Nowhere Else on Earth:
An Interpretive Toolkit for Ex-Situ Conservation of Sri Lanka's Endemic Flora

A Thesis
Presented to the Faculty of the Graduate School
of Cornell University
in Partial Fulfillment of the Requirements for the Degree of
Master of Professional Studies in Integrative Plant Science

by
Mary Margaret Lee
August 2023

ABSTRACT

In 2017, Nature Plants published the most comprehensive inventory of botanic garden living collections that has been conducted to date. The analysis found that botanic gardens worldwide house roughly 30% of all formally recognized plant species.[1] Furthermore, the data revealed a substantial discrepancy in the ratio of plants native to temperate regions versus those native to tropical. Approximately 76% of the plant species not currently accessioned by any garden are native to tropical areas.[1]

Within this subset of tropical plants, there are substantiated concerns that endemic plants might more easily become endangered or extinct as other stressors compound with their already restricted distribution scale.[2]

Sri Lanka's landscape is teeming with floristic species, a trait that may be the result of evolution in terrestrial solitude. As of 2020, 863 angiosperms were considered endemic to the island.[3] Of these 863 endemics, 625 (approximately 73% of the total endemic island plants) were classified as threatened.[4]

I have fully executed the design process and interpretive planning for a conservatory display, a venture rooted in the belief that humans are primed to feel an attachment to the things we can directly experience and understand. Above retention of fact or reiteration of experience, I hope the exhibit will facilitate a chance for the lens through which they engage with local flora to become more intentional.

BIOGRAPHICAL SKETCH

Mary Lee is a graduate student at Cornell University, where she is in the final stages of completing a Master of Professional Studies in Integrative Plant Science with a concentration in Public Garden Leadership. During her enrollment in the program, she was also a Graduate Fellow at Cornell Botanic Gardens.

Mary comes to Cornell having graduated summa cum laude with a bachelor's degree in Anthropology and minors in Deaf Studies and Creative Writing from the State University of New York at New Paltz.

Mary's capstone research at Cornell is focused on the floristics of South Asia and the public gardens' role in protecting biodiversity through ex-situ collections. To this end, her culminating work has been centered on the interpretive design process for a living collection of plants endemic to Sri Lanka.

In May of 2023, she was selected as a recipient of the American Public Gardens Association Garden Scholar Award. This award provided granted Mary the opportunity to present this capstone toolkit at the American Public Garden Associations Annual Conference in June of 2023.

Mary would like to extend immense gratitude to her advisors, friends, and family for their thoughtful perspectives and ongoing support throughout her academic journey.

ACKNOWLEDGEMENTS

I would like to express my immense gratitude to the following individuals:

Dr. Sonja Skelly and Dr. Donald Rakow for their advisement and support throughout my Cornell experience. Their invaluable insight played a crucial role in the completion of this capstone.

Sarah Fiorello and Kevin Moss for their professional perspectives and kindness.

Dr. William Crepet, Craig Cramer, and Tara Reed for providing me with encouragement and opportunities to grow.

And lastly, thank you to my Mom, Ky, and Olive for always cheering me up and cheering me on.

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STATEMENT OF INTENDED IMPACT

01 To educate the botanical community, policymakers, conservation groups, and the public on safeguarding plants endemic to Sri Lanka.

02 To educate the botanical community, policymakers, conservation groups, and the public about the challenges faced by island endemic plants.

03 To offer valuable knowledge about the ecological and biocultural significance of Sri Lanka's unique plant life.

04 To share this information in an inspirational and motivational way rather than an alarmist one.

05 To bring this inspiration through practical guidance, highlighting successful conservation stories.

This design was intended to encourage collaboration, knowledge-sharing, and innovative conservation strategies. It is my hope that this capstone work will play a part in building increased awareness and shared responsibility for protecting Sri Lanka's extraordinary plant life.

Top Image: Sri Prada, also known as Adam's Peak

Middle Image: Wild Elephants in Yala National Park

Bottom Image: Galle Lighthouse, Sri Lanka's Oldest Light Station

SUMMARY OF COMPONENTS & INTENDED FUNCTIONS

User Guide

This is the toolkit in its entirety. The full text of this document is intended to function as a resource for garden staff, providing comprehensive information about the exhibit. It includes details about the exhibit layout, plant species, interpretive messaging, and visitor engagement suggestions.

This handbook aims to ensure consistency in knowledge and operations among the staff, facilitating effective management and maintenance of the exhibit while minimally increasing the workload burden of garden staff.

Collection of "Postcards" for Plant Specimens

This collection features identification labels and images of various plant specimens the garden might acquire. The postcards serve as informational resources for visitors, providing details about the featured plants, including their common and scientific names, endemic status, and notable characteristics.

They can be used as self-guided tools or for educational purposes if the living collection is not on display, ensuring that visitors still have access to information and visuals of the plants.

SUMMARY OF COMPONENTS & INTENDED FUNCTIONS

Core Panels of the Exhibit

These core panels form the backbone of the exhibit narrative. They present essential information about the importance of endemic flora, its ecological significance, cultural connections, conservation challenges, and conservation efforts. The core panels provide a comprehensive overview, engaging visitors and conveying key messages about the importance and urgency of conserving endemic plant species.

Visual Renderings of the Exhibit

These depict the exhibit in three different forms, allowing for better visualization and planning.

Robust living collection alongside interpretive materials:

- This rendering showcases how the living plant collection is displayed within the exhibit, integrated with interpretive materials such as signage, interactive displays, or multimedia elements. It illustrates the spatial arrangement, plant placements, and the overall immersive experience for visitors.

Specimen plants accompanying interpretive materials:

- This rendering highlights the display of individual plant specimens alongside interpretive materials, providing a closer look at the featured plants. It demonstrates how the highlighted representatives are integrated within the exhibit to enhance educational value and visual appeal.

Interpretive materials as a stand-alone exhibit:

- This rendering focuses on the interpretive materials, illustrating their design, layout, and arrangement as a stand-alone exhibit.

ANNOTATED BIBLIOGRAPHY & CONTEXTUAL DATA FOR GARDEN STAFF USAGE

This design was intended to encourage collaboration, knowledge-sharing, and innovative conservation strategies. It is my hope that this capstone work will play a part in building increased awareness and shared responsibility for protecting Sri Lanka's extraordinary plant life.

Section One:
Connecting the exhibit content on Wild Crop Relatives to a larger narrative and understanding the relevance of food security, sustainable agriculture, and climate change.

Section Two:
Reflecting on the opportunity botanic gardens have to take on a critical role in sustaining cultural heritage and preserving ethnobotanically significant stories.

Section Three:
Connecting the modern role of botanic gardens to conservation education and research efforts.

Section Four:
Reflecting on the role of ex-situ conservation at botanic gardens in the protection of biodiversity and considering how to interpret genetics-related materials for the general public's consumption.

SECTION ONE:

Connecting the exhibit content on Wild Crop Relatives to a larger narrative and understanding the relevance of food security, sustainable agriculture, and climate change.

"Ceylon cinnamon": Much more than just a spice. (Suriyagoda, 2021).

Ceylon cinnamon is vital to the Sri Lankan economy, providing income for hundreds of thousands of families. Its uses span the culinary, wellness, and cosmetics industries. There are opportunities for crop improvement using genomic and genetic approaches to enhance yield, disease resistance, and sustainability in the face of environmental challenges. This source highlights the potentially positive impact of crop and product improvement on the lives and livelihoods of the population in Sri Lanka.

Unlocking plant resources to support food security and promote sustainable agriculture. (Ulian, 2020).

This resource emphasizes the vital role of biodiversity in ensuring global food security and nutrition. It focuses on edible plants, particularly neglected and underutilized species, intending to harness their potential as valuable food resources. It also examines the role that traditional knowledge plays in promoting sustainable agriculture, environmental protection, and the provision of ecosystem services. The intention is to raise awareness across various groups (politicians, scientists, farmers, and the general public) about the importance of biodiversity.

With more than 7,000 plant species potentially suitable for human consumption, many edible species are used in different ways. (medicinal, ecological, cultural). This resource focuses on neglected and underutilized edible plants and their potential as food resources.

