Dipterocarpaceae of Northern Siam.

The Natural Order Dipterocarpaceae consists wholly of trees or shrubs and is confined to the Indo-Malayan Region. The order is one of great economic importance, most of the species yield valuable timber, they all abound in essential oils, which form, on exposure to the air, resins or camphor, and the seeds of some contain a tallow like fat. The Sāl tree of India, *Shorea robusta*, Gaertn. f., and the Bornean camphor tree, *Dryobalanops aromatica*, Gaertn. f., may be mentioned as noteworthy trees of this order occurring outside our area.

Northern Siam though rich in individuals of this order is poor in species; it is not, in this respect, to be compared with the Malay Archipelago, which is the headquarters of the order. O. Beccari tells us that in Borneo he collected fifty species within one mile of his camp.

Several of the species are gregarious, no doubt owing to their adaptation to conditions unfavourable to most other trees. Some of these gregarious species form jungles, locally known as "*pah paa*," which occupy at least half of the forest clad area of Northern Siam. Among the other species are some of the largest and loftiest trees to be met with in the jungles of this country.

Only nine species occurring in this area are known to us. It is probable that two or three other species will be discovered in the future.

All the trees which we deal with here can be readily recognised, when seeding, by their remarkable fruit, which, as the name of the order implies, are winged. These wings are formed by the continued growth, after pollination has occurred, of two or more of the calyx lobes. The genera and species of the order are, to a large extent, distinguished by the character of the fruit, some of which are illustrated on Plate I.

The three genera containing the known species of Northern Siam may be identified by the aid of the following key.—

I. Ovary in the fruit quite enclosed by the enlarged calyx tube, two of the calyx lobes enlarged in the fruit to form wings.

1. *Dipterocarpus.*

II. Calyx tube not, or hardly, enlarged in the fruit, two or more of calyx lobes enlarged to form wings in the fruit, which is surrounded by the stalk-like bases of the wings.

A. Three or more of calyx lobes enlarged in fruit to form wings.

2. *Shorea.*

B. Two only of calyx lobes enlarged in fruit to form wings.

3. *Hopea.*

The following diagnoses of genera and species are based upon, as far as possible, only prominent, and readily recognizable characters.

1. DIPTEROCARPUS, Gaertn. f.

Trees with tall regularly shaped trunks. Stipules large amplexicaul, deciduous. Flowers large, usually pink. Calyx 5 lobed with a rather long tube free from the ovary. Stamens numerous, connective produced into a long point. In the fruit the calyx tube encloses the woody nut but is not adnate to it, two of the three calyx lobes grow out into long wings.

A. Calyx tube in fruit without tubercles or ridges.

a. Fruit globular ; leaves blunt, pubescent.

1. *D. obtusifolius.*

b. Fruit ovoid ; leaves acuminate.

2. *D. turbinatus.*

B. Calyx tube in fruit with 5 compressed tubercles at top, alternating with calyx lobes.

3. *D. tuberculatus.*

C. Calyx tube in fruit with 5 longitudinal ribs or wings.

a. Ribs on calyx tube narrow, $\frac{1}{4}$ or less the diameter of the fruit.

4. *D. costatus.*

b. Ribs on calyx tube broad, ½ diameter of fruit or more.

5. *D. alatus.*

1. D. OBTUSIFOLIUS, Teysm.

Lao and Siamese, ***Mai hieng*** (ไม้เหียง); Karen, ***Tă la aw a meu*** (ตะ หล่า ออ อา หมื่อ), or ***Kău la tĕu*** (เคาะ หล่า เทอะ); Burmese, ***Kanyin bok.***

Tree to eighty feet high. Bark grey, longitudinally fissured or cracked, and slightly transversely cracked. Cut reddish brown, dry. Young shoots, petioles, stipules and inflorescence densely clothed with long tawny fascicled hairs. Stipules up to 8 ins. long. Petiole about 1½ ins. long. Leaves 7-10 ins. long, blunt tomentose beneath, pubescent above, secondary nerves 11-16 pairs, parallel, blade of leaf thrown into ridges between the secondary nerves. Inflorescence, short racemes of 4-8 flowers in the axils of the leaves. Calyx usually covered with a soft dense pubescence, petals to 1½ ins. long. In the fruit the calyx tube globular, plum coloured with scattered fascicled hairs, to 1½ ins. diameter, the 2 wing like lobes 4-6 ins. long, 3 shorter lobes about ½ in. long.

D. OBTUSIFOLIUS var. SUBNUDUS.

In this variety the young shoots and stipules are quite glabrous, the petioles are glabrous for the greater part of their length, but have a few fascicled hairs towards their junction with the blade of the leaf, and the calyx tube is either quite glabrous or silky pubescent. I have several intermediate forms between the hairy and subnude varieties, in one the petioles are hairy for their whole length while the young shoots and stipules are glabrous, in another the stipules alone are glabrous.

Flowering, November—January ; fruiting, March—April.

2. D. TURBINATUS, Gaertn. f.—Syn. D. LAEVIS, Ham.

Lao, and Siamese, ***Mai yang*** (ไม้ยาง); Burmese, ***Kanyin ni.***

Tree to 120 ft. high or more. Bark light grey, irregularly flaking or cracking. Cut yellowish brown, moist. Young shoots and stipules covered with very fine short pubescence, leaves, petioles and inflorescence glabrescent. Petioles to about 1½ ins. long. Leaves ovate, acuminate, to 8 ins. long, secondary nerves 13-17 pairs, straight, parallel, blade of leaf flat. Inflorescence a raceme, sometimes branched, of 4-6 flowers in axils of leaves. Petals to 1¼ ins. long. Fruiting calyx pruinous, ovate, wings glabrous 4 ins. long.

Flowering, April; fruiting, May.

There is a form of *D. turbinatus* with tomentose leaves, but we have not seen it in this country.

