

Combined community ecology and floristics, a synthetic study on the upper montane evergreen broad-leaved forests in Yunnan, southwestern China

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ABSTRACT

The upper montane evergreen broad-leaved forest in Yunnan occurs mainly in the zone of persistent cloud and has a discontinuous, island-like, distribution. It is diverse, rich in endemic species, and likely to be sensitive to climate change. Six 1-ha sampling plots were established across the main distribution area of the upper montane evergreen broad-leaved forest in Yunnan. All trees with d.b.h. > 1 cm in each plot were identified. Patterns of seed plant distributions were quantified at the specific, generic and family levels. The forests are dominated by the families Fagaceae, Lauraceae, Theaceae and Magnoliaceae, but are very diverse with only a few species shared between sites. Floristic similarities at the family and generic level were high, but they were low at the specific level, with species complementarity between plots. Diversity varied greatly among sites, with greater species richness and more rare species in western Yunnan than central Yunnan. The flora is dominated by tropical biogeographical elements, mainly the pantropic and the tropical Asian distributions at the family and genus levels. In contrast, at the species level, the flora is dominated by the southwest or the southeast China distributions, including Yunnan endemics. This suggests that the flora of the upper montane forest in Yunnan could have a tropical floristic origin, and has adapted to cooler temperatures with the uplift of the Himalayas. Due to great sensitivity to climate, high endemism and species complementarity, as well as the discontinuous, island-like, distribution patterns of the upper montane forest in Yunnan, the regional conservation of the forest is especially needed.

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1. Introduction

Yunnan Province of southwestern China lies between 21°09' and 29°15' N, 97°32' and 106°12' E, and occupies an area of 394,100 km². It has a mountainous topography with mountain ridges generally running in a north-south direction, decreasing in elevation southward. Its elevation ranges from 76.4 m at the lowest valley bottom in the southeast (Red River) to 6740 m at the highest mountain summit in the northwest. Yunnan is extremely diverse in habitats and topography. The general climatic pattern consists of tropical wet climates in the southern lowlands, tropical dry climates in deep valleys below 1000 m alt. due to the Foehn effect,

subtropical climates on the central plateau, and temperate to cold temperate climates in the northern high mountains.

Several comprehensive vegetation studies in Yunnan (Wu, 1987; Shimizu, 1991; Jin, 1979, 1992) have also been published. Previously, the evergreen broad-leaved forest was treated as a vegetation type in the vegetation classification of Yunnan (Wu, 1980, 1987). The upper montane evergreen broad-leaved forest was classified into the type of mid-montane wet evergreen broad-leaved forest (Jin, 1979).

The upper montane evergreen broad-leaved forest in Yunnan is a species-rich vegetation type and of important significance in the ecosystem and conservation. Aside from several works on community characteristics (Meng et al., 2013) and species composition (Yang et al., 2010) based on one site plot survey, there have been fewer studies on the upper montane forests in Yunnan. Due to geographical isolation and habitat heterogeneity, the floristic

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composition, species diversity and vegetation structure of this kind of forest has conspicuous variation across its distribution area. Studies on single plots can give limited information (Peng and Wu, 1998; Wang and Peng, 2004; Liu and Peng, 2007; Gong et al., 2011). To provide a better understanding of this kind of forest, we established six 1-ha plots across the main distribution area of the upper montane evergreen broad-leaved forest in Yunnan.

The upper montane evergreen broad-leaved forest in Yunnan has been likened to cloud forests or mossy forests of Asia (Shi and Zhu, 2009). Studies on cloud forests have mainly been done in tropical America, especially focusing on the Mexican montane forests (Alcántara et al., 2002; Cavelier et al., 1996; Hamilton et al., 1994; Kapos and Tanner, 1985; Kelly et al., 1994; Luna-Vega et al., 2001; Nadkarni et al., 1995; Sugden, 1982; Torre-Cuadros et al., 2007; Williams-Linera, 2002; Williams-Linera et al., 2005), while relatively few studies have been conducted in SE Asia (Aiba and Kitayama, 1999; Bruijnzeel et al., 1993; Meijer, 1959; Ohsawa, 1991; Sakhan et al., 2002).

As a new attempt, community ecology and floristics were combined in vegetation studies by Wu Zhengyi in his huge works (Wu, 1980, 1987). Recently, this integrated approach has successfully been used in the tropical forest studies in southern Yunnan to clarify the nature of vegetation types (Zhu, 1997, 2004, 2008; Zhu et al., 1998, 2005, 2006a,b, 2015a,b). In this article, the combination of community ecology and floristics are used to explore the physiognomy, species composition, plant diversity and biogeography of the forest, and to provide suggestions for its conservation.

