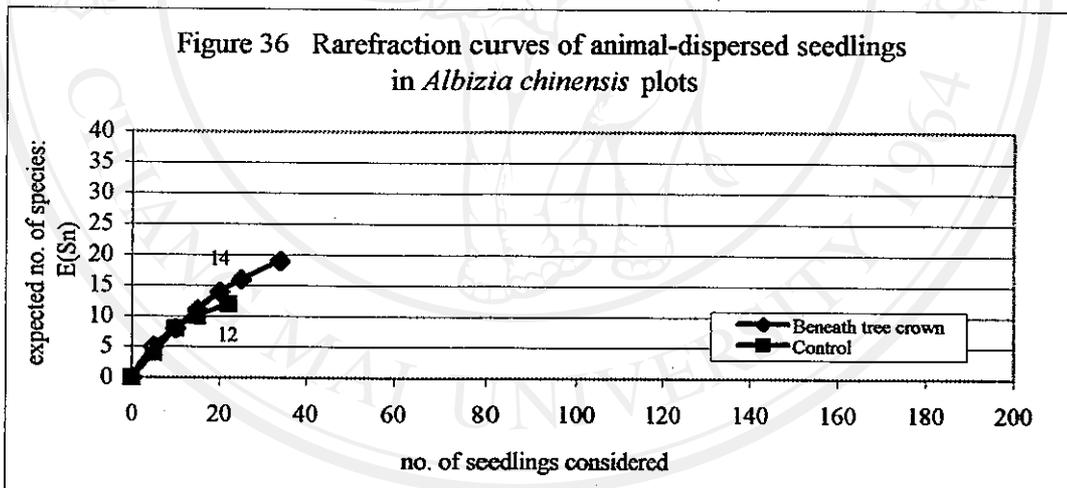
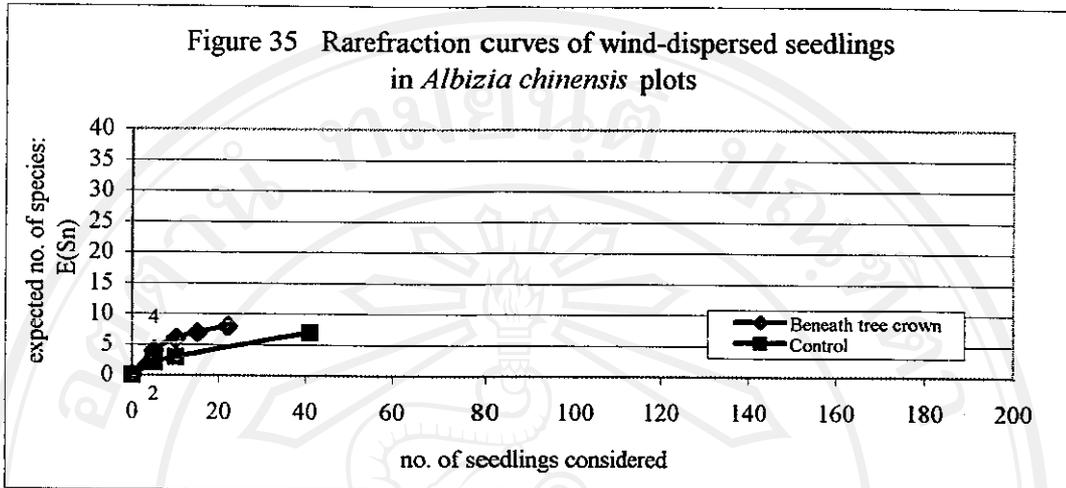


### Rarefaction

The rarefaction method is used to calculate expected number of seedling species from different communities if all samples of the seedling community plots were reduced to a standard number of individuals. Since, in this study, seedling density varied greatly among plots, and plot size varied according to the dimensions of the tree crowns, it is a more appropriate technique than standard species/area curves. Rarefaction curves were used to compare expected numbers of seedling species beneath the tree crowns and in the control plots. Separate curves for wind-dispersed, animal-dispersed, and total seedlings are shown in Figures 35-55. Most charts show similar relationships between numbers of individuals and number of species beneath the tree crowns and in control plots. The expected numbers of seedling species beneath tree crowns was higher than in control plots in charts of wind-dispersed seedlings in *Albizia chinensis*-plots, animal-dispersed seedlings in *Erythrina stricta*-plots, and total seedlings in *Albizia chinensis* and *Erythrina stricta*-plots. The opposite result was found in all charts of *Schima wallichii*-plots and for animal-dispersed seedlings and total seedlings in the *Callicarpa arborea*-plots.

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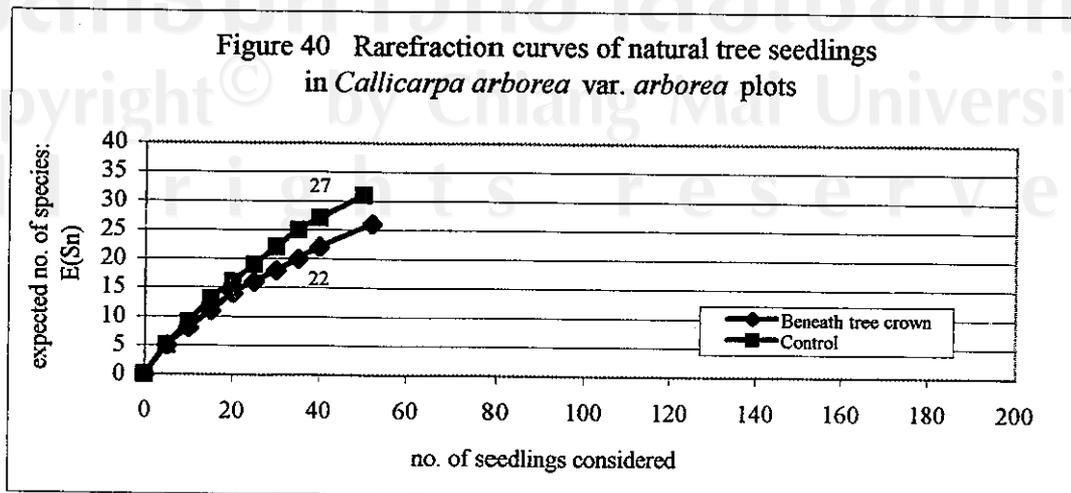
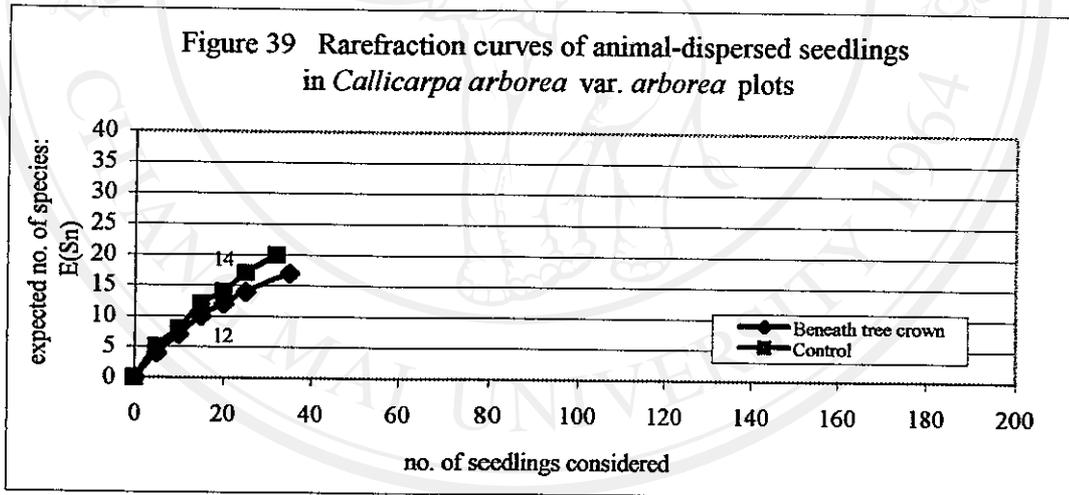
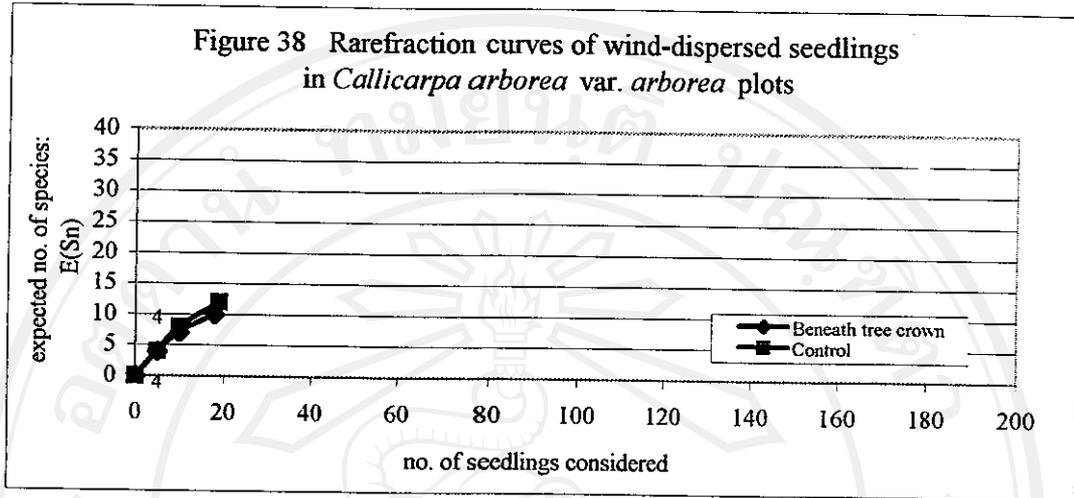


Figure 41 Rarefraction curves of wind-dispersed seedlings in *Castanopsis diversifolia* plots

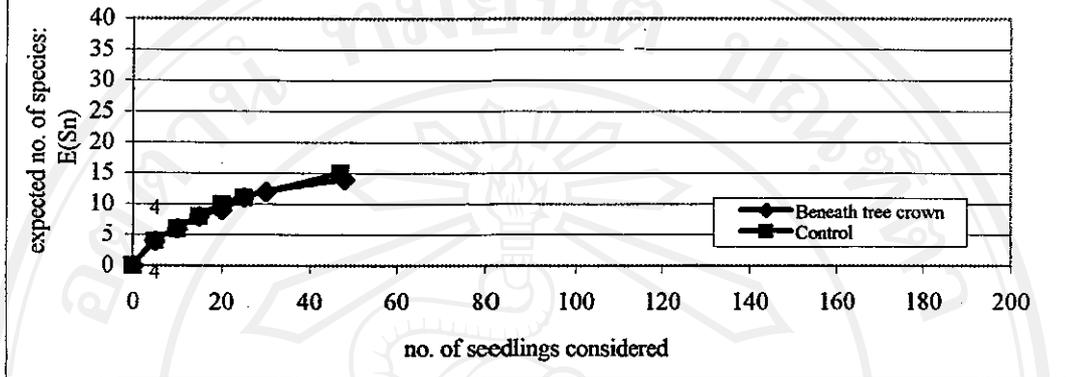


Figure 42 Rarefraction curves of animal-dispersed seedlings in *Castanopsis diversifolia* plots

