

Review and Progress

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The Role and Value of Ancient Trees in the Ecosystem

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Abstract This study aims to explore the roles and values of ancient trees in ecosystems, providing scientific basis for the conservation and rational utilization of these trees. Through in-depth research on aspects like root systems, canopies, and ecology, this study reveals the significant roles and values of ancient trees within ecosystems. The research findings indicate that ancient trees possess well-developed root systems and dense canopies, enabling them to maintain soil fertility, enhance microenvironments, and uphold biodiversity, thereby playing crucial roles in maintaining ecological balance and preserving biodiversity. Ancient trees hold extensive and profound natural scientific value, offering essential resources and data for multiple disciplinary studies. This study emphasizes the importance of conserving ancient trees and suggests strategies for their scientific utilization. It provides scientific evidence concerning the ecological functions and values of ancient trees, offering vital insights for their conservation and informed utilization.

Keywords Ancient tree; Biodiversity; Ecological value; Protective measures; Sustainable development

Ancient trees, as a special form of life, have attracted much attention for their rich ecological functions and scientific value. However, there is still some controversy regarding the definition of ancient trees. According to the *Regulations on the Protection of Ancient and Famous Trees*, China defines trees over 300 years old as ancient trees. However, some scholars believe that the age standard cannot fully reflect the attributes of ancient trees, and the standard for ancient trees should also consider the longevity of the tree species and their environment. Generally speaking, rare trees with a hundred year old age can be considered as ancient trees as well as ordinary trees with a 300 year old age. Therefore, the definition of ancient trees still needs further discussion and improvement (Mölderet al., 2020).

As a precious component of the ecosystem, ancient trees contain rich natural scientific value, not only of great significance in the field of biology, but also provide valuable information for multiple fields such as geology and climatology. In addition, the original ecological environment where ancient trees are located is also a habitat for many species to survive, playing an important ecological function, and their existence plays a crucial role in maintaining local biodiversity. With the acceleration of modernization and urbanization, many ancient trees are facing survival threats due to development activities. Therefore, strengthening the protection and utilization of ancient trees is not only a need to protect biodiversity, but also an inherent requirement for achieving harmonious and sustainable development between humans and nature.

This review aims to focus on the ecological functions and scientific value of ancient trees through literature review, in order to provide reference for the theory and practice of ancient tree protection and sustainable utilization. In terms of focusing on the ecological functions and functions of ancient trees, analyze their unique role in maintaining biodiversity, climate regulation, and other aspects. Finally, the strategies for strengthening the protection of ancient trees are prospected, providing scientific basis for the protection and sustainable utilization of ancient tree resources.

1 The Ecological Function of Ancient Trees

1.1 Maintaining biodiversity

Ancient trees refer to trees that are older, slower growing, and have unique shapes, and have important ecological roles and values. Its definition is based on tree age and morphological characteristics, usually referring to trees that are over several decades or even hundreds of years old and have unique shapes, huge volumes, or unique trunk textures. They have irreplaceable ecological functions in the ecosystem and play an important role in maintaining biodiversity and ecological balance (Piovesan et al., 2022).

In biodiversity conservation, ancient trees are considered a key species as they provide unique habitats and food sources for many organisms. The trunks, bark, and holes of ancient trees provide rich habitats and have become habitats for many wild animals to inhabit, forage, and breed. For example, many birds choose to build nests in the holes of ancient trees to provide a safe environment for their offspring (Figure 1). Bats often inhabit the trunks and caves of ancient trees, and also play important roles as pollinators and pest control. In addition, the dense branches and leaves of ancient trees provide shelter and shelter for other organisms, enabling them to find safe habitats in complex ecosystems.