Prioritizing crop wild relatives to enhance agricultural resilience in sub-Saharan Africa under climate change. (Satori, 2022).

Climate change threatens smallholder farmers in sub-Saharan Africa, worsening food insecurity. Incorporating climate-resilient crops is crucial. Breeding with wild relatives (CWRs), which possess traits for coping with climate change, is a potential solution. This study assessed trait documentation and conservation status of CWRs for 29 crops. Resilient CWRs showed distinct traits; some were threatened and absent from seed collections.

Though not geographically relevant, the content of the study emphasizes the need to conserve CWRs, enhance trait information, and improve agricultural resilience for food security in a changing climate.

Building a feral future: Open questions in crop ferality. (Mabry, 2023).

This text emphasizes the importance of innovative approaches to address future food insecurity issues in our changing climate. It highlights the potential of feral crops, plants that have escaped cultivation and established free-living populations, as a source of genetic diversity to enhance resilience in domesticated crops. However, wild plants can also act as aggressive weeds, threatening food security. The text emphasizes the importance of multidisciplinary research efforts to understand the potential of feral crops.

While research on feral crops and the process of feralization has made progress in recent years, there is a need for more comparative studies across different crop species and other relevant factors. Considering the importance of international collaboration, the text summarizes the current state of research on feralization and provides a roadmap for future studies. The identified research questions encompass various aspects, including definitions and drivers of ferality, genetic architecture, evolutionary history, agronomy, ecology, conservation, taxonomy, and best practice. By addressing these questions, researchers in the field of ferality can contribute significantly to improving food security in the context of climate change.

Resetting the table for people and plants: Botanic gardens and research organizations collaborate to address food and agricultural plant blindness. (Krishnan, 2019).

This article highlights the importance of addressing plant blindness through increased awareness and appreciation of food and agricultural plants. Collaboration between botanic gardens, academic institutions, nonprofits, and agricultural research organizations has led to successful initiatives that engage the public and raise awareness about these plants. However, limited opportunities for direct contact with agriculture contribute to plant blindness.

The article emphasizes the need to utilize food and agricultural plants to bridge this gap and promote an understanding of the challenges and innovations in the agriculture sector. By doing so, organizations can combat plant blindness and foster a greater appreciation for the significance of these plants in our daily lives.

Botanic gardens are an untapped resource for studying the functional ecology of tropical plants. (Perez, 2018).

This study addresses the importance of functional traits in studying plant ecology and predicting their responses to global changes. Trait data still needs to be included for many plant species, particularly those with hard-to-measure features and tropical species in remote rainforest systems. Botanic gardens' living collections offer access to diverse tropical species. These collections can help augment trait databases and advance our understanding of species' responses to climate change.

The source quantitatively assesses the availability of trait data for tropical and temperate species and explores species diversity in the exemplar tropical botanic gardens. The analysis confirms that botanic gardens' living collections are a valuable scientific resource for studying plant functional ecology and conservation.

SECTION TWO:

Reflecting on the opportunity botanic gardens have to take on a critical role in sustaining cultural heritage and preserving ethnobotanically significant stories.

New potential for conservation and repatriation of local and indigenous knowledge by botanical gardens (Hart, 2021).

Botanical gardens have played a crucial role in collecting and preserving local and indigenous knowledge associated with their plant collections. This knowledge, encompassing plant names, uses, cultivation techniques, and cultural values, has been integrated into Western scientific disciplines. In line with the Convention on Biological Diversity, botanical gardens have actively supported the conservation of local and indigenous knowledge by repatriating this knowledge to communities.

One approach to repatriation is increasing the accessibility of information. By making data and knowledge available online in free and accessible formats, botanical gardens can empower communities, promote community involvement, and center local and indigenous knowledge in botanical science. Additionally, targeted methods such as translating ethnobotanical information into appropriate formats like multilingual publications or audio-visual representations can facilitate knowledge sharing.

Modern botanic gardens, including the Missouri Botanical Garden, are actively repatriating local and indigenous knowledge. They strive to establish ongoing involvement and relationships with communities, especially in cases where knowledge transmission has been disrupted. Collaborative networks connecting institutions and communities hold great promise for the future, offering opportunities for mutual learning and support in conserving and revitalizing local and indigenous knowledge.

Medicinally Important Herbal Flowers in Sri Lanka. Evidence-Based Complementary and Alternative Medicine (Gunawardana, 2019).

This article focuses on the medicinal importance of flowers in Sri Lanka's traditional medicine systems, including Ayurveda, Unani, and Deshiya Chikitsa. These systems commonly use flowers to treat various diseases, although they receive less attention than other plant parts. The article highlights specific examples, such as Sesbania grandiflora flowers exhibiting anticancer properties and Woodfordia floribunda flowers used as fermenting agents in Ayurvedic preparations.

The method employed for this study involved a comprehensive literature survey, gathering data from Ayurveda libraries in Sri Lanka and scientific databases. The results indicate that many flowers are used for their astringent, cardiac tonic, and febrifuge properties. They also treat dysentery, diarrhea, indigestion, asthma, and bronchitis.

The study concludes that there are numerous flowers with beneficial therapeutic effects in Sri Lanka. Traditional medicine systems have utilized these flowers to treat diseases. Reviewing these medicinally important flowers provides valuable knowledge and pharmacological leads for human well-being. Further studies are needed to identify the chemical composition of these flowers, a process that botanic gardens could assist in the pursuit of.

The importance of harnessing the rich diversity of Sri Lankan flora for their medicinal value. (Jayasinghe, 2017).

This paper highlights the importance of ethnomedicine, which is rooted in traditional plant-based remedies. It emphasizes the need to explore these remedies' therapeutic potential and scientific validation. Sri Lanka's rich biodiversity and endemism make it a promising source for discovering new bioactive compounds. The authors discuss the current status and progress of studies on Sri Lankan medicinal plants and emphasize the importance of further efforts to uncover their medicinal value.

A survey on medicinal materials used in traditional systems of medicine in Sri Lanka. (Kankanamalage, 2014).

This study examines the challenges faced by the medicinal plant industry in Sri Lanka. Medicinal plants play a crucial role in providing healthcare to the rural population, but it needs up-to-date information on medicinal materials and faces various obstacles. The study gathers data from stakeholders and highlights the diverse range of medicinal materials used, including plants, minerals, animals, and other sources.

The Leguminosae family is particularly prominent. The industry faces high prices, poor quality, inadequate supply, and a lack of cultivation and processing protocols. The study calls for a national strategy to address these issues and suggests using the findings for sustainable development planning.

SECTION THREE:

Connecting the modern role of botanic gardens to conservation education and research efforts.

Botanical boom: A new opportunity to promote the public appreciation of botany. (Burke, 2022).

Plant science and botany need increased awareness. Interest in these fields has declined, but recent trends like "plantfluencers" and the therapeutic value of plants offer opportunities for engagement. Effective science communication can boost appreciation, generate interest, and contribute to plant biodiversity conservation.

These trends allow researchers and educators to leverage plant-focused communities and online groups to engage with new audiences. Topics such as houseplants, plant-based diets, and the benefits of interacting with plants for mental health provide a fertile ground for science outreach and botany-focused conversations.

Ex-situ conservation of plant diversity in the world's botanic gardens. (Mounce, 2017).

This study examines the role of botanic gardens in conserving plant diversity ex-situ. The research reveals that botanic gardens manage over 105,000 plant species worldwide, representing 30% of global plant diversity, and conserve more than 41% of known threatened species. However, there is a clear lack of representation of tropical species in living collections.

Additionally, the study reveals that only 10% of the capacity of botanic gardens is dedicated to threatened species. The study emphasizes the importance of botanic gardens in plant conservation but identifies the need for further actions to enhance biodiversity conservation in the future.

Global shortfalls in threat assessments for endemic flora by country. (Gallagher, 2020).

This text emphasizes the importance of conducting systematic conservation assessments to protect plant diversity. The study focuses on endemic plant species found in only one specific location and examines how their threats have been assessed in different countries.

The Global Strategy for Plant Conservation aimed to assess the conservation status of all recognized plant taxa by 2020, but this target was not fully achieved. However, conservation assessments are needed due to plant extinctions and increasing human environmental impacts.

