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THE TROPICAL RAINFOREST VEGETATION IN XISHUANGBANNA

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ABSTRACT: The tropical rainforest in Xishuangbanna, Yunnan Province of China, is introduced in detail in this paper. Situated at the northern margin of tropical mainland SE Asia and controlled by monsoon climate, the region has been climatically at the lower limits for tropical rainforests, however true tropical rainforests exist and develop luxuriantly in the region. The reasons for this are discussed. In general phytocoenological characteristics such as vertical stratification, life form spectrum, species riches etc. the tropical rainforest in Xishuangbanna is very similar to the typical tropical rainforest in equatorial region, but it is characterized by a clear change of physiognomy between different season. As occurred at the latitudinal and altitudinal limits of tropical rainforest, the flora of the rainforest is endowed with the nature of northern margin of tropical zone of SE Asia and is transitional toward the flora of subtropical forest of China. In recent years the region has been opened up to use in a large scale and the primary forests, especially rainforests, have been severely destroyed. The conservation and research to the tropical rainforest are very urgent and have to be done at once.

KEY WORDS: Tropical rainforest, Xishuangbanna

I. GENERAL GEOGRAPHY

1. Location and Topography

Xishuangbanna, a region of exceptional interest to biologists, is located in the south of Yunnan and bounded approximately by the geographical coordinates of 21° 09′ and 22° 36′ northern latitude, and of 99° 58′ and 101° 50′ eastern longitude. Xishuangbanna borders Laos to the east and south, and Burma to the southwest, and to

the north adjoins the plateau of Yunnan. The area is about 19,223 square kilometers. Topographically the region is mountainous and the mountain area takes up more than 90% of whole region. The larger or smaller depressions and wide valleys, so called "lowland", are less than 10% of the whole and they are mostly more than 600 m above sea level. The mountain ranges are the southern end of the Henddwan Mts. and run across the region from the north to the south, becoming lower southwards.

2. Climate

The region has a typical tropical monsoon climate. Based on the information from Mengla weather station (631.9 m. above sea level) in the south of the region, the annual mean temperature is 21℃, the annual temperature summation of ≥ 10℃ accounts for 7,639℃, the monthly mean temperature is 24.6℃ in the hottest month and 15.2℃ in the coldest month, the average of the extreme lowest temperature for many years is 5.6℃. There is a sharp contrast between a prolonged dry season which for months may be completely rainless and a wet season when the monsoon winds sweep in mainly from the southwest and bring heavy precipitation. The rainy season usually begins in May and lasts till October, and the dry season is from November to April. The annual precipitation is 1532 mm of which 281 mm fall during the dry season.

3. Particular Factors

Tropical rainforests occur mainly in tropical wet lowlands of the world where the annual mean temperature is more than 24℃. In mainland SE Asia controlled by tropical monsoon climate, the representative tropical rainforest is the type characterized by a clear change of physiognomy between different season[1], called tropical seasonal rainforest[2–3] or tropical semi–evergreen rain forest[4]. The tropical seasonal rainforest covers mainly the areas where annual temperature summation is usually more than 8,000℃ and annual precipitation is 1,500–2,000 mm. Xishuangbanna is situated at the northern margin of tropical mainland SE Asia and its annual temperature summation and precipitation are at the lower limits for tropical rainforest developing because of the relatively high latitude and elevation. There still are typical tropical seasonal rainforest existing in Xishuangbanna owing to the particular geographical location and topography of the region. The northern, western and eastern parts of the region are higher than its central and southern parts and toward the northwest lie the high ranges of the Hengduan mountains which form a huge barrier keeping out the cold air from north in winter. This compensates for the insufficient temperature summation of the region. In the lower areas of the region there is usually dense fog everyday during the whole dry season which compensates for the insufficient precipitation. Therefore, the tropical rainforest can exist and develop luxuriantly in the region.

II. THE CHARACTERISTICS AND SYSTEMATICALLY CLASSIFIABLE POSITION OF THE TROPICAL RAINFOREST OF XISHUANGBANNA

1. Characteristics

The tropical rainforest of Xishuangbanna has the following characteristics:

1) High species riches. There are about 180 species of vascular plant in a sample plot of 2500 sq.m. area. Neighboring trees are seldom found to be same species in the forest.