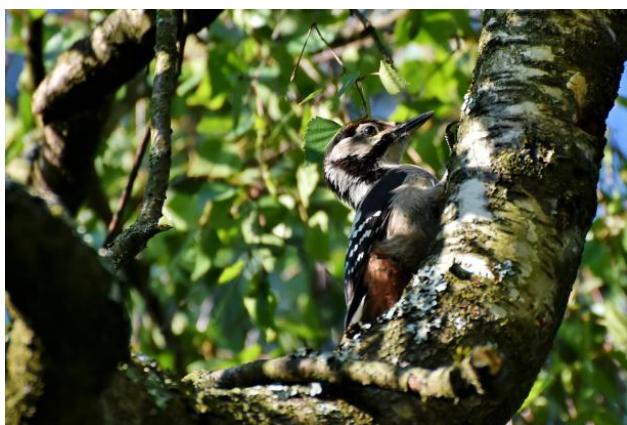


Figure 1 Ancient trees provide a place for habitat, foraging and breeding

The protection of ancient trees is particularly important for some endangered species. Taking giant pandas as an example, they rely on bamboo as their main food source, and bamboo forests often require symbiosis with ancient trees. Ancient trees provide the habitat and food resources required by giant pandas, and protecting ancient trees means protecting the living environment of giant pandas.

In addition to its protective effect on specific species, ancient trees also promote the maintenance and increase of biodiversity. Due to the long growth cycle of ancient trees, they have accumulated a large number of biological communities and ecological processes over a long period of time. This makes ancient trees an important living space for other organisms. For example, the environment around ancient trees is often rich in various flowers and plants, attracting a large number of insects, which in turn attracts high-ranking consumers such as birds. This complex food chain and ecological network enable biodiversity to be maintained and thrive under the protection of ancient trees. Therefore, the existence and protection of ancient trees play an important role in maintaining biodiversity. As an important component of the ecosystem, ancient trees have a significant impact on regulating microclimate. Microclimate refers to the local climate conditions formed by factors such as trees, terrain, and architecture, relative to the surrounding environment. Ancient trees, through their unique morphological and physiological characteristics, have an impact on the temperature, humidity, wind speed and other parameters of the surrounding environment, thereby creating a unique microclimate environment.

Due to the dense branches and leaves of ancient trees, they can block direct sunlight and reduce the absorption of radiant heat of the ground. This makes the environment under the shade of trees relatively cool, forming a natural sunshade umbrella. Ancient trees also release water through transpiration, increasing the moisture content in the

surrounding air, thereby reducing the evaporation and heat dissipation of the environment. For example, an old banyan tree in a park has a broad crown and dense branches and leaves. The canopy of the old banyan tree can provide a large area of shadow, reducing direct sunlight on the ground. This helps to reduce surface temperature and slow down the formation of the heat island effect. In summer, people can feel cooler temperatures under the shade of trees, enjoy outdoor leisure activities, and avoid exposure to hot sunlight (Figure 2).



Figure 2 Ancient trees can affect the temperature and humidity of the surrounding environment

The dense branches and leaves of ancient trees can intercept precipitation and slow down the impact of precipitation. The environment under the tree canopy is relatively humid, and the rate of water evaporation is slow, forming a microclimate area with relatively high humidity. This humid environment is conducive to plant growth and the maintenance of biodiversity. At the same time, the roots of ancient trees can absorb and store underground water sources, providing a stable water supply and playing an important role in preventing soil drought and water loss.

Ancient trees have a wide leaf surface area and release water into the air through transpiration. This increases the humidity of the surrounding air, especially in dry urban environments. The presence of ancient trees can increase the moisture content in the air, improve air quality, slow down the rate of water evaporation, and promote the comfort of plants and humans.

1.3 Purifying the environment

As a precious resource in nature, ancient trees not only have unique charm in landscape, but also play an important role in environmental purification. Ancient trees have a positive impact on environmental purification by absorbing harmful gases, fixing carbon sources, purifying air, and improving water quality.

Ancient trees absorb carbon dioxide through their stomas and release oxygen, which helps improve air quality. Ancient trees filter and adsorb particulate matter, harmful gases, and volatile organic compounds in the air, reducing the risk of people being exposed to harmful substances. For example, some ancient trees are often planted along the roads in cities, which can absorb harmful gases such as nitrogen dioxide from vehicle exhaust and play a certain role in air purification (Figure 3).

