CHAPTER 2
SITE DESCRIPTIONS

2.1 Northern Thailand

2.1.1 Geography

Northern Thailand lies between 17 and 20° N. It is dominated by four mountain ranges running roughly north-south, intersected and separated by valleys and flood-plains (Figure 2.1, map). Most of the mountains are less than 2,000 m high and rock types are diverse, including shale, granite and limestone. Soils are mostly either red-yellow to red-brown podzols or reddish brown laterites (Santisuk, 1988).

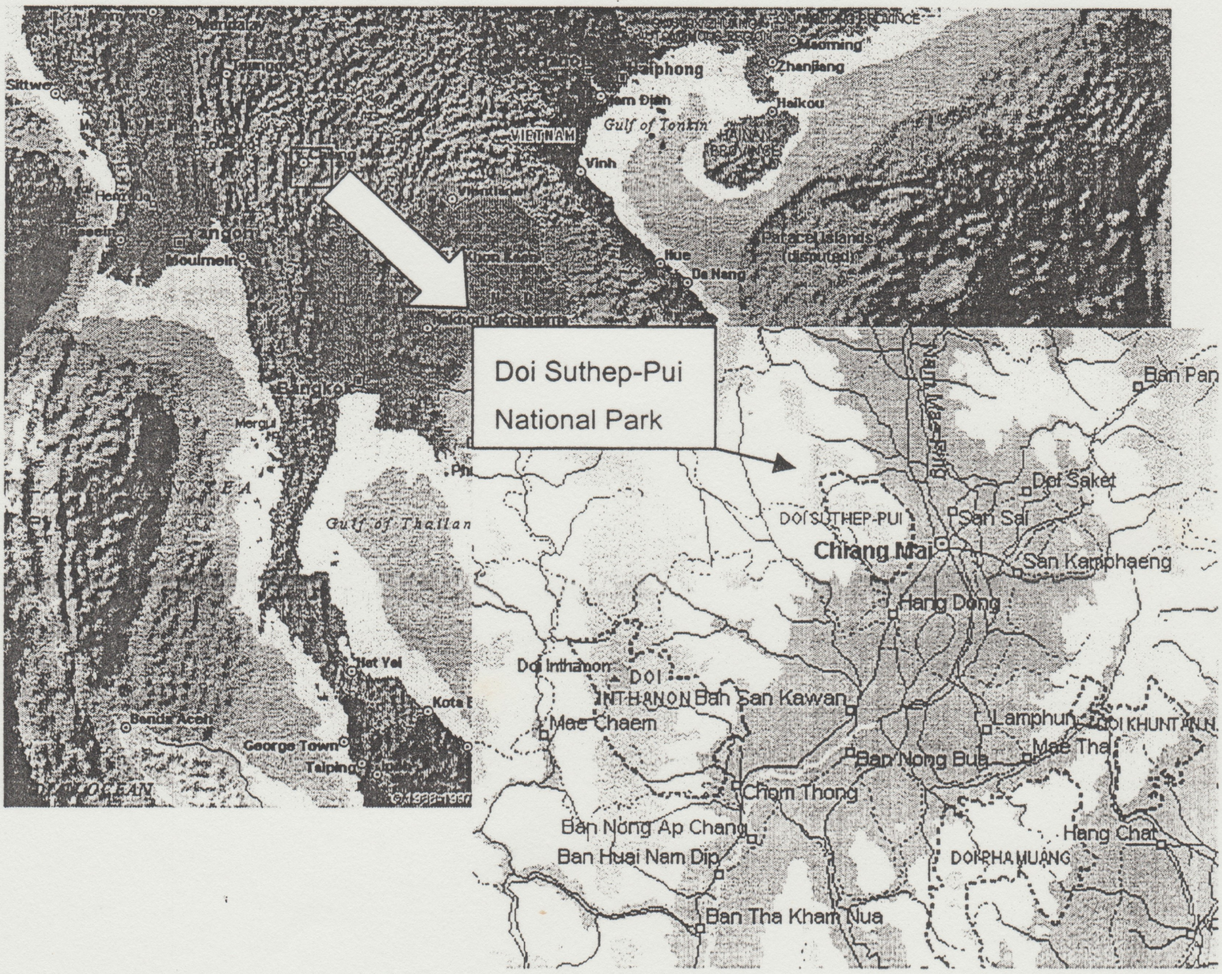


Fig. 2.1. Map of Thailand with Doi Suthep-Pui National Park inset.

2.1.2 Climate

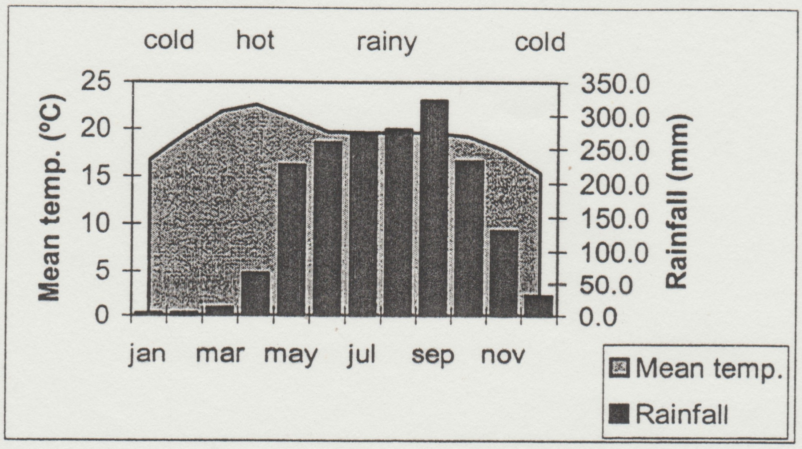
The region is within the seasonally dry climatic zone (Santisuk, 1988); most of the rainfall is restricted to six or seven months of the year (Fig. 2.2c). Throughout northern Thailand there are three seasons. The **rainy season** starts in April or May and lasts until October or November. During this period temperatures are moderate and humidity is high (Figs. 2.2a and b). It is followed by the **cold season**, a period of cool, mostly rain-free weather lasting until about mid-February, when the **hot season** begins: the temperature suddenly rises while humidity continues to fall due to the lack of rainfall. The hot season lasts until rain returns in April or May, causing a fall in temperature and a rise in humidity.

