# Postprint of the Study on Schima argentea Community in the Middle Section of the Luoxiao Mountains

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## Abstract

Schima argentea is an evergreen tall tree in the family Theaceae, commonly employed as a fire-resistant species in afforestation and possessing significant ecological value. The Luoxiao Mountains represent an important habitat in eastern Asia. To augment vegetation type research in the Luoxiao Mountains region and investigate the relationships between S. argentea communities and both elevation and latitude, this study utilized phytocoenological methods to survey four typical S. argentea communities in the middle section of the Luoxiao Mountains: Jinggangshan, Qiyunshan, Nanfengmian, and Wuzhifeng. The results demonstrate: (1) The four communities comprised 84, 106, 78, and 99 species of vascular plants belonging to 50, 70, 47, and 66 genera within 30, 45, 33, and 38 families, respectively. (2) S. argentea served as the dominant species in Jinggangshan and Qiyunshan, exhibiting the highest importance value within these communities; it functioned as a sub-dominant species in Nanfengmian and Wuzhifeng. (3) The S. argentea communities in Jinggangshan, Qiyunshan, and Wuzhifeng displayed high species richness with uniform distribution, whereas the community in Nanfengmian exhibited relatively low species richness with non-uniform distribution. (4) The successional stages of S. argentea differed among the four communities: populations in Jinggangshan and Qiyunshan represent a transition from stable to declining types; the Nanfengmian population occupies a declining stage; the Wuzhifeng population, following a period of decline, can recolonize the community. (5) Phanerophytes exceeded 75% of total species across all four communities, followed by geophytes and hemicryptophytes. Conclusion: The four S. argentea communities can be categorized into two types: the first is the Nanfengmian community, characterized by features of Rhododendron simiarum forests; the second comprises the Jinggangshan, Qiyunshan, and Wuzhifeng communities, which are taxonomically rich with high biodiversity,

dominated by tropical genera, and exhibit decreasing species numbers with increasing elevation and latitude. S. argentea communities constitute a typical representative of mid-subtropical evergreen broad-leaved forests. The coexistence of S. argentea communities at various successional stages provides additional evidence that the middle section of the Luoxiao Mountains region functions as a plant habitat.

## Full Text

## Preamble

### Schima argentea Communities in the Middle Luoxiao Mountains

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## Abstract

*Schima argentea* is a tall evergreen tree in the family Theaceae, commonly used as a fire-resistant species in afforestation and possessing significant ecological value. The Luoxiao Mountains represent an important habitat in eastern Asia. To enrich vegetation type studies in this region and explore the relationship between *S. argentea* communities and elevation and latitude, we investigated four typical *S. argentea* communities in the middle Luoxiao Mountains: Jinggangshan, Qiyunshan, Nanfengmian, and Wuzhifeng. The results show: (1) The four communities contained 84, 106, 78, and 99 vascular plant species belonging to 50, 70, 47, and 66 genera and 30, 45, 33, and 38 families, respectively. (2) *S. argentea* was the dominant species in Jinggangshan and Qiyunshan, with the highest importance values in these communities, while it was a secondary dominant species in Nanfengmian and Wuzhifeng. (3) The *S. argentea* communities in Jinggangshan, Qiyunshan, and Wuzhifeng exhibited high species richness and even distribution, whereas Nanfengmian showed relatively low species richness and uneven distribution. (4) The successional stages of *S. argentea* populations differed among the four communities: Jinggangshan and Qiyunshan populations were transitioning from stable to declining stages, Nanfengmian populations were in a declining stage, and Wuzhifeng populations, after a period of decline, could re-invade the community. (5) Phanerophytes accounted for over 75% of total species in all four communities, followed by geophytes and hemicryptophytes.

**Conclusion:** The four *S. argentea* communities can be divided into two types: First, the Nanfengmian community, characterized by *Rhododendron simiarum*

forest features; second, the Jinggangshan, Qiyunshan, and Wuzhifeng communities, which are species-rich with high biodiversity, dominated by tropical genera, and show decreasing species numbers with increasing elevation and latitude. *S. argentea* communities are typical representatives of mid-subtropical evergreen broad-leaved forests. The coexistence of *S. argentea* communities at different successional stages further demonstrates that the middle Luoxiao Mountains region serves as an important plant habitat.

