SEED DISPERSAL MECHANISMS OF FLORA IN THE FORESTS OF DOI SUTHEP-PUI NATIONAL PARK CHIANG MAI, THAILAND

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INTRODUCTION

I chose to do this project because a great deal of data about forest ecosystems is needed for scientific research, which additionally can lead to more successful methods of restoring degraded forest areas in Thailand. At the Biology Department, Chiang Mai University, staff and students are currently carrying out some of the research that will be needed, using Doi Suthep-Pui National Park as a study site. They are investigating ways to germinate tree seeds and rear seedlings; studying the annual cycles of leaf, flower and fruit production of trees growing on Doi Suthep; and investigating pollination and seed dispersal mechanisms. They are also investigating which soil and climatic factors determine the distribution of different tree species, so that they will be able to provide advice as to which tree species should be planted at each particular site, in forest restoration projects. My efforts, plus those of other people's will hopefully produce a better understanding on how the whole forest ecosystem functions.

In my part of the scientific research, I chose to study the seeds of trees and their dispersal mechanisms (animals, wind, water, etc) which ultimately affect the survival of tree species in the forest ecosystem. The purpose of my project was to gather data about the prevalence of seed dispersal mechanisms in three forest-types on Doi Suthep. I chose Doi Suthep as a study site because it has exceptionally high biological diversity (biodiversity) for a dry tropical forest and matches that of some tropical rain forests. Specifically, I investigated what seed dispersal mechanisms exist and which ones are most dominant in

each forest-type: Deciduous Dipterocarp-Oak forest, "Mixed" Deciduous-Evergreen forest, and Primary Evergreen forest.

The high biodiversity of Doi Suthep has attracted scientists since 1901, making Doi Suthep's forest one of the most intensely studied in Thailand.[23] In just four years of collecting, Mr. J.F. Maxwell, a botanist from Chiang Mai University has found nearly 2,000 species of flowering plants and ferns on Doi Suthep.[13]

Doi Suthep has also been important as a field site for the study of birds (Deignan, 1945; Dickinson & Chaiyaphun, 1987; Round, 1984; Beaver & Sritasuwan, 1988), reptiles and amphibians (Nabhitabhata, 1987) and insects (Malicky, 1987; Banziger, 1985; Banziger & Fletcher, 1988).

There are at least 275 plant species (Maxwell) and 60 animal species (Banziger) for which Doi Suthep is the type locality. The final total may be nearly 400 species. In spite of Doi Suthep's long history of scientific research, new species continue to be discovered there every year. Among Mr. Maxwell's plant collection are at least two species new to science, while Dr. Banziger, an entomologist at the Faculty of Agriculture, Chiang Mai University, has discovered 11 new moth species from Doi Suthep since 1987.[15]

This high biodiversity may be due in part to Doi Suthep's geographical location. Its position on the boundary of the Himalayan and Indo-Malesian biogeographical realms means that Doi Suthep's flora and fauna contain representatives of both; temperate species from the north and equatorial species from the south. The wide range of elevation found in the park imposes an

overall gradient in climate from cool and wet near the summit to hot and dry near the base of the mountain. The severe topography also creates a wide range of niches, varying in exposure to sun, wind, and rain within a small area. Therefore, it is hardly surprising that a wide range of different organisms are present to exploit this wide range of niches.[16]

As the remaining forest in northern Thailand rapidly disappears, Doi Suthep will become increasingly more important as an area where ecologists can carry out the essential research that will be needed to manage forest surviving in protected areas for conservation and to restore native forest to degraded areas. In particular, the high tree species richness could play an important role in forest restoration projects. Compared with other regions of Thailand, the north has suffered least from deforestation. Even so, between 1961 and 1985, the region lost 28% of its forest. (Thailand Development Research Institute, 1987) In Chiang Mai Province, the area of deforestation doubled in the ten years between 1975 and 1985 from 323,458 hectares to 651,302 hectares. (Global Resource Information Database, 1988) At this rate, there will be little forest left in about 10 years. Inside protected areas, attempts should be made to restore the original forest ecosystem, rather than to establish monocultures of pines or eucalypts. Doi Suthep, with its many tree species, suited to a wide range of soil and climate conditions, could provide a valuable seed source for the use of native tree species in forest restoration projects. However, planting seeds does not make a forest. In order to restore forest to degraded areas within national parks and wildlife sanctuaries, research must be

carried out in relatively undisturbed forest.[15]

STUDY SITE

To the west of Chiang Mai City lies Doi Suthep, which covers an area of 261 km^2 and was designated a national park in 1981. The elevation ranges from 350 to 1685 meters above sea level. The bedrock of the park is mostly granite with some shale in a few places in the southern and western parts. (Maxwell, 1988) Soils are generally deep and highly weathered, ranging from coarse grey sands on dry ridges to red-brown loams in gullies. Rainfall varies from about 1,000mm per year at the base of the mountain to about 2,000mm per year near the summit, with a marked dry season from December to March when there is usually little or no rain. Temperatures also vary with elevation, ranging from 5 degrees Celsius in January to 35.5 degrees Celsius in March near the summit and from 9.2 degrees Celsius in November to 40.3 degrees Celsius in March near the base of the mountain. (Meteorological Dept., Bangkok)[16]

Deciduous Dipterocarp-Oak forest

Deciduous forest is found from the base of the mountain up to elevations of 900-1,000m above sea level. The deciduous forest is composed of widely spaced trees, rarely exceeding 15m tall, with a ground vegetation mostly of grasses and sedges. Common trees include members of the Dipterocarpaceae (e.g. Dipterocarpus obtusifolius, D. tuberculatus, Shorea siamensis and Shorea obtusa) and Fagaceae (e.g. Lithocarpus sootepensis, Quercus aliena, and Quercus kerrii). Above about 400m elevation and in particularly dry areas, trees such as Tristania rufescens

(Myrtaceae), Wendlandia tinctoria (Rubiaceae), Craibiodendron stellatum (Ericaceae), and Aporusa villosa (Euphorbiaceae) are also common. These tree species are mostly deciduous and the forest is largely leafless from January to mid-April. Fallen leaves and dried grass at this time of the year provide a perfect fuel for fires, which burn throughout the dry season. Many plants and smaller animals appear able to survive moderate litter fires. However, if fires are too frequent or too severe, they may threaten the long term survival of the forest by destroying tree seedlings and wiping out animal species unable to move away from the approaching flames.[16] A picture of deciduous forest is shown in Fig. 1.

"Mixed" Deciduous-Evergreen forest

The "mixed" deciduous forest occurs in moister areas, intermixed with the deciduous dipterocarp-oak forest. The trees are generally taller, about 20-30m high, than those of the deciduous forest, and the canopy is more or less closed except during the dry season. The "mixed" deciduous forest is transitional between evergreen and deciduous forests and includes many evergreen species such as Dipterocarpus costatus (Dipterocarpaceae), one of the tallest tree species on the mountain, easily recognizable by it long, straight, light grey trunk, compact crown and grey-green foliage. A very wide range of tree species grow in the "mixed" deciduous forest, none of which dominates, and many have very beautiful flowers e.g. Bauhinia variegata (Leguminosae, Caesalpinioideae) and Metadina trichotoma (Rubiaceae). A great many woody climbing plants called lianas grow in "mixed" deciduous forest e.g. Spatholobus parviflorus (Leguminosae,

Papilionoideae). Such plants reach the light above the forest canopy by hitching a ride on a larger tree. They save energy by not having to grow woody trunks and branches to support their weight and can therefore grow much faster than ordinary trees. 16
One picture of "mixed" deciduous forest is shown in Fig. 2, and a picture of both the deciduous and "mixed" deciduous separated by a dry stream is shown in Fig. 3.

The "mixed" deciduous forest supports a wide variety of birds, including scarlet-backed flowerpeckers (Dicaeum cruentatum), common tailorbirds (Orthotomus sutorius), long-tailed shrikes (Lanius schach), lineated barbets (Megalaima lineata), at least six different species of bulbul and many others.[4]

The mammal species of the "mixed" deciduous forest include animals such as the Indochinese ground squirrel (Menetes berdmorei) and the Burmese ferret-badger (Melogale personata), which is still quite common, though rarely seen because it is active only at night, spending the daytime in a burrow. Most of the other animals active only at night are bats. Doi Suthep is home to no fewer than 21 bat species. The short-nosed fruit bat (Cynopterus brachyotis) occurs, fluttering through the tree canopy in search of fruit.[4]

Primary Evergreen forest

At about 1,000m elevation, evergreen trees become more common and deciduous species [illegible]. The trees are taller (35-50m high), the canopy denser, and it is cool and shady. The soil changes from a hard-baked, brick-red to a rich, dark brown. This

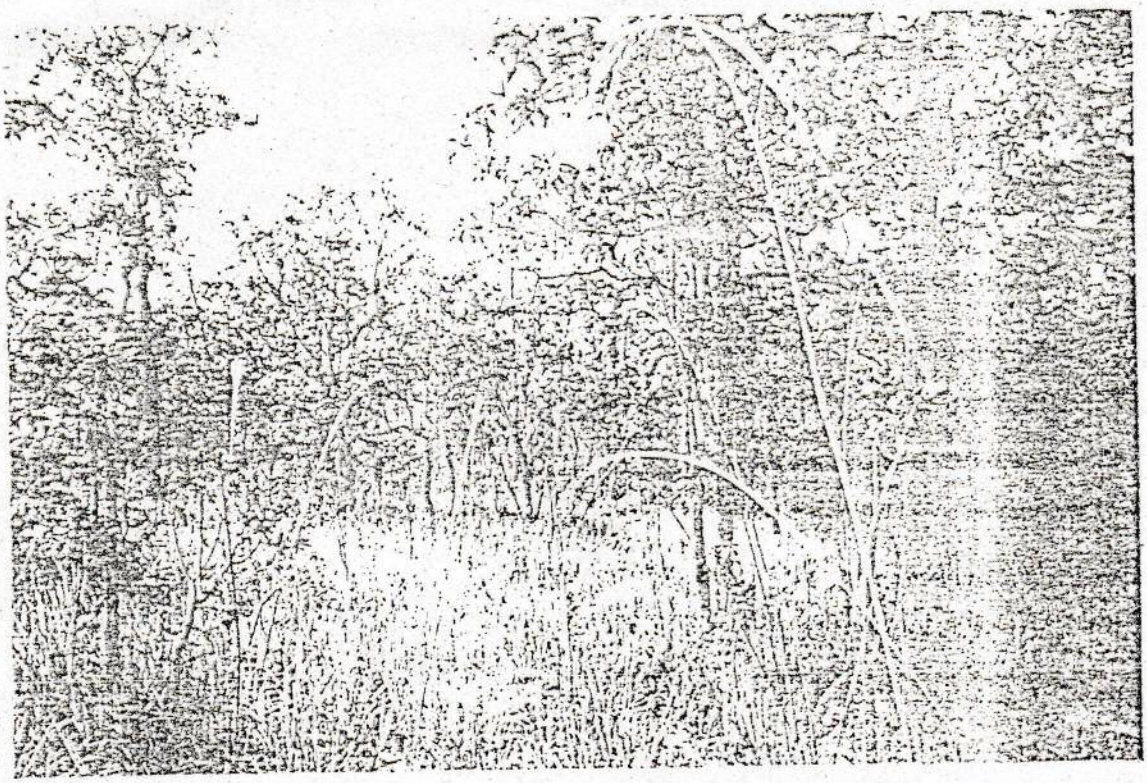


Fig. 1 Deciduous Dipterocarp-Oak forest (Nov 1991)

Fig. 2 "Mixed" Deciduous-Evergreen forest (Nov 1991)

Fig. 3 A dry stream between the Deciduous and "Mixed" Deciduous forests (Nov 1991)

Fig. 4 Primary Evergreen forest (Dec 1991)

Fig. 5 Primary Evergreen forest at the summit (Dec 1991)

soil is more efficient at holding water and retains moisture for longer, compared with the deciduous forest soil. Therefore the trees have less need to shed their leaves to conserve water and so the forest can remain more or less green throughout the dry season.[28] The evergreen forest contains a great variety of tree species. Although no species become dominant, trees of the families Magnoliaceae (e.g. Talauma hodgsonii and Michelia champaca) and Fagaceae (e.g. Lithocarpus elegans and Castanopsis tribuloides) are characteristic. Sarcosperma arboreum (Sapotaceae), Metadina trichotoma (Rubiaceae), Turpinia pomifera (Staphyleaceae), and Baccaurea ramiflora (Euphorbiaceae) are also characteristic. The canopy is dense, and consequently, the undergrowth is rather sparse, consisting mainly of tree saplings and shade-tolerant shrubs.[28] A picture of the evergreen forest is shown in Fig. 4.

Near the summit, the evergreen forest changes somewhat in character. The trees become stunted perhaps due to wind chill, and they support a dense epiphytic flora of lichens, ferns, orchids and other flowering plants.[28] A picture of the evergreen forest at the summit is shown in Fig. 5.