3. D. TUBERCULATUS, Roxb.

Lao, *Mai teung* (ไม้เต็ง); Siamese, *Mai pluang* (ไม้พลวง); Karen, *Tă la aw a kwa* (ตะหล่า ออ อ่า ขว่า), or *La teŭ* (หล่า เทอะ); Burmese, *Eng*.

Tree to about 80 ft. high. Bark longitudinally fissured and slightly transversely cracked, grey or light grey. Cut brown, dry. Stipules covered with a dense, long, grey tomentum, young shoots, petioles, leaves and inflorescence glabrous. Stipules to 6 ins. long. Petioles to 2½ ins. long. Leaves large, cordate-ovate, reaching a length of 2½ ft., glabrous beneath, secondary nerves 9-16 pairs, not parallel, blade of leaf flat or angled at midrib. Inflorescence a simple or branched raceme of 6-12 flowers in axils of leaves. Calyx glabrous with 5 small compressed tubercles above between each pair of lobes. Petals to 1½ ins. long. Fruiting calyx tube to 1 in. diameter, glabrous at upper end produced into 5 compressed knobs alternating with calyx lobes, wings glabrous, to 6 ins. long.

D. TUBERCULATUS, var. TOMENTOSUS.

Lao, *Mai teung kow* (ไม้เต็ง ขาว)

In this variety the young shoots and petioles are densely tomentose while the leaves are tomentose beneath. Intermediate forms between this and the above are found, but are not common.

Flowering, March; fruiting, April—May.

4. D. COSTATUS, Gaertn.

Lao, *Mai yang pai* (ไม้ยาง ปาย)

Tree to about 150 ft. high. Bark irregularly flaking, usually dark brown. Cut light brownish yellow. Young shoots, inflorescence and petioles densely clothed with rather long yellow hairs, brown on older parts, leaves with a scattered pubescence below, tomentose along midrib and secondary nerves, glabrescent above. Stipules, covered with brown silky hairs, to $2\frac{1}{4}$ inches long. Petioles to $1\frac{1}{4}$ inch long. Leaf ovate, acute or shortly acuminate, rounded or acute at base, to $4\frac{1}{2}$ ins. long, secondary nerves 10-15 pairs, parallel. Inflorescence a short raceme of 2-4 flowers. Calyx tomentose, calyx tube with 5 longitudinal ridges along its whole length. Corolla to 3/4 in. long. Fruiting calyx tube globular, compressed above and below, about $\frac{1}{2}$ ins. diameter, with scattered stellate pubescence, 5 narrow longitudinal ridges alternating with calyx lobes, wings to about $3\frac{3}{4}$ ins. long.

Flowering, March ; fruiting, May.

5. D. ALATUS, Roxb.

Lao, and Siamese, *Mai yang* (ไม้ยาง); Karen, *Kău* (เคาะ) or *Kau* (คอ); Burmese, *Kanyin byu.*

Tree to about 180 ft. high. Bark grey, rather smooth, flaking. Cut light yellow. The young shoots, inflorescence, stipules and petioles covered with a very short grey, or yellowish, tomentum. Leaves with tomentum along midrib below, less along secondary nerves. Petioles about 1 in. long. Leaf oblong-ovate, shortly acuminate, to 13 ins. long, secondary nerves 12-22 pairs. Inflorescence a short simple or branched raceme. Calyx densely tomentose, tube with 5 broad longitudinal ribs alternating with calyx lobes. Corolla about 1 in. long. Fruiting calyx tube about $\frac{3}{4}$ in. diameter glabrescent, with longitudinal ribs abont 5/8 in. broad, wings $5\frac{1}{2}$ ins. long.

Flowering, February ; fruiting, March.

II. SHOREA, Roxb.

Large or medium sized trees. Stipules usually small and early deciduous. Flowers rather small. Stamens 15-100. Calyx tube in fruit not

enlarged but the fruit is more or less enclosed by the imbricating bases of the calyx lobes, which are all enlarged to form wings, but 3 usually larger than the others.

A. Stamens 20 or more.

1. *Shorea obtusa.*

B. Stamens 15 only.

a. Petals spreading.

2. *Shorea floribunda.*

b. Petals incurved and forming a hollow globe, open above.

3. *Shorea Siamensis.*

1. S. OBTUSA, Wall.

Lao, *Mai ngaa* (ไม้แงะ); Siamese, *Mai teng* (ไม้เต็ง); Karen, *Tŭ la aw a kaw* (ตะหล่า ออ อา กอ); or *La ni* (หล่า นิ). Tree to about 80 ft. high. Bark blackish grey, roughly flaking. Cut brown, rather dry. Young shoots, inflorescence, stipules and petioles of young leaves covered with a short scurfy tomentum, sometimes only a scattered stellate pubescence. Petioles glabrescent, to $\frac{3}{4}$ in. long. Blade to $6\frac{1}{2}$ ins. long, oblong or oblong-ovate, blunt or shortly acuminate, secondary nerves 14-20 pairs, net-veination not prominent beneath. Inflorescence, axillary or terminal panicles. Flowers yellowish, scented. Calyx with white tomentum. Corolla 3/8 in. long. Fruiting calyx with all lobes enlarged to form wings but 3 of them larger than other two, bases of wings broad, completely enclosing nut, larger wings to 2 ins. long, shorter to $1\frac{1}{2}$ ins.

Flowering, March ; fruiting, April-May.

2. S. FLORIBUNDA, Kurz.

Lao, *Mai kăyaum* (ไม้ ขะยอม); Siamese, *Mai păyaum* (ไม้พยอม). Tree to about 30 ft. high, rather mis-shapen. Bark dark grey or nearly black, flaking in rectangular pieces. Cut yellowish brown.

Young shoots, petioles and inflorescence covered with a fine velvety tomentum, stipules with yellow tomentum, young leaves with scattered short grey pubescence, old leaves glabrescent. Petioles about ½ in. long. Leaves oblong-ovate, rounded at base, acuminate, to 5 ins. long, secondary nerves 17-22 pairs. Inflorescence, large axillary and terminal panicles. Flowers white, fragrant. Calyx with scattered short pubescence. Corolla to 5/8 in. long. Fruiting calyx glabrous, bases of wings broad and enclosing nut, larger wings to 4 ins. long, one of 2 smaller wings very small and linear.

