A legacy of medicine and biodiversity: Protecting the cinchona tree

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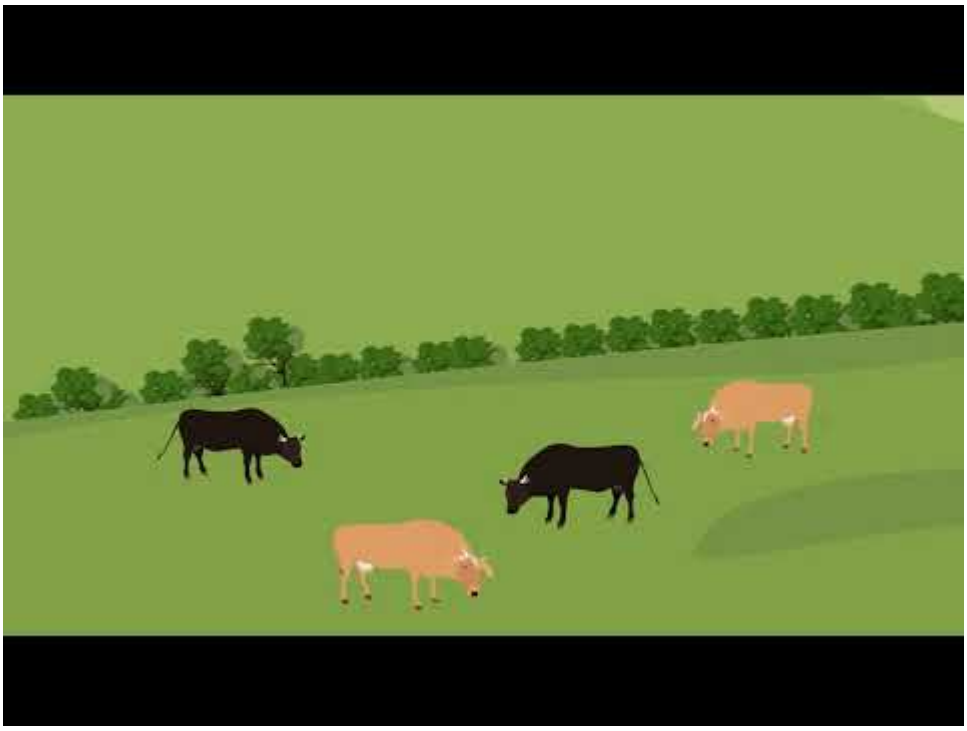
The endangered *Cinchona officinalis,* native to the Andean foothills, produced the world's first anti-malarial drug. Augusta Cueva-Agila explains why it is crucial to conserve this species and how conservation efforts can be implemented

The medicinal properties of the cinchona

The cinchona tree (*Cinchona officinalis, L.*), a species endemic to the Andean cloud forests of Ecuador and Peru, is a very special tree in the history of humanity. This species is the source of quinine, a breakthrough medicine against malaria that saved the lives of hundreds of people, making it one of the most important plants in history. However, centuries of over-harvesting, followed by deforestation and the advance of agricultural frontiers, have pushed this species to the brink of extinction. Its conservation is a challenge and a priority for biodiversity conservation.

Indigenous tribes of the Andes, specifically from Loja in southern Ecuador, were the first to use cinchona bark to cure fever. In the 16th and 17th centuries, Spanish missionaries learned of cinchona's properties and introduced quinine to Europe, establishing the first effective treatment for malaria. Subsequently, cinchona was so thoroughly exploited – especially in southern Ecuador – that by the mid-1800s, nearly all wild populations had been decimated. Although exploitation of the tree was greatly reduced after the 19th century with the establishment of cinchona plantations in Asia, the tree faced a second wave of exploitation during the Second World War when quinine supplies were cut off worldwide.



