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MAEJO INTERNATIONAL JOURNAL OF SCIENCE AND TECHNOLOGY

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Text:

[2] Vogel, A. I. "A Textbook of Practical Organic Chemistry", 3rd Edn., Longmans, London, **1956**.

Chapter in an edited Text :

[3] Gore, P. H., in "Friedel-Crafts and Related Reactions." (Ed. G. A. Olah.), Vol. 3, Interscience, London, **1964**, Ch. 31.

Thesis / Dissertation :

[4] Chowwanapoonpohn, S. *PhD. Thesis*, **2003**, Chiang Mai University, Thailand.

Patent:

[5] Miwa, K., S. Maeda, and Y. Murata, Purification of Stevioside by Electrolysis", *Jpn. Kokai Tokkyo Koho 79 89,066* (**1979**).

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Invited Article

The role of Science and Technology for Thailand

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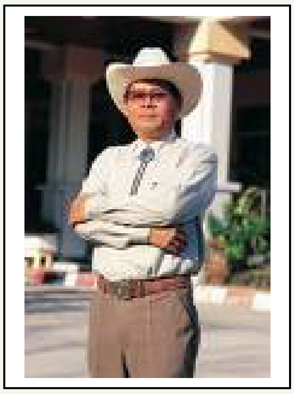


It can be said that every human being has three needs, namely, material need, social need, and spiritual need. The most basic need is, obviously, the first one, as it is the most pressing of the three. This need is satiated, directly or indirectly, by the environment. As man is also a part of the environment and nourished by it, he cannot live without or apart from it. As the most extreme example, just think of what will happen if suddenly there is no air for him to breathe just for a few minutes. Sadly, however, we tend to take the environment for granted and treat it as if it were valueless, a thing that just receives our wastes of all kinds imaginable. Thus for the tangible material need alone, we can see that man has undermined his very own welfare due to his wrong views and thoughts, which translate into wrong deeds and actions.

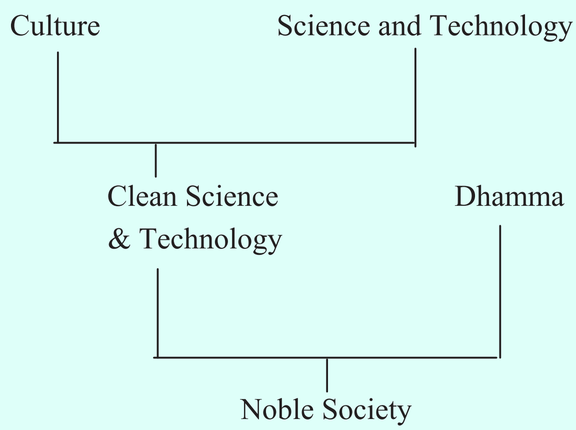
In Buddhism, it is regarded that the most deadly sin of all is the holding of wrong views and thus, by corollary, the highest merit possible is to hold the Right Views or Sammaditthi. Science also, in its noblest form, is an embodiment of the spirit in quest of Truth, which is more or less a form of Sammaditthi. Lord Buddha once said, in effect, that you should not believe what you have heard, or what you have read, or even what you have seen. You should neither believe in anything because it is a custom, a theory, or even your own reasoning. So, in a way, the Buddha can be called the first scientist of the world.

What has all this got to do with the role of Science and Technology for Thailand? Well, for one thing as mentioned above, Science at least seems to be very compatible with Buddhism, the oldest religion of Thailand. The principle of Science and Buddhism is definitely in common, but differences surely exist in the two disciplines regarding the way of attaining the goal. These differences, however, are rather complimentary than in opposition to each other. Einstein once said that religion without science is blind, and science without religion is lame. (In fact, however, it should be the other way round, viz. religion without science is lame, while science without religion is blind.)

Maybe because of this factor at least, that the Thai people tend to accept Science and Technology readily, or in fact too quickly or even indiscriminately the so-called pendulum phenomenon. What should happen though, is that Science and Technology for the Thai society should complement and be in accordance with Thai culture or original Thai way of life, which has been intrinsically and practically a Buddhist culture since times past. As well-known throughout the world, the prominent characteristics of atheistic Buddhism are, among others, compliance with Dhamma or the Law of Nature according to the Buddha, and also attainment of Nirvana or Absolute Freedom, which is the highest goal in Buddhism. As a result, the Buddhists have been normally mild, peace-loving and nature-loving people who tend to lead a life of self-sufficiency with a high degree of independency.

Desirably then, Science and Technology for the Thai society should not be those of the aggressive type, both to life and the environment, directly or indirectly. It should not be the type that 'conquors Nature' or promote or stress material dependency. Instead, Thai scientists should focus more on researches that lead to self-dependency with a certain degree of freedom and on how to live a moderate life that is friendly with nature.

And last but not least, Science and Technology should be used as a tool that, together with the Thai Culture and Dhamma, helps ushering the Thai people toward a noble society of the New Age in future. To make this possible, scientists and



technologists should first admit their intrinsic limitations and that they themselves cannot know everything, no matter how hard they try with their physical methods. However, together with other disciplines, they can contribute a large part of their share of the role of helping the present society toward a better status for all of its members.

Acknowledgements

The author would like to thank Assoc. Prof. Dr. Duang Buddhasukh and Mrs. Maria Diana Jantakad for their help.

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Editor talk

Duang Buddhasukh
Editor-in-Chief

The purpose of a scientific journal is to provide an outlet for new knowledge in science and technology. Nowadays, there are probably hundreds of this kind of journal worldwide, so why another one? The justification for this may vary from case to case. In ours, first of all, we think that the fact that there are already a lot of scientific journals available is not really the reason for withholding the birth of yet another journal, in the same way as that the presence of a lot of good people should not be the cause for stopping us to be good ourselves. This is probably one reason why there still is a number of new journals appearing every year around the world, apart from the fact that specialized fields still abound waiting for more new appropriate journals to take care of.

Again, in our case, we believe in the general principle that the more choices there are of anything, so much the better. Thus, at the very least, this journal, the brainchild of Maejo University, will serve as the one its staff can fall back on as a last resort. However, this is not to say that we are willing to behave as one at the expense of the minimum requirements as accepted in general for a good journal. As a matter of fact, this is the first peer-reviewed journal of Maejo University. It is also one of the first open-access electronic journals in this country, which are fully and readily available online (as well as in print later).

All in all, the launching of a new journal is obviously not as easy task, especially for an online journal. Apart from the normal cooperation of many people from various academic institutions, both local and abroad, and the invaluable help from the private sectors, it also requires an expertise of a special kind. The most crucial factor to the success of a journal, however, is the confidence of contributors (particularly the pioneer ones) to the journal. Regarding this, we are therefore grateful to all of them who contribute their articles to this first issue of the journal, and we invite every academic fellow, both local and international, to publish in our new journal.

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Full Paper

Flavour compounds of the Japanese vegetable soybean "Chakaori" growing in Thailand

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Abstract: The vegetable soybean ("Chakaori") grown in Thailand was examined to determine its flavour components. The analyzed sample was prepared by solvent extraction and the chemical components were identified by gas chromatography–mass spectrometry (GC-MS). Twenty-seven components were detected including 2-acetylpyrrole which was identified for the first time in soybean. The most abundant flavour compounds detected were *n*–hexanal (0.91%), 1-hexanol (1.79%), 2-hexanal (0.48%), 3-hexene-1-ol (0.49%) and phenylethyl alcohol (0.40%)

Keywords: Chakaori, Soybean, Flavour Compounds, 2-acetylpyrrole

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Introduction

Vegetable soybean, called Edamame in Japan and Mao Dou in China is one of the oldest vegetables known to man. Vegetable soybeans have been grown and consumed for more than 5000 years in China and in the Far East. It is not only an excellent source of vegetable protein (34 – 39%, with a balanced composition containing all the essential amino acids) and of vegetable oil (18 – 20%, containing all the essential fatty acids), but also fiber, carbohydrates, phytoestrogens, steroids, vitamins A, C and E, minerals and flavour [1]. There are many breeds of vegetable soybeans in the world providing different flavours, the good varieties of which are mostly from Japan [2]. It is a popular food in Japan and increases in consumption of edible soybeans in other countries have been attributed to their health benefits and flavour [3]. In Thailand, many Japanese breeds of vegetable soybeans have been grown and developed. The most interesting one is "Chakaori" which provides a good flavour similar to rice [4]. A few reports concerning "Chakaori" breed showed only the maximum of the total sucrose and starch [5-6] and no report on the flavour analysis. Only one study on flavour analysis was conducted using another soybean breed from Japan, the "Dadachamame" which has a flavour similar to that of aromatic rice and found to contain 2-acetyl-1-pyrroline [4]. However, studies on the flavour composition of "Chakaori" breed have not been reported**.** Here we report on the identification of the flavour compounds in Japanese vegetable soybean "Chakaori" grown in Thailand.

Materials and Methods

1. Materials

The vegetable soybean "Chakaori" grown in Thailand was used. The fresh vegetable soybean "Chakaori" was harvested in October - November 2005 in Maejo University farm, Chiang Mai province, Thailand. Samples were packed in sealed plastic bags and kept at –20 ^{o}C for no more than 2 days before being subjected to acid-phase solvent extraction. A synthetic sample of 2-acetyl-1-pyrroline was obtained using the method outlined by Buttery [7]. All chemicals and a standard sample of 2-acetypyrrole were purchased from Fluka.

2. Acid-phase solvent extraction of aroma compounds

Fresh vegetable soybean "Chakaori" seeds (100 g) were milled, 200 mL of 0.1 M HCl was added and the mixture was stirred for 60 min before filtration. The filtrate (~200 mL) was divided into two equal parts and transferred to two 250 mL separatory funnels. This was followed by the addition of 3 mL of 5 M NaOH to make the solution slightly basic. The aqueous phase was then extracted with dichloromethane (3 x 100 mL). After drying the combined extracts with anhydrous sodium sulfate, the solution was concentrated to ~1 mL using a rotary evaporator under reduced pressure and a temperature of 40 ^{o}C. The concentrated extract was further concentrated under a flow of nitrogen prior to GC-MS analysis. The extract provided a similar flavour as the fresh vegetable soybean seed before extraction.

3. Capillary GC-MS conditions

GC-MS analysis was performed on an Agilent 6890(GC)/HP 5975(MS). Separation was achieved using helium as the carrier gas (ca.1 mL/min) with a fused silica capillary column (HP-5MS), 30 m long, 0.25 mm i.d., and 0.25 µm film thickness. The GC injector was in a splitless mode. Injector and detector temperatures were 250 °C and 260 °C, respectively. The oven temperature was programmed starting at 45 ^{0}C, 3 min isothermal, then at 3°C/min to 60 °C/min (3 min isothermal), then at10 °C/min to 250 °C (10 min isothermal). The effluent from the capillary column went directly into the mass spectrometer. The MS instrument was operated in the full scan and electron impact ionization mode with an ionization voltage of 70 eV and an acceleration voltage of 3000 V. The ion source temperature was 230 ^{o}C and the GC-MS transfer line was set to 250 ^{o}C.

Results and Discussion

The results of the GC-MS analysis are shown in Figure 1. The chromatogram shows a great number of components that may contribute to the aroma of vegetable soybean "Chakaori". Compounds corresponding to the peaks and their major ions from mass spectra are listed in Table 1. The compounds were identified mainly by comparing their mass spectra with those of the standard compounds in the NIST and Wiley library, together with the comparison of their GC retention times with those of standard compounds and were confirmed by the standard addition technique. Tentatively identified components based only on a comparison of the mass spectra with the reference spectra of the NIST and Wiley library that yielded < 90% matches were identified as unknown in Table 1.

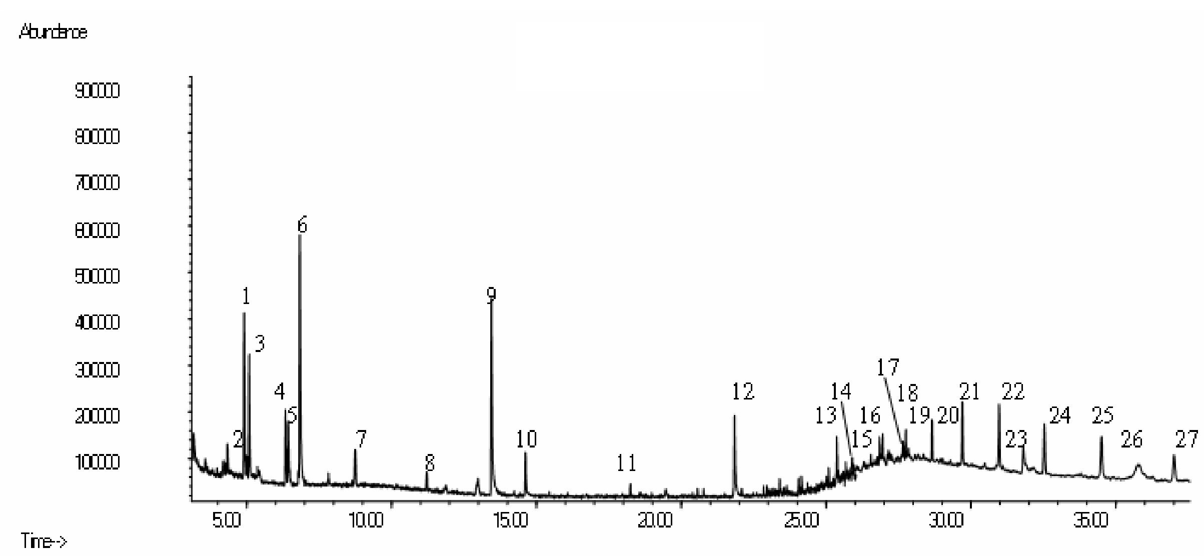

Figure 1. Reconstructed total ion chromatogram of an acid-phase solvent extract of vegetable soybean "Chakaori" obtained by GC-MS.

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Table 1. Components in vegetable soybean “Chakaori”.

Peak No.	Retention Time	Compounds	*m/z* (% relative abundance)	MW[a]	Quality[b] (%)
1	4.859	*n*-Hexanal	100, 82, 72, 67, 56, 51, 49(100), 39	100	90
2	4.936	Unknown	59(100), 44, 40(100)	87	59
3	5.031	4-Methyl-2-Pentanol	87, 69, 57, 51, 45(100), 39	102	40
4	6.264	2-Hexanal	98, 83, 69(100), 63, 55(100), 50, 40(100)	98	96
5	6.365	3-Hexene-1-ol	100, 97, 82, 72, 67(100), 55, 50, 41	100	94
6	6.762	1-Hexanol	84, 69, 56(100), 51, 43, 38	102	91
7	8.694	Unknown	123, 107, 91, 81, 69, 55, 40(100)	182	45
8	11.125	Unknown	85, 82, 81, 73, 72, 71, 70, 69, 68, 67, 60, 58, 57(100), 56, 55, 54, 53, 51, 44(100), 43, 42, 41, 40, 39	100	43
9	13.379	2–Acetyl Pyrrole	109(100), 94(100), 80, 66, 53, 44, 39	109	94
10	14.515	Phenylethyl Alcohol	122, 91(100), 86, 77, 65, 51	122	95
11	18.185	Unknown	100,(100)58,44(100),39	100	25
12	21.682	Plasticizer	222, 177, 149(100), 132, 121, 105, 93, 81, 76, 65 55, 50, 39	222	97
13	25.185	Methyl ester Hexadecanoic acid	270, 277, 239, 213, 199, 185, 171, 157, 143, 135, 129, 123, 115, 109, 101, 95, 87(100), 74(100), 69, 55, 43	270	98
14	25.909	Nebirinane 6,7-dihydro	282, 258, 240, 215, 193, 179, 165, 141, 119, 85, 71(100), 57(100), 43	288	97
15	26.537	Lapachone	242, 227(100), 214, 199, 171, 157, 128, 105, 76, 55	242	90
16	26.845	*n*-Eicosane	252, 238, 183, 169, 155, 141, 127, 111, 97, 91, 85, 79 71, 57(100), 43	282	98
17	26.746	4-Methyl-6-phenyl-2-pyrimidinamine	185(100), 128, 105, 77, 44	185	93
18	27.651	1,7-Trimethylene-2, 3-dimethylindole	185(100), 179, 171, 157, 128, 89	185	92
19	27.746	*n*-Eicosane	253, 239, 195, 155, 141, 127, 111, 97, 91, 85, 71, 57(100), 43	282	97
20	28.647	*n*-Tricosane	324, 281, 252, 239, 183, 169, 155, 141, 125, 111, 97, 85, 71, 57(100), 43	324	97

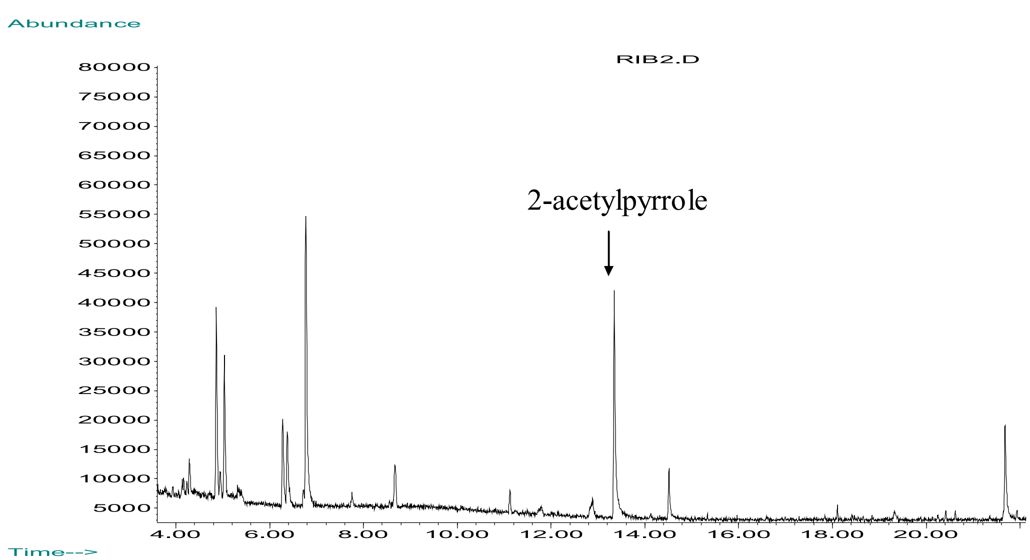
(continue)

Peak No. (%)	Retention Time	Compounds	m/z (% relative abundance)	MW[a]	Quality[b]
21	29.702	*n*-Tetracosane	338, 309, 295, 281, 267, 253, 239, 225, 154, 141, 127, 113, 106, 99, 85, 71, 57(100), 43	338	98
22	30.977	*n*-Octacosane	394, 323, 309, 295, 281, 267, 253, 239, 225, 197, 183, 169, 155, 141, 127, 113, 97, 85, 71(100), 57(100), 43	394	98
23	31.819	Diisooctyl 1,2-Benzenedicarboxylic acid	279, 167, 149(100), 121, 112, 104, 83, 70, 55, 41	390	90
24	32.524	*n*-Hexacosane	366, 309, 295, 281, 267, 253, 239, 225, 197, 183, 169, 155, 141, 127, 111, 99, 85, 71, 57(100), 43	366	96
25	34.504	*n*-Heptacosane	380, 351, 323, 309, 295, 281, 267, 253, 239, 225, 207, 183, 169, 155, 141, 127, 113, 97, 85, 71(100), 57(100), 43	380	98
26	35.749	Unknown	396(100), 159, 145, 135, 121, 105, 95, 81(100), 69, 55(100)	396	53
27	37.023	Unknown	397, 313, 309, 295, 281, 267, 253, 225, 183, 169, 155, 141, 121, 113, 97, 85, 71(100), 57(100), 43	397	58

[a] molecular weight from GC-MS (EI) data
[b] MS quality comparison with database

It is clear from Table 1 that approximately 27 prominent peaks were identified. Of these, there appeared the presence of alcohols, aldehydes, ketones, hydrocarbons and others. The major peaks comprise those of 2-acetyl pyrrole (peak No. 9), *n*-hexanal (peak No. 1), 1-hexanol (peak No. 6), methyl ester of hexadecanoic acid (peak No. 13), 4-methyl-6-phenyl -2-pyrimidinamine (peak No. 17), *n*-eicosane (peak No. 19), *n*-tricosane (peak No. 20), *n*-tetracosane (peak No. 21), *n*-octacosane (peak No. 22), diisooctyl 1,2-benzenedicarboxylic acid (peak No. 23), *n*-hexacosane (peak No. 24) and *n*-heptacosane (peak No. 25). Smaller peaks included 4-methyl-2-Pentanol (peak No. 3), 2-hexanal (peak No. 4), 3-hexene-1-ol (peak No. 5), phenylethyl alcohol (peak No. 10), nebirinane 6,7-dihydro (peak No. 14), lapachone (peak No. 15), *n*-eicosane (peak No. 16), and 1,7-trimethylene-2,3-dimethylindole (peak No. 18). Many of these compounds have been shown to be the products of lipid oxidation [8], such as aldehydes, *n*-hexanal and 2-hexanal, the important products produced by oxidative cleavage of lipids [9]. 2-Acetyl-1-pyrroline, reported as an important aroma component of aroma rice [7], and found in wheat bread crust [10], popcorn [11] and vegetable soybean "Dadachamame", was expected to be found in 'Chakaori'. However, it was concluded, after checking with library mass spectra and using the standard addition technique, that 2-acetyl-1-pyrroline was not present in the vegetable soybean "Chakaori". However, other flavour components were found including the non- odourous compound, 2-acetylpyrrole. It was thought that 2-acetylpyrrole might result from the oxidation of 2-acetyl-1-pyrroline during the isolation process, although the method used in this study was the same as the reported extraction method for 2-acetyl-1-pyrroline [12]. The same results were found in each "Chakaori" sample analysis. The chromatograms and the mass spectra of 2-acetylpyrrole are shown in Figure 2.

A



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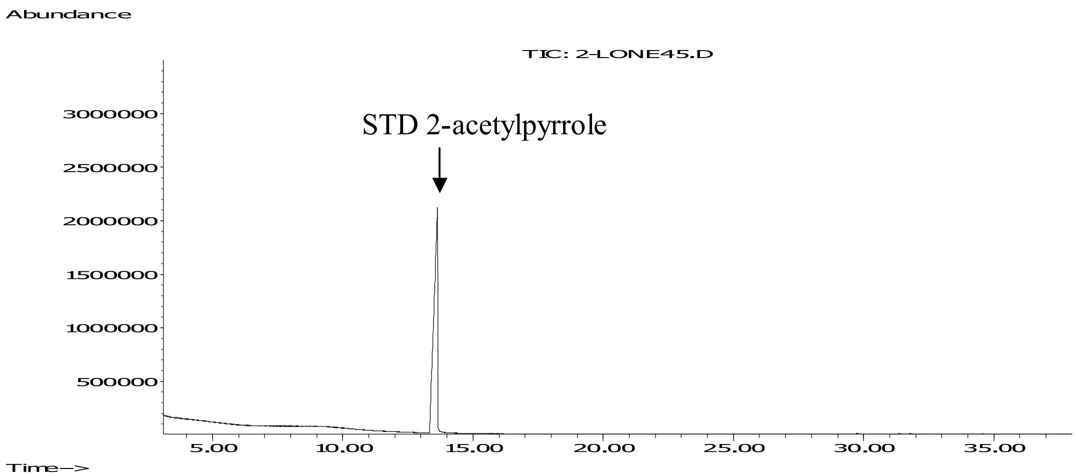
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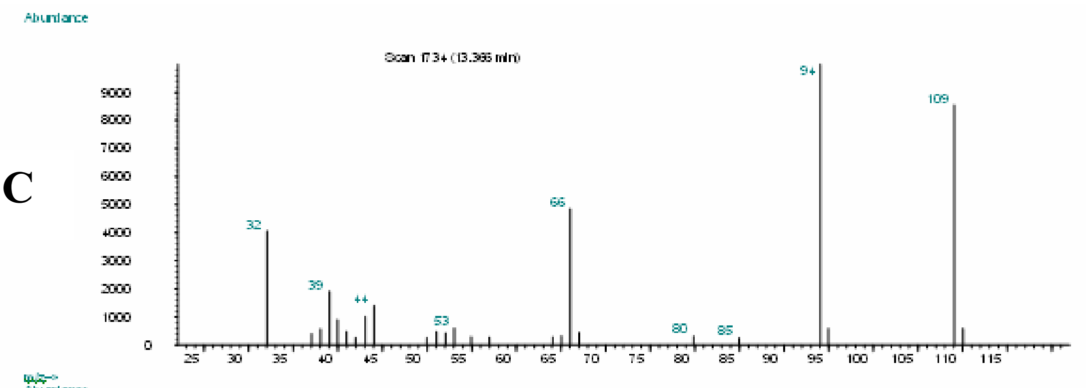
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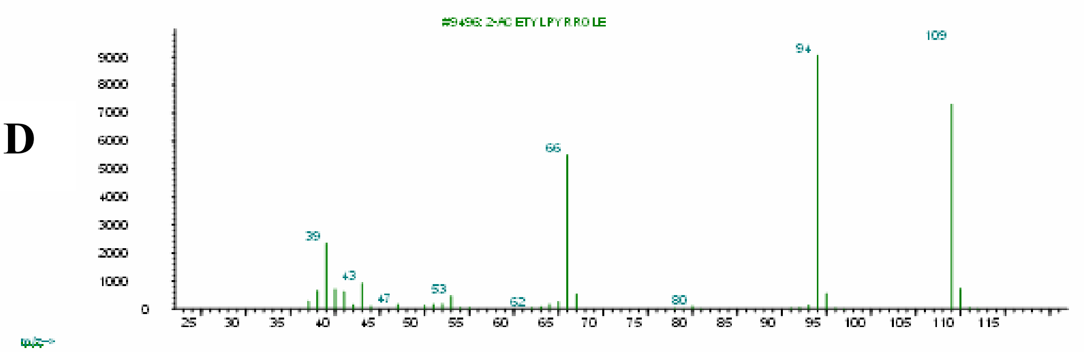
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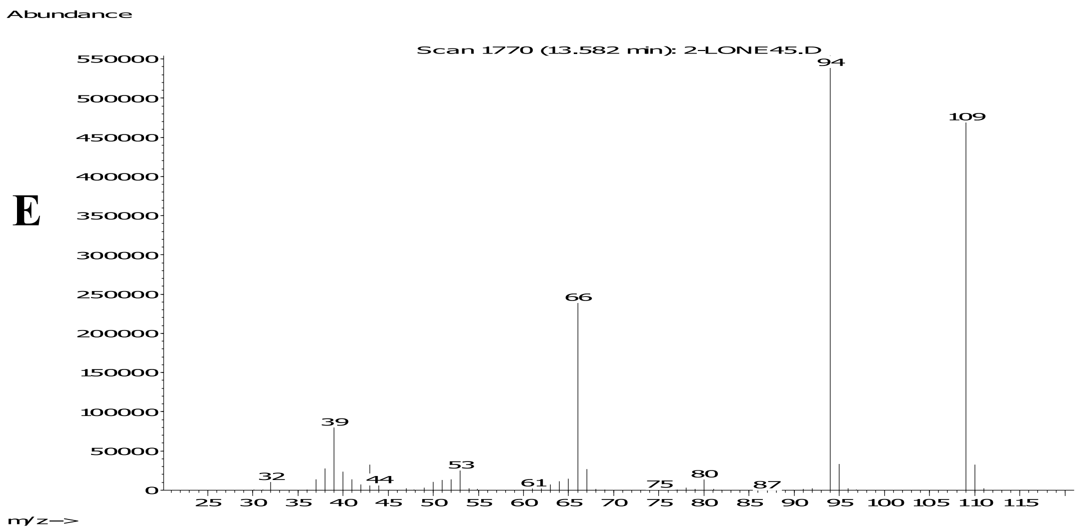

Figure 2. (A) Reconstructed total ion chromatogram of the extract of vegetable soybean "Chakaori" obtained by GC-MS using a DB-5 column. (B) Reconstructed total ion chromatogram of the standard 2-acetylpyrrole. (C) EI mass spectrum of 2-acetylpyrrole present in the sample. (D) EI mass spectrum of 2-acetylpyrrole from the MS library. (E) EI mass spectrum of standard 2-acetylpyrrole

Conclusion

Twenty-seven components were detected in an acid-phase solvent extract of vegetable soybean "Chakaori, including 2-acetylpyrrole, which was found for the first time in the vegetable soybean 'Chakaori' from Thailand. Those compounds identified as potential contributors to the flavour of vegetable soybean "Chakaori" were *n*–hexanal (0.91%), 1-hexanol (1.79%), 2-hexanal (0.48%), 3-hexene-1-ol (0.49%) and phenylethyl alcohol (0.40%)

Acknowledgements

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Full Paper

Vegetation of Doi Tung, Chiang Rai Province, Northern Thailand

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Abstract: The climate of Doi Tung, Chiang Rai Province, is monsoonal with three distinct seasons, viz. cool-dry, hot-dry, and rainy. The elevation ranges from c. 350-1525m and most of the bedrock is limestone and granite. Vegetation below c. 1000m is mostly deciduous, while above this it is evergreen. A mixed evergreen + deciduous facies is present on the limestone peaks (up to 1425m). Forest destruction as well as settlements are widespread, thus creating increasingly severe problems with water resources, soil quality and stability, and biodiversity. The planting on pine monocultures in deforested areas 20 years ago in upland granite areas has resulted in much environmental degradation which requires immediate rectification.

Keywords: Doi Tung, vegetation, deciduous, evergreen, hardwood forest

Introduction

Doi (Mt.) Tung (pronounced “dtung”) is a mountainous area situated in the northern part of Chiang Rai Province, northern Thailand at approximately 20° 20' N latitude, 99° 50' E longitude. The northern part of the mountain is in Mae Sai District, while the southern part is in Mae Fa Luang District. The area is under the jurisdiction of the Mae Fa Luang Foundation, Doi Tung Development Project, which was established in 1988 by HRH the late Princess Mother (1901-1995) who had a retreat there. This project is directed by MR Disnadda Diskul, former secretary to HRH the Princess Mother. The main objectives of the Doi Tung Development Project are the alleviation of poverty and assistance of the various hill tribe folk living in the area, environmental and natural resource conservation, sustainable agricultural development, and reforestation. Prior to 1988 the entire area was a major centre of opium (*Papaver somniferum* L., Papaveraceae) production which caused the destruction of much of the natural forest cover there (Figure 1). Subsequent replanting with *Pinus kesiya* Roy. *ex* Gord. (Pinaceae, 3-needled pine) has covered most of the denuded slopes in the area. Various environmental problems created by planting monocultures of this inappropriate species are now becoming realized.

The Doi Tung Development Project includes an area of *c*. 150 km^2. There are 27 villages and, as of 2004, 10,741 people living in the project area. There are 7 ethnic groups present with Akha (*c*. 48%), Lahu (*c*. 16%), Tai Yai (*c*. 17%), Chinese (*c*. 9%), Lua (*c*. 5%), Thai (*c*. 2%), and Lisu (<1%)[1].

Figure 1. View east of Pah He (Abha) Village, cool season 1988. Uncontrolled and rampant forest destruction by hilltribe immigrants combined with their primitive agricultural practices resulted in widespread denuded and eroded land throughout northern Thailand. This picture, taken in late 1988-early 1989 of a granite ridge SE of Pah He (Akha) village, shows what much of Doi Tung was like prior to the establishment of the Doi Tung Development Project. The ridge is presently covered with a mixture of secondary growth and planted pine. Doi Nahng Nawn is visible in the upper left corner of the photo. Source: Doi Tung Development Project, Doi Tung, Chiang Rai.

The Doi Tung area has at least a thousand year history of human influence. In AD 911 (B.E. 1454), King Achutarat Yonoknakapahn with Pra (priest) Maha Kassapapera established a pagoda (stupa) just below the summit of Doi Tung at 1375 m elevation. This shrine is believed to contain the left clavicle and about 500 other relict pieces of the Lord Buddha, thus establishing the first pagoda in the Lanna kingdom. This pagoda was restored by Krubah (priest) Sivichai in 1927 (B.E. 2470) and was enclosed in a larger structure in 1973 (B.E. 2516). This pagoda is now called Wat (temple) Pra Taht Doi Dung and is a popular tourist attraction. Doi is a Thai word for mountain, while "tung" are long flags/banners on tall poles which indicate important Buddhist areas. They symbolize victory, brightness, luck, and good wishes. Apparently there were many "tung" on the summit area when the pagoda was established. Some of these "tung" are still found at the temple.

[1] Statistics from the Doi Tung Development Project, Doi Tung

Geology

The Doi Tung area is in the Pi Pahn (Nahng Nawn) range and consists of continuous Middle Permian limestone from the eastern lowlands of the mountain (450 m) to summit of Pah Hoong (*c*. 1425 m), which is slightly above Wat Pra Taht Doi Tung [1]. Adjacent to, north of, and of similar elevation as Pah Hoong are Doi Pah He and Doi Nahng Nawn—the later two having had much of their vegetation cleared by local hill tribe villagers. The valley between these two peaks is a major water catchment area for the east side of the mountain. Several upland tributaries eventually form Laeng and Dtone Fai Streams. This limestone was originally formed from calcareous deposits in the sea *c*. 250 million years ago, the sediment subsequently being lithified by pressure. There is also a shale deposit in the Pah Mee Cave area which is contiguous with the limestone. Shale is a sedimentary rock formed by compression and hardening of original deep water silt and mud deposits.

Doi Chang Moop[2] (c. 1525 m), situated west of Doi Tung along with the Royal Villa area (1000 m), consists of Middle-Upper Triassic granite [1] which was originally formed *c*. 200 million years ago from plutonic activity in the earth's crust. Metamorphic sandstone, similar in age as the limestone, is found in the Royal Villa area. This was originally sandstone formed from sea sediment which has been subsequently altered by heat and pressure, *i.e*. it has been metamorphosed.

The collision of the India plate with SE Asia beginning *c*. 50 million years ago has caused the gradual uplift of mountains in the region. Subsequent tectonics and erosion have resulted in the present geomorphology of the area.

Climate

The climate in northern Thailand has 3 distinct seasons. The cool-dry season is from November-February which is followed by a hot-dry period from March to May. The rainy season begins in May-June and ends in November. Climatic data, provided by the Doi Tung Development Project, has been recorded at 3 stations located at 550, 570, and 1200 m elevation. There is a distinct dry season from December to March during which there is little to no rain. The first rains are in April, but it is not until May that there is any regularity in rainfall. The highest amount of rainfall is during July-September. The average annual rainfall at 550 m is 1925 mm, 2100 mm at 750 m, and 2500 mm at 1200 m. Figure 2 shows the average monthly amounts of rainfall at all 3 elevations.

Temperatures are lowest from November to February with an average minimum at 500 m of 13˚ C in January-February and c. 21˚ C from June-August. At 750 m the lowest average temperature is 13˚ C in December and the highest is in April with 31˚ C. At 1200 m the temperatures are lower with November-January having average temperatures at c. 13˚ C and a peak in April of c. 23˚C (Figures 3 & 4).

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[2] Thai=kneeling elephant, in reference to a large, smooth, granite exposure on the summit which is envisioned to resemble this shape; *i.e.* Chang Moop shrine (1500 m).

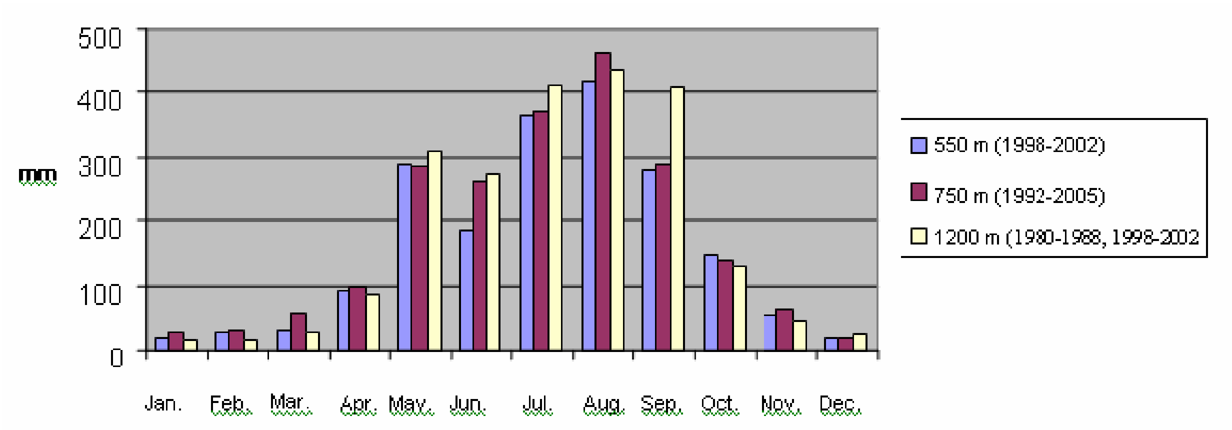

Figure 2. Average montly rainfall (mm) at Doi Tung. Source: Doi Tung Development Project, Doi Tung, Chiang Rai, Graphics by Ricky Ward

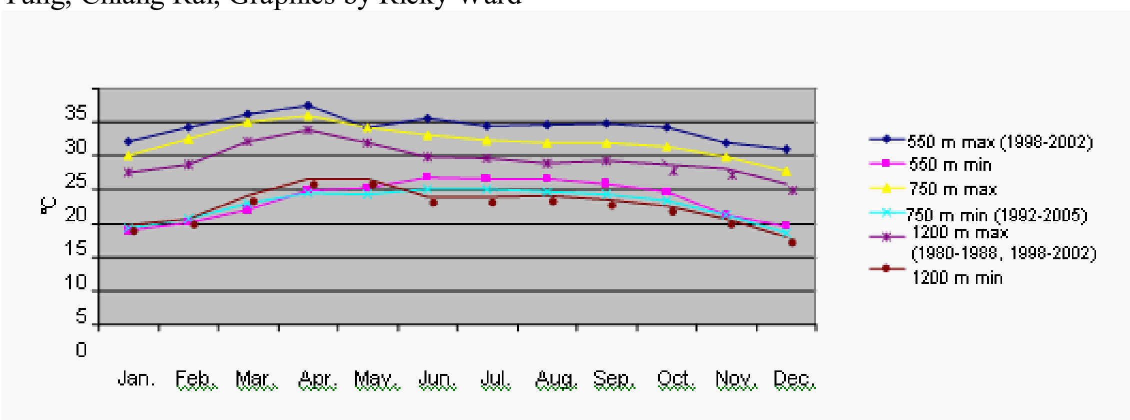

Figure 3. Average monthly temperatures (˚C) at at Doi Tung. Source: Doi Tung Development Project, Doi Tung, Chiang Rai, Graphics by Ricky Ward

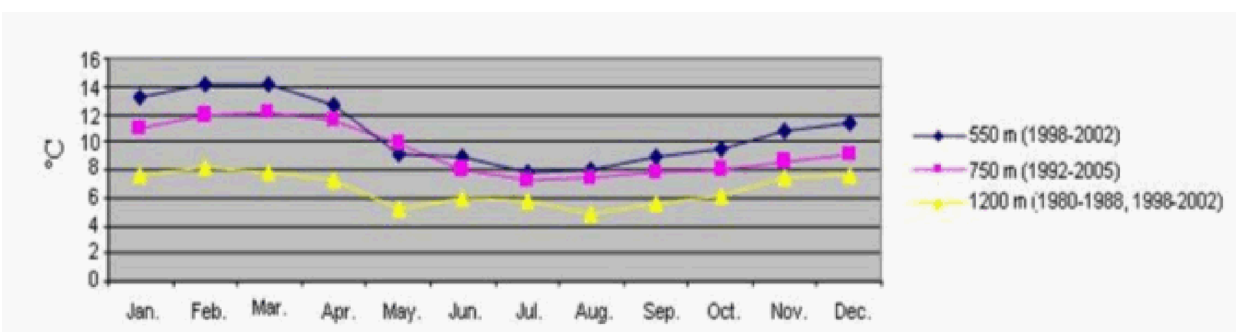

Figure 4. Average monthly diurnal temperature (˚C) fluctuations at Doi Tung. Source: Doi Tung Development Project, Doi Tung, Chiang Rai, Graphics by Ricky Ward

Vegetation

The vegetation of Thailand, especially the north, is seasonal. There is a distinct dry period of various lengths ranging from 4-6 weeks in the south to several months in the north. The vegetation is greatly influenced by the amount and periodicity of rainfall. Seasonality, rainfall, elevation, and disturbance all directly influence vegetation while bedrock, especially limestone, can be a factor in floristics. Doi Tung has vegetation typical for the region and bedrocks, *i.e.* deciduous and evergreen. The basic system used to classify Thai vegetation follows my observations and analyses [2]. Lowland areas, 450-*c*.1000 m elevation, on both granite and limestone bedrocks, are deciduous and have often been severely degraded, frequently burned, and eroded.