The Lao natives distinguish two varieties of this tree, (1) *Kayaum deng*, with the branches of the inflorescence red (glabrous?); (2) *Kayaum kow*, with the branches of the inflorescence white (tomentose?)

Flowering, February-March; fruiting, March-April.

3. S. Siamensis, Miq.—Syn. Pentacme suavis, A. DC., Pentacme Siamensis, Kurz. var. suavis, Pierre.

Lao, *Mai pau* (ไม้เปา), or *Mai pau kau* (ไม้เปาขาว); Siamese *Mai rang* (ไม้รัง); Karen *Tă la aw* (ตะหล่าออ) or *La bŭw* (หล่าเปาะ); Burmese, *Eng yin.*

Medium sized or small tree. Bark grey, fissured longitudinally, cracked transversely. Cut reddish brown. All parts glabrous, young leaves occasionally with scattered pubescence beneath. Stipules rather large, to ¾ in. long, membranous and persisting till leaf reaches its full size. Petiole to 2 ins. long. Leaves oblong or oblong-ovate, shortly acuminate, cordate at base, secondary nerves 13-17 pairs, net-veination prominent beneath. Inflorescence, large, branching, in axils of fallen leaves. Flowers yellow, fragrant. Calyx glabrous. Petals incurved. Nut supported below by broad bases of calyx wings, exposed above, wings all large, 3 somewhat larger than other 2, larger to 3¾ ins. long.

S. Siamensis, var. Mekongensis, Pierre.

Lao, *Mai pau deng* (ไม้เปาแดง).

In this variety the leaves have a dense tomentum beneath, and there is a very fine pubescence on outside of calyx and corolla. The stipules

are smaller than in the type, and deciduous before the leaf reaches full size. Leaves blunt, rarely shortly acuminate.

Flowering, March ; fruiting, April—May.

III. HOPEA, Roxb.

Trees. Stipules very small, early deciduous. Flowers in unilateral spikes, or racemes, arranged in panicles. Stamens 15. Calyx tube in fruit not enlarged, two of the five calyx lobes enlarged and wing-like, other three lobes remaining very short. Nut embraced by calyx lobes.

1. H. ODORATA, Roxb.

Lao and Siamese, *Mai takien* (ไม้ ตะเคียน); Karen, *So ke* (โซเก); Burmese, *Thingan.*

Tree to about 100 ft. high. Bark grey with irregular longitudinal cracks. Cut yellow or reddish. Young petioles, and midribs, and secondary nerves beneath, covered with short brown tomentum, inflorescence with grey tomentum. Petioles glabrescent, $\frac{1}{2}$-$\frac{3}{4}$ in. long. Leaves oblong-ovate or nearly elliptical, bluntly acuminate, glabrescent, to $4\frac{1}{2}$ ins. long, secondary nerves 11-16 pairs. Calyx grey velvety outside. Corolla 1/8-3/16 in. Fruiting calyx grey tomentose, 2 lobes greatly enlarged to form wings, other 3 lobes remaining short, wings about $1\frac{1}{2}$ ins. long.

Flowering, March-April ; fruiting, April-May.

The Karen names of some of these trees are interesting ; mai teung they call the male mai pau, mai hieng the female mai pau and mai ngaa the red mai pau.

JUNGLES IN WHICH THE "DIPTEROCARPACEAE" OCCUR.

Several species of the *Dipterocarpaceae* are remarkable in that they form jungles almost as pure as the European oak or pine forests. There are very few other trees growing in the Tropics, at moderate altitudes, that approach them in this respect ; most tropical forests are marked by the variety of their species. Kurz calculates that the evergreen tropical forests of Burma contain 200-300 species of trees to the square mile. In Northern Siam the gregarious species grow in dry deciduous jungle called by the Laos pah paa, and by Burmese eng jungle. Pah paa is found always on soils with a very low

capacity for retaining water, such as red clay, or laterite, sandy and rocky soils. This character of the soil, together with the long dry season, prohibits the growth of any vegetation which is not able to withstand long periods of drought.

Pah paa is best developed on undulating ground, foot-hills, and the lower slopes of mountains ; it is met with to some extent also on the plain, when the conditions are suitable.

There are several varieties of pah paa, but they all have certain general characteristics. The jungle is open, approaching the savannah type, and the trees are usually small. Most of the shrubs are small, as they are burnt down by forest fires every year, and are only able to throw up annual shoots in the rains. Woody climbers are scarce, or absent. Herbaceous plants are, in most of the varieties of pah paa, abundant, coming up in the rains, and flowering towards the end of the rains, or in the cold season ; they are almost all perennials with tuberous roots ; the few annuals found are small, and flower during the rains.

The pah paa in Northern Siam may be divided into four main varieties :—

1. Mai teung jungle.
2. Mai hieng jungle.
3. Mai pau jungle.
4. Mai ngaa jungle.

1. Mai Teung Jungle.

This jungle is found from the plain to an altitude of about 2,000 ft. above sea level, most frequently on red clay. Of the four varieties of pah paa it has the greatest number of different trees. Mai teung is usually the predominant tree, mai hieng and mai ngaa are also plentiful and the glabrous form of mai pau is found in small quantities. Both mai teung and mai hieng reach a good height, 60-70 ft., but most of the other trees are small. Besides these dipterocarps there are a large number of other trees belonging to many different orders, the commonest being *Terminalia tomentosa* (mai ba hok fa), *Buchanania latifolia, Melanorrhoea usitata* (mai hak), which supplies the black varnish used for Lao lacquer work, *Tristania rufescens* (mai kāw), *Ochrocarpus Siamensis* (salup pi), *Diospyros chretoides,*

and *Quercus sp.* (mai kaw). There are many smaller trees and a few shrubs, such as *Aporosa villosa*, *Ochna Wallichii*, which appears in the dry season as a few inches of leafless twig covered with large yellow flowers, occasionally it grows out into a small tree, *Strychnos nux-vomica* (mai ba teung), *Gardenia erythroclada*, noticeable for its smooth red bark, *Blinkworthia lycioides*, and a small, almost stemless, palm with edible fruit, *Phoenix acaulis* (pum peng); a dwarf cycad, *Cycas Siamensis*, is found in great abundance in some districts.

