

# THE FLORISTIC CHARACTERISTICS OF THE TROPICAL RAINFOREST IN XISHUANGBANNA

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**ABSTRACT:** The general floristic characteristics of the tropical rainforest of Xishuangbanna have been summarized in the present paper. The tropical rainforest is estimated to consist of more than 3,000 species of seed plant pertaining to more than 1,000 genera and about 180 families. Based on the comprehensive analysis of the distribution of taxa in two representative communities of the rainforest, the deduction is given as follows: the families, genera and species of tropical distribution take up about 80%, 94% and more than 90% of the total of the flora separately in which the genera of tropical Asia take up 33%–42% of the total and the species of tropical Asia take up about 74% of the total. The flora is explicitly of tropics in nature and as a part of tropical Asian flora. Occurring at the montane habitats of northern margin of tropical SE Asia, the flora also embodies conspicuous characters of marginal tropics. Xishuangbanna is geographically a transitional area from true tropics to subtropics and an ecotone where the floristic element of Indo–Malaysia from south, the one of S Asia or S Himalayas from west, the one of Indochina–S China from southeast and the one of S China from northeast meet and overlap in their areal boundaries each other. The flora is therefore endowed with the characteristics of floristic ecotone.

**KEY WORDS:** floristic characteristics; tropical rainforest; Xishuangbanna

## I. INTRODUCTION

Xishuangbanna is situated at the northern margin of tropical mainland of SE Asia with a typical monsoon climate. In spite of its relatively high latitude and elevation, Xishuangbanna still has a tropical moist climate in the lower area of its southern part, be-

cause the Hengduan Mountains form a huge barrier keeping out the cold air from north in winter and its montane topography produces dense fog during the whole dry season to supplement the insufficient precipitation. Therefore the tropical rainforest, as a marginal type of tropical SE Asia, can exist and develop luxuriantly in the region<sup>(1-2)</sup>. Xishuangbanna is geographically a transitional area from true tropics to subtropics and its particular topography ascending from south to north intensifies the climatic difference in the region. As a result, Xishuangbanna is an ecotone where the tropical rainforest and some other vegetation types, especially montane evergreen broad-leaved forest shows a mosaic distributional pattern. Based on some studies on geological history of the region<sup>(3)</sup>, the tropical moist climate did not exist until the Hengduan Mountains was lifted up to certain elevation after the late Tertiary. This leads to the conjecture that the tropical rainforest developed later than the evergreen broad-leaved forest in the region. In floristic geography, Xishuangbanna occupies a key location where the floristic elements of Indo-Malaysia from south, the one of S Asia or S Himalayas from west, the one of Indochina-S China from southeast and the one of S China from northeast meet and overlap in their areal boundaries each other. These geographical elements are naturally the direct sources of the flora. As the tropical rainforest of Xishuangbanna occurs at latitudinal and altitudinal limits<sup>(4)</sup>, its floristic composition and distributional pattern in the region will change conspicuously when just a little change of climate occurs. It is inevitable that its floristic composition and distributional pattern have been changeable since the late Tertiary. Under such an intricate background the tropical rainforest arose and developed in the region.

## II. FLORISTIC COMPOSITION

Based mainly on physiognomical characteristics the tropical rainforest of Xishuangbanna are divided into two community types (vegetation subtype) i.e. seasonal rainforest on lowland and montane rainforest on montane habitat as a variety of the former. However, either the former or the later has almost the same floristic composition.

The tropical rainforest is estimated to consist of more than 3,000 seed plant species, pertaining to more than 1,000 genera and about 180 families. Among these families the ones with more than 100 species are Rubiaceae and Euphorbiaceae; the ones with more than 50 species are Lauraceae, Anonaceae, Asclepiadaceae, Moraceae, Apocynaceae, Orchidaceae, Urticaceae, Rutaceae, Acanthaceae and Papilionaceae; the ones with more than 30 species are Sterculiaceae, Vitaceae, Fagaceae, Zingibraceae, Verbenaceae, Piperaceae, Meliaceae, Myrsinaceae, Cucurbitaceae, Araceae, Araliaceae etc.

