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Research on Ecological Wisdom of Jingmai Mountain Tea Culture Landscape in Pu'er

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Abstract Since the second half of the 20th century, the concept of global green development has gained increasing global attention, with the harmonious coexistence between humans and nature emerging as a critical issue. The cultural landscape of Jingmai Mountain old tea forest, as a typical representative of ecological wisdom in agricultural civilization, showcases a sustainable practice in tea production and livelihood system. Employing a combination of field investigation and literature analysis, this study systematically examines the ecological wisdom of the "forest-tea coexistence" system in Jingmai Mountain from 5 dimensions: tea forest cultivation, land use, village construction, residential buildings, and ethnic culture. The results indicate that Jingmai Mountain has established an integrated system of "ecological technology—spatial planning—cultural institution" for synergistic development: a multi-layered planting structure and vertical gradient development mode have enabled efficient resource utilization; The village layout of "Following the mountain terrain and close to the tea forest" and the climate-adaptive architecture reflect the harmonious unity of living environment and the natural environment; the belief in "Tea Spirit" and community-based governance mechanism ensure the institutionalization and sustainability of ecological protection. This system transforms traditional ecological knowledge into modern practices, providing important reference for the protection of agricultural cultural heritage and serving as a model for ecological protection and rural revitalization in the context of global green development.

Keywords Jingmai Mountain, Ecological wisdom, Tea culture landscape, World Cultural Heritage, Resource utilization

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Ecological wisdom, proposed by Arne Naess in 1973, emphasizes maintaining ecological balance in development and achieving mutual benefits and coexistence between humans and nature[1]. In recent years, international ecological wisdom research has focused on sustainable science, interdisciplinary integration, and emphasized the transformation of traditional wisdom into modern urban applications. The research on ecological wisdom in China is currently in the exploratory stage, gradually increasing in recent years. It mainly focuses on traditional ecological culture to explore sustainable development paths for urban and rural areas with a stronger emphasis on cultural inheritance.

The core value of the cultural landscape of Jingmai Mountain old tea forest is reflected in its well-preserved vast expansion of 1 000-year-old cultivated old tea forest, which is an early example of mutual benefit and coexistence between humans and nature, as well as a living witness to the traditional tea cultivation of indigenous communities in Southwest Chinese and a "living fossil" of early human tea cultivation patterns[2]. In September 2023, the landscape was successfully listed in the The World Heritage List, becoming the world's first world cultural heritage with tea as the theme, and it is acclaimed as the "World Museum of Natural History of Tea".

1 Ecological wisdom in tea forest cultivation

The tea trees in the Jingmai Mountain area adopt an understory planting approach. Understory planting is a sustainable agricultural system that involves selectively thinning competitive trees and shrubs in the forest while retaining shade-providing trees and aromatic trees. Tea tress are cultivated using sexual reproduction with tea seeds, forming a multi-layered composite structure of trees—tea plants—herbaceous plants[3], thereby achieving efficient resource utilization and ecological balance. The upper layer consists of tall trees such as *Cornus officinalis*, *Schisandra chinensis*, *Docynia delavayi*, *Toona ciliata* Roem.; the middle layer is mainly composed of tea plants, interspersed with low shrubs like Lauraceae and Rhododendron; the lower layer comprises herbaceous plants such as poaceae, ferns, medicinal herbs, and wild vegetables[4]. As a unique living heritage distinct from the globally dominant plantation tea cultivation systems, the understory tea planting model constitutes a distinctive characteristic element of the cultural landscape of the old tea forest of Jingmai Mountain.

The understory planting method can be traced back to as early as the 10th century, when the ancestors of the Blang tribe settled in Jingmai Mountain and developed the "understory tea" cultivation technique, which involved interplanting trees within the forest ecosystem and cultivating tea plants beneath the tall trees. This approach ingeniously enhances the efficiency of light energy and nutrient absorption across various plant layers, while also allowing the natural fragrance of forest plants to infuse the tea leaves, thereby improving tea quality. More importantly, the fallen leaves and twigs from trees and old tea plants, together with herbaceous plants, form loose, fertile, humus-rich, and well-drained soil conditions. The food chain formed by birds, insects, and other organisms in the forest effectively address pest and disease issues while promoting pollination. Various organisms within the tea forests depend on and constrain one another, forming a complex and intricate ecological network that robustly ensures the integrity and stability of the ecological functions of the old tea forest. This has allowed the old tea forest to continue exhibiting vibrant vitality and resilience through the passage of time. According to statistics, compared to modern terrace tea plantations, Jingmai Mountain old tea

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forest exhibit exceptionally rich biodiversity and extremely high ecosystem stability, representing a healthy and highly efficient forest ecosystem[5].