The trees are in open order, their crowns as a rule not touching, and the ground beneath is covered with a tufted growth of grasses and cyperads.

Woody climbers are rare in all forms of pah paa, but we sometimes met with *Spatholobus Roxburghii* in mai teung jungle.

Orchids and other epiphytes are very plentiful, two of the finest orchids found in the North, *Dendrobium pulchellum* and *Dendrobium calceolaria*, are abundant, while *Ærides multiflorum*, *Ærides falcatum*, *Sarcanthus Williamsonii*, *Eria Griffithii*, *Bromheadia aporoides*, *Dendrobium secundum* and species of *Hoya* and *Loranthus* are frequently seen, but, perhaps, the most remarkable of the epiphytes is *Dischidia Rafflesiana*, whose clusters of tawny pitcher-leaves give it the appearance of a fungus rather than a flowering plant. Perennial herbaceous plants are numerous, many of them with grass-like leaves ; annuals, when present, are small, often minute, and belong chiefly to the orders *Scrophulariaceae* and *Polygalaceae*, the presence of a species of *Utricularia*, a water loving genus, in this dry jungle is interesting, but it only appears in the middle of the rains when the ground is almost constantly damp.

On the Khoon Youam plateau, a narrow plateau at an altitude of about 1,500 ft. stretching for 7 or 8 miles, there is a form of this jungle in which *Pinus Merkusii* is the predominant tree, mai teung coming next in order of frequency ; the soil is a gravelly sand.

By counting all trees over 20 ft. in height, within about 30 yards of the path, we have been able to arrive at a rough estimate of the composition of some of the varieties of pah paa. Estimated in this way the composition of an average sample of mai teung jungle was :—

Dipterocarpus tuberculatus (mai teung)	37
Dipterocarpus obtusifolius (mai hieng)	17
Shorea obtusa (mai ngaa)	17
Shorea Siamensis (mai pau) glabrous form, ...	1
Melanorhoea usitata (mai hak)	14
Quercus sp. (maikaw)	9
Tristania rufescens (mai kăw)	2
Other species less than 1%	3
	100

2. Mai Hieng Jungle.

Mai hieng jungle is commonly found in two situations; on the plain, where the soil is sandy, and on steep slopes and crests of ridges at from 2,000-3,000 ft. altitude. In both these places mai teung is absent, and mai hieng forms at least 40% of all the trees present.

On mountains this jungle is found usually on red clay; here from 50-60 % of the trees are mai hieng, most of the other trees being oaks, of which there are three common species; mai ngaa is occasionally met with and, more rarely, the glabrous form of mai pau; both these trees grow to a larger size here than they do in the mai teung jungle below. Near the upper limit of the mai hieng jungle, we first find *Pinus Khasya*.

The ground is covered with a tufted growth of grass as in the mai teung jungle, but there is not such an abundance of other herbaceous plants, nor are there as many shrubs and small trees.

The epiphytes are much the same as those in mai teung jungle, but some of those found below, such as *Dendrobium secundum* and *Eria Griffithii* are not found, their place being taken by *Bulbophyllum nigrescens, Coelogyne Rhodiana* and others.

A count of the trees in mai hieng jungle between 2,500-3,000 ft. altitude on Doi Sootep gave the following result:—

Dipterocarpus obtusifolius (mai hieng)	59
Shorea obtusa (mai ngaa)	2
Quercus, various species, ...	28
Species less than 1%	11
	100

3. Mai Pau Jungle.

Mai pau jungle is found on dry and very stony soil, sometimes on red clay, usually covering low hills not more than 500-600 ft. above the plain. In the hot season it is one of the most trying jungles to travel through ; the small grey leafless trees afford no overhead protection while the heat is strongly reflected from the stony ground, at this time of the year devoid of vegetation. Mai pau jungle sheds its leaves more completely than any other jungle in this country, they drop towards the end of January and the new ones do not appear till April.

The mai pau found here is always the tomentose variety, mai pau deng, so called on account of the reddish tinge of its leaves; mai ngaa is, perhaps, the commonest of the other trees, a stunted species of *Pterocarpus* and a *Dalbergia* are also often seen ; these trees, like the mai pau, are all small, the general height being about 30-35 ft.

Patches of small bamboo, mai huak, are not uncommonly met with in mai pau jungle. Shrubs are scarce, but sometimes *Cycas Siamensis* (mai prau tau) is abundant.

The herbaceous vegetation is not nearly so plentiful as it is in mai teung or mai hieng jungle.

The trees are frequently infested with parasites, species of *Loranthus* and *Phacellaria*. Other epiphytes, with the exception of a species of *Hoya* and a few small orchids, such as *Vanda parviflora* and *Sarcanthus Williamsonii*, are not common.

The following count was made on Doi Sootep, where this jungle only occurs in small patches which merge into other forms of pah paa ; in a typical developement of mai pau jungle mai hieng is not present :—

Shorea Siamensis (mai pau deng), ...	75
Shorea obtusa (mai ngaa)	3
Dipterocarpus obtusifolius (mai hieng)	7
Melanorrhoea usitata (mai hak), ...	7
Tristania rufescens (mai kău)	1
Various	7
	100

4. MAI NGAA JUNGLE.

The jungle which has mai ngaa as its predominant tree is very similiar to mai pau jungle, and also occurs on stony ground or red clay. The trees are small and grow in open order.

There is as a rule a better development of herbaceous plants than we find in mai pau jungle.

We have not been able to obtain a count of the trees in mai ngaa jungle.