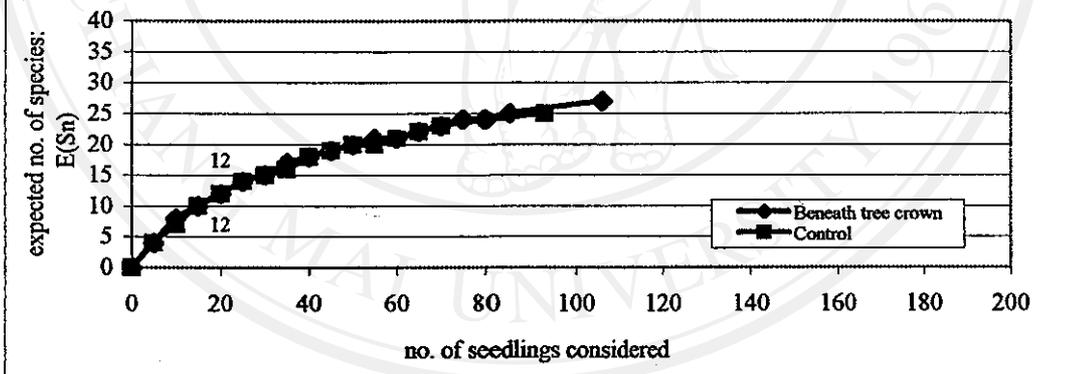


Figure 43 Rarefraction curves of natural tree seedlings in *Castanopsis diversifolia* plots

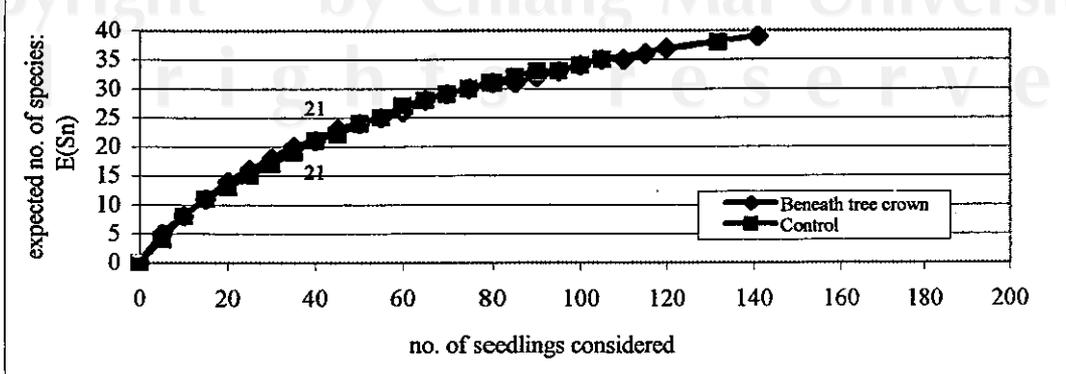


Figure 44 Rarefaction curves of wind-dispersed seedlings in *Erythrina stricta* plots

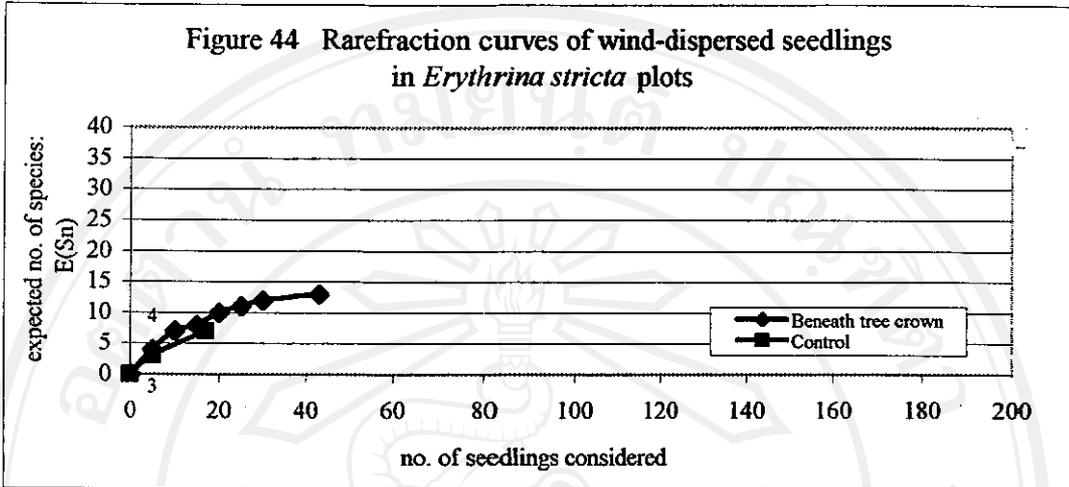


Figure 45 Rarefaction curves of animal-dispersed seedlings in *Erythrina stricta* plots

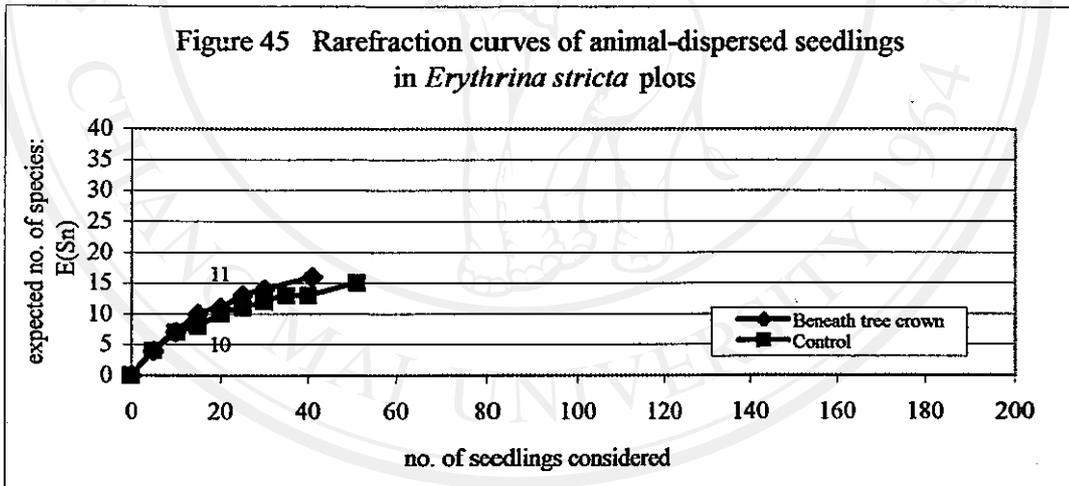
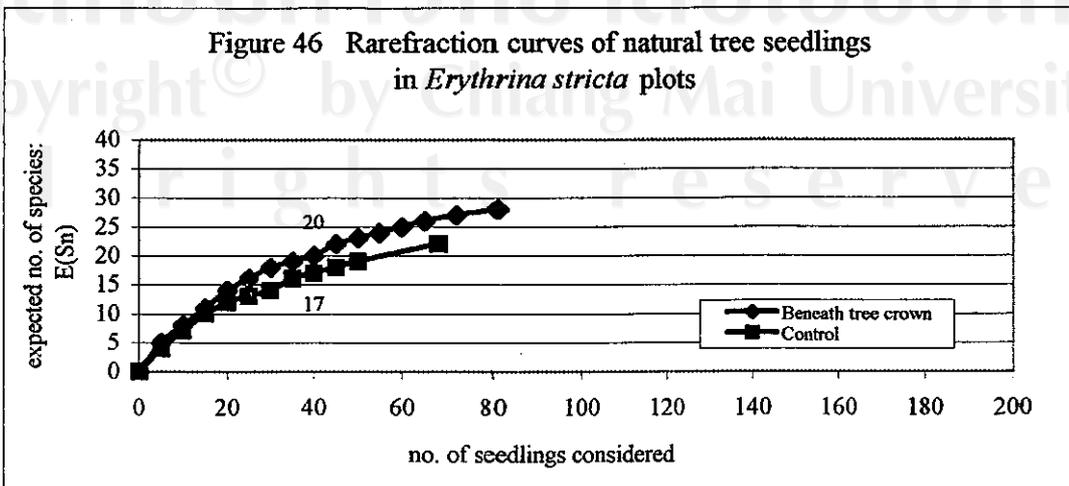
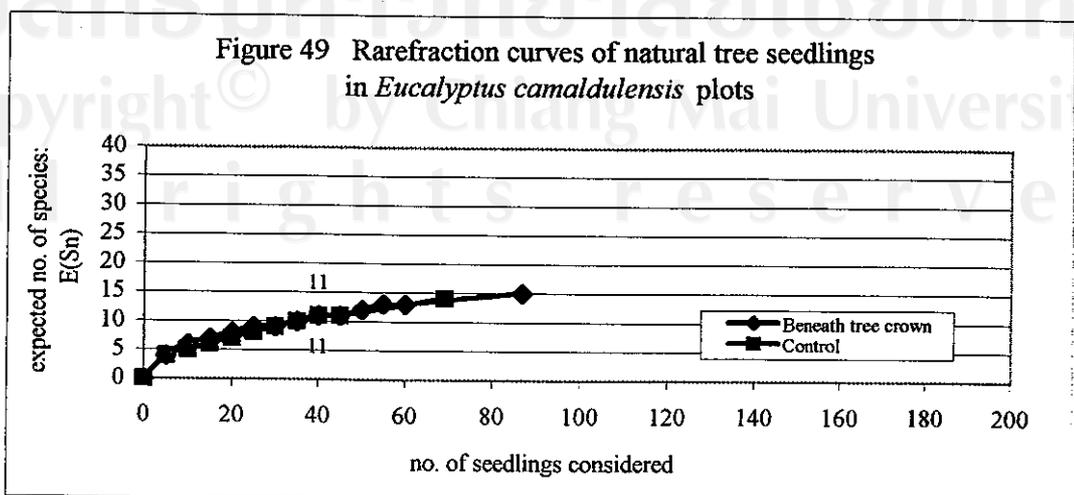
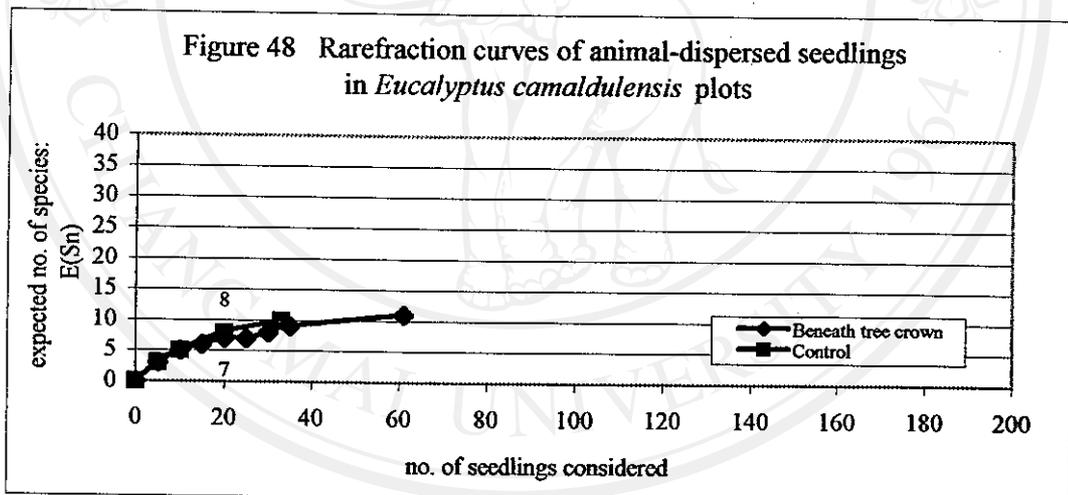
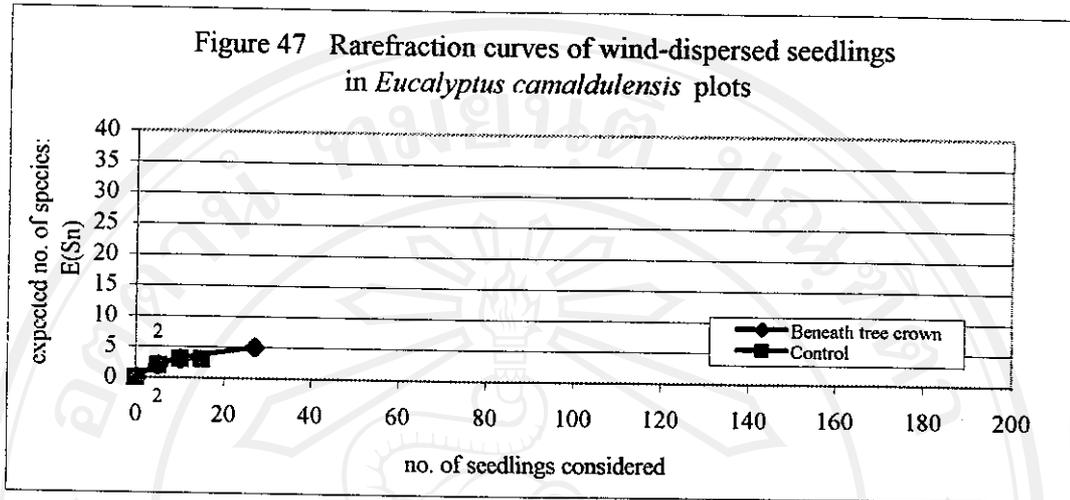