Average temperatures and total rainfall vary widely depending on elevation and local topography. In Doi Suthep-Pui National Park, northern Thailand, mean annual precipitation ranges from c. 1000 mm near the base of the mountain to c. 2000 mm near the summit. Mean minimum and maximum monthly temperatures are 9.2 and 40.3 °C in the lowlands, 5.0 and 35.5 °C in the highlands (Elliott *et al*, 1989). Although geographically in the tropics, the climate of the highlands is not "tropical" *sensu* Richards (1992) as the mean temperature in the coldest month is below 18°C. However, neither is it temperate as it is subject to a tropical insolation regime (Whitmore, 1984). It is best described by the term "tropical montane", as used by Whitmore (1984).

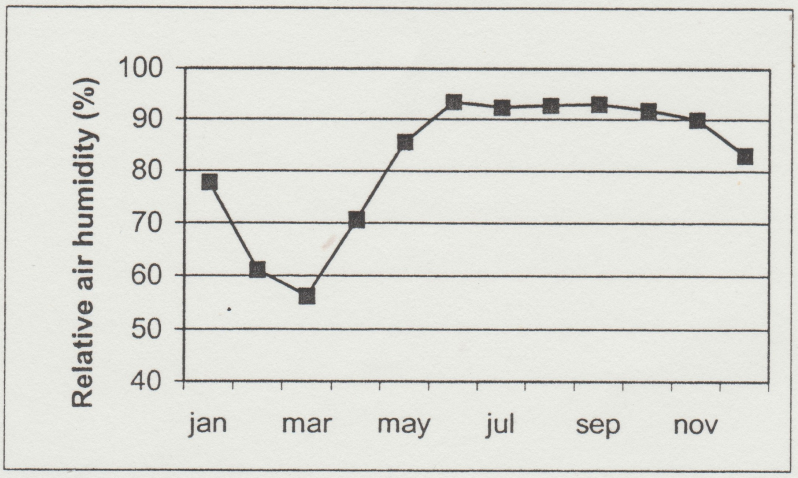
The regularity in length and timing of the dry period can be assessed by comparing the mean number of dry months occurring over several years (DMi), with the number of dry months as indicated by average monthly rainfall figures (DM), Richards (1992). Richards defined a dry month as having less than 100 mm of precipitation. A large disparity between DMi and DM indicates high variation. Monthly rainfall data for 1980 to 1988 at 1400 m a.m.s.l. in Doi Suthep-Pui National Park (Kasetsart University Research Station, see Fig. 2.2c), gave a DMi of 5.2 and DM of 5 months.

Comparison with the tropical rain forest localities described by Richards showed that the highlands of northern Thailand have a relatively long and regular dry season, although its length can vary by about a month at each end.

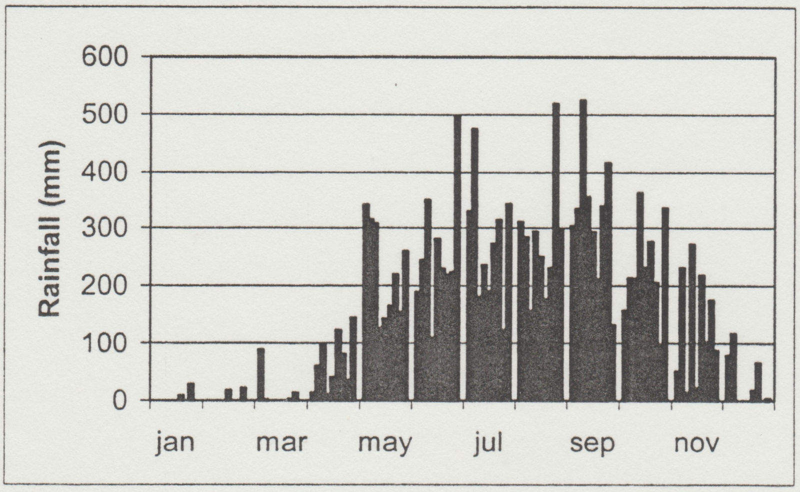
During the study period total rainfall was near average in 1995 and 1996, but somewhat greater than average in 1994 (Fig 2.3a). The distribution of rainfall was rather atypical in each year, with unseasonal rain during the dry seasons of 1994 and 1996, and exceptionally heavy rain at the end of the rainy season in 1995 (Fig. 2.3b).



