Databook on endangered tree and shrub species and provenances

Forest Resources Division
FAO Forestry Department

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ABSTRACT

Based on a list of species in need of attention drawn up by the FAO Panel of Experts on Forest Gene Resources, 81 monographs on endangered woody species and provenances were prepared in collaboration with researchers and institutes from all over the world. The monographs include information on the botany and silvics of the species, as well as their status in terms of genetic depletion; and outline action needed to conserve existing genetic variation in them.

FOREWORD

At its 5th Session in Rome in 1981, the FAO Panel of Experts on Forest Gene Resources included in its list of species in need of attention, 81 species considered threatened with extinction or subject to severe, genetic depletion. These 81 species, endangered either at the species or provenance level, form the basis for the present book. Some of these were also described in FAO's 1981 Draft Data Book on Endangered Forest Tree Species and Provenances elaborated in cooperation with IUFRO (International Union for Forestry Research Organizations) and UNEP (United Nations Environment Programme).

The list of species included is by no means a complete list of endangered woody species, but represents a cross-cut of those species which the Panel considered should urgently be included in genetic resources programmes. Many national lists exist on endangered flora and fauna, and these complement the present list of species of international socioeconomic importance. Information from national lists is regularly collated and computerized by the International Union for Conservation of Nature and Natural Resources (IUCN), which concentrates on recording information on species considered endangered, threatened and vulnerable, at the species, rather than intraspecific, level.

The main purpose of the present book is to draw the attention of decision-makers, scientists and international and national organizations to the conservation needs of the species included in the book.

To facilitate conservation activities, the book gives information on distribution, ecology, biology; actual or potential uses; silviculture; genetic status; and remedial action underway or recommended to safeguard the genetic resources at species and provenance levels.

The book attempts to give as reliable an account as possible of each species, and over fourty scientists from more than twenty institutes worldwide have contributed to the Data Sheets (See acknowledgements).

Information for many species is, however, still far from complete and conservation action will thus have to be complemented by further, basic studies on the species in question.

The catalytic work of FAO's Forest Resources Division in the field of forest genetic resources, under the guidance of the FAO Panel of Experts on Forest Gene Resources and within the framework of the Tropical Forestry Action Plan, continues to focus on the inter-related activities of exploration, collection, evaluation, conservation and utilization. The work is carried out in collaboration with, and through support to, national institutes especially in tropical countries.

It is hoped that the present Data Book will lead to conservation action in both the species listed and in species identified at the national level; and, as the need emerges, to the description and conservation in and ex situ of additional species threatened with extinction or genetic depletion.

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(Araucaria angustifolia, Aspidosperma polyneuron, Astronium urundeuva, Balfourodendron riedelianum, Dalbergia nigra, Dipterix alata, Esenbeckia leiocarpa, Ilex paraguaiensis, Joannensia princeps, Machaerium villosum, Ocotea porosa, Piptadenia peregrina, Plathymenia foliosa, Pterogyne nitens, Zeyheria tuberculosa)

Brazil (cont.)	:	C.E.S. Nascimento and I.E. Pires EMBRAPA/CPATSA P.O. Box 23 Petrolina, PE (Anadenanthera macrocarpa, Mimosa caesalpiniaefolia, M. verrucosa, Schinopsis brasiliensis, Tabebuia impetiginosa)
		L.G.S. Costa, S.T. Ohasi and O. Daniel Forestry Department Faculdade de Ciências Agrarias do Pará P.O. Box 917 Belém, Pará (Aniba duckei, Bertholetia excelsa, Didymopanax morotoni)
Chile	:	Corporación Nacional Forestal (CONAF) Avenida Bulnes 285, OF. 703 Santiago (Transmitted by R. Romero Alpe) (Acacia caven, Atriplex repanda)
China, Peoples Republic of	:	Pan Chih Kang The Arboretum Chinese Academy of Forestry Wan Shou Shan Beijing (Cercidiphyllum japonicum, Fagus longipetiolata, Glyptostrobus lineatus, Pseudotsuga gaussenii, Pseudotsuga sinensis, Taiwania cryptomerioides, Taiwana flousiana)
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Greece	:	K. Panetsos Laboratory of Forest Genetics Aristotelian University School of Agriculture and Forestry Thessaloniki (Platanus orientalis)
Guatemala	:	J.M. Saraiva, J.E. Sosa and C. Girón Instituto Nacional Forestal (INAFOR) Ciudad de Guatemala (Abies guatemalensis)
Italy	:	R. Morandini Istituto Sperimentale per la Selvicoltura Arezzo, Italy (Abies nebrodensis, Cedrus libani, Pinus eldarica)
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Norway	:	T. Hedegart Saatvedt Skollenborg (*Tectona hamiltoniana*, *Tectona philippinensis*)
Papua New Guinea	:	N.H.S. Howcroft Office of Forests Forest Research Station Bulolo Morobe Province (*Araucaria cunninghamii*, *Araucaria hunsteinii*)
Sudan	:	Ahmed El Houri Ahmed Forest Research Institute Soba, Khartoum (*A. tortilis* subsp. *raddiana*, *A. tortilis* subsp. *tortilis*)

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The author(s) of each species monograph is duely mentioned in the text.

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TABLE OF CONTENTS

INSTITUTIONAL ACRONYMS/ABBREVIATIONS USED IN THE TEXT

BASA	Banca da Amazonia, Belém, Brazil.
CAMCORE	Central America and Mexico Coniferous Resources Cooperative, School of Forest Resources, North Carolina State University, USA.
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza, Turrialba, Costa Rica.
CITES	Convention on International Trade in Endangered Species of Woodland Fauna and Flora.
CONAF	Corporación Nacional Forestal, Chile.
CONIF	Corporación Nacional de Investigación y Fomento Forestal, Colombia.
CNPq	Conselho Nacional de Desenvolvimento Cientifico e Tecnologico, Brazil.
CPATU	Centro de Pesquisas Agricolas dos Trópicos Umedos, Belém, Brazil.
CPATSA	Centro de Pesquisas Agricolas dos Trópicos Semiáridos, Petrolina, Brazil.
CSIRO	Commenwealth Scientific and Industrial Research Organization, Melbourne, Australia.
CTM	Centro de Tecnologia Madeireira, Pará, Brazil.
DID	Departamento de Informaçao e Difusao, EMBRAPA.
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária, Brasilia, Brazil.
ESALQ	Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, Brazil.
FAO	Food and Agriculture Organization of the United Nations, Rome, Italy.

FPRI	Forest Products Research Institute, Ghana.
IBDF	Instituto Brasileiro de Desenvolvimento Florestal, Brazil.
IFSP	Instituto Florestal de Sao Paulo, Brazil.
INAFOR	Instituto Nacional Forestal, República de Guatemala.
INDERENA	Instituto Nacional de los Recursos Naturales Renovables, Colombia.
INPA	Instituto Nacional de Pesquisas da Amazônia, Brazil.
IPEF	Instituto de Pesquisas e Estudos Florestais, Brazil.
IPT	Instituto de Pesquisas Tecnológicas do Estado de São Paulo, Brazil.
OFI	Oxford Forestry Institute, UK.
PNPF	Programa Nacional de Pesquisas Florestais, Brazil.
PNUD	Programa de las Naciones Unidas para el Desarrollo (= United Nations Development Programme).
PRODEPEF	Projeto de Desenvolvimento e Pesquisa Florestal (PNUD/FAO/IBDF).
RENARE	Dirección Nacional de Recursos Naturales Renovables, Panamá.
SIF	Sociedade de Investigaçoes Florestais, Vicosa, Brazil.
UFPB	Universidade Federal da Paraiba, Brazil.
UFV	Universidade Federal de Vicosa, Brazil.
URPFCS	Unidade Regional de Pesquisas Florestais do Centro Sul, Brazil.

USDA	United States Development Agency
USP	Universidade de São Paulo.

Abies guatemalensis Rehder [1/]

SYNONYMS

Pinus religiosa sensu Parl. (1868)
A.tacanensis Lundell (1940)
A.guatemalensis Rehd. var. jaliscana Mart. (1948)
A.guatemalensis Rehd. var. tacanensis (Lundell) Mart.(1963)

(A. religiosa (HBK.) Schlecht. + Cham. is closely related to A. guatemalensis, and is occasionally, and wrongly cited as a synonym of it. This species is widespread in C. and E. Mexico, but also occurs further south on a few high mountains in N.W. Guatemala. The two species are, in fact, easily separated on vegetative material alone, and any nomenclatural confusion probably dates back to Parlatore's citation of Pinus religiosa (above) for a specimen of A. guatemalensis. Following the division of the genus Pinus into Picea, Abies and Pinus, Pinus religiosa became A. religiosa.)

FAMILY

Pinaceae

VERNACULAR NAMES

Paxaque or Pajachac (local Guatemalan dialects); Pinbete (Spanish); Guatemalan fir, Guatamala fir (English); Sapin du Guatemala (French); Guatemalatanne (German).

1/ Based on the work of i) P.S. McCarter (Oxford Forestry Institute, Dept. Plant Sciences, University of Oxford, OX1 3RB, U.K.) and ii) J.M. Saraiva, J.E. Sosa and C. Giron (Instituto Nacional Forestal, INAFOR, Republica de Guatemala).

BOTANICAL DESCRIPTION

General

An impressive and quite magnificent forest tree, which can attain a height of 45 m, with a trunk of up to 1 m in diameter. Branchlets of the current year purplish-red, turning a deeper blackish red-purple, slightly grooved and with a sparse pubescence of greyish-brown hairs. Leaf scars ovate to round. Winter buds long-ovate to ovoid, about 5 cm long, resinous; the scales broadly triangular-ovate, obtuse at apex, keeled outside. Branches spreading, or slightly ascending, whorled and growing gradually shorter, resulting in a conical spire-like crown.

Fruit

Cones sessile or shortly peduncled, oblong-cylindrical, 8-12 cm long, 4-5.5 cm wide, obtuse or rounded and truncate, purplish-brown, with concealed bract scales. Bract scales broader than long, 18-22 mm long, 26-30 mm wide, with puberulous external margins. Seeds cuneate-obovoid, 8-9 mm long, light brown; wings broadly and obliquely obovate 10-13 mm long by 10 mm wide; erose along the outer margins.

Foliage

Leaves more or less pectinately arranged, 12-25 mm or more long, 1.2-1.4 mm wide, obtuse or broadly emarginate, with two teeth at apex, slightly twisted at base. Upper surface shining green, curved downwards with a deep central furrow; lower surface with two white bands each of four to six lines of stomata - one on either side of a broad midrib. Marginal resin canals two - which lie close to the lower epidermis, one on each side of the leaf.

Bark

Bark greyish, rough and fissured with small, irregular plates, 1.5 mm thick in older trees, but smooth with resinous blisters in young plants.

WOOD PROPERTIES AND PRODUCTS

Compared with many of its coniferous associates, the timber of A. guatemalensis is softer, weaker and less durable. In spite of this, or perhaps because of it, it is more readily worked by crude tools and is frequently used locally as a sawn timber for building. It is also reputed to be valued by the local Indian population for the construction of hand looms for weaving. Its pulping properties are reported to be acceptable.

Other Uses

Probably the greatest value of the species, however, is simply in providing the cover for mountainous watersheds which is so critical for the maintenance of high quality, well regulated streams. A. guatemalensis also produces a viscous, acrid, aromatic and semi-transparent resin, which is used by the pharmaceutical industry as a balsam, and in the manufacture of varnish. Recently there has been interest in the potential of the species for tropical highland afforestation.

NATURAL DISTRIBUTION

A. guatemalensis is the most southerly occuring of the forty or so species of the genus, which is restricted to the northern hemisphere. It is one of the few

boreal species of fir found wild within the subtropics.

Its distribution is rather limited, spanning sporadically a latitudinal range of just under 5°. The most northerly recorded site at 19° 35' is in the State of Jalisco, Mexico. Here the species also reaches its lowest elevation of about 1 800m. There is then a large gap of some 500 km to the south-east where it is next found in the States of Guerrero and Oaxaca. It is in the mountains of central Oaxaca, S.Mexico that some of the most extensive stands of the species still occur, mainly between 2 800 and 3 200 m. In the state of Chiapas it is recorded over a wide altitudinal range of between 2 000 to 4 083 m, the latter on Volcán Tacaná. (This is one of the highest tree lines anywhere in the world.)

In Guatemala, the species is found only in the West of the country, in the Departments of Huehuetenango, Tontonicapán, Quetzaltenango and San Marcos. It is also reported to occur in the Departments of Solalá and Jalapa, but no herbarium material is available to confirm the identity of these citations. The common altitude range here is between 2 500 and 3 000 m, although once again it is found almost at the tree line of Volcán Tajumulco at about 4 000 m. In Honduras the species has been recorded at or near the summits of the countries two highest mountains, Montaña Celaque in the Department of Lempira between 2 700 and 2 850 m and Montaña Santa Bárbara (2 500-2 750 m) in the Department of the same name.

Finally, the southernmost recorded occurence of the species at latitude 14° 24'N is in El Salvador, where

it is found at between 1 900 and 2 400 m on Montaña Bajo close to La Palma in the Department of Santa Ana.

CLIMATE

The climate is distinctly temperate - rainy with dry winters. Mean annual rainfall is in the range 1 200-1 800 mm, and mean annual temperature is of the order of 12° C. Maximum temperatures range from 20°-35° C and minimum temperatures from -5° to -10° C. In part of its range the species probably experiences upwards of 200 days per year of frost.

SOILS

In general the soils are sandy loams, up to 2 m deep and acidic (pH 5-6). All are in the process of podsolisation. Although well drained, they are moist all the year round. Organic matter content is high.

HABITAT

The natural range extends from moist, subtropical, low-montane forest through moist, subtropical, mountainous to very moist, subtropical mountainous forest. Throughout this range, A. guatemalensis is commonly associated with Pinus ayacahuite and Cupressus lusitanica. At the lower altitudes it has been recordered in association with P. pseudosfrobus and Taxus globosa, along with various Quercus spp. and Arbutus spp. At the upper end of the range, P. hartwegii is found in mixture with it.

SEED HANDLING

Throughout its natural range the cones of A. guatemalensis are ripe between October and December. The

period available for collection is short - less than a month between fruit ripening and the beginning of seed dispersal. Since the cones disintegrate at maturity, collection is not possible after dispersal begins. The germinative capacity of Abies seed increases almost up to the time of dissemination, and significant improvement of the germinability of seed can be obtained by storing the cones for several weeks or months post-harvest. Sacks of cones should not be stacked, however: good air circulation is needed to prevent heating and moulding. Processing of the seed is similar to that of other conifers. The seed is extracted from dried cones by tumbling and shaking with screening to remove the impurities. The seed is fragile and easily damaged and care should be taken with dewinging. Viability losses with storage are frequently the result of processing damage. The seed can remain viable for 5 years or more if stored at a low moisture content (9-12%) in sealed containers at or near -15°C. Under ordinary storage conditions (room temperature, open containers) Abies seed retains little or no viability after 1 year. Germination is improved by cold moist stratification for about 1 month. Without this treatment germination is of the order of 10-25%. The germinative capacity is however, typically low (< 50%), reflecting the presence of many unfilled or partially filled seeds.

SILVICULTURE

In the nursery seedlings have a slow initial growth. Stock is usually outplanted as 2-3 year old seedlings or 3-4 year old transplants. When seedlings are being

transplanted in their definitive location they should be 20 - 25 cm tall and spaced 2 x 2m apart. This arrangement will provide an initial density of 2 500 plants per ha. The tree is cultivated in Guatemala both for woodworking purposes and to produce Christmas trees. Growth is relatively fast; even though the tree grows rather slowly during the first eight years, it develops quite rapidly therafter.

STATUS

In large parts of its range, particularly in Guatemala and southern Mexico, the species is extremely rare and in imminent danger of extinction. Where it does remain, dysgenic fellings have greatly impoverished the gene pool.

REASONS FOR DECLINE

Human pressure on land for agricultural cultivation is the main cause of the destruction of these forests. Local demand for lumber and firewood, too, take their toll. The cone crop is frequently poor, and what regeneration does emerge is grazed by sheep and other livestock. The popularity of saplings of A. guatemalensis for Christmas trees and the frequent lopping of branches of mature trees for decoration of houses and churches during religious festivals has undoubtedly also contributed to its general decline.

PROTECTIVE MEASURES TAKEN

With the backing of 86 member countries concerned about the imminent danger of extinction of A. guatemalensis, this species was included in Appendix 1 of the Convention on International Trade in Endangered Species of

Woodland Fauna and Flora (CITES) signed in Washington, March 3, 1983. The above stipulation had then already been approved by Decree No. 63 - 79 of the Republic of Guatemala, issued October 2, 1979. Furthermore, based on the National Palace Accord of June 7, 1983 (Art. 1°), the harvesting of small christmas trees was forbidden, and the cutting or marketing of trees from natural forest stands was outlawed. The practices were however allowed to continue in man-made plantations. Guatemala's Instituto Nacional Forestal (INAFOR) currently forbids the marketing of small Christmas trees of this species, which originate from natural stands. Clandestine depredation never-the-less still occurs, due to the religious value placed on the young trees for use at Christmas. The marketing of wood from A. guatemalansis was restricted in Guatemala, from June 1981 to February 1984 by an internal provision of Guatemala's forestry authorities. This stipulation was later abolished because it did not meet all the legal requirements for full observance. Some seed is collected annually by the National Seed Centres in Guatemala and Mexico. CAMCORE (Central America and Mexico Coniferous Resources Cooperative), based at the North Carolina State University, USA, collect seed of A. guatemalensis for their members in most of the known stands of the species in Mexico and Guatemala for the establishment of ex-situ conservation and breeding stands. Much of the forest already occurs on protected Government land, but this has done little for in-situ conservation.

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Abies nebrodensis (Lojac.-Poj.) Mattei [1/]

SYNONYMS

Abies pectinata Gauss. (1844)
A. pectinata var. nebrodensia Lojac.-Poj. (1904)
A. alba nebrodensis (Lojac.-Poj.) Svob. (1964)
A. alba ssp. nebrodensis (Lojac.-Poj.) Nitz. (1969)

FAMILY

Pinaceae

VERNACULAR NAMES

Abete dei Nebrodi (Italian);
Sicilian fir (English).

BOTANICAL DESCRIPTION

General

A medium-sized tree reaching 8-15 m in hight and 35 cm or more in diameter. Trunk straight, with an expanded, almost semi-orbicular crown. Branchlets of the current year greyish green, turning to yellowish brown; furrowed and alternately ridged, smooth, glabrous, rarely with short-brown hairs. Leaf-scars rhomboid-orbicular, light-red, tinged with a white centre.
Winter buds resinous, ovate, acute at apex, with 3-4 series of scales; the scales triangular-ovate, somewhat mebranous and slightly laciniate on margins.

1/ FAO acknowledges the assistance of R. Morandini
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Fruit

Cones shortly pedunculate, cylindrical, acute or conical at apex, 7-8 cm long, 3-3.2 cm wide, with slightly exserted, reflexed bract-scales; pale greenish brown or yellow in colour. Cone-scales obovate-rhomboid or cyathiform-flabellate, 2.8 cm long and 3.3 cm wide, with reddish pubescence; upper margin convex, undulate or entire, lateral margins denticulate, with two short wings above the base, curving and obscurely auriculate on each side of the cuneate claw. Bract-scales linear-spathulate, with lamina erose-denticulate on margins, slightly obcordate at apex, with a slender tip extended from the midrib.

Foliage

Leaves irregularly arranged in two lateral sets, spreading horizontally; those on cone-bearing branchlets curved upwards forming many series in a single plane; linear or ligulate-linear, 13-20 mm long, 2-3 mm wide; stiff flat, truncate, obtuse or slightly emarginate, those on old branchlets rounded with a minute rigid point or a short acumen; sometimes cuspidate at apex; upper surface with a central furrow, with broken lines of stomata near the apex; lower surface with white stomatal bands, each of 6-11 lines and with the midrib broader than its two lateral revolute margins. Resin-canals marginal; hypodermal cells in a continous band only interrupted by rows of stomata on lower surface.

Bark

Bark fissured into small irregular flakes on the old trees.

WOOD PROPERTIES AND PRODUCTS

As for Abies alba

NATURAL DISTRIBUTION

Sicilian fir is found growing on Monte Scalane, Polizzi Generosa (Palermo), Sicily, at elevations between 1 400 and 1 600 m altitude.

It is said that Sicilian Fir was once widely distributed on the higher mountains of the northern part of Sicily; in ancient times or some time before 1750, but it is now very scarce. It is cultivated in the Arboretum Vallombrosa, Italy, Arboretum des Barres in Paris and in the Rock Garden at Bayfordbury. Also specimens of this fir are found at Kew and Bedgebury in England.

CLIMATE

Montane mediterranean climate

HABITAT

This fir has probably formed extensive forests in the past on all the higher mountains in Sicily, Italy.

SILVICULTURE

As for Abies alba.

STATUS

Abies nebrodensis, a fir endemic to Sicily, has been almost completely destroyed. At the beginning of this century it was considered as an extinct species. Later investigations led to the discovery of a few trees. In order to start the protection conservation and reconstitution of this fir on a sound basis, an

inventory of the remaining living trees has been carried out: the following firs are the actual remnants:

- 21 native (wild) trees, at Monte Scalone (Sicily);
- 1 tree, grown from seed, but artificially planted, in Polizzi, Generosa (Sicily);
- 3 trees, grown from seed, artificially planted, in the Arboretum at Vallombrosa (Florence);
- 3 grafted trees at Villa Lanza di Gibilmanna (Sicily);
- 3 grafted trees in the Arboretum at Les Barres (France);
- 2 grafted trees in the Arboretum at Amance-Nancy (France);
- 1 grafted tree at Borde Hill, Sussex (Great Britain).

Some of the native firs are fertile.

REASONS FOR DECLINE

Exploitation and increasing human pressure.

PROTECTIVE MEASURES TAKEN

The area where the 21 wild firs grow has been declared a natural park. Young plants are grown from seed and planted in the same region to establish new groups.

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Liu, Tang-Shui, 1971 — A Monograph of the Genus Abies, Dept. of Forestry, National Taiwan University, Taipei, Taiwan, China. 608 p.

Abies numidica de Lann.[1/]

SYNONYMS

Abies pinsapo var. baborensis Coss (1861)
Pinus pinsapo var. baborensis Christ (1865)
Abies baborensis Coss (1866)
Pinus numidica R. Smith (1875)
Abies pinsapo var. numidica Salomon (1884)
Abies numidica var. aurea Blaringhen (1929)
A. numidiensis Alphand (1929)
A. pinsapo var. numidica Svob. (1953).

FAMILY

Pinaceae

VERNACULAR NAMES

Taument (Berber)
Algerian fir , Algerian silver fir (English)
Sapin de Numidie, Sapin d'Algerie , Sapin de Babors (French)
Numidische Tanne, Numidsche Weisstanne, Algierische Tanne (German).

BOTANICAL DESCRIPTION

General

Tree attaining 15-20 m in height and 50-80 cm in diameter near the base, usually with a dense pyramidal crown. Trunk short, stout, often free of branches to a height of three to four metres; occasionally more or less

1/ Based on the work of P.J.Stewart, Oxford Forestry Institute, Dept. Plant Sciences, University of Oxford, OXI 3RB, UK.

twisted and often divided into several stems. Branches slightly pendulous; 1st and 2nd order branchlets smooth, often becoming grey-brown.

Fruit

Cones shortly pedunculate, surrounded by three series of scales at the base; cylindrical, 12-18 cm long, 4-6 cm in diameter; mucronate at apex, rounded at base or slightly tapering at both ends, with completely hidden bract-scales; brown in color tinged with purple. Seeds (with wings) a little shorter than the cone-scales; wings oblong, truncate at apex, about 1½ times as long as the body of seed. Cotyledons five to seven in number, about 2 cm long.

Foliage

Needles broad and thick, 15 to 25 mm long by 2 to 2.5 mm broad, apex rounded: longer and upward curving on underside of shoot, parted along upper side. Upper surface of needle finely furrowed dark green; lower surface with two bands of stomata. Needles more thickly set and sharply pointed on fertile shoots. Buds ovoid, brown, only slightly resinous.

Bark

Bark grey and smooth when young, becoming fissured scale on the surface of old trees.

WOOD PROPERTIES AND PRODUCTS

No serious study of the timber appears to have been made, presumably because its rarity at present precludes commercial use. But there should be no

reason to suppose that its wood is very different from that of other firs.

Other Uses

It is greatly appreciated as an ornamental tree.

NATURAL DISTRIBUTION

Endemic on Mounts Babor and Tababor in Algeria (5°30 East, 36°30 North) covering about 200 ha on the former, in mixture with oak and cedar, and being represented by a few old trees on the latter. At altitudes between 1 800 m and 2 000 m.

CLIMATE

Mediterranean climate with summer dry season of several weeks; rainfall c.2 500 mm, temperatures probably with average summer maximum of 18°C and winter minimum of -1°C, with extreme frosts of -8°C or -10°C.

SOILS

The trees occur on brown forest soils with a limestone base.

HABITAT

It forms dense forests almost always in association with other conifers and broadleaved trees at higher elevations and even grows towards the mountain summit.

SEED HANDLING

As for other firs.

SILVICULTURE

No special measures are called for: the usual procedures for firs are successful.

STATUS

In danger of slow decline

REASONS FOR DECLINE

Grazing; clandestine removal of wood for local use.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

The naturally occurring firs are within the limits of the National Park of the Babors. This, however, is not included in the United Nations list of National Parks. The species is well represented in arboreta and botanic gardens, but most of these specimens probably derive from the seed of only a few trees. Systematic seed collection should be undertaken and protective measures should be reinforced.

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Acacia albida Del.

SYNONYMS

A. albida Del. var. senegalensis Benth. (1842)
A. saccharata Benth. (1842)
A. gyrocarpa Hochst. ex A. Rich. (1847)
A. mossambicensis Bolle (1861)
Prosopis ? kirkii Oliv. (1871)
A. albida Del. var. microfoliolata De Wild. (1925)
A. albida Del. var. variofoliolata De Wild. (1925)
Faidherbia albida (Del.) A. Chev. (1934)

A. albida is a very distinct and systematically isolated species, without any close relatives. Brenan (1959) mentioned the presence of two well-defined geographical races within A. albida based on leaflet size and the presence or absence of pubescence. In his study of West African Acacias, Nongonierma (1978) also indentified several intraspecific categories within the species. Although there is no concensus on the taxonomic status of the reported intraspecific categories, an important conclusion which may be drawn from such reports is that A. albida shows important intraspecific variation. This suggests a wide genetic base and therefore a high potential for genetic improvement.

FAMILY

Leguminosae - Subf. Mimosoideae

VERNACULAR NAME

Haraz (Arabic)

BOTANICAL DESCRIPTION

General

Tree 4-30 m high, sometimes shrub-like. Trunk usually single up to 2 (rarely 6) m in diameter. Young shoots ashen grey to whitish. Crown rounded in outline, spreading, with branches often drooping in mature trees. Spines paired, 0.2-3.2 cm long, stipular in origin, straight, never enlarged or inflated, often tipped with orange or brown, especially when young.

Inflorescence

Flowers in a spicate inflorescence, 3.5 - 15.7 cm long, borne on peduncles 0.8-6.3 cm long; flowers creamy yellow, sweetly scented. Stamen filaments shortly tubular at base. Anthers 0.2-0.4 mm wide, eglandular in bud.

Fruit

Pods bright orange to reddish brown, falcate, curved into a circular coil or twisted; when straightened out 6-35 cm long and 1.4-6 cm wide, indehiscent. Seeds 11-29 per pod, lying transversely to the long axis of pod.