Figure 46 Rarefaction curves of natural tree seedlings in *Erythrina stricta* plots





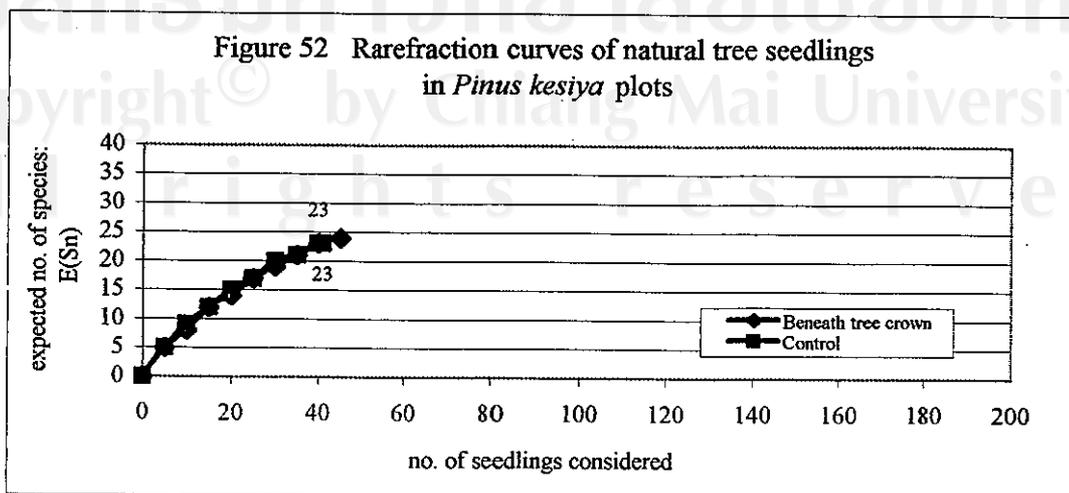
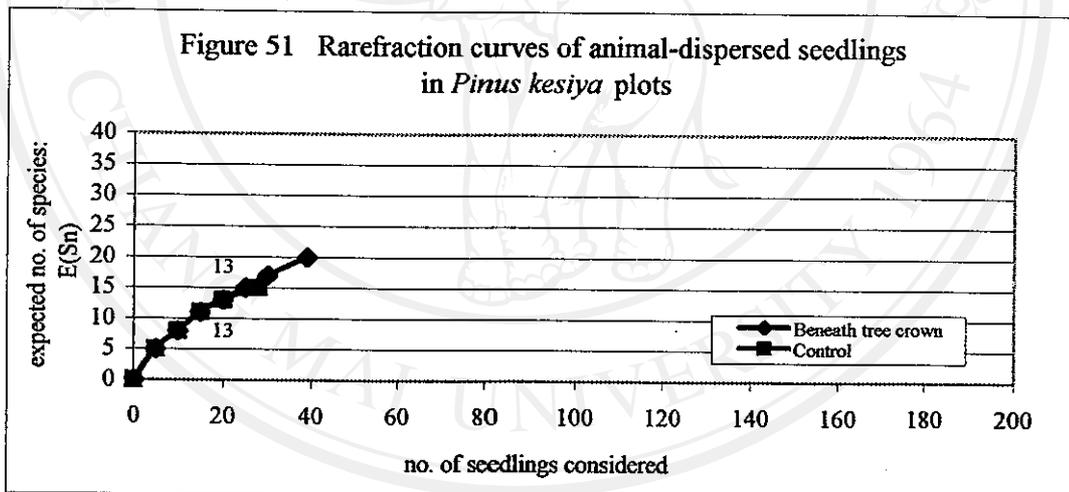
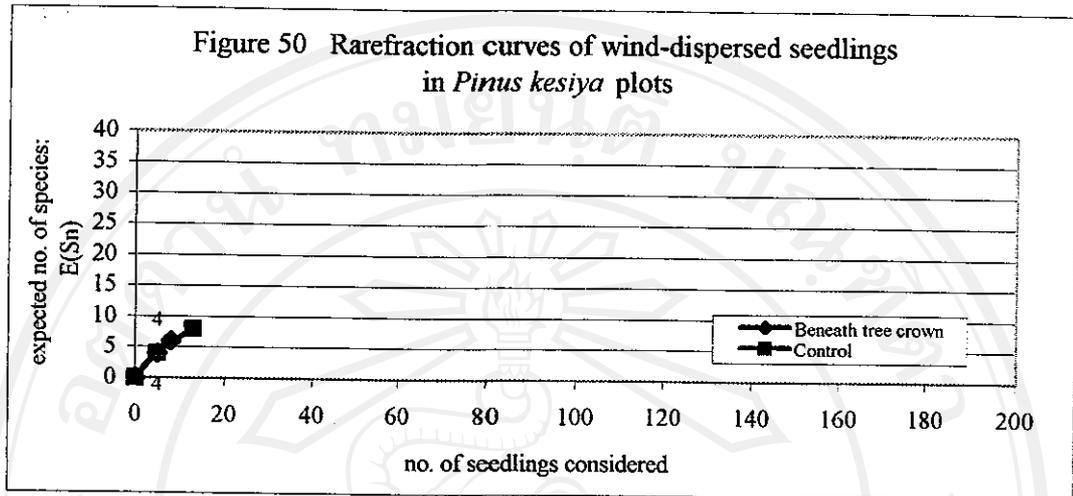


Figure 53 Rarefaction curves of wind-dispersed seedlings  
in *Schima wallichii* plots

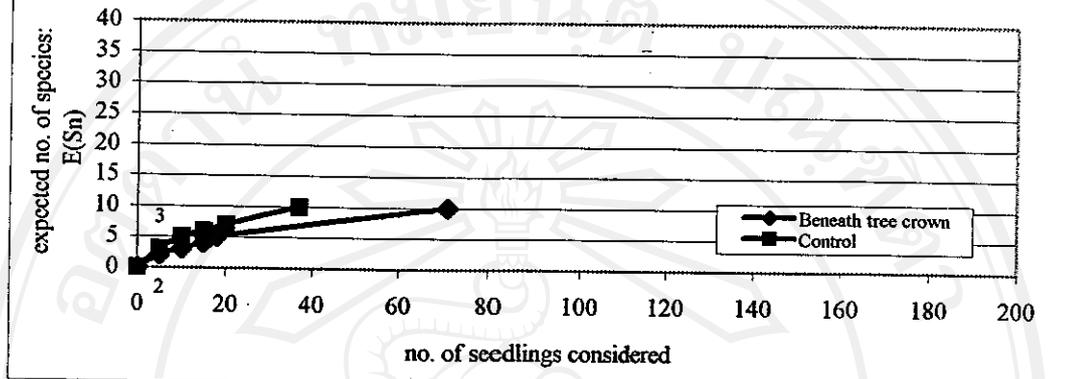


Figure 54 Rarefaction curves of animal-dispersed seedlings  
in *Schima wallichii* plots