These are deciduous, seasonal, hardwood forests, often with much bamboo (BB-DF), which are leafless from about December to April. More shaded and moist places, especially along permanent streams, often include evergreen species, *i.e.* mixed evergreen + deciduous, seasonal, hardwood forest (MXF). MXF is also found on the two limestone peaks at *c*. 1425 m. During the hottest and driest period from March-May, this MXF is manifest when the deciduousness of some species is obvious. The original vegetation of areas above 1000 m elevation was evergreen (EGF) and in some places with pine (EG-Pine), but rampant destruction by hill tribe people in the past century has eradicated much of this primary facies on both major bedrocks. The Doi Tung-Doi Chang Moop area has the most intact vegetation in the entire project area. After the first rains in May and June, all deciduous and MXF areas are green again. The particular phenologies of the species found in each forest type vary considerably. Flowers and fruits can be found in all areas throughout the year.

In general, the lowland and upland vegetation of Doi Tung is similar to that in Doi Chiang Dao Wildlife Sanctuary, Chiang Mai Province, *c*. 150 km SW of Doi Tung [3,4]. Both areas have granite and limestone bedrocks and within their corresponding elevations similar floras. The limestone of Doi Chiang Dao is continuous from 450-2175 m and granite rises west of this to *c*. 1550 m. The floras of the two areas are quite similar, including vast areas of degraded or destroyed forest caused by primitive hill tribe agricultural practices, frequent fires, domesticated cattle, hunting, and for Doi Chiang Dao totally ineffective protection and conservation of natural resources.

Lowland Deciduous Forests

From the plains at 450 m to *c*. 1000 m the vegetation is mostly deciduous during the dry season (November-May)—the peak of leaflessness being during the hottest and driest period of March and April. There are two basic kinds of deciduous forest, most of which have been obliterated by humans. Deciduous hardwood forest, once dominated by *Tectona grandis* L. f. (Verbenaceae, teak) is now absent. Other components of this formerly vast forest facies are: *Xylia xylocarpa* (Roxb.) Taub. var. *kerrii* (Craib & Hutch.) Niels. (Leguminosae, Mimosoideae), *Pterocarpus macrocarpus* Kurz (Leguminosae, Papilionoideae), *Afzelia xylocarpa* (Kurz) Craib and *Sindora siamensis* Teysm. *ex* Miq. var. *siamensis* (both Leguminosae, Caesalpinioideae)—all commercially valuable timber trees. The remnant of this once magnificent vegetation is a continuously degraded, burned, grazed, and eroded deciduous growth with much bamboo, especially *Dendrocalamus membranaceus* Munro, *D. nudus* Pilg., and *Bambusa tulda* Roxb. (all Gramineae, Bambusoideae). This kind of degraded deciduous forest is now a bamboo-deciduous, seasonal, hardwood forest (BB-DF). Many tree species which were part of the original forest still remain as survivors of the botanical holocaust since they are not good for timber, firewood, or charcoal. *Lagerstroemia cochinchinensis* Pierre var. *ovalifolia* Furt. & Mont. and *L. tomentosa* Presl (Lythraceae), *Tetrameles nudiflora* R. Br. *ex* Benn. (Datiscaceae), *Spondias pinnata* (L. f.) Kurz (Anacardeaceae), and *Garuga pinnata* Roxb. (Burseraceae) are some common examples which can occasionally be found—often as isolated individuals. Deciduous trees of less stature which formed the understorey of the original forest persist in many places, especially in regenerating areas include: *Millettia brandisiana* Kurz, *Dalbergia lanceolaria* L. f., and *D. cultrata* Grah. *ex* Bth. (all Leguminosae, Papilionoideae); *Cratoxylum formosum* (Jack) Dyer ssp. *pruniflorum* Kurz) Gog. (Guttiferae, Hypericeae); *Colona floribunda* (Kurz) Craib, *C. flagrocarpa* (Cl.) Craib, and *Berrya moills* Wall. *ex* Kurz (all Tiliaceae); *Mitragyna rotundifolia* (Roxb.) O.K. (Rubiaceae), *Schleichera oleosa* (Lour.) Oken (Sapindaceae), *Phyllanthus columnaris* M. A. and *Falconeria insigne* Roy. (both Euphorbiaceae); *Vitex canescens* Kurz and *V. limoniifolia* Wall. *ex* Kurz (Verbenaceae), *Alstonia scholaris* (L.) R. Br. (Apocynaceae), and *Anogeissus acuminata* (Roxb. *ex* DC.) Guill. & Perr. (Combretaceae).

Woody climbers and scandent shrubs, previously common, are often scarce since suitable tree support is often lacking. Common examples are: *Ziziphus oenoplia* (L.) Mill. var. *oenoplia* (Rhamnaceae), *Harrisonia perforata* (Blanco) Merr. (Simaroubaceae), and *Acacia megaladena* Desv. var. *megaladena* (Leguminosae, Mimosoideae)—all of which are variously aculeate. *Cissus repens* Lmk. (Vitaceae), *Dalbergia volubilis* Roxb. (Leguminosae, Papilionoideae), and *Combretum latifolium* Bl. (Combretaceae) are some frequent inermous counterparts. Treelets and shrubs, forming the lowest woody level up to 5 m high, were also common and dense, but have been reduced in density and diversity because of exposure and degradation. *Helicteres elongata* Wall. *ex* Boj. and *H. isora* L. (Sterculiaceae), *Ellipelopsis cherrevensis* (Pierre *ex* Fin. & Gagnep.) R. E. Fr. (Annonaceae), *Desmodium velutinum* (Willd.) DC. ssp. *velutnum* var. *velutinum*, *D. pulchellum* (L.) Bth., and *D. triangulare* (Retz.) Merr. (Leguminosae, Papilionoideae); and *Thespesia lampas* (Cav.) Dalz. & Gibs. var. *lampas* (Malvaceae) are frequently encountered.

The herbaceous ground flora is usually absent during the dry months of November-May. After the first rains in May several deciduous herbs produce flowers before their leaves appear, *e. g. Hapaline benthamiana* Schott, *Amorphophallus krausei* Engl, and *A. paeoniifolius* (Denn.) Nicol. (all Araceae); *Geodorum siamensis* Rol. *ex* Dow. and *Nervilia aragoana* Gaud. (both Orchidaceae); *Curcuma zedoaria* (Berg.) Rosc., *Globba nuda* Craib, and *Kaempferia rotunda* L. (all Zingiberaceae). By the peak of the rainy season in August-September, the ground is covered with vegetation, both annual and deciduous species. Some common dicots include: *Andrographis laxiflora* (Bl.) Lindau, *Barleria cristata* L. and *B. strigosa* Willd., and *Neuracanthus tetragonostachys* Nees ssp. t*etragonostachys* (all Acanthaceae); *Blumea mollis* (D. Don) Merr., *Eupatorium odoratum* L. and *Pluchea polygonata* (DC.) Gagnep. (all Compositae); *Torrenia violacea* (Aza. *ex* Blanco) Pell. (Scrophulariaceae), *Sauropus quadrangularis* (Willd.) M. A. and *Phyllanthus virgatus* Forst. f. (both Euphorbiaceae).

Monocots are also common ground flora components and include: *Commelina paludosa* Bl. and *Cyanotis cristata* (L.) D. Don (both Commelinaceae); *Globba schomburgkii* Hk.f. var. *schomburgkii*, *Kaempferia roscoeana* Wall., and *Zingiber kerrii* Craib (all Zingiberaceae); *Crinum wattii* Baker (Amaryllidaceae), and *Scleria terrestris* (L.) Fass. (Cyperaceae). Many Gramineae (grasses) are found in BB-DF and provide much fuel for the fires after they dry, none of which occur naturally, during the dry season. *Apluda mutica* L., *Microstegium vagans* (Nees *ex* Steud.) A. Camus, *Oryza meyeriana* (Zoll. & Mor.) var. *granulata* (Watt) Duist., and *Themeda triandra* Forssk. are common representatives.

Pterodophytes (ferns and allies) are often found in BB-DF with *Selaginella ostenfeldii* Hieron. (Selaginellaceae), *Lygodium flexuosum* (L.) Sw. (Schizaeaceae, a vine), *Cheilanthes tenuiflolia* (Burm. f.) Sw. (Parkeriaceae), and *Tectaria impressa* (Fee) Holtt. (Dryopteridaceae).

Many vines, both annual and deciduous, can be found in BB-DF. Dicot examples include *Zehneria wallichii* (Cl.) C. Jeff. (Cucurbitaceae), *Paederia pallida* Craib (Rubiaceae), *Ipomoea obscura* (L.) Ker-Gwal. and *Jacquemontia paniculata* (Burm. f.) Hall. f. var. *paniculata* (both Convolvulaceae). Some monocot vines are: *Smilax perfoliata* Lour. (Smilacaceae), *Dioscorea hispida* Denn. var. *mollissima* (Bl.) Pr. & Burk. (Dioscoreaceae), and *Stemona burkillii* Prain (Stemonaceae).

Vascular epiphytes are much less common now because of habitat destruction and extraction for cultivation. *Hoya kerrii* Craib, *H. verticillata* (Vahl) G. Don var. *verticillata*, and *Dischidia major* (Vahl) Merr. (all Asclepiadaceae); *Cymbidium aloifolium* (L.) Sw., *Aerides flacata* Lindl., and *Dendrobium signatum* Rchb. f. (all Orchidaceae); *Drynaria bonii* C. Chr., *Platycerium wallichii* Hk. f., and *Pyrrosia adnascens* (Sw.) Ching (all Polypodiaceae) are some species which are now rare because of commercial exploitation.

Deciduous Diptercarp-Oak, Seasonal, Hardwood Forest (DOF)

BB-DF areas that have been cleared, burned, farmed, grazed, and eroded usually do not regenerate into the original facies. The consequent loss of coppicing trees, depletion of soil fertility and structure, and absence of animals which distribute seeds of BB-DF species result in a different kind of forest regrowth which is essentially a fire-maintained, climax secondary growth. I have called this man-induced growth deciduous, dipterocarp-oak, seasonal, hardwood forest since it is dominated by Dipterocarpaceae and Fagaceae (oaks *et al.*) [1,3]. DOF is always of lower stature, has less diversity, poorer soil, and lower number of different species than BB-DF. BB-DF often reverts to DOF, but I have not seen the opposite occurring. I suspect that soil degradation is the main reason which DOF will not develop into BB-DF—at least as long as humans continue to subvert the environment.

Dipterocarpaceae trees are common with: *Dipterocarpus obtusifolius* Tiejsm. *ex* Miq. var. *obtusifolius*, *D. tuberculatus* Roxb. var. *tuberculatus*, *Shorea obtusa* Wall. *ex* Bl. and *S. siamensis* Miq. var. *siamensis*. Fagaceae include *Quercus kerrii* Craib var. *kerrii*, *Q. kingiana* Craib, *Q. aliena* Bl.; *Lithocarpus polystachyus* (A. DC.) Rehd., and *Castanopsis argyrophylla* King *ex* Hk. f.. DOF also includes many other trees which are usually found in BB-DF, *viz*. *Anneslea fragrans* Wall. (Theaceae), *Buchanania glabra* Wall. *ex* Hk. f., *B. lanzan* Spreng., *Gluta usitata* (Wall.) Hou, and *Lannea coromandelica* (Houtt.) Merr. (all Anacardiaceae); *Terminalia alata* Hey. *ex* Roth and *T. chebula* Retz. var. *chebula* (Combretaceae), *Eugenia cumini* (L.) Druce (Myrtaceae), *Dillenia parviflora* Griff. var. *kerrii* (Craib) Hoogl. (Dilleniaceae), and *Aporosa villosa* (Lindl.) Baill. (Euphorbiaceae).

Trees of lower stature include: *Tristaniopsis burmanica* (Griff.) Wils. & Wats. var. *rufescens* (Hance) Parn. & Lug. (Myrtaceae), *Craibiodendron stellatum* (Pierre) W.W. Sm. and *Vaccinium sprengelii* (D. Don) Sleum. (both Ericaceae); *Strychnos nuxvomica* L. (Loganiaceae); *Morinda tomentosa* Hey. *ex* Roth and *Wendlandia tinctoria* (Roxb.) DC. ssp. *floribunda* (Craib) Cow. (both Rubiaceae); *Antidesma acidum* Retz. and *Phyllanthus emblica* L. (both Euphorbiaceae).

Olax psittacorum (Willd.) Vahl (Olacaceae), *Spatholobus parviflorus* (Roxb.) O.K. (Leguminosae, Papilionoideae), *Aganosma marginata* (Roxb.) G. Don (Apocynaceae), *Celastrus paniculatus* Willd. (Celastraceae), and *Cansjera rheedii* J. F. Gmel. (Opiliaceae) are some common woody climbers in DOF. Shrubs and treelets include: *Grewia abutilifolia* Vent. *ex* Juss. (Tiliaceae); *Gardenia obtusifolia* Roxb. *ex* Kurz, *Pavetta fruticosa* L., *Catunaregam spathulifolia* Tirv., and *Meyna pubescens* (Kurz) Roby. (all Rubiaceae); *Blinkworthia lycioides* Choisy (Convolvulaceae); *Premna herbacea* Roxb. and *P. nana* Coll. & Hemsl. (Verbenaceae); *Breynia fruticosa* (L.) Hk. f. and *B. glauca* Craib (Euphorbiaceae). *Phoenix loureiroi* Kunth var. *loureiroi* (Palmae), with its characteristic pachycaulous habit, is occasionally found in DOF, often in burned places.

The herbaceous ground flora in DOF includes both annual and deciduous species. Some common annuals are: *Crotalaria alata* D. Don and *C. albida* Hey. *ex* Roth (Leguminosae, Papilionoideae), *Sonerila erecta* Jack (Melastomataceae); *Borreria brachystemma* (R. Br. *ex* Bth.) Valet., *Hedyotis pinifolia* Wall. *ex* G. Don, and *Knoxia corymbosa* Willd. (all Rubiaceae); *Striga asiatica* (L.) O.K. (Scrophulariaceae); *Cyperus flavidus* Retz. and *Rhynchospora rubra* (Lour.) Mak. (both Cyperaceae); *Aristida cumingiana* Trin. & Rupr., *Digitaria siamensis* Henr., and *Perotis indica* (L.) O.K. (all Gramineae). Deciduous herbs are also abundant in DOF. Some frequently seen species are: *Crotalaria neriifolia* Wall. *ex* Bth. and *Indigofera squalida* Prain (both Leguminosae, Papilionoideae); *Gynura pseudochina* (L.) DC. (Compositae), *Platostoma coloratum* (D. Don) A. J. Pat. (Labiatae), *Hypoxis aurea* Lour.(Amaryllidaceae); *Cyperus niveus* Retz. and *Scleria kerrii* Turr. (both Cyperaceae); *Apluda mutica* L., *Arundinella setosa* Trin. var. *setosa*, *Heteropogon contortus* (L.) P. Beauv. *ex* Roem. & Schult., and *Eulalia siamensis* Bor (all Gramineae). *Adiantum zollingeri* Mett. *ex* Kuhn and *Chelanthes belangeri* (Bory) C. Chr. (both Parkeriaceae) are two common, deciduous pteridophytes found in DOF.

DOF vines are plentiful during the rainy season with *Dunbaria bella* Prain and *Grona grahamii* Bth. (both Leguminosae, Papilionoideae), *Gymnema griffithii* Craib (Asclepiadaceae), *Aristolochia kerrii* Craib (Aristolochiaceae), and *Stemona kerrii* Craib (Stemonaceae). The epiphytic and epilithic vascular flora is quite similar to that found in BB-DF and has also been similarly exploited and extirpated. As in less degraded and more intact BB-DF and DOF areas, there is usually an abundance of seedlings and saplings which are mostly destroyed or damaged by fire and cattle before the next rainy season.

Mixed Evergreen + Deciduous, Seasonal, Hardwood Forest (MXF)

In northern Thailand there is a distinct forest type situated above deciduous forests and below evergreen forest. In shale, metamorphic sandstone, and granite zones, such as Doi Sutep-Pui National Park, Chiang Mai Province, this MXF can be found from *c*. 600-1000 m elevation [5]. This MXF has often disappeared due to forest destruction, Doi Tung included. Limestone areas frequently have MXF at lower elevations, *c*. 450 m, up to the summit of Doi Chiang Dao (2175 m). This is also the situation on some of the riverine limestone on the east side of Doi Tung where MXF is found along the Pah He-Mae Gawk valley starting at *c*. 550 and on the summits Pah Hoong and Doi Pah He (both *c*. 1425 m). Other limestone areas, especially typically steep cliffs, have deciduous cover in the lowlands and evergreen facies above 1000 m.

MXF is best distinguished during the hot-dry season (March-May) when lowland deciduous forest are leafless and MXF areas partially so. Many MXF species, especially those epilithic on limestone, are only found in this habitat. Typical MXF trees on the limestone summits which are deciduous include:

Brassiopsis hainla (B.-H. *ex* D. Don) Seem. and *Schefflera ptelotii* Merr. (both Araliaceae), *Radermachera hainanensis* Merr. (Bignoniaceae), *Falconeria insigne* Roy. (Euphorbiaceae, also in BB-DF), *Acer chiangdaoensis* Santi. (Aceraceae); *Firmiana kerrii* (Craib) Kosterm. and *Sterculia villosa* Roxb. (both Sterculiaceae), and *Debgreasia wallichiana* (Wedd.) Wedd. ssp. *wallichiana* (Urticaceae). Evergreen counterparts are *Eriobotrya salwinensis* Hand.-Mazz. (Rosaceae), *Dicellostyles zizyphifolia* (Griff.) Phup. (Malvaceae), and *Buxus* sp. (Buxaceae). Most of these species are common on the summits of the two limestone peaks.

Deciduous treelets include *Brucea javanica* (L.) Merr. (Simaroubaceae), *Cipadessa baccifera* (Roth) Miq. (Meliaceae), and *Premna racemosa* Wall. *ex* Schauer (Verbenaceae). Some evergreen representatives are: *Capparis sabiifolia* Hk. f. & Th. (Capparaceae), *Glycosmis cochinchinensis* (Lour.) Pierre *ex* Engl. (Rutaceae); *Agapetes megacarpa* W.W. Sm., and *A. lobbii* Cl. (Ericaceae), *Myrsine semiserrata* Wall. (Myrsinaceae), and *Fagraea ceilanica* Thunb. (Loganiaceae), *Clematis fulvicoma* Rehd. & Wils. (Ranunculaceae), *Hiptage bullata* Craib (Malpighiaceae), and *Acacia megalandena* Desv. var. *garrettii* Niels. (Leguminosae, Mimosoideae) are some deciduous woody climbers. Some common evergreen vines/woody climbers include: *Tetrastigma cruciatum* Craib & Gagnep. (Vitaceae), *Secamone elliptica* R. Br. ssp. *elliptica* (Asclepiadaceae), and a presently unidentified species of *Thunbergia* (Acanthaceae)—all found in mostly open, rugged limestone areas.

The herbaceous summit flora is mostly different from that found in other places in the project area. Most of these species are confined to this open, very rugged, and occasionally burnt habitat. The basic vegetation is MXF and in disturbed areas it is EG/BB. *Dendrocalamus giganteus* (Wall.) Munro (Gramineae, Bambusoideae), the only bamboo found in this habitat, is very common. I have not found flowering material of this species. Almost all of these summit species are deciduous and include mainly epiphytes and epiliths, with a few geophytes which grow in thin, black soil.

Impatiens salangensis T. Shim. (Basalminaceae) and *Clerodendrum subscaposum* Hemsl. (Verbenaceae) are common annual herbs. Deciduous dicot epiliths include *Clematis fulvicoma* Rehd. & Wils. (Ranunculaceae, a vine), *Impatiens clavigera* Hk. f. and *I. kerriae* Craib (Basalminaceae), *Senecio scandens* B. –H. *ex* D. Don and *Vernonia attenuata* DC. (both Compositae), *Paraboea glabrisepala* Burtt and *Trisepalum prazeri* Burtt (both Gesneriaceae), *Argostemma verticillatum* Wall. (Rubiaceae), and *Peperomia tetraphylla* (Forst. f.) Hk. & Arn. (Piperaceae). Deciduous epilithic monocots are also common with: *Hedychium ellipticum* Ham. *ex* J.E. Sm. (Zingiberaceae) and many Orchidaceae, *viz. Coelogyne lactea* Rchb. f., *Eria bilobulata* Seid., *Habenaria furcifera* Lindl., and *Panisea uniflora* (Lindl.) Lindl. Epilithic pteridophytes are frequent with *Cheilanthes fragilis* Hk. (Parkeriaceae), *Asplenium interjectum* Christ (Aspleniaceae), and *Microsorum zippelii* (Bl.) Ching (Polypodiaceae).

Epiphytic herbs are numerous and include some species which are also epilithis. *Eria globulifera* Seid., *Pholidota articulata* Lindl., *Porpax lanii* Seid. (all Orchidaceae); *Araiostegia imbricata* Ching and *Davallodes membranuloslum* (Wall. *ex* Hk.) Copel. (both Davalliaceae), and *Loxogamme involuta* (D. Don) Presl (Polypodiaceae) are common. In addition to these vascular plants there are many algae, fungi, lichens, and bryophytes on the woody vegetation and rocks.

Primary, Evergreen, Seasonal, Hardwood Forest (EGF)

EGF is present on both bedrocks from *c*. 1000-1525 m—the summit of Doi Chang Moop which is the highest point in the project area. Aside from MXF zones and the epilithic limestone flora, EGF is uniform throughout the area. The structure and composition of EGF is similar on both granite and limestone bedrocks. Thousands of years of soil development and floristic stabilization has resulted in this primary, climax vegetation. Unfortunately, much of the original EGF has been destroyed or degraded. The most intact area is on Doi Tung and the east side and valley below Doi Chang Moop. EGF in most of Mae Fa Luang and Mai Sai Disticts as well as adjacent areas in Myanmar have been devastated. EGF is distinct because of its appearance with a continuous canopy 20-30 m high and similarly dense understorey and ground flora. Biodiversity is highest in EGF and, in contrast to deciduous forests, EGF cannot recover from fire, extensive grazing, and constant human exploitation.

Typical canopy trees include: *Schima wallichii* (DC.) Korth. (Theaceae), *Sarcosperma arboretum* Bth. (Sapotaceae), *Cinnamomum iners* Reinw. *ex* Bl. (Lauraceae), *Balakata baccata* (Roxb.) Ess. (Euphorbiaceae); and several Fagaceae, *e.g*. *Castanopsis armata* (Roxb.) Spach., *C. tribuloides* (Sm.) A. DC., and *Lithocarpus elegans* (Bl.) Hatus. *ex* Soep.. Some understorey trees are *Turpinia pomifera* (Roxb.) Wall. *ex* DC. (Staphyleaceae), *Semecarpus cochinchinensis* Engl. (Anacardiaceae), *Ormosia sumatrana* (Miq.) Prain (Leguminosae, Papilionoideae), *Heynea trijuga* Roxb. *ex* Sims (Meliaceae); *Phoebe lanceolata* (Wall. *ex* Nees) Nees (Lauraceae). *Baccaurea ramiflora* Lour. and *Bridelia glauca* Bl. (both Euphorbiaceae), and *Ficus annuata* Bl. (Moraceae).

Woody climbers are common with *Mucuna macrocarpa* Wall., *Dalbergia rimosa* Roxb., and *D. stipulacea* Roxb. (all Leguminosae, Papilionoideae); *Rourea minor* (Gaertn.) Leenh. ssp. *minor* (Connaraceae), and *Tetrastigma laoticum* Gagnep. (Vitaceae), with its distinctive, flat stems up to *c*. 15 cm diameter. *Leea indica* (Burm f.) Merr. (Leeaceae), *Melicope pteleifolia* (Champ. *ex* Bth.) T. Hart. (Rutaceae); *Psychotria monticola* Kurz var. *monticola* and *P. ophioxyloides* Wall. (Rubiaceae), *Maesa permollis* Kurz (Myrsinaceae), *Strobilanthes rex* Cl. (Acanthaceae), and *Antidesma sootepense* Craib (Euphorbiaceae) are some common treelets and shrubs found in shaded places.

The ground flora is mostly evergreen and in undisturbed places it is typically dense. Common representatives include: *Mycetia glandulosa* Craib and *Ophiorrhiza trichocarpon* Bl. var. *trichocarpon* (both Rubiaceae), *Lepidagathis incurva* Ham. *ex* D. Don (Acanthaceae), *Pollia hasskarlii* R. Rao (Commelinaceae), *Zingiber smilesianum* Craib (Zingiberaceae); and several pteridophytes, *e.g*. *Brainea insignis* (Hk.) J. Sm. (Blechnaceae) and *Thelypteris parastica* (L.) Fosb. (Thelypteridaceae). Seedlings and saplings also contribute to the density and diversity of the ground flora and understorey.

Upper water catchment valleys, ranging in elevation from 925-1352 m, include several ground flora species which are unique or most common to this habitat. The soil is typically moist, thick, and black on all bedrocks. *Musa itinerans* Chees. (Musaceae) and *Phrynium capitatum* Willd. (Marantaceae) are especially common and are good indicators of intact forest conditions. These areas are very important for overall forest stability and sustainability, and are very succeptible to environmental degradation. All of these water sources should have top conservation and protection priorities.

Weeds and Secondary Growth

After vegetation has been thinned or cleared leaving bare soil, primary invaders in the form of weeds (herbs) and secondary growth (woody species) rapidly colonise during the rainy season. The development of vegetation on vacant land depends on the degree and number of times an area has been denuded and/or burned. The fertility and quality of the soil plus its seed bank with seeds of primary invaders is directly related to the history of land abuse. Areas with one or intermittent clearance, *i.e.* swidden or slash and burn agricultural histories, rapidly regenerate into degraded forms of the original forest cover with coppices of many cut trees. Other areas, especially places that have been repeatedly farmed without fallow periods or with regrowth for only several years, are not able to readily restore forest cover since all vestiges of the original growth have been destroyed.

Weeds

Weeds grow rapidly on destroyed forested land and if these areas are not disturbed for several years a natural succession of permanent vegetation will develop. Weeds are very diverse and include mostly annual, often naturalized, species. Some examples of common annual alien dicots are: *Capparis ruditosperma* DC. and *C. viscosa* L. (Capparaceae), *Mimosa diplotricha* C. Wright *ex* Sauv. var. *diplotricha* and *M. pudica* L. (Leguminosae, Mimosoideae), *Aeschynomene americana* L. var. *americana* (Leguminosae, Papilionoideae); *Borreria laevis* (Lmk.) Griseb. and *Mitracarpus villosus* (Sw.) DC. (both Rubiaceae); *Ageratum conyzoide*s L., *Eupatorium odoratum* L., and *Mikania cordata* (Burm. f.) B. L. Rob. (all Compositae); *Euphorbia heterophylla* L. and *E. hirta* L., *Phyllanthus amarus* Schum. & Thonn. and *P. urinaria* L. (all Euphorbiaceae). Native dicot weeds are also diverse and plentiful. *Portulaca oleracea* L. (Portulacaceae), *Drymaria diandra* Bl. (Caryophyllaceae), *Oxalis corniculata* L. (Oxalidaceae); *Glinus oppositifolius* (L.) A. DC. and *Mollugo pentaphylla* L. (both Aizoaceae), *Hedyotis cormbosa* (L.) Lmk. (Rubiaceae); *Blumea balsamifer*a (L.) DC., *B. mollis* (D. Don) Merr., *Conyza sumatrensis* (Retz.) Walk., *Gynura nepalensis* DC., *Laggera pterodonta* (DC.) Sch. Bip. *ex* Oliv., and *Vernonia cinerea* (L.) Less. var. *cinerea* (all Compositae); *Lindernia crustacea* (L.) F. Muell. var. *crustacea* (Scrophulariaceae), and *Alternanthera sessilis* (L.) DC. var. *sessilis* (Amaranthaceae) are common examples.

Native monocot weeds include: *Commelina benghalensis* L. (Commelinaceae), *Dioscorea bulbifera* L. (Dioscoreaceae), a vine; *Cyperus cyperoides* (L.) O.K., *C. kyllingia* Endl., and *Fimbristylis dichotoma* (L.) Vahl ssp. *dichotoma* (all Cyperaceae); *Chloris barbata* Sw., *Digitaria setosa* Roth *ex* Roem. & Schult. var. *setigera*, *Eleusine indica* (L.) Gaertn., *Imperata cylindrica* (L.) P. Beauv. var. *major* (Nees) C. E. Hubb. *ex* Hubb. & Vaugh., *Phragmites vallatoria* (Pluk. *ex* L.) Veldk., and *Thysanolaena latifolia* (Roxb. *ex* Horn.) Honda (all Gramineae). *Pteridium aquilinum* (L.) Kuhn ssp. *aquilinum* var. *wightianum* (Ag.) Try. (Dennstaedtiaceae) is an aggressive fern which tolerates fire and forms dense growth which shades out succession. *Dicranopteris linearis* (Burm. f.) Underw. var. *linearis* (Gleicheniaceae), another evergreen pteridophyte, is commonly found on soil embankments and eroded places.

Secondary Growth

Some woody species also grow rapidly in open, abandoned, weedy places. These are fast-growing, short-lived species which are beneficial in providing initial canopy cover which is necessary for plant succession, erosion control, as well as providing food and refuges for animals. Some common trees are: *Anthocephalus chinensis* (Lmk.) A. Rich. *ex* Walp. (Rubiaceae), *Callicapa arborea* Roxb. var. *arborea* (Verbenaceae), *Broussonetia papyrifera* (L.) Vent., *Ficus fistulosa* Reinw. *ex* Bl. and *F. hispida* L. f. var. *hispida* (all Moraceae); *Muntigia calabura* L. (Tiliaceae), which is naturalized; *Oroxylum indicum* (L.) Vent. (Bignoniaceae), and *Trema orientalis* (L.) Bl. (Ulmaceae). *Lantana camara* L. (Verbenaceae) and *Eupatorium adenophorum* Spreng. (Compositae), shrubs; and *Mimosa pigra* L. (Leguminosae, Mimosoideae), a treelet, are all naturalized and often form dense thickets which eliminate native species. *Melastoma malabathricum* L. ssp. *malabathricum* (Melatomataceae), a shrub or treelet, and *Rubus blepharoneurus* Card. (Rosaceae), scandent, both grow in open, disturbed places.

Pinus kesiya Roy. ex Gord. (Pinaceae), 3-needled Pine

This native species was formerly abundant in ridges above 1000 m on granite bedrock, but has been virtually eliminated by uncontrolled deforestation during the past century. It was used by the Royal Forest Department to cover many barren, deforested areas on Doi Tung as well as in may other places in northern Thailand. This species, albeit creating rapid regrowth, is totally unsuitable for several reasons. Natural areas with this species are in evergreen hardwood + pine forest, with pines never being more than half as much as the evergreen hardwoods. Dense monocultures of pine have resulted in a low (acidic) soil pH which has prevented other species from developing as well as slowing the decomposition of pine litter on the ground. This organic litter is a very serious fire problem in all places where pines have been planted. Consequent growth of these pine plantations, all without culling or maintenance, has also shaded out succession. As the pines mature there has also been an obvious decrease in biodiversity and water, combined with increases in erosion which has caused recent flash-flooding, landslides, and siltation of waterways.

The planting of pine trees on Doi Tung limestone has not been successful because of the inherent incompatibility of calcareous (basic) bedrock and acid-loving pines. This is a fundamental concept which any competent forester should have realized prior to making such a serious and wasteful replanting error. It is recommended that all pine areas on granite and metamorphic sandstone bedrocks on Doi Tung be thinned by at least 50% so that there is less shade and acidic biomass available. The ground litter must be removed so that the soil pH can be increased to a level similar to that found in natural EG + Pine areas in the region. Planting with native species found in EG + Pine forest should be done in accordance to the natural tree diversity in these forests. All pines on limestone should be removed and the slopes planted with native species found on nearby undisturbed forest.

Taxonomic notes

Doi Tung, because of its mainly granite and limestone bedrocks, broad elevation range of *c*. 450-*c*. 1500 m, diverse remnant vegetation, and specific habitats, such as the summit of Pah Hoong, is a very botanically rich area. In addition to many species which are either rare or poorly known, other species of special botanical interest have been collected there.

Sauropus poomae Welz. & Chay. (Euphorbiaceae) was collected from Doi Tung on 1 March 1997 and described as a new species in 2001. Dr. Pranee Palee collected topotype material of this very rare species while collecting with me there. I have been able to collect four species which are new records for Thai flora--all from Pah Hoong. These include:

1. *Eriobotrya salwinensis* Hand.-Mazz. (Rosaceae), an evergreen treelet or tree up to 6 m tall [6]
2. *Wendlandia ternifolia* Cow. (Rubiaceae), an evergreen, epilithic treelet or slenderly scandent species l [6]
3. *Trisepalum prazeri* Burtt (Gesneriaceae), a deciduous, epilithic herb-shrub, and
4. *Premna subcapitata* Rehd. (Verbenaceae), a deciduous, epilithic shrub 1-1.5 m tall.

In addition I have also collected *Clerodendrum subscaposum* Hemsl. (Verbenaceae) on the summit of Pah Hoong. This species was reported by Leeratiwong, C. & P. Chantaranothai [7] as a new record for the Thai flora based on previous specimens from Doi Tung as well as Doi Chiang Dao. This is a deciduous herb which grows in exposed, rocky areas on the summit.

Sageretia cordifolia Tard. (Rhamnaceae), described in 1946 from material from Laos, is only known in Thailand from Doi Tung. I reported this species as a new record for the Thai flora [8]. CMU Herbarium now has 4 specimens of this species, all from the summit of Pah Hoong. It is an evergreen woody climber which flowers in September-October and fruits in November-December.

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Plants of Doi Tung

Notes

Habit:
t = tree   s = shrub   sc = scandent   l = treelet   v = vine   cr = creeping   wc = woody climber   h = herb

Aped:
a = annual   pe = perennial evergreen   pd = perennial deciduous   ped = perenninal evergreen + deciduous

Life mode:
aqu = aquatic   gro = ground   rhe = rheophyte   car = carnivorous   hyp = hyperparasite   sap = saprophyte
cul = cultivated   int = introduced/not native   str = strangler   epi = epiphyte   nat = naturalized
wee = weed   epl = epilithic   par = parasite

Abundance:
0 = Probably extirpated
1 = Down to a few individuals, in danger of extirpation
2 = Rare
3 = Medium abundance
4 = Common, but not dominant
5 = Abundant

Habitat:
dof = deciduous dipterocarp+oak forest   do/pine = dipterocarp-oak+pine forest   bb/df = bamboo+deciduous forest
mxf = mixed evergreen+deciduous forest   egf = evergreen forest   eg/pine = evergreen with pine forest
eg/bb = evergreen with bamboo forest   da = disturbed areas, roadsides   sg = secondary growth

Bedrock:
gr = granite   ls = limestone   ss = sandstone

Table 1. List of plant species under phylum angiospermae surveyed at Doi Tung, Chiang Rai Province.