2 Ecological wisdom in land use

The land use practices in Jingmai Mountain exemplify the ecological philosophy of coordinated coexistence between humans and nature, with the core being vertical gradient development, a forest-tea symbiosis system, fine soil and water management, and cultural-ecological regulations. Through stratified utilization according to altitude: water-conserving forests at mountain summits, mixed tea gardens on slopes, and grain terraces at the foothills (Fig.1), a multilayered "trees—tea plants—herbaceous plants" planting model has been established. This is complemented by soil and water conservation techniques such as stone-embanked terraces and bamboo pipe irrigation, forming a sustainable agricultural ecosystem. Furthermore, ecological balance is maintained through the "seven-harvest, three-fallow" rotational system, sacred mountain beliefs that impose ecological constraints, and community-based governance mechanisms. This achieves a multidimensional integration of biodiversity conservation (60% reduction in pests and diseases in mixed forests), sustained soil fertility (organic matter content reaching 6.8%), and efficient resource utilization, providing a model of traditional wisdom for modern ecological agriculture.

3 Ecological wisdom in village construction

3.1 "Following the mountain terrain and close to the tea forest" village site selection concept

The village site selection principle of "following the mountain terrain and close to the tea forest" embodies the unique wisdom developed by the Blang, Dai, and other ethnic minorities of Jingmai Mountain through long-term coexistence with nature. It reflects a profound understanding of topography, climate, ecology, and culture. The villages of Jingmai Mountain are predominantly built on mountain slopes or gentle inclines at altitudes between 1 200 and 1 600 m, avoiding steep slopes and mountain summits. The moderate gradient of the slopes facilitates drainage and prevents waterlogging, while also avoiding soil erosion during land development. The villages are typically nestled against forested mountains (which block cold winter winds) and face valleys or rivers (enabling summer ventilation and water access), creating a natural microclimate. The village peripheries adjoin the old tea forest, facilitating tea grove management while preventing occupation of core tea-growing areas. Between the settlements and tea forest, natural woodlands or economically valuable trees (such as camphor and walnut) are preserved, serving as ecological buffers for fire prevention and pollution control. This settlement approach not only adapts to the mountainous environment but also protects the old tea forest ecosystem, forming a sustainable human habitation model characterized by the "tea—forest—village" trinity.

3.2 "Centripetal" village layout

The traditional villages within the heritage site of the Jingmai Mountain old tea forest feature a centralized spatial layout constructed around the "village center" (Fig.2), reflecting the unique ecological wisdom of the mountain-dwelling ethnic groups. The village center, serving as the sacred heart and spiritual symbol of the settlement, acts as both the starting point for construction and the organizational base for spatial arrangement. After selecting the village center, the ancestors of the Blang and Dai peoples built residential structures around it, establishing village gates and Buddhist temples according to the terrain. Temples were often constructed on surrounding terraces, forming a spatial sequence of "village center — village gates—Buddhist temples" and defining clear village boundaries[6]. The village design incorporates a protective system comprising the "village center+sacred trees". The entire village is compactly built around the center, sheltered by the elevated temples and the tall sacred trees surrounding the settlement. This spatial pattern inherits the settlement wisdom of ancient civilizations, such as the Banpo Site, achieving harmony in human-land relationships through the organization of sacred spaces and demonstrating an ecological adaptation strategy of "flowing with nature and thriving together"[7]. Such a layout not only enriches the village's spatial form, integrating the spatial environment with the villagers' living customs, but also enhances their sense of belonging, facilitates communication, and fosters strong neighborly relationships.