Some families, such as Sapindaceae, Anacardiaceae, Burseraceae, Elaeocarpaceae, Ebenaceae and Combretaceae etc., have less species than the former ones, but they are the

dominant or representative families in the tree layers of the forest. Still some other families which just have a few species, such as Dipterocarpaceae (2 species)<sup>(5)</sup>, Baringtoniaceae (1 sp.), Tetrameleaceae (1 sp.), Myristicaceae (9 sp.), Guttiferae (8 sp.), Icacinaceae (9 sp.), Ixonanthaceae (1 sp.), Sapotaceae (6 sp.), Marantaceae (3 sp.), Musaceae (2 sp.) etc., are the characteristic families because of their higher importance value in the forest.

In areal type the families which are distributed strictly in tropics take up 16%–22% of the total families (Table 1), including pantropic ones such as Dipterocarpaceae, Connaraceae, Myristicaceae, Hernandiaceae, Taccaceae, Burseraceae, Sapotaceae, Icacinaceae etc., palaeotropical ones such as Pandanaceae, Sonneratiaceae, Baritonaceae etc., the ones of tropical Asia, Africa to America such as Symphoremataceae, Ixonanthaceae etc.; the ones of tropical Asia to Australia such as Cadipteridaceae, and the ones of tropical Asia such as Carlemaniaceae, Crypteroniaceae, Tetramleaceae, Pentaphragmaceae etc. The families which are distributed mainly in tropics but more or less beyond tropics take up 57%–64% of the total, such as Rubiaceae, Euphorbiaceae, Lauraceae, Moraceae, Anonaceae, Apocynaceae, Meliaceae, Rutaceae, Acanthaceae, Sapindaceae, Vitaceae, Urticaceae, Araceae etc. The families which are distributed mainly in subtropical area take up 9%–13%, such as Fagaceae, Magnoliaceae, Theaceae Symplocaceae, Hamamelidaceae, Aceraceae, Schizananaceae etc. The families which are distributed mainly in temperate area take up 8%–10%, such as Compositae, Gramineae, Liliaceae, Scrophulariaceae etc. of which herbaceous families take up the most.

The flora in this area is dominated by tropical families, so it is explicitly tropical one in nature. However, in tropical flora, the families which are distributed mainly in tropics, extend to subtropical and temperate zones are dominant. There are still some subtropical and temperate families in the flora. These facts suggest that the flora is endowed with the features of marginal tropics, it is the northern margin of tropical Asian flora.

In the rainforest, *Ficus*, *Piper*, *Lasianthus*, *Syzygium*, *Lithocarpus*, *Castanopsis*, *Elaeocarpus*, *Dysoxylum*, *Fissistigma*, *Millettia*, *Tetrastigma*, *Polyalthia* etc. are the outstanding genera which have more than 10 species each. Among them *Castanopsis*, *Lithocarpus*, *Elaeocarpus*, *Cinnamomun*, *Polyalthia*, *Amoora* etc. are abundant in the upper tree layer, while *Ficus*, *Litsea*, *Dysoxylum*, *Syzygium*, *Millettia* etc. are abundant in the middle and lower tree layers, *Lasianthus* in the shrub layer, *Piper* and *Elatostemma* in the herbaceous layer, and *Fissistigma*, *Trichosanthes*, *Rhaphidophora*, *Aschynanthus* etc. in the inter-layer.

About 1/3 of the genera in the flora are so-called big genera which contain more than 100 species each in tropical areas. Oligospecific genera such as *Mezzettiopsis*,

*Euchresta*, *Kydia*, *Pseudostreblus* etc. and monotypic genera such as *Zippelia*, *Borthwichia*, *Sumbaviopsis*, *Natsiatopsis*, *Mayodendron* etc., take up 9%–12% and about 4% of the total separately. In comparison with Chinese flora in which oligospecific and monotypic genera take up 23.3% and 14.4% of total genera separately<sup>(6)</sup>, the flora of Xishuangbanna is far less in the percentages of oligospecific and monotypic genera. Oligospecific and monotypic genera are usually considered as the relatively ancient and isolated ones in phynogeny. The lower percentages of oligospecific and monotypic genera show that the flora is relatively not ancient and isolated, implying that the flora is a marginal type of tropical Asian flora.