Doi Suthep's evergreen forest provides an important stop-over for birds during their annual migrations. Many birds stop to feed there before resuming their travels e.g. grey nightjar (Caprimulgus indicus), slender-billed oriole (Oriolus tenuirostris) and orange-flanked bush-robin (Tarsiger cyanurus). Thus Doi Suthep is important not only for local birds but also for birds which may nest in distant countries. Some of Doi Suthep's more colorful resident bird species of the evergreen

forest include irridescent green pigeons (Treron sp.), barbets (Megalaima sp.), leafbirds (Chloropsis sp.), orange and black minivets (Pericrocotus sp.), broadbills (Serilophus lunatas), and tiny blue flycatchers (Ficedula sp.). Birds are not the only flying animals in the evergreen forest. Lizards glide from tree to tree, landing with a splat on tree trunks, their camouflaged skins rendering them instantly invisible, until they move. Tiny grey squirrels (Petinomys setosus) also avoid the descent to the forest floor, where predators lurk, by gliding between trees on membranes stretched between their fore and hind legs. The evergreen forest is home to seven non-flying squirrel species e.g. the belly-banded squirrel (Callosciurus flavimanus) easily recognizable by a bright orange patch on its abdomen.[4]

Doi Suthep is a last refuge for many species near extinction. Of the 250 or so orchid species found, fifty of them have been declared by the International Union for the Conservation of Nature as endangered, threatened or rare. Seven of them are found nowhere else in the world. (Banziger, 1987) The crocodile salamander (Tylotriton verrucosus), an amphibian, and birds including, the giant nuthatch (Sitta magna), silver pheasant (Lophura nycthemera), wedge-tailed green pigeon (Treron sphenura), Jerdon's Baza (Aviceda jerdoni), fire-capped tit (Cephalopyrus flammiceps), five species of thrush (Turdus sp.), rufous-faced warbler (Abroscopus albogularis), pygmy blue [illegible] (Muscicapella hodsoni) and Tristram's [illegible] (Amberiza tristrami) are endangered with extinction. (Conservation Data Center, Bain & Humphrey, 1982)

Unfortunately, all of Doi Suthep's larger animals are known to be extinct including stump-tailed macaques (Macaca arctoides), common palm civets (Paradoxurus hermaphroditus), leopard cats (Felis bangalensis), porcupines (Hystrix brachyura and Atherurus macrourus), barking deer (Muntiacus muntjak), and slow loris (Nycticebus coucang).[4]

Yet Doi Suthep is still rich with species of plants and wildlife. Animal species include at least 326 birds (Round, 1984), 500 butterflies (Pinratana, 1977-1985), 300 moths (Banziger, 1988), 61 mammals (Conservation Data Center, Stephen Elliott, 1989), 28 amphibians and 50 reptiles (Nabhitabhata, 1987), all in a national park which covers just 261 square kilometers. In comparison, at Khao Yai National Park, which is ten times larger than Doi Suthep, and should therefore contain many more species, only 206 butterfly (Banziger, 1988) and 318 bird species (Conservation Data Center, 1989) have so far been recorded.[4]

METHODS

To record data from the whole community is virtually impossible, but small samples (quadrats or plots) may be selected for detailed analysis. Such samples must, however, be representative of the community as a whole. Each sample should be taken at random.[50]

Due to a limited period of time to finish the project and for sheer convenience, I used existing study sites as samples which had tree positions already recorded and labelled by the staff and students of the Dept. of Biology, Chiang Mai University for other on-going research projects on the forests of Doi

Suthep. Since the study sites were determined by a compass bearing, regardless of any physical or biological features of the forest, the sample may be regarded as effectively random. (Causton, 1988, p. 16)

The total area of the study sites in the deciduous forest was 5050 m^2 while in the "mixed" deciduous, the total area of the study sites was 6370 m^2. The study sites were: a 1.38 km long transect using 29 contiguous quadrats for the deciduous forest and 40 contiguous quadrats for the "mixed" deciduous forest, with each quadrat measuring 20 m long and 6 m wide (area= 120 m^2) at a location, starting just below Prataht Doi Suthep Temple at 960 m elevation following a compass bearing of 76 degrees to a point just above Palant Temple at 670 m elevation; and 40 contiguous circular plots (20 plots each in the deciduous and the "mixed" deciduous) with a 10 m diameter each plot (area= 78.5 m^2) at a location near the Chiang Mai University Observatory at approximately 800 to 850 m elevation. Circular plots were used for conveniency without sacrificing accuracy.[16]

The total area of the study sites in the evergreen forest was 2770 m^2. The study sites were: an upper transect consisting of five contiguous quadrats at an elevation of 1070 m and a lower transect of five contiguous quadrats at an elevation of 1050 m, with each quadrat measuring 20 m long and 6 m wide (area= 120 m^2) at Chang Kian Valley, southern end near Doi Suthep National Park Headquarters; and 20 contiguous circular plots with a 10 m diameter each plot (area= 78.5 m^2) at a location called Ru-see Valley at approximately 1000-1100 m elevation.

In all the study sites, a central line was marked out using a tape measure, and all trees and woody climbers of girth at breast height (gbh) > or = to 10 cm within 3 m on either side of the tape measure were recorded and labelled with metal tags. 16

Nonetheless, field expeditions were done to confirm identifications of tree individuals and to identify ones that were still unidentified due to reasons such as: lack or insufficient visibility to see tree's leaves, flowers or fruits; or lack of access to collect specimens (leaves, flowers, or fruits) for positive identification. Although much progress was done to identify all of the tree individuals, three tree individuals are still labelled "unknown": one in the "mixed" deciduous forest and two in the evergreen forest. Since there were only a few individuals unidentified, this did not affect the results of my research dramatically. Even so, I noted them in Appendix 1. Specimens of all species were deposited at the Herbarium, Faculty of Pharmacy, Chiang Mai University.

RESULTS

Density may be used in assessing the abundance of the various species present in a study site. Density is the number of individuals per unit area. The number of individuals of each species is recorded and can easily be converted into any area (m^2, ha, acre, etc.) so that results obtained from study sites of different area can be readily compared. 50,24

Densities for each tree species, recorded at study sites in all three [illegible] in Appendix 1. The unit area of density is per hectare.

Species diversity may be thought of as being composed of two

components. The first is the number of species in the community, which ecologists often refer to as species richness. The second component is species evenness or equitability. Evenness refers to how the individuals are distributed among the species. For example, in a community composed of ten species, if 90% of the individuals belong to a single species and the remaining 10% are distributed among the nine other species, evenness would be considered low. On the other hand, if each of the ten species accounted for 10% of the total number of individuals, evenness would be considered maximum.[26]

A number of indices have been proposed for characterizing species richness and evenness. Such indices are termed richness indices and evenness indices. Indices that attempt to combine both species richness and evenness into a single value are referred as diversity indices.[26]

It would appear that an unambiguous and straightforward index of species richness would be S, the total number of species in a community. However, since S depends on the sample area size or on the number of individuals counted, it is limited as a comparative index. (Yapp, 1979)

Because the densities of the species and the total area for each study site are known, it is possible to compute an idealized or expected species-area curve for each forest-type under the assumption of random dispersion of all species in each forest-type.[26]

The mean and variance of the expected number of species in a given fraction, a, of the total area, given known densities of

the species in the total area, can be derived by a simple statistical equation, as Coleman (1979)[10] has shown. Let S be the total number of species in the entire area, in which there are n(i) individuals of the ith species. Then the probability that the species i is absent from fractional subarea, a, is given by: $(1 - a)^{n(i)}$. Since the species are assumed to be independently distributed under the null hypothesis, the mean (s) and variance (v) of the number of species expected in fractional area, a, are given by:

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

$$v(a) = \sum_{i=1}^{S} (1 - a)^{n(i)} - \sum_{i=1}^{S} (1 - a)^{2n(i)}$$

An idealized or expected species-area curve of each forest-type is shown together in Fig. 6. Since the idealized species-area curves have different total areas, an area size of A= 2770 m^2 was used as the standard, corresponding to the smallest area size of all three forest-types. This is illustrated on the graph as the vertical dashed line at A= 2770m^2. At this area size, the three forests can be ordered in terms of their species richness. "Mixed" deciduous has the highest richness, with an expected species number of 149; evergreen has the next highest richness, with an expected species number of 77; and deciduous has the lowest richness, with an expected species number of 65.

Additionally, a number of indices have been proposed to measure species richness that are independent of the number of individuals counted. They are based on the relationship between S and the total number of individuals observed, n, which increases with increasing sample individual size, but these indices are of limited use.[26]

Thus, an alternative to richness indices is to use direct counts of species numbers in samples of equal size. In situations where sample individual sizes are not equal, a statistical method known as rarefraction may be used to allow comparisons of species numbers between communities (Hulbert, 1971; Sanders, 1968). To use the rarefraction method, one assumes that sample size biases or sampling differences between communities can be overcome by some underlying sampling model that applies to all communities concerned. An example of such a model is shown below.

Hulbert (1971)[20] shows that the number of species that can be expected in a sample of n individuals [denoted by $E(S_n)$] drawn from a population of N total individuals distributed among S species is:

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

where n_i is the number of individuals of the ith species. In words, this equation computes the expected number of species in a random sample of size n as the sum of the probabilities that each species will be included in the sample.[26]

An idealized species-individuals curve of each forest-type is shown together in Fig. 7. Since the idealized species-individuals curves have different sample sizes, a number of individuals of I= 238 was used as the standard, corresponding to the smallest sample size of all three forest-types. This is illustrated on the graph as the vertical dashed line at I= 238. At this sample size, the three forests can be ordered in terms of their species richness. "Mixed" deciduous has the highest

Fig. 6 Idealized Species-area Curve of each forest-type on Doi Suthep

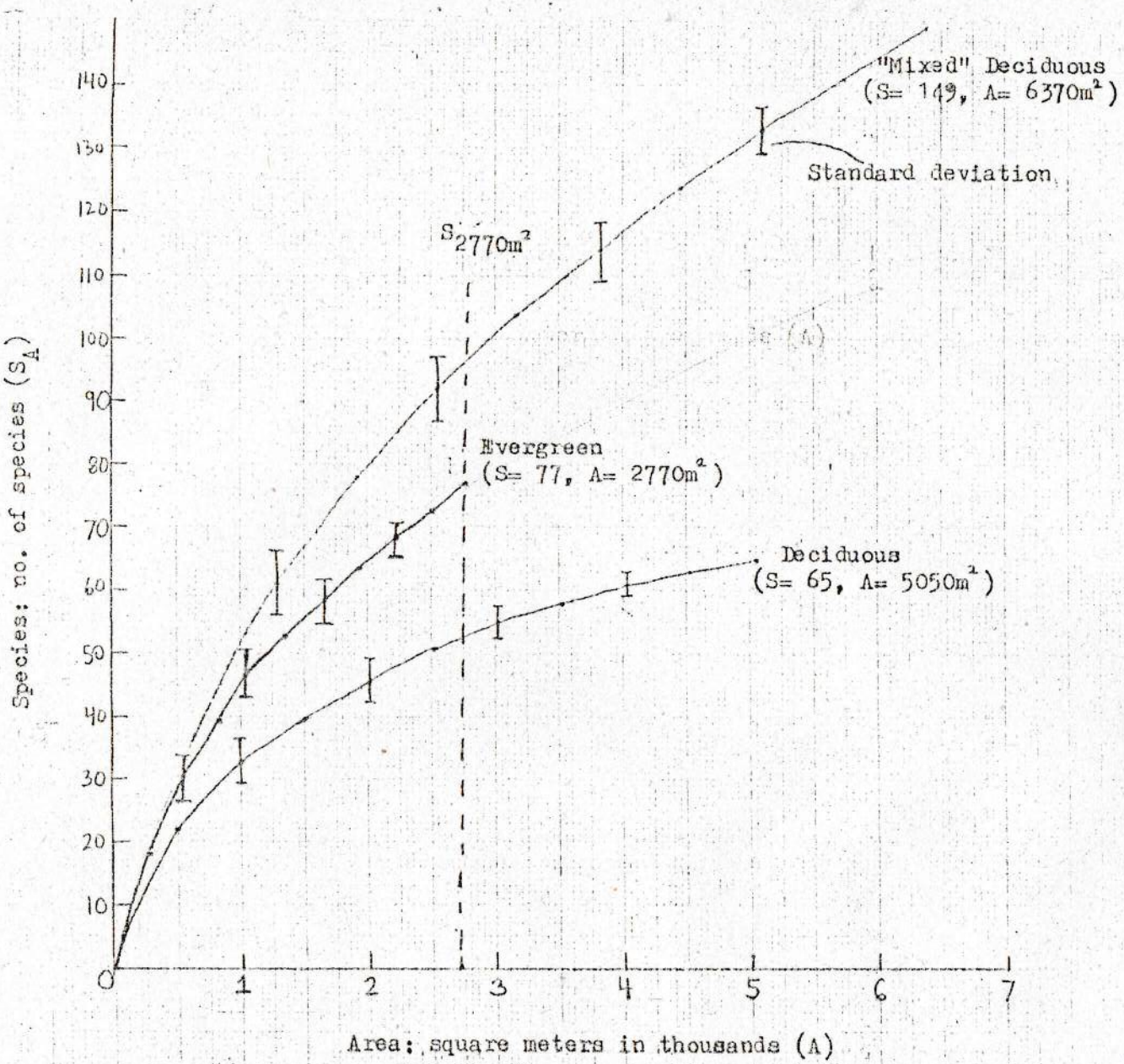
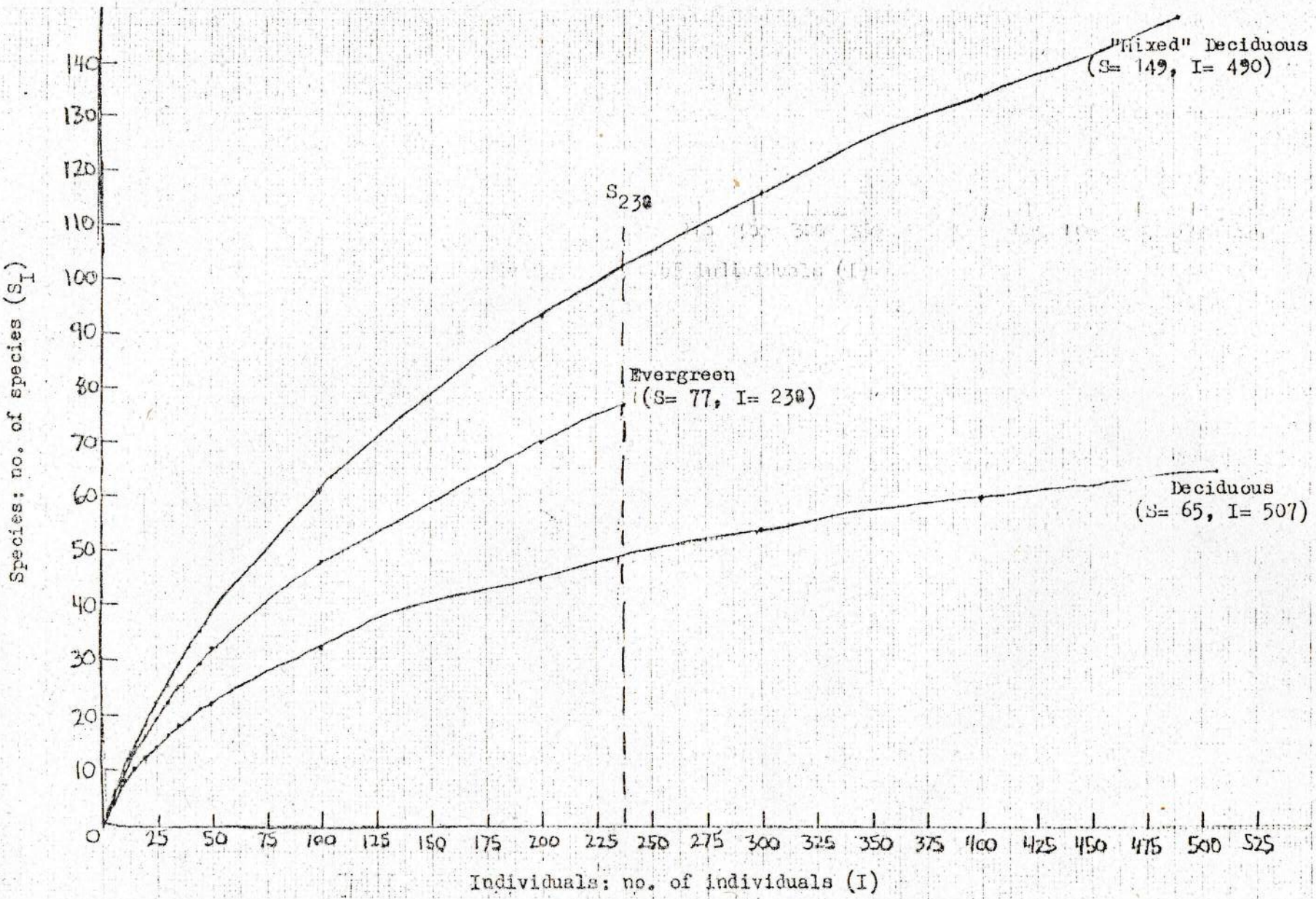


Fig. 7 Idealized Species-individuals Curve of each forest-type on Doi Suthep



richness, with an expected species number of 149; evergreen has the next highest richness, with an expected species number of 77; and deciduous has the lowest richness, with an expected species number of 65.

