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VEGETATION OF KHAO KHIEO GAME SANCTUARY CHONBURI PROVINCE, THAILAND

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Introduction

Khao Khieo was established as a Game Sanctuary by the Royal Forest Department in June 1974, and is under the administration of the Wildlife Conservation Division. The Sanctuary, enclosing an area of 145.7 square kilometres, includes two major mountains: Khao Khieo (green mountain) and Khao Chomphu (rose apple mountain). These mountains are isolated remnants of what was formerly a vast evergreen forest which covered most of the province. However, continuous logging, swidden agriculture, and the establishment of permanent towns and villages during this century have all been at the expense of the forest and its wildlife. Until about 1970, sawmills in the nearby towns of Chon Buri and Si Racha actively exploited these two mountains for timber. Indeed, early this century the sawmill at Si Racha constructed a narrow gauge railway to haul logs to the sawmill, with one branch passing through the valley between the two mountains and extending to the northern tip of Khao Chomphu, and another line encircling the southern lobe of Khao Chomphu with branches to the south and east. The original routes have now been converted into dirt roads. It has been difficult, however, for forestry officials to halt the cutting of trees and hunting of game in the sanctuary by local villagers, but concerted efforts are being made to protect the area from further exploitation. Even with their limited personnel and insufficient equipment, the Wildlife Conservation Division hopes to preserve Khao Khieo as a natural area for students, tourists, and scientists.

From 1911 to the early 1930's the flora of the Si Racha area were sampled extensively by Mrs. **D.J. Collins** and during these years Dr. **A.F.G. Kerr, Put,** and **A. Marcan** also collected in the area. From the labels on the specimens collected by these people, which have been deposited in the Department of Agriculture Herbarium (BK), Bangkok, it is apparent that they collected at the seashore and mostly along the railway from the sawmill.

I have found very few specimens that were collected at over 200m elevation, in fact most of the inland collections were made in the lowland evergreen forest and foothills of Khao Chomphu. These areas are now, unfortunately, sugar cane and tapioca fields.

Since Mrs. Collins stopped collecting it seems that very few botanists have taken an interest in the flora of Khao Khieo. LARSEN (1964) reported on a short visit to the northeastern part of Khao Khieo in Ban Bueng District, however no extensive survey on the vegetation was made.

My first visit to Khao Khieo was in December 1973, and in August 1974 I began a detailed study of the flora there, Field work continued until November 1976, during which I collected about 925 species of vascular plants, and a general collection of lichens, fungi, and mosses were made (MAXWELL & CHANTRAPRASONG, 1976).

RESULTS AND DISCUSSION

Due to their entirely different vegetational facies, I have divided the description of the vegetation of the Sanctuary into two parts, viz. Khao Khieo and Khao Chomphu. It is certain, however, that prior to the devastation of the evergreen forest on Khao Chomphu and the localized cutting on Khao Khieo, both mountains had simillar, if not identical, vegetation and floristic components.

Khao Khieo

Lowland evergreen forest associations. The evergreen forest habitat at Khao Khieo can be divided into two distinct formations: lowland (up to 500–600m), and upland (600–800m). The major reason for this stratification is humidity, since the upland areas are frequently covered with mist or clouds (especially before dawn), even during the dry season (December to May), while the lowland vegetation remains quite dry during this time.

The lowland formation consists of two canopy layers: a low, woody (1–5 m) understorey; and a herbaceous ground flora. The upper canopy, often quite thin due to logging, rises to 40 m in some areas with the following trees:

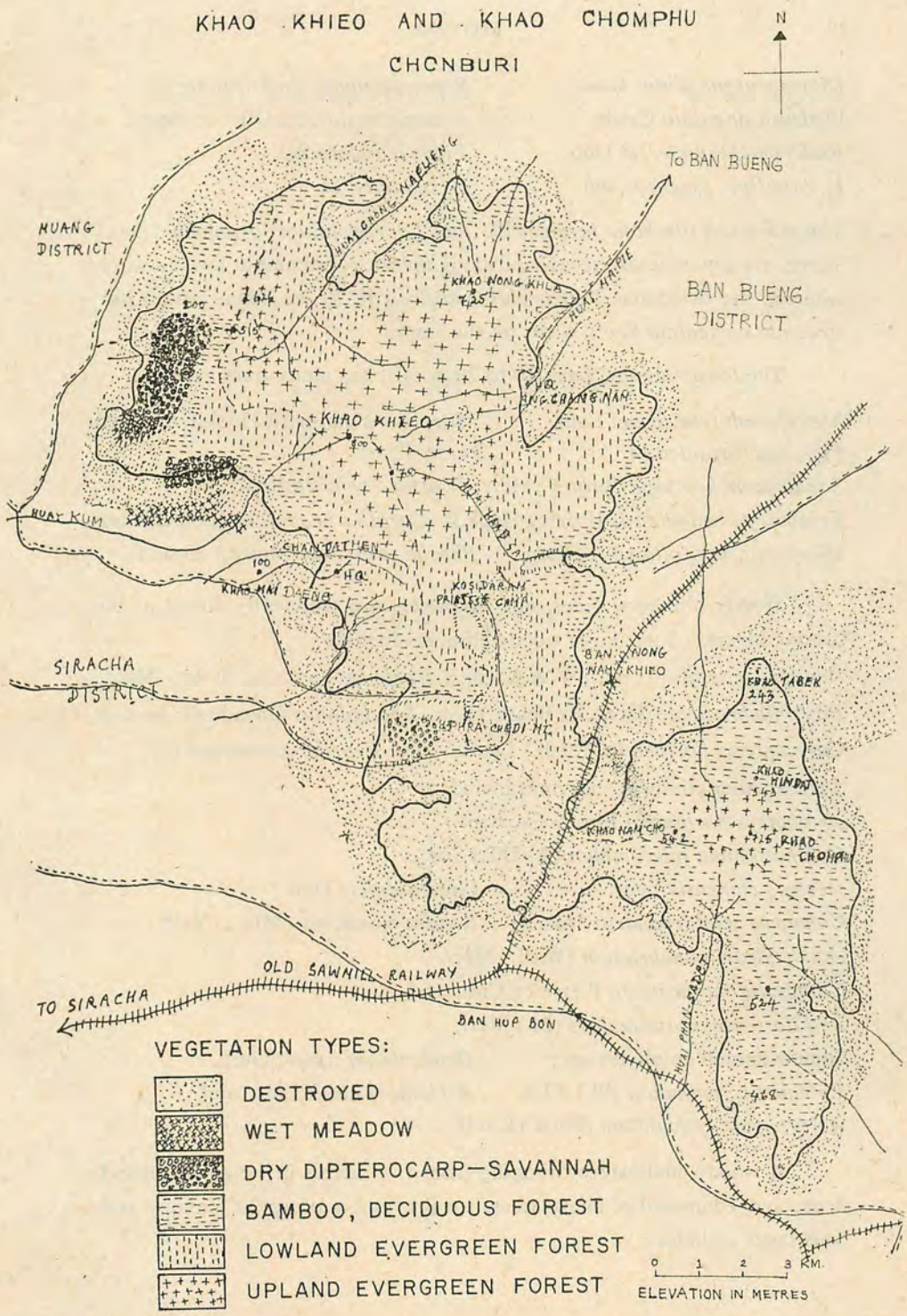

Fig. 1. Map showing vegetation types of Khao Khieo Game Sanctuary refer to Storer's map.

Dipterocarpus alatus Roxb. *Pterospermum diversifolium* Bl.
Walsura angulata Craib *Irvingia malayana* Oliv. ex Benn.
Radermachera pierrei Dop *Ficus annulata* Bl.
F. capillipes Gagnep. and *F. sundaica* Bl.

The evergreen *Bischofia javanica* Bl. and *Lophopetalum javanicum* (Zoll.) Turcz. are common tall trees found along the rocky streams at low elevations, whereas the deciduous *Tetrameles nudiflora* R. Br. ex Benn. and *Lagerstroemia calyculata* Kurz, occur on the slopes.

The lower canopy, from 10 to 20 m tall, has many trees such as:

Melodorum fruticosum Lour. *Mitrephora maingayi* Hook.f. & Th. var.
Picrasma javanica Bl. *kurzii* King
Sandoricum koetjape (Burm.f.) Merr. *Walsura robusta* Roxb.
Eriobotrya bengalensis (Roxb.) Hook.f. *Carallia brachiata* (Lour.) Merr.
Diospyros buxifolia (Bl.) Hiern *Phoebe tavoyana* (Meisn.) Hook.f.