**Table 1 The areal types of the families of the rainforest**

Areal type of family	Dipterocarpaceae forest(%)	Rainforest on lower hills(%)
Typical tropics (strictly tropics)	22.0	16.0
Tropics to subtropics or temperate (mainly tropics)	56.9	64.0
Tropics to subtropics (mainly subtropics)	12.8	9.3
Cosmopolitan (mainly temperate)	8.3	10.7

### III.THE AREAL TYPES OF GENERA AND SPECIES

According to the areal types of the genera of Chinese seed plants published by Wu Zhengyi in 1991<sup>(7)</sup>, the areal types of the genera of the Dipterocarpaceae forest and the rainforest on lower hills of Xishuangbanna are compiled into Table 2. Thirteen areal types of genera are summarized and the results are given as follows: the genera of tropical distribution(type 2–7) make up about 94% of the total genera; the ones of temperate distribution (type 8–11) make up 3%–4% of the total; the ones endemic to China less than 2%. Among the genera of tropical distribuion, the ones of tropical Asia occupy the most and make up 33%–42% of total genera; the ones of pantropics make up 20%–25% of the total; the ones of Old World tropics 13%–14%; the ones of tropical Asia to Australia 9%–10%; and the ones of tropical Asia to Africa 5%–7%.

It is furthermore confirmed from the composition of the genera that the flora is dominated by tropical genera and has conspicuous features of tropical Asian flora. As a part of

the latter it has also extensive connection with those of other tropical areas in geographical elements but has slightly direct connection with those of temperate areas and E. Asia.

**Table 2 Areal types of the genera**

Areal types	Dipterocarpaceae forest(%)	Rainforest on lower hills(%)
1. Cosmopolitan	—	—
2. Pantropic	19.6	25.3
3. Tropical Asia to Tropical America disjuncted	4.3	4.6
4. Old World Tropic	14.0	13.7
5. Tropical Asia to Tropical Australia	9.2	10.2
6. Tropical Asia to Tropical Africa	4.8	7.3
7. Tropical Asia to Tropical Africa	42.3	33.2
8. N. Temperate	1.8	1.9
9. E. Asia and N.America disjuncted	1.8	1.5
10. Old world Temperate	0.3	0
11. Mediterranean- W.Asia to C. Asia	0.3	0
12. E. Asia	0.3	1.5
13. Endemic to China	1.5	0.6

Based on the distributional patterns of each species and referring to some features of floristic regionalization and origin, the species are catalogued into 9 areal-types and 6 subtypes (Table 3). Each of them is enumerated as follows:

### 1. Pantropic

The species of this type are distributed in the tropical areas all over the world. Only one species is recorded i.e. *Geophilia herbaceus* of Rubiaceae.

**Table 3 The areal types of species in two rainforest communities**

Areal types	Dipterocarpaceae forest(%)	Rainforest on lower hills(%)
1. Pantropic	—	0.3
2. Tropical Asia and Tropical America disjuncted	—	0.3
3. Old World Tropic	0.3	0.6
4. Tropical Asia to Tropical Australia	2.9	3.2
5. Tropical Asia to Tropical Africa	—	2.2
6. Tropical Asia and its subtypes	(73.3)	74.6
6.1. India–Malaysia	21.4	26.7
6.2. Mainland SE Asia to Malaysia	7.5	8.3
6.3. S Asia to Mainland SE Asia	21.3	19.4
6.4. Mainland SE Asia to S China	23.7	19.4
7. SE to SW China and its subtypes	(8.2)	(10.1)
7.1. SE to SW China	1.7	3.8
7.2. Yunnan, Guangxi(or S Guangdong), Hainan	3.4	3.5
7.3. Yunnan, Guangxi or to S Guizhou	3.1	2.8
8. Endemic to Yunnan	8.9	5.4
9. Endemic to Xishuangbanna	6.5	3.2

## **2. Tropical Asia to Tropical America Disjuncted**

The species of this type usually originated from tropical America and acclimated to

tropical Asia. Only one species is recorded in the rainforest i.e. *Eupatorium odoratum* of Compositae which is a widely dispersed weed species in tropical Asia.

