

CHAPTER II

Literature review

Habitats of Doi Inthanon National Park

Graham (1991) reported about habitats of Doi Inthanon National Park that

“Doi Inthanon is located in the northern province of Chiang Mai, the park incorporates Thailand’s highest mountain of Thailand. It is a granitic massif rising to 2,565 metres. This national park is part of the Thanon Thongchai Range, a southern extension of the Shan Hills of Burma. Sandy loams are the predominant soils on the mountain.

The area of Doi Inthanon is regarded as a vital watershed. Cascading down the forested slopes are four major tributaries of the Ping River, a lifeline of northern Thailand. The Ping, tapped for irrigation, hydroelectric power, transport and tourism, in turn forms one of the four major tributaries of the Chao Phraya River.

The park provides a wonderful spectrum of vegetation. As one ascends, the deciduous forests on lower slopes shade into seasonal broadleaved evergreen, submontane evergreen and montane evergreen forests. Native pines are found at moderate elevations; wild flowers abound including a large number of orchid species.

Above 1,800 metres, in the montane evergreen forests, the atmosphere becomes more temperate, with mists sweeping through low trees laden with orchids and moss. The forest around the peak is the only one in Thailand which resembles a true upper montane formation, Doi Inthanon rising about 300 metres above any other mountain in the country. A small sphagnum bog at the summit is dense of living-organisms, especially plants.

Doi Inthanon experiences a strongly monsoonal climate. Although precise readings have not been recorded, about 2,000 millimetres of rain a year falls on the upper slopes, most of it between May through October.

The mean annual average temperature in the Chiang Mai lowlands is 25.8°C, but that on the mountain is substantially lower. The coldest months are December and January when ground frost may cover the exposed ridges near the summit where a low of -8°C has been recorded. Nights are cool even in the hottest months."

General features of upper montane rain forest in Thailand

Suntisuk (1988) stated about upper montain rain forests in Thailand as follows :

"Only a few peaks of mountains in Thailand, that are higher than 1,800 m.a.s.l., carry upper montane rain forest. These forests in the Northern Highlands, once luxuriant in the moist soils rich in organic matter and humus at elevations from 1,800-2,595 m, are at present reduced to patches covering the peaks and moist gullies of mountains as a result of the drastic destructions by various mountain tribes. Fortunately, a few patches of the primary upper montane rain forest have been left uncleared intentionally by the hill tribes cultural beliefs. On Doi Inthanon of Chiang Mai Province, the upper montane rain forest changes imperceptibly into lower montane rain forest below the cloud belt, and it is very difficult to say exactly where one forest ends and the other begins.

Upper montane rain forest is tall and dense, but the general canopy, in comparison with that of lower montane rain forest, is reduced to less than 23 m (usually 16-22 m high). The forest is typically characterized by closed, more or less evenly continuous, flat crown canopy. The forest almost approaches single storey, the lower tree storey is poorly developed on the summit areas of Doi Inthanon. Quite a few trees attain considerable sizes with straight boles. The foliage crowns are typically dome-shaped supported by the crooked branches on which epiphytic flower plants, ferns, mosses and lichens are luxuriantly developed. Under the dense canopy, undergrowth is sparse or inconspicuous, whilst a thin moss layer is frequently developed on the forest floor, on stems and branches of trees. Along the forest margin a tall shrub, *Strobilanthes involucrata*, forms a very dense undergrowth which gradually thins towards the inner forest. A small area of sphagnum bog is developed in the perpetually wet depression ground. The luxuriant epiphytes heavily loaded on branches of tree and the bog mosses on the ground are symptoms of the cool climate and high humidity.

Upper montane rain forest can be differentiated floristically from lower montane rain forest. Almost all magnolias (e.g. *Magnolia henryi*, *Michelia floribunda*, *Paramichelia baillonii* and *Talauma hodgsonii*), the common associated members in lower montane rain forest, gradually fade out with increasing altitudes together with typical lowland genera such as *Antiaris*, *Ficus* (Moraceae), *Canarium* (Burseraceae), *Sapium* (Euphorbiaceae), *Terminalia* (Combretaceae), *Aglaia*, *Toona* (Meliaceae), *Pterospermum* (Sterculiaceae), etc. Only a few magnolias are occasionally found on moderate to steep slopes with drier soils: *Manglietia garrettii* and *Michelia rajaniana*. Gymnosperms associated with lower montane rain forests, *Cephalotaxus griffithii* (Podocarpaceae), are evidently absent from upper montane rain forest. The majority of oaks, commonly encountered in lower montane rain forest (and lower montane oak forest), are not found in

upper montane rain forest (e.g. *Catanopsis acuminatissima*, *C. tribuloides*, *Lithocarpus elegans*, *Quercus helferiana* and *Q. kingiana*)

