Comparative Study on Seed Dispersal and Tree Seedling Diversity Between a Natural Forest and a Restored Forest Area in Mae Rim District, Chiang Mai

Atcharawan Saeaiew[a], Titaree Yamsri[a], Chrismas Kerdsak[a*], Alice Sharp[b], and Pimonrat Tiansawat[a]

[a]Department of Biology, Chiang Mai University, 239, Huaykeaw Road, Suthep Sub-District, Muang District, Chiang Mai 50200, Thailand
[b]Environmental Science Research Center, Chiang Mai University 239, Huaykeaw Road, Suthep Sub-District, Muang District, Chiang Mai 50200, Thailand

Abstract

Accelerating forest regeneration in degraded areas is one of the essential tasks to mitigating global climate change. Natural regeneration can occur if seeds from the neighboring forest disperse to degraded areas, germinate, and thrive. The study compared seed rain and tree seedling diversity in natural and adjacent5-year-old restored forests in Mae Rim District, Chiang Mai. From January to September 2021, to ensure that data collection covers both wet and dry seasons, ten hanging-mesh seed traps were installed in each site, and seeds deposited in the traps were collected and identified once a month. Tree seedling diversity was carried out by establishing three 10-m-diameter circular plots in each site. Natural seedlings ranging in height from 10 to 100 cm were recorded and identified. The seed trap experiment shows seeds of eight tree species in the natural forest and two species in the restored forest. Similarity seeds found in both sites show that 20% of the seed species can disperse from natural forests to neighboring areas. The study of seedlings in both sites revealed 23 species in the natural forest and 11 species in the restored forest. When the species found in seed traps and seedling surveys were compared, six species were the same in the natural forest and one in the restoration plot, resulting in a 30% and 15% similarity index, respectively. These findings imply that natural regeneration in restoration forests is slower and less diverse than natural forests. As a result, additional intervention such as planting native tree seedlings and regular weeding may be required to speed up the regeneration process.

Keyword: Forest restoration/ Seed dispersal/ Seedling/ Seed trap/ Similarity index/ Circular plot

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*Corresponding Author: Chrismas Kerdsak, Tel: +66854747259
E-mail address: chrismas_k@cmu.ac.th

1. Introduction

Agricultural expansion is the primary cause of forest destruction and degradation, causing forest biodiversity to decline (FAO, 2020). Chiang Mai Province is still dealing with deforestation to convert the land for occupations and residence. Some communities in Chiang Mai Province's Mae Rim District, for example, burn down forests and encroach on arable land. Consequently, the forest area has been significantly reduced. As a result, the forest must be restored (Ratchapruek Institute Foundation, 2012). Forest restoration aims to restore biomes, biodiversity, and ecological processes (Silva et al., 2015).

One of the most critical factors in biodiversity conservation is seed dispersion (Traveset et al., 2008). Also, seed production, germination, and seedling survival are essential in maintaining plant populations (Almeida and Galetti 2007; Harper 1977; Hille Ris Lambers and Clark 2003; Jordano 2000; Levine and Murrell 2003). Plants develop various mechanisms for dispersing seeds from the parent plant. These are wind-dispersed, water-dispersed, gravity-dispersed, explosion-dispersed, and zoochory-dispersed (Stoner & Henry, 2005). These mechanisms allow seeds to disperse directly into appropriate locations (Wenny and Levey, 1998).

The goal of this study was to compare seed and seedling distribution in natural and rehabilitation forests. In addition, the study aims

to determine whether the environment in the disturbed area is capable of natural regeneration.

2. Methodology

The study was carried out in the Mon Jam area (18°56'16.8" N, 98°49'12.0" E), Mae Rim District, Chiang Mai Province. The forest in this area is an evergreen forest. The site is 1,300-1,420 meters above sea level, with an average temperature of about 23 degrees Celsius all year and an average rainfall of 1,314 millimeters per year (Nong Hoi Royal Project Development Center, 2019). The natural forest plot and reforestation plot are adjacent with an area of 3,277 and 1,058 square meters, respectively. Figure 1 depicts the location of the study sites and their characteristics.

Figure 1. Location of study sites. (a) Map of Mae Rim District; (b) natural forest; and (c) reforestation area.

2.1 Seed dispersal

Place ten seed traps in each area. The seed trap used is a hanging mesh trap with a seed receiving area of 50×50 cm nylon net. The legs were constructed from 100 cm long PVC pipes (Figure 2). In each area, seed traps were placed 5 meters apart. The GPS coordinates were saved. Once a month, seeds deposited in the trap were removed for laboratory analysis.

Figure 2. Hanging mesh seed trap

2.2 Tree seedling

A Circular Sampling Unit (CSU) was used to collect seedling data. Each area has three CSUs. Each CSU had a diameter of 10 m. (5 m radius). The seedlings that germinated naturally in each circular plot were identified, and their heights were measured. The seedlings must be between 10 and 100 centimeters in height.