Woody climbers, vines, and epiphytes are frequently found in both canopy layers. Some large woody climbers include:
Anamirta cocculus (Linn.) W. & A. *Ancistrocladus tectorius* (Lour.) Merr.
Bauhinia bracteata (Grah. ex Benth.) Bak. *Spatholobus harmandii* Gagnep.
Calycopteris floribunda (Roxb.) Lamk. and *Erycibe glomerata* Bl.
Some smaller climbers and vines include:
Artabotrys harmandii Fin. & Gagnep.
Cyathostemma micranthum (A. DC.) Sincl.
Desmos chinensis Lour. *Uvaria dulcis* Dun.
Connarus semidecandrus Jack *Randia siamensis* (Miq.) Craib
Anodendron manubriatum (Wall.) Merr.
Campestigma purpurea Pierre ex Cost. and
Poikilospermum suaveolens (Bl.) Merr.
Some common epiphytes are: *Dendrobium tixieri* Guill.
Robiquetia spathulata (Bl.) J.J.S. *Asplenium nidus* Linn. and
Antrophyum reticulatum (Forst.) Kaulf.

A woody understorey ranging from 1–5 metres in height is typically dense and composed of many trees, shrubs, and saplings of canopy trees. This layer includes:

Goniothalamus marcanii Craib
Rinorea virgata (Thw.) O.Ktze.
Helicteres hirsuta Lour. var. *vestita* King
Glycosmis pentaphylla (Retz.) Corr.
Eurycoma longifolia Jack
Lepisanthes rubiginosa (Roxb.) Leenh.
Pavetta indica Linn.
Memecylon floribundum Bl.
Alchornea rugosa (Lour.) Muell.-Arg.
Erismanthus sinensis Oliv.
Dracaena angustifolia Roxb. and
Orophea polycarpa A. DC.
Hydnocarpus ilicifolia King
Murraya paniculata (Linn,) Jack
Aglaia odoratissima Bl.
Ixora cibdela Craib
Xantonnea quocensis Pierre ex Pit.
Ardisia solanacea Roxb.
Baccaurea ramiflora Lour.
Microdesmis caseariifolia Planch.
Didymospermum caudatum Wendl. & Drude.

A few of the more common epiphytes, in addition to those found in the upper levels, are: *Aerides falcatum* Lindl., *Drymoglossum piloselloides* (Linn.) Presl, and *Vittaria ensiformis* Sw.

The herbaceous ground flora is generally dense and remains green in all parts throughout the year. Some of the more common species in this zone are:

Uraria hamosa Wall. ex W. & A.
Geophila herbacea (Linn.) O.Ktze.
Cenolophon oxymitrum (K. Schum.) Holtt.
Curculigo orchioides Gaertn.
Peliosanthes teta Andr. ssp. *humilis* (Andr.) Jess.
Aneilema scaberrimum (Bl.) Kunth
Aglaonema simplex Bl.,
Centotheca lappacea (Linn.) Desv.
Doryopteris ludens (Wall. ex Hook.) J. Sm.
Microlepia speluncae (Linn.) Moore
Bolbitis appendiculata (Willd.) K. Iwats. and
Tectaria variolosa (Wall. ex Hook.) C. Chr..
Agrostemma unifolioides King (common rocks)
Amomum uliginosum Koen.,
Globba villosula Gagnep.
Tacca chantrieri Andr.
Aclisia secundiflora (Bl.) Bakh.f.
Scleria lithosperma (Linn.) Sw.
Selaginella involvens (Sw.) Spr.

In addition to the vascular flora, bryophytes, fungi and lichens are common throughout the forest.

Upland evergreen formation

Between 500 and 600m elevation in the evergreen forest the flora begins to change into a taller and denser facies. Many species found in these upland areas are not, or are rarely, found at lower elevations. There are, however, many species that are common to both formations. The species mentioned in this section are more commonly found in the upland formation, and only on infrequent occasions have I seen them below 500m elevation.

The canopy is generally composed of tall, strongly buttressed trees with a denser crown which provides more shade than canopy trees in the lowland formation. Typical canopy trees found in this upland evergreen formation include:

Sterculia alata Roxb.
Amoora gigantea Pierre
Chukrasia tabularis A. Juss.
Litchi chinensis Sonn.
Cassia javanica Linn.
Cryptocarya chanthaburiensis Kost.
Erythrina arborescens Roxb.
Alstonia scholaris (Linn.) R. Br.
Pterocymbium tinctorium (Blanco) Merr. var. *javanicum* (R. Br.) Kost., a deciduous species, is also a frequent component of the upper canopy. The trees of the upper canopy are often 40–50m tall, with diameters (DBH) of over 1 metre, and buttressed bases 1–3 metres wide. This formation includes the largest and most impressive trees of the entire research area.