Santisuk (1988) had surveyed on the florestics of Doi Inthanon as follows :

The principle trees are *Quercus glabricupula*, *Lithocarpus aggregatus*, *L. recurvatus*, *Castanopsis purpurea* (Fagaceae), *Schima wallichii*, *Eurya nitida*, *Gordonia dalglieshiana* (Theaceae), *Lindera thomsonii*, *Neolitsea folitsea*, *Litsea garrettii*, *Beilschmiedia globularia*, *Cinnamomum tamala*, *Actinodaphne* sp. (Lauraceae), *Myrica esculenta* (Myricaceae), *Heliciopsis terminalis* (Proteaceae), *Acer laurinum*, *A. calcaratum* (Aceraceae), *Prunus cerasoides* (Rosaceae) and *Symingtonia populnea* (Hamamelidaceae).

Common small trees are *Helicia formosana* (Proteaceae), *Myrsine semiserrata* (Myrsinaceae), *Osmanthus fragrans* (Oleaceae), *Symplocos dryophila* (Symplocaceae), *Macropanax oreophilus* (Araliaceae), *Neocinnamomum caudatum* (Lauraceae), *Turpinia cochinchinensis* (*T. nepalensis*), *T. montana* (Staphyleaceae), and *Cleyera japonica* (Theaceae). The following trees are found fringing the forestmargins: *Lyonia ovalifolia*, *Vaccinium sprengelii* (Ericaceae), *Wikstroemia indica* (Thymelaeaceae), *Maesa indica*, *M. ramemtaea* (Myrsinaceae) and *Photinia integrifolia* (Rosaceae). The gnarled *Rhododendron arboreum* spp. *delavayi* (Ericaceae), a typical species of the upper montane forest zone, attains a height of 6-9 metre along the periphery of sphagnum bogs. The trees are also found sporadically on the disturbed slopes of the upper montane rain forest.

The shrubs are mainly found fringing the forest margins and include *Strobilanthes involucrata* (Acanthaceae), *Cornus oblonga* var. *siamica* (Cornaceae), *Dichroa febrifuga* (Hydrangeaceae), *Zanthoxylum acanthopodium* (Rutaceae), *Embelia subcoriacea* (Myrsinaceae), *Astibe*

rivularis (Saxifragaceae), *Verbunum kerrii* (Caprifoliaceae), *Gaultheria notabilis* and *Rhododendron microphyton* (Ericaceae).

The most common epiphytic shrubs, *Aeschynanthus hildebrandii* (Gesneriaceae), *Agapetes hosseana* and *Rhododendron veitchianum* (Ericaceae), grow on mossy branches along with a parasitic shrub, *Hymenopogon parasiticus* (Rubiaceae).

Herbs are also commonly found along the forest margins and include *Arisaema consanguineum* (Araceae), *Carex baccans*, *C. indica* (Cyperaceae), *Impatiens longiloba*, *I. Racemosa* (Balsaminaceae), *Polygonum chinense*, *P. molle* (Polygonaceae), *Viola betonicifolia*, *V. pilosa* (Violaceae), *Gentiana crassa* (Gentianaceae), *Paris polyphylla* (Trilliaceae), *Disporum calcaratum*, *Ophiopogon intermedium* (Liliaceae), *Elatostema monandrum* (Urticaceae), *Polygala karenium*, *P. kerrii*, *P. lacei* (Polygalaceae), *Ainsliaea latifolia*, *Anaphalis margaritacea* (Compositae), *Stellaria saxatilis* (Caryophyllaceae), *Lobelia pyramidalis* (Campanulaceae), *Hypericum hancokii* and *H. wightianum* (Hypericaceae).

