CHAPTER 4

METHODOLOGY

Materials and Equipment (Figure 6)

1. Measuring tape (1.5 m and 50 m)

2. Plant press, newspapers, and cutters

3. Camera and film

4. Nails and hammer

5. PVC poles (30 cm) and Bamboo poles

6. Metal labels

7. Binoculars (8 x 10 mm)

8. Bird Guide (Lekagul and Round, 1991)

9. Altimeter (m)

Remnant tree species studied (Figure 7-13)

1. *Albizia chinensis* (Obs.) Merr. (Leguminosae, Mimosoideae)

2. *Callicarpa arborea* Roxb. var. *arborea* (Verbenaceae)

3. *Castanopsis diversifolia* (Kurz) King *ex* Hk. f. (Fagaceae)

4. *Erythrina stricta* Roxb. (Leguminosae, Papilionoideae)

5. *Eucalyptus camaldulensis* Dehnh. (Myrtaceae)

6. *Pinus kesiya* Roy. *ex* Gord. (Pinaceae)

7. *Schima wallichii* (DC.) Korth. (Theaceae)

Method

Study of tree seedling establishment

Tree selection for research

Seven species of remnant tree that were present in the deforested sites were chosen, based on various characteristics: six native species and one exotic species (*Eucalyptus camaldulensis* Dehnh.): different fruit types. They were isolated from other tree crowns and had no big trees beneath their crowns.

Sampling plots

A total of 102 plots, 51 beneath the trees studied and 51 in open areas, away from tree crowns were demarcated. Circular plots, dependent on the width of canopies of these trees, were established, along with control plots (containing no trees) nearby each tree. Fifty-one pairs of plots consisted of 6-pairs of both *Albizia chinenesis*-plots and *Erythrina stricta*-plots, 7-pairs of *Callicarpa arborea*-plots, and 8-pairs of *Castanopsis diversifolia*-plots, *Eucalyptus camaldulensis*-plots, *Pinus kesiya*-plots, and *Schima wallichii*-plots. The trees sizes and plots areas are listed in Appendix A.

Data collection

All naturally established tree seedlings present in each plot were surveyed, excluding seedlings from the remnant trees studied. Seedlings were labeled, identified, and classified according to their seed-dispersal method (by wind or animals). Furthermore, seedling heights were recorded to determine relative growth

rates. The first survey was made in the dry season, March-May 2000, and the second for measuring seedling height during the next dry season, March-May 2001. Seedlings were identified by comparing them with seedlings in FORRU nursery and with seedling vouchers in Chiang Mai University Herbarium. Unknown seedlings were identificied by J.F. Maxwell, curator of CMU Herbarium.

Bird observations

Bird observations in the remnant trees

Observations were made during March 2001 – May 2001 from the ground at about 15-30 m from each remnant tree. Observation periods were divided 4 daily periods, 0600-0900, 0900-1200, 1200-1500, and 1500-1800 hrs. using 8 x 40 binoculars. The bird species observed, number of birds, time of visit, and their behavior were recorded.

Bird observations in fruiting trees in intact forest

Observations of birds feeding in fruiting trees was done during March – December 2002. Observations were made from ground, about 15-20 m from fruiting trees in mature forest. Birds were observed for 3 hours in the morning and 3 hours in evening. The fruiting tree species, location, bird feeding species, number of birds, time of visiting (minute), and their behavior were also recorded.

Data analysis

Data were analyzed by 2 main methods. Ecological indices were calculated by using a basic computer program (Ludwig and Reynold, 1998). Secondly, data were analyzed using the Excel spreadsheet program and SPSS computer programs.

Ecological Indices

Ecological indices of tree seedlings consisted of species richness (N0), species diversity (N1, N2), and evenness ($E5$) were calculated for each plot by using the SPDIVERS.BAS programe. Resemblance in species composition among plots was also analyzed by similarity or distance coefficients.

Species/area curves

Calculations were done by using the Excel spreadsheet programe, which has the following formula.

$$S(a) = S - \sum_{i=1}^{S} (1-a)^{n_i}$$

where: $S(a)$ = expected number of species in a fraction (a) of the total area surveyed, (a = 0 to 1)

S = total number of species encountered

n_i = number of individuals of the ith species

Rarefraction

Calculation for rarefraction was made by RAREFRAC.BAS programe and created charts in Excel spreadsheet programe.

$$E(S_n) \ = \ \sum_{i=1}^{S} [\ 1 - (\frac{\binom{N-n_i}{n}}{\binom{N}{n}})\ ]$$

where:

$E(S_n)$ = number of species expected in a sample of n individuals

N = total number of individuals

S = total number of species encountered

n_i = number of individuals of the ith species

Species richness

N0 = Total number of species

Species diversity (Hill's number)

N1	=	$e^{H'}$
N2	=	$1/\lambda$

where: N1 = number of abundant species in the sample

N2 = number of very abundant species in the sample

H' = Shannon's index

λ = Simpson's index

Shannon's index (H')

$$H' = \sum_{i=1}^{s} p_i \ln p_I$$

Simpson's Index (λ)

$$\lambda = \sum_{i=1}^{s} p_i^2$$

where: p_i = proportion of individuals of the ith species

$$p_i = n_i / N$$

where: n_i = number of individuals of the ith species

N = total number of individuals

s = total number of species

Evenness (Modified Hill's index)

$$E5 = \frac{(1/\lambda) - 1}{e^{H'} - 1}$$

Similarity coefficient by Sorensen's index

Calculation was made by Excel spreadsheet program by using following formula.

$$\text{Sorensen's index} = \frac{2C}{A + B}$$

where: C   =   number of species found in both sampling units (SUs)