Some lower canopy and understorey trees are:

Polyalthia jucunda (Pierre) Fin. & Gagnep.
Sageraea elliptica (A. DC.) Hook.f. & Th.
Garcinia xanthochymus Hook.f.
Aglaia pirifera Hance
Dysoxylum cauliflorum Hiern
Mischocarpus sundaicus Bl.
Cinnamomum iners Reinw. ex Bl.
Cryptocarya lecomtei Kost.
Epiprinus siletianus (Baill.) Croiz.
Gironniera nervosa Planch.

Commonly found woody climbers, vines, and creepers in the upland evergreen formation are:

Uvaria grandiflora Roxb.
Ventilago cristata Pierre
Buettneria aspera Colebr.
Entada phaseoloides (Linn.) Merr.
Mucuna collettii Lace
Combretum punctatum Bl.
Schefflera elliptica (Bl.) Harms
Beaumontia brevituba Oliv.
Trachelospermum curtisii King & Gamble
Aeschynanthus longicaulis Wall.

Piper ribesoides Wall. *Calamus poilanei* Con.
C. viminalis Willd. var. *fasciculatus* (Roxb.) Becc.
Pothos scandens Linn. *Scindapsus officinalis* (Roxb.) Schott.
and *Gnetum macrostachyum* Hook.f.

The shrubs and treelets in the understorey are often dominated by *Salacca wallichiana* Mart. and immature *Calamus* spp. which form impenetrable clumps. Associated with these thorny species are:
Chassalia ophioxyloides (Wall.) Craib
Lasianthus setosus Craib *L. subinaequalis* King & Gamble
Maesa montana A. DC. *Ervatamia luensis* (Pierre ex Pit.) Kerr
Wikstroemia polyantha Merr. *Aporusa dioica* (Roxb.) Muell.-Arg.
and *Antidesma japonicum* Sieb. & Zucc.
A tree fern, *Cyathea contaminans* (Wall. ex Hook.) Copel., is also present in the understorey of the upland evergreen formation, but it is rare.

The ground flora is dense and the species are generally different from those found in the lowland evergreen areas. The upland ground flora includes:

Ardisia impressa Fletch. *Strobilanthes subflaccidus* Kurz
Calanthe triplicata (Will.) Ames *Alpinia macroura* K. Schum.
Schumannianthus dichotoma Gagnep. *Pandanus ovatus* Warb. and
Leptaspis urceolata (Roxb.) F. Br.

The fern flora is especially rich and includes:
Asplenium pellucidum Lamk. *Athyrium simplicivenium* (Holtt.) Holtt.
Cibotium barometz (Linn.) J. Sm. *Angiopteris evecta* (Forst.) Hoffm.
Tectaria polymorpha (Wall. ex Hook.) Copel. and
Thelypteris validus (C. Chr. & Tard.) Ching.
Several other ferns, e.g. *Davallia trichomanoides* Bl., *Drynaria quercifolia* (Linn.) J.Sm. (both epiphytes), and *Stenochlaena palustris* (Burm.) Bedd. (a climber); and epiphytic orchids, e.g. *Agrostophyllum bicuspidatum* J.J. Sm., *Dendrobium acerosum* Lindl., and *Pholidota pallida* Lindl. are frequently seen in the upland evergreen formation.

The vascular parasite/saprophyte ground flora of Khao Khieo is restricted to the upland evergreen zone, and in all instances the populations of these species are few and widely scattered. These rare, unusual and

interesting species, which can only be seen during the wet season (especially August to November), are generally whitish and contain no green pigmentation They include: *Cotylanthera tenuis* Bl., *Balanophora abbreviata* Bl. (both dicots), *Burmannia oblonga* Ridl., *Gastrodia exilis* Hook.f., and *Stereosandra javanica* Bl. (monocots, the latter two being orchids). *Aeginetia indica* Linn., a parasitic herb common in several dry evergreen forests in the Kingdom (e.g. Sam Lan, Saraburi Province; and in the Dongrak Range, Si Saket Province) has not been found in the reserve.