2.3 Data analysis

2.3.1 Similarity index

The Sorensen's Similarity Coefficient (Krebs, 1999) was used to calculate the similarity index. The formula is as follows.

$$\text{Sorensen Coefficient} = 2C \times 100 / A + B$$

Where; A=No. of species found in area 1; B=No. of species found in area 2; C=No. of species found in both areas

2.3.2 Seedling density, D

The total number of seedlings counted is divided by the total area surveyed to determine the mean seedling density.

2.3.3 Seed and seedling identification

Seeds and seedlings were identified following the "Tree Seeds and Seedlings for Restoring Forests in Northern Thailand" (FORRU, 2000) and "A Field Guide to Forest Trees of Northern Thailand" (Gardner et al., 2007).

3. Results and Discussion

According to the seed dispersal and seedling survey, a total of 8 seeds species and 26 seedling species were discovered in the natural forest area. A total of 2 species of seeds and 11 species of seedlings were found in the reforestation area. Seed dispersal results can be found in Table 1.

Table 1. Seed species found in seed traps.

Species found in natural forest	Species found in the restoration area	Similarity
Schima wallichii	*Prunus cerasoides*	Sorensen Coefficient=20%
Dalbergia cultrata	*Engelhardia spicata*	
Castanopsis diversifolia		
Engelhardia spicata		
Lithocarpus polystachyus		
Lannea coromandelica		
Phoebe lanceolata (Wall. ex Nees) Nees		
Quercus lamellosa		

Eight types of seeds were found in the natural forests, two in the reforestation area. Only one species can be found on both sites, *Engelhardia spicata*. Seeds of *Engelhardia spicata* are wind-dispersed. Therefore, it is possible that the seeds were dispersed from the nearby natural forest into the restoration area. When comparing the seed dispersal similarity between the two forests, the two sites have a similarity coefficient of 20%.

The results of the tree seedlings study in both forest areas revealed that 270 seedlings from 23 species were found in the natural forest area, while 134 seedlings from 11 species were found in the restored forest area. In terms of seedling density, a natural forest has 1.145 seedlings per square meter, while a restored area has 0.568 trees per square meter. When comparing the similarity index of the two forests' seedlings, the seedling species discovered had a similarity index of 55 percent. The seedling species found in both areas are shown in Table 2. Most of the seedlings found in the natural forest can thrive and grow well. Appropriate physical conditions include temperature, light, hydrology (such as rainfall and soil moisture), and infrequent events that reshape ecological systems, such as fires and storms, encourage seedling growth.

The comparison between seed and tree seedlings found in each site revealed that six species were similar in the natural forest area and one in the restoration area, with the similarity index of 30 and 15 percent, respectively. The higher number of seeds/seedlings found in the natural forest may be due to the capacity to produce seeds together with the favorable physical conditions for seed germination and seedlings growth.

Table 2. Seedling species found in the study areas.

Species found in natural forest	Species found in the restoration area	Similarity
Schima wallichii	*Prunus cerasoides*	Sorensen Coefficient=33%
Dalbergia cultrata	*Litsea glutinosa (Lour.) C.B. Rob.*	
Castanopsis diversifolia	*Bauhinia variegata Linn.*	
Lithocarpus polystachyus	*Glochidion kerrii*	
Phoebe lanceolata (Wall. ex Nees) Nees	*Castanopsis diversifolia*	
Quercus lamellosa	*Michelia Floribunda*	
Aporusa villosa	*Phoebe lanceolata (Wall. Ex Ness)Ness*	
Helicia nilagirica	*Eurya acumminata*	
Wendlandia tinctoria	*Alangium kurzii*	
Antidesma bunius	*Eugenia fruticosa*	
Glochidion acuminatum	*Syzygium claviflorum (Roxb.) A.M.Cowan & Cowan*	
Castanopsis acuminatissima (Blume) A.DC.		
Lithocarpus elegans		
Castanopsis argyrophylla		
Prunus cerasoides		
Elaeocarpus lanceifolius		
Alstonia scholaris		
Anneskea fragrans		
Litsea glutinosa (Lour.) C.B. Rob.		
Syzygium claviflorum (Roxb.) A.M.Cowan & Cowan		
Gluta obovata Craib		
Eugenia fruticosa		
Decaspermum parviflorum		

4. Conclusions

Tree seeds can be dispersed to the adjacent area. However, the ability to disperse may be limited by several factors: distance from the forest's edge, the seed's shape, size, and dispersal mechanism. Even when the seed can disperse into the degraded area, it does not guarantee the germination and survival of seedlings. Other environmental factors may influence seedling germination and growth. More research should be done on the factors that limit seed germination and seedling growth. Climate, seed predators, seed dispersers, and seasonal influence may be investigated further. Additional intervention such as planting native tree seedlings and regular weeding may be required to speed up the restoration process.

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