STUDIES ON THE FOREST ECOSYSTEM IN AILAO MOUNTAINS YUNNAN,CHINA

哀牢山森林生态系统研究

中国科学院昆明生态研究所
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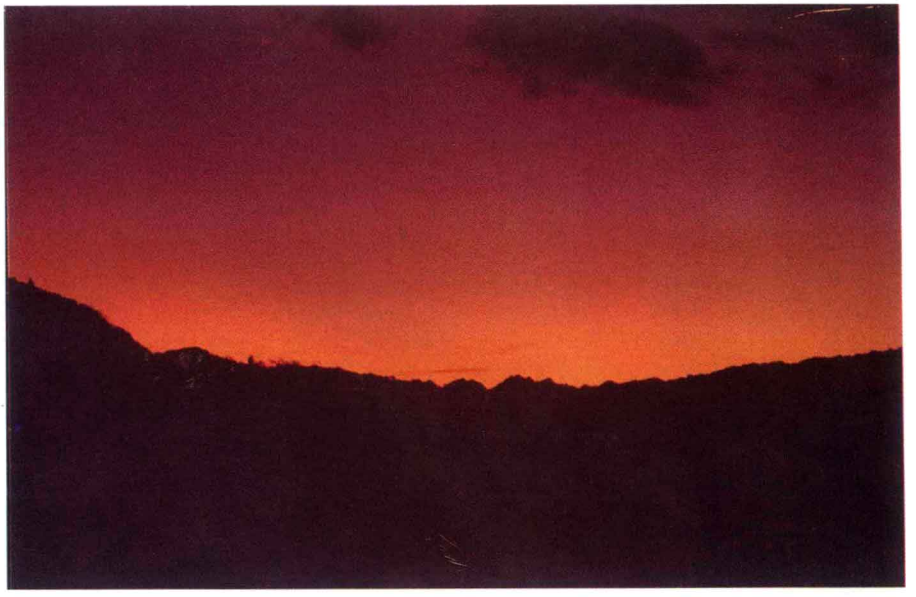
刘起蓉