Foliage

Leaves bipinnate; petiole eglandular. Pinnae 2-12 pairs, with a single conspicuous gland on the rhachis at the junction of each pair. Leaflets 6-23 pairs per pinna, glabrous to pubescent, 2.5-12 mm long, 0.7-5 mm wide. Leaves shed at start of dry season, new leaves produced at the beginning

of the rainy season. This may occur twice per year where, (as in East Africa), there are two rainy seasons. Davidson & Jeppe (1981) state that trees may bear leaves all the year round where there is no waterlogging.

Bark

Bark brown to dull grey or whitish, rough and somewhat corky, scaly and fissured.

WOOD PROPERTIES AND PRODUCTS

The sapwood is dirty white. The soft, yellowish-white heartwood is subject to attack by borers and termites. Although it is easy to work, it springs and twists after sawing, even when the wood is seasoned. It is used for furniture, joinery, interior fittings, boxes, shutters and for structural purposes. In Nigeria the stems of mature trees are fastened together to make dugout canoes; stems are also used for constructing Nile ferry boats. The wood is used locally for mortars, pestles, oil presses, drums and light carpentry. In some areas it is also used for charcoal burning.

Other Uses

The foliage is a valuable fodder for all types of stock. Young leaves and shoots are usually avidly browsed. Livestock that eat Acacia albida remain in good condition during the dry season when it is often the only green growth available. The tree is often lopped and branches carried to camels, cattle, sheep, and goats. The pods, too, are eaten by livestock, especially cattle, and also by elephants, antelope,

and baboons. The nutritional value does not deteriorate on drying, (which is the case with many other acacias). Thus A. albida is fed dry in many parts of Africa. In the Sudan, trees produce an average of 135 kg of pods per tree and the yield from a stand of 12 trees in the Sudan has been calculated to be 200 kg of crude protein from the pods alone. The seeds contain up to 27 percent crude protein and are eaten by people in Zimbabwe during times of famine. The seeds are boiled to loosen the skin and then reboiled to separate the kernels. A mature tree can produce more than a million seeds a year. Acacia albida pods may be mixed with maize and ground nut meal for food, or combined with hay and succulents for fodder. The old bark is rich in tannin (28 percent), the roots and pods are not (5 percent). In northern Nigeria, the pounded bark makes a packing material for pack saddles for oxen and donkeys. In West Africa and Tanzania the tree yields a gum of good quality.

NATURAL DISTRIBUTION

The natural distribution range of A. albida extends from Senegal to Ethiopia, and southwards through East Africa to the Transvaal and Lesotho. The largest concentration of the species occurs on the sandy alluvial soils of the Jebel Mara drainage system in the Sudan, where pure stands are found in belts often a mile wide. Outside Africa, A. albida occurs in Israel, Lebanon and Jordan and reportedly in Yemen. It has been introduced to Cyprus and Pakistan and is presently being tested in India and

Peru under the FAO project on Genetic Resources of Arid and Semi-Arid Zone Arboreal Species for the Improvement of Rural Living.

CLIMATE

In Africa A. albida is found wherever there is a prolonged dry season.

SOILS

The tree occurs on a wide range of different types of soil (alluvial, sandy alluvial, reddish brown clays, dunes and basalts), but often with a preference to good moisture conditions. Leaf-litter decay and excreta from grazing animals during the dry season enrich the soil, which has resulted in greatly increased yields.

HABITAT

In southern and eastern Africa, A.albida is always found in riparian communities, but in West Africa it also grows away from river banks and watercourses; often in cultivated lands, however, access to ground water seems to be important. Its distribution patterns vary widely; sometimes the trees grow singly, sometimes in groups, whose upper branches grow together forming a canopy. Although it can be found at altitudes up to 1 800 m in Uganda, and as high as 2 300-2 500 m in the Sudan, it more usually occurs below 1 200 m.

SEED HANDLING

Fresh seeds with soft seed coats require no pre-treatment or can be soaked in cold water for 24 hours before sowing. More mature seed can be soaked in

concentrated sulphuric acid for 20-60 minutes.
No. of seeds/kg: 10 000-40 000.

SILVICULTURE

Although generally there seems to be adequate seed production, natural regeneration by seed may be limited because of heavy seed predation and high seedling mortality. Regeneration by vegetative means is often more successful under natural conditions, and suckers may develop in a radius as wide as 20-25 m from the mother tree. Vegetative reproduction is the main means of natural regeneration where the natural stands produce little viable seed. Growth of A. albida seedlings may be relatively slow during the first few years after planting, while the plant develops a deep tap root. Saplings and young trees are relatively fast growing. In Chad it has been recommended to plant 100 seedlings per hectare which should be five times the optimum number of mature trees. This planting area consists of marginal farmlands just north and south of the 400 mm rainfall belt, with annual rainfall ranging from less than 200 mm up to 700 mm.

STATUS

A. albida as a species in not in danger of extinction. However, some stands in Israel may be threatened, because the species is regarded as being of little value to the country and no priority is given to conserving the stands for national purposes. Because of its reportedly disjunct distribution in Israel, A. albida is considered to be a Sudano-Deccanian

relic, its habitats being fragments of a formerly continous area of distribution in Palestine during the Oligocene and Miocene. This disjunct distribution should be explained by historical reasons rather than by particular site factors limiting its occurrence under present climatic conditions.

REASON FOR DECLINE

Increasing human pressure including use as fuelwood,fodder and browse and changing land-use patterns.

PROTECTIVE MEASURES TAKEN

Is one of the species included in the FAO/IBPGR Project on Genetic Resources of Arid/Semi-arid Zone Arboreal Species for the improvement of Rural Living. Seed collections for species provenance-trials and conservation have been implemented in Israel and Senegal and are planned in the Sudan.
In Israel the collection sites are:
Shimron (Nahalal) on the road from Nazareth to Haifa; Menahamia; Emeh Haela (valley of the Pistacea), Ashod.

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Acacia caven (Mol.) Mol.[1/]

SYNONYMS

Mimosa caven Mol. (782)
Acacia cavenia (Mol.) Hook & Arn. (1830)
Acacia farnesiana (L.) Wild. var cavenia (Hook. & Arn.) O.Kuntze (1898)
Vachellia farnesiana (L.) Wight & Arnott fma cavenia (Mol.) Spreng. (1923)

FAMILY

Leguminosae Subf. Mimosoideae

VERNACULAR NAMES

Espinillo, chusqui, aromita (Argentina); espinillo, espino, caven (Chile); churqui (Bolivia).
Thornbush (english).
Quirinca (fruits).

BOTANICAL DESCRIPTION

General

A small tree, averaging 6 m high. Crown almost perfectly hemispherical; trunk gnarled, up to 50 cm in diameter. Branches thick, crooked, scored, mottled. Branchlets flexible, knotty, pubescent. Spines stipular, paired, horizontal, delicate; varying a great deal in size: 5 - 25 mm long; very sharp, light grey in colour and pubescent at the base; dark and glabrous toward the apex.

1/ Based on the work of Corporacion Nacional Forestal, CONAF, (Avda. Bulnes 285, Santiago, Chile).

Inflorescence

Inflorescences of dense rounded heads, 1 cm in diameter; yellow-gold to orange-yellowish; slightly aromatic; peduncle 5-10 mm long, flowers growing together with the leaves; flowers hermaphrodite, sessile, 5-7 mm long. Calyx reddish, 4-6 toothed, corolla yellowish, five-toothed; stamens polydelphous, numerous (i.e. 40-60); ovary, oblong, pubescent, unilocular, multiovulate; style glabrous, 5 mm long, stigma hardly noticeable.

Fruit

Fruit ovoid-cylindrical, either straight or recurved. Although it is generally shorter, thicker or even much smaller, it may attain a length of 10.5 cm and a diameter of 2.5 cm; torulose; the surface smooth, or with faint lengthwise striations; sutures barely visible; pericardium somewhat fibrous, though sometimes harder; little or no resin.

Foliage

Leaves deciduous, bipinnate, fascicled; axillary primary rhachis pubescent, 1 - 4cm long, with 7-12 pairs; of opposed, secondary axes, 5-10 mm long. Leaflets, 12-20 pairs; entire, opposite, sessile, oblong, glabrous; 1-2 mm long and about 0.5 mm wide.

WOOD PROPERTIES AND PRODUCTS

Bark blackish thick, fissured lengthwise. Used for fuelwood and charcoal. Wood hard, heavy and very compact, used in handicrafts and for tool handles.

Other Uses

During periods of scarce forage, the foliage is browsed by animals.

Flowers may be removed to manufacture perfume or left on the tree to promote honey production. With its vigorous root system, the species is a soil stabilizer, which is optimal for harnessing rainfall, and consequently regulating the water supply on watersheds. This unquestionably helps to increase agricultural production. The fruit characteristics are such that it can be predicted that in the future it might be used as concentrated cattle fodder. The protein composition of the seed has been examined and compared to egg protein. The main results show a relatively high sulphur amino acid content and an adversely low content of valine. Because many other plant proteins have a deficit in sulphur amino acids, A. caven seed protein could be useful as a diet supplement.

NATURAL DISTRIBUTION

It occurs in semi-arid and semi-humid areas of steppe, savannah or dry forest; from the inter-Andean region of Bolivia,in the civil jurisdictions of Chuquisaca and Tarija up to elevations of 2 000 - 3 500 m,to Chaco and Mesopotamia in Argentina; western Uruguay; the central region of Coquimbo and Aconcagua as far as the 37th parallel south of Nuble, Chile.

CLIMATE

Rainfall 100 - 1 000 mm; dry winters, with an average temperature of approximately 17° C, and a minimum of -8° C.

SOILS

It adapts to a large variety of soils, preferably with a clayey or sandy texture, with pH close to neutral. Can tolerate saline and slightly acid soils.

HABITAT

Often found as the main woody species in savannah (Chile) areas together with Prosopis chilensis and Prosopis tamarugo. Vegetation in the area ungrazed by domestic livestock has two characteristic strata, one shrub-stratum normally not higher than 2.5 m, and a second stratum of annual and herbaceous plants.

SEED HANDLING

Thornbush seeds have an impermeable layer of surface cells which form a barrier preventing absorption of the water essential for germination, and therefore the percentage of natural germination is normally low, around 15 percent. Prior to planting, therefore, the seed must be pretreated to ensure a high final germination rate as well as rapid, uniform germination after sowing. Experiments in the central region have produced the following recommendation: soak seeds in concentrated sulpheric acid (H_2SO_4) for 90-120 minutes. Approximately 10 000 seeds per kg.

SILVICULTURE

In Chile the following practical guidelines are recommended:

a) nursery: the best time for sowing is September-October to November (springtime in the southern hemisphere) at the latest. Recommended sowing depth is twice the size of the seed. Once the seeds have

germinated and the first true leaves appear, they should be replanted in 10 cm x 20 cm plastic tubes, with a preprepared substrate, a blend of leaf litter, sand and soil in equal proportions, i.e. one-third each. The mixture should be presterilized with methyl bromide or its equivalent. The seedlings must be planted under shade, which should be gradually withdrawn until the plants are in full sunlight. This will allow them to lignify slightly in preparation for transplanting;
b) transplanting: the best time to plant is usually during the rainy months, beginning soon after the first rains, roughly by the end of May in the central region. The planting process may go on all winter, with the peak period in June and July. The most common soil preparation techniques are ploughing or digging planting holes.
A caven also resprouts readily and adventitious buds are easily observed in secondary roots which give rise to true shoots.

STATUS

The species is endangered in parts of its geographical range.

REASONS FOR DECLINE

Increasing human pressure including use of fuelwood and changing land-use patterns with intensive livestock grazing (Espinal, Chile).

PROTECTIVE MEASURES TAKEN

Is one of the species included in the FAO/IBPGR Project on Genetic Resources of Arid and Semi-Arid Zone Arboreal

Species for the Improvement of Rural Living. Seed collections for species provenance trials and conservation have been implemented in Chile.

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Acacia tortilis subsp. tortilis (Forssk.) Hayne[1/]

SYNONYMS

Mimosa tortilis Forssk. (1775)

A. spirocarpa var. minor Schweinf. (1867-8)

/ Brenan (1983) recognises four subspecies of Acacia tortilis

subsp. tortilis

subsp. raddiana

subsp. spirocarpa

subsp. heteracantha

subsp. raddiana is sometimes treated as a distinct species (Karschon, 1961)./

FAMILY

Leguminosae subf. Mimosoideae

VERNACULAR NAMES

Umbrella thorn (Africa)

Israeli babool (India)

Sayal, Samor (Egypt, Sudan)

Seing, Tortilis (Senegal), Mgunga (Tanzania)

Kandili, Bisaw (Niger), Seyal, Seyyal (Arabic)

BOTANICAL DESCRIPTION

General

Shrub or small tree 2-6 m high, with flattened crown. Young branchlets densely to sparsely pubescent or glabrous to subglabrous. Spines paired, some short

1/FAO acknowledge the assistance of Ahmed El Houri Ahmed (Forest Research Institute, Soba, Khartoum, Sudan)

and hooked; up to 5 mm long, others long and straight, slender, whitish, 1.2-8(-10) cm long, never enlarged or inflated. Petiole usually with a gland.

Inflorescence

Flower cluster (heads) 1-4, on slender stalks at leaf base. Flowers white or yellowish-white, scented, in round fluffy heads 0.5-1.1 cm in diameter; on axillary peduncles 0.4-2.5 cm long; flowers composed of a 5-toothed calyx 1 mm long, 5 petals, 2 mm long and many threadlike stamens; pistil with a thread-like style.

Fruit

Pods appressed-puberulous, shortly pubescent, slightly narrowed between seeds, not opening.
Seeds several, beanlike, elliptical, 6-7 mm long, light brown.

Foliage

Pinnae 2-10, occasionally up to 14 pairs (Ross,1979), on a short rhachis up to 2(-4) cm long; usually glandular between the upper 1-3 and lowest 1-2 pairs of pinnae. Leaflets 6-20 pairs per pinna, glabrous to densely pubescent, 0.5-2.5(-6) mm long, 0.2-1(1-.5)mm wide.

Bark

Grey or dark brown to blackish, rough deeply furrowed, scaly.

WOOD PROPERTIES AND PRODUCTS

Wood reddish with whitish sapwood, heavy; it warps upon drying and is often riddled by borers; used mainly for superior firewood and charcoal production; also used for fenceposts and small implements.

Other Uses

Protein-rich, nutritious pods are eaten from the ground by livestock and wildlife. Foliage, including new shoots and seedlings, also browsed. Plants survive heavy grazing.

Trees form attractive ornamentals, and provide good shade. The gum from the trunk is said to be edible. Pods can be strung into necklaces.

NATURAL DISTRIBUTION

Subsp. tortilis occurs in Somalia, Ethiopia, and the Sudan, northwards to Egypt and Israel and extending to the Yemen Arab Republic, P.D.R.Yemen, Oman, Saudi Arabia, Abu Dhabi and Qatar.

CLIMATE

An extremely drought resistant species which can survive in climates with less than 100 mm annual rainfall and long, erratic dry seasons. It does well in hot climates with maximum temperatures as high as 50°C, and grows where minimum temperatures are close to 0°C.

SOILS

Occurs on a wide range of soils provided they are well drained and non-saline.

HABITAT

Common in dry savannas, forming groves, and in other types such as bushlands, thornbush, bushveld, lowveld. The last woody species bordering the desert.

SEED HANDLING

Trees flower freely and produces seed copiously which is ready for collection in June-July. Seeds are 3-5 mm long by 2-3 mm wide, 50 000 per kg,but with as many as 40% affected by Bruchid larvae by the time they are collected.. Pre- treatment: a) Soak in concentrated sulphuric acid for 20-120 minutes, optimum soaking period will vary with different seed-lots; b) Immerse in boiling water for 5-30 seconds or pour boiling water on to the seeds and afterwards allow them to remain in water until it cools to room temperature. c) Make holes or cracks mechanically in the seed to allow water to enter.

SILVICULTURE

Coppices vigorously and tolerates lopping of large limbs.

STATUS

This subspecies is endangered in parts of its geographical range.

REASON FOR DECLINE

The reason for its decline is pressure from humans and their animals which is beyond the recuperative resilience of the species. Some trees, if allowed to survive, are dwarfed by continous

grazing where the new growth (before the thorns become rigid and protective) are eaten. However, if it is allowed to grow it can produce a huge crop of pods which are highly nutritious to animals.

PROTECTIVE MEASURES TAKEN

Is one of the species included in the FAO/IBPGR Project on Genetic Resources of Arid/Semi-arid Zone Arboreal Species for the Improvement of Rural Living. Seed collections for species/provenance-trials and conservation have been made in India, Israel, Yemen and Senegal.

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Acacia tortilis subsp. raddiana (Savi) Brenan[1/]

SYNONYMS

A. raddiana Savi (1830)
A. fasciculata Guill. & Perr. (1832), non H.B.K.
A. tortilis var. lenticellosa Chiov. (1932)
A. tortilis forma raddiana (Savi) Roberty (1984)
A. tortilis subsp. raddiana var. pubescens A.Chev.(1927)
A. fasciculata var. pubescens (A. Chev.) A.Chev. (1928)
A. tortilis var. pubescens Aylmer ex Burtt Davy (1930), (illegitimate name)
A. raddiana var. pubescens (A.Chev.) A.F. Hill (1940)

/ Brenan (1983) recognizes four subspecies of Acacia tortilis:

subsp. tortilis
" raddiana
" spirocarpa
" heterocantha

subsp. raddiana is sometimes treated as a distinct species, A. raddiana Savi, (Karshon, 1961).
Brenan divides A. tortilis subsp. raddiana into two variants: var. raddiana and var. pubescens. Var. pubescens maybe a hybrid between subspecies tortilis and subspecies raddiana/.

FAMILY

Leguminosae subf. Mimosoideae

1/ FAO acknowledge the assistance of Ahmed El Houri Ahmed (Forest Research Institute, Soba, Khartoum,Sudan)

VERNACULAR NAMES

Umbrella thorn (Africa)
Israeli babool (India)
Sayal, Samor (Egypt, Sudan)
Seing, Tortilis (Senegal), Mgunga (Tanzania)
Kandili, Bisaw (Niger), Seyal, Sayyal (Arabic)

BOTANICAL DESCRIPTION

General

Tree 1.2-10 m high, with more or less rounded crown.

a) var. raddiana: young branchlets and leaves glabrous or subglabrous.

b) var. pubescens: young branchlets shortly more or less pubescent.

Inflorescence

Flower cluster (heads), 1-4, on slender stalks at leaf base. Flowers white or yellowish - white, scented, in round fluffy heads 0.5-1.1 cm in diameter; flowers many, crowded, stalkless, about 4mm long, composed of a 5-toothed calyx 1 mm long, 5 petals 2 mm long, and many threadlike stamens; pistil with thread-like style.

Fruit

a) var. raddiana:
pods glabrous or nearly so, eglandular

b) var. pubescens:
pods appressed puberulous, eglandular, 6-9 mm wide.

Foliage

Pinnae 2-10, occasionally up to 14 pairs, on a short rhachis up to 2(-4) cm long, usually glandular between the upper 1-3 and lowest 1-2 pairs of pinnae.

Leaflets 6-20 pairs per pinna, glabrous to densely pubescent, 0.5-2.5 (-6) mm long, 0.2- 1(-1.5) mm wide.

Bark

Grey or dark brown to blackish, rough, deeply furrowed, scaly.

WOOD PROPERTIES AND PRODUCTS

Wood reddish with a whitish sapwood, heavy. It warps upon drying and is often riddled by borers. It is used mainly for superior firewood and charcoal, also used for fenceposts and small implements.

Other Uses

Protein-rich, nutritious pods are eaten from the ground by livestock and wildlife. Foliage, including new shoots and seedlings also browsed. Plants survive heavy grazing.

Trees form attractive ornamentals and provide good shade. The gum from the trunk is said to be edible. Pods can be strung into necklaces.

NATURAL DISTRIBUTION

a) var. raddiana: occurs in northern Africa from Senegal eastwards to the Sudan, Somalia and Kenya. Its status (native or introduced) in Kenya is uncertain. It also extends through Egypt to Israel, Jordan and Saudi Arabia. It is cultivated in India (Pakistan).

b) var. pubescens: has been found in Mali, Algeria and the Sudan.

CLIMATE

The species has a relatively wide temperature tolerance, being controlled in its distribution by temperature rather than precipitation. In Israel, its northern limit corresponds more or less to the 300 mm isohyet and a mean annual isotherm of 20°C.

SOILS

Occurs on various soils, including sand dunes, sandy loams and rocky and alkaline substrates.

HABITAT

Because of its relatively high demand for water, it is often found in hilly regions where the sharp relief has deeper wadis.

SEED HANDLING

Trees flower freely and produce copious seed. Seeds are 3-7 (6) mm long by 3.5-4.5 (4) mm wide. There are about 19 000 per kg but as much as 40% of crop is normally completely destroyed by Bruchid larvae when collected.

Pre-treatment:

a) Soak in concentrated sulphuric acid for 20-120 minutes; optimum soaking period will vary with different seedlots.
b) Immerse in boiling water for 5-30 seconds or pour boiling water on the seeds and afterwards allow them to remain in water until it cools to room temperature.

c) Make holes or cracks mechanically in the seed to allow water to enter.

SILVICULTURE

The tree coppices vigorously and tolerates lopping of large branches. It has an extensive and deep root system, which enables the tree to thrive in dry desert wadis where sufficient accessible soil moisture at deepest levels is available throughout the year. Tolerates low temperatures and occasional frosts.

STATUS

This subspecies is endangered in parts of its geographical range.

REASON FOR DECLINE

The reason for its decline is pressure from humans and their animals which is beyond the recuperative resilience of the species. Some trees, if allowed to survive, are dwarfed by continous grazing where the new growth (before the thorns become rigid and protective) are eaten. However, if it is allowed to grow it can produce a huge crop of pods which are highly nutritious to animals.

PROTECTIVE MEASURES TAKEN

Is one of the species included in the FAO/IBPGR Project on Genetic Resources of Arid/Semi-Arid Zone Arboreal Species for the improvement of Rural Living. Seed collections for species/provenance trials and conservation have been made in India (maybe A.tortilis), Israel, Senegal, Sudan and Yemen.

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Alnus acuminata O.Ktze[1/]

SYNONYMS

Alnus ferruginea H.B.K.

A. jorullensis H.B.K.

FAMILY

Betulaceae

VERNACULAR NAMES

Jaul (Costa Rica)

Aliso (Argentina, Peru)

Lambrán (Peru)

Alder (English)

BOTANICAL DESCRIPTION

General

Tree up to 30 m in height, which depending upon the habitat, is either straight or irregularly shaped. Stem 20-50 cm or more in diameter; stem form semi-circular, elliptical or triangular.

Inflorescence

The alder is a monoecious plant, the inflorescences appear in catkins with 4 to 9 very short female aments on each branchlet which gradually transform into ovoid, lignified "cones" with permanent scales. Female flower bracteate, each bracht bearing 2 flowers, with 2 styles. When cones become

1/ Based on the work of P.Rosero (Batan 405, Quito, Ecuador).

mature, they are 16 to 22 mm in length and 10 to 12 mm in diameter and adhere to the plant long after the seeds have been shed. From 3 to 5 male catkins occur, c. 5 cm from the end of each inflorescence-bearing branchlet. Each bract bears 3 flowers and 4 bractlets.

Fruit

The fruit is a monospermous indehiscent, nut, dark yellow to light bronze in colour, with expanded tissue in the form of wings, and 2 persistent styles that turn black when mature. The seeds are located along the axis of the scales of the cone, one or two per scale.

Foliage

Leaves simple, alternate, ovate, with somewhat wavy serrate edges, asymmetric, tips slightly acuminate or pointed, base obtuse. The surface of the leaf darkish green and glabrous; the underside, light green or pale pinkish. The underside of very young leaves is covered with a mucilage; nervation prominent and somewhat pubescent. Size of leaves varies from 6 to 15 cm in length and 3 to 7.5 cm in width, with 10 to 14 pairs of nerves on adult leaves. Stipules caducous Petioles from 1.5 to 3 cm in length, colour from light green to pinkish.

Bark

Outer bark normally smooth, in places wrinkled or with certain parts splitting and fissured; lenticels arranged in horizontal rings which enclose the brownish or greyish-coloured heart wood.

WOOD PROPERTIES AND PRODUCTS

Used for fuel and small construction work. The wood is pale brown or superficially bronze coloured, with low luster. Odourless and tasteless when dry. Light in weight, but firm.

Other Uses

Of potential value as a soil improver especially on eroded soils; the bark and leaves are used for tanning and dyeing and their astringent properties are also useful in local medicine.

NATURAL DISTRIBUTION

In Mexico and the Cordillera of Central America, from Guatemala to Costa Rica and in the Andes of South America (Argentina, Bolivia, Equador and Peru). Altitudinal range from 1,500 m (Costa Rica) up to 3,800 m (Peru).

CLIMATE

In Costa Rica this alder is found in the area where dairy cattle are raised; the area has an average annual rainfall of 3 100 mm and temperatures ranging from 4° to 27°C; it is a zone of constant fog. The foggy weather starts in May and persists until the month of November, although foggy days also occur during other months of the year. In Peru it prefers a rainfall in the range from 1 500 to 2 000 mm and a mean annual temperature of 18°C.

SOILS

It occurs on both fertile (Costa Rica) and less fertile soils (Andes). In Peru it is found in humid situations.

HABITAT

In its area of distribution, up to altitudes around 2 000 m, A. acuminata is found along small streams. At higher altitudes it grows in small valleys protected from the cold and dry winds coming from the highest mountains. On the best sites the development of the species has been the same whether it has been planted at the river-banks or in drier localities.

SEED HANDLING

Around 2 000 000 seeds/kg., germination normally above 30%, no pre-treatment is needed before sowing.

SILVICULTURE

Artificial regeneration of Alnus is carried out using normal silvicultural practices, and bare-rooted plants of 30-90 cm in height. The tree can also readily be reproduced from cuttings of 1 to 1½ cm in diameter, taken from adult trees. The rate of growth depends on management practices, which are adapted to the end-use of the tree. Yield also varies according to soil type and altitude. With a rotation of 18 to 22 years, the yield in a stand, grown for timber, is around 10-15 m^3/ha/an.

In Costa Rica alder is, as a rule, grown at a wide spacing (15 x 15 m) to improve pastures for dairy cattle. Under this management regime, trees will average 37 cm in diameter and 15 m in height at age 11, and over

40 cm in diameter and 29 m in height at age 32. As with all species of the genus Alnus, Alnus acuminata is able to fix atmospheric nitrogen through its root nodules. The formation of nodules (symbiosis between bacteria and the tree) depends on soil texture and aeration. Along slopes and riverbanks there is a better formation of nodules than when the trees are grown in combination with grazing or agriculture on relatively rich soils.

STATUS

Further study is needed. The species is likely to be endangered in parts of its geographic range. It is in danger of genetic impoverishment.

REASONS FOR DECLINE

Although A. acuminata regenerates very easily naturally, the trend to substitute native by introduced, fast-growing species has led to a gradual decrease in its natural area. Since the species requires deep, well-drained soils for optimum development, it also often competes with agricultural crops.

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Anadenanthera macrocarpa (Benth.) Brenan[1/]

SYNONYMS

Acacia grata Wild. (1809)
Adenanthera colubrina (Vell.) Brenan var. *cebil* (Gris.) Alts.
Piptadenia macrocarpa Benth. (1842)
Piptadenia microphylla Benth. (1842)

FAMILY

Leguminosae subfam. Mimosoideae

VERNACULAR NAME

Angico-vermelho, angico, angico-bravo, angico-preto, angico rajado, cambuí-ferro, guarapiraca, angico do campo, arapiraca, curupahi, angico castanho.