Some parasitic epiphytes commonly seen in the canopy of the evergreen forest are: *Helixanthera cylindrica* (Jack) Dans., *H. parasitica* Lour., and *Scurrula atropurpurea* (Bl.) Dans. (all Loranthaceae).

Deciduous/Bamboo association

The foothills and slopes up to ca 300m elevation are characterized by a mixture of deciduous species and bamboo. These areas have experienced considerable disturbance from cutting and burning in the past, thus the former evergreen facies of these places has been succeeded by a mixture of secondary elements which has become stabilized, i.e. there is little redevelopment of the evergreen forest occurring in these areas. The present facies, perhaps a climax, is distinguished by a variety of deciduous trees and shrubs, bamboos, and a distinct ground flora facies.

The taller trees are typically well spaced, deciduous, up to 30m tall, generally without buttresses, with diameters of over 100 cm, and provide less shade (even during the wet season) than the canopy trees in the evergreen forest. Common species include:

Bombax anceps Pierre var. *cambodiense* (Pierre) Robyn
Sterculia hypochra Pierre — *S. pexa* Pierre
Afzelia xylocarpa Craib — *Xylia kerrii* Craib & Hutch.
Terminalia bellirica (Gaert.) Roxb. *T. triptera* Stapf
Hymenodictyon excelsum (Roxb.) Wall. and *Sapium insigne* (Royle) Benth.

Smaller trees in the deciduous/bamboo association are:

Cratoxylum cochinchinense (Lour.) Bl. *C. formosum* Dyer
C. prunifolium Dyer — *Firmiana colorata* (Roxb.) R. Br.
Protium serratum Engl. — *Spondias pinnata* Kurz

Albizia odoratissima Benth. *Dialium cochinchinense* Pierre
Erythrina stricta Roxb. *Millettia pubinervis* Kurz
Holarrhena antidysenterica (Roth) Wall. ex A. DC.
Wrightia javanica DC. *Vitex canescens* Kurz
V. limonifolia Wall. ex Kurz *Phyllanthus emblica* Linn. and
Ficus rumphii Bl.

Throughout the deciduous/bamboo association are scattered evergreen trees such as :

Capparis micrantha DC. *Siphonodon celastrineus* Griff.
Anogeissus acuminata (Roxb. ex DC.) Guill. & Perr.
Prismatomeris fragrans Geddes *Memecylon ovatum* Sm.
Diospyros areolata King. & Gamble *D. malabarica* (Desv.) Kost. and
Meliantha suavis Pierre.

All of these except for *Memecylon ovatum* Sm., are not usually found in the evergreen forest. Epiphytic orchids, e.g. *Aerides falcatum* Lindl., and *Cymbidium simulans Rolfe*; and epiphytic ferns, e.g. *Platycerium wallichii* Hook., and *Pyrrosia adnascens* (G. Forst.) Ching, are frequently seen on boulders and on the branches of the deciduous (less frequently evergreen) trees. During the dry season these epiphytes experience maximum exposure and dryness, however, these ferns and orchids manage to survive from year to year without any ill effects.

The major species of bamboo are *Dendrocalamus membranaceus* Munro and *Gigantochloa albo-ciliata* (Munro) Kurz, the latter being much more common. Generally speaking, the shrubs, treelets, and seedlings of taller trees in the deciduous/bamboo areas are mixed with bamboo. Some of these shrubs and treelets, all of which drop their leaves during the dry season, are :

Thespesia lampas (Cav.) Dalz. & Gibs. *Helicteres elongata* Wall. ex Boj.
Grewia elatostemoides Coll. & Hemsl. *Harrisonia perforata* Merr.
Bauhinia hirsuta Weinm. *Indigofera uncinata* Roxb.
Desmodium triangulare (Retz.) Merr. *Randia longispina* DC.
Coffea merguensis Ridl. var. *orientalis* (Wall. ex Hk.f.) Craib
Croton sublyratus Kurz and *Phyllanthus collinsae* Craib

Several vines and deciduous woody climbers are present in this habitat:
Stephania glabra (Roxb.) Miers *Butea superba* Roxb.
Entada phaseoloides (Linn.) Merr. *Hymenopyramis brachiata* Wall. ex Kurz
Dioscorea hispida Dennst. var. *reticulata* Hook.f. and
Stemona collinsae Craib

Some herbs include:
Hibiscus lobatus (Murr.) O.Ktze., *Desmodium laxiflorum* DC.
Desmodium heterocarpon (Linn.) DC. var. *birmanicum* (Wall. ex Prain) Ohashi
Barleria strigosa Willd. *Premna herbacea* Roxb.
Baliospermum montanum (Willd.) Muell.-Arg.
Strophioblachia glandulosa Pax var. *pandurifolia* Airy-Shaw
Geodorum citrinum Jacks *Habenaria columbae* Ridl.
Curcuma cf. *domestica* Valet. *Gagnepainia* sp.
Kaempferia pulchra Ridl. *Zingiber zerumbet* (Linn.) Sm. and
Amorphophallus longituberosus ((Engl.) Engl. & Geh.