The study evaluates the completeness of threat assessments for endemic plants in 179 countries by combining distribution data with information from the ThreatSearch database. The analysis finds that under local laws, 58% of country-based endemic species lack conservation assessments, indicating a lack of regulations to protect plant species, especially endemic ones.

Species-richness patterns of the living collections of the world's botanic gardens: a matter of socio-economics? (Golding, 2010).

The text explores the factors influencing species richness in botanic gardens, which serve as ex situ collections of plant biodiversity. The study finds that species richness in botanic gardens is positively associated with the size of the surrounding town's population and the country's GDP per person. However, it is unrelated to the native flora richness of the country.

Botanic gardens in more populous towns and wealthier countries tend to have larger areas and a greater number of species, contributing to the observed latitudinal gradient. These socio-economic factors shape the species richness of botanic gardens worldwide, providing insights that can support plant conservation and biodiversity preservation efforts.

The role of botanic gardens as resource and introduction centres in the face of global change. (Heywood, 2011).

Botanic gardens have a crucial role in addressing global challenges. This article emphasizes their need to expand their focus beyond ornamental horticulture and collaborate with agricultural and genetic resource communities. By collecting and preserving crop wild relatives and underutilized crops, botanic gardens can respond effectively to climate change demands. Closer ties with agricultural genebanks are essential for advancing plant conservation and introduction initiatives. Clear agreements, rigorous evaluation, and information sharing are important for avoiding duplication.

The challenge for botanic garden science. (Smith, 2019).

Over 20% of plant species are at risk of extinction, threatening the stability of many global economic, culinary, and medicinal practices. Botanic gardens are crucial in conserving and managing plant diversity, but they must expand their efforts to prevent further extinctions.

Traditionally focused on economic botany and taxonomy, botanic gardens need to shift their focus toward plant conservation, management, and utilization. Their extensive knowledge, skills, data, and collections are vital for addressing food security, renewable energy, human health, and biodiversity conservation challenges. While botanic gardens are often viewed as visitor attractions, refocusing their efforts to benefit the gardens and society is crucial.
Examples demonstrate how botanic gardens are already contributing, such as providing crop wild relatives for plant breeding, assessing resilience to climate change and vulnerability to pests, and conserving rare and threatened plant species.

However, only a small fraction of plant scientists and horticulturists in botanic gardens actively engage in impactful research on plant diversity conservation and management.

SECTION FOUR:

Reflecting on the role of ex-situ conservation at botanic gardens in protecting biodiversity and considering how to interpret genetics-related materials for the general public's consumption.

Darwin in the Garden: Engaging the public about evolution with museum collections of living objects. (Friedman, 2020).

Plants have played a central role in the evolution of biodiversity, and botanical gardens and arboreta house diverse collections that showcase ongoing evolution. These living collections offer a unique platform to engage and educate the public about the mechanisms of evolution, such as mutation, variation within species, and natural selection.

Drawing inspiration from Charles Darwin, who extensively studied horticulture and botanical literature to develop his evolutionary ideas, botanical gardens can use plants to promote an understanding of evolution. Darwin's botanical tactics from the 19th century are still relevant
today and can effectively communicate evolutionary concepts to scientists and the broader society.

By embracing their role as museums of living, evolving objects, botanical gardens, and arboreta have the potential to contribute to public education and engagement with evolutionary science significantly.

Saving plants, saving ourselves. (Raven, 2019).

Humans have significantly impacted the planet, but we have not adequately safeguarded the global ecosystem and the biodiversity it supports. As a species, we rely on plants and agriculture for survival, making their conservation and protection crucial. Plant scientists have a vital role in ensuring a sustainable future for all.

At the 2017 International Botanical Congress, suggestions were proposed, emphasizing how plant scientists can contribute to this goal. These include conducting research in a changing world, promoting plant science and collaboration, harnessing big data, documenting plant species, preserving indigenous knowledge, and engaging the public.

Ex-situ conservation of threatened plant species in island biodiversity hotspots: A case study from Hawai'i. (Werden, 2020).

Global plant extinction rates have risen significantly in recent years, posing a particular challenge in Hawaii due to habitat loss and invasive species. To address this, an integrated approach utilizing a co-located seed bank, micropropagation laboratory, and greenhouse has successfully rescued and conserved threatened Hawaiian plant species.

This perspective highlights the importance of ex-situ conservation techniques and partnerships with external organizations. It also presents a decision tree applicable to other regions, aiming to achieve regional and global zero-extinction goals.

Botanic garden solutions to the plant extinction crisis (Westwood, 2021).

Botanic gardens and arboreta have transformed from exclusive spaces to conservation powerhouses, attracting millions of yearly visitors. These gardens are well-equipped to tackle the pressing issues of preserving plant diversity.

Despite their significance–resources and awareness for these efforts remain limited worldwide. It is crucial for funders, governments, corporations, and individuals to increase their support for gardens, acknowledging their vital role in a global effort to prevent plant extinction. As all life depends on plants, investing in botanical gardens is essential for a scientifically informed and coordinated approach to plant conservation.

Ex-situ conservation in botanical gardens – challenges and scientific potential preserving plant biodiversity. (Kovacs, 2021).

In the Anthropocene era, plant diversity faces a severe threat of extinction, with many vascular plant species at risk. Ex-situ conservation has emerged as a critical tool to address biodiversity loss, and its importance has been emphasized in global conservation strategies.

However, there needs to be more studies focusing on plant materials' sustainability, quality, and usability in establishing garden collections, creating gaps in best practices for ex-situ conservation. This overview provides insights into ex-situ conservation, specifically in living plant collections. The case studies highlighted future needs, perspectives, and potential applications in ex-situ conservation, emphasizing priorities for future research and action.

INTERPRETATIVE APPROACH & NARRATIVE STRUCTURE

Core Interpretive Narrative

The core interpretive narrative emphasizes Sri Lanka's endemic flora's immense biocultural and ecological significance. It highlights the importance of prioritizing conservation efforts for these unique species globally.

Subtheme One: Climate Concerns for Endemic Species

Evolution in isolation refers to species evolving in a specific geographic area with limited interactions with other species.[26] In the case of the island of Sri Lanka, its isolation as a landmass has provided unique opportunities and vulnerabilities for the evolution of endemic species. With limited interactions with species from other regions, endemic species on the island have been able to occupy vacant ecological niches and adapt to the specific environmental conditions of the island.[27] The absence of competition allows endemic species to exploit available resources and adapt to specialized ecological roles, diversifying forms and functions.

While isolation has provided opportunities for evolutionary processes, it also makes endemic species vulnerable to threats. One of the key vulnerabilities is the heightened susceptibility to invasive species.[28]

Subtheme One:
Climate Concerns for Endemic Species

Due to their long isolation, endemic species often lack natural defenses or adaptations to cope with the presence of introduced species. Invasive species, such as plants, animals, and pathogens, can destroy their habitats and lead to population declines.[28]

As human activities, including urbanization, agriculture, and infrastructure development, continue to expand, natural habitats are being destroyed or fragmented. Endemic species, often specialized to specific habitats, can suffer from the loss of their preferred environments, resulting in reduced population sizes and restricted distributions.[29] Habitat fragmentation also isolates populations, reducing genetic diversity and making them more susceptible to the negative effects of inbreeding and genetic bottlenecks.[30]

Climate change poses additional risks to endemic species in Sri Lanka. Changes in temperature and rainfall patterns can disrupt the ecological conditions to which endemic species have adapted.[31] They may face challenges adjusting to rapid shifts in their habitats, changes in phenology (timing of life cycle events), and altered interactions with other species. The inability to cope with these changes can lead to decreased reproductive success, reduced food availability, and increased vulnerability to diseases, potentially pushing endemic species toward endangerment and extinction.[31]

Endemic species' limited range and specialized adaptations make them inherently more vulnerable to environmental changes and disturbances than more widespread and generalist species.[26]

Subtheme Two: Ethno-pharmaceutical Significance

Ethno-pharmaceutical significance refers to the importance of plants in traditional medicine and their potential for use in pharmaceutical applications. At least 174 endemic plants from Sri Lanka are considered to have medicinal value,[32] highlighting the rich ethno-pharmaceutical heritage of the country. Along with their quantity, their traditional history also contributes to their conservation value. The indigenous system of medicine known as Ayurveda ("science of life" in Sanskrit) has been practiced for more than 3000 years.[33]

Exploring the ethno-pharmaceutical significance of these endemic plants contributes to preserving traditional knowledge and cultural heritage and holds promise for developing new medicines and treatments. It allows for integrating traditional medicine with modern healthcare practices, potentially offering more accessible and sustainable healthcare options for the population.[34] Accessibility plays a significant role in meeting the healthcare needs of a considerable portion of the rural population. It is estimated that traditional medicinal practices cater to the healthcare needs of 60% to 70% of the rural population in the country.[35]

This demonstrates the continued reliance on indigenous and traditional medicine as an accessible and culturally appropriate healthcare option.