Large woody lianas are absent from upper montane rain forest, but the common herbaceous vines are *Amphicarpaea siamensis* (Leguminosae), *Jasminum dispernum* (Oleaceae), *Hedera himalaica* (Araliaceae), *Trtrastigma serrulatum* (Vitidaceae), *Streptolirion volubile* (Commelinaceae), *Smilax china* (Smilacaceae), and species of *Clematis* (Ranunculaceae)

The epiphytic orchids are plentifully represented by species of *Dendrobium*, *Bulbophyllum*, *Coelogyne*, *Eria*, *Luisia*, *Mlaxis*, *Otochilus* and *Pholidota*."

Hasting and Lieansakul (1984) presented the profile of forest zones from sea-level to the peak of Doi Inthanon (altitude about 2500metres above sea level) (Fig. 1). They devided the vegetation of the mountains in to three

forest zones in addition to division of climatic interpretation. The area from sea level up to 1,000 metres was defined as tropical savannah with dry dipterocarp forest type. The climate at above 1,000 metres up to the highest peak was indicated as humid subtropical climate. The florestics consisted of pine forest covered the area of altitude 800 metres to 1,300 metres above sea level. The topmost forest zone was defined as hill evergreen forest.

Smitinand (1977) mentioned that hill evergreen forest is confined to the upper elevation area from 1,000 metres upwards and is scattered all over the country with layer percentage in the northwestern highland. This type of forest is known under names as temperate evergreen forest or montane forest of some auther.



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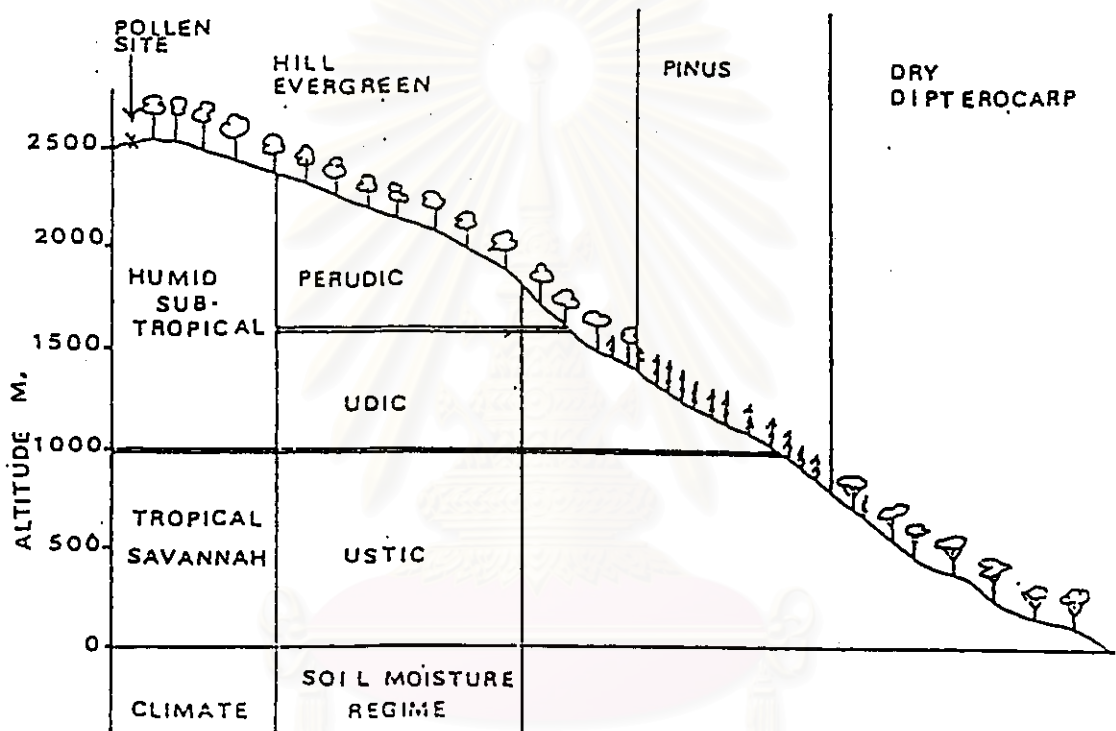


Fig. 1 The forest zones of Doi Inthanon National Park.
(Hasting and Liengsakul, 1984)

The palaeo-vegetation of Asia

Southern and Eastern Asia 18,000 years ago (in radiocarbon chronology).

The Last Glacial Maximum or LGM.