a) Mean monthly temperature and rainfall, 1980 to 1988



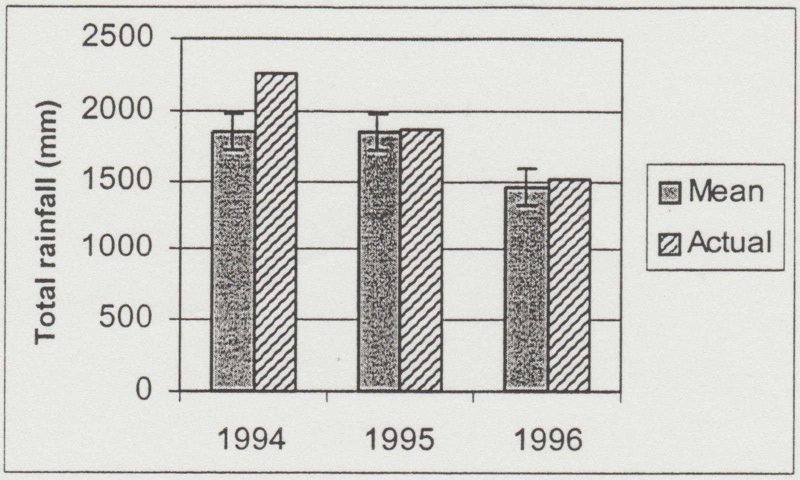
b) Mean monthly humidity for 1982 to 1987



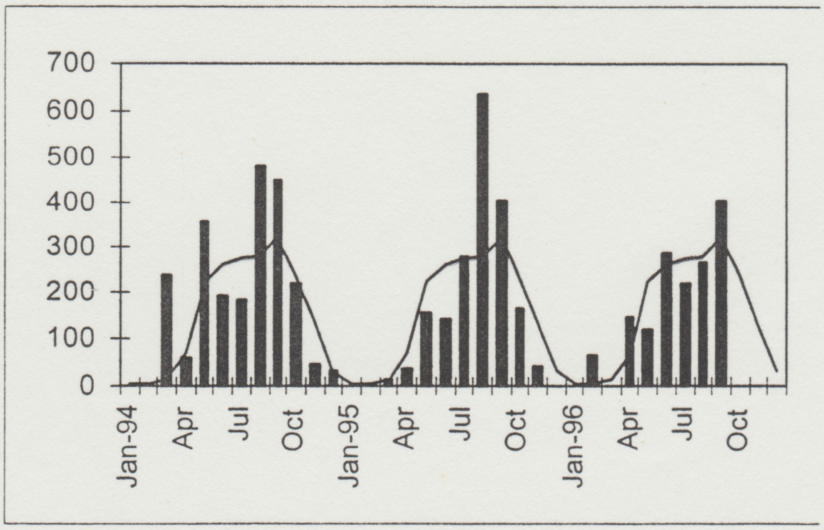
c) Monthly rainfall for each year, 1980 to 1988.

Fig. 2.2. Seasonal fluctuations in temperature, humidity and rainfall on in Doi Suthep-Pui National Park, Chiang Mai Province.

Source: Kasetsart University Research Station, at 1400 m in Doi Suthep-Pui National Park.



a) Annual total rainfall, January 1994 to September 1996 compared with mean total rainfall, 1980 to 1988. Solid columns and bars show the mean and standard error of total rainfall over eight years. Mean and actual rainfall for 1996 is to September only, when the study terminated.



b) Monthly rainfall, January 1994 to September 1996. Line is average rainfall for 1980 –1988, bars are actual rainfall.

Fig. 2.3. Rainfall during study period near summit of Doi Pui.

Source: Kasetsart University Research Station, at 1400 m in Doi Suthep-Pui National Park.

2.1.3 Vegetation

Northern Thailand is botanically very diverse as it lies at the meeting point of several distinct biogeographical areas - the Himalayas, Yunnan, Indo-China and Malaysia (Maxwell, 1988). The wide range of altitude-related microclimates can support a spectrum of species with diverse environmental requirements. These factors result in a mixture of typically temperate families (e.g. Aceraceae, Magnoliaceae and Rosaceae, Sayer *et al*, 1992) and typically tropical families (e.g. Dipterocarpaceae). The precise size of Thailand's flora is not yet known as the Flora of Thailand is incomplete, but there are thought to be between 10,000 and 15,000 species (Sayer *et al*, 1992).

In the moisture stressed lowlands the dominant forest type is monsoon forest, *sensu* Schimper (1903), which is "more or less leafless during the dry season, especially towards its termination". In the cooler, more mesic highlands most of the trees are evergreen and the forest is tropical montane rain forest, *sensu* Whitmore (1984). Within each major forest type there are various distinct formations depending primarily on microclimate (especially moisture availability) and the degree of anthropogenic disturbance (see 2.3.2).

2.2 Doi Suthep-Pui National Park

2.2.1 General description

This study was carried out in Doi Suthep-Pui National Park (DSPNP), Chiang Mai Province, northern Thailand, at 18°50'N, 98°50'E. The national park was established in 1981 and is 261 km^2 in area (IUCN, 1994). Most of the park is on the slopes of a twin peaked mountain, Doi Suthep and Doi Pui, of which the highest peak is Doi Pui, rising from 350 m to 1,685 m a.m.s.l.. "Doi Pui" means "Mount Fluffy" in Thai, the name probably alluding to the fact that the peak is often obscured by clouds during the rainy season. As a result of the rainfall gradient between the top and the bottom of the mountain (see 2.2.1) the drier lower slopes are covered in deciduous forest and the moister slopes above 850 to 950 m support predominantly evergreen forest (Maxwell, 1988). The western slopes of the mountain are severely disturbed while the eastern slopes are still largely intact although degraded by long-term agriculture and fire in some areas.

