

Emblematic
TREES
and **PALMS**
of the Americas



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of the Americas



Inter-American Institute for Cooperation on Agriculture (IICA), 2020
Tropical Agricultural Research and Higher Education Center (CATIE), 2020



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This publication is also available in electronic (PDF) format from the Institute's web site:
<http://www.iica.int>.

Concept and edition: Manuel Otero and Muhammad Ibrahim
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Cover design: Grupo Glomo AP, S.A.

Emblematic Trees and Palms of the Americas / Inter-American
Institute for Cooperation on Agriculture, Tropical Agricultural
Research and Higher Education Center. – San Jose, C.R. : IICA,
2020.
142 p.; 00 cm x 00 cm

ISBN: 978-92-9248-897-0
Published also in Spanish

1. Trees 2. Oil palms 3. Sugar palms 4. International
cooperation 5. Soil sciences 6. Climatology 7. Ecosystem
services 8. Silviculture 9. Seed 10. Plant propagation 11.
Planting 12. Nature conservation 13. Americas 14. Caribbean
I. Montiel, Karen II. Detlefsen, Guillermo III. Ureña, Celeste IV.
IICA V. CATIE VI. Title

AGRIS
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DEWEY
634.9

San Jose, Costa Rica
2020

ACKNOWLEDGMENT

We express our special thanks to those who made this catalog possible by providing information and images, especially to the personnel in the IICA offices.

To those who provided photos : Aaron González Zúñiga (Costa Rica), allysonsovis -iNaturalist, Agrotendencia (Venezuela), Anthony Pelletier -iNaturalist, A.R. - Flickr, Ariel Rodriguez-Vargas (Panama), Canadian Wildlife Federation, Charlie Hohn -iNaturalist, Christian -iNaturalist, CATIE Dominican Republic, Corporación Nacional Forestal de Chile (CONAF), Craig Thomas (Antigua and Barbuda), Deborah -iNaturalist, Ethan H. Freid (The Bahamas), Félix Pozo (Nicaragua), IICA Brazil, IICA El Salvador, IICA Mexico, IICA Suriname, Instituto Alexander von Humboldt (Colombia), Instituto de Botánica Darwinion (Argentina), Instituto Nacional de Innovación Agraria (Peru), Jessica West -iNaturalist, Leonel Jacinto (Guatemala), Lidia Pérez de Molas (Paraguay), margauxkaz -iNaturalist, Natalia Caballero (Uruguay), Omar Vacas Cruz (Ecuador), Organización A Todo Pulmón Paraguay Respira (Paraguay), Shannon -iNaturalist, Sian Lange (Barbados), Silvanus Augustin (St. Lucia), spresogna -iNaturalist, Willie Chan (Belize), Tamara Gentles (Jamaica), Tom Norton -iNaturalist, Xavier Claros - Proyecto Biocultura y Cambio Climático (Bolivia).



CONTENT

Foreword	1
Introduction	3
Andean Region	
Bolivia	6
Colombia	10
Ecuador	14
Peru.....	18
Venezuela.....	22
Caribbean Region	
Antigua and Barbuda	28
Bahamas.....	32
Barbados	36
Guyana.....	40
Haiti.....	44
Jamaica	48
Dominican Republic	52
Saint Lucia	56
Suriname.....	60



Central Region

Belize	66
Costa Rica.....	72
El Salvador	76
Guatemala	84
Honduras	88
Nicaragua.....	92
Panama.....	96

North Region

Canada.....	102
United States of America	106
Mexico.....	110

South Region

Argentina	116
Brazil	120
Chile.....	124
Paraguay	128
Uruguay.....	132



FOREWORD

The Inter-American Institute for Cooperation on Agriculture (IICA) and the Tropical Agricultural Research and Higher Education Center (CATIE) are pleased to present this catalogue of “Emblematic Trees and Palms of the Americas”.

This catalogue seeks to show the tree wealth of the Americas and recognize the multiple services offered to society by the different tree species (trees and palms) considered of high importance in each country and which, as a result, have been declared by the authorities as national or patriotic symbols that are representative of their people. The information presented on each emblematic species of the member Countries of the Inter-American Board of Agriculture (IABA) is expected to motivate and inspire the countries to boost and promote tree planting in the Americas.

This catalogue is the result of a collaboration between two related, naturally complementary institutions. In

2017, the IABA entrusted the Directors General of IICA and CATIE with the creation of a strategic proposal to strengthen a synergy-based relationship between both institutions to boost political-institutional and research strengths respectively. This led to the creation of the IICA-CATIE Joint Unit, with the purpose of focusing on technical cooperation in the member countries; sharing information and exchanging experiences on the adoption of innovation by smallholder farmers; and carry out research, studies and programs aimed at training technical experts and specialists in the region.

It is our hope that this catalogue, which constitutes the first publication generated within the framework of the IICA-CATIE Joint Unit, will contribute to the continued appreciation of the products, services and benefits that trees and palms provide to society, as well as to strengthen the role of agriculture in the life of rural and urban dwellers in the countries of the Americas.

Manuel Otero
Director General
Inter-American Institute for
Cooperation on Agriculture
(IICA)

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(CATIE)



INTRODUCTION

This catalogue of emblematic trees and palms of the Americas is a joint initiative of the Inter-American Institute for Cooperation on Agriculture (IICA) and the Tropical Agricultural Research and Higher Education Center (CATIE). Its purpose is to show the value and wealth of tree species in the hemisphere, and to acknowledge the ecosystemic goods and services that trees and palms of the Member States of the Inter-American Board of Agriculture provide to society. The catalogue, which is the result of an auspicious team effort, constitutes the first publication generated within the framework of the IICA-CATIE Joint Unit.

Trees and palms produce multiple goods, such as fruits, timber, a wide range of wood-based products, medicines and cattle feed. They also provide a large number of environmental services; for instance, they contribute to the improvement of soils and water resources, promote carbon capture, facilitate pollination and provide shade for cattle. Moreover, they are essential elements in the agricultural landscape and scenic beauty. For all these reasons, they are indispensable in the effort to increase profitability and resilience, and for climate change adaptation and mitigation. It is therefore paramount to promote sustainable use and conservation of species such as the ones described in this catalogue, particularly those that have been threatened by human activity.

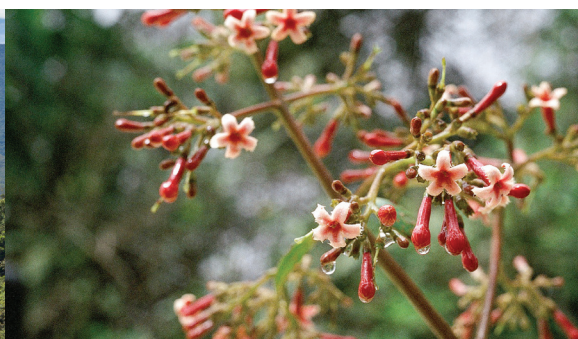
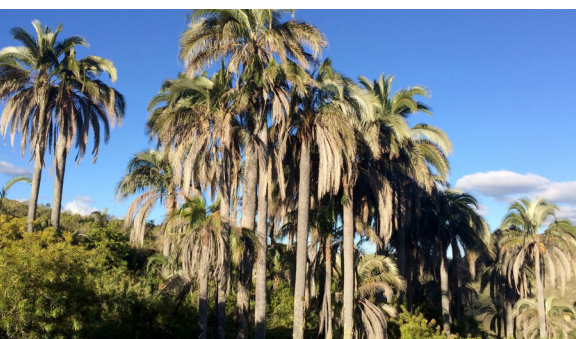
In addition to the widely recognized environmental importance of trees and palms, the cultural significance originally given to them by our ancestors is certainly of relevance. Likewise, we must not forget the major role that trees play in the urban milieu.

The emblematic trees and palms described in this catalogue are of great significance to their countries, which is why they were declared official national symbols by way of decrees, agreements or laws underscoring their historical, economic, cultural and environmental importance.

There are very diverse reasons for which certain species of trees or palms were officially designated by the countries. In some cases, it constituted an acknowledgement of their beauty and the admiration they inspire; in others, it was due to the important role played by the national tree or palm in the industrial and economic activity of the country. The latter applies to Belize and Argentina, where the trees have made a significant contribution to their economies.

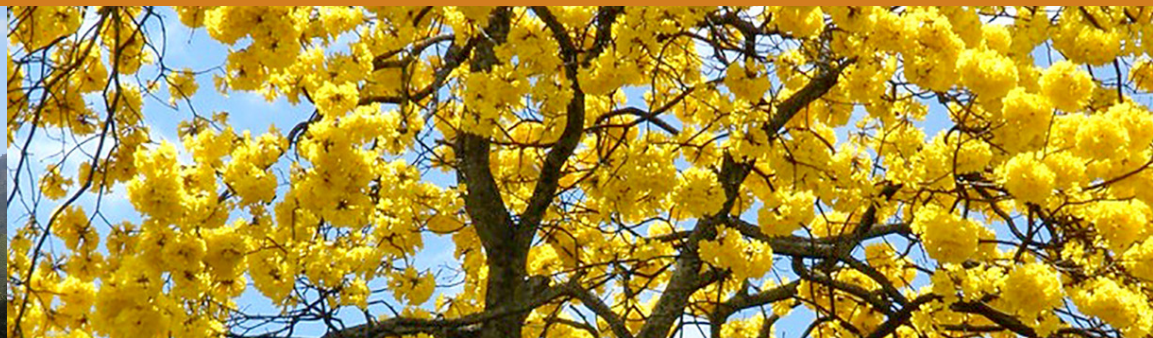
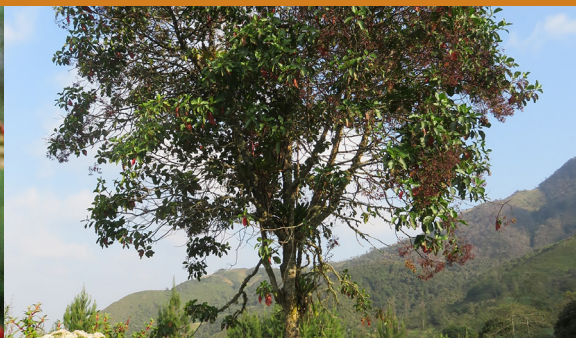
The creation of this catalogue involved a thorough review of the relevant literature and many consultations with competent entities. 30 woody species (24 trees and 6 palms) from 29 countries are described in its pages. We would like to clarify that 5 countries in the Caribbean (Dominica, Grenada, St. Kitts and Nevis, St. Vincent and the Grenadines and Trinidad and Tobago) have not yet declared a national tree, and were therefore not included in this publication.

The aim of this catalogue is to increase the knowledge and appreciation of a group of trees and palms in the Americas which, in addition to having been declared national symbols, have become vital elements for their people due to their environmental, cultural, economic and historical importance.



Bolivia
Colombia
Ecuador
Peru
Venezuela

ANDEAN REGION



Bolivia

PASOPAYA

Scientific name: *Parajubaea torallyi*

Common name: *pasopaya*, Bolivian mountain coconut, janch'icoco

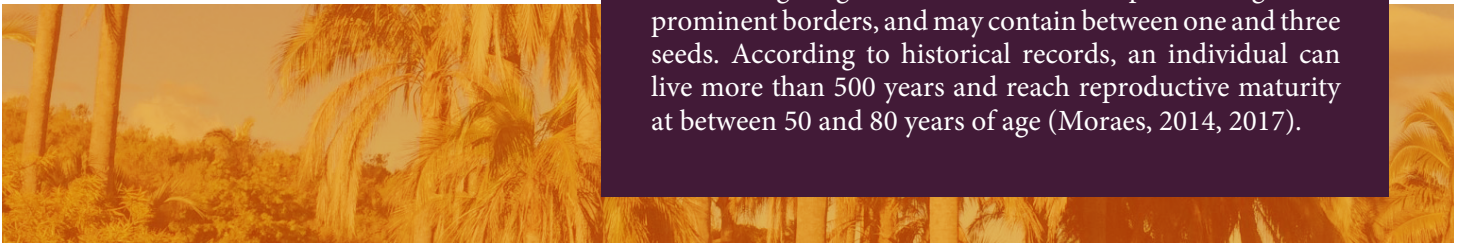
The *Parajubaea torallyi* is a national symbol of Bolivia, and represents its plant richness (Supreme Decree No. 27630). It is one of the endemic palm trees of the inter-Andean valleys of the country, and provides multiple resources for the local population. Apart from being used for commercial and ornamental purposes, for construction and as fuel, its edible fruits and mesocarp are used as animal fodder for cattle and pigs (Moraes 2017; Moraes *et al.* 2020).

GENERAL DESCRIPTION

Palm trees constitute the most important group of plants in the Amazon forest. They are significant because of their composition, dynamics and structure, and therefore are relevant in maintaining ecological balance. The Pasopaya genus includes two native species of Bolivia. The *P. torallyi* palm tree grows in high-density groups or in more disseminated layouts, next to semi-deciduous or evergreen forests, amongst shrubs or in mountain grasslands (Thompson *et al.* 2009; Moraes, 2017).

The palm is considered a vulnerable Andean species due to its slow growth, unsustainable use, accidental fires in its habitat, seasonal frosts that reduce fruit production, forest fragmentation gradually affecting the quality of its natural conversion and the intensive use of land for local crops. In Bolivia, they are geographically distributed from the center to the south of Chuquisaca and east of Potosí (Moraes, 2014).

The stem can reach up to 27 m in height and 70 cm in DBH for older individuals. Its trunk is smooth and cylindrical with leaf scars. The crown has between 15 and 40 pinnate leaves, which can measure up to 4.5 m; a 90 cm-long petiole; and a 3.5 m rachis. The lanceolate pinnate leaves, 80 by 116 per side, are generally found in a single plane. Their color is a lustrous green on the surface and green-glaucous on the underside. Inflorescences are ramified, in yellow or orange, with a peduncle and a rachis of 65 cm of length; it has a 1.5 cm coriaceous peduncular bract. These trees can produce approximately 100 ovoid fruits, 5 cm in diameter and 8.5 cm in length, green, with an endocarp featuring three prominent borders, and may contain between one and three seeds. According to historical records, an individual can live more than 500 years and reach reproductive maturity at between 50 and 80 years of age (Moraes, 2014, 2017).



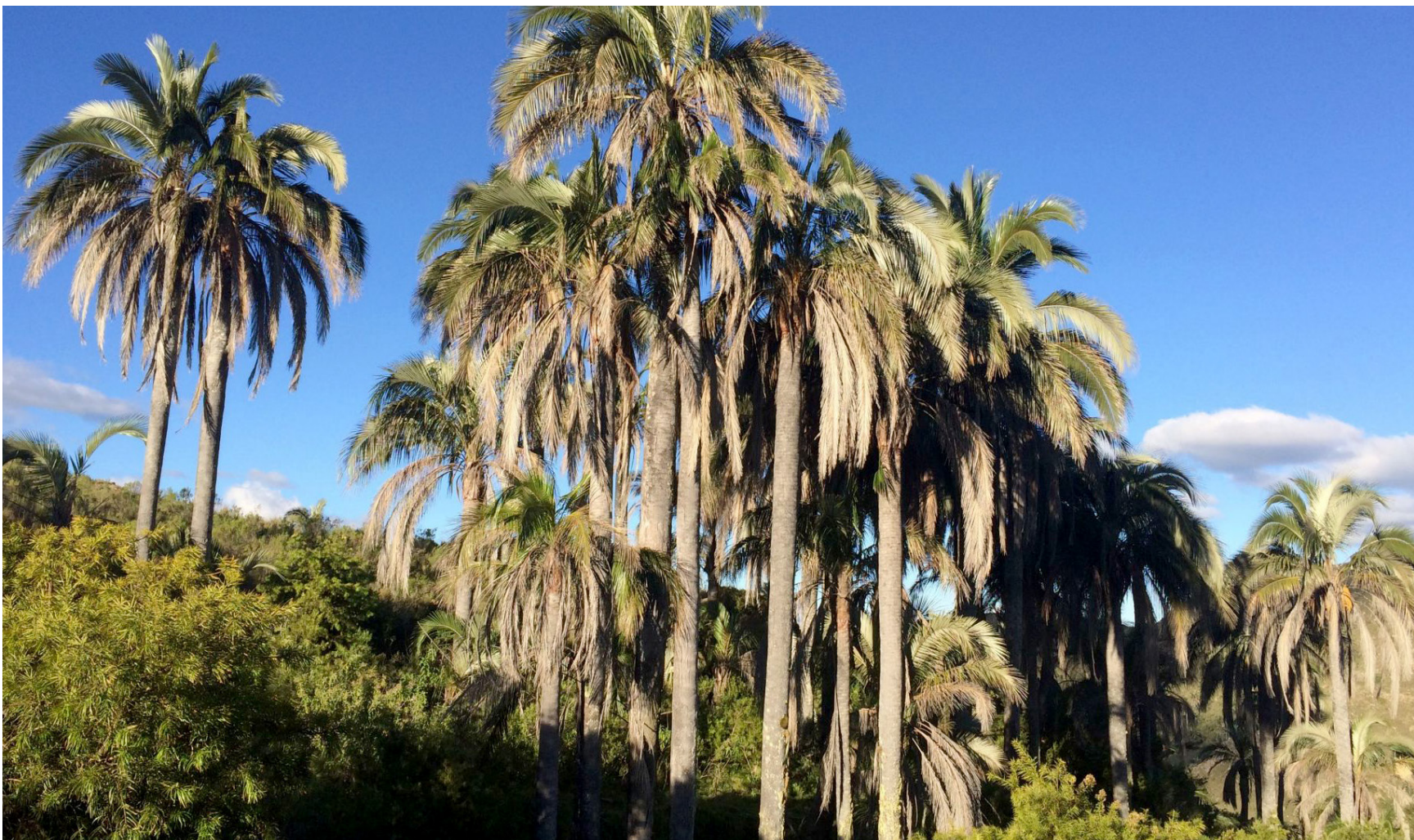


Photo: Xavier Claros, Proyecto Biocultura y Cambio Climático, Bolivia.

SOIL AND CLIMATE CHARACTERISTICS

Climate	Soils
Ecosystem of the prickly-dry forest Altitude: 2700 to 3400 masl Annual rainfall below 500 mm	In Bolivia, they grow on sandstone substrates.

Source: Moraes, 2014; Moraes *et al.* 2020.

MORE FREQUENT USES

Local dwellers utilize the trunk, the fruits, the leaves and the fibers of the pasopaya palm for subsistence and trade. The leaves and trunks are used for construction of local homes and for the carving of utensils. The fruits and seeds are used to feed the animals and as fodder, and the fibers of its leaves are utilized in the manufacture of home utensils, cords, ropes, sieves, baskets and craftwork (Moraes, 2014; Moraes *et al.* 2020).

The local population of Sucre trades the seeds and handicrafts on a small scale to generate the family income. They harvest the fallen endocarp and let it dry, and later collect the seeds and sell them (Thompson *et al.* 2009).

Did you know that...



P. torallyi is an endemic species of the Bolivian Andes, which is in danger of extinction due to agricultural activity, according to the Red List of Threatened Species of the International Union for Conservation of Nature (Moraes, 1998). Therefore, it is imperative that strategies and programs for adequate conservation and utilization of the species be implemented (Moraes *et al.* 2020).

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

The mature leaves are used in the construction of temporary roofs, by overlapping the layers without the petiole. The softer leaves are used to manufacture fans, hats, baskets and different types of ropes and braided cords, and have been also utilized as fodder for cattle (Thompson *et al.* 2009; Moraes, 2014).

The apical meristem or heart of palm is consumed locally. A traditional, ancestral beverage known as *manzana* is prepared with the fruit's endocarp, based on a mix of crushed seeds and

milk, and later sold in the cities of Sucre and Cochabamba. Additionally, a fermented drink or *chicha* is produced with the fruits (Thompson *et al.* 2009; Moraes, 2014, 2017).

ESTABLISHMENT AND MANAGEMENT

In view of the fact that this palm tree is used for subsistence purposes, no relevant studies are available regarding its commercial or productive management.

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Colombia

PALMA DE CERA DEL QUINDÍO

Scientific name: *Ceroxylon quindiuense*

Common name: palma de cera del Quindío, quindío waxpalm, waxpalm, chontapalmtree

According to Law 61 (1985), the Congress of the Republic of Colombia declared the Quindío wax palm as the country's national tree and national symbol. The *C. quindiuense* is an endemic species growing mainly in the Colombian Andes.

SOIL AND CLIMATE CHARACTERISTICS

Climate

The wax palm can be openly grown in frost-free temperate climates at an average temperature of 9 to 15°C and annual rainfall of 1000 to 2000 mm. It grows abundantly in cloud forests.

Soils

It can be grown in soils rich in humus, open with bright light filtering through, a high level of cold moisture and good drainage; the plant also tolerates acid soils.

Source: Prepared with information from Bernal and Galeano, 2013, Elsemillero.net 2020, and The Ferns 2020.

GENERAL DESCRIPTION

The *C. quindiuense* is a monocotyledonous palm of the humid montane forest. It grows in the Colombian Andes from the northern highlands of Antioquia to the Tenerife zone of the Cauca Valley, as well as in Peru, in Cajamarca and Amazonas. The species grows more abundantly at 2500 to 2900 m above sea level, attaining a height of 20-40 m (Bernal *et al.* 2015; Gómez-Zapata and Salazar-Yepes, 2017).

The wax palm has a solitary trunk that measures approximately 0.35 m DBH and is covered by a grayish wax less than 1 mm thick. The trunk becomes narrow at 12 or 14 m and the top is crowned with 14 to 20 narrow hanging leaves with brownish scales and pinnae 4 m in length. Its blooms are composed of three petals and its orangey red fruit are spherical in shape and present black dots when ripe (Bernal *et al.* 2015).

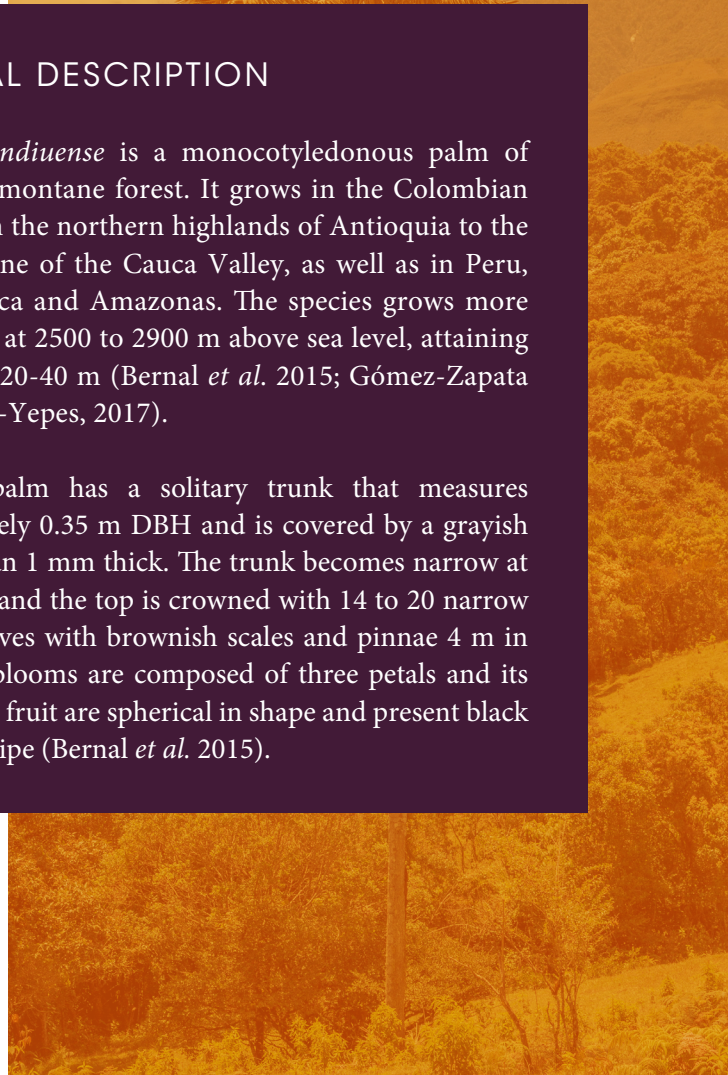
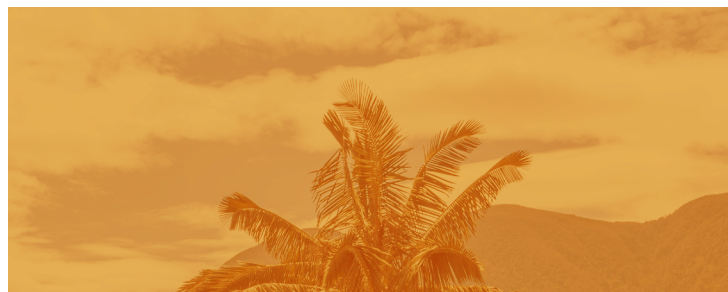




Photo: Federico Pardo. Banco de Imágenes Ambientales (BIA), Instituto Alexander von Humboldt.

MORE FREQUENT USES

C. quindiuensis has been used mainly for commercial, religious, artisanal and construction purposes. The wax palm has been used to manufacture candles and matches and its leaves (buds) have been used to make the branches that feature in religious ceremonies during Holy Week. Similarly, the trunks are used as material to construct ceilings and roofing, to cover interior walls and floors and to make garden enclosures and corrals. Its fruit serves as animal feed (cows, swine, Great thrushes, toucans, green jays and parrots), and they also have ornamental uses (Bernal and Galeano, 2013; Bernal *et al.* 2015). Bernal and Sanín (2013) indicate there is public interest in conserving the Quindío wax palm and that, as a tourist attraction, Colombia could offer tours in areas where the tallest palm trees on the planet grow.

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

Pollination of the wax palm is facilitated by the sap beetle (1-6 mm in length) of the Mystropini tribe. Every 6 to 7 years the palm produces fruit that ripen in 8 months (4 to 7 bunches per plant in the most intense periods). The species propagates by way of seeds that germinate in a period of 5 to 15 months. Around 3000 seedlings can grow beneath a female palm; however, depending on the conditions of light, there can be a high mortality rate (Bernal *et al.* 2015).

Growth

C. quindiuense can grow to be very tall, although in the beginning, growth of the trunk is slow, as is also the production of leaves (0.9 leaves per annum). The species is very vulnerable during this stage since the meristem is completely exposed; it is very susceptible to grazing and direct exposure to the sun. Once the palm surpasses one meter in height it can tolerate greater exposure to solar radiation and, once it forms the trunk (in forest conditions the trunk is formed in the fiftieth year onwards), growth of the species accelerates and it is capable of growing nearly 1 m per annum up to 12-18 m in height (Bernal *et al.* 2015).