Low lake levels over northern China generally support the view that conditions were more arid at the LGM than at present. Yet although the level of Delai Lake (112 °E, 40 °N) was much lower at the LGM than during most of the Holocene, it was apparently higher than it is today (An *et al*, 1993). Pollen recovered from surfaces correlated as being approximately contemporaneous with the LGM, in the same area in North-western China, close to Mongolia (112 °N, 40 °S), shows that xerophytic plants (especially *Artemisia* and *Chenopodiaceae*) were virtually the only ones present (An *et al*, 1993), in a region that presently has a much denser grassy steppe cover.

For arid steppe in the north China plain and NE China (Manchuria), a cold and very sparse steppe-tundra dominated by *Artemisia* with grasses and chenopods was the predominant vegetation (Liu, 1986 and Wang and Sun, 1994). Trees appear to have been absent during the period of the LGM itself. The aridity itself seems likely to have prevented pollen deposition in many sites at the LGM, but radiocarbon-dated pollen diagrams from Beizuanaguan (109 °N, 34 °S) and also near Beijing indicate this sparse *Artemisia* vegetation.

From a pollen sequence dated to just before the LGM (finishing at 20,000 yr. BP) at Xishuang-banna in the present subtropical rainforest zone in the uplands of Yunnan Province of the extreme SW of China, Liu (1991) suggests that the LGM climate was nearly warm as at the present, but with much higher precipitation in winter (as indicated by the presence of the

subalpine tree *Dacrydium*) and the driest period at this particular site, in which pine-oak scrub land with abundant herbs replaced the forest apparently due to a reduction in winter rainfall, is suggested as occurring after 18,000 years ago rather than within the interval 20-18,000 years ago.

In Japan, the abundant plant fossil from both onland and offshore cores shows a general southwards shift of the vegetation zones under LGM conditions (Reynolds and Kanser, 1990). Radiocarbon and ash-dated pollen-bearing sites near Lake Biwa in east-central Japan and at several other localities across the centre of Japan (Ooi and Sei-ichiro, 1989) indicated that the lowland vegetation at the LGM was Cyperaceae-rich grassland with sparse scattered stands of *Alnus*, *Fraxinus* and *Salix*. Forests of a rather open character with *Quercus* and *Pinus* seem to have been widespread in the mid-altitude uplands. Open boreal-type woodland (consisting mainly of *Pinus*, with *Abies* and *Betula*) covered much of Japan's uplands (Heusser, 1990), from about the middle of the main island to the south of the linked chain of islands. *Artemisia* was often present, indicating dryness (Ooi *et al.*, 1990). Warmer temperate elements of the flora (e.g. *Cryptomeria*) persisted only locally as minor components in lowlands towards the south, which seem to have had a dry cool-temperate climate with open vegetation and scattered woodland on the uplands (Ooi *et al.*, 1990).

Drier condition in Thailand, Morley and Flenley (1983) referred to undated pollen evidence for pine forest occurring in the present rainforest areas of Thailand and Malaysia, which they suggest as possibly being of LGM age. In the lower Mun river basin, north eastern Thailand, there is loosely dated geomorphological evidence of widespread desiccation associated with aeolian activity and an increase in ground water salinity after 20,000 years ago (Loeffler *et al.*, 1984). The aeolian activity does not seem to have been

sufficient to form true dune systems, but riverine sands and silts were blown as sand sheets and loess layers onto the slopes and uplands surrounding the Mun River. Loeffler et al. (1984) noted that savanna species occur in pollen-bearing cores further south, but they do not state how much further south or what sources they are referring to. In addition, Thomas and Thorp (1992) emphasised that one might expect that if there was a large area of shelf exposed in SE Asia, this central area would tend to receive less rainfall from the sea, and an initial loss of forest would provide a feedback due to a loss of water recycling.

Southern and Eastern Asia 8,000 years ago (in radiocarbon chronology), early Holocene.

For warmer and moister China, vegetation maps published by An *et al.* (1990) and Winkler and Wang (1993) are based on fossil and sedimentological evidence that at 8,000 years ago conditions were significantly warmer and moister than present. A northwards shift of the forest belts is shown; this was the result of a sudden rise in high forest tree species at the expense of *Betula* just before 8,000 years ago (Winkler and Wang 1995). In the Loess-Plateau area of north-central China, the vegetation seems to have been existing under moister conditions than a present. The proportion of drought-tolerant C4 plants in the vegetation seem to have reached its lowest point during the early-to-mid Holocene, before increasing slightly towards the present (Frakes and Jianzhong, 1994). At the Linxia site in the western part of the Loess Plateau, magnetic susceptibility suggests a rainfall of around 460 mm compared to the present 350 mm, between about 8,000 and 3,000 years ago, with temperatures about 2 °C warmer than at present (Li *et al.*, 1995).