BOTANICAL DESCRIPTION

General

Tree with a crooked or straight trunk sometimes reaching heights above 15 m, a 30 to 50 cm diameter. Angular branching at the top of the crown; lacking thorns in the adult phase.

Inflorescence

Flowers in a globose capitulum, clustered and axillary flowers small, whitish in colour, with a 1-2 mm tubiform calyx with a serrate margin; corolla flat, two times larger than calyx. Flowering takes place from August to December, in trees of 4 to 5 years of age.

1/Based on the work of I.E.Pires and C.E.S.Nascimento, EMBRAPA/CPATSA, P.O.Box 23, Petrolina, PE, Brazil.

Fruit

A flat pod 32 cm long; brownish-yellow in colour, with a rough, wrinkled surface with small out-growths and few veins; 15 to 30 cm long by 2 to 3 cm wide.

Foliage

With up to 30 pairs of pinnae measuring from 4 to 8 cm, folioles in 50 to 60 pairs; opposite, sessile; membranaceous, lance-shaped, rounded and asymmetrical at the base, with a well pronounced midrib. Leaflets measure approximately 3 to 6 mm in length and 1 to 2 mm in width.

Bark

Greyish in colour, smooth, sometimes presenting small wrinkles or lengthwise fissures, with few thorns. When young, it has a thickness of about 2 to 5 mm.

WOOD PROPERTIES AND PRODUCTS

A chestnut-yellow colour, becoming a dark-red with distinguishable growth rings; yellow or rose sapwood, that is easily distinguished from the heartwood. It is a heavy hardwood (specific gravity 1.07), which is resistant to deterioration. The wood is used for construction, pillars, posts, fence posts, carpentry, beams, rafters, tile blocks, fuel, charcoal and other purposes.

Other Uses

Bark is used in the leather industry due to its high tannin content, up to 32%.

NATURAL DISTRIBUTION

This species occurs from the state of Marnhão to the state of São Paulo, including the "caatinga" in the Northeastern region, and the "cerrados" and the dry forest of Central Brazil. It is also found in Northern Argentina, Peru, Bolivia and Paraguay.

CLIMATE

Although widely distributed and found in the most diverse climatic conditions, from dry sub humid tropical to arid tropical, this tree prefers dry climates.

SOILS

It thrives best in deep soils. In the "caatinga" it is normally found on deep tableland soils and alluvials, and does not withstand excessively humid conditions.

HABITAT

Can be found isolated as well as along with other species, sometimes in dense and uniform formations. Generally in low mountain tropical forest of the Atlantic Coast, while in the Northeast it prefers the borders of streams and creeks.

SEED HANDLING

To obtain healthy seeds with good germination, the fruits must be collected when physiologically mature and before falling. In the Northeastern Brazil, physiological ripening is reached approximately 220

days after fruit setting begins. Storage in open conditions as well as in cold chambers provides an average germination above 80% after 5 months, independent of the type of packaging used.

The seeds of this species do not present dormancy problems, and will germinate without treatment within a period of 10 days. One kg may contain from 11000 to 17000 seeds.

SILVICULTURE

The cultivation of this species for commercial purposes is not common. However, based on the existing experiments, it is possible to establish pure stands. At 6 years of age, the stand renders wood for fence posts, fuel and charcoal. Studies in the Northeastern region, showed high survival and height for the species, under the semi-arid conditions of this area.

STATUS

The species is suffering a slow decline.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

No measures have yet been taken, neither for ex situ nor in situ conservation to preserve the original genetic pool. The studies underway on this species are limited to pure stands. Studies of the reproductive system and establishment of base populations is recommended, to preserve the genetic variation and to provide reproductive material.

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Aniba duckei Kostermans[1/]

SYNONYMS

Licaria guianensis Aublet (1775)
Aniba rosaeodora Ducke (1926)
Aniba rosaeodora var. amazônica Kostermans (1938)

FAMILY

Lawaceae

VERNACULAR NAMES

Pau-rosa, pau-rosa-mulatinho, pau-rosa-itaúba and pau-rosa-imbúba.

BOTANICAL DESCRIPTION

Inflorescence

A multi-flowered panicle, flowers with a small pedicel, flowering occurs between April and May; ferrugineours.

Fruit

With a very thick cupule.

Foliage

Narrow leaves, 4 to 5 cm in width, slightly curved or flat, acute at the base and with a pointed apex, semicoriaceous, the secondary ribs diverging from the primary rib at 45^{o} to 60^{o} angle.

1/ Based on the work of L.G.S. Costa, S.T.Ohashi and O.Daniel. Department of Forestry, Faculdade de Ciências Agrarias do Para, P.O.Box 917, Belém, Para, Brazil.

In a primary tropical forest, near Manaus this species presents yearly leaf changes, always during the dry period, which does not happen for the flowering and fruit setting phases. Due to irregular flowering and fruit setting and attacks on the fruits by birds, the seed supply is jeopardized.

Bark

The bark is a brownish yellow, and falls off in large plates or sheets.

WOOD PROPERTIES AND PRODUCTS

Wood heavy (0.80 to 0.90 g/cm^3); a brownish-yellow heartwood with pink highlights; yellow sapwood; a regular to irregular grain; medium texture, a shiny, smooth surface; an attractive aroma, which becomes stronger when the wood is cut; astringent and pungent to taste. Indians use this wood for making canoes and other similar purposes. In carpentry, the wood is described as easy to work with, and with an elegant finish. However, the use of this wood for carpentry purposes is rare, due to its economical importance to the perfume industry.

Other Uses

An essence (linaloil), which is widely used in the perfume industry, is extracted from distilled wood, leaves, and roots.

NATURAL DISTRIBUTION

In Surinam, this tree grows in the Tapanahoni and Gonini River basins, and, in French Guiana, it grows in Oiapoque. It extends to Peru (Iquitos, Rio Napo and Pucalpa), Colombia and Ecuador. In Brazil, besides the State of Amapá, and on the border of French Guiana, it prefers the high and mid Amazon region.

SOILS, CLIMATE

The climate where this species occurs naturally are of the Am and Aw type in the Köepen classification. 1/ It is found in clayey as well as sandy phase yellow and red latosols, and also on gley podzols. Its largest productivity is in soils originating from the upper carboniferous formations.

HABITAT

Aniba duckei occurs mainly in high land rain forests.

SILVICULTURE

This is an intolerant species, natural regeneration taking place only when there are clearings in the forest. The first planting of Aniba duckei took place in 1933 when plantings were established with 18 000 trees, of which a total of 8 000 remain. In general, plantations of this species shows very little development. The main limiting factors for seed germination are related to the harvest of the seeds.

1/ See page 219.

STATUS AND REASONS FOR DECLINE

In the Amazon Aniba duckei has long been a victim of excessive exploitation. Very often the root systems of the cut trees are torn out, eliminating the possibilities of asexual regeneration, thus contributing to the extinction of the species.

PROTECTIVE MEASURES RECOMMENDED

For conservation of the species some basic, biological information will be needed. It is therefore strongly recommended to step up research on floral biology, seed technology (germination and storage), and propagation methods (including vegetative propagation); and to initiate studies on the specific light, temperature and nutrient requirements during the initial growth phase, with the aim of developing appropriate silvicultural methods. Drawing on knowledge of the above establishment of pilot plantations and of base populations for genetic conservation, in and ex situ, is recommended.

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Araucaria angustifolia (Bert.) O.Ktze[1/]

FAMILY

Araucariaceae

VERNACULAR NAMES

Pinho brasileiro, pinho do paraná, pinheiro brasileiro, pinheiro das missões, curiúva, curi, araucaria-pinho (Brasil). Parana pine, parana wood, brazilian pine (England). Piñno Brasil, piñno de missiones, piñno paraná (Spain).

BOTANICAL DESCRIPTION

General

Tree, flat topped at maturity; when growing in open situations it is said to resemble the Chile Pine (A. araucana) "Monkey Puzzle". As the tree matures in forest conditions, the habit changes, the side branches being suppressed and lost, and those of upper whorls turning upwards to the light in the manner often referred to as 'candelabra' shaped. Branches: - verticillate, 4-8 in number, drooping with age; at first arranged so as to give the young tree a conical shape, which later becomes campanulate or, in old trees, a corymb or umbrella shape; phorb of branches horizontal, the tips curved slightly upwards or, less often, downwards; initially greenish-blue, becoming dark green and shiny. Trunk: - straight, occasionally forked, cylindrical and straight base.

1/ Based on the Work of Mario Tomazello (Forest Dept., University de São Paulo, Piracicaba, São Paulo, Brazil).

Inflorescence

A dioecious tree, bearing male and female flowers on different individuals.

- Male flowers: grouped in catkins or cylindrical cones, full of scales, crowning the short, lateral young shoots; they may be solitary or more often in pairs, attached to thin, downward-curving, somewhat flexible branches, slightly pointed, 8-17 cm long and 1.5 - 3.0 cm in diameter when ripe; they bear scales tightly attached to each other, which only become detached at maturity; scales narrow, thickened on the outside and enclose on the inside 15-26 anthers, about 5-6 mm long; the wind is responsible for pollination.

- Female flowers: - arranged in a multiseriate helix on a thick, fusiform axis, forming an exillary strobilus or cone, solitary, in the centre of a bracteate capsule, ellipsoidal or ovoid, green in colour, 7-8 x 5-6 cm; the surface is erinous because of the tips of the hard, prickly scales; scales triangular, flat with a rigid outer appendix, 15-20 mm long; each scale bearing a single ovule, by virtue of the complete and invisible fusion of the ovuliferous scale with the bract scale.

Flowering: - April to June.

Fruit

Cones: After fertilization, which occurs during September and October, the cone grows and the ovules develop into seeds; these are called "pinhões" and the cones "pinhos". The cones are globose-ovoid in shape and 20-25 cm in diameter; a cone is ripe and

opens 20-22 months after fertilization, when it drops the seeds; among these there are many empty, narrow, delicate, angular and elongated sterile scales; each cone may contain between 40 and 100 seeds, 4-7 cm long and 1.5 - 2.0 cm in diameter, which look exactly like the scales; due to the long period of ripening, large ripe cones as well as small ones may be found on the same tree; one tree may bear between 50 and 80 cones.

Seed: - consists of a nut, protected by a coriaceous-woody shell; this shell is rusty-brown in colour, with a smooth, shiny surface; underneath this is a thinner layer of wood fibre, and lastly a membranous skin, attached directly to the seed itself. This is ovate-oblong, white, starchy, 2.5 - 3.0 cm long.

Foliage

Leaves: simple, persistent, supporting several vegetative cycles, alternate, net-veined, oblong-lanceolate, acuminate, with a sharp point, dilated at the base, sessile, pronouncedly glaucous green, coriaceous, with a longitudinal concavity of the ventral face, turned towards the end of the branches, 2-6 cm long by 5-25 mm broad.

Bark

Dark, thick (2-15 cm), spongy and resinous; bearing thick, sunken plaques and rings at more or less regular intervals (former knots); exuding large amounts of resin, which hardens in contact with the air.

WOOD PROPERTIES AND PRODUCTS

When first cut, there is only little difference between the heartwood and sapwood, because both are whitish-yellow in colour; as time passes, the heartwood turns more ochreous; the design is softly outlined by the different density of the spring and summer layers; the veins are sometimes grey, but more often pink; of a medium to thin texture, grain straight to oblique; light in weight, easy to work; the growth rings distinctly visible. In Brazil it is the most important wood on the market. Much used in civil construction work and for all uses which require soft resistant wood, easy to work. Used on a large scale for the manufacture of medium or good quality plywood. However, a more rational use is for the manufacture of chemical pulp or mechanical pulp for paper in general and more particularly for newspaper.
(For Macroscopic and General Descriptions see Mainieri & Pereira, 1965).

Other Uses

The seeds are much in demand as food, preferably eaten cooked. The thick, spongy, resinous bark is a good fuel and can be fermented to make a pleasant drink. It has medicinal properties, and its ashes are rich in potassium.

NATURAL DISTRIBUTION

Araucaria angustifolia occurs naturally throughout southern and south-eastern Brazil, between latitudes 19°30' and 31°30' S and longitudes 41°30' and 54°30' W, including part of the province of Misiones in Argentina.

The region can be delimited as follows (Fig. 1):
Southern limit: in Rio Grande do Sul it is a very common forest species, but restricted to the mountainous regions in the north of the State; to the south of Jacuí there are a few isolated araucarias, but no continous forests.
Eastern limit: - nowhere does araucaria grow near the sea, either in isolation or in forests; generally the limits of the araucaria forests coincide with the watershed of the Serra do Mar; this leaves a strip of land, 20-40 km wide, between it and the coast - a strip which is even wider in the State of São Paulo.
Northern limit: in recent literature on the subject the northernmost recorded finding is near the Rio Doce, at about 18°.
Western limit: - Araucaria forests extend into Argentina, into the Province of Misiones and apparently there are even some isolated specimens west of the Paraná River. Recordings of the species in Goiás and Cuiabá are incorrect, according to Schenck. (Hueck, 1972; Shimizu & Oliveira, 1983).

CLIMATE

The species thrives within the climatic types classified, according to the Köppen's system, as "Cfa" and "Cfb" (humid subtropical without dry season and mild to hot summer). Such climatic types are predominant through the southern highlands where araucaria forests are concentrated. Within the given range of latitudes, these types of climate are found from lower altitudes in the north. Exceptions to these altitudinal

limits are also found, especially in the south, where the species occurs at altitudes of about 300 m in Sao Martinho and Tenente Protela (Mattos, 1972) and as low as 250 m (Pitcher, 1975) and 198 m (Gurgel Filho & Pisani, 1975) in Lauro Müller, near the coast of Santa Catarina. As mentioned by Maack (1968), Araucaria angustifolia extends to altitudes lower than 500 m only where cool air flows from the highlands towards the valleys. Normal mean temperatures in the araucaria region are 20 to 21° C in the summer and 10 to 11° C in the winter (Oliveira, 1948). Not only cool to mild temperatures but also plenty of rainfall throughout the year is required for this species. Annual rainfall figures ranging from 1270 to 2494 mm (Golfari, 1971) are usual but not less than 1 000 mm (Hueck, 1972). A. angustifolia is intolerant of water deficit and this is the main reason for its restriction to altitudes above 800 m in the northern part of its distribution area.

SOILS

A. angustifolia grows on a variety of soils derived from granites, basalts, diorites, phyllites, sandstones, schists and slates. It can survive on poor and shallow soils. The amount of plant food available in the soil plus the ability of the soil to retain moisture, appear to be of greater importance than soil texture. Because of its long taproot, deep fertile soil is absolutely essential for optimum growth; otherwise the plants very often die after 6-8 years when the roots reach stony layers or hardpan. Parana Pine requires good drainage.

HABITAT

As regards the growth patterns of araucaria forests in the southern states, it can be stated as follows:

Rio Grande do Sul: - In the southernmost state of Brazil, parana pine forests are the dominant plant formation of the plateau; south of the Vacacaí and the Jacuí there are some isolated specimens. In the northeast, between the Guarita and Turvo rivers, there are isolated specimens as far as the River Uruguai, even extending into Argentina. In the northwestern part of the state the forests join with the parana pines of the state of Santa Catarina.

Santa Catarina: - In this state the parana pine is the main feature of the landscape on the high ground of the Serra da Fortuna, that is, on the watershed between the River Chapecó and the Rio Chopim, in the river basin of the middle and upper reaches of the Uruguai, Peixe, Pelotas, Cavairas and Marombas rivers. Parana pine forests are also the dominant elements along the border with the State of Paraná. There are even virgin forests in the municipal districts of São Joaquim, Curitibanos and Chapecó. In the region of the coastal rivers, particularly in the River Itajaí valley, which penetrates deep into the State, parana pine forests lose their predominance and even disappear in places.

Paraná: - The protected area of parana pine in Paraná includes mainly the regions north and south of the middle reaches of the Iguaçu, the region around the source of the Piquiri and part of the region around

the upper reaches of the Ivai, i.e. mainly the western half of the State. As in the southern States, parana pine grows mainly on the plateau. Lower land is covered by subtropical rain forest. Today the parana pine forests join up to the east with the area which is now the most highly populated region of the State, where formerly it never formed extensive forests. This region extends as far as the western side of the Serra do Mar and the Serra da Virgem Maria, interrupted by expanses of steppe with few or no trees.

São Paulo: - In São Paulo, parana pine is restricted to the south. On both sides of the road from Curitiba to Capão Bonito its area of distribution extends beyond the limits of the two States. East of Capão Bonito the parana pine forests break up into isolated clusters. Around the city of São Paulo some parana pine forests still remain, for example in the Serra da Cantareira.

The lower limit of parana pine forests in the south-west of São Paulo is 200 - 300 m higher than in the southernmost states, i.e. it occurs at a minimum altitude of 700-750 m. There follows a vast blank area in terms of parana pine distribution until, only 100 km northwest of São Paulo, a new, more extensive area of distribution appears, in the Serra da Mantiqueira.

The best-known parana pine forests are the ones of Campos do Jordão, at altitudes of between 1 400 and 1 800 m, penetrating deep into the State of Minas Cerais. South of the Vale do Paraiba there are some highly exploited forests in the region of Paraibuna, in the Serra do Quebra Cangalha and the Campos da Bocaina.

Rio de Janeiro: - The best-known parana pine forests in this region are those of Itatiaia in the Serra da Mantiqueira. They grow at an altitude of 1 400 to 1 600 m, and usually form the upper forest limit. More specimens are to be found in the Serra dos Orgãos. Isolated trees can be found near Rio de Janeiro, especially on Corcovado and in the Tijuca forest. These are probably, at least in part, native trees.

Minas Gerais: - Various specimens exist in the southern part of this state. The area of distribution extends from the states of São Paulo and Rio de Janeiro, encompassing a large portion of the northern slopes of the Serra da Mantiqueirs. The centres of distribution are above all the countryside around Campos do Jordão (for the most part in the State of São Paulo) and the region of Passa Quatro. The altitude is normally between 1 300 and 1 600 m. On the pateau north of Itatiaia, open parana pine forests extend as far as Livramento, although they are now nothing but remnants. To the east of this there are specimens in the Serra da Mantiqueira, as far as Juiz de Fora. Further west parana pine occurs even in Minas Gerais, in the higher parts (about 1 000 m in the Serra Mata da Corda, particularly in Santo Gotardo, where, however, it is not the dominant species, but grows in the midst of primary forest vegetation, occasionally forming large clusters.

Espirito Santo: - There are no definite reports of the occurrence of native parana pine in this state, but naturalized specimens originating from plantations are often mentioned.

Goias and Mato Grosso: - References in literature to the occurrence of this tree in the region Cuiaba and Goias are almost certainly mistaken.

Argentina: - In Argentina, Araucaria angustifolia is restricted to the Territory of Misiones. There are forests on the western slopes of the Sierra Central de Misiones, i.e. in the lateral valleys of the Peperi-Guazu River, a right-bank tributary of the Uruguai, at altitudes up to 800 m. As a native tree Araucaria does not extend to the province of Corrientes.

SEED HANDLING

Seeds are regularly produced annually, and in Brazil they mature from late April to late May. The cones are said to take three years to ripen. Seeds: 100 - 180/kg. The seed does not retain its viability for long and not longer than six weeks when stored at atmospheric temperatures. Because of its short viability, seed should be sown within one month of collection. Seeds larger than 6 cm in length produce significantly better seedlings. Treatment against pests with methyl bromide gas at the rate of 20 cc per cubic metre of seed for 24 hours in heat-sealed plastic bags is recommended. After 24 hours the treated bags should be opened and the gas allowed to disperse.

SILVICULTURE

Germination is hypogeous, the cotyledons remaining within the seed, but they may emerge a little above the ground, forming a strong hypocotyl that continues below in the primary root, which will give rise to

a strong axial root. The seedling is a strong light demander, which does not develop under forest shade. The early method of establishment was by direct seeding in previously prepared areas. In the nursery it is best grown with high shade, giving about 50% light. After root-pruning the seedlings remain in the seed beds for about five months. For transplanting a spacing of 2 m x 2 m is recommended, but correct spacing and ideal basal area will vary from place to place. Correct tending in the first two years is particularly important. Pruning and thinning would depend on the object of management.

Parana pine's major demands are undoubtedly on the soil, so much so that, paradoxically, only 20 percent or less of the area of its natural range offers the right conditions for commercial cultivation. Its initial growth rate, is lower than that of both P. taeda and P. elliottii, and its demands for better quality soil are the main reasons why cultivation of parana pine is limited. With the practice of direct sowing its growth during the first year is very slow, and this obliges the planters to employ a number of cultural treatments which raise the costs of planting. However, this is not sufficient reason for abandoning cultivation of this conifer, which has many merits. It is an indigenous species, almost immune to diseases and epidemics of economic importance. Under particular environmental conditions it reproduces at a very satisfactory rate and supplies a wood which constitutes an excellent material for sawing, plywood and mechanical and semi-chemical pulp. In the Serra da Mantiqueira its cultivation is economically viable in areas of

former forest, on slopes or in humid valleys with fertile soils and good drainage. It is not suitable for cultivation in open space, where the limitations are nutrient deficiency, aluminium toxicity and the shallowness of the soil, which causes the tree to become very sensitive to the effects of drought during the winter season. (Golfari, 1971; Golfari et.al.,1978).

STATUS

Endangered in parts of its natural range.

REASON FOR DECLINE

Araucaria forests have been the main source of high quality timber for construction, frame work, furniture, veneer, pulp and other uses. Saw timber and veneer have been exported to several countries for a long period; at times they were rated second only to coffee in export value. The araucaria reserves in the State of São Paulo were exhausted in the period between 1930 and 1940 (Krug, 1964). As estimated by Maack (1968), 7.4 million hectares of natural araucaria forest which existed in the State were further reduced to 433 - 580 ha (Machado, 1975) in 1967 and 316-620 ha (FUPEF/BDF, 1978) in 1977, the latter being only 4.3% of the original area.

Araucaria timber production in all States increased from 1.5 million cubic metres in 1945 to 3.3 million in 1950. From that year to 1966, the output was steady around 2,8 million cubic metres a year. Then until 1972, it decreased to an annual output of 1.8 million cubic metres (Paraná, 1976). (Shimizu & Oliveira, 1983).

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

Reforestation with araucaria was done at first by a few companies as well as by the Federal Government. Close to 90,000 ha had been planted by 1979, according to the estimates from several sources. Araucaria angustifolia is not considered a fast growing species in Brazil. Due to this, plantation rates have declined sharply during the last years (not more than 300 ha a year), giving place to the introduced Pinus elliottii, P. taeda and Eucalyptus which are less site demanding and have higher growth rates.

A few planted or natural stands have been maintained for seed production areas by the Brazilian Institute for Forestry Development (IBDF) and some companies as well. Further experiments for the study of provenance and progeny variation are under way, in connection with the formation of genetic base populations for improvement work, under the coordination of the Brazilian Working Group on Forest Tree Improvement. Preliminary seed zones have been determined based on these experiments. The material will be followed closely up to rotation age, to ascertain the accuracy of these zones.

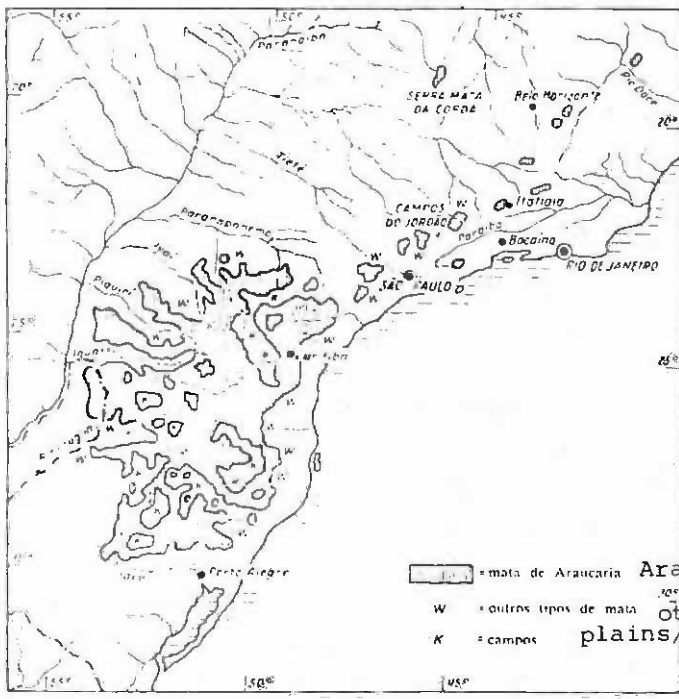

FIGURA 1 - Área de distribuição da *Araucaria angustifolia* no sul do Brasil e Argentina (segundo HUECK, 1972).

Figure 1 - Distribution of Araucaria angustifolia in southern Brazil and Argentina (according to HUECK, 1972)

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Araucaria cunninghamii Aiton ex Lambert[1/]

SYNONYMS

Altingia cunninghamii D. Don t.79 (1830)
Araucaria cunninghamii Sweet (1830)
Araucaria cunninghamii D. Don (1839)
Araucaria beccari Warb. (1900)
Araucaria cunninghamii Ait. var. *papuana* Laut. (1913)

FAMILY

Araucariaceae

VERNACULAR NAMES

Papua New Guinea:
Wasik (Bulolo), Gobe (Waria), Gobe (Mai.ama), Kuru (Mt. Kumme), Mau (Agaun), Nimola (Fergusson Is.), Toe'okera (Suwaira), Beneba (Lufa), Gapma'aa (Warabung), Gama (Sina Sina), Kumane (Poinduma), Manemoi (Manegoima), Gilman (Kurumul), Taya (Pogera-Paiela), Wiru (Erave), Escera (Pimaga), Escila (Kutubu), Bantu'ump (Bumbu), Bontuan (Kaigorin), Alloa (Arfaks), Ningwik (Fak Fak Mts.) Sari (Bembi), Warir (Gurumbu), D'Li (Oksapmin-Telefomin), Musalo Wutung, Pien (Kebar Valley).

Australia:
Richmond River Pine (New South Wales), Hoop pine.

BOTANICAL DESCRIPTION

General

A large, unbuttressed, symmetrical tree, 50-70 m high. Bole straight, cylindrical, self-pruning, clean to 30 m

1/Based on the work of N.H.S.Howcroft (Office of Forests, Forest Research Station, P.O. Box 134, Bulolo Morobe Province, Papua New Guinea).

or more on mature trees, 1.2-1.7 m diameter. Crown pyramidal to flat.
Branches in whorls of up to six, more or less horizontal, with second to fifth order branchlets.
Trunk internodes variable, 1-4 m.

Seedling: Cotyledons four, small, narrow linear, 10-30 x 1-4 mm, glabrous, flat.

Inflorescence

Monoecious. Male strobili usually borne on lower and mid-crown branches, terminal, green, yellow at anthesis. Red-brown later, elongated, about 90x 10 mm. Pollen spheroidal, without air sacs, wind dispersed. Female strobili borne mostly in upper crown, terminal, green consisting of clustered, spirally arranged ovuliferous scales fused with ligulate scales.

Fruit

Cone: green, ovoid 70-100 x 60-80 mm; the cone is covered with short spines, 9-10 mm long, porrect or deflexed.

Seed: in the form of ovulate cone scales, more or less flat, woody, triangular with two thin wings, indehiscent. Scale terminating in a sharp spine; reddish brown in colour; seed (excluding wing), 20-30 x 9-10 mm.

Foliage

Juvenile foliage: Leaves longer and flatter than adult, 23-27 x 20-25 mm. Persist until trees are bout 10 years old.

Adult foliage: Leaves crowded in overlapping whorls on ends of branches, persistent, without petioles, narrow to broadly triangular, slightly curved, 8-10 mm long, glabrous, dull green colour.

Bark

Outer bark dark plum, red-brown or grey coloured, rough, peeling off around circumference in stringy papery layers; middle bark reddish brown; inner bark mottled white.