Species	Family	Habit	Aped	Life mode	Abun-dance	Habitat	Bed rock	Lower	Upper	Flowering	Fruiting	Leafing	Collected
								Elevation (m)		Months			
Abelmoschus moschatus Medic. ssp. *moschatus* var. *moschatus*	Malvaceae	h	a	gro	2	da, sg	gr	1000	1200	oc		my-dc	
Acacia megaladena Desv. var. *garrettii* Niels.	Leguminosae, Mimosoideae	wc	pd	gro	3	rocks in mxf cliffs	ls	1300	1425	ap-my	ja-fb	ap-ja	flowers , fruits
Acalypha kerrii Craib	Euphorbiaceae	s	pe	gro	3	rocks in mxf, eg/bb	ls	1200	1400	my-jn		ap-dc	flowers
Acer chiangdaoensis Santi.	Aceraceae	t	pd	gro, epl	3	rocks in mxf, egf cliffs	ls	1300	1425	my-jn	jl-fb	ja-nv	flowers, fruits
Achyranthes aspera L.	Amaranthaceae	h	a	gro, wee	3	da, sg	ls	400	700			my-dc	
Achyranthes bidentata Bl. var. *bidentata*	Amaranthaceae	h	a	gro, wee	3	egf, eg/bb	ls	1200	1375	sp-oc	nv-dc	my-dc	flowers
Achyrospermum densiflorum Bl.	Labiatae	h	a	gro	2	eg/bb	gr	1100	1250		nv-dc	my-dc	fruits
Acrocarpus fraxinifolius Wight *ex* Arn.	Leguminosae, Caesalpinioideae	t	pd	gro	3	rocks in egf, cliffs	gr,ls	1000	1400	ja-fb	ap	ap-nv	
Actephila excelsa (Dalz.) M. A. var. *excelsa*	Euphorbiaceae	t	pe	epl	2	rocks in egf	ls	1300	1375	ag-sp	oc-nv	ja-dc	fruits
Actinodaphne henryi Gamb.	Lauraceae	t	pe	gro	3	egf, eg/bb	gr, ls	925	1400	ja	my	ja-dc	
Adenia penangiana (Wall. ex G. Don) Wilde var. *parvifolia* (Pierre *ex* Gagnep.) Wilde	Passifloraceae	v	a	gro	2	da, sg	gr	1000	1150			my-dc	
Adenosma indiana (Lour.) Merr.	Scrophulariaceae	h	a	gro	3	eg/pine	gr	1250	1325	sp-oc	nv-dc	my-dc	flowers
Aeginetia indica Roxb.	Orobanchaceae	h	pd	gro, par	3	rocks in mxf cliffs, egf	gr,ls	600	1500	sp	oc-dc	leafless	
Aerva sanguilonenta (L.) Bl.	Amaranthaceae	h	a	gro	3	rocks in egf cliffs	ls	1200	1400	ja-ap		ja-dc	flowers
Aeschynanthus hildebrandii Hemsl.	Gesneriaceae	h	pe	epi	2	egf, eg/bb	ls	1200	1400			ja-dc	
Aeschynanthus macranthus (Merr.) Pell.	Gesneriaceae	v	pe	epi	2	rocks in mxf, eg/bb	gr,ls	1300	1425	jl-sp	dc-mr	ja-dc	flowers, fruits
Aeschynomene americana L.	Leguminosae, Papilionoideae	h	a	gro, int, nat, wee	3	da, sg	gr	400	1000	sp-oc	dc	my-dc	flowers
Aesculus assamica Griff.	Hippocastanaceae	t	pd	gro, cul	3	eg/pine da	ls	1300	1350	ap		fb-dc	flowers
Afgekia fillipes (Dunn) Gees.	Leguminosae, Papilionoideae	wc	pd	gro	3	egf	gr	1000	1500			fb -dc	
Afzelia xylocarpa (Kurz) Craib	Leguminosae, Caesalpinioideae	t	pd	gro	2	bb/df	gr,ls	500	700			my-dc	
Agalia	Meliaceae	t	pe	gro	2	rocks in egf, cliffs	ls	1350	1375			ja-dc	

Agalia elliptica Bl.	Meliaceae	t	pe	gro	2	egf	ls	1200	1400		ja-fb	ja-dc	fruits
Agapetes lobbii Cl.	Ericaceae	l	pe	epl , gro	3	rocks in mxf cliffs	ls	1375	1425	ja-fb		ja-dc	flowers
Agapetes megacarpa W.W. Sm.	Ericaceae	l	pe	epl	3	rocks in mxf cliffs	ls	1375	1425	oc-fb	ap	ja-dc	flowers
Ageratum conyzoides L.	Compositae	h	a	gro, wee	3	da, sg	gr,ls,s s	400	1525	sp-fb	oc-fb	my-fb	
Aglaia lawii (Wight) Sald. *ex* Rama.	Meliaceae	t, l	pe	gro	3	mxf, egf, eg/bb	ls	1200	1400	sp	ap-my	ja-dc	flowers, fruits
Aglaia spectabilis (Miq.) Jain & Benn.	Meliaceae	t	pe	gro	3	streams in egf, eg/bb	gr	1100	1300	jl-ag		ja-dc	flowers
Aglaonema simplex (Bl.) Bl.	Araceae	h	pe	gro, epl	3	rocks in egf, mxf	ls,sh	550	1350	mr-ap	sp-dc	ja-dc	flowers
Ajuga brateosa Wall. *ex* Bth.	Labiatae	h	a	gro	2	eg/bb, da		1100	1225	ja-fb	mr	ag-mr	flowers
Alangium barbatum (R.Br.) Baill. var. *barbatum*	Alangiaceae	l	pe	gro	2	egf	ls	1100	1400	ap	sp-oc	ja-dc	flowers, fruits
Alangium chinense (Lour.) Harms	Alangiaceae	t	pd	gro	3	eg/bb, da, sg	gr, ls	550	700		nv	my-fb	
Alangium kurzii Craib	Alangiaceae	t	pd	gro	3	egf, da	gr,ls	1000	1500	ap-my		ap-dc	flowers
Albizia chinensis (Osb.) Merr.	Leguminosae, Mimosoideae	t	pd	gro	3	da, sg, eb/bb	gr	1000	1525	ap-jn	dc-fb	mr-ja	flowers , fruits
Albizia crassiramea Lace	Leguminosae, Mimosoideae	t	pd	gro	3	da, sg	gr	800	1100	ag-sp		fb-dc	flowers
Albizia lucidor (Steud.) I. Niels.	Leguminosae, Mimosoideae	t	pe	gro	2	eg/bb	gr	1000	1250			ja-dc	
Albizia odoratissima (L. f.) Bth.	Leguminosae, Mimosoideae	t	pe	gro	3	egf ,da ,sg	gr	1000	1550	ap-my		ja-dc	flowers
Alchornea rugosa (Lour.) M. A. var. *rugosa*	Euphorbiaceae	t	pe	gro	3	rocks in mxf, egf cliffs	ls	1200	1400	ja-fb		ja-dc	flowers♂,♀
Alectra avensis (Bth.) Merr.	Scrophulariaceae	h	a	gro	2	eg/pine, da	gr	1250	1325	oc-nv		my-dc	
Allium chinense G. Don	Liliaceae	h	a	gro, cul, int	2	da	gr	1000	1100	sp-oc		my-dc	flowers
Allophyllus cobbe (L.) Raeus.	Sapindaceae	t,l	pe	gro	3	rocks in mxf, egf, eg/bb	ls	1200	1400	jl-nv	oc-fb	ja-dc	flowers, fruits
Alocasia macrorhizos (L.) G. Don	Araceae	h	pe	gro	3	streams in egf, mxf	gr, ls	550	1350	my		ja-dc	
Alpinia malaccensis (Burm.f.) Rosc.	Zingiberaceae	h	pe	gro	3	eg/bb, streams in egf	gr, ls	1100	1375	fb-my	mr-sp	ja-dc	flowers, fruits
Alseodaphne	Lauraceae	t	pe	gro	2	streams in egf, eg/bb	gr	1100	1300		jl-ag	ja-dc	fruits
Alstonia scholaris (L.) R.Br. var. *scholaris*	Apocynaceae	t	pd	gro	3	egf, da	gr	1000	1400	sp-oc		mr-dc	flowers
Alternanthera sessilis (L.) DC. var. *sessilis*	Amaranthaceae	h	pe	gro	3	streams in egf, wet areas in eg/bb	gr	900	1100	my-jn	jn-jl	ja-dc	flowers

Amalocalyx microlobus Pierre *ex* Spire	Apocynaceae	v,wc	pe	gro	3	egf, eg/pine, da	gr	1000	1400	my-jl		ja-dc	flowers
Amaranthus spinosus L.	Amaranthaceae	h	a	gro, wee	3	da	gr	400	1150	dc-fb	ja-mr	sp-mr	flowers
Amomum	Zingiberaceae	h	pe	gro	3	streams in egf,eg/bb	gr	1100	1300		jl-ag	ja-dc	fruits
Amomum (? *uliginosum* Koen.)	Zingiberaceae	h	pe	gro	3	eg/bb, da	ls	550	1350			ja-dc	
Amomum repoense Pierre *ex* Gagnep.	Zingiberaceae	h	pe	gro	3	eg/bb, da	ls	1200	1350			ja-dc	fruits
Amorphophallus	Araceae	h	pd	gro	2	rocks in egf	ls	1300	1375		jl-ag	jn-dc	
Amorphophallus yunnanensis Engl.	Araceae	h	pd	gro	3	rocks in eg/bb	gr, ls	1200	1400	fb-mr (sp)	my-jl	jl-dc	flowers, fruits
Anacolosa ilicoides Mast.	Olacaceae	t	pe	gro	2	egf	gr, ls	1100	1350	jn-sp	mr-my	ja-dc	
Anaphalis adnata DC.	Compositae	h	a	gro	3	eg/pine, da, eg/bb	gr	1100	1325	oc-dc	nv-ja	my-ja	flowers, fruits
Anaphalis margaritacea (L.) Bth.	Compositae	h	a	gro	3	eg/pine, da	gr	1200	1325	sp-fb	oc-fb	my-fb	flowers
Andrographis laxiflora (Bl.) Lindau	Acanthaceae	h	a	gro, epl	2	rocks, streams, wet areas in eg/bb, cliffs	gr,ls	1200	1375	ag-oc		my-dc	
Anneslea fragrans Wall.	Theaceae	t	pe	gro	3	egf, eg/pine	gr	1200	1450			ja-dc	flowers
Anogeissus acuminata (Roxb. *ex* DC.) Guill.& Perr.	Combretaceae	t	pd	gro	3	bb/df, eg/bb	gr, ls	500	1100			my-dc	
Antidesma acidum Retz.	Euphorbiaceae	l	pd	gro	3	eg/bb, da	gr	1000	1400	my-jn		my-dc	flowers♀
Antidesma bunius (L.) Spreng. var. *bunius*	Euphorbiaceae	t	pe	gro	3	egf, eg/bb	gr, ls	1200	1500		ag-sp	ja-dc	fruits
Antidesma montanum Bl. var. *montanum*	Euphorbiaceae	t	pe	gro	3	egf, eg/bb	ls	1200	1350	ap		ja-dc	flowers♂
Antidesma sootepense Craib	Euphorbiaceae	t,l	pe	gro	3	egf,eg/bb	gr,ls	800	1300	my-ag	jl-dc		fruits ♂
Aphanamixis polystachya (Wall.) R.Parker	Meliaceae	t	pe	gro	3	egf, eg/bb	gr	1000	1400		ap-my	ja-dc	fruits
Aphyllorchis montana Rchb. f.	Orchidaceae	h	pe	gro, sap	2	eg/bb, da	gr	1200	1300	ag-sp	sp-oc	leafless	flowers, fruits
Apluda mutica L.	Gramineae	h	pe,pd	gro, wee	3	da, sg	gr,ls, sh,ss	800	1525	oc-dc	nv-ja	my-ja	flowers
Aporosa octandra (B.-H. *ex* D.Don) Vick. var. *octandra*	Euphorbiaceae	t	pd	gro	3	eg/bb, da	gr, ls	1200	1375		my-jn	my-dc	fruits
Aporosa octandra (B.-H. *ex* D.Don) Vick. var. *yunnanensis* (Pax & Hoffm.) Schot	Euphorbiaceae	t	pd	gro	3	egf	gr	1100	1450		my-jn	ap-dc	fruits
Aporosa villosa (Lindl.) Baill.	Euphorbiaceae	t	pd	gro	3	eg/bb, da, sg	gr	1000	1200	ja-fb		ap-ja	flowers♂
Aporosa yunnanensis (Pax & Hoff.) Metc.	Euphorbiaceae	t	pe	gro	3	egf, da, sg	gr	1100	1300	ja-fb		ja-dc	flowers♂
Aquilaria crassna Pierre *ex* Lec.	Thymeleaceae	t	pd	gro	1	eg/bb	ls	1200	1250			fb-dc	
Aralia thomsonii Seem. *ex* Cl.	Araliaceae	l	pe	gro	3	egf, da, sg	gr, ls	1000	1450	my-jn	jl-ag	ja-dc	flowers, fruits

Archidendron clyperia (Jack) Niels. ssp. *clypearia* var. *clypearia*	Leguminosae, Mimosoideae	t	pe	gro	3	da, sg	gr, ls	1000	1400			ja-dc	
Ardisia attenuata Wall.*ex* A. DC.	Myrsinaceae	l	pe	gro	2	rocks in mxf, egf cliffs	ls	1400	1425	ja-dc		ja-dc	flowers
Ardisia corymbifera Mez var. *corymbifera*	Myrsinaceae	l	pe	gro	3	egf	gr,ls	1000	1375		oc-dc	ja-dc	fruits
Arenga ? *westerhousii* Griff.	Palmae	t	pe	gro, epl	2	rocks in egf	ls	1200	1350			ja-dc	
Argostemma lobbii Hk. f.	Rubiaceae	h	a	epl	3	rocks in egf, eg/bb	ls	1200	1400	ja ag		my-dc	flowers
Argostemma verticillatum Wall.	Rubiaceae	h	pd	epl	3	rocks in mxf, eg/bb	ls	1200	1425	jn-jl	jl-ag	my-dc	flowers, fruits
Argyreia aggregata (Roxb.) Choisy	Convolvulaceae	wc	pd	gro	3	eg/bb, egf,da,sg	ls	1100	1500	oc-ja		my-dc	flowers
Argyreia henryi (Craib) Craib	Convolvulaceae	wc	pe	gro	3	da, sg	gr	1000	1200	oc-nv		ja-dc	flowers
Argyreia wallichii Choisy	Convolvulaceae	v	pd	gro	3	egf,da,sg	gr,ls	1000	1525	sp-oc	nv-dc	my-dc	flowers, fruits
Aristolochia tagala Cham.	Aristolochiaceae	v	pd	gro	3	da	ls	525	900			my-dc	
Artemisia indica Willd.	Compositae	h	pd	gro, wee	3	da, sg	gr,ls	1200	1525	sp-dc	nv-ja	my-dc	flowers
Arthraxon lanceolatus (Roxb.) Hochst. var. *lanceolatus*	Gramineae	h	a	epl	3	rocks in bb/df, cliffs	ls	400	600	sp-oc	nv	my-dc	flowers
Arthraxon lancifolius (Trin.) Hochst. var. *lanceolatus*	Gramineae	h	a	gro, epl	3	rocks in bb/df, egf, eg/bb, da,sg, cliffs	gr,ls	400	1400	sp-oc	nv-ja	my-dc	flowers, fruits
Artocarpus thailandicus C.C. Berg	Moraceae	t	pe	gro	3	egf, da	gr	1000	1500	my, da	my-jn	ja-dc	flowers, fruits
Arundina graminifolia (D.Don) Hochr.	Orchidaceae	h	pe	gro	2	da	gr	1000	1300	jl-oc		ja-dc	flowers
Arundinella setosa Trin. var. *setosa*	Gramineae	h	pd	gro	3	eg/pine, da, sg	gr	1200	1325	nv-dc	dc-ja	my-dc	
Asparagus filicinus Ham. *ex* D.Don	Liliaceae	h	pd	gro	3	egf, eg/bb	gr	900	1500	my		my-dc	flowers
Aspidocarya uvifera Hk. f. & Th.	Menispermaceae	v	pe	gro	2	streams in eg/bb	gr	1200	1300	my-jn		ja-dc	flowers♂
Aspidopterys (aff. *thorelii* Dop)	Malpighiaceae	wc	pe	gro	3	rocks in mxf cliffs	ls	1375	1425	sp-oc	oc-nv	ja-dc	flowers
Asystasiella neesiana (Wall.) Lindau	Acanthaceae	h	pe	gro	3	streams in egf	gr,ls	1200	1350	oc- nv		ja-dc	flowers
Baccaurea ramiflora Lour.	Euphorbiaceae	t	pe	gro	3	mxf	ls	600	1300	fb-mr	my-jn	ja-dc	flowers, fruits
Balakata baccata (Roxb.) Ess.	Euphorbiaceae	t	pe	gro	3	mxf, streams in egf	ss, gr,ls	500	1100	fb-mr	jl	ja-dc	flowers, fruits
Balanophora abbreviata Bl.	Balanophoraceae	h	pd	gro, par	2	streams in egf, eg/bb, da	gr,ls	1125	1350	oc-nv	nv-dc	leafless	flowers♀♂
Balanophora fungosa J.R. & G. Forst. ssp. *indica* (Arn.) B. Han. var. *indica*	Balanophoraceae	h	pe	gro	2	egf	ls	1000	1400	dc-fb		leafless	

Baliospermum calycinum M. A.	Euphorbiaceae	l	pe	gro	2	egf, rocks in eg/bb	gr,ls	1200	1375	ag-sp	sp-oc	ja-dc	flowers♂,♀, fruits
Bambusa balcooa Roxb.	Gramineae, Bambusoideae	h	pe	gro	3	streams in eg/bb cliffs	gr, ls	1100	1425	jl-ag	ag-sp	ja-dc	flowers
Barleria strigosa Willd.	Acanthaceae	h	pd	gro	3	bb/df, eg/bb	gr,ls	500	900	oc-nv		my-dc	
Bauhinia ornata Kurz var. *kerrii* (Gagnep.) K. & S.S. Lar.	Leguminosae,Cae salpinioideae	wc	pe	gro	3	egf ,da	ss	900	1100	fb-mr		ja-dc	flowers
Bauhinia variegata L.	Leguminosae,Cae salpinioideae	t	pd	gro	3	eg/pine, eg/bb, bb/df	gr	650	1525	ja-fb		jn-fb	
Begonia acetosella Craib	Begoniaceae	h	pe	gro, rhe	3	streams in egf, wet areas	gr, ls	900	1500	mr-ap	mr-my	ja-dc	flowers, fruits
Begonia cathcartii Hk..f. *ex* Hk. f. & Th.	Begoniaceae	h	pe	gro, epl	3	mostly streams in egf,eg/bb, rarely cliffs in egf on ls	gr, ls	1200	1375	sp-dc	nv-ja	ja-dc	flowers, fruits
Begonia putii Craib	Begoniaceae	h	pd	epl	2	rocks in mxf, egf cliffs	ls	600	1425	oc		jn-dc	flowers
Begonia sect.Uniplacentales Cl.	Begoniaceae	h	pd	epl	3	rocks and cliffs in mxf	ls	550	1375	sp-nv	nv-dc	my-dc	flowers
Beilschmiedia aff. *intermedia* Allen	Lauraceae	t	pe	gro	2	egf, eg/bb	gr	1050	1200	my-jn		ja-dc	
Berchemia floribunda (Wall.) Wall. *ex* Brongn.	Rhamnaceae	wc	pe	gro	3	streams in egf, eb/bb	gr	1000	1300		fb-mr	ja-dc	fruits
Betula alnoides Ham. *ex* D.Don	Betulaceae	t	pd	gro	2	egf, eg/bb	gr	1100	1400	ja-fb	fb-mr	fb-dc	flowers♂
Bidens pilosa L.	Compositae	h	a	gro, wee	3	eg/pine, da, sg	gr	1000	1525	ag-oc	oc-nv	my-dc	
Bischofia javanica Bl.	Euphorbiaceae	t	pd	gro	2	streams in egf, eg/bb	gr	1000	1300	fb-mr	sp-nv	mr-fb	fruits
Blumea balsamifera (L.) DC.	Compositae	h	a	gro, wee	3	da, sg	gr	500	1500	ap-my	my-jn	ja-dc	flowers
Blumea lacera (Burm.f.) DC.	Compositae	h	a	gro	3	eg/bb	gr	1000	1500	ja-fb	fb-mr	jl-mr	flowers
Blumea napifolia DC.	Compositae	h	a	gro	3	eg/bb	gr	1000	1500	ja-fb	fb-mr	jn-mr	flowers
Blumeopsis flava (DC.) Gagnep.	Compositae	h	a	gro	3	egf,eg/bb da	gr	1000	1500	dc-ja	fb-mr	jn-mr	flowers
Boehmeria aff.*thailandica* Yaha.	Urticaceae	l,s	pe	gro	3	egf,da,sg	ls	1000	1100	oc-dc	ja-dc	ja-dc	fruits
Boehmeria clidemioides Miq. var. *clidemioides*	Urticaceae	s	pe	gro	3	mxf, da	ls	1300	1400	ag-sp		ja-dc	flowers♀♂
Boehmeria diffusa Wedd.	Urticaceae	s, l	pe	gro	3	egf, eg/pine, da, sg	gr	1200	1525	sp-oc		ja-dc	flowers♂
Boehmeria hamiltoniana Wall. *ex* Wedd.	Urticaceae	wc,s	pe	epl	3	streams in egf	gr	1100	1300	ja-dc		ja-dc	flowers
Boehmeria malabarica Wall. *ex* Wedd.	Urticaceae	s	pe	gro,epl	3	rocks in egf, mxf	ls	550	1400	sp	fb-mr	ja-dc	flowers♂, fruits
Boehmeria nivea (L.) Gaud. var. *tenacissima* (Roxb.) Miq.	Urticaceae	t	pe	gro	3	streams in mxf,da	ls	550	700		fb-mr	ja-dc	fruits
Boehmeria penduliflora Wedd. *ex* Long	Urticaceae	l	pe	gro	3	egf,da,sg	gr	600	900		oc-nv	ja-dc	fruits

Boehmeria pilosiuscula (Bl.) Hassk.	Urticaceae	h	pe	gro	3	egf,da,sg	gr,ls	1200	1425		sp-nv	ja-dc	fruits
Boehmeria platyphylla D.Don	Urticaceae	s,h	pe	gro	3	egf,eg/bb da	ls	600	1200	ag-oc	ja-dc	ja-dc	fruits
Boehmeria zollingeriana Wedd. var. *zollingeriana*	Urticaceae	s	pd	epl	3	eg/bb,da	ls	400	600	oc-nv		my-dc	flowers
Boeica glandulosa Burtt	Gesneriaceae	l	pe	gro	2	streams in egf	gr	1200	1350	sp	oc-nv	ja-dc	flowers, fruits
Boenninghauseana albiflora (Hk.) Roxb. *ex* Meissn.	Rutaceae	s	pd	epl	2	cliffs, rocks in egf	ls	1300	1400	oc	nv-dc	my-dc	flowers, fruits
Bombax anceps Pierre var. *anceps*	Bombacaceae	t	pd	gro	3	bb/df, eg/bb	gr	400	1000	ja-fb		my-dc	
Borreria alata (Aubl.) DC.	Rubiaceae	h	pe	gro, wee	3	da, sg	gr	900	1200			ja-dc	flowers
Borreria laevis (Lmk.) Griesb.	Rubiaceae	h	a	gro, wee	3	da, sg	gr, ls	1000	1375	sp-nv	nv-dc	my-dc	
Borreria repens DC.	Rubiaceae	h	a	gro	3	da,sg	gr	1000	1400	oc-nv	nv-dc	my-dc	flowers, fruits
Bothriochloa bladhii (Retz.) S. T. Blake	Gramineae	h	pd	gro, wee	3	da, sg	gr	1100	1525	sp-ja	oc-fb	my-fb	flowers
Brassiopsis hainla (B.-H. *ex* D. Don) Seem.	Araliaceae	t, l	pd	gro	3	rocks in mxf cliffs	ls	1375	1425	nv-dc	ap	my-dc	flowers, fruits
Breynia retusa (Denn.) Alst.	Euphorbiaceae	l	pe	gro	3	egf, eg/bb	gr	1000	1500	ap-jl	jl-sp	ja-dc	flowers♂
Bridelia glauca Bl.	Euphorbiaceae	t	pe	gro	3	egf	gr	1000	1550	ap-my		ja-dc	flowers
Bridelia stipularis (L.) Bl.	Euphorbiaceae	sc, wc	pd	gro	3	da, sg	gr	900	1200	sp-oc	ja-mr	my-mr	flowers♂, fruits
Bridelia tomentosa Bl.	Euphorbiaceae	t,l	pe	gro	3	egf,da,sg	gr	1000	1200	oc-nv	nv-dc	ja-dc	fruits♂
Broussonetia papyrifera Vent.	Moraceae	t,l	pe	gro	3	da, sg	gr	1000	1400	my	my-jn	ja-dc	flowers, fruits
Brucea javanica (L.) Merr.	Simaroubaceae	l	pd	gro	3	rocks in mxf cliffs	ls	1200	1425	fb-mr	sp-dc	mr-dc	flowers, fruits
Buddleja asiatica Lour.	Loganiaceae	l	pd	gro	3	da, sg	gr	500	1500	sp-fb		my-mr	flowers
Bulbophyllum affine Lindl.	Orchidaceae	h, cr	pe	epi	2	egf, eg/pine	gr	1200	1400	my		ja-dc	flowers
Bulbophyllum pulchellum Ridl.	Orchidaceae	h	pd	epi	2	rocks in mxf, eg/bb cliffs	ls	1375	1425	sp-oc		my-dc	flowers
Buxus	Buxaceae	t	pe	gro	3	rocks in mxf cliffs	ls	1400	1425		nv-dc	ja-dc	fruits
Byttneria aspera Colebr.	Sterculiaceae	wc	pe	gro	3	streams in mxf, da	gr, ls	500	1500	oc-nv		ja-dc	flowers
Cajanus goensis Dalz.	Leguminosae, Papilionoideae	v	a	gro	3	egf ,eg/pine sg	gr	600	1400	fb-mr		my-ap	flowers
Calamus nambariensis Becc.	Palmae	s	pe	gro	2	rocks in egf, eg/bb	ls	1200	1375			ja-dc	
Calanthe labrosa (Rchb. f.) Rchb. f.	Orchidaceae	h	pd	epi,epl	2	rocks in mxf, egf	ls	1300	1425	oc-dc		my-nv	flowers
Callerya atropurpurea (Wall.) Schot	Leguminosae, Papilionoideae	t	pe	gro	2	egf, eg/bb	gr	1200	1300		ag-sp	ja-dc	
Callicarpa arborea Roxb. var. *arborea*	Verbenaceae	t	pe,pd	gro	3	egf, da ,sg	gr	1000	1500	mr-ap		ja-dc	flowers
Calophyllum polyanthum Wall *ex* Pl. & Tr.	Guttiferae	t	pe	gro	3	egf	gr	1100	1500			ja-dc	

Calopogonium mucunoides Desv.	Leguminosae, Papilionoideae	v	a	gro	3	da, sg	gr	900	1200	oc-nv	dc-ja	my-dc	fruits
Camellia sinensis (L.) O.K. var. *assamica* (Mast.) Kita.	Theaceae	l	pe	gro also cul	2	streams in egf	gr	1100	1400	oc		ja-dc	flowers
Cannvalia ensiformis (L.) A. DC.	Leguminosae, Papilionoideae	v	a	gro	3	da, sg	gr	1000	1200	oc-nv		my-ja	flowers
Canthium parviflorum Roxb.	Rubiaceae	l	pd	gro	3	egf, da, eg/bb,eg/pin e	gr,ls	1000	1550	(fb)ap-my	jn-sp	fb-dc	flowers, fruits
Capillipedium parviflorum (R. Br.) Stapf	Gramineae	h	pe	gro, wee	3	da, sg	gr, ls	1000	1525	sp-nv	oc-dc	ja-dc	flowers
Capparis assamica Hk.f. & Th.	Capparaceae	l	pe	gro	2	eg/bb	ls	1200	1300	ap		ja-dc	flowers
Capparis sabifolia Hk.f. & Th.	Capparaceae	l	pe	gro	3	rocks in mxf, cliffs	ls	1350	1400	ap		ja-dc	flowers
Carallia brachiata (Lour.) Merr.	Rhizophoraceae	t	pe	gro	3	egf	gr,ls	1000	1500		ap-my	ja-dc	fruits
Cardamine hirsuta L.	Cruciferae	h	a	gro, wee	2	da, sg	ls	1300	1375	oc	nv	my-dc	flowers
Carex baccans Nees	Cyperaceae	h	pe	gro	3	da,sg	ls	1000	1400		ja-fb	ja-dc	fruits
Carex phyllocaula Nel.	Cyperaceae	h	pd	epl	2	rocks in egf, cliffs	ls	1300	1400	ag-sp	sp-oc	my-dc	fruits
Careya arborea Roxb.	Lecythidaceae	t	pd	gro	2	bb/df, eg/bb	gr	400	1500			my-dc	
Carlemannia tetragona Hk. f.	Caprifoliaceae	h	a	gro	2	streams in eg/bb, wet areas	gr	1200	1200	jl-ag	oc-nv	ap-dc	flowers, fruits
Caryota maxima Bl.	Palmae	t	pe	gro	2	egf, eg/bb	gr	1000	1100	ja-dc	ja-dc	ja-dc	
Caryota mitis Lour.	Palmae	l	pe	gro	2	streams in egf	gr	1000	1350			ja-dc	
Casearia grewiifolia Vent. var *gelonioides* (Bl.) Sleum.	Flacourtiaceae	t	pe	gro	3	egf	gr	1000	1550	mr-ap		ja-dc	fruits
Castanopsis acuminatissima (Bl.) A. DC.	Fagaceae	t	pe	gro	3	egf, eg/bb,eg/pin e	gr	1200	1525	ja-fb	oc-nv	ja-dc	flowers♂,♀, fruits
Castanopsis argyrophylla King *ex* Hk. f.	Fagaceae	t	pe	gro	3	egf	gr	900	1200	fb-ap		ja-dc	flowers
Castanopsis armata (Roxb.) Spach	Fagaceae	t	pe	gro	3	egf eg/bb	gr	1000	1500	nv-dc	sp-oc	ja-dc	flowers♂,♀
Castanopsis tribuloides (Sm.) A. DC.	Fagaceae	t	pe	gro	3	egf	gr, ls	1000	1525	ap-my	oc	ja-dc	flowers♂,♀, fruits
Castanposis diversifolia (Kurz) King *ex* Hk. f.	Fagaceae	t	pe	gro	3	egf, eg/pine	gr	1100	1300	ja-fb		ja-dc	flowers♂
Cayratia japonica (Thunb.) Gagnep.	Vitaceae	v	pd	gro	3	mxf streams, egf	ls	500	1425	jl-nv		my-dc	flowers
Cayratia pedata (Lour.) Juss.	Vitaceae	v	a	gro	2	rocks in mxf, da, sg, eg/bb cliffs	ls	1200	1425	jl ag	sp-oc	my-dc	flowers
Celastrus	Celastraceae	wc	pe	gro	2	rocks in mxf cliffs	ls	1400	1425		oc	ja-dc	fruits
Centella asiatica (L.) Urb.	Umbelliferae	h,cr	pe	gro	3	egf, da, sg	gr	900	1500			ja-dc	

Chamaecrista leschenaultiana (DC.) Deg.	Leguminosae,Caesalpinioideae	h	a	gro	3	eg/pine, da	gr	1200	1500	sp-oc		my-dc	flowers
Chionanthus ramiflorus Roxb.	Oleaceae	t	pe	gro	3	egf	ss	900	1100	fb-mr		ja-dc	flowers
Chirita hamosa Wall. *ex* R. Br.	Gesneriaceae	h	a	epl	4	rocks in bb/df, mxf cliffs	ls	400	700	sp-nv	oc-dc	my-dc	flowers
Chisocheton cumingianus (C.DC.) Harms	Meliaceae	t	pe	gro	2	egf, eg/bb	gr	1000	1100	jl-ag		ja-dc	flowers
Chloranthus nervosus Coll. & Hemsl.	Chloranthaceae	h	pd	gro	2	egf, eg/bb	gr, ls	1300	1400	my		my-dc	flowers
Chloris pycnothrix Trin.	Gramineae	h	a	gro, int, nat, wee	3	da, sg	gr, ls	900	1375	oc-dc	nv-ja	my-dc	flowers
Choresthes lanceolata (T. And.) B.Han.	Acanthaceae	h	pe	gro	2	rocks in eg/bb	ls	1200	1300		ap	ja-dc	fruits
Chrysopogon aciculatus (Retz.) Trin.	Gramineae	h	pe	gro, wee	3	da,sg	gr	1000	1525	jl-sp	ag-oc	ja-dc	
Cinnamomum	Lauraceae	t	pe	gro	2	streams in eg/bb	gr	1200	1250			ja-dc	
Cinnamomum caudatum Nees	Lauraceae	t	pe	gro	2	egf	gr, ls	1000	1300	my-jl		ja-dc	flowers
Cinnamomum iners Reinw. *ex* Bl.	Lauraceae	t	pe	gro	3	mxf, egf	gr,ss	500	1100	ja-fb		ja-dc	flowers
Cipadessa baccifera (Roth) Miq.	Meliaceae	t,l	ped	gro,epl	3	rocks and streams in mxf, eg/bb cliffs	ls	450	1425	ap-oc (dc)	fb-oc	ja-dc ap-dc	flowers, fruits
Cissus adnata (Wall. *ex* Wight & Arn.) Roxb.	Vitaceae	wc	pe	gro	3	egf, eg/pine, sg	gr	1000	1200	jl ag		ja-dc	flowers
Cissus convolvulacea Pl.	Vitaceae	v	ped	gro	3	streams in egf	ls	600	800		fb-mr	ja-dc	fruits
Cissus discolor Bl. var. *discolor*	Vitaceae	v	pe	gro	3	egf, da, eg/bb, mxf cliffs	gr, ls	550	1500	my-sp	oc-dc	ja-dc	flowers, fruits
Clarkella nana (Edgew.) Hk. f. var. *nana*	Rubiaceae	h	a	epl	2	rocks in mxf, egf, eg/bb cliffs	ls	1375	1425	jl-sp	sp-oc	jn-dc	flowers, fruits
Cleidion javanicum Bl.	Euphorbiaceae	t	pe	gro	2	mxf, egf	gr	500	900	fb-mr	jn	ja-dc	
Cleisostoma racemiferum (Lindl.) Garay	Orchidaceae	h	pe	epi	2	rocks in mxf, eg/bb cliffs	ls	1300	1425	jl-ag		ja-dc	flowers
Clematis eichleri (Tam.) Tam.	Ranunculaceae	v	pd	gro	2	da,sg	gr	1000	1100	nv-dc		my-dc	flowers
Clematis fulvicoma Rehd. & Wils.	Ranunculaceae	wc, v	pd	epl, gro	3	rocks in mxf cliffs	ls	1375	1425	sp-oc	oc-nv	my-dc	flowers, fruits
Clematis thaimontana Tam.	Ranunculaceae	v	pd	gro	2	streams in mxf da sg	ls	700	800	ja-dc	fb	jn-fb	fruits
Clerodendrum chinense (Osb.) Mabb. var. *chinense*	Verbenaceae	l	pe	gro	3	mxf, egf, da, sg	gr, ls	1000	1500	my-jn (oc)	oc-nv	ja-dc	flowers

Clerodendrum disparifoilum Bl.	Verbenaceae	l,s	pe	gro	3	rocks in mxf, egf, eg/bb	ls	500	1400	oc-nv		ja-dc	flowers
Clerodendrum glandulosum Colebr, *ex* Lindl.	Verbenaceae	l	pe	gro	3	da, sg	gr	1000	1400	sp-oc		ja-dc	
Clerodendrum serratum (L.) Moon var. *wallichii* Cl.	Verbenaceae	l	pe	gro	3	bb/df, eg/bb, dg, sg	gr,ls	500	1525	sp-oc	jl-ag	ja-dc	flowers
Clerodendrum subscaposum Hemsl.	Verbenaceae	h	a	gro, epl	3	rocks in egf, mxf, eg/bb	ls	1375	1425	sp	oc-nv	my-dc	flowers, fruits
Codonopsis javanica (Bl.) Hk. f.	Campanulaceae	v	pe	gro	2	eg/pine, eg/bb	gr	1100	1350	sp-oc		ja-dc	flowers
Coelogyne lactea Rchb. f.	Orchidaceae	h	pe	epl	3	rocks in mxf cliffs	ls	1200	1425	fb-mr		ja-dc	flowers
Colebrookia oppositifolia Sm.	Labiatae	s	pe	gro	3	mostly streams in mxf, egf eg/pine	gr,ls	500	1300	ja-fb	fb-mr	ja-dc	flowers, fruits
Colocasia fallax Schott	Araceae	h	pd	epl	3	rocks in mxf, egf, eg/bb, cliffs	gr,ls	500	1425	my		my-dc	flowers
Colona flagrocarpa (Cl.) Craib	Tiliaceae	t	pd	gro	3	eg/bb	gr	900	1400		ja fb	my-fb	fruits
Colona floribunda (Kurz) Craib	Tiliaceae	t	pd	gro	3	egf,da,sg	gr	600	1300	oc	nv-dc	my-dc	fruits
Colquhounia elegans Wall. var. *tenuiflora* Pr.	Labiatae	sc	pe	gro	2	rocks in mxf, egf cliffs	ls	1200	1400	ja-fb		ja-dc	flowers
Combretum griffithii Heur. & M. A.	Combretaceae	wc	pd	epl	3	rocks in bb/df cliffs	ls	400	800			my-dc	
Combretum latifolium Bl.	Combretaceae	wc	pd	gro	3	mxf, eb/bb, sg	sh	500	800	dc-ja		jn-fb	flowers
Commelina benghalensis L.	Commelinaceae	h	a	gro, wee	3	da, sg	gr, ls	400	800	sp-oc		my-dc	
Commelina diffusa Burm. f.	Commelinaceae	h	pe	gro	3	eg/pine, da	gr	1200	1500	sp-oc		ja-dc	flowers
Commelina paludosa Bl.	Commelinaceae	h	pe	gro	3	mxf, eg/bb, da	gr, ls	550	1400	sp-oc		ja-dc	flowers
Congea rockii Mold.	Verbenaceae	wc	pe	gro	2	rocks in eg/bb	ls	1100	1300	fb-mr	ap-my	ja-dc	fruits
Congea tomentosa Roxb. var. *tomentosa*	Verbenaceae	wc	pe	gro	3	eg/bb, da	gr	1000	1400	ja-fb		ja-dc	flowers
Cordia	Boraginaceae	t	pe	gro	2	da, sg	gr	1000	1100		oc-nv	ja-dc	fruits
Cordia grandis Roxb.	Boraginaceae	t	pe	gro	2	eg/pine,da, sg	gr	1200	1300		ja-mr	ja-dc	fruits
Coriandrum sativum L.	Umbelliferae	h	a	cul	3	da	gr	900	1100	oc-nv	nv-dc	my-dc	flowers
Corymborkis veratrifolia (Reinw.) Bl.	Orchidaceae	h	pe	gro	1	mxf	sh	550	550			ja-dc	
Costus globosus Bl.	Zingiberaceae	h	pe	gro	2	streams in egf	gr, ls	1200	1350			ja-dc	
Costus speciosum (Koen.) J E. Sm.	Zingiberaceae	h	pd	gro	3	mxf, eg/bb	gr, ls	1000	1525			my-dc	