**Keywords:** species composition, community structure, importance value, species diversity, size structure, life type

## Introduction

*Schima argentea* is a tall evergreen tree in the Theaceae family that shows little soil selectivity, tolerates poor conditions, and possesses strong wind resistance. It is commonly used as a fire-resistant tree species (Li Yonglu, 1988) and demonstrates good afforestation effects (Cao Zhanbo et al., 2014), holding important ecological value. Current community studies on *S. argentea* have focused on a permanent 500 $m^2$ plot at 820 m elevation on Jinyun Mountain in Chongqing (Liu Yucheng and Miao Shili, 1992; Liu Yucheng et al., 1993; Tang Yuanhui et al., 2010; Zeng Hua et al., 2010). However, research on *S. argentea* communities in mid-elevation montane zones and investigations into how environmental factors such as elevation and latitude affect these communities remain unreported. This study examines *S. argentea* communities distributed in the mid-elevation montane zones above 1800 m in Nanfengmian, Jinggangshan, Qiyunshan, and Wuzhifeng in the middle Luoxiao Mountains. By comparing these communities with those on Jinyun Mountain at lower elevations, we explore the effects of elevational and latitudinal changes on *S. argentea* communities to more comprehensively reflect their community ecological characteristics. Additionally, this research enriches the vegetation type database for the Luoxiao Mountains and further confirms the region' s status as an important habitat in eastern Asia.

### 1.1 Study Area Overview

The Luoxiao Mountains span across Jiangxi, Hunan, and Hubei provinces in a humid subtropical monsoon climate zone, with zonal vegetation characterized by subtropical evergreen broad-leaved forests. The region harbors rich biodiversity and serves as an important habitat in eastern Asia, containing various vegetation types from humid regions of the Northern Hemisphere (Gong Huili et al., 2016). Based on the distribution of *S. argentea* in the middle Luoxiao Mountains, we established four 1600 $m^2$ sample plots in evergreen broad-leaved forests where *S. argentea* was dominant: Jinggangshan (Ji' an City, Jiangxi), Qiyunshan (Guidong County, Hunan), Nanfengmian (Suichuan County, Jiangxi), and Wuzhifeng (Shangyou County, Jiangxi). Detailed geographical information for each plot is provided in Table 1 (Jing Huijuan et al., 2014; Zhou Lanping et al., 2010; Wang Lei et al., 2013; Liu Lei et al., 2011).

### 1.2 Sample Plot Survey

In each *S. argentea* community, we established a 1600 $m^2$ sample plot divided into 10 m × 10 m quadrats. Using complete enumeration, we recorded all trees and shrubs with diameter at breast height (DBH) ≥ 1.5 cm and height > 2 m, including species name, girth, height, and crown width. Within each quadrat, we also established a 2 m × 2 m subplot to record seedlings and herbaceous species, documenting species name, height, individual number, and coverage (Wang Boxun et al., 1996).

### 1.3 Data Analysis

**(1) Areal-type analysis:** We classified distribution patterns following Wu Zhengyi' s (1991) principles for Chinese seed plant genera.

**(2) Importance value analysis:** For trees and shrubs above the measurement threshold, we calculated relative abundance (RA), relative frequency (RF), relative dominance (RD), and importance value (IV) using the following formulas (Wang Boxun et al., 1996):

RA = (Number of individuals of a species / Total number of individuals of all species) × 100%
RF = (Frequency of a species / Sum of frequencies of all species) × 100%
RD = (Basal area of a species / Sum of basal areas of all species) × 100%
IV = RA + RF + RD

**(3) Size structure analysis:** We analyzed the size structure of the top seven species by importance value in each community and compared it with *S. argentea*. Size classes were defined as: Class I, H < 33 cm; Class II, H ≥ 33 cm and DBH < 2.5 cm; Class III, 2.5 ≤ DBH < 7.5 cm; Class IV, 7.5 ≤ DBH < 22.5 cm; Class V, DBH ≥ 22.5 cm (Wang Boxun et al., 1996).