It should also be noted that the boundaries between the mixed bamboo/deciduous zones and lowland evergreen areas are often indistinct. Transition zones between these major habitats are common, and in these areas it is common to find a mixture of deciduous/bamboo and evergreen species. In some of these transition areas, for example, the ground flora and the understorey are distinctly of an evergreen forest type, while the canopy is composed of widely spaced deciduous trees. In other areas the ground flora, understorey, and canopy species are thoroughly mixed, and in these areas it is difficult to determine whether or not a deciduous/bamboo or evergreen facies predominates. Undoubtedly the amount of disturbance that each of these areas has undergone, e.g. selective cutting, is the major reason for the present appearance of these transition zones.

Dry dipterocarp habitat

An association of plants found in several widely scattered areas can be considered as comprising a distinct habitat. These dry dipterocarp areas, such as on the top of Phra Chedi Mountain, are characterized by a single

canopy up to 5 m tall with widely spaced deciduous trees a very thick, mostly grassy, ground flora, and frequent fires during the dry season. Unfortunately, most of the areas with this type of habitat are relatively small and are being destroyed by wood cutters and charcoal makers. One area of about 5 ha (the last vestige of a formerly large dry dipterocarp forest) was completely clear-cut, plowed, and planted with tapioca in 1975.

Common tree species include :

Xylopia caudata Hook.f. & Th. *Shorea siamensis* Miq.
Dipterocarpus obtusifolius Teij. var. *subnudus* Ryan & Kerr
Berrya mollis Wall. ex Kurz *Hiptage candicans* Hook.f.
Ochna integerrima (Lour.) Merr. and *Gardenia erythroclada* Kurz

Some shrubs and treelets found in this habitat include :

Helicteres gagnepainiana Craib *Helicteres isora* Linn.
Ixora javanica (Bl.) DC. *Desmodium dunnii* Merr.
Pavetta tomentosa Roxb. ex Sm. var. *canescens* (Kurz) Craib
Cycas siamensis Miq. and *Antidesma ghaesembilla* Gaertn.

The ground flora in this habitat is dominated by *Arundinaria ciliata* A. Cam., which provides most of the fuel for the frequent fires during the dry period. Other common herbs include :

Selaginella ostenfeldii Hiern. *Eriosema chinense* Vog.
Tephrosia repentina Drum. & Craib *Kaempferia galanga* Linn.
Hedyotis pinifolia Wall. ex G. Don *Arundinella setosa* Trin.
Hackelochloa granularis (Linn.) O. Ktze. *Mnesithea laevis* (Retz.) Kunth and *Schima* wallichii Korth.

The exposed granite cliffs on the top of Phra Chedi Mountain (325 m) include a rather distinct association of epiphytes which are generally not found elsewhere. Some of these include : *Davallia denticulata* (Burm.) Mett., *Oleandra undulata* (Willd.) Ching, and *Bulbophyllum lepidum* (Bl.) J.J.S.

Wet meadow or Savanna flora

Included in the research area are a few places, all of them located on flat lowland areas, which have numerous species of annual herbs which are rarely found in a forest habitat. In general, these areas are sandy, very

exposed, and are found either mixed with or in the vicinity of dry dipterocarp zones. Since these distinct areas are neither fully aquatic nor marshy, plus the fact that the habitat is quite dry and barren from December to June, these areas are referred to, for want of a better term, as wet meadows or savannas. From July to November these areas are wet, and especially during September and October, the unique association of herbs is fully developed and flowering reaches its peak. Generally speaking, most of these species are small (under 6 cm tall) with typically inconspicuous flowers. Some of the more common representatives found in this habitat include:

Crotalaria acicularis Buch.-Ham. ex Benth.
C. linifolia Linn.
Limnophila repens (Benth.) Benth.
L. oblonga (Benth.) Kerr
U. caerulea Linn.
Xyris pauciflora Willd.
Fimbristylis ferruginea (Linn.) Vahl
Rhynchospora rubra (Lour.) Makino
Capillipedium longistylum Bor
Drosera indica Linn.
Lindernia ciliata (Colbr.) Penn.
Utricularia bifida Linn.
U. minutissima Vahl
Eriocaulon xeranthemum Mart.
Fuirena ciliaris (Linn.) Roxb.
Apocopis siamensis A. Cam.
Perotis hordeiformis Nees

Some shrubs that are found about the margins of the wet meadow habitat are *Colona auriculata* (Desf.) Craib, *Desmodium dunnii* Merr. and *Moghania stricta* (Roxb.) O. Ktze. Many of the herbs found in this habitat are often found in abandoned rice fields and other disturbed areas where the ground is continuously moist during the wet season.

Khao Chomphu

In contrast to Khao Khieo, the vegetation of Khao Chomphu has little zonation; in fact most of the mountain has been severely disturbed. The only area which has not been, or which has been only moderately cut, is an evergreen area of about 2 km^2 near the highest peak — from c 600 to 725 m elevation. This area resembles the upland evergreen areas on Khao Khieo; however, there is a noticeable scarcity of *Calamus* spp., *Salacca wallichiana* and woody understory species. There is a great abundance of herbaceous understorey species e.g. *Amomum uliginosum*, *Cenolophon oxymitrum*, and *Schumannianthus dichotoma*, all of which frequently grow to over 2 m tall.

The entire northern, eastern and most of the southern and western portions have regrown as a mixed deciduous/bamboo forest due to extensive timbering. There are, however, a few areas (except for large rock outcrops) that are entirely open and covered with secondary herbaceous growth. The forest vegetation of Khao Chomphu, while extensively denuded of its original evergreen cover, is regrowing as a deciduous/bamboo facies. This is in marked contrast to many areas outside of the sanctuary that have been cut, burned, and planted repeatedly which are covered with a herbaceous weed flora. Indeed, these cultivated or abandoned areas extend up to at least 50 m elevation all about the mountain.

A striking difference with Khao Chomphu is the fact that *Bambusa arundinacea* (Retz.) Willd., a very large and thorny species, is very common and dominates the understorey of the deciduous/bamboo zones from about 100 to 700 m elevation. This bamboo is relatively rare on Khao Khieo, but it does grow in widely scattered clumps in the disturbed lowland areas about Huai Hat Sai in the South-East. *Gigantochloa albo-ciliata*, a much smaller and unarmed bamboo, is more common from the limits of the fields to about 100 m elevation and is rarely found in the upland areas of Khao Chomphu in association with *Bambusa arundinacea.*

The ground flora, understorey, and canopy of the deciduous/bamboo forest are quite similiar to that on Khao Khieo. There are, however, some notable exceptions which are either rare or have not been found on Khao Khieo, e.g. *Pterolobium macropterum* Kurz, *Moghania macrophylla* (Willd.) O. Ktze., *Argyreia osyrensis* (Roth) Choisy, *Aporusa planchoniana* Baill. ex Muell.-Arg., *Croton thorelii* Gagnep., and *Pteris ensiformis* Burm.

Platycerium wallichii., a very spectacular epiphytic fern, althoug not common, is more frequently found on Khao Chomphu than on Khao Khieo. The opposite is true for other species of epiphytes, e.g. lichens, mosses, ferns, and orchids.

It is quite obvious that Khao Chomphu has not only been disturbed much more extensively and drastically than Khao Khieo, but cutting by villagers has still not ceased. When the railroad was in operation, elephants were used to drag logs from the mountain to the plains. An extensive

network of trails is still well marked and frequently used by hunters and timber poachers. In recent years, that is after the sawmill abandoned the forest, extensive areas have been cut and cultivated by migrant farmers. Along Huai Phan Sadet on the southern side, tapioca and sugar cane fields now extend well into the valley and up the slopes to over 200 m elevation. The same is true for the northern watershed along Huai Hin Dat where the entire valley consists of fields with *Imperata cylindrica* (L.) P. Beauv. thriving in the abandoned and now overgrown areas.