Rarefraction methods are preferred over the simple richness indices available when community sample sizes differ, and it appears to have potential as a richness measure. However, Peet (1974) shows that for two communities possessing very different number of species and relative densities, rarefraction may predict that both communities have the same number of species at small sample sizes. Thus, when using this method, it is assumed that the communities being studied do not differ in their species-individuals relationships. Thus, while the use of rarefraction in species counts are useful, one should be aware of the limitations of any diversity method.[33]

Both species-area and species-individuals were done instead of doing just one because both types of curves combined give not only a verification check of the results of both but also are different methods of showing further supporting details or general trends from the information given.

Indices of evenness and diversity of each forest-type are shown in Fig. 8.

When all species in a sample are equally abundant, it seems intuitive that an evenness index should be maximum and decrease toward zero as the relative abundances of the species diverge away from evenness. The index of evenness was calculated by using E5 or the modified Hill's ratio:[19]

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

Fig. 3 Indices of Evenness and Diversity of each forest-type on Doi Suthep

Indices	Deciduous	"Mixed" Deciduous	Evergreen
1. Evenness[1]	E5= 0.56	E5= 0.80	E5= 0.73
2. Diversity[2]	N1= 24.92 N2= 14.28	N1= 92.52 N2= 74.51	N1= 48.43 N2= 37.96

[1] Modified Hill's Ratio:

$$E5 = \frac{(1/\lambda) - 1}{e^{H'} - 1}$$ where λ is Simpson's Index $= \sum_{i=1}^{S} P_i^2$

P_i is the proportional abundance of the ith species, (i.e. n_i/n)

[2] Hill's Diversity Index $N_1 = e^{H'}$ where H' is the Shannon function:

$$H' = -\sum_{i=1}^{S} \left[\left(\frac{n_i}{n}\right) \ln \left(\frac{n_i}{n}\right) \right]$$

where λ is Simpson's Index[42] $= \sum_{i=1}^{S} P_i^2$

P_i is the proportional abundance of the ith species (i.e. n_i/n), see Ludwig & Reynolds (1988, chap.8).

E5 approaches zero as a single species becomes more and more dominant in a community. This is clearly a desirable property for an evenness index and is why E5 is preferred.

(Alatalo, 1981) An evenness index should be independent of the number of species in the sample.[1]

From the results of Fig. 8, the "mixed" deciduous has the highest evenness index; the evergreen has the next highest; and the deciduous has the lowest evenness index.

Diversity indices incorporate both species richness and evenness into a single value. To calculate the index of diversity, Hill's equation[19] to find values for N1 and N2 was used:

$$H' = -\sum_{i=1}^{S}\left[\left(\frac{n_i}{n}\right)\ln\left(\frac{n_i}{n}\right)\right] \qquad N_i = e^{H'}$$ where H' is the Shannon function[41]

The units in Hill's numbers are species and as the number increases, less weight is placed on rare species (N0, the lowest number, is the number of all species in the sample), and lower values are obtained for N1 and N2, since they measure the number of abundant and very abundant species, respectively, in the sample.[26]

Fig. 8 shows that the index of diversity of the "mixed" deciduous is the highest; the evergreen the next highest; and the deciduous the lowest.

[illegible] up of the three forest-types on Doi "mixed" deciduous forest is the most diverse, and thus, Doi Suthep's high biodiversity is due to this forest-type.

Further calculations to explain why the "mixed" deciduous forest is more diverse than the other two forest-types was done by using Sorensen's equation[44] of the index of similarity between two sample communities: $S = \frac{2C}{A+B}$ where A = no. of species in sample A, B = no. of species in sample B, C = no. of species common in A and B

Calculations were done three times using two sample communities: deciduous and "mixed" deciduous; "mixed" deciduous and evergreen; and deciduous and evergreen. The results are shown in Fig. 9. A high value for the index means that the similarity is high whereas a low value for the index means that the similarity is low.

The index of similarity between the deciduous and "mixed" deciduous is the highest, which means that there are many common species that both communities share. The index between the evergreen and "mixed" deciduous is the next highest, and the index between the deciduous and evergreen is the lowest. It appears that the "mixed" deciduous forest may act as an ecotone.

An ecotone is a transition between two or more diverse communities as, for example, between forest and grassland. It is a junction zone or tension belt which may have considerable linear extent but is narrower than the adjoining community areas themselves. The ecotonal community commonly contains many of the organisms of each of the overlapping communities and, in addition, organisms which are characteristic of and often restricted to the ecotone. Often, both the number of species and the population density of some of the species are greater in the ecotone than in the communities flanking it. The tendency for increased variety and density at community junctions is known as

Fig. 9 Indices of Similarity (S) between Two Sample Communities

Two samples	Indices
1."Mixed" Deciduous & Deciduous	3.56
2.Evergreen & "Mixed" Deciduous	2.97
3.Deciduous & Evergreen	2.36

Sorensen's Index of Similarity (1948):

$$S = \frac{2C}{A + B}$$

where A= number of species in sample A
B= number of species in sample B
C= number of species common to both samples

the edge effect. 32

To confirm if the "mixed" deciduous forest acts as an ecotone, a proportional diagram on ecotone in relation to the number of species in the ecotone zone and the total number of species in each forest was done. This is shown in Fig. 10. The results show that the edge effect concept is occurring at community junctions.

A table (Fig. 11) was made to support the ecotone and edge effect concepts. From the results, 56% of the total species in the "mixed" deciduous forest is in common with one of the other two forest-types. Interestingly, 44% of the total species is unique only to "mixed" deciduous.

Thus, the results confirm that the "mixed" deciduous acts as an ecotone and due to this reason, is causing high biodiversity on Doi Suthep.

A table of fruit characteristics and dispersal mechanisms of tree species in each forest-type is shown in Appendix 2. The main sources for the fruit data used for the table came from the Herbarium, Faculty of Pharmacy, Chiang Mai University and reference books. The dispersal mechanism data came from primarily reference books. A summary chart of the criteria for designating what types of dispersal mechanisms disperse which fruits is shown in Fig. 12. (van der Pijl, 1972) Some fruits of tree species are dispersed by more than one mechanism. In Fig. 13-17, [illegible] examples of fruits and dispersal mechanisms are shown.

A summary table of the dispersal mechanisms in each forest-

Fig. 10 Diagram in relation to No. of Species in Ecotone Zone and Total No. of Species in each forest

D= Deciduous forest
M= "Mixed" Deciduous forest
E= Evergreen forest
*= Ecotone Zone

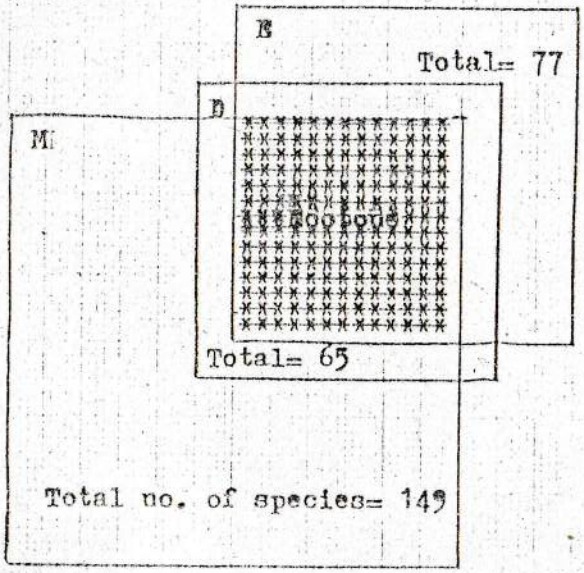


Fig. 11 Summary of Data from Ecotone Diagram (Fig. 10)

Sample communities (Sample A,B,C)	No. of common species (out of total no. of species in Sample A)	% of total no. of species in "Mixed" deci that are from Sample A
1. Deciduous and "Mixed" Deciduous	47(65)	31%
2. Evergreen and "Mixed" Deciduous	37(77)	25%
3. Deciduous and Evergreen	11	-
4. Deciduous, "Mixed" Deciduous, and Evergreen	10(total no. of all forests= 291)	-

Fig. 3.2 Dispersal syndromes. From van der Pijl (1972), Janzen (1983), Wheelwright *et al.* (1984), Gautier-Hion *et al.* (1985), and Howe (1986).

Agent	Colour	Odour	Form	Reward
		Primarily self-dispersed		
Gravity	Various	None	Undistinguished	None
Explosive dehiscence	Various	None	Explosive capsules or pods	None
Bristle contraction	Various	None	Hydroscopic bristles in varying humidity	None
		Primarily abiotic dispersal		
Water	Various, usually green or brown	None	Hairs, slime, small size, or corky tissue resists sinking or imparts low specific gravity	None
Wind	Various, usually green or brown	None	Minute size, wings, plumes, or balloons impart high surface to volume ratio	None
		Primarily vertebrate dispersal		
Hoarding mammals	Brown	Weak or aromatic	Tough thick-walled nuts; indehiscent	Seed itself
Hoarding birds	Green or brown	None	Rounded wingless seeds or nuts	Seed itself
Arboreal frugivorous mammals	Brown, green, white, orange, yellow	Aromatic	Often arillate seeds or drupes; often compound, often dehiscent	Aril or pulp rich in protein, sugar, or starch
Bats	Green, white, or pale yellow	Aromatic or musty	Various; often pendant	Pulp rich in lipid or starch
Terrestrial frugivorous mammals	Often green or brown	None	Tough, indehiscent often > 50 mm long	Pulp rich in lipid
Highly frugivorous birds	Black, blue, red, green or purple	None	Large arillate seeds or drupes; often dehiscent; seeds > 10 mm long	Pulp rich in lipid or protein
Any frugivorous birds	Black, blue, red, orange or white	None	Small or medium-sized arillate seeds, berries or drupes; seeds ≤ 10 mm long	Various; often only sugar or starch
Animal fur or feathers	Undistinguished	None	Barbs, hooks, or sticky hairs	None
		Primarily insect dispersal		
Ants	Undistinguished	None to humans	Elaiosome attached to seed coat	Oil of starch body with chemical attractant

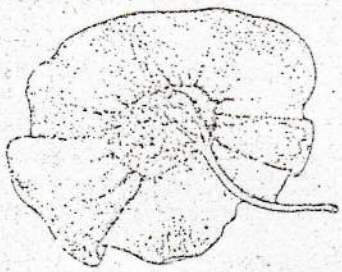
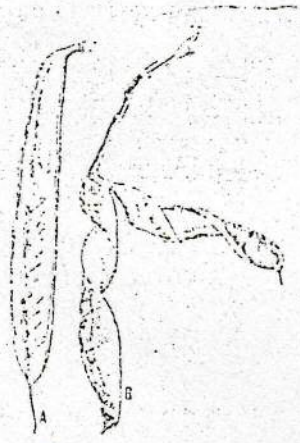


Fig. 13 One-seeded winged legume of *Pterocarpus* sp., × 1.
This is an example of a fruit that is dispersed by wind through the use of a wing. Wings come in many sizes and shapes. This one has a wing that encircles the seed.

Fig. 14



Legume of *Bauhinia* sp. A, before; B, after, dehiscence, × 1.
This is an example of a fruit that dehisces along both sutures to all its many seeds to be released into the wind to be dispersed.

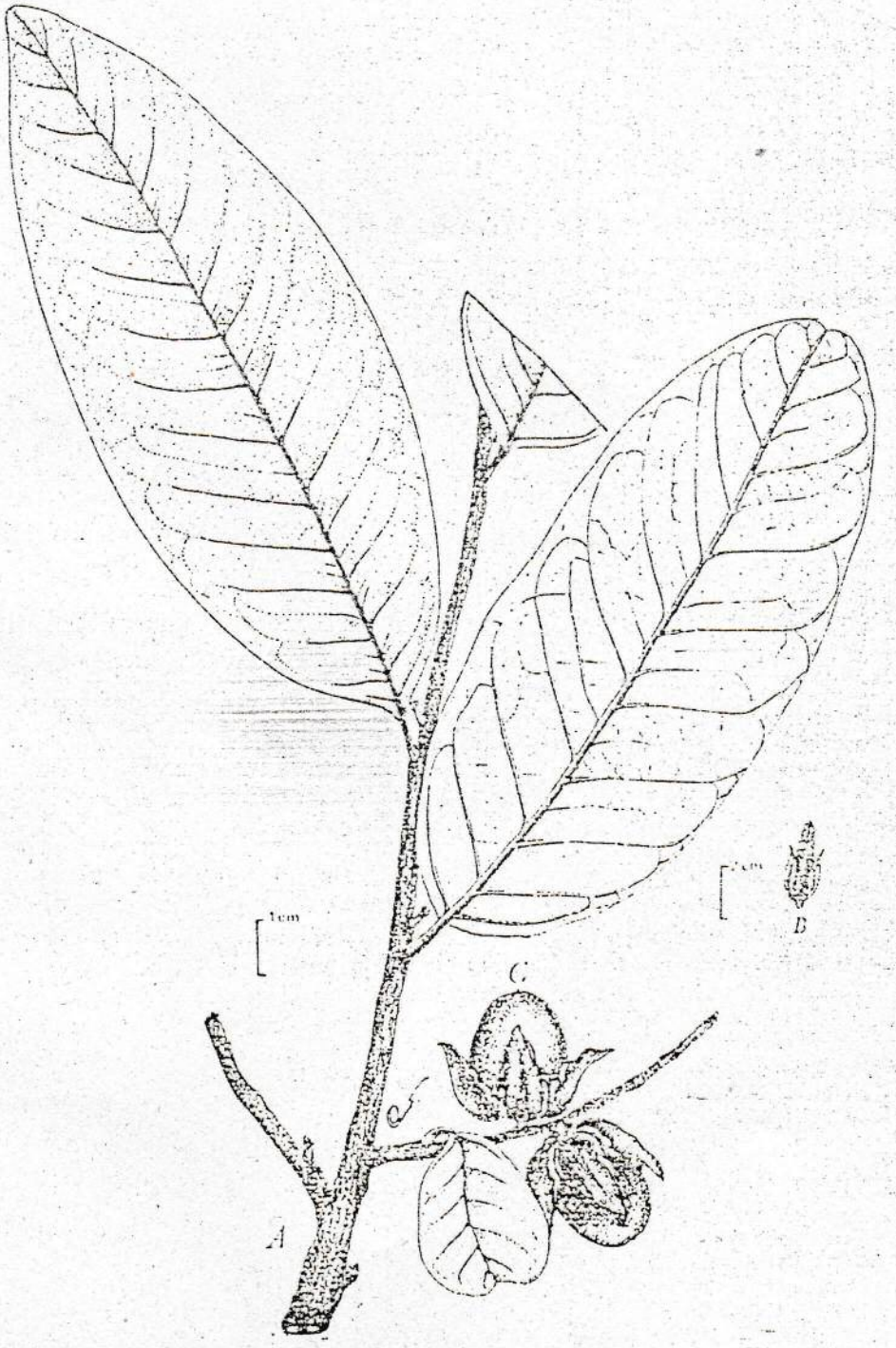


Fig. 15 *Diospyros pilosanthera* Blanco *A* Habit and fruits; *B* Female flower; *C* Fruit.
This is an example of a fruit that is eaten by seed dispersal mechanisms such as birds, bats, and perhaps primates.