WOOD PROPERTIES AND PRODUCTS

Wood cream to almost white in colour. Exudate thick, viscous, white and resinous. It is an important tree for the saw-milling and plywood industry in Papua New Guinea and has potential for wood pulp and chips.

NATURAL DISTRIBUTION

In the island of New Guinea, this conifer has a discontinous distribution ranging from the headwaters of the Saga Aho River in the Milne Bay area of Papua at latitude 10°04'S, longitude 150°15'E, altitude 550-900 m a.s.l., up to the north-western end of the Vogelkop of West Irian near Sausapor at latitude 0°03'S, longitude 132°05'E, altitude approximately 800 m a.s.l. (Aubréville, 1965; Gray 1971; Havel, 1971; Zieck, 1975 pers. comm.). This species is also indigenous to Australia and West Irian. It has a discontinuous and narrow distribution along the east coast there, ranging from Kempsey in New South Wales at latitude 31°S to Cape Grenville on Cape York Peninsula in North Queensland at latitude 12°S. It

occurs naturally from sea level to over 1 000 m a.s.l. throughout its range in Australia (Reilly 1974).

CLIMATE

The altitudinal range of the species in New Guinea is from 60 to 2 745 m a.s.l. Due to the remoteness of many of the known stands, there are no accurate meteorological data from them. Mean monthly maximum temperatures range from 25°C on the coast to less than 15°C in the highlands. The mean monthly minimum temperature for stands at extreme elevations (e.g. Mt. Suckling, altitude 2 745 m a.s.l.) is not known but it is probably quite low. The species is likely to be sensitive to frost. Mean monthly relative humidity ranges between 78 and 90 percent on the coast, 60 and 80 percent in the highlands. Mean annual rainfall at localities near natural stands in Papua New Guinea ranges from 1 929 to 4 787 mm (McAlpine et al. 1975) The climate of south-eastern Queensland is sub-tropical with warm humid summers and mild winters. Near the sea there are no frosts, but inland at altitudes up to 700 m there are up to 20 frosts a year. The annual rainfall is mainly in the range of 1 000-1 500 mm with more than half falling from December to March. Even during the driest period from July to September, however, there is seldom less than 35 mm a month.

SOILS

Stands of A. cunninghamii occur on loam, clay, sand or peat soils derived from breccias, agglomerates, coralline or limestone formations, lacustrine deposits or old volcanic deposits.

HABITAT

Papua New Guinea: A. cunninghamii occurs in isolated remnant pockets or in fairly dense stands on ridges. In some instances it is found on swampy terrain. It is often associated with Araucaria hunsteinii, Castanopsis, Lithocarpus, Flindersia, Elaeocarpus, Podocarpus and Toona (Havel, 1971; Gray, 1975) and may be found less frequently associated with Nothofagus.

Australia: Hoop pine mainly occurs as scattered, predominant trees over an understorey of rain-forest. Only rarely does it form pure forests. Amongst the more important associated rain-forest species in Australia are yellow-wood (Flindersia xanthoxyla), crow's ash (F. australis), southern silver ash (F. pubescens), various mahoganies (Dysoxylum spp.) members of the laurel family (Lauraceae), and the family Celastraceae, to which orange boxwood (Celastrus dispermus) and ivorywood (Siphonodon australe) belong. In New South Wales a principal associate of hoop pine is coachwood (Ceratopetalum apetalum).

SEED HANDLING

There are approximately 4 000 dry seeds per kg. No special pre-treatment is needed.

SILVICULTURE

Seedlings can be raised by the pregermination technique as used for klinkii pine or by sowing into beds. These techniques are adequately covered by such publications as "Technique for establishment and maintenance of hoop pine" (Qld. For.Dept. 1963); the handbook "Silvicultural Techniques in Papua New

Guinea Forest Plantations" (Dept. Primary Industry Office of Forests, Papua New Guinea); Ntima (1968); and Howcroft (1974).

Araucaria cunninghamii can be successfully grafted by using scion budding (patch grafting) with material taken from the apical leader of the main stem, or by side approach grafting and bottle grafting using the apical shoot of the main stem. Grafted branch material produces plagiotropic grafts and has little use other than for pollen production.

STATUS

Not endangered as a species but endangered in parts of its geographic range, especially in New Guinea where the species has been reduced to relic pockets in the wild. Two large stands are left - MacAdam National Park and the Susu Mt. Nature Reserve.

REASONS FOR DECLINE

There appear to be five main reasons for the decline of the species in some areas of New Guinea. Several of these are related:

(i) Demand for arable land.

(i) A number of stands are known to have been seriously reduced by the fires started by natural causes or by man for agricultural or hunting purposes, or through indiscriminate burning of adjacent grasslands or old gardens. Vigour and regenerative capacity of survivors in burnt

stands are reduced and soil erosion can become a significant problem.

(iii) In small remnant stands domesticated and feral pigs can completely destroy regeneration of Araucaria seedlings and adversely affect the health of maiden stand trees (western highlands of Papua New Guinea).

(iv) Industry in some areas has reduced large stands of this conifer to small pockets of remnant regeneration. Sometimes these logged areas are occupied by gardens and the small population of survivors is reduced further in size.

This situation can deteriorate further with termite infestation to which hoop pine is susceptible and, as viability declines rapidly without storage at $12^{o}C$, there is no reserve of dormant seeds in the soil under natural stands; replacement of destroyed or logged, mature stems must wait for any existing seedlings to reach reproductive age which commences around age 15.

(v) There are signs that some stands are over-mature and in some of these there is little or no regeneration due to low seed vigour and viability or destruction of cones by cockatoos, animals and insects.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

A number of reconnaissance and seed collecting trips were made from 1972 to 1975, to assess tree characteristics, accessibility of stands, size of cone crops, best time for cone collection, and to collect seed if available. The reconnaissance of Araucaria stands covered sections of the south-east of Papua, the Morobe Province, Eastern, Western and Southern Highlands Provinces and the West Sepik Province of Papua New Guinea and the Arfak Mountains of West Irian. Successful seed collections were made in the Morobe and the three highland provinces of Papua New Guinea and an unsuccessful but informative attempt was made in West Irian (see Forest Genetic Resources Information No.6, FAO 1977). Seedlings of six Papua New Guinea provenances have been raised to establish small conservation stands and a provenance trial has been recently planted at Bulolo to test four provenances. These are as follows:

1. Bulolo - lat. 7°13'S, long. 146°45'E, alt. 1 158 m a.s.l. Rainfall (p.a.) 1 615 mm

2. Elaro - lat. 7°27'E, 146°47'E, alt. 1 500 m a.s.l. Rainfall ± 1 880 mm

3. Bumbu - lat. 6°42'S, long. 147°00'E, alt. 1 219 m a.s.l. Rainfall ± 1 916 mm

4. Pumaga - lat. 6°30'S, long. 143°30'E, alt. 750 m a.s.l. Rainfall 3 405 mm.

Further collections are required from the Milne Bay Province covering the northern slopes of Mt.Nelson and Fergusson Island; in the Papuan province near Mt.Oberee, Woitape and Mt. Suckling; in the Morobe Province from Paiaway; in the Chimbu Province from the Tua River and Chuave; in the Western Sepik Province from Oksapmin; Telefomin and Wutung; in West Irian from Anggi lakes; Arfak Mts., Babor, Japen Island, Sausapor and other accessible areas.

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Araucaria hunsteinii K. Schumann[1/]

SYNONYMS

Araucaria schummaniana Warb. (1900)
Araucaria klinkii Laut. (1913)

/There are two distinct varieties of this Araucaria species. One variety has green leaves, flowers and cones, and the other, which is the original Araucaria klinkii Laut., has dusky glaucous grey blue leaves that become dark green with age./

FAMILY

Araucariaceae

VERNACULAR NAMES

Klinkii pine (trade name), Pa's (Watut.Bulolo), (Waria-Kaisinik), Gerau* (Waria), Bimu (Toma), Yanguman* (Agaun), Yomojo (Kotte-Pindui), Karina (Bembi, Madang), Rassu (Ongoruna), Nd'uk (Wareng), Kembaga, Saa'vara (Taiora), Sowes (Erave, Mt.Matmuri), (*Blue-grey or glaucous variety).

BOTANICAL DESCRIPTION

General

A large,unbuttressed, symmetrical tree, 50-80 m high, bole straight, cylindrical, self pruning, clear to 35 m or more, up to 2 m diameter. Crown pyramidal to rounded. Branches in whorls of 5 or 6,

1/Based on the work of N.H.S.Howcroft (Office of Forests, Forest Research Station,P.O. Box 134, Bulolo Morobe Province, Papua New Guinea).

mostly horizontal, partly denuded, with second order branches clustered at the end of the first order branches. Second order branches pendant or partly erect. Trunk internodes regular per tree but variable within stands, 0.5-2 m long.

Inflorescence

Monoecious. Male strobili borne at the apex of second order branches in the mid and lower crown, sessile, cylindrical; immature strobili green or blue green, with or without white exudate depending on the variety, yellow brown at anthesis, brown later, elongated, up to 21.0 x 1.1 cm. Female strobili borne in mid and upper crown, terminal, green or grey-blue, consisting of clustered, spirally arranged ovuliferous scales fused with ligulate scales, developing into large cones that fragment at maturity.

Fruit

Cone: Obovoid, cylindrical, apex conical to slightly depressed, basal portion flattened, up to 25 x 14-16 cm, consisting of overlapping seed scales spirally around a central axis, c. 10-14 x 1.5 cm in size. Cone covered with sharp spines.

Seed: Seed scales broadly triangular, to 6 cm long x 8 cm wide, consisting of a firm but not woody, central portion, 4.5-6 x 1 cm, grading into two persistent membraneous lateral wings. Apex of each scale with a rhomboidal marginal swelling or apophysis, bearing a sharp brittle spine 9-15 mm long, giving the cone its spiny appearance. Seed ovate in shape,

lenticular in section, borne centrally on the seed scale, 3-4 x 1 cm.

Foliage

Juvenile foliage: Leaves in whorls, glabrous, light green to green, lanceolate to narrowly lanceolate, mostly shorter, narrower and flatter than the adult, sessile, 3.5-9.0 x 0.5-1.5 cm. Trees retain juvenile foliage in mid and lower crown at least until 19 years of age or until they become emergent.

Adult foliage: Leaves in overlapping whorls, persistent, sessile, lanceolate or narrowly lanceolate, broadly channelled with apex slightly rounded or inflexed, abaxially slightly keeled near apex, up to 11.5 long x 1.5 cm wide, green dusky grey or very dark green.

Bark

Outer bark red to grey-brown, rough, peeling in small or large broad coarse pieces around circumference of bole; middle bark reddish, inner bark yellow-white.

WOOD PROPERTIES AND PRODUCTS

Wood creamy pink to yellowish white. Exudate thick, viscous, white and resinous.

A. hunsteinii often develops into a larger tree than the other indigenous species A. cunninghamii (Gray 1975). It is regarded as having a bole form superior to that of A. cunninghamii, particularly in plantations, and due to this it is highly valued in the sawmilling and plywood industry in Papua New Guinea. The timber of this species, as for other species, is excellent

for interior work such as moulding, joinery, cabinet work and for flooring, match and match boxes as high quality plywood, including marineply. It is recommended for aircraft frame construction.

NATURAL DISTRIBUTION

This conifer is restricted to Papua New Guinea (Fig. 1 and Table 1) and occurs as scattered stands within the area 142°74'E to 150°01'E, 5°11'S to 10°11'S (Gray 1973).

The species occurs at altitudes ranging from 520 to 2 100 m a.s.l. The size and location of nearly all known stands has been discussed at length by Gray (1973).

CLIMATE

Due to the remoteness of most stands of A.hunsteinii there is no accurate meteorological data for them. Known climatic details for sites near mature klinkii stands are as follows: rainfall 1 615-4 586 mm p.a., mean monthly maximum temperatures 22.8° to 31.1°C, mean monthly minimum temperatures 12.3° to 20.8°C, and mean monthly relative humidity 50 to 89 percent (McAlpine et al. 1975). Klinkii pine is likely to be frost sensitive.

SOILS

The species occurs on acid clay loams derived from breccias, agglomerates, lacustrian laterites or old volcanic deposits.

HABITAT

A.Hunsteinii occurs as isolated remnant pockets of forest or as fairly dense stands on mountain sides and ridges. It is most frequently associated with Castanopsis, Calophyllum, Garcinia, Eleaocarpus, Podocarpus, Toona, Flindersia, Gnetum, Litsea, Cryptocaria, Pometia and in a number of instances, with Araucaria cunninghamii.

SEED HANDLING

There are 2000-2500 dry dewinged seeds per kg.Seedlings can be raised by the pregermination technique or by sowing into beds with overhead shade (White and Cameron, 1965, Ntima, 1968; Howcroft, 1974).

SILVICULTURE

A. hunsteinii can be grafted using budwood patches taken from the apical leader of the main stem, or by using side approach or bottle grafting techniques. The techniques are the same as those used to graft hoop pine as outlined by Higgins (1969). Grafted branch material produces plagiotropic grafts that are only useful for pollen production.

STATUS

Not endangered as a species, but endangered in parts of its geographic range.

REASONS FOR DECLINE

Shifting agriculture, fire and local and commercial demands for timber are the main causes for the decline of stands in various areas. The Agaun stand has been reduced since 1949 from more than 200 trees to about 50 trees by intensive gardening and fire. Feral pigs have disturbed and destroyed much of the natural

regeneration in this area (Howcroft, Dept. Report 1975). Similar examples may be found at Bulolo, Wau. Garaina and the Finisterre Range (locality No. 5), the Gimi Valley and Tagari (Gray 1973). Saw milling operations have depleted stands in the Settleberg Range. Kudjip, Bulolo and Wau areas.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

A number of field trips were made between 1972 and 1977 to numerous natural stands to assess tree characteristics, accessibility of stands, size of cone crops,best time for cone collection and to collect seed,where available. Stands investigated so far are those in the Garaina-Waria region in the Morobe Province, Toma in the Northern Province, Agaun in the Milne Bay Province and the Jimi Valley in the Western Highlands Province. A previously unknown stand was located south west or Erave near Mt.Matmuri in 1976. Successful seed collections were made at Garaina and in the Jimi Valley. Seedlings from three provinces have been raised to establish conservation stands and provenance trials. These provinces are as follows:

1. Bulolo - Lat. 7°13'S, Long. 146°45'E. Alt. 1 158 m a.s.l., rainfall 1 615 mm per annum.
2. Garaina - Lat. 7°54'S, Long. 147°10'E.Alt. 600-950 m a.s.l., rainfall 2 806 mm p.a.
3. Jimi Valley - Lat. 5°33'S, Long. 144°50'E. Alt.1 500m a.s.l., rainfall 3 000 mm p.a.

Other stands which need to be investigated are those at the Sattleberg Range and Paiawa in the Morobe Province, Bomai-Karimui in the Chimbu Province, and the Tagari and Adzugari stands as these are the most western known

occurrences of the species. Collections from the Toma stand would also be desirable but access may be difficult without the use of a helicopter to reach the major portions of the stand.

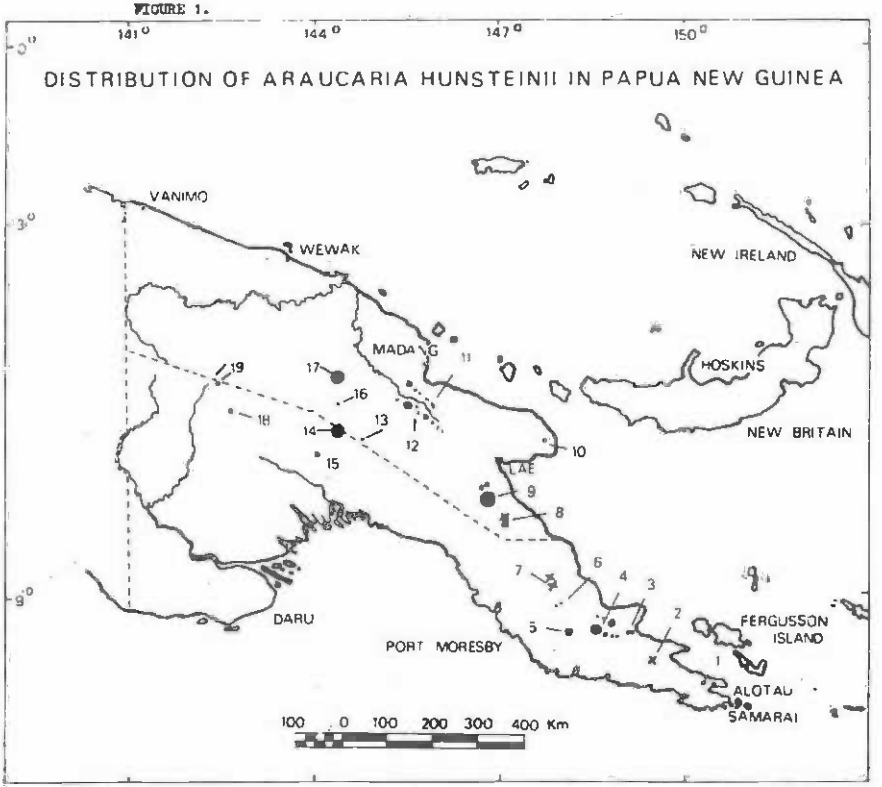
Further studies are required to evaluate the potential of the glaucous variety and to determine its range.

TABLE 1

KEY TO LOCALITIES ON MAP (FIG. 1)

Locality No.	Name of Stand Localities	Latitude	Longitude	Altitude (metres)
1	Damura River	10°10'00"	150°02'30"	± 650
2	Agaum	09°55'45	149°23'00	1 200
3	Mt.Suckling-Didana Range	09°45'00	148°58'00	800-1 100
4	Baryi and Musa Valley	09°15'30	148°16'30	550-1 100
		09°12'30	148°23'45	Not known
5	Mt.Oberee	09°28'00	148°02'45	900-1 200
6	Kokoda gap & Kailili Creek	08°53'00	147°47'00	750-1 500
7	Mambare and Chirima River	08°38'15	147°36'30	± 1 000
8	Garaina	07°54'00	147°10'30	800
9	Bulolo-Wau-Watut	07°11'30	146°39'00	760
10	Pindiu Sattleberg	06°29'00	147°32'00	884-950
11	Finisterre Range	05°35'30	145°33'30	± 600
12	Bismark Range	05°56'00	145°36'30	950-1 000
13	Jimi	06°33'00	145°24'00	± 2 100
14	Tua River	06°22'00	144°38'00	750-1 500
15	Erave	06°40'10	144°00'00	± 1 000
16	Kudjip Mission	05°50'10	144°30'10	± 1 550
17	Jimi Valley	05°32'00	144°38'00	915-1 525
18	Tagari River	05°45'30	143°00'00	1 000-1 550
19	Adzugari	05°33'30	142°44'00	Not known

FIGURE 1.



X— KNOWN LOCALITIES OF THE GLAUCOUS VARIETY

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Aspidosperma polyneuron Muell. Arg.[1/]

SYNONYMS

Aspidosperma peroba Fr. All. (1865)
Aspidosperma dugandii Standl. (1933)

FAMILY

Apocynaceae

VERNACULAR NAMES

Peroba rosa, amargoroso, peroba mirim, peroba amarela, peroba rajada, peroba açú, sobro, peroba amargosa, peroba de São Paulo, peroba paulista.

BOTANICAL DESCRIPTION

General

A large tree, with a height varying from 25 to 30 m, cylinder shaped stem of 12 to 15 m in length and 0.7 to 0.8 m in diameter, sometimes reaching 1.0 m; crown thin with ascendant branches, and typical corymb-type ramification.

Inflorescence

An axillary inflorescence on the ends of the branches, forming a small dichotomous cyme 1 to 4 cm in length. Small green-yellow flowers, hermaphrodite, 4 mm in length; calyx consists of a tube with five laciniate lobes; corolla consists of a tube which is longer than the calyx. Flowering occurs in November-December; for

1/Based on the work of M.Tomazello, M.L.Marques, and R.Chiaranda. Forestry Department, ESALQ/USP, P.O.Box 9, Piracicaba, S.P., Brazil.

the Southern region during the months of April- May; other authors report flowering in June - July.

Fruit

A dehiscent capsule almost always paired, brown, striped lengthwise with yellow spots. Fruits approximately 5.5 to 6.0 cm in length and 1.0 to 1.5 cm in width. The shape of the fruits is similar to a short pod, wider towards the apex, pointed, sessile, with a somewhat prominent cyst; outside heavily covered with easily visible lenticels. Fructification occurs in October and during the months of June - August in the Southern region; other authors have reported fruit setting in October-November.

Foliage

Leaves varies in shape, oblong to eliptic - obovate with an obtuse apex, and narrower at the base; membranaceous; dark green on the upper side and lighter colored underneath; 6 to 8 cm long and 2 to 4 cm wide; alternate arrangement, short petiole (1 cm in length), leaf blade glabrous, with numerous secondary veins. Branches are round, trichotomous, with leaves on the ends.

Bark

The trunk is slender, with a slightly cracked grey bark, rigid, brownish color, lactiferous, bitter, rhytidome with a pinkish tinge internally and the alive portion of yellow color.

WOOD PROPERTIES AND PRODUCTS

Wood heavy, heartwood varying from a pink-yellow to a lightly rose colored burnt-yellow, uniform or with vein or dark patches; the surface is smooth but not shiny; indistinct smell, a slightly bitter taste; straight; fine texture. In laboratory trials, peroba-rosa wood revealed low resistance to rot and to dry wood termite attacks. As the peroba-rosa has many minute pores which are partially obstructed by oil-resin and tyloses, it has a low permeability to preservative solutions in treatments under pressure.

The peroba-rosa wood is primarily used in civil construction, mainly in the state of São Paulo, for beams, rafters, laths, door-jambs, shutters, gates, frames, boards and tiles for floors, stairs, etc.. As it has a medium mechanical resistance and medium retractability, it is recommended for heavy furniture, school desks, for the production of veneers, construction of wagons, truck-bodies, etc.. It is also used for sleepers, not so much because of its durability, which to-date is around 6 years, but due to the relative facility in acquiring this wood, its workability, and mainly due to the good fixation of nails. Presently the railways are using a good part of the sleepers that have undergone treatment with preservatives under pressure.

NATURAL DISTRIBUTION

The original area of natural distribution of this species is vast, covering Southern and South Eastern Brazil, although in some States of this region the

occurrence of this species is minute. It is found in the state of Bahia (extreme South), Minas Gerais, Mato Grosso, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul. This species is also found in Argentina, Paraguay and Peru (Hueck, 1972; Rizzini and Mors, 1976). Presently, due to the intense exploitation of the species, its occurrence has been significantly reduced (IPEF/EMBRAPA, 1981).

CLIMATE

The climate in the areas of occurrence varies and includes the following types:

a) subtropical moderate humid: annual average temperature between 18 and 22°C; average annual precipitation varying beteeen 1250 and 2000 mm, with a uniform distribution in the Paraná river basin, and a seasonal distribution in the Central Eastern part of the State of São Paulo, Southern Minas Ferais, South-eastern Espirito Santo); b) subtropical or tropical subhumid: average annual temperature between 21° and 24°C, and annual average precipitation varying between 1200 and 1500 mm, with a seasonal distribution and a water deficit in the winter.

SOILS

Depending on the region in which it is located, A.polyneuron may occur from 150 to 1100 m in altitude, thriving in several soil types; developing well in soils of decomposed basaltic and diabasic rocks (Klein, 1963), and humid deep soils (Klein, 1972).

HABITAT

This species is found in several types of forest formations, such as low altitude forests in the Paraná river basin; however it is not found in the Uruguai river basin (Klein, 1972); seasonal evergreen mountainous forests, and seasonal evergreen forests. In the state of Paraná, the species penetrates sometimes into Araucaria forest (Araucaria angustifolia), were it becomes dominant in the understory (Klein, 1963).

SEED HANDLING

Germination which takes place 16 days after sowing, does not require pre-germination treatments. One kg contains approximately 11500 seeds. In terms of substrate and temperature for seed germination, the temperature has a more significant influence on germination than the substrate utilized. A germination percentage of between 76 and 90% was obtained at temperatures of 20 and 25°C using several substrates (vermiculite, green blotter paper etc.).

SILVICULTURE

In a trial carried out in the Vale do Rio Doce. MG, an average height of 7.8 m; a DBH of 9.7 cm; and a 76.4% survival at 12 years of age were observed. On the other hand, in Santa Rita doPassa Quatro-SP an average height of 6.5m; and a DBH of 6.1 cm at 13 years of age were obtained. In Bauru - SP, in a provenance trial, an average height of 4.7 m and a DBH of 5.6 cm at 12 years of age was noted.

STATUS AND REASONS FOR DECLINE

Due to its wood resistance and durability, this species has been exploited intensively during the last decades and the lands have been taken over by pastures and agriculuture. Today the surviving trees of this species are found in small remaining clusters of forests.

PROTECTIVE MEASURES TAKEN

In 1964, the Instituto Florestal de São Paulo out-planted a provenance trial in Bauru - SP, using two provenances. Results from this trial have shown genetic variation between the provenances. This Institute has another mixed stand where A. polyneuron with 35 other species are maintained.

Three base populations propagated from 76 selected trees, resulting from a contract between the Conselho Nacional de Desenvolvimento Cientifico e Tecnologico (CNPq) and the Programa Nacional de Pesquisas Florestais (PNPF) with the Instituto Florestal do Estado de Sao Paulo has been implemented.

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Astronium urundeuva (Fr. All.) Engl.[1/]

SYNONYM

Myracroduon urundeuva Fr. All. (1862)
Astronium juglandifolium Griseb. (1879)

FAMILY

Anacardiaceae

VERNACULAR NAMES

Aroeira, aroeira do sertão, aroeira legítima, aroeira da serra, aroeira do campo, urundeúva, arindeúva, arendeúva, aroeira preta, orindeúva.

BOTANICAL DESCRIPTION

General

Small tree in the "cerrado", approximately 5 m in height and 0.15 m in diameter, and large in the tropical forest, where it may reach up to 30 m in height and 1 m in diameter.

Inflorescence

Flowers purple or cream in colour, small, in very congested panicless on the ends of leafless branches, with little pubescence; the inflorescence is approximately 10 to 15 cm in length; flowering occurs from July to August.

Fruit

Small ovoid globose drupes, with a short apiculus, approximately 4.5 mm in diameter, maturing in the months of September - October. In the Amazon, fructification

1/ Base on the work of M.Tomazello F°, R.Chiaranda and M.L.Marques. Forestry Department, ESALQ/USP, P.O. Box 9, Piracicaba, S.P., Brazil.

occurs during the period of January to February. Fruiting in a pure 3 year old stand has been noted.

Foliage

Leaves composite, imparipinnate, alternate, with 7-15 folioles oblong or oval; wide, with a rounded or a shortly acuminate apex; the orbicular base is somewhat oblique; sub coriaceous with delicate veins; margins ciliated on both the sides; somewhat hairy, slightly serrated or crenate, 3-6 cm in length by 2-3.5 cm in width; petiole pubescent; 2-4 mm long, strong odor. Branches: When young, flaccid and pubescent, lenticelate, light grey.

Bark

Trunk: Straight, its base exibiting few distinct characteristics, normally straight; in young trees the bark is smooth, grey and lenticeled; in adults, the bark is dark brown, and sub-divided into scaly sheets.

WOOD PROPERTIES AND PRODUCTS

Very heavy with a high mechanical resistance; heartwood pinkish beige or light brown when recently cut, later turning dark brown-red in colour; sapwood slightly distinguishable, white to slightly pink in colour; a somewhat shiny surface and smooth, medium texture, uniform; irregular to interlocked grain; no distinct odor or taste.