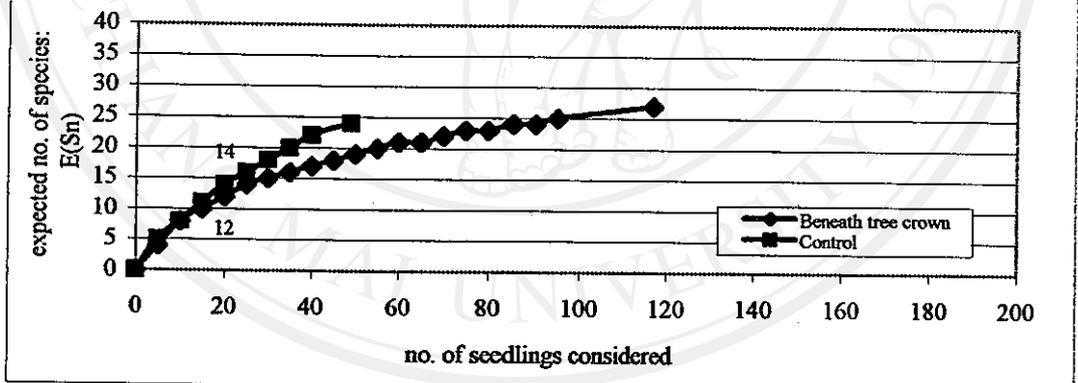
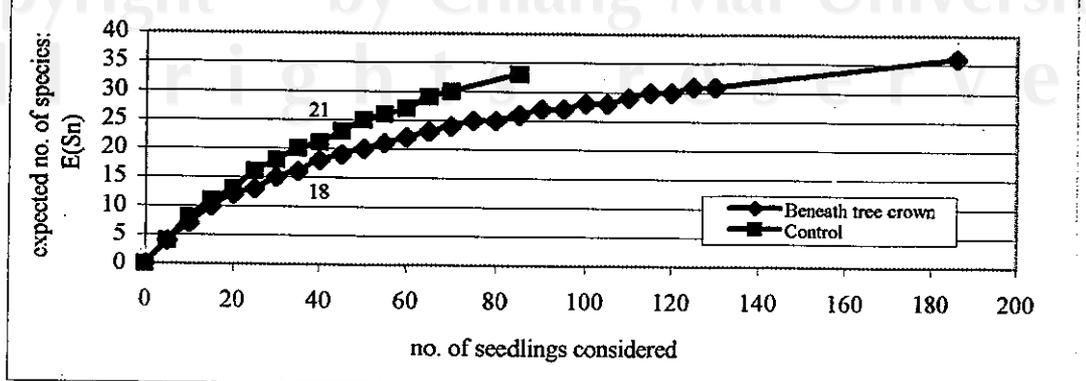


Figure 55. Rarefaction curves of natural tree seedlings  
in *Schima wallichii* plots



### Similarity and difference indices

Sorensen's index was used to compare the species composition of the seedling communities beneath tree crowns and in control plots (Table 9). The maximum value of this coefficient is 1, when two communities have same species and the minimum value is 0, when there are no common species.

Therefore, a low value of Sorensen's index would indicate that remnant tree crowns have a large influence on the species composition of the tree seedling community establishing in deforested areas. The lowest values of Sorensen's index (below 0.5) were obtained with 2 species (*Albizia chinensis* and *Eucalyptus camaldulensis*).

The data were also tested using the difference coefficient, Chord distance, which, unlike Sorensen's index, takes into account the relative abundance of the different species (Table 9). The highest value of Chord distance is 1.41, whilst the lowest value is 0. Therefore, values of above 0.7 would indicate a substantial effect of tree crowns in altering the species composition of the tree seedling community. Chord distance values of above 0.7 were attained with *Albizia chinensis*, *Callicarpa arborea*, *Erythrina stricta*, *Eucalyptus camaldulensis*, and *Pinus kesiya*.

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Table 9 Similarity coefficient (Sorensen's index) and difference coefficient (Chord distance; CRD) of natural seedling communities between tree crowns and control plots

Mature tree species	no. of seedling species			Sorensen	CRD
	Beneath tree	Control	Both (C)		
<i>Albizia chinensis</i> (1)	3	2	1	0.40	1.09
<i>Albizia chinensis</i> (2)	11	4	2	0.27	0.89
<i>Albizia chinensis</i> (3)	4	3	2	0.57	1.20
<i>Albizia chinensis</i> (4)	10	4	2	0.29	1.39
<i>Albizia chinensis</i> (5)	2	1	1	0.67	0.77
<i>Albizia chinensis</i> (6)	8	10	2	0.22	1.01
<b><i>Albizia chinensis</i></b>	<b>27</b>	<b>19</b>	<b>10</b>	<b>0.43</b>	<b>1.12</b>
<i>Callicarpa arborea</i> var. <i>arborea</i> (1)	6	8	3	0.43	1.14
<i>Callicarpa arborea</i> var. <i>arborea</i> (2)	4	3	0	0.00	1.41
<i>Callicarpa arborea</i> var. <i>arborea</i> (3)	3	5	0	0.00	1.41
<i>Callicarpa arborea</i> var. <i>arborea</i> (4)	8	8	1	0.13	1.37
<i>Callicarpa arborea</i> var. <i>arborea</i> (5)	6	1	1	0.29	0.63
<i>Callicarpa arborea</i> var. <i>arborea</i> (6)	2	1	1	0.67	0.24
<i>Callicarpa arborea</i> var. <i>arborea</i> (7)	9	9	2	0.22	1.02
<b><i>Callicarpa arborea</i> var. <i>arborea</i></b>	<b>26</b>	<b>31</b>	<b>16</b>	<b>0.56</b>	<b>0.91</b>
<i>Castanopsis diversifolia</i> (1)	12	9	4	0.38	1.02
<i>Castanopsis diversifolia</i> (2)	11	14	6	0.48	0.47
<i>Castanopsis diversifolia</i> (3)	9	5	1	0.14	0.54
<i>Castanopsis diversifolia</i> (4)	8	8	3	0.38	1.13
<i>Castanopsis diversifolia</i> (5)	6	7	1	0.15	1.33
<i>Castanopsis diversifolia</i> (6)	10	7	4	0.47	1.23
<i>Castanopsis diversifolia</i> (7)	17	8	5	0.40	1.25
<i>Castanopsis diversifolia</i> (8)	3	12	2	0.27	1.26
<b><i>Castanopsis diversifolia</i></b>	<b>39</b>	<b>38</b>	<b>30</b>	<b>0.78</b>	<b>0.49</b>
<i>Erythrina stricta</i> (1)	11	5	2	0.25	1.27
<i>Erythrina stricta</i> (2)	13	5	5	0.56	0.86
<i>Erythrina stricta</i> (3)	4	13	3	0.35	1.28
<i>Erythrina stricta</i> (4)	8	5	4	0.62	0.73
<i>Erythrina stricta</i> (5)	3	5	1	0.25	1.24
<i>Erythrina stricta</i> (6)	10	4	3	0.43	1.24
<b><i>Erythrina stricta</i></b>	<b>28</b>	<b>22</b>	<b>16</b>	<b>0.64</b>	<b>0.72</b>

Table 9 (continued)

Mature tree species	no. of seedling species			Sorensen	CRD
	Beneath tree	Control	Both (C)		
<i>Eucalyptus camaldulensis</i> (1)	5	2	2	0.57	0.42
<i>Eucalyptus camaldulensis</i> (2)	1	1	0	0.00	1.41
<i>Eucalyptus camaldulensis</i> (3)	2	0	0	0.00	
<i>Eucalyptus camaldulensis</i> (4)	6	2	1	0.25	1.32
<i>Eucalyptus camaldulensis</i> (5)	5	6	3	0.55	0.98
<i>Eucalyptus camaldulensis</i> (6)	2	1	0	0.00	1.41
<i>Eucalyptus camaldulensis</i> (7)	5	3	2	0.50	0.21
<i>Eucalyptus camaldulensis</i> (8)	8	5	2	0.31	0.68
<b><i>Eucalyptus camaldulensis</i></b>	<b>15</b>	<b>14</b>	<b>8</b>	<b>0.55</b>	<b>0.73</b>
<i>Pinus kesiya</i> (1)	5	5	1	0.20	1.29
<i>Pinus kesiya</i> (2)	11	11	3	0.27	1.28
<i>Pinus kesiya</i> (3)	3	2	0	0.00	1.41
<i>Pinus kesiya</i> (4)	0	2	0	0.00	
<i>Pinus kesiya</i> (5)	4	2	1	0.33	1.14
<i>Pinus kesiya</i> (6)	1	1	0	0.00	1.41
<i>Pinus kesiya</i> (7)	5	2	0	0.00	1.41
<i>Pinus kesiya</i> (8)	4	2	1	0.33	1.14
<b><i>Pinus kesiya</i></b>	<b>24</b>	<b>23</b>	<b>11</b>	<b>0.47</b>	<b>1.18</b>
<i>Schima wallichii</i> (1)	9	8	6	0.71	0.54
<i>Schima wallichii</i> (2)	4	4	2	0.50	0.86
<i>Schima wallichii</i> (3)	13	10	7	0.61	1.07
<i>Schima wallichii</i> (4)	8	10	3	0.33	1.27
<i>Schima wallichii</i> (5)	15	5	2	0.20	1.35
<i>Schima wallichii</i> (6)	8	5	3	0.46	0.50
<i>Schima wallichii</i> (7)	12	5	3	0.35	1.27
<i>Schima wallichii</i> (8)	6	6	2	0.33	1.13
<b><i>Schima wallichii</i></b>	<b>36</b>	<b>33</b>	<b>25</b>	<b>0.72</b>	<b>0.63</b>
<b>Total</b>	<b>72</b>	<b>60</b>	<b>54</b>	<b>0.82</b>	<b>0.50</b>

*Krusal Wallis*-test, used to test for statistical differences in mean Sorensen's index and mean Chord distance of natural seedling communities between tree crowns and control plots among remnant tree species (Table 10), showed no statistically significant differences ( $P \geq 0.05$ ).

Table 10 Mean Sorensen's index and mean Chord distance of natural seedling communities between tree crowns and control plots

Species	Sorensen <sup>ns</sup>			Chord distance <sup>ns</sup>		
	n	Mean	SD	N	Mean	SD
<i>Albizia chinensis</i>	6	0.402	0.180	6	1.058	0.221
<i>Callicarpa arborea</i>	7	0.247	0.241	7	1.031	0.447
<i>Castanopsis diversifolia</i>	8	0.334	0.132	8	1.029	0.337
<i>Erythrina stricta</i>	6	0.409	0.154	6	1.103	0.243
<i>Eucalyptus camaldulensis</i>	8	0.272	0.251	7	0.919	0.492
<i>Pinus kesiya</i>	8	0.142	0.158	7	1.297	0.121
<i>Schima wallichii</i>	8	0.437	0.165	8	0.999	0.332
Total	51	0.315	0.203	49	1.060	0.337

Remark: ns = no significant differences ( $P \geq 0.05$ )

### Effect of the species of remnant tree on seedling establishment

A comparison of seedling communities among the remnant tree species was analyzed by using a *Kruskal Wallis*-test and a *Mann Whitney*-test on seedling density and species richness.