Conservation

According to the International Union for Conservation of Nature (IUCN) “Red List of Threatened Species”, the *C. quindiuense* is categorized as a vulnerable species. The main threats to the habitat of this species are the increase in agriculture and the ornamental and religious uses of the species (IUCN 2020). On the other hand, other studies have shown that many of these palms grow in pastures where grazing and direct exposure to sunlight contribute to low levels of regeneration; moreover, the species also grows in very small forests where permanence is not guaranteed. All of this has contributed to a 50% reduction in individual populations over the past 210 years (Bernal *et al.* 2015).

Did you know that...



The wax palm is the tallest palm tree on the planet (it can surpass 40 m in height), it is the only one that is sown between 2000 to 3000 m above sea level, and it can live more than 100 years (Bernal and Sanín, 2013).

The “Conservation, management and sustainable use of the Quindío wax palm plan” contemplates four lines of action for conserving the species over the long term (Bernal *et al.* 2015):

- a. Research and monitoring: Increase the knowledge base in terms of distribution, condition, ecology and management of the palm, as well as monitor measures for its conservation.
- b. Conservation: compile the necessary measures to protect and restore the habitat, increase the number of specimens and their connection to the forest and promote the
- c. Policies and management tools: Foster protection of the species in public and private areas and promote the design and implementation of corresponding norms and legal instruments.
- d. Education and communication: Disseminate information on the importance, potential and need to conserve the Quindío wax palm.

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Ecuador

CASCARILLA

Scientific name: *Cinchona pubescens* and *Cinchona officinalis*

Common name: *cascarilla*, quina, quinine tree, chinchona

In Ecuador and Peru, the *Cinchona officinalis* is recognized as the national tree. However, the official species in Ecuador is the *Cinchona pubescens*. This genus is distributed from the center of Bolivia to the north of Colombia and Venezuela, but only the *Cinchona pubescens* can be found outside the Andes, in this case in the mountains of Costa Rica and the north of Venezuela (Cuvi, 2011).

Like the *C. officinalis*, the *C. pubescens* was used all over Europe to treat malaria in the 1650s. It was initially known as “Jesuit’s powder”, because it was them who first introduced this plant (CABI 2020).

GENERAL DESCRIPTION

The *C. pubescens* is a perennial, erect, fast-growing tree. It has a DBH of 20 cm and, although it can reach 30 m in height, specimens usually grow between 4 and 10 m (CABI 2020). The tree features small pubescent branches, with large, oval-shaped stipules which can be either acute or obtuse. Its thin, petiolate leaves usually feature a large film (Paniagua-Zambrana *et al.* 2020). It is native to the area ranging from the Andean region (north of Bolivia) to Costa Rica (CABI 2020).

It normally grows at altitudes ranging from 800 to 2800 masl; however, it can also occur at 3500 as well as at 120 masl, in the lowland tropical Amazonian forest. Wet, fertile habitats promote its growth and propagation. Specimens have been found on both sides of the Andes mountain chain, in the sub-montane tropical forest. The wide altitude range explains the great variability found within the species and the use of numerous synonyms to refer to it (CABI 2020). The tree grows in lowland forest ecosystems and in montane and pre-montane rainforests, and is commonly found in mature forests (Reynel and Marcelo, 2009).

The quinine tree is widely cultivated in the tropics. Other countries that plant the species are Sri Lanka, Bolivia, Colombia, Costa Rica, India, Tanzania and Kenya (CABI 2020; Rodríguez Barrutia *et al.* 2020).

In the 1850s, specimens were sent to India and Sri Lanka, both British colonies at the time, for production. Large plantations of quinine trees were established in Africa during the Second World War and production continues to take place in South America, Indonesia and India to a limited extent. At first, it was mostly cultivated in similar wet montane habitats in the Indian states of Tamil Nadu (Nilgiri Hills) and Sikkim (Himalaya foothills), at an altitude of 700 to 1800 AMSL; however, it can also be planted in different habitats (CABI 2020).

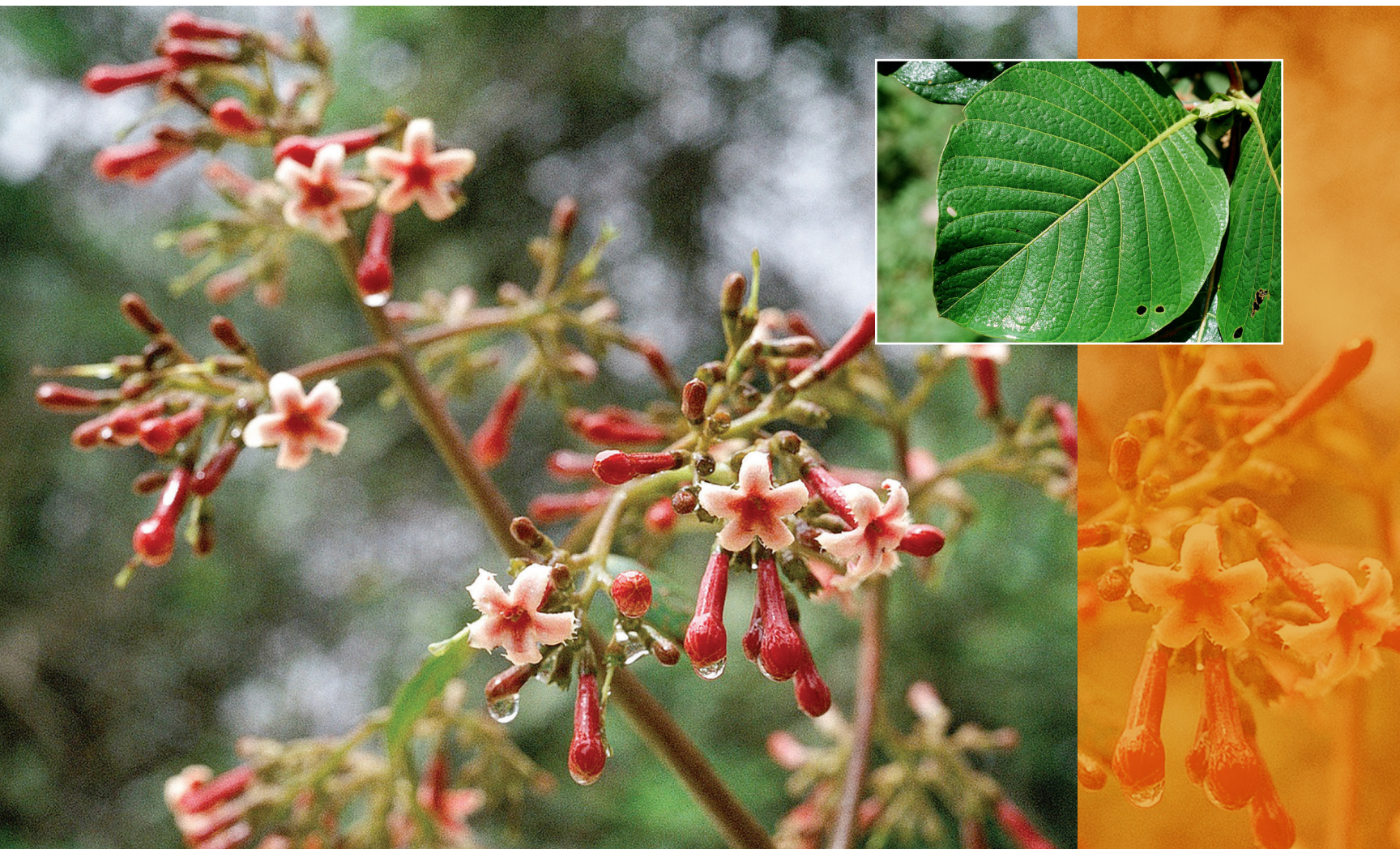


Photo: Omar Vacas Cruz, Reserva geobotánica Pululahua, 2019.

SOIL AND CLIMATE CHARACTERISTICS

Climate	Soils
It grows in lowland forest ecosystems and pre-montane and montane rainforests.	It grows in fertile soils and does not tolerate flooding.

Source: CABI 2020.

MORE FREQUENT USES

The uses of the quina are very similar to other species in the *Cinchona* genus. Paniagua-Zambrana *et al.* (2020) specifically mention the species *C. pubescens*, whose stems and roots are used for pain relief and whose bark was once utilized to treat diarrhea, fever, indigestion and malaria. Quina has curative, anti-inflammatory and anti-hemorrhagic properties. It has also been used to treat cardiac arrhythmias.

ESTABLISHMENT AND MANAGEMENT

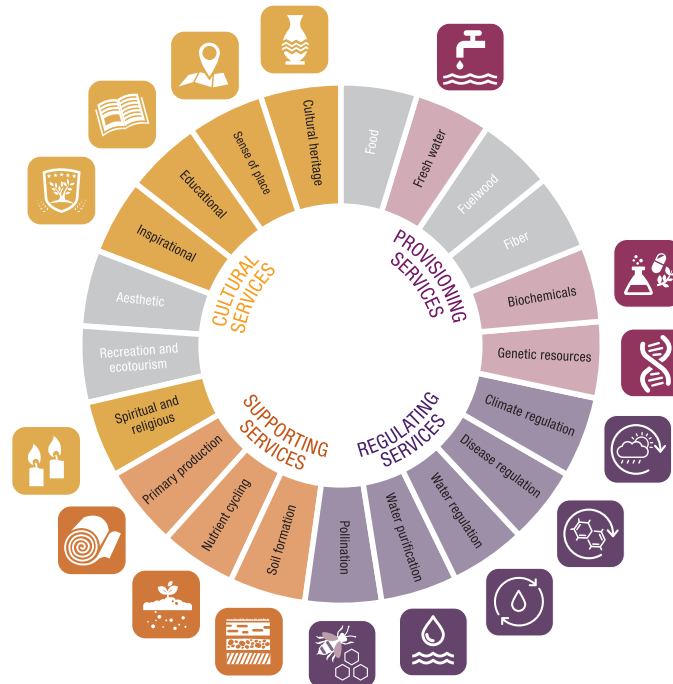
Forestry



Seed

The seeds of *C. pubescens* are small, and therefore spread immediately after the fruits open. For this reason, it is recommended that the fruits be

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Source: Prepared based on MA 2003.

collected while still on the tree by cutting off the entire branch. Afterwards, they must be placed on a sac and exposed to the sun for them to open. Seed viability dwindles quite fast after harvest, for which they must be placed in the germination site after their extraction (Reynel and Marcelo, 2009).



Propagation

Germination usually occurs 15 to 22 days after planting. The seedlings must be pricked out once they reach a height of 5 cm and have two to three pairs of leaves (Reynel and Marcelo, 2009).

Management

In order to be sown in the field, seedlings must have a height of 30 to 50 cm and be 1-2 years old. If planting is done for commercial purposes, a distance of 1.3 x 1.3 m is recommended. Once the plantation is established, the plants must be pruned once and only the main stem must be kept. If the goal is to obtain high yields, chemical management must be performed. Four years after planting, the first annual selective thinning must be carried out with a final harvest at eight and twelve years of age. Quinine production per tree is 150 to 250 g, resulting of 5 to 8 kg of bark (Reynel and Marcelo, 2009).

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Perú

QUINA

Scientific name: *Cinchona officinalis*

Common name: *quina, cascarilla*

The cinchona genus, commonly known as quina, possesses historical medicinal properties. The alkaloids contained in its bark - cinchonine, cinchonidine, quinidine and quinine, in different concentrations depending on the species (Cuvi 2001) - are used to prevent and cure malaria, although quinine is the most suitable for this purpose. They are extracted from various species of trees in the genus, including the *Cinchona succirubra* and *Cinchona calisaya*, which belong to the Rubiaceae family (Bharadwaj *et al.* 2018).

For more than four centuries these plants have been given many scientific names, which has created confusion in its taxonomic designation. Although around 330 specific scientific names exist for the genus, only 23 are accepted as distinct species.

The *Cinchona officinalis* species, Peru's national tree, is one of the first Andean Region trees exploited for its medicinal properties, specifically in Loja in southern Ecuador (Paniagua-Zambrana *et al.* 2020).

GENERAL DESCRIPTION

The tree is native to the Andean Region, where it grows in predominantly warm, humid climates with abundant rain and cloud cover most of the year. Its natural habitat is mountainous tropical rainforest (Barrutia, 2020). The species extends from Bolivia up to Colombia (Paniagua-Zambrana *et al.* 2020). In Peru it has been found in fragmented woodlands in the province of Huancabamba, department of Piura (Huamán *et al.* 2019).

In a study on the Cinchona genus carried out in northern Peru, Huamán *et al.* (2009) identified the species between 2400 and 2800 masl, on mountainsides with sandy-loam soil, an abundance of organic material and very strong winds. It is often confused with similar species like *C. capuli*, *C. lancifolia* and *C. macrocalyx*, since they occur in similar habitats and altitudinal ranges. They are also similar morphologically, especially in their leaves and the color of their flowers (Huamán *et al.* 2019).

The exploitation and commercialization of quina began in northern Peru and southern Ecuador during colonial times. The Jesuits were the first to exploit it, carrying out controlled extraction; however, after 1830, the practice was to tear down the entire tree instead of just taking the bark. Moreover, the tree was cut down indiscriminately since it was difficult to identify in the field.

Extraction diminished in the 19th century due to the synthesis of the alkaloid; however, it continues to be extracted to discover new compounds in the bark (Huamán *et al.* 2019).



Photo: Instituto Nacional de Innovación Agraria.

SOIL AND CLIMATE CHARACTERISTICS

Climate

It grows on hillsides in a wide variety of habitats (warm and humid).

Soils

It grows on Sandy-loam soils with abundant organic material.

Source: Huamán *et al.* 2019.

MORE FREQUENT USES

The most well-known use of the quina is its bark, for the extraction of quinine. This compound has been used for over 300 years to fight malaria. Native Andean towns knew its properties and benefits, which extended to Europe and the rest of the world during the colonial era. The cascarilla is believed to be one of the trees that has saved the most lives in the world (Rodríguez Barrutia *et al.* 2020).

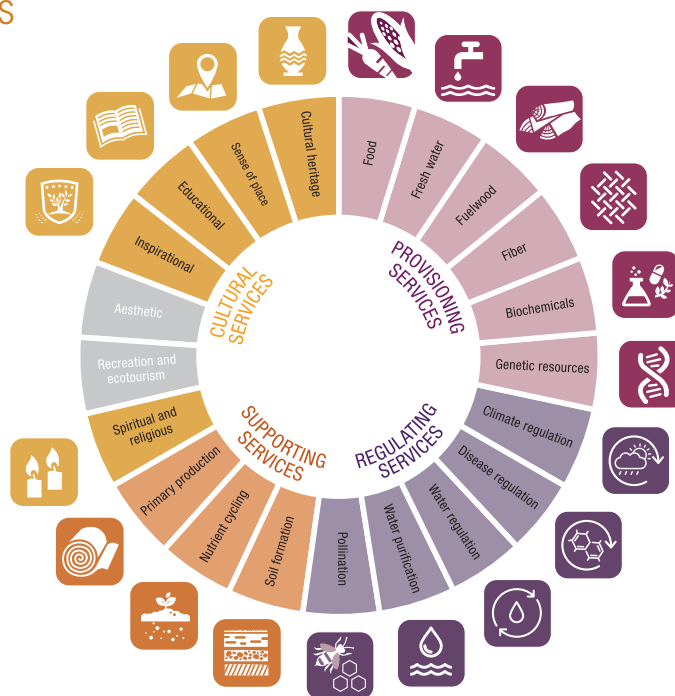
Medicinal properties

The alkaloids extracted from the *C. officinalis* have been exploited for centuries. At first its crude bark was used, and then later, with technological advances, its active compounds were

isolated; however, these compounds continue to be extracted and purified in their natural source. It is estimated that around 700 tons per annum are extracted. Its natural abundance and special medicinal properties explain its historical popularity in human civilization (Bharadwaj *et al.* 2018).

According to Paniagua-Zambrana *et al.* (2020), the quina's dry bark is used in Colombia as an antimalarial drug (soaked in water); as treatment for gallbladder attacks, and in concoctions to treat hair loss. Additionally, its leaves are used in infusions to clean wounds. In Ecuador, the dry bark is used against fever, malaria, for weight loss, flu, bone pain and colds. Also, scraped bark is used to eliminate pimples from the skin. In Peru, its flowers and dried leaves are used against coughs and its dry bark is a treatment for infertility, sexual impotence, rheumatism, colds and cancer.

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Source: Prepared based on MA 2003.

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Venezuela

ARAGUANÉY

Scientific name: *Handroanthus chrysanthus*
Common name: araguaney, yellow guayacan

The *Handroanthus chrysanthus* is a deciduous tree, measuring 20 m in height and 20 to 40 cm DBH. Its trunk is straight, cylindrical and sparsely ramified. During blooming season, its yellow flowers fill the forest with its color, creating a scenic beauty that is characteristic of the species (Cárdenas 2016). In 1948, by a National Executive Decree, the araguaney was declared the “National Tree of Venezuela”.

SOIL AND CLIMATE CHARACTERISTICS

Climate

It grows at altitudes of 0 to 1900 masl, with a range in temperature from 18 to 25°C, and precipitations from 500 to 3000 mm.

Soils

It grows in moderately deep, slightly moist and fertile soils on moderate slopes.

Source: Cárdenas, 2016.

GENERAL DESCRIPTION

This tree occurs naturally in dry ecosystems in southern Ecuador, northern Peru, the Antioquia department in Colombia (Villacis Rivas *et al.* 2015; Cárdenas, 2016) and in Venezuela. It grows in very dry tropical ecosystems, in dry tropical ecosystems, tropical rainforests, pre-montane moist forests, and very moist pre-montane forests (Cárdenas, 2016). Its crown is wide, extended and irregular, and its furrowed bark is dark brown in color. It presents palm-shaped, compound leaves opposite in arrangement, with a pointed apex, five leaves, with serrated edges, measuring 6 to 12 cm in length and a rough, pubescent underside. The bloom is tubular and measures 5 cm in length. The corolla presents five yellow petals and a calyx with five coffee-colored sepals. The fruit is a pubescent, cylindrical capsule measuring 15 to 30 cm in length (Villacis Rivas *et al.* 2015).



Photo: Agrotendencia



Photo: Agrotendencia

MORE FREQUENT USES

H. chrysanthus has often been indiscriminately cut down for its wood. During its flowering period it produces a large quantity of material that serves as fodder for goats and cattle (Villacis Rivas *et al.* 2015).

In the dry Ecuadorian forest, the guayacan's flowering season is a very special occurrence since, as a result of the bloom's yellow color, the forest takes on the same color. This scenic beauty can be exploited as a tourist attraction (Villacis Rivas *et al.* 2015). The yellow guayacan has medicinal and agroforestry uses (Cárdenas, 2016).

ESTABLISHMENT AND MANAGEMENT

Forestry



Propagation

It is recommended to sow 50 g/m of seed in the germinator, preferably in a loose, moist, well drained substrate. It must then be covered with a layer of substrate. Germination occurs between eight to ten days after sowing. The average germination period is 26 days. The plant should be

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Source: Prepared based on MA 2003.

transferred to a bag once it attains 5 to 10 cm in height and sprouts actual leaves (Cárdenas, 2016).



Planting

This species is not recommended for commercial fields; however, in coffee and cacao fields, a distance of 10 to 15 m is recommended. When used as an ornamental tree near buildings, growing them beneath stretches of overhead cables should be avoided. There must be 8 to 15 m of distance between the trees (Cárdenas, 2016).

Management

If sown as an ornamental tree, the leaves and blooms that fall to the ground will need to be cleared, and light pruning should be done (Cárdenas, 2016).

Protection

Its adult trees are attacked by ants and it has been found that the *Amblycerus* weevil damages its seeds (Cárdenas, 2016).

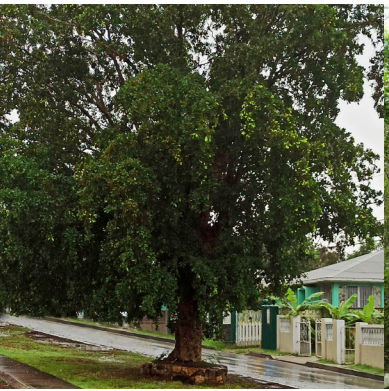
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Antigua and Barbuda

Bahamas

Barbados

Guyana

Haiti

Jamaica

Dominican Republic

Saint Lucia

Suriname

CARIBBEAN REGION



Antigua and Barbuda

WHITEWOOD

Scientific name: *Bucida buceras* L.

Common names: whitewood, black gregory, old antiguan, black-olive, olive-bark tree, bullet-tree, bullywood, bully-tree, *bois gri-gri*, *gris-gris des montagnes*, *gue'gue'*, *bois gli-gli*, *bois gris-gris*, *grignon*.

The *B. buceras* L. is Antigua and Barbuda's national tree (Museum of Antigua & Barbuda 2020). It is naturally distributed in the Upper Florida Keys in the United States, The Bahamas, Cuba, Jamaica, Hispaniola, Puerto Rico, the Virgin Islands, the Lesser Antilles, from the south of Mexico to Panama and the coast of Colombia, Venezuela and the Guyanas, between latitudes 5° N and 25° N (Little *et al.* 1977; Francis and Lowe, 2000). In Antigua and Barbuda, it is found on river banks (Museum of Antigua & Barbuda, 2020).

GENERAL DESCRIPTION

The whitewood is a timber and shade species that reaches between 9 and 25 m in height. Its trunk measures 1 m DBH, and has a wide, symmetrical crown with branches that hang almost horizontally (Little *et al.*, 1977; Szabó, 2010). Its alternating leaves are elliptical and grouped in petioles. They measure 1 to 3 cm in length and 2 inches in width. The tree's wood is very hard, heavy, of a dark yellow color and with a black heart. Its small flowers are of a greenish white or light brown, and occur in clusters measuring 1 to 4 inches. The fruits are slightly fleshy or dry, of a light brown color, have an ovoid-conic shape and measure 14 inches in length with their calyx adhered to the apex. The tree produces a hard, yellowish brown sapwood similar to its duramen, which is also heavy, resistant and features a fine, durable texture, resistant to the attacks of insects (Little *et al.* 1977).



Photo: Craig Thomas

SOIL AND CLIMATE CHARACTERISTICS

Climate

It grows in semi-moist and moist forests and coastal areas.

Annual precipitation: In Puerto Rico, between 750 and 1400 mm; in Mexico, less than 2000 mm.

Average annual atmospheric temperature between 24°C and 28 °C.

It tolerates drought events.

Soils

It grows in a variety of soils, but it does so optimally in deep, nutrient-rich, well-drained moist soils of medium texture. It can however tolerate barren, compacted, poorly-drained soils.

Most natural stands grow in saline soils, highly drained limestone rocky ridges and sandy hills. There is a concentration of trees in lowlands, seasonally marshy soils, mangroves and along intermittent streams at the foot of dry hills.

Source: Little *et al.* 1977; Francis and Lowe 2000; Szabó 2010.

MORE FREQUENT USES

The whitewood is highly appreciated for its ornamental qualities, valuable wood and for providing optimal shade. Its hard, dense wood has been used in the construction of fences, work benches, stilts, woodwork, naval constructions, boat decks, frames, posts, train sleepers and carriages (Little *et al.* 1977, Francis y Lowe 2000, Museum of Antigua & Barbuda 2020). In addition, it has been used to manufacture high-quality furniture and flooring, doors and interior moldings (Francis and Lowe, 2000). Although the wood has several

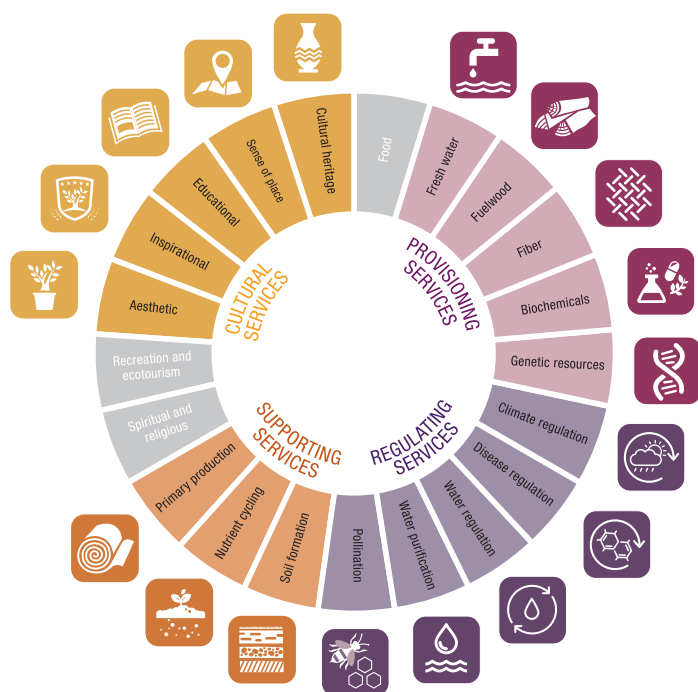
uses, it is considered difficult to work with manually. Although satisfactory and even excellent results can be obtained using electrical tools for molding, sanding, lathing, drilling and chiseling, it is not optimal in terms of brushing and resistance to splitting caused by screws (Little *et al.* 1977)

The species is also used as fuel and charcoal (Little *et al.* 1977, Francis and Lowe 2000).

It has been displayed in urban settings due to its ornamental value; however, it requires periodic pruning or a spacing of 6 to 8 m (Szabó, 2010). It is not advisable to plant this tree in parking lots because of the sticky, dark substance that it produces (Francis and Lowe, 2000).

It is considered a shade tree, particularly in coastal or arid areas (Francis and Lowe, 2000). Birds commonly nest in it (Szabó, 2010) and its nectar attracts bees (Francis and Lowe, 2000).

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Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

Although florescence can vary significantly from one tree to another, the production of flowers and fruits can occur throughout the entire year (PPA, 2012). The whitewood seeds are light: one kilogram can contain about 38,000 seeds. Their germination is epigeous and about 6% of them germinate 12 to 17 days after planting (Francis and Lowe, 2000)



Propagation

The whitewood can propagate through soft wood cuttings in mist chambers or by using layers. The species can re-sprout by cutting the tree up to 30 cm DBH (Francis and Lowe, 2000).

Management

Harvest shift and growth

Studies conducted in Puerto Rico between 1944 and 1961 have shown that the growth of the species differed between natural and artificial stands. The diameter growth of natural stands in dry forests with no stressors was 1.3 mm per year, whereas in moist forestry stands, it was 4.3 mm per year. The individuals of this species are generally distributed either dispersedly or in groups of trees in the most humid microsites of the dry forest (Francis and Lowe, 2000).

Protection

The main threat for the species in dry habitats is the risk of fires, especially for isolated individuals. Fire can easily damage the tree due to its thin bark and the fact that many trees are surrounded by grass (Francis and Lowe, 2000). Szabó (2010) explains that the species is resistant to hurricanes.

The wood of the *B. buceras* is resistant to the West Indian drywood termite (*Cryptotermes brevis*) and to subterranean termites. However, it is not resistant to the naval shipworm (*Teredo* spp.) or to moist wood termites (*Nasutitermes* spp.). In ornamental trees in Florida, damage has been observed as a result of the *Aleurodicus dispersus* white fly (Francis and Lowe, 2000).