Fig. 16

Fruit-eating bats can often be seen carrying fruits through the forests they inhabit. Many will deposit seeds at roosts or in branches as they fly over the forest.

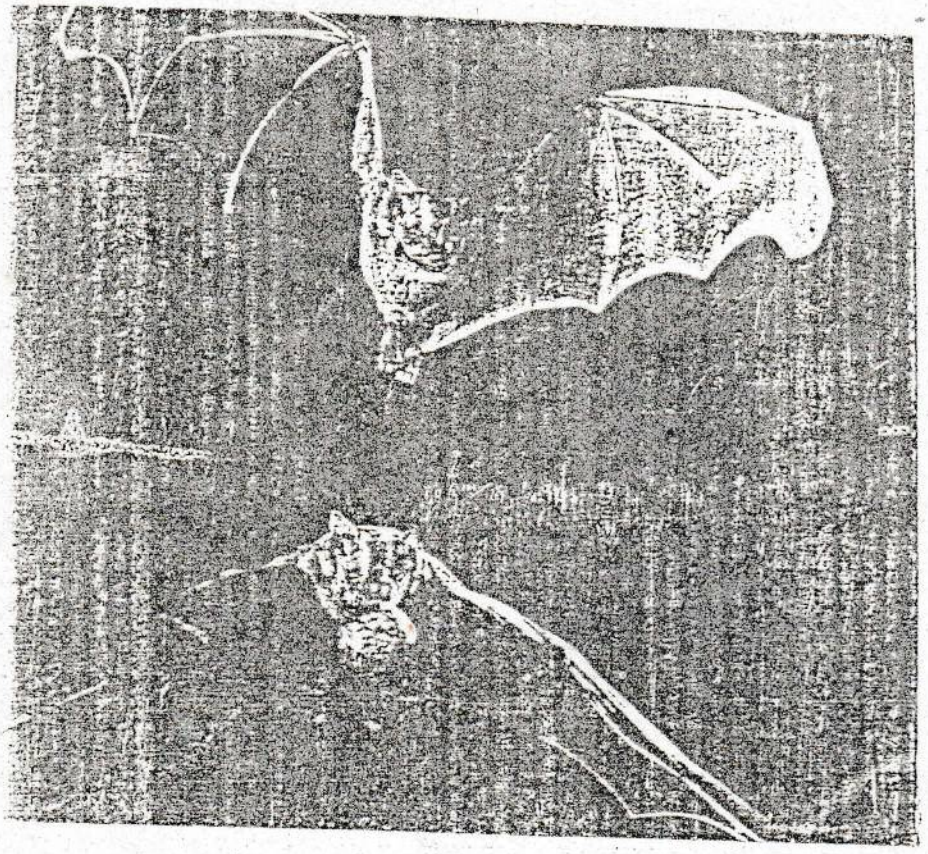


Fig. 17

Now extinct from Doi Suthep, the slow loris used to be one of many primates that were important seed dispersal mechanisms. The slow loris is active at night feeding on fruits as its primary source of food.

Fig. 18

No. of Tree Species (% of total species) Dispersed by each Seed Dispersal Mechanism

Note: Some species may have more than one dispersal mechanism. "Unknowns" not counted.

D= Deciduous forest
M= "Mixed" Deciduous forest
E= Evergreen forest

Dispersal mechanism	D	M	E
1. Bats	9(14%)	34(23%)	21(28%)
2. Birds	26(40%)	73(49%)	46(61%)
3. Exploding device	0(0%)	1(0.7%)	0(0%)
4. Primates	7(11%)	29(20%)	16(21%)
5. Rodents(excluding #6)	9(14%)	17(11%)	14(19%)
6. Squirrels	9(14%)	15(10%)	9(12%)
7. Water	1(2%)	4(3%)	1(1%)
8. Wind	26(40%)	46(31%)	12(16%)
Total no. of species	65	143	75

Fig. 19

No. of Tree Individuals per hectare (% of total individuals per hectare) Dispersed by each Seed Dispersal Mechanism

Note: Some individuals may have more than one dispersal mechanism. "Unknowns" not counted.

Dispersal mechanism	D	M	E
1. Bats	44(4%)	167(21%)	278(32%)
2. Birds	230(23%)	357(45%)	437(50%)
3. Exploding device	0(0%)	2(0.3%)	0(0%)
4. Primates	40(4%)	132(17%)	244(28%)
5. Rodents(excluding #6)	148(15%)	126(16%)	245(28%)
6. Squirrels	148(15%)	118(15%)	122(14%)
7. Water	4(0.4%)	19(2%)	4(0.5%)
8. Wind	626(62%)	260(33%)	94(11%)
Total no. of individuals	1016	799	873

Fig. 20

No. of Tree Individuals per hectare (% of total individuals per hectare) Dispersed by each General Category of Seed Dispersal Mechanisms

Note: Some individuals may have more than one dispersal mechanism. "Unknowns" not counted.

Dispersal mechanisms	D	M	E
1. Animals (can fly)	274(27%)	524(66%)	715(82%)
2. Animals (cannot fly)	336(34%)	376(48%)	611(70%)
3. Water	4(0.4%)	19(2%)	4(0.4%)
4. Wind and exploding device	626(62%)	262(33.3%)	94(11%)
Total no. of individuals	1016	799	873

type and the number of species each mechanism disperses is shown in Fig. 18. Some species may have more than one dispersal mechanism. Another summary table of the dispersal mechanisms in each forest-type and the number of individuals per hectare each mechanism disperses is shown in Fig. 19. Again, some individuals may have more than one dispersal mechanism. A third summary table was made grouping dispersal mechanisms together into categories in each forest-type and the number of individuals per hectare each category disperses, shown in Fig. 20.

From the results of Fig. 18 and 19, one can see that in the deciduous forest, wind and birds are the most dominant seed dispersal mechanisms, in order repectively; in the "mixed" deciduous forest, birds and wind are the most dominant mechanisms, in order respectively; and in the evergreen forest, birds and bats are the most dominant, in order repectively. From the results of Fig. 20, one can see that in the deciduous forest, the wind and exploding device category is highest, and in the "mixed" deciduous and evergreen, the animals (fly) category is highest though animals (non-fly) is also very high in all forests.

To sum up, birds, bats, and animals (non-fly), though few primates are left, are very important seed dispersal mechanisms in all of the forests of Doi Suthep, especially in the highly biodiverse "mixed" deciduous forest and the evergreen forest.

DISCUSSION

From the results above, one can see that the "mixed" deciduous forest is more urgently needed to be preserved than the other two forest-types. Additionally, the results show that

birds, bats, and animals (non-fly) are important seed dispersal mechanisms on Doi Suthep. Thus, they must continue to live in their natural habitat in order to continue the fruit and seed dispersal mechanism relationship that sustains the present forest ecosystem on Doi Suthep especially in the "mixed" deciduous forest.

However, despite its status as a national park, Doi Suthep is constantly threatened by encroachment and an array of destructive development projects. Each one considered in isolation appears insignificant, but together they are causing the gradual deterioration of the forest. The continuing expansion of tourist facilities, the upgrading of dirt tracks into surfaced roads, the construction of television transmitters and the continuation of slash and burn agriculture within the park have all taken their toll on the forest. More than 500 hilltribe families who live within the park have encroached upon more than 800 hectares, while agricultural research stations, run by various government agencies, cover a similar area. (Kasetsart University, 1989)

Although Doi Suthep retains a highly diverse flora and fauna, several species have disappeared in recent years due to hunting and collecting. Hunting has caused the disappearance of all large mammal species including gibbons (Hylobates lar), bears (Ursus thibetanus), sambar deer (Cervus unicolor) and wild boar (Sus scrofa). All of these species were common on the mountain [illegible] years ago. Hunting has also exterminated [illegible] bird species including all species of hornbills (5 species were

formerly present; Deignan, 1945; Round, 1984) and vultures. Even now, hunting continues unabated. With the extermination of many large animals from the park, hunters now turn their attention towards smaller animals: squirrels and song birds. In several areas where once the forest echoed with the sound of birdsong, there is now an eerie silence.[15]

The loss of some animal and bird species may be of crucial importance to the survival of the forest as a whole. Many bird species and flying squirrels are important pollinators of trees. Many seeds are unable to germinate unless they have passed through the digestive tract of a gibbon or hornbill. Many tree seeds must be dispersed by animals well away from the parent tree if they are to germinate successfully and produce the next generation of trees. If key seed-dispersing animal species disappear, the trees will be unable to reproduce. As the older trees die, they will not be replaced with younger ones and slowly the forest will become poorer in tree species.[16]

Even where the forest habitats remain, wildlife is seriously threatened from people who live in or near the park, gathering firewood, felling trees to obtain honey from beehives, collecting butterflies, large spiders and scorpions for the tourist trade, capturing birds and squirrels as pets and killing birds of prey considered to be pests.[16]

Plants too are threatened by collectors. Two species which have disappeared from Doi Suthep in recent years include Mussaenda sanderiana (Rubiaceae) (Cockerell, 1929), collected for its ornamental value and Psilotum nudum (Psilotaceae), which is of great scientific interest, since it is the most primitive of

vascular plants found in Thailand. (Maxwell) Another loss has been that of the lady's slipper orchid (Paphiopedilum callosum) which was probably removed from the park by collectors for the horticulture trade. (Banziger, 1987)

Another worry is the annual occurrence of fires during the dry season. Such fires mostly are man-made. They are started by villagers to clear land for agriculture, to flush out small mammals and birds for hunting and supposedly to increase the yield of wild mushrooms. Fire is a natural part of the ecology of dry deciduous forests in Southeast Asia, (Stott, 1986) and most mature trees are protected from fire by having very thick bark. However, evergreen trees at higher elevations are not so protected. Even at lower elevations, the unnaturally high frequency of fires on Doi Suthep may be a cause for concern since small seedlings are susceptible to fire until they have become large enough to grow thick bark. Repeated burnings every year may therefore lead to a decrease in the number of very young trees.

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In conclusion, unless such development and encroachment are controlled, the value of the park for conservation and scientific research will be dramatically reduced.

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APPENDIX 1.

List of Tree Species Recorded at Study Sites in Deciduous Dipterocarp-Oak Forest
Note: Density=no. of individuals per hectare

	Species name and author citation	Family name	Density
1.	Albizia odoratissima (L.f.) Bth.	Leguminosae, Mimosoideae	4
2.	Anneslea fragrans Wall.	Theaceae	20
3.	Aporusa villosa (Lindl.) Baill.	Euphorbiaceae	66
4.	Aporusa wallichii Hk. f.	Euphorbiaceae	14
5.	Artocarrus gomezianus Wall. ex Trec.	Moraceae	2
6.	Bombax malabarica DC. (B. ceiba L.)	Bombacaceae	4
7.	Buchanania glabra Wall. ex Hk.f.	Anacardiaceae	4
8.	Buchanania latifolia Roxb.	Anacardiaceae	12
9.	Canarium subulatum Guill.	Burseraceae	8
10.	Castanopsis indica (Roxb.) A. DC.	Fagaceae	2
11.	Castanopsis tribuloides (Sm.) A. DC.	Fagaceae	4
12.	Catunaregam tomentosa (Bl. ex DC.) Tirv.	Rubiaceae	12
13.	Colona flagrocarpa (Cl.) Craib	Tiliaceae	10
14.	Colona floribunda (Kurz) Craib	Tiliaceae	4
15.	Craibiodendron stellatum (Pierre) W.W. Sm.	Ericaceae	22
16.	Dalbergia dongnaiensis Pierre	Leguminosae, Papilionoideae	4
17.	Dalbergia fusca Pierre	Leguminosae, Papilionoideae	10
18.	Dillenia aurea Sm. var. aurea	Dilleniaceae	6
19.	Dillenia parviflora Griff. var. kerrii (Craib) Hoogl. (Topotype of paratype)	Dilleniaceae	2
20.	Diospyros ehretioides Wall. ex G. Don	Ebenaceae	6
21.	Dipterocarpus obtusifolius Teijsm. ex Miq. var. obtusifolius	Dipterocarpaceae	82
22.	Dipterocarpus tuberculatus Roxb. var. tuberculatus	Dipterocarpaceae	62
23.	Engelhardia serrata Bl.	Juglandaceae	4
24.	Eugenia albiflora Duth. ex Kurz	Myrtaceae	2
25.	Eugenia cumini (L.) Druce	Myrtaceae	2
26.	Gardenia sootepensis Hutch. (Topotype)	Rubiaceae	6
27.	Gluta usitata (Wall.) Rou	Anacardiaceae	4
28.	Lagerstroemia macrocarpa Kurz var. macrocarpa	Lythraceae	4
29.	Lithocarpus elegans (Bl.) Hatus. ex Soep.	Fagaceae	2
30.	Lithocarpus lindleyanus (Wall.) A. Cam.	Fagaceae	8
31.	Lithocarpus sootepensis (Craib) A. Cam. (Topotype)	Fagaceae	28
32.	Lophopetalum wallichii Kurz	Celastraceae	2
33.	Metadina trichotoma (Z. & M.) Bakb. f.	Rubiaceae	2
34.	Millettia extensa Bth. ex Baker	Leguminosae, Papilionoideae	6
35.	Mitragyna hirsuta Hav.	Rubiaceae	2
36.	Oroxylum indicum (L.) Vent.	Bignoniaceae	4
37.	Parinari anamensis Hance	Rosaceae	2
38.	Phoebe lanceolata (Wees) Nees	Lauraceae	4
39.	Pterocarpus macrocarpus Kurz	Leguminosae, Papilionoideae	2
40.	Quercus aliena Bl.	Fagaceae	32
41.	Quercus brandisiana Kurz	Fagaceae	2
42.	Quercus kerrii Craib var. kerrii (Topotype)	Fagaceae	68
43.	Quercus lakuta J. Smith	Fagaceae	2
44.	Rhus chinensis Mill.	Anacardiaceae	2
45.	Semecarpus cochinchinensis Engl.	Anacardiaceae	2
46.	Shorea obtusa Wall. ex Bl.	Dipterocarpaceae	26

47.	Shorea siamensis Miq. var. siamensis	Dipterocarpaceae	172
48.	Spatholobus parviflorus (Roxb.) O.K.	Leguminosae, Papilionoideae	4
49.	Sterculia ornata Wall. ex Kurz	Sterculiaceae	2
50.	Stereospermum colais(B.-H. ex Dillw.) Mabb.	Bignoniaceae	4
51.	Stereospermum neuranthum Kurz	Bignoniaceae	8
52.	Strychnos nux-vomica L.	Loganiaceae	8
53.	Styrax benzoides Craib (Topotype)	Styracaceae	4
54.	Symplocos racemosa Roxb.	Symplocaceae	4
55.	Tectona grandis L.f.	Verbenaceae	8
56.	Terminalia alata Hey. ex Roth	Combretaceae	10
57.	Terminalia mucronata Craib & Hutch. (Topotype)	Combretaceae	10
58.	Tristania rufescens Hance	Myrtaceae	134
59.	Vaccinium sprengelii (D. Don) Sleum.	Ericaceae	6
60.	Vitex canescens Kurz	Verbenaceae	2
61.	Vitex limoniifolia Wall. ex Kurz	Verbenaceae	4
62.	Vitex peduncularis Wall. ex Schauer	Verbenaceae	2
63.	Wendlandia tinctoria DC. var. floribunda (Craib) Cowan (Topotype)	Rubiaceae	44
64.	Xylia xylocarpa (Roxb.) Taub. var. kerrii (Craib & Hutch.) Kiels. (Topotype)	Leguminosae, Mimosoideae	8
65.	Zizyphus rugosa Lmk. var. rugosa	Rhamnaceae	4