Subtheme Two:
Ethno-pharmaceutical Significance

The presence of over 20,000 registered Ayurvedic physicians and 8000 traditional practitioners further highlights the significance and popularity of traditional medicine in Sri Lanka.[36] These practitioners possess knowledge and expertise in medicinal plants and other traditional therapies passed down through generations.

Recognizing the importance of traditional medicine, several universities in Sri Lanka offer degrees in Indigenous Medicine.[37] These educational programs provide formal training and knowledge in traditional medicinal practices, including identifying, preparing, and utilizing medicinal plants.

The 174 endemic plants considered medicinally valuable in Sri Lanka offer a unique and valuable resource for ethno-pharmaceutical research.[32] Through scientific studies and research, there is a potential to discover new drugs, identify bioactive compounds, and develop pharmaceutical applications based on the traditional uses of plants.

Subtheme Three:
Ecological Relationships

Ecological relationships refer to the interactions and connections between organisms within an ecosystem. These relationships play a crucial role in maintaining the balance and functioning of ecosystems. One important aspect of ecological relationships is the interdependence between endemic plants and local wildlife; this interdependence often appears in mutualism.[38]

Sri Lanka's endemic flora has exceptional importance. These plants have evolved in isolation, adapting to the island's specific environmental conditions and forming intricate relationships with the other island residents. Endemic plants provide critical ecosystem services. Their presence enhances biodiversity and strengthens the resilience of ecosystems against disturbances.[38]

These mutualistic relationships are intricate and finely tuned, with plants often displaying specific adaptations to attract their respective pollinators, such as brightly-colored flowers, fragrances, or nectar guides.[38] Similarly, pollinators have evolved characteristics that enable them to collect nectar or pollen from the flowers effectively.[4] These endemic plants' success and pollinators' survival are interconnected. If the plants' populations decline or the plants themselves become extinct, the associated wildlife that relies on them for resources will be adversely affected.[39]

Subtheme Three:
Ecological Relationships

Loss of suitable food sources or nesting sites can disrupt animals' life cycles and reproductive patterns, potentially leading to population declines. Furthermore, these population declines can have cascading effects on the entire ecosystem.[40]

Therefore, endemic plants' conservation, preservation, and ecological relationships with wildlife are paramount. Efforts to protect and restore habitats, promote biodiversity, and ensure the sustainability of ecosystems contribute to maintaining the intricate web of ecological relationships and the long-term health of the environment.

Subtheme Four:
Value of Agrodiversity

This concept emphasizes the importance of preserving crop wild relatives (CWR) and highlights the numerous benefits of their conservation.[41]

Adaptability and Resilience of Global Food Networks: Crop wild relatives play a crucial role in enhancing the adaptability and resilience of global food networks, particularly in the face of climate change. CWR possess genetic traits valuable for crop improvement, including resistance to pests, diseases, and environmental stresses. By conserving CWR, we ensure the availability of genetic diversity that can be used to develop new crop varieties with improved traits, such as drought tolerance, heat resistance, and nutritional quality. This adaptability and resilience are essential for maintaining stable and sustainable food production systems.[42]

Sustainable Agricultural Practices: Preserving CWR contributes to promoting sustainable agricultural practices. The genetic diversity found in CWR can be utilized to develop crop varieties that require fewer inputs, such as fertilizers, pesticides, and water. By incorporating genetic traits from CWR into cultivated crops, farmers can reduce their reliance on synthetic inputs and practice more environmentally friendly and sustainable agriculture. This approach can help minimize the negative impacts of conventional agriculture on ecosystems, soil health, and water resources.[43]

Subtheme Four:
Value of Agrodiversity

Economic Fortification of Farming Livelihoods: The preservation of CWR has economic benefits for farming communities. Crop varieties developed through CWR genetic diversity can improve crop yields, enhance market value, and increase income opportunities for farmers. Additionally, maintaining diverse agricultural systems incorporating CWR helps farmers diversify their income sources, reducing their vulnerability to market fluctuations and crop failures. The economic fortification of farming livelihoods through the conservation of CWR contributes to the overall resilience and well-being of rural communities.[43]

Improved Access to Nutrition: CWR conservation impacts human nutrition. Many CWRs possess valuable nutritional attributes, including higher levels of vitamins, minerals, and antioxidants. By preserving CWR, we ensure the availability of diverse and nutritious food sources. Incorporating CWR into diets can help address micronutrient deficiencies and improve health outcomes.[44]

Safeguarding Culturally Significant Foodways: CWRs are often deeply intertwined with culturally significant foodways and traditional knowledge systems. These wild relatives may be integral to traditional cuisines, rituals, and cultural practices. Preserving CWR ensures the continuity of these cultural traditions, supporting the preservation of local knowledge, biodiversity-based farming systems, and the identity of indigenous and local communities.[45]

Subtheme Four:
Value of Agrodiversity

By conserving CWR, we can enhance the adaptability and resilience of global food networks, promote sustainable agricultural practices, fortify farming livelihoods, improve access to nutrition, and safeguard culturally significant foodways. Emphasizing the importance of CWR conservation is essential for maintaining agricultural biodiversity, ensuring food security, and supporting the well-being of ecosystems and human communities.

Interpretive Learning Objectives

In designing the exhibit on the endemic flora of Sri Lanka, it was crucial to identify and formulate specific learning objectives that align with educational goals and desired visitor outcomes.

Knowledge

Visitors will gain an understanding of the unique characteristics of Sri Lanka's endemic flora, including their ecological significance, cultural connections, and medicinal properties.

60% of attendees will be able to articulate at least one example of how endemic flora is connected to an environmental, traditional, or medicinal process in Sri Lanka.

Skills

Visitors will develop observational and inquiry skills to understand adaptations to diverse habitats. In the month following the exhibit.

30% of visitors will consider the adaptations of plants or animals in their own environment.

Visitors will cultivate an appreciation for biodiversity, recognize the importance of conserving endemic species, and feel inspired to take action to protect the environment.

10% of attendees will join the garden's mailing list. 5% will make a monetary donation.

Attitudes

Engagement strategies that were used to meet these objectives.

Cognitive: Providing informative and scientifically accurate content that stimulates visitors' curiosity, critical thinking, and understanding of complex ecological concepts—incorporating interactive elements (questions, prompts, etc.) to reinforce learning and encourage active engagement.

Affective: Creating an emotionally engaging exhibit that evokes a sense of wonder, awe, and empathy toward endemic flora's unique beauty and fragility. Using storytelling, personal narratives, and visual media allows visitors to connect emotionally with the plants and their conservation significance.

Behavioral: Including actionable messages, calls to action, and suggested behavior changes that empower visitors to make a positive impact (e.g., providing information on local conservation organizations or simple steps individuals can take to support biodiversity conservation in their lives).

General Interpretive Goals

- Foster Appreciation and Understanding: The exhibit aims to cultivate visitors' appreciation for Sri Lanka's endemic flora's unique beauty and ecological importance. It seeks to enhance understanding of the interconnections between these plants, their habitats, and the broader ecosystem.

- Inspire Conservation and Action: The exhibit inspires visitors to value and protect biodiversity. It aims to motivate individuals to take action by promoting sustainable behaviors, supporting conservation initiatives, and advocating for the preservation of endemic species.

- Promote Cultural Awareness and Connection: The exhibit seeks to highlight the cultural significance of Sri Lanka's endemic flora and foster a connection between visitors and the rich cultural heritage of these plants. It aims to promote cross-cultural understanding and respect.