1. 哀牢山山顶夷平面上的明珠——杜鹃湖，湖周为亚热带中山湿性常绿阔叶林所环绕，湖水清澈，山水相映，一派迷人的景色。

2. 杜鹃湖一角。

3. 浓郁和微波状起伏的林冠，春末夏初在绿色之外貌上常缀以黄、淡黄、肉红色的斑块和斑点，使林貌显得格外的醒目和美丽。

4. “云海”是一种由于冷空气下沉形成的奇特景观，这是在哀牢山地区冬春季节常见的云海景色，海拔1520m。



5. 山顶夷平面上之晚霞。

6. 座落在杜鹃湖畔和密林深处的哀牢山森林生态系统定位研究站。

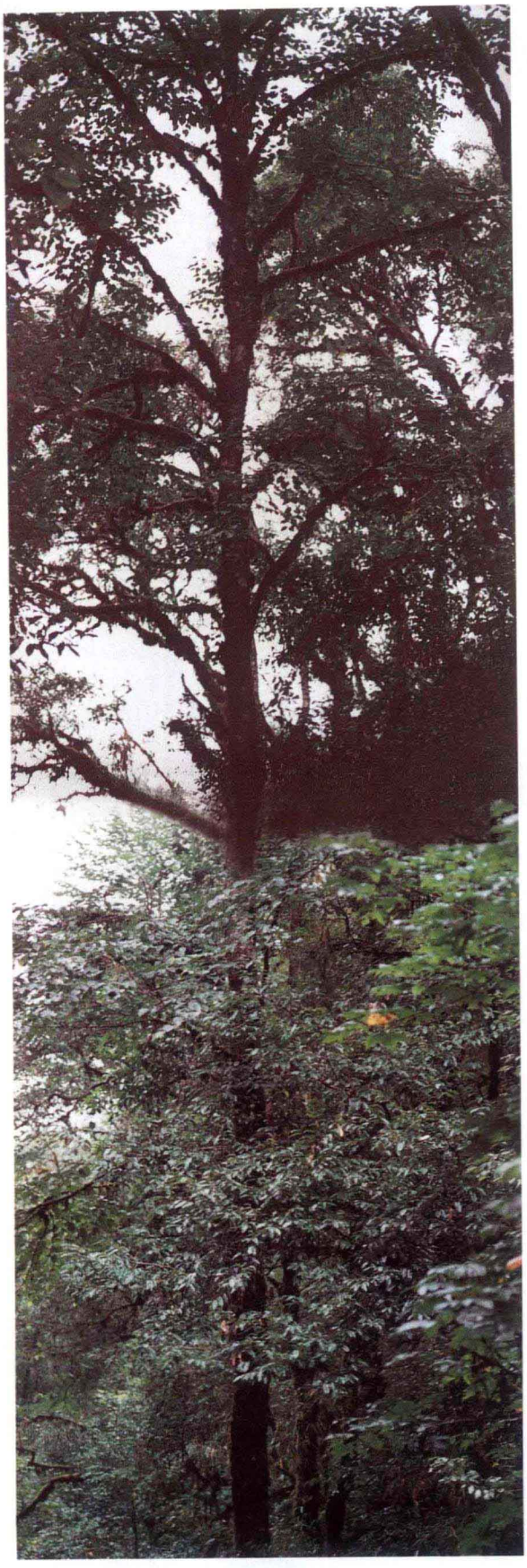
7. 设置在林外旷地上的小气候观测站，海拔2500m。

8. 林下优势草本植物——西南瘤足蕨(Plagiogyria communis)。

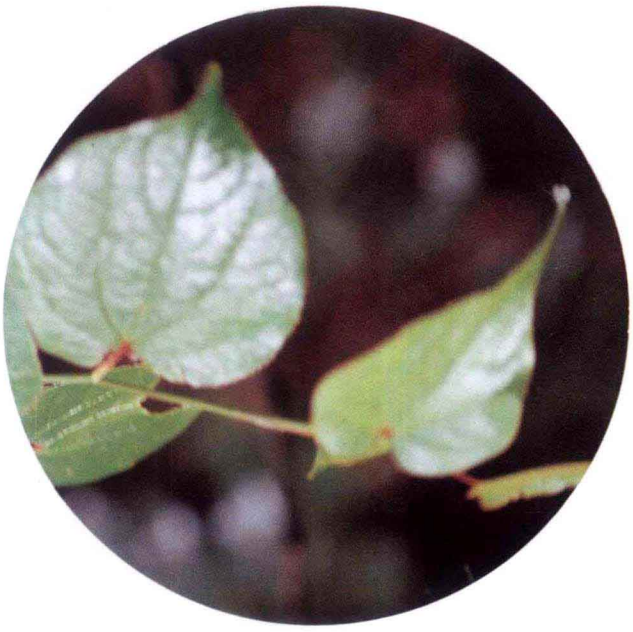
9. 林内挺拔的树干及粗壮的常绿蔷薇(Rosa longicuspis)。

10. 林内树干及树枝上满布的苔藓及附生植物。

11. 附生蕨类植物



12. 高大而挺拔的国家二级保护植物——水青树(Tetracentron sinense)。



13. 水青树的小枝。

14. 常年流水不断的枇杷箐瀑布。

15. 组成乔木亚层的优势种——小花山茶(Camellia forrestii)。

16. 花色秀丽的露珠杜鹃(Rhododendron irroratum)。

17. 哀牢山区分布甚广的马樱花(Rhododendron delavayi)杜鹃。

18. 林内常见的大花八角(Illicium macranthum)。

19. 滇木荷(Schima nolonhae)——组成森林上层乔木的优势种之一。