It is considered as the wood with the highest resistence to decay; its vessels are excessively obstructed by

tyloses of oil resin; extremely reduced lumen fibers; its permeability to preservative solutions is extremely low in treatments under pressure. It is recommended for external structures such as framework of bridges, stakes, posts, fence posts, sleepers, etc. In civil construction it may be used for beams, floor tiles, etc. May also be used for the manufacturing of carved pieces.

NATURAL DISTRIBUTION

The areas of most frequent occurrence are in Northeastern Brazil, the western part of the States of Minas Gerais and São Paulo, the southern part of the States of Goias and Mato Grosso. It also occurs in Argentina and Paraguay.

SOILS/CLIMATE

This species occurs in a wide range of climates, varying from semi-arid tropical with periodical rains to subtropical humid with periodical rains, with an average annual temperature varying between 19 and 28^{o}C, and an average annual precipitation varying between 700 and 2000 mm. In Northeastern Brazil this species occurs in several soils that are of pre-cambrian as well as tertiary/quartenary origin, which are generally poor and shallow. It is also common in terrain undergoing transition from "cerrado" soil to "terra roxa" soil.

HABITAT

Is found in the most varied types of vegetation, from the "caatinga" to the tropical rain forest, passing through "cerrado" formations. In the forest formations the species appears to be associated with Piptadenia spp., Choriza speciosa, Tabebuia impetiginosa and Hymenea stilbocarpa. In the secondary forests it may be found in almost pure stands, with plants of varying ages.

SEED HANDLING

Seeds are not naturally released from the fruit and should be collected when physiologically ripe, but before they are extremely dry, as they are easily dispersed by the wind. One kg consists usually of about 47 000 seeds. Only 14 000 per kg has also been reported. Seeds stored in the open, as well as in a cold chamber, maintain a germination percentage above 70% up to 13 months in storage. In the nursery, germination takes place within two weeks.

SILVICULTURE

In trials carried out in Petrolina - PE, an average height of 1.70 m and a survival above 75%, at 3 years of age was obtained. In Assis - SP, an average height of 9.60 m and a DBH of 9.70 cm, at 9 years of age was noted.

In São José do Rio Preto - SP, as average height of 5.11 m was obtained at 4 years of age. Any spacing influence on the tree growth at this age was not found.

Behavior of the "aroeira" in homogeneous as well as mixed stands has been studied. In Petrolina - PE, research workers from EMBRAPA are studying its behavior in the enrichment of the natural vegetation ("caatinga").

STATUS AND REASONS FOR DECLINE

Due to the durability of the wood when in contact with soil, this species has been intensively exploited for posts and fence posts. For this reason, it is now difficult to find it in natural stands that can satisfy present demands; however, the few existing adult trees are being gradually cut down for obtaining fence posts and wood for construction, consequently endangering the species.

Other factors that contribute to the extinction of this species are the exploitation for medicinal purposes and for obtaining tannin to the leather industry.

PROTECTIVE MEASURES TAKEN

In 1981 the Instituto Florestal do Estado de São Paulo implemented a test using 5 provenances, with a total of 91 progenies, with the objective of determining this species' genetic variability and at the same time guarantee the preservation of the material. An evaluation of this trial at 36 mounths of age with respect to height did show genetic variability for some of the provenances.

A planting of 6 base populations, from 109 selected trees, as a result of a contract between the Conselho Nacional de Desenvolvimento Cientifico e Tecnologico (CNPq), and the Programa Nacional de Pesquisa Florestal (PNPF), is reported.

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Atriplex repanda Phil.[1/]

FAMILY

Chenopodiaceae

VENARCULAR NAMES

Pasto salado, Sereno (Chile).

BOTANICAL DESCRIPTION

General

A. repanda is a perennial shrub; its longevity is estimated to more than 40 years; it is of medium size, greyish in colour and has evergreen leaves. Mature plants reach 1 - 2m high and 1 - 2 m wide. Branching is abundant from the base; branches are rigid; woody and brittle. The corky crown of older branches is scored by longitudinal fissures. The plant has a highly developed taproot with numerous secondary rootlets.

Inflorescence

Flowers are not very colourful; stamens and pistils occur on the same plant (monoecious). Male flowers small and yellowish in colour; appearing in racemes at the apex of the young shoots during spring and summer. Female flowers green, sessile, grouped along the shoot in the leaf axils.

1/ Based on the work of CONAF (Corporacion Nacional Forestal) Avda. Bulnes 285, of. 703, Santiago, Chile).

Fruit

Fruit develops gradually during the summer, ripens and falls during autumn. Even though the plant bears fruit in its very first year, production does not really begin until the second year.

Foliage

Leaves dark green, small, oblong. They have a wedge-shaped base, obtuse apex, toothed edges, ashen-green colour on the underside and brighter green on the upper surface, not more than 3 cm long and 3 - 8 mm wide. Foliage remains throughout the winter, although a small proportion does fall off during the coldest months.

USES

This very productive species is extremely valuable as a fodder shrub. It is highly palatable to sheep and goats, recovers well after browsing, and grows the whole year round, especially during the spring and summer months. During the dry summer the plant continues to grow despite the extremely low water content of the soil. The plant is low enough to be accessible to livestock and has a high fruit and foliage ratio with respect to trunk area and primary branching. It is highly resistant to pests and diseases. Gastó and Caviedes (1976)/ estimated that optimum productivity was achieved with plants 18-30 months old at densities of c. 1 300 and 1 060 plants/ha, with a total individual output of roughly 1.6-1.8 kg of total aerial dry matter per plant.

NATURAL DISTRIBUTION

A. repanda is indigenous to Chile's North Chico, the region between Quilimarí and the valley of the Huasco River, between latitudes south 28° 34' and 32° 07'. In the past, this area hosted an extensive natural distribution of the plant. Badilla (1975) concludes that the original habitat of this species must have been lowland areas with groundwater close to the surface and high salinity, as is typical of river mouths. The main species with which Atriplex repanda was associated were Frankenia erecta, Distichlis sp. and Lycium sp.; at that time A. repanda also covered areas with no other vegetation.

CLIMATE

Mean annual rainfall is 126.5 mm and the median is 107.2 mm. The variation is due to the extreme conditions of some years when precipitation is exceptionally abundant. This occurs only once every several years. Consequently, the vegetation cannot utilize most of this moisture efficiently. Neither can the moisture be stored in the soil for use during subsequent years. It is therefore, more realistic to use the median figure, which eliminates the rainfall of the extreme years from the calculation of average precipitation. Precipitation occurs in the form of rain during the colder months of the year, usually three or four months. However, the seasons vary so much from year to year, that it is not unusual for a year to have dry periods of ten, eleven and even twelve months. The effects of the climatic conditions on the vegetation are

those characteristic of dry and semi-arid mediterranean regions, and give rise to vegetative formations which physiologically resemble shrub underbrush and thicket.

SOILS

The soils are varied. There are soils with a grey-cinnamon humus horizon 5 cm thick and soils with a more reddish metamorphic horizon of 50 cm, forming fragmentary soils under alluvial conditions in acid rocks, and similar soils formed in sasalto rocks. Lailhacar (1976) concludes that Atriplex repanda is able to behave as a salt-loving plant in saline or alkaline areas. Its presence in such areas may well be determined by a move away from less saline environments as a result of grazing. Badilla (1975) links the distribution of the species directly to wet lands (with groundwater) and saline areas, as well as highly altered habitats.

Badilla points out that the soil pH of the sites sampled in his study, varied from 5.5 to 10.1 with good species behaviour in both areas. How the species responds to other different soil variables was studied by Lailhacar (1976) in California, where he worked with A. repanda and A. polycarpa on 44 sample soil sites in central and southern California. Lailhacar investigated the dependency of aerial and root growth on soil variables, under wintertime conditions. He found that the soil variables which gave the highest aerial biomass yield in A. repanda were, in order of importance: phosphorus, ammonium,

nitrogen and nitric nitrogen. He attributed the lesser dependence of yields on nitrogen, as compared to the phosphorus demand, to the low content and poor distribution of nitrogen in the soils sampled. Gargano (1978) undertook a similar study sampling 20 soil sites on the coastal sector of IV region (Chile). Both Badilla (1975) and Gargano (1978) points out that the aerial biomass of A. repanda responds positively to sodium. Arentsen (1972) and Badilla established the fact that A. repanda, like A. semibaccata, can absorb water in the atmosphere and transfer it to the soil.

SEED HANDLING

Seed collection from February onwards. Estimated 250 000 - 1 120 000 seeds/kg. Natural germination normally very low (less than 3%). Sulphuric acid treatment is recommended. The best period of treatment depends on the age of the fruit. One-year-old fruits need 7 hours in sulphuric acid to show high percentage of germination, whilst 5 year old fruits must be exposed only for 2 hours. Dry and 24 hours water-pretreated fruits have showed different response when exposed to various sulphuric acid exposures. Seed-age is fundamental both for the germination percentage obtained and the time required for germination. 6-year old fruits have shown better germination than fruits between 9 months and 4 years old. Fruits immediately after harvest have shown total dormancy during 7 months.

SILVICULTURE

Best results have been achieved with a sowing depth of 0.5-1.0 cm in sandy soils when maximum gas exchange between seed and atmosphere is possible. Partly removal of the soil also tends to promote gas exchange; soil removal 15 days after sowing is therefore recommended (Olivares and Johnston, 1978).

The method of direct seeding has not been completely mastered as some elements of the seed handling tecniques related to germination are, as yet, unknown. Gastó and Contreras (1972) recommend sowing in the winter and indicate that 40-100 nuts were required for each plant established.

Sowing should be in rows 3 to 4 m apart at rates of 300-600 seeds per metre. At these rates, 3-6 kg of seeds would be needed per hectare. Peña (1978) did research on vegetative propagation by cuttings. His conclusions are that the best time of the year to collect cuttings and propagate them is in the spring (September to December); light and temperature conditions being optimal at that time of the year. In addition, root development capability apparently undergoes seasonal cycles, springtime being the peak season. The best results with rooting and sprouting of A. repanda are achieved in the spring, using apical shoots with leaves. The shoots should be planted in plastic tubes with a good substratum, exposed to the open air, with no environmental control (except wind control). About 90 percent of the plants rooted, produce good quality, highly vigorous plants (Peña,1978).

The results of hormone applications were not conclusive (Penã, 1978). Propagation by shoots is now extensively practised in forest nurseries with excellent results.

STATUS

Endangered in parts of its natural range.

REASON FOR DECLINE

The manner in which A. repanda was formerly exploited, especially its over-utilization for livestock, reduced natural occurrence so drastically that only isolated populations in very limited areas may be found nowadays.

PROTECTIVE MEASURES TAKEN

After analysing the results of specific investigations into the status of A. repanda, Chile's national forestry corporation (CONAF) started a massive plantation programme in 1976. Plantation efforts were rapidly extended as a result of the governmental Decreto 701, which was promulgated expressly to stimulate the planting of forests.

In 1975, only four hectares of A. repanda shrubs were planted; the following year, the area was 404 ha; in 1977, a total of 1 115 ha was planted and in 1978, the figure reached 2 800 ha. The 1979 season was so severely drought-stricken and moisture conditions were so unsuitable that planting took place in only a few very small sectors in the extreme south of Region IV. Thus, the surface area planted that year was a meagre 200 ha. Plantations have also been

attempted in other areas of the country with only limited success. The future of Atriplex repanda depends, to a significant extent, on the success of such plantations.

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Balfourodendron riedelianum Engl.[1/]

SYNONYMS

Balfourodendron eburneum Mello (1877)
Esenbeckia riedeliana Engl. (1863)
Helietta multiflora Engl. (1863)

FAMILY

Rutaceae

VERNACULAR NAMES

Marfim, pau marfim, farinha seca, guatambu, pau liso, guataia, guamixinga, pau cetim, guarataia, pequiã, pequiã mamona, pequiã mamao, muxinga.

BOTANICAL DESCRIPTION

General

Tree with moderate growth rate, reaching 25 m to 35 m in height and 40 to 90 cm in diameter.

Inflorescence

A terminal panicle, pilose, white and small, clustered on the ends, each one with a short pedicel and a bract; flowering occurs from September to November.

Fruit

An achene with four large wings, broad, green, yellow when ripe, veined; auriculated at the base; 2.5-4 cm in length by 2-3 cm in width; 4 seeds per loculus that may

1/Based on the work of R.Chiaranda, I.E.Pires and M.Tomazello F°. Forestry Department, ESALQ/USP, P.O. Box 9, Piracicaba, S.P.Brazil.

reduce by aborting; fructification occurs from August to September; fruit is samara type and thus dispersed by the wind. Seeds ellipsoid, black, approximately 4 or less per fruit, 8-9 mm in length.

Foliage

Leaves opposite, digitate, long-petiolate with three oblong-obovate folioles; pointed or with short ends, glabrous or with hairs on the veins of either side, entire, membranaceous, pale, the underside with numerous black dots and domacias, 5 - 13 cm in length by 2 - 5cm in width; the medial foliole is larger and petioled; petioles 3 - 8 cm in length.

Bark

Straight trunk, with a smooth grey bark that is very lenticellate.

WOOD PROPERTIES AND PRODUCTS

Wood heavy; heartwood is straw-white to yellow, darkening to a pale yellow; uniform; sapwood indefinite, white with a yellow tinge; surface smooth with a medium shine; grain is irregular to interlocked; texture fine; taste somewhat bitter; odor indistinct. Pratical observations of the "pau-marfim" wood have shown a low natural resistance to rot. In an experiment, treatment under pressure, revealed a good permeability to preservative solutions. The "pau-marfim" wood which may have a light colour, a handsome aspect and a medium mechanical resistance, is recommended for furniture, decorative veneer,

frames, carved pieces, pieces for sports and other artefacts. It may be used for civil construction as beams, rafters, laths, skirting boards and floor tiles, as well as for tool handles etc.. It is frequently used for furniture, agricultural instruments, propellers for small airplanes, shoe patterns, pool balls, rulers, linings, doors, and other internal objects. It is also widely used in carpentry.

NATURAL DISTRIBUTION

This species occurs in Southern Brazil (States of São Paulo, Paraná, Santa Catarina, Rio Grande do Sul), Paraguay and Argentina.

SOIL/CLIMATE

The tree is frequent on fertile land, occurring in stony as well as in deep soils, in altitudes up to 700 meters. The climate in the areas where the species occurs is subtropical moderate humid (average annual temperatures between 18 and 21°C, and precipitation between 1250 and 2000 mm, evenly distributed throughout the year) and subtropical sub-humid (average annual temperature varying between 21 and 24°C, and annual average precipitation varying between 1200 and 1500 mm, evenly distributed).

HABITAT

B. riedelianum is common in the forests along the Paraná and Uruguay rivers (wet forests) where it is normally abundant; is also found in regions where the forest becomes "cerrado". It grows in the secondary forests also, becoming dominant in some locations along

with Aspidosperma polyneuron. It is a pioneer species and not common in high land forest, thriving better on gentle slopes.

SEED HANDLING

Germination occurs 40 days after sowing, without breaking of dormancy; a 30% germination in the laboratory has been observed. One kg includes approximately 2 300 seeds.

SILVICULTURE

Average heights of 0.9 m at age 1 year; 4.56 m at 4 years; 5.89 m at 8 years; 7.56 m at 12 years have been measured. In São Simão - SP, in an experiment implemented in 1958, an average height of 10.96 m and a survival of 97.4%. is reported at 14 years of age. At 6 years of age, there were no significant differences among spacings. A relative superiority for the height of Baufourodendron riedelianum in a mixed stand at Cascavel, in Campo Mourão, during the first year is reported whilst testing the competition among species in mixed stands set up in 4 localities. It was observed that at 7 years Baufourodendron riedelianum presented higher average height and diameter, as well as a larger survival percentage. In Santa Rita do Passa Quatro, in a homogeneous stand set up in 1956, an average height of 21.2 m and a DBH of 20.5 cm were observed at 26 years of age. This species has a great affinity for mixed planting.

STATUS AND REASONS FOR DECLINE

As this species occurs naturally in regions with large urban and agricultural development, and as its wood has favorable and useful characteristics, it is becoming scarse, due to exploitation, in these areas.

PROTECTIVE MEASURES TAKEN

This species is found in some conservation units. However, these areas are not sufficient to guarantee its conservation neither *in situ*, nor *ex situ*.

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Bertholletia excelsa H.B.K.[1/]

FAMILY

Lecythidaceae

VERNACULAR NAMES

Castanha-do-Pará, Castanha-do-Brasil as well as Castanha-do-Maranhao. The local tribes have their own denominations: arái, for the Chahuas; inia, nha, niá for the Chipayas, tcai for the Parecis; tuca tucari, ya, and invia in the region of the Vale do Orenoco; and touca for the old Portuguese. In English para nut or brazil nut and in French noix du Brésil.

BOTANICAL DESCRIPTION

General

Large majestic and frondose tree, reaching up to 50 m in height, and diameter 2 to 4 m at the base. The stem is cylinder shaped without branches to the crown. The crown is formed of long and numerous branches that are curved towards the end. It reaches up to 4 m in diameter.

Inflorescence

Inflorescence is of an axillary type or a terminal panicle, with little ramification, rachis erect, reaching up to 40 cm in length; pubescent, with pedunculate, sub-sessile or sessile flowers, with 2 or 3 ovate bracts at the base. The calyx is light green, and at anthesis is bilobate. The corolla has

1/Based on the work of S.T.Ohashi, O.Daniel and L.C.da S.Costa. Forestry Department. Faculdade de Ciências Agrárias do Pará, P.O.Box 917, Belém, Pará,Brazil.

six unequal petals, thick and fleshy at the base; whitish-yellow in colour, perfumed; oblong-ovate and crossed two-by-two.

Fruit

The fruit is a pyxidium with a thick tegumen, ligneous and hard, commonly known as "ourico"; sphere or sub-globose in shape with a variable weight and size, with a small operculum on the top side. Each fruit contains 18 to 22 seeds, which are in a series on the placentary column; the seeds are called "castanhas"; these are angular, with a hard tegument, wrinkled, with somewhat triangular faces. When young the seeds are yellow, and with age they turn a dark grey almost brown in colour.

Foliage

The leaves are oblong or ovate-oblong, with a sharp base, a rounded-obtuse apex and slightly pointed; coriaceous, bright green on the superior face and a light green on the inferior face, margin wavy; up to 36 cm in length by 12 cm in width; the main rib is prominent on the underside, numerous secondary ribs which are parallel at a 60° angle; the petiole is semi-cylindrical, canaliculate 5 to 6 cm in length, tomentose.

Bark

The bark is dark and cracked.

WOOD PROPERTIES AND PRODUCTS

The wood is moderately heavy (0.70 to 0.75 g/cm^3) with a brownish-pink heartwood, somewhat different from the brownish yellow sapwood; irregular to regular grain;

medium texture, indistinct smell and taste. Easily worked, with an elegant finish with a medium shine.

Uses

The "castanheira" is known as one of the most noble and valuable plants of the amazon forest, as both the wood and the fruit may be used, although the greater commercial value is that of the fruit through the industrialization of the nut (exported mainly to Europe and USA). However, the wood of this tree is of good quality, and may be used for civil or naval construction, walls, floors, stakes, etc. The bark is good for ship caulking.

NATURAL DISTRIBUTION

The "castanha do Brasil" occurs naturally in several countries such as Venezuela, Columbia, Peru and Bolivia. However, it is Brazil where it is most abundant, in the States of Pará, Maranhão, Mato Grosso, Amazonas, Rondônia, Acre, and the Territory of Amapá.

CLIMATE

The "castanha-do-Brasil" has its natural occurrence in locations of three climatical types prevailing in Amazon: Aw, Am and Af (Koeppen)[1/]. However, it is concentrated in areas of Aw or Am climates, which reveals that the "castanha-do-Brasil" has a better development in humid tropical climates, with relatively short dry spell.

SOILS

The Brazil nut, under natural conditions, is found in deep and rich soils, mainly oxisols and ultisols.

1/See top of page 219.

HABITAT

The habitat of the Brazil nut extends throughout Amazon, in rain forest located on upland "terra firme". It grows in several climate types, but does not withstand swamp or humid conditions. In some locations it is found in clusters that are somewhat extensive and called "castanhais". However, B.excelsa is always associated with other large tree species, and never constitutes a pure forest.

SEED HANDLING

The seed from the Brazili nut does not easily germinate as it has a very hard and resistant tegumen, which makes seedling production a very time consuming process. It takes about 12 to 18 months, to germinate under normal conditions, with a low and irregular germination percentage. The tegumen does not prevent initial water absorption, so the dormancy could possibly be attributed to tegumen and/or endosperm impermeability to gas exchanges, and/or the presence of germination inhibitors, or maybe immature embryos.

Mechanical scarification followed by soaking of the seeds has no influence on germination; however the scarification of the germination poles has rendered promising results, which may be attributed to tegumen resistance or embryo expansion. Other treatments, stratification and heat shocks, do not give good results.

Presently, sowing of the seeds without the coat is recommended, and yields a 78% germination if the seeds

are young and of good quality. With this process, seedling emergence begins 20 to 30 days after sowing, considerably reducing the period for seedling production.

SILVICULTURE

Previously, the long period required for seed germination, along with a long juvenile period, hindered the rational cultivation of this species. To-day, techniques have been developed to overcome these problems, and are fundamental for the good establishment of plantations. These techniques, which include breaking the dormancy by removal of the tegumen and vegetative propagation by bud grafting, are now being used in pioneer stands, and proving to be viable. When planted under direct sunlight and under understorey conditions, respectively, great differences in the behaviour of the plants occur. Greater development and early flowering are obtained under direct sunlight. This shows the species' aptness to locations that are completely open. Another problem related to the species in plantations is its pollination, as there is a specific pollinator (wild bees) of the flower which is important for the production of fruit. As the natural habitat of the pollinator is the forest and the "capoeiras" (open woodland), these should be conserved around the areas of the plantations.

STATUS

Researchers, technicians and politicians in Brasil are already concerned with the preservation and rational cultivation of the species. Due to the great importance of its fruit in Brazil, laws have already been passed, prohibiting this tree to be cut down in natural forests, and seeking its preservation. In many cases the prohibition alone does not guarantee its survival, as the transformation of forests into agricultural areas by clearing and burning, along with the lack of suitable conditions for the survival of the pollinator, contribute to the extinction of this tree.

REASONS FOR DECLINE

Several reasons for the decline of the species could be cited: the colonization programme in the region where this species occurs; the construction of hydroelectrical power plants, which flood vast areas; the lack of conscientiousness towards the preservation of the Brasil nut and the negligence of the industrial sector in establishing plantations, etc.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

The Empresa Brasileira de Pesquisa Agropecuaria has a germplasm bank for the Brazil nut. However, establishing base populations including many provenances is of great importance for conserving genetic material. These populations will serve for conservation as well as for species improvement programmes.

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Bombacopsis quinata (Jacq.) Dugand[1/]

SYNONYM

Bombacopsis fendleri (Seem) Pittier (1916)

FAMILY

Bombacaceae

VERNACULAR NAMES

Pochote (Nicaragua, Costa Rica)
Cedro espino (Honduras, Nicaragua, Panama)
Saquisaqui (Venezuela)
Ceiba tolua, Ceiba roja, Ceiba colorada (Colombia)

BOTANICAL DESCRIPTION

General

An impressive forest tree reaching a height of 20-40 m with a stem diameter up to 2 m. Butresses up to 4 or 5 metres in height generally develop on mature trees. Tree crowns are well developed, wide and irregular, up to 30 m in diameter.

Inflorescence

The flowers vary in length from 10 to 15 cm and have linear strap-shaped petals and numerous white stamens. The flowers mainly open at night under conditions of low temperature (below 25°C) and high humidity (relative humidity over 69%) and shed the petals and stamens the following morning.

1/Based on the work of C..E.Hughes, Oxford Forestry Inst, Univ.of Oxford,South Parks Road, Oxford, U.K. and Marcelino Quijada R., Fac. de Ciencias Forestales, Univ.de Los Andes,Mérida, Venezuela.

Fruit

The fruit is a dehiscent capsule with 5 loculi reaching between 4 and 10 cm in length and 2-4 cm in width. Each fruit contains on average 45 seeds covered in a light fluffy cotton which facilitates seed dispersal by wind. The ripe fruits are orange-brown in colour.

Foliage

Alternate leaves are composite with three to seven oblong or obovate glabrous leaflets.

Bark

The bark is pale greyish-brown in colour and the trunk and branches generally covered by hard, stout spines up to 2 cm long. The degree of spinyness is extremely variable and some trees are completely spineless. Progeny experiments in Venezuela indicate that this character is under close genetic control.

WOOD PROPERTIES AND PRODUCTS

As indicated by the vernacular name Cedro espino, the wood of Bombacopsis quinata in many ways resembles that of the highly appreciated Spanish cedar, Cedrela spp. The wood is uniform pale pinkish or pinkish brown when freshly cut becoming light to dark redish brown on exposure. It is fairly resistant to attack by insects and fungi, apparently due to the presence of a rubbery exudate Basic specific gravity ranges from 0.38 - 0.45. The straight grained wood has been reported as easy to work,easy to nail,and finishing smoothly. It is used locally for general construction, interior finish, millwork, furniture stock, veneer and

plywood, particle board and pulp and paper products. In the past the species has been important in many parts of its natural range commanding a high price. In the period 1963-65 it was the second most important species in Venezuela in terms of volume produced (Finol and Melchior, 1970) and today remains the most important timber species in the Llanos Occidentales region. It is considered an important reforestation species in northern Colombia for veneer and plywood.

NATURAL DISTRIBUTION

B. quinata is distributed in tropical America from 2°N to 13°30 N. It reaches its southerly limit in the Llanos Orientales of Colombia probably extending into the extreme limits of the Amazon basin near the Rio Yari. It occurs widely in the Llanos Orientales of Colombia and the northern portion of the Orinoco basin in the Llanos Occidentales of Venezuela. Further north it occurs extensively on the north costal plains of Colombia, through the Darien region on Panama and throughout the Pacific side of the Central American isthmus as far north as Honduras where a few scattered stands are found around the Golfo de Fonseca. It has not been reported to date from El Salvador.

CLIMATE

The species occurs from sea level up to 750 m elevation and is found in tropical rainforest with a short dry season of less than four months and in seasonally dry tropical forest with a longer, more severe dry season of up to six months' duration. Mean annual precipitation is in the range 1 500 to 2 500 mm.

SOILS

B. quinata occurs on a range of different soil types from well drained gravelly soils on low hills and ridges to deeper less well drained black vertisols. In these areas the clay content is generally high and water-logging occurs. In some parts temporary flooding occurs, but the species does not appear to thrive in these parts. In the dry season soil fissuring is common.

HABITAT

B. quinata is commonly found in association with Cedrela odorata, Anacardium excelsum, Hura crepitans, Ceiba pentandra, Enterolobium cyclocarpum and Samanea saman.

SEED HANDLING

Flowering occurs during the dry season in January and February and fruits generally ripen from mid-March to early April. There is considerable variation in ripening time both between trees and even within trees, and this, combined with the explosive dehiscence of the capsules on ripening, means that capsules need to be collected slightly before full ripeness is reached. Artificial ripening has been successfully carried out in Honduras in cool dry conditions (Hughes, 1981). On average there are 45 seeds per capsule. Frequently a high proportion of fruits are damaged by parrots. Viable seeds are usually rounded, with a smooth surface and a certain resistance to flattening by the fingers. Seeds that are not viable are usually wrinkled and can easily be flattened by

a slight pressure of the fingers.

Seeds selected in this way have a germination of up to 100 percent for three months after collection and without special storage. If the seeds are stored in cold rooms, good viability can be maintained for two years. The seeds are usually small (4 to 5 mm). The number of seeds per kilo ranges from 20 000 to 45 000, with averages of 32 000.