Craibiodendron stellatum (Pierre) W.W. Sm.	Ericaceae	t	pe	gro	3	eg/pine	gr	1200	1450			ja-dc	
Crassocephalum crepidioides (Bth.) S. Moore	Compositae	h	a	gro, wee	3	da, sg	gr, ls	900	1525	ag-fb	sp-mr	jn-mr	
Cratoxylum cochinchinense (Lour.) Bl.	Guttiferae, Hypericeae	t	pd	gro	3	egf,da,sg	gr	1000	1300	ap-my	oc-dc	my-dc	flowers, fruits
Cratoxylum formosum (Jack) Dyer ssp. *pruniflorum* (Kurz) Gog.	Guttiferae, Hypericeae	t	pd	gro	3	eg/bb, da, sg	gr	500	1100	ap		my-dc	
Crepedium acuminatum (D.Don) Szl.	Orchidaceae	h	pd	epl	2	rocks in mxf cliffs	ls	1375	1400	my-jn		ap-dc	flowers
Crotalaria assamica Bth.	Leguminosae, Papilionoideae	h	a	gro	3	bb/df, da, sg	gr	500	800	oc-nv		my-fb	
Crotalaria bracteata Roxb. *ex* DC.	Leguminosae, Papilionoideae	h	a	gro, wee	3	eg/bb, da, sg	gr	900	1500	sp-oc		my-fb	
Crotalaria cytisoides Roxb. *ex* DC.	Leguminosae, Papilionoideae	l	pd	gro	3	eg/pine, eg/bb	gr	1200	1325		nv-ja	my-ja	fruits
Crotalaria kurzii Baker *ex* Kurz	Leguminosae, Papilionoideae	h	a	gro	3	egf, eg/pine, eb/bb, da	gr	1200	1500	sp-oc		my-dc	flowers
Crotalaria pallida Ait.	Leguminosae, Papilionoideae	h	a	gro, wee	3	da, sg	gr	400	800	sp-oc		my-fb	
Croton robustus Kurz	Euphorbiaceae	t	pe	gro	3	eg/bb,egf,da ,sg	gr	1000	1500	nv-fb	fb-ap	ja-dc	flowers♂,♀, fruits
Cruddasia insignis Prain	Leguminosae, Papilionoideae	v	pe	gro	3	egf, eg/bb	gr	1100	1400	jl-sp		ja-dc	flowers
Cryptocarya amygdalina Nees	Lauraceae	t	pe	gro	3	egf, eg/bb	gr, ls	1100	1400	my	ap-my	ja-dc	fruits
Curculigo capitulata (Lour.) O.K.	Amaryllidaceae	h	pe	gro	3	streams in egf, eg/bb	gr,ls	1000	1350		ag-sp	ja-dc	fruits
Curcuma	Zingiberaceae	h	pd	gro	2	eg/bb	gr	1100	1350	my		my-dc	flowers
Cyanotis cristata (L.) D. Don	Commelinaceae	h	a	gro	3	rocks in mxf, eg/bb cliffs	gr,ls	900	1425	jl-sp	sp-oc	my-dc	flowers
Cyclea polypetala Dunn	Menispermaceae	wc	pe	gro	3	egf, eg/bb	gr, ls	1000	1400	nv-mr	ap-my	ja-dc	fruits
Cymbidium	Orchidaceae	h	pe	epi	2	eg/bb	gr	1100	1300		oc	ja-dc	
Cymbidium lancifolium Hk.	Orchidaceae	h	pe	gro	2	eb/bb	gr	1200	1300	dc-ja	nv-ja	ja-dc	flowers, fruits
Cyperus exalatus Retz.	Cyperaceae	h	pe	gro	3	streams in egf, ponds, wet areas	gr	900	1100	my-jn	jn-jl	ja-dc	flowers
Cyperus kyllingia Endl.	Cyperaceae	h	a	gro, wee	3	eg/pine, da, sg	gr	1000	1525	ag-oc	oc-nv	my-dc	
Cyperus laxus Lmk. var. *laxus*	Cyperaceae	h	pe	gro, wee	3	mxf, eg/bb, da	gr, ls	500	1350	ag-oc	sp-nv	ja-dc	flowers
Cyperus phyllocaula Nel.	Cyperaceae	h	pd	epl	2	rocks in egf cliffs	ls	1300	1400	ag-sp	sp-oc	my-dc	fruits
Cyrtococcum accrescens (Trin.) Stapf	Gramineae	h	a	gro	3	eg/pine, eg/bb, da	gr, ls	400	1500	sp-oc	oc-nv	my-dc	flowers
Cyrtococcum oxyphyllum (Steud,) Stapf	Gramineae	h	pe	gro		eg/bb, da	gr, ls	1100	1400	ag-sp	sp-oc	ja-dc	flowers
Dalbergia cana Grah. *ex* Kurz var. *cana*	Leguminosae, Papilionoideae	t	pd	gro	3	mxf ,egf	gr,ls	900	1350		my-jn	ap-dc	fruits

Dalbergia cultrata Grah. *ex* Bth.	Leguminosae, Papilionoideae	t	pd	gro	3	eg/pine da sg	gr, ls	800	1350	fb-mr		mr-dc	flowers
Dalbergia lanceolaria L.f. var. *lanceolaria*	Leguminosae, Papilionoideae	t	pd	gro	3	bb/df	gr	500	800	ap	jn	ap-dc	flowers
Dalbergia ovata Grah. *ex* Bth	Leguminosae, Papilionoideae	t	pe	gro	2	egf, eg/bb	gr	950	1350	ja-fb		ja-dc	flowers
Dalbergia rimosa Roxb.	Leguminosae, Papilionoideae	wc	pe	gro	3	egf, eg/bb	gr	1000	1500	my-jl		ja-dc	flowers
Dalbergia stipulacea Roxb.	Leguminosae, Papilionoideae	sc	pd	gro	3	egf,da	gr	1000	1500	ap-my	nv-dc	ja-dc	fruits
Debgreasia longifolia (Burm. f.) Wedd.	Urticaceae	l	pe	gro	3	eg/bb, egf,da,sg	gr,ls	500	1500	sp-nv	nv-ja	ja-dc	flowers♀♂, fruits
Debgreasia wallichiana (Wedd.) Wedd. ssp. *wallichiana*	Utricaceae	l,t	pd	gro	3	rocks in mxf, cliffs	ls	1250	1425	my	ag-sp	my-dc	flowers♀, fruits
Dendrobium compactum Rol. *ex* Hack.	Orchidaceae	h	pd	epi	2	rocks in mxf cliffs	ls	1400	1425	oc		my-dc	flowers
Dendrocalamus giganteus (Wall.) Munro	Gramineae, Bambusoideae	h	pe	gro	4	rocks in eg/bb	ls	1300	1425			ja-dc	
Dendrocalamus hamiltonii Nees & Arn. *ex* Munro	Gramineae, Bambusoideae	h	pe	gro	3	eg/bb	gr	1100	1300			ja-dc	
Dendrocalamus membranaceus Munro	Gramineae, Bambusoideae	h	pe	gro	4	eg/bb,da	gr	400	1500	nv-dc	ja-dc	ja-dc	flowers
Dendrocalamus nudus Pilg.	Gramineae, Bambusoideae	h	pe	gro	4	eg/bb,da	gr	900	1200	nv-fb	ja-mr	ja-dc	flowers
Dendrocnide sinuata (Bl.) Chew	Urticaceae	t	pe	gro	2	rocks in mxf cliffs, da	gr,ls	550	700	oc-nv	oc-nv	ja-dc	flowers♀, fruits
Dendrophthoe kerrii (Craib) Barl.	Loranthaceae	s	pe	epi, par	2	eg/bb	ls	1200	1425	nv-ja	fb-mr	ja-dc	flowers,fruits
Derris tonkinensis Gagnep.	Leguminosae, Papilionoideae	wc	pd	epl	3	rocks in bb/df cliffs	ls	400	800			my-dc	
Desmodium heterocarpon (L.) DC. ssp. *heterocarpon* var. *heterocarpon*	Leguminosae, Papilionoideae	h	pe	gro	3	bb/df, eg/pine, eg/bb	gr	700	1400	sp-nv	oc-dc	ja-dc	
Desmodium laxiflorum DC. ssp. *laxiflorum*	Leguminosae, Papilionoideae	h	pd	gro	3	bb/df, eg/bb	gr	1000	1400	oc-nv		my-ja	flowers
Desmodium multiflorum DC.	Leguminosae, Papilionoideae	l	pd	gro	3	eg/bb, da, sg	gr	1000	1400		ja-fb	my-fb	fruits
Desmodium oblatum Baker *ex* Kurz	Leguminosae, Papilionoideae	l	pd	gro	2	eg/bb	gr	1000	1300	oc-dc	dc-ja	jn-ja	fruits
Desmodium repandum (Vahl) DC.	Leguminosae, Papilionoideae	v	pe	gro	3	da, sg	gr	1000	1525	oc-nv	dc-ja	ja-dc	flowers, fruits
Desmodium triflorum (L.) DC.	Leguminosae, Papilionoideae	h	pe	gro, wee	3	eg/pine, eg/bb, da, sg	gr	700	1400	oc-dc	ja-fb	ja-dc	flowers
Desmodium triquetrum (L.) DC. ssp. *triquetrum*	Leguminosae, Papilionoideae	l	pe	gro	3	da, eg/bb	gr, ls	1000	1350	oc-nv	ja-dc	ja-dc	flowers
Desmodium velutinum (Willd.) DC. ssp. *velutinum* var.*velutinum*	Leguminosae, Papilionoideae	s	pe	gro	3	egf,da,sg	gr	1000	1400	oc-dc	ja-dc	ja-dc	flowers
Desmos (Dasymaschalon yunnanense (Hu) Ban)	Annonaceae	t,l	pe	gro	3	egf	ls	1200	1400		oc-nv	ja -dc	fruits

Dianella ensifolia (L.) DC.	Liliaceae	h	pe	gro	3	egf, eg/bb	gr	1000	1500		jl-sp	ja-dc	
Dicellostyles zizyphifolia (Griff.) Phup.	Malvaceae	t	pe	gro	3	rocks in mxf	ls	1300	1400		nv-dc	ja-dc	fruits
Dichorisandra thyrsiflora Mikan	Commelinaceae	h	pe	gro,cul	3	egf	gr	1000	1000	ja-dc	ja-dc	ja-dc	flowers
Dichroa febrifuga Lour.	Saxifragaceae	l	pe	gro	2	streams in eg/bb, egf	gr,ls	1200	1400	my-jn		ja-dc	flowers
Dichrocephala integrifolia (Lmk.) DC.	Compositae	h	a	gro, wee	3	egf, da	gr, ls	1200	1375	ap-jn	my-jn	ap-dc	flowers
Didymocarpus tristis Craib	Gesneriaceae	h	pd	epl	2	streams, rocks in egf, eg/bb	gr,ls	1250	1400	jl-ag	sp-oc	jn-dc	flowers, fruits
Dienia ophrydis (Koen.) Orm. & Seid.	Orchidaceae	h	pd	gro	2	da	gr	1100	1350	jl-ag	sp-oc	my-dc	flowers
Digitaria radicosa (Presl) Miq.	Gramineae	h	a	gro, wee	3	da, sg	gr	1000	1300	sp-nv	oc-dc	my-dc	flowers
Digitaria setigera Roth *ex* Roem. & Schult. var. *setigera*	Gramineae	h	a	gro, wee	3	da, sg	gr	800	1200	sp-ja	oc-fb	jn-fb	flowers
Dillenia parviflora Griff. var. *kerrii* (Craib) Hoogl.	Dilleniaceae	t	pd	gro	3	egf, eg/bb, da	gr	1000	1500	ja	ap-jn	my-dc	fruits
Dinetus racemosus (Wall.) Sweet	Convolvulaceae	v	a	gro	3	egf,da,sg	ls	1100	1500	oc-nv		my-dc	flowers
Dinochloa maclellandii (Munro) Gamb.	Gramineae, Bambusoideae	h	pe	gro	4	egf, eg/bb, da, sg	gr	1100	1450			ja-dc	
Dioscorea alata L.	Dioscoreaceae	v	pd	gro, wee	3	da, sg	gr	800	1525	oc-nv		my-fb	flowers♂
Dioscorea birmanica Pr. & Burk.	Dioscoreaceae	v	pd	gro	3	rocks in mxf, egf, eg/bb	ls	1300	1425	jl-sp		my-dc	flowers♂
Dioscorea bulbifera L.	Dioscoreaceae	v	pd	gro	3	da,sg	gr	1100	1525			jn-dc	
Dioscorea glabra Roxb. var. *glabra*	Dioscoreaceae	v	pe	gro	3	egf,da	gr	1000	1500	oc-nv		ja-dc	flowers♂
Dioscorea hamiltonii Hk. f.	Dioscoreaceae	v	pd	gro	3	da, sg		1200	1500	oc-nv	dc-fb	my-fb	flowers♂
Dioscorea hispida Denn. var. *mollissima* (Bl.) Pr. & Burk.	Dioscoreaceae	v	pd	gro	3	eg/bb, da,sg	gr,ls	900	1400	my-jn		my dc	flowers, imm. fruits
Dioscorea pentaphylla L. var. *communis* Pr. & Burk.	Dioscoreaceae	v	pd	gro, wee	3	da,sg	gr	1000	1525	oc		jn-dc	flowers♂♀
Dioscorea prazeri Pr. & Burk.	Dioscoreaceae	v	pd	gro	3	egf, da	gr	1200	1350	sp-oc		my-dc	flowers♂
Dioscorea rockii Pr. & Burk.	Dioscoreaceae	v	pd	gro	3	rocks in mxf, eg/bb cliffs	ls	1300	1425	jl-ag		my-dc	flowers♂
Diospyros lotus L.	Ebenaceae	t	pe	cul, int	2	egf	gr	1400	1400	fb-mr		ja-dc	native to Japan
Diospyros martabanica Cl.	Ebenaceae	t	pe	gro	3	egf	ls	1100	1400	fb-mr		ja-dc	flowers
Diospyros winitii Flet.	Ebenaceae	t	pe	gro	3	egf, eg/bb	ls	1200	1375	ap	ap	ja-dc	flowers♂, fruits
Disporopsis longifolia Craib	Liliaceae	h	pd	gro	2	eg/bb	gr	1000	1400	my-jn		ap-dc	flowers
Disporum calcaratum Wall. *ex* G. Don	Liliaceae	h	pd	gro	2	eg/pine, da, sg	gr	1000	1500			my-dc	

Docynia indica (Wall.) Decne.	Rosaceae	t	pe	gro, cul, int	2	egf, da	gr	1100	1350			ja-dc	
Dolichos trilobus L.	Leguminosae, Papilionoideae	v	a	gro	2	mxf, da, sg	gr, ls	1000	1450	ja-fb		jn-ap	fllowers
Dracaena angustifolia Roxb.	Agavaceae	l	pe	gro	2	rocks in egf, mxf	gr,ls, sh	500	1400		oc-nv	ja-dc	
Dracaena loureiri Gagnep.	Agavaceae	pe	pe	epl	2	rocks in egf, mxf cliffs	ls	500	1300			ja-dc	
Drymaria diandra Bl.	Caryophyllaceae	h	a	gro, wee	3	eg/pine, da, sg	gr	1100	1525	ag-fb	sp-fb	my-fb	flowers
Duabanga grandiflora (Roxb. *ex* DC.) Walp.	Sonneratiaceae	t	pe	gro	3	eg/bb, egf	gr, ls	1000	1375	fb-ap		ja-dc	flowers
Echinochloa colona (L.) Link	Gramineae	h	pe	aqu, gro	3	ponds in bb/df	ls	400	600	ag-oc	sp-nv	ja-dc	flowers
Echinochloa stagnina (Retz.) P. Beauv.	Gramineae	h	pe	gro, wee	3	da, sg	gr, ls	1200	1525	sp-dc	oc-ja	ja-dc	flowers
Elaeagnus conferta Roxb.	Elaeagnaceae	wc	pe	gro also cul	2	streams in eg/bb	gr	1000	1250	sp-oc	oc-nv	ja-dc	flowers
Elaeocarpus floribundus Bl. var. *floribundus*	Elaeocarpaceae	t	pe	gro	3	eg/bb, egf	gr,ls	1000	1400	my	sp-oc	ja-dc	flowers, fruits
Elaeocarpus stipularis Bl.	Elaeocarpaceae	t	pe	gro	3	egf, eg/bb	gr,ls	900	1400	my-jn	sp-oc	ja-dc	flowers, fruits
Elatostema cyrtandraefolium (Zoll. & Mor.) Miq.	Urticaceae	h	a	gro,ep l	3	rocks in mxf, egf	ls	1300	1425		sp-oc	my-dc	fruits
Elatostema monandrum (Ham. *ex* D. Don) Hara	Urticaceae	h	pd	epl	3	rocks in mxf, egf, eg/bb	ls	1300	1425	jn-jl	jl-ag	jn-dc	fruits
Elatostema salvinioides W. T. Wang	Urticaceae	h	pd	epl	2	rocks in mxf, eg/bb cliffs	ls	575	1375	ag-sp		my-dc	flowers
Elatostemma lineolatum Wight var. *majus* Wedd.	Urticaceae	h	pe	gro, epl	2	streams, wet areas in egf	gr,ls	1200	1350		nv-ja	ja-dc	fruits
Elephantopus scaber L. ssp. *scaber* var. *scaber*	Compositae	h	pe	gro, wee	3	da, sg	gr, ls	800	1500	sp-oc	nv	ja-dc	flowers
Eleusine indica (L.) Gaertn.	Gramineae	h	pe	gro, wee	3	da	gr,ls	500	1525	jn-nv	jl-dc	ja-dc	
Elsholtzia blanda H. Keng	Labiatae	h	pd	gro	2	eg/pine	gr	1200	1325	nv-dc		my-ja	flowers
Embelia sessiflora Kurz	Myrsinaceae	wc	pd	gro	3	eg/bb egf, da, sg	gr	650	1500	ap-my	jl	my-mr	flowers, imm. fruits
Engelhardia serrata Bl. var. *serrata*	Juglandaceae	t	pd	gro	3	eg/pine, sg, egf, eg/bb	gr	1000	1500	ja-fb	mr-ap	ja-nv	flowers♀
Engelhardia spicata Lechen. *ex* Bl. var. *integra* (Kurz) Mann.	Jugladaceae	t	pd	gro	3	eg/bb, da	ls	1000	1350	fb-mr	mr-ap	ap-fb	
Engelhardia spicata Lesch. *ex* Bl. var. *spicata*	Juglandaceae	t	pd	gro	3	eg/pine sg	gr	700	1400	ja fb	fb-mr	mr-dc	fruits
Entada rheedii Spreng. (ssp.*rheedii*)	Leguminosae, Mimosoideae	wc	pd	gro	3	egf	gr	900	1500		ja-ap	fb -dc	

Epigynum cochinchinensis (Pierre) Midd.	Apocynaceae	wc	pe	gro	3	streams in mxf	ls	550	700	ag-sp		ja-dc	flowers
Epithema carnosum Bth.	Gesneriaceae	h	pd	epl	2	rocks, streams in egf	gr, ls	1100	1350	ag-sp	sp-oc	my-dc	flowers, fruits
Eranthemum tetragonum Wall. *ex* Nees ssp. *tetragonum*	Acanthaceae	h	pe	gro	3	egf, eg/pine, eg/bb	gr	550	1450	dc-fb		ja-dc	flowers
Eria bilobulata Seid.	Orchidaceae	h	pd	epi, epl	3	rocks in mxf, eg/bb cliffs	ls	1300	1425	jl-ag	oc	my-dc	flowers
Eria globulifera Seid.	Orchidaceae	h	pd	epi	3	rocks in mxf, eg/bb cliffs	ls	1300	1425	jl-ag	oc	my-dc	flowers
Eriobotrya salwinensis Hand.-Mazz.	Rosaceae	t	pe	gro	3	rocks in mxf cliffs	ls	1375	1425	nv-dc	fb	ja-dc	flowers, fruits
Eriolaena candollei Wall.	Sterculiaceae	t	pd	gro	3	egf ,eg/pine, da ,sg	gr	1200	1500		dc-fb	jn-fb	fruits
Erythrina stricta Roxb.	Leguminosae, Papilionoideae	t	pd	gro	3	mxf, da	ls , gr	1200	1400	ap		jn-dc	flowers
Erythrina subumbrans (Hassk.) Merr.	Leguminosae, Papilionoideae	t	pe	gro	3	streams in egf, eg/bb	gr, ls	550	1400	ja-fb		ja-dc	flowers
Erythropalum scandens Bl.	Olacaceae	wc	pe	gro	3	streams in mxf	ls	550	800	ag-sp		ja-dc	flowers
Etlingera littoralis (Kon.) Gise.	Zingiberaceae	h	pe	gro	3	streams, wet areas in mxf, egf	gr, ls	550	1300	ap-jn	oc-nv	ja-dc	flowers
Eugenia albiflora Duth. *ex* Kurz	Myrtaceae	t	pe	gro	3	eg/bb, eg/pine	gr					ja-dc	
Eugenia formosa Wall.	Myrtaceae	t	pe	gro	3	streams in mxf	gr, ls	500	700		ag-sp	ja-dc	
Eugenia fruticosa (DC.) Roxb.	Myrtaceae	t	pe	gro	3	egf, eg/bb, da, sg	gr	900	1500	ap-my		ja-dc	flowers
Eugenia megacarpa Craib	Myrtaceae	t	pe	gro	3	egf	ls	1100	1400	ja-fb		ja-dc	flowers
Eulophia spectabilis (Denn.) Sur.	Orchidaceae	h	pd	gro	2	da, sg	gr	1100	1300	my		jn-dc	
Euonymus cochinchinensis Pierre	Celastraceae	l	pe	gro	3	egf	ls	1000	1400	fb-mr	oc-nv	ja-dc	fruits
Euonymus laxiflora Champ. *ex* Bth.	Celastraceae	s	pe	gro	2	rocks in egf cliffs	ls	1300	1375	jl-sp	oc-nv	ja-dc	fruits
Euonymus sootepensis Craib	Celastraceae	cr,v, wc	pe	gro	3	egf	ls	1100	1425	fb-mr	oc-nv	ja-dc	flowers, fruits
Eupatorium adenophorum Spreng.	Compositae	h	pe	gro, int,wee	4	da, sg	gr	600	1525	mr-ap	ap-my	ja-dc	
Eupatorium doichangensis H. Koy	Compositae	h	a	gro	2	bb/df, da	gr	1100	1200	ja-fb	mr	ag-dc	flowers
Eupatorium odoratum L.	Compositae	h	pe	gro, nat,wee	4	da,sg	gr,ls	400	1525	nv-dc	ja-fb	ja-dc	
Euphorbia thymifolia L.	Euphorbiaceae	h	a	gro, wee	3	da	gr,ls	425	800	ag-nv	oc-dc	my-dc	fruits
Eurya acuminata DC. var. *wallichiana* Dyer	Theaceae	t	pe	gro	3	da,sg in egf	gr	1000	1500	nv-dc	ja-fb	ja-dc	flowers, fruits

Eurysolen gracilis Prain	Labiatae	s,l	pe	gro	3	mxf, egf, da	gr , ls	1100	1425	nv-fb	ja-mr	ja-dc	flowers, fruits
Exacum pteranthum Wall. *ex* Griseb.	Gentianaceae	h	a	gro	3	eg/pine	gr	1250	1325	sp-oc	nv	my-dc	flowers
Fagerlinidia	Rubiaceae	t, l	pe	gro	2	streams in egf	gr, ls	1200	1300	ap	ja-fb	ja-dc	flowers, fruits
Fagopyrum cymosum (Trev.) Meisn.	Polygonaceae	h	pd	gro	3	egf, da	gr	1000	1400	oc-nv		my-ja	flowers
Fagraea ceilianica Thunb.	Loganiaceae	s	pe	epl	2	rocks in mxf cliffs	ls	600	1400		nv-ap	ja-dc	fruits
Falconeria insigne Roy.	Euphorbiaceae	t	pd	gro	2	rocks, cliffs in mxf	ls	1200	1425	ja-fb		jn-dc	flowers♂
Fernandoa adenophylla (Wall. *ex* G. Don) Steen.	Bignoniaceae	t	pd	gro	3	da, sg	gr	500	1100	jl-ag		ja-fb my-dc	flowers
Ficus	Moraceae	t,s	pe	epl	2	cliffs in bb/df, egf	ls	400	1300	dc-fb	dc-fb	ja-dc	flowers
Ficus annulata Bl.	Moraceae	t	pe	str, epl	3	mxf, egf	gr, ls	600	1400	ap-sp	ap-sp	ja-dc	flowers, fruits
Ficus anserina (Corn.) Berg	Moraceae	wc	pd	epl	3	rocks in bb/df cliffs	ls	400	800			my-dc	
Ficus auriculata Lour.	Moraceae	t	pe	gro	3	da, streams in egf, wet areas in eg/bb	gr	900	1500	dc-ag	mr-sp	ja-dc often changing lvs in dc	flowers
Ficus cyrtophylla Wall. *ex* Miq.	Moraceae	l	pe	gro, epl	2	streams in egf, mxf	ls	550	1350	ap-sp	ap-sp	ja-dc	flowers, fruits
Ficus fistulosa Reinw. *ex* Bl.	Moraceae	t	pe	gro	3	egf, da	gr	1000	1525	ja-dc	ja-dc	ja-dc	flowers
Ficus glaberrima Bl. var. *glaberrima*	Moraceae	t, l	pe	epl	2	rocks , cliffs	ls	1300	1425	nv-dc	nv-dc	ja-dc	
Ficus hirta Vahl var. *hirta*	Moraceae	l	pe	gro	3	da, sg, egf	gr,ls	1000	1400	jn-sp	jl-oc	ja-dc	flowers, fruits
Ficus hirta Vahl var. *roxburghii* (Miq.) King	Moraceae	t	pe	gro	3	egf	gr,ls	1000	1400	ap-my	ap-my	ja-dc	flowers, fruits
Ficus hispida L. f. var. *hispida*	Moraceae	t	pe	gro	3	da, sg	gr	400	1500	ja-dc	ja-dc	ja-dc	
Ficus kurzii King	Moraceae	t	pe	epi	3	rocks in egf	ls	1200	1500	ag-nv	ag-nv	ja-dc	flowers, fruits
Ficus semicordata B.-H. *ex* J.E. Sm. var. *semicordata*	Moraceae	t	pe	gro	3	egf, eg/bb, da, mxf, sg	gr, ls	550	1525	ja-dc	ja-dc	ja-dc	
Ficus subincisa Ham. *ex* J.E. Sm. var. *subincisa*	Moraceae	t,l	pe	gro	3	egf,da, sg	gr, ls	1200	1400	ja-dc	ja-dc	ja-dc	flowers
Ficus subpisocarpa Gagnep. ssp. *pubipoda* C.C. Berg	Moraceae	t	pd	gro	3	egf	gr	1000	1450	jl-ag	sp-oc	mr-ja	flowers
Ficus variegata Bl. var. *variegata*	Moraceae	t	pd	gro	2	streams in egf, eg/bb	gr	1000	1200			my-fb	
Firmiana colorata (Roxb.) R. Br.	Sterculiaceae	t	pd	gro	3	rocks, cliffs	gr, ls	1000	1425	ja-mr	mr-ap	jn-dc	flowers, leaves
Firmiana kerrii (Craib) Kosterm.	Sterculiaceae	l	pd	gro	2	rocks in mxf cliffs	ls	1350	1425	ja-fb	ap	jn-dc	flowers, leaves
Fissistigma oblongum (Craib) Merr.	Annonaceae	wc	pe	gro	2	egf, eg/pine	gr	900	1100			ja-dc	
Flacourtia indica (Burm.f.) Merr.	Flacourtiaceae	t	pe	gro	3	egf, da ,sg	gr	900	1500		jl-ag	ja-dc	fruits
Flemingia sootepensis Craib	Leguminosae, Papilionoideae	l	pe	gro	3	mxf, eg/bb, da, sg	gr, ls	550	1400		ja-fb	ja-dc	fruits

Fluggea virosa (Roxb. *ex* Willd.) Voigt	Euphorbiaceae	s, l	pd	gro	3	rocks in mxf, eg/bb,da	gr, ls	525	1425	jl-sp	sp-oc	my-dc	flowers♂, fruits
Galium punduanum Wall. *ex* Craib	Rubiaceae	h	a	epl	2	rocks in egf cliffs	ls	1300	1400	oc-nv	dc	my-dc	flowers
Garcinia cowa Roxb.	Guttiferae	t	pe	gro	3	mxf, egf, eg/bb	gr,ls	1200	1375	ap	sp	ja-dc	flowers♀
Garcinia propinqua Craib	Guttiferae	t	pe	gro	3	rocks in egf, eg/bb cliffs	ls	1350	1375	my-jn		ja-dc	flowers♂
Garcinia xanthochymus Hk. f. *ex* T. And.	Guttierae	t	pe	gro, epl	3	bb/df, eg/bb	gr,ls, sh	500	900			ja-dc	
Gardenia sootepensis Hutch.	Rubiaceae	t	pd	gro	3	bb/df, eg/bb	gr	900	1100	ap		my-dc	flowers
Garuga pinnata Roxb.	Burseraceae	t	pd	gro	3	eg/bb, da, sg	ls	500	1350			my-dc	
Gigantochloa apus (Schult.) Kurz	Gramineae, Bambusoideae	h	pe	gro	3	bb/df, eg/bb	gr, ls	500	1500			ja-dc	
Girardinia hibiscifolia Miq.	Urticaceae	h	a	gro	3	egf,da	ls	1150	1500	oc-nv	nv-dc	my-dc	flowers
Globba clarkei Baker	Zingiberaceae	h	pd	gro	3	rocks in mxf, egf	gr,ls	600	1400	jl-sp	oc-nv	my-dc	flowers
Globba schomburgkii Hk. f. var. *schomburgkii*	Zingiberaceae	h	pd	gro	3	egf, eg/bb	gr	1000	1300	jl-ag		my-dc	flowers
Glochidion eriocarpum Champ.	Euphorbiaceae	l	pe	gro	3	egf, eg/pine	gr	1200	1400		ja-fb	ja-dc	fruits
Glochidion oblatum Hk. f.	Euphorbiaceae	t	pe	gro	2	eg/bb	gr	1100	1400		jl-ag	ja-dc	fruits
Glochidion rubrum Bl.	Euphorbiaceae	t	pe	gro	3	da, sg	gr	1000	1500		ja-fb	ja-dc	fruits
Glochidion sphaerogynum (M. A.) Kurz	Euphorbiaceae	t	pe	gro	3	eg/bb, da, sg	gr	1000	1400	ja-fb	dc-ja	ja-dc	flowers, fruits
Glycosmis cochinchinensis (Lour.) Pierre *ex* Engl.	Rutaceae	l	pe	gro	3	rocks in mxf	ls	1200	1425	ja-fb	ag	ja-dc	flowers
Glyptopetalum sclerocarpum Kurz	Celastraceae	l	pe	gro	2	egf	ls	1100	1375	ap-my	oc-nv	ja-dc	flowers, fruits
Gmelina arborea Roxb.	Verbenaceae	t	pd	gro	3	da/sg, bb/df, eg/bb	gr	500	1500			my-dc	
Gomphogyne heterosperma (Wall.) Kurz	Cucurbitaceae	v	a	gro	3	cliffs, rocks in mxf, eg/bb, bb/df	ls	400	1425	sp-oc		my-dc	flowers♂
Gomphostemma crinitum Wall. *ex* Bth.	Labiatae	h	a	gro	2	streams in mxf	ls	650	700	oc		my-dc	
Gomphostemma lucidum Wall. *ex* Bth.	Labiatae	h	pe	gro	2	rocks in eg/bb	ls	1350	1375	ag		ja-dc	
Gomphostemma strobilinum Wall. *ex* Bth. var. *viridis* (Wall. *ex* Bth.) Hk. f.	Labiatae	h	pe	gro	2	mxf, eg/bb	gr,ls	1300	1425	sp		ja-dc	flowers
Gomphostemma wallichii Pr.	Labiatae	h	pd	gro	2	streams in egf, eg/bb	gr	1000	1300	oc-nv		my-fb	flowers
Goniothalamus cheliensis Hu	Annonaceae	t, l	pe	gro	2	streams, wet areas in egf	gr, ls		1325			ja-dc	
Gouania javanica Miq.	Rhamnaceae	wc	pd	gro	3	rocks in mxf cliffs	ls	1400	1425	sp	nv-dc	my-dc	flowers, fruits

Grewia lacei Drum. & Craib	Tiliaceae	s	pd	gro	3	eg/bb, da	ls	1000	1400	sp-oc		my-dc	flowers
Gynostemma pentaphyllum (Thunb.) Mak.	Cucurbitaceae	v	a	gro	3	egf, da	gr, ls	1200	1375	my-jn		my-dc	flowers♂
Gynura longifolia Kerr	Compositae	v	pd	gro	2	streams in egf, eg/bb	gr	1100	1300	fb		jn-mr	
Gynura nepalensis DC.	Compositae	h	a	gro	3	da, weed	gr,ls	600	1525	sp-jl	nv-ag	oc-sp	flowers, fruits
Habenaria furcifera Lindl.	Orchidaceae		pd	epl	3	rocks in mxf, eg/bb cliffs	ls	1400	1425	jl-ag		my-dc	flowers
Habenaria malintana (Blanco) Merr.	Orchidaceae	h	pd	gro	2	bb/df, eg/bb	gr	850	1400	oc		my-dc	flowers
Harpullia arborea (Blanco) Radlk.	Sapindaceae	t	pd	gro	3	streams in mxf	ls	500	900	ja-fb		fb-dc	flowers
Hedychium ellipticum Ham. *ex* J.E. Sm.	Zingiberaceae	h	pd	epl	3	rocks in mxf,eg/bb cliffs	ls	1375	1425	jl-ag	sp	my-dc	flowers, fruits
Hedychium gardnerianum Rosc.	Zingiberaceae	h	pd	gro	3	egf, eg/pine, da	gr	1100	1500	sp-oc		my-dc	flowers
Hedyotis coronaria (Kurz) Craib	Rubiaceae	h	pd	gro	2	mxf, eg/bb	gr	800	1300	jl-ag		my-dc	
Hedyotis corymbosa (L.) Lmk.	Rubiaceae	h	a	gro, wee	3	da, sg	gr	400	1200	sp-oc	oc-nv	ja-dc	flowers
Hedyotis elegans Wall. *ex* Kurz	Rubiaceae	h	pe	gro	3	eg/bb	gr	1000	1300		dc-ja	ja-dc	fruits
Hedyotis scandens Roxb.	Rubiaceae	v,h	pe	gro	3	wet areas egf, da	gr,ls	950	1150	oc-nv		ja-dc	flowers
Helicia formosana Hemsl. var. *oblanceolata* Sleum.	Proteaceae	t	pe	gro	2	egf, eg/bb	gr	1000	1400	ap-my	fb-mr	ja-dc	
Helicia nilagirica Bedd.	Proteaceae	t	pe	gro	3	egf	gr	1200	1500	ap		ja-dc	flowers
Heliciopsis terminalis (Kurz) Sleum.	Proteaceae	t	pe	gro	2	egf, eg/bb	gr	1000	1400	ap-my	dc-fb	ja-dc	
Helicteres elongata Wall. *ex* Boj	Sterculiaceae	s,l	pd	gro	3	eg/bb	gr	1000	1400	my-jn		ap-dc	flowers
Helixanthera parasitica Lour.	Loranthaceae	s	pe	epi, par	3	egf, eg/pine	gr	1000	1500	ap-my		ja-dc	flowers
Hemipilia calophylla Par. & Rchb. f.	Orchidaceae	h	pd	epl	1	rocks in mxf, eg/bb	ls	1350	1425	jl-ag		my-dc	flowers
Heracleum barmanicum Kurz	Umbelliferae	h	pd	gro	3	rocks in mxf, eg/bb cliffs	ls	1375	1425	sp-nv	oc-nv	jl-dc	flowers
Heriteria macrophylla Wall. *ex* Kurz	Sterculiaceae	t	pe	gro	2	eg/bb, egf	ls	1200	1400	mr-ap		ja-dc	seedling, flowers
Heteropanax fragrans (Roxb. *ex* DC.) Seem.	Araliaceae	l	pd	gro	2	da, sg	gr	900	1300			my-dc	
Heterostemma siamica Craib	Asclepiadaceae	v	pe	gro	3	mxf,da	ls	500	800	oc-nv		ja-dc	flowers
Heynea trijuga Roxb. *ex* Sims	Meliaceae	t	pe	gro	2	egf	gr	900	1200		nv-dc	ja-dc	fruits
Hibiscus macrophyllus Roxb.*ex* Horn.	Malvaceae	t	pe	gro	3	egf, da, sg	gr, ls	900	1400	mr-ap		ja-dc	
Hiptage bullata Craib	Malpighiaceae	sc	pe	gro	3	rocks in mxf cliffs	ls	1300	1400	ap-my		ja-dc	flowers
Homalium ceylanicum (Gardn.) Bth.	Flacourtiaceae	t	pd	gro	2	egf, eg/bb	gr	1000	1200	jl-ag		my-fb	flowers