A *Kruskal Wallis*-test was used to test for statistical differences in the density and the species richness of seedling establishment beneath the tree crowns and in the control plots among the 7 remnant tree species. In this study, the differences of seedling density and species composition varied according to seed-dispersal mechanism, wind and animal. The differences beneath the tree canopies were statistically significant ( $P < 0.05$ ) for density and species component of wind-dispersed seedlings, but not significant ( $P \geq 0.05$ ) for density and species component of animal-dispersed seedlings (Table 11). Furthermore, the differences in the control plots among the 7 remnant tree species were statistically significant ( $P < 0.05$ ) in species component of animal-dispersed seedlings.

Table 11 Summary results of *Kruskal Wallis*-test on density (no./m<sup>2</sup>) and species richness (no.species/m<sup>2</sup>) of seedling establishment among the 7 species of isolated tree studied

Dispersed type	Beneath tree crown		Control	
	Density	Species Richness	Density	Species Richness
wind-dispersed seedling	P=0.032	P=0.033	ns	ns
animal-dispersed seedling	ns	ns	ns	P=0.026
Total seedling	P=0.014	P=0.012	ns	P=0.024

Remark: ns = no significant differences ( $P \geq 0.05$ )

The *Mann Whitney*-test was used to test for significant differences in density and species richness between pairs of remnant tree species. Average density of seedlings beneath remnant tree species studied was highest beneath *Erythrina stricta* and lowest beneath *Albizia chinensis* and *Pinus kesiya* (Table 12). The density of animal-dispersed seedlings was highest beneath *Schima wallichii* and lowest beneath *Albizia chinensis*, but the differences were insignificant ( $P \geq 0.05$ ). The density of wind-dispersed seedlings was highest beneath *Erythrina stricta* and lowest beneath *Pinus kesiya*, and the differences were statistically significant ( $P < 0.05$ ).

Table 12 Summary results of *Mann Whitney*-test on average density (no./m<sup>2</sup>) of seedling establishment beneath isolated tree species ( $P < 0.05$ )

Species	Dispersal means		Total
	Wind	Animal <sup>ns</sup>	
<i>Albizia chinensis</i>	0.069 bc	0.084	0.153 c
<i>Callicarpa arborea</i>	0.065 bc	0.148	0.209 bc
<i>Castanopsis diversifolia</i>	0.072 b	0.172	0.224 abc
<i>Erythrina stricta</i>	0.219 a	0.197	0.399 a
<i>Eucalyptus camaldulensis</i>	0.068 bc	0.202	0.268 abc
<i>Pinus kesiya</i>	0.031 c	0.132	0.156 c
<i>Schima wallichii</i>	0.143 ab	0.232	0.372 ab

Remark: ns = no significant differences ( $P \geq 0.05$ )

Mean species richness of seedlings beneath the studied trees was highest beneath *Erythrina stricta* and lowest beneath *Eucalyptus camaldulensis* (Table 13). The diversity of animal-dispersed seedlings was highest beneath *Erythrina stricta* and lowest beneath *Albizia chinensis*, but the differences were insignificant ( $P \geq 0.05$ ). The species richness of wind-dispersed seedlings was highest beneath *Erythrina stricta* and lowest beneath *Eucalyptus camaldulensis*, the differences were statistically significant ( $P < 0.05$ ).

Table 13 Summary results of *Mann Whitney*-test on average species richness (no.species/m<sup>2</sup>) of seedling establishment beneath isolated tree species ( $P < 0.05$ )

Species	Dispersal means		Total
	Wind	Animal <sup>ns</sup>	
<i>Albizia chinensis</i>	0.041 b	0.067	0.108 c
<i>Callicarpa arborea</i>	0.052 ab	0.106	0.154 abc
<i>Castanopsis diversifolia</i>	0.044 b	0.091	0.122 bc
<i>Erythrina stricta</i>	0.108 a	0.156	0.247 a
<i>Eucalyptus camaldulensis</i>	0.023 b	0.075	0.097 c
<i>Pinus kesiya</i>	0.031 b	0.094	0.116 bc
<i>Schima wallichii</i>	0.037 b	0.126	0.161 ab

Remark: ns = no significant differences ( $P \geq 0.05$ )

Considering among control plots of the 7 species of remnant trees studied, the differences among remnant species in seedling density were insignificant ( $P \geq 0.05$ ) (Table 14). The differences of species richness were almost insignificant. Differences among remnant species in species richness of establishing seedlings were significant ( $P < 0.05$ ) (Table 15). However, this was due almost entirely to the very high number of animal-dispersed species in control plots of *Erythrina stricta*.

Table 14 Summary results of *Mann Whitney*-test on average density (no./m<sup>2</sup>) of seedling establishment between control plots of remnant tree species ( $P < 0.05$ )

Species	Dispersal means		Total <sup>ns</sup>
	Wind <sup>ns</sup>	Animal <sup>ns</sup>	
<i>Albizia chinensis</i>	0.086	0.068	0.155
<i>Callicarpa arborea</i>	0.070	0.138	0.206
<i>Castanopsis diversifolia</i>	0.058	0.125	0.170
<i>Erythrina stricta</i>	0.077	0.292	0.369
<i>Eucalyptus camaldulensis</i>	0.109	0.089	0.198
<i>Pinus kesiya</i>	0.044	0.091	0.135
<i>Schima wallichii</i>	0.079	0.120	0.199

Remark: ns = no significant differences ( $P \geq 0.05$ )

Table 15 Summary results of *Mann Whitney*-test on average species richness (no.species/m<sup>2</sup>) of seedling establishment between control plots of remnant tree species (P<0.05)

Species	Dispersal means		Total
	Wind <sup>ns</sup>	Animal	
<i>Albizia chinensis</i>	0.026	0.048 b	0.074 b
<i>Callicarpa arborea</i>	0.049	0.104 ab	0.152 ab
<i>Castanopsis diversifolia</i>	0.036	0.071 ab	0.098 b
<i>Erythrina stricta</i>	0.044	0.168 a	0.212 a
<i>Eucalyptus camaldulensis</i>	0.021	0.036 b	0.057 b
<i>Pinus kesiya</i>	0.035	0.055 b	0.089 b
<i>Shima wallichii</i>	0.038	0.097 ab	0.133 ab

Remark: ns = no significant differences (P≥0.05)

### Effects of the sizes of remnant trees on seedling establishment

Relationships between remnant tree size with seedling establishment were analyzed by linear regression. Linear- regression charts of each studied tree species were made to determine the relationships and statistical analysis. Results varied greatly according to parameters of tree size, seed-dispersed mechanism, and species of remnant tree.

Most analyses showed no relations between any parameters of tree size with density or species richness of seedlings (Table 16). However, there were some significant inverse relationships beneath *Castanopsis diversifolia*, *Eucalyptus camaldulensis*, and *Schima wallichii*.

Table 16 Summary results of linear-regression test between remnant tree size with density (no./m<sup>2</sup>) and species richness (no.species/m<sup>2</sup>) of natural seedling establishment beneath similar remnant tree species

Species	Density			Species richness		
	Height	GBH	Canopy width	Height	GBH	Canopy width
<i>Albizia chinensis</i>	ns	ns	ns	ns	ns	ns
<i>Callicarpa arborea</i>	ns	ns	ns	ns	ns	ns
<i>Castanopsis diversifolia</i>	ns	ns	P=0.006(-)	ns	ns	P=0.007(-)
<i>Erythrina stricta</i>	ns	ns	ns	ns	ns	ns
<i>Eucalyptus camaldulensis</i>	ns	P=0.038(-)	ns	ns	ns	ns
<i>Pinus kesiya</i>	ns	ns	ns	ns	ns	ns
<i>Schima wallichii</i>	ns	ns	ns	ns	P=0.032(-)	P=0.027(-)
Total	ns	ns	ns	ns	ns	P=0.009(-)

Remark: ns = no significant differences ( $P \geq 0.05$ )

(-) = inverse linear regression

Considering only wind-dispersed seedlings (Table 17) most analyses indicated no statistical relationships except a relationship between canopy width of *Castanopsis diversifolia* and species richness of seedlings.

Table 17 Summary results of linear-regression test between remnant tree size with density (no./m<sup>2</sup>) and species richness (no.species/m<sup>2</sup>) of wind-dispersed seedlings beneath similar remnant tree species

Species	Density			Species richness		
	Height	GBH	Canopy width	Height	GBH	Canopy width
<i>Albizia chinensis</i>	ns	ns	ns	ns	ns	ns
<i>Callicarpa arborea</i>	ns	ns	ns	ns	ns	ns
<i>Castanopsis diversifolia</i>	ns	ns	ns	ns	ns	P=0.014(-)
<i>Erythrina stricta</i>	ns	ns	ns	ns	ns	ns
<i>Eucalyptus camaldulensis</i>	ns	ns	ns	ns	ns	ns
<i>Pinus kesiya</i>	ns	ns	ns	ns	ns	ns
<i>Schima wallichii</i>	ns	ns	ns	ns	ns	ns
Total	ns	ns	ns	ns	ns	ns

Remark: ns = no significant differences ( $P \geq 0.05$ )

(-) = inverse linear regression

Considering only animal-dispersed seedlings (Table 18) most analyses indicated no statistical relationships between tree size with density or species richness of seedlings except some relationships beneath *Albizia chinensis*, *Castanopsis diversifolia*, and *Schima wallichii*.

Table 18 Summary results of linear-regression test between remnant tree size with density (no./m<sup>2</sup>) and species richness (no.species/m<sup>2</sup>) of animal-dispersed seedlings beneath similar remnant tree species

Species	Density			Species richness		
	Height	GBH	Canopy width	Height	GBH	Canopy width
<i>Albizia chinensis</i>	ns	ns	P=0.03(+)	ns	ns	ns
<i>Callicarpa arborea</i>	ns	ns	ns	ns	ns	ns
<i>Castanopsis diversifolia</i>	ns	ns	P=0.003(-)	ns	ns	P=0.005(-)
<i>Erythrina stricta</i>	ns	ns	ns	ns	ns	ns
<i>Eucalyptus camaldulensis</i>	ns	ns	ns	ns	ns	ns
<i>Pinus kesiya</i>	ns	ns	ns	ns	ns	ns
<i>Schima wallichii</i>	ns	ns	ns	ns	P=0.003(-)	P=0.025(-)
Total	ns	ns	ns	ns	ns	P=0.025(-)

Remark: ns = no significant differences (P≥0.05)

(-) = inverse linear regression

(+) = relative linear regression

### Relative growth rate (RGR)

Relative growth rates of different natural tree seedling species were calculated by using remainder of seedling height (cm). The RGR results did not include all recorded seedlings due to random sampling of seedlings for monitoring in some plots and the loss of some seedlings during the study period. Average RGR's of 58 seedling species (339 seedlings) are presented in Appendix E. The average RGR's combined from beneath remnant trees and in control plots are reported in Table 19. The range of average RGR was 5.23 – 228.24 (% / year). Height RGR of seedling species was highest for *Trema orientalis* (L.) Bl. (Ulmaceae), 228.24 (% / year) followed by *Callicarpa arborea* Roxb. var. *arborea* (Verbenaceae), 114.83 (% / year), and lowest for *Ficus fistulosa* Reinw. ex Bl. var. *fistulosa* (Moraceae), 5.23 (% / year).