SILVICULTURE

Cultivation is straight forward. No seed pre-treatment is required (preliminary soaking in natural water for 24 hours can be applied) and stump planting is generally successful. The species is strongly light demanding and a wider than normal spacing is usually employed. The species coppices readily and vegetative propagation is easy.

STATUS

The species is severely threatened at the provenance level. The main undisturbed reserves are in the Darien region of Panama and the southern part of the Llanos Occidentales in Venezuela. Even here, active exploitation is rapidly reducing the remaining stands. In all other parts stands have been cleared leaving only a few degraded remnants. The stands in southern Honduras, North-West Nicaragua and the Los Santos Peninsula in southern Panama are under particular threat of extinction.

REASONS FOR DECLINE

The timber is highly sought after and this has led to extensive felling throughout its range in the past. The seasonally dry Pacific coastal plains in Central America, along with the Llanos areas and north coastal Colombia are all well-suited to extensive agricultural development and many areas have been cleared for cotton, sugar and cattle production.

PROTECTIVE MEASURES TAKEN

In Central America two areas where degraded stands still survive have been included in National Parks. These are the Santa Rosa National Park in Guanacaste, Costa Rica and the Masaya National Park in Nicaragua and should contribute to in-situ conservation. In Venezuela considerable work on genetic improvement of B. quinata in the Llanos Occidentales was carried out by the Universidad de los Andes in Mérida. Seed was collected from selected trees and seed orchards have been established. There is a need to expand this work to incorporate a wider genetic base.

Sporadic seed collections have been carried out by the Commonwealth Forestry Institute in Oxford, UK in recent years and seed is now available for limited range provenance trials. Limited plus-tree selection work has also been carried out in Costa Rica and Northern Colombia.

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Brachylaena huillensis O.Hoffm. 1/

SYNONYMS

Brachylaena hutchinsii Hutch. (1910)

FAMILY

Compositae

VERNACULAR NAMES

Kenya & Uganda: Muhuhu (standard name) Muhugu (trade name) Mvumo, Mschenze, Watho, Kipungupungu, Avud Mubuubu.

Tanzania: Muhugwe (Zigua), Muhuhu, Mkarambaki (Swahili), or Magogo (Masai).

BOTANICAL DESCRIPTION

General

Dioecious tree 10-20 m high and up to 1.3 m in diameter, with a fluted and often curved bole, making large dimension timber difficult to obtain.

Inflorescence

Capitula small, white, cylindrical, in axillary woolly panicles up to 2.5cm long. Male capitula shortly pedicellate and about 12-flowered; female subsessile and about 5-flowered. Pappus in 1 row of scabrid bristles; flower heads white, in small terminal panicles or racemes; flowers tubular or discoid.

1/Based on the work of J.A. Odera (Forestry Research Dept., Kenya Agricultural Research Institute, Kikuyu, Kenya) and Ms.C.Kabuye (East African Herbarium, National Museums of Kenya, Nairobi, Kenya).

Fruit

Small winged achene in a white capitulum.

Foliage

Leaves entire or dentate, oblanceolate, up to 13 cm long and to 2.5 cm wide; grey felty below; apex acute, base long cuneate; petiole 1.2 cm long.

Bark

Bark grey, smooth or rough with longitudinal cracks.

WOOD PROPERTIES AND PRODUCTS

The timber is pale yellow to pale brown with characteristic storeyed structure, scented somewhat like sandalwood, straight-grained with conspicuous growth rings; texture very fine, even, strong and stiff, but failure in bending is sudden and complete. It is hard but works and turns well with sharp tools, takes a high polish, but splits easily along the grain. Extremely durable in the ground and sea water.

Used for fencing posts, flooring blocks, furniture, joinery and wood carving. It is considered a first class flooring timber and an excellent fuel. Basic specific gravity (even dry weight/green volume) 0.75.

Other Uses

Oil distilled from the wood has a pleasant vetiver-like perfume.

NATURAL DISTRIBUTION

Coastal area of Tanzania and Kenya; it has also been recorded in Uganda and Central Kenya, Mozambique, Angola, and Transvaal.

CLIMATE

Rainfall from around 600 mm.

SOILS

Bright red soil

HABITAT

Dominant in evergreen bush. It is common in dry coastal forests and is also found in lowland dry forests, and in semi-decidous dry upland forests 1550-2000 m above sea level.

SEED HANDLING

Easy to germinate.

SILVICULTURE

Trees are easy to raise in plantations. Increment is fast on average on good soils, with mean annual rainfall from 700 to 1,800 mm.

STATUS

Endangered.

REASONS FOR DECLINE

Settlement and cultivation. Its wood is in great demand. Firewood, charcoal, fencing posts and wood carving being the chief reasons for removal.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

The forest department (Kenya) has planted a few plots at the coast province. Tight control on exploitation has been introduced country wide.

Recommended Protective Measures are:

1. Detailed local surveys to determine population size so that conservation measures can be taken.

2. An ecological study to identify the requirements of the species with the aim to bring it into more intensive cultivation.

3. Reservation of selected blocks for conservation.

4. Provision of alternative material for wood carving.

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Caesalpinia dalei Brenan & Gillet [1/]

SYNONYMS

Caesalpinia sp. nov. in Dale & Greenway.

Although fruits and seeds of this species have yet to be collected it almost certainly belongs in the genus Caesalpinia. Its position within the genus however is distinctly isolated among the african species.

FAMILY

Leguminosae subfam. Caesalpinioideae

VERNACULAR NAMES

None recorded

BOTANICAL DESCRIPTION

General

A small thornless tree or treelet up to 10 m tall; crown spreading; bole buttressed at the base, somewhat corrugated. Young branchlets clothed with a short, velvety, dark brown indumentum, composed of a mixture of glands and hairs.

Inflorescence

Racemes terminal on main or lateral branches 2 - 8 cm long, simple, very densely clothed in a short velvety dark brown indumentum like the young stems, bracts

1/Based on the work of J. A.Odera (Forestry Research Dept.,Kenya Agricultural Research Institute, Kikuyu, Kenya) and Ms.C.Kabuye(East African Herbarium, National Museums of Kenya, Nairobi, Kenya).

1 mm long; pedicels 4 - 11 mm; sepals 5.5 - 6 mm long, brown-velvety especially outside. Petals bright yellow, the upper one with brown spots, narrowly obovate-spathulate, 9 - 10 mm long, 3 - 4 mm wide; the upper petal bent upwards at apex of claw, but without a transverse projection on inner side. Anthers glabrous, ovary and lower part of style densely covered with brown glands and pubescence.

Fruit

Fruit and seeds unknown.

Foliage

Leaf-petiole with rachis 1.5 - 10 cm long, stipels absent, pinnae 1-3 pairs, 1-8 cm long; leaflets (2-)3-4 pairs per pinna, elliptic or narrowly elliptic, slightly obliquely rhombic, 1.2 - 8.2 cm long 0.6 - 3 cm wide, obtuse at apex, glabrous except for inconspicuous pubescence on midrib beneath and for sessile reddish peltate glands scattered on lower surface; venation raised and reticulate on both surfaces.

Bark

Smooth and grey

WOOD PROPERTIES AND PRODUCTS

Hard

NATURAL DISTRIBUTION

Kenya: (1) Kwale District at Mwachi
(2) Kilifi District - Mbwaka "Kaya" forest.

So far only these 2 sites have been recorded. Repeated searches have failed to locate the tree elsewhere and it is perhaps otherwise extinct.

CLIMATE

Coastal dry, evergreen forest

SOILS

Sandy, gley, or on red soil over limestone

HABITAT

Evergreen forest and in a wooded gully; 150 m.

SILVICULTURE

There is no record of cultivation of this species and occurrence of its seeds is unknown.

STATUS

Endangered - a few trees were growing near the railway at Mwanchi: 1936.
Collected again in 1978 at Mbwaka 'Kaya' forest and in 1981 (Hawthorne, pers. comm.)

Only a very small population of this species is known to exist where it is likely to be critically endangered. Its area of distribution is very small, the forest in which this tree grows is becoming depleted each year giving way to human settlement.

REASONS FOR DECLINE

Intensive agricultural cultivation.

PROTECTIVE MEASURES RECOMMENDED

No protective measures are recorded to have been taken.

1. The Kaya forests in Kilifi and Kwale districts should be preserved as nature reserves or national monuments. Today, 1985, some Kayas are still held as sacred forest stands by the local people. But the majority of Kayas have been plundered for wood and many opened by cultivation.

2. Detailed local surveys of existing sites are needed, in particular to assess the number of remaining individuals on each site, so that protective measures can be formulated.

3. Further research should be done, to bring the species into cultivation.

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Cedrela fissilis Vell.[1/]

SYNONYMS

Cedrela brasiliensis A. Juss. (1829)
C. tubiflora Bert. (1918)
C. macrocarpa Ducke (1922)

FAMILY

Meliaceae

VERNACULAR NAMES

Cedro (throughout S.America); Cedro colorado, Cedro misionero, Cedro rosado, Cedro blanco (Argentina), Cedro branco, Cedro diamantina, Cedro rosa (Brazil).

BOTANICAL DESCRIPTION

General

A deciduous tree up to 30 m high (40 m also recorded), with a straight cylindrical bole and rounded crown.

Inflorescence

A very large, much-branched panicle 60-80 (-95) cm long. Flowers greenish-white, sometimes with a pinkish tinge, scented; monoecious, but male and female flowers very similar; sepals and petals 5, small; stamens 5, free. Ovary (in female flowers) globose, with 5 locules, each with numerous ovules.

1/ Based on the work of B.T.Styles, (Oxford Forestry Institute, University of Oxford. OX1 3RB England).

Foliage

Leaves very large, from 25-80 (-120) cm long, paripinnate, densely tomentose or very shortly pubescent; leaflets numerous, 12-18 pairs, generally sessile or subsessile or rarely with a short petiolule; broadly lanceolate, oblong-lanceolate to ovate-lanceolate, 19-15 (-20) cm and 3-5 cm broad.

Fruit

An oblong to ovoid, rarely pear-shaped,pendulous 5-valved capsule; from 4.5-8.5 (-11) cm long, valves 4-6 mm thick, woody; dark brown or brownish-black, surface rough with raised lenticels. Columella with 5 broad wings. Seeds dark chestnut-brown, 2.5-4.5 cm long, (including the wing), from 30-50 per capsule. Flowers appear from October to February, fruits mature 9-10 months later.

Bark

Bark is very similar to that of C. odorata. All parts similarly smell of garlic when crushed.

WOOD PROPERTIES AND PRODUCTS

This tree produces a dark reddish timber, but which lacks the scent of C.odorata Locally it is used for general carpentry, furniture and cabinet-making. It is claimed that it is less susceptible to Hypsipyla attack.

NATURAL DISTRIBUTION

Now very scattered and sparse distribution from Costa Rica to Argentina.

CLIMATE

Tropical moist

SOILS

In Brazil the tree occurs on well-drained soils (terra firme), but nowhere it is as common as C. odorata. Like the latter species it also thrives best on more fertile sites, and is a strong light demander.

HABITAT

Particularly in lowland rain forest up to 800 m a.s.l.

SEED HANDLING

As for C. odorata

SILVICULTURE

As for C. odorata

STATUS

The best phenotypes of many provenances have mostly disappeared, although the species as a whole is not under threat.

REASONS FOR DECLINE

Over-exploitation of the best stands by logging contractors. It is now a rare tree in lowland Amazonia. In other areas only trees of poor form survive. The species as a whole is suffering from severe genetic erosion.

PROTECTIVE MEASURES TAKEN

A few superior populations from Brazil have been included in both of the provenance trials organized by the Oxford Forestry Institute, Oxford. These have already been established as ex situ experiments in various parts of the tropics. Their performance is being assessed at the present time.

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Cedrela odorata L. [1/]

SYNONYMS

(Selected)

Cedrela guianensis A. Juss. (1830)

C. paraguariensis Martius (1837)

C. mexicana M.J. Roem. (1846)

C. occidentalis C.DC. and Rose (1899)

C. sintenisii C.DC. (1907)

FAMILY

Meliaceae

VERNACULAR NAMES

Cedro (throughout Latin America and the Caribbean), Cedro rojo (Belize, Venezuela, Mexico); Cedro real (Nicaragua and El Salvador); Cedro colorado (Peru, Venezuela); Cedro hembra, Cedro cubano (Cuba); Acajou (French speaking countries); Cedar, cigarbox cedar, red cedar (English).

BOTANICAL DESCRIPTION

General

A deciduous tree with a rounded crown of several large, arching branches, normally up to 35 m; exceptional heights of 50-60 m have been recorded. Bole up to 1.5 m diameter, sometimes with low, blunt buttresses up to 1m high.

1/ Based on the work of B.T.Styles (Oxford Forestry Institute, University of Oxford, OX1 3RD).

Inflorescence

A large, much branched panicle, 20-40 cm long. Flowers white or greenish, monoecious, but male and female flowers very smilar; sepals and petals small; stamens 5, free; ovary (in female flowers) globose, with 5 locules, each with numerous ovules.

Foliage

Leaves generally between 30-60 cm long; imparipinnate; leaflets sessile or with a short petiolule; in 6-12 ± opposite pairs; ovate-lanceolate to oblong-lanceolate; glabrous or with short hairs on the midrib beneath, 7-15 cm long and 3-5.0 cm broad.

Fruit

An oblong-ellipsoid to ovoid,pendulous, 5-valved capsule 2-3.5 (-4.0) cm long, dehiscing from the apex; valves thinly woody. Columella with 5 broad wings. Seeds light brown 2-3 cm long (including the wing) from 30-40 per capsule. Fruits mature in March to May, almost a year after the tree flowers.

Bark

Bark very characteristic, greyish-brown to grey-black, regularly and evenly furrowed or fissured longitudinally; all parts of tree strongly smell of garlic when cut or crushed.

WOOD PROPERTIES AND PRODUCTS

C. odorata provides the famous Spanish cedar of commerce which has been widely used for all types of joinery including cabinet making. It is still the preferred wood for the manufacture of cigar boxes. The

timber is light-weight, pinkish in colour and very fragrant. The rapid growth of the tree and its good form make it an excellent plantation subject in some old world countries.

Other Uses

In some areas used as a shade tree over coffee.

NATURAL DISTRIBUTION

This species has an enormous distribution from Sinaloa in northern Mexico to Chiapas in the south and on the subtropical atlantic coast from Nuevo León to Yucatán. Throughout lowland Central America and South America as far south as northern Argentina (Misiones). Also on most of the Caribbean islands.

CLIMATE

It survives in wet areas with a rainfall of 2 000 mm - 3 000 mm p.a. and in semi-arid regions with precipitation as low as 600 mm.

SOILS

Preferring the richer well-drained soils.

HABITAT

Formerly a major constituent of both dry and moist lowland decidous forest, up to 1 200 m alt. It is a pioneer species and a strong light demander, appearing as a fast growing tree in secondary forest or on abandoned pastures and agricultural land.

SEED HANDLING

Germination of fresh seed is quick and easy. Seed collected after 4 years and maintained under refrigerator still shows a high percentage of viability.

SILVICULTURE

Polypots, stumps and striplings are best used for planting directly into the field. Mixed plantations of conifers and Cedrela spp. are also recommended for rainforest sites.

STATUS

Not endangered as a species, though provenances with the best trees have mostly been lost through over-exploitation (dysgenic selection). In some parts of the range it is now a rare tree (Amazonia). Large trees of good form only occur in inaccessible areas.

REASONS FOR DECLINE

Over-exploitation of the best phenotypes through selective logging and 'creaming' of the natural forest besides clearing of lowland forest. Plantation crops have frequently failed because of the depredations of the shoot borer Hypsipyla.

PROTECTIVE MEASURES TAKEN

The O.F.I. Oxford has organised two separate sets of research trials where seed of provenances of the species has been collected from a limited part of the natural range and which is being grown on in and ex situ sites throughout the tropics. Hypsipyla grandella however attacks all trees in the Neotropics.

Some seed is still available from O.F.I. free of charge for any one wishing to establish a trial or conservation stands.

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Cedrus libani A. Rich.[1/]

SYNONYMS

Pinus cedrus L. (1753)
Cedrus libanensi Juss. ex Mirb. (1805)
Cedrus patula K.Koch (1853)
Cedrus libanitica Trew ex Pilger (1926)
Cedrus libanitica subsp. stenocoma O.Schw. (1944)

FAMILY

Pinaceae

VERNACULAR NAMES

Sedir (Turkey); Lebanon Cedar (English);
Cèdre du Liban (French speaking countries)

BOTANICAL DESCRIPTION

General

A majestic tree, 20-35 m high, with a massive trunk 5-8 m or more in girth. Branches of young tree often erect or ascending, the leading shoot usually drooping or bent at the tip. Trunks of old trees often divided into several stout, erect branches; side branches horizontal, sometimes extending for a considerable distance from the trunk. Branchlets numerous and spreading so as to form a wide, table-like surface.

1/ FAO acknowledges the assistance of R.Morandini, Instituto Sperimentale per la Selvicoltura, Viale S. Margherita 80-82, I - 52100, Arezzo, Italy.

Fruit

Cones ovoid to barrel-shaped, 7.0-11.0 cm long; 4.5 - 6.5 cm wide; scales up to 15 mm wide, seed about 1.2 cm long, seed and wing together 2.5 - 2.8 cm long; wing wedge-shaped.

Foliage

Leaves 10-40 mm long, green or glaucous, needle-like, frequently with silvery stomatal lines, somewhat flattened, acute.

WOOD PROPERTIES AND PRODUCTS

The oily, sweet-scented wood is very durable and has been a valuable source of timber (King Solomon's Temple).

Other Uses

Ornamental plantings

NATURAL DISTRIBUTION

In Syria it grows in the Lebanon mountains at elevations as high as 3 400 m, and in the Kedisha valley, at approximately 2 000 m. Also in Turkey in the Taurus and Anti-Taurus ranges, from 1 000-2 000 m.

CLIMATE

Continental cold, mediterranean or temperate cold climate with winter rainfall. It is an adaptive species but does not withstand high atmospheric humidity. It has proved very frost resistant.

HABITAT

Dominant tree or in mixed forest.

SEED HANDLING

Germination normally around 45%. The cones may be opened by soaking them for 48 hours in warm water. After the scales are dry, they can be put through a screen-covered sieve to remove the seed. Seed keeps its vitality for at least 4-5 months in ordinary storage conditions. No pre-treatment is needed as the germination is quick (3-5 weeks). 10-15 000/kg.

SILVICULTURE

In Lebanon it has been found necessary to establish terraces and do soil preparation.

STATUS

In Lebanon natural stands are found in seven different localities (Ehden, 140 ha; Tannourine and Hadeth, 85 ha; Barrouk, 40 ha; Ain Zahalta, 40 ha; Jabal Quammoa, 30 ha; Bcharre 7 ha; Jaje, 2 ha). Total area: 344 ha.

In Turkey extensive natural stands are found on the Taurus mountains. Natural regeneration is often very abundant and vigorous.

REASONS FOR DECLINE

Exploitation and grazing, especially in Lebanon, has been a major problem because it destroys the natural regeneration.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

In Lebanon the Government has forbidden the felling of trees in the natural stands. A large reforestation scheme, which will include C. libani, has also been planned.

In Turkey some old stands are protected as natural reserves.

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Cercidiphyllum japonicum Sieb.et Zucc.[1/]

The genus Cercidiphyllum was widely distributed in the northern hemisphere during Upper Cretaceous and Tertiary period, but nowadays is known only from Eastern Asia, with 2 species in Japan and a variety (Cercidiphyllum japonicum var. sinense Rehd. and Wils.) in China.

FAMILY

Cercidiphyllaceae

VERNACULAR NAMES

Katsura Tree

BOTANICAL DESCRIPTION

General

A huge deciduous tree up to 30 m in height and 2 m in diameter; branchlets dull brown, with numerous prominent transverse lenticels; shoots reddish with small greyish lenticels. Winter-buds purplish-red, covered by 3 scales; the terminal bud absent, the shoot branching pseudo-dichotomously in the next season.

Inflorescence

Flowers in May before it leafs; dioecious, developing from axillary or terminal buds on dwarf-shoots; perianth absent. Staminate inflorescences nearly

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1/ FAO acknowledge the assistance of Pan Chih Kang. The Arboretum, Chinese Academy of Forestry, Beijing, China.

sessile, composed of 2-4 bracts and 15-35 stamens; anthers red, linear, apiculate by the prolongation of the connective. Pistillate inflorescences pedicelled, consisting of 2-6 carpels, each subtended by a bract; ovary fusiform, cylindrical, dark green, with an extrorse ventral suture; style elongated, stigmatic only on the outer dark, scarlet surface.

Fruit

Follicles 2-6 in a stalked cluster, ripening dark brownish grey in October, with a 2-layered pericarp, dehiscent and exposing numerous winged seeds, imbricated in 2 rows.

Foliage

Leaves on long shoots opposite or subopposite, ovate or ovate-orbicular, with a more or less acutish apex; leaves on dwarf-shoots solitary, obtuse or nearly rounded at the apex; blade crenulate with glandular tips on the margin, glabrous, palmately 7-nerved with anastomosing veinlets.

Bark

Bark dark-greyish brown, deeply furrowed, separating into flakes.

WOOD PROPERTIES AND PRODUCTS

The katsura-tree is one of the most important trees producing valuable timber in Japan. The wood which is light and soft and fine grained, is largely used for the interior finish of buildings, furnitures, cabinet-works etc. Specific gravity: 0.51-0.63.

Other Uses

In some places used as an ornament.

NATURAL DISTRIBUTION

Mostly in the northern part of Japan; with a scattered occurence throughout the southern part. In China the variant Cercidiphyllum japonicum var. sinense is found in Western Hupeh, and Western Szechuan (at elevations between 1 000-2 600 m in Western Szechuan, 900 - 1 350 m in western Hupeh, and 820 - 1 450 m in Anhwei).

CLIMATE

Cool - temperate.

SOILS

Prefers neutral to acid soils, and sites where the soil is very moist or wet.

HABITAT

In Japan it is often found in valleys in the cool-temperate beech forests together with Aesculus turbinata. These beech forests are widely distributed throughout the islands of Japan. The valley forests are formed on rather moist concave slopes and on relatively stable colluvial or flooded soils of valley bottoms. In China it is mainly found in Mixed mesophytic forest and Evergreen Oak and Schima forest.

STATUS

Certain provenances are endangered (in China).

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

None at present. In China there is need for botanical and genecological exploration.

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Cheng Wan-chun 1982	Sylva Sinica - Vol.1, p. 542-544.

Chlorophora excelsa (Welw.) Benth. & Hook. f.

FAMILY

Moraceae

VERNACULAR NAMES

Ghana: Iroko (trade name) Odum, Elunli, Elui, Ala, Edi.

Kenya: Iroko (standard name), Mvule (trade name), Mururi, Minarui, Mutumba, Murumba, Olua.

Uganda: Mbara, Mutumba, Kimrumba.

Senegal and Guinea: Toumbohiro Noir

Guinea: Simmé

Siere Leone and Liberia: Semli

Ivory Coast, Ghana and Togo: Odoum

S. Nigeria, Cameroon and Equatorial Guinea: Rokko, Oroko, Iroko.

Central Africa Republic, Zaire: Kambala, Moloundou, Bangni.

Angola: Mereira

Mozambique: Mufula, Mvule, M'Gonde

BOTANICAL DESCRIPTION

General

Large deciduous tree occurring in forest and savanna. In forest it frequently attains 50 m, with a straight

cylindrical bole 17-27 m long; in savanna it rarely exceeds 30 m, usually branching within 13 m from the ground. Crown large, composed of a few stout widely spreading limbs; ultimate branchlets often pendulous, especially in male trees. Buttresses small or absent. Surface roots usually extensive.

Inflorescence

Flowers green, dioecious. Male flower-spikes pendulous, slender, up to 15 cm long; female spikes erect, stout, closely packed, to 6.4 cm long.

Fruit

The fertilised female inflorescence develops into a green mulberry-like or fleshy caterpillar-like syncarp of which the individual fruits are small achenes.

Foliage

Leaves very variable, those on flowering shoots entire, very shortly acuminate, oblong-elliptic, 12-15 cm long, 7.5 - 10.2 cm broad; those on young trees and coppice shoots serrate, much larger, usually long-acuminate.

Bark

Bark thick, pale ash-grey to dark brown or almost black, scaling slightly at the base.

WOOD PROPERTIES AND PRODUCTS

The timber of male and female trees is practically identical; sapwood yellow-white, sharply defined, very liable to borer attack and not durable; heartwood yellow to yellow-brown when freshly cut, darkening to deep golden-brown or russet-brown with lines of paler tissue, sometimes marked with darker streaks, becoming deep brown if repeatedly oiled or if treated with lime. The wood is somewhat variable in hardness and weight; it is fairly coarse in texture and has a typically interlocked, sometimes wavy, grain; it is scentless and tasteless, almost teredo and termite proof, very resistant to fungi, and classified as fire resistant. The wood of male trees is very slightly denser than that of female trees and is consequently slightly more difficult to saw. It turns easily, material from the denser male trees giving the best results, bends moderately, nails well, and takes a fine polish. The high quality timber is used as a teak substitute. The best finish for the timber is its natural colour with wax polish.

Other Uses

The bark is used for roofing houses and also for dyeing leather and clothes, and contains a fibre. The bark, its ashes, the leaves and the latex all have uses in local medicine.

NATURAL DISTRIBUTION

C.excelsa occurs naturally in tropical and sub-tropical Africa. It is found in Sierra Leone, Gabon, Cameroon,

Ivory Coast, Nigeria, Congo, Zaire, Malawi, Uganda, Kenya and Tanzania.

CLIMATE

The lower limit of average rainfall is about 760 mm per annum, but this will not enable C. excelsa to regenerate itself naturally. The upper limit is about 2 500 mm, provided that soils do not get waterlogged.

In Uganda C. excelsa grows in areas with about 1 250 mm annual rainfall.

SOILS

The soil preferred is a deep, light red loam and freely drained. In Africa this is formed by disintegration through weathering of the underlying rocks. The type that appears to make the best soil is granite gneiss.

HABITAT

In Tanzania the tree occurs naturally in the moister areas. Normally it grows at elevations from sea level up to altitudes of about 1 200 m. In Tanzania it has even been found on Kilimanjaro at about 4 500 m above sea level. Elsewhere it is found in the transitional region between closed forests and savanna. In Kenya also by the coast.

SEED HANDLING

Ripe fruits fall on the ground from where they may be collected and seed extracted. The seed loses viability quickly. If the fruit is fully ripe, four days

soaking in water is sufficient to rot the pulp, and longer soaking reduces the viability.

SILVICULTURE

C. excelsa has been recorded as striking readily from stem cuttings. But it is an expensive propagation method and produces trees of very bad form. It also regenerates naturally by seed, coppice and root suckers. To germinate and grow well there should be adequate moisture, no root competition, some soil tilth and some shade.

Root suckers are provided when roots are wounded in any way. C. excelsa stumps or striplings should be planted on areas where all the herbaceus vegetation has been cleared, line piled and burnt. It will also thrive beneath a suitable canopy, but at the same time it is extremely sensitive to competition. Growth is in particular depressed by grass.

STATUS

Endangered

REASONS FOR DECLINE

Extensive logging.

PROTECTIVE MEASURES TAKEN

None known.