Ancient trees absorb a large amount of carbon dioxide through photosynthesis and convert it into organic matter. In this way, ancient trees play a role in carbon sequestration and help mitigate global climate change. The trunk, branches, and leaves of ancient trees accumulate a large amount of carbon during their growth process, forming important carbon sinks. Therefore, protecting and increasing ancient tree resources is of great significance for alleviating greenhouse gas emissions and protecting ecological balance.

In addition, the roots of ancient trees can absorb nutrients and harmful substances from the soil, preventing them from entering groundwater or water bodies. Ancient trees reduce the content of pollutants in water bodies and improve the purification effect of water quality through the filtration and adsorption of their roots. For example,

ancient trees along rivers can prevent soil erosion and soil erosion, maintain the clarity of water bodies, and maintain the health of ecosystems.

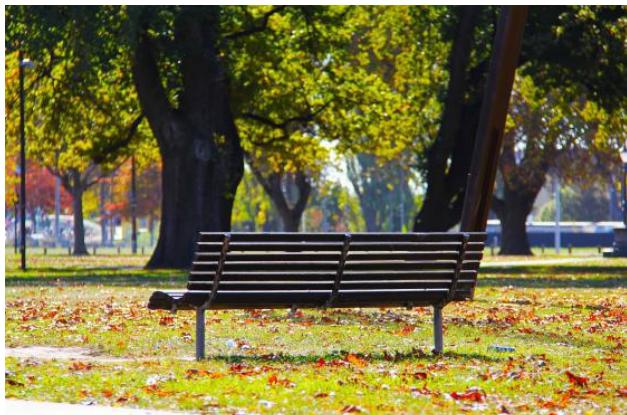


Figure 3 Ancient trees can influence the noise absorption and light pollution

1.4 Soil and water conservation

As a precious resource in nature, ancient trees play an important role in preserving soil and water. They help prevent soil erosion, maintain soil stability, and improve water quality through root system maintenance and soil protection, thus playing an important role in the healthy development of ecosystems and the environment.

The roots of ancient trees can firmly fix the soil and prevent soil erosion. The roots of ancient trees are usually well-developed and crisscrossed, forming a sturdy network structure. This root structure helps to resist wind and water erosion, reducing soil erosion and erosion. For example, ancient trees on the riverbank can prevent the erosion of water, maintain the integrity of the riverbank, and prevent the collapse and soil erosion of the riverbank (Figure 4).



Figure 4 Ancient trees can slow down soil erosion

The roots of ancient trees can increase the soil's water retention capacity. The roots of ancient trees can penetrate deep soil, absorb and store a large amount of water. This helps to increase the soil's moisture content and water retention capacity, reducing water loss and evaporation. In arid areas, the presence of ancient trees can provide water sources for surrounding vegetation and alleviate the degree of soil drought. At the same time, the roots of ancient trees can also improve soil structure, increase soil permeability and water retention, and facilitate water infiltration and retention.

2 The Scientific Value of Ancient Trees

As a natural treasure in the ecosystem, ancient trees have rich natural scientific value in various fields such as biology, geology, and climatology. Their existence not only provides opportunities for studying and understanding nature, but also provides important scientific basis for environmental protection and sustainable development.

2.1 The biological value of ancient trees

In the field of biology, ancient trees represent a long life journey, providing biologists with the opportunity to delve into biological phenomena such as growth, reproduction, and adaptation. As the "elders" of the ecosystem, ancient trees have experienced multiple natural disasters and environmental changes, and their ability to survive represents a form of resilience and ecological adaptability. Studying the adaptive mechanisms and disaster resistance of ancient trees can help to gain insight into the stability and resilience of ecosystems (Dong, 1989). For example, the "General Sherman Tree" located in California, USA is the largest tree in the world, with an age of over 2 500 years. Studying the annual rings and trunk growth rates of these ancient trees can reveal information on climate change and environmental adaptation at different periods, providing valuable time series data for ecological and evolutionary biology research.

2.2 Geological value of ancient trees

In the field of geology, ancient trees are also a "living history book" that records the historical changes of the Earth. The annual rings of ancient trees record the years of their growth, providing valuable information for understanding the evolution of the natural environment. For example, in the ancient tree clusters of Yunnan, China, there are thousands of years old ginkgo trees that have witnessed historical geological and geomorphological changes, climate fluctuations, and so on. By analyzing the tree rings and trunk fossils of these ancient trees, geologists can reconstruct the evolution of the Earth's ancient environment, providing important clues for understanding the long-term evolution of the Earth (Dong, 1989).