2) Multilayered vertical structure(Fig.1). The forest is characteristically stratified with three tree layers. The top layer reaches up 45—60 m high and its trees have crown branches near the top and umbellate or semiorbicular crowns. They are discontinuous, and emerge from the more continuous canopy of the second tree layer. The second tree layer, reaching up to 18—30 m high, has the most density of stems and continuous crowns and is the canopy layer of the forest. The third tree layer, occupies a vertical space of 5—20 m, with subcontinuous crowns, and can be divided into two sublayers in some stands. Under the tree layers are a sapling—shrub layer and a herb layer. The sapling—shrub layer consists mainly of sapling. True shrubs which branch from bases are few and most of them can grow into a form like young tree and up into tree layer. The herb layer is variable. Usually on slopes and under dense crown it is poorly developed while by streams and in crown gaps it develops well and is dense and thick.

3) clear change of aspect in physiognomy. The second and third tree layers of the forest are whole evergreen but the top tree layer is partially deciduous. Typical deciduous tree species take up 1/ 4—1/ 3 of total species of the uppermost trees.

4) The forest is characterized by megaphaenerophytes and mesophaenerophytes with simple, coriaceous, entire mesophylls predominate in its life form spectrum. Trees usually have smooth palecoloured bark. The uppermost trees have buttresses and lower and middle trees generally have cauliflory. Epiphytes are abundant and epiphyllous mosses on the surface of leaves are also common in the forest. Woody lianas are especially luxuriant. Strangling plants are also common.

2. Classifical Position

Based on above characteristics the tropical rainforest of Xishuangbanna is very similar to the typical tropical rain—forest in equatorial region. According to ecophysiognomical principle of vegetational classification, a true tropical rain—forest is stratifies into three tree layers[5]. The forest of Xishuangbanna, which does have three tree layers, is undoubtedly a true tropical rainforest. In physiognomy and structure the forest resembles the evergreen seasonal forest in tropical America[6] which was reclassified by P.W.Richards[7] as a subformation of the tropical rain—forest formation of tropical America. Thus the author

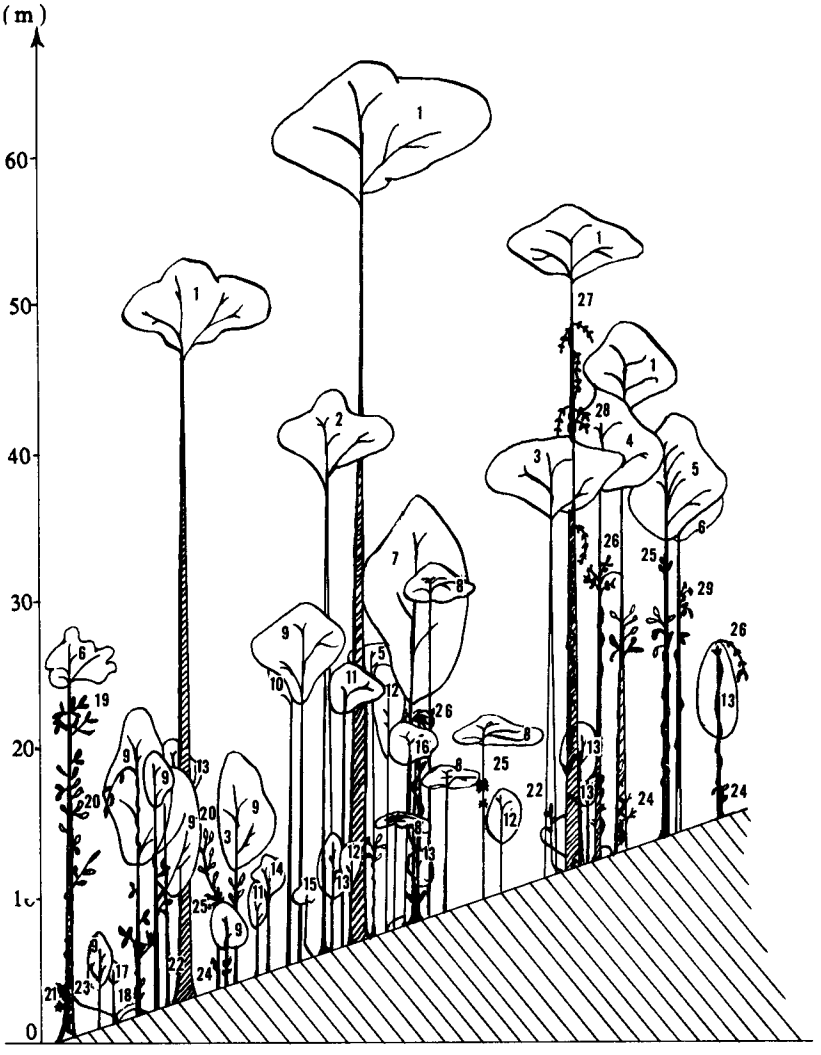

Fig.1 The profile diagram of tropical seasonal rain forest (*Parashorea chinensis* comsociation)