Frequency of histograms of average RGR values displayed in Figures 56-58. Most seedling species (39 species) recruited beneath remnant tree crowns had wide ranges in average RGR (10-60 % / year) (Figure 56). In the control plots, the number of seedling species peaked clearly at 13 species, which had average RGR's of 20-30 % / year (Figure 57).

Table 19 Average relative growth rate (% per year) of naturally established tree seedlings

No.	Botanical Name	Family	Under tree crown			Control			Total		
			n	Mean	SD	n	Mean	SD	n	Mean	SD
1	<i>Aleodaphne andersonii</i> (King ex Hk. f.) Kosterm.	Lauraceae	1	54.69	-				1	54.69	-
2	<i>Anneslea fragrans</i> Wall.	Theaceae				1	26.83	-	1	26.83	-
3	<i>Antidesma acidum</i> Retz.	Euphorbiaceae	7	60.49	34.60	1	39.60	-	8	57.88	32.88
4	<i>Antidesma bunius</i> (L.) Spreng. var. <i>bunius</i>	Euphorbiaceae	3	72.75	24.86	3	30.96	17.67	6	51.85	29.94
5	<i>Aporosa villosa</i> (Wall. ex Lindl.) Baill.	Euphorbiaceae	13	38.21	21.47	4	28.09	8.72	17	35.83	19.48
6	<i>Archidendron clypearia</i> (Jack) Niels. ssp. <i>clypearia</i> var. <i>clypearia</i>	Leguminosae, Mimosoideae				1	90.43	-	1	90.43	-
7	<i>Artocarpus lakoocha</i> Roxb.	Moraceae	3	18.50	16.55	6	28.75	6.69	9	25.34	11.08
8	<i>Artocarpus lanceolata</i> Trec.	Moraceae	3	43.45	36.15	1	32.66	-	4	40.75	30.01
9	<i>Baccaurea ramiflora</i> Lour.	Euphorbiaceae				1	32.63	-	1	32.63	-
10	<i>Bauhinia variegata</i> L.	Leguminosae, Caesalpinoideae	2	45.11	53.48				2	45.11	53.48
11	<i>Beilschmiedia</i> aff. <i>intermedia</i> Allen	Lauraceae	1	39.60	-				1	39.60	-
12	<i>Callicarpa arborea</i> Roxb. var. <i>arborea</i>	Verbenaceae	1	114.83	-				1	114.83	-
13	<i>Canarium subulatum</i> Guill.	Burseraceae	1	17.20	-				1	17.20	-
14	<i>Canthium parvifolium</i> Roxb.	Rubiaceae	3	41.77	25.61	3	27.39	5.06	6	34.58	18.29
15	<i>Castanopsis acuminatissima</i> (Bl.) A. DC.	Fagaceae				1	31.54	-	1	31.54	-
16	<i>Castanopsis argyrophylla</i> King ex Hk. f.	Fagaceae	3	55.54	23.46				3	55.54	23.46
17	<i>Castanopsis diversifolia</i> (Kurz) King ex Hk. f.	Fagaceae				1	65.37	-	1	65.37	-
18	<i>Cinnamomum longipetiolatum</i> H.W. Li	Lauraceae	2	58.12	39.39	1	54.09	-	3	56.78	27.95
19	<i>Dalbergia cultrata</i> Grah. ex Bth.	Leguminosae, Papilionoideae				2	14.10	15.94	2	14.10	15.94
20	<i>Dalbergia ovata</i> Grah. ex Bth.	Leguminosae, Papilionoideae	37	57.20	22.85	15	58.11	25.86	52	57.46	23.50

Table 19 (continued)

No.	Botanical Name	Family	Under tree crown			Control			Total		
			n	Mean	SD	n	Mean	SD	n	Mean	SD
21	<i>Dillenia parviflora</i> Griff. var. <i>kerrii</i> (Craib) Hoogl.	Dilleniaceae	1	11.43	-			1	11.43	-	
22	<i>Dimocarpus longan</i> Lour. ssp. <i>longan</i> var. <i>longan</i>	Sapindaceae	1	24.00	-			1	24.00	-	
23	<i>Diospyros glandulosa</i> Lace	Ebenaceae	4	44.91	33.26	1	31.89	5	42.31	29.38	
24	<i>Elaeocarpus lanceifolius</i> Roxb.	Elaeocarpaceae	2	91.42	83.27			2	91.42	83.27	
25	<i>Eugenia claviflora</i> Roxb.	Myrtaceae	2	43.84	32.24	1	50.45	3	46.05	23.11	
26	<i>Eugenia fruticosa</i> (DC.) Roxb.	Myrtaceae	3	57.31	26.82	6	57.33	9	57.33	16.78	
27	<i>Eurya acuminata</i> DC. var. <i>wallichiana</i> Dyer	Theaceae	2	33.06	30.59	2	87.26	4	60.16	44.54	
28	<i>Ficus fistulosa</i> Reinw. ex Bl. var. <i>fistulosa</i>	Moraceae				1	5.23	1	5.23	-	
29	<i>Ficus hispida</i> L. f. var. <i>hispida</i>	Moraceae				1	19.08	1	19.08	-	
30	<i>Ficus semicordata</i> B.-H. ex J.E. Sm. var. <i>semicordata</i>	Moraceae	1	67.81	-			1	67.81	-	
31	<i>Ficus subulata</i> Bl. var. <i>subulata</i>	Moraceae	1	54.69	-			1	54.69	-	
32	<i>Firmiana colorata</i> (Roxb.) R. Br.	Sterculiaceae	1	28.10	-			1	28.10	-	
33	<i>Glochidion acuminatum</i> M.-A. var. <i>stamense</i> A.S.	Euphorbiaceae	2	18.50	10.96			2	18.50	10.96	
34	<i>Glochidion sphaerogynum</i> (M.-A.) Kurz	Euphorbiaceae	4	39.51	8.92			4	39.51	8.92	
35	<i>Gluta obovata</i> Craib	Anacardiaceae	1	26.44	-	2	55.70	3	45.95	20.05	
36	<i>Gmelina arborea</i> Roxb.	Verbenaceae	1	26.25	-			1	26.25	-	
37	<i>Helicia nilagirica</i> Bedd.	Proteaceae	2	32.58	0.04			2	32.58	0.04	
38	<i>Ilex umbellulata</i> (Wall.) Loesn.	Aquifoliaceae						1	45.96	-	
39	<i>Litsea cubeba</i> (Lour.) Pers. var. <i>cubeba</i>	Lauraceae	21	51.03	37.27	9	61.36	30	54.13	38.59	
40	<i>Litsea glutinosa</i> (Lour.) C.B. Rob. var. <i>glutinosa</i>	Lauraceae				1	18.07	1	18.07	-	

Table 19 (continued)

No.	Botanical Name	Family	Under tree crown			Control			Total		
			n	Mean	SD	n	Mean	SD	n	Mean	SD
41	<i>Lisea monopetala</i> (Roxb.) Pers.	Lauraceae	15	50.75	39.19	3	87.98	28.79	18	56.95	39.57
42	<i>Machilus bombycina</i> King ex Hk. f.	Lauraceae	2	73.60	11.63	6	29.73	15.49	8	40.70	24.56
43	<i>Mallotus philippensis</i> (Lmk.) M.-A.	Euphorbiaceae	1	39.36	-	5	26.64	25.47	6	28.76	23.36
44	<i>Markhamia stipulata</i> (Wall.) Seem. ex K. Sch. var. <i>kerrii</i> Sprague	Bignoniaceae	4	25.00	19.31	2	22.52	23.12	6	24.17	18.23
45	<i>Phoebe lanceolata</i> (Wall. ex Nees) Nees	Lauraceae	1	47.06	-	2	69.98	28.84	3	62.34	24.31
46	<i>Phyllanthus emblica</i> L.	Euphorbiaceae	8	53.78	21.94	1	16.68	-	9	49.66	23.96
47	<i>Rhus chinensis</i> Mill.	Anacardiaceae	12	34.37	18.72	1	4.69	-	13	32.09	19.72
48	<i>Sapindus rarak</i> DC.	Sapindaceae	1	17.70	-				1	17.70	-
49	<i>Saurauia roxburghii</i> Wall.	Saurauiaceae	2	53.46	44.96				2	53.46	44.96
50	<i>Schima wallichii</i> (DC.) Korth.	Theaceae	9	60.81	45.19	31	66.31	31.75	40	65.07	34.64
51	<i>Sterculia villosa</i> Roxb.	Sterculiaceae	3	23.15	19.98	3	27.56	12.78	6	25.36	15.20
52	<i>Stereospermum colais</i> (B.-H. ex Dillw.) Mabb.	Bignoniaceae	4	89.56	38.23				4	89.56	38.23
53	<i>Syrax benzoides</i> Craib	Styracaceae	2	39.99	31.52	4	34.26	31.50	6	36.17	28.34
54	<i>Toona ciliata</i> M. Roem.	Meliaceae	2	33.64	16.94	3	39.86	26.91	5	37.38	21.11
55	<i>Trema orientalis</i> (L.) Bl.	Ulmaceae				1	228.24	-	1	228.24	-
56	<i>Turpinia pomifera</i> (Roxb.) Wall. ex DC.	Staphyleaceae	2	45.14	34.07	2	52.31	30.08	4	48.72	26.56
57	<i>Vernonia volkameriifolia</i> DC. var. <i>volkameriifolia</i>	Compositae	2	83.65	40.60				2	83.65	40.60
58	<i>Wendlandia tinctoria</i> (Roxb.) DC. ssp. <i>floribunda</i> (Craib) Cowan	Rubiaceae	2	38.50	3.01	8	61.48	25.21	10	56.89	24.28
	Total		201	49.47	30.76	138	51.36	33.89	339	50.24	32.04

Figure 56 Frequency of seedling species beneath remnant tree crowns separated by periods of average RGR