Did you know that...

The scientific name *Bucida buceras* means "ox's horn" and was inspired by the horn-shaped gills that form in the tree caused by a non-identified mite (Francis and Lowe, 2000).

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Bahamas

LIGNUM VITAE

Scientific name: *Guaiacum sanctum*

Common name: holywood, lignum-vitae

This ornamental, low tree has a dense, regular-shaped crown. It is naturally distributed in the Florida Keys, Bahamas, Cuba, Hispaniola, Puerto Rico and La Mona, as well as in the area of Yucatan (Mexico) and Guatemala, Honduras and Nicaragua (Little *et al.* 1977).

GENERAL DESCRIPTION

The *Guaiacum sanctum*, commonly known as *Lignum vitae*, is a perennial, slow growing tree that reaches up to 9 m in height. It lives for a long time and its yellow fruits serve as food for birds (Szabó, 2010). A dry forest tree, it is typical in arid, hot areas. It grows near the coast, in altitudes of about 5 to 700 m above sea level (masl). Furthermore, it adapts very well to rocky, limestone soils with moderate to pronounced slopes and to draught and strong winds (Cordero and Boshier, 2003).

Its wood is considered precious; however, when regulations allow, it can only be obtained from the natural forest. The fallen branches are sometimes used to avoid toppling the tree completely. Due to the slow growth of the species, it is not recommendable in pure forest plantations, although this may be a possibility if combined with fast-growing species that will yield economic

benefits in a shorter period of time. In parks and gardens, it can be found as an ornamental tree due to its periodic blooming and the striking purple hue of its flowers. When the tree fruits, these flowers change into a yellowish color with a black seed, which also makes it very aesthetically pleasing (Cordero and Boshier, 2003).

There are few specimens and the species has been very exploited over the years, for which it is paramount to implement research and protection plans. As with many species of the genus, it is included in the Convention on International Trade in Endangered Species of Wild Fauna and Flora, and its marketing and utilization must therefore be monitored. Its trade depends on the specific legislation of each country, but the market for its wood is good and well-established (Cordero and Boshier, 2003). According to Rivers (2017), the tree population of *Guaiacum sanctum* has declined and the species is threatened mainly by the loss of habitat.



Photo: Ethan H. Freid



SOIL AND CLIMATE CHARACTERISTICS

Climate

Dry forest, semiarid climate
Height 5 to 700 masl
Annual rainfall below 1500 mm

Soils

Rocky limestone soils, with slopes
Tolerance of plants to humid or dry soils

Source: Gilman *et al.* 1993; Cordero and Boshier, 2003.

MOST FREQUENT USES

Due to its extreme hardness, its wood is used to manufacture industrial bushing caps subject to friction and considerable mechanical stress. Being extremely heavy, it has been used in the manufacture of bowling balls, steam boat propeller shafts, gears, mallets and tool handles. Owing to its beauty, it is used to fabricate canes, clock assemblies, instrument cases and chess pieces (Gilman *et al.* 1993; Cordero and Boshier, 2003).

The *Lignum vitae* also has medicinal properties. Its bark is used to treat diabetes and syphilitic diseases as well as to wash wounds. A

bath in its boiled leaves and cortex can help relieve rheumatism, and its flowers are used for cough relief. The extract obtained through the distillation of the wood and the resin is known commercially as guaiac. This substance is used for pharmaceutical purposes due to its stimulating, sudorific, expectorant and antiseptic properties (Cordero and Boshier, 2003).

ESTABLISHMENT AND MANAGEMENT

Cordero and Boshier (2003) generally do not recommend the *G. sanctum* for pure plantations due to reasons related to forestry practices.

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Source: Prepared based on MA 2003.



Seed

In Nicaragua, the seeds are collected at the same time as regular harvests, that is, between August and September. This harvest takes place when the fruits open. The seeds are stored for up to nine months. 1 kg of seeds is believed to contain between 4000 and 5000 units (Cordero and Boshier, 2003).



Propagation

The species does not have good natural regeneration, particularly in the parts of the soil covered with seedlings, which limit their survival rate. When reproduced through seeds, a 30% germination rate is achieved, for which it is recommended that fresh seeds and a light substrate such as sawdust or dirt be used. However, germination usually does not exceed 50% (Cordero and Boshier, 2003).

A pre-germination treatment can be applied, consisting of submerging the seed in water at room temperature for eight hours before planting

it. It is recommended that they be sown in beds. Germination takes between eight and twelve days and can extend up to 20 days. After being placed in bags, their development is accelerated if kept under shade. Due to their slow growth, the plants must remain in a greenhouse over a period of about one year (Cordero and Boshier, 2003).

Management

As a result of its full exposure to sunlight, the tree is extensively ramified, which causes the formation of several main branches. For this reason, it is recommended that it be planted under shade or within agroforestry systems, in which other quick-growing species can provide shade for its adequate development (Cordero and Boshier, 2003).

Harvest shift and growth

The growth of this species is very slow. The trees located in the Santa Rosa National Park in Costa Rica are believed to be between 20 and 25 years old (Cordero and Boshier, 2003).

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Barbados

BEARDED FIG TREE

Scientific name: *Ficus citrifolia*

Common name: bearded fig tree, shortleaf fig, wild banyan tree, jagüey blanco

The *Ficus citrifolia*, commonly known as jagüey or bearded fig tree, has a twisted, ramified foliage and adventitious roots. It grows in subtropical dry forests, but can also be found extensively in subtropical rainforests. It is considered a hemi epiphyte plant because it must use a host tree to grow. It is shade-intolerant, and therefore needs a sunny environment like tree crowns or rock ledges to develop. It grows by strangling the parent tree. The main adventitious root, which comes from a seed in the crown of the host tree, becomes a trunk when it touches the ground, and slowly kills the host through competition and shading (Francis and Lowe, 1994).

GENERAL DESCRIPTION

This semideciduous plant grows between 12 and 15 m in height. Its simple, oval-shaped, alternating leaves are 5 to 10 cm in length and have a rounded base and a pointed tip. They are dark green, smooth and with a full border, and feature a leathery texture. The main characteristic of this genus is its inflorescence or syconium (Andreu *et al.* 2010; Canesqui da Costa and Graciolli, 2010).

The natural distribution of the *F. citrifolia* is difficult to determine, given the existing confusion about the official name of the species (Francis and Lowe, 1994; Berg, 2003). However, in general, the jagüey grows from the south of Florida and the Bahamas through the Lesser and Greater Antilles. Other populations of *Ficus* spp. can be found throughout Central America down to South America (Francis and Lowe, 1994).

SOIL AND CLIMATE CHARACTERISTICS

Climate	Soils
It grows in areas with annual precipitations of between 750 and 2000 or 2500 mm, with annual temperatures of 20 to 27.5°C and a dry season of 2 to 5 months.	It normally grows in sandy or clay soils with a pH ranging from 5 to 8.5. Although it grows in many different types of soils, the most favorable ones for the species are those derived from limestone.

Source: Francis and Lowe, 1994.



Photo: Sian Lange

MORE FREQUENT USES

It is generally used as a living posts, because its large stakes are easily rooted. It is used to a limited extent as fuel, for carpentry and to manufacture musical instruments. Its wood is easily sanded and brushed; however, when other types of machinery are used, the wood falls apart given its wooly surface. On occasion, they are found as shade trees in coffee plantations. Its fruit is a very important source of food for birds (Francis and Lowe, 1994). Many species in the *Ficus* genus possess antibacterial, anti-inflammatory and pain-relieving properties (Andreu *et al.* 2010).

Did you know that...



The *Ficus* genus includes approximately 750 species from around the world, 100 of which are found in the Neotropical realm. Its distinctive feature is its urn-shaped inflorescence or syconium, where the flower grows and later develops as a bract. It is in this micro-environment where mutualism and antagonism relationships are established (Canesqui da Costa and Graciolli, 2010).

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Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

Like other species in the *Ficus* genus, the jagüey features a leathery structure called syconium, which is home to many female and male flowers. Throughout the year, the fruits appear in large amounts, and each of them contains hundreds of minuscule, yellowish white seeds. Approximately 4.6 million seeds/kg of fruit are obtained. The birds, which feed on its fruits, are in charge of spreading the seeds through their excrement (Francis and Lowe, 1994).



Propagation

When the seeds germinate, the seedlings grow in tree hollows or in rocky ledges. Specimens are only very rarely found in the underwood. These hemi epiphyte plants obtain nutrients from the rain and

from the leaching of the crown. They grow slowly until one of its adventitious roots reaches the ground and eventually becomes the trunk (Francis and Lowe, 1994).

Harvest shift and growth

Little information is available on the growth of the *F. citrifolia*; however, it appears to grow moderately when it has no competition, due to the vast amount of light it requires. It normally develops with a straight, single trunk, with layered branches whose irregular shapes prevent it from being used as timber. The average height of the jagüey is 15 m (Francis and Lowe, 1994; Andreu *et al.* 2010).

Protection

Although it is normal to observe numerous species of insects living in and feeding on its foliage, the bark, the wood and the fruit of the *F. citrifolia* are not significantly affected. However, the color of jagüey wood can easily fade as a result of fungus attacks to the sapwood during the drying process, hence the importance of treating it with a fungicide (Francis and Lowe, 1994).

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Guyana

MORICHE PALM

Scientific name: *Mauritia flexuosa*

Common name: moriche palm, buriti, aguaje

The *Mauritia flexuosa*, frequently called buriti or moriche, is one of the native palms of the Amazon forest, and belongs to the family of the Arecaceae. It is often found along rivers, ponds or *morichales*. Throughout its history, the palm has provided a versatile range of uses for humans, offering them products such as its oil or its fibers to be used as construction material (Freitas *et al.* 2017; Van der Hoek *et al.* 2019).

GENERAL DESCRIPTION

The *M. flexuosa* is a native Amazonian species, distributed throughout the western Andes, mainly in the Amazonia basin, in countries like Peru, Bolivia, Colombia, Ecuador, Venezuela, Brazil, the Guyanas up to the north of Trinidad and Tobago and Panama. The palm grows naturally in flooded soils, rivers and streams, forming dense monospecific groups known in Peru as *aguajales* and in Venezuela as *morichales* (Delgado *et al.* 2017).

Moriche is a Neotropical palm species found within a wide, heterogeneous range, which encompasses closed lowland rainforests in the Amazonian basin and more open savanna landscapes in countries like Brazil or Venezuela. Although it sometimes grows only in this vast region, it is found predominantly in ponds or temporarily flooded lands. It is considered a key plant resource since it is used by many animals that nest in the palm or eat off its fruits, as is the case of frugivorous birds (Van der Hoek *et al.* 2019). The fruit also plays a key role in the diet of certain mammals such as *Tayassu pecari*, *T. tajacu*, *Agouti paca*, *Dasyprocta variegata*, *Tapirus terrestris*, *Cacajau calvus* and *Lagothrix lagothricha*, and birds such as the guacamayo (*Ara ararauna* and *A. macao*) and the

toucan (*Ramphastos tucanus*), which disperse the seed of the palm (Delgado *et al.* 2017).

In countries like Peru, it has been used in pure plantations or in combination with other fruit trees, and even on private farms. Many isolated palms can be found, and in groups of between two and five in gardens and grasslands (Delgado *et al.* 2017). However, not much information is available on forest plantations and management of palms to establish the species at a commercial scale in Amazonia (Freitas Alvarado *et al.* 2019).

The *M. flexuosa* is a dioecious palm, which means that its male and female inflorescences can be found in separate plants, making it impossible to distinguish between sexes before the first flowering. The tree can reach 35 to 40 m in height and 50 cm in DBH. Its stem is straight, smooth and cylindrical, with an interfoliar space always above 10 cm. It features about 25 leaves per plant, which can measure up to 6 m in length and each one featuring between 120 and 236 segments. The petiole measures between 1.6 and 4 m in length, and 4 to 5 cm in diameter. The *aguaje* blooming, for males and females, as well as fruiting, begin at the age of seven or eight years, when the plant reaches a height of 6 to 7 m. The *aguaje* reaches its commercial fruiting point between 12 and 20 years of age (Delgado *et al.* 2017).



Photo: Depositphotos.com

SOIL AND CLIMATE CHARACTERISTICS

Climate

Average annual temperature of 25.1 to 17.2°C

Maximum annual precipitation of 3419 to 936 mm

Altitude between 50 and 850 masl

Soils

Flooded soils

Source: Delgado *et al.* 2007

MORE FREQUENT USES

The fruit's rind covers a smooth, oily pulp, whose color varies between darkish yellow and reddish after full maturation. The oil is extracted from the pulp using cold-pressing. 45 kg of oil can be produced from 1000 kg of ripe fruit (Freitas *et al.* 2017). This type of oil, a significant source of energy and vitamins, is similar to palm oil due to its reddish yellow color and its flavor; however, it features a high concentration of monounsaturated fatty acids (which help reduce LDL cholesterol in the blood) (Freitas *et al.* 2017), with values higher than those found in olive oil or Amazonian nuts. Other studies have shown that this fruit is a potential source of carotenoids and natural anti-oxidants (Cândido *et al.* 2015). Furthermore, its pulp can be consumed directly, dry, fermented or as flour, and constitutes an important part of the diet of many Amazonian indigenous communities. For example, in Peru, the fruits are sold and consumed directly or as pulp, and are used to prepare a beverage called *aguajina y helado* (Delgado *et al.* 2017).

On the other hand, the petioles, used to decorate bars and restaurants, have a spongy part used for paper and wine production. The leaves are utilized to cover house roofs, and fibers are extracted to manufacture clothes, hammocks, baskets and toys. Starch is also extracted from the stem core. In Brazil, the larvae of weevils, called *suri* (*Rhynchophorus palmarum*), are consumed traditionally, and can be found on the fallen buriti branches (Delgado *et al.* 2017).

BIODIVERSITY AND LEVEL OF VULNERABILITY

The destructive harvesting method and the indiscriminate exploitation of the *M. flexuosa* have threatened the ecological and evolutionary processes that occur in these specific ecosystems. The species and the genetics are dwindling, as well as the feeding of animals as a result. Moreover, many families rely upon this resource, since they use it as food for their subsistence. It is important to highlight the fact that only the female palms are harvested, thus reducing the probability

of natural regeneration and survival of the species, as well as its genetic variability. In view of all this, further research is required to come up with alternatives for the sustainable production and harvesting of palm fruit (Delgado *et al.* 2017; Freitas Alvarado *et al.* 2019).

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Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

The palm grows in temporarily or permanently flooded soils, in swamplands or poorly drained areas (Delgado *et al.* 2017).



Seed

The germination period is variable, and often depends on the condition of the seed and its development physiology, as well as its substrate, humidity and temperature. With adequate organic substrate, germination can reach up to 88% in 60 days and a minimum germination of 9% in 61 days (Delgado *et al.* 2017).



Propagation

Flowering can occur at any moment of the year. When the flowers open, they emit a strong, pleasant fragrance that attracts insects. Fruiting also takes place at any point during the year, with greater abundance in the months of August and October. Under different developmental conditions, a plant can have up to eight inflorescences per year, whereby each can produce up to 900 fruits (Delgado *et al.* 2017).

Management

The fruits are usually harvested in their natural environment, and to a lesser extent, in the backyards of homes. People usually cut the entire palm and then collect the fruits, and then place them in sacs (about 40 kg per sac) (Delgado *et al.* 2017).



Did you know that...

The Amazonia is home to about 50% of the world's palms, as well as 30% of all palm species in the Americas. The stem of the *M. flexuosa* remains submerged for long periods of time, without causing any damage to the plant thanks to its pneumatophors (aerial roots), which allow it to grow in anaerobic conditions (Delgado *et al.* 2017).

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Haiti

CARIBBEAN ROYAL PALM

Scientific name: *Roystonea oleracea*

Common name: caribbean royal palm

The Caribbean royal palm is a native species of the Lesser Antilles, northern South America (Venezuela and Colombia) and Guatemala. It is highly valued as an ornamental plant. The species has been widely planted for landscaping purposes.

GENERAL DESCRIPTION

According to CABI (2020), the *R. oleracea* grows to a height of 40 m, with a trunk that is light grey, erect, and cylindrical up to 22m. At the crown, the leaves occur on the upper end of the trunk. The flowers grow in large panicles that are at risk of losing seed fecundation, and which are revealed when the leaf sheaths beneath them fall. The tree has an abundance of small, bluish-purple fruit that are ovoid in shape and stemless. The tree's roots can often be seen emerging from the stem, just above soil level. Individual trees present between 16 to 22 or 20 to 22 leaves measuring 3 to 5 m in length, with two horizontal rows of leaflets measuring approximately 1 m. The species stands out and is relatively easy to identify for several reasons, one being that normally the leaves at the crown do not hang much below the horizontal row, unlike other species where the leaves lean over and obscure the shaft of the crown.

According to Henderson *et al.* (1995), the *R. oleracea* normally occurs in areas prone to flooding at least part of the year, especially coastal areas. It grows in low-lying coastal areas such as ravines and marshes and has been found in both freshwater and salt marshes. It can also be found in gallery forests, on savannahs where flooding is possible such as in Colombia and Venezuela. It has been found that its long-term survival is best in areas that are far away from extreme water levels but which have an adequate degree of moisture (Bonadie, 1998).



Photo: Depositphotos.com

SOIL AND CLIMATE CHARACTERISTICS

Climate

According to the Köppen climate classification, it is found predominantly in tropical climates. It performs better in areas of high precipitation, although it can tolerate dry seasons up to five months, with average annual temperatures of 18 to 26°C and warm temperate climates. The average annual precipitation ranges between 1200 mm and 2500 mm. In view of its native distribution it is well adapted to hurricanes, it can easily release its leaves and resist strong winds (Henderson *et al.* 1995).

Soils

The species tolerates wet soils, periodically flooded with slightly saline water. It can often be found in wet locations such as marshes and riversides. It can be found on neutral to alkaline soils (Henderson *et al.* 1995).

Source: Henderson *et al.* 1995.

MORE FREQUENT USES

The *R. oleracea* has been described as the most attractive species of its genus. In the tropics it is valued as an ornamental and landscaping species. It is an excellent option for planting along avenues or near tall buildings. It also plays an important role in the landscaping industry, with commensurate economic value. Although its highest value worldwide is probably its aesthetic value, in some places the species is also valued for its multiple uses. In the Caribbean its fruit is used as a source of oil, the base of its leaves as straw, its trunk as wood and its terminal bud as food. The apical growth bud or palmetto is cooked and eaten like cabbage and the core of the stalk is used to make an edible starch (CABI 2020).

Did you know that...



The royal palm, besides being very beautiful, is invasive in wetlands or nearby areas due to the high germination rates of its seeds and dispersion by animals.

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Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

The species propagates through seeds; germination takes two to three months. In a swampy environment germination and successful establishment of saplings take place at the start of the wet season when there is an adequate level of water, but in conditions where the forest soil does not flood suddenly and the flood period is short-lived (CABI 2020).

In terms of growing them in a nursery, Ly and Grageola (2016) consider production of saplings a simple task although some exceptions and variance can occur. The main operational factors to bear in mind in this environment is preparation of the substrate, sowing, protection of the crop, irrigation, transplanting and shade. When transplanting from nursery to the field these plants should be managed like most palms.

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Jamaica

BLUE MAHOE

Scientific name: *Hibiscus elatus*

Common names: blue mahoe, majagua

The majagua, endemic to Jamaica, is this country's national tree. The name *blue mahoe* refers to the blue lines that can be seen when the wood is polished. It is very attractive, with a straight trunk, wide green leaves and famous hibiscus flowers. The color of its flower is bright yellow to orange red (Jamaica Information Center 2020).

SOIL AND CLIMATE CHARACTERISTICS

Climate

It grows naturally in rain forests with an annual precipitation greater than or equal to 1500 mm, and a temperature that varies between 20 and 25°C. It can also occur in elevated areas with precipitations ranging from 1800 to 3800 mm.

Soils

In Jamaica, it grows especially on limestone-derived soils, at elevations of 150 m above sea level and on residual soils on volcanic rock or schistose clay.

Source: Weaver and Francis n.d.

GENERAL DESCRIPTION

Hibiscus elatus grows naturally only in Cuba and Jamaica, especially in moist, elevated zones. It was introduced and naturalized in the south of Florida, Mexico, Peru, Brazil, the West Indies and neighboring islands such as Puerto Rico (Weaver and Francis n.d.).

It is an evergreen tree that attains a height of 25 m. It presents a tall, straight trunk around 0.4 m DBH. Its leaves alternate with leafstalks of slender round leaves, with clear green stipules 3 cm in length that detach quickly and leave a scar on the ring. They are heart-shaped and almost round, 13 to 18 cm in length. The flowers, which measure 13 mm in diameter, grow at the base of the leaves, at the end of the twigs. They possess a light green hairy basal cup 2 cm in length and nine long pointed lobes. The calyx, hairy and tubular, measures 4 to 5 cm and presents five long, narrow, extended lobes. Its five yellow petals feature a dark red patch on the interior base (CABI 2020).

It is considered an early successional species which grows in montane forests, wet lowlands, foothills, secondary forests and disturbed moist sites (CABI 2020).



Photo: Tamara Gentles.

MORE FREQUENT USES

The majagua is used in the manufacture of high-quality furniture and, thanks to the blue and purple hues of its heartwood, its wood is very highly priced. It is used in the manufacture of flooring, finished lathing and in the construction of houses and boats (Weaver and Francis n.d.). In Cuba it is used as windbreakers and in traditional medicine. The hibiscus flowers contain flavonoids, amino acids and tannings which give them expectorant properties (Márquez *et al.* 1999).

ESTABLISHMENT AND MANAGEMENT

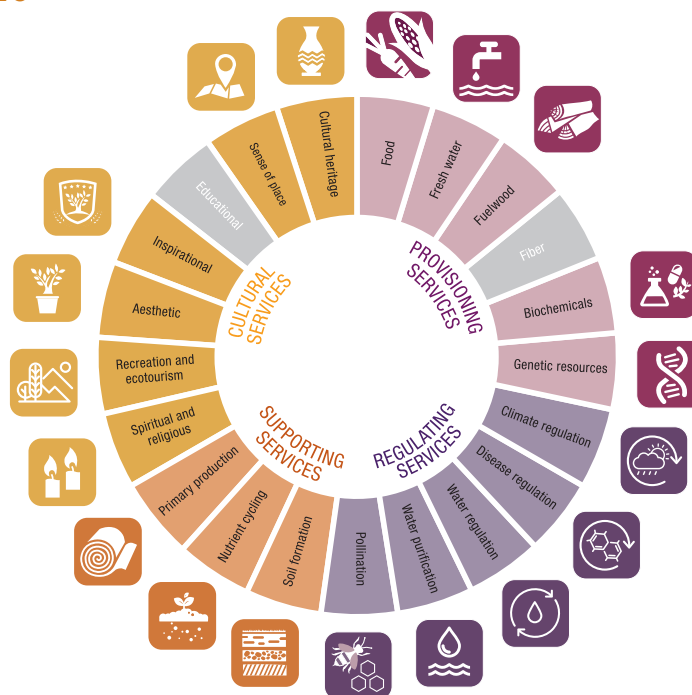
Forestry



Seed

The seeds are small and hairy and present in elliptical capsules which, once ripened, become dry and then crack open, thus dispersing on the parent tree over a period of one week. The capsules are harvested by cutting them from the tree before they open, after

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Source: Prepared based on MA 2003.

which they are placed in the sun to open. The seeds can be separated by shaking the capsules. There are an estimated 100 units in 1.8 to 1.9 g of seed. Close to 80% germination can be attained after harvesting the seeds (Weaver and Francis n.d.).



Propagation

In Jamaica, the potential for natural regeneration of the species is very low in spite of the high production of seeds. If the seeds are sown in nurseries, the one-year old saplings, with a size of 45 to 60 cm, can be transplanted to the field. It is recommended to remove the leaves when sowing. Its growth rate accelerates six months after transplant. In Puerto Rico, the saplings are harvested directly from wild trees and are placed in a nursery under the shade to grow, after which they are transplanted to the field (Weaver and Francis n.d.).

Its propagation can also be vegetative, by means of hardwood cuttings harvested from the saplings and seedlings. The appropriate size for the cuttings is 45 cm long and 5 to 15 mm thick. When transplanting, two thirds of the cutting should be inserted into wet soil in the shade. It is calculated

that at least 50% will take root within a period of three months (Weaver and Francis n.d.).

Management

Pruning is recommended since cases of epicormic branching do occur; however, if pruning is not done, the branches that develop can be used as stakes and poles (Weaver and Francis n.d.).

Harvest shift and growth

In Puerto Rico, 34 plots report volumes of 90 to 154 m³/ha, with an annual increase of 14.4 to 23.7 m³/ha between 6.5 and 8.5 years of age, in addition to an average diameter of 1.52 to 2.52 cm p.a. and an average height of 11.9 to 21.9 m. On older plantations, 16 to 27 years, the volume was between 97 and 979 m³/ha/p.a., with diameters between 11.5 and 25.8 cm (Weaver and Francis n.d.).

Protection

There is no report of diseases or plagues that may severely damage the tree. In Jamaica, there have been observations of leaf spots caused by *Septoria sp.* and *Pestalstia heterocornis*. The trees can also be affected by cotton stainer insects, and it is suspected that certain ants feed on its seeds. Its wood is very resistant to fungi that cause decomposition (Weaver and Francis n.d.).

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Dominican Republic

CAOBA

Scientific name: *Swietenia mahagoni* Jacq.

Common name: caoba, West Indies mahogany, small leaf mahogany

Mahogany (*Swietenia mahagoni* Jacq.) was officially declared the national tree of the Dominican Republic pursuant to Law No 146 from 2011 (Eco-Hispaniola 2020). It is worth mentioning that in the mid-20th century, the mahogany flower had been chosen as a national symbol (Decree No 2944). The natural area of distribution of the mahogany includes the island of Hispaniola, the Florida Keys and southern end (United States), Bahamas, Cuba and Jamaica (Francis and Lowe, 2000).

GENERAL DESCRIPTION

The mahogany is a tree that can live hundreds of years and attain a height of 12 to 30 m depending on the fertility of the soils (Francis and Lowe, 2000; Szabó, 2010). The trunk has a DBH of more than 1 m. Its wood features a reddish brown color, and is heavy, hard and insect-resistant. The tree's duramen can be a strong red, pink or yellow, and becomes darker with the passing of time. It features a round, symmetrical crown measuring approximately 12 m in diameter. Its paripinnate leaves have 4 to 6 shiny oval-shaped or lanceolate leaflets (Szabó 2010). The mahogany flowers between March and June, and displays white-petal flowers and ovoid-shaped fruits measuring 6 to 10 cm in length with a woody skin (Francis and Lowe, 2000; PPA, 2012). The tree has a pivoting root and large lateral roots (Szabó, 2010).