The *Dipterocarpaceae* not occurring in pah paa are found in various jungles:—

Hopea odorata (mai takien) grows almost exclusively along the banks of streams and rivers in evergreen or semi-evergreen jungle, it is met with from the plain to an altitude of 2,000 ft.

Dipterocarpus alatus (mai yang) is also usually found along river banks, but differs from mai takien in that it does not extend far up mountain streams. Its tall, regular, light grey trunk is a conspicuous object in the jungle along the river between Paknampo and Raheng.

Dipterocarpus laevis (mai yang), which resembles *D. alatus* in general appearance, is found in the same situations as mai takien and has the same range of altitude.

Dipterocarpus incanus (mai yang pai) grows in evergreen jungle at an altitude of 2,000–3,500 ft. and is inclined to be gregarious.

Shorea floribunda (mai kayaum) is found in mixed dry jungle, sometimes associated with teak.

CONDITION OF GROWTH AND REPRODUCTION.

The soil, altitude remaining constant, exercises an important part in determining the type of jungle. Pah paa, as we have pointed out, is always found on a porous well drained soil above the reach of the highest floods. As a rule on red clay we find mai teung, on sandy soil mai hieng and on stony ground mai pau jungle, but it is probable that there are other factors besides soil which have an influence on the type of jungle. Thus we sometimes find mai pau jungle on a red clay showing no gross dissimilarity from that on which mai teung flourishes; even in two areas divided only by a stream considerable differences may be noticed, such as the predominance of mai hieng on one side and of mai teung on the other, instances of this sort are not uncommon. Mai hieng seems to be more readily affected by adverse circumstances than the other trees of pah paa, in some districts it is completely absent from the mai teung type of jungle.

Most of the dipterocarps in pah paa jungle have thick fissured bark and the leaves have various devices, such as position, texture and hairy clothing, for limiting transpiration, this is necessitated by the fact that the soil is such a poor retainer of water. In mature exposed trees of mai teung we find the large leaves hang more or less vertically, so that the surface of the leaf is nearly parallel to the rays of the mid-day sun and in consequence gets less intensely heated; a similar result is achieved by the leaves of mai hieng but in a different way, the general direction of these leaves is horizontal, but the blade is thrown up in high folds between the secondary nerves, so that no part of the green surface is actually horizontal. Correlated with this we find a considerable difference in the habit of the two trees, mai hieng has few branches below, but spreads above somewhat in an umbrella form, while mai teung has a pyramidal shape, thus both trees obtain a large leaf surface without exposing their leaves to the vertical strike of the sun rays; in young trees growing in the shade of old trees these characteristics are not so well marked.

It is interesting to find that several of the species have two forms, one with tomentose, the other with glabrous leaves. The rate

of growth of these two forms is different, that of the tomentose being the slower. It is probable that the tomentose forms affect a drier and more barren soil than the glabrous; this certainly holds good for mai pau, the tomentose variety of which is found on very dry stony ground, while the glabrous grows usually on clay, frequently near streams. We have not been able definitely to establish this difference of soil for the two forms of mai teung and mai hieng, though the mai hieng found above 2,000 ft. on mountain slopes is always the hairy variety.

The ability of some species to store water is also an adaptation to their dry habitat. A characteristic of the young mai hieng tree is that, when cut, it exudes quite a quantity of water; if the stem be cut and turned upside down, water will at once start dropping out and can be easily collected. In pah paa water is often very difficult to find in the dry season, and on shooting expeditions one has frequently to resort to the mai hieng for a drink.

The dipterocarps not occurring in pah paa are, for the most part, hygrophilous, enjoying the vicinity of streams and rivers. Mai yang (*Dipterocarpus alatus*), growing usually on a sandy soil, is often found in places which are flooded every year. Mai yang pai is best developed in damp evergreen forests where the ground is covered with a rich layer of humus.

Many of the devices for protection against intense light coincide, as Schimper has pointed out, with those which restrict transpiration. The position of the leaves, as described in mai hieng and mai teung, probably acts in both these ways, as do the large sheathing stipules of the young leaves in the same two trees. A more particular protection against strong insolation is the deep red colour of the young leaves of several species; this red colour is very marked in the young leaves of mai pau, which has not sheathing stipules.

The trees growing in pah paa are all deciduous, but in some species the period of leaf fall is not so well marked as in others. In the case of mai pau all the leaves fall at about the same time, leaving the tree completely bare, this fall takes place about the end of January and the tree remains leafless till the middle or end of March. In the

other trees of this jungle the leaves fall at the same season, but the bareness is not so marked, as the new leaves have already begun to appear before the old ones have all dropped. The same species of tree may vary, in this respect, in different localities, mai pau in mai pau jungle becomes quite leafless, but when found in other jungles, it is never completely devoid of leaves, this is particularly noticeable in the glabrous variety.

Flowering takes place towards the middle or end of the period of leaf-fall, except in mai hieng, which flowers before the leaves begin to fall.

The length of the period of growth varies in the different species, but in all the growth may be said to be greatest during the first month after the appearance of the new leaves. In mai pau deng and mai ngaa growth is limited to that time, it starts about the end of March and is quite over by the end of April, that is there is only about a month during which the young shoots are lengthening and producing new leaves. It is remarkable that this period is in the dry season which, as far as plant life is concerned, physiologically corresponds to the winter of temperate latitudes. Although the other species have their period of maximum growth in April or May, they continue growing more or less throughout the rains, particularly young or damaged trees.

In the dipterocarps of Northern Siam root-shoots are not an important means of reproduction, we have only noticed them in mai pau and mai teung, and that only very occasionally.

A large number of the species coppice, mai pau, mai hieng, mai teung, mai ngaa and mai kayaum do so, but not mai yang (*Dipterocarpus alatus*).

All these trees have flowers adapted for insect pollination ; the flowers of the species of *Dipterocarpus* are large and showy, while those of the others, appearing while the trees are out of leaf, are scented and produced in great abundance.