Exploration of How the Exhibit Contributes to Broader Goals of Education, Conservation, and Public Engagement:

(The goal is aligning with aspects of BG missions that are applicable at a general level to most United States-based operations).

Education: The exhibit promotes environmental education by providing an engaging and informative platform for learning about endemic flora, ecological systems, and conservation principles. It fosters curiosity, critical thinking, and a lifelong interest in botanical and environmental sciences.

Conservation: The exhibit directly supports the goal of biodiversity conservation by raising awareness of the threats faced by endemic species and the importance of their preservation. It aims to mobilize public support for conservation initiatives and inspire individuals to become advocates for biodiversity protection.

General Interpretive Goals

Public Engagement: The exhibit facilitates public engagement by creating opportunities for dialogue, interaction, and shared experiences. It aims to connect visitors with scientists, conservationists, and local communities involved in preserving endemic flora. It encourages visitors to participate in discussions actively, contribute to citizen science projects, and explore ways to get involved in conservation efforts.

Education: The exhibit promotes environmental education by providing an engaging and informative platform for learning about endemic flora, ecological systems, and conservation principles. It fosters curiosity, critical thinking, and a lifelong interest in botanical and environmental sciences.

Conservation: The exhibit directly supports the goal of biodiversity conservation by raising awareness of the threats faced by endemic species and the importance of their preservation. It aims to mobilize public support for conservation initiatives and inspire individuals to become advocates for biodiversity protection.

Identification of Target Audience

The target audience for the exhibit can be defined as follows:

- Nature Enthusiasts and Botanical Garden Visitors: Individuals interested in nature, botanical gardens, and ecological systems. They may be curious about unique plant species and want to learn about their significance.

- Students and Educators: School and college students, as well as educators, who seek educational opportunities to expand their knowledge of biodiversity, ecology, and cultural connections. They may visit the exhibit as part of their curriculum or for enrichment.

- Conservation Advocates: Individuals actively engaged in environmental conservation efforts and passionate about preserving biodiversity. They may be interested in learning about conservation challenges and initiatives related to endemic flora.

The selection of the identified target audience is justified based on the following considerations:

Relevance and Interest: The conceptualized target audience has a pre-existing interest in nature, plants, and environmental topics. They are likely to be receptive and engaged in learning about the endemic flora of Sri Lanka, given their existing curiosity and enthusiasm for botanical knowledge.

Educational Potential: Students and educators will likely represent a significant audience for the exhibit, as they can benefit from the educational content and contribute to spreading awareness about the importance of endemic flora among their peers and communities.

Influence on Conservation Efforts: Conservation advocates are a key audience group as they are actively involved in environmental issues. Engaging them with the exhibit can lead to a deeper understanding of the conservation challenges faced by endemic flora and further inspire their commitment to conservation efforts.

Flexibility, Scalability, and the Importance of Catering to an Individual Audience
Flexibility, scalability, and catering to individual audiences were vital aspects to consider when designing the exhibit on the endemic flora of Sri Lanka. By factoring in the accommodations potentially needed by different venues (spatial limitations and audience sizes) and exploring strategies for tailoring the exhibit experience to the individual needs of a garden (visitor, preferences, levels of visitation, visitor demographics such as age and education level), the exhibit aims to engage diverse audiences and provide a personalized learning experience effectively.

Scalable Content: Content materials can be adjusted based on the size and capacity of the venue. This allows the exhibit to be easily expanded or condensed to suit different audience sizes and exhibition spaces.

Modular Display Elements: The signage components comprise modular display elements that can be rearranged and reconfigured to suit different spatial limitations. This ensures the exhibit can adapt to various venues without compromising its coherence and message.

VISUAL RENDERINGS OF EXHIBIT AT VARYING SCALE

Scalability options:
Interpretive materials only

Scalability options:
Interpretive material and specimen plants

Scalability options:
Interpretive materials and full living collection display

PRIMARY DISPLAY PANELS

Nowhere Else on Earth: Exploring the Endemic Flora of Sri Lanka

FUTURE

LEARN CONSERVATION METHODS

CONNECT LOCAL ACTIONS TO GLOBAL IMPACTS

UNDERSTAND RESEARCH POTENTIAL

ENDEMIC PLANTS ARE SPECIES FOUND LIVING IN ONLY ONE LOCATION ON THE PLANET.

NATURE

UNDERSTAND ISLAND ECOSYSTEMS

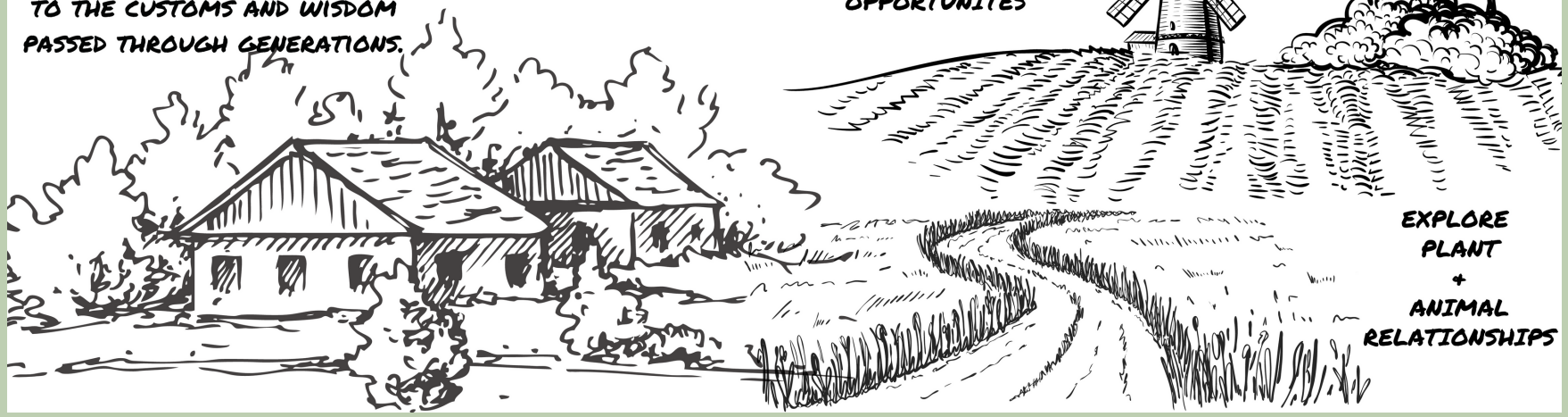
LEARN HOW RELATIVES OF COMMON CROPS HOLD BREEDING POTENTIAL AND AGRICULTURAL OPPORTUNITES

EXPLORE PLANT + ANIMAL RELATIONSHIPS

CULTURE

LEARN ABOUT MEDICINAL AND CULINARY USES

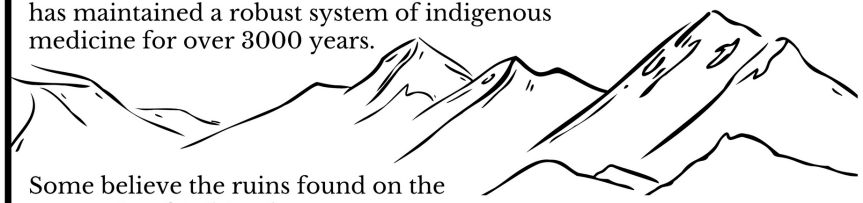
SEE HOW THESE PLANTS ARE A LIVING TESTAMENT TO THE CUSTOMS AND WISDOM PASSED THROUGH GENERATIONS.



History of the Forest Pharmacy: Understanding the Medicinal Significance of Plants

An Age-Old Practice

Historic rock inscriptions indicate that the island has maintained a robust system of indigenous medicine for over 3000 years.

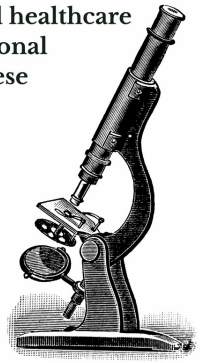


Some believe the ruins found on the mountain of Mihintale are remnants of the first hospital in the world.

Many traditional healing practices rely on the use of the island's unique plants.