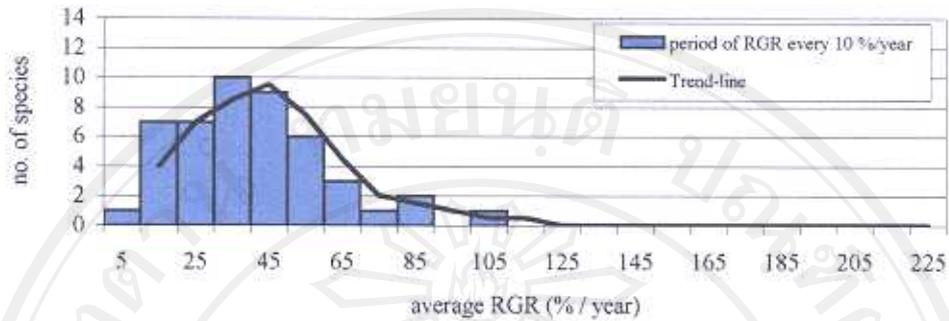


Figure 57 Frequency of seedling species in control plots separated by periods of average RGR

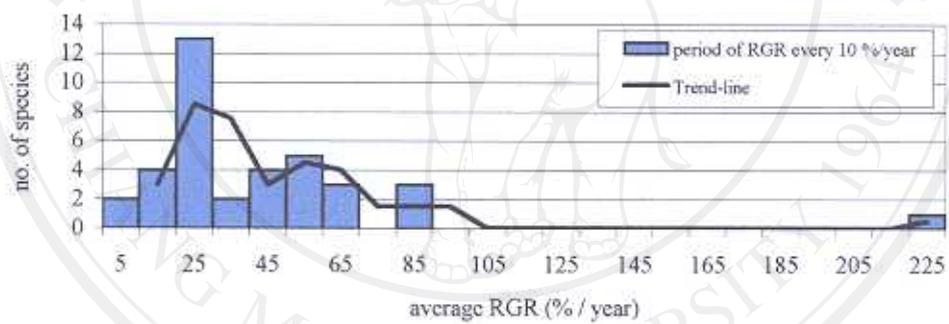
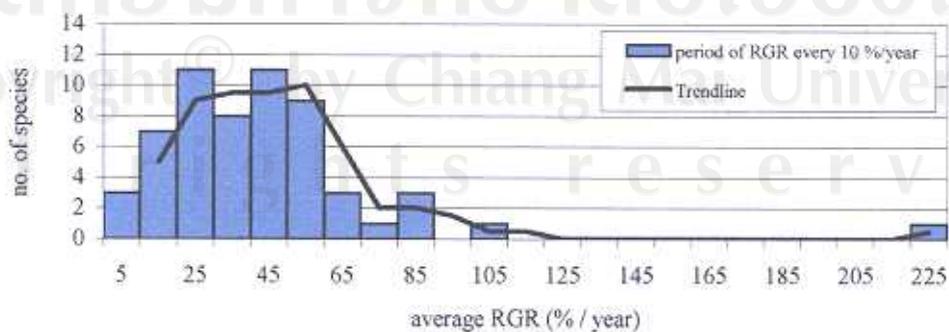


Figure 58 Frequency of seedling species in both, beneath tree crowns and control plots separated by periods of average RGR



A comparison of average RGR of tree seedlings beneath tree crowns and in control plots was carried out by considering 10 seedling species, which were abundance (Table 20). The *Mann Whitney*-test was used to determine statistical differences in RGR. There were no significant difference in mean RGR's of seedlings beneath remnant tree crowns and those in control plots ( $P < 0.05$ ).

Table 20 *Mann Whitney*-test on average RGR's of 10 seedling species between beneath remnant tree crowns and in control plots

Species	Mean RGR (% / year)		Statistical result
	Beneath tree crown	Control	
<i>Antidesma bunius</i> (L.) Spreng. var. <i>bunius</i>	72.75	30.96	ns
<i>Aporosa villosa</i> (Wall. ex Lindl.) Baill.	38.21	28.09	ns
<i>Artocarpus lakoocha</i> Roxb.	18.50	28.75	ns
<i>Canthium parvifolium</i> Roxb.	41.77	27.39	ns
<i>Dalbergia ovata</i> Grah. ex Bth.	57.20	58.11	ns
<i>Eugenia fruticosa</i> (DC.) Roxb.	57.31	57.33	ns
<i>Litsea cubeba</i> (Lour.) Pers. var. <i>cubeba</i>	51.03	61.36	ns
<i>Litsea monopetala</i> (Roxb.) Pers.	50.75	87.98	ns
<i>Schima wallichii</i> (DC.) Korth.	60.81	66.31	ns
<i>Sterculia villosa</i> Roxb.	23.15	27.56	ns

Remark: ns = no significant differences ( $P \geq 0.05$ )

## Bird observations

### Bird visitations to the remnant trees studied

During two hundred and thirty-one hours of observations at remnant trees in a deforested site, thirteen species of bird were observed visiting the trees studied (Table 21). Considering all trees combined, the Inornate Warbler visited the longest followed by the Flavescent Bulbul. The Inornate Warbler was the most prevalent visitor in most of tree species studied, *Albizia chinensis* (Obs.) Merr. (Leguminosae, Mimosoideae), *Erythrina stricta* Roxb. (Leguminosae, Papilionoideae), *Eucalyptus camaldulensis* Dehnh. (Myrtaceae), *Pinus kesiya* Roy. ex Gord. (Pinaceae), and *Schima wallichii* (DC.) Korth. (Theaceae), whereas for *Callicarpa arborea* Roxb. var. *arborea* (Verbenaceae) it was the Flavescent Bulbul and for *Castanopsis diversifolia* (Kurz) King ex Hk. f. (Fagaceae) it was the Burmese Shrike. *Schima wallichii* was most attractive remnant tree species to birds.

Most birds observed were insectivorous (6 species), general or omnivorous (5 species) and a few were carnivorous (2 species) (Appendix F). Insectivorous birds were the most dominant group in *Albizia chinensis* (Obs.) Merr. (Leguminosae, Mimosoideae), *Erythrina stricta* Roxb. (Leguminosae, Papilionoideae) and *Schima wallichii* (DC.) Korth. (Theaceae). Omnivorous birds, which eat both insects and fruits were the longest visiting group in *Callicarpa arborea* Roxb. var. *arborea* (Verbenaceae), *Eucalyptus camaldulensis* Dehnh. (Myrtaceae), and *Pinus kesiya* Roy. ex Gord. (Pinaceae). Whilst carnivorous birds predominated in *Castanopsis diversifolia* (Kurz) King ex Hk. f. (Fagaceae) (Table 22).

Table 21 Ratios of minutes bird observed / total observation minutes for each tree species

Scientific Name	Common Name	<i>Albizia chinensis</i>	<i>Calliarcya arborea</i> var. <i>arborea</i>	<i>Castanopsis</i> <i>diversifolia</i>	<i>Erythrina stricta</i>	<i>Eucalyptus</i> <i>camaldulensis</i>	<i>Pinus kesiya</i>	<i>Schinus molle</i>	Total
<i>Aegithina tiphia</i>	Common Iora	0.0014	0.0014		0.0049	0.0014	0.0007	0.0056	0.0022
<i>Chrysococcyx maculatus</i>	Asian Emerald Cuckoo		0.0005						0.0001
<i>Lanius collurio</i>	Burmese Shrike	0.0005	0.0005	0.0272	0.0007	0.0007	0.0004		0.0032
<i>Lanius schach</i>	Long-tailed Shrike							0.0048	0.0009
<i>Pericrocotus cinnamomeus</i>	Small Minivet							0.0274	0.0050
<i>Phaenicophaeus tristis</i>	Green-billed Malkoha							0.0004	0.0001
<i>Phylloscopus inornatus</i>	Inornate Warbler	0.0116	0.0028	0.0007	0.0188	0.0049	0.0085	0.0913	0.0230
<i>Pteruthius melanotis</i>	White-browed Shrike-Babbler	0.0005					0.0007	0.0091	0.0019
<i>Pycnonotus atriceps</i>	Black-headed Bulbul		0.0005						0.0001
<i>Pycnonotus aurigaster</i>	Sooty-headed Bulbul	0.0037	0.0019	0.0007	0.0028	0.0014	0.0052	0.0183	0.0057
<i>Pycnonotus flavescens</i>	Flavescens Bulbul	0.0019	0.0120	0.0007	0.0021	0.0035	0.0037	0.0331	0.0096
<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	0.0015	0.0042	0.0007	0.0069	0.0035	0.0025	0.0079	0.0040
<i>Sitta frontalis</i>	Velvet-fronted Nuthatch					0.0007		0.0012	0.0003
Total		0.0209	0.0236	0.0300	0.0361	0.0160	0.0218	0.1990	0.0559

Table 22 Percent of individual visit minutes by each bird group (according to diet) in the trees studied

Bird types	<i>Albizia chinensis</i>	<i>Callicarpa arborea</i>	<i>Castanopsis diversifolia</i>	<i>Erythrina stricta</i>	<i>Eucalyptus camaldulensis</i>	<i>Pinus kesiya</i>	<i>Schima wallichii</i>	Total
Carnivorous bird	2.2	1.9	90.7	1.9	4.3	1.7	2.4	7.2
Insectivorous bird	64.2	19.6	2.3	65.4	43.5	45.9	67.6	58.1
Omnivorous bird	33.6	78.4	6.9	32.7	52.2	52.4	29.9	34.6
% total	100	100	100	100	100	100	100	100

Bird behavior, while they visited the trees could be divided in to three main activities. First, birds perched for a moment and then flew out. This behavior was observed for all bird species. Some birds dropped faeces. Secondly, birds visited for feeding which took longer, depending on the abundance of food. Sooty-headed Bulbul, Flavescent Bulbul, Red-whiskered Bulbul spent a long time in fruiting trees, of *Callicarpa arborea* var. *arborea* (6). Common Iora, Small Minivet, Inornat Warbler, White-browed Shrike-Babbler, Sooty-headed Bulbul, Flavescent Bulbul, Red-whiskered Bulbul, and Velvet-fronted Nuthatch spent a long time foraging for caterpillars or adult insects in almost all trees. Lastly, birds visited trees to defend their territories. Burmese Shrike spent a long time visiting *Castanopsis diversifolia* (3) without feeding and the Long-tailed Shrike spent a long time visiting *Schima wallichii* (3) and *Schima wallichii* (5). Both birds, which are carnivorous, often called and attacked other birds coming in their territories. Nests of both birds were found nearby.

### Bird feeding on fruiting trees in intact forest

Birds were observed in fruiting trees of one individual of *Aporusa octandra* (B.-H. ex D. Don) Vick. var. *octandra* (Euphorbiaceae), one *Bischofia javanica* Bl. (Euphorbiaceae), two *Callicarpa arborea* Roxb. var. *arborea* (Verbenaceae), one *Debregeasia longifolia* (Burm. f.) Wedd. (Urticaceae), and one *Heynea trijuga* Roxb. ex Sims (Meliaceae). *Aporusa octandra* (B.-H. ex D. Don) Vick. var. *octandra* (Euphorbiaceae) was located at the National Park Headquarters (FORRU tree number s205) and two *Callicarpa arborea* Roxb. var. *arborea* (Verbenaceae) trees were located along the road near the National Park Headquarters. *Debregeasia longifolia* (Burm. f.) Wedd. (Urticaceae) and *Heynea trijuga* Roxb. ex Sims (Meliaceae) were located at the Coffee Research Station. *Bischofia javanica* Bl. (Euphorbiaceae) is located near the Chang Kian Highland Agriculture Research Station.