2.2.2 Forest types on Doi Suthep-Pui

The deciduous forest on the lower slopes of Doi Suthep-Pui is monsoon forest, *sensu* Schimper (1903). Its structure and formation varies between the two following types, probably depending on soil moisture availability during the dry season (Elliott *et al*, 1989). Xeric areas are dominated by deciduous dipterocarp forest (*sensu* Santisuk, 1988) which is here 88% deciduous and characterised by species including *Aporusa villosa* (Lindl.) Baill., *Shorea* *siamensis* Miq. var. *siamensis* and *Dipterocarpus obtusifolius* Teijsm. Ex Miq. var. *obtusifolius* (Elliott *et al*, 1989). Mesic areas are dominated by tropical mixed deciduous forest (*sensu* Santisuk, 1988) which is here 50% deciduous and is characterised by species including *Antidesma acidum* Retz., *Metadina trichotoma* (A. & M.) Naud. and *Vitex peduncularis* (Wall. Ex Schauer), (Elliott *et al*, 1989).

Maxwell (1988) calls the undisturbed forest above c. 900 m primary evergreen forest. A minority of the tree species are deciduous, but most of these lose their leaves only briefly, so the forest appears constantly green. The undisturbed evergreen forest below 1,800 m is classed as lower montane rain forest by Santisuk (1988). Typical characteristics of this formation are a high, dense, continuous canopy, a three layered structure poor in undergrowth and a predominance of the families Fagaceae, Lauraceae, Magnoliaceae and Theaceae (Santisuk, 1988). In places where the forest has been disturbed, especially by shifting agriculture and fire, Santisuk classes the forest as lower montane oak forest. Here the common families are similar to those in lower montane rain forest, although Fagaceae is much more prevalent. Indicator species are *Castanopsis tribuloides* and *Castanopsis acuminatissima* (both Fagaceae), *Betula alnoides*, *Carpinus viminea* (both Betulaceae) and *Engelhardia spicata* (Juglandaceae). The canopy may be closed or open, depending on the degree of disturbance. In this thesis, these formations will be referred to as simply “evergreen forest”.

2.2.3 Fire

The monsoon forest on the lower slopes is regularly burnt by man during the dry season. Reasons for burning may include clearance of the forest floor to facilitate hunting and to promote the growth of certain edible plants, clearance of roadside vegetation and careless disposal of cigarettes (Stott, 1986). The dominant deciduous tree species can tolerate some fire due to features including thick bark on the trunk and the lateral roots, the ability to coppice after fire and fruiting phenology which avoids fire-prone periods (Stott, 1986). However, the fires sometimes spread into evergreen forest areas where the tree species mostly lack such protective features. Fire damaged evergreen forest is characterised by discontinuous canopy cover and a predominance of grass in the understorey, features typical of the lowland deciduous forest.

2.2.4 Fauna

Many of the larger mammals and birds have disappeared from DSPNP including sambar deer (*Cervus unicolor*), bear (*Selenarctos thibetanus*), primates (*Hylobates lar, Presbytis phayrei* and *Nycticebus coucang*) (Elliott *et al*, 1989a) and five species of hornbills (Round, 1984). About 61 mammal species remain (Elliott *et al*, 1989b), of which the largest is the barking deer (*Muntiacus muntjak*), now very rare (pers.obs.).

2.3 Study sites

2.3.1 Site selection

Sites were required where the processes of succession (seed production, seed dispersal, germination and seedling establishment) could be monitored using permanent seed traps and plots. Three abandoned agricultural clearings and their adjacent forests (Sites 1,2 and 3) were selected, based on the following criteria:

- The clearings should be relatively homogenous and completely free of remnant forest trees.
- The clearings should be actively and measurably regenerating and be free of absolute limiting factors such as constant disturbance and absence of seed source.
- In the absence of data on the effect of clearing size on regeneration at this scale, the size criterion was that the central area should receive direct solar irradiation for the greater part of the day. In the literature on the effect of clearing size on succession, the dimensions of large gaps are either not stated (e.g. Raich and Gong, 1990) or they are too small to be relevant (e.g. Kennedy, 1991, whose largest gap was only 0.1 ha, smaller than most agricultural clearings, pers.obs. and Uhl *et al*, 1990).
- The clearing should be adjacent to relatively undisturbed forest to serve as a seed source and to provide a contrasting microenvironment in which to compare regeneration.
- There should be easy access for regular monitoring.

Seedling transplant experiments were carried out at Site 1 and Site 4. The following selection criteria were most important:

- Sufficient space to do the experiment
- Lack of shading from trees
- Lack of disturbance.

2.3.2 Description of clearings at survey sites

The soil analysis results (Table 2.1) were obtained from analysis of bulked samples taken from the top 10 cm of soil at each permanent plot (three from each edge and six from the clearing centre and forest at each site). The Agriculture Department of Chiang Mai University did the analyses.

Table 2.1. Results of soil analysis (top 10 cm)[a]

	Site 1				Site 2				Site 3			
ZONE[a]	F	S	N	C	F	S	N	C	F	S	N	C
PH	6.5	6.4	6.1	6.3	5.3	5.7	5.5	5.8	5.8	5.8	5.8	6.0
sand(%)	67	75	73	73	61	67	67	73	62	57	56	60
silt (%)	24	16	17	15	17	21	17	16	20	18	14	21
clay (%)	9	9	10	12	22	12	16	11	18	25	30	19
Texture	sandy loam	sandy loam	sandy loam	sandy loam	sandy clay loam	sandy loam	sandy loam	sandy loam	sandy loam	sandy clay loam	sandy clay loam	sandy loam
OM (%)	13	12	13	11	12	9	8	9	10	8	8	7
N (%)	0.56	0.46	0.50	0.43	0.49	0.46	0.40	0.44	0.47	0.36	0.37	0.31
P (ppm)	28	29	12	39	3.5	9.5	10	13	6.5	8.5	31	14
k (ppm)	190	240	145	240	90	155	140	185	200	110	200	315

[a] F=forest; S=south edge of clearing; N=north edge of clearing; C=centre of clearing.