### 3. Old World Tropic

The species of this type are distributed in the tropical areas of Asia, Africa and Australia, such as *Carallia brachiata* of Rhizophoraceae, *Cudrania cochinchinensis* of Moraceae etc. Only few species are recorded from this type.

### 4. Tropical Asia to Tropical Australia

The species of this type range as indicated by the title, including *Alstonia scholaris*, *Bischofia javanica*, *Sauropus macranthus*, *Cucurliigo capitulata* etc. They make up about 3% of total species.

### 5. Tropical Asia to Tropical Africa

The species of this type are distributed from tropical Asia to tropical Africa or Madagascar, including *Apodytes dimidiata*, *Lepisanthes senegalensis* etc. This type contains only a few species in the rainforest.

### 6. Tropical Asia and Its Subtypes

Tropical Asia occupy a large area which ranges from India and S Himalayas at west to Solomon Islands at east. The area is a complex consisting of several heterogeneous parts, for instance, India and New Guinea pertain to Gandwana land; Malay Peninsula, Sumatra, Borneo, Java etc. had been a whole of Sunda Shelf pertaining to Asia land; while most of Philippines are a series of pacific islands. As the particular geographical location and geological background, the flora of Xishuangbanna has extensive and various connections with different parts of tropical Asia. In the flora, the species considered to be of tropical Asia make up about 74% of the total, which can be primarily divided into 4 subtypes.

#### 6.1 India-Malaysia

The species of this subtype are distributed from India or S Himalayas to the whole Malaysia. The word "Malaysia" means the whole geographical area which ranges from Malay Peninsula to New Guinea and Solomon Islands including Philippines. The species of this subtype are the typical representatives of tropical Asia and make up 21%–27% of total species, including *Pometia tomentosa*, *Harpulia cupanioides*, *Tetracera asiatica*, *Alocasia*

*macrorrhiza*, *Antiaris toxicaria*, *Tetrameles nudiflora*, *Dillenia indica*, *Terminalia bellirica*, *Crypteronia paniculata*, *Platea latifolia* etc.

## 6.2 Mainland SE Asia to Malaysia

This subtype coincides basically with the former subtype in range but differs from the latter in the way that it borders Upper Burma or Syunnan at west or northwest and not to India and S Himalayas. The species of this subtype make up 7%–8% of the total, including *Gironniera subaequalia*, *Knema furfuracea*, *Nephelium lappaceum* var. *pallens*, *Arytera litoralis*, *Mitrephora mangayi*, *Mezzettiopsis creaghii*, *Barringtonia macrostachya* etc.

## 6.3 S Asia to Mainland SE Asia

This subtype ranges the continental part of tropical Asia. The typical species are distributed from India or S Himalayas to Indochina Peninsula and S China. The species of this subtype make up 19%–21% of the total, including *Gomphandra tetrandra*, *Garcinia xanthochymus*, *Garuga floribunda* var. *gamblei*, *Pterospermum lanceae-folium*, *Pouteria grandielora*, *Leea crispa*, *Milusa velutina sessili-fructus* etc.

## 6.4 Mainland SE Asia to S China

The typical species of this subtype are distributed from Burma, Thailand to Indochina and S China, including *Chreostes lanceolata*, *Mayodendron igneum*, *Schizomussaenda dehiscens*, *Duperrea pavettaefolia* etc. However most species of this subtype are distributed from Vietnam or Indochina to S Yunnan or S China, including *Canarium album*, *Amoora tetrapetala*, *Artocarpus tonkinensis*, *Polyosma cambodiana*, *Pseuduvaria indochinensis* etc. The species of this subtype make up 19%–24% of the total.