4 Ecological wisdom in residen–tial buildings

4.1 Architectural forms adapted to local climate

The traditional residential architecture in the Jingmai Mountain area fully embodies ecological wisdom adapted to the local tropical mountain climate. In terms of materials, the buildings predominantly utilize natural locally-sourced resources such as wood, bamboo, and thatch. The low thermal conductivity of wood effectively blocks external heat, while the high porosity of bamboo-woven walls further enhances ventilation efficiency, achieving an air exchange rate of 2–3 times per hour. Structurally, the steeply sloped roofs facilitate rapid drainage while reducing heat accumulation from solar radiation. Stilted architecture elevates the living space, creating a ventilation layer that not only reduces indoor humidity but also utilizes valley wind pressure differences to promote air circulation, enabling passive cooling. The deep overhanging eaves serve dual purposes: shielding against heavy rainfall during the monsoon season and blocking high-angle summer sunlight, while permitting the entry of low-angle winter sunlight for seasonal thermal regulation. This architectural approach not only effectively addresses the challenges of a hot and humid climate but also minimizes energy dependence through passive design, demonstrating the sophistication of bioclimatic design. Furthermore, the harmonious coexistence between the architecture and the natural environment reflects the sustainable utilization of ecological resources and profound environmental adaptation wisdom of the local ethnic minorities, offering significant reference value for modern mountain residence design.

4.2 Spatial layout aligned with local tea production and lifestyle

The spatial layout of traditional residential buildings in the Jingmai Mountain area forms a highly coordinated organic system integrated with tea-processing activities, reflecting a deep fusion of production, daily life, and ecology. In terms of spatial function, the elevated open ground floor of the stilted structure is used for spreading and withering fresh tea leaves, where the well-ventilated design provides an ideal environment for the initial processing of tea. The hearth (Huotang) area serves a dual purpose, providing household heating while also being used for the fixation (Shaqing) and drying of tea leaves, creating an efficient "multi-purpose hearth" model. The loft storage space utilizes the moisture-resistant characteristics of mountain architecture to ensure tea storage quality. Overall, the natural ventilation of the buildings regulates the micro-environment for tea processing, while tea production by-products are recycled as supplementary building materials or agricultural fertilizer, forming a sustainable flow of materials. This spatial layout not only ensures the quality and efficiency of Pu'er tea production but also shapes the distinctive tea cultural landscape of

Jingmai Mountain, providing a valuable model for the integrated development of contemporary ecological architecture and traditional industries, highlighting the exceptional creativity of ethnic minorities in achieving multi-functional spatial integration under limited resource conditions[8-9].

5 Ecological wisdom in ethnic cultures

5.1 "Man–tea coexistence" ecological belief concept

The people of Jingmai Mountain have established a comprehensive eco-cultural system through the religious belief of "human-tea coexistence". Within their religious framework, the people of Jingmai Mountain deify ancient tea trees as either ancestral incarnations (such as the Blang people's tea ancestor Pa Ai Leng) or as sacred trees bestowed by the Buddha, forming the "Tea Spirit" belief. Rituals like "ancestor worship ceremonies" and "calling the tea spirit" establish the spiritual status of tea trees. Through the "Holy Forests" (Huolin) belief, they demarcate sacred mountain sanctuaries and set religious taboos like "tea deity trees" to define ecological protection boundaries. During religious ceremonies, tea offered in Buddhist temples must be sourced from ancient tea trees and blessed by monks through sutra chanting, demonstrating reverence for ancestors. In production practices, sacrificial rituals are held before the spring tea harvest, offering chicken blood and rice wine to the tea spirit. During harvesting, the "selective plucking" method is adopted to preserve the tea plants' vitality. In life rituals, tea processing involves ceremonies like hearth sacrifices, and the preparation of hearth-roasted tea requires "triple-roasting and nine-infusions" to show respect for nature. Wedding and funeral ceremonies incorporate tea rituals using an odd number of offerings, reflecting the principle of "harvesting in moderation". These practices integrate the concept of "human-tea coexistence" into daily life, forming a comprehensive system of ecological wisdom that permeates all aspects of production and livelihood for the people in Jingmai Mountain. Ultimately, this integrates ecological ethics into the core of their ethnic spirit, achieving sustainable inheritance at the level of cultural genes.

