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The Growth and Morphological Characteristics of Ancient Trees

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Abstract Ancient trees, as an important resource, possess historical, ecological, and cultural value. This review aims to compare and analyze the growth and morphological characteristics of different types of ancient trees, revealing their biological attributes and aesthetic features. Research findings indicate a close correlation between the growth and morphological characteristics of ancient trees and factors such as their growth environment, tree species, and age. Different types of ancient trees exhibit unique growth patterns and morphological features. Through in-depth research and analysis of the growth and morphological characteristics of ancient trees, a better understanding of their biological attributes can be achieved. The objective of this review is to provide a theoretical basis for the conservation and sustainable utilization of ancient trees.

Keywords Ancient trees; Growth; Morphological characteristics; Conservation and utilization

With the increasing attention paid to the ecological environment and the increasing awareness of cultural heritage protection, the protection and utilization of ancient tree resources has become one of the current research hotspots. Ancient trees refer to trees with a certain age, historical value, and ecological value, and are an indispensable component of the ecosystem. As an important component of the ecosystem, ancient trees not only provide people with oxygen, purify air, and protect water sources, but also have important cultural value and historical significance. Therefore, the study of the growth and morphological characteristics of ancient trees can provide theoretical basis for the protection and utilization of ancient trees, and promote the rational development and utilization of ancient tree resources.

At present, there has been some progress in the study of ancient trees both domestically and internationally. Abroad, research on ancient trees is mainly concentrated in countries and regions such as Europe, North America, and Japan. The research mainly includes aspects such as ancient tree protection, ecological and biological characteristics of ancient trees. In China, the study of ancient tree resources has also received widespread attention. The relevant research mainly focuses on the distribution characteristics, ecological characteristics, growth laws of ancient trees. Although there has been some progress in the study of ancient trees, research on their growth, and morphological characteristics is still relatively weak, and further in-depth exploration is needed.

The research content of this review mainly includes the study and analysis of the growth and morphological characteristics of ancient trees. Specifically, it mainly includes the growth mode and speed of ancient trees, ring structure and growth characteristics, tree height, crown and trunk morphology, and compares and analyzes the growth and morphological characteristics of different types of ancient trees, further revealing the growth laws and morphological characteristics of ancient trees. In the research process, scientific methods and means will be used as much as possible to ensure the reliability and scientificity of the research results.

1 The Growth Characteristics of Ancient Trees

1.1 The growth mode and speed of ancient trees

The growth mode of ancient trees mainly includes two types: upright growth and expansive growth. Upright growth refers to the upright growth of the trunk of an ancient tree, forming a relatively straight tree shape. This growth method is commonly found in some tall tree species, such as pine, oak, and cypress. Ancient trees that

grow upright usually have relatively sturdy trunks and relatively compact crowns. Sequoia is characterized by an upright growth pattern, with its tall trunk standing upwards, forming a spectacular tree shape. According to research, the growth rate of redwood is very fast, growing by several feet per year, thus forming tall ancient trees in a relatively short period of time.

Expandable growth refers to the growth pattern of ancient trees exhibiting a relatively lateral expansion, with the main trunk extending outward and branching out into multiple branches, forming a relatively open canopy. This growth method is commonly found in some broad tree species, such as beech, ginkgo, and rhododendron trees. Taking the "*Ginkgo biloba* L." at the entrance of Yangtang Village in Wuxie Town, China as an example, the tree has a chest circumference of 584 centimeters, a height of 28 meters, and a tree age of over 800 years (Figure 1). The crown is dense, and the branches are abundant, giving a sense of prosperity and grandeur. In contrast, the olive tree (*Olea europaea*) is a representative of an ancient tree that grows extensively. The trunk of the olive tree extends outward and branches out, forming a broad canopy. Although the growth rate of olive trees is relatively slow, due to their dense branches, they can form large ancient trees over many years of growth.