Looking Ahead

In recent years, the Sri Lankan government and healthcare institutions have recognized the value of traditional medicine and have made efforts to integrate these practices into the modern healthcare system.



The Institute of Indigenous Medicine at the University of Colombo offers both undergraduate and graduate-level degrees.

Knowledge-sharing efforts like these greatly contribute to the preservation and continued relevance of medicinal systems.

Endemic and Essential

WRIGHTIA ANTIDYSENTERICA

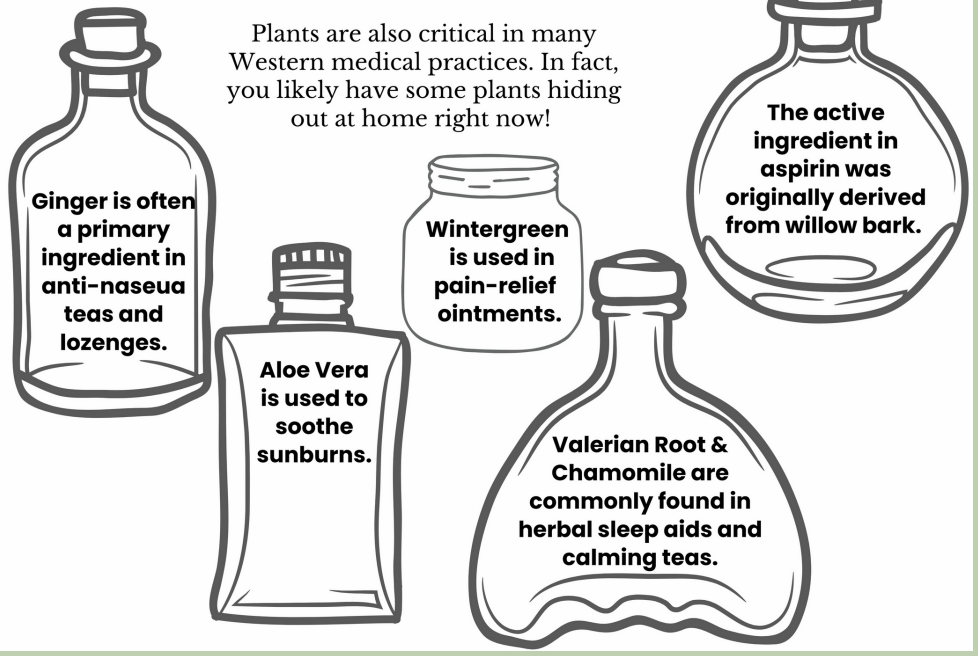
Juice extracted from the bark is used to treat mouth sores.

OSBECKIA OCTANDRA

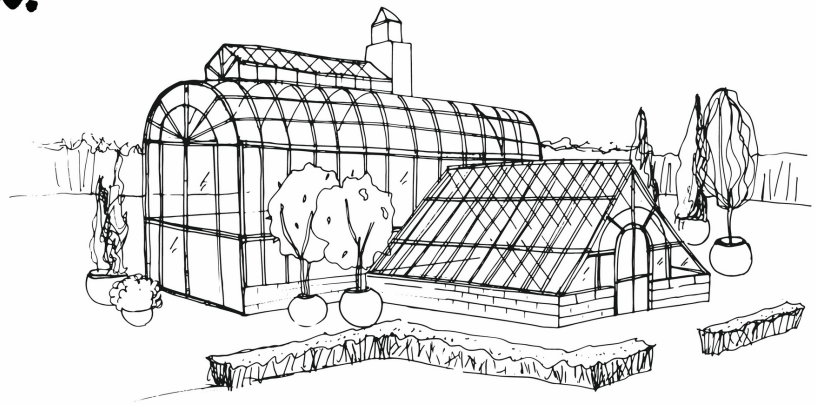
An herbal tea made from mature, dry leaves is used in the treatment of diabetes.

Sneaky Specimens!

Plants are also critical in many Western medical practices. In fact, you likely have some plants hiding out at home right now!



Evolution in Isolation: Changing climates vs. endemic plants



Limited interactions with the outside world mean endemic plants adapt to the specific environmental conditions of the island.

These specialized adaptations make endemic plants inherently more vulnerable to environmental changes.

They may face challenges adjusting to rapid shifts in their habitats, and altered interactions with other species.

The inability to cope with change can lead to decreased reproductive success and increased vulnerability to diseases.

Potentially pushing endemic species toward endangerment and extinction.

By growing endemic species, botanic gardens can protect against the total extinction of varieties.

Having access to these plants for research increases our understanding of their needs.

By better understanding the plants, we can protect them in the wild.

Supporting your local botanic garden can protect plant species (and the animals who rely on them) from extinction.

This support also ensures that cultural heritages around the globe are preserved.

Nature's Delicate Dance:

Ecological Relationships in Sri Lanka's Endemic Flora

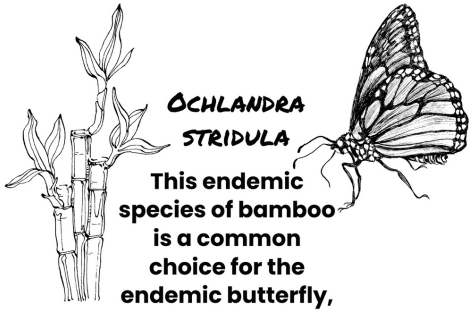
Pollination Partnerships

From birds and bats to butterflies and bugs, these plants have evolved unique adaptations to attract and rely on specific pollinators for successful reproduction.

Sri Lanka's endemic plants have evolved unique adaptations and characteristics that cater to the needs of local wildlife.

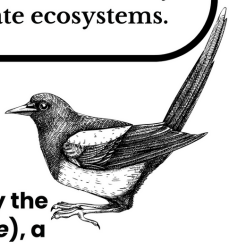
Guardians of Biodiversity

Understanding and preserving these harmonious adaptations is essential for protecting Sri Lanka's rich biodiversity and sustaining its delicate ecosystems.



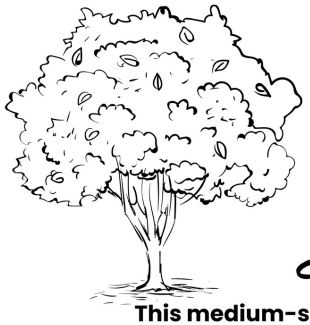
Ochlandra stridula

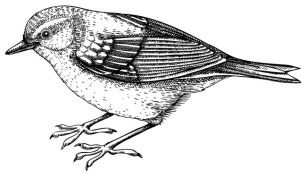
This endemic species of bamboo is a common choice for the endemic butterfly, *Mycalesis rama*, to lay its eggs.



Freycinetia pycnophylia

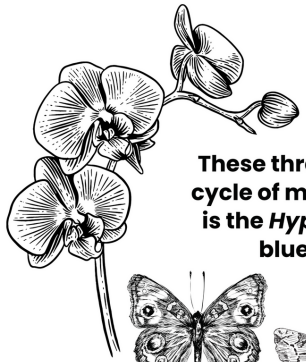
Produces a juicy fruit that is favored by the Sri Lanka Blue Magpie (*Urocissa ornate*), a vibrantly colored bird that is also endemic to the island.





Campnosperma zeylanica

This medium-sized endemic tree produces small, purple fruits attractive to many endemic birds of the island.



Peristylus trimenii, Dendrobium maccarthiae, & Ipsea speciosa

These three endemic orchids support the life cycle of many island butterflies. Among them is the *Hypolycaena nilgirica*, an uncommon blue butterfly found in the region.

Fragile Balance

Every factor in an ecosystem depends on every other element in the ecosystem. If a change occurs, this can throw an ecosystem out of balance.