Fruit are borne in great quantities by all, more especially by the species of *Shorea* and mai takien, which have small, light fruit. Only about one in every twelve trees of mai takien will be found

seedings in one season, so it is highly probable that this species does not seed every year; all the others, as far as we know, seed yearly.

The fruit have no thick or hard covering which would protect them from the forest fires, but this is not of great importance as they fall towards the end of the dry season when these fires are mostly over. At this period of the year, the end of the dry season, there are high gusty winds, which must help to some extent in the distribution of the fruit; indeed from their wings one might regard them as being adapted for dispersal by wind, but it is doubtful if such heavy fruit as those of mai hieng are ever carried, by this means, more than 100 yards; the lighter ones are certainly blown much farther, during high winds they may often be seen whirling through the air at a great height.

The fruit of all the species mentioned in this paper, except those of mai takien, which were not experimented with, floated well and showed no signs of sinking after seven hours in water. This property must be of considerable importance in aiding the dispersal of those species growing along streams and rivers, in fact their fruit may be frequently seen in the debris left by floods and freshets.

The seeds of all species germinate almost at once on reaching the ground. We have never observed germination to occur on the tree, as is sometimes the case in the sāl tree.

In pah paa, where jungle fires in the dry season are the rule, the young trees are constantly being burnt back and so take some years to establish themselves; mai teung takes 5 to 8 years, mai hieng only about 3 years. As with all the other trees in pah paa an extensive woody growth is formed under-ground before this establishment takes place.

ECONOMIC PRODUCTS.

Timber. Of the 9 species mentioned in this paper Mai Takien is perhaps the most useful, it is certainly in greater demand than any of the other species. Since the felling of teak has been prohibited except under the conditions of a lease, Mai Takien has taken its place and the wood is so extensively used for building purposes that the more accessible areas are being rapidly worked out and it is most necessary that Government should introduce regulations to stop indiscriminate fellings. In addition to being used for building purposes, the larger trees are also cut into hulls for the local built boats. These hulls last for years in fresh water, but sea water appears to have an injurious effect on the wood, for it has been noticed that the life of a boat is longer now that it only goes as far as rail-head (Paknampo) than in the old days when boats were sent right down to Bangkok.

Boats are also built out of the Mai Kaiyaum tree, but they are not to be compared to those built out of Mai Takien.

Mai Teung, Mai Hieng, Mai Ngaa and Mai Pau are also used for building p oses. The two former are not much in demand as they are attacked by white ants and are said to rot when exposed to the weather, but in the absence of Mai Takien they are used for inside walling and flooring. Mai Ngaa and Mai Pau are also used for flooring and walling to a certain extent; both woods are comparatively hard to convert and but for this fact would be far more extensively used.

Mai Ngaa and Mai Pau are in great requisition for posts and for this purpose are second to no timber in the North with the exception perhaps of Mai Deng. Mai Ngaa and Mai Pau are highly recommended for telegraph posts, and the Government would be wise if they always insisted on being supplied with these woods for their telegraph lines. A few words must be written on posts cut from Mai Teung. The posts of this wood are considered rather inferior, but it does not appear to have been recognised that the posts are very durable in water. Posts of this wood planted by the British Consulate in May 1889, *i. e.*, over 20 years ago, to protect the front of the Chiengmai compound from erosion, were found to be in a remarkably sound condition, and there were fewer signs of the wood decaying below than above the water line.

Firewood. Mai Hieng and Mai Teung are the best known firewoods in the North. They both burn green, and, so large a local trade is growing up round the large towns, that if the future needs of the population are to be considered, steps should be taken to bring the forests under a working plan.

Both Mai Hieng and Mai Teung coppice and in 15 years yield timber of suitable size for firewood; thus the preparation of a working plan is rendered comparatively easy.

Coppice with standards is, no doubt, the best method to adopt, as a certain quantity of large timber is required.

Speaking of Chiengmai, the drainage area on both banks of the Me Ping for a distance of 20 miles above Chiengmai and the drainage area on both banks of the Me Ping for a distance of 20 miles below Chiengmai might be brought under two separate working plans of a rotation of 15 years each, in which case each area will be divided into 15 coupes and only one coupe in each area will be worked annually. Thus we shall have 2 coupes being worked annually and in 15 years the area reserved for the production of firewood will be under a systematic management much to the benefit of the future population.

Resins and Oils. The chief resin is that obtained from the Mai Yang known locally as "Numon Yang." Mixed with the resin of Mai Teung or Mai Pau it is used for painting boats and is said to preserve the wood. The oil of Mai Teung or Mai Pau is added to form a better sticking mixture, this mixture is also used to make bamboo buckets water tight.

The resin from the Mai Hieng tree is used as a substitute for cocoanut oil in the native lamps and the natives rub the Mai Takien resin on the strings of their fiddles, while the Mai Teung resin mixed with Kin Nya (the wax deposited by the sweat fly, Trigona laviceps*) is used for caulking boats.

Leaves. The leaves of Mai Teung are used for thatching, those from Mai Teung Khow are preferred as they are thicker. The leaves

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* Scientific name to be looked up.

are cleverly stitched together with bamboo into strands of 1 wah (80 inches) in length, the breadth being the length of the leaf; these strands are tied to rafters, the upper strands almost cover the whole of the lower ones. The leaves should be collected during the period of leaf fall, *i. e.*, about the end of January, and they should be gathered early in the morning when they are still wet with dew; they should then be soaked in water and stitched into strands when time permits. It is essential that the leaves should not become dry at any time before being worked into strands as they become brittle and crumble to pieces. Treated in this manner a roof is said to last as long as three years.

The leaf roof has one advantage over the grass roof in that it does not burn so easily and quickly. These leaf roofs are common throughout the whole of Northern Siam, and, owing to the excessive price of shingles, the Forest Department have most of their Rangers and Foresters' quarters thatched with Mai Teung leaves.