## 7. SE to SW China and Its Subtypes

The typical species of this type are distributed from SW China to SE China. Some species are distributed in S Yunnan, S Guangxi and Hainan as one subtype and other species are distributed only in Yunnan, Guangxi or to S Guizhou as another subtype. The species of this type make up 8%–10% of the total, including *Ophiorhiza cantoniensis*, *Dysoxylum lukii*, *Elaeocarpus viridiscens*, *Amoora yunnanensis*, *Alphonsea monogyna* etc.

## 8. Endemic to Yunnan

The species of this type make up 5%–9% of the total, including *Connaris yunnanensis*,



*Actinodaphne henryi*, *Cinnamomum austroyunnanensis*, *Cinnamomum chartophyllum*, *Cryptocarya yunnanensis*, *Myristica yunnanensis* etc.

## 9. Endemic to Xishuangbanna

As the absence of detailed references of neighboring regions, the species which are temporarily considered to be endemic to Xishuangbanna make up 3%–7% of the total, including *Kopsia officinalis*, *Elaeocarpus sphaerocarpus*, *Diospyros xishuangbannaensis*, *Schefflera menglaensis*, *Garcinia lancilimba*, *Pellacalyx yunnanensis* etc.

## IV. CONCLUSION

The floristic characteristics of the tropical rain-forest are summarized as follows:

### 1. Tropical Floristic Elements Dominating Absolutely and Conspicuous Features of Tropical Asian Flora

The flora of the rainforest, in which tropical families make up 80% of the total and the tropical genera make up 94% of the total, is explicitly of tropics in nature. Among the tropical genera the ones of tropical Asia occupy the most. The species strictly in tropics make up 76%–80% of the total species. Adding the ones of marginal tropics of S China, the species of tropics make up more than 90% of the total. Among the species of tropics the ones of tropical Asia dominate.

Dipterocarpaceae is an exactly tropical family which occurs mainly in tropical rainforest (Fig.1). Most species of the family are in tropical Asia and they are the most representative elements of the rainforest of tropical Asia. Dipterocarpaceae, though only two species in Xishuangbanna, is the most convincing evidence that the rainforest of Xishuangbanna is a part of the flora of tropical Asia.

### 2. Extensive Connections with Those of Tropical Areas of the World and the Closest Relationship to That of Northern Parts of Tropical Asia

It can be seen from the composition of areal-type of the genera that the flora has extensive connections with those of other tropical areas but has direct relationships to those of tropical Asia. It is the matter of course that the flora has the closest relationship to that of northern parts of tropical Asia. About 46% of the total species of the flora are shared by those of NE India and S Himalayas, and about 30% of the total are shared by those of Malaysia (only 10% are shared by eastern Malaysia). The close relationship between the

flora and those of NE India and S Himalayas is based on not only their near locations but also their similar histories of floristic generation, while the close relationship between the flora and those of Malaysia relates with the link of the end part of Hengduan Mts. through Malay Peninsula. The flora has also close relationships to those of SE Yunnan, SW Guangxi and Hainan of China mainly through the geographical elements of India–Malaysia and SE Asia.