Due to the high demand for wood for export (Francis and Lowe, 2000), the timber trade has remained one of the main commercial activities of the country for a long time.



Photo: Illustrative photo of mahogany trees, Catie.



Photo: CATIE – RD

SOIL AND CLIMATE CHARACTERISTICS

Climate	Soils
<p>In its natural distribution area: Annual rainfall of 760 to 1780 mm Annual dry season of 2 to 6 months</p> <p>It can withstand occasional frosts.</p> <p>It grows in wet and semi-dry forests at low altitudes.</p>	<p>It grows in moist, deep soils. The species can be found inside mangroves in soils with marlstone and limestone content. It can tolerate relative high pH values (up to 8.5).</p> <p>In Jamaica, it grows in areas located near the sea (up to 99 m in altitude) and is limited by humid and cold conditions and a low soil pH, particularly in clayey soils.</p>

Source: Drafted based on data from Francis and Lowe 2000; Szabó 2010; and PPA, 2012.

MORE FREQUENT USES

Its high quality wood is easy to work with and has a very good finish, which is why it has been used for cabinetmaking, for example, to construct luxury Victorian or Georgian Chippendale furniture from the mid-18th century, as well as to manufacture musical instruments, balustrades, moldings, carved figures and crafts. The wood has also been used to build houses; furthermore, in the West Indies the branches or small trees have been used as posts, firewood and charcoal (Francis and Lowe, 2000).

The species is believed to have medicinal properties. The oil extracted from its seeds is used as a purging agent. Its bark is prepared as an infusion for its astringent properties and as medicine for influenza (Francis and Lowe, 2000). The bark also has a high content of tannins, which can be used for leather tanning (Francis and Lowe, 2000).

Mahogany is also used for ornamental purposes, for which it is planted in urban spaces such as parks, squares and roads. However, its large lateral roots can sometimes break the pavement or narrow sidewalks (Szabó, 2010; PPA, 2012).

Did you know that...



Mahogany (*Swietenia mahagoni* Jacq.) is a timber species that possesses great beauty, resistance and durability, and is easy to work with (He *et al.* 2020). In the Dominican Republic, families appreciate and take pride in having mahogany furniture in their homes.

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

The mahogany begins to produce flowers and fruits at 12 or 13 years of age (up to 100 capsules). When the fruit ripens, its skin opens and the capsule falls on the ground, thus releasing up to 60 seeds measuring 5 to 6 cm in length and of a yellow or dark red color. Human activity can accelerate the propagation of the Dominican mahogany in new habitats (Francis and Lowe, 2000).



Propagation

According to Francis and Lowe (2000), germination is approximately 70% and the seedlings sprout after an average of 18 days. Several planting methods have been used. One of them is the so-called "striplings" method, where the seedling is kept in the greenhouse for a year with bare roots and no leaves to protect it from perspiration stress until it reaches 0.6 to 0.9 m in height, after which it is transplanted. Another method is direct seeding in moist areas, which has produced more successful results when

the soil is prepared and weeded beforehand during the first months of the planting period. Once in the greenhouse, the seeds can be put in soil-filled trays or directly in containers or plastic bags, and will germinate within an average of 9 months.

Protection

There is evidence indicating that the Dominican mahogany is resistant to extreme weather events such as hurricanes, to certain pests such as mahogany stem borers (*Hypsipyla grandella* Zell.) and the West Indian drywood termite (*Cryptotermes brevis*). Its duramen is more resistant to rotting, except in the case of old trees that may suffer from heart rot and decay at the trunk base. However, there have been cases of Dominican mahogany in natural habitats which present defoliation due to the attack of the webworm moth (*Macalla thyrsisalis*). There is also evidence of damage caused by the *Apate monachus* in Puerto Rico, and low resistance to the *Teredo navalis* in Hawaii (Francis and Lowe, 2000).

Conservation

Three mahogany species, including the *Swietenia mahagoni* Jacq, are regulated by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (He *et al.*2020) to protect the species and its habitat from indiscriminate logging and illegal trade.

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Saint Lucia

CALABASH TREE

Scientific name: *Crescentia* spp

Common name: calabash tree, *jícara*

The Bignoniaceae family is made up of plants found mainly in the tropics. The *Crescentia* genus has six species located only in tropical America, from Mexico down to the Brazilian Amazon and in the Caribbean islands. It was introduced as a crop outside of the continent (Elias and Prance, 1978). The most well-known species of the genus are the calabash tree, *Crescentia cujete*, and the winged calabash, *Crescentia alata*. Both species are considered to be of great economic importance for the Americas, since they possess culinary and medicinal properties (López *et al.* 2014).

SOIL AND CLIMATE CHARACTERISTICS

Climate

It grows in the dry tropics.

Soils

It occurs on soils typical to tropical savannahs.

Source: Little *et al.* 1977.

GENERAL DESCRIPTION

The majority of the trees in this genus occur in dry habitats where there is an abundance of thickets and thorny shrubs as a form of defense in the dry seasons. They are characterized by a light, irregular crown divided into two parts. Their estimated life span is up to 200 years (López *et al.* 2014).

The *C. alata* species attains a height of 6 to 12 m and a DBH of 20 cm. Its extended branches measure 6 to 10 m in length. It has smooth, whole, coriaceous, trifoliate leaves with winged petioles. Its blooms and fruit present directly from the trunk. The round fruit measure 7 to 12 cm in diameter. Its shell is hard and its seeds are covered by a soft pulp (López *et al.* 2014; Pinedo-Espinoza *et al.* 2019). The *C. cujete*, on the other hand, attains a height of 10 m and its branches are extended. Its leaves are oblanceolate, they measure 6 to 15 cm in length and are shaped in the form of a spoon. Its blooms are large, purplish-yellow in color and measure 5 to 6 cm in length. Its bark is smooth in young specimens, later developing grooves and becoming light brown and gray (Little *et al.* 1977; López *et al.* 2014).



Photo: Silvanus Augustin, IICA Delegation in Saint Lucia.

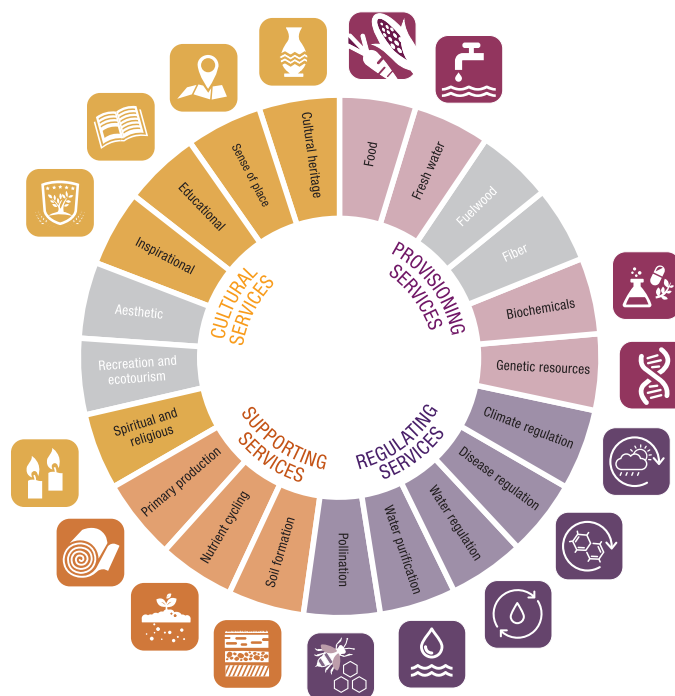
MORE FREQUENT USES

The *C. alata* and *C. cujete* species have very similar uses and properties. The former produces a fruit that has a sweet pulp and numerous seeds, which constitute around 5% of the entire fruit. Throughout Mesoamerica, its pulp is used to make a traditional drink, horchata, which is an important food source because of its high protein and vitamin C content. Moreover, it is used to treat pain and inflammation caused by blows. Its lignified pericarp is used to make the famous small drinking bowls. On the other hand, it can be used in silvopastoral systems since it adapts well to drought and possesses a deep radicular system which it uses to absorb nutrients and water

from the soils of the savannah. One tree produces around 750 fruits per annum. Three hundred and fifty of these trees can be planted on one hectare (Pinedo-Espinoza *et al.* 2019).

The fruit of the calabash tree (*C. cujete*) is used as a container and for craftwork and making household utensils. Its pulp is used as fodder for livestock. Cultivation of this crop stretches from America to Africa and Asia, where it appears as a typical component in home gardens. It is also grown for firewood, and as a source of shade in urban settings (Arango-Ulloa *et al.* 2009). In traditional medicine its leaves are used to make infusions to treat stomach aches, colds, bronchitis, asthma, coughs and diarrhea (Paladines *et al.* 2017).

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

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Suriname

ROYAL PALM

Scientific name: *Roystonea regia*
(Kunth) O.F. Cook

Common name: royal palm, Cuban royal palm, Florida royal palm, palmier royal, Königspalme, kubanische Königspalme, kungspalm

The *Roystonea regia* is known as the national tree of Suriname, and is also called Cuban royal palm (CABI, 2020). It is distributed naturally in the southeast of the United States (Florida), the south of Mexico (Campeche, Tabasco, Veracruz de Ignacio de la Llave, Yucatan), The Bahamas, Cuba, the Cayman Islands, Suriname, Belize and Honduras. The species can also be planted (USDA, 2020).

GENERAL DESCRIPTION

The royal palm belongs to the Arecaceae family. It has a smooth, light greyish trunk measuring 15 to 34.5 m in height. Its DBH is 61 cm and the upper part features a green column with foliar sheaths measuring 1 to 3 cm in length (Connor, 2002). Young palms have a bulge in the middle of the trunk (CABA, 2020). The trunk is surrounded by the *yagua* (sheathed petiole) which is located at the base of the leaves. The pinnate leaves measure up to 6 m in length and feature a large number of shiny, dark green leaflets. The flowers are lanceolate, with five external and five internal tepals. The male and female flowers develop in the same panicle (Connor, 2002). The species produces more fruit clusters than other palms like the *R. oleracea*. The fruit is smooth, oval-shaped, and purple; it measures 13 mm in length and has a single, light brown seed (Connor 2002; CABI 2020; EcuRed 2020).

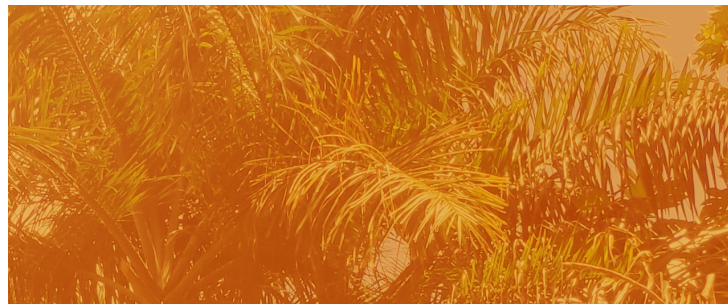




Photo: IICA Suriname

SOIL AND CLIMATE CHARACTERISTICS

Climate

Neotropical

The royal palm grows in full sunlight and can tolerate drought once it is established. It also tolerates the relatively low temperatures of subtropical climates (-2.2°C) and the Mediterranean.

Soils

It grows in fertile, humid soils with plenty of sunlight.

Sources: Connor 2002; Gutiérrez and Jiménez 2007; UF IFAS 2020.

MORE FREQUENT USES

The royal palm offers environmental and ornamental services, as well as materials for construction. The wood is used to build houses, the fibers and leaves are utilized in the construction of thatched roofs (USDA, 2020), and the *yaguas* to build hut walls and to wrap cured tobacco leaves (EcuRed, 2020). The spathes are used to manufacture baskets and the dry palm clusters are transformed into rustic brooms. The oil contained in the seeds has been commercially extracted to manufacture soap (Connor 2002; EcuRed 2020).

The *R. regia* is also utilized as food. Its fruits are eaten by birds and pigs, and its flowers by bees. It is also believed to have medicinal properties. The liquid that results from the cooking of its roots is used as a diuretic (not proven) and as

an emollient, and also to pass kidney stones and treat diabetes (Vicente-Murillo *et al.* 2011; EcuRed 2020).

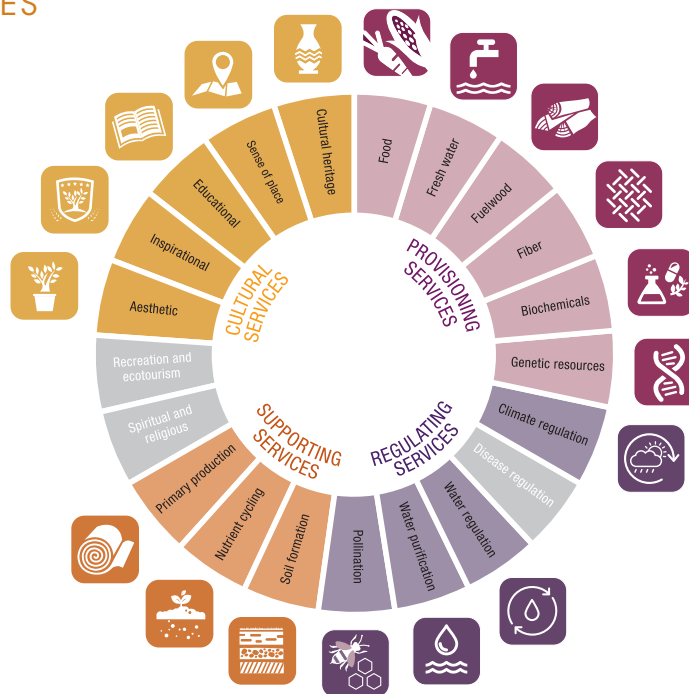
Owing to its majestic beauty, the royal palm is used for ornamental and decorative purposes in urban areas such as shopping malls, avenues, gardens and parks (Connor 2002; Gutiérrez and Jiménez 2007; UF IFAS 2020).

Did you know that...



The royal palm (*Roystonea regia*) is the national tree of Suriname and Cuba.

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

According to Connor (2002), the flowers develop in panicles from the sprouts that grow in the trunk under the leaves. In places like Florida, the royal palm blooms in the spring and its fruits ripen in the fall.



Propagation

Animals contribute to the propagation of the species. In Puerto Rico, both the birds and the bats eat off the oily pericarp, and other animals clean the seed if it falls to the ground. The seeds can then be found on the ground, lightly covered and clean,

where they can be collected in large amounts. Germination of the seeds under natural conditions begins 50 or 60 days later and may take up to 100 days (Connor, 2002).

When the seed is planted, it is advisable to handle the fruit with gloves because of the calcium oxalate crystals contained in it. The fleshy pulp must then be removed and seeds must be rinsed with water. Seeds can be planted in potting soil to ensure proper drainage, uniform moisture, and must be kept at a high temperature, ideally 35° C. Germination can occur 5 to 8 months after planting (UF IFAS, 2020).

With respect to storage, the ripest seeds can be cleaned and dried in the open air with a relative humidity of 80% to 90%, then treated and sealed airtight (Connor, 2002).

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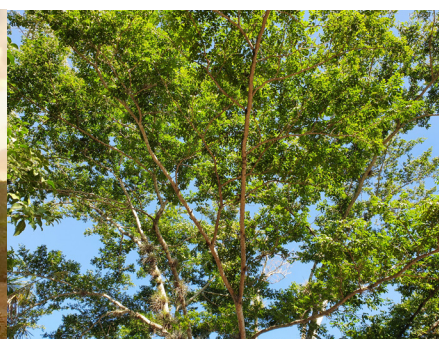
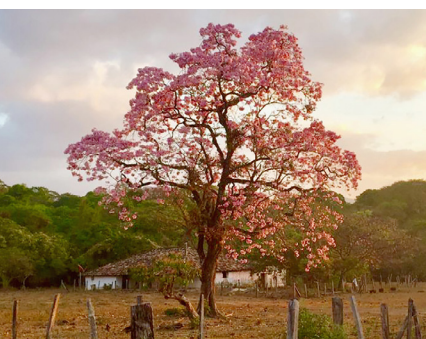
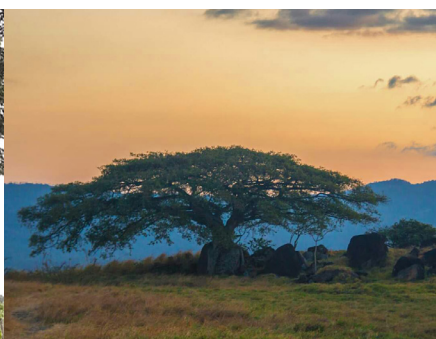
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Belize
Costa Rica
El Salvador
Guatemala
Honduras
Nicaragua
Panama

CENTRAL REGION



Belize

MAHOGANY

Scientific name: *Switenia macrophylla*

Common name: *caoba* (in Spanish-speaking Mesoamerica) and mahogany (in Belize and English spoken all over the world)

In 1981, upon declaring its independence, Belize acknowledged mahogany as the national tree, as can be seen in its national emblem (Motion No. 7, 1981).

GENERAL DESCRIPTION

The large-leaved mahogany (*Switenia macrophylla*) is a majestic species, which grows more than 45 m in height (25 m to the first branch) and 1.8 m in DBH. It carries great value due to its attractive reddish color and superior visual characteristics. For centuries, it has been the most valuable wood species in the Neotropical realm from a commercial standpoint (Weaver and Sabido, 1997). It can be naturally found from Mexico to the southern Amazonian basin of Brazil, Bolivia and Peru (Cordero and Boshier, 2003). However, it has been depleted in many of these forests, which is a cause for concern with respect to the future of the species and its trade.

S. macrophylla produces a long, straight shaft with large buttress roots. The crowns of older trees can have up to 20 m in diameter. Their bark is grey and smooth when young, and turns dark brown, grooved and flaky when it reaches maturity. Its composite, alternating leaves are grouped at the end of the twigs with a length of 16 to 40 cm. Each one has three to six pairs of opposing small leaves measuring 9 to 14 cm in length. Its small flowers, with five yellowish white petals, are grouped in axillary inflorescences. These are unisexual, and the tree is monoecious. Its fruit is comprised of ligneous, erect capsules measuring 12 to 22 cm in length and 6 to 10 cm in width. When mature and dry, the four or five valves of the fruit open up at their base, thus exposing the seeds, which hang on the wings at the center of the fruit. Each fruit contains 35 to 45 winged seeds, of a brownish color and with a length of 7.5 to 12 cm, including the wing (Cordero and Boshier, 2003).



Photo: Willie Chan

SOIL AND CLIMATE CHARACTERISTICS

Climate	Soils
<p>Mahogany grows in lowland tropical and subtropical forests, with a dry season of around four months, at an altitude of 50 to 500 masl. The annual average temperature is 22 to 28°C and the annual precipitation is 1000 to 2500 m, although it can grow in drier or more humid areas as well. The tree requires a lot of light and a dry period for flowering.</p>	<p>It grows in a wide variety of soils ranging from sandy to clay, but prefers deep, well-drained, fertile alluvial soils ranging from alkaline to neutral. It can also grow in acid soils with a pH of up to 4.5.</p>

Source: Cordero and Boshier, 2003.

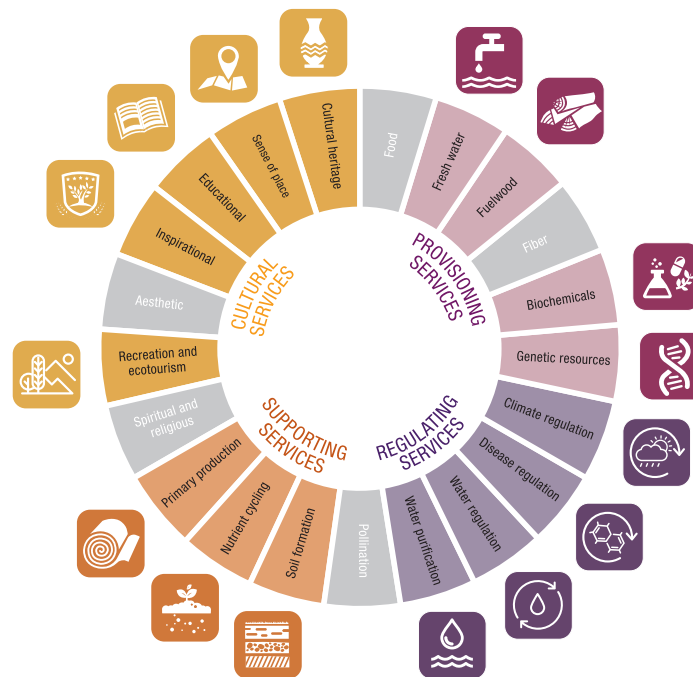
MORE FREQUENT USES

Mahogany is one of the most popular and widely appreciated timbers to manufacture furniture in the world, and has been traded and utilized for over 400 years. Its easy management and resistance, compared to its weight, allows for multiple uses, such as light constructions, ships, musical instruments and scale models. It carries an extremely high commercial value in the industry of high-quality boards. Its specific gravity is 0.40 to 0.68 g/cm³. It dries easily in the open or in ovens, with no noticeable defects. It is easy to work with and has an exceptional finish. Its heartwood is very resistant to rotting and moderately resistant to termites (Cordero and Boshier, 2003).

Moreover, the tannins of its bark are used to manufacture medicines and dyes. An infusion made with its bark and seeds is used to treat diarrhea and fever. The seed, which is very bitter, is used to relieve tooth aches and contains oils utilized to manufacture cosmetic products.

Mahogany has been planted extensively in every tropic within the framework of reforestation programs. It has also been used in agroforestry systems as a timber species and for shade. It is not recommended for pure plantations due to the attack of shoot borers, but it can be combined with other timber species or in enrichment rows in forests and secondary forests (Weaver and Sabido, 1997; Cordero and Boshier, 2003).

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

The species grows fairly quickly, and is suitable for plantations. It can produce sawn wood in rotation shifts of 30 to 40 years. In this sense, its main disadvantage is its vulnerability to shoot borers (*Hypsipyla grandella*), which attack the main sprout in young trees and cause branching and bifurcations that reduce or eliminate the commercial value of the tree (Cordero and Boshier, 2003).

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

The tree's brown seeds are collected before the capsules open, when almost ripe. The capsules are transported in jute bags and left to dry for five days in a cool, covered area. Afterwards, they are sun-dried for up to four hours per day for three days. The seeds can be stored with a humidity of between 3 and 7% and 3°C for up to 8 years. They can also be stored at room temperature in paper sacks or airtight containers at 4°C for up to four years (Cordero and Boshier, 2003).



Propagation

The seeds are planted in seedbeds with no pre-germination treatment. Afterwards, they can be planted out or else the seeds can be directly placed in bags, placing one or two per bag in an area with little shade. Although it has been used in depths of up to 8 cm, the recommended depth is 2 or 3 cm into the substrate, horizontally or vertically, with the wing facing up, in order to allow for natural germination. Under favorable conditions, germination begins ten days after planting and continues for 20 days. When the first leaves appear, the seedlings are ready to be placed in bags or spaced out every 15 x 20 cm in nurseries to produce pseudo-stake or bare-root plants. After bagging,

the seedling needs strong shade (70%), which must drop down to 30% after a week, and then must be fully exposed to sunlight after three or four weeks. At four months, upon reaching 30 to 50 cm in height, the seedling bags are ready to be taken to the field. In the case of pseudo stakes, plants must have a diameter at root neck of at least 2 cm, a stem of 15 to 20 cm and a root of 20 to 40 cm. It can also propagate vegetatively with young, rooted small stakes or through *in vitro* cultivation (Cordero and Boshier, 2003).



Planting

Although there have been plantations established with a spacing of 2 or 3 m between trees, pure plantations are generally not recommended for this species due to severe attacks by shoot borers (*Hypsipyla grandella*). There is evidence that lateral shade can reduce the damage caused by this pest. Several options can be resorted to, including a combination with other, faster-growing species (*Leucaena* or eucalyptus, for example); planting in rows in young forests or secondary forests; and applying weeding procedures along the plantation lines, leaving a strip of weeds at the center to act as a natural barrier between the rows of trees. The first option carries the additional advantage of producing other trees, which in turn can generate income in a shorter term while completing the commercial harvest shift for mahogany. It can also be combined with annual or perennial agricultural crops (such as coffee or cocoa), with a wide space of up to 15 x 15 m in-between them, depending on the crop and the goals (Cordero and Boshier, 2003).

The inputs and procedures used to protect agricultural crops also benefit the trees, since they can grow faster and overcome the phase of susceptibility to borers more quickly. Another system that can be applied is enrichment planting,

where 2-meter wide strips of forest are cleaned out, with a spacing of 10 to 12 m, and the mahogany is planted with a space of 2 to 5 m along these strips based on the intensiveness of the management. In general, vigorous, well-shaped trees of other species and which are located along these strips are respected. This system is ideal for forests that have been overexploited or which are characterized by a prevalence of low commercial species (Cordero and Boshier, 2003).

Management

During its first years, the *S. macrophylla* features a narrow crown, and therefore regular cleaning must be performed along the plantation strips at least during the first three or four years. In forest enrichment systems, the growth of lianas must be properly controlled, by avoiding their proliferation in these environments which can severely damage the trees. Mahogany trees can adequately self-prune, especially in systems with lateral shade; in broad spaces, a low crown can become a problem due to its short shaft. The trees planted for timber must be pruned to obtain a single, long, branch-free shaft and preserve the necessary foliage for the tree's adequate growth. Sanitary pruning to prevent attacks by borers is done in two steps: first, the damaged or attacked sprout is removed; three months later, once the main shaft is defined, the rest can be removed. This prevents bifurcations in the lower part of the tree, thus increasing its value as timber. This procedure is repeated as many times as necessary to achieve a solid section of straight shaft, or until it reaches secondary branches, where the damaging effect is not as significant. In the case of older trees that have responded to the damage by producing two or more shafts, pruning must be performed to conserve only the best among them (Cordero and Boshier, 2003).

Harvest shift and growth

Over the course of four years, Shono and Snook (2006) analyzed the measurements of the annual diameter of

75 natural forest mahogany trees in the north of Belize in order to determine their growth rate. The mean increase in diameter was 1 cm/year, with growth rates slightly higher in trees with a diameter at breast height (DBH) of 50 cm. The inter-individual variation in growth rates was significant: the fastest growing individuals showed rates above 2 cm/year. Also significant were the inter-annual growth rate variations, where the diameter grew by 1.21 ± 0.1 cm during a more humid year (1456 mm), exceeding by 75% the value of a drier year (1181 mm), which was 0.69 ± 0.1 cm. The study revealed that small mahogany trees, with a DBH of 23 cm, and which were still standing after the harvests, could reach the commercial diameter of 60 cm in the 40 years between cutting cycles (Cordero and Boshier, 2003).