2.3.2.1 *Clearing at Site 1*

Site 1 was situated near the summit of Doi Pui. It was the highest site (Table 2.2) and the furthest from the village. The clearing was surrounded by forest although on one side it was highly disturbed in places. The clearing was originally created to grow maize and fruit trees in about 1961, 33 years before the beginning of the study and was then abandoned 12 years before the project began (D. Nimnoo, RFD, personal communication, 1996). After abandonment, both the clearing and surrounding forest were burnt occasionally, the last fire occurring in the dry season of 1993, a year before the start of the project (N. Chaleerat, RFD, pers. comm., 1996). The widespread grass, *Imperata cylindrica* (L.) P. Beauv. var. *major* (Nees) C.E. Hubb. ex Hubb. & Vaugh. (Gramineae), at the northern end of the clearing and in its adjacent forest indicated that the fire was probably restricted to this end. The area was not burnt again during the study.

Eupatorium adenophorum Spreng. (Compositae) was the dominant species in the clearing. Also significant were *Imperata cylindrica* at the northern end (see above) and bracken, *Pteridium aquilinum* (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try. (Dennstaedtiaceae). There were several clumps of tall broom grass, *Thysanolaena latifolia* (Roxb. ex Horn.) Honda (Gramineae). A sparse scattering of small pioneer trees had established, mostly *Debregeasia longifolia* (Burm. f.) Wedd. (Urticaceae) and *Trema orientalis* (L.) Bl. (Ulmaceae). There were also a few isolated, abandoned fruit trees remaining from the period of agricultural use.

Table 2.2. Summary of general information about Sites 1,2 and 3

	Site 1	Site 2	Site 3
Last known disturbance	Partially burnt 1 year before study	Maize grown 6 years before study	Cut 1 year before and burnt during study
Elevation	1,500 m	1,300 m	1,200 m
Length	160 m	100 m	60 m
Narrowest width	50 m	40 m	30 m + (cleared areas to each side)
Approx. area of clearing	0.9 ha	0.5 ha	0.2 ha +
Steepest slopes:			
Forest	35°	30°	22°
Edge	27°	27°	25°
Centre	21°	12°	17°
Aspect	South-east	South-east	East
Soil types in top 30 cm	Sandy loam	Sandy loam and sandy clay loam	Sandy loam, sandy clay loam and loam
O.M. content in top 10 cm (%):			
Forest	13	12	10
Edge	13	9	8
Centre	11	9	7
Vegetation around clearing	Mostly forest, some disturbed areas	Forest	Forest, orchards and disturbed areas
Dominant vegetation in clearing	*Eupatorium denophorum* Pteridium aquilinum Imperata cylindrica Secondary trees & shrubs	*Eupatorium adenophorum* *Pteridium aquilinum* Imperata cylindrica Secondary trees & shrubs	Pteridium aqulinum Imperata cylindrica

2.3.2.2 Clearing at Site 2

Site 2 was near the village of Chiang Kien. The clearing was in a shallow valley with forest on the surrounding slopes, although on one side the forest was less than 100 m wide, separating the clearing from the village. The soil in the clearing was a sandy loam, with higher sand content and lower clay content than the forest soil. The difference may have been due to sand being washed down from the slopes into the valley bottom.

The detailed history of this clearing is unknown, although its close proximity to the village suggests that it may have been originally cleared when the village was established about 60 years ago. The clearing had been left fallow since the last crop of maize 6 years prior to the study (S. Elliott, Chiang Mai University, pers. comm., 1994). Both clearing and forest had been protected from fire during this period, presumably because of the nearness of the village.

The composition of the vegetation in the Site 2 clearing was similar to that at Site 1, with *Eupatorium adenophorum* being the dominant species and *Imperata cylindrica* and *Pteridium aquilinum* being common. At the beginning of the study a few small secondary trees had begun to establish, mostly near the edge, in particular *Macaranga denticulata* (Bl.) M.-A., *Macaranga kurzii* (O.K.) Pax & Hoffm. (both Euphorbiaceae) and *Trema orientalis* (L.) Bl. (Ulmaceae). By the end of the study two years later these were about six metres high. A few remnant coffee bushes were present and at the eastern end (not used in the study) there were isolated citrus and guava (*Psidium guavaja* L.) trees.

2.3.2.3 Clearing at Site 3

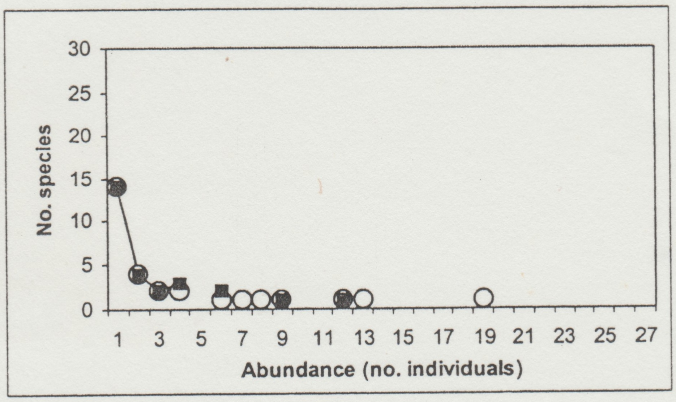
Site 3 was the lowest site in the most deforested area. It was situated about 2 km away from Site 2 and the village, on the periphery of the village's agricultural land. The clearing sloped down to the east, with secondary scrub and orchards above and a dirt road and another orchard below. A c.30-m-wide strip of forest bordering a gully was on the north side and forest lay to the south. The soil was a mixture of loam, sandy loam and sandy clay loam.