**(4) Diversity analysis:** We calculated species diversity indices for tree and shrub layers, including Shannon-Wiener index (H), Simpson index (D), and corresponding evenness indices Eh and Ed:

H = - Pi lnPi
D = 1 - Pi
Eh = H / lnS
Ed = D / (1 - 1/S)

Where Pi = Ni/N represents the probability of species i, Ni is the number of individuals of a given species, N is the total number of individuals observed, and S is the total number of individuals in the quadrat (Sun Ruyong et al., 1993).

**(5) Community similarity analysis:** We calculated Sorensen' s coefficient (Cs):

Cs = 2j / (a + b)

Where j is the number of shared genera between two communities, and a and b are the total number of genera in each community (Wang Xinghua, 1987).

**(6) Life form analysis:** Following Raunkiaer' s system, plants were classified as therophytes (Th), cryptophytes (Cr), hemicryptophytes (H), chamaephytes (Ch), and phanerophytes (Ph) (Wang Boxun et al., 1996).

## Community Appearance and Species Composition

The appearance and species composition of the four communities are summarized in Table 2 .

*Community appearance: S. argentea* is a tall evergreen tree with thick, leathery, oblong or oblong-lanceolate leaves that are shiny above and silvery-white below. It flowers from July to August with white blossoms. In *S. argentea*-dominated communities, the canopy appears bright green in spring and summer, white-flowered in July-August, and yellowish-green in autumn and winter.

*Species richness:* Each *S. argentea* community contained 78-106 vascular plant species with relative densities of 12.9-18.0, indicating rich species composition and relatively even distribution.

*Tree and shrub layer:* Dominant species were concentrated in Fagaceae, Lauraceae, Ericaceae, Theaceae, Styracaceae, Pinaceae, and Aquifoliaceae. In Jinggangshan, *S. argentea* was the constructive species, co-dominating the upper canopy with *Pinus taiwanensis*. Mid- and lower-canopy trees included *Rhododendron latoucheae*, *Alniphyllum fortunei*, *Machilus thunbergii*, and *Rhododendron ovatum*, while shrubs comprised *Eurya loquaiana*, *Castanopsis eyrei*, *Lindera reflexa*, and *Castanopsis faberi*. In Qiyunshan, *S. argentea* and *Machilus thunbergii* were co-dominant constructive species forming the canopy, with *Pinus taiwanensis*, *Daphniphyllum oldhamii*, and *Daphniphyllum macropodum* emerging above the canopy. Lower canopy trees included *Eurya muricata*, *Machilus thunbergii*, *Symplocos laurina*, and *Eurya alata*, while shrubs featured *Symplocos laurina*, *Lindera fragrans*, and *Indocalamus tessellatus*. In Nanfengmian, community stratification was indistinct with a well-connected, gently undulating canopy line. *Rhododendron simiarum* was the constructive species, forming the canopy profile across all tree heights, while *S. argentea* was a secondary dominant species, along with *Cyclobalanopsis myrsinifolia*, *C. multinervis*, and *Fagus engleriana*, forming slightly elevated portions of the canopy. Shrubs included *Rhododendron simiarum*, *Pieris formosa*, *Ilex suaveolens*, *Cyclobalanopsis myrsinifolia*, and *Cinnamomum subavenium*. In Wuzhifeng, community stratification was also indistinct with a continuous, gently undulating canopy. *Castanopsis eyrei* was the constructive species forming the upper canopy, followed by *S. argentea*, *Alniphyllum fortunei*, *Machilus thunbergii*, *Lithocarpus hancei*, and *Machilus phoenicis* as secondary dominants that connected vertically with *Castanopsis eyrei*. Shrubs primarily included *Neolitsea aurata*, *Lithocarpus hancei*, and *Cinnamomum wilsonii*.