Hopea odorata Roxb. var. *odorata*	Dipterocarpaceae	t	pe	gro	2	egf	ss	900	1000	fb-mr		ja-dc	flowers
Horsfieldia amygdalina (Wall.) Warb. var. *macrocarpa* Wilde	Myristicaceae	t	pe	gro	2	egf	gr	1000	1000		ap	ja-dc	fruits
Houttuynia cordata Thunb.	Saururaceae	h	pe	gro	3	streams in egf, wet areas in da	gr	800	1500	(dc) ap-my		ja-dc	flowers
Hovenia dulcis Thunb.	Rhamnaceae	t	pd	gro	2	egf, streams in eg/bb	gr	1200	1400			my-dc	
Hoya kerrii Craib	Asclepiadaceae	v	pe	epl	2	rocks in bb/df cliffs	ls	400	600			ja-dc	
Hoya thomsonii Hk. f.	Asclepiadaceae	v	pe	epi, epl	2	rocks in egf	gr	1300	1400		nv-ja	ja-dc	fruits
Hunteria zeylanica (Retz.) Gard. *ex* Thw.	Apocynaceae	t	pe	gro	3	rocks in egf, cliffs	ls	1200	1375	my	ap-my	ap-dc	flowers, fruits
Hydrocotyle javanica Pont. *ex* Thunb.	Umbelliferae	h	pe	gro, cr	3	mostly wet areas in egf, da, eg/bb	gr,ls	1100	1400	jn-sp	jl-nv	ja-dc	flowers, fruits
Hydrocotyle sibthorpioides Lmk.	Umbelliferae	h	a	gro, wee	3	da, sg	gr	900	1500		ap-oc	my-dc	fruits
Hydrolea zeylanica (L.) Vahl	Hydrophyllaceae	h	a	gro	3	wet areas in da		800	1100	ap-my	ap-jn	mr-oc	flowers, fruits
Hymenodictyon orixense (Denn.) Mabb.	Rubiaceae	t	pe	gro	2	rocks in mxf, eg/bb	ls	1000	1425			my-dc	
Hypericum henryi H. Lev. & Van. ssp. *hancockii* H. Rob.	Guttiferae, Hypericeae	s	pe	epl	2	rocks in egf, cliffs	ls	1300	1400	oc	dc-fb	ja-dc	fruits
Hypericum japonicum Thunb. *ex* Murr.	Guttiferae, Hypericeae	h	a	gro	3	wet areas in da, egf	gr	900	1050	ap-my	ap-my	my-dc	flowers, fruits
Ichnocarpus polyanthus (Bl.) P.I. Forst.	Apocynaceae	wc	pe	gro	3	egf	gr	1000	1525	ap-my		ja-dc	flowers
Ilex umbellulata (Wall.) Loesn.	Aquifoliaceae	t	pe	gro	3	egf	gr, ls	1000	1400		jl	ja-dc	fruits
Impatiens claviger Hk. f.	Balsaminaceae	h	pe	gro	3	streams, wet areas in egf	gr,ls	1200	1350	oc-nv	nv-dc	ja-dc	flowers
Impatiens kerriae Craib	Balsaminaceae	h	pd	epl	3	rocks in mxf cliffs	ls	1375	1425	my-nv	nv-dc	my-dc	flowers
Impatiens salangensis T. Shim.	Balsaminaceae	h	a	epl	3	rocks in mxf	ls	1400	1425	jl-dc	sp-ja	my-dc	flowers
Impatiens vioaeflora Hk.f.	Balsaminaceae	h	a	gro	3	egf, eg/bb	gr	1000	1525	ag-dc	sp-dc	my-dc	
Imperata cylindrica (L.) P. Beauv. var. *major* (Nees) C..E. Hubb. *ex* Hubb. & Vaugh.	Gramineae	h	pe	gro, wee	4	da, sg	gr,ls	500	1525	oc		ja-dc	
Inula cappa (Ham. *ex* D.Don) DC. forma cappa	Compositae	h	pd	gro	3	eg/bb,sg	gr,ls	900	1500	nv-dc	ja-dc	my-dc	flowers
Inula nervosa Wall. *ex* DC.	Compositae	h	a	epl	2	rocks in mxf, egf cliffs	ls	1200	1400	ja-fb	mr	jn-mr	flowers
Inula wissmanniana Hand.-Mazz.	Compositae	h	pd	gro	2	rodks in eg/pine, eg/bb cliffs	gr	1200	1425	dc-fb	mr	my-mr	flowers
Iodes cirrhosa Turcz.	Icacinaceae	wc	pe	gro	2	egf, da, sg	gr	1000	1200		jl	ja-dc	fruits

Ischaemum	Gramineae	h	pd	epl	2	rocks in egf cliffs	ls	1300	1400	oc-nv	dc	my-dc	flowers
Isodon coetsa (B. -H. *ex* D. Don) Kudo	Labiatae	s,h	pd	gro	2	eg/bb, da	ls	1200	1400	dc-ja		jl-fb	flowers
Isodon lophanthoides (B. -H. *ex* D. Don) Hara var. *lophanthoides*	Labiatae	h	a	gro	2	eg/bb	gr	1100	1400	sp-oc	nv-dc	my-dc	fruits
Ixora	Rubiaceae	sc	pe	gro	2	streams in mxf	ls	550	600		sp	ja-dc	fruits
Ixora cibdela Craib	Rubiaceae	l	pe	gro	3	egf, eg/bb	gr	900	1100		oc-nv	ja-dc	
Ixora rugosula Wall. *ex* Hk. f.	Rubiaceae	l, wc	pe	gro	2	eg/bb	ls	1275	1350	ap		ja-dc	flowers
Jasminum dispermum Wall. ssp. *forrestianum* (Kob.) P.S. Green	Oleaceae	s	pe	gro	2	rocks in egf	ls	1200	1400		ja dc	ja-dc	friuts
Jasminum funale Decne. *ssp.* funale	Oleaceae	wc	pe	gro	3	rocks in mxf cliffs	ls	1375	1425	ag-sp		ja-dc	flowers
Jasminum nervosum Lour.	Oleaceae	v	pe	gro	3	rocks in mxf, eg/bb	ls	1200	1400	my	my-jn	ja-dc	flowers
Justicia helferi Cl.	Acanthaceae	h	pe	gro	2	streams in mxf, egf	ls	600	1300	ja-fb		ja-dc	flowers
Justicia procumbens L.	Acanthaceae	h	a	gro	3	eg/pine, eg/bb, da, sg	gr	900	1525	sp-dc		my-dc	flowers
Justicia quadrifaria (Wall. *ex* Nees) T. And.	Acanthaceae	h	pe	gro		streams in egf, eg/bb	gr	1000	1300	sp-fb	nv-mr	ja-dc	flowers
Knema lenta Warb.	Myristicaceae	t	pe	gro	3	egf, eg/bb	gr	1000	1300			ja-dc	
Knema tenuinervia Wilde ssp. *setosa* Wilde	Myristicaceae	t	pe	gro	2	mxf, eb/bb	gr	500	700			ja-dc	
Kydia calycina Roxb.	Malvaceae	t	pd	gro	3	da sg	gr	1100	1500	oc-nv		my-dc	flowers
Lactuca parishii Craib *ex* Hoss.	Compositae	h	pd	gro	3	eg/pine, eg/bb, da, sg	gr	1100	1400	ja-fb	fb-mr	jn-ap	flowers
Lagerstroemia tomentosa Presl	Lythraceae	t	pd	gro	3	bb/df, egf	gr	900	1100	ap	oc-nv	ap-dc	flowers
Lagerstroemia villosa Wall. *ex* Kurz	Lythraceae	t	pd	gro	3	da, sg	gr	900	1500		oc-nv	my-fb	fruits
Laggera alata (D. Don) Sch. Bip. *ex* Oliv.	Compositae	h	a	gro, wee	3	da, sg	gr	1100	1525			my-dc	
Laggera pterodonta (DC.) Sch. Bip *ex* Oliv.	Compositae	h	a	gro, wee	3	da	gr	600	1250			ag-mr	
Lantana camara L.	Verbenaceae	s, l	pe	gro, int, nat, wee	2	da, sg	gr, ls	1100	1400	ag-oc		ja-dc	
Laportea interrupta (L.) Chew	Urticaceae	h	a	gro, epl, wee	3	mxf, egf, da	gr,ls	500	1025	ag-oc	sp-nv	my-dc	flowers, fruits
Laportea violacea Gagnep.	Urticaceae	h	a	gro	3	egf,da,sg	ls	1200	1400	oc-nv	nv-dc	my-dc	flowers
Leea indica (Burm.f.) Merr.	Leeaceae	s,l	pe	gro	3	egf, eg/bb	gr,ls	500	1500	my-jl	ag-sp	ja-dc	flowers, fruits
Lepidagathis incurva Ham. *ex* D.Don	Acanthaceae	h	pe	gro	3	rocks in mxf, bb/df, eg/pine	gr, ls	400	1500	dc-mr		ja-dc	flowers

Lespedeza parviflora Kurz	Leguminosae, Papilionoideae	l	pe	gro	3	eg/bb, da, sg	gr	1000	1500	nv-ja	ja-fb	ja-dc	fruits
Lespedeza sulcata (Schindl.) Craib	Leguminosae, Papilionoideae	l	pd	gro	3	rocks in mxf cliffs	ls	1100	1425	fb		my-ja	
Leucaena leucocephala (Lmk.) De Wit	Leguminosae, Mimosoideae	t, l	pe	gro, int, nat, wee	3	da, sg	gr	400	700			ja-dc	
Leucas decemdentata (Willd.) J.Sm.	Labiatae	h	a	epl	3	egf da	ls	1200	1400	oc-nv		my-dc	flowers
Lindenbergia indica (L.) Vat.	Scrophulariaceae	h	a	epl, gro	3	bb/df, mxf,da	ls	400	700	oc-nv	nv-dc	my-dc	flowers
Liparis olivacea Lindl.	Orchidaceae	h	pd	gro	3	bb/df,eg/bb	gr	1100	1300	jl-ag		my-dc	flowers
Liparis tenuis Rol. *ex* Dow.	Orchidaceae	h	pd	epi	2	rocks in mxf, eg/bb cliffs	ls	1350	1425	jl-ag		my-dc	flowers
Liparis viridiflora (Bl.) Lindl.	Orchidaceae	h	pe	epi, epl	3	rocks in mxf cliffs	ls	1375	1425	ag-sp	oc	ja-dc	flowers
Lithocarpus elegans (B.) Hatus. *ex* Soep.	Fagaceae	t	pe	gro	3	egf	gr	1000	1500		sp-oc	ja-dc	fruits
Lithocarpus polystachyus (Wall. *ex* A. DC.) Rehd.	Fagaceae	t	pe	gro	2	egf, eg/pine	gr	1200	1525	♂oc, ♀dc-ja	jl-ag	ja-dc	flowers♂,♀, fruits
Lithocarpus quriculatus (Hick. & A. Camus) Baun.	Fagaceae	t	pe	gro	3	egf	gr	1000	1400		sp-oc	ja-dc	fruits
Lithocaupus truncatus (King *ex* Hk. f.) Rehd. & Wils.	Fagaceae	t	pe	gro	2	eg/pine	gr	1250	1325		ag-sp	ja-dc	
Litsea	Lauraceae	t	pe	gro	3	egf, eg/bb	gr	1200	1500			ja-dc	
Litsea cubeba (Lour.) Pers. var. *cubeba*	Lauraceae	t	pe	gro	3	da, sg	gr	1000	1300	ja-fb		ja-dc	flowers
Litsea garrettii Gamb.	Lauraceae	l	pe	gro	3	egf, eg/bb	gr, ls	1100	1300	ap		ja-dc	flowers
Litsea glutinosa (Lour.) C. B. Rob. var. *glutinosa*	Lauraceae	t	pe	gro	3	eg/pine	gr	1100	1350	ap		ja-dc	flowers♂
Litsea semecarpifolia Wall. *ex* Nees	Lauraceae	t	pe	gro	3	eb/bb	gr	1100	1500	ja-fb		ja-dc	
Litsea umbellata (Lour.) Merr.	Lauraceae	t	pe	gro	3	egf	gr	1000	1350	jl-sp		ja-dc	flowers
Litsea zeylanica (Nees) Nees	Lauraceae	t	pe	gro	3	streams in egf	gr, ls	1200	1350	nv-ja		ja-dc	
Lobelia alsinoides Lmk.	Campanulaceae	h	a	gro	3	eg/bb,da,sg, eg/pine	gr	1000	1325	oc	nv	my-dc	flowers
Lobelia zeylanica L.	Campanulaceae	h, cr	pe	gro	3	da in egf, eg/bb	gr,ls	1000	1500	jn-oc	jl-dc	ja-dc	flowers, fruits
Lophatherum gracile Brongn. var. *gracile*	Graimineae	h	pd	gro	3	eg/bb, da	gr	1100	1300	sp-oc	oc-nv	my-dc	flowers
Lysionotus serratus D.Don	Gesneriaceae	h	pd	epi, epl	3	rocks in egf, da, cliffs	ls	1375	1400	jl-sp	sp-oc	my-dc	flowers, fruits
Macaranga denticulata (Bl.) M. A.	Euphorbiaceae	t	pe	gro	3	egf, da, sg	gr	500	1500		my-jn	ja-dc	fruits
Macaranga kurzii (O.K.) Pax & Hoffm.	Euphorbiaceae	l	pe	gro	3	da, sg	gr	1100	1350	jn-ag	jl-sp	ja-dc	flowers♀, fruits

Macaranga siamensis S. J. Davies	Euphorbiaceae	t	pe	gro	3	da, sg	gr	600	900			ja-dc	
Machilus bombycina King *ex* Hk. f.	Lauraceae	t	pe	gro	2	egf	gr	1100	1500	ja-fb		ja-dc	flowes
Maclura fruticosa (Roxb.) Corn.	Moraceae	wc	pe	gro	3	egf, eg/pine	ls	1200	1400	sp-oc		ja-dc	flowers♂
Macropanax dispermus (Bl.) O.K.	Araliaceae	t	pe	gro	3	egf	gr	1000	1400	ag-oc	dc-ja	ja-dc	flowers, fruits
Maesa montana A. DC.	Myrsinaceae	s,l	pe	gro	3	egf,eg/pine da,sg, eg/bb	gr	1000	1500	ja-fb	my-jn	ja-dc	flowers, fruits
Maesa permollis Kurz	Myrsinaceae	l	pe	gro	3	egf, streams in mxf	gr,ls	600	1500	ja-fb	ap-my	ja-dc	flowers, fruits
Maesa ramentacea (Roxb.) A. DC.	Myrsinaceae	t	pe	gro	3	da, sg	gr	950	1400	oc-fb		ja-dc	flowers
Magnolia lilifera (L.) Baill. var. *obovata* (Korth.) Gov.	Magnoliaceae	t	pe	gro	3	streams in mxf, egf	gr, ls	550	1300	mr-my		ja-dc	flowers
Mallotus	Euphorbiaceae	t	pe	gro	2	egf	gr,ls	1300	1375		jl-oc	ja-dc	fruits
Mallotus cuneatus Ridl.	Euphorbiaceae	l	pe	gro	2	rocks in egf, mxf,eg/bb cliffs	ls	600	1375	sp	sp-oc	ja-dc	fruits
Mallotus mollissimus (Geisel.) A.S.	Euphorbiaceae	t	pd	gro	2	egf	gr	1000	1100	ap-my	jl	mr-fb	flowers♂, fruits
Mallotus paniculatus (Lmk.) M. A.	Euphorbiaceae	t, l	pe	gro	3	da,sg	gr	900	1525			ja-dc	
Mallotus philippensis (Lmk.) M. A.	Euphorbiaceae	t	pe	gro	3	da,sg, streams in mxf,eg/bb	gr,ls	600	1500	oc-nv	ja-mr	ja-dc	flowers♂, fruits
Mallotus tetracoccus (Roxb.) Kurz	Euphorbiaceae	t	pe	gro	3	egf, eg/bb	gr	1000	1200	my		ja-dc	flowers♂
Mammea	Guttiferae	t	pe	gro	3	mxf, egf	ls	425	1400		my-jn	ja-dc	fruits
Mangifera caloneura Kurz	Anacardiaceae	t	pe	gro	2	streams in mxf, eg/bb	gr	550	1100	fb		ja-dc	
Maoutia puya (Wall. *ex* Hk.) Wedd.	Urticaceae	h,l	pd	gro	2	bb/df,da,sg	gr	1000	1525	jl-ag	sp-oc	my-dc	flowers♂, fruits
Markhamia stipulata (Wall.) Seem. *ex* K. Sch. var. *kerrii* Sprague	Bignoniaceae	t	pd	gro	3	egf, eg/bb, da, sg	gr, ls	1000	1400	dc-ja	mr-ap	fb-my	
Marsdenia ?glabra Cost.	Asclepiadaceae	v	pe	gro	2	rocks in egf cliffs	ls	1300	1375			ja-dc	
Marsdenia calcicola Kerr	Asclepiadaceae	v	pe	gro	2	rocks in eg/bb, cliffs	ls	1200	1375	ap	sp-oc	ja-dc	flowers
Maytenus (Gymnosporia stylosa Pierre var. *rectispinosa* Craib*)*	Celastraceae	sc	pe	gro	3	rocks in mxf	ls	1300	1375	my		ja-dc	flowers
Melastoma malabathricum L. ssp. *malabathricum*	Melastomataceae	t, l	pe	gro	3	egf, da ,sg	gr	1000	1525	ja-my		ja-dc	flowers
Melia toonsenden Sieb. & Zucc.	Meliaceae	t	pd	gro	3	bb/df, eg/bb	gr, ls	500	1300		oc-fb	my-dc	
Melicope pteleifolia (Champ. *ex* Bth.)T.Hart.	Rutaceae	l,s	pe	gro	3	egf, da, sg	gr, ls	1100	1500	mr-ap	jn-jl	ja-dc	flowers, fruits
Melicope viticina (Wall. *ex* Kurz) T. Hart.	Rutaceae	s	pe	gro	2	eg/bb	gr	1100	1400		my-jn	ja-dc	fruits
Melinus repens (Willd.) Zizka	Gramineae	h	a	gro, int, nat, wee	3	da, sg	gr	400	700	sp-oc	sp-oc	my-dc	

Meliosma pinnata (Roxb.) ssp. *barbulata* (Cufod.) Beus. *ex* Welz. var.*barbulata*	Sabiaceae	t	pe	gro	3	egf	gr	1000	1550	ap-my		ja-dc	flowers
Meliosma simplicifolia (Roxb.) Walp. ssp. *fordii* (Hemsl. *ex* Forb. & Hemsl.) Beus.	Sabiaceae	t	pe	gro	2	eg/bb, egf	ls	1200	1375			ja-dc	
Melocanna baccifera (Roxb.) Kurz	Gramineae, Bambusoideae	h	pe	gro	2	streams in mxf, eg/bb	gr	1000	1300			ja-dc	
Melodinus cochinchinensis (Lour.) Merr.	Apocynaceae	wc	pe	gro	3	egf	ls	1200	1350	ap		ja-dc	flowers
Memecylon umbellatum Burm.f.	Melastomataceae	l	pe	gro	2	rocks in mxf, eg/bb	ls	1200	1425	jl-ag		ja-dc	flowers
Merremia umbellata (L.) Hall. f. ssp.*orientalis* (Hall. f.) Oost.	Convolvulaceae	v	a	gro	3	egf,da,sg	ss	800	1100	fb-mr		jn-ap	flowers
Merremia vitifolia (Burm. f.) Hall. f.	Convolvulaceae	v	a	gro, wee	3	da	gr, ls	500	1525	ja-fb		jn-ap	flowers
Michelia baillonii Pierre	Magnoliaceae	t	pd	gro	3	egf, eg/bb	gr	1000	1300	my-jn	ap-my	my-dc	flowers, fruits
Michelia champaca L. var. *champaca*	Magnoliaceae	t	pe	gro	2	egf	gr	1000	1400	ap-my	my-jn	ja-dc	fruits
Microcos paniculata L.	Tiliaceae	t	pe	gro	3	eg/bb, da, sg	gr, ls	500	900			ja-dc	
Micromelum hirsutum Oliv.	Rutaceae	t	pe	gro	3	egf, eg/bb	gr,ls	1100	1500	ja-fb	mr-ap	ja-dc	flowers, fruits
Micromelum minutum (Forst. f.) Wight & Arn.	Rutaceae	l,s	pe	gro	3	rocks in egf , mxf, cliffs, eg/bb	gr,ls	1000	1500	oc-mr	dc-jl	ja-dc	flowers
Microstegium vagans (Nees *ex* Steud.) A. Camus	Gramineae	h	pe	gro, wee	4	da, sg	gr, ls	450	1500	dc-ja	ja-fb	ja-dc	flowers
Microtropis discolor (Wall.) Wall. *ex* Arn.	Celastraceae	l	pe	gro	2-3	streams in egf	gr,ls	1100	1325	fb-mr	oc-nv	ja-dc	flowers, fruits
Miliusa cuneata Craib	Annonaceae	l	pe	gro	2	streams in egf	ls	1200	1400	my-nv	nv	ja-dc	flowers
Miliusa thorelii Fin. & Gagnep.	Annonaceae	l	pe	gro	2	streams in bb/df, mxf	gr	500	700	oc		ja-dc	flowers
Millettia pachycarpa Bth.	Leguminosae, Papilionoideae	wc	pd	gro	3	egf, eb/bb	gr	1100	1500			my-fb	
Mimosa diplotricha C. Wrigt *ex* Sauv. var. *diplotricha*	Leguminosae, Mimosoideae	v	a	gro, int, nat, wee	3	da, sg	gr	400	1500	sp-oc		my-dc	
Mimosa pigra L.	Leguminosae, Mimosoideae	h	pe	gro, int, wee	3	da, sg	gr	400	1525	jl-sp		ja-dc	
Mischocarpus pentapetalus (Roxb.) Radlk.	Sapindaceae	t	pe	gro	3	egf	gr	1000	1500	ja-mr	my	ja-dc	flowers, fruits
Mitracarpus villosus (Sw.) DC.	Rubiaceae	h	a	gro, int, nat, wee	3	da, sg	gr	900	1500	sp-oc	nv	my-dc	
Mitragyna rotundifolia (Roxb.) O.K.	Rubiaceae	t	pd	gro	3	da, sg	gr	900	1200	sp-oc		ap-fb	flowers

Mitrephora wangii Hu	Annonaceae	t	pe	gro	3	egf	ls	1200	1425	(dc) fb-mr	jl-sp	ja-dc	flowers, fruits
Mnesithea striata (Nees *ex* Steud.) Kon. & Sos.	Gramineae	h	pd	gro	3	da	gr	1000	1300	ag-oc	oc-nv	my-ja	flowers
Mormordica charantia L.	Cucurbitaceae	v	a	gro, wee	3	da	gr, ls	400	700	ag-oc	oc-nv	my-dc	flowers, fruits
Morus macroura Miq.	Moraceae	t	pd	gro	3	egf,eg/pine	gr	1000	1400	fb-mr	ap	fb-dc	flowers, fruits
Mucuna bracteata A. DC.	Leguminosae, Papilionoideae	v	pe	gro	3	eg/bb, da, sg	gr	1000	1500	ja-fb		ja-dc	flowers
Mucuna interrupta Gagnep.	Leguminosae, Papilionoideae	wc	pe	gro	3	mxf, da, sg	ls	1200	1375	ap-sp	sp-oc	ja-dc	flowers, fruits
Murdannia nudiflora (L.) Bren.	Commelinaceae	h	a	gro, wee	3	egf, da, sg	gr	900	1300	sp-nv	oc-dc	my-dc	flowers
Musa itinerans Chees.	Musaceae	h	pe	gro	3	streams, wet areas in egf, eg/bb	gr, ls	950	1375	ag-oc		ja-dc	
Mussaenda dehiscens Craib	Rubiaceae	t	pe	gro	2	egf, eg/bb, da	gr	1000	1200	my-jl		ja-dc	flowers
Mussaenda parva Wall. *ex* G. Don	Rubiaceae	l	pd	gro	3	rocks in mxf, eg/bb cliffs	ls	1200	1425	jl-sp		my-dc	flowers
Mussaenda sanderiana Ridl.	Rubiaceae	wc	pe	gro	3	egf,eg/pine, eg/bb,da,sg	gr	1000	1500	dc-ap		ja-dc	flowers
Mycetia glandulosa Craib	Rubiaceae	h	pe	gro	3	egf	gr, ls	1000	1500	ap-my	ap-my	ja-dc	flowers
Mycetia gracilis Craib	Rubiaceae	l	pe	gro	3	streams in mxf, egf	gr,ls	600	1350	oc-nv	ja-fb	ja-dc	flowers, fruits
Myrsine semiserrata Wall.	Myrsinaceae	l	pe	gro	2	rocks in mxf, cliffs	ls	1200	1425	ja-fb		ja-dc	flowers♀
Nelsonia canescens (Lmk.) Spreng.	Acanthaceae	h	pe	gro	3	egf, eg/bb, da	gr	900	1100	mr-ap	ap-my	ja-dc	flowers, fruits
Nephelium hypolecum Kurz	Sapindaceae	t	pe	gro	3	egf, eg/bb	gr	950	1200	ja-fb		ja-dc	flowers
Nervilia aragoana Gaud.	Orchidaceae	h	pd	gro	2	mxf, eg/bb	ls	1200	1350			jn-dc	leaves
Nervilia crociformis (Zoll. & Mor.) Seid.	Orchidaceae	h	pd	gro	2	bb/df, eg/bb	gr	1100	1300			my-dc	leaves
Oberonia	Orchidaceae	h	pe	epi	2	rocks in eg/bb ,mxf, cliffs	ls	1200	1425		fb-mr	ja-dc	
Oenanthe javancia (Bl.) DC.	Umbelliferae	h	a	gro	2	streams in egf, eb/bb	gr	600	1475	dc-ja		jn-mr	flowers
Olea rosea Craib	Oleaceae	t, l	pe	gro	2	da, sg	gr	1000	1100		oc-nv	ja-dc	fruits
Ophiopogon longifolius Decne.	Liliaceae	h	pe	gro	3	egf, eg/bb	ls	1200	1400	my-sp	dc-ja	ja-dc	flowers, fruits
Ophiorrhiza aff. *nutans* Cl. *ex* Hk. f.	Rubiaceae	h	pe	gro	2	egf	gr,ls	1100	1375	ap-jl	jn-ag	ja-dc	flowers, fruits
Ophiorrhiza pseudofasciculata Schan.	Rubiaceae	h	a	gro	3	eg/bb	gr	1200	1350	ag-sp	sp-oc	my-dc	flowers, fruits
Ophiorrhiza trichocarpon Bl. var. *trichocarpon*	Rubiaceae	h	pe	gro	3	egf, eg/bb	gr	1000	1400	my-jl	jn-ag	ja-dc	flowers
Ophiorrhiziphyllon macrobotryum Kurz	Acanthaceae	h	pe	gro	2	egf	gr	1100	1400	ja-mr		ja-dc	flowers

Oplismenus burmannii (Retz.) P. Beauv.	Gramineae	h	pe	gro, wee	3	da, sg	gr	800	1500	oc-ja	nv-fb	ja-dc	flowers
Oplismenus compositus (L.) P. Beauv.	Gramineae	h	a	gro	3	da in eg/pine, eg/bb	gr, ls	400	1500	sp-oc	oc-nv	my-dc	flowers
Oreocnide rubescens (Bl.) Miq.	Urticaceae	t,l	pe	gro	3	streams in eg/pine, egf, mxf	gr,ls	600	1400	fb -ap	sp-dc	ja-dc	fruits
Ormosia sumatrana (Miq.) Prain	Leguminosae, Papilionoideae	t	pe	gro	2	egf,eg/bb	gr	1050	1250		oc-nv	ja-dc	fruits
Ornithoboea wildeana Craib	Gesneriaceae	h	pd	epl	3	rocks in mxf cliffs	ls	425	625	oc-nv		my-dc	flowers
Ornithochilus difformis (Wall. *ex* Lindl.) Schltr.	Orchidaceae	h	pe	epi	2	egf, eg/bb	gr	1100	1400	jl-ag		ja-dc	flowers
Orophea polycarpa A.DC.	Annonaceae	l	pe	gro	3	streams in mxf	ls	600	800	ja-fb		ja-dc	flowers
Osbeckia stellata Ham. *ex* Ker-Gawl. var. *crinita* (Bth. *ex* Naud.) C. Han.	Melastomataceae	s	pe	gro	3	eg/bb, egf,da,sg	gr, ls	1100	1500	sp-dc	ja	ja-dc	flowers
Ostodes paniculata Bl.	Euphorbiaceae	t	pe	gro	3	streams in mxf, egf, eg/bb	gr, ls	600	1350		ag-sp	ja-dc	fruits
Oxalis corniculata L.	Oxalidaceae	h	a	gro, wee	3	eg/bb,da, sg	gr,ls	1200	1400	(fb) my-oc	jn-nv	ap-dc	flowers, fruits
Paederia pallida Craib	Rubiaceae	v	a	gro	3	rocks in mxf,egf,da cliffs	gr,ls	1100	1500	sp-oc	nv-dc	my-dc	flowers, fruits
Palaquium garrettii Flet.	Sapotaceae	t	pe	gro	2	egf	gr	1000	1400	sp-oc		ja-dc	flowers
Pandanus sect. Rykia (de Vr.) Kurz	Pandanaceae	l	pe	gro	2	rocks in egf, cliffs	ls	1300	1375			ja-dc	
Pandanus sect. Rykia (de Vr.) Kurz	Pandanaceae	l	pe	gro	2	streams in bb/df, mxf	gr	500	600			ja-dc	
Panicum brevifolium L.	Gramineae	h	a	gro, wee	3	da, sg	gr	900	1200	sp-oc	oc-nv	my-dc	flowers
Panicum maximum Jacq.	Gramineae	h	pe	gro, wee	3	da, sg	gr	500	1100	sp-oc	oc-nv	ja-dc	
Panicum notatum Retz.	Gramineae	h	pe	gro	3	egf, eg/bb	gr	1000	1450	my-jl	my-jl	ja-dc	flowers
Panisea uniflora (Lindl.) Lindl.	Orchidaceae	h	pe	epi	4	rocks in egf, mxf cliffs	ls	1300	1425	ap	ap-my	ja-dc	flowers, fruits
Paphiopedilum charlesworthii (Rol.) Pfitz.	Orchidaceae	h	pe	epl	0,1	rocks in mxf, eg/bb cliffs	ls	1200	1425			ja-dc	
Parabaena sagittata Miers *ex* Hk. f. & Th.	Menispermaceae	v	pe	gro	3	rocks in mxf, streams in egf, eg/bb	ls	500	1400	my-jn	sp-nv	ja-dc	flowers, fruits
Paraboea glabrisepala Burtt	Gesneriaceae	h	pd	epl	3	rocks in egf, mxf cliffs	ls	1200	1425	ag-oc	oc-nv	jn-dc	flowers, fruits
Paraboea kerrii (Craib) Burtt	Gesneriaceae	s,h	pe	gro	2	egf	ls	1050	1250		nv-dc	ja-dc	fruits

Paris polyphylla J. E. Sm.	Liliaceae	h	pd	gro	2	rocks in egf cliffs		1200	1375		sp	jn-dc	
Parthenocissus semicordata (Wall.) Pl.	Vitaceae	wc	pe	gro	2	rocks in mxf cliffs	ls	1200	1425	sp	ja-dc	ja-dc	fruits
Paspalum conjugatum Berg.	Gramineae	h	a	gro, wee	3	da	gr, ls	1100	1525	ag-oc	sp-nv	my-dc	
Pavetta tomentosa Roxb. *ex* Sm. var. *tomentosa*	Rubiaceae	l	pd	gro	3	egf, eg/bb	gr	900	1400	my	nv	my-dc	flowers, fruits
Peliosanthes teta Andr. *ssp. humilis* (Andr.) Jess.	Liliaceae	h	pd	gro	2	rocks, streams in egf	gr,ls	1000	1325			ja-dc	
Pennisetum purpureum Schumach.	Gramineae	h	pd	gro, wee	3	da, sg	gr	800	1500	nv-ja	dc-fb	jn-fb	flowers
Peperomia pellucida (L.) H. B. K.	Piperaceae	h	a	gro, epl, nat	3	rocks in mxf cliffs, da in egf	gr,ls	500	1200	ag-oc	sp-nv	my-dc	flowers
Peperomia tetraphylla (Forst.f.) Hk. & Arn.	Piperaceae	h	pe	epl, epi	3	rocks in egf, mxf cliffs	gr,ls	1200	1500	ag-sp	sp-nv	ja-dc	flowers, fruits
Pericampylus glaucus (Lmk.) Merr.	Menispermaceae	v	pe	gro	3	egf, da	gr	1100	1400	mr-ap	jl-ag	ja-dc	flowers♀ fruits
Perilla frutescens (L.) Britt.	Labiatae	h	a	cul	2	egf	gr	1050	1500		nv-dc	my-dc	fruits
Peristylus constrictus (Lindl.) Lindl.	Orchidaceae	h	pd	gro	2	eg/bb	gr	1250	1400	my		my-dc	flowers
Petrocosmea	Gesneriaceae	h	pd	epl	2	rocks in egf, cliffs	ls	1300	1400	sp	oc-nv	jn-dc	flowers, fruits
Peucedanum siamicum Craib	Umbelliferae	h	pd	gro	2	da, sg	gr	1500	1525	sp-oc		my-dc	flowers
Phaulopsis dorsiflora (Retz.) Sant.	Acanthaceae	h	pe	gro	3	egf, mxf, eg/bb, da, sg	gr	400	1400	dc-fb		ja-dc	flowers
Phlogacanthus curviflorus (Wall.) Nees var. *curviflorus*	Acanthaceae	s,l	pe	gro	2	streams in egf, eg/bb	gr	1000	1300	nv-fb	dc-mr	ja-dc	flowers, fruits
Phoebe lanceolata (Wall. *ex* Nees) Nees	Lauraceae	t, l	pe	gro	3	egf, eg/bb	gr, ls	1000	1400	ap-my	oc	ja-dc	flowers, fruits
Phoebe pallida (Nees) Nees	Lauraceae	t	pe	gro	3	egf	gr	1000	1200	jl-ag		ja-dc	flowers, imm. fruits
Phoebe paniculata Nees	Lauraceae	t	pd	gro	3	egf	gr	1300	1500	fb-mr		ja-dc	flowers
Pholidota articulata Lindl.	Orchidaceae	h	pd	epi	3	rocks in mxf, cliff	ls	1300	1425			jn-dc	
Pholidota bracteata (D. Don) Seid.	Orchidaceae	h	pd	epi, epl	3	rocks in mxf, egf, eg/bb cliffs	ls	1200	1425		oc-ja	my-dc	fruits
Phragmites vallatoria (Pluk. *ex* L.) Veldk.	Gramineae	h	pe	gro, wee	4	da	gr,ls	500	1525	oc-dc	nv-ja	ja-dc	
Phrynium capitatum Willd.	Marantaceae	h	pe	gro	4	streams in egf	gr, ls	925	1350			ja-dc	
Phylacium majus Coll. & Hemsl.	Leguminosae, Papilionoideae	v	pe	gro	2	bb/df, eb/bb	gr	950	1200	oc	ja-fb	ja-dc	flowers,fruits
Phyllanthus debilis Klein *ex* Willd.	Euphorbiaceae	h	a, pd	gro	3	eg/pine, eg/bb, da, egf cliffs	gr, ls	1100	1400	sp-fb	oc-fb	jn-fb	flowers, fruits

Phyllanthus emblica L.	Euphorbiaceae	t	pd	gro	3	eg/pine, eg/bb, da, sg	gr	1100	1400		sp-fb	my-dc	
Phyllanthus reticulatus Poir.	Euphorbiaceae	sc	pd	gro	3	streams in bb/df, mxf, da	ls	500	700		sp-oc	my-dc	fruits
Phyllanthus urinaria L.	Euphorbiaceae	h	a	gro, wee	3	da	gr, ls	500	1375	ag-oc	sp-nv	my-dc	flowers, fruits
Picrasma javanica Bl.	Simaroubaceae	t, l	pe	gro	3	streams in mxf, egf	ls	500	1300	ap-nv	ag-sp	ja-dc	flowers
Pilea microphylla (L.) Liebm.	Urticaceae	h	pe	epl, nat	3	egf, eg/bb, da	gr,ls	400	1500	ag-oc	sp-nv	ja-dc	flowers
Pilea stipulosa Miq.	Urticaceae	h	a	epl	3	rocks in mxf, eg/bb	ls	500	1425	jl-ag	sp	my-dc	flowers♂, fruits
Pilea trinervia Wight	Urticaceae	h	pe	gro,epl	3	streams in eg/bb, rocks in mxf, egf	gr, ls	1100	1475	my-sp		ja-dc	flowers♂
Piper boehmeriaefolium (Wall.*ex* Miq.) C.DC.	Piperaceae	s	pe	gro	3	rocks in egf	ls	1100	1400	fb-mr		ja-dc	flowers
Piper brevicaule D.DC.	Piperaceae	v	pe	gro	3	egf	ls	1200	1375		my-jn	ja-dc	fruits
Piper umbellatum L. var. *glabrius* (Miq.) DC.	Piperaceae	s, l	pe	gro	2	egf	gr	700	950	ag-sp	sp-oc	ja-dc	flowers
Plantago major L.	Plantaginaceae	h	pe	gro, wee	3	egf, da, sg	gr,ls	1200	1500	my-sp	jn-sp	ja-dc	flowers
Platostoma hispidum (L.) Pat.	Labiatae	h	a	gro, wee	3	da, sg	gr	1000	1200	sp-oc	nv	my-dc	flowers
Platostoma intermedium Pat.	Labiatae	h	pd	epl	2	rocks in egf cliffs	ls	1300	1400	oc-dc	dc-ja	my-dc	flowers
Plectranthus bracteatus (Dunn) Sud.	Labiatae	h	a	epl	3	rocks in mxf, eg/bb	ls	1200	1425	sp-oc	nv-dc	my-dc	flowers, fruits
Pogostemon purpurascens Dalz.	Labiatae	l	pe	gro	3	egf eg/pine sg	gr	1100	1400	ja-fb		ja-dc	flowers
Pollia haskarlii R. Rao	Commelinaceae	h	pe	gro	3	streams in egf, mxf, eg/bb	gr,ls	500	1400	my-sp	sp-fb	ja-dc	flowers, fruits
Polygala persicariifolia DC.	Polygalaceae	h	a	gro	3	eg/pine, eg/bb, da	ls	1200	1400	sp-oc	oc-nv	my-dc	flowers
Polygala umbonata Craib	Polygalaceae	h	a	gro, epl	2	rocks, cliffs, mxf, eg/bb	ls	1300	1425	ag-dc	sp-ja	my-ja	flowers
Polygonatum kingianum Coll. & Hemsl.	Liliaceae	h	pd	gro	2	egf,eg/bb cliffs	ls	1375	1425	ap-my	sp-oc	ap-nv	flowers, fruits
Polygonum chinense L. var. *chinense*	Polygonaceae	h	pe	gro	3	mxf,egf,da,sg	gr,ls	500	1500	sp-fb	nv-mr	ja-dc	flowers, fruits
Polygonum chinense L. var. *hispidum* Hk. f.	Polygonaceae	h	pe	gro	3	streams in egf, da	gr	1000	1200	nv-dc	ja-dc	ja-dc	flowers
Polygonum nepalense Meisn.	Polygonaceae	h	a	gro, wee	2	da in egf, eg/pine	gr, ls	1400	1500	ag-oc	sp-nv	my-dc	flowers, fruits
Polygonum odoratum Lour.	Polygonaceae	h	pe	gro	3	streams and wet areas in egf, eg/bb	gr	1100	1300	ja-dc	ja-dc	ja-dc	flowers, fruits