A   =   total number of species in the first SU

B   =   total number of species in the second SU

Difference coefficient by Chord Distance (CRD)

Calculation was made by using SUDIST.BAS program which the formular is:

$$CRD_{jk} = \sqrt{2(1 - c\cos_{jk})}$$

where: CRD_{jk} =   Chord distance between the jth SU and k^{th} SU

range from 0 to $2^{1/2}$

$c\cos_{jk}$ =   Chord cosine

$$c\cos_{jk} = \frac{\sum (X_{ij} X_{ik})}{\sqrt{\sum X_{ij}^2 . \sum X_{ik}^2}}$$

where: X_{ij} =   number of individuals of the ith species in the jth SU

X_{ik} =   number of individuals of the ith species in the kth SU

Statistical Analysis

Density (no./ m^2) and species richness (no.species/ m^2) of seedlings were tested for differences among pair-plots (beneath the studied tree crown and control) for each studied tree species and for each dispersal agent by using *t*-Tests with the Excel spreadsheet program. Non-parametric tests, the *Kruskal-Wallis* test and the *Mann-Whitney* test were used to test for differences among the studied tree species for each dispersal agent by using SPSS program. Regression analysis using in Excel spreadsheet program, was used to test for relationships between remnant tree size and seedling density.

Relative growth rate (RGR)

The relative growth rate (% RGR year^{-1}) of each individual tree seedlings was analyzed by using the height of seedlings.

$$RGR = \frac{[\ln h2 - \ln h1]}{[t2 - t1]} \times 100 \times 365$$

where: *h1*   =   height (cm) of seedling in first monitoring

             h2   =   height (cm) of seedling in last monitoring

             t2 - t2 =   number of days between the monitoring
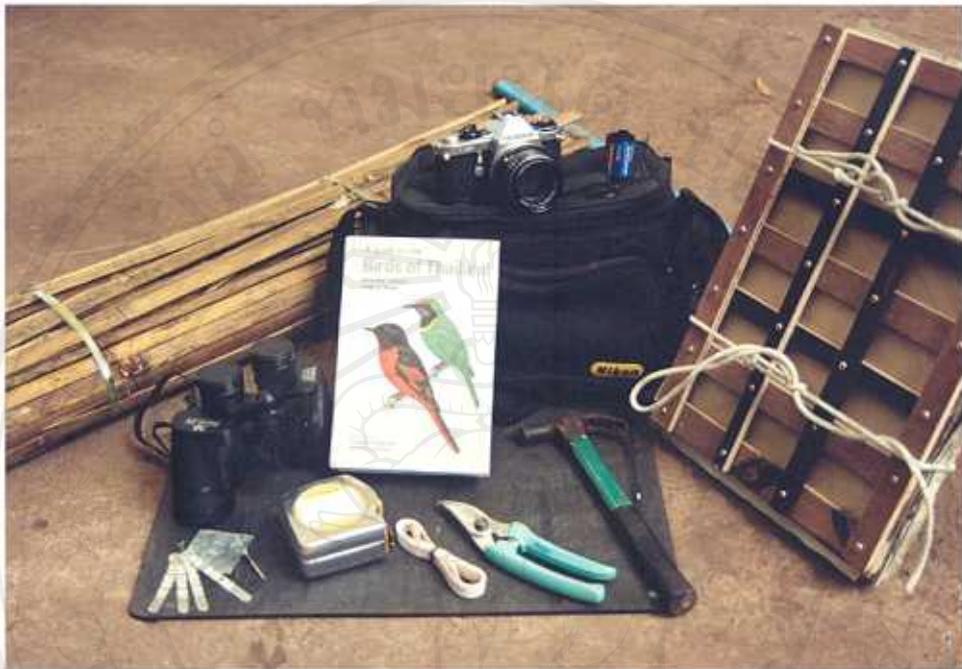
Figure 6   Materials and equipment

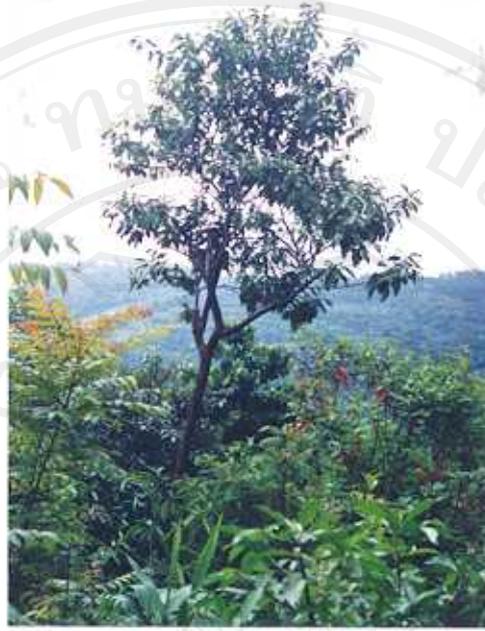Figure 7   *Albizia chinensis* (Obs.) Merr. (Leguminosae, Mimosoideae)

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Figure 8   *Callicarpa arborea* Roxb. var. *arborea* (Verbenaceae)

Figure 9   *Castanopsis diversifolia* (Kurz) King *ex* Hk. f. (Fagaceae)

Figure 10   *Erythrina stricta* Roxb. (Leguminosae, Papilionoideae)

Figure 11   *Eucalyptus camaldulensis* Dehnh. (Myrtaceae)

Figure 12   *Pinus kesiya* Roy. *ex* Gord. (Pinaceae)

Figure 13   *Schima wallichii* (DC.) Korth. (Theaceae)