In general, Khao Chomphu does not have the diversity of habitats, number and abundance of species, and undisturbed areas of Khao Khieo. While Khao Chomphu may have a few species that do not grow on Khao Khieo, the entire mountain lacks collecting appeal since the monotony of the deciduous/bamboo regrowth is rather depressing – especially during the dry season.

Secondary development

Throughout the sanctuary are numerous areas that have redeveloped as a consequence of the disturbance or destruction of the original vegetation. In the evergreen forest, in both the lowland and upland formations, secondary development, characterized by several species of trees, shrubs and herbs, is rather common. Among the more common trees growing in open disturbed zones in the evergreen forest are *Hibiscus macrophyllus* Roxb., *Claoxylon indicum* (Reinw. ex Bl.) Hassk. and *Mallotus paniculatus* (Lamk.) Muell.-Arg. These are light-demanding species, and when some of the primary species begin to crowd and shade these secondary species there in succession. Thicket areas which include other invading secondary species have:

Cyclea barbata Miers
Stephania japonica (Thunb. ex Murr.) Miers var. *discolor* (Miq.) Form.
Brucea javanica (Linn.) Merr.
Cardiopteris javanica Bl.
Pisonia aculeata Linn. and
Harrisonia perforata Merr.
Acacia pennata (Linn.) Willd.
Musa acuminata Collo ssp. *siamea* Sim.

As mentioned in the section on the mixed deciduous/bamboo habitat, these areas are secondary since they were originally (before the 1920s and

in some places more recently) evergreen. There are, however, sections in this deciduous/bamboo habitat where burning and cutting have continued throughout the years, thus preventing the majority of woody deciduous species and bamboo shoots from developing. The result in these places is perennial growth of noxious weeds, such as *Imperata cylindrica*, *Eupatorium odoratum*, etc. growing where most of the top soil has washed away. Therefore, it will take even longer for these completely denuded areas to regenerate since the organics in the soil must be replenished before any succession can take place.

Among the more common woody species found on the open slopes in the deciduous/bamboo habitat are: *Caesalpinia digyna* Rottl., *Cassia timorensis* DC., *Bridelia ovata* Decne., *Trema orientalis* (Linn.) Bl., *Broussonetia kurzii* (Hook.f.) Corner., and *Ficus hispida* Linn.f.

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Fig. 1. *Salacca wallichiana* Mart. (Palmae), very common evergreen shrub or treelet found in evergreen areas above 600 m. showing spiny leaf bases and inflorescences. 26 Sept. 1976.

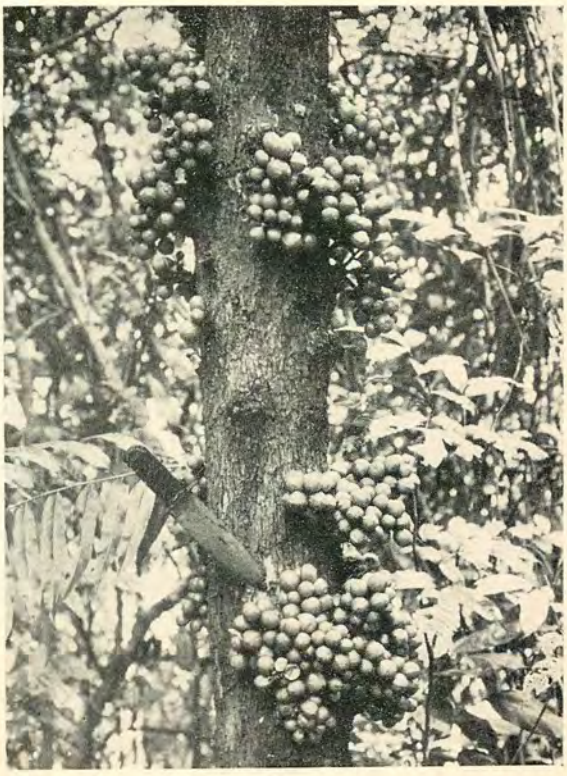

Fig. 2. *Dysoxylum cauliflorum* Hiern. (Meliaceae), a common cauliflorous evergreen tree found in upland evergreen areas. Note mature fruit. 26 Sept. 1976.

Fig. 3. *Asplenium nidus* Linn. (Aspleniaceae), a common epiphytic fern found in the evergreen forests. 26 Sept. 1976.

Fig. 4. *Dehaasia sp.* (Lauraceae), one of the largest and most impressive trees at Khao Khieo. Note knife in trunk for scale. 26 Sept. 1976.