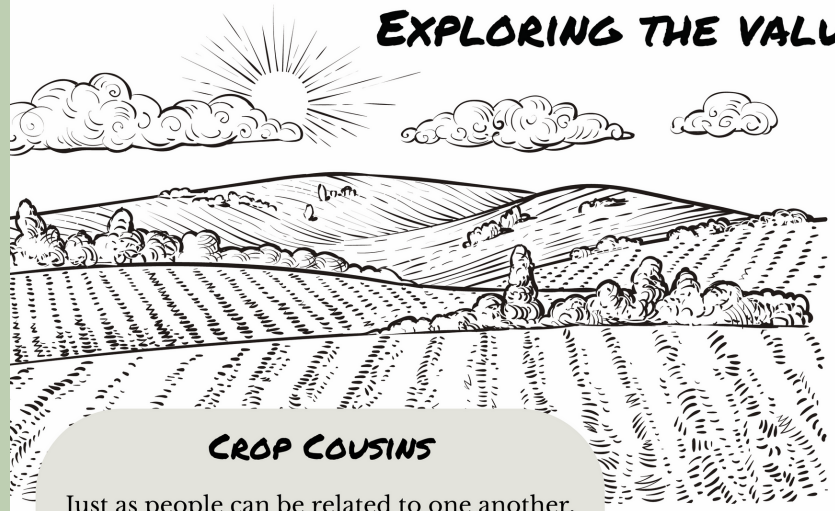
This change forces those organisms to adapt or move in order to survive. In an island setting like Sri Lanka's, moving isn't much of an option.

Think about it:

How do these ecological relationships compare to the interconnectedness in your own backyard?

How can we foster similar connections and support local biodiversity in our communities?

Farming for the future:
Exploring the value of wild crop relatives



Crop Cousins

Just as people can be related to one another, some plants share genetics.

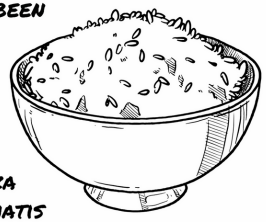
Wild relatives of food crops may hold the key to vital genetic resources that can help plants thrive in a changing climate and fight off diseases and pests.

From Field to Fork:

By studying crop relatives, we can empower local farmers with the knowledge to use these resources in sustainable agriculture practices.

The genetic potential of these plants opens doors to new varieties, improved yields, and economic opportunities for farming communities, enhancing their resilience and prosperity.

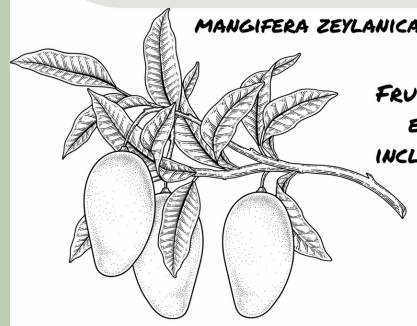
5 species of wild rice (Oryza), including the endemic species Oryza rhizomatis have been recorded in Sri Lanka.



Oryza rhizomatis

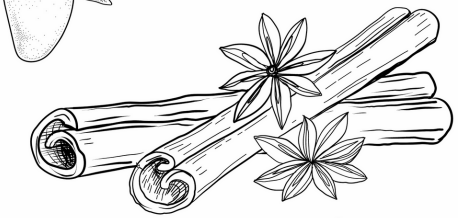
Myristica dactyloides

Sri Lanka is home to 3 wild relatives of nutmeg, one of which is endemic.



Mangifera zeylanica

Fruits with wild relatives endemic to Sri Lanka include mango, durian, and breadfruit.



Cinnamomum verum has eight species of wild relatives, all of which are endemic to Sri Lanka.

Cinnamomum zeylanicum

Culinary connections

These plants have evolved alongside island residents for centuries, contributing to diverse culinary traditions.

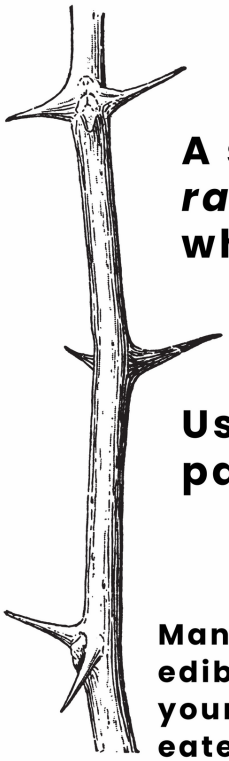
Just like preserving family histories, safeguarding wild crop relatives ensures that future generations can enjoy a rich array of flavors, textures, and nutritional diversity.

Food for Thought:

Consider supporting your own farming community by purchasing heirloom or locally grown crops to promote biodiversity and food security.

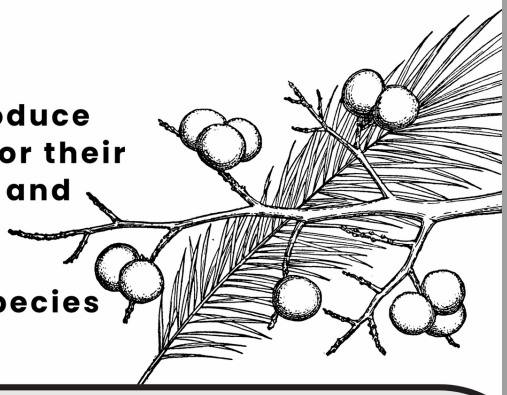
DISPLAY MATERIALS FOR INDIVIDUAL PLANTS

CALAMUS RADIATUS



A spiny, climbing palm *Calamus radiatus* produces long, thin stems which are covered in sharp prickles.

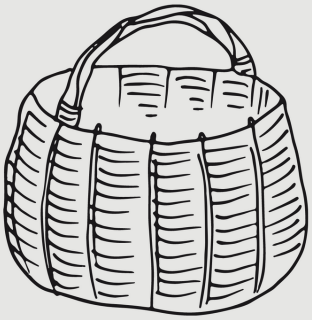
Using the prickles as support, the palm climbs up nearby vegetation.



Many members of this genus produce edible fruits. Others are known for their young shoots, which are cooked and eaten as a vegetable.

The edibility of this particular species has not been documented.

NATURAL RESOURCE

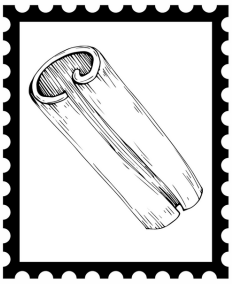


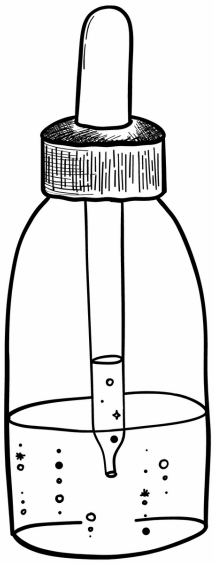
The canes of the plant are a popular choice for the production of baskets. Often, these baskets are used to hold tea leaves during the harvest process.

Because of their pliability, the stems of the plant can be split into thin strips and used to create chair bottoms. When twisted, the strips also make for very strong towing rope.

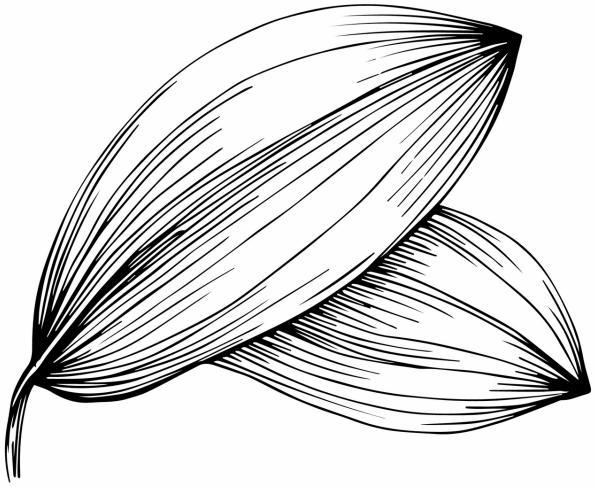
CINNAMOMUM ZEYLANICUM

'CEYLON CINNAMON'

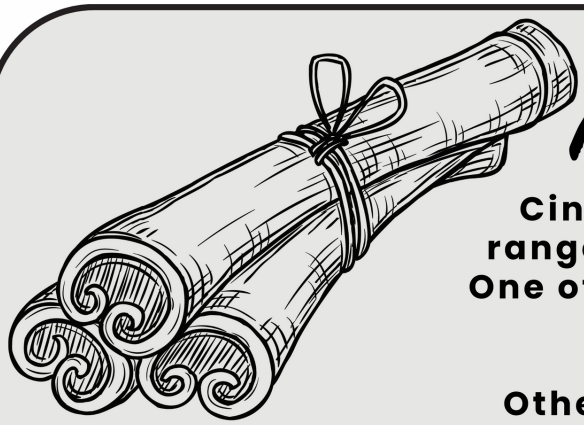




Essential oils extracted from the leaves and bark are used to flavor a wide range of foods- from sauces, to baked goods, to beverages.