1. Parashorea chinensis; 2. Canarium bengalense; 3. Pometia tomentosa; 4. Elaeocarpus varunua; 5. Semecarpus reticulatus; 6. Antidesma sp.; 7. Nephelium chryseum; 8. Garcinia cowa; 9. Pseudouvaria indochinensis; 10. Vitex quinata var. *puberula; 11. Diospyros atrotricha; 12. Drypetes hoaensis; 13. Diospyros xishuangbannaensis; 14. Dysoxylum lenticellatum; 15. Pittosporopsis kerrii; 16. Baccaurea ramiflora; 17. Diospyros nigrocartex; 18. Uvaria tonkinensis; 19. Ficus subulata; 20. Rhaphidophora hongkongensis; 21. Arthropteris palisotii; 22. Ficus sagitata; 23. Rhaphidophora crassicaulis; 24. Piper mullesua; 25. Neottopteris somonsiana; 26. Salacia cochichinensis; 27. Parameria laevigata; 28. Symphorema invulucrata; 29. Ficus gibbosa* Var. *cuspidifera*

considers it appropriate that the forest type of Xishuangbanna is systematically classified by Chinese botanists such as C.Y.Wu [2-3] as tropical seasonal rainforest, a formation of Indo-Malesian tropical rainforest.

Distributed in the northern margin of the tropical mainland SE Asia and lying at more than 600 m above sea level, the tropical seasonal rainforest of Xishuangbanna occurs at the latitudinal and altitudinal limits of tropical rainforest. Its flora is endowed with the nature of northern margin of tropical zone of SE Asia and is transitional toward the subtropical flora of China. For instance, in the tropical rainforests of the core area of SE Asia the family Dipterocarpaceae predominates not only in the number of species but also in individual big trees, while in the forest of Xishuangbanna only two species of the family, i.e. *Shorea chinensis* and *Vatica guangxiensis* have been found. Other families, e.g., Myristicaceae, Guttiferae, Sapotaceae, Icacinaceae, and some genera such as *Pometia, Baringtonia, Homalium, Nephelium, Baccaurea* which have many species in tropical SE Asia, have a few or a single representative in Xishuangbanna. Most of the families which predominate in the forest of Xishuangbanna are also shared by the subtropical forests in S.China. The same tropical seasonal rainforest occurs also in SE Yunnan and SW Guangxi of S China. The kind of forest, which has the general characteristics of tropical rainforest but appears to be transitional to subtropical forests in floristic composition, is considered as the forest type of tropical seasonal rainforest at the latitudinal and altitudinal limits.

III. THE DISTRIBUTION AND TYPES OF THE TROPICAL RAINFOREST OF XISHUANGBANNA

According to the vegetational system of Yunnan[3], the tropical rainforest of Xishuangbanna can be divided into two vegetation subtypes pertaining to tropical rainforest vegetation, i.e. the tropical seasonal rainforest and the tropical montane rainforest which both contain three formations.

1. Tropical Seasonal Rainforest

Tropical seasonal rainforest is the main forest type of tropical rainforests of Xishuangbanna and the regional representative vegetation. It occurs mainly in valleys, mountains and hills below 1000 m elevation, and centring in the southeast of the region.

1. Form. Antiaris toxicaria, Pouteria grandiflora, Canarium album

This forest formation which is also called dry seasonal rainforest, occurs mainly on lower hills and lower mountains surrounding wide depressions below 800 m elevation. The areas have now been opened up to use for agriculture on a large scale and so primitive forests of the formation have been severely destroyed and there are only some more or less disturbed for ests remained in so-called "holy hill" near to villages, such as Mangyan and

Mangyanguan of Menglong, Mangjin and Chengzi of Menglun, Manfa and Mangyuan of Menghan etc..