*Herbaceous layer:* Species were generally rich, consisting mainly of tree and shrub seedlings such as *S. argentea*, *Cyclobalanopsis glauca*, *Castanopsis eyrei*, and *Lindera aggregata*. Jinggangshan had 43 species including woody seedlings plus *Woodwardia japonica*, *Lophatherum gracile*, *Miscanthus sinensis*, *Dicranopteris pedata*, and *Smilax china*. Qiyunshan had 56 species including *Symplocos laurina* seedlings, *Woodwardia japonica*, *Diplopterygium glaucum*, *Carex* spp., *Rubus swinhoei*, and woody seedlings. Nanfengmian had 50 species including *Plagiogyria japonica*, *Arachniodes* spp., *Phyllagathis cavaleriei*, *Smilax stans*, and woody seedlings. Wuzhifeng had 63 species including woody seedlings plus *Woodwardia japonica*, *Smilax arisanensis*, *Ampelopsis grossedentata*, and *Carex chinensis*.

### Geographic Composition of Community Species

As shown in Table 3 , the proportion of tropical genera (areal types 2-7) in Jinggangshan, Qiyunshan, and Wuzhifeng all exceeded 60%, indicating strong south subtropical characteristics in these *S. argentea* communities. In Nanfengmian, tropical and temperate genera (areal types 8-15) were equally represented, suggesting the plot lies in a transitional zone between subtropical and temperate zones.

### 2.2 Community Importance Value Analysis

Tables 4-7 compare importance values of dominant species in each plot. For brevity, only species with importance values >5 are listed.

*S. argentea* was the dominant species in both Jinggangshan and Qiyunshan, with the highest importance values in these communities, while serving as a secondary dominant species in Nanfengmian and Wuzhifeng. In Jinggangshan, *S. argentea* had an importance value of 53.18, far exceeding other species and indicating a mature community. In Qiyunshan, *S. argentea* had the highest importance value, followed by *Machilus thunbergii*, with both serving as constructive species. In Nanfengmian, *Rhododendron simiarum* had the highest importance value at 52.93, making it the community dominant, followed by *S. argentea* and *Cyclobalanopsis myrsinifolia* as secondary dominants with relatively high dominance that played important roles in community structure. In Wuzhifeng, *Castanopsis eyrei* showed the highest dominance with an importance value of 61.06, holding absolute advantage, while *S. argentea* ranked seventh with relatively low dominance.

### 2.3 Community Diversity Analysis

As shown in Table 8 , the Shannon-Wiener index (H) values for Jinggangshan, Qiyunshan, and Wuzhifeng all exceeded 3.2, with corresponding evenness indices (Eh) above 0.756, both higher than Nanfengmian. The Simpson index (D) and its evenness for Jinggangshan, Qiyunshan, and Wuzhifeng were all above 0.93, indicating high species richness and even distribution. Nanfengmian showed

noticeably lower values at 0.865 and 0.884, respectively, indicating lower richness and uneven distribution.

The four *S. argentea* communities contained a total of 266 seed plant species belonging to 129 genera and 66 families. Similarity coefficient analysis (semi-matrix) of community genera is shown in Table 8. Using 50% as the threshold for determining similarity in generic composition between communities (Liu Zhongcheng et al., 2017), the four communities were divided into two types: Jinggangshan, Qiyunshan, and Wuzhifeng formed one group with similarity coefficients above 0.50, while Nanfengmian formed a second group with similarity coefficients below 0.40 compared to the other three sites.

### 2.5 Community Population Size Structure Analysis

Size structure analysis of the top seven trees and shrubs by importance value in each community is shown in Figure 1 [Figure 1: see original paper]. Based on size structure characteristics, *S. argentea* populations can be divided into three types.