The land was first cleared about 31 years before the start of the study and agriculture ceased about 10 years before. It was burnt 4 years prior to the study and cut 1 year before to harvest grass for thatch (Kuhn Naeng, Hmong villager, pers.comm., 1994). In March 1994, 1 year into the study, a fire burnt evenly across the whole clearing, but did not enter the forest. Although it was not a planned part of the study, it enabled the after-effects of fire to be included in the research.

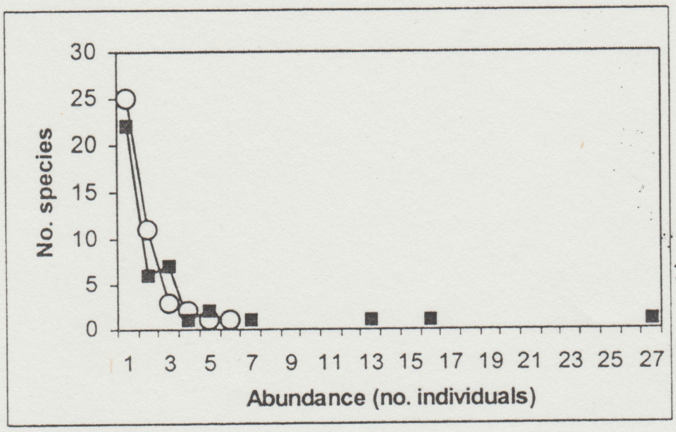
The Site 3 clearing was at an earlier successional stage than the other 2 clearings. At the beginning of the study, it was dominated by grass and ferns (*Pteridium aquilinum* and *Imperata cylindrica*), a sign of its history of frequent disturbance. There were also a few scattered, mostly immature *Rhus chinensis* Mill. (Anacardiaceae) trees. Secondary vegetation was a little more advanced at the northern edge of the clearing, with *Thysanolaena latifolia* and *Eupatorium adenophorum* predominant. After the fire *Imperata cylindrica* increased its dominance thoughout the site and *Pteridium aquilinum* remained significant. The aerial parts of the *Rhus chinensis* trees were destroyed but vigorous basal shoots were rapidly produced.

2.3.3 Description of forest at survey sites

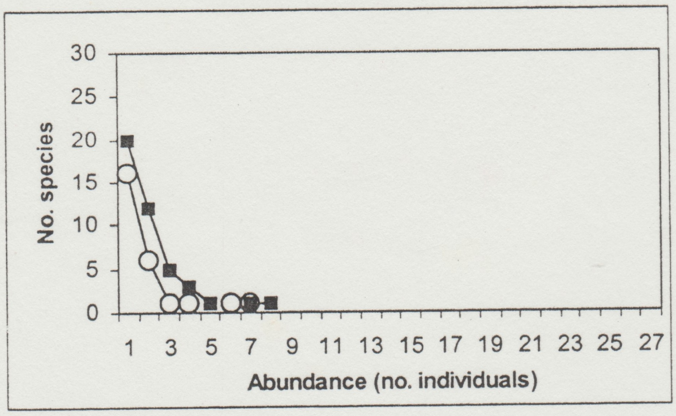
At each site, seed production, dispersal, germination and seedling establishment were monitored in the area of forest adjacent to the clearing. Although diverse in the ways described below, the forest at all sites was predominantly evergreen, with many rare species and few common species (Fig.2.4). The descriptive statistics in Tables 2.3 and 2.4 are based on data from circular, 10-m-diameter forest phenology plots, as described in Chapter 4. The percentage incidence of multi-stemmed and deciduous trees is based on numbers of individuals rather than basal areas, because basal areas were heavily influenced by a few very large trees. Lists of the most abundant species at each site are presented in Chapter 4.



a) Site 1: forest edge and interior



b) Site 2: forest edge and interior



c) Site 3: forest edge and interior

■ =forest interior plots (at least 10 m from clearing) ○ = forest edge plots (within 10 m of clearing)

Fig. 2.4. Frequency distribution of species at each site. Site 1: interior, n=73, edge, n=110; Site 2: interior, n=132, edge, n=75; Site 3, interior, n=91, edge, n=48.

Table 2.3 Details of tree species composition of forest at Sites 1,2 and 3[a]

	Site 1	Site 2	Site 3
Number of species	27	42	43
Species diversity Index (Hills's,N1)	18.6	22.5	34.6
4 most abundant families in terms of no. individuals (no. species)	Lauraceae (5)	Fagaceae (6)	Fagaceae (3)
	Fagaceae (2)	Styraceae (1)	Compositae (1)
	Proteaceae (2)	Theaceae (5)	Euphorbiaceae (4)
	Compositae (1)	Lauraceae (5)	Theaceae (4)

[a] Data from 12 circular 10-m-diameter plots at each site, situated at least 10 m away from clearing edge (see Chapter 4).

Table 2.4 Details of forest structure at Sites 1,2 and 3[a].

a) Interior forest: 10 – 100 m away from clearing.