The forest reaches up to 35—45 m high.,The top tree layer with discontinuous crowns and a projective cover degree of 20%—30%, emerge above the continuous crown canopy of the second tree layer. The representative tree species of the layer are *Chukrasia tabularis, Pouteria grandiflora, Ficus altissima, Ixonanthes cochinchinensis, Canarium album, Amoora dasyclada, Gironniera subaequalis* etc.. The second tree layer reaches up to 15—28 m high, and has a continuous crown canopy. The most representative tree species are *Knema globularis, Polyalthia cheliensis, Acronychia pedunculata, Xanthophyllum siamensis, Microcos paniculata, Garcinia xanthochymus, Mangifera siamemsis, Arytera litoralis, Turpinia montana, Mitrephora thorelii, Knema furfuracea* etc.. The lower tree layer is 5—15 m high, and the common species are *Suregoda glomerulata, Aporusa dioica, Aporusa villosa, Memecylon polyanthum, Glycosmis cochinchinensis, Ardisia depressa, Hyptianthera stricta, Millettia leptobotrya, Ostodes paniculata* etc.. The sapling—shrub layer is 1—5 m high and has a projective coverage of 30—40%. This layer consists of sapling, young lianas and shrubs. The most frequent shrub species are *Prismatomeris tetranda, Canthium horridum, Euodia lepta, Clausena dentata, Pandanus furcatus, Psychotria henryi* etc.. The herb layer is about 1 m high, and has a projective coverage of 20—80%. The frequent herbaceous plants are *Geophila herbacea, Lepidagathis incurva, Hypoestes triflora, Oplismenus compositus, Pleocnemia winittii, Tectaria variolosa* etc..

Lianas are abundant in the forest and most of them are woody. The predominant species are *Randia bispinosa, Connarus yunnanensis, Salacia polysperma, Combretum latifolium, Ventilago calyculata, Strychnos nitida, Fissistigma maclurei, Neuropeltis racemosa, Acacia intsia* var. *caesia, Thunbergia grandiflora* etc.. Epiphytes are not abundant. The common species which can be found in most stands are *Pothos chinensis, Cymbidium pendulum, Pseudodrynaria coronans, lepisorus* spp. etc..

1.2. Form. Terminalia myriocarpa, Pometia tomentosa

This forest type which is also called wet seasonal rain—forest or valley rainforest based on its habitats, occurs mainly in wetter parts of valleys and lower mountains below 1000 m elevation in the south of the region, mainly in Mengla County.

The forest of this formation has fewer deciduous trees in its top tree layer and more woody lianas as well as conspicuously more abundant epiphytes than the last one.

The forest is typically stratified with three tree layers, reaching up to 35—45 m high. The top tree layer has a projective coverage of 25—30% of which some trees are so hugh that they soar above the canopy as emergent. The representative tree species of the layer are *Terminalia myriocarpa, Pometia tomentosa, Homalium laoticum* var. *glabrescens, Elaeocarpus varunua, Sapium baccatum, Neonauclea griffithii, Garuga floribunda, Tetrameles nudiflora, Semecarpus reticulatus, Pterospermum lanceaefolium* etc.. The second tree layer with continuous crowns reaches up to 18—30 m high and is wholly evergreen. The represen-

tative tree species are *Garcinia cowa, Knema cinerea* var. *glauca, Myristica yunnanensis, Barringtonia macrostachya, Baccaurea famiflora, Mitrephora wangii, Lasiococca comberi* var. *pseudoverticillata, Symphyllia silhetiana, Nephelium chryseum, Caryota ochlandra.* The lower tree layer occupies a vertical space of 6—18 m high, and has a projective coverage of less than 50%. The common species are *Pittosporopsis kerrii, Goniothalamus griffithii, Syzygium latilimbum, Cleidion bracteosum, Trigonostemon thyrsoideum, Aglaia perviridis, Beilschmiedia purpurascens, Phoebe lanceolata, Horsfieldia tetratepala* etc.. The sapling—shrub layer consists of sapling, young lianas, and shrubs of which sapling predominate not only in individuals but also in number of species. The most frequent shrubs are *Lasianthus* spp., *Ardisia tenera, Ardisia virens, Psychotria yunnanensis, Mycetia hirta, Ixora fulgens, Duperrea pavettaefolia, Miliusa chunii, Miliusa velutina, Saprosma ternatum* etc.. The herb layer usually has a projective coverage of less than 30% and the common species are *Bolbites heteroclita, Tectaria variolosa, Phrynium capitatum, Rhynchotechum obovatum, Phlogacanthus curviflorus* var. *brevicalyx, Eranthemum polyanthum, Rungia robusta, Gomphostemma* spp., *Piper* spp..