**Type 1 (Jinggangshan and Qiyunshan):** *S. argentea* populations were transitioning from stable to declining stages. These populations contained numerous Class IV (medium trees) and Class V (large trees) individuals, but Classes I (seedlings), II (saplings), and III (small trees) still represented substantial proportions, indicating ongoing regeneration and future maintenance of certain advantages in the community. In Jinggangshan, *Rhododendron latoucheae* and *Machilus thunbergii* also showed stable-to-declining transitions, but with maximum numbers in Classes III and IV and limited Class I and II regeneration. *Rhododendron ovatum*, *Alniphyllum fortunei*, and *Pinus taiwanensis* showed declining patterns, while *Eurya muricata* showed an increasing pattern. In Qiyunshan, *Machilus thunbergii*, *Eurya muricata*, *Eurya alata*, and *Rhododendron ovatum* showed stable patterns, while *Pinus taiwanensis* and *Daphniphyllum oldhamii* showed declining patterns.

**Type 2 (Nanfengmian):** The *S. argentea* population comprised only 19 individuals, all Class V large trees, indicating a declining population. The community' s most important species, *Rhododendron simiarum*, had 253 individuals with numerous small and medium trees plus some seedlings, suggesting it could maintain stability for an extended period (stable type). *Cyclobalanopsis myrsinifolia* and *Neolitsea pulchella* also had numerous saplings and small trees, indicating stable populations. However, *Cleyera pachyphylla*, *Fagus engleriana*, and *Ilex suaveolens* were dominated by medium and large trees with few or no seedlings, indicating declining populations.

**Type 3 (Wuzhifeng):** *S. argentea* had low dominance and a small population of only 13 individuals, including both Class IV-V medium and large trees and Class I-II seedlings and saplings, but no Class III small trees, suggesting the population could re-invade the community after a period of decline. The community' s most important species, *Castanopsis eyrei*, showed a similar trend. Addition-

ally, *Machilus thunbergii* and *Rhododendron latoucheae* were declining populations, while *Lithocarpus hancei*, *Neolitsea aurata*, and *Cinnamomum wilsonii* were increasing populations.

### 2.6 Life Form Analysis

As shown in Figure 2 [Figure 2: see original paper], phanerophytes accounted for the highest proportion in all four communities, exceeding 75% of total species, followed by geophytes and hemicryptophytes, while chamaephytes and therophytes were relatively scarce. Phanerophytes were the constructive and dominant species occupying tree and shrub layers, such as *S. argentea* and *Machilus thunbergii*. Chamaephytes were primarily subshrubs like *Phyllagathis cavaleriei*. Hemicryptophytes included evergreen tufted plants such as *Carex* spp. Geophytes included ferns and some Liliaceae species like *Diplopterygium glaucum* and *Liriope spicata*. Therophytes included species like *Viola* spp.

## Discussion

The four *S. argentea* communities contained 266 species in 129 genera and 66 families, all higher than the 57 species in 46 genera and 24 families reported for Jinyun Mountain (Liu Yucheng et al., 1993). This likely reflects the larger 1600 $m^2$ plot size in our study compared to the 500 $m^2$ plot on Jinyun Mountain. Generally, larger plot sizes include more rare species, increasing total species counts. Elevationally, the four communities were all in mid-montane zones, decreasing in elevation from Nanfengmian (highest) to Qiyunshan, Wuzhifeng, and Jinggangshan (lowest), all higher than Jinyun Mountain. Except for Nanfengmian, species numbers in Qiyunshan, Wuzhifeng, Jinggangshan, and Jinyun Mountain decreased with decreasing elevation, suggesting *S. argentea* communities are better adapted to lower elevations where *S. argentea* exerts stronger control, reducing rare species invasion. Latitudinally, the four communities decreased from Qiyunshan (lowest latitude) to Wuzhifeng, Nanfengmian, and Jinggangshan, with Jinyun Mountain further north. Generally, species numbers decrease with increasing latitude, a pattern followed by Qiyunshan, Wuzhifeng, Jinggangshan, and Jinyun Mountain. However, Nanfengmian had slightly fewer species than Jinggangshan to its north, possibly due to the influence of the constructive species *Rhododendron simiarum*. Although diversity and evenness indices for all four communities were higher than those for Jinyun Mountain (Tang Yuanhui et al., 2010), Nanfengmian showed relatively low values. Studies on *Rhododendron simiarum* communities in Jinggangshan (Deng Xianlan et al., 2011) and evergreen broad-leaved forests in Jiulianshan, Jiangxi (Jian Minfei and Liu Qijing, 2009) indicate that *Rhododendron* forests have low diversity indices but high individual density. The *Rhododendron simiarum* forest in Nanfengmian likely follows this pattern, where interspecific relationships in *Rhododendron* communities exert greater influence on species numbers and biodiversity than environmental factors like elevation and latitude. The biodiversity and evenness indices for Jinggangshan, Qiyunshan, and Wuzhifeng are comparable to those for