20. 正处于盛花的红花木莲(Mangleitia insignis)是组成乔木亚层的优势种。

21. 在乔木亚层中常见的主要种多花含笑(Michelia floribunda)。

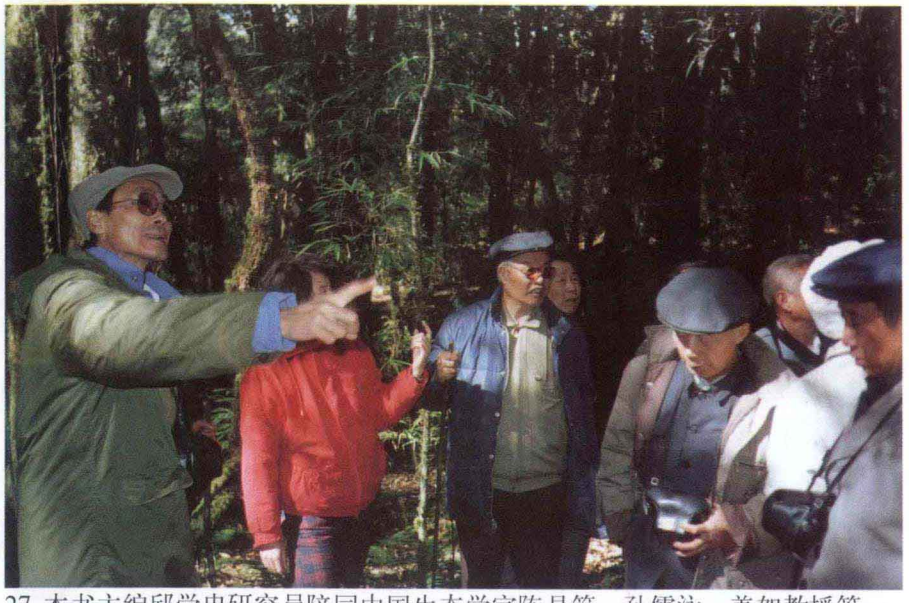
22. 正处于盛果季节的吴茱萸叶五加(Acanthopanax evodiaefolius)。

23. 林下密集生长和发达的箭竹(Sinnarundinaria nitida)层片。

24. 设置在林内的森林小气候观测站，海拔 2498m。

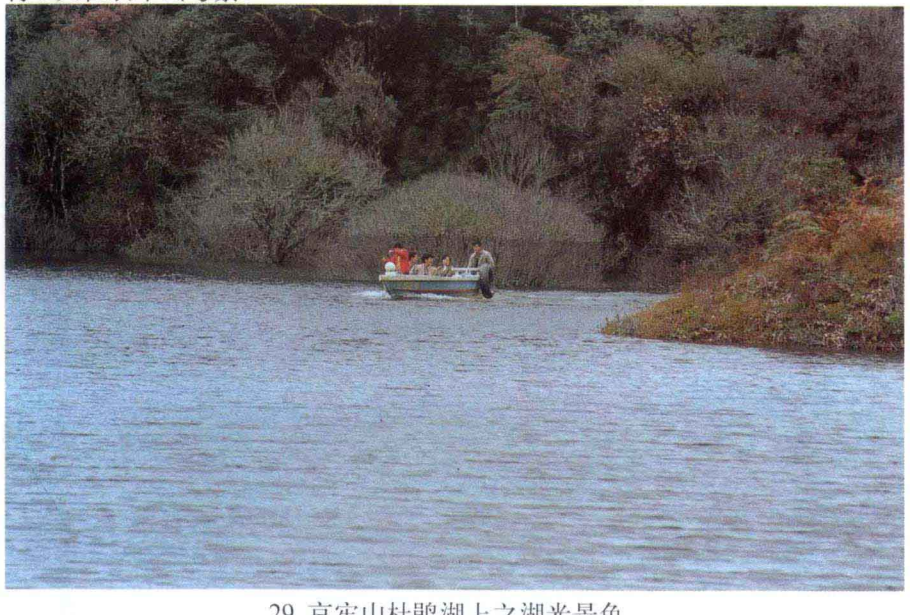
25. 观测树干茎流。

26. 收集森林凋落物。



27. 本书主编邱学忠研究员陪同中国生态学家陈昌笃、孙儒泳、姜恕教授等一行6人在哀牢山考察。

28. 美国自然研究组织一行10余人在哀牢山进行科学考察。



29. 哀牢山杜鹃湖上之湖光景色。

30. 本书主编和中国生态学家在哀牢山之巅合影留念。

前　言

云南哀牢山常绿阔叶林生态系统结构和功能的动态监测研究，系云南省基金委员会“八五”期间着重支持的主要项目之一，为期5年，即1991～1995年。

常绿阔叶林是发育在亚热带气候条件下的一种常绿林植被类型，它是全球亚热带大陆东岸湿润气候和季风气候下的产物，是一种湿润性的常绿森林类型。目前在世界上，它主要分布在亚热带地区大陆东岸，大致分布于南北纬度22°～40°之间的地区，即分布在亚洲的中国，北起秦岭—淮河，南到两广南部，西至四川和云南的大部分地区，以及朝鲜和日本的南部；非洲的东南部；大西洋中的加那利群岛、马德拉群岛；美国的东南部和大洋洲的一些地区。常绿阔叶林以我国分布面积最大，发育最为典型，它横跨了10个纬度，约250余万平方公里，因而具有巨大的生态效益和社会、经济效益。