Woody lianas are very luxuriant in this forest type. The dominant species are *Randia bispinosa, Fissistigma* spp., *Tetrastigma* spp., *Parameria* laevigata, *Combretum latifolium, Salacia polysperma, Tinomiscum tonkinensis, Erythropalum scandens, Parabarium* spp., *Calamus* spp. etc.. Epiphytes are abundant on tree trunks and branches, and the frequent species are *Rhaphidophora hongkongensis, Rh. decursiva, Hoya* spp., *Piper mullesua, Dischidia* spp. and many species of Orchidaceae and Gesneriaceae. Strangling plants such as *Ficus* spp. are common in this forest type.

This forest formation, up to now, has the largest covering area and is the relatively well—conserved and the regional representative forest type.

1.3 Form. Shorea chinensis

This forest type has been found only in the limiting habitats of Mengla County, in the far south of the region, covering about 800 ha. The formation contains only one consociation with single dominant species *Shorea chinensis* of Dipterocarpaceae. The dipterocarp consociation occurs intermittently along the Nanna river and its tributaries, the Nanhang and Nansha rivers at 700—950 m above sea level. In comparison with the former two formations this forest type is richer in species and appears more similar to typical tropical rainforest. Its floristic composition is also more similar to that of tropical SE Asia. This forest type belongs to the dipterocarp forests of SE Asia and is a type of northern margin of the latter.

This dipterocarp forest, reaching up to 60 m high, is the tallest forest in S China. The top tree layer with very uneven crown canopy reaches 30—60 m high and has a projective cover degree about 30%. As emergent the single dominant species *Shorea chinensis* is the tallest tree which with crown branches near the top and semiorbicular crown soars high. Other top tree species, such as *Pometia tomentosa, Terminalia myriocarpa, Sapium*

baccatum, Neonauclea griffithii, Machilus tenuipilis, Semecarpus reticulatus, Cyclobalanopsis chrysocalyx, Sloanea dasycarpa, Canarium bengalense, Amoora tetrapetala etc. usually occupy a space of 30–45 m high above the continuous crown canopy of the second tree layer and under the crown of *Shorea chinensis*. The second tree layer reaches up to 18–30 m high. *Garcinia cowa* predominates in this layer and representative species are *Ficus langkokensis, Symphyllia silhetiana, Knema furfuracea, Pseudouvaria indochinensis, Barringtonia macrostachya, Gironniera subaequalis, Knema cinerea* var. *glauca, Pterospermum monglunensis, Diospyros xishuangbannaensis, Nephelium chryseum* etc.. The third tree layer is 6–20 m high and can be roughly divided into two sublayers. The upper sublayer occupies 10–20 m high and has the common species i.e. *Baccaurea ramiflora, Dichapetalum genonioides, Eurya astroyunnanensis, Beilschmiedia purpurascens, Diospyros atrotricha, Memecylon cyanocarpus* etc.. The lower sublayer is 6–10 m high. The species *Pittosporopsis kerrii predominates and other common species are Phoebe lanceolata, Cleidion bracteosum, Syzygium latilimbum, Trigonostemon thyrsoides, Diospyros nigrocortex, Mezzettiopsis creaghii,* Litsea *garrettii* etc.. The sapling–shrub layer is 1.5–5 m high and has a projective coverage of 20–30%. The frequent shrub species are *Saprosma ternatum, Ixora amplexicaulis, Urophyllum sinensis, Drypetes hoaensis, Lasianthus sikkimensis, Lasianthus wallichii, Mycetia gracilis, Randia yunnanensis, Psychotria yunnanensis* etc.. The herb layer has the projective coverage which varies from 10% to 70% depending on microhabitats. The frequent species are *Acanthus leucostachys, Phrynium placentarium, Rhynchotechum obovatum, Amischotolype hookeri, Elatostemma megacephalum, Pteris quilleana* etc.