List of Tree Species Recorded at Study Sites in "Mixed" Deciduous-Evergreen Forest
Note: Density=no. of individuals per hectare; g= gulley

	Species name and author citation	Family name	Density
1.	Acacia megaladena Desv. var. megaladena	Leguminosae, Mimosoideae	2
2.	Afgekia filipes (Dunn) Gees.	Leguminosae, Papilionoideae	2
3.	Aganosma marginata (Roxb.) G. Don	Apocynaceae	2
4.	Alangium kurzii Craib	Alangiaceae	2
5.	Albizia odoratissima (L.f.) Bth.	Leguminosae, Mimosoideae	9
6.	Amoora polystachya (Wall.) Hk.f. & Jacks.	Meliaceae	2
7.	Anacolosa ilicoides Mast.	Olacaceae	13
8.	Anneslea fragrans Wall.	Theaceae	6
9.	Antidesma acidum Retz.	Euphorbiaceae	16
10.	Antidesma bunius (L.) Spreng.	Euphorbiaceae	2
11.	Antidesma montanum Bl.	Euphorbiaceae	2
12.	Antidesma sootepense Craib (Topotype)	Euphorbiaceae	2
13.	Aporusa villosa (Lindl.) Baill.	Euphorbiaceae	2
14.	Aporusa wallichii Hk.f.	Euphorbiaceae	13
15.	Artocarpus gomezianus Wall. ex Trec.	Moraceae	2
16.	Baccaurea ramiflora Lour.	Euphorbiaceae	2
	Bauhinia variegata L.	Leguminosae, Caesalpinioideae	2
	Bombax kerrii Craib (Topotype B. anceps Pierre var. cambodense (Pierre Robyns))	Bombacaceae	3
19.	Bridelia pubescens Kurz	Euphorbiaceae	5
20.	Canarium subulatum Guill.	Burseraceae	3
21.	Canarium sp.	Burseraceae	2
22.	Canthium umbellatum Wight	Rubiaceae	2
23.	Cassia bakeriana Craib (Topotype)	Leguminosae, Caesalpinioideae	2
24.	Castanopsis acuminatissima (Bl.) A. DC.	Fagaceae	5
25.	Castanopsis armata (Roxb.) Spach	Fagaceae	3
26.	Castanopsis diversifolia King	Fagaceae	28
27.	Castanopsis indica (Roxb.) A. DC.	Fagaceae	2
28.	Castanopsis tribuloides (Sm.) A. DC.	Fagaceae	13
29.	Catunaregam tomentosa (Bl. ex DC.) Tirv.	Rubiaceae	3
30.	Celastrus paniculatus Willd.	Celastraceae	3
31.	Chukrasia velutina Wight & Arn. ex Roem.	Meliaceae	2
32.	Colona flagrocarpa (Cl.) Craib	Tiliaceae	8
33.	Colona floribunda (Kurz) Craib	Tiliaceae	5
34.	Congea tomentosa Roxb. var. tomentosa	Verbenaceae	2
35.	Craibiodendron stellatum (Pierre) W.W. Sm.	Ericaceae	2
36.	Cratoxylum cochinchinensis (Lour.) Bl.	Hyperiaceae	6
37.	Croton robustus Kurz	Euphorbiaceae	3
38.	Dalbergia dongnaiensis Pierre	Leguminosae, Papilionoideae	5
39.	Dalbergia fusca Pierre	Leguminosae, Papilionoideae	9
40.	Dalbergia stipulacea Roxb.	Leguminosae, Papilionoideae	2
41.	Dalbergia sp.	Leguminosae, Papilionoideae	2
42.	Dimocarpus longan Lour. ssp. longan var. longan	Sapindaceae	2
43.	Diospyros ehretioides Wall. ex G. Don	Ebenaceae	3
44.	Diospyros ferrea (Willd.) Bakh. var. littorea (R.Br.) Bakh.	Ebenaceae	6
45.	Diospyros pilosanthera Blanco	Ebenaceae	22
46.	Diospyros undulata Wall. ex G. Don var. cratericalyx (Craib) Bakh.	Ebenaceae	5

47.	Dipterocarpus costatus Gaerth. f.	Dipterocarpaceae	3
48.	Dipterocarpus obtusifolius Teijsm. ex Miq. var. obtus.	Dipterocarpaceae	14
49.	Dipterocarpus tuberculatus Roxb. var. tuberculatus	Dipterocarpaceae	2
50.	Dipterocarpus turbinatus Gaerth.f.	Dipterocarpaceae	2
51.	Elaeocarpus bracteatus Watt ex Cl.	Elaeocarpaceae	2
52.	Engelhardia serrata Bl.	Juglandaceae	11
53.	Engelhardia spicata Lechen. ex Bl. var. spicata	Juglandaceae	2
54.	Eryeibe subspicata Wall. ex G. Don	Convolvulaceae	2
55.	Erythrina subumbrans (Hassk.) Merr.	Leguminosae, Papilionoideae	2
56.	Eugenia albiflora Duth. ex Kurz	Myrtaceae	25
57.	Eugenia grata Wight var. grata	Myrtaceae	2
58.	Ficus benjamina L. var. benjamina	Moraceae	2
59.	Ficus fistulosa Reinw. ex Bl. var. fistulosa	Moraceae	3
60.	Ficus hispida L.f. var. hispida	Moraceae	2
61.	Flacourtia indica (Burm. f.) Merr.	Flacourtiaceae	2
62.	Garcinia cowa Roxb.	Guttiferae	2
63.	Garcinia merguensis Wight	Guttiferae	2
64.	Garcinia speciosa Wall.	Guttiferae	2
65.	Gardenia sootepensis Hutch. (Topotype)	Rubiaceae	3
66.	Glochidion eriocarpum Champ.	Euphorbiaceae	2
67.	Gmelina arborea Roxb.	Verbenaceae	3
68.	Gnetum montanum Mgf.	Gnetaceae	2
69.	Goniothalamus griffithii Hk.f. & Thoms.	Annonaceae	2
70.	Grewia eriocarpa Juss.	Tiliaceae	2
71.	Heynea trijuga Roxb. var. trijuga	Meliaceae	2
72.	Holarrhena pubescens (BrH.) Wall. ex G. Don	Apocynaceae	5
73.	Hopea odorata Roxb. var. odorata	Dipterocarpaceae	2
74.	Ilex umbellulata (Wall.) Loesn.	Aquifoliaceae	9
75.	Irvingia malayana Oliv. ex Benn.	Irvingiaceae	5
76.	Kydia calycina Roxb.	Malvaceae	2
77.	Lagerstroemia cochinchinensis Gagnep. var. ovalifolia Furt. & Mont.	Lythraceae	2
78.	Lagerstroemia macrocarpa Kurz var. macrocarpa	Lythraceae	3
79.	Lithocarpus elegans (Bl.) Hatus. ex Soep.	Fagaceae	11
80.	Lithocarpus lindleyanus (Wall.) A. Camus	Fagaceae	2
81.	Lithocarpus sootepensis (Craib) A. Camus (Topotype)	Fagaceae	27
82.	Litsea salicifolia Roxb.	Lauraceae	3
83.	Litsea sp.	Lauraceae	3
84.	Lophopetalum wallichii Kurz	Celastraceae	2
85.	Luvunga scandens (Roxb.) Ham. ex Wight	Rutaceae	2
86.	Machilus aff. cochinchinensis H. Lec.	Lauraceae	2
87.	Mallotus sp.	Euphorbiaceae	3
88.	Mangifera caloneura Kurz	Anacardiaceae	2
89.	Markhamia stipulata (Wall.) Seem. ex Sch.	Bignoniaceae	2
90.	Meliosma simplicifolia (Roxb.) Wall. ssp. fordii (Hemsl. ex Forb. & Hemsl.) Beus. (Topotype of Meliosma simplicifolia (Roxb.) Walp. var. sootepensis Craib	Sabiaceae	5
91.	Melodorum affine Craib (Topotype)	Annonaceae	2
92.	Melodorum oblongum Craib (Topotype)	Annonaceae	2
93.	Memecylon plebejum Kurz var. siamense Craib (Topotype)	Melastomataceae	8
94.	Memecylon scutellatum (Lour.) Naud.	Melastomataceae	2
95.	Metadina trichotoma (Z. & M.) Bakh. f.	Rubiaceae	19

96.	Michelia champaca L.	Magnoliaceae	2
97.	Millettia caerulea Grah. ex Baker	Leguminosae, Papilionoideae	2
98.	Millettia extensa Bth. ex Baker	Leguminosae, Papilionoideae	3
99.	Millettia sp.	Leguminosae, Papilionoideae	2
100.	Mischocarpus grandis (Pierre) Radlk.	Sapindaceae	2
101.	Mitrephora maingayi Hk.f. & Thoms. (q.v.M. vandiflora Kurz)	Annonaceae	2
102.	Nyssa javanica (Bl.) Wang.	Nyssaceae	6
103.	Olea rosea Craib (Topotype)	Oleaceae	2
104.	Olea salicifolia Wall. ex G. Don	Oleaceae	8
105.	Oroxylum indicum (L.) Vent.	Bignoniaceae	13
106.	Pavetta petiolaris Wall. ex Craib	Rubiaceae	3
107.	Phoebe lanceolata (Nees) Nees	Lauraceae	9
108.	Phyllanthus emblica L.	Euphorbiaceae	6
109.	Phyllanthus roseus (Craib & Hutch.) Beille (Topotype)	Euphorbiaceae	2
110.	Protium serratum (Wall. ex Colebr.) Engl.	Burseraceae	9
111.	Pterolobium macropterum Kurz	Leguminosae, Caesalpinioideae	2
112.	Quercus brandisiana Kurz	Fagaceae	5
113.	Quercus kerrii Craib var. kerrii (Topotype)	Fagaceae	8
114.	Quercus kingiana Craib (Topotype)	Fagaceae	5
115.	Randia sootepensis Craib (Topotype)	Rubiaceae	17
116.	Rapanea neriifolia (Sieb. & Zucc.) Mez var. yunnanensis (Mez) Walk.	Myrsinaceae	3
117.	Schima wallichii (DC.) Korth.	Theaceae	13
118.	Scleropyrum wallichianum Arn. var. siamensis H. Lee, (Topotype)	Santalaceae	5
119.	Semecarpus cochinchinensis Engl.	Anacardiaceae	6
120.	Shorea obtusa Wall. ex Bl.	Dipterocarpaceae	2
121.	Shorea roxburghii G. Don	Dipterocarpaceae	9
122.	Shorea siamensis Miq. var. siamensis	Dipterocarpaceae	8
123.	Spatholobus parviflorus (Roxb.) O.K.	Leguminosae, Papilionoideae	8
124.	Sphenodesme pentandra Jack var. wallichiana (Schauer) Munir	Verbenaceae	2
125.	Spondias axillaris Roxb.	Anacardiaceae	2
126.	Sterculia angustifolia Roxb.	Sterculiaceae	3
127.	Stereospermum colais (B. H. ex Dillw.) Mabb.	Bignoniaceae	2
128.	Stereospermum neuranthum Kurz	Bignoniaceae	2
129.	Styrax benzoides Craib (Topotype)	Styracaceae	22
130.	Tarenna disperma (Hk.f.) Pit.	Rubiaceae	14
131.	Tectona grandis L.f.	Verbenaceae	2
132.	Terminalia mucronata Craib & Hutch (Topotype)	Combretaceae	25
133.	Ternstroemia gymnanthera (Wight & Arn.) Bedd.	Theaceae	2
134.	Tetrastigma serrulatum (Roxb.) Pl.	Vitaceae	3
135.	Toona microcarpa (C. DC.) Harms.	Meliaceae	2
136.	Trema orientalis (L.) Bl.	Ulmaceae	2
137.	Tristania rufescens Hance	Myrtaceae	2
138.	Turpinia pomifera (Roxb.) Wall. ex DC.	Staphyleaceae	8
139.	Vaccinium sprengelii (D. Don) Sleum.	Ericaceae	2
140.	Viburnum [illegible]	Caprifoliaceae	
141.	Vitex limoniifolia Wall. ex Kurz	Verbenaceae	2
142.	Vitex peduncularis Wall. ex Schauer	Verbenaceae	22
143.	Walsura intermedia Craib	Meliaceae	2

144.	Wendlandia tinctoria DC. var. floribunda (Craib) Cowan (Topotype)	Rubiaceae	17
145.	Xanthophyllum flavescens Roxb.	Polygalaceae	2
146.	Xanthophyllum virens Roxb.	Polygalaceae	6
147.	Xylia xylocarpa (Roxb.) Taub. var. kerrii (Craib & Hutch.) Niels. (Topotype)	Leguminosae, Mimosoideae	19
148.	Ziziphus rugosa Lmk. var. rugosa	Rhamnaceae	2
149.	Unknown g.13.03 (plot and tree no.)		2

List of Tree Species Recorded at Study Sites in Primary Evergreen Forest
Note: Density=no. of individuals per hectare; eg= evergreen