Protection

Attacks by *H. grandella* constitute a major problem in greenhouses and plantations, which is further exacerbated during the rainy season. This pest is the biggest obstacle for the establishment of mahogany in Latin America and the Caribbean. As mentioned before, it is possible to mitigate this attack by combining mahoganies with other forest species, planting them in rows in scrublands or secondary forests by applying the forest enrichment system, and with careful management aimed at maximizing its vigor during the initial stages. The tree is most susceptible during its first two or three

Did you know that...



The mahogany tree (*Swietenia macrophylla*) is part of the emblem that appears on the Belizean flag. The mahogany industry was the basis of the economy of this country during the 18th and 19th centuries (Belize.com 2020).

years; later on, once it is older and has more foliage, the attack is distributed among other possible sites for oviposition, no longer focusing solely on the main axis. Pruning is not a prevention method, but is efficient in mitigating the effect of

the attacks. Several natural enemies of the borer have been identified, including parasitoids and predators, but none of them have achieved an efficient control in plantations (Cordero and Boshier, 2003).

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Costa Rica

GUANACASTE

Scientific name: *Enterolobium cyclocarpum*

Common name: *guanacaste*

In 1959, in the midst of a national campaign to protect natural resources, the guanacaste (*Enterolobium cyclocarpum*) was declared the National Tree of Costa Rica, symbolizing its people's devotion to this tree (Decree No. 7, 1959). These efforts have contributed to the environmental awareness of the country ever since.

SOIL AND CLIMATE CHARACTERISTICS

Climate

Dry forest

Dry season, three to six months

Annual average temperature 23 to 28°C

Annual rainfall 750 to 2500 mm

Soils

Well-drained sandy or clay soils

Source: Drafted based on Cordero and Boshier, 2003.

GENERAL DESCRIPTION

The *E. cyclocarpum* is a leguminous tree, native to dry tropical forests and is widely distributed throughout the Neotropical realm. It covers the area from Central Mexico to Northern South America, and is mostly found in dry, lowland deciduous and semi-deciduous forests. In countries like Costa Rica, it normally grows with low density in intact forests, in areas with forest disturbances where it tends to be more abundant (Rocha and Aguilar, 2001).

According to Cordero and Boshier (2003), this is a typical tree from the Pacific watershed of Central America, specifically in areas with seasonally dry grass. It is considered a forage crop due to the high protein content of its seeds. It is used in the open field to provide shade and pods for cattle. Most of the natural individuals are the remains of the original dry forest, and it is therefore frequently considered to be indicative of disturbed vegetation (with forest destruction) in humid tropical areas. It is also used as an ornamental tree in streets and parks, but has never been planted on a large scale.

The species grows very well in altitudes ranging from 0 to 1200 masl, it attains a height of 40 m and a DBH of 3 m. It prefers profound medium-textured soils and tolerates a wide range of pH in these types of soils, from alkaline to lightly acid ones. It does not, however, tolerate ponding or high concentrations of aluminum (Cordero and Boshier, 2003).



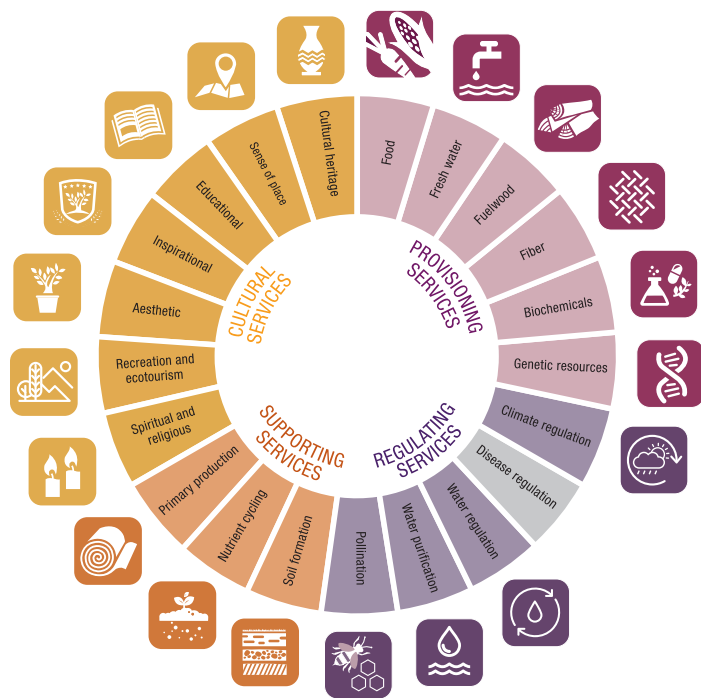
Photo: Aaron González Zúñiga.

MORE FREQUENT USES

The guanacaste fixates atmospheric nitrogen. It is often produced in open pastures to provide the cattle with shade, forage and nutritive pods with a high content of protein and starch. Its fruit is a wide, curved, flat pod. During the dry season, and due to its slow digestibility, it is a viable source of energy and protein for ruminants. Multiple studies have

shown that it can also be utilized to increase the content of solids and viscosity in food systems (Ivan *et al.* 2004; Jiménez-Hernández *et al.* 2011). When ripe, the seeds feature a hard, waterproof head. In different states of Mexico, they are used as food, either toasted, crushed or mixed. The mature tree's wood can be employed for construction, carpentry and the manufacture of crafts and furniture, and is also used as firewood.

ECOSYSTEM SERVICES



Source: Drafted based on MA 2003

Germination requires a pre-treatment which involves breaking its cover mechanically, when working with small batches, or immersing them in near-boiling water for 30 seconds, and then keeping them in water at room temperature for 24 hours for large batches. 1 kg of seeds is believed to contain between 800 and 2000 units (Cordero and Boshier, 2003).



Propagation

The seed must be planted at a depth of 1 to 2 cm with the micropyle facing downwards, and must germinate within three to four days. Its initial growth is quite fast and vigorous. The greenhouse must be located in a place with little shade. Planting can be done after three months, when the seedling has reached a height of 20 to 25 cm (Cordero and Boshier, 2003).



Planting

The guacanaste is a large, long-lived tree. When in open conditions, its trunk grows short and thick to support its broad branches and large top. It is not often found as a plantation, and individuals found on farms are usually remains from the natural forest. Although it is not commercially planted, the *E. cyclocarpum* is found experimentally in

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

Between the age of 15 and 25, the *E. cyclocarpum* produces crops almost every year. An adult tree can produce up to 2000 pods, each one with 10 to 16 seeds, which can be picked up from the ground at the end of the dry season. The seeds are manually extracted to be crushed and sieved.

Did you know that...



The name "guanacaste" means ear-shaped tree. It comes from nahuatlquauitl (tree) and nacaztil (ear). In the Costa Rica of yesteryear, dwellers used its fruits as soap to wash their clothes. The name has also been included in traditional tales (MEP 2018).

Guatemala, Honduras, Costa Rica and Panama. In order to improve the commercial shape and size of the trunk, narrow spaces of approximately 3x3 or 3x4 m must be used. It grows better in deep, medium-texture soils with a wide range of pH values (Cordero and Boshier, 2003).

Management

Plants are not very competitive in the field, and therefore a high level of moisture is needed for transplantation as well as permanent weeding. The trunk is managed by applying silviculture pruning practices (Cordero and Boshier, 2003).

Harvest shift and growth

Although the tree can grow well on plantations, this is not comparable with other timber-yielding species. The tree has been shown to grow better and faster in pasture conditions,

with DBH of up to 10 cm per year. On plantations, on the other hand, it displays a slow initial development; however, the process is accelerated when the tree reaches a dominant position and is able to grow a large crown.

At the age of eight years, the tree can reach a height of 8 to 15 m and a DBH of 8 to 12 cm. In Costa Rica, in the province of Guacacaste, a 2 cm mean annual increment (MAI) in DBH was observed at a height of 1.2 m, with a volume productivity of 9.2 m³/ha/year, in plantations of twelve years of age, with initial spacing and management of 3x3 m. On the other hand, in Progreso, Guatemala, in a plantation with loam soil with neutral pH at an altitude of 360 masl and in combination with maize, the MAI at three years was 1.1 to 1.3 cm DBH and featured a height of 0.6 to 0.8 m. However, in other locations, the species was unable to adapt to conditions established in experiments carried out in Honduras and Panama, where the growth obtained was far below expectations (Cordero and Boshier, 2003).

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El Salvador

MATILISGUAT

El Salvador has two official trees as national symbols: the rosy trumpet tree (*Tabebuia rosea*) and the balsamo (*Myroxylum balsamum*). Both were designated as national trees pursuant to an Executive Order decree published in the Official Gazette on July 5, 1939 (Decree No. 15, 1940). Following is a description of both species.

Scientific name: *Tabebuia rosea*

Common name: rosy trumpet tree, *matilishuat*

The *Tabebuia rosea* is a deciduous species from the Bignoniaceae family which widely occurs in tropical areas. It is native to Mexico, Central America and northern South America. It grows in tropical dry forests, lowland rainforests, mountain forests and abandoned agricultural fields (Cordero and Boshier, 2003).

GENERAL DESCRIPTION

T. rosea is a deciduous tree that is medium to large in size, measuring 28 to 37 m in height and 50 to 100 cm DBH. It presents a wide, open, irregular or conical crown. Its bark is dark gray, squamous and vertically fissured. Its leaves appear in opposite arrangement and are comprised of five leaflets. The bloom is hermaphrodite, measures 8 cm in length and is pink and purple to near white in color. It produces a dehiscent linear pod that contains 240 to 300 seeds each (Cordero and Boshier, 2003).

It is considered a secondary species in the mountain forests with great potential for use in ecological restoration of dry zones. It has been used as shade and its pink blooms make it very appealing as an ornament, hence its importance to attract tourists. It is also used in enclosed silvopastoral systems and as specimens scattered in the area, since several studies show its potential in agroforestry systems in general (Cordero and Boshier, 2003; Plath *et al.* 2011).

SOIL AND CLIMATE CHARACTERISTICS

Climate	Soils
Dry forest and low rain forest. Seasonal dry period of 0 to 6 months. Altitude of 0 to 1300 masl. Annual average temperature: 19-27°C. Annual precipitation: 1200 a 2500 mm/yr. The tree requires abundant light and a dry season to initiate blooming.	Sandy, alluvial. The plant can tolerate clay loam, poor, acid and infertile soils with occasional flooding, however when the latter conditions present, growth slows.

Source: Cordero and Boshier, 2003.



Photo: IICA El Salvador



Photo: IICA El Salvador

MORE FREQUENT USES

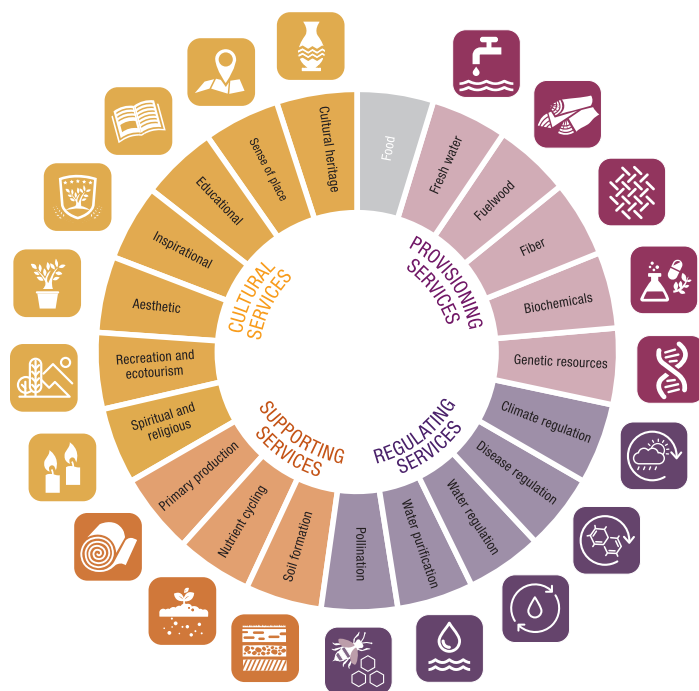
The wood from *T. rosea* is of good quality and high value for Central America. It is considered excellent to work on, since it results in an attractive finish and sheen and can be applied to a wide variety of uses. It is used extensively for making furniture and other lightweight objects such as boats and sporting equipment, in addition to flooring and cladding. Its sapwood is pale pink in color, while the heartwood is golden coffee or a dark tan brown in color. When the trees are sourced from mature forests it is possible to get good quality pieces of lumber 12-25 m in length and 25-70 cm in diameter, easy to dry and characterized by a strength similar to teak (*Tectona grandis*).

Moreover, its blooms make it one of the most attractive trees in Central America (Cordero and Boshier, 2003).

It is used in traditional Thai medicine since its bark possesses antimicrobial, anti-inflammatory, anti-bacterial, anti-fungal, diuretic and laxative properties (Sichaem *et al.* 2012). Several South American countries also use it for its medicinal properties.

The plant has been shown to perform adequately in the countryside, so it has been propagated through agroforestry systems. It possesses great potential as a species for ecological restoration projects in dry ecosystems (Cordero and Boshier, 2003).

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

The seeds are produced in quantities of approximately 42,000 seeds/kg. They can be collected from the tree pods or directly from the ground. The pods must be transported in sacks to

a covered spot where they can dry in the shade for three days until they open, after which the seeds are extracted manually. After extraction, the seeds must be exposed to the sun for 3 to 5 hours until they attain a humidity of approximately 7%. They must subsequently be stored at a temperature of 5°C (Cordero and Boshier, 2003).



Propagation

The seed germinates within 14-21 days without pre-treatment. If good seed is harvested they can be sown directly in bags, and when the plants attain a height of 60 cm or around 3 to 4 months of age, they can be transplanted to the field. If the objective is for the trees to serve as living fences then they can be propagated by way of stakes. It is recommended to control weed invasion while the species is taking set (Cordero and Boshier, 2003).



Planting

The tree has not been used frequently in pure plantations since, in the initial years, bifurcations occur. Moreover, as a monoculture it presents high mortality rates due to major outbreaks of pathogens. In this case, agroforestry systems are a good option, or planting with reduced spacing (Cordero and Boshier, 2003; Plath *et al.* 2011).

Did you know that...



Two national trees were declared in El Salvador, the Matilishuat being the more popular of the two.

Management

The tree tolerates a limited amount of pruning. Its blooms, which stand out as one of its uses, peak several weeks after the leaves fall off and during a dry period, and subsequently activate with rains (Cordero and Boshier, 2003; Pluemjit *et al.* 2018).

Harvest shift and growth

Its growth rate can be slow or fast depending on the location. It is estimated that in a suitable environment it can grow up to 9 m in around 3 years. At different locations in Central America (dry forest, pre-montane dry forest, rainforest) a growth rate of 0.7-2.2 m/annum in height, 0.8-2.6 cm/annum DBH and 0.5-4.0 m²/per annum in basal area was registered. On the

other hand, a DBH of 13 cm and height of 14 m was reported for 14-year-old trees located in silvopastoral systems along alleys. In Nicaragua, timelines of 30-40 years are expected on plantations with final densities of 150-200 trees per hectare (Cordero and Boshier, 2003).

Protection

No significant health problems have been reported in Central America. However, in Colombia, the *Prosopidium sp* and *Marasmiu ssp* fungi have been associated with infestation and rotting of the leaves. In Venezuela, the *Rhabdotale brasignata* sucks on the newer leaves, causing a yellowish stain that changes to dark brown, after which the leaf falls off. Nematode (*Melioidogyne sp.*) attacks on the roots have been reported during the nursery stage (Cordero and Boshier, 2003).

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BALSAMO

Scientific name: *Myroxylum balsamum*

Common name: *balsamo*, tolu balsam tree

The Tolu balsam tree (*Myroxylum balsamum*) is the second national tree of El Salvador. It grows wild in Mexico, across Central America and into the Amazon forest in Brazil and Peru, in addition to Bolivia (Cordero and Boshier, 2003).

SOIL AND CLIMATE CHARACTERISTICS

Climate

Low primary wet forest in evergreen jungles.
Seasonal dry season from 0 to 6 months.
Altitude of 100 to 700 masl.
Average annual temperature: 23-30°C.
Annual precipitation: 1300-4000 mm p.a.
It needs light or open spaces in the canopy in order to survive.

Soils

It prefers calcareous soils or soils derived from igneous materials, on hills or level, well drained areas; in other words, with a level to moderate slope, an alkaline pH and light to heavy texture. In Bolivia it occurs on relatively dry, poor soils.

Source: Cordero and Boshier, 2003.

GENERAL DESCRIPTION

The *M. balsamum* is a tree that in El Salvador attains a height of up to 30-45 m and up to 1 m DBH. It has a straight trunk, alternate imparipinnate leaves, alternate leaflets with translucent tips and veins, acuminate apices, papilionaceous flowers, samaroid fruit with one or two kidney-shaped seeds with a smooth seedhead and acuminate apices. Its rough, dark bark secretes a dark grayish colored sap that is subjected to a process of steaming to produce a pure balsam, commercialized under the name “black balsam” (Fuentes, 1993; Cordero and Boshier, 2003).



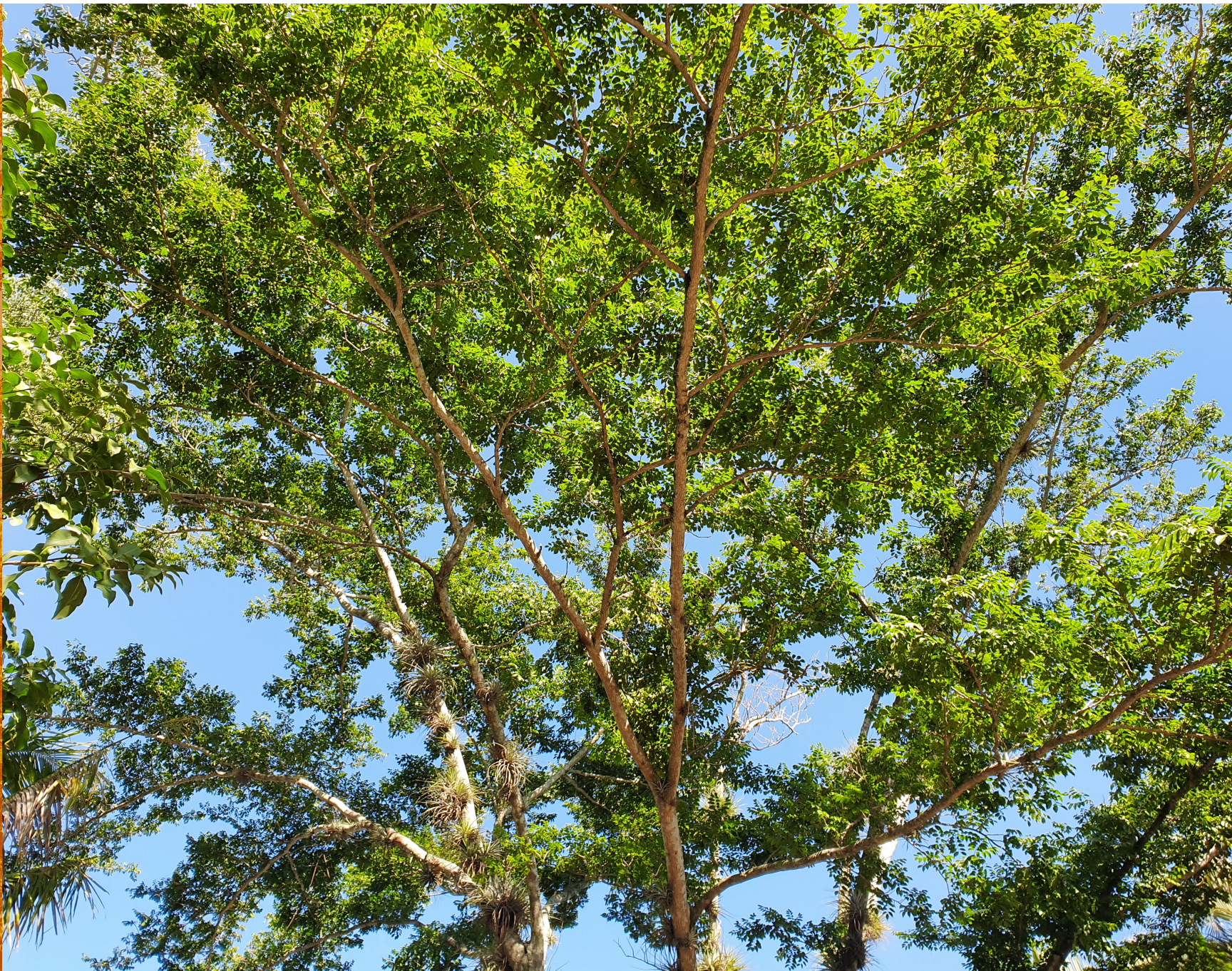


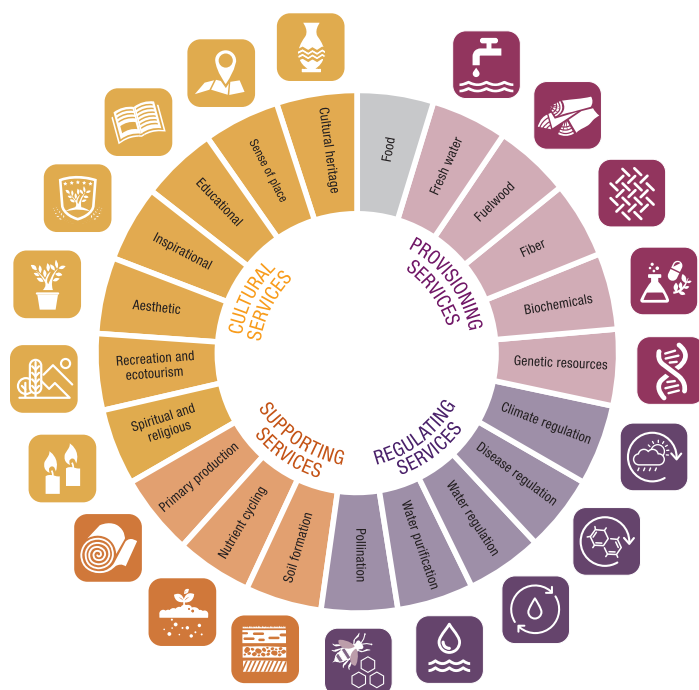
Photo: IICA El Salvador

MORE FREQUENT USES

Balsam tree wood is hard, resistant, heavy to very heavy (0.82-0.96 density) with a strong, pleasant aroma. There is no distinction between sapwood and heartwood, being dark reddish in color, sometimes with an attractive purple tint. Its texture is fine, so it finishes well. At first glance it resembles mahogany, but it is pinker. The grain is interlocked. Its wood is difficult to work, but it produces good results. It is free of silica and it is naturally highly durable with respect to insects and fungi. In Costa Rica, the lumber from this species has traditionally been used for fine woodwork, furniture, flooring,

shingles and laths. Currently there is a trend towards other uses such as the manufacture of decorative sheet wood, parquet floors, souvenirs and craftwork. In El Salvador, the wood has been used for tool handles and parts, wooden sleepers, axles for cart shafts and farming instruments, lightweight furniture (night tables, mantelpieces, toy boxes, corner pieces and shelving) and rural constructions. It also produces excellent quality firewood, and because of the quality wood, even small pieces can be exploited for other uses. In Nicaragua and Costa Rica, the wood is considered precious, of high quality, suitable for structures, cabinetry, bodywork, decorations, musical instruments such as guitars and marimbas, as well as residential and industrial floors, since it is very stable when dried (Cordero and Boshier, 2003).

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

Another important use is its resin as incense or as a medicinal substance. To extract the balsam, V-shaped incisions are made in the bark to collect the fluid in containers. Patches of bark are also removed and covered with a cotton cloth to absorb the liquid, which is then boiled and pressured to extract the balsam. The latter is yellowish brown in color, transparent and somewhat viscous, and it solidifies into bright crystalline pieces that have a pleasant aroma (Cordero and Boshier, 2003).

In Guatemala, its dried fruit is used for treating scabies, and in the Coban region it is customary to add its seeds to rum for a better flavor. Moreover, in many countries, this species is used for nitrogen fixation (Cordero and Boshier, 2003).

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

The fruit can be recovered from the ground or harvested from the tree when they change from yellowish-green to a clear yellow. In the forest, it has been observed that abundant germination of up to 80% occurs beneath the canopy of trees. In nurseries, germination rates of 60-75% have been

reported. Seed stored at ambient temperature retains viability for 6-12 months, while seed stored in rooms at 5°C and a 6-8% moisture content can be preserved for up to three years. It is estimated that 1 kg contains approximately 1600 fruits (Cordero and Boshier, 2003).



Propagation

Seed extraction is not practical, so the fruit can be sown in sand beds for transplant after 2-3 weeks, or directly in containers, whether these are bags or plastic propagation cell trays. The germination rate is normally high and quick in temperatures of 25-35°C. On occasion, there has been pretreatment by way of immersion in water for 24 hours or combined with a longitudinal cut in the fruit. Satisfactory results have also been reported from submerging it in water at 50°C for 5 minutes. The saplings emerge between 15-30 days and can be transplanted to the field at the end of 4-6 months (Cordero and Boshier, 2003).



Planting

The tree has largely been planted for ornamental purposes or at wide spacings in agroforestry systems, for example as shade for coffee. They have been tested in Brazil in more dense plantations

at 2 x 2 m, 1.5 x 3 m or 3 x 3 m, on fertile soils. Germination in the forest is abundant; however, fungi, insects and other pathogens cause the death of many of the plants. The few that survive suffer from lack of light, which is the reason for seeing few medium-aged specimens beneath the canopy (Cordero and Boshier, 2003).

Management

In establishment systems created through natural regeneration, it is crucial to open the canopy to allow light to enter and foster the establishment and growth of the plants (Cordero and Boshier, 2003).

Harvest shift and growth

The tree normally displays slow growth on plantations. In Minas Gerais, Brazil, when established at 1.5 x 3m, the trees attained a height of 0.4-0.7 m by 27 months of age. In this same location, when established at 3 x 3 m on more fertile soils, they attained a height of 2.3 m and DBH of 1.4 cm by 3 years of age. In Sao Paulo, when planted at 2 x 2 m the tree attained a height of 7.5 m and DBH of 6.2 cm by 14 years. When used as shade trees on coffee plantations, they have reached heights of 10 m in 10-12 years and 20 m in 25 years. In the forest, *M. balsamum* trees have been able to produce 1.5-2.5 kg of balsam p.a. for at least 30 years (Cordero and Boshier, 2003).

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Guatemala

CEIBA

Scientific name: *Ceiba pentandra*

Common name: *ceiba*, kapok

At the request of botanist Ulises Rojas on March 8th 1955, during the administration of Carlos Castillo Armas, the kapok was declared the National Tree of Guatemala. It was recognized as a symbol of the Guatemalan flora, to illustrate the pride of the country's Mayan roots (Prensa Libre, 2019). During the Spanish domination, it was planted in every square near the town councils (Universidad Galileo, n.d.).