Lianas are very abundant in the dipterocarp forest. There are about 40 liana species in a sample plot of 2,500 square meters area of which woody lianas take up about 90 %. The dominant lianas are *Tetracera scandens, Randia bispinosa, Parameria laevigata, Bythneria intergrifolia, Calamus gracilis, Combretum latifolium.*

Epiphytes are also abundant in the forest. The frequent species are *Rhaphidophora hongkongensis, Ficus sagittata, Neottopteris somonsiana, Rh. decursiva, Rh. crassicaulis, Arthropteris palisotii, Piper mullesua, Aeschynanthus* spp., *Micrechites polyantha* and a number of Orchidaceae species etc.. Strangling plants, such as *Ficus subulata, Fidus gibbosa* var. *cuspidifera* etc., are common. Some root parasitic plants, such as *Aphyllorchis caudata, Balanophora* spp. etc., also occurs in the forest.

2. Tropical Montane Rainforest

Tropical montane rainforest is a transitional forest type from seasonal rainforest (in Xishuangbanna) toward monsoon evergreen broad–leaved forest of tropical mountains, and is also the limiting altitudinal type of tropical rainforest. In Xishuangbanna, the tropical montane rainforest is usually located between the seasonal rainforest and the monsoon evergreen broad–leaved forest at an altitude of 800–1,000 m above sea level. In some

montane habitats affected by temperature inversion the montane rainforest appears disjunctively in or above the altitudinal zone of the evergreen broad-leaved forest in 1,200–1,800 m elevation, but in the mountains surrounding lower depressions the montane rainforest occurs as low as 700 m elevation.

The montane rainforest has the basic physiognomical and structural characters and floristic composition of tropical rainforest, but in comparison with the seasonal rainforest in the region the montane rainforest indicates the features that the forest usually reaches up 25–30 m high; its top tree layer with continuous crowns forms the forest canopy without emergent; buttresses, cauliflory and caudate leaves are less frequent than in seasonal rainforest; and woody lianas are a little less abundant but epiphytes are conspicuously more abundant. In addition family Cyatheaceae is frequent in the forest as characteristic plants.

The montane rainforests in Xishuangbanna do not cover a large area. Many places which the montane rainforest covered have now completely changed to agricultural fields, and the relict forests can be divided into three formations as following:

2.1 Form. Alstonia scholaris, Paramichelia baillonii

This forest type occurs mainly in the lower mountains surrounding the depressions in Mengla County, above the altitudinal belt of seasonal rainforest and at 700–1000 m elevation. The representative species in the top tree layer are *Alstonia scholaris, Paramichelia baillonii, Castanopsis histryx, Schima wallichii, Actinodaphne henryi.*

2.2 Form. Dysoxylum spicatum, Semecarpus reticulatus, Phoebe nanmu

This forest type occurs in the middle mountains of 900–1500 m elevation in the north of the region. The representative species are *Dysoxylum spicatum, Semecarpus reticulatus, Harpullia cupanioides, Phoebe nanmu, Schima wallichii, Calophyllum polyanthum, Castanopsis indica* etc..

2.3 Form. Manglietia wangii

The forest formation contains one consociation with *Manglietia wangii* the single dominant tree species, and occurs in Manpa of Mengla County.

IV. THE URGENCY OF CONSERVATION OF THE TROPICAL RAINFOREST

Xishuangbanna occupies geographically a special position where not only in latitude but also in altitude the rapid transition from true tropics to subtropics happens. It also occurs at the boundary of the Indian plate of Gandwana and the Eurasian plate of Laurasia in continental drift. Therefore, the vegetation and flora of the region occupies a key position in the connection of that of subtropical China to tropical SE Asia and have important scientific research value.

The tropical rainforest and other vegetation types in the region show a mosaic distributional pattern and compete severely each other. Once destroyed the tropical rainforest can hardly recover naturally because of the strong competition of other vegeta-

tion types.

In 1950s, the natural forest coverage in Xishuangbanna is more than 50% of total area but the investigation in 1978 indicated that the coverage had decreased to 34%. Up to now the natural forests have been largely destroyed for rubber tree plantation and shifting cultivation. The area where the tropical rainforest occurs is the most densely populated area, and so in the activities referring to the natural forest destruction the tropical rainforest suffers most. Now the conservation and research to the forest vegetation of Xishuangbanna, especially the tropical rainforest, are very urgent and have to be done at once.

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