	Species name and author citation	Family name	Density
1.	Acrocarpus fraxinifolius Wight ex Arn.	Leguminosae, Caesalpinioideae	4
2.	Acronychia pedunculata (L.) Miq.	Rutaceae	25
3.	Actinodaphne henryi Gamb.	Lauraceae	7
4.	Adinandra integerrima T. And. ex Miq.	Theaceae	18
5.	Afgekia filipes (Dunn) Gees.	Leguminosae, Papilionoideae	11
6.	Alangium kurzii Craib	Alangiaceae	4
7.	Allophyllus cobbe (L.) Raeusch. (Topotype of Allophyllus sootepensis Craib)	Sapindaceae	4
8.	Alstonia scholaris (L.) R. Br. var. scholaris	Apocynaceae	4
9.	Amoora polystachya (Wall.) Hk.f. & Jacks.	Meliaceae	29
10.	Antidesma acidum Retz.	Euphorbiaceae	4
11.	Antidesma bunius (L.) Spreng.	Euphorbiaceae	18
12.	Aporusa dioica (Roxb.) M.-A.	Euphorbiaceae	4
13.	Artocarpus lanceolata Trec.	Moraceae	4
14.	Baccaurea ramiflora Lour.	Euphorbiaceae	36
15.	Bischofia javanica Bl.	Euphorbiaceae	7
16.	Castanopsis acuminatissima (Bl.) A. DC.	Fagaceae	4
17.	Castanopsis armata (Roxb.) Spach.	Fagaceae	11
18.	Castanopsis diversifolia (Kurz) King	Fagaceae	22
19.	Castanopsis indica (Roxb.) A. DC.	Fagaceae	4
20.	Castanopsis tribuloides (Sm.) A. DC.	Fagaceae	40
21.	Cinnamomum iners Reinw. ex Bl.	Lauraceae	4
22.	Cleidion spiciflorum (Burm.f.) Merr.	Euphorbiaceae	22
23.	Combretum punctatum Bl.	Combretaceae	4
24.	Connarus semidecandrus Jack.	Connaraceae	4
25.	Cryptocarya aff. ferrea Bl.	Lauraceae	14
26.	Dalbergia stipulacea Roxb.	Leguminosae, Papilionoideae	4
27.	Dimocarpus longan Lour. ssp. longan var. longan	Sapindaceae	7
28.	Elaeocarpus petiolatus (Jack) Wall. ex Kurz	Elaeocarpaceae	4
29.	Engelhardia serrata Bl.	Juglandaceae	4
30.	Eriobotrya bengalensis (Roxb.) Hk.f. forma bengalensis	Rosaceae	4
31.	Eugenia albiflora Duth. ex Kurz	Myrtaceae	22
32.	Euonymus similis Craib (Topotype)	Celastraceae	4
33.	Ficus benjamina L. var. benjamina	Moraceae	4
34.	Ficus fistulosa Reinw. ex Bl. var. fistulosa	Moraceae	4
35.	Garcinia mckeaniana Craib (Topotype)	Guttiferae	7
36.	Garcinia xanthochymus Hk.f. ex T. And.	Guttiferae	4
37.	Glochidion kerrii Craib (Topotype)(G. dasystylum Kurz var. kerrii (Craib) T. Chak. & Gang.)	Euphorbiaceae	4
38.	Gordonia dalglieshiana Craib (Topotype)	Theaceae	4
39.	Helicia nilagirica Bedd.	Proteaceae	7
40.	Knema conferta (King) Warb.	Myristicaceae	4
41.	Lithocarpus elegans (Bl.) Hatus. ex Soep.	Fagaceae	29
42.	Litsea glutinosa (Lour.) C.B. Rob.	Lauraceae	7
43.	Litsea salicifolia Roxb.	Lauraceae	22
44.	Markhamia stipulata (Wall.) Seem. ex Sch.	Bignoniaceae	4
45.	Melia toosendan Sieb. & Zucc. (q.v. Melia dubia Cav.)	Meliaceae	4

46.	Melodorum affine Craib (Topotype)	Annonaceae	11
47.	Memecylon plebejum Kurz var. siamense Craib (Topotype)	Melastomataceae	4
48.	Metadina trichotoma (Zoll. & Mor.)Bakh.f.	Rubiaceae	43
49.	Michelia champaca L.	Magnoliaceae	29
50.	Miliusa cuneata Craib (Topotype)	Annonaceae	4
51.	Miliusa velutina (Dun.) Hk.f. & Thoms.	Annonaceae	4
52.	Mischocarpus grandis (Pierre) Radlk.	Sapindaceae	14
53.	Mitrephora maingayi Hk.f. & Thoms. (q.v.M.vandiflora Kurz)	Annonaceae	4
54.	Morus macroura Miq.	Moraceae	7
55.	Nyssa javanica (Bl.) Wang.	Nyssaceae	7
56.	Phoebe lanceolata (Nees) Nees	Lauraceae	18
57.	Phoebe sp.	Lauraceae	4
58.	Phyllanthus roseus (Craib. & Hutch.) Beille (Topotype)	Euphorbiaceae	4
59.	Planchonella punctata Flet.	Sapotaceae	4
60.	Protium serratum (Wall. ex Colebr.) Engl.	Burseraceae	4
61.	Pterocarpus macrocarpus Kurz	Leguminosae, Papilionoideae	4
62.	Sapium baccatum Roxb.	Euphorbiaceae	7
63.	Sarcosperma arboreum Bth.	Sapotaceae	83
64.	Schima wallichii (DC.) Korth.	Theaceae	4
65.	Semecarpus cochinchinensis Engl.	Anacardiaceae	14
66.	Styrax benzoides Craib (Topotype)	Styraceae	11
67.	Symplocos macrophylla Wall. ex DC. ssp. sulcata (Kurz) Noot. var. sulcata (Topotypes of Symplocos kerrii Craib var. kerrii and Symplocos rajaniana Craib	Symplocaceae	4
68.	Talauma hodgsonii Hk.f. & Thoms.	Magnoliaceae	29
69.	Tarenna disperma (Hk.f.) Pit.	Rubiaceae	18
70.	Trevesia palmata (Roxb.) Vis.	Araliaceae	4
71.	Turpinia pomifera (Roxb.) Wall. ex DC	Staphyleaceae	36
72.	Viburnum inopinatum Craib (Topotype)	Caprifoliaceae	4
73.	Vitex peduncularis Wall. ex Schauer	Verbenaceae	4
74.	Vitex quinata (Lour.) Will.	Verbenaceae	14
75.	Wendlandia paniculata (Roxb.) DC. ssp. scabra (Kurz) Cowan	Rubiaceae	4
76.	Unknown eg.10.03, 10.04 (plot and tree no.)		7
77.	Unknown eg.19.14 (plot and tree no.)		4

Seed dispersal

Appendix 2. Fruit Characteristics and Dispersal Mechanisms of Tree Species in Lo... Dipterocarp-Oak Forest

Note: NA=Not Available; Fl.=Flowering; Fr.=Fruiting

Species name	Form of fruit	Fruit charac...	Fl. time	Fr. time	Dispersal method
1. Albizia oloratissima	Pod	16-22 by 3.5cm, flat, dull brown ... dehiscent, pendulous. Seeds: 9 by ...	4	10	Wind
2. Anneslea fragrans	Capsule	Light yellowish to pale reddish. S...	11,12,1	5	Birds
3. Aporusa villosa	Drupe	Greenish to red-brownish	2	3	Birds
4. Aporusa wallichii	Drupe	Green	1,2	4	Birds
5. Artocarpus gomeziamus	Syncarp	Axillary, subglobose, lumpy, pedun... green, cream-whitish inside; ripe ... out, 9 X 8cm, flesh sour, somewhat ...	NA	3,6	Bats
6. Bombax malabaricu	Capsule	Open into 4 valves and release very...	1	NA	Wind
7. Buchanania glabra	Drupe	Dark greenish to maroonish	10,12	12	Birds
8. Buchanania latifolia	Drupe	Green to red-brown	1,2	3	Birds
9. Canarium subulatum	Drupe	Glossy light green with dull red-br... light green inside, mostly large, ... hard stony, oblong seed, outer cove...	4,5	6,7	Birds
10. Castanopsis indica	Nut	often resinous, with a carpenting ...			
11. Castanopsis tribuloides	Nut	Nut green to brown, spines sharp	2	7,8	Squirrels,Rodents
12. Catunaregam tomentosa	Drupe	Nut green to brown, thick spines	5	8-1	Squirrels,Rodents
13. Colona flagrocarpa	Winged-fruit	Light green to yellow-greenish outs... pale green-whitish inside	4	8,9	Birds,Bats,Primates
14. Colona floribunda	Drupe	Dull greenish with dull reddish hue...	8	9	Wind
15. Craibiodendron stellatum	Berry	Greenish to dull reddish	9	10,11	Birds
16. Dalbergia dongnaiensis	Winged-pod	Light green, seed area encircled wi...	9	1,2	Birds
17. Dalbergia fusca	Winged-pod	"	3	7	Wind
18. Dillenia aurea var aurea	Berry	Dull greenish to orangish filled wi... seeds light brown	2,3	5,7,11,1	Wind
19. Dillenia parviflora var kerrii	Berry	Light orangish, juice inside with f... 25mm diameter	NA	6	Birds,Bats,Primates
20. Diospyros ehretioides	Drupe	Yellow-green to dull red, endosperm ... shape, 1.5-2.5 by 1-2cm	2,3	4,5	Birds,Bats,Primates
21. Dipterocarpus obtusifolius var ob.	Winged-nut	Nuts light green, lower part of calyx ... lobes red both sides	3-5	4-6	Birds,Bats
22. Dipterocarpus tuberculatus var tu.	Winged-nut	Fruits pendulous, 2 large lobes (wi...	11	2-4	Wind
23. Engelhardia serrata	Winged-nut	Nut more or less enclosed in a cup ... wing; nut dull green, wing light gree...	3	4	Wind
24. Eugenia albiflora	Berry	Green, 20-25 X 12-13mm	1,2	NA	Wind
25. Eugenia cumini	Berry	Light green to dark violet, 7-8mm l...	2-4	5-7	Birds
26. Gardenia scotepensis	Drupe	Dull green outside, whitish-cream p... whitish-cream	3,4	6	Birds
27. Gluta usitata	Winged-fruit	Fruit dull greenish-purplish, fruiti... stalk reddish-greenish, wings red to...	NA	1,4	Birds,Bats,Primates
28. Lagerstroemia macrocarpa var mac.	Capsule	Yellow-greenish with brownish hue at... calyx pale yellow-greenish; seeds br...	2	3,11	Wind
29. Lithocarpus elegans	Nut	Cupules greyish-pale greenish to brow... greenish	3,4	7	Wind
30. Lithocarpus lindleyanus	Nut	"	9	9	Squirrels,Rodents
31. Lithocarpus scotepensis	Nut	"	3,5	9	Squirrels,Rodents
32. Lophopetalum wallichii	Capsule	Have fairly large sameroid seeds in ... ing at top into a number of valves	9	3,9	Squirrels,Rodents
33. Metadina trichotoma	Capsule	Fruiting heads; brownish-dull dark gr...	1,10	NA	Wind
34. Millettia extensa	Pod	Light greenish to brown; dehiscent	1-3	NA	Wind
35. Mitragyna hirsuta	Capsule	Fruiting heads dry; brownish-dull dar...	3,4	11	Wind
			NA	1,10	Wind

36. Oroxylum indicum	Pod	Seed surrounded by a large paper	y transparent wing that is a cir-	MA	3	Wind,Water
		cular shape; seeds stored in gige	ntic sword-like pods usually 3			
		feet long; winged seeds dispersed	to some extent by water; O. indi-			
		cum frequently grows in damp spot	s along edge of river, stream banks;			
		dehiscent				
37. Parinari anamensis	Drupe	Hard, subglobose or ellipsoid; gr	ey-brownish with grey dots outside,	4	4	Bats,Primates
		yellow-green inside; 30-40 by 30	m; 1-2 seeds in each			
38. Phoebe lanceolata	Berry	Light green to blackish		2,3	6,7,9	Birds
39. Pterocarpus macrocarpus	Winged-pod	Fruit and wings yellow-green; see	d area more dull yellowish	MA	4,6	Wind
40. Quercus aliena	Nut	Cupules greyish-pale greenish to	brown. Nut: glossy dark olive-	3	MA	Squirrels,Rodents
		greenish				
41. Quercus brandisiana	Nut	"	"	MA	4	Squirrels,Rodents
42. Quercus kerrii var kerrii	Nut	"	"	4	5,6,8,9	Squirrels,Rodents
43. Quercus lanata	Nut	"	"	1	MA	Squirrels,Rodents
44. Rhus chinensis	Drupe	Orangish to brownish; has citric	haste	8	12,1	Birds
45. Semecarpus cochinchinensis	Drupe	Hypocarp green to yellowish; sof		MA	4	Birds
46. Shorea obtusa	Winged-nut	Usually have larger wings in pro	portion to the fruits	3,4	MA	Wind
47. Shorea siamensis var siamensis	Winged-nut	"	"	2,3	MA	Wind
48. Spatholobus parviflorus	Winged-pod	Fruiting pedicels and upper marg	n of fruit brown; pods pendulous;	7	10,12,1	Wind
		seed area dark brown; wing dull	ellish; indehiscent			
49. Sterculia ornata	Follicle	Light greenish to reddish outsid	, very pale light greenish inside;	1,2	3	Birds
		peduncles yellow-greenish; testa	glossy brown to blackish; fruits			
		consist of 5 carpels which devel	p in the follicles (4-6 inches long),			
		and split septicidally, forming	anceolate, or ovate lanceolate lobes			
		of a brillant scarlet color or o	casionally of a rosy red. Lower edge			
		of opened carpels hang 4 or 5 bl	e-black oblong seeds, which contrast			
		with the scarlet color of the ca	pel. Beneath the thin black outer			
		layer of seed is a very thin, wh	ta, pulpy layer, overlying the hard			
		inner coat of the seed for birds	to eat.			
50. Stereospermum colais	Capsule	Brownish with whitish lenticels;	pendulous	4	12	Wind
51. Stereospermum neurantium	Capsule	" "		6	12	Wind
52. Strychnos nux-vomica	Berry	Green to orangish outside. Seeds	attain a considerable size and are	4	6,8	Birds, Primates
		disc-like with a central hilum.	seeds covered with a juicy, orange			
		flesh				
53. Styrax benzoides	Drupe	Glaucous greyish-very pale light	greenish	5,6	7	Bats,Primates
54. Symplocos racemosa	Drupe	Green to purplish; ellipsoid, 8-	11 by 4-10mm, 2-3 celled; often	11-1	12,3	Bats
		celled; mesocarp fleshy, slight	y juicy; mostly 1 seed			
55. Tectona grandis	Drupe	Globose with a pithy covering en	closed in a bladder-like calyx	9	MA	Birds
56. Terminalia alata	Winged-fruit	Light greenish to dark red; 5-wi	nged	5,6	7,8,10	Wind
57. Terminalia mucronata	Winged-fruit	Greenish to brownish		2,4	10	Wind
58. Tristania rufescens	Capsule	Green		2	3	Wind
59. Vaccinium sprengelii	Berry	Light green to dark reddish to d	ull dark purplish	1,2	4	Birds
60. Vitex canescens	Berry	Glossy dark green to blackish, s	lightly juicy; exocarp forms a 4-	3	4,5	Birds
		chambered stone				
61. Vitex limoniifolia	Berry	" " ; 9-	10mm diameter	8,9	10	Birds
62. Vitex peduncularis	Berry	" " ; 6	X 8mm	5,6	5,7	Birds
63. Wendlandia tinctoria var flor.	Capsule	Fruiting heads; brownish-dull da	rk greenish	1,2	MA	Wind
64. Xylia xylocarpa var kerrii	Pod	Red-brownish; 12-17 by 3.5-6cm,	slightly shaped as a boomerang,	2,3	1	Wind
		tardily dehiscing from apex alon	g both sutures. Seeds; 7-10 seeds;			
		11 by 7mm, ellipsoid, flat				
65. Ziziphus rugosa var rugosa	Berry	Dull green		2	4	Birds

Fruit Characteristics and Dispersal Mechanisms of Tree Species in Pri mary Evergreen Forest