The leaf of the Mai Hieng is also used for thatching but only when Mai Teung leaves cannot be procured in sufficient quantities; but for walling the leaves of the former tree are considered far superior. For walling the leaves are prepared in the same way as for thatching, but instead of being worked into strands they are worked into bamboo frames of 1 wah square and tied to bamboo or timber supports. Such walling is commonly used by the poorer classes and is in great demand in erecting temporary timber camps.

The leaves of the Mai Pau are commonly used for thatching elephant howdahs, and the leaves of Mai Teung and Mai Hieng are used by the people for wrapping up parcels much in the same way as paper is used by a shop assistant at home.

Flowers. The flowers of the Mai Kaiyaum have a strong scent and are much admired by the natives. On feast days and on occasions when girls wish to look particularly bewitching the Kaiyaum flower is worked into garlands which are tied round the hair. The result is picturesque, but the odour is strong and once smelt can never be forgotten.

Miscellaneous. The Lac insect, which is extensively cultivated in parts of North Siam, is grown on Mai Pau when Mai Kwaw cannot be found.

Hai or Thaungya plantations. Siam like Burma and India has to face the question of shifting cultivation known locally as "Hais" and in Burma as "Thaungyas." It is not possible at present to stop "Hai" cultivation, but it is thought that the planting of Mai Hieng seed in "Hais" would be a palliation though not a complete remedy for the deforestation that is taking place over the whole country. It is true that Mai Hieng does not grow in moist ever-green jungles and could not therefore be introduced into every "Hai", but in the lower slopes one constantly sees Mai Hieng saplings growing luxuriantly in an old "Hai;" in fact if the saplings are at all numerous, their dense shade kills all other forest growth. The Mai Hieng is not a valuable wood, but it is far better to have the country clothed with this tree than to see miles upon miles of treeless country, which at one time was covered with valuable forest, but which now is clad with nothing but a rank growth through which both man and animals find it hard to penetrate.

Medicinal uses. The bark of several species, chiefly of Mai Takien, Mai Pau and Mai Yang, ground up and mixed with other drugs is used as a cure for toothache. This remedy owes its efficacy, no doubt, to the essential oils contained in the barks. A mixture, with the barks of mai ngaa and mai pau as its principal ingredients, has some reputation for fattening elephants, buffaloes, cattle, ponies and sometimes human beings. A decoction made from several barks, one of which is mai yang, is given as a tonic for anaemic girls and young children.

Medicines from these barks are usually made in one of two ways, in one a watery extract is obtained by boiling, in the other a powder is got by rubbing the bark down on a stone.

The oil of mai yang is used as a remedy for gonorrhoea, about the same dose being given as of Copaiba, which the natives also call namun yang. This oil is also used externally as an application for wounds in cattle.

In concluding we should like to express our thanks to The Director of the Royal Botanic Gardens, Kew, for the identifications of

most of the species we have mentioned, one species was very kindly identified by The Curator of The Royal Botanic Gardens, Calcutta.

In the preparation of this paper we freely consulted the following works :—

S. Kurz, *Forest Flora of Burma*, Calcutta, 1877.
D. Brandis, *Indian Trees*, London, 1907.

F. D. RYAN.

A. F. G. KERR.

APPENDIX.

Dipterocarpaceae recorded from Southern Siam not included in foregoing list.

DIPTEROCARPUS ANGUSTIALATUS, Heim
Jungle near Klong Son, Schmidt.
Native name, *Ton Yang* (Schmidt).

DIPTEROCARPUS INTRICATUS, Dyer
Korat, 60-90m., Witt.
Vernacular, *Mai Krat* (Witt).

DIPTEROCARPUS PARVIFOLIUS, Heim
Jungle near Lem Dan, Schmidt.

DIPTEROCARPUS SCHMIDTII, Heim
Jungle near Lem Dan, Schmidt.

ANISOPTERA COCHINCHINENSIS, Pierre
Lim Dan & Klong Prao, Schmidt.
Native name, *Ton Tabak* (Schmidt).

ANISOPTERA MARGINATOIDES, Heim
Klong Munse, Schmidt.

SHOREA HENRYANA, Pierre, var. RIGIDA, Heim
Lem Dan, Schmidt.

SHOREA HYPOCHRA, Hance
Klong Munse, Klong Son, Schmidt.

SHOREA OBTUSA, Wall., var. KOH-CHANGENSIS, Heim
Klong Sarlakpet in the jungle near the sea, Schmidt.

SHOREA SIAMENSIS, Miq., var. LAEVIS, Pierre
Klong Prao, on rocks in the jungle, Schmidt.

SHOREA SIAMENSIS. Miq., var. OBTUSIFOLIA, Heim
Klong Majum, alt. 700ft., on rocks in the jungle, Schmidt.

SHOREA ROBUSTA, Gaertn. f, var. SCHMIDTII, Heim
Klong Son, Schmidt.
Heim, who described this from the fruit only, remarks that perhaps it should be referred to *Shorea vulgaris*, Pierre.

HOPEA AVELLANEA, Heim
Klong Munse, Schmidt.

HOPEA SCHMIDTII, Heim
Klong Son, Schmidt.

HOPEA SIAMENSIS, Heim
Klong Son, Schmidt.

The above list is for the most part compiled from The Preliminary Report on the Botanical Results of the Danish Expedition to Siam (1899-1900), an excerpt from which Dr. Foxworthy of Manila very kindly sent us.

ERRATA.

P. 3, line 21, for " D. OBTUSIFOLIUS var. SUBNUDUS " read

" D. OBTUSIFOLIUS, Teysm., var. SUBNUDUS, Kerr, var. nov."

P. 3, line 25, for " I have " read " There are ".

P. 4, liue 28, for D. TUBERCULATUS, var. TOMENTOSUS " read

" D. TUBERCULATUS, Roxb., var. TOMENTOSUS, Kerr, var. nov."