When mature leaves of this small, evergreen tree are rubbed together, they release a spicy aroma.



MEDICINAL ROLE

Cinnamomum zeylanicum has a range of Ayurvedic medicinal uses. One of the most common is its use as a digestive aid.

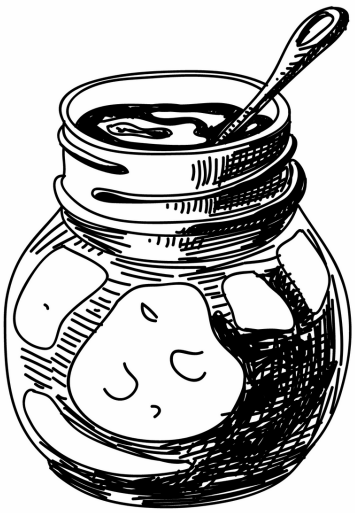
Other noted uses include treating headaches and common colds, as well as soothing sore throats.

DOVYALIS HEBECARPA

'CEYLON GOOSEBERRY'

***Dovyalis hebecarpa* grows as a shrub or small tree.**

The edible fruits of wild plants are often harvested for individual use.

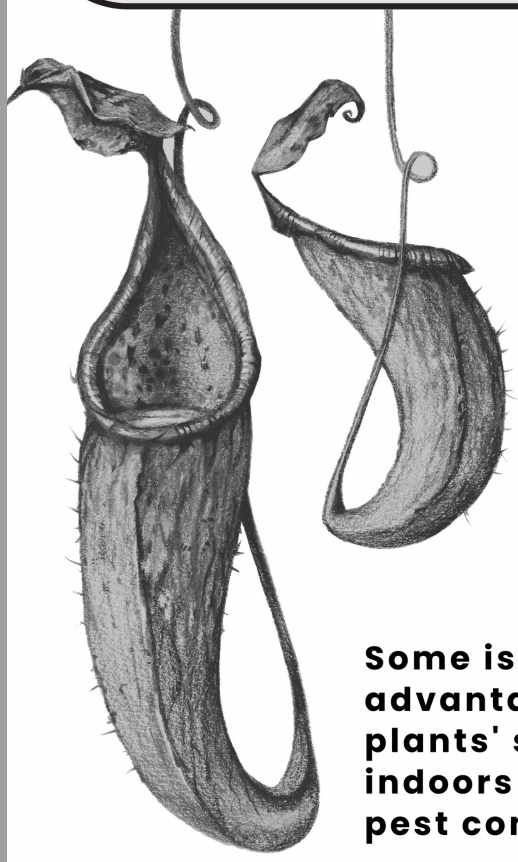


It is a popular choice for use in jellies and preserves.

With a sweet inside but bitter skin, the taste is compared to similar to gooseberries.

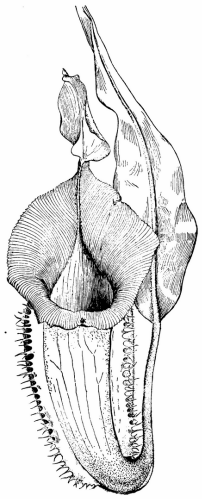
This is where *Dovyalis hebecarpa* gets its common name, the 'Ceylon gooseberry.'

NEPENTHES DISTILLATORIA



Nepenthes distillatoria **is a carnivorous climbing plant with pitcher-like traps at the ends of its leaves.**

These "pitchers" collect any insects that fall inside. The insects are then digested in the fluid at the bottom of the pitcher.



Some island residents take advantage of the carnivorous plants' skills and bring them indoors as a natural form of pest control.

VERSATILE MATERIAL

An excellent source of tying materials, ***Nepenthes distillatoria*** **has a reputation as one of the most useful fiber plants in the region.**

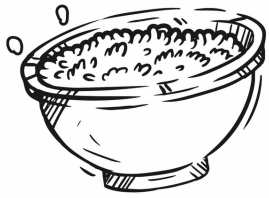
Stems are widely used in the construction of buildings and fences, as well as for small structural repairs to the home.

Because the long stems are so easy to manipulate, they are often used to make more elaborate woven products such as teapot holders.

ORYZA RHIZOMATIS

Oryza rhizomatis has a robust and extensive root system.

This root system allows the plant to survive periods of heavy drought--a trait that will become increasingly important in our changing climate.



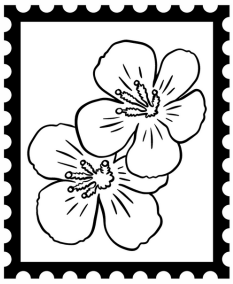
An estimated 1.8 million families in Sri Lanka are involved in rice paddy cultivation.

PEST PROTECTION

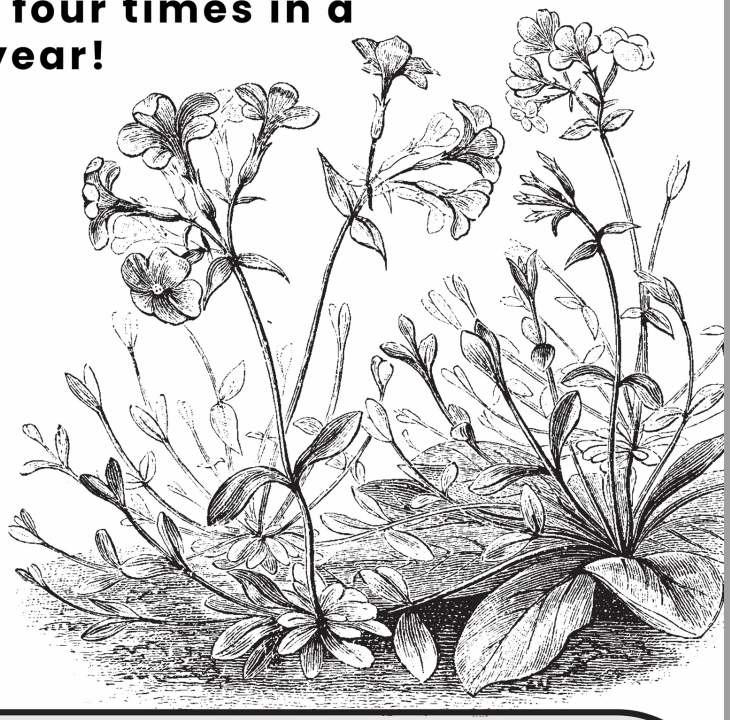
Oryza rhizomatis **is also being explored as a potential source of resistance to the brown planthopper pest (BPH), which is a serious pest of rice grown throughout Asia.**

OSBECKIA OCTANDRA

'EIGHT STAMEN OSBECKIA'



Though *Osbeckia octandra* is a small shrub, it has been known to bloom as often as four times in a single year!



In recent studies, extracts of *Osbeckia octandra* have been observed to diminish the spread of some head and neck cancer cells (oral squamous cell carcinoma).

TRADITIONAL KNOWLEDGE:

The bark, stem, and leaves of *Osbeckia octandra* are widely used in Ayurvedic medicine.

An herbal tea made from mature, dry leaves is used as a diabetes treatment.

A porridge prepared from the plant's young leaves is used as a treatment to soothe the liver and remedy symptoms of jaundice.

WRIGHTIA ANTIDYSENTERICA

The bark of the plant is considered to be both anti-inflammatory and anti-microbial.

Juice extracted from the bark is used to treat mouth sores.

The leaves are used to treat a variety of skin irritations including psoriasis.

CULTURAL SIGNIFICANCE

The sweet-scented flowers are often used in offerings at Buddhist temples, a practice believed to pay homage to the Buddha and evoke a sense of beauty and impermanence.

Historically, it has been believed that cultivating *Wrightia antidysenterica* across from one's house brings good fortune to the occupants.

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