The growth rate of ancient trees is influenced by various factors, including tree species, climate, soil, and nutrients. The growth speed of different tree species varies greatly. Some fast-growing tree species, such as poplar and willow, can rapidly grow in a short period of time, forming larger ancient trees. Some slow-growing tree species, such as cypress and redwood, require long-term accumulation to become ancient trees. Climate conditions also have a significant impact on the growth rate of ancient trees. Adequate sunlight, suitable temperature, and precipitation are crucial for the growth of ancient trees. For example, a warm and humid climate is conducive to the growth of ancient trees, while a dry or cold climate can limit their growth rate. The texture and nutrient content of the soil are also key factors affecting the growth rate of ancient trees. A soil rich in nutrients and well drained is beneficial for the growth and absorption of nutrients by ancient tree roots, promoting growth rate. On the contrary, poor soil and poorly drained environment will limit the growth of ancient trees.

1.2 The ring structure and growth characteristics of ancient trees

The annual ring is a circular structure composed of a layer of xylem and a layer of phloem that grow annually on a tree trunk, which can be used to determine the age and growth history of ancient trees. The thickness of the xylem and phloem formed each year varies, forming distinct dark and light colored rings, known as annual rings. The light colored ring represents the period of vigorous growth in spring and summer, while the dark colored ring represents the period of slower growth in autumn and winter. By observing the number and width of annual rings, the age and growth rate of ancient trees can be inferred. The age and growth history of ancient trees can be understood by using the ring structure. For example, by conducting ring analysis on cypress trees (*Juniperus spp*.) in a certain region, it can be determined that the growth rate of cypress trees is relatively slow. The annual rings formed are relatively narrow, indicating their adaptability to growth in arid or cold environments.

Figure 1 Expanding growth of ancient trees

The annual ring structure of ancient trees can also provide some information about their growth environment and climatic conditions. For example, the width of the annual ring can reflect the climatic conditions of that year. In years with good climate conditions, the annual rings are usually wider; In harsh or dry years, the annual rings are usually narrower. By analyzing the width changes of ancient tree rings, one can understand the climate changes and environmental pressures experienced during the growth process of ancient trees. On the contrary, for *Ginkgo biloba* trees located in warm and humid regions, the width of their annual rings is usually wider, indicating their fast growth rate and good growth under suitable climatic conditions. The changes in these annual rings can provide information about the growth environment and climatic conditions of ginkgo trees.

Generally speaking, sufficient light and appropriate temperature are conducive to the formation and growth of annual rings. The supply of water and nutrients also plays an important role in the growth of annual rings. Take the "*Podocarpus macrophyllus*" at Baiyun Temple Site, Meixi Natural Village, Sanbaoli Village, Paitou Town, China as an example (Figure 2). It is recorded that it is the oldest Luohansong and the only ancient tree with a biography in Zhuji. The ancient tree has a clear ring structure, a relatively high ring density, a relatively narrow ring width, and a significant fluctuation in ring morphology.

1.3 The structural characteristics and branching patterns of ancient trees

The structural characteristics of ancient trees include the morphological characteristics and organizational structure of the trunk, crown, and root system. The trunk is the main supporting part of ancient trees, and its structural characteristics can reflect their growth history and environmental adaptability. Some ancient trees exhibit a robust and sturdy trunk, which is the result of their long-term growth and accumulation. The texture and texture of tree trunks can also provide information about the growth process and environmental conditions of ancient trees.

The crown is the upper extension of an ancient tree, including the main and secondary branches. The crown forms of ancient trees are diverse, with some appearing circular, conical, or umbrella shaped, while others exhibit flat or irregular shapes. The shape of a tree crown is influenced by factors such as tree species, growth environment, and growth mode. Taking the *Quercus acutissima* Carruth. in Shangyang Natural Village, Dongzhuang Village, Zhaojia Town, China as an example (Figure 3), its structural features include a wide trunk and a broad crown. Their crown unfolds relatively straight, and the branches extend to form a wide and lush crown, providing people with a cool and beautiful landscape.

Figure 2 Growth characteristics of ancient trees

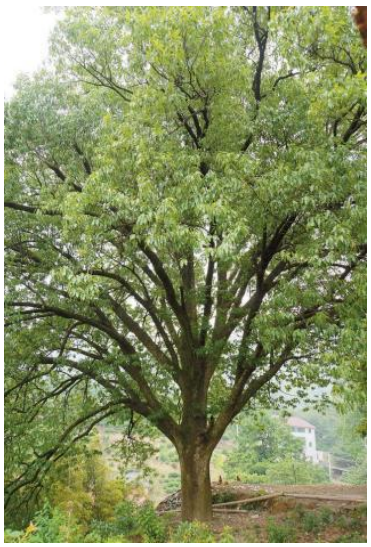

Figure 3 Structural features of the ancient trees

The root system of ancient trees is an important guarantee of their vitality and stability. The structural characteristics of the root system determine the ability of ancient trees to absorb soil moisture and nutrients. Some ancient trees have well-developed and deep roots that can obtain more water and nutrients, thereby ensuring their growth.

