

Role of Botanical Gardens and Herbaria in Plant Conservation

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INTRODUCTION

Plants form the basis of all life on Earth. They provide food, oxygen, medicine, fuel, and raw materials, and they regulate climate and maintain ecological balance. However, human activities such as deforestation, industrialization, and urbanization have led to the rapid loss of plant species and habitats. According to international reports, thousands of plant species are now threatened with extinction. Therefore, plant conservation has become a global priority.

Plant conservation involves all activities aimed at protecting plant species and their habitats to ensure their survival for future generations. Two major institutions — botanical gardens and herbaria — play a pivotal role in this effort. While botanical gardens conserve living plants under controlled conditions, herbaria preserve dried plant specimens as permanent scientific records. Together, they represent complementary approaches to understanding, documenting, and conserving plant biodiversity.

2. Botanical Gardens and Their Role in Conservation

A botanical garden is a well-planned scientific institution that maintains a collection of living plants for research, conservation, education, and display. Each plant is properly labeled with its botanical name, family, and origin. These gardens act as centers for ex situ (off-site) conservation and public education.

2.1 Ex Situ Conservation

Botanical gardens are crucial for ex situ conservation, where plants are conserved outside their natural habitats. Endangered and rare species are cultivated, monitored, and propagated under controlled conditions to ensure their survival. Seeds and cuttings from these plants are preserved for reintroduction into the wild when necessary.

2.2 Germplasm and Seed Banks

Many botanical gardens maintain seed banks and germplasm collections that serve as repositories of genetic material. These resources are valuable for plant breeding, ecological restoration, and research on climate resilience.

2.3 Research and Scientific Studies

Botanical gardens provide living laboratories for studying plant taxonomy, physiology, ecology, and biotechnology. Scientists can experiment with propagation, hybridization, and adaptation of species to changing environments. They also support climate change research by monitoring plant responses to temperature and rainfall variations.

2.4 Environmental Education and Public Awareness

Through guided tours, exhibitions, and educational programs, botanical gardens educate visitors about plant diversity, conservation, and the importance of environmental protection. They inspire communities to participate in conservation efforts and sustainable living.

2.5 Conservation of Medicinal and Economic Plants

Botanical gardens preserve plants with medicinal, ornamental, and economic value. This helps protect indigenous knowledge systems and supports sustainable utilization of natural resources.

3. Herbaria and Their Role in Plant Conservation

A **herbarium** is a systematically organized collection of dried, pressed, and labeled plant specimens that serve as permanent records of plant diversity. Each specimen includes details such as scientific name, locality, date of collection, and collector's name. Herbaria act as reference centers for plant identification, taxonomy, and conservation research.

3.1 Documentation of Plant Diversity

Herbaria record the flora of different regions, providing an essential database for biodiversity studies. These specimens offer historical evidence of plant distribution, helping scientists track changes in vegetation patterns due to climate change or habitat destruction.

3.2 Support for Taxonomy and Systematics

Accurate identification of plant species is crucial for conservation planning. Herbarium specimens are used by taxonomists to classify plants, describe new species, and revise existing classifications. They serve as **type specimens**, the definitive reference for species identification.

3.3 Research and Reference Material

Herbarium specimens are valuable sources of morphological, anatomical, and genetic information. Researchers extract DNA, study plant evolution, and analyze traits important for conservation and sustainable use. Historical

herbarium records also aid in reconstructing past ecosystems and predicting future ecological shifts.

3.4 Role in Legal and Environmental Policy

Herbaria provide verified plant records that are used in biodiversity assessments, environmental impact studies, and national conservation policies. They help governments and conservation organizations prioritize species and habitats for protection.

3.5 Digitization and Global Data Sharing

Modern herbaria are increasingly digitizing their collections. Digital herbarium databases allow global access to plant data, enabling researchers worldwide to collaborate on conservation initiatives and share information about threatened species.

4. Combined Role in Plant Conservation

Botanical gardens and herbaria complement each other in multiple ways:

1. **Documentation and Preservation:**
Herbaria document and preserve dried specimens, while botanical gardens maintain living plant collections.
2. **Research Integration:**
Data from herbarium specimens guide field collection and cultivation in botanical gardens, ensuring correct identification and genetic diversity.
3. **Restoration Programs:**
Botanical gardens provide living material for reforestation and habitat restoration projects, supported by herbarium-based research on native species.
4. **Public Education and Awareness:**
Both institutions engage the public through exhibitions, workshops, and awareness programs promoting biodiversity conservation.
5. **Climate Change Monitoring:**
Herbaria offer historical records of plant phenology, while botanical gardens provide real-time observations — together they help study the effects of climate change on plant life.

5. Notable Botanical Gardens and Herbaria in Plant Conservation

- **Royal Botanic Gardens, Kew (United Kingdom):**
Houses one of the world's largest living and preserved plant collections and leads global conservation programs.

- **Missouri Botanical Garden (USA):**
Renowned for its research on tropical plant conservation and global herbarium databases.
- **Botanical Survey of India, Kolkata:**
Maintains one of Asia's largest herbaria and plays a key role in documenting Indian flora.
- **National Botanical Research Institute (Lucknow, India):**
Focuses on plant biotechnology, conservation, and sustainable use of natural resources.
- **Singapore Botanic Gardens:**
A UNESCO World Heritage Site that conserves Southeast Asian plant diversity and supports regional conservation initiatives.

6. Challenges and Future Prospects

Despite their importance, both botanical gardens and herbaria face challenges such as limited funding, space constraints, and lack of trained taxonomists. Climate change, invasive species, and habitat loss further increase the urgency for conservation action.

The future of plant conservation lies in integrated approaches combining traditional plant collection with modern technologies such as:

- **Molecular biology and DNA barcoding**
- **GIS-based plant distribution mapping**
- **Seed cryopreservation**
- **Digitization and global networking**

By adopting these techniques, botanical gardens and herbaria can play a stronger role in achieving the Global Strategy for Plant Conservation (GSPC) and the Sustainable Development Goals (SDGs) related to biodiversity.

7. CONCLUSION

Botanical gardens and herbaria are the twin pillars of plant conservation. While botanical gardens safeguard living plants through ex situ conservation and public education, herbaria preserve plant specimens as permanent scientific records. Together, they help in the identification, documentation, and restoration of plant species, ensuring that valuable genetic resources are not lost forever.

In an era of ecological crisis and rapid biodiversity loss, strengthening the infrastructure, collaboration, and global networking of these institutions is vital. By integrating scientific research with community involvement and policy support, botanical gardens and herbaria can continue to serve as guardians of plant diversity and play a decisive role in maintaining the planet's green heritage for future generations.

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