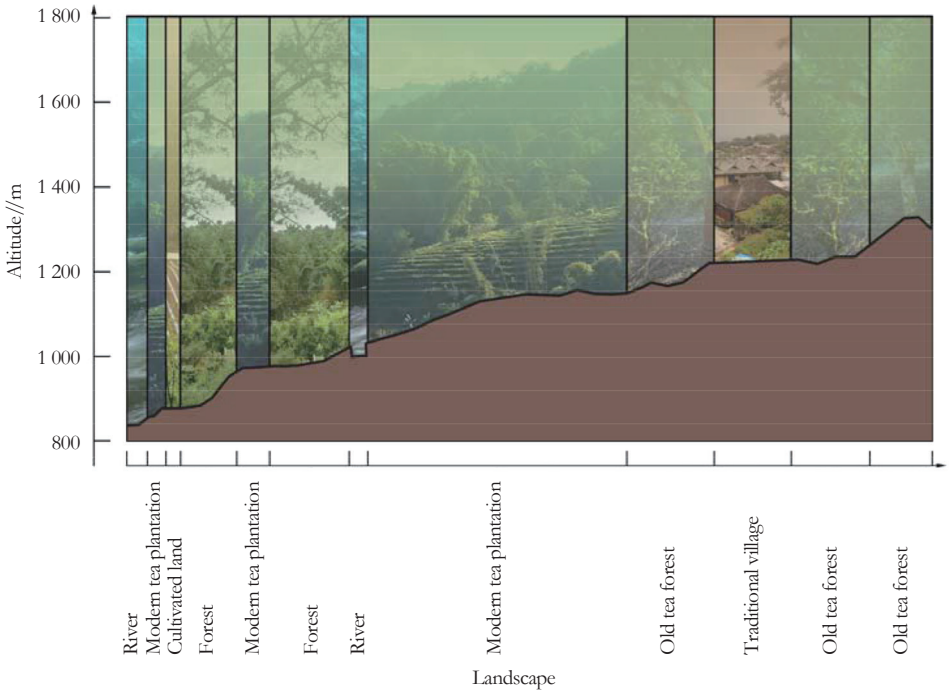

Fig.1 Land Use Analysis at Different Altitudes

5.2 "Community–based governance" ecological management concept

The village management system of Jingmai Mountain is rooted in cultural beliefs and has achieved sustainable ecological conservation through community-based governance mechanisms. The traditional governance structure, centered on the Council of Village Elders, relies on customary laws to regulate community behavior, forming an ecological wisdom of

Fig.2 Centripetal layout

"harvesting in moderation, using with restraint". This is concretely reflected in resource utilization rules such as the tea tree rotational harvesting system (seven-harvest, three-fallow) and water allocation methods. With social development, this traditional management system has progressively integrated modern elements, achieving an organic combination of cultural heritage and contemporary needs. Village regulations have transformed religious taboos into actionable environmental protection clauses, such as prohibiting pesticide use in old tea forest and restricting tree felling in sacred mountains. Specialized departments, such as Tea Forest Protection Associations, have been established to enhance management efficiency, while modern policy tools like ecological compensation mechanisms have been introduced to further stimulate community participation. The distinctive features of this management system are as follows: First, it institutionalizes cultural beliefs, translating spiritual values into concrete management measures to enhance enforcement effectiveness. Second, it integrates tradition with modernity, maintaining cultural roots while incorporating scientific methods to achieve dynamic adaptation. Third, it fosters multi-stakeholder collaboration, utilizing a synergistic framework involving the Council of Village Elders, Village Committees, and Protection Associations to make ecological conservation a conscious practice among community members.The practice in Jingmai Mountain demonstrates that an ecology management model centered on community-based governance can both preserve cultural identity and improve governance efficacy, providing a significant paradigm for the sustainable development of traditional villages. Its success lies in activating endogenous motivation through cultural identity, thereby achieving an organic unity of conservation and development goals within community management.

6 Conclusion

The Jingmai Mountain Old Tea Forest Cultural Landscape is the first project in the world to be listed in the World Heritage List with "tea cultural landscape" as its core value. It showcases the ecological wisdom of traditional Chinese agricultural civilization to the world through its unique "forest-tea coexistence" ecosystem and profound ethnic cultural heritage. The value of this living heritage lies not only in its well-preserved 1 000-year-old tea forest but also in its establishment of a comprehensive sustainable development model of "harmonious coexistence between humans and nature". Through long-term practice, the people of Jingmai Mountain have developed an ecological ethic of "human-tea coexistence" and management wisdom of "community-based governance", ranging from the multi-layered ecosystem of understory planting and vertical gradient land use patterns to village construction that conforms to nature and climate-adaptive residential design. Their ability to transform religious beliefs into ecological constraints and elevate traditional norms into modern institutions has enabled Jingmai Mountain to achieve the dual goals of cultural preservation and ecological conservation. The core insight is that genuine sustainable development must be rooted in cultural identity, internalized through beliefs to foster conscious behavior, and perpetuated across generations via institutional innovation. The Jingmai Mountain model provides a Chinese solution of a "culture—ecology—institution" tripartite framework for the conservation of global agricultural heritage, highlighting the Eastern wisdom of harmonious coexistence between humans and nature, and offering significant reference value for contemporary ecological civilization construction.

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