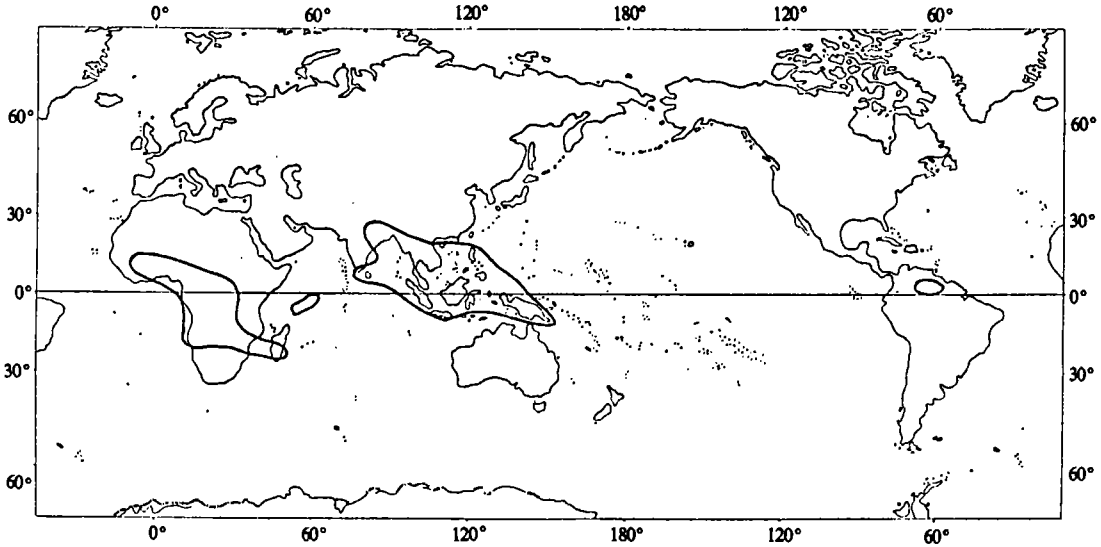
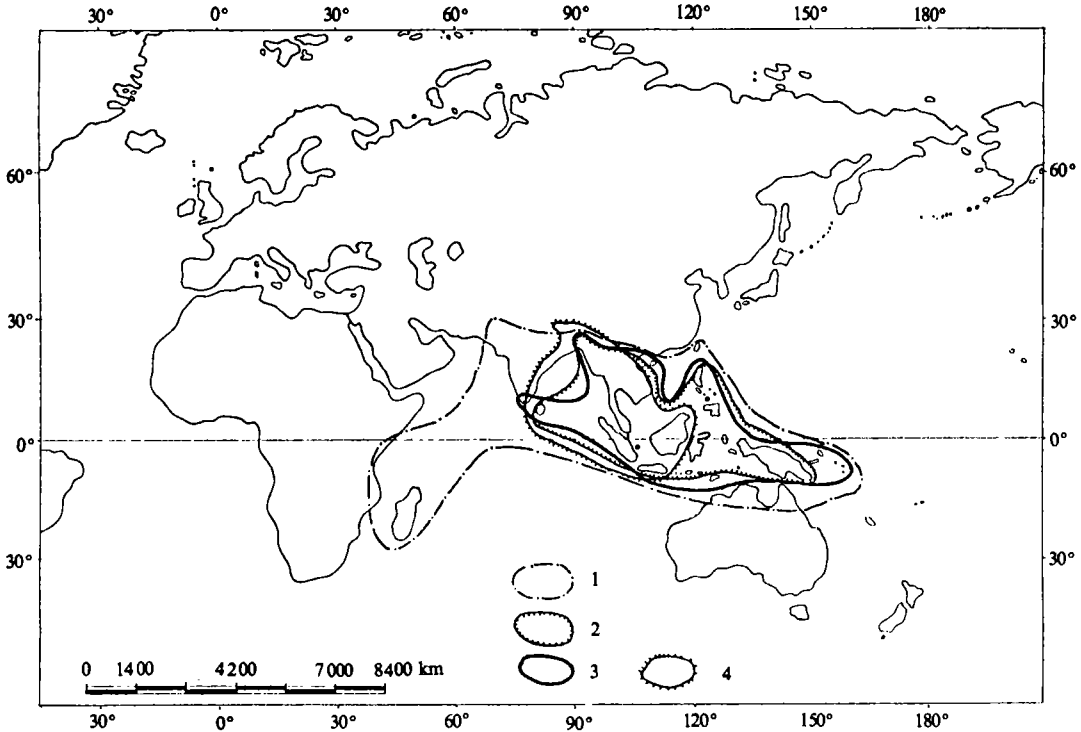