	Site 1	Site 2	Site 3
Density (trees ha^{-1})	777	1,404	968
Girth at breast height, mean ±SE (cm)	61 ± 6.6	36 ± 3.8	45 ± 4.9
Multi-stemmed trees (% of total individuals)	15	8	10
Deciduous trees[b] (% of total individuals)	12	5	12

b) Edge forest: 10-m-wide strip around clearing

	Site 1	Site 2	Site 3
Density (trees ha^{-1})	1,170	1,596	1,021
Girth at breast height, mean ±SE (cm)	44 ± 4.1	43 ± 5.1	50 ± 8.6
Multi-stemmed trees (% of total individuals)	25	3	23
Deciduous trees (% of total individuals)	25	12	21

[a] Data from circular 10-m-diameter plots at each site. Inner forest: n = 12. Edge forest: Site 1, n = 12. Sites 2 and 3, n = 6.

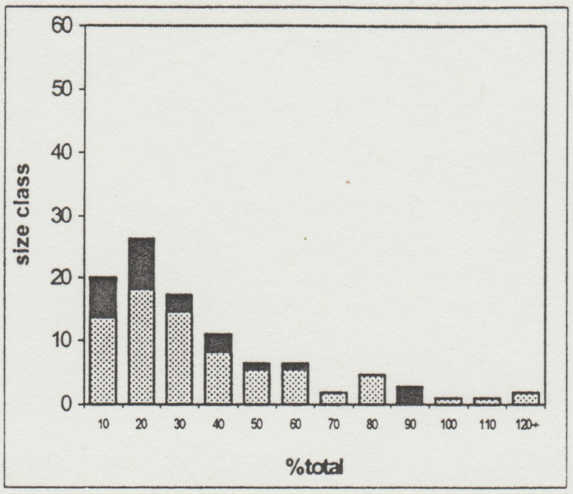
[b] Species listed in Chiang Mai University Biology Department's Doi Suthep database as deciduous or deciduous / evergreen.

2.3.3.1 Forest at Site 1

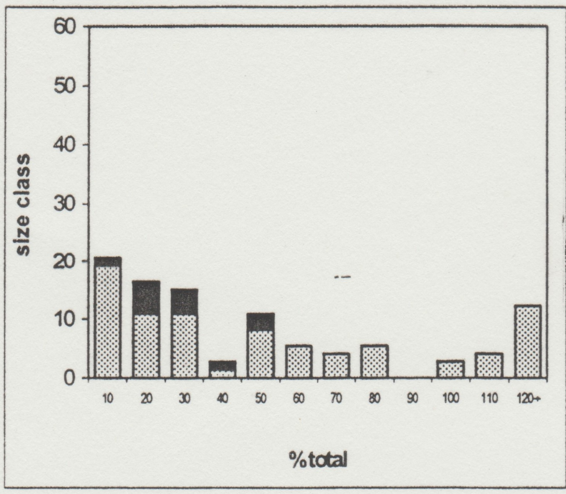
The structure of the forest at site 1 was heterogeneous: highly disturbed by fire, open and grassy in some areas, less disturbed with a continuous canopy in others. The interior forest (i.e. at least 10 m away from the clearing edge) was the least dense of the three monitoring sites (Table 2.4a), largely due to the extensive disturbance. It also had the lowest species richness and diversity, a characteristic partly attributable to its elevation: in DSPNP, species richness decreases with elevation between about 700 m and the summit of the mountain (unpublished data, CMU database). Throughout, the canopy was dominated by evergreen species such as *Castanopsis diversifolia* King ex Hk. f. (Fagaceae) and *Helicia nilagirica* Bedd. (Proteaceae), but also included a few deciduous species (12% of all individual trees in the interior forest, Table 2.4), such as *Engelhardia spicata* Lechen. ex Bl. var. *spicata* (Juglandaceae). As at all sites, the proportion of deciduous trees was higher at the clearing edge than in the interior forest, indicating that disturbance favours deciduous species. In the interior forest there were more multi-stemmed trees than in Sites 2 and 3 (Table 2.4a and Fig. 2.5a), due to an abundance of small, multi-stemmed, evergreen species including *Vernonia volkameriifolia* DC. var. *volkameriifolia* (Compositae) and *Saurauia roxburghii* Wall. (Saurauiaceae). The species composition largely corresponded with Santisuk's lower montane oak forest (*sensu* Santisuk, 1988, see section 2.2.2 this thesis).

2.3.3.2 Forest at Site 2

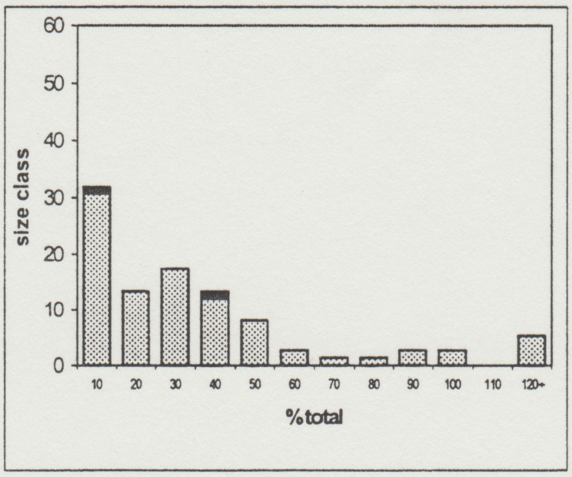
The community living in the village adjacent to Site 2 made use of the forest, removing many of the larger trees for timber and protecting the forest from fire. This encouraged the growth of saplings and consequently the forest at Site 2 was denser than at the other two sites and the average girth at breast height was lower (Table 2.4 and Fig. 2.5). There were fewer multi-stemmed trees and deciduous trees than at the other two sites, which may also have been a consequence of protection from fire (Table 2.4 and Fig. 2.5). The commonest trees species was *Styrax benzoides*, an indicator of lower montane oak forest, while the fifth most common species, *Acronychia pedunculata*, was an indicator of lower montane rain forest. Other common species were indicators of both forest types: *Castanopsis acuminatissima*, *C. tribuloides* and *C. diversifolia* (Santisuk, 1988). The ten most common species were all evergreen, although a few deciduous species, such as *Wendlandia scabra* were present.