The branching pattern of ancient trees refers to the distribution and arrangement of the main and secondary branches of the tree trunk. Some ancient trees exhibit relatively uniform and symmetrical branching patterns, while others exhibit irregular and scattered forms. The formation of branching patterns is influenced by the genetic factors and growth environment of tree species.

2 Morphological Characteristics of Ancient Trees

2.1 Characteristics of the trunk and bark of ancient trees

The trunk characteristics of ancient trees are usually characterized by being thick, tall, and sturdy. The trunks of ancient trees have undergone a long growth process, so they are often thicker and taller than ordinary trees. For example, *California redwood* is a famous ancient tree with trunks that can reach a huge diameter and a height of over 100 meters, making it one of the tallest tree species in the world.

The bark characteristics of ancient trees vary, and can be smooth, thick, textured, or have unique colors. For example, the bark of *Betula platyphylla* presents a smooth gray white color, giving a refreshing feeling. However, the bark of some ancient trees has obvious textures and patterns, such as the bark of oak trees showing longitudinal cracks of varying depths. In addition, the bark color of some ancient trees is also very unique, such as the deep red bark of *Sequoia sempervirens*, giving people a solemn and ancient impression. For example, in the Shilin Scenic Area of Yunnan Province, China, there is a "White Dragon Sophora" tree that is over 1 000 years old. The bark of this ancient tree appears gray, and there are multiple vertical cracks on the surface of the bark, giving it a rough overall appearance (Figure 4).

2.2 Characteristics of leaves and flowers and fruits of ancient trees

The characteristics of leaves, flowers, and fruits of ancient trees are diverse in leaf morphology, which can be large, small, compound or single leaf. For example, *Ginkgo biloba* is an ancient tree species with fan-shaped leaves that are large and distinct, making it one of its unique characteristics. In contrast, the leaves of pine trees are small and needle shaped, which adapts to the needs of dry environments and reduces water evaporation.

Figure 4 Bark morphology and color of ancient trees

The flower and fruit characteristics of ancient trees also vary depending on the tree species. Some ancient trees have bright and colorful flowers, such as cherry trees. When their flowers bloom, they can bring a beautiful scenery to people. The fruits of ancient trees also come in various forms, such as the nuts of oak trees and the fruits of apple trees. These flower and fruit characteristics not only endow ancient trees with unique beauty, but also play an important role as food and reproductive resources in the ecosystem. For example, in the Wudang Mountain Scenic Area of Hubei Province, China, there is a "yew spruce" tree that is over 1300 years old. The leaves of this ancient tree are elongated, 25 cm long and about 3 cm wide, and the texture of the leaves is soft (Figure 5).

2.3 Root characteristics of ancient trees

The root system of ancient trees is usually developed and expansive. Some ancient trees have horizontally expanded roots, such as banyan trees, which can extend to a larger area around them, providing trees with a wider area for nutrient absorption (Figure 6). For example, *Banyan Tree*, located in India, is one of the largest ancient trees in the world, with its roots covering approximately 4 acres of land.

Figure 5 Leaf color and size of ancient trees

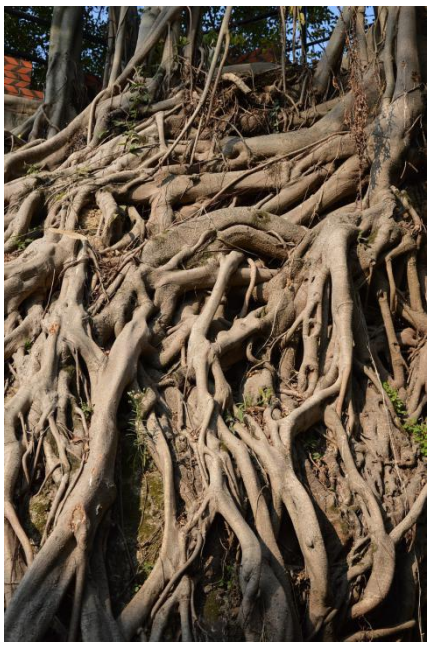

Figure 6 Root system characteristics of ancient trees

The roots of ancient trees can also demonstrate their depth of rooting and stability. For example, the roots of cypress can reach depths of tens of meters deep underground, making ancient trees more stable in natural disasters such as strong winds and soil erosion.