Polygonum persicaria L.	Polygonaceae	h	a	gro, wee	3	da, sg	gr, ls	900	1400	mr-my	mr-my	ap-dc	flowers
Polygonum plebeium R.Br.	Polygonaceae	h	a	gro, wee	3	da, sg	gr	900	1100	mr-my		ap-dc	flowers
Pometia pinnata J.R. & G.Forst.	Sapindaceae	t	pd	gro	2	streams in mxf, egf	gr, ls	550	1250			mr-dc	
Porpax lanii Seid.	Orchidaceae	h	pd	epi	3	mxf,egf,eg/bb	ls	1300	1425	jl-ag		my-dc	flowers
Pothos chinensis (Raf.) Merr.	Araceae	v	pe	epi, epl	3	streams, wet areas in egf, mxf, eg/bb	gr, ls	550	1325	ag-sp		ja-dc	flowers
Pottsia laxiflora (Bl.) O.K.	Apocynaceae	v	pe	gro	3	egf, da, sg	gr	900	1100	my-jn		ja-dc	flowers
Pouzoulzia hirta Hassk.	Urticaceae	h	a	gro, wee	3	egf, da	gr	600	1325	ag-sp	oc-nv	my-dc	flowers
Prema flavescens Ham. *ex* Cl. *var. flavescens*	Verbenaceae	s	pd	epl	2	eg/pine, eg/bb	gr	1200	1275			my-dc	
Premna fulva Craib	Verbenaceae	wc	pd	gro	3	egf, eg/bb	gr, ls	1100	1350		my-jn	ja-ap jn-dc	
Premna latifolia Roxb.var. *latifolia*	Verbenaceae	wc	pe	gro	3	egf	gr	1000	1500	ap-my		ja-dc	flowers
Premna racemosa Wall. *ex* Schauer	Verbenaceae	l	pd	gro	3	rocks,cliffs in mxf	ls	1300	1425	mr-ap		ap-dc	flowers
Premna subcapitata Rehd.	Verbenaceae	s	pd	epl	3	rocks in mxf, eg/bb cliffs	ls	1375	1425	jl-sp	sp-oc	my-dc	flowers
Protium serratum (Wall. *ex* Colebr.) Engl.	Burseraceae	t	pe	gro	3	egf	gr	1000	1400		jl-ag	ja-dc	fruits
Prunus cerasoides Ham. *ex* D.Don	Rosaceae	t	pd	gro, cul	3	da, sg	gr, ls	1000	1375	ja-fb		ap-oc	flowers
Pseuderanthemum latifolium (Vahl) B. Han.	Acanthaceae	s,l	pe	epl,gro	3	rocks, streams in mxf, egf	gr, ls	400	1200	oc-fb	dc-mr	ja-dc	flowers
Pseudodissochaeta septentrionalis (W.W.Sm.) Nayar	Melastomataceae	t, l	pe	gro	3	egf, eg/bb	gr	1000	1350	jl-ag	nv-dc	ja-dc	flowers, fruits
Pseudodracontium	Araceae	h	pd	gro	2	rocks in mxf, eg/bb cliffs	ls	1375	1425			my-oc	
Pseudoechinolaena polystachya (H.B.K.) Stapf	Gramineae	h	a	gro	3	egf,da,sg	gr,ls	550	1525	oc-nv	nv-dc	my-dc	flowers
Psidium guajava L.	Myrtaceae	l	pe	gro,cul,int,nat	3	da, sg	gr	1000	1300	my-jn		ja-dc	flowers
Psychotria monticola Kurz var. *monticola*	Rubiaceae	l,s	pe	gro	3	egf	gr, ls	1000	1500	ap-my		ja-dc	flowers
Psychotria ophioxyloides Wall.	Rubiaceae	l	pe	gro	3	egf	gr, ls	1000	1500	ap-my		ja-dc	flowers
Psychotria winitii Craib	Rubiaceae	h	pe	gro	3	egf	ls	1000	1400		oc-nv	ja-dc	fruits
Pterospermum grande Craib	Sterculiaceae	t	pe	gro	2	da	gr, ls	1250	1375	my		ja-dc	flowers
Pterospermum grandiflorum Craib	Sterculiaceae	t	pe	gro	3	streams in mxf, egf	ls	550	1000			ja-dc	

Pterospermum semisagittatum B.-H. *ex* Roxb.	Sterculiaceae	t	pe	gro	2	eg/bb	gr	800	1000	my		ja-dc	flowers
Pueraria alopecuroides Craib	Leguminosae, Papilionoideae	v	a	gro	3	da, sg	gr, ls	400	1525	ja-fb		jl-my	flowers
Pueraria montana (Lour.) Merr. var. *chinense* (Ohwi) Maes. & Alm.	Leguminosae, Papilionoideae	v	pe	gro	2	da, sg	gr	900	1225	sp-oc		ja-dc	flowers
Pueraria rigens Craib	Leguminosae, Papilionoideae	wc	pe	gro	3	egf, eg/pine	gr	1100	1450		dc-fb	ja-dc	fruits
Pyrenaria garrettiana Craib	Theaceae	t	pe	gro	3	egf	gr	1100	1400		jn-jl	ja-dc	
Quercus semiserrata Roxb.	Fagaceae	t	pe	gro	3	egf, eg/pine	gr	1100	1400	ja	sp-oc	ja-dc	fruits
Quisqualis indica L. var. *indica*	Combretaceae	wc	pe	gro	3	da, sg	gr	500	1150	ap-my	sp-oc	ja-dc	flowers, imm. fruits
Radermachera hainanensis Merr.	Bignoniaceae	t	pd	gro	3	rocks in mxf cliffs	ls	1375	1425	ap		ap-dc	flowers
Radermachera ignea (Kurz) Steen.	Bignoniaceae	t, l	pe	gro	2	rocks in bb/df cliffs	ls	450	600	sp-oc		my-dc	
Rapanea yunnanensis Mez	Mysinaceae	t	pe	gro	2	eg/bb	gr	1100	1300		sp-oc	ja-dc	fruits
Rauvolfia verticillata (L.) Baill.	Apocynaceae	l	pe	gro	2	egf, da	gr	1200	1400	mr-ap		ja-dc	flowers
Reinwardtia indica Dum.	Linaceae	h	pd	gro	3	egf,eg/bb da	gr, ls	1100	1500	nv-dc (fb)	ja-fb	ja-dc	flowers, fruits
Rhaphidophora decursiva Schott	Araceae	v, cr	pe	epi, epl	3	mxf, egf, eg/bb	gr, ls,sh	525	1400	sp-oc		ja-dc	flowers
Rhaphidophora gigantea (Schott) Ridl.	Araceae	v, cr	pe	epl	3	rocks in egf, mxf cliffs	ls	500	1375	ag	fb	ja-dc	
Rhaphidophora hookeri Schott	Araceae	v, cr	pe	epi, epl	3	streams in eg/bb, rocks in mxf, egf	gr,ls	550	1375	sp	my-jn	ja-dc	flowers, fruits
Rhinacanthus calcaratus Nees	Acanthaceae	l	pe	gro	3	streams in mxf	ls	700	800	ja-fb		ja-dc	flowers
Rhopalephora scaberrimum (Bl.) Faden	Commelinaceae	h	pe	gro	3	eg/pine, eg/bb	gr	1200	1375	ag-oc		ja-dc	flowers
Rhus	Anacardiaceae	l,t	pd	gro	3	rocks in mxf cliffs	ls	1400	1425	jl-sp	oc-nv	jn-dc	flowers, fruits
Rhus chinensis Mill.	Anacardiaceae	l	pd	gro	3	da sg	gr	900	1400	jl-oc	oc-nv	my-dc	fruits
Rhus rhetsoides Craib	Anacardiaceae	t	pd, pe	gro	3	egf	gr	1000	1300	ap	oc-nv	ja-dc	flowers♂, fruits
Rhynchoglossum obliquum Bl.	Gesneriaceae	h	a	epl, gro	3	rocks in mxf cliffs,eg/bb, eg/pine	gr,ls	400	1500	sp-nv	nv-dc	my dc	flowers
Rhynchotechum obovatum (Griff.) Burtt	Gesneriaceae	l	pe	gro	3	streams in eg/bb, egf	gr	1150	1400	my-jn	oc	ja-dc	flowers, friuts
Rinorea ? macrophylla (Decne.) O.K.	Violaceae	l	pe	gro	2	steams in mxf	ls	550	650	ag-sp	sp-oc	ja-dc	flowers, imm fruits
Rorippa indica (L.) Hiern	Cruciferae	h	a	epl	2	rocks in eg/pine	gr	1450	1500	ag	sp-oc	jn-nv	fruits
Rourea minor (Gaertn.) Leenh. ssp. *minor*	Connaraceae	wc	pe	gro	3	egf, eg/bb	gr	1000	1400		ap-my	ja-dc	fruits
Rubus blepharoneurus Card.	Rosaceae	sc	pe	gro	3	egf	gr,ls	1100	1500	ap-my	ap-my	ja-dc	flowers, fruits
Rubus dielsianus Focke	Rosaceae	v	a	gro	2	eg/bb	gr	1100	1250			jn-mr	

Rubus ellipticus J.E. Sm. forma *obcordatus* Franch.	Rosaceae	v	pe	gro	3	eg/bb, da	gr	1200	1525	dc-ja	fb-mr	ja-dc	
Rungia parviflora (Retz.) Nees var. *parviflora*	Acanthaceae	h	a	gro	3	bb/df, eg/bb,da	gr	900	1300	sp-fb	nv-fb	my-fb	flowers
Rungia rivicola Craib	Acanthaceae	h	pe	gro	3	rocks in egf	ls	1100	1400	fb-mr		ja-dc	flowers
Sabia limoniacea Wall. *ex* Hk.f. & Th..	Sabiaceae	wc	pe	gro	2	egf	ls	1200	1400	ja-fb		ja-dc	flowers
Saccharum arundinaceum Retz.	Gramineae	h	pe	gro, wee	3	da, sg	gr,ls	500	1525	sp-dc	nv-ja	ja-dc	flowers
Saccharum spontaneum L.	Gramineae	h	pe	gro, wee	3	da, sg	gr, ls	400	1525	sp-dc	nv-ja	ja-dc	flowers
Sacciolepis indica (L.) A. Chase	Gramineae	h	a	gro, wee	3	da, sg	gr	900	1525	sp-dc	nv-ja	my-dc	flowers
Sageretia cordifolia Tard.	Rhamnaceae	wc	pd	gro	3	rocks in mxf cliffs	ls	1375	1425	sp-oc	nv-dc	my-dc	flowers, fruits
Salix tetrasperma Roxb.	Salicaceae	t	pd	gro	2	streams in egf, eg/bb	gr	1000	1500	sp-oc	dc-nv	oc-sp	flowers♂
Salomonia cantoniensis Lour.	Ploygalaceae	h	a	gro	3	egf, eg/pine, da	gr	1000	1400	sp-nv	oc-dc	my-dc	flowers
Salvia riparia Kunth	Labiatae	h	pe	gro, wee	3	da, sg	gr	900	1300	oc-fb	nv-mr	ja-dc	flowers
Sambucus javanica Reinw. *ex* Bl. ssp. *javanica*	Caprifoliaceae	s,l	pe	gro	3	eg/bb, egf, da, sg	gr,ls	1000	1525	jl-sp	sp-oc	ja-dc	fruits
Sapindus rarak DC.	Sapindaceae	t	pd	gro	2	egf, eg/bb	ls	1000	1375			my-dc	
Sapria himalayana Griff.	Rafflesiaceae	h	pd	gro, par	1	egf, eg/bb	ls	1350	1350	ja-fb		leafless	
Saprosma consimile Kurz	Rubiaceae	l	pe	gro	3	rocks in mxf, egf	ls	1200	1400	my		ja-dc	flowers
Sarcosperma arboreum Bth.	Sapotaceae	t	pe	gro	3	egf	gr	1000	1550	ja-fb	ap-my	ja-dc	flowers, fruits
Saurauia nepaulensis DC.	Saurauiaceae	t	pe	gro	3	egf,da,sg	gr,ls	1100	1400	my-jn		ja-dc	flowers
Saurauia roxburghii Wall.	Saurauiaceae	t	pe	gro	3	egf eg/pine eg/bb	gr	1000	1500	ja-dc	ja-dc	ja-dc	flowers
Sauropus macranthus Hassk.	Euphorbiaceae	l	pe	gro	2	rocks in egf,eg/bb cliffs	ls	1300	1400	my-jn	sp	ja-dc	flowers♂,♀, fruits
Sauropus poomae Welz. & Chay.	Euphorbiaceae	h	pe	epl	2	rocks in egf cliffs	ls	1250	1400	oc-mr	oc-nv	ja-dc	flowers, fruits
Schefflera bengalensis Gamb.	Araliaceae	s	pe	epi, epl	3	egf	gr,ls	1000	1500	ap-my	my	ja-dc	flowers, fruits
Schefflera ptelotii Merr.	Araliaceae	t ,l, s	pd	epl	3	rocks in mxf	ls	650	1400	ja-fb	fb-ap	my-ap	flowers, fruits
Schefflera pueckleri (C. Koch) Frod.	Araliaceae	s	pe	epi	2	rocks in egf, cliffs	ls	1300	1375	jn-jl		ja-dc	
Schima wallichii (DC.) Korth.	Theaceae	t	pe	gro	4	egf	gr	700	1525	ap-my	dc-mr	ja-dc often changing lvs dc-ja	flowers, fruits
Schizachyrium brevifolium (Sw.) Nees	Gramineae	h	a	gro	3	da,sg	gr	1000	1400	nv-dc	nv-dc	jn-dc	flowers, fruits
Scirpus juncoides Roxb.	Cyperaceae	h	pe	gro	3	wet areas in da, sg	gr	800	1100	mr-my	mr-my	ja-dc	flowers

Scleropyrum pentandrum (Denn.) Mabb.	Santalaceae	t	pe	gro	2	rocks in egf, eb/bb	ls	1200	1400		jl-ag	ja-dc	fruits
Scoparia dulcis L.	Scrophulariaceae	h	a	gro, int, nat, wee	3	da, sg	gr	400	1500	sp-nv	oc-dc	my-dc	
Scurrula ferruginea (Jack) Dans.	Loranthaceae	s	pe	epi, par	3	da, sg	gr	900	1525	jl-sp		ja-dc	flowers
Secamone elliptica R.Br. ssp. *elliptica*	Asclepiadaceae	v,wc	pe	gro	3	rocks in egf/bb mxf cliffs	ls	1300	1425	ap-my	oc-nv	ja-dc	flowers, fruits
Semecarpus cochinchinensis Engl.	Anacardiaceae	t	pe	gro	3	mxf, egf	gr, ls	525	1500	dc-mr	ap	ja-dc	flowers
Senecio scandens B.-H. *ex* D. Don	Compositae	sc	pd	gro	2	rocks in egf cliffs	ls	1400	1425	ja-fb	fb-mr	my-mr	flowers, fruits
Sericocalyx quadrifarius (Wall. *ex* Nees) Brem.	Acanthaceae	h	pe	gro	3	eg/bb	gr	1000	1400	dc-ja		ja-dc	flowers
Setaria palmifolia (Koen.) Stapf var. *palmifolia*	Gramineae	h	pe	gro	3	da	gr, ls	1000	1525	ag-fb	sp-fb	ja-dc	flowers
Setaria parviflora (Poir.) Kerg.	Gramineae	h	a	gro, wee	3	eg/bb, da, sg	gr	1000	1525	sp-oc	oc-nv	my-dc	flowers
Shorea roxburghii G. Don	Dipterocarpaceae	t	pd	gro	2	bb/df, eg/bb	gr	750	1100	fb		my-fb	
Shuteria hirsuta Baker	Leguminosae, Papilionoideae	v	pe	gro	3	egf,da,sg	gr	1000	1300	nv-dc		ja-dc	flowers
Shuteria involucrata (Wall.) Wight & Arn. *var. involucrata*	Leguminosae, Papilionoideae	v	pd	gro	3	egf,da,sg, eg/pine	gr	1100	1500	oc-nv	dc-ja	ja-dc	flowers, fruits
Shuteria vestita Wight & Arn.	Leguminosae, Papilionoideae	v	a	gro	2	eg/bb	gr	1100	1300	dc-ja		my-fb	flowers
Sida rhombifolia L. ssp. *rhombifolia*	Malvaceae	h	pe	gro, wee	3	da, sg	gr, ls	400	1500	sp-fb	ja-mr	ja-dc	flowers
Smilax corbularia Kunth ssp. *corbularia*	Smilacaceae	v	pe	gro	3	egf,eg/bb,da ,sg	gr	1000	1450	jn		ja-dc	flowers
Smilax lanceifolia Roxb.	Smilacaceae	v	pe	gro	3	egf	gr, ls	1000	1500	ja-fb	jl-ag	ja-dc	flowers, fruits
Smilax ovalifolia Roxb.	Smilacaceae	v	pe	gro	3	egf, eg/bb	gr	800	1200			ja-dc	
Smilax perfoliata Lour.	Smilacaceae	v	pe	gro	3	da,sg,eg/bb, egf	gr	1000	1525		ap-jn	ja-dc	fruits
Solanum aculeatissimum Jacq.	Solanaceae	h	a	gro,na t	3	eg/bb,da,sg	gr	1100	1400	my-jn		ap-dc	flowers
Solanum barbisetum Nees	Solanaceae	h	pd	gro	3	eg/bb, da	gr	1100	1400	my-jn		ap-dc	flowers
Solanum macrodon Wall. *ex* Nees	Solanaceae	h	a	gro	3	mxf, eg/bb	gr, ls	600	1400	my-sp	sp-oc	ap-dc	flowers
Solanum verbascifolium L.	Solanaceae	l	pe	gro	3	da	gr, ls	500	700	ag-oc	sp-nv	ja-dc	
Solena heterophylla Lour. ssp. *heterophylla*	Cucurbitaceae	v	a	gro	2	eg/bb, da, sg	gr	1000	1200			my-dc	
Sonchus wightianus DC. ssp. *wightianus*	Compositae	h	pe	gro, wee	3	weed, eg/pine, da, sg	gr	900	1525	ja-fb	fb-mr	ja-dc	
Sonerila erecta Jack	Melastomataceae	h	a	gro	3	egf, eg/bb da	gr	1125	1500	oc-nv	nv-dc	my-dc	flowers

Sophora velutina Lindl.	Leguminosae, Papilionoideae	l	pe	gro	2	bb/df, mxf,cliffs	ls	1400	1425		nv-dc	ja-dc	fruits
Spilanthes paniculata Wall. *ex* DC.	Compositae	h	a	gro, wee	3	eg/pine, da, sg	gr,ls	1000	1525	sp-fb	nv-mr	my-mr	flowers
Spondias axillaris Roxb.	Anacardiaceae	t	pd	gro	3	egf	gr, ls	1100	1400	ja-fb	sp-oc	mr-dc	flowers♂
Stauranthera grandiflora Bth.	Gesneriaceae	h	pe	epl	2	rocks, streams in egf	gr, ls	1200	1325	ag-sp		ja-dc	
Stephania elegans Hk.f. & Th.	Menispermaceae	v	a	gro	3	rocks in egf, mxf cliffs	ls	1300	1425	oc	oc-nv	my-dc	fruits♂
Stephania japonica (Thunb.) Miers var. *discolor* (Bl.) For.	Menispermaceae	v	a	gro	3	egf, eg/bb, da	gr	1000	1300	my-ag		my-dc	flowers♂
Stephania oblata Craib	Menispermaceae	wc	pd	epl	3	rocks in mxf, eg/bb cliffs	ls	1200	1400	ap		my-dc	flowers♂
Sterculia balanghas L.	Sterculiaceae	t	pd	gro	3	egf, eg/pine	gr	1000	1500			fb-dc	
Sterculia guttata Roxb.	Sterculiaceae	l	pd	gro	2	rocks in mxf	ls	1300	1425	fb-mr		mr-nv	flowers
Sterculia lanceolata Cav. var. *lanceolata*	Sterculiaceae	l	pe	gro	3	egf, mxf	ls	550	1350	sp-nv	my-sp	ja-dc	flowers, fruits
Sterculia lanceolata Cav. var.*principis* (Gagnep.) Pheng.	Sterculiaceae	l	pe	gro	3	egf, eg/bb, bb/df	gr	1000	1400		my-jn	ja-dc	fruits
Sterculia pexa Pierre	Sterculiaceae	t	pd	gro	3	mxf,da,sg	gr, ls	400	750	ja	fb-mr	my-dc	
Sterculia villosa Roxb.	Sterculiaceae	t	pd	gro	3	rocks in mxf, bb/df cliffs	ls	600	1425	ja-fb		ap-dc	flowers
Stereospermum colais (B.-H.*ex* Dill.) Mabb.	Bignoniaceae	t	pd	gro	3	egf	gr	1100	1500	ap	ja-mr	ap-fb	flowers
Streblus ilicifolius (Vidal) Corn.	Moraceae	l	pe	gro	3	rocks in mxf cliffs	ls	400	700			ja-dc	
Streptocaulon juventas (Lour.) Merr.	Asclepiadaceae	v	pe	gro	3	eg/bb da	gr	1000	1450	my-ja		ja-dc	flowers
Strobilanthes erectus Cl. *ex* Hoss.	Acanthaceae	l	pe	gro	3	rocks in egf, mxf cliffs	ls	1200	1425	oc-nv		ja-dc	flowers
Strobilanthes rex Cl.	Acanthaceae	l, s	pe	gro	3	egf	gr, ls	1000	1425	ja-fb		ja-dc	flowers
Strobilanthes speciosus Bl.	Acanthaceae	l	pe	gro	4	rocks in egf	ls	1200	1400	oc-nv		ja-dc	flowers
Strobilanthes viscidus Im.	Acanthaceae	h	pe	gro	2	streams in egf, eg/bb	gr	1100	1250			ja-dc	
Styrax benzoides Craib	Styracaceae	t	pe	gro	3	egf, eb/bb,da,sg	gr	1000	1500	my-jn	oc-nv	ja-dc	flowers, fruits
Sumbaviopsis albicans (Bl.) J.J. Sm.	Euphorbiaceae	t	pe	gro	3	rocks, streams in mxf	ls	500	700			ja-dc	
Symplocos hookeri Cl.	Symplocaceae	t	pe	gro	2	streams, wet areas in egf	gr		1325	oc-nv	ag-sp	ja-dc	
Symplocos macrophylla Wall. *ex* DC. ssp. *sulcata* (Kurz) Noot. var. *sulcata*	Symplocaceae	t	pe	gro	3	egf, eg/bb	gr	1000	1500		mr-ap	ja-dc	

Synedrella nodiflora (L.) Gaertn.	Compositae	h	a	gro, wee	3	da, sg	gr,ls, sh	500	1500	oc-dc	nv-ja	my-fb	
Tabernaemontana bovina Lour.	Apocynaceae	l	pe	gro	3	egf, eg/bb	gr, ls	1100	1425	my	nv-dc	ja-dc	flowers, fruits
Tacca chantrieri Andre	Taccaceae	h	pe	gro	2	egf	ls	1200	1350			ja-dc	
Tarenna elliptica Craib var. *elliptica*	Rubiaceae	l,s	pe	gro	3	streams in egf, rocks in mxf	gr,ls	1100	1400	jn	oc-nv	ja-dc	flowers, fruits
Tarenna vanprukii Craib var. *vanprukii*	Rubiaceae	t.l	pe	gro	3	rocks in mxf, cliffs	ls	1300	1425	fb-mr	oc-dc	ja-dc	
Tarennoidea wallichii (Hk, f.) Tirv. & Sastre	Rubiaceae	t	pe	gro	2	egf, eg/bb	gr	1200	1400			ja-dc	
Tephrosia kerrii Drum. & Craib	Leguminosae, Papilionoideae	l	pe	gro	3	eg/bb, da, sg	gr	1000	1300		ja-fb	ja-dc	fruits
Ternstroemia gymnanthera (Wight & Arn.) Bedd.	Theaceae	t	pe	gro	3	egf, eg/pine	gr	1200	1400	my	oc	ja-dc	flowers, fruits
Tetradium glabrifolium (Champ.*ex* Bth.) T.Hart.	Rutaceae	t,s	pe	gro	3	egf, da	gr,ls	1000	1375	my-jl	jl-oc	ja-dc	flowers♂♀, fruits
Tetrastigma cruciatum Craib & Gagnep.	Vitaceae	wc	pe	epl,gro	3	streams in bb/df, mxf cliffs	ls	500	1425	fb-ap	nv	ja-dc	flowers♀
Tetrastigma garrettii Gagnep.	Vitaceae	v	pe	gro	3	streams in egf, eg/bb	gr, ls	1000	1300	dc-ja	my-jn	ja-dc	flowers♀, fruits
Tetrastigma laoticum Gagnep.	Vitaceae	wc	pe	gro	2	eg/bb	gr, ls	1200	1350	ap	ag	ja-dc	flowers♀
Tetrastigma quadrangulum Gagnep & Craib	Vitaceae	wc	pe	gro	2	mxf, eg/bb	sh	500	700	oc		ja-dc	flowers♀
Thaia saprophytica Seid.	Orchidaceae	h	pd	gro, epl	2	rocks in egf	ls	1300	1375	oc		jn-nv	flowers
Themeda triandra Forssk.	Gramineae	h	pe	gro, wee	3	da, sg	gr, ls	500	1525	sp-oc	oc-nv	ja-dc	flowers
Thespesia lampas (Cav.) Dalz. & Gibs. var. *lampas*	Malvaceae	l	pd	gro	2	eg/bb, da, sg	gr	525	1200	oc		my-dc	
Thladiantha cordifolia (Bl.) Cogn.	Cucurbitaceae	v	a	gro	2	egf eg/pine da sg	gr	1350	1525	ja-dc	oc-nv	my-mr	flowers, fruits
Thladiantha hookeri Cl.	Cucurbitaceae	v	a	gro	2	eg/bb, da, sg	gr	1100	1300	my		my-dc	flowers♂
Thunbergia	Acanthaceae	wc	pe	gro	3	rocks in mxf cliffs, egf, eg/pine	gr,ls	1350	1525	oc-dc	mr	ja-dc	flowers
Thunbergia coccinea Wall.	Acanthaceae	wc	pe	gro	3	streams in egf, eg/bb, da	gr	1100	1500	nv-dc		ja-dc	flowers
Thunbergia grandiflora Roxb.	Acanthaceae	v	pe	gro	3	eg/bb, da	gr	800	1500	ja-fb		ja-dc	flowers
Thunbergia laurifolia Lindl.	Acanthaceae	wc	pe	gro	3	da, sg		500	1500	nv-fb		ja-dc	
Thunbergia similis Craib	Acanthaceae	v	pd	gro	3	bb/df, eg/bb	gr	1000	1300	oc-nv		my-dc	flowers
Thysanolaena latifolia (Roxb. *ex* Horn.) Honda	Gramineae	h	pe	gro, wee	3	da,sg	gr, ls	500	1525			ja-dc	
Tinomiscium petiolar Hk. f. & Th.	Menispermaceae	wc	pe	gro	2	streams in egf, eg/bb	gr	1000	1200	my-jn	sp-oc	ja-dc	

Tirpitzia bilocularis Suks. & K. Lar.	Linaceae	h	pd	gro	2	rocks in mxf, da cliffs	ls	1200	1300	ag-sp	ja-fb	jn-fb	flowers
Tithonia diversifolia (Hemsl.) A. Gray	Compositae	h	pe	gro, int, wee	3	da, sg	gr	550	1525	oc-dc		ja-dc	
Toddalia asiatica (L.) Lmk.	Rutaceae	wc	pe	gro	3	egf eg/bb	gr	1000	1400		ap-my	ja-dc	fruits
Torenia pierreana Bon.	Scrophulariaceae	h	a	gro	3	egf, eb/bb	gr	1100	1400	jl-oc	sp-nv	my-dc	flowers
Torenia violacea (Aza. *ex* Blanco) Penn.	Scrophulariaceae	h	a	gro	3	egf, eg/bb, da	gr, ls	1000	1500	sp-oc	nv-dc	ap-dc	flowers
Toxocarpus aff. *wightianus* Hk. & Arn.	Asclepiadaceae	v	pe	gro	3	mxf, egf, da	ls	1250	1400	my-jn		ja-dc	flowers
Trema orientalis (L.) Bl.	Ulmaceae	t	pe	gro	3	da, sg	gr,ls	500	1200	oc	dc	ja-dc	flowers♂
Trevesia palmata (DC.) Vis.	Araliaceae	l	pe	gro	3	mxf, egf	gr, ls	550	1500	fb-mr		ja-dc	
Trichosanthes kerrii Craib	Cucurbitaceae	v	a	gro	2	cliffs in bb/df, mxf	ls	1200	1350	my-oc	my-jn	ap-dc	flowers♂, fruits
Trichosanthes ovigera Bl.	Cucurbitaceae	v	a	gro	3	da,sg	gr	1000	1500	sp-nv		my-dc	flowers♂
Trichosanthes pubera Bl.spp.*rubriflos* (Thor.*ex* Cay.) Duy. & Prue. var. *rubriflos*	Cucurbitaceae	v	a	gro	3	bb/df, egf, eg/bb, da	gr, ls	400	1525	jn-oc	sp-oc	my-dc	flowers, fruits
Trichotosia dasyphylla (Par. & Rchb. f.) Krzl.	Orchidaceae	h	pe	epi	3	eg/pine	gr	1200	1375			ja-dc	
Tridynamia spectabilis (Kurz) Stap.	Convolvulaceae	v	a	gro	3	mxf,da,sg	ls	450	600	fb-mr	mr-ap	jn-ap	flowers
Trigonostemon thyrsoideus Stapf	Euphorbiaceae	l	pe	gro	2	rocks in eg/bb, cliffs	ls	1250	1300	ap		ja-dc	flowers♀
Trisepalum prazeri Burtt	Gesneriaceae	s	pd	epl	3	rocks in mxf cliffs	ls	1400	1425	ag-oc	nv-dc	ja-dc	flowers, fruits
Tristaniopsis burmanica (Griff.) Wils. & Wat. var. *rufescens* (Hance) Parn. & Lug.	Myrtaceae	t,l	pe	gro	2	eg/pine	gr	1250	1300	ja-fb		ja-dc	flowers
Triumfetta annua L.	Tiliaceae	h	a	gro, wee	3	da	gr, ls	1000	1500	sp-nv	nv-dc	my-dc	flowers
Triumfetta pilosa Roth	Tiliaceae	h	a	gro	3	eg/bb, da	gr	1000	1525	sp-nv	ja-fb	ag-fb	fruits
Triumfetta rhomboidea L.	Tiliaceae	h	a	gro, wee	3	da, sg	gr,ls, sh,ss	500	900		nv-dc	my-dc	
Tupistra albiflora K. Lar.	Liliaceae	h	pe	gro	2	egf	ls	1300	1400	oc-nv		ja-dc	flowers
Turpinia pomifera (Roxb.) Wall. *ex* DC.	Staphyleaeaceae	t	pe	gro	3	egf	gr, ls	900	1500	fb-mr	jn-oc	ja-dc	flowers, fruits
Ulmus lancaefolia Roxb. *ex* Wall.	Ulmaceae	t	pe	gro	3	rocks in egf cliffs	ls	1250	1400	sp-oc		ja-dc	flowers
Uncaria macrophylla Wall.	Rubiaceae	wc	pe	gro	3	streams in egf, eg/bb	gr	900	1300	sp-oc	nv-ja	ja-dc	
Uraria poilanei Dy Phon	Leguminosae, Papilionoideae	s	pe	gro	2	egf,da,sg	gr	1050	1250	nv-dc		ja-dc	flowers
Urena lobata L. ssp. *lobata* var. *lobata*	Malvaceae	h	a	gro, wee	3	da, sg	gr,ls, sh,ss	500	1500	oc-dc	nv-fb	my-dc	

Urochloa ruziziensis (Germ. & Evr.) Morr. & Zul.	Gramineae	h	pe	gro, int, nat, wee	3	da, sg	gr	800	1200	oc-ja	nv-fb	ja-dc	flowers
Utricularia striatula Sm.	Lentibulariaceae	h	a	epl	2	rocks in eg/pine, egf cliffs	gr, ls	1500	1500	ag-sp	sp-oc	jn-oc	
Vaccinium sprengelii (D. Don) Sleum.	Ericaceae	t, l	pe	gro	3	eg/pine	gr	1200	1450	ja-fb		ja-dc	flowers
Verbena officinalis L.	Verbenaceae	h	a	gro,wee	3	da, sg	gr	1100	1300	jn-fb	jl-mr	my-mr	flowers, fruits
Vernonia attenuata DC.	Compositae	l	pd	gro, epl	3	rocks in eg/bb, mxf cliffs	ls	1250	1425	oc-nv	nv-dc	my-dc	flowers
Vernonia cinerea (L.) Less. var. *cinerea*	Compositae	h	a	gro, wee	3	da, sg	gr,ls, sh,ss	800	1500	nv-ja	dc-fb	my-fb	
Vernonia divergens (DC.) Edgew.	Compositae	h	pd	gro	3	egf eg/pine da sg	gr,ls	1200	1500	nv-dc	ja-fb	my-fb	flowers, fruits
Vernonia parishill Hk.f.	Compositae	l	pe	gro	3	egf		1100	1500	mr-ap	ap-my	ja-dc	fruits
Vernonia sutepensis Craib	Compositae	h	pe	gro	3	eg/bb	gr	1000	1500	ja-fb	fb-mr	ja-dc	flowers
Vibunum odoratissimum Ker	Caprifoliaceae	sc	pe	gro	3	rocks in mxf cliffs	ls	1375	1425	dc-ja		ja-dc	flowers
Viburnum garrettii Craib	Caprifoliaceae	s,l	pe	gro	2	streams in egf, eg/bb	gr	1000	1100	jn-jl	oc	ja-dc	fruits
Vigna radiata (L.) Wilcz. var. *sublobata* (Roxb.) Verdc.	Leguminosae, Papilionoideae	v	a	gro	3	egf,da	gr	900	1100	oc-nv		my-dc	flowers
Vitex canescens Kurz	Verbenaceae	t	pd	gro	3	bb/df	gr	400	1100			my-dc	
Vitex peduncularis Wall. *ex* Schauer	Verbenaceae	t	pd	gro	3	bb/df,egf	gr	800	1100	ap-my		mr-nv	flowers
Vitex quinata (Lour.) Will. var. *puberula* (Lam) Mold.	Verbenaceae	t	pe	gro	3	mxf,egf	gr, ls	600	1500	ap	sp	ja-dc	flowers, fruits
Wallichia siamensis Becc.	Palmae	l	pe	gro	3	egf	gr,ls	1200	1375	sp-oc		ja-dc	flowers
Wendlandia ternifolia Cow.	Rubiaceae	l	pe	epl	2	rocks in egf, cliffs	ls	1200	1400	dc-fb	fb	ja-dc	flowers, fruits
Wendlandia tinctoria (Roxb.) DC. ssp. *orientalis* (Craib) Cow.	Rubiaceae	t,l	pe	gro	3	egf,eg/pine, sg	gr	1000	1500	ja-fb		ja-dc	flowers, fruits
Xanthophyllum virens Roxb.	Polygalaceae	t	pe	gro	2	egf, eg/bb	gr	1100	1200	mr-ap	ja-ag	ja-dc	
Xyris lobbii Rend.	Xyridaceae	h	pd	gro	2	eg/pine	gr	1250	1325	sp-oc	nv-dc	my-dc	flowers
Youngia japonica (L.) DC.	Compositae	h	a	gro, wee	3	eg/bb, da, eg/pine	gr,ls	500	1500	ag-dc	sp-ja	my-dc	flowers
Zanthoxylum oxyphyllum Edgew.	Rutaceae	wc	pe	gro	3	egf	ls	1200	1350	ja		ja-dc	
Zehneria bodinieri (Lev.) Wilde & Duy.	Cucurbitaceae	v	a	gro	3	egf,da	gr, ls	900	1500	oc-nv	nv-dc	my-dc	flowers♂♀, fruits
Zehneria tenuispica Wilde & Duy.	Cucurbitaceae	v	a	gro	3	da, rocks and cliffs mxf, egf	gr, ls	1000	1425	sp-nv	nv-dc	my-dc	flowers♂♀, fruits
Zingiber aff. *integrum* Tong	Zingiberaceae	h	pd	gro	3	mxf, da	ls	1300	1375	ag-sp	oc-nv	my-dc	flowers, imm. fruits

Zingiber bradleyanum Craib	Zingiberaceae	h	pe	gro	3	streams in egf, eg/bb	gr	1100	1300		nv	ja-dc	
Zingiber kerrii Craib	Zingiberaceae	h	pd	gro	2	bb/df, eg/bb	gr	1000	1300	jl-ag	oc-nv	my-dc	
Zingiber smilesianum Craib	Zingiberaceae	h	pd	gro	3	egf	gr,ls	1000	1400	jl-ag	oc-nv	my-dc	fruits
Ziziphus incurva Roxb.	Rhamnaceae	t	pe	gro	3	egf	ls	1200	1400	my-sp	oc-nv	ja-dc	
Ziziphus ?attopensis Pierre	Rhamnaceae	wc	pe	gro	3	mxf, eg/bb	gr	500	700			ja-dc	
Ziziphus oenoplia (L.) Mill. var. *oenophia*	Rhamnaceae	wc	pd	gro	3	eg/bb, da, sg	gr	600	1150	mr-ap	oc-nv	my-fb	
?	Orchidaceae	h	pd	epl	2	rocks in egf cliffs	ls	1300	1400		oc-nv	jn-nv	fruits

Table 2. List of plant species under phylum gymnospermae surveyed at Doi Tung, Chiang Rai Province.