Note: MA=Not Available; Fl.=Flowering; Fr.=Fruiting

Species name	Form of fruit	Fruit char acteristics	Fl. time	Fr. time	Dispersal method
1. Acrocarpus fraxinifolius	Pod	Yellow-green to green to black dark brown; dehiscent; pod: 8-1	1,2	3	Wind
2. Acronychia pedunculata	Drupe	Hard; dark green; aromatic with	8	1,9	Bats,Primates,Rodents
3. Actinodaphine henryi	Berry	Green to blackish	1	MA	Birds
4. Adinandra integerrima	Berry	Dull green to dark purplish	7	7,10,6	Birds,Bats
5. Afgekia filipes	Pod	Valves with brown, velvety indum testa dark brown; dehiscent	2,3	9	Wind
6. Alangium kurzii	Drupe	Light greenish to purplish-black	5	7	Birds
7. Allophyllus cobbe	Berry	Green to orangish to red; juicy;	6-8	9	Birds
8. Alstonia scholaris var scholaris	Pod	Slender pods dehiscing along one oblong seeds. Pods: 12 inches (glabrous except for the tufts of edges. Seed in most of these is tuft of long hairs at each end i	10,12	2,3	Wind
9. Amoora polystachya	Capsule	Pale cream with pinkish hue, spl red; seeds: 25 X 23mm	8,10	3	Birds
10. Antidesma acidum	Berry	Light green to green	5,6	7,10	Birds
11. Antidesma bunius	Berry	Red to purplish-maroon, juicy, 1	MA	6,9	Birds
12. Aporusa dioica	Drupe	Green; 18 X 8mm; aril orangish;	MA	4,8	Birds
13. Artocarpus lanceolata	Drupe	Green to yellow to red; up to 4- common; seeds: whitish	10	5	Bats,Rodents,Birds
14. Baccaurea ramiflora	Drupe	Pale pinkish-red outside, whitis	2,3	5	Bats,Primates
15. Bischofia javanica	Berry	Brown	MA	10	Birds
16. Castanopsis acuminatissima	Nut	Cupules and spines grey-light g	1,12	6,9	Squirrels,Rodents
17. Castanopsis armata	Nut	Cupules light green, nuts brown,	2,3	5,9	Squirrels,Rodents
18. Castanopsis diversifolia	Nut	Covered with dull light yellowis	MA	10	Squirrels,Rodents
19. Castanopsis indica	Nut	Nut green to brown, spines sharp	2	7,9	Squirrels,Rodents
20. Castanopsis tribuloides	Nut	Nut green to brown, thick spines	5	8-1	Squirrels,Rodents
21. Cinnamomum iners	Drupe	Dark green with lighter green do	1,3	3,4	Bats
22. Cleidion spiciflorum	Drupe	Light green; testa cream to dark	1,2	4-6	Birds
23. Combretum punctatum	Winged-fruit	Light greenish to dull reddish:	4,6	6,10,3	Wind
24. Connarus semidecandrus	Capsule	Capsules inflated; light greenis 1.5-3.5 by 1-2cm, the stipe 5-15 pubescent inside; seeds: glossy	2-4	4-6	Birds
25. Cryptocarya aff. ferrea	Berry	Greenish	4	10	Birds
26. Dalbergia stipulacea	Winged-pod	Light green, seed area encircled 4-5cm	4	7,9,11	Wind
27. Dimocarpus longan ssp. lon. var lon.	Drupe	Green to brown; globose, 18-20mm testa dark brown	2-4	7	Bats,Primates,Rodents
28. Elaeocarpus petiolatus	Drupe	Green; ellipsoid; 1.2-2 by 0.8-1	NA	8,9	Birds,Bats,Primates
29. Engelhardia serrata	Winged-nut	Nuts dull green; bracts light gr	1,2	NA	Wind
30. Eriobotrya bengalensis forma ben.	Berry	Light green to green; ovoid; up	11-2	12,1	Birds
31. Eugenia albiflora	Berry	Green, 20-23 X 12-13mm	2-4	5-7	Birds
32. Euonymus similis	Capsule	Light green; The pendent capsule are covered with a sweet orange	7	9	Birds
33. Ficus benjamina var benjamina	Drupe	Figs soft; pea-shaped; dull dark whitish inside	4,12	12,4	Birds,Bats,Primates Squirrels,Rodents
34. Ficus fistulosa var fistulosa	Drupe	Figs ramiflorous, cauliflorous; outside, cream color inside; de to dull dark reddish	2,10	10,2	Birds,Bats,Primates Squirrels,Rodents
35. Garcinia mckeaniana	Drupe	Pedicels, sepals green; fruits l lines from tip to base; ripening 5.5 X 4.5cm; soft; aril light ye	12	4	Bats, Primates

36. Garcinia xanthochymus	Drupe	Green to light yellowish; 6.5 X 7cm; juicy with yellow sap; soft; aril yellow; slightly sour	NA	1	Bats,Primates	
37. Glochidion kerrii var kerrii	Capsule	Pedicels and capsules pale light greenish-whitish to marconish;3-lobed; aril: pink or orange	NA	1,9,10	Birds	
38. Gordonia dalglieshiana	Capsule	Fruiting calyx brownish-greenish; capsules dark greenish to brown; 3-3.5cm long; seeds: 1.3-2cm long including the wing; dehiscent	2	9,10	Wind	
39. Helicia nilagirica	Berry	Green	3,5	10	Birds	
40. Knema conferta	Capsule	Valves tan outside, cream-tan inside; fruits common on ground; dehiscent; aril dark red, juicy; capsule: 23-32 X 16-24cm	0	5	Birds,Rodents,Squirrels	
41. Lithocarpus elegans	Nut	Cupules greyish-pale greenish to brown. Nut: glossy dark olive-greenish	9	9	Squirrels,Rodents	
42. Litsea glutinosa	Berry	Green with minute, paler dots to purplish-black	7,8	6	Birds	
43. Litsea salicifolia	Berry	Glossy dark green to dark red to black	9,11,12	2,3,5,8	Birds	
44. Markhamia stipulata	Pod	Fruit indumentum dull brown; Pod is fuzzy; 35cm long	11,12	3	Wind,Water	
45. Melia toosendan	Drupe	Hard; green outside; whitish-very pale light greenish inside; stone tan	2,3	8,10	Bats,Primates	
46. Melodorum affine	Capsule	Brown-greenish outside; whitish inside; testa blackish	NA	7,9	Birds	
47. Memecylon plebejum var siamense	Berry	Light yellow-greenish to dull orangish	5-8	12,2,5	Birds	
48. Metadina trichotoma	Capsule	Fruiting heads dry; brownish-dull dark greenish	1-3	NA	Wind	
49. Michelia champaca	Capsule	Fruiting carpels free and well-spaced, dehiscing along the dorsal suture; individual carpels woody, ovoid or subglobose; 1-2cm long; green to dull reddish; seed: dull orangish	1	8	Birds	
50. Miliusa cuneata	Berry	Pedicels, stalks, fruits light green	5	10	Birds	
51. Miliusa velutina	Berry	Pedicels, stalks, fruits light greenish-yellow to glossy orangish; 20 X 17mm	NA	6	Birds, Bats	
52. Mischocarpus grandis	Berry	Fruits and stalks glossy dark green	5	7	Birds	
53. Mitrephora maingayi	Berry	Fruits and stalks glossy dark greenish to yellow-orangish	1-3	6,8	Birds,Bats,Primates	
54. Morus macroura	Berry	Green to purplish-black	2,3	NA	Birds	
55. Nyssa javanica	Drupe	Light green to dark red to blackish with minute cream dots	3-5	5-10	Birds,Bats,Primates	
56. Phoebe lanceolata	Berry	Light green to blackish	2,3	6,7,9	Birds	
57. Phoebe sp.	Drupe,Berry	Green to purplish-black; some drupes up to 4.5 X 2.3cm	1,4,6-8	9,12,2,3	Birds(berry) Bats,Primates(drupe)	
58. Phyllanthus roseus	Drupe	Green to purplish-black	1,8,9,11	NA	Birds	
59. Planchonella punctata	Drupe	Light yellowish-greenish to light yellowish; light yellowish inside; 45 X 40mm; testa dark glossy brown	1,5	4,5	Bats,Primates,Rodents	
60. Protium serratum	Drupe	Dull light yellow-greenish to dull dark reddish; white inside;sour; juicy; testa light brown; 1-3 seeded lobed	2,3	6,7,9	Birds	
61. Pterocarpus macrocarpus	Winged-pod	Fruits and wings yellow-green; seed area more dull yellowish;indehiscent	NA	4,6	Wind	
62. Sapium baccatum	Drupe	Dull greenish to maroon to blackish	3	8,9	Birds	
63. Sarcosperma arboreum	Drupe	Glaucous green to dark purple; soft; slightly juicy; juice white to pinkish; 29-30 X 19-20mm; testa tan	1,2	5	Bats,Primates,Rodents	
64. Schima wallichii	Capsule	Green with lighter dots, eventually splitting into five pieces; subglobose; 2-4cm across; silky (when young) to glabrous (when old); seeds: flat	3,4	10,1,2	Wind	
65. Semecarpus cochinchinensis	Drupe	Hypocarp green to yellowish; soft	NA	4	Birds	
66. Styrax benzoides	Drupe	Glaucous greyish-very pale light greenish	5,6	7	Bats,Primates	
67. Symplocos macrophylla ssp sul. var ke.	Drupe	Green, hard; elliptic to cylindrical; 7-9 by 4mm; mesocarp thin;fleshy	9-11	1,2	Bats,Birds	
68. Talauma hodgsonii	Capsule	Infructescence cone-like; scales light green with maroonish-brown dots; Carpels concrescent at least at the base, in fruit woody or cartilaginous, circumscissile, the upper portions separating from the persistent lower portions, and falling away singly or in irregular masses; individual carpels: 2.5cm long; woody; exposing a seed covered in an aril; dehiscent	4	8	Birds	
69. Tarenna disperma	Berry	Dark glossy green to brownish; depressed globose	4,5	9,1	Birds	
70. Trevesia palmata	Berry	Dull greenish	1	5	Birds	
71. Turpinia pomifera	Drupe	Light green to yellowish outside; whitish inside; 35 X 45mm	2,3	6,8	Bats, Primates	

72. Viburnum inopinatum	Berry	Dark reddish-brown		9	5,9-11		Birds
73. Vitex peduncularis	Berry	Glossy dark green to blackish chambered stone; 6 X 3mm	, slightly juicy; exocarp forms a 4-	3,6	5,7		Birds
74. Vitex quinata	Berry	Dull greenish to purplish; e	ocarp fleshy	4	7,8,10,11		Birds
75. Wendlandia paniculata ssp.scabra	Capsule	Fruiting heads; brownish-dul	l dark greenish	3,4	- NA -		Wind

Fruit Characteristics and Dispersal Mechanisms of Tree Species in Mixed Deciduous-Evergreen Forest

Note: NA=Not Available; Fl.=Flowering; Fr.=Fruiting

Species name	Form of fruit	Fruit characteristics	Fl. time	Fr. time	Dispersal method
1. Acacia megaladena var Leg.	Pod	9.5-17 by 1.3-3.5cm, oblong, ... brown, glabrous, dehiscing alo... 5.5mm, ovate-elliptic to ellip...	6,7	10	Wind
2. Afgekia filipes	Pod	Valves with brown, velvety inn... testa dark brown; dehiscent	2,3	9	Wind
3. Aganosma marginata	Follicle	Green with tan lenticels; pend...	4,5	NA	Wind
4. Alangium kurzii	Drupe	Light greenish to purplish-blac...	5	7	Birds
5. Albizia odoratissima	Pod	16-22 by 3.5cm, flat, dull brow... dehiscent, pendulous. Seeds: 9 ...	4	10	Wind
6. Amoora polystachya	Capsule	Pale cream with pinkish hue, sp... bright red; seeds: 25 X 23mm	8,1...	3	Birds
7. Anacolosa ilicoides	Drupe	Yellow to dark red with paler d... juicy and somewhat sweet	7	4,5	Bats,Primates,Birds
8. Anneslea fragrans	Capsule	Light yellowish to pale reddish...	11,1	5	Birds
9. Antidesma acidum	Berry	Light green to green	5	7,10	Birds
10. Antidesma bunius	Berry	Red to purplish-maroon, juicy, ...	M	6,9	Birds
11. Antidesma montanum	Berry	Whitish to red; edible but sour	1,4	9	Birds
12. Antidesma sootepense	Berry	Green to dark red to purple; edi...	5	8,10	Birds
13. Aporusa villosa	Drupe	Greenish to red-brownish		3	Birds
14. Aporusa wallichii	Drupe	Green	1	4	Birds
15. Artocarpus gomeziamus	Syncarp	Axillary, subglobose, lumpy, pe... green, cream-whitish inside; rip... out, 9 X 8cm, flesh sour, somewh...	M	3,6	Bats
16. Baccaurea ramiflora	Drupe	Pale pinkish-red outside, whitis...	2	5	Bats,Primates
17. Bauhinia variegata	Pod	20-30 by 2-2.5cm; dehiscent obli... 10-15mm diameter	2	A	Exploding-device
18. Bombax kerrii	Capsule	Open into 4 valves and release v...	1		Wind
19. Bridelia pubescens	Berry	Light greenish to dark red to da... sap; 12 X 9mm	3-1,4		Birds
20. Canarium subulatum	Drupe	Glossy light green with dull red... light green inside, mostly large, stony, oblong seed, outer coveri... resinous, with a turpentiny taste	4		Birds
21. Canarium sp.	Drupe	Light greenish; stone brown			Bats,Primates,Birds
22. Canthium umbellatum	Berry	Dark green to yellowish; green in...			Birds
23. Cassia bakeriana	Pod	Terete, softly grey to brownish ... 1-1.5cm diameter. Seeds: 30-40, s...			Wind
24. Castanopsis acuminatissima	Nut	Cupules and spines grey-light gre...	1,		Squirrels,Rodents
25. Castanopsis armata	Nut	Cupules light green, nuts brown, ...	2		Squirrels,Rodents
26. Castanopsis diversifolia	Nut	Covered with dull light yellowish	M		Squirrels,Rodents
27. Castanopsis indica	Nut	Nut green to brown, spines sharp			Squirrels,Rodents
28. Castanopsis tribuloides	Nut	Nut green to brown, thick spines			Squirrels,Rodents
29. Catunaregam tomentosa	Drupe	Light green to yellow-greenish out... pale green-whitish inside			Birds,Bats,Primates
30. Celastrus paniculatus	Capsule	Arillate seeds do not hang out fro... sule opens widely to expose the re... yellow valves; very conspicuous; s...	4		Birds
31. Chukrasia velutina	Drupe	Hard, dark red-brown, light greeni...			Bats,Primates
32. Colona flagrocarpa	Winged-fruit	Wings and fruit dull greenish with...	4		Wind
33. Colona floribunda	Drupe	Greenish to dull reddish			Birds
34. Congea tomentosa var tomentosa	Winged-fruit	Has bract wings	2		Wind
35. Craibiodendron stellatum	Berry	Light green, depressed globose fai... ridged when dry	5		Birds