P. 6, lines 9 & 10, delete " and forming a hollow globe, open above ".

P. 6, line 2, et seq., for " kayaum " read " kayawm ". On same line for " payaum " read " payawm ".

P. 13, line 22, for " INCANUS " read " COSTATUS ".

P. 14, line 1, for " CONDITION " read " CONDITIONS ".

P. 19, for " Numon " read " Namun ".

P. 19, delete note at foot of page.

P. 20, line 29, for " Kaiyaum " read " Kayawm."

PLATE I.

Fruit of Dipterocarpaceae.

Fig. 1. *Dipterocarpus obtusifolius*, Teysm.

Fig. 2. *Dipterocarpus turbinatus*, Gaertn. f.

Fig. 3. *Dipterocarpus tuberculatus*, Roxb.

Fig. 4. *Dipterocarpus costatus*, Gaertn. f.

Fig. 5. *Dipterocarpus alatus*, Roxb.

Fig. 6. *Shorea obtusa*, Wall.

Fig. 7. *Shorea floribunda*, Kurz.

Fig. 8. *Shorea Siamensis*, Miq.

Plate I.

PLATE II.

Fig. 1. A growing shoot of the ordinary form of *Dipterocarpus obtusifolius*, showing the dense hairy covering of the young shoot, petioles and long sheathing stipules.

Fig. 2. A growing shoot of the subnude variety of *Dipterocarpus obtusifolius* with all parts, except the leaves and a small portion of the petioles, glabrous.

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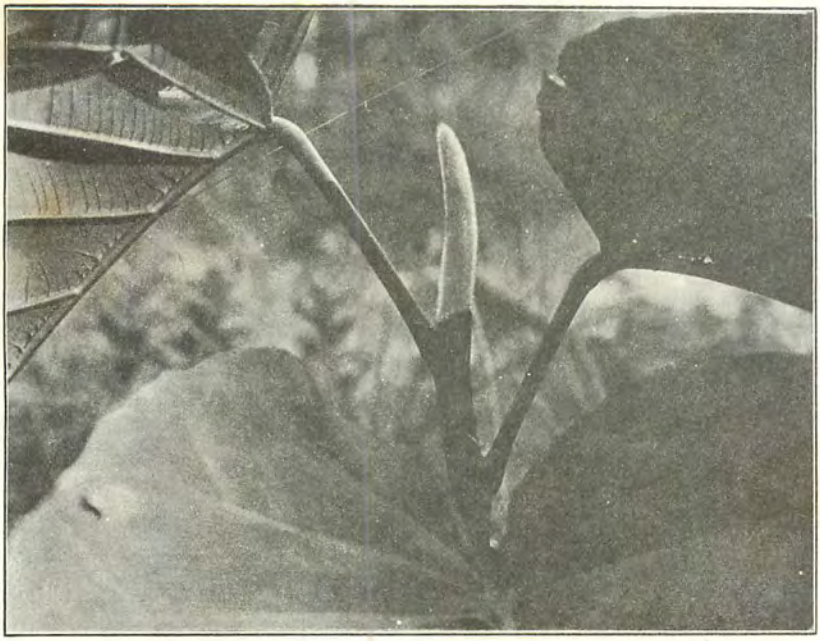
Plate II.

PLATE III.

Fig. 1. A growing shoot of the common form of *Dipterocarpus tuberculatus*, the sheathing stipules only tomentose.

Fig. 2. A growing shoot of the tomentose form of *Dipterocarpus tuberculatus*. The young shoots and petioles as well as the stipules have a dense hairy covering. The tomentum on the under side of the leaves is too fine to show on the photograph but it will be noticed the under side of the leaf, where lighted by the sun, looks whiter in Fig. 2 than in Fig. 1.



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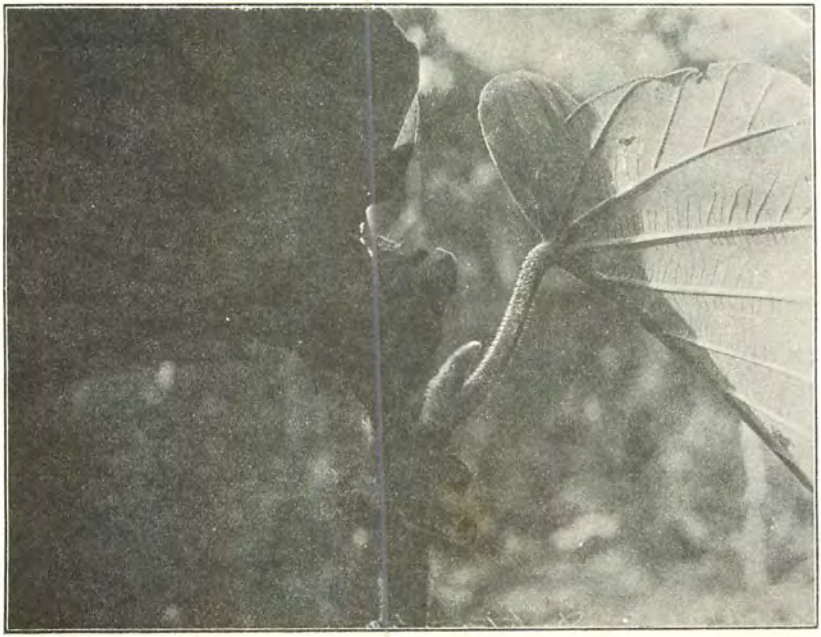

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Plate III.

PLATE IV.

Fig. 1. *Mai pau* jungle in February with leafless trees. The trees in the foreground are all *Shorea Siamensis*, mai pau. On the road between Lakon and Phre.

Fig. 2. Trees of *Dipterocarpus alatus*, mai yang, along the road between Chiengmai and Lumpoon.

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Plate IV.

PLATE V.

Mai Teung jungle on Doi Sootep at an altitude of about 1,500 ft. The tree to the left is *Dipterocarpus tuberculatus*, mai teung, that more to the right is *Dipterocarpus obtusifolius*, mai hieng; the pyramidal form of the mai teung and the spreading form of mai hieng is well shown. In the foreground is seen the typical grassy undergrowth characteristic of this jungle.

Plate V.