Species	Family	Habit	Aped	Life mode	Abundance	Habitat	Bedrock	Lower	Upper	Flowering	Fruiting	Leafing	Collected
								Elevation (m)		Months			
Cephalotaxus griffithii Hk. f.	Cephalotaxaceae	t	pe	gro	2	egf	ls	1375	1400		jl-dc	ja-dc	fruits
Pinus kesiya Roy. *ex* Gord.	Pinaceae	t	pe	gro also cul	2	eg/pine	gr	1200	1500	fb-mr		ja-dc	

Table 3. List of plant species under phylum pteridophyta surveyed at Doi Tung, Chiang Rai Province.

Species	Family	Habit	Aped	Life mode	Abun-dance	Habitat	Bedrock	Lower	Upper	Flowering	Fruiting	Leafing	Collected
								Elevation (m)		Months			
Adiantum philippense L.	Parkeriaceae	h	pd	gro, epl	3	mxf, egf, eg/bb	gr, ls	500	1250	sp-dc	sp-dc	my-dc	sori
Adiantum zollingeri Mett. *ex* Kuhn	Parkeriaceae	h	pd	epl	3	rocks in bb/df, mxf, eg/bb cliffs	gr, ls	500	1500	ag-oc	ag-oc	my-dc	sori
Aglaomorpha coronans (Wall. ex Mett.) Copel.	Polypodiaceae	h	pe	epi	2	eg/bb	ls	1100	1325			ja-dc	
Angiopteris evecta (Forst.) Hoffm.	Marattiaceae	h	pe	gro	3	streams in egf,eg/bb	gr	1100	1400	ja-dc	ja-dc	ja-dc	sori
Aniscocampium cumingianum Presl	Athyriaceae	h	pd	gro	3	bb/df, eg/bb	gr, ls	550	1100	sp-nv	sp-nv		sori
Araiostegia imbricata Ching	Davalliaceae	h	pd	epi	3	rocks in mxf, eg/bb cliffs	ls	1300	1425	jl-sp	jl-sp	my-dc	sori
Asplenium cheilosorum Kunze *ex* Mett.	Aspleniaceae	h	pe	epl	3	rocks and streams in egf	gr	1100	1325	nv-fb	nv-fb	ja-dc	sori

Asplenium greviellei Wall. *ex* Hk. & Grev.	Aspleniaceae	h	pe	epl	3	rocks in eg/bb, mxf,cliffs	ls	1300	1400	sp-nv	sp-nv	ja-dc	sori
Asplenium interjectum Christ	Aspleniaceae	h	pd	gro	3	rocks in egf,eg/bb cliffs	ls	1300	1425	jl-sp	jl-sp	my-dc	sori
Asplenium obscurum Bl.	Aspleniaceae	h	pe	epl	2	streams in eg/bb	gr	1050	1200	ja-dc	ja-dc	ja-dc	
Athyrium anisopterum Christ	Athyriaceae	h	pd	gro	3	bb/df, eg/bb	gr	1000	1400	jl-sp		my-dc	sori
Blechnum orientale L.	Blechnaceae	h	pe	gro	3	streams in egf, wet areas in eg/bb	gr	500	1500	jn-nv	jn-nv	ja-dc	sori
Blechnum orientale L.	Dryopteridaceae	h	pe	gro	3	streams in egf	gr, ls	1100	1300	dc-fb	dc-fb	ja-dc	sori
Bolbitis sinensis (Bak.) K. Iw. var. *sinensis*	Lomariopsidaceae	h	pe	epl	3	streams, wet areas in egf	gr, ls	900	1350	nv-ja	nv-ja	ja-dc	sori
Bolbitis virens (Wall. *ex* Hk. & Grev.) Schott var. *virens*	Lomariopsidaceae	h	pe	epl	2	rocks, streams in egf	gr,ls	1000	1325			ja-dc	
Brainea insignis (Hk.) J. Sm.	Blechnaceae	h, l	pe	gro	3	egf, eg/pine	gr	1200	1450			ja-dc	sori
Brainea insignis (Hk.) J. Sm.	Dryopteridaceae	h	pe	gro	3	eg/bb,da	gr	1100	1400	nv-dc	nv-dc	ja-dc	sori
Cheilanthes fragilis Hk.	Parkeriaceae	h	pd	epl	3	rock in mxf, eg/bb cliffs	ls	1300	1425	jl-ag		my-dc	sori
Cheilanthes pseudoargentea (S.K.Wu) K. Iw.	Parkeriaceae	h	pd	gro	3	rocks in mxf, cliffs	ls	1375	1400	fb-ap	fb-ap	jn-ap	sori
Cibotium baromtez (L.) J. Sm.	Dicksoniaceae	h	pe	gro	3	egf, da	ls	1200	1500	sp-oc	sp-oc	ja-dc	sori
Davallia trichomanoides Bl. var. *lorranii* (Hance) Holtt.	Davalliaceae	h	pd	epi	3	egf	gr	1000	1300	jl-sp		my-dc	sori
Davallodes membranulosum (Wall. *ex* Hk.) Copel.	Davalliaceae	h	pd	epi, epl	3	rocks in bb/df, mxf, cliffs	ls	1300	1425	jl-sp	jl-sp	my-dc	sori
Dicranopteris curranii Copel.	Gleicheniaceae	h	pe	gro	3	da	gr	1200	1350	jl-sp		ja-dc	sori
Dicranopteris linearis (Burm. f.) Underw. var. *linearis*	Gleicheniaceae	h	pe	gro	3	da	gr	600	1525	jn-sp		ja-dc	sori
Diplazium esculentum (Retz.) Sw.	Athyriaceae	h	pe	gro	3	streams in bb/df, wet areas in eg/bb	gr	700	1150	ja-fb	ja-fb	ja-dc	sori
Diplazium muricatum (Mett.) v. A. v. Ros.	Athyriaceae	h	pe	gro	3	rocks in egf,eg/bb	ls	1125	1400	oc-nv	oc-nv	ja-dc	sori
Drymoglossum piloselloides (L.) Presl var. *piloselloides*	Polypodiaceae	h, cr	pe	epi, epl	3	rocks in mxf, egf	ls	1100	1400	ag-oc	ag-oc	ja-dc	sori
Drynaria propinqua (Wall. *ex* Mett.) J. Sm. *ex* Bedd.	Polypodiaceae	h	pd	epi	2	egf, eg/bb	gr, ls	1000	1500	jl-sp	jl-sp	my-ja	sori
Drynaria rigidula (Sw.) Bedd.	Polypodiaceae	h	pd	epi	3	eg/bb	gr	1000	1400	my-jl	my-jl	my-dc	sori
Dryopteris cochleata (D. Don) C. Chr.	Dryopteridaceae	h	pe	gro	3	eg/bb,da	gr	1100	1400	nv-dc	nv-dc	ja-dc	sori
Equisetum debile Roxb. *ex* Vauch.	Equisetaceae	h	pe	gro	2	wet areas in bb/df	gr, ls	400	800			ja-dc	
Hymenophyllum polyanthos (Sw.) Sw.	Hymenophyllaceae	h	pe	epi	2	egf	ls	1200	1375	sp-nv	sp-nv		sori
Lepisorus nudus (Hk.) Ching	Polypodiaceae	h	pe	epi	3	egf, eg/pine	gr, ls	1200	1525	ag-oc	ag-oc	ja-dc	sori
Leptochilus ellipticus (Thunb.) Noot.	Polypodiaceae	h	pe	gro	2	streams in egf, eg/bb	gr, ls	1100	1350	ag-oc	ag-oc	ja-dc	sori

Leucostegia immersa Presl	Davalliaceae	h	pd	epi, epl	3	rocks in mxf, eg/bb cliffs	gr, ls	1300	1425	jl-sp	jl-sp	my-dc	sori
Loxogramme involuta (D. Don) Presl	Polypodiaceae	h	pe	epi,epl	3	rocks in mxf cliffs	ls	1300	1425	sp-nv	sp-nv	ja-dc	sori
Lycopodium cernuum L.	Lycopodiaceae	h	pe	gro	3	egf,da,sg	gr	600	1300	ja-dc	ja-dc	ja-dc	strobili
Lygodium flexuosum (L.) Sw.	Schizaeaceae	v	pd	gro	3	eg/bb, da	gr	500	1500	sp-oc	sp-oc	my-dc	sori
Microlepia speluncae (L.) Moore	Dennstaedtiaceae	h	pe	gro	3	eg/bb, da	gr	1200	1500	ja-dc	ja-dc	ja-dc	sori
Microsorum zippelii (Bl.) Ching	Polypodiaceae	h	pd	epi, epl	3	rocks and streams in egf, mxf, eg/bb cliffs	gr,ls	1000	1425	sp-ja	sp-ja	jn-fb	sori
Oleandra undulata (Willd.) Ching	Oleandraceae	h	pd	gro	3	eg/pine, eg/bb	gr	1100	1400	ag-oc	ag-oc	my-dc	sori
Ophioglossum petiolatum Hk.	Ophioglosaceae	h	pd	gro, epi	2	egf, da	gr, ls	950	1375	jn-oc	jn-oc	my-dc	sori
Phymatosorus lucidus (Roxb.) P.S.	Polypodiaceae	h	pe	epl	3	rocks in mxf cliffs	ls	1200	1425	dc-ap	dc-ap	ja-dc	sori
Pityogramma calomelanos (L.) Link	Parkeriaceae	h	pe	gro	2	egf,da,sg	gr	1100	1200	oc-dc	oc-dc	ja-dc	sori
Platycerium wallichii Hk.	Polypodiaceae	h	pd	epi	2	dof, eg/bb	gr	500	1050	ag-oc	ag-oc	jn-dc	
Polypodium mamneiense H.Christ	Polypodiaceae	h	pd	epi, epl	3	egf	ls	1100	1400	jl-sp	jl-sp	jn-dc	sori
Polystichum lindsaefolium Scort. *ex* Ridl.	Dryopteridaceae	h	pe	epl	3	mxf, egf	ls	1300	1425	sp-nv	sp-nv	ja-dc	sori
Pteridium aquilinum (L.) Kuhn *ssp. aquilinum* var. *wightianum* (Ag.) Tyr.	Dennstaedtiaceae	h	pe	gro	4	da, sg	gr, ls	1000	1525			ja-dc	
Pteridrys cnemidaria (Christ) C. Chr. & Ching	Dryopteridaceae	h	pe	gro	2	streams in mxf	sh	500	700	nv-ja	nv-ja	ja-dc	sori
Pteris biaurita L.	Pteridaceae	h	pe	gro	3	mxf, da	gr, ls	500	1500	sp-oc	sp-oc	ja-dc	
Pteris longipes D. Don	Pteridaceae	h	pe	gro	2	streams in egf	gr, ls	1200	1350			ja-dc	
Pteris subquinata Wall. *ex* Ag.	Pteridaceae	h	pd	epl	3	rocks in egf cliffs	ls	1200	1400	sp-nv	sp-nv		sori
Pteris venusta O. K.	Pteridaceae	h	pe	gro	2	eg/bb, da	ls	1100	1350	ag-oc	ag-oc	ja-dc	
Pyrrosia lingua (Thunb.) Far. var. *heteractis* (Mett. *ex* Kuhn) Hoven.	Polypodiaceae	h	pe	gro, epl	3	rocks in mxf cliffs	ls	500	1425	sp-dc	sp-dc	ja-dc	sori
Pyrrosia porosa (Wall. *ex* Presl) Hoven. var. *tonkinensis* (Gies.) Hoven.	Polypodiaceae	h	pe	gro, epi, epl	3	rocks in mxf, egf cliffs	gr, ls	1200	1425	sp-dc	sp-dc	ja-dc	sori
Selaginella helferi Warb.	Selaginellaceae	v, h	a	gro	3	eg/bb, da	gr	500	1150	oc-fb	oc-fb	my-ja	sporangia
Selaginella involvens (Sw.) Spr.	Selaginellaceae	h	pd	epi,epl	3	rock in mxf, eg/bb	ls	1300	1425	jl-sp	jl-sp	my-dc	sporangia
Selaginella kurzii Bak.	Selaginellaceae	h	a	epl	3	rocks in bb/df cliffs	ls	400	800	sp-oc	sp-oc	jn-dc	sporangia
Selaginella minutifolia Spr.	Selaginellaceae	h	a	gro	3	eg/bb	ls	1100	1300	oc-nv	oc-nv	my-nv	sporangia
Selaginella roxburghii (Hk. & Grev.) Spr. var. *roxburghii*	Selaginellaceae	h	a	epl	3	rocks in mxf, egf, eg/bb cliffs	ls	1300	1400	sp-nv	sp-nv	my-dc	sporangia
Selaginella tenuifolia Spr.	Selaginellaceae	h	a	gro	3	egf, da	gr	900	1450	sp-nv	sp-nv	my-dc	sporangia
Sphenomeris chinensis (L.) Maxon var.*chinensis*	Lindsaeaceae	h	pe	gro	3	egf,da	gr	1100	1400	ja-dc	ja-dc	ja-dc	sori

Tectaria decurrens (Presl) Copel.	Dryopteridaceae	h	pe	gro	3	streams in egf	gr, ls	1100	1300	dc-fb	dc-fb	ja-dc	sori
Tectaria herpetocaulos Holtt.	Dryopteridaceae	h	pe	gro	3	egf, eg/bb	gr, ls	550	1375	sp-nv	sp-nv	ja-dc	sori
Thelypteris nudata (Roxb.) Mort. var. *nudata*	Thelypteridaceae	h	pe	gro	3	mostly streams, wet areas in eg/bb, egf	gr, ls	1100	1500	jl-oc	jl-oc	ja-dc	sori
Thelypteris parasitica (L.) Fosb.	Thelypteridaceae	h	pe	gro	3	egf,da,sg	gr	1100	1500	ja-dc	ja-dc	ja-dc	sori
Thelypteris subelata (Bak.) K. Iw.	Thelypteridaceae	h	pe	gro	3	egf,eg/bb	ls	1125	1400	sp-nv	sp-nv	ja-dc	sori
Thelypteris terminans (Hk.) Tag. & K. Iw.	Thelypteridaceae	h	pe	gro	3	eg/bb	gr,ls	800	1250	ag-dc	ag-dc	ja-dc	sori
Thelypteris truncate (Poir.) K. Iw.	Thelypteridaceae	h	pe	gro	2	streams in egf, eg/bb	gr	1000	1200	ja-dc	ja-dc	ja-dc	sori
Woodwardia japonica (L. f.) Sm.	Blechnaceae	h	pe	gro	2,3	eg/bb, egf	gr, ls	1100	1400	jl-dc	jl-dc	ja-dc	sori

Table 4. Lis of plant species under phylum bryophyta surveyed at Doi Tung, Chiang Rai Province.

Species	Family	Habit	Aped	Life mode	Abun-dance	Habitat	Bed rock	Lower	Upper	Flowering	Fruiting	Leafing	Collected
								Elevation (m)		Months			
Brachymenium	Bryaceae	h	pe	epl	3	rocks in eg/pine	gr	1450	1525	sp-oc	sp-oc	ja-dc	capsules
Brachymenium nepalense Hk.	Bryaceae	h	pe	epi	3	eg/pine	gr	1450	1525	sp-oc	sp-oc	ja-dc	capsules
Dumortiera hirsuta (Sw.) Nees	Marchantiaceae	h	pe	epl	3	rocks, streams in egf, eg/bb	gr	1100	1200	oc-nv	oc-nv	ja-dc	sporophyte
Entodon macropodus (Medw.) Mitt.	Entodontaceae	h	pe	epl	3	rocks in egf, mxf	ls	1300	1425	sp-oc	sp-oc	ja-dc	capsules
Entodon plicatus C. Muell.	Entodontaceae	h	pe	epi	3	rocks in egf, eb/bb	ls	1200	1400	sp-nv	sp-nv	ja-dc	capsules
Fissidens nobilis Griff.	Fissidentaceae	h	pe	epl	2	rocks, streams wet areas in egf	gr, ls	1200	1325			ja-dc	
Hyophila involuta (Hk.) Jaeg.	Pottiaceae	h	pe	epl	3	rocks in eg/pine	gr	1450	1525	sp-oc	sp-oc	ja-dc	capsules
Hypopterygium flavolimbatum Mull. & Hal.	Hypoterygiaceae	h	pe	epl	3	rocks in egf, cliffs	ls	1200	1400			ja-dc	
Leucobryum aduncum Dozy & Molk. var.*scalare* (C. Muell. *ex* Fleisch.) A. Eddy	Leucobryaceae	h	pe	epi	3	eg/bb	gr	1100	1400	jl-nv	jl-nv	ja-dc	capsules
Meteoriopsis squarrosa (Hk.) Fleish. var. *squarrosa*	Meteoriaceae	h	pe	epi, epl	4	rocks, cliffs	ls	1200	1425			ja-dc	
Papillaria semitorta (C. Muell.) Jaeg.	Meteoriaceae	h	pe	epi	4	rocks in mxf, cliffs	ls	1300	1425			ja-dc	
Phaeoceros laevis (L.) Prosk.	Anthocerotaceae	h	pe	gro	2	eg/bb	gr	1100	1500	sp-oc	sp-oc	ja-dc	sporophyte
Plagiomnium succulentum (Mitt.) Kop.	Mniaceae	h	pe	epl	3	rocks in mxf, egf, cliffs	ls	1200	1400			ja-dc	
Pogonatum neesii (C.Muell.) Dozy	Polytrichaceae	h	pe	gro	4	eg/bb	gr	1100	1400	oc-nv	oc-nv	ja-dc	capsules
Racopilum orthocarpum Wils. *ex*	Racopiliaceae	h	pe	epi	3	egf	gr, ls	1100	1400	my-ag	my-ag	ja-dc	capsules

Mitt.													
Rhodobryum giganteum (Schwaegr.) Par.	Bryaceae	h	pe	epl	3	rocks in eg/bb, cliffs	ls	1200	1425	ag-oc	ag-oc	ja-dc	
Rhytidium	Rhitidiaceae	h	pe	epi	3	eg/pine	gr	1450	1525	sp-oc	sp-oc	ja-dc	capsules
Stereophyllum	Plagiotheciaceae	h	pe	epi	3	egf, eg/pine	gr	900	1200	jl-sp	jl-sp	ja-dc	capsules
Thuidium orientale Mitt. *ex* Dix.	Thuidiaceae	h	pe	epi	3	mxf, egf, cliffs	ls	1200	1400			ja-dc	

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Full Paper

Estimation of number and density, and random distribution testing of important plant species in Ban Pong Forest, Sansai District, Chiang Mai Province, Thailand using T-Square sampling

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Abstract: A study by T-square sampling method was conducted to investigate important plant species in Ban Pong Forest, Sansai district, Chiang Mai province by estimation of their number and density, and testing of their random distribution. The result showed that, there were 14 kinds of important plant species, viz. *Dipterocarpus tuberculatus Roxb*., *Shorea obtuse Wall. exBlume, Bridelia retusa (L.) A. Juss*, *Derris scandens Benth., Thysostachys siamensis*, *Parinari anamense Hance, Vitex pinnata L.f., Canarium subulatum Guill.*, *Litsea glutinosa C.B.Roxb., Alphonsea glabrifolia Craib., Pueraria mirifica*, *Vatica stapfiana van Slooten, Walsura robusta Rox.* and *Dipterocarpus alatus Roxb.* By far, *Dipterocarpus tuberculatus Roxb* was greatest in number and density, and all of the species had random distribution, except *Walsura robusta Roxb* and *Dipterocarpus alatus Roxb*

Keywords: plant species, density, random distribution, and T-square sampling

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Introduction

Forests are an important part of nature. For one thing they are the main source of streams and rivers, the lifeblood of humanity. Their variety stems from the differences in climate and geographical area. Thailand has about 32% of its land covered with forests, in which the northern part is richest;

about 54% of its soil is forest area [1], of which a large part is in Chiang Mai, the biggest province of the country.

An important forest of Chiang Mai is Ban Pong Forest in Sansai District. Included in a conservation scheme in 1995, it has nourished and old settlement of ethnic Thai community nearby since 1858, or more than 140 years ago. Nowadays, the settlement has 178 homes and 789 people who depend mainly on agriculture for their livelihood. Ban Pong Forest is still rather virgin. It has a large spring and is the source of an important stream. Coupled with the varied environment-friendly agricultural activities of the Ban Pong settlement, it is potentially an important tourist attraction. Motivated by the importance of this forest, we are interested in studying its plant population, and this investigation is a result of our study, which concentrated on the kind, density, and distribution of the plant species in the forest [2].

Materials and Methods

In this work, the sampling for estimation of the number and density, and the random distribution testing of the studied plant species were performed using the T-square sampling method, whose principle is as follows [3,4].

T-square sampling method

T-square sampling method is one kind of distance-based methods for sampling points in space, which are sometimes called nearest neighbor methods. They are widely used in forestry, for example, to estimate the density of trees in a region. Various types of distances have been used in this context, such as distances from trees to their nearest neighbours or distances from random points to their nearest trees and then to the nearest neighbouring trees. Of course, all these types of distances can also be used for sampling other objects.

One approach to the estimation of the density of points requires the assumption that objects occur at random positions, and that the distances from *m* random points to their nearest objects have been measured as $X_1, X_2, X_3, \ldots, X_m$. This means that the area searched from the i*th* random point before an object was found in the area within a circle with radius X_i, i.e. $A_i = \pi X_i^2$. Hence, an unbiased estimate of the area in the population that is occupied by one object is

$$\overline{A} = \sum_{i=1}^{m} A_i \,/\, m = \frac{\pi \sum_{i=1}^{m} X_i^2}{m}$$

where the summations are over the *m* random points. It follows that an estimate of the density of objects per unit area is

$$\hat{D} = 1/\overline{A} = \frac{m}{\pi \sum_{i=1}^{m} X_i^2}.$$

It can be shown that $\hat{D}$ has the approximate standard error $SE(\hat{D}) = \sigma_A D^2 / \sqrt{m}$ where σ_A is the population standard deviation of A_i values. The standard error can therefore be estimated by $\hat{SE}(\hat{D}) = s_A \hat{D}^2 / \sqrt{m}$ where s_A is the sample standard deviation of A_i values.

For a regular pattern of objects the distance from random points to objects will tend to be smaller than with a random pattern, while the distances from each object to its nearest neighbour will tend to be larger than with a random pattern. The reverse is true with a clustered pattern, so that the distances from random points to their nearest objects will tend to be large and the distances between neighbouring objects will tend to be small. One useful way to obtain both point to object distances involves the use of T-square sampling. Here, the distance is measured from a random point to the nearest object, and then from that object to the nearest neighbour in the direction away from the initial point, as shown in Figure 1. Therefore, the area searched for the first object is omitted in the search for the second object. Hence, if objects are located at random then the search area for the first object and the search area for the second object will be independent random variables.

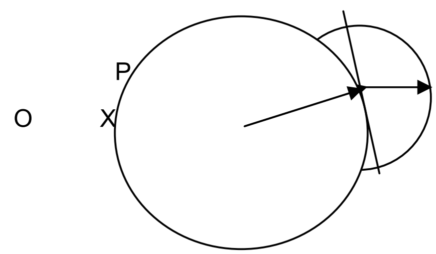

Figure 1. T-square sampling. The point O is randomly chosen, and the nearest object is found at P. The nearest neighbour to P is then found by searching only in the area above the T which is formed by the line OP and the line through P that is perpendicular to OP.

Suppose that a T-square sample of size *m* is taken (this study uses m=10), so that the distances X_1, $X_2, X_3,\ldots,X_m$ from m random points to the nearest objects are determined, and also the distances Y_1, $Y_2, Y_3,\ldots,Y_m$, from each of the m objects to their nearest neighbours in the directions away from the random points. The search area from the *i*th random point to the nearest object is then $A_{X_i} = \pi X_i^2$, so that an estimate of density based on the X distances is

$$\hat{D}_X = \frac{m}{\sum_{i=1}^{m} A_{X_i}}$$

On the other hand, the half-circle search area from the *i*th object to its nearest $A_{Y_i} = \frac{1}{2}\pi Y_i^2$, so that an estimate of density based on the Y distances is

$$\hat{D}_Y = \frac{m}{\sum_{i=1}^{m} A_{Y_i}} .$$

A combined estimate of density that may be somewhat robust to a non-random pattern is then $\hat{D}_p = \sqrt{(\hat{D}_X \hat{D}_Y)}$. The standard errors of $\hat{D}_p$ can be estimated by

$$\hat{SE}(\hat{D}_p) = \frac{\sqrt{\hat{SE}(\hat{D}_X)^2 + \hat{SE}(\hat{D}_Y)^2}}{(2\hat{D}_p)} .$$

A test for randomness can be carried out using the same data since for randomly located objects, the statistic U is

$$U = \frac{\sum_{i=1}^{m} \frac{A_{X_i}}{A_{X_i} + A_{Y_i}}}{m} .$$

The U statistic has an approximately normal distribution with mean = ½ and standard error SE(U) = $\frac{1}{\sqrt{12m}}$. Hence the statistic

$$Z_U = \frac{U - \frac{1}{2}}{\sqrt{\frac{1}{12m}}}$$

will approximately have a standard normal distribution. Significantly low values of Z_U indicate regularity in the point pattern, non-significant values indicate randomness, and significantly large values indicate clustering.

Results

The results revealed that there were 14 important plant species of Ban Pong forest, viz. (from the most to the least abundant) *Dipterocarpus tuberculatus Roxb.(1), Shorea obtuse Wall. exBlume(2), Bridelia retusa (L.) A. Juss(3)*, *Derris scandens Benth.(4), Thysostachys siamensis(5)*, *Parinari anamense Hance(6), Vitex pinnata L.f.(7), Canarium subulatum Guill.(8)*, *Litsea glutinosa C.B.Roxb.(9), Alphonsea glabrifolia Craib.(10), Pueraria mirifica(11), Vatica stapfiana van Slooten(12), Walsura robusta Rox.(13)* and *Dipterocarpus alatus Roxb.(14).* The results of the estimation of the number and density, and those of the random testing are shown in Tables 1 and 2.

Table 1 shows that of all 14 kinds of plant species, *Dipterocarpus tuberculatus Roxb* was the highest in number and density, i.e. about 1.08 millions and *Dipterocarpus alatus Roxb.* was the lowest, i.e. about 79.6 thousands.

From Table 2, it was found that of the 14 plant species studied, 12 gave no statistical significance for the randomness test, thus indicating random distribution. These were *Dipterocarpus tuberculatus Roxb*., *Shorea obtuse Wall. exBlume, Bridelia retusa (L.) A. Juss*, *Derris scandens Benth., Thysostachys siamensis*, *Parinari anamense Hance, Vitex pinnata L.f., Canarium subulatum Guill.*, *Litsea glutinosa C.B.Roxb., Alphonsea glabrifolia Craib., Pueraria mirifica*, and *Vatica stapfiana van Slooten*. Only 2 plant species, *Walsura robusta Rox.* and *Dipterocarpus alatus Roxb.*, showed statistical significance for the randomness test implicating non-random distribution.

Table 1. Number and density estimation of plant species

Plant species (descending order)	Average in number (per 100 m^2) $\hat{D}_p$	Interval estimation of number at 95%(per 100 m^2) $\hat{D}_p \pm Z_{\alpha/2} \hat{SE}(\hat{D}_p)$	Interval estimation of number at 95% of Ban Pong forest (9.7152 km^2)
1	11.14	11.14 ± 1.86	1,082,273.28±180,702.72
2	8.63	8.63 ± 1.23	838,421.76±119,496.96
3	5.28	5.28 ± 1.71	512,962.56±166,129.92
4	4.00	4.00 ± 1.33	388,608.00±129,212.16
5	3.01	3.01 ± 1.27	292,427.52±123,383.04
6	2.80	2.80 ± 0.96	272,025.60±93,265.92
7	2.75	2.75 ± 1.45	267,168.00±141,744.76
8	2.70	2.70 ± 1.64	262,310.40±159,329.28
9	2.69	2.69 ± 0.42	261,338.88±40,803.84
10	2.49	2.49 ± 0.56	241,908.48±54,405.12
11	2.22	2.22 ± 0.54	215,677.44±52,462.08
12	1.63	1.63 ± 0.32	158,357.76±31,088.64
13	1.48	1.48 ± 0.38	143,784.96±36,917.76
14	0.82	0.82 ± 0.19	79,664.64±18,458.88

Table 2. Test for randomness of plant species

Plant species (descending order)	U	Z_U
1	1.003	0.551 ns
2	1.477	1.070 ns
3	1.475	1.069 ns
4	1.831	1.458 ns
5	1.564	1.165 ns
6	1.431	1.020 ns
7	1.679	1.292 ns
8	1.134	0.695 ns
9	1.969	1.609 ns
10	1.307	0.884 ns
11	2.231	1.897 ns
12	1.269	0.842 ns
13	2.410	2.093 *
14	2.873	2.600 *

note : ns = no statistical significance at alpha = .05
* = statistical significance at alpha = .05

Discussion and Conclusion

Our conducted survey indicated that there were 14 important plant species in Ban Pong Forest, viz. *Dipterocarpus tuberculatus Roxb., Shorea obtuse Wall. exBlume, Bridelia retusa (L.) A. Juss, Derris scandens Benth., Thysostachys siamensis, Parinari anamense Hance, Vitex pinnata L.f., Canarium subulatum Guill., Litsea glutinosa C.B.Roxb., Alphonsea glabrifolia Craib., Pueraria mirifica, Vatica stapfiana van Slooten., Walsura robusta Rox*., and *Dipterocarpus alatus Roxb.* Among these, Dipterocarpus tuberculatus Roxb. was found to be highest in number and density. The reasons may stem from the fact that this plant can grow in poor soil and that its wood is less useful for timber than other woods, hence less chance of being cut down. On the other hand, *Dipterocarpus alatus Roxb.* was lowest in density, which is most probably due to the fact that the plant is slow-growing, slowly propagating and is frequently cut for its useful timber. As to the random distribution testing result, this shows that most plant species had random distribution in Ban Pong Forest. Considering its general uniformity in soil type, moisture, and inclination, this finding is not surprising. The exception which is found in Walsura robusta Rox. and *Dipterocarpus alatus Roxb.* is most likely due to the rarity of these 2 plant species, thus making their propagation rather limited to the vicinity of the parent plants.

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Photos of Studied plants

Litsea glutinosa C.B.Roxb.

Parinari anamense Hance

Vitex pinnata L.f.

Pueraria mirifica

Canarium subulatum Guill.

Dipterocarpus tuberculatus Roxb.

Walsura robusta Roxb.

Bridelia retusa (L.) A. Jus

Dipterocarpus alatus Roxb.

Shorea obtuse wall exBlume

Thysostachys Siamensis

Derris scandens ROXB. Benth.

Vatica stapfiana van Slooten

Alphonsea glabrifolia Craib.

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Full Paper

Seed production and dispersal of four Lauraceae species in a tropical lower montane forest, Northern Thailand

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Abstract: Seed production and dispersal of two pioneer species (*Litsea cubeba* and *Lindera metcalfiana*) and two shade-tolerant species (*Cinnamomum soegengii* and *Cryptocarya densiflora*) of Lauraceae were studied at a tropical lower montane forest in Doi Inthanon National Park, northern Thailand. Mature seed fall was monitored weekly to monthly using seed traps or belt transects for 1-3 trees per species. During the two-year study period (1998-2000), we observed only one fruiting episode for each of ten sample trees. Fruiting period was synchronized within each species, while there was no overlap in fruiting among the species. The seed fall periods were relatively short in *Litsea cubeba* (16-54 days), *Lindera metcalfiana* (25-65 days) and *Cinnamomum soegengii* (69 days), while quite long in *Cryptocarya densiflora* (159-187 days). The seed dispersal distance was short for all the species (less than 12 m), and the density of seed dispersal had a mode at 0-2 m from mother tree. The total seed production of each tree was estimated by a Weibull seed dispersal model as 93-6029, 985-3977, 1035-8910 and 6331 for *Lindera metcalfiana*, *Litsea cubeba*, *Cryptocarya densiflora* and *Cinnamomum soegengii*, respectively. Total fruit dry weight of each tree was estimated to be comparable to the leaf dry weight for the shade-tolerant species, while less than 3% of the leaf dry weight for the pioneer species. The studied method should be applied for other species in order to gain more ecological knowledge to maintain the montane forest.

Key words: Doi Inthanon National Park, Lauraceae, seed dispersal, seed production, tropical montane forest

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Introduction

Lauraceae is an important family in many tropical montane forests. For example, Lauraceae occupied 14% (1st in rank) and 15% (2nd after Fagaceae) of all trees more than 1 cm dbh in individual number and basal area, respectively, at a 15-ha plot established in a montane forest in Thailand (Kanzaki *et al.* 2004) [1]. In addition, Luaracea is the most species rich family in the same plot, including 25 species [1].

This study is a part of ecological studies on Lauraceae trees in an Asian tropical montane forest [2,3]. In this paper, seed production and dispersal of Lauraceae species will be described. Studies of seed production and dispersal have substantial consequences for forest conservation because the production and dispersal of seeds are important stages in the life-cycle of many plants [4].

On any given plant, seed production may be limited by various factors such as the amount of nutrients and photosynthate available for allocation to fruits and seeds, the presence of pre-dispersal predators and diseases [5], and annual variation in climate [6,7]. It is well known that Asian tropical rain forests flower and fruit at irregular super-annual intervals [8]. However, the phenology of flowering and fruiting are uncertain for tropical montane forests in Asia.

Successful regeneration of plants depends largely on the dispersal of their seeds into the good locations that provide the optimum capability for seed germination and seedling survival. The distance and location of dispersal could have significant impact on the seed germination [9]. Attaining suitable sites for germination is considered to be a crucial factor affecting seedling establishment and hence the regeneration and maintenance of plant species population [10]. Recruitment of a species at a certain site within a forest is often limited merely by lack of seed input due to the limited seed dispersal, which is called 'dispersal limitation' [11,12]. Not surprisingly, recruitment of trees with short dispersal is also limited in the disturbed forests where no seed source trees remain within and around the focal forests.

There have been a considerable number of field studies on the phenology and seed dispersal of Lauraceae species in the neotropics [7,13-17], but none, to our knowledge, have been conducted in Asia. More specifically, no research has been carried out on the seed production and dispersal of tropical montane forest trees in Thailand. Therefore, the purpose of this study was to clarify the phenology of seed fall, seed dispersal and total seed production of Lauraceae species in a montane forest in order to gather more knowledge for the ecological characters and their conservation of montane forests in Thailand.

Material and Methods

Study site

All studies were carried out in the tropical lower montane forest at Doi Inthanon National Park (18° 24′ N to 18° 40′ N latitude, and 98° 24′ E to 98° 42′ E longitude), Chiang Mai Province, Northern Thailand. The national park is characterized by the hilly and mountainous terrain (*ca*. 400-2,565 m a.s.l.), and approximately 40 % of the area is covered with montane forest [18]. The average annual rainfall is 2,279 mm (1982-1999), measured at a radar base of the Royal Thai Air Force on the summit of Doi Inthanon (2,565 m a.s.l.). Three distinct seasons are recognizable: a rainy season from June to October, a cool and dry season from November to February, and a hot and dry season from March to May.

A 15-ha Forest Dynamics Plot was established in a lower montane forest located about 7 km south of the summit of Doi Inthanon at an altitude of *ca.* 1700 m. All trees more than 1 cm diameter at breast height (dbh) in the plot were tagged, mapped, identified into species, and their dbhs measured [1,19].

Studied species

The two pioneer and two climax species of Lauraceae were selected, which flowered in the studied forest during the two-year study period (1998-2000): (1) *Lindera metcalfiana* Allen, (2) *Litsea cubeba* Pers., (3) *Cryptocarya densiflora* Bl. and (4) *Cinnamomum soegengii* Kostermans. The former two are pioneer, and the latter were climax species. The description of these selected species will refer only the genus name hereafter.

Lindera is a large evergreen tree, which reaches to 31 m height in the studied plot, though most species of the genus *Lindera* are shrubs or small to medium sized trees. This species seems to be a pioneer in lower montane forests in northern Thailand, occurring on the disturbed sites. *Litsea* is a small to moderate sized evergreen tree, growing to *ca*. 15-20 m tall; the maximum height in the plot was 16 m. *Litsea* is also a pioneer species which often forms monospecific patches in the disturbed sites. In Nepal, this species is found mainly between 1500 and 2400 m in altitude [20]. *Cryptocarya* and *Cinnamomum* are both large, evergreen trees with the maximum heights of 31 m and 38 m in the studied plot, respectively. *Cryptocarya* has the largest total basal area (2.2 m^2/ha) in the 15-ha studied plot. *Cryptocarya* shows a peculiar characteristic of vigorous forking of the stems.

The fruits of all the species are one-seeded berries, which seem to be dispersed by vertebrates including birds, and they have no special characteristic for wind dispersal. The sizes and weights of fruits and seeds of each species are shown in Table 1. The fruits and seeds of *Lindera* and *Litsea* are smaller than those of *Cryptocarya* and *Cinnamomum* (Table 1). The seeds of *Lindera* and *Litsea* are dormant at the time of dispersal and require a period of burial in the soil for their germination [3]. In contrast, the seeds of *Cryptocarya* and *Cinnamomum* have no dormancy character and germinate promptly after falling [2].

Table 1. Size and weight of a fruit and seed (Mean±SD) of the four Lauraceae species studied.