GENERAL DESCRIPTION

Ceiba pentandra is a tree from the Malvaceae family (previously from the Bombacaceae family). It is believed to be a species native to Central America, and widely planted in the tropics. It is also found in South America, Africa and Asia in perennial deciduous forests, as well as in rainforests, dry and gallery forests. It can also be found in secondary forests, and shows good natural regeneration capacity as a pioneer species. In Central America, it is abundant in coastal flatlands up to 600 masl, although it tends to grow at higher altitudes (Cordero and Boshier, 2003).

This large tree normally reaches a height of 30 to 50 m, although it can grow up to 70 m, and features a DBH of 2 to 4 m. The trunk contains no leaves in the first 2/3 m of its total height. The lower part of the trunk shows well-developed buttress roots that can extend up to 8 m along the ground. The trunk and many of its young branches contain cone-shaped spines. The palmate leaves are divided into seven, and up to nine smaller leaflets measuring 10 to 20 cm. Its

flowers occur in fascicles (up to fifteen) or can also be axillary or solitary, and feature five yellowish white or pink petals. The fruits are dehiscent capsules of 10 to 15 cm which contain between 120 and 175 small, rounded black seeds measuring approximately 5 mm, wrapped in a grayish white cottony wool (Cordero and Boshier, 2003).

The kapok has become very popular due to its high potential for reforestation in degraded areas. It plays a significant role in the soil protection of dry forests due to its low nutritional requirements, high tolerance to competition and drought and its capacity for regeneration after forest disturbances. In South America, it has shown to have a better ability to establish itself in degraded soils with very low fertility and depth, when compared to other dry forest native species. However, in different parts of the world, its population is gradually dwindling (Bocanegra *et al.* 2018), for example, certain native populations of the Peruvian and Brazilian Amazonia that are facing the threat of intensive exploitation for the plywood industry (Brondani *et al.* 2003).



Photo: Leonel Jacinto

MORE FREQUENT USES

Although its wood is very light and soft, it is especially used for plywood sheets, boxes and packaging, and to a lesser extent, to build kayaks, tables and doors. In Costa Rica, it is used to manufacture plywood sheets for export, and in Honduras, for plywood and to build ships. Its price in Costa Rica has fluctuated over time: in 1985, the m³ was worth CRC 1848; between 1986 and 1987, it was CRC 2079; and in 1990, it cost CRC 4620 (Cordero and Boshier; 2003).

The wool obtained from the fibers of the fruit is the most important byproduct of this tree, 60% of which is glucose. This

SOIL AND CLIMATE CHARACTERISTICS

Climate

The kapok grows in tropical rainforests and dry forests with a dry season lasting less than six months.

It can adequately develop at an altitude below 600 masl, but can grow up to 1500 masl at an average annual temperature of 20 to 35°C and precipitations of 750 to 4000 mm per year.

The species needs plenty of sunlight and is highly sensitive to fires.

Soils

The kapok prefers alluvial soils with medium textures and neutral or slightly acid pH, although it has adapted to different types of soils. It does not tolerate waterlogged soils, only waterlogging during short seasons.

Sources: Cordero and Boshier, 2003; China Rivera, 1990.

makes it a suitable resource for the production of bioethanol (Tye *et al.* 2013). The wool is also used to manufacture seatbelts, mattresses, lifejackets and lifebelts, pillows and insulation.

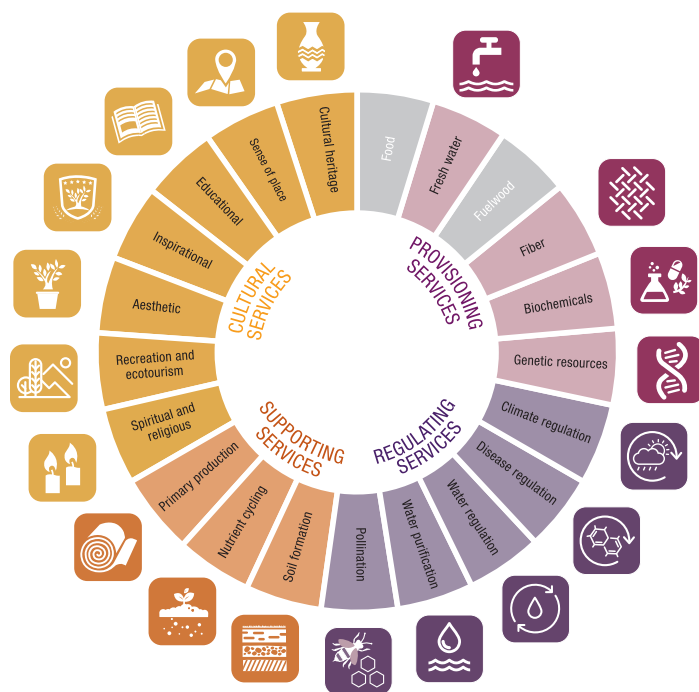
Its oil is used to manufacture soaps, for lamps and as cooking oil.

Furthermore, its leaves, which are used as forage, manure or mulch, have capsules that turn edible when tender.

According to studies that analyzed the characteristics of the kapok's bark fibers, they are an excellent alternative to synthetic fibers in polymer matrix composites due to their optimal levels of cellulose, hemi-cellulose and lignin (Kumar *et al.* 2017).

The flowers, bark and seeds have a wide range of medicinal properties. In Guatemala, the bark is crushed and boiled to wash wounds and stop hemorrhages, and in Costa Rica, as a treatment for hemorrhoids. Besides, it is macerated to be used as a diuretic, to stimulate breast milk production and to treat malaria and gonorrhea. An infusion made with its flowers is used to relieve constipation. The young flowers and fruits are crushed and used to treat vertigo and headaches (Cordero and Boshier, 2003).

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

The collection of the seeds or the fruits must take place between March and April, when the capsules mature and turn brown. They must then be sundried for two or three days for periods of three to four hours. Once they open, the seeds are extracted and the wool is separated by hand or by using a sieve. Between 7,000 and 45,000 seeds/kg are extracted, and one tree can produce up to 1 kg of seeds. When fresh, the seed has a germination percentage of between 90 and 95%. It is an intermediate seed, since it cannot be stored for long periods of time due its oil content. It is best to soak it in cold or tepid water for 24 hours or in boiling water for 5 minutes before planting it (Cordero and Boshier, 2003).



Propagation

The seed is planted 1 or 2 cm into the ground and germinates 8 to 21 days afterwards. The seedlings must be placed under a light shade until they reach a height of 12 to 15 cm. Later, the shade is removed and the seedlings are exposed to the sun so that they can harden and be ready to be moved into the field, once they reach 30 to 60 cm in height over a period of four to seven months (Cordero and Boshier, 2003).



Forest plantation

In plantations used for wool production, a distance of 3 x 3 m is recommended. After the thinning process, this will result in a final density of 156 trees/ha. There are plantations with economic significance in Colombia, Venezuela, Ecuador,

Mexico, Malaysia, Indonesia, West Tropical Africa and the Caribbean (Cordero and Boshier, 2003).

Management

Ceiba pentandra is a demanding species in terms of light and weed competition; its maintenance is therefore essential. During the first stages of its growth, it is very tasty for ruminants, which is why they must be kept far away from the tree (Cordero and Boshier, 2003).

Harvest shift and growth

Wool production takes place in shifts of 30 to 45 years. Three-year old trees produce 150 to 300 kg/ha; when they reach the age of eight, this increases to 800-1600 kg/ha; finally, mature trees produce between 2000 and 4000 kg/ha. Approximately 200 fruits are required to harvest approximately 1 kg of wool. With a spacing of 8 to 10 m, in rows, trees can reach 5 m in height in 5 years. In Costa Rica, twelve-year old plantations with a spacing of 2 x 2 m and a survival rate of 44% produced a mean annual increment of 2 cm in DBH and 0.9 cm in height,

with an estimated productivity of 22.8 m³/ha/year (Cordero and Boshier, 2003).

Protection

Once it is cut, the wood can be quickly affected by different bark beetles. It is also prone to blue-stain fungi and rotting, hence it is essential to quickly transport it outside the logging area. It is vulnerable to fire, environmental damages and attack from different fungi (*Armillaria mellea* and *Fomes lignosus*) (Cordero and Boshier 2003).



Did you know that...

For the Mayas, the kapok tree supported the entire universe. According to this belief, the branches are in the sky, the trunk is where we live and the root is in the underworld. Owing to its richness, it is considered a symbol of wisdom and protection. (Prensa Libre 2019).

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Honduras

OCOTE PINE

Scientific name: *Pinus oocarpa*

Common name: ocote pine

The *Pinus oocarpa* species, commonly called ocote pine, was declared the national tree of Honduras by the President of the Republic, pursuant to Agreement No. 429 of 1928, for being the most abundant pine species in the country.

GENERAL DESCRIPTION

Pinus oocarpa, commonly known as ocote, is the most common pine tree of Mesoamerica. Its distribution covers the north of Mexico all the way to northeast Nicaragua. It commonly grows at altitudes ranging from 200 to 2500 masl, but reaches optimal development at between 600 and 1800 masl. It is the dominant species in pine forests in countries like Honduras, Guatemala and El Salvador. Owing to its vast range of distribution, it cannot be categorized as belonging to one single climate type; however, it can be described as a pre-montane habitat species that grows on the side of steep mountains with good drainage (Schwarz *et al.* 1991; Farfán-Valencia and Urrego, 2004; De Waal *et al.* 2017).

The species forms pure stands that are often associated with oaks (*Quercus* spp.) or other pines. Although it is not considered an endangered tree, the increasing number of fires has threatened its regeneration and productivity (Cordero and Boshier 2003; Farfán-Valencia and Urrego, 2004; Dvorak *et al.* 2009)

The ocote pine is considered a pioneer species that regenerates naturally and adapts to the erosion and to sandy, rocky soils with acid to neutral pH; however, it does reach optimal development in deep soils. Its presence in forest ecosystems largely depends on the frequency and intensity of the fires. It is used in plantations to control erosion and is suitable for soil recovery due to its capacity to grow in infertile areas (Farfán-Valencia and Urrego, 2004; Dvorak *et al.* 2009).

The tree can reach 45 m in height and a DBH of up to 1 m, with a straight, cylindrical shaft. Its crown is irregular, with fine, relatively sparse branches. Its bark features many cracks and may be dark red or grayish. Its needle-shaped leaves are upright, thick and coarse, with finely closed borders. Its terminal inflorescences appear in the upper part of the crown. The fruits are heavy and strong with an ovoid, globular shape. They measure 5 to 10 cm in length and have a lustrous, dark brown color, with ligneous flakes, and occur in groups of two or three. Its small seeds measure 4 to 7 mm in length, they are triangular and of a dark brown color, and feature a membranous wing measuring 10 to 12 mm in length (Cordero and Boshier, 2003).



Photo: Guillermo Detlefsen

MORE FREQUENT USES

The ocote pine wood is moderately heavy (0.42-0.60 g/cm³). Its heartwood is pale brown with a creamy yellowish sapwood. Its growth rings are clearly visible, which is why it has a very marked grain. Its resin has a very distinctive smell. The wood can be conserved with any method and is easy to dry, saw and work with (Cordero and Boshier, 2003). It is used to construct floorings, walls, doors and interiors, and to manufacture a wide array of boxes, sheets, decorative objects, toys, crafts and furniture. The resin is used as raw material to produce cosmetics, ornaments and medicines (Cordero and Boshier, 2003). The timber is exported to the United States in large amounts, where the best quality wood is used to manufacture furniture and boards and the rest is used for plywood or to extract its pulp (Ferro *et al.* 2018).

Pine is the second most important forest species in countries like Brazil, where the majority of its production is focused on cellulose pulp. The highly resinous heartwood is utilized in the production of high-quality turpentine and colophony. It has

SOIL AND CLIMATE CHARACTERISTICS

Climate	Soils
<p>The ocote pine tree grows in the pre-montane rainforest and the pre-montane dry forest, with a dry season of five to six months, at an altitude of 600 to 1800 masl, with an annual mean temperature of 13 to 23°C and precipitations of 650 to 2000 mm/year.</p> <p>It is sometimes found in areas where precipitations are 3000 mm/year.</p> <p>The tree requires a lot of sunlight and needs a dry period to begin flowering.</p>	<p>It adapts to eroded, sandy, rocky soils with a pH ranging from acid to neutral. It reaches optimal development in deep, well-drained limestone clayey soils and sandy soils. It cannot grow in floodable soils.</p>

Source: Cordero and Boshier, 2003.

been successfully planted due to its high growth potential in areas with low fertility (Ferro *et al.* 2018; Schwarz, 1991).

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

The fruits are of a greenish brown color, and must be collected while still closed. They must be transported in jute bags and removed to be evenly

dried out over a period of three to five days, three to four hours per day. When they open, the cones are beaten to extract the seeds, which feature wings that must be removed by gently rubbing them between one's hands. They are then stored in airtight containers for five to ten years at a temperature of between 3 and 4°C and a humidity of 6 to 9%. If stored at room temperature, they are viable for 4 to 6 weeks. 1 kg of fruit is estimated to contain between 40,000 and 78,000 seeds (Cordero and Boshier, 2003).



Propagation

The seeds do not need any pre-germination treatment, but if germination needs to be expedited, the seeds can be soaked in water for 12 to 24 hours before planting. They can be cultivated in sandboxes and then transplanted into bags, using a substrate of three parts soil, one part sand. It is essential to inoculate the substrate with mycorrhizae to obtain proper development of the seedlings. It can be used on the topsoil of a well-established pine forest by mixing it with the substrate in the bags. Germination occurs seven to fifteen days later. The pricking out must take place when the seedling reaches a height of 3 to 4 cm. After transplantation or germination, the plants must be placed in a shaded area for the first few days. After five to seven months, the plants reach a height of 20 to 25 cm (Cordero and Boshier, 2003).

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.



Planting

In pure plantations, a spacing of 3 x 3 m is usually applied. In plantations used for pulp or firewood production, this spacing decreases to 2.5 x 2.5 m. There are small-scale plantations in Costa Rica, and trial plantations in tropical and sub-tropical countries (Cordero and Boshier, 2003).

Management

For the first two or three years, weed control is essential, since the tree grows slowly. In lumberyard plantations, pruning is vital to improve the quality of the shaft, since the species does not self-prune. A thinning process for cleaning purposes is recommended at the age of 6-8 years, because this is when the canopy closes; afterwards, a thinning of 30-50% every five to six years is advisable until the best 250-400 specimens/ha are obtained (Cordero and Boshier, 2003).

Harvest shift and growth

In natural stands, the growth rate is 3 to 4 m³/ha/year; however, in poor soils and/or at altitudes below 900 masl, this rate can be 1 m³/ha/year. For the first ten years, the species shows an annual average increase in height of 1.5 m, and can grow 10 to 18 m³/ha/year. Rotation shifts are 23 to 30 years (Cordero and Boshier, 2003).

Protection

The terminal buds of young plants are attacked by the *Rhyacioniasp.* moth. Moreover, in Nicaragua, Honduras, Guatemala, Mexico and Belize, the species has been attacked by bark beetles (*Dendroctonus* sp.). Its heartwood can resist the attack of termites and withstand inclemency, but its sapwood cannot (Cordero and Boshier, 2003).



Did you know that...

The common name "ocote pine" comes from the Nahuatl word "octl", which means torch. In ancient times, its wood was used as fuel to cook food (Cordero and Boshier, 2003).

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Nicaragua

MADROÑO

Scientific name: *Calycophyllum candidissimum*

Common name: degame, madroño, palocamarón, lemonwood

GENERAL DESCRIPTION

The degame is considered a pioneer species and one of the most commonly occurring in the degraded seasonal dry forest of Central America. This tree, whose canopy is pollinated by insects and dispersed by the wind, occurs naturally from the south of Mexico, across Panama, up to the northern part of South America, and it is produced in the Greater Antilles. It can be found in the transitional zones of tropical rain forests, where precipitation values range from 800 to 2000 mm per annum. It also forms part of the upper canopy of the tropical dry forest. The tree occurs at altitudes ranging from 0 to 900 masl, with average temperatures greater than 26°C (Cordero and Boshier, 2003; Lara *et al.* 2017).

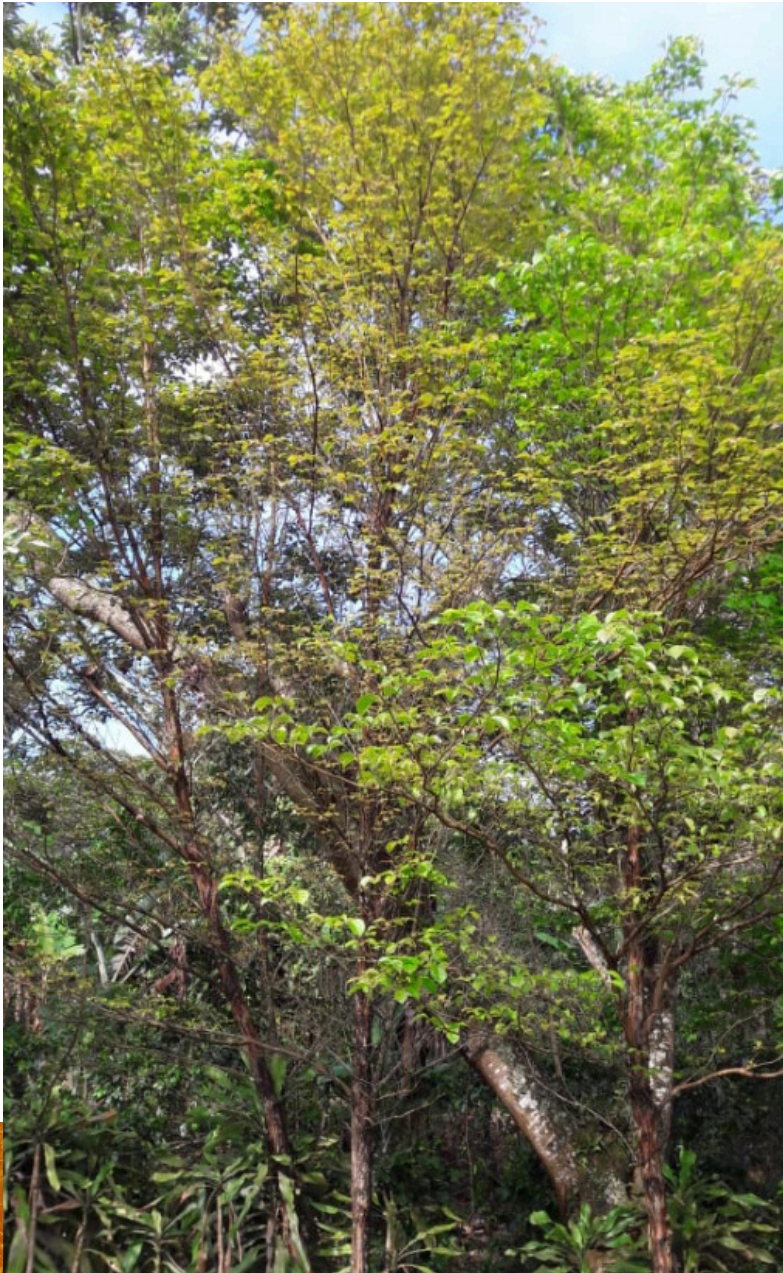
In Nicaragua especially, the degame is one of the most common species to be found in the seasonal dry forests, and it covers a large part of the original vegetation zone of the country's dry forest. It grows especially along shady hillsides and watercourses in secondary and/or riparian fragments of the forest (Lara *et al.* 2017).

According to a study conducted on the Santa Rosa sector, in the Guanacaste Conservation Area, Costa Rica, the degame was the dominant species in the late successional stage of the dry forest, which is characterized by the occurrence of deciduous species that are tolerant of shade (Kalacska *et al.* 2004).

The *Calycophyllum candidissimum* is the National Tree of Nicaragua (Law No. 1891 1971). It is a species that forms part of Nicaraguan religious traditions since its blossoms, which bloom from November to January, coincide with the celebration of the Immaculate Conception and are used to adorn altars (Barrance *et al.* 2003).

The *C. candidissimum* frequently attains a height of between 15 and 20 m, even up to 30 m. It usually features DBH of 50 to 60 cm, with a straight stem bare of branches for up to 55% of its height. The crown is stratified, with horizontal branches. Its bark is reddish brown, scaly with fine fissures and it detaches longitudinally in long thin reddish strips. Its leaves are simple and opposite in arrangement; they are grouped densely at the end of the branches and measure between 5 and 20 cm in length, and 1.5 to 11 cm in width. The leaf has a full edge, green on the surface and light green on the backside, with distinct veins. The blossoms are creamy white, measuring 1 to 1.5 cm in diameter and occur in groups of terminal panicles measuring between 4 and 13 cm in length. The fruit are characterized by an elliptic or cylindrical capsule between 6 and 10 mm in length which contains the seeds, which are small, wing-like and brown in color (Cordero and Boshier, 2003).

The duramen is dark to yellowish brown, more or less veined, and the sapwood is of a similar color, making it difficult to distinguish. The wood is odorless and tasteless. It is hard, heavy, strong and resistant, with a fine, uniform texture. When it dries it develops cracks and kinks; it is that recommended that drying be done in the shade and in well ventilated places. It presents a low resistance to insects and rotting. It is moderately difficult to work and shape with a lathe and it is not easily split (Cordero and Boshier, 2003).



SOIL AND CLIMATE CHARACTERISTICS

Climate

Dry forest
Low-lying zones with dry periods of 3 to 6 months
Height from 0 to 900 masl
Annual precipitation of 800 mm

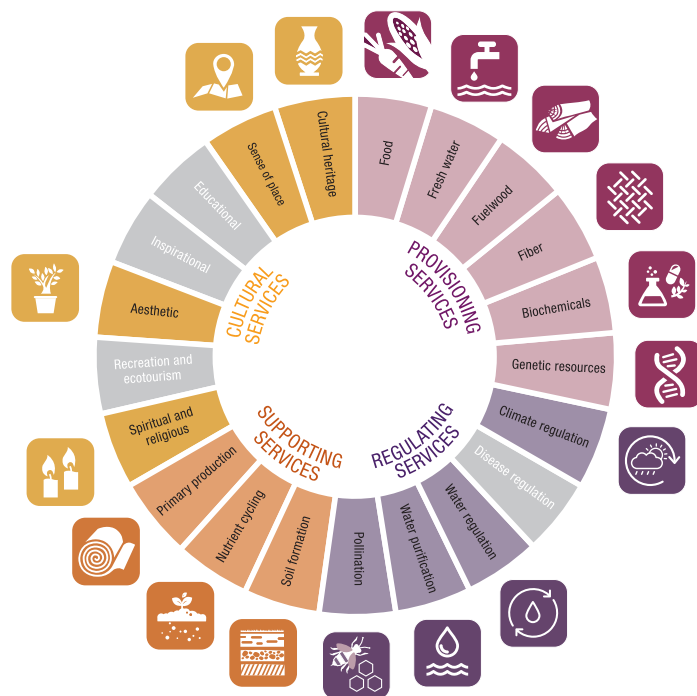
Soils

Good drainage with medium texture and a neutral or alkaline pH.

Source: Cordero and Boshier, 2003

Photo: Félix Pozo

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

MORE FREQUENT USES

The degame is used in different parts of Central America for the construction of wood slats, luxury flooring, end pieces, tool handles and fine combs, and it is also used in carpentry and joinery. It is exported to the United States, especially for the manufacture of hunting and sports accessories such as archery bows and fishing rods. The wood can bend without breaking and is considered the best option for sculpting and carving. Moreover, it is used as firewood and coal (Cordero and Boshier, 2003).

The bark possesses medicinal properties against diarrhea and it acts as a febrifuge when prepared as a decoction. In

Guanacaste, Costa Rica, it is used to relieve kidney pain and to eliminate gall bladder stones. In Mexico, its blossom is used to prepare an infusion against diarrhea (Cordero and Boshier, 2003; Kaiser, 2007).

In the Pacific south of Nicaragua, where the degame is used as a source of shade on coffee plantations, it is recommended that this tree be combined with crops of beans, maize and green manure such as the *Mucuna* spp. and *Cannavalia* spp., or to use it as a hedgerow or boundary. On plantations where the trees are cultivated for firewood, the pruning of low branches and thinning of trees are recommended in order to arrive at a density of 3000 to 4000 trees/ha. In other parts of southern Nicaragua near the border with Costa Rica, the degame is used as an ornamental tree, or can be found scattered in pastureland (Cordero and Boshier, 2003).

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

The fruit must be harvested between April and May, when it is greenish brown in color; to do this, the branches must be cut directly from the tree. The branches are transported in jute sacks and left exposed in the sun for one or two days during periods of three to four hours. When the fruit opens, the seeds are extracted manually. About 0.8 to 3.2 million seeds per kilogram are harvested (Cordero and Boshier, 2003).



Propagation

No pre-germinative treatment is required for the seeds. They can be sowed in furrows or in boxes, with germination starting within eight to fifteen days. The plants can be transplanted to bags when they attain a height of 3 to 5 cm. The plant nursery must be kept in the shade for the first

month, after which it can be slowly reduced until they are exposed to full sunlight. After six months, the saplings will attain an appropriate height for transfer to the field (Cordero and Boshier, 2003).



Planting

Since the plant has been used as an ornament, there is a lack of experience in cultivating it on plantations; nevertheless, the plant should normally be transferred to the field once it reaches a height of 30 to 40 cm. Since its growth is slow, care must be taken during the first three years with regard to the appearance of weed around the plant, and the plantation must be protected against livestock and fire. Where plantations are geared toward the production of firewood, a distance of 2 x 3 m, 2.5 x 2.5 m or 3 x 3 m is suggested. If it is

being used as a boundary or hedgerow, a spacing of 2 to 3 m between trees is recommended. Sowing can be done using the triangle technique (Cordero and Boshier, 2003).

Management

It is recommended that the lower branches be pruned in the third and subsequent years, in addition to intermediate thinning to create a density of 300 to 400 trees per hectare (Cordero and Boshier, 2003).

Schedule and growth

In Nicaragua, logging is estimated at every eight to ten years for plantations whose purpose is to produce firewood, while for those geared toward producing lumber, felling is estimated at every 25 to 30 years (Cordero and Boshier, 2003).

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Panama

PANAMA TREE

Scientific name: *Sterculia apetala*

Common name: Panama tree

According to Rodríguez (2007), the Panama tree was declared a national tree by Cabinet Decree No. 371 of 26 November 1969 and the name of the country is considered to have been derived from this.

GENERAL DESCRIPTION

The *Sterculia apetala* is a deciduous tree, between 15 to 40 m in height, with grouped horizontal branches in the upper level. It occurs from southern Mexico through Central America down to Brazil, Peru and Bolivia. It can be found in the southeast tropical forests of Mexico and the warm areas of Venezuela and Bolivia. In countries such as Guatemala in Central America, the tree grows between 0 and 300 masl and it occurs abundantly on the Pacific side of Nicaragua (Cordero and Boshier, 2003; Dvorak *et al.* 2018).