2.3 Climatological value of ancient trees

In the field of climatology, the existence of ancient trees provides a unique data source for studying climate change. The leaf morphology and growth status of ancient trees are influenced by environmental changes and can serve as "sensitive indicators" of ecosystem changes (Dong, 1989). For example, in the alpine forests of the European Alps, there are some ancient spruce trees whose annual rings record climate information such as temperature and precipitation over the past few hundred years. By analyzing these annual rings, climatologists can reconstruct past climate change trends, providing important evidence for understanding the impact of modern climate change.

3 Measures for Protecting Ancient Trees

Ancient trees are rare and non renewable resources. The number of ancient trees over a few hundred years old is rare and takes an extremely long time to form. Once damaged, they cannot be restored and gradually decrease over time, making them precious and scarce. However, considering the time span of the formation of ancient trees, the overall number is relatively limited. Even through artificial cultivation, it is difficult to fully simulate and restore its form and function. As human activities continue to disrupt the forest ecological environment, ancient tree resources are also facing enormous pressure and threats. Excessive logging, environmental pollution, and other issues have led to a sharp decrease in the number of ancient trees, which will have an irreversible impact on the entire ecosystem (Figure 5). Many rare ancient tree species are already in an endangered state.

Therefore, the protection and management of ancient tree resources are of great necessity (Zhang and Zhang, 1989; Zhao et al., 2022). Protecting ancient trees requires taking various proactive measures (Blicharska, and Mikusiński, 2014; Jiang et al., 2020). The government and society should strengthen the protection and management of ancient trees, establish systems and regulations for ancient tree protection, and formulate and implement plans for ancient tree protection. At the same time, strengthen the monitoring and evaluation of ancient trees, timely detect and deal with problems such as ancient tree diseases and pests, wind disasters, etc. Strengthen the protection and

restoration of the ecological environment of ancient trees, establish ecological protection areas around ancient trees, and reduce human interference and damage to ancient trees.



Figure 5 Effects of excessive logging

In addition, strengthen public education and publicity, increase public awareness and importance of ancient tree protection, and encourage public participation in ancient tree protection activities. Protecting ancient trees requires joint efforts from all parties. Governments, enterprises, the public, and other parties should jointly participate in the protection of ancient trees, form a joint force, jointly protect ancient tree resources, and achieve the goals of ecological balance and sustainable development.

4 Summary and Outlook

Ancient trees are an indispensable and important component of the ecosystem. From an ecological perspective, ancient trees play a crucial role in maintaining biodiversity. The environment where ancient trees are located maintains the characteristics of the original ecosystem and is an ideal habitat for many species. The ancient trees themselves provide a three-dimensional living space, allowing various organisms to find food and shelter within them. At the same time, ancient trees maintain the balance of the surrounding ecological environment by regulating the microclimate, maintaining water and soil, and purifying the environment. The value of these ecosystem services far exceeds the wood value of ancient trees.

As a unique presence in natural ecosystems, ancient trees are not only a magnificent natural landscape, but also carry rich natural scientific values. In addition to their value in biodiversity, ecological balance, ecological function regulation, and carbon cycling, they cover multiple fields such as ecology, geology, and climatology. The existence of ancient trees to a certain extent reflects the stability of the local environment and the ecological health status. Protecting and researching ancient trees can help formulate more scientific natural resource management strategies, maintain ecological balance and sustainable development.

In summary, the ecological functions of ancient trees are multifaceted and irreplaceable, and their recorded natural values are profound and unique. Protecting ancient trees is of great significance for sustainable human development. The protection of ancient tree resources should be viewed from a strategic perspective, and the cause of ancient tree protection should be promoted by strengthening legislation and popular science education. Fully exploring the ecological and natural value of ancient trees will be beneficial for promoting the construction of ecological science. I also hope that all sectors of society can work together to promote this noble environmental protection cause, so that the precious ecological science wealth of ancient trees can be passed down.

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