The root characteristics of ancient trees are crucial for maintaining ecological functions such as soil stability, maintaining water sources, and providing habitats. They can maintain the structure of the soil and absorb and store a large amount of water and nutrients, providing good living conditions for surrounding organisms.

3 Current Situation and Problems in the Protection and Utilization of Ancient Trees

Due to the lack of effective management and protection, some ancient tree resources have been destroyed and wasted, even being felled and indiscriminately exploited. Some people harvest ancient trees for personal gain or ignorance, which damages the ecological environment and ecosystem of ancient trees, leading to ecological disasters and the loss of biodiversity. At present, the laws, regulations and systems for the protection of ancient trees in China are not yet perfect, and there is a lack of unified protection standards and management mechanisms. Although there are some relevant laws and regulations, such as the Forest Law of the People's Republic of China and the Cultural Relics Protection Law of the People's Republic of China, there are still some gaps and shortcomings in the protection and management of ancient trees. Insufficient publicity and education on the protection and utilization of ancient trees have led to insufficient public awareness and attention to the protection and utilization of ancient trees. Some people have misconceptions about ancient trees, believing that they are just a natural resource without realizing their ecological and cultural value, and lacking emphasis and sense of responsibility for the protection of ancient trees.

Establish a sound protection mechanism and management system, formulate unified protection standards and management norms, strengthen the monitoring and protection of ancient trees, and increase the crackdown on illegal logging and destruction of ancient trees. Strengthen the excavation and inheritance of ancient tree culture, promote the development and innovation of ancient tree culture, strengthen the promotion and education of ancient tree culture, and increase public awareness and importance of ancient tree culture. Strengthen scientific research on the ecological and cultural value of ancient trees, improve the scientificity and feasibility of their protection and utilization, and provide scientific basis and technical support for their protection and utilization. Strengthen public participation and sense of responsibility in the protection and utilization of ancient trees,

increase public awareness and importance of ancient tree protection and utilization, and promote sustainable development of ancient tree protection and utilization.

4 Summary and Outlook

The growth and morphological characteristics of ancient trees are important aspects of ancient tree research. There are differences in growth speed, lifespan, and morphology among different types of ancient trees, which are closely related to the tree species, age, and growth environment to which they belong. The morphological characteristics of ancient trees are influenced by environmental factors such as light, soil, and climate. Adequate nutrients and sunlight can promote the vigorous growth of ancient trees, while dry climate and poor soil may lead to sparse and weak ancient tree morphology. A deep understanding of the growth, development, and morphological characteristics of ancient trees can help to better understand their ecological functions and adaptability.

The importance of protecting and utilizing ancient trees cannot be ignored. As a part of natural heritage, ancient trees have important ecological, cultural, and landscape values. Ancient trees provide stable habitats for ecosystems, maintain biodiversity, purify air, and maintain ecological functions such as water supply. At the same time, ancient trees carry the memory of history and represent the symbiotic relationship between humans and nature, with profound cultural connotations. The magnificent momentum and unique form of ancient trees also add beauty and charm to the landscape, which has a positive impact on the tourism industry and local economic development. Therefore, protecting and reasonably utilizing ancient trees is a task that should be taken seriously.

This review found that there are still some shortcomings in the protection and utilization of ancient trees. The laws, regulations, and systems for the protection of ancient trees are not yet perfect, and further improvement and strengthening are needed. The promotion and education on the protection and utilization of ancient trees are insufficient, and it is necessary to strengthen public awareness and attention. The scientific research on the protection and utilization of ancient trees still needs to be further deepened to improve the scientificity and feasibility of their protection and utilization.

In summary, the protection and utilization of ancient trees is a complex system engineering that requires the joint participation and efforts of the government, scholars, social organizations, and the public. I hope that in the future, there will be more research and practice to promote the sustainable development of ancient tree protection and utilization, and make positive contributions to the construction of human ecological civilization and cultural inheritance.

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