哀牢山纵贯云南中南部，是我国云贵高原、横断山地和青藏高原三大自然地理区域的结合部，是云南亚热带北部与亚热带南部的过渡区，是生物多样性较丰富及植物区系地理成分荟萃之地。保存着我国亚热带地区目前面积较大，且以云南特有植物种为优势的常绿阔叶林。

被选定的研究对象为地处哀牢山山体上部徐家坝附近的亚热带中山湿性常绿阔叶林，约当北纬24°32′，东经101°01′，本森林有别于亚热带半湿润常绿阔叶林，其面积之大，分布之广及性质之原始，实属世间罕见。为探索该森林生态系统的结构、功能及其动态规律，以定位研究之基本方法，设置了永久样地，从生态环境、区系组成、群落结构、种群动态、植物生长及发育节律、生物量及净生长量、养分循环以及水分动态等方面进行了监测和研究，已按计划要求完成了任务，取得了初步结果，现分十二章分述于后。由于受业务水平之所限，错误和不当之处在所难免，恳请大家指正。

STUDIES ON THE STRUCTURE, FUNCTIONS AND DYNAMICS OF EVERGREEN BROAD-LEAVED FOREST ON Mt. AILAO IN YUNNAN

SUMMARY

Evergreen broad-leaved forest is formed under the humid climate and monsoon conditions of the subtropical east coastal region. In present world, this type of forest is declining, it distributes mainly in the subtropical areas from 22° to 40° north and south altitudes of east coastal areas of the continent. China's evergreen broad-leaved forest is the biggest in area in the world and is well developed. Wet evergreen broad-leaved forest on mountains, a subgroup of subtropical evergreen broad-leaved forest, distributes widely in Yunnan. It covers almost all subtropical middle mountains. It is not only the major forest type but the characteristic and representative vegetation type of the vertical forest spectra of mountains in Yunnan as well. Therefore, subtropical wet evergreen broad-leaved forest on middle mountains is selected to conduct studies on the forest structure, functions and dynamics. The studies have important scientific value and global significance.

Meteorological studies indicate that the study area is controlled by both the south sub-current of the west current from India and Pakistan, which is divided by the Tibetan plateau, and the southeastern monsoon. Thus the climate of this area has obvious dry and wet alternation and is the western monsoon climate type of China. The ecological climate of wet evergreen broad-leaved forest on middle mountain, that is, the climate connected with organisms is warm temperate according to the accumulated temperature. The overall characteristics of this climate is that it is not cold in winter, not hot in summer and mild and wet around a year.

Mountain yellow-brown soil is developed under the wet evergreen broad-leaved forest on middle mountain and distributes continuously as belts. The soil property and its use direction are different from the horizontal representative yellow-brown soil. This soil has soft structure, deep layer, medium soil quality, big porosity, good surface water penetrating ability and big water retention. It has high content of organic matter ($>10\%$) and nitrogen ($\sim 0.4\%$).

The flora of the forest has the characteristics of multiple families and genera based

on the typical investigation. *Lauraceae*, *Theaceae*, *Fagaceae*, *Magloniaceae* and *Rosaceae* are the main families that constitute the forest plant communities. Those families are also the characteristic flora of the western subtropical evergreen broad-leaved forests in China. The flora constitution is the subtle combination of tropical, temperate and endemic species. And China's endemic species has the largest proportion. The distribution of the five flora types in the forest community is as followings: northem marginal types of tropical southeast Asia, China Himalaya type, China and Japan type and Yunnan endemic occupy the tree layer A and B; especially the layer B; Under the canopy, China Himalaya type has the biggest number, next are China and Japan type, Yunnan endemic and northem marginal type of southeast Asia. To sum up, China Himalaya species are the major constituents, endemic species of southwestern China are the characteristic constituents, they two occupy 60.2% of the total flora, and both of them interact and overlap in every layers with the northern marginal species of tropical southeastern Asia. All of these indicate that the study area and the above related areas have same origin of flora development.