During fifty-four hours of observations seventeen bird-species visited the trees (Table 23). Most birds were omnivorous, except the Black-throated Sunbird (nectar/insectivorous), Common Iora, Inornate Warbler (insectivorous), Burmese Shrike, Blue Whistling Thrush (carnivorous), and Wedge-tailed Pigeon (frugivorous). Black-crested Bulbul visited the longest time on *Aporusa octandra* and *Bischofia javanica*. Red-whiskered Bulbul visited the longest time on *Debregeasia longifolia* and *Heynea trijuga*. Flavescent Bulbul visited the longest time on *Callicarpa arborea*. *Bischofia javanica* was most attractive to birds ate them fruits compare with other trees. Red-whiskered Bulbul ate fruits widely by feeding every fruiting tree studied.

Table 23 Ratios of minutes bird observed / total observation minutes for each fruiting tree species

Scientific Name	Common Name	<i>Aporosa octandra</i>	<i>Bischofia javanica</i>	<i>CalliCARPA arborea</i> var. <i>arborea</i>	<i>Debregeasia longifolia</i>	<i>Heynea triyca</i>	Total
<i>Aegithina tiphia</i>	Common Iora			0.00417			0.00093
<i>Aethopyga saturata</i>	Black-throated Sunbird					0.00069	0.00015
<i>Chloropsis aurifrons</i>	Golden-fronted Leafbird	0.00185					0.00031
<i>Chloropsis hardwickii</i>	Orange-bellied Leafbird		0.00417				0.00093
<i>Criniger pallidus</i>	Puff-throated Bulbul		0.92361			0.01667	0.20895
<i>Hypsipetes flavala</i>	Ashy Bulbul		0.03194				0.00710
<i>Hypsipetes maclellandii</i>	Mountain Bulbul	0.00185					0.00031
<i>Lanius collurioides</i>	Burmese Shrike			0.00139			0.00031
<i>Megalaima asiatica</i>	Blue-throated Barbet		0.00028				0.00006
<i>Myiophonus caeruleus</i>	Blue Whistling Thrush		0.00139				0.00031
<i>Phylloscopus inornatus</i>	Inornate Warbler			0.00278			0.00062
<i>Pycnonotus aurigaster</i>	Sooty-headed Bulbul	0.03593		0.00417			0.00691
<i>Pycnonotus flavescens</i>	Flavescent Bulbul		0.09722	0.03611			0.02963
<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	0.24667	0.69444	0.00556	0.19222	0.43292	0.32491
<i>Pycnonotus melanicterus</i>	Black-crested Bulbul	0.27259	1.3875				0.35377
<i>Treron sphenura</i>	Wedge-tailed Pigeon		0.08472				0.01883
<i>Zosterops palpebrosus</i>	Oriental White-eye	0.00074					0.00012
Total		0.55963	3.22528	0.05417	0.19222	0.45028	0.95414

Most birds visited the trees to feed on fleshy fruits, except the Common Iora and Inornate Warbler, which foraged for insects, while Burmese Shrike and Blue Whistling Thrush only perched for a moment. Black-throated Sunbird visited *Heynea trijuga* to pick white arils and then flew out, only once.

*Aporusa octandra* (B.-H. ex D. Don) Vick. var. *octandra* (Euphorbiaceae) fruits during March to May. The fruit type is a septicidal capsule, light green-yellow when ripe. The fruit size is about 10 mm x 8 mm x 8 mm. The birds ate the fruits by using their bills to rip open the green epicarp and then pecked out the orange aril, including the seeds which were swallowed immediately. Whilst foraging for ripe fruit, some birds defecated. Most birds spent a few minutes feeding, ate about 1-4 arils, and then flew away. Red-whiskered Bulbuls often visited in flocks of 5-10 individuals for a few minutes. Sooty-headed Bulbuls often visited as individuals and fed for a few minutes. Black-crested Bulbuls visited in small flocks of 2-3 individuals, but spent the longest time in *Aporusa octandra* var. *octandra* compared with other bulbuls.

*Bischofia javanica* Bl. (Euphorbiaceae) fruits from June to February. The fruit type is a slightly fleshy globose drupe, brown-black when ripe. The fruit size is about 7-10 mm diameter. The birds ate whole fruits and some of them defecated while foraging. Red-whiskered Bulbuls often visited in large flocks of 10-15 individuals and spent a few minutes feeding. Puff-throated Bulbuls and Black-crested Bulbuls visited in smaller flocks of 3-7 individuals and spent a very long time in the tree. Wedge-tailed Pigeons visited the fruiting tree alone and spent 15-45 minutes feeding.

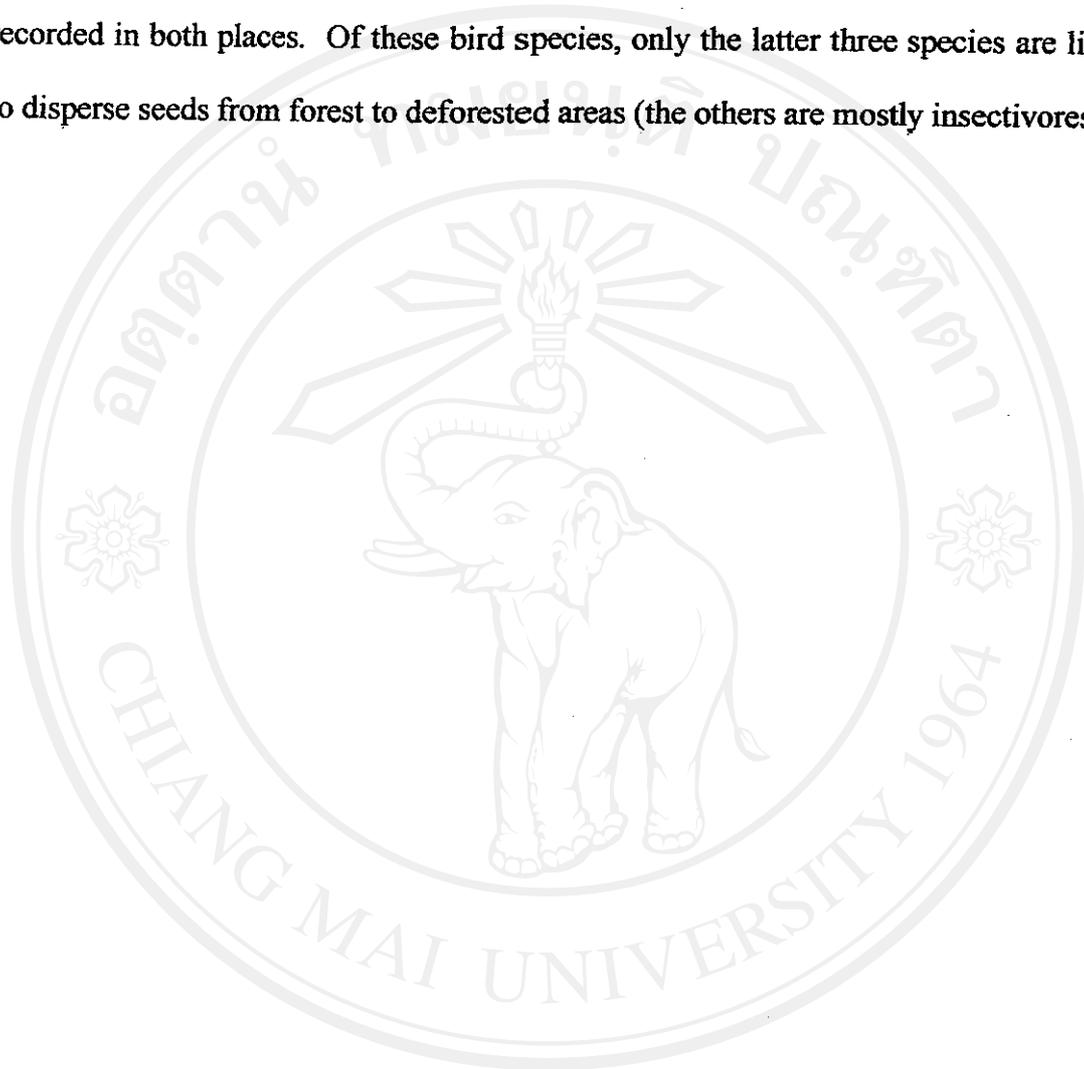
*Callicarpa arborea* Roxb. var. *arborea* (Verbenaceae) fruits from August to October. The fruit type is a globose drupe, dark purple when ripe. The fruit size is about 4 mm diameter. The birds ate whole fruits and some of them dropped faeces while perched in the trees. Most birds visited singly or in groups of 2-3 individuals. They usually spent 1-2 minutes feeding on the fruits.

*Debregeasia longifolia* (Burm. f.) Wedd. (Urticaceae) fruits from October to March. The fruit is an achene, surrounded by a fleshy receptacle, orange when ripe. The fruit size is about 5 mm diameter. I observed only Red-whiskered Bulbuls visiting this tree. The birds ate whole fruits. Large flocks of Red-whiskered Bulbuls visited this species, but usually separated into small groups of 2-3 whilst foraging. Visits were rare and usually last only a few minutes

*Heynea trijuga* Roxb. ex Sims (Meliaceae) fruits from August to December. The fruit type is a septicidal capsule, globose, fleshy, maroon when ripe. The fruit size is about 12-14 mm diameter. Red-whiskered Bulbuls and Puff-throated Bulbuls ate fruits by using their bills to peck at the white arils, but did not swallow seeds. Red-whiskered Bulbuls visited in large flocks of 10-15 individuals and spent about 4-8 minutes per visit. Puff-throated Bulbuls visited in smaller flocks of about 4 individuals and spent about 3 minutes feeding but were observed only once.

Birds attracted to fruiting trees in the forest were mostly different species to those observed in remnant trees in the deforested area. Although bird species recorded differed between forest and remnant trees, the following species: *Aegithina tiphia* (Common Iora), *Lanius collurioides* (Burmese Shrike), *Phylloscopus inornatus* (Inornate Warbler), *Pycnonotus aurigaster* (Sooty-headed Bulbul), *Pycnonotus*

*flavescens* (Flavescent Bulbul), *Pycnonotus jocosus* (Red-whiskered Bulbul) were recorded in both places. Of these bird species, only the latter three species are likely to disperse seeds from forest to deforested areas (the others are mostly insectivores).



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