Although its natural occurrence is generalized, it rarely presents as the dominant tree species. It is normally a medium-sized tree that can attain a height of 50 m when it occurs on fertile soils in moist ecosystems. In its mature state it presents a smooth greenish white bark, a wide extended crown when cultivated freely, and a drooping stem near the base of the tree (Dvorak, 2018).

Due to its wide geographical distribution in the neotropical region, it is not considered an endangered species; however, small populations of the tree where it occurs have been destroyed as a result of the replacement of native forests with commercial crops such as pastureland for livestock (Santos *et al.* 2013).

In Panama and the Caribbean, the tree is planted for ornamental use. According to trials conducted in Colombia and Venezuela, the tree performs well and grows quickly (Cordero and Boshier, 2003).



Photo: Ariel Rodriguez-Vargas

SOIL AND CLIMATE CHARACTERISTICS

Climate	Soils
Dry forest Four to six months dry season Average annual temperature of 23 to 25°C Annual precipitation from 800 to 3000 mm	Deep, lateritic soil, varied texture, acid to neutral pH, with good drainage and flat sloped undulating surface

MORE FREQUENT USES

The wood of the Panama tree —moderately light, very soft and spongy, with a reddish duramen and yellow sapwood— is generally used in construction, the building of treated fence posts, in carpentry, furniture making, for shade and firewood, and in the production of honey (Cordero and Boshier, 2003). It is also used for manufacturing canoes, moulds, packing boxes, matches, medical spatulas and plywood.

Its seeds are edible when cooked or boiled and its flavor can be compared to that of cashew and peanuts. They can also be ground to taste like chocolate (Herrera *et al.* 2014). Monkeys eat the seeds in their natural environment. Moreover, in view of the seeds' high oil content they are used to grease machine parts, make watches and manufacture soap.

Did you know that...

The name of the Panama tree derives from the Latin *stercus*, which means excrement, due to the characteristic smell of its leaves and flowers. It belongs to the *Sterculiaceae* family, like the cocoa tree (Rodríguez, 2007).

It has been found that they contain a large quantity of polysaccharides with possible applications as a thickener in the food and pharmaceutical industries, to increase the viscosity of aqueous systems and as a stabilizer or emulsifier (Pérez *et al.* 2013).

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

S. apetala possesses medicinal properties. Its bark and leaves are used to prepare infusions to treat chest conditions and colds, and, in the form of a decoction, to cure rheumatism. Its flower is boiled to produce a liquid for drinking to treat coughs, insomnia, bronchitis, flu and asthma. Moreover, substances have been discovered in its roots that can serve as raw material to manufacture cortisone, a compound commonly used to combat arthritis and rheumatism (Rodríguez, 2007).

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

The time to harvest is when the fruit opens, since the seed remains trapped inside the fruit and this facilitates harvesting. The fruit must be harvested directly from the tree since insects will rapidly eat it if it falls to the ground. The fruit is covered with an abundance of very fine, erect hairs that can pierce the skin, so it is important to wear goggles, respiratory filters and gloves while harvesting, drying and cleaning (Cordero and Boshier, 2003).



Propagation

Fresh seed presents a germination rate of around 75%, which begins 18 to 25 days after sowing. They can be planted in beds or directly in bags; shade is recommended during the initial months. They must spend five months in a nursery (Cordero and Boshier, 2003).



Planting

The tree is cultivated for ornamental purposes only, since its wide, elegant crown provides shade. Experimental parcels of land have been established in countries such as Venezuela and Colombia. In Central America single isolated trees can be found on boundary lines, along roads and on pastureland, where they are maintained to provide shade to livestock. There are not many plantations since demand is not significant, even though in countries such as Colombia there is growing interest in the tree because of its good performance and rapid growth in dry areas (Cordero and Boshier, 2003).

Management

There is not a lot of experience or information in terms of its management.

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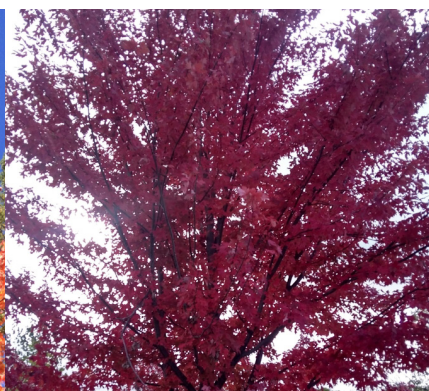
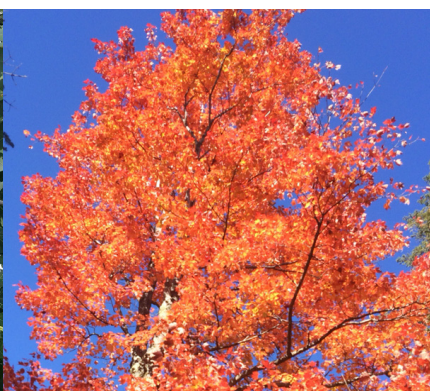
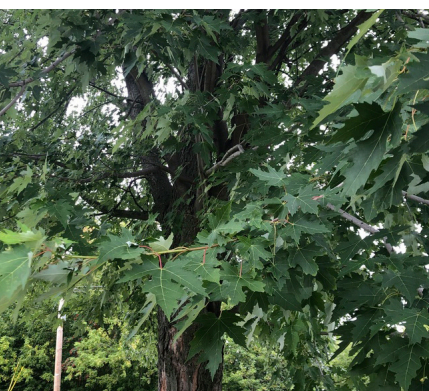
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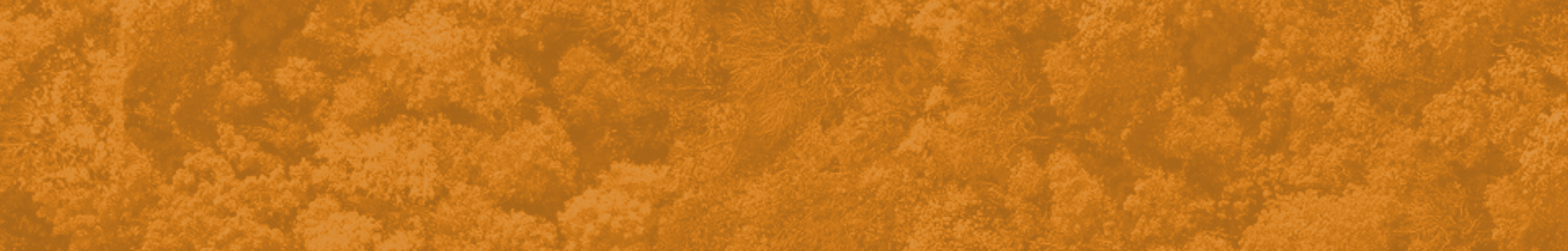
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Canada
United States of America
Mexico

NORTH REGION



Canada

MAPLE

Scientific name: *Acer* spp. (with ten native species in Canada)

Common name: maple

The maple tree leaf is known both locally and internationally as the representation of the Canadian people and a symbol of its natural wealth and national identity. This tree also constitutes a relevant, environmentally sustainable engine for economic activity in Canada. For these reasons, it was declared Canada's Arboreal Emblem in 1996 (Government of Canada, 2020).

GENERAL DESCRIPTION

Acer spp. (maple) is one of the most abundant hardwood trees in Eastern North America. Its area of distribution is located at latitude between 35° and 48° degrees north, from the state of Tennessee, USA, to Quebec, Canada. The species is not present in the higher altitude areas of the Appalachians. It is one of the dominant forest species in communities located on riversides, lake shores or next to stagnant water streams. It occasionally grows near ponds, in ravines and small, slow-draining depressions. Although in general it cannot compete with other species in highland environments, maple seedlings can survive long periods of flooding in lowlands, where inundations are among the factors determining the composition of individual growth stands (Burns and Honkala, 1990).

The maple with the widest distribution in Canadian territory is the silver maple, which can be found on stream banks, feeding plains and lakeshores, where it achieves optimal growth on alluvial, moist soils with good drainage (Burns and Honkala, 1990).

The main product of maple is its syrup for human consumption. The maple syrup industry supports thousands of farmers and offers permanent services and seasonal income for local farms and indigenous communities that have historically used maple for their own consumption and for trade purposes. Over the last decade, the production of maple syrup is estimated to have grown by 10% in the United States, with prices remaining high and stable due to market concentration and supply management in Quebec (Rapp *et al.* 2019).



Photos (left to right): margauxkaz, iNaturalist; Shannon, iNaturalist; christian6668, iNaturalist; Jessica West, iNaturalist; A.R., Flickr; spresogna, iNaturalist; Charlie Hohn, iNaturalist; Deborah, iNaturalist; Tom Norton, iNaturalist; Anthony Pelletier, iNaturalist; allysonsovis, iNaturalist.

SOIL AND CLIMATE CHARACTERISTICS

Climate	Soils
<p>For silver maple: total annual rainfall: 810-1520 mm; average annual snowfall: 0-2540 m; average duration of the frost-free period: 120-240 days.</p> <p>The tree is not found in high mountain areas with colder weather. In the driest regions, its area of distribution is limited to high-moisture water banks (Burns and Honkala, 1990).</p>	<p>Brown podsols and inceptisols for silver maple trees, but the species is more often found in areas with alluvial inceptisols and mollisols. It grows better in moist soils with good drainage. At times, the silver maple can grow in low pH soils (2.2 to 2.3) or in shallow peat (histosol), but is generally not found in areas where acidity falls below 4.0 (Burns and Honkala, 1990).</p>

Source: Burns and Honkala, 1990.

MORE FREQUENT USES

Maple honey or syrup is a natural sweetener obtained from the tree sap. It is mostly extracted from the species *A. saccharum* and to a lesser extent from *A. rubrum* and *A. nigrum* (N'guyenQuang *et al.* 2018). The product is part of the cultural tradition and local economic activity of the entire northeast of Canada and the United States (Rapp *et al.* 2019).

Its wood, known in the market as hard maple, has economic importance in the states of the Great Lakes region, both in Canada and the United States. It is utilized to manufacture veneers, sawn timber, floors, pallets, pulp, fiber and firewood (Kaminski *et al.* 2019).

The composition of the sap is the result of a complex system involving tree metabolism and microbial activity during the

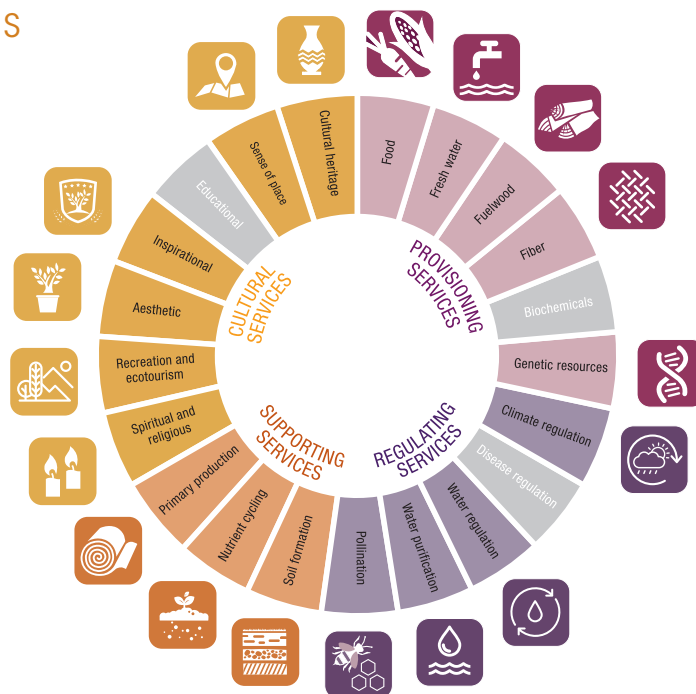
Did you know that...



The maple tree was declared the National Tree of Canada at the Government House in Ottawa on 25 April 1996, in what marked the forty-fifth year of the reign of Queen Elizabeth II (Government of Canada, 2020).

process of collection and transformation. Furthermore, the *A. saccharum* constitutes a vital link in the food chain of the squirrel population, and also plays a key role as a source of food for beavers (Burns and Honkala, 1990).

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

Forest plantations



Seed

The maturation and propagation of seeds begins in April and ends in June. The number of seed-filled fruits/kg is between 1980 and 7050, with an average of 3920. Seeds do not require pretreatment for their germination, and are capable of germinating immediately after maturity. Silver maple seedlings require between 2000 and 2500 hours of cold treatment to break dormancy (Burns and Honkala, 1990).



Planting

Sowing will prove more successful when on moist soils with a considerable amount of organic matter. In the first year after planting, seedlings can grow

between 30 and 90 cm, and if not liberated, can have a high mortality rate. Their capacity to deal with temporary flooding gives them the advantage of competing with other species for space. When planted for ornamental purposes, trees grow vigorously under a wide range of climatic factors (Burns and Honkala, 1990).

Management

The physical mechanism of the sap flow is primarily based on temperature. This is very important when managing the production of maple syrup. Fluctuations, which are strongly tied to inter-annual climate variability, and the overall performance, will respond to climate changes occurring in the area of distribution of sugar maple trees (Rapp *et al.* 2019).

In the North, high quality wood was found in lesser amounts than in the Northwest of North America. The quality of existing hardwood trees has been studied mostly in southern areas (Guillemette and Bédard, 2019)

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United States of America

OAK

Scientific name: *Quercus* spp.
(with 30 native species in the United States)
Common name: oak

The *Quercus* genus, popularly known as oak, is the National Tree of the United States of America. The most recent constitutional amendments regarding the designation of the oak as the National Tree were issued by decree by the Senate and the Chamber of Representatives on April 10th, 2003 (Bill No. S.860. 2003). Given that no species in particular has been defined as the national tree of the country, this section will make reference to the red oak (*Quercus rubra*), one of the most widely distributed trees in the country, especially in humid areas.

GENERAL DESCRIPTION

The species in the *Quercus* genus are predominant in the 95th meridian, and spans about 28 – 48° N in latitude, in the ecosystems of the deciduous hardwood forests of eastern United States. They cover the region delimited by central Maine to the north of Minnesota, and the central north of Florida to the east of Texas. Although these woods are estimated to be home to approximately 30 different species in the *Quercus* genus, the most predominant ones in the eastern biome are *Q. alba*, *Q. velutina*, *Q. rubra*, *Q. prinus*, *Q. stellata* and *Q. coccinea* (Abrams, 1996).

According to Burns and Honkala (1983), the large variety of climate, soil and topography results in very different compositions of the oak stands. The white

oak (*Q. alba*), the northern red oak (*Q. rubra*) and the black oak (*Q. velutina*) are the most representative species of the rainforest. Other common types of oaks in drier areas are the scarlet oak (*Q. coccinea*) and the chestnut oak (*Q. prinus*).

The wooded area with oaks and hickories alone occupies nearly 46,100,000 ha of the commercial forestry areas located in eastern United States, more than any other type of forest in the county (excluding the Alaskan woods). It is found along the prairie borders from the north of Texas to the Dakotas, to the east, throughout the central states and the region of the Appalachians, all the way to the south of New England, and from the hardwood transition area from north to south, up until the Piedmont plateau and the coastal flatlands (Burns and Honkala, 1983).



Photo: PIXABAY.COM

SOIL AND CLIMATE CHARACTERISTICS

Climate	Soils
<p>Hardwood forests grow in temperate climate conditions, within an average range of 16°C in the summer in the upper Great Lakes, to 18°C in the northeast and more than 27°C in the south.</p> <p>Annual precipitation varies significantly according to latitude and longitude, increasing from west to east and from north to south, from a minimum of 430 mm in North Dakota to a maximum of 1400 mm in Louisiana (Abrams, 1996).</p>	<p>Eastern forests feature a wide variety of soils. In the northeast and the states of the Great Lakes region, young soils are predominant, including inceptisols and spodosols, which are generally acid and have materials laid down by wasting glaciers.</p> <p>In the southeast, profound, sandy soils with scarce availability of water and nutrients are predominant. In the Atlantic area, alfisols can be found. These soil and climate differences affect the distribution and dominance of the species (Abrams, 1996).</p>

Source: Abrams, 1996.

MORE FREQUENT USES

In the United States, the *Quercus* is the most important deciduous genus form an economic, ecological and cultural perspective. Its wood has been used throughout the history of humanity for different purposes including construction, extraction of tannins and other components for the manufacture of furniture, interior moldings, floors and wine barrels. It also provides environmental services, such as the protection of water basins and of the habitat of wildlife species. The tree is also used for food and ornamental purposes. As a result, many oak species are planted extensively for a wide range of applications (Burns and Honkala, 1983).

The northern red oak offers a wide range of ecosystem services: protection/stabilization of soils, carbon sequestration, wildlife

Did you know that...



The natural reproduction of oaks largely depends on seed dispersion (acorns) carried out by squirrels and field mice, which store and bury these nuts for feeding purposes (Burns, 1983).

habitat (birds, mammals, rare insect species), shelterbelt, wind protection (flat areas, continental sand dunes) and fire protection (pine regions). It is often planted in public parks and gardens for ornamental purposes.

ECOSYSTEM SERVICES



Source: Drafted based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

Forest plantations



Seed

Within the same species and in the same forest, the production of acorns differs significantly between years, species and trees. In certain years, the seeds of some of the species fail completely, and in many cases the birds, insects and other animals eat most of the acorns. During the first year, germination and survival of the seedlings improve when the acorns are buried approximately 2.54 cm into the ground. In natural seedbeds, most of the oak seedlings grow under moderately dense canopies (Burns and Honkala, 1983).



Planting

The most common plantations of this genus, found in eastern United States (23 to 47° latitude N and 62 - 96° longitude W), is the northern red

oak (*Q. rubra*), a broad-leaved, highly valuable tree species. This northernmost American oak species, popularly known as tan borealis, grows from low altitudes up to 1680 m in the southern Appalachian Mountains. Within its natural range, it forms pure or mixed stands with broad leaves (*Quercus* spp., *Fraxinus* spp., *Acer* spp., *Populus* sp. and *Carya* spp.) (Nicolescu *et al.* 2018).

Management

According to Burns and Honkala (1983), oak management is done through plantations or natural regeneration. If the purpose is to produce wood, the latter is used, by applying clear-cut harvests and a management of seedlings to regenerate an equivalent of 1075 samplings/ha. When the stands unite their crowns, thinning must be performed to allow natural light into the forest and the growth of the remaining trees. Furthermore, formative pruning (conformation) is also necessary, due to insufficient natural pruning and a tendency to bifurcate as a result of frosts. These are vigorous, fast-growing trees, which are often able to resist attacks by pests and diseases.

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Mexico

AHUEHUETE

Scientific name: *Taxodium mucronatum*

Common name: ahuehuete, Montezuma bald cypress, weeping willow, sabino, river cypress

The ahuehuete (*Taxodium mucronatum*) is the national tree of Mexico. It was declared a national symbol during the celebration of the first centenary of the consummation of the Independence of Mexico in 1921 (Tapia R-Esparza, 2010). It is characterized as being a long-living tree species of large dimensions (Enríquez-Peña and Suzán-Azpíri, 2011) and it is widely distributed among Mexican states, especially in riparian forests (Contreras-Medina and Luna-Vega, 2007).

GENERAL DESCRIPTION

T. mucronatum is a tree that measures between 30 and 45 m in height and has a diameter of 2 to 10 m (Salazar *et al.* 2000). Its area of distribution spans the United States, Mexico and Guatemala. In Mexico, it appears in Sonora and Coahuila up to Tabasco and Chiapas (Enríquez-Peña y Suzán-Azpíri 2011; Tiwari *et al.* 2012).

The ahuehuete is characterized by a straight trunk which, on occasion, presents irregular bulges and often divides into two or three from the base. Its bark is smooth, grayish or reddish brown in color with an astringent taste; longitudinal pieces of fibrous structures peel away from the bark. It has a wide, irregular crown, with strong, twisted, widespread branches that present simple scaly alternate leaves that are dark green in color and measure 10 to 22 mm in length and 0.5 to 1 mm in width. The species is monoecious, carrying both masculine and feminine flowers. Its fragrant fruit is oval to balloon-shaped with internal resin glands (Salazar *et al.* 2000; Enríquez-Peña and Suzán-Azpíri, 2011).



Photo: Rep. IICA México

SOIL AND CLIMATE CHARACTERISTICS

Climate

This tree grows at altitudes ranging from 300 to 2100 masl, in temperatures from 10 to 26°C, in warm and semi-warm climates. It also adapts to temperate climates.

Soils

It grows in soils with a high retention of moisture and pH values greater than 7. It generally occurs alongside bodies of water such as rivers, springs, streams and canals.

Source: Salazar *et al.* 2000; Enríquez-Peña and Suzán-Azpíri, 2011.

MORE FREQUENT USES

The *T. mucronatum* has various environmental uses, such as control of soil erosion and stabilization of sediments, improvement in water quality and soil recharge, and filtration of nutrients (Enríquez-Peña and Suzán-Azpíri, 2011). It has also been used in construction work, for adornment purposes and for its medicinal properties.

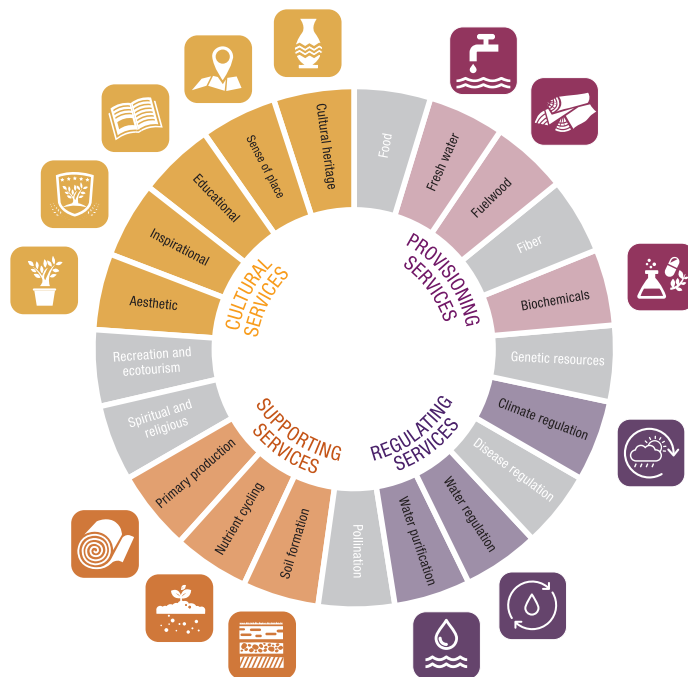
Wood derived from the ahuehuate is highly durable and easy to work, preserve or dry, hence it has been used in

the construction of beams, posts and canoes and in the manufacture of rustic furniture (Salazar *et al.* 2000).

The antimicrobial, anti-fungal and anti-inflammatory properties of different parts of the *T. mucronatum* were exploited by the Aztecs in the practice of popular medicine. Its leaves, bark, branches and fruit serve in the preparation of infusions and ointments to treat skin problems, wounds, renal infections, gout, cardiac illnesses, hemorrhoids, ulcers, varicose veins and bronchial problems (Cortés-Arroyo *et al.* 2011; Luján-Hidalgo *et al.* 2012).

This tree boasts great beauty, facilitates diversity in flora and fauna and offers recreational benefits (Suzán-Azpíri *et al.* 2007; Enríquez-Peña and Suzán-Azpíri, 2011). Likewise, the ahuehuate carries great historical and cultural importance for Mexico (Suzán-Azpíri *et al.* 2007).

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

The fruit can be harvested directly from the tree when it changes from green to greenish yellow. It must be transferred in jute sacks and then laid on a tarpaulin for exposure to the sun for one or two days for periods of three to four hours. Seed extraction must be done manually; the quantity ranges from 1500 to 7,400 seeds/kg (Salazar *et al.* 2000).



Propagation

A pre-germinative process must be carried out whereby the seeds are soaked in water for 24 hours at ambient temperature. They must be sowed in germinators, using previously disinfected sand as a substrate. Two weeks after germination, they must

be transferred to plastic bags. After three to four months, or when they attain a height of 25 to 30 cm, the plants are ready to be transferred to the field (Salazar *et al.* 2000).

Did you know that...



The word “ahuehuete” comes from the Nahuatl language and means “old water tree”. This is because the tree can live for many years near rivers and its foliage is reminiscent of grey hair. The species carries high cultural and historical importance. Legend has it that conqueror Hernan Cortes wept under an ahuehuete when he lost the battle against the Mexican people (CONAFOR, 2020).

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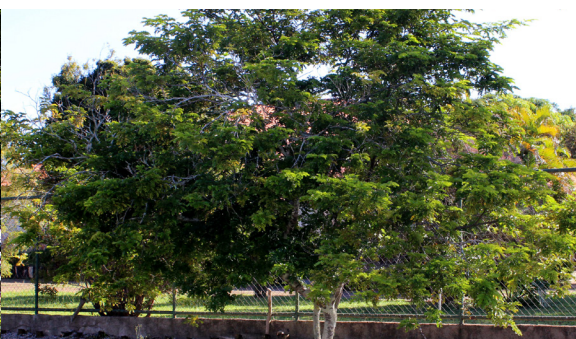
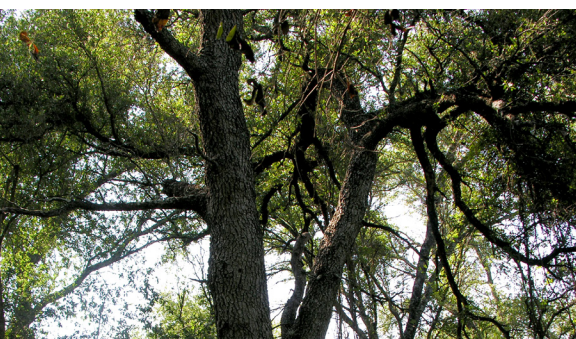
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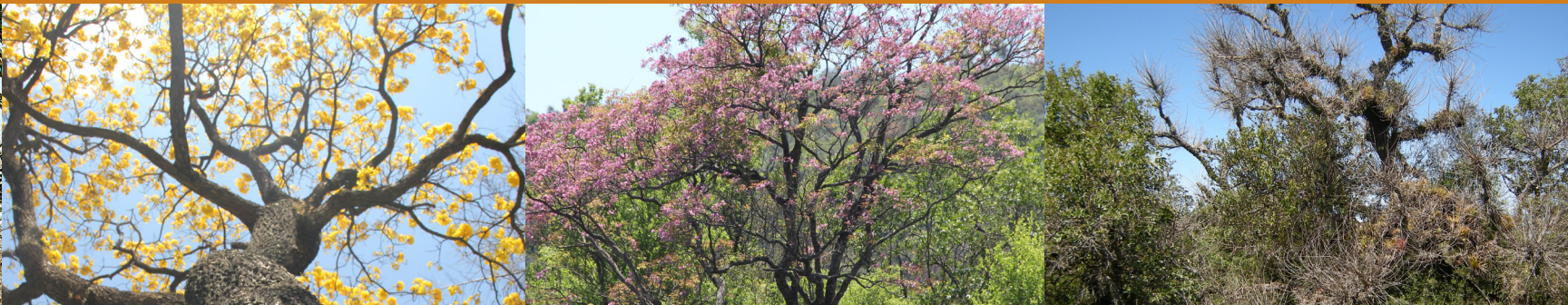
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Argentina
Brazil
Chile
Paraguay
Uruguay

SOUTH REGION



Argentina

WILLOW-LEAF RED QUEBRACHO

Scientific name: *Schinopsis balansae*

Common name: willow-leaf red quebracho

The red quebracho (*Schinopsis balansae* Engl.) was declared the “National Forest Tree” by the National Executive Branch under decree No. 15190 in 1956. It can be found in the northern and eastern regions of the country. It was used in the past as raw material for leather tanning and was highly valued for its medicinal properties.