Like typical subtropical evergreen broad-leaved forest, this type of forest has distinct four layers with relative rich inter-layer species, including big and tall tree layer and well developed shrub layer (*Sinarundinaria nitida* layer). The upper part of tree layer is constitute of *Castanopsis wattii*, *Lithocarpus xylocarpus*, *Schima noronhae* and *Lithocarpus chintungensis* mainly, these are the dominating species of the upper with above 100 obviousness value. *Machilus viridis*, *Manglietia insignis* and *Vaccinium duclouxii* etc. are the dominating species of the tree sub-layer. Tree species with importance value between 50 to 70, such as *Camellia forrestii*, *Eurya obliquifolia*, *Eriobotrya bengalensis* and *Michelia floribunda* are the main constituents of the tree sub-layer. Like typical evergreen broad-leaved forest of southern China, 1. this forest's trees are belonging to *Lauraceae*, *Theaceae*, *Fagaceae* and *Magloniaceae* mainly, 2. in its understorey there is a well developed layer of *Sinarundinaria nitida*, and shrubs and grasses, which are common in southern China, 3. it is rich in vines and epiphytes comparatively, 4. it has a continuous and uniform evergreen canopy and 5. the major leave form of trees is the medium-sized leave of ellipse shape. It is a real'laurisilvae', a forest of shining leaf which is the common characteristics of evergreen broad-leaved forest. Moreover, evergreen high bud species is the dominating life-form of its plant community, som trees have buttress, many plants' leaf have pointed end for dropping water and it is rich in mosses and other epiphytes due to its special location and unique habitat. The above ecological characteristics reflect the wet aspect of the habitat in certain extent.

Biodiversity of the Forest. Investigation on eight plots of 3200 m^2 at different developing stages indicates that this forest is not rich is species, with 40～69 species only, which is lower than that of wet evergreen broad-leaved forests on middle mountains in

northeastern, central (Mt. Wumeng in Luquan) and southeastern Yunnan. Followings are species diversity indexes and homogeneity of the forest: Simpson index is between 0.7 to 0.9, homogeneity is around 0.70～0.95; Shannon index is around 2.0～3.0, homogeneity is 0.6～0.8; while McIntosh index is around 0.5～0.7, homogeneity is 0.5～0.7. No doubt, all of these data can be used as the diversity index of this forest. Comparison of diversity between different layers of the forest community shows that species richness decreases from bottom layer (grass layer) to the top layer (tree layer A), however, species diversity index and homogeneity have no such tendency. The number of plants and species richness of same BHD (breast high diameter) decreases with the increase of BHD as well. The above data shows the continuousness of the vertical structure of the forest and the stability of the community. However, there is no regular law but great irregular variation in the species diversity in the forest. This just reflects the difference of the constitution of the tree layer in certain extent.

Not like temperate forest, the growth rhythm of the forest is similar to that of the tropical forest. Plants flower and bear fruits almost around a year. March and April are the major flowering (70%) and fruit bearing (75%) season. All nuts and the fruits of *Schima noronhae* ripe in the next year's summer or autumn. This phenomenon is related with the low temperature and the high altitude. It is also a bio-ecological characteristics of the forest. Excluding deciduous species, which have a obvious winter dormancy, all evergreen species has no obvious leave fall season. Change of leaf is the way of the leaf alternation and it occurs usually during winter and spring. There are three types of ecological phenology, namely, warm temperate, temperate and temperate cool in the forest. Warm temperate is the most common type. Thus, it shows the characteristics of warm temperate further. In short, the growth and develop rhythm of this forest shares some characteristics with the tropical rain forest, and has some properties of temperate forest as well, and meanwhile, it shows its own uniqueness which is different from other forests.

Biomass and the Net Productivity of the Forest. According to measurement, the total biomass of this forest is 507.70t/ha, among which, 98.3% is from the tree layer, shrub layer and grass layer only occupy 1.5% and 0.2% respectively. This indicates that tree layer is the major constituent of the biomass. Net productivity, i.e., yearly mean net production of the forest, is 12.1051 t/ha, which is produced mostly by tree layer also. The net productivity of this forest is higher than that of the 30 years old *Fagus* evergreen broad-leaved forest in Jianqing County of Zhejiang province.

Structure and Dynamics of the Population. According to the investigation and analysis of the four dominating species of *Lithocarpus xylocarpus*, *L. Chintungensis*, *Castanopsis wattii* and *Schima noronhae*, all of them have a growing population. Based on the comprehensive analysis of the size, structure and survival curve of the population, the popu-