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Cordia Milleni Baker [1/]

SYNONYMS

C. longipes Bak. (1894)
C. irvingii Bak. (1895)
C. unyorensis Staff (1906)
C. ugandensis S. Moore (1916)

FAMILY

Boraginaceae

VERNACULAR NAMES

Ghana:	Drum Tree, Akaboa Kyenedua (i.e.drum tree) Kyeneduru, Twenboa, Tweneboakadua, Kyeneboa, Tweneduru.
Kenya:	Mungoma
Uganda:	Mukebu, Mutumba, Ketumba, Mujugagoma (Musical instruments)
Nigeria:	Omo
Cameroon:	Ebe
Tanzania:	Mzingatti, Mkibu

BOTANICAL DESCRIPTION

General

Tree up to 35 m high or more, with spreading crown. Bole thick, rarely straight, usually short (10-13 m). Buttresses short and blunt.

1/ Based on the work of J.A.Odera (Forestry Research Dept., Kenya Agricultural Research Institute,Kikuyu, Kenya) and Ms.C.Kabuye (East African Herbarium, National Museums of Kenya, Nairobi, Kenya).

Inflorescence

Flowers longer than calyx, yellowish; stamens exerted in crowded cymes.

Fruit

Fruit ovoid, 3.8 - 4.4 cm long, about 1.9 cm diameter cupped in the enlarged calyx.

Foliage

Young parts pale brownish tomentose; leaves alternate, obovate - suborbicular to orbicular, usually 15.0 - 25.0 cm long and 6.4 - 11.4 cm broad. (occasionally up to 30 cm long and 18 cm broad); entire or crenulate; scabrid above, tomentose-pilose beneath; apex usually rounded, base rounded to cordate; petiole usually 3.8 - 7.6 cm long, occasionally up to 15.2 cm long.

Bark

Bark pale brown, fibrous.

WOOD PROPERTIES AND PRODUCTS

Wood fairly soft and close-grained, yellow and lustrous, with brownish heartwood. It makes durable roof shingles lasting 4 years, and useful furniture. It seasons and finishes well, and it is said to be impervious to termites. It is much used to make drums, including the Ashanti "talking drums" (cf.kyne 'drum'), bowls, and other domestic utensils. In Uganda, the wood is used for making musical instruments. Easily adzed and floating well, it is used to make canoes (Eggeling, Uganda) and canoe

keels, and is useful when dry as firewood. In Ghana the wood is used for shingles. Basic specific gravity about 0.34.

Other Uses

It is used as a shade tree in Yoruba villages and sometimes regarded as a sacred tree. The leaves are boiled and the liquid bottled and administered two spoonfuls morning and evening for roundworms. A leaf decoration, of the dried leaves is smoked as tobacco and used in Nigeria for asthma, colds, cough, etc. The pulverized seeds mixed with palm-oil are used against ringworms.

NATURAL DISTRIBUTION

Widely distributed in tropical Africa.

SOILS

Very variable.

HABITAT

Found in closed deciduous forests and old secondary formations.

SEED HANDLING

None recorded

SILVICULTURE

It is commonly planted in towns.

STATUS AND REASONS FOR DECLINE

Rare in Kenya; known only from a few scattered localities. Populations in these localities tend to be shrinking as the forests in which they grow are becoming further reduced in size each year. Where found it is commonly prefered for musical instruments like drums.

PROTECTIVE MEASURES TAKEN

None recorded.

PROTECTIVE MEASURES PROPOSED

1. Conservation of the forests where the species are found.
2. Surveys to determine full extent of distribution.
3. Research to study the ecological requirements and possible cultivation of the species.

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Irvine, F.R. 1961	Woody Plants of Ghana with special references to their uses. London, Oxford University Press.

Cupressus atlantica Gaussen[1/]

Some authorities still regard this species as a small-coned population of Cupressus sempervirens L., but there appear to be sufficient differences to justify its separation.

SYNONYM

Cupressus maroccana (name erroneously attributed to Gaussen by L. Emberger (1960)).

FAMILY

Cupressaceae

VERNACULAR NAME

Azel (Berber)

BOTANICAL DESCRIPTION

General

Medium-sized tree, up to 35 m high and 4 m in diameter. Conical form with straight trunk, no fastigiate forms have been recorded. Branches set at a wide angle, upward curving. Branchlets of first and second order distichous. First order shoots are slightly flattened in section, very fine (diameter 0.5).
Seedling with two apiculate cotyledons and apiculate leaves, glaucous.

1/ Based on the work of P.J.Stewart, Oxford Forestry Institute, Department of Plant Sciences, University of Oxford, U.K.

Inflorescence

Monoecious: male strobili, terminal, yellow, elonganted, c. 5 - 2 mm; female strobili terminal, 8 mm broad.

Fruit

Cones globose,18 to 22 mm in diameter, with 6 to 10 cone scales. Mucro of scales hardly visible. Seed with very narrow wing.

Foliage

Adult foliage: leaves of cupressoid scales, opposite, decussate, imbricate, appressed, acuminate, strongly keeled; 1 mm long with a very prominent and active resin gland. General aspect of foliage fine-grained, slightly glaucous, especially on young trees.

Bark

Bark grey-brown, longitudinally fissured: not exfoliating.

WOOD PROPERTIES AND PRODUCTS

It produces long, high-grade sawlogs and has an attractive aromatic wood.

Other Uses

Wood very durable and potentially valuable for dendrochronology.

NATURAL DISTRIBUTION

The species is endemic to the High Atlas Mountains of Southern Morocco where there are several stands and a number of isolated trees, over a total area of about

200 km^2 around 11° West, 31° North. The largest stand is in the Forest of Aghbar, in the valley of the Oued Nefis, where the species occupies about 6 000 ha. The altitude is between 1 100 and 2 000 m.

CLIMATE

The climate is mediterranean with a summer dry season, and rainfall is from 350 mm to 700 mm. There are no direct data on temperatures: summer maxima are likely to average at about 30° and winter minima at -1°, or less. Extreme frosts of -15° are thought to occur and have been measured at an arboretum where this species has survived.

SOILS

The soils are more or less eroded, on parent materials consisting mainly of schists and basaltic rocks.

HABITAT

The species is extremely long-lived, the oldest specimen being at least 2 000 years old according to known growth rates. The species is drought resistant and extremely frost resistant and adapts itself to a variety of soils.

SEED HANDLING

Germination normally low. No special pre-treatment is recommended. Around 140 000 seeds/kg.

SILVICULTURE

No special methods are necessary: the usual procedures for temperate conifers are suitable for raising and planting Atlas Cypress. Cuttings and grafts can be

used, presumably by the same techniques as those required for Cupressus dupreziana, q.v.

STATUS

Endangered at the species level.

REASONS FOR DECLINE

Exploitation and increasing human pressure.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

The forests of Atlas Cypress are managed by the Moroccan Forest Service with the objective of maintaining and improving them. However, the future of the forest depends on natural regeneration, and it remains to be seen how successful the conditions for this can be re-created despite continued grazing. The Forest Research Station of Rabat has undertaken a long-term programme of research on the species, including the designation of plus trees for seed collection. The species has been little planted outside North Africa and France. It should be introduced into many more countries for experimental planting in regions subject to drought and frost, and for tree breeding programmes.

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Cupressus dupreziana Camus[1/]

SYNONYM

C. lereddei Gaussen (1950)

FAMILY

Cupressaceae

VERNACULAR NAME

Tarout (Touareg)

BOTANICAL DESCRIPTION

General

Medium-sized tree, able to attain more than 20 m height and up to 3 m diameter. All known fully-grown trees are too badly mutilated for the natural form to be seen. Young specimens grown in protected conditions show bushy form at first but with subsequent development of a straight central axis. Branches leave trunk at large angle, curving upwards. Branching of first and second order shoots tends strongly to be in two planes; first order shoots are considerably flattened. Seedlings: with two cotyledons and aciculate leaves, glaucous; juvenile leaves sharp, 2-3 mm long.

Inflorescence

Monoecious; male strobili terminal, yellow, elongated, c.6 x 3 mm; female strobili terminal, purple, ovoid, c. 2.5 mm.

1/ Based on work of P.J.Stewart, Oxford Forestry Institute, University of Oxford OX1 3RB, UK.

Fruit

Cone: Elongated c. 18-24x16-20 mm, grey-brown, matt, with 12 sometimes 10 scales, each with a very small, rounded mucro.

Seeds: reddish-brown, oval, flattened 4x5 mm to 5x6 mm, with wide, thin wings. Pollen grain 38 microns in diameter - a specific character.

Foliage

Adult foliage: leaves of cupressoid scales, opposite, decussate, imbricate, slightly appressed, acuminate, 1 to 1.5 mm long; resin gland elongated, not noticeable except on base of old leaves. Dull green in colour, slightly glaucous, especially on the young tree. Foliage very dense.

Bark

Reddish-brown, with deep longitudinal fissures; no exfoliation.

WOOD PROPERTIES AND PRODUCTS

The wood is suitable for the most exacting uses, being of medium density, stable and aromatic. The stems are straight in cultivated trees and the branches fine.

Other Uses

Potential value for afforestation in arid regions.

NATURAL DISTRIBUTION

Confined to an area of some 200 km^2 on the Edehi (or Tamrit) Plateau of Tassili N'Ajjer massif in Central

Sahara, around 9°E and 25°N, in eastern Algeria. 153 living specimens have been counted and many more dead ones. The altitude varies between 1 000 m and 1 800 m.

CLIMATE

The climate is not known by direct measurement: the average maxima and minima in summer are estimated at 30°C and 20°C, those in winter at 13° and 1°C. Frosts down to 7°C are probable. The average annual rainfall is perhaps 30 mm, with great irregularities.

SOILS

Alluvial gravels and sands

HABITAT

The trees are in wadi bottoms. Only two cases of naturally occurring seedlings have ever been recorded, and there are no trees younger than at least a century (only five trees are recorded with a diameter of 50 cm or less, the smallest being 13 cm). Fossil pollen shows that the species was once widespread in the Sahara. The trees are extremely long-lived, the oldest being probably at least 2 000 years old.

SEED HANDLING

The seed of this cypress is reputed to germinate with difficulty. However, this is not a general rule. Sowing can be carried out in the usual way, with thorough precautions against fungal infection.

SILVICULTURE

Cuttings can be grown under mist as with other conifers.

Grafting has been successfully achieved onto Cupressus sempervirens by scion-budding, by crown-grafting and by inarching. The latter method can be used for cuttings if the base of the scion dips into water and is perhaps the most successful. Growth is reportedly a little slower than that of Cupressus sempervirens in similar conditions. This is one of the most drought-resistant species known, with considerable frost tolerance.

STATUS

In imminent danger of complete disappearance from its natural range.

REASONS FOR DECLINE

Nomads often shelter under the trees and their herds destroy any regeneration. There is still sporadic exploitation of living branches for firewood, but systematic cutting of the cypresses has been brought to an end by their rarity and remoteness. There were still many living trees in 1863 according to the first European report and they were a major source of timber for local use.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

Expeditions at various dates have made unsystematic collections of cones, and seedlings have been raised at many botanic gardens in France and Algeria. The biggest collection was made by the Algerian Forest Service in 1969 and several hundreds of trees were successfully germinated. The Forest Research Centre at Ariana, Tunis, possesses a good collection of young

trees. Seeds from two adult trees in Lebanon have been distributed to interested persons and institutes, i.e. CSIRO, Canberra (Australia). There seems little prospect for protecting the surviving natural population, scattered over 200 km^2 at a density of less than one tree per km^2. A more promising approach would be to take cuttings from every specimen and to grow a complete set in a number of places so as to save the whole surviving gene resource and to duplicate it as an insurance against accident. The fullest possible use should be made of the Saharan specimens, both living and dead. A collection of material for dendrochronological purposes should be organized at the earliest possible date. There is a danger that almost all the dead wood will be taken for local use before it can be examined scientifically.

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Dalbergia nigra Fr. Allem.[1/]

FAMILY

Leguminosae subfam. Papilionoideae

VERNACULAR NAMES

Jacarndá-da-Bahia, jacarandá, jacarandá-caviuna, jacarandá-preto, jacarandá-rajado, jacarandá-coco, caviúna, cabiúna, pau-preto, uruúna. (Brazil). Brazilian rosewood, palisander (England), palissandre (France), Jacarandaholz, Palisanderholz (Germany), madera de palisandro (Spain), legno di jacaranda, palissandro (Italy).

BOTANICAL DESCRIPTION

General

Tree with heights varying between 15 and 25 metres; trunk relatively thin, most measuring between 0.30 and 0.40 m in diameter; irregular and slightly conical at the base. Trees with a thick trunk are rarely found nowadays.

Branches dark, roundish, tomentose when young, fairly broad, growing in a slightly zig-zag fashion.

Inflorescence

Flowers pale violet, scented, small, approximately 9 mm long, arranged in short axial bunches, 5-6 cm long, shorter than the leaves, appearing on leafless shoots and may join together to form panicles about 20 cm long, with reddish hairs. Calyx, campanulate

1/ Based on the work of Mario Tomazello (Forest Dept. University de Sao Paulo, Piracicaba, Sao Paulo, Brazil).

fairly smooth, with 5 long teeth, one longer than the rest. Corolla yellowish-white with 10 monodelphous stamens. Flowering from October to November (Ramalho, 1973; Rizzini, 1971); November to December (Pickel, 1951).

Fruit

An elliptical or oblong samara, shiny, with prominent longitudinal venation, 3-8 cm long by 12-15 cm wide. Seeds 1 or 2 per fruit, central, kidney-shaped, flattened, black and smooth.

Foliage

Leaves compound, imparipinnate, alternate, with 12-18 small folioles, 7-15 mm long by 4-8 mm wide; alternate, elliptical, oblong or somewhat obovate and emarginate, pilose on both sides when young, later becoming glabrous, or always glabrous; delicately veined; petioles glabrous or more often pilose.

Bark

Thin, grey, rough bark with irregular parallel fissures, scaling fairly slowly, with a tendency for small plaques to curve outwards.

WOOD PROPERTIES AND PRODUCTS

The heart wood is dark greyish-purple in colour with black stripes or markings; it may occasionally be pinkish-beige with orange stripes or very pale, almost without design, which reduces its commercial value. The surface is irregularly shiny and smooth and has a distinctive, pleasant, subtle smell and a sweet

taste. It is hard, heavy and resistant, and splits easily. The sap wood is pale yellow, almost white.

It is the most valuable Brazilian wood, particularly in demand for furniture-making, although nowadays only for veneers for plywood. Because the tree is now so rare, it is difficult and expensive to produce furniture wholly made of this timber.

Other Uses

The wood is often found as decoration in a great variety of forms, domestic utensils and even women's jewellery, mainly in places where its ornamental aspect can be displayed.

NATURAL DISTRIBUTION

South of Bahia as far as Minas Gerais, including Río de Janeiro and Espírito Santo (fig.1). Felling is restricted to the area south of Bahia. In the Mata area, in Minas Gerais, young specimens are abundant and regeneration is fairly easy. A study carried out by Leao & Vinha (1975) in the southern part of the State of Bahia showed that the species is present around Teixeira de Freitas, Itamaraju, Itabela, Guaratinga, Eunápolis, Itagimirim, Itapebí, Itaimbé, Gurupá-Mirim, Potiraguá, Mascote, Camacá, Arataca, Juçari, Uruçuca, Uguaí, Porçoes, Banco Central, Itapitanga, Gongogi, Ubata, Ibirapitanga, Itagibá, Itagi, Aiquara, Ipiaú, Apuarema, Itamari, Wenceslau Guimaraes, Ipiuna and between Valença and the BR-101.

CLIMATE

There are four different climatic types in the area: Af, Am, Aw and Bsh (Koeppen-classification). Af is a hot, damp climate, with no dry season, rainfall over 1 300 mm/year; Aw is a humid, savanna-type cliamte, with a dry winter season; Am is a transition between Af and Aw; and Bsh is a hot, semi-arid climate, with serophilous vegetation (fig. 2).

SOILS

According to Domingos & Keller (1958), the southern part of Bahia State consists of sandy terrain of marine origin, barren tablelands and hills. To the west the land rises in a series of crests and ledges in a general SW-NE direction which look like steps leading up to the South Bahian Plateau. The surface here is eroded, moulded in gneiss and granite, and the average altitude is 750 - 850 metres. From an edaphic point of view, the region is fairly complex: oxisols are predominant - deep soils with low natural fertility. There are also fairly extensive areas of alfisols, entisols and mollisols - fertile soils used for the cultivation of cacao and as pasture land. Near the coast and in the channels of the rivers there are inceptisols, histosols, entisols and spodosols. To the north-east, where the climate is semi-arid, there are aridisols. The study indicated that in 89 percent of cases, Dalbergia nigra occurs on undulating or mountainous terrain, on the tops and sides of hills where the soil is clayey and clayey-sand, deep and well-drained. The results of the study indicate that palisander is not a

species that requires phosphorous and that it prefers soils with a low content of aluminium.

HABITAT

It was further observed that specimens occur with greater frequency in a specific belt of hilly and mountainous land extending northwards from the river Jequiriça (fig. 1). To the east, the species rarely reaches the coast, probably due to edaphic factors - the occurrence of low-fertility soils (oxisols). To the west, it reaches the escarpment of the South Bahian Plateau, being found mainly in the valleys of the Cachoeira, Contas and Almas rivers.
South of the Pardo river, the largest concentration of the species is to be found on the boundaries of climatic zones Af and Am, while to the north it is found in climatic zones Af and Am and in the transition zone between climatic zones Am and Bsh (fig.2). Due to the length of time during which this species has been utilized, it has become rare in the more accessible and unprotected areas.

SEED HANDLING

Fructification: September to October (Ramalho, 1973; Rizzini, 1971); January (Pickel, 1951).
One kilogramme may contain 14 000 seeds capable of germinating within 12-25 days.

SILVICULTURE

Few experiments have been carried out on palisander cultivation in Brazil. Data obtained in the Biological Reserve of Pau Brasil in Porto Saguro (BA) indicate

that 34 one-year-old specimens, planted with a spacing of 2.0 x 2.0 m, measured 3.0 cm in diameter and 2.0 m in height (Leao & Vinha, 1975). Palisander is generally considered to be a slow-growing species, but Mattos Filho & Coimbra Filho (1975) state that in Rio de Janeiro palisander grows better than various species of Machaerium with a spacing of 1.5 x 1.5 m (the first pruning being effected when the tree is 4 years old and already covers the ground).
Heringer (1957) states that growth is rapid in the state of Minas Gerais. Golfari & Caser (1977) mention the existence of only a few experimental specimens of between 1 and 10 years of age in the northeastern region. According to these two authors, palisander grows in a great variety of forms, from a bushy type with branches growing up from the base to specimens with relatively straight trunks. They also report the existence of an experimental specimen, 8 years old, 8 m high and with a diameter of 0.10 m, in Linhares-ES.
Galvao et al. (1979), analysing experimental cuttings from a palisander tree in the region of Manaus, 57 months old, growing in yellow latosol of low fertility in climatic zone Am, according to Koeppen, concluded that this species would have great potential if grown in Amazonia.

STATUS

In danger of extinction

REASONS FOR DECLINE

Palisander is the most valuable of the innumerable

species that grow in Brazil. Because it has been intensively logged, it is on the way to extinction. Unfortunately there are, as yet, no commercial plantations of this species and research on the possibilities of cultivating it are only just beginning.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

Lack of interest in the cultivation of palisander is due largely to the widespread misconception that it is slow-growing. But bearing in mind the great value of its wood and the fact that it belongs to the Leguminosae, some members of which have the ability through symbiotic microbial reduction to convert nitrogen from the air into nitrogen-components that can be assimilated by plants, research should be carried out into the conservation of this important genetic resource both in situ and ex situ.

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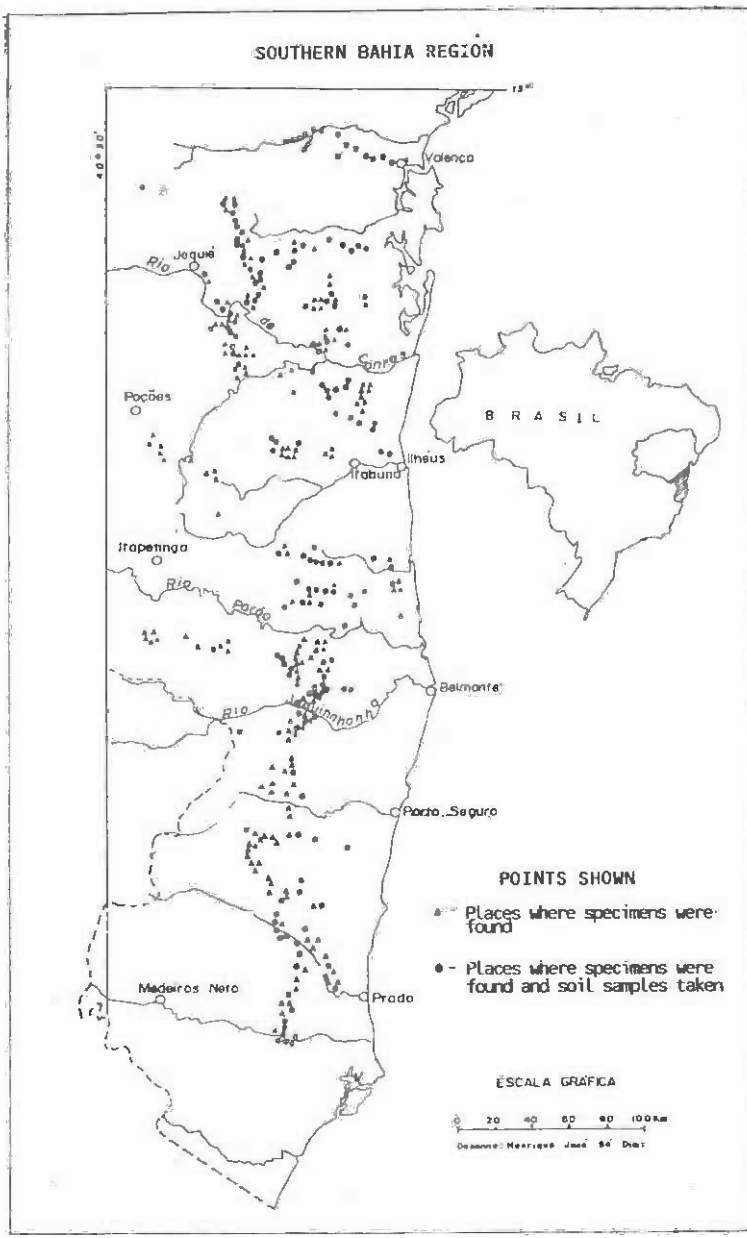

FIGURE 1 - Occurrence of palisander, Dalbergia nigra, in Southern Bahia (Leão & Vinha, 1975).

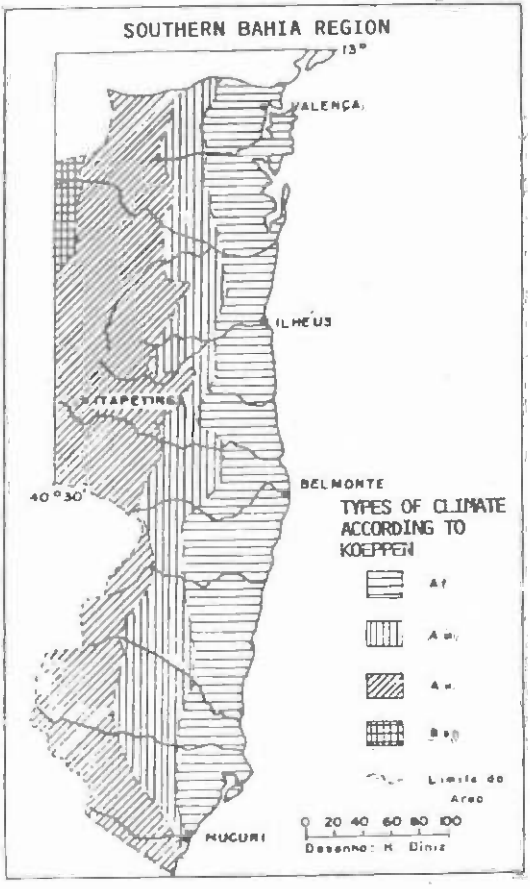

FIGURE 2 - Climatic sketch of the Southern part of the State of Bahia (Leão & Vinha, 1975).

Didymopanax morototoni (Aubl.) Decne & Planch.[1/]

SYNONYMS

Panax morototoni Aubl. (1775)
Didymopanax calophyllum Decne and Planch. (1878)
Didymopanax chrysophyllum Decne and Planch. (1878)
Didymopanax speciosum (Willd.) Decne and Planch. (1878)
Panax chrysophyllum Vahl (1796)
Panax speciosum Willd. (1806)
Panax spinosa Poiret (1811)
Schefflera morotoni (Aubl.) Frodin (ined.).

FAMILY

Araliaceae

VERNACULAR NAMES

Brazil: Morototó, Mucututú, Pará-pará, Marupaúba - flaso, Sambacuim, Mandioci, Mandioqueira, Pixixica, Marupaúba, Pau-caixeta, Marupá.

French Guiana: Córdovan, Bois de maí, Bois de Sanit Jean.

Guiana: Karohoro, Matchwood, Morototo.

Surinam: Morototo, Cassavehout, Bigi boesie, Papaja-hoedoe, Kasabahoedoe.

Peru: Sanch-uva, Anonillo.

1/ Based on the work of O.Daniel, L.G. da Costa and S.T.Ohashi, Forestry Department of the Faculdade de Ciências Agrarias do Para, P.O. Box 917, Belém, Para, Brazil.

Bolivia: Guitarrero.

Columbia: Yrumero, Yagrume.

Venezuela: Yarumo de Savana, Y. Macho, Orumo Macho, Sun-sun, Higuereto, Tinajero.

Argentina: Ambay-guazú.

Costa Rica: Pava, Pavilha, Probado, Pino del general.

Panamá: Jagueme, J. Macho, Pyume Pyume Macho, Pava, cimarrona, Grayumo, Yagrume, Y.Macho, Yarumero, Manabé, Gorgoram.

Trinidad: Match-wood, Jeretón.

Dominican Rep.: Palo de sable, sablito, Yagrumo Macho.

Cuba: Sapatón, Yagrumo Macho, Arriero, Gavilan, Badana, Cordobán, Padero, Papayón.

México: Chancaro blanco, Robla blanco.

Nicarágua: Costilla de danto.

Honduras: Mountain trumpet.

Puerto Rico: Yagruma Macho, Pava cinuanoria.

BOTANICAL DESCRIPTION

General

A tree with ornamental possibilities due to its rapid growth and handsome aspect, medium sized, 8 to 30 m in height, cylinder-shaped bole that is straight and may reach up to 80 cm in diameter at the base; crown

small with ramification only at the apex; the branches are not numerous; scars on the leaf peduncles occur.

Inflorescence

A terminal, panicule, 20 to 40 cm in length, with groups of multi-flowered umbels (30 flowers), forming the following types:

Type "A" - The umbels form on the tertiary petiole, with solitary flowers appearing below the umbels;

Type "B" - The umbels form on the fourth peduncle;

Type "C" - Of intermediary structure; umbels are on the tertiary peduncles, on the lower half the inflorescence and, on the other half, aborted flowers in quaternary peduncles.

In Panama, the trees begin to cease flowering when rainfall reaches levels above 300 mm/month, from August to December. In Brazil, they flower from November to January. The flowers may be pedicelate or sessile; not articulated; calyx with five sepals that are heavily pubescent; corolla with five petals in eliptical buds; five stamens alternate with the petals, with very small filaments.

Fruit

The fruits are drupes, transversally eliptical; wider than long, measuring 11 to 12 mm in width by 8 to 9 mm in length; 4 to 6 mm and 7 to 9 mm respectively are also reported.

In Panama, Brazil and Peru, fructification is from November to December, and the number of seeds per 100 g is 5 900.

Foliage

Leaves large, compound, digitate, 15-40 cm long alternate, long petioled (30-60 cm), with well developed stipules; inserted obliquely on the stem; 10 to 11 folioles, with eliptical lance-shaped limb, acuminate, undulate, sinuate on the margin, semi coreaceous, dark green on the upper surface and brown-red underneath, where it is heavily pilose.