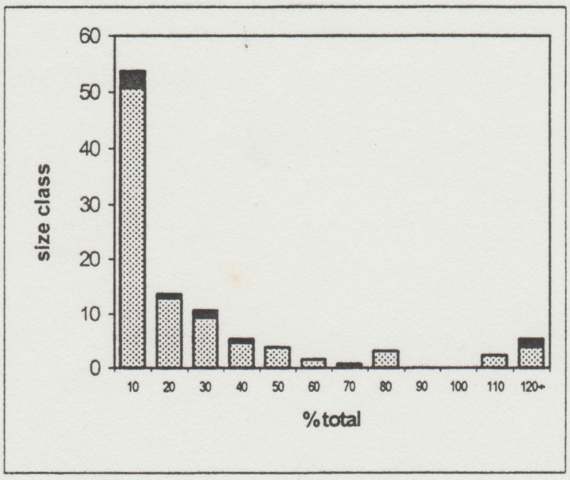
a) Site 1: forest edge



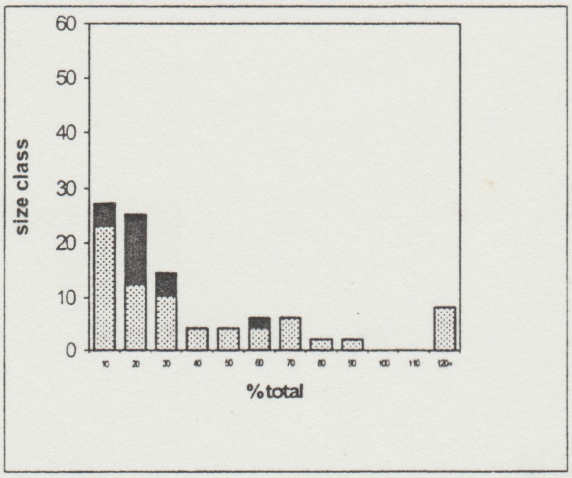
b) Site 1: forest interior



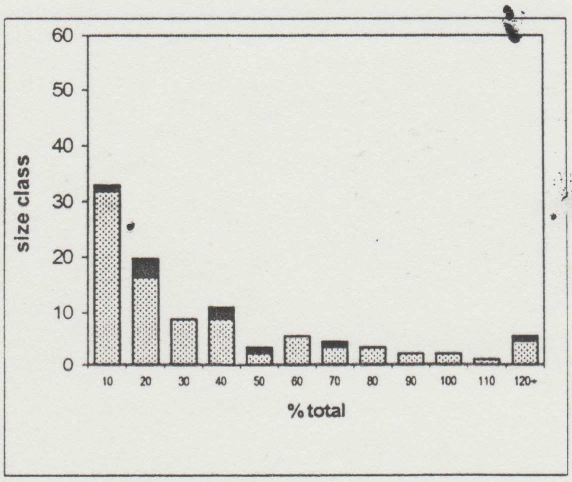
c) Site 2: forest edge



d) Site 2: forest interior



e) Site 3: forest edge



f) Site 3: forest interior

Fig. 2.5. Size class distribution of trees > 10 cm GBH.

Pale bars = single stemmed trees, black bars = multi-stemmed trees (GBH measured on largest trunk).

2.3.3.3 Forest at Site 3

As at Site 1, the forest at Site 3 was heterogeneous in structure due to the uneven effects of past fires. As at Site 1, 12% of individuals in the forest interior were deciduous. Site 3 had intermediate mean tree girth and percentage of multi-stemmed trees compared to the other two sites (Table 2.4). As at site 2, the forest comprised a mixture of species uniquely indicative of lower montane oak forest (e.g *Vernonia volkameriifolia* and *Styrax benzoides*), species indicative of lower montane rain forest (e.g. *Elaeocarpus floribundus* and *Saurauria roxburghii*) and species common to both forest types (e.g. *Castanopsis tribuloides* and *Lithocarpus elegans*). The pioneer tree *Eurya acumminata* DC. var. *wallichiana* Dyer (Theaceae) was common at the clearing edges.

2.3.4 Experimental sites:

Site 1, described above, was the site of the first seedling establishment experiment in 1994.

The second seedling establishment experiment was carried out at the Sunkoo study site, also in Doi Suthep-Pui National Park, situated about 1.5 km from the Doi Pui study site at 1,450 m a.m.s.l. The clearing was about 1 ha in area, roughly square in shape, on a deforested, south facing, 25° slope. Like the Doi Pui clearing, it was first cleared at least 30 years prior to the experiment and is still occasionally burnt, although not during the course of this study. The agricultural history is unknown. Grass (mainly *Imperata cylindrica*) and bracken fern (*Pteridium aquilinum*) dominated the site. There were a few remaining isolated forest trees such as *Castanopsis tribuloides* and scattered small pioneer trees such as *Litsea cubeba*.