Between 8,000 and 5,000 years ago, many species of forest trees extended that their ranges further north and west than present. Thus, indicated precipitation about 100 mm higher than today in many area of China. The temperatures were perhaps 2-4 °C warmer (An *et al*, 1990 ; Winkler and Wang, 1993). For example, conditions according to palynological evidence seem to have been around 3-4 °C higher than now in Beijing and 2-4 °C higher in the lower Yangtze river area (Sun and Chen, 1991), reflected in terms of the northward movement of tree taxa. The deciduous forest of north-eastern China seems to have been expanded a couple of hundred kilometres northward into the Russian far east (Velichko, 1991). In this north-eastern area, *Betula* and *Pinus* pollen were at lower percentages than at present, their place being taken by other, warmer-climate broad-leaved species (Tong and Shao, 1991).

In central Asian desert belt, Jaekel (1995) reviewed evidence from various sites in inner Mongolia (at around 100 °E and 41-43 °N) which suggested that conditions were moist and he suggested on this basis that steppe vegetation covered the region, instead of the present-day desert and semi-desert vegetation.

In SW China (around 30 °N), Jarvis (1993) also found pollen evidence for a considerably stronger summer monsoon than at present between 9,100 and 7,800 years ago, with deciduous oaks (*Quercus*) being more abundant than sclerophyllous evergreen ones in the mid-altitude forests close to the edge of the Tibetan plateau.

There was early Holocene humidity in Thailand. In the Chi River basin, northeast Thailand, Tamura (1992) regards sedimentation rates and sediment grades as indicating that a more humid than present climate from

early to mid Holocene time, up until around 3,500 years ago. Likewise, the evidence from palaeoriver channels in the northern part of the central plain of Thailand (Yom River) is that water discharges were greater than at present during the early to mid Holocene (Bishop and Godley, 1994). The present-natural vegetation of these regions is rainforest, and given a still moister climate at 8,000 years ago, the vegetation must presumably have been rainforest at that time. Jarupongsakul (1987) suggested that Chao Phaya basin, Central Thailand, used to be the mangrove forest in Holocene period because there are the pollen grains of the mangrove forest in this site.

Southern and Eastern Asia by 5,000 years ago.

Morley (1982) suggested that by 5,000 years ago the vegetation across the tropical rainforest region would have been generally very similar to the present nature. Wanthanachiseang (1997) noted that the upper montane rain forest in Holocene period (about 4,300 years ago) at the peak of Doi Inthanon, Northern Thailand, was similar to the present. Two possible non-climate explanations for type of the vegetation change about 4,300 years ago were the uplift of the site above the *Pinus* habitat and man's activities which these evidence further supported the theory that the Holocene climate was unstable (Hasting and Leangsakul, 1984). In southern Borneo (Kalimantan), various studies on the coastal peat swamps have shown peat deposition starting around 5,000-6,000 years ago (Morley, 1981). At the upper montane rainforest boundary in central Sumatra, Morley (1982) also suggested that the first evidence of forest clearance occurs at about 4,000 years ago. Conditions across much of China at 5,000 years ago seem to have been slightly warmer than present, but cooler than in the early Holocene (Winkler and Wang, 1993).

Warmer and moister conditions in China, Sun and Chen (1991) noted that the palynological records indicated temperatures 2-4 °C warmer than at present, cooling after about 3,000-4,000 years ago. In the northeast of China (Manchuria), peat deposition seems to have begun mainly around the mid-to-late Holocene, coincident with a cooling of climate just after around 5,000 years ago and lake levels indicate conditions moister than present over most of China up until 3,500 years ago (Fang, 1991 and Li *et al.*, 1995). Agriculture in north-western regions of China currently too arid for crop-growing is future testimony of the moister climate which prevailed at around 5,000 years ago (Petit-Maire *et al.*, 1994). Agriculture was already present and expanding throughout the south-east Asia region, but deforestation in Southern China and in the monsoon zones of Indo-China does not appear to have been significant until after around 4,000 years ago (Tallis, 1990).



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