Species	Fruit					Seed				
	width (mm)	length (mm)	fresh weight (g)	dry weight (g)	*n*	width (mm)	length (mm)	fresh weight (g)	dry weight (g)	*n*
Lindera metcalfiana	7.2 ± 0.36	6.4 ± 0.35	0.176	0.060	50	5.9 ± 0.21	5.0 ± 0.15	0.108	0.046	20
Litsea cubeba	6.7 ± 0.22	7.7 ± 0.32	0.194	0.046	50	5.1 ± 0.12	5.5 ± 0.17	0.080	0.027	20
Cryptocarya densiflora	20.7 ± 2.15	19.6 ± 1.92	4.890	2.470	170	17.6 ± 1.62	17.5 ± 1.58	2.622	1.085	50
Cinnamomum soegengii	16.7 ±1.25	24.4 ± 2.37	5.850	2.540	212	14.5 ± 0.59	22.1 ± 0.98	2.890	1.760	71

n: sample size

Seed fall study

Three isolated fruiting trees of each species, except for *Cinnamomum* ($n = 1$), were selected in the studied forest. For each sample tree, diameter at breast height (DBH) was measured with diameter tape, and height (H) was estimated from the DBH using the following equation, which is obtained from DBHs and heights of sample trees in the 15-ha plot including various species.

$$\frac{1}{H} = \frac{1}{1.42DBH} + \frac{1}{51.72}. \qquad (1)$$

Two belt transects were established from the base of each sample tree of *Cryptocarya* and *Cinnamomum*. The directions of the two transects of each sample tree were selected to keep them straight and to minimize the slope inclination along the transects. The 1-m-width transects were used for *Cryoptocarya* and the 2-m-width transects for *Cinnamomum* because the density of fallen seeds was lower for *Cinnamomum*. The lengths of the transects varied depending on the dispersal ranges of the sample trees. The transects were terminated when no seeds were found on the ground further from the sample trees. The transects were divided into 1 m x 1 m quadrats for two sample trees of *Cryptocarya*, 1 m x 1.5 m for the other tree of *Cryptocarya*, and 2 m × 2 m for the sample tree of *Cinnamomum*. All mature seeds falling in each quadrat were checked and labeled by numbered flags. Observations were made at irregular intervals of one week to one month during the periods January-September 1999 for *Cryptocarya* and June 1998 - February 1999 for *Cinnamomum*, which included the seed dispersal periods of all sample trees.

Seed traps were used to monitor seed production and dispersal of *Lindera* and *Litsea* because their seeds were too small to observe on the ground. Seed traps of various sizes (0.5 m x 1 m - 1.5 m x 1.5 m) depending on the seed rain density of the sample trees were established continuously from the base of each sample tree. The seed traps were set in two directions until no dispersed seeds were found on the forest floor for each tree (7-9 m) in the same way as for belt transects. Mature seeds in each seed trap were collected and the seed number was counted at irregular intervals of two weeks to one month during the period May 1999 to February 2000, which included the seed dispersal periods of all sample trees.

Analysis of seed fall phenology

Pheonological patterns of seed fall were analyzed assuming that the probability of seed fall dates followed the Weibull distribution for each sample tree. Then, the cumulative number of fallen seeds at a date d is given by the equation,

$$F(d) = N\left\{1 - \exp\left[-\left(\frac{d-\xi}{a}\right)^m\right]\right\}, \tag{2}$$

where N is the total number of fallen seeds in the transect/traps during the study period, a is a scaling parameter, m is the shape parameter and ξ is the first date of mature seed fall. The value of ξ for each tree was determined as one day before the date when the first mature seed fall was observed under the canopy of the tree. For some sample trees, the first seed-fall dates pre-dated the establishment of the transects or traps. The coefficients of the Weibull distribution were estimated by non-linear regression with DeltaGraph ver. 4.0J (SPSS Inc, USA). In order to compare the lengths of seed fall periods, the period during which 90% of the total seeds (excluding the earliest 5% and the latest 5%) fell to the ground was estimated for each sample tree using equation (2). The period in days is given by d_1 - d_2, where

$$\begin{cases} F(d_1) = 0.95N \\ F(d_2) = 0.05N \end{cases}$$

of equation (2).

Analysis of seed dispersal

The seed dispersal of each sample tree was analyzed using the Weibull distribution seed dispersal model [21]. We assumed that seed density at x meters from the center of the canopy [$\rho(x)$ (seed m^{-2})] follows the Weibull distribution expressed by the equation,

$$\rho(x) = N\frac{m}{a^m}x^{m-1}\exp\left[-\left(\frac{x}{a}\right)^m\right] \quad , \tag{2}$$

where N is the total number of seeds in the 1-m-wide transect (x = 0 to infinity), a is the scaling parameter, and m is the shape parameter. The center of the canopy was chosen so that the seed dispersal curves would be symmetrical in both directions of the transects. Therefore, the center of the canopy was not necessarily identical to the base of the sample tree. The values of the coefficients were estimated by non-linear regression using SYSTAT ver. 5 (SPSS Inc, USA). Then, the total number of dispersed seeds or the total seed production (N*) was estimated by the equation,

$$N^* = 2\pi\int_0^\infty x\rho(x)dx = 2\pi NE(x)\,, \tag{3}$$

where $E(x)$ is the mean value of the Weibull distribution. $E(x)$ is expressed by the equation,

$$E(x) = a\Gamma\left(\frac{1}{m}+1\right), \tag{4}$$

where Γ (-) is the gamma function. The values of $E(x)$ were also used to compare the seed dispersal ability among sample trees.

Results and Discussion

Phenology of seed fall

During the two-year study period, only one episode of fruiting was observed for each sample tree (Fig. 1). This result, as well as additional field observations on fruiting in the study site [22], suggests that individual trees of many Lauraceae species would not produce seeds every year at the studied forest. It is also suggested that different species may fruit at different times or different years because no overlap in seed fall was observed among the four studied species, though seed fall periods were synchronized within each species (Fig. 1).

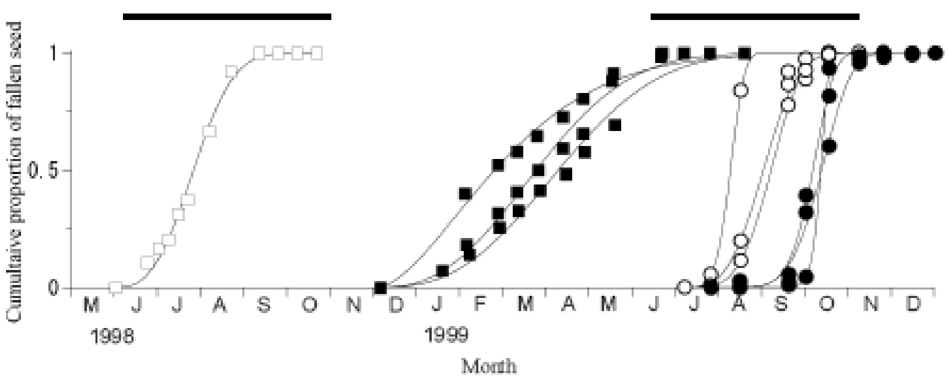

Fig. 1. Time courses of mature seed fall of four Lauraceae species. Changes in cumulative proportion of the seed fall are plotted for each sample tree. Open squares: *Cinnamomum soegengii*, closed squares: *Cryptocarya densiflora*, open circles: *Lindera metcalfiana*, closed circles: *Litsea cubeba*. The curves estimated by the Weibull distribution models (see Table 2) are also shown for each tree (see text for the details of the model). The solid bars stand for the rainy seasons.

At a Costa Rican tropical montane forest, similar fruiting phenology of Lauraceae was reported [7]: few individual trees of 22 Lauraceae species fruited every year during a 7-year study, and fruiting years of individuals were not completely synchronized even among the same species [7]. Although fruiting periods of conspecific individuals were synchronized in our study, this may possibly be because we selected only fruiting trees during the study period. We do not know whether these individuals will fruit synchronously again in the next fruiting time. Wheelwright [7] reported that fruiting of Lauraceae as a whole showed three mast years followed by 1-2 poor fruiting years during the 7-year period. It is not clear whether the Lauraceae of our studied forest also have mast years at the community level because the period of our observations had been too short so far. Long-term observations are definitely required to know the fruiting intervals of each individuals and species. We are continuing the phenoloical observations of flowering and fruiting of Lauraceae species in the studied forest.

The duration of mature seed fall differed among the studied species (Table 2). The periods during which 90% of the seeds fell were relatively short for *Litsea* (16-54 dyas), *Lindera* (26-61 days) and *Cinnamomum* (69 days), while very long for *Cryptocarya* (159-187 days). The estimated seed fall date probability by the Weibull distribution model (Fig. 2) clearly showed that *Lindera*, *Litsea* and *Cinnamomum* showed a clear peak in seed fall rate, while *Cryptocarya* fell seeds constantly during the six-month seed fall period.

Table 2. Estimated coefficients of the Weibull distribution of seed fall date for *Lindera metcalfiana* (LNM), *Litsea cubeba*, *Cryptocarya densiflora* (CRD), and *Cinnamomum soegengii* (CIS). a: the scaling parameter, m: the shape parameter of the Weibull distribution. Zero stands for the starting date of mature seed fall. Seed fall period is the period during which 90% of the total seed fell.

Mother tree	Zero date	*a*	*m*	Seed fall period (days)
LNM1	02-Jul-99	61.9	3.34	60.5
LNM2	02-Jul-99	35.2	4.69	25.8
LNM3	02-Jul-99	66.5	4.08	54.9
LTC1	20-Jul-99	75.9	6.60	41.2
LTC2	09-Aug-99	73.5	4.66	54.2
LTC3	20-Jul-99	78.7	18.88	16.2
CRD1	01-Dec-98	143.6	2.64	171.0
CRD2	01-Dec-98	127.0	2.49	158.8
CRD3	01-Dec-98	101.7	1.59	187.1
CIS	01-Jun-98	62.8	2.90	69.1

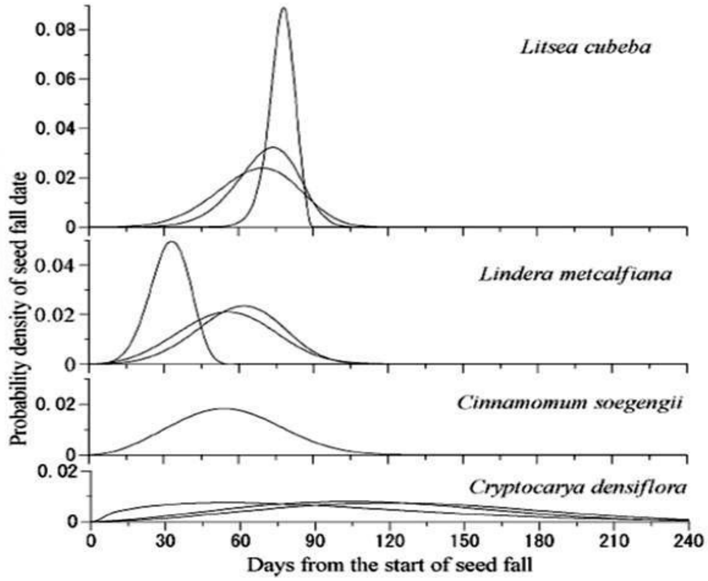

Fig. 2. Simulated probability densities of fruit fall dates for ten sample trees of four Lauraceae species by the Weibull distribution models (see text for the model). Actual dates of the start of seed fall varied among the trees (see Table 2 for the model coefficients for each tree).

The season of seed fall was also unique for *Cryptocarya* in that it fell seeds from the midst of the dry season until the beginning of the rainy season (Fig. 1). The other three species fell seeds at the midst of the rainy season (Fig. 1). The typical seed fall season was the rainy period in Costa Rican Lauraceae [7]. Lauraceae species which disperse fruits in the dry season as *Cryptocarya* are generally rare [7].

The unique phenology in fruit fall in *Cryptocarya*, viz the long and constant seed fall starting from the dry season, is worth studying further. Although the reason of this unique phenology is unclear, it might be related to the seed dispersal mechanisms of this species. While seeds of the other three species are dispersed mainly by birds, the seeds of *Cryptocarya* are likely to be dispersed by some ground vertebrates after seed fall [22]. A long and gradual seed fall might enhance the possibility of seed dispersal if the dispersers are rare and relatively inactive compared to birds.

Seed dispersal

The Weibull distribution model fitted satisfactorily the seed dispersal data of each sample tree (r^2 = 0.93-0.99; Fig. 3, Table 3). Seed dispersal distance was rather short for all species; the fallen seed density had a peak at 0-2 m from the center of the mother tree and no seeds were dispersed further than 12 m. The mean seed dispersal distance, $E(x)$, was positively correlated with tree height within each species (Fig. 4). There was no evidence that small-seeded pioneers gained greater dispersal distances than large-seeded climax species because values of $E(x)$ of *Litsea* and *Lindera* were not larger than the other two species, which were taller than the former two species (Fig. 4). *Litsea* had larger $E(x)$ values than those of *Lindera* trees even though their height and fruit size were similar. Thus, tree height seems more important than fruit size in seed dispersal at least in the Lauraceae species studied. The short dispersal distances observed in the four species suggested a strong dispersal limitation [11] on their recruitment at the sites away from mother trees. Therefore, remaining seed source trees are an important strategy for conservation of the studied species.

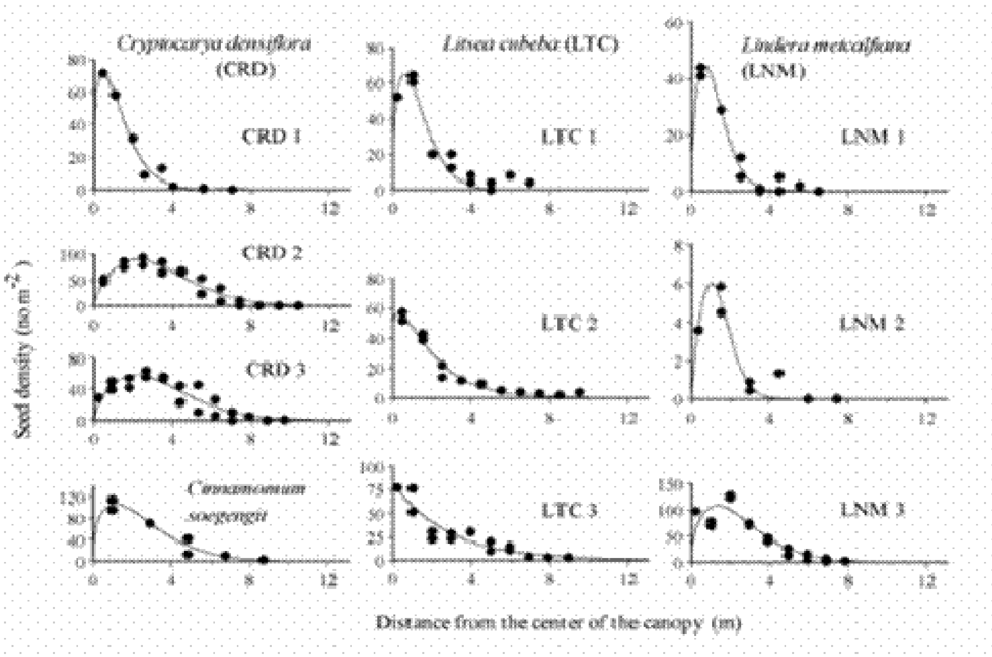

Fig. 3. Seed dispersal curves for ten sample trees of four Lauraceae species. Solid lines represent regression lines based on the Weibull-distribution seed dispersal model (see text for details, see also Table 2 for the coefficients of the model). Note that scales of *y*-axis are standardized to make the total area below the lines of the same magnitude using the regressed Weibull-distribution models in order to show the differences in dispersal patterns clearly.

Table 3. Coefficients of the Weibull distribution seed dispersal model for trees of four Lauraceae species; *Lindera metcalfiana* (LNM), *Litsea cubeba*, *Cryptocarya densiflora* (CRD), and *Cinnamomum soegengii* (CIS). Mean distance stands for the mean value of the Weibull distribution, *E(x)*. See text for details of the model.

Mother tree	DBH (cm)	Height (m)	Coefficients			Mean distance (m)	Total seed production (No./tree)
			N	*a*	*m*		
LNM1	20.6	18.7	76.2	1.305	1.585	1.2	560
LNM2	26.7	21.9	11.0	1.525	1.895	1.4	93
LNM3	30.2	23.4	391.4	2.718	1.506	2.5	6029
LTC1	13.4	13.9	123.0	1.404	1.427	1.3	985
LTC2	16.0	15.8	142.6	1.981	1.121	1.9	1701
LTC3	23.6	20.3	229.2	2.762	1.000	2.8	3977
CRD1	24.2	20.7	132.0	1.355	1.316	1.2	1035
CRD2	37.5	26.2	425.5	3.736	1.701	3.3	8910
CRD3	46.1	28.9	278.3	3.688	1.673	3.3	5759
CIS	40.9	27.4	398.8	2.773	1.402	2.5	6331

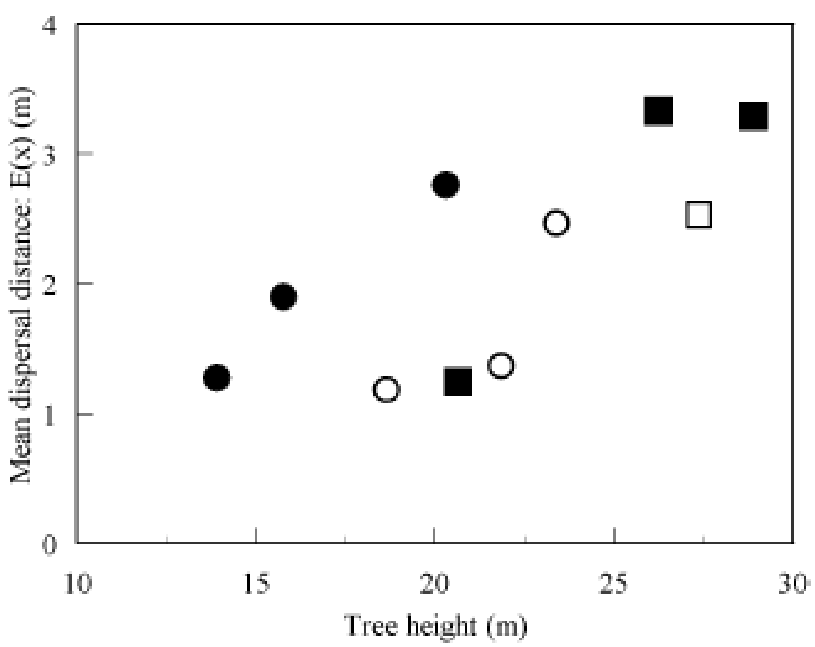

Fig. 4. Relationship between tree height and the mean of Weibull distribution, $E(x)$, which is an index of mean seed dispersal distance (see text for the model). Open squares: *Cinnamomum soegengii*, closed squares: *Cryptocarya densiflora*, open circles: *Lindera metcalfiana*, closed circles: *Litsea cubeba*.

It should be noted that the estimated seed dispersal in this study might be considerably underestimated especially for *Litsea* and *Lindera* because their seeds are dispersed mainly by birds. Turner [23] reviewed seed dispersal patterns of zoochorous tropical trees and found that at least half of any seed crop falls beneath the parent crown but that the tail of the distribution is generally long. In our study, we observed that some of the fruits in the traps and transects had endcarps from which exocarps and mesocarps had been removed, suggesting bird-dissemination [24]. However, the proportion of bird-disseminated seeds was unclear. The proportion of bird-disseminated seeds was reported to be highly varied even among conspecific trees in a forest. The proportions of fruits removed by birds were 0-100% with a mean value of 46.2% for 29 *Ocote tenera* trees, a small tree species of Lauraceae at a Costa Rican tropical montane forest [7]. Only 17% of mature fruits were dispersed by birds for a temperate deciduous canopy tree species of Lauracea, *Cornus controversa*, in Japan [24]. Since bird-disseminated seeds are generally dispersed farther than directly fallen seeds [24], our method possibly missed long-dispersed seeds. Therefore, we should conclude that the dispersal distance of all studied species was very limited (less than 12 m) but that some seeds were possibly dispersed further by birds especially for *Lindera* and *Litsea*. Quantitative studies on bird dispersal are necessary to understand fully the seed dispersal of bird-dispersed species, though they are generally very difficult [24].

Seed production

Estimated total seed production differed among species and the sample trees within the same species (Table 3). Figure 5 shows the relationship between the leaf dry weight and fruit dry weight of each sample tree. The leaf dry weight of each tree was estimated from its diameter and height using the allometric equations of Yamakura *et al.* [25]. Each sample tree of the two shade-tolerant canopy species, *Cinnamomum* and *Cryptocarya*, produced a comparable weight of fruit to its total leaf dry weight. Rokujo [26] reported that the fruit weights of four shade-tolerant species were similar to their leaf weights in a Bornean tropical rain forest during a mast fruiting year. It is noteworthy that climax species produced a similar mass of fruit on a dry matter base during a single fruiting event regardless of species and in both a tropical rain forest and a tropical montane forest. We cannot conclude whether similar relationships between leaf mass and fruit production would be found more generally in other species and forests, because there are no other quantitative studies on fruit production and leaf mass of individual trees, as far as we know. We need to accumulate more data on fruit production of individual trees.

In contrast to the shade tolerant species, the two pioneer species, *Litsea* and *Lindera*, produced less than 3% of the total leaf weight in most sample trees (Fig. 5). This seems inconsistent with the general idea that pioneers make more effort in reproduction and produce larger number of smaller seeds comparing to the climax species [27]. However, in spite of the relatively small allocation to the fruit mass, *Litsea* and *Lindera* produced a comparable or rather larger number of seeds than *Cryptocarya* and *Cinnamomum* did when similar-sized trees were compared (Table 3). This is because the fruits and seeds of the two pioneers were much smaller (Table 1). Thus, the larger number of seeds produced by pioneers does not necessarily indicate the larger allocation to reproductive organs. It is yet to be studied whether pioneers generally allocate less to seeds and fruits than climax species, as was shown in this study. Do pioneers produce much larger number of seeds merely by making their fruits and seeds small? Or, do they allocate more to reproduction as well? The reproductive allocation of the tropical trees need to be further studied and long-term ecological research should be done to conclude this.

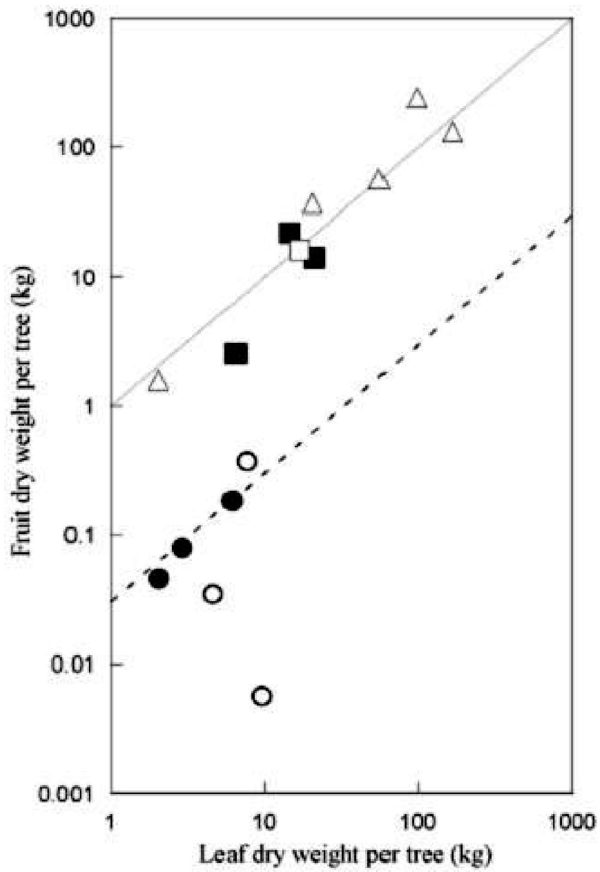

Fig. 5. Relationship between leaf dry weight and fruit dry weight of individual trees for four Lauraceae species in a montane forest of Thailand (this study) and four species of a tropical rain forest in Sarawak, Malaysia [26]. Open square: *Cinnamomum soegengii*, closed squares: *Cryptocarya densiflora*, open circles: *Lindera metcalfiana*, closed circles: *Litsea cubeba*, open triangles: Bornean rain forest species, i.e. *Dryobalanops aromatica* (Dipterocarpaceae), *Dryobalanops lanceolata* (Dipterocarpaceae), *Shorea xanthophylla* (Dipterocarpaceae), *Drypetes xanthophylloides* (Euphorbiaceae). The solid and dotted lines stand for $y = x$ and $y = 0.03x$, respectively.

Conclusion

This study, which covers a period of 2 years, shows firstly that the fruiting of the four studied Lauraceae species do not occur annually in a tropical montane forest in Thailand, though there are relatively distinct seasons in the climate there. Secondly, it was found that tree height seems likely more important than fruit size in seed dispersal, at least in the Lauraceae species studied. The short dispersal distances observed in the four species suggest a strong dispersal limitation. Furthermore, for shade-tolerant species in this study, i.e. *Cinnnamomum soegengii* and *Cryptocarya densiflora*, there was no difference between the percentage of seed germination and seed survival away from the mother tree. For the two pioneer species, i.e. *Litsea cubeba* and *Lindera metcalfiana*, germination was not observed during the two-year study period. So, relationship between seed production and germination from mother tree could not be clarified. The very limited seed dispersal of all the species suggests the possibility of 'seed limitation', and thus, the importance of seed sources for their conservation. Though this study obtains some interesting information on seed production of Lauracea species, further long term studies are required on phenology of Asian tropical montane forests. This study also suggests that more data are needed to understand fully the ecology of reproduction of Lauraceae, though there is a considerable number of studies on the phenology and the reproduction in the neotropics. The most recommendable subjects of future researches are 1) proportion and distance of bird-dispersed seeds, and 2) allocation to reproductive and vegetative organs by individual trees.

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Full Paper

Agro-industrial by-products as roughage source for beef cattle: Chemical composition, nutrient digestibility and energy values of ensiled sweet corn cob and husk with different levels of Ipil – Ipil leaves.

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Abstract: This experiment was carried out to determine the nutritive value of agro-industrial by-products and nutrient digestibility of ensiled sweet corn cob and husk with different levels of Ipil - Ipil leaves (*Leucaena leucocephala*). Four native cattle were assigned by Latin Square Design to receive all dietary treatments in four experimental periods, i.e. ensiled sweet corn cob and husk (ESCH), ensiled sweet corn cob and husk + 10 % Ipil - Ipil leaves (ESCH + 10% IL), ensiled sweet corn cob and husk + 20% Ipil - Ipil leaves (ESCH + 20% IL) and ensiled sweet corn cob and husk + 30% Ipil - Ipil leaves (ESCH + 30% IL), respectively. Total collection method was used to determine the digestibility coefficients. Results showed that digestibility coefficients of ESCH were low (P>0.05) in all the nutrients. Supplementation of Ipil - Ipil leaves in ESCH increased digestibility coefficients. Total digestible nutrients (TDN) and digestible energy were higher in the silages supplemented with Ipil - Ipil leaves. Average TDN contents of ESCH, ESCH + 10% IL, 20% IL and 30% IL were 62.78 $\pm$ 6.14, 70.41 $\pm$ 4.04, 72.73 $\pm$ 2.78 and 63.07 $\pm$ 4.06 %DM, respectively.

Keywords: apparent digestibility, energy value, agro-industrial by-products, sweet corn cob and husk, silages, Ipil - Ipil leaves

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Introduction

In dry season, the main problem of ruminant production in Thailand is nutrition, especially the quality and quantity of roughage which force farmers to use other resources as feed. Crop residues especially rice straw are commonly used as main sources of roughage for cattle even though the nutritive value is low. When cattle are fed with rice straw or low quality roughage, supplemented feed containing protein or other energy source is required to improve both roughage utilization and growth performance.

At present, agro-industrial by-products from canning factory such as pineapple waste, passion fruit peel, baby corn waste and sweet corn cob and husk are commonly used as feed resources, especially as roughage. However, these by-products are high in moisture content and soluble carbohydrates, so they decay very quickly. Therefore, the ensiling of these by-products is a suitable method of preservation even though the acidity of the cannary waste silage is usually high. Silage additives should be used for improving silage quality [1,2]. *Leucaena leucocephala* (Ipil-Ipil) is the most popular legume species in cattle feeding. Because their protein content is high, fresh or dried leaves are usually used as protein supplement. For preserving them ensiling process is also a good method [3]. In order to find out the appropriate methods of using agro-industrial by-products as new feed resources and how to preserve them throughout the dry season, analytical work to develop the database on chemical composition, nutritive value and nutrient digestibility was conducted. The objectives of this experiment were to determine the nutritive value of agro-industrial by-products which farmers usually use as roughage for cattle, as well as to determine the apparent digestibility and energy value of ensiled sweet corn cob and husk with different levels of Ipil - Ipil leaves.

Materials and Methods

1. Chemical composition

Agro-industrial by-products such as pineapple waste, passion fruit peel, baby corn waste and steamed cob and husk of sweet corn, which are by-products from canning factories in Chiang Mai were collected and sampled for analysis. To obtain a sufficient and uniform sample, each agro-industrial by-product was repeatedly sampled from several transport trucks and mixed thoroughly. Samples were then randomly taken for analysis of dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), nitrogen free extract (NFE), calcium (Ca), phosphorus (P)and gross energy (GE) according to the methods described in AOAC [4]. The analysis of neutral detergent fiber (NDF) and acid detergent fiber (ADF) were done according to Detergent method [5].

2. Digestibility study

For digestibility study, sweet corn cob and husk (SCH) collected from a canning factory was ensiled with different levels of Ipil - Ipil leaves and used as experimental diets. Ipil - Ipil leaves were prepared by chopping the whole branch whose diameter was not bigger than 1.5 cm before mixing. They were packed without additives in double layer polyethylene bags (25 x 30 inches) with vacuum suction. Each bag contained 20 kg. of silage and was stored for 21 days prior to use. Four native beef cattle at two years of age with an average body weight 174 ± 13.5 kg. were randomly allocated to one of the four dietary treatments according to Latin Square Design. The treatments were (1) ensiled sweet corn cob and husk (ESCH), (2) ensiled sweet corn cob and husk and Ipil - Ipil leaves at 90:10 (ESCH + 10%IL), (3) ensiled sweet corn cob and husk and Ipil - Ipil leaves at 80:20 (ESCH + 20%IL), and (4) ensiled sweet corn cob and husk and Ipil - Ipil leaves at 70:30 (ESCH + 30%IL) (Figure 1). The silages were fed as single feed twice daily at least 1.5% of the body weight (DM basis). Total collection method was assigned for the determination of apparent total tract digestibility of nutrients.

Each digestibility period lasted 21 days while preliminary period took place in the first 14 days and collection period was in the last 7 days. Silage intake was recorded daily through the entire experiment. Silage DM intake was calculated on DM basis. Feces and leftover feed were collected and used for the calculation of nutrient digestibility. Total digestible nutrients (TDN) were calculated using the equation : TDN = digestible CP + digestible CF + digestible NFE + digestible EE × 2.25 [6]. Gross energy of feed and feces were determined using adiabatic bomb calorimeter (IKA calorimeter system C 5000). Digestibility was then calculated. The data were analyzed according to 4 × 4 Latin Square Design [7].


SCH


SCH+ Ipil Ipil leaves


ESCH


ESCH+ 10%IL


ESCH+ 20%IL


ESCH+ 30%IL

Figure 1. Sweet corn cob and husk (SCH), ensiled steamed sweet corn cob and husk (ESCH) with different levels of Ipil - Ipil leaves (IL).

Results and Discussion

Chemical composition of agro-industrial by-products

The dry matter contents of pineapple waste and pineapple silage (ensiled pineapple waste) were lower than those of baby corn husk, passion fruit peel, ensiled pineapple waste with rice straw and ensiled passion fruit. The average CP contents of agro-industrial by-products from the canning factories (Table 1) showed that all of these by-products were not the good roughage sources and should not be used as the main roughage for ruminants because of their low contents in CP and DM. However, baby corn husk was the highest in CP content (9.88% in DM) but the lowest in NDF and ADF contents (54.44 and 22.38% in DM), when compared to other by-products. The physical characteristics of ensiled pineapple wastes with or without rice straw were in good condition even though their DM content was lower than the optimal range of good ensiling products. These might be due to the high NFE contents in pineapple waste especially fructose which are converted to lactic acid by lactic acid bacteria. Moreover, the supplement of rice straw increased DM content of the silage but decreased CP content. The physical characteristic of rice straw was better after the ensiling process. It had a lactic acid odor with light yellow color and the structure was softer.

Table 1. Chemical composition of agro-industrial by-products used in the experiment.

Items	DM (%)	% of DM		
		CP	NDF	ADF
Baby corn husk	19.35	9.88	54.44	22.38
Pineapple waste	9.12	7.32	78.98	31.45
Ensiled pineapple waste	8.11	7.42	70.43	34.58
Ensiled pineapple waste with rice straw (90:10)	17.23	5.76	76.51	44.56
Passion fruit peel	16.65	6.34	45.72	36.54
Ensiled passion fruit peel	18.76	7.06	44.68	32.25

The chemical compositions of SCH and ESCH without or with different levels of Ipil - Ipil leaves on DM basis were presented in Table 2. The data from the chemical compositions showed that SCH and ESCH could be used as roughage sources for ruminants even though their CP contents were lower than 8 % and the DM contents were lower than 20%. Furthermore, increasing Ipil - Ipil leaves in the silage tended to increase DM and CP contents, but the average percentages of organic matter (OM), CF, NDF and ADF tended to decrease with increasing Ipil - Ipil leaves in the silage. The positive effect of the silage with Ipil - Ipil leaves was due to the nutritive value of this legume, which was high in protein, DM and GE contents [8-9]. Although ESCH and ESCH + IL were good-quality silages, ESCH+ 30% IL had a high pH (4.32). The high pH of this treatment might be due to the buffering capacity of IL which is a leguminous plant. Therefore, the recommended Ipil – Ipil levels ensiling with ESCH is at 10 – 20 %.

Table 2. Chemical composition of sweet corn cob and husk (SCH), ensiled sweet corn cob and husk (ESCH) with out or with Ipil-Ipil leaves (IL).

Item	DM (%)	% of DM									GE (kcal/gDM	pH
		OM	CP	CF	EE	NFE	NDF	ADF	Ca	P		
SCH	19.32	96.56	8.69	23.26	5.24	59.37	75.62	34.04	0.43	0.20	4.41	-
Ipil – Ipil leaves	33.76	91.62	18.15	18.47	4.21	50.79	63.47	28.60	0.73	0.31	4.17	-
ESCH	18.73	96.54	9.13	22.86	5.34	59.21	74.27	31.94	0.61	0.23	4.33	3.92
ESCH + 10% IL	18.89	96.38	12.29	20.22	5.68	58.19	72.92	30.80	0.63	0.30	4.65	4.04
ESCH + 20% IL	19.47	95.52	13.57	20.74	5.32	55.89	69.47	30.62	0.64	0.28	4.85	4.15
ESCH + 30% IL	20.69	95.18	14.08	21.65	5.47	53.98	68.42	30.28	0.56	0.26	4.76	4.32

Apparent digestibility of nutrients

Table 3 shows the digestibility of ESCH with or without Ipil - Ipil leaves. It was shown that cattle fed with ESCH+ IL consumed slightly higher dry matter content than the ESCH-fed group (2.69, 2.89, 3.01 and 3.05 kg/h/d which are equal to 1.58, 1.64, 1.72 and 1.74% BW, respectively). This might be due to the supplement of Ipil – Ipil leaves in the silages, which provided more nutrients, especially nitrogen for microbial growth and activities. The result from this experiment agreed with that of Oldham [10], who found that dry matter intake and nutrient digestibility of the diet increased with increasing crude protein contents. Therefore, the digestibility of nutrients in cattle fed with ESCH + IL were higher than the ESCH group. The apparent digestibility of DM, OM and CP were significantly different among treatments ($P<0.05$). ESCH had lower DMD, OMD and CPD than other treatments. No significant differences among groups were found on the apparent digestibility of CF, EE and ADF ($P>0.05$).

Table 3. Apparent digestibility of ensiled sweet corn cob and husk (ESCH) with or without Ipil - Ipil leaves (IL) in 4 native beef cattle.

Apparent digestibility, %	**ECSH**	**ESCH+ 10% IL**	**ESCH+ 20% IL**	**ESCH+ 30% IL**
DM*	52.77 ^{c} ± 6.12	66.24 ^{ab} ± 5.33	70.32^{a} ± 3.24	60.28 ^{b} ± 4.11
OM*	56.90 ^{c} ± 5.68	68.09^{a} ± 4.21	73.34 ^{a} ± 4.53	63.68 ^{ab} ± 5.37
CP*	49.27 ^{c} ± 5.22	56.08 ^{b} ± 5.13	68.59 ^{a} ± 1.88	55.49 ^{b} ± 3.26
CF	62.41 ± 5.08	64.50 ± 3.17	61.42 ± 1.02	57.44 ± 3.86
EE	75.68 ± 2.45	81.43 ± 3.01	82.40 ± 2.32	76.82 ± 1.87
NFE*	53.96 ^{b} ± 4.13	69.05 ^{a} ± 3.76	73.52 ^{a} ±3.17	67.57 ^{a} ± 3.34
NDF*	59.34 ^{b} ± 4.11	63.34 ^{b} ± 2.68	72.27 ^{a} ± 1.91	62.54 ^{b} ± 4.16
ADF	46.53 ± 4.28	52.00 ± 4.02	53.93 ± 3.24	49.73 ± 1.85

* Means with different superscripts differ significantly (P<0.05)

The apparent digestibility of NFE and NDF followed the same pattern as DM digestibility and was significantly different (P<0.05) as influenced by supplementation with Ipil - Ipil leaves.

Calculation of TDN from digestibility of nutrients showed that ESCH had a high average value of TDN and they could be used as roughage source for ruminants. Digestible energy contents of the silages followed the same pattern as TDN contents (Table 4).

Table 4. Total digestible nutrients (TDN) and digestible energy of ensiled steamed cob and husk of sweet corn (ESCH) without or with Ipil - Ipil leaves (IL) in 4 native beef cattle.

Item	**DM (%)**	**DM basis**	
		TDN (%)	**DE (Mcal / kg)**
ESCH	18.73	62.78 ± 6.14	2.54 ± 0.23
ESCH + 10% IL	18.89	70.41 ± 4.04	2.96 ± 0.07
ESCH + 20% IL	19.47	72.73 ± 2.78	3.11 ± 0.04
ESCH + 30% IL	20.69	63.07 ± 4.06	2.68 ± 0.12

Conclusion

The chemical composition of all the wastes from canning factories, e.g. pineapple waste, passion fruit peel, is low in CP and DM contents. Sweet corn cob and husk is one of the agro-industrial by-products from the canning factory which can be preserved as silage and used as roughage for ruminants. The supplement of ensiling material with Ipil - Ipil leaves increases CP, TDN and DE contents as well as the digestibility of nutrients, compared to the unsupplemented sweet corn cob and husk silage.

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