36. Cratoxylum cochinchinensis	Capsule	Seeds: very small and light; dehiscent	NA	4	Wind
37. Croton robustus	Capsule	Green	NA	2,3	Birds
38. Dalbergia dongnaiensis	Winged-pod	Light green, seed area encircled with darker green; indehiscent	3	7	Wind
39. Dalbergia fusca	Winged-pod	" "	2,3	5,7,11,1	Wind
40. Dalbergia stipulacea	Winged-pod	" " ;pods: 4-5cm	4	7,9,11	Wind
41. Dalbergia sp.	Pod	Light green to brown	2-4	4-1	Wind
42. Dimocarpus longan ssp. lou. v r lon.	Drupe	Green to brown; globose, 18-20mm diameter; juicy; aril whitish; testa dark brown	2-4	7	Bats,Primates,Rodents
43. Diospyros ehretioides	Drupe	Yellow-greenish to dull red; pedicel brownish; fruiting calyx greenish; ovoid shape, 1.5-2.5 by 1-2cm; testa brown	3-5	4-7,11,1	Birds,Bats
44. Diospyros ferrea var littorea	Drupe	Fruiting calyx and fruits green; ellipsoid to globose; 1-1.5 by 0.5-1cm	1-4	3-7	Birds,Bats
45. Diospyros pilosanthera	Drupe	Fruiting calyx greenish; fruits tan-greenish with golden brown indumentum; ovoid shape; 2-4 by 1.5-3cm	1-6	3-7	Birds,Bats
46. Diospyros undulata var cratericalyx	Drupe	Fruiting calyx: cup-shaped; calyx and fruits dark greenish; globose, 1.5 by 1.5-2cm; seeds: brown	4-6	3-12	Bats,Primates
47. Dipterocarpus costatus	Winged-nut	One-seeded nut enclosed in a persistent calyx; sepaline winged	12	NA	Wind
48. Dipterocarpus obtusifolius var ob.	Winged-nut	Nuts light green, lower part of calyx lobes yellow-green, enlarged lobes red both sides	11	2-4	Wind
49. Dipterocarpus tuberculatus var tu.	Winged-nut	Fruits pendulous, 2 large lobes (wings) red both sides	3	4	Wind
50. Dipterocarpus turbinatus	Winged-nut	Fruiting calyx tube glaucous green, 3 smaller lobes light yellowish, 2 larger wings red turning brown on both sides	3	5	Wind
51. Elaeocarpus braceanus	Drupe	Dull olive-light greenish; woody; ellipsoid; 3 by 2cm	1-5	1-5	Bats,Birds,Primates
52. Engelhardia serrata	Winged-nut	Nuts dull green; bracts light green to light brown; 3-lobed wing	1,2	NA	Wind
53. Engelhardia spicata var spicata	Winged-nut	" "	12,1,2	2-4	Wind
54. Erycibe subspicata	Berry	Green to blackish; 15 X 10mm; slightly juicy	10	3	Birds
55. Erythrina subumbrans	Pod	Narrow pods containing seeds that float readily due to inborn buoyancy characteristic; dehiscent	1,2	NA	Wind,Water
56. Eugenia albiflora	Berry	Green, 20-23 X 12-13mm	2-4	5-7	Birds
57. Eugenia grata var grata	Berry	Bright white; 12 X 10mm; pithy	4	7	Birds
58. Ficus benjamina var benjamina	Drupe	Figs soft; pea-shaped; dull dark red to purplish-black outside; whitish inside	4,12	12,4	Birds,Bats,Primates, Squirrels,Rodents
59. Ficus fistulosa var fistulosa	Drupe	Figs ramiflorous, cauliflorous; glossy light green to dull dark red outside, cream color inside; depressed globose; peduncles light green to dull dark reddish	2,10	10,2	Birds,Bats,Primates, Squirrels,Rodents
60. Ficus hispida var hispida	Drupe	" "	NA	6	Birds,Bats,Primates, Squirrels,Rodents
61. Flacourtia indica	Berry	Green with paler green lenticels turning dark red to dark purple; juicy; 18-20 X 22-25mm	2,5	5,9	Birds
62. Garcinia cowa	Drupe	Contains 3 to 5 soft seeds; pulpy	2,12	NA	Bats,Primates
63. Garcinia merguensis	Drupe	Green with white sap, latex; pulpy with soft seeds	4	11	Bats,Primates
64. Garcinia speciosa	Drupe	Hard; 4.5-5 X 6cm, green outside, light yellowish inside	2	6,7,1	Bats,Primates
65. Gardenia scotepensis	Drupe	Dull green outside, whitish-cream pulp inside, 50 X 30mm, seeds whitish-cream	NA	1,4	Birds,Bats,Primates
66. Glochidion eriocarpum	Capsule	Light greenish; 6-8 lobed; aril red-orange	4,9,10	9	Birds
67. Gmelina arborea	Drupe	Glossy dark green outside, light green inside; exocarp fleshy, slightly juicy; up to 3 X 2.5cm	2,8	3	Bats,Primates
68. Gnetum montanum	Berry	Green to red; ellipsoid; 1.5 by 1cm	2-5	3-7	Birds
69. Goniothalamus griffithii	Berry	Fruits green to orange; juicy	7	11,12	Birds,Bats
70. Grewia eriocarpa	Berry	Grey-green to dull pale purplish	4-6	9	Birds
71. Heynea trijuga var trijuga	Capsule	Light yellowish to red; aril white; testa black	2,3	11	Birds
72. Holarrhena pubescens	Follicle	Green with tan lenticels; pendulous	3,4	9	Wind
73. Hopea odorata var odorata	Winged-nut	Wings that are only 2 inches long and 0.5 inch wide with pea-sized fruits	3	NA	Wind
74. Ilex umbellulata	Berry	Yellowish to orangish to bright red; 6-7 X 8-9mm diameter; seeds: 2 to 4	4	7,10	Birds
75. Irvingia malayana	Drupe	Glaucous green; large, 6 by 4cm, ellipsoid or ovoid; endocarp very hard; 1 seeded; fleshy with yellow exocarp; seed: white	4,6	7	Bats,Primates
76. Kydia calycina	Capsule	Tan	11	12,1	Wind
77. Lagerstroemia cochinchinensis var ov.	Capsule	Dull brown-greenish; dehiscent; seeds: samaroid type and small	7,9	10	Wind,Water

Lagerstroemia macrocarpa var mac.	Capsule	Yellow-greenish with brownish hue at to; calyx pale yellow-greenish; seeds brown;	, fruiting pedicels and	3,4	7	Wind
79. Lithocarpus elegans	Nut	Cupules greyish-pale greenish to brown. greenish	Nut: glossy dar olive-	9	9	Squirrels, Rodents
80. Lithocarpus linileyanus	Nut	" "		3,5	9	Squirrels, Rodents
81. Lithocarpus sootepensis	Nut	" "		9	3,9	Squirrels, Rodents
82. Litsea salicifolia	Berry	Glossy dark green to dark red to black		3,11,12	2,3,5,8	Birds
83. Litsea sp.	Berry	Green to purplish-black		8-11,12-4	5-8,11,12	Birds
84. Lophopetalum wallichii	Capsule	Have fairly large samaroid seeds in long ing at top into a number of valves	capsules, usually open-	1,10	NA	Wind
85. Luvunga scandens	Drupe	Dark green outside, light greenish inside	a; strong citrus odor	3	7	Bats, Primates
86. Machilus aff. cochinchinensis	Berry	Green to purplish-black		6	NA	Birds
87. Mallotus sp.	Capsule	Green		1-5,9-12	12-8	Birds
88. Mangifera caloneura	Drupe	Green to yellowish to orangish outside; fragrant inside	35 X 28mm; juicy and	2	4	Bats, Primates
89. Markhamia stipulata	Pod	Fruit indumentum dull brown; Pod is fuzz	y; 35 cm long	11,12	3	Wind, Water
90. Meliosma simplicifolia ssp.for. var so.	Berry	Dull greenish		2,3	5,7	Birds
91. Melodorum affine	Capsule	Brown-greenish outside; whitish inside;	testa blackish	NA	7,9	Birds
92. Melodorum oblongum	Capsule	Carpels outside grey-light greenish; red dark brown	brown inside; testa glossy	2,8	5	Birds
93. Memecylon plebejum var siamense	Berry	Light yellow-greenish to dull orangish		5-8	12,2,5	Birds
94. Memecylon scutellatum	Berry	Green		4,7	8-10,2	Birds
95. Metadina trichotoma	Capsule	Fruiting heads; brownish-dull dark green	ish	1-3	NA	Wind
96. Michelia champaca	Capsule	Fruiting carpels free and well-spaced, d suture; individual carpels woody, ovoid green to dull reddish; seeds: dull orang	shissing along the dorsal or subglobose; 1-2cm long; ish	1	8	Birds
97. Millettia caerulea	Pod	Greenish to brown; pods have small hairs	; dehiscent	4,5	7	Wind
98. Millettia extensa	Pod	Light greenish to brown; dehiscent		3,4	11	Wind
99. Millettia sp.	Pod	" "		3-5	7,11	Wind
100. Mischocarpus grandis	Berry	Fruits and stalks glossy dark green		5	7	Birds
101. Mitrephora maingayi	Berry	Fruits and stalks glossy dark greenish t	o yellow-orangish	1-3	6,8	Birds, Bats, Primates
102. Nyssa javanica	Drupe	Light green to dark red to blackish with	minute cream dots	3-5	5-10	Birds, Bats, Primates
103. Olea rosea	Berry	Dull green		3	8,9	Birds
104. Olea salicifolia	Berry	Dark green		1,2,7,9,11	2	Birds
105. Oroxylum indicum	Pod	Seed surrounded by a large papery transp cular shape; seeds stored in gigantic sw feet long; winged seeds dispersed to som cum frequently grows in damp spots along dehiscent	arent wing that is a cir- ord-like pods usually 3 extent by water; O. indi- edge of river, stream banks;	NA	3	Wind, Water
106. Pavetta petiolaris	Berry	Light green to blackish		7	11	Birds
107. Phoebe lanceolata	Berry	Light green to blackish		2,3	6,7,9	Birds
108. Phyllanthus emblica	Drupe	Hard, globose with 4-6 hard cocci, (each 19-20mm; yellow-greenish; sour	containing 1 seed); 22-23	2,3	9,11	Birds
109. Phyllanthus roseus	Drupe	Green to purplish-black		1,8,9,11	NA	Birds
110. Protium serratum	Drupe	Dull light yellow-greenish to dull dark juicy; testa light brown; 1-3 seeded lo	reddish; white inside; sour; seed	2,3	6,7,9	Birds
111. Pterolobium macropterum	Winged-pod	Stalked above the receptacle (2-3mm); se dorsal margin of the pod-wing 35-40mm lo the base and enlarged towards the middle pod green, fruit wing dull reddish	ed-bearing part 20 by 12mm; ng; the wing narrowed towards ; indehiscent; seed area of	3-4	4-6	Wind
112. Quercus brandisiana	Nut	Cupules greyish-pale greenish to brown. greenish	Nut: glossy dark olive-	NA	4	Squirrels, Rodents
113. Quercus kerrii var kerrii	Nut	" "		4	5,6,8,9	Squirrels, Rodents
114. Quercus kingiana	Nut	" "		NA	4	Squirrels, Rodents
115. Randia scotepensis	Drupe	Dull greenish to dark brown-blackish ou black inside; hard	tside; cream to greenish-	2	9,12,1	Birds, Bats, Primates
116. Rapanea neriifolia var yunn.	Drupe	Dull dark greenish		1	12,1	Birds, Bats, Primates

117. Schima wallichii	Capsule	Green with lighter dots, eventually splitting into five pieces; subglobose; 2-4cm across; silky (when young) to glabrous (when old); seeds:flat	3,4	10,1,2	Wind	
118. Scleropyrum wallichianum var siam.	Drupe	Dark green	2,3	4,7	Birds,Bats,Primates	
119. Semecarpus cochinchinensis	Drupe	Hypocarp green to yellowish; soft	NA	4	Birds	
120. Shorea obtusa	Winged-nut	Usually have larger wings in proportion to the fruits	3,4	NA	Wind	
121. Shorea roxburghii	Winged-nut	Green; all wings yellow-green with more greenish main venation; calyx becomes dull red-brown	1,2	3	Wind	
		" "	2,3	NA	Wind	
122. Shorea siamensis var. siamensis	Winged-nut		7	10,12,1	Wind	
123. Spatholobus parviflorus	Winged-pod	Fruiting pedicels and upper margin of fruit brown; pods pendulous; seed area dark brown; wing dull reddish; indehiscent	1,3	4	Wind	
124. Sphenodesme pentandra var. wallic.	Winged-fruit	Fruits dark brownish; bracts (wings) light green; fruiting calyx greenish and becoming light brown	2	3,6,8	Squirrels,Primates Bats	
125. Spondias axillaris	Drupe	Green to light yellow outside; whitish inside; 20-22 X 17-18mm;	NA	4	Birds	
126. Sterculia angustifolia	Follicle	Bright red; testa dull blackish; aril	4	12	Wind	
127. Stereospermum colais	Capsule	Brownish with whitish lenticels; pendulous	6	12	Wind	
128. Stereospermum neuranthum	Capsule	" "	5,6	7	Bats,Primates	
129. Styrax benzoides	Drupe	Glaucous greyish-very pale light greenish	4,5	9,1	Birds	
130. Tarenna disperma	Berry	Dark glossy green to brownish; depressed globose	9	NA	Birds	
131. Tectona grandis	Drupe	Globose with a pithy covering enclosed in a bladder-like calyx	2,4	10	Wind	
132. Terminalia mucronata	Winged-fruit	Greenish to brownish	5	9	Birds	
133. Ternstroemia gymnanthera	Berry	Green to red-brown; ovoid or subglobose; up to 1.5 by 1.2cm	5	7,10-12	Birds	
134. Tetrastigma serrulatum	Berry	Brownish to reddish to maroon-purplish; 12-13 X 9-10mm; juicy	2	5	Wind	
135. Toona microcarpa	Capsule	Yellow-greenish to dark brown with brown lenticels outside; Stramineous inside; seeds and its wings are white; dehiscent	3	3,10	Birds	
136. Trema orientalis	Berry	Dark green to black; 4-5mm diameter	2	3	Wind	
137. Tristania rufescens	Capsule	Green	2,3	6,8	Bats,Primates	
138. Turpinia pomifera	Drupe	Light green to yellowish outside; whitish inside; 35 X 45mm.				

139. Vaccinium sprengelii	Berry	Light green to dark reddish to dull dark purplish	1,2	4	Birds	
140. Viburnum inopinatum	Berry	Dark reddish-brown	9	5,9-11	Birds	
141. Vitex limoniifolia	Berry	Glossy dark green to blackish, slightly juicy; exocarp forms a 4-chambered stone; 9-10mm diameter	8,9	10	Birds	
		" " ; 6 X 8mm	3,6	5,7	Birds	
142. Vitex peduncularis	Berry		2,4,6	7	Birds	
143. Walsura intermedia	Berry	Yellow-green to dull reddish; whitish inside	1,2	NA	Wind	
144. Wendlandia tinctoria var flor.	Capsule	Fruiting heads; brownish-dull dark greenish	3	4,6	Primates,Bats,Rodents	
145. Xanthophyllum flavescens	Drupe	Hard; green; usually found on ground	4	4,5	Primates,Bats,Rodents	
146. Xanthophyllum virens	Drupe	Dull grey-greenish outside; light yellowish inside; 20-23 X 16-18mm; fruits on the ground	2,3	1	Wind	
147. Xylia xylocarpa var kerrii	Pod	Red-brownish; 12-17 by 3.5-6cm, slightly shaped as a boomerang, tardily dehiscing from apex along both sutures. Seeds: 7-10 seeds; 11 by 7mm, ellipsoid, flat	2	4	Birds	
148. Ziziphus rugosa var rugosa	Berry	Dull green				