*Exbucklandia tonkinensis* forests in Jinggangshan (Liu Zhongcheng et al., 2017) and approach those for the *Cyclobalanopsis glauca-Cleyera japonica-Woodwardia japonica* community in Qiyunshan (Guo Chuanyou, 1997), representing typical mid-subtropical evergreen broad-leaved forests.

In Jinggangshan and Qiyunshan, *S. argentea* ranked first in importance value, and size structure analysis indicated populations transitioning from stable to declining stages. Research on Jinyun Mountain (Tang Yuanhui et al., 2010) also showed that *S. argentea* importance values decreased along with reduced basal area. However, as a tall tree species, *S. argentea* still dominated the upper canopy layer, as observed in Nanfengmian and Wuzhifeng. In Nanfengmian, *Rhododendron simiarum* had the highest importance value while *S. argentea* was a declining population, yet the elevated canopy portions remained dominated by *S. argentea* and Fagaceae species. In Wuzhifeng, *S. argentea* importance value had dropped to seventh place, yet it still co-constructed the canopy layer with the dominant *Castanopsis eyrei*.

The dominant species in the four *S. argentea* communities were concentrated in Fagaceae, Lauraceae, Ericaceae, Theaceae, Styracaceae, Pinaceae, and Aquifoliaceae. Except for Ericaceae and Pinaceae, these are pantropical families (Li Xiwen, 1996). At the generic level, tropical genera accounted for slightly over 60% in Jinggangshan, Qiyunshan, and Wuzhifeng, similar to the 61.36% reported for Jinyun Mountain (Liu Yucheng et al., 1993), indicating strong subtropical characteristics and typical mid-subtropical evergreen broad-leaved forests. In Nanfengmian, tropical and temperate genera were equally represented, indicating a transitional zone between subtropical and temperate zones. This transitional nature was also observed in *Abies beshanzuensis* var. *ziyuanensis* communities in Nanfengmian (Wang Lei et al., 2013) and likely relates to the constructive species *Rhododendron simiarum*. Community similarity analysis also showed that Jinggangshan, Qiyunshan, and Wuzhifeng formed one type, differing substantially from Nanfengmian, consistent with the areal-type analysis.

*S. argentea* exhibits characteristics of a light-demanding species. In ridge environments with strong sunlight, high wind, and intense evaporation, *S. argentea*-dominated communities represent typical climax evergreen broad-leaved forests composed of heliophilous broad-leaved species that permanently occupy these habitats (Liu Yucheng and Miao Shili, 1992). This is exemplified in Wuzhifeng, where *S. argentea* includes both Class IV-V medium and large trees and Class I-II seedlings and saplings, but no Class III small trees, indicating that after a period of decline, the population can re-invade the community and continue to occupy a dominant position.

## Conclusion

In summary, the four *S. argentea* communities in the middle Luoxiao Mountains can be divided into two types: First, the Nanfengmian community, characterized by *Rhododendron simiarum* forest features; second, the Jinggangshan,

Qiyunshan, and Wuzhifeng communities, which are species-rich with high biodiversity, dominated by tropical genera, and show decreasing species numbers with increasing elevation and latitude. *S. argentea* communities are typical representatives of mid-subtropical evergreen broad-leaved forests. The coexistence of *S. argentea* communities at different successional stages provides further evidence that the middle Luoxiao Mountains region serves as an important plant habitat.

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*Note: Figure translations are in progress. See original paper for figures.*