Fig. 1 The map of distribution of Dipterocarpaceae

### 3. The Character of Marginal Tropics

Although tropical elements dominate absolutely, the flora, after all occurred at the montane habitat of northern margin of tropical SE Asia, has the character of marginal tropics. Among the tropical families of the flora the ones which are distributed more or less beyond tropics take up the most and the ones which are distributed strictly in tropics take up only a small part of the total. Even strictly tropical families and genera, they have a few species in Xishuangbanna, for example, in comparison with Malay Peninsula<sup>(8)</sup>, Dipterocarpaceae has 2 species in Xishuangbanna and 163 species in Malay Peninsula, Sapotaceae 6 species in the former and 62 species in the latter, Guttiferae 9 species in the former and 134 species in the latter etc. Some families such as Pedaliaceae, Epacridaceae, Anisophyllaceae etc., which occur only in the tropical core area of Asia, are naturally absent in Xishuangbanna. There are at least 4 families which have the northern limits of range in Xishuangbanna (Fig.2). In the flora most of the tropical species reach to their northern limits, of which some do not reach to their latitudinal limits but to the altitudinal

limits there. These facts express that the flora has the character of marginal tropics and is a northern and marginal part of tropical Asian flora in floristic regionalization.

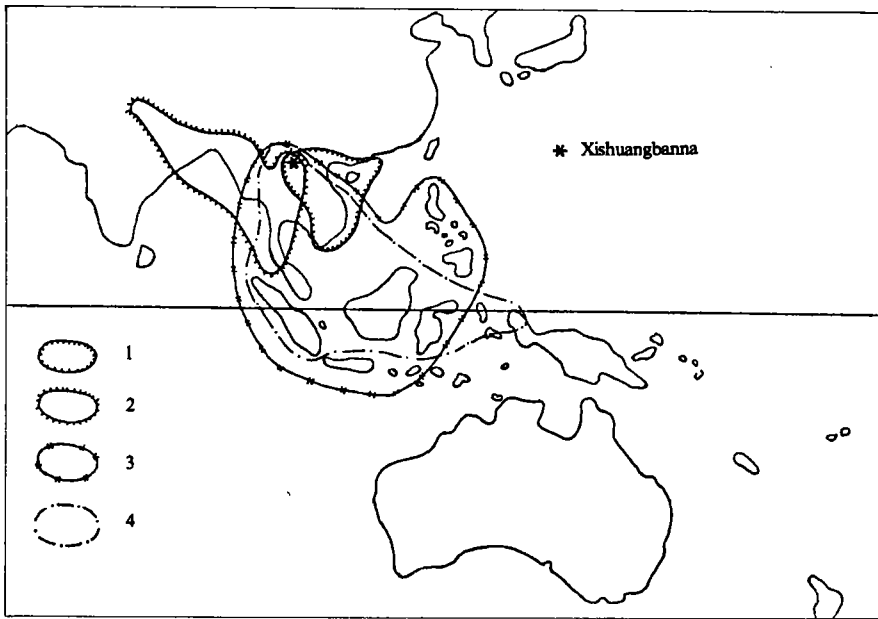


**Fig.2** The distributions of four tropical families

1. Barringtoniaceae; 2. Crypteroniaceae; 3. Mastixiaceae; 4. Tetrameleaceae

#### 4. Floristic Ecotone

Xishuangbanna is geographically a transitional area from true tropics to subtropics and geologically an end part of the relatively young Hengduan Mts. neighbouring on the ancient S China land. These geographical and geological backgrounds make the region a floristic ecotone. It can be seen from the example of Fig. 3 that the floristic element of Indo-Malaysia from south, the one of S Asia or S Himalayas from west, the one of Indochina-S China from southeast and the one of S China from northeast (do not enumerated in Fig.3) meet and overlap their areal boundaries in the region. The flora of the rainforest, therefore, is endowed with the characteristics of floristic ecotone.



**Fig. 3** The distribution of four species showing the overlap of their areal boundaries in Xishuangbanna

1. *Artocarpus tonkinensis* A. Chev. ex Gagn.; 2. *Ariocarpus lakoocda* Roxb.;  
3. *Tetracera scanolens* Merr.; 4. *Knema farfuracea* (Hook. F) Warb.

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