2. Methods

Six 1-ha sampling plots were established in well-conserved forest patches across the main distribution area of the upper montane evergreen broad-leaved forest in Yunnan (Fig. 1), among them three are located in western Yunnan and three in central Yunnan. Our plots were selected in currently well-conserved patches of the forest (it is impossible to design well-distributed sampling plots according to normative latitude and altitude in Yunnan due to the complicated topography and serious human disturbances). Each 1-ha sampling plot was divided into 100 10 m × 10 m subplots. All trees with d.b.h. > 1 cm in each plot were identified and their d.b.h. and height measured. Importance value indices (IVI) (Curtis and McIntosh, 1951) were calculated for each tree species in the six 1-ha plots (IVI = Relative abundance + Relative dominance + Relative frequency). In each 1-ha sampling plot, importance value indices at family level were calculated by the sum of all species in this family. Shannon–Wiener index ($H' = -\sum(P_i \cdot \ln P_i)$) and Simpson's diversity index ($D = 1 - \sum P_i^2$) for species diversity were calculated from the plot data. Species authorities follow *Flora Reipublicae Popularis Sinicae* (*Flora of China*). Patterns of seed plant distributions were quantified at the specific level from data in the *Flora of China*, at the generic level based on Wu's documentation (1991) and at the family level following Wu et al. (2003). Comparisons of both floristic composition and geographical elements were made to assess floristic similarities and variation in these sites, as well as to determine biogeographical affinities of the upper montane forest.

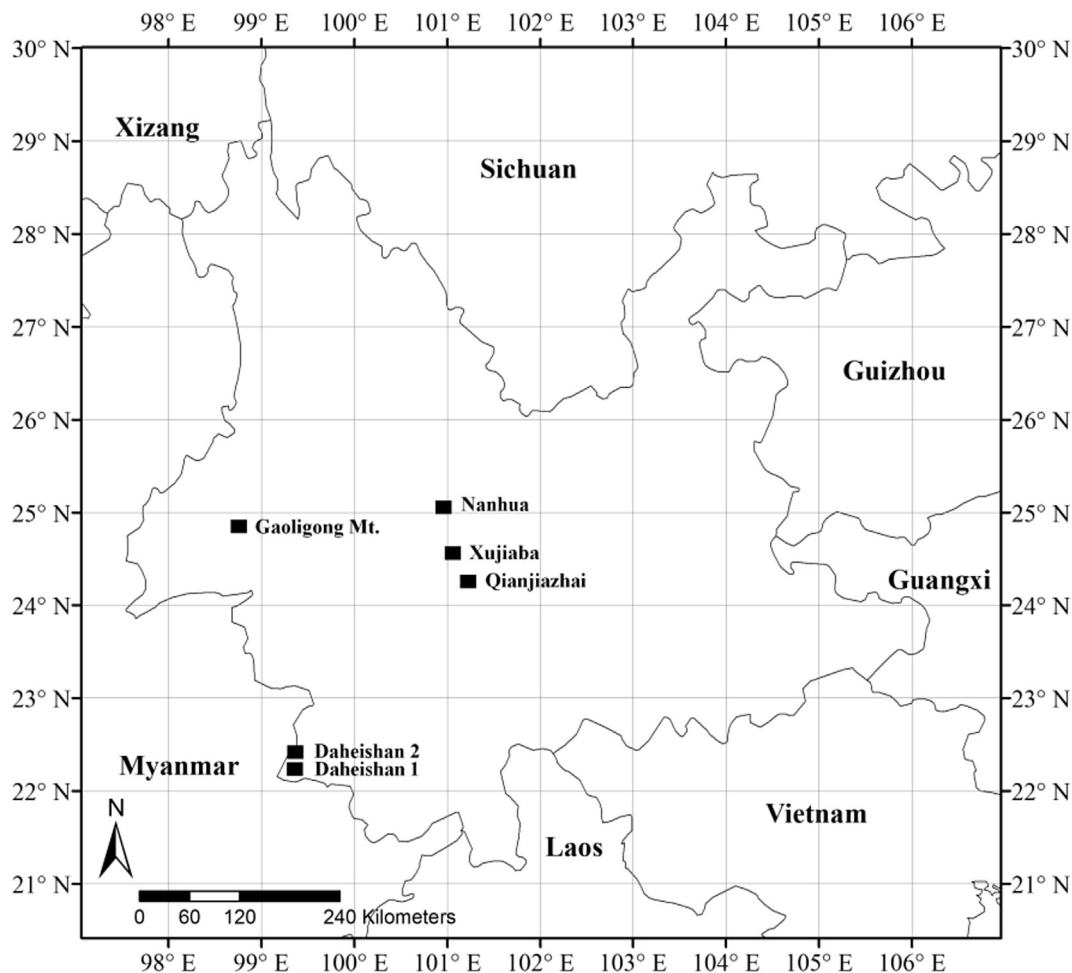


Fig. 1. Location of plot sites.

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