SOIL AND CLIMATE CHARACTERISTICS

Climate

Humid or Eastern Chaco Forest
High-rainfall area

Soils

It is ecologically optimal in clay and alkaline soils with insufficient draining; however, in the northwest of Corrientes and the easternmost point of Chaco and Formosa, it grows in mollisols.

Source: Barberis *et al.* 2012.

GENERAL DESCRIPTION

This tree can grow to a height of 10 to 25 m and has a diameter at breast height (DBH) of 1.5 m. It is naturally distributed in the provinces of Chaco, Corrientes, Entre Ríos, Formosa, Santiago del Estero and Santa Fe. Due to its tanning properties, its overexploitation is estimated to have started in 1826 and lasted until mid-20th century, the purpose of which was tannin and wood extraction (González, 2013).

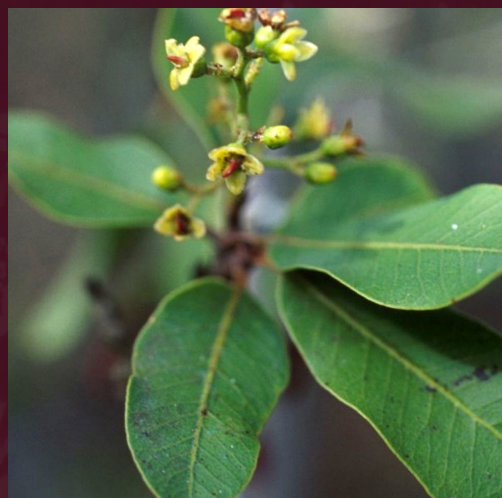


Photo: Instituto de Botánica Darwinion.



Photo: Instituto de Botánica Darwinion.

MORE FREQUENT USES

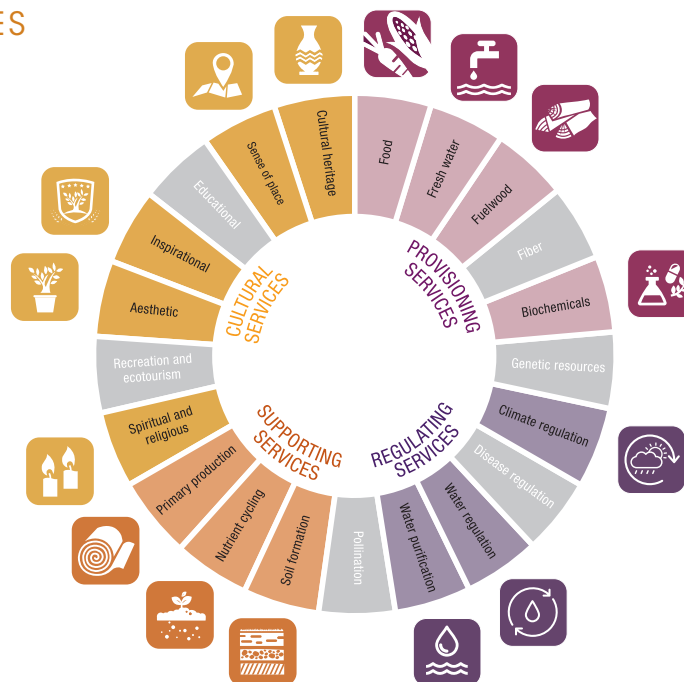
The *S. balansae* is an indigenous tree species belonging to the family of Anacardiaceae, is mainly used as raw material for tannin extraction¹ (Valentini, 1960). Due to its easy extraction, high concentration of phenols (Acosta, 1999) and significant proanthocyanidin or condensed tannin content (Barberis *et al.* 2012), quebracho has been traded and exported at high levels, which positions it as a significant source of resources for the Argentine economy. The yield of tannin extraction is between 30 and 35%, of which between 65 and 67% are tannins.

In the Chaco region, quebracho wood has been historically used for the construction of mallets, hammers, shovels and digging sticks. In Paraguay, the Maskoy indigenous peoples used its long branches to build houses and as firewood to prepare food. Moreover, shamans used the wood to chase away evil spirits (Barberis *et al.* 2012).

With respect to its medicinal properties, its dry bark has antimicrobial agents (Barberis *et al.* 2012). It is boiled in water to be used for anti-inflammatory, healing and antiseptic purposes. The wood and the root also offer astringent properties and are utilized to treat diarrhea and for vaginal douches. Its leaves are cut to treat warts and also softened in hot water to be applied on wounds for disinfection and healing. The sap is used to prepare infusions and decoctions to treat mycosis.

¹ Tannins are substances utilized in tanneries and leather treatment facilities (Barberis *et al.* 2012); moreover, phenol extracts have been included in ruminants' diets to control gastrointestinal parasites (Athanasiadou *et al.* 2001).

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

Forest plantations

In the province of Santa Fe, where basic forestry practices failed to be implemented, the agricultural and livestock activity has caused the disappearance of quebracho forests. Below is a description of how the species can be established for reforestation purposes.



Seed

1 kg of seeds is considered to contain approximately 10,000 units. Its percentage of germination varies from 85% when fresh, to 30-50% when preserved under natural conditions. If seeds are to be preserved, it is recommended that this be done in a cold chamber with low relative humidity (Valentini, 1960).



Propagation

No pre-germination treatment has been reported. It is recommended that the freshest seeds possible be collected in order to obtain the highest germination yield possible.



Planting

The most advisable time of year for sowing is immediately after the seed harvest. Planting must be done directly and in rows, with a distance of 30 cm between plants and 2 m in-between lines. The seed must be covered with leaf litter, dense flower cordgrass or similar materials to protect the cotyledons from sunstroke and avoid excessive evaporation. With direct seeding, an estimated 30 seeds are planted per position. After germination, the area must be monitored to identify lines with

missing plants and proceed to replanting. This type of planting requires a large amount of seeds per hectare. If harvest is insufficient, individual trees must be planted in a greenhouse (Valentini, 1960).

Management

During winter months, seedlings can be affected by frost, and for that reason it is advisable to maintain the weeds as protection. In the spring, they are protected with a circle of about 1 m in DBH. In summertime, this practice is discontinued since seedlings less than two years old may be destroyed by the sun.

Conservation

In the province of Santa Fe and part of Chaco, the expansion of the farming and livestock border has caused the indiscriminate

deforestation of quebracho forests. In the past, certain areas would be burnt to be used as new meadows once the tannin extract factories had completed the extraction from the tree; this led to the mass exploitation of quebracho forests, without proper management, or forestry knowledge, or a plan for natural repopulation (Valentini, 1960).

Did you know that...



Quebracho wood is very resistant and durable. Its name is derived from the expression “*queiebra hacha*” (axe-breaker) (Barberis *et al.* 2012).

In 1942, the ceibo flower (*Erythrina crista galli*) was declared National Argentine Flower.

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Brazil

PAU-BRASIL

Scientific name: *Caesalpinia echinata*
Common names: pau-Brasil,
pernambuco wood, brazilwood

The brazilwood is a tree species typical of the Brazilian coastal flatlands. Since the beginning of the colonial period, its wood has been extensively exploited to extract a red dye used in the textile industry. Due to its high demand and the fact that the species is almost extinct, it is currently planted to manufacture bows for violins, violas and cellos (Rodrigues *et al.* 2009; Dapson and Bain, 2015).

GENERAL DESCRIPTION

The brazilwood is a semi-deciduous, heliophilous plant that reaches a height of 10 to 20 m and a DBH of 25 to 40 cm. Its gold yellow flowers, measuring 17 cm in length, appear in clusters and feature red spots on their petals. (Alves Aguiar *et al.* 2005).

C. echinata is native to the mid-stratum of the Brazilian Atlantic forest. It is mainly found in the driest areas of the coastal and mountain rainforest of the Brazilian *Mata Atlântica* (Borges *et al.* 2009; Dapson and Bain, 2015). The Atlantic rainforest, which originally covered 12% of the land surface of Brazil, is considered the second densest area in the tropical rainforest after Amazonia. This type of ecosystem is one of the most endangered tropical forests, due to the fact that it is also home to the most populated areas of Brazil, which were first subject to the historical settlement of Europeans and later to the construction of megacities. The area is believed to have kept only 5% of its original cover, particularly in protected areas and mountain hillsides (Oliveira-Filho and Fontes, 2000). The brazilwood is closely tied to this ecosystem, with specimens that can only be found in certain sections of the *Mata Atlântica*.

It is naturally distributed along the Brazilian Atlantic coast, especially in the northeast of Rio Grande do Norte and the southeast of Sao Paulo, but only small native populations can be found (Rodrigues *et al.* 2009).

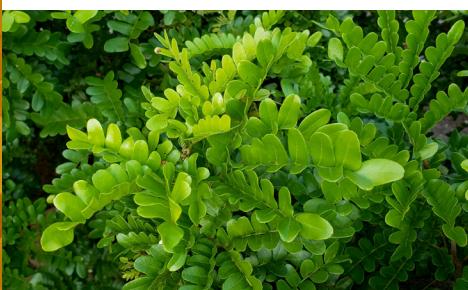


Photo: Rep. IICA Brasil

SOIL AND CLIMATE CHARACTERISTICS

Climate	Soils
It is found in ecosystems of the Brazilian Mata Atlântica, especially in the dry area.	It grows in sandy soils.

Source: Alves Aguiar *et al.* 2005.

MORE FREQUENT USES

This plant has been mainly exploited to extract a red dye called brazilin, a pigment obtained from the heartwood of different species of the *Fabaceae* family. According to Dapson and Bain (2015), brazilin has antibacterial, antihelminthic, antioxidant and antitumoral properties, as well as positive effects on the immune and cardiac systems.

Its hard, heavy wood is easy to work with and features a natural polish. Although it has been used for the construction of floors, it is considered the ideal raw material to manufacture bows for violins and string instruments in general due to its high flexibility and resistance, and is now used exclusively for that purpose (Schimleck *et al.* 2009).

Did you know that...



The dye and other components of *Caesalpinia echinata* wood make it ideal for the manufacture of bows for string instruments, since they are capable of preserving the vibrations over time (Dapson and Bain, 2015).

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

Conservation

For over 500 years, the species and its ecosystem were exploited in an uncontrolled manner to extract a red pigment used in the textile industry (Rodrigues *et al.* 2009). In 2007, the brazilwood was included in the list of non-threatened species in appendix II of the CITES list; however, its international trade must be strictly regulated to avoid a dramatic decline in its population (Dapson and Bain, 2015). Apart from producing this red dye,

the tree's wood features special attributes for the manufacture of bows for violins and other string instruments, for which it is considered unique in the market and its use is strictly limited to this purpose (Longui *et al.* 2014).

Borges *et al.* (2009) conducted a study identifying the phenology, pollination and reproduction system of the species. The study concluded that, in addition to its devastating exploitation, the brazilwood grows slowly and has limited seed viability under natural conditions, which has contributed to its loss of habitat.

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Chile

ARAUCARIA

Scientific name: *Araucaria araucana* (Mol.) K. Koch
Common names: *araucaria*, monkey puzzle tree, monkey tail tree, *piñonero*, pehuen or Chilean pine

The *Araucaria* (or *pehuen* in Mapuche language) is Chile's national tree. It is a conifer, endemic tree declared a Natural Monument pursuant to decree No. 43 of 19 March 1990, published in the Official Gazette, and in keeping with the "Convention for the Protection of Flora, Fauna and Natural Scenery of America" (Decree No. 43, 1990).

SOIL AND CLIMATE CHARACTERISTICS

Climate

The tree grows in sub-Antarctic temperate rainforests of South America. In Argentina, it grows on rainy, xeric forests. Pehuen forests are distributed throughout different areas with Mediterranean climate, within a wide range of annual rainfall patterns that go from 800 mm and 4000 mm and with a minimum winter temperature of -5 to -10°C and a maximum temperature of 30° C.

Soils

Soils developed over well-drained, quaternary andesitic and basaltic volcanic rocks covered with volcanic ashes and slag.

Source: González *et al.* 2006; Donoso *et al.* 2014, Goth *et al.* 2014; Carranza *et al.* 2017.

GENERAL DESCRIPTION

The species is native to Chile and Argentina. Taha (2010) estimates the total surface area occupied by this tree to be approximately 450,000 ha, distributed in Chile from the Biobío region to the southern slope of the Villarrica volcano in the Lakes region, in the Andes range and the Nahuelbuta range (263,525 ha) (González *et al.* 2006); in Argentina, it is found in RucaChoroy (Neuquén) and Pulmarí (179,289 ha).

Araucaria is a slow-developing, long-living species with a lifespan of up to approximately 1000 years (González *et al.* 2006). It has a straight, cylindrical trunk with a thick, coarse bark made up of dark grey or reddish rectangular plates. Its hard, leathery, resinous leaves are between 3 and 4 cm long and feature a thorn on their tip. The species grows at an altitude of 800 to 1000 masl (optimal altitude) (Moraga and Sartori, 2016) and up to 1700 masl in the Andes (Hechenleitner *et al.* 2005). It can reach a height of 50 m and 2,5 m in DBH.

Within the Andes range, *Araucarias* are distributed over very steep volcano slopes and form widespread stands with other species in the temperate rainforest (Hechenleitner *et al.* 2005).



Photo: CONAF

MORE FREQUENT USES

Piñones, the large pine nuts obtained from this tree, are widely used as food and for commercial purposes. Mapuche-Pehuenche communities and other dwellers have included it in their family diet due to its rich fiber content (starch, cellulose, hemicellulose, pectin, hydrocolloids, and lignin), carbohydrates and fat (Taha, 2010, Henríquez *et al.* 2007).

Piñones can be consumed raw or processed, as pine nut flour or other byproducts including cookies, biscuits, sweets, beer, marmalade, pine nut paste, liquor, *chuchoca* and purée (Taha, 2010). It is worthwhile mentioning that piñon trade and sales are restricted to the national level. According to Donoso (2014), in one year it is possible to harvest up to 32 sacs containing nearly 2,500 kg of piñones. Approximately one third of this harvest is sold by Mapuche-Pehuenche communities. In Argentina, the fruit is also consumed as food by animals, including the Austral parakeet, several rodents and boars.

Previously, pehuen forests were exploited to extract wood, which was later used for construction and to manufacture furniture, airplane structures, crates, car bodywork, flooring, interior and exterior veneer, plywood, pulp, paper and masts for ships.

Furthermore, the native peoples used to treat skin ulcer with the trunk's resin. The dietary fiber of the *piñón* is used to prevent and treat diverticular diseases, colorectal cancer, diabetes, obesity and cardiovascular diseases (Henríquez, 2007; Taha, 2010).

As a long-lived species with a thick bark that can withstand fires of medium intensity, *A. araucana* has become an indicator for analysis and reconstruction of the history of fires in Chile. Also important is the fact is that it takes between 30 and 32 years for a healthy tree to regenerate after a fire and recover its reproductive capacity as well as its seed productivity (Vargas *et al.* 2017).

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

According to Donoso (2014), when the male cones of the *Araucaria* mature, they release the pollen which is later received by female cones for reproduction. The seeds or piñones can be expelled up to one year and a half after fertilization. The tree is estimated to produce 260 seeds/kg with an average weight per pine nut of 3.8 g (Muñoz, 1984;

Serra, 1987; Caro, 1995; González *et al.* 2006, cited by Donoso, 2014)



Propagation

According to Duplancic *et al.* (2015), *pehuen* seeds can germinate in xeric forests within a range of cardinal temperatures of between 15 and 30°C, with an optimal temperature of 25°C and average germination time of 17 to 23 days. According to studies by this author, more than 90% of sexual regeneration fails in the first two years and, in the case of asexual reproduction, new individuals account for 37.6% of the total.



Planting

A. araucana is considered to be endangered species, and this calls for urgent repopulation. According to Goth (2014), the planting of this species is possible and safe, with a 50% survival rate and a very slow growth of 12 cm per year, even in the best possible conditions.

Did you know that...



A. araucana is included in the Red List of Threatened Ecosystems of the International Union for Conservation of Nature. The species is seriously fragmented and their area of occupation continues to dwindle due to fires, illegal logging, overgrazing (Premoli *et al.* 2013) and the overexploitation of its seeds. In the 2015-2017 period, the partial death of the crown and sporadic death of *pehuen* individuals was observed in Chile and Argentina, which has been attributed to climate change (high summer temperatures, extreme, prolonged drought spread of microorganisms and insects that caused abnormal damage to vegetation) (Carranza *et al.* 2017; Sanguinetti, 2018).

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Paraguay

LAPACHO

Scientific name: *Handroanthus heptaphyllus*
(*Tabebuia heptaphylla*)

Common name: *lapacho*, pink trumpet tree, flowering tree

Pursuant to Law 4631 of the Republic of Paraguay of 2012, all the species included in the genus *Tabebuia* and *Handroanthus*, commonly known as pink trumpet tree and flowering tree (*tajyin* Guarani) are declared a National Tree of Paraguay (Law 4631 2012).

SOIL AND CLIMATE CHARACTERISTICS

Climate

It grows in various climate types. It occurs naturally in seasonal deciduous forests, flood-prone sub-humid forests and in dense rainforests.

Soils

It grows in moist or red clay soils on hillsides. It has shown the capacity to grow in moderately degraded soils.

Source: Prepared based on Montagnini et al. 2006; Grings and Brack, 2011; Valdovinos and Paula, 2017.



Photo: Lidia Pérez de Molas

GENERAL DESCRIPTION

The pink trumpet tree belongs to the Bignoniaceae family. It occurs naturally in South America, specifically Brazil, Uruguay, Paraguay, Argentina and Bolivia (Grings and Brack, 2011). In Paraguay it can be found in the rainforest of the Eastern Region, the flood-prone sub-humid forest of the Paraguay River and the arid Chaco forest (Perez, 2015).

The tree attains a height of 20 to 25 m and 60 to 80 cm in DBH. It features a large stem, more or less straight and cylindrical, sometimes bent. It is characterized by a thick bark with deep, spaced longitudinal fissures that are grey-brown in color. Its leaves are opposite in arrangement, compound, with oval leaflets that have a serrated edge. Its blossom can be pink, lilac, yellow or white with five fused funnel-shaped petals measuring between 4 and 5 cm in length (Grings and Brack, 2011).



Photo: Lidia Pérez de Molas.

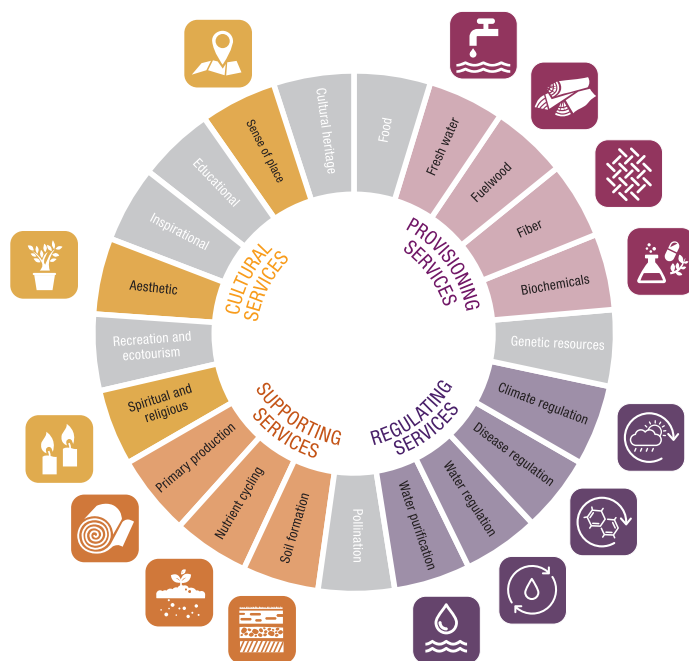


Photo: Lidia Pérez de Molas.



Photo: A Todo Pulmón Paraguay Respira Organization.

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

MORE FREQUENT USES

H. heptaphyllus carries significant value since its wood, which is very hard due to its high level of lapachol content, is of a high quality and presents a high degree of malleability. It weighs between 0.90 and 1.07 g/cm³ and is very resistant to water and insect attacks. As a result, it has been used in civil and naval construction works (Perez, 2015; Valdovinos and Paula, 2017; Grings and Brack, 2011).

Its blossoms and coloring make it very attractive and for this reason the tree has been used for ornamental, tree planting and landscaping purposes in urban settings (Lorenzi, 2011). In rural areas it has been used in agroforestry fields and environmental restoration (Canabrava-Lisboa *et al.* 2018).

The pink trumpet tree is also recognized for its medicinal properties. Its bark has been used in the treatment of tumors and influenza and in blood purification. Its leaves are used to prepare tea for the treatment of ulcerations caused by syphilis and gonorrhea (Grings and Brack, 2011).

Other commercial uses of its wood include the extraction of substances to make fabric and cotton dyes.

ESTABLISHMENT AND MANAGEMENT

Forestry



Seed

This tree produces a lot of seed and they demonstrate a greater capacity to germinate if sown quickly after the harvest (Grings and Brack, 2011). The seeds do not undergo a period of dormancy and they show a high rate of germination at 71.8% (Da Silva *et al.* 2015).



Propagation

H. heptaphyllus propagates mainly through harvesting the seeds directly from the tree, when the fruit is ripe (Grings and Brack, 2011). According to some studies, germination occurs between six to eight days after sowing, however, it normally takes between ten to fifteen days. This depends on the availability and quality of light, which means that the capacity of the species is less in natural conditions where there is undergrowth. Nevertheless, it is possible to find species with

Did you know that...



The meaning of the name *tajy* in Guaraní is "where the fire or lightning comes down."

seedlings at a more advanced stage of growth beneath the crown of the forest, without direct sunlight (Peixoto *et al.* 2014).



Forest plantations

The pink trumpet tree is suitable to grow in full sunlight and in the shade. The species is seen to exhibit greater growth and a superior accumulation of biomass under sunny conditions (Peixoto *et al.* 2014). Furthermore, there are known benefits in terms of soil treatment. According to studies in Argentina, this tree can also adapt to soils with moderate degradation, where soil fertility ranges from medium to low (Montagnini *et al.* 2006).

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Management

Harvest shift and growth

According to Valdovinos and Paula (2017), this species rapid growth and ability to adapt to different soils and climates makes it equally suitable for agroforestry systems and for industrial use forestry.

Conservation

Per BGCI and IUCN (2020), the *H. heptaphyllus* is in stable condition (least level of concern) and is not encountering any threats as a result of its wide distribution and population. Several studies have revealed the genetic diversity of this species, which is particularly important in terms of its conservation or improvement (Valdovinos and Paula, 2017).

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Uruguay

CEIBO

Scientific name: *Erythrina crista-galli*

Common name: *ceibo*

The *Erythrina crista-galli* is a plant that belongs to the Fabaceae family and is commonly known as ceibo. It bears a striking blossom, making it very attractive as an ornamental tree; as a result, it is widely used in South America and in the tropical and subtropical regions of Asia. Moreover, it is the national flower of Uruguay and Argentina. Phytochemical studies have revealed the pharmacological properties of its seed extracts (Qing-Wei *et al.* 2017).

GENERAL DESCRIPTION

This native species occurs naturally in Paraguay, southern Bolivia and throughout all territories in Uruguay and northern Argentina. In all the Americas, it is the most widespread of its kind in the south, given that it extends to the La Plata River (Galletto *et al.* 2000). It can be found naturalized in other regions of the world, such as southern and southeastern Africa, eastern Australia and southern United States (Mello *et al.* 2019).

It is a medium-size nitrogen-fixing tree; it is considered a pioneer plant since it can grow in various soil types, degraded, poor or very moist soils (Mello *et al.* 2019). Some species of the *Erythrina* genus have been used in the recovery of degraded ecosystems and the restoration of riparian forests, both very important for the rivers because they avoid water logging, guarantee the survival of aquatic organisms and promote water quality (Larré *et al.* 2013).

The tree is protected by Brazil's National Environment Council since its natural habitat in this country has undergone enormous devastation and the species plays an important role in maintaining the wild fauna and flora (Larré *et al.* 2013).



Photo: Natalia Caballero



Photo: Natalia Caballero

SOIL AND CLIMATE CHARACTERISTICS

Climate

The ideal climate for the ceibo to grow is the typical climate for the zones where the leguminous tree originated. It normally adapts to humid, mild and warm climates, so it is susceptible to cold climates and is affected by frost, especially when recently planted or while still young (AGROMÁTICA 2020).

Soils

The tree can be found in moist and waterlogged soils, in water streams or irrigation ditches and soggy ditches between 200 and 1300 masl (Lozano and Zapater, 2010).

Source: Lozano and Zapater, 2010.

MORE FREQUENT USES

Its ornamental use lies in the beauty of its flowers, which are red in color, resupine, odorless and diurnal, and they last three or four days. The anthesis occurs in an acropetal order, resulting in many flowers being open simultaneously in each cluster (Galetto *et al.* 2000).

Ceibo seeds and bark possess curative attributes and are used in infusions or poultices for their sedative properties and analgesic effect (Etcheverri *et al.* 2003). Among its active components are bioactive alkaloids, flavonoids, isoflavonoids,

pterocarpan, flavones and isoflavones, substances that possess antimicrobial properties against *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis* and *Candida mycoderma* (Mello *et al.* 2019).

Moreover, it is believed that the natives of Uruguay used to chew the young leaves and flowers of the ceibo tree for their psychotropic effect (Etcheverri *et al.* 2003). On the other hand, according to chemical studies on its non-alkaloid components, the flavonoids, cinnamyl phenols and pterocarpan function as phytoalexins, which present an antimicrobial effect (Qing-Wei *et al.* 2017).

ECOSYSTEM SERVICES



Source: Prepared based on MA 2003.

ESTABLISHMENT AND MANAGEMENT

Borer attacks are affecting the natural regeneration of the species. Moreover, the genus carries latent seeds and is low in the production of fruit as compared against flowers. It is

estimated that only about 6% of flowers in well conserved natural populations develop seeds. The use of herbaceous mini cuttings harvested from young plants (less than one-year-old) is recommended since these are the most suitable for propagation (Gratieri-Sossella *et al.* 2008).

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