Watch Video At: https://youtu.be/7ygIMc_l4mA

Cinchona officinalis: an endangered tree

Today, *Cinchona officinalis* is threatened not only by historical overharvesting but also by bark harvesting methods that often kill the trees. Habitat fragmentation caused by agricultural expansion and deforestation in Ecuador significantly reduces its ecosystems, resulting in small, isolated populations. Such fragmented habitats reduce gene flow and genetic diversity while increasing the likelihood of local extinctions.

In addition, *Cinchona officinalis* has very limited potential for natural regeneration. Factors such as the small size of its seeds and the low viability of germinated seedlings limit the ability of populations to recover naturally. Currently, the species is found mainly in degraded habitats or private reserves in southern Ecuador.

Strategies for in-situ and ex-situ conservation

The conservation of *Cinchona officinalis* requires a dual approach that includes both *in-situ* and *ex-situ* methods.

In situ conservation: The protection of natural populations in their native habitats is essential, particularly in the province of Loja-Ecuador. Conservation efforts should focus on remnant populations, such as those of Angashcola and Gonzanamá, which contain unique genetic diversity, but also on populations of El Cristal, El Madrigal, Vilcabamba, and Yangana, some of which have very few trees but maintain genetic diversity, as you can see in our study and in this video. However, they continue to face ongoing deforestation and agricultural encroachment. Additionally, recent intense forest fires in the province of Loja have increased the risk to these populations, so it is very important to protect their habitat.

In addition, more research is needed to improve seedling growth in the field. The species can be germinated in greenhouses, but the seedlings do not grow once reintroduced into the forest, making restoration efforts difficult.

Ex-situ conservation: Given the challenges of the natural regeneration of the species, advanced techniques are being used to conserve its genetic material outside its native habitat.

This approach will be important to ensure that genetic resources are protected and available for restoration even if natural populations continue to decline. Under in vitro conditions, germination can reach up to 90% by exposing seeds to hydrogen peroxide and adjusting photoperiod conditions to optimize the process. Tissue proliferation can also increase significantly by stimulating the formation of shoots and calluses through the use of plant hormones, utilizing cultivated nodal segments. For more details, it is recommended to consult the corresponding study.

For the in vitro regeneration of *Cinchona officinalis* tissues, it is recommended to use combinations of 6-benzylaminopurine (BAP) with indole-3-butyric acid (IBA), as they produce genetically more stable explants. In contrast, it is essential to avoid the use of 2,4 dichlorophenoxyacetic acid (2,4-D) in reintroduction and restoration programs, as it increases genetic variability and compromises the stability of regenerated plants. This study provides valuable information to optimize *in vitro* propagation protocols, thereby contributing to the conservation of this endangered species.

In a recent publication, we present the results of in *vitro slow-growth* techniques and cryopreservation.

In vitro slow-growth techniques

Explants stored under controlled conditions using osmotic substances such as sorbitol and sucrose can be maintained for up to 12 months without subculture. These methods reduce the growth rate while maintaining tissue viability. Sorbitol, in particular, has been shown to be effective in minimizing growth and mortality rates and is an excellent method for short-term preservation of plant material.

Cryopreservation

Long-term preservation can be achieved through techniques such as vitrification and encapsulation dehydration. These methods involve freezing plant tissues in liquid nitrogen, effectively stopping biological activity while preserving genetic material for future restoration efforts.

The knowledge generated about Cinchona officinalis should be taken into account by governmental and private organizations that can unite efforts to promote its conservation, not only in Ecuador but also in Peru, where the species is distributed. If we do not unite our efforts, the remaining populations will be in increasing danger of disappearing.

The conservation of *Cinchona officinalis* is not only the conservation of a tree; it's the conservation of a heritage. This species represents the intersection of natural history, human health, and cultural identity.

Educational campaigns are needed to raise awareness among the population and promote concrete actions that contribute to the conservation of this emblematic species. Empowering local communities to participate in restoration activities can help bridge the gap between scientific studies and tangible conservation results. As we reflect on the legacy of the cinchona tree, let it inspire a broader commitment to protecting biodiversity. By conserving this species, we honor its historic contributions and ensure its story continues for generations.

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