Bark

The Bark has a whitish colour with a smooth surface.

WOOD PROPERTIES AND PRODUCTS

Wood is moderately heavy, light cream in colour with some grey; regular grain; medium texture; shiny and smooth surface; indistinct odor and taste. Easily worked with a fine finish.

Wood is used in general carpentry, veneer, ceiling construction etc.; match sticks, boxes and cartons, pencils, pulp and paper. It frequently appears on the market as "Marupá" - (Simaruba amara).

Other Uses

In Panama the petioles are used for making bird cages.

NATURAL DISTRIBUTION

This species has a wide distribution, being found in Brazil, Argentina, Peru, Guianas, Venezuela, Colombia,

Antilles, Costa Rica, Panama, Guatemala, Mexico and Bolivia.

SOIL/CLIMATE

In Brazil, according to the classification made by Koeppen, Didymopanax morototoni grows in Am and Aw type climates[1/]. In other countries where this tree grows naturally, the climates are also tropical with and without dry seasons, with the exception of Argentina which has a sub-tropical climate. It occurs frequently in clayey, acid soil.

HABITAT

Frequently found in the upland forests, in old open woodlands. In Peru it is common on the savana margins. It prefers open forests with abundant light. In surveys made on the region between the Tapajós and Xingu rivers, 60.8% of Didymopanax morototoni trees with more than 25 cm of dbh, was found in the dominant stratum.

SILVICULTURE

Didymopanax morototoni is a light-demanding species, abundant mainly in openings, secondary forests and on road sides. These locations are susceptible to fires in dry periods, and this species is essentially favored due to the resistance of its seeds. Soon after burning, which practically cleans the soil, the seeds germinates.

1/See top of page 219.

Didymopanax morototoni has been cultivated mainly for the manufacturing of match sticks in the Brazilian Amazon. At three years of age a better growth in height (4.66 m) was obtained in a 3 x 2 m spacing and the larger diameter (9.3 cm) with a 4 x 4 m spacing. The average annual increase in diameter from 1951 to 1978 in stands in Puerto Rico was 0.82 cm/year. In Brazil this figure should be higher. An expected production of 15 - 18 m^3/ha/year in uniform stands is forecasted.

STATUS

Didymopanax morototoni is a species that is very abundant in secondary forests of all Central and South American countries, where there is a tropical or sub-tropical climate. Its regeneration is due to dispersal by birds. The genetic variability is large, but exploration is still necessary to discover new provenances. However, even with the availability of abundant native raw material, forest enterprises do need this wood in such large quantities that they are already concerned with reforestation, which has shown good tree development and form. This species is not generally in genetic deline, and good provenances are found throughout the area of its natural distribution.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

As already stressed, this species is not undergoing extinction at the moment. However, due to its wide use, which is becoming more intense in the pulp

and paper industry, and as a white wood for many purposes, some recommendations may be made:

(a) more in-depth study on the management of its natural regeneration and on its silviculture.

(b) planting of base populations for the preservation of provenances.

(c) study on the genetic variability among and within populations.

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Diospyros hemiteles J.B.K.Richardson[1/]

Of the fourteen species of Diospyros endemic to the Mascarenes, twelve are from the island of Mauritius in the Indian Ocean, one D. borbonica is from Réunion Island and one, D. diversicolor is from Rodrigues. D. argulata, one of the Mauritian species may have become extinct already. Diospyros hemiteles is now known by only one female specimen. It is a tree growing at midelevation which has a height of 8 meters.

SYNONYMS

Diospyros polyandra sensu Vaughan

FAMILY

Ebenaceae

VERNACULAR NAME

Bois d'Ebene

BOTANICAL DESCRIPTION

Inflorescence

Flowers unisexual, male flowers stalkless, mostly solitary in the leaf axils, the parts in 6 to 8; calyx cup-shaped, 12-15 mm broad, corolla up to 3.5 cm wide when expanded, with reflexed white lobes, silky on the outside. Stamens numerous (c.60 per male flower); female flowers with 20-30 staminodes.

1/ Based on the work of A.W.Owadally (Conservator of Forest, Forestry Service, Curepipe, Mauritius).

Fruit

Fruit ovoid to ellipsoid, 2-3 cm wide, with a persistent, slightly winged, woody and enlarged calyx attached to the base.

Foliage

Leaves oblong-elliptic, blunt tipped, 6-12 x 2.5 cm, subcoriaceous, dark green with lighter translucent veins.

Bark

Dark-grey, more or less smooth.

WOOD PROPERTIES AND PRODUCTS

No annual ring present. Wood brittle.

NATURAL DISTRIBUTION

Mauritius, Indian Ocean; west and south west of the island.

CLIMATE

Hot rainy season, December to April. Cool dry season with occasional showers, April to November.

SOILS

Lithosols with basalt parent rock. Soil shallow.

HABITAT

The single female tree occurs at c. 350 m in mid-altitude of a forest of other indigenous species. It grows just beside a road and is only a short distance from the edge of the forest.

SEED HANDLING

Seed rare. Must be sown in a rich soil immediately after collection. It may take up to six months to germinate.

STATUS

Endangered. As mentioned in the introduction only one individual of this potentially valuable tree is now known. It grows along Magenta road in the forest of Cabinet on the western slopes of Trois Mamelles Mountain. This tree is a female and unless a male is found and measures taken to obtain seed, the species is clearly doomed to extinction. It is over 100 years old so it is likely to be near the end of its life. Recently half a dozen other trees have been found, but they have not yet been fully identified.

REASONS FOR DECLINE

Cultivation, illegal wood cutting, monkey and deer damage, and invasion by vigorous introduced weedy species.

PROTECTIVE MEASURES TAKEN

Propagation tried by cuttings but so far not successful.

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Dipterix alata Vog.[1/]

SYNONYMS

Dipterix pterota Mart ex Benth. (1838)
Coumarouna alata Taub. (1891)

FAMILY

Leguminosae Subfam. Papilionoideae

VERNACULAR NAMES

Combaru, baru, barujo, côco feijao, combarú, emburena brava, feijão côco, pau camarú.

BOTANICAL DESCRIPTION

General

Tree with a tall, straight stem, reaching up to 15-25 m in height and 0.50-0.90 m in diameter.

Inflorescence

A divaricate branchy, panicle, from 20 to 23 cm in width, with angular and pubescent branches; flowers pinkish-white, calyx campanulate. Flowering occurs from October to January.

Fruit

An elliptical, long pod, 5 cm in length by 4 cm in width; with a coriaceous epicarp. Fructification occurs from May to June.

1/Based on the work of P.Y.Kageyama; M.L.Marques and M. Tomazello Fº. Forestry Department, ESALQ/USP, P.O.Box 9, Piracicaba, SP, Brazil.

Foliage

Leaves: Alternate, winged, compound, with 6-12 alternate folioles, with a short petiole, ovate-oblong or almost elliptical, roundish at the apex and shortened at the base, up to 12 cm in length, the midrib nearer the right side has oleaginous glands visible to the naked eye. Branches: well developed, with high resistance to wind; large crown.

WOOD PROPERTIES AND PRODUCTS

Wood heavy. Heartwood brownish-yellow with an attenuated fibrous aspect, emphasizing stripes of vascular lines; distinct white-yellow sapwood, surface with little shine; no distinct odor or taste; irregular or interlocked grain; is considered as a wood with high rot-resistance. The heartwood of the "combaru" is likely to have low permeability to preservative solutions in treatments under pressure. The combaru wood is very similar in terms of anatomical constitution to that of the faveiro - Pterodon pubescens Benth., which renders it the same uses. It is recommended for the construction of external structures, stakes, fence posts, sleepers, etc. and in civil construction for beams, door frames, floor boards and tiles etc., as well as for truck bodies and agricultural implements etc.

Other Uses

The fruits (seeds) are used for food and medicinal purposes. Dipterix alata is recommended for planting as a street tree.

NATURAL DISTRIBUTION

This species is wide-spread in Brazil throughout the states of Minas Gerais, Mato Grosso, Goiás, Maranhao and Piauí.

SOIL/CLIMATE

D.alata is found in soils of moderate fertility and acid pH, with preference to lateritic, sandy-clay with predominance of the coarse fraction. According to the area of occurrence and the habitat of the species, it is found in subtropical or tropical, humid or subhumid climates, with average annual temperatures varying between 19 and 25°C, and average annual precipitation between 1100 and 2 000 mm, relatively evenly distributed throughout the year, with water deficiency varying from moderate to high.

HABITAT

Dipterix alata is common in dry open woodland, the "cerrados", but never occurs in the high forest. It occupies the same habitat as Astronium fraxinifolium, Hymenaea stigneoerpa, Bowdidria sp. and Pterodon sp.

SEED HANDLING

Seed germination is influenced by irrigation, temperature and drying. It is necessary to remove the almond from the fruit. Germination in a period of 20-57 days after sowing gave between 55% and 75% success (without treatment for breaking dormancy). Seeds per kilo vary between 32-48 although 525 have been reported.

SILVICULTURE

Planted in the understorey of a *Pinus elliottii* stand after the second thinning, *D. alata* presented an average height (at 8 years of age) of 3.74 meters, a dbh of 3.11 cm, and a 96% survival.

STATUS AND REASONS FOR DECLINE

The natural distribution area of this species is in the regions of Brazil that present the highest rates of forest devastation, due to the expansion of agriculture. The wood of *D. alata* is of excellent quality and its seeds can be used for human and animal consumption, as well as for medicinal purposes, thus contributing to its intensive and disorderly exploitation and decline.

PROTECTIVE MEASURES TAKEN

In 1980 and 1982 a provenance/progeny trial was set up in the region of Pederneiras-SP, through the tree improvement programme of the Instituto Florestal do Estado de Sao Paulo, using 4 provenances and approximately 25 progenies per provenance, aiming at the genetic conservation of the species.

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Entandrophragma angolense (Welw.)C.DC. 1/

SYNONYMS

Swietenia angolensis Welw. (1859)
Entandrophragma macrophyllum A.Chev. (1909)
E. angolense var. macrophyllum (A.Chev.) Panshin (1933)
E. septentrionale A. Chev. (1909)
E. rederi Harms (1910)
E. leplaei Vermoesen (1921)
Leipotyx congensis Pierre ex. De Wild (1908)
Entandrophragma pierrei A. Chev. (1909)

FAMILY

Meliaceae

VERNACULAR NAMES

Muyovu, Kikura, Cedu Nohor, Mukusu, Koupri, Lokoa Popo, Edinam, Kikura, Zougou Bari, Cedar, Muyovu, Ziziezara, Tiama, Budongo Mahogany.

BOTANICAL DESCRIPTION

General

Deciduous forest tree up to 56 m tall, with bole clean up to 27m. Branches usually few, frequently steeply ascending. Buttresses generally only moderately strong, but sometimes prominent and extending as much as 7 m up the stem. Inflorescences in very showy panicles, inserted in the axils of the terminal leaves.

1/ FAO acknowledge the assistance of B.T.Styles Oxford Forestry Institute, University of Oxford, OX1 3RB, U.K).

30 to 40 cm long. Axes puberulous. Flowers greenish-white, scented, 5-6 mm long. Calyx cupuliform with 5 short, obtuse, glabrescent lobes. Petals oblong, concave, glabrous, spread out almost flat in the fully-open flower. Staminal column, sub-conical, glabrous, with serrulate edges, 4 mm long. Disc, reddish, stipitiform, fairly distinct from the ovary. Ovary conical, narrowing to a very distinct style as long as the anthers. Stigma, capitate. Ovary of 5 loculi with 5-8 ovules in each, in two series.

Fruit

Cylindrical, pointed at both ends. The apex somewhat pointed, sometimes rather obtuse and a little acuminate. 15 to 20 cm long, 4 to 5 cm wide. Valves thick, woody, black on the outside and purplish-black inside, 2.5 to 3 cm wide. Columella, purplish or reddish-black, shiny, with 5-6 fairly deep depressions on each face, where the seeds are attached. Clearly winged, with very straight edges to the loculi. Valves detach themselves from the fruit and fall. The columellas then remain hanging from the tips of the branches and the seeds are dispersed by the wind. Seeds subquadrangular, brown with a very long wing, occupying almost the entire width of the seed.

Foliage

Terminal bud, green, glabrous. Leaf-rachis, dark green, glabrous. Petiole biconvex with two indistinct lateral ridges, bent back at the point of insertion in the branch. Leaves are sometimes 60 cm long, with 9 to 12 pairs of subopposed or opposed leaflets;

lamina oblong or obovate-oblong, 10 to 16 cm long completely glabrous, shiny above. Apex rounded or attenuated abruptly prolonged by a very short, obtuse point. The edges of this small point are usually bent upwards. Base of leaflet sometimes rounded, often fairly acutely cuneiform. The median nerve, very prominent below, is often covered with dense reddish hairs on each side of the median crest. Ten or so lateral nerves. The network of small veins is very faint. The first simple leaves of the seedlings are obovate, oblong, acuminate, cuneiform at the base and with completely glabrous nerves. The pubescence appears on the nerves and later on the composite leaves of the older plants. The leaflets of E. angolense vary considerably: a broad oblong type with a rounded tip in some trees, a narrow oblong, markedly smaller one, in very old trees, sometimes with an attenuated but not rounded tip. This polymorphism has resulted in several closely related species having been given different names; it has not been thought necessary to maintain these, as there are intermediate forms which connect the apparently distinct types of these species.

Bark

Bark smooth, pale grey-brown with pinkish or rusty-orange patches, scaling in large or small, irregular flakes, which leave concave scars. Slash soft, blood red with distinct vertical white or yellowish streaks.

WOOD PROPERTIES AND PRODUCTS

Sapwood pale pink; heartwood with a wide colour-range, varying from the normal dull uniform, dark red or purple-brown to a pale pink, very similar to the sapwood. In dark-coloured wood the cells are heavily infiltrated with gum; in light-coloured wood the gum is almost entirely lacking. The darker wood is appreciably denser, and has rather better working qualities and takes longer to season than the light-coloured wood, which is wooly and more difficult to saw. In both types the grain is broadly interlocked and produces a rather wide and often irregular stripe on the quarter-cut surface, used for cabinet wood, joinery and furniture. It is considered inferior in quality to E. utile and E. cylindricum.

NATURAL DISTRIBUTION

Guinea to Angola, Central African Republic, Zaire, Sudan and Uganda.

CLIMATE

Annual rainfall, 1 450 - 1 800 mm.

SOILS

Moist tropical high forest soils.

HABITAT

Lowland tropical rain-forest

SEED HANDLING

The seeds soon lose their viability, if not kept under adequate refrigeration. About 2 000 - 4 000 seeds/kg. Acid or other pretreatment not required.

SILVICULTURE

Cannot be grown easily in monoculture and enrichment line planting has not proved successful either. Germination is often prolific.

STATUS

Distinctly threatned in some parts of West Africa. Severe genetic erosion has been noted in Nigeria and very few large trees are known to exist. It is still fairly common in the lake-side forests in Uganda.

REASONS FOR DECLINE

Creaming of forests in commercial exploitation of this species has completely wiped it out in many parts of West Africa. In East Africa it is only known in quantity from Uganda where it is under threat for similar reasons.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

Formation of forest reserves in National Parks. Greater attempt to get more trees (in mixture with others) grown in plantations. Pure monocultures have failed because of Hypsipyla attack in young stages.

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Esenbeckia leiocarpa Engl.

FAMILY

Rutaceae

VERNACULAR NAMES

Guaranta, antã forte, pau duro, guarataia.

BOTANICAL DESCRIPTION

General

Trees small to large, with heights varying between 20 to 30 m, and with a diameter of approximately 0.50m.

Inflorescence

Inflorescence of small flowers, 2 - 3 cm in length, light colored, pilose, short-pedicillate, in terminal panicles; flowering occur in the period from November to January.

Fruit

Capsules obovate, pilose, smooth; c. 3 cm in diameter, dehiscence in 5 smooth loculi. Fructification is between the months of June-July.

Foliage

Leaves alternate, sometimes sub-opposite, simple, large, entire, oblong, pointed or acuminate at apex membranaceous somewhat pubescent or glabrous with

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1/ Based on the work of P.Y.Kageyama, M.L.Marques, and M.Tomazello Fº. Forestry Department, ESALQ/USP, P.O. Box 9, Pircicaba, SP, Brazil.

prominent ribs underneath; 7 - 20 cm in length by 4 - 7 cm in width; generally auriculate at the base; giving a nauseous odor when crushed.
Branches: In general, horizontal, round, green- grey, lenticellate, with scars of the leaves.

Bark

Straight trunk with a grey bark with small lengthwise crevices.

WOOD PROPERTIES AND PRODUCTS

Very heavy; with bright yellow heartwood, uniform when first cut, darkening to a golden yellow when exposed; smooth and shiny surface; medium texture, uniform, straight grain; indistinct odor and taste. The guarantã wood is considered as one of the most resistant to decay.
The guaranta wood has a very high density, resistant to rot and a high mechanical resistance, and is particularly recommended for construction and external structures, sleepers, posts, fence posts, stakes, etc. In civil constructions it is used as beams, rafters, door frames, boards and floor tiles, etc. Also recommended for structures subject to dynamic efforts, such as tools, handles, truck bodies, etc.

NATURAL DISTRIBUTION

This species occurs in the humid forests in the Southern State of Bahia in the States of Rio de Janeiro, São Paulo and the southern part of the State of Goiás and Mato Grosso do Sul. Also in Eala region of Zaire, Africa.

SOIL/CLIMATE

Esenbeckia leiocarpa is typical of sandy but fertile soils, and is rarely found in "terra roxa" and wet valley bottoms. The climate in the main areas of occurence is subtropical, moderately humid (average annual temperatures between 18° and 22°C, with occasional frosts, average annual precipitation between 1 200 and 1 700 mm, seasonal distribution, with a water deficit varying from little to moderate in the winter), and subtropical or tropical sub-humid (average annual temperature varying between 21° and 24°C, with rare frosts, average annual precipitation varying between 1 100 and 1 500 mm, seasonal distribution with a periodical water deficit in the winter).

HABITAT

This is a shade species, distributed throughout the humid forests in the regions of its natural occurrence.

SEED HANDLING

Germination occurs up to 20-30 days after sowing without pregermination treatments. A 32% germination has been observed using paper filter as substrate in the laboratory. This species has around 12 000 seeds per kilogram.

SILVICULTURE

In a trial set up in Santa Rita do Passa Quatro - SP. it was observed that the species reached a height of 12.36 m, requiring permanent pruning to define the stem.

In a mixed stand, the guarantã grown along with Pinus elliottii, showed an average height of 4.7 meters and an 87% survival, at 8 years of age after the second thinning. For guaranta grown along with Piptadenia comunis, a height of 10.2 meters is reported, at 23 years of age.

STATUS AND REASONS FOR DECLINE

The regions of natural occurrence of this species are those which have undergone the most severe forest devastation during this last century, due to clearence of the natural vegetation for development of agriculture, and livestock or plantation projects using fast-growing species. As E. leiocarpa is of economic value, the last trees are being gradually cut down.

PROTECTIVE MEASURES TAKEN

The Instituto Florestal de São Paulo has studied the E. leiocarpa since 1953, when this species was planted in a mixed stand with 35 other species at the Estação Experimental in Tupi - SP. In 1959, the species was planted in a 1.5 ha area along with Piptadenia comunis. Such a small area is, however, not of significance for the genetic conservation.

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Eucalyptus deglupta Bl. [1/]

SYNONYMS

E. multiflora (A.Rich.) A.Gray (1854)

E. naudiniana F. Muell. (1886)

E. schlechteri Diels (1922)

FAMILY

Myrtaceae (sub-family Leptospermoideae)

VERNACULAR NAMES

Kamarere, Bagras, Kaju Leda

BOTANICAL DESCRIPTION

General

Large tree, 35-60 m high, 0.5-2.0 m diameter, occasionally reaching 80 m height and 3 m diameter. Buttressing to 3-4 m heigh occurs where soils unstable.

Inflorescence

Terminal or axillary panicle 5-20 x 5-18 cm, umbels 3-7 flowered; peduncles terete or slightly angular, 0.5-1.0 cm long; pedicels about 5 mm long, young buds small, green, with double opercula, developed buds pale green or cream, globular, apiculate, 0.2-0.4 x 0.2-0.5 mm, operculum hemispherical, apiculate and wider than long; flowers with many white to pale yellow stamens 2-10 mm long, strongly reflexed in the unopened bud, anther dehiscing by separate slits.

1/Based on the work of J.Davidson (Eucalyptus and Forestry Services,P.O.Box 419,Armidale,N.S.W. 2 350 Australia).

Fruit

Fruit pedicellate, hemispherical, valves 3-4, thin, deltoid, exserted to 2 mm making the capsule appear globular ,3-5 x 3-5 mm, disc very narrow. Mature fruits brown to dark brown, containing 3-12 well formed seeds per valve. Seeds minute, brown, flattened, with a small terminal wing.

Foliage

Seedling leaves: opposite, thin, petiolate, ovate, ovate lanceolate or oblong lanceolate, first 1-3 pairs 2-4 x 0.5-1.5 cm then 6-10 x 2.5-4.0 cm; lateral veins visible, very few, initially 40-50° to the midrib then curving to form the remote intramarginal vein; upper surface light green to green, lower pale green to purplish.

Juvenile leaves: opposite, thin, shortly petiolate, broadly ovate, ovate lanceolate, oblong lanceolate or acuminate, 7-11 x 5-7 cm; lateral veins visible, few, curved to form an irregular, remote intramarginal vein; upper surface green to dark green and slightly shiny; lower surface light green to greenish purple and dull.

Intermediate leaves: no discernible intermediate stage.

Adult leaves: opposite to sub-opposite, rarely alternate, shortly petiolate, ovate to ovate lanceolate or acuminate, thicker than juvenile leaves, 10-20 x 6-10 cm occasionally larger; lateral veins visible, few initially inclined about 60° to the mid-vein, then curving to form the intramarginal vein, upper surface green to dark green and shiny, lower surface pale green and dull. Leaves and terminal

branches held horizontally, terminal branchlets and twigs mainly square or flattened in cross-section, often with four longitudinal keels.

Bark

A gum, 3-8 mm thick, expoliating in strips of varying shape and size, leaving a smooth white to pale green surface which ages through light green, green, grey, pink, red and orange to a deep purple.

WOOD PROPERTIES AND PRODUCTS

Light to dark red-brown, more like a coarse-grained rain-forest wood than a eucalypt; moderate strength but not durable; density 560-800 kg/m^3 in mature natural stands and 270-400 kg/m^3 in young plantations. Useful for building and joinery, wood pulp and wood-based panels.

NATURAL DISTRIBUTION

The species occurs between tropical latitudes 9°N and 11°S in a markedly discontinuous distribution through Mindanão, Celebes, Ceram, Irian Jaya and Paupa New Guinea. The best developed stands occur on riverain sites less than 150 m above sea level in East New Britain. The full range of altitude is from sea level to 2 500 m.

CLIMATE

Type: summer rainfall; with 3 750 - 5 000 mm per ann. No dry season. Mean maximum of hottest month 24-32°C, mean minimum of coldest month 20-22°C; no frost.

SOILS

E.deglupta has been planted on a wide variety of soils. Papua New Guinea reports that it can grow successfully on coarse-textured sands and loamy soils, volcanic ash and on limestone-derived soils (pH 6 to 7.5) but that best growth occurs on deep, well-drained sandy alluvial loams. In the Congo it is reported to grow better on the heavy clays of Loudima than on the infertile, free-draining ochraceous sands at Pointe-Noire. In British Solomon Islands the main soils to be planted are deep weathered volcanic clay soils of low nutrient status, but good performance has also been shown on shallower clay soils of moderate nutrient status overlaying coral and limestone.

HABITAT

E. deglupta is the only species of eucalypt occurring naturally north as well as south of the equator and is adapted to thrive in conditions of uniformly high rainfall and temperature throughout the year, in which other species may be susceptible to disease. In these conditions it is fast growing and of reasonably good form. It is very susceptible to fire. It flowers and sets seed at an early age and cuttings from young trees can be rooted readily, but coppicing ability is so poor that this is not a practicable method of regenerating plantations.

SEED HANDLING

15 000 - 18 000 seeds/g .

Plants can be grown from seed in carefully sterilized

soil. Damping off is a problem where seed trays, implements and soil are not disinfected prior to use. The seed germinates in about five days at 30°-34°C.

SILVICULTURE

Prospects for planting: Possibly very valuable in high-rainfall equatorial localities with no pronounced dry season. Provenance testing is necessary because of the wide discontinuous natural occurrences. These are proceeding and it is apparent that there are variations in the species.

With an altitudinal range from sea-level to 1 800 m (Turnbull, 1974) and a geographical distribution which covers a number of widely separated islands between 9°N and 11°S, E. deglupta is likely to exhibit considerably differences between provenances. Provenance trials are still in their early stages, but Papua New Guinea has reported that in trials on the main island, early performance of provenances from New Britain (Keravat), Mindanão and Sulawesi has in general been superior to provenances from mainland Papua New Guinea. In eastern Mindanão (Philippines), the majority of trees planted of a Papua New Guinea provenance have been attacked by a borer (Agrilus sexignatus). Therefore emphasis was shifted to local provenances, which, at the time, were observed to be apparently highly resistant to the borer. However with the phasing out of stands of Papua New Guinea origin, increasing attack on the native provenances has been observed.

Most early introductions outside Southeast Asia have been of the New Britain provenance. Since the species is an early and profuse seeder, many introducing countries can already produce their own seed.

At Turrialba in Costa Rica two apparently distinct provenances have been introduced but the seed origins are not known. They are known locally as "red" or "green" from the general appearance of both foliage and bark. Hybrid offspring have been produced which are of superior form to either parent and of rapid growth. The F_1 generation produces fertile seed and the resulting F_2 generation shows surprising uniformity.

STATUS

Endangered in parts of its geographic range.

REASONS FOR DECLINE

There are three main reasons for the decline of the species in several areas: (i) The species is intolerant. Older stands are invaded by rainforest. There is no regeneration of E. deglupta under itself. (ii) Older stands are being heavily logged for building timbers and firewood. (iii) The species occurs on fertile river flats which are rapidly being cleared for food gardens and agricultural purposes, especially in Mindanão and Indonesia. For example, it is estimated that more than 60 percent of the finest stands on the Caliawan River, an east-bank tributary of the Agusan River in Mindanão, has been destroyed ahead of agricultural activity. This destruction is continuing and, unless the stand is reserved for seed collection purposes, it will be virtually non-existent in a few years. This is one of

the largest riverain stands in Mindanão and has been used by the Bislig Bay Lumber Company as a seed source. This particular provenance has been determined to be one of the best for forestry purposes in ecologically similar areas.

PROTECTIVE MEASURES TAKEN

Bislig Bay Lumber Company and its associated Company, Paper Industries Corporation of the Philippines (PICOP), are now using E. deglupta, in reforestation activities and some areas are being reserved for future seed collection. The Government of the Philippines has declared an area of Cotabato Province a forest reserve in order to protect the only good stand of E. deglupta in that Province from logging activities.

Seed collections were made in Mindanão and Celebes in 1969. These have been combined with Papua New Guinea provenances for comparative trials at three locations in Papua New Guinea.

During 1980-83 seed collections have been carried out in natural stands of E. deglupta Blume in the west and east New Britain provinces of Papua New Guinea. The collections have been done within the framework of an FAO/Office of Forests, Papua New Guinea, programme. The seed is now available for international provenance trials. (Information can be requested from the Forest Resources Division, FAO, Via delle Terme de Caracalla, 00100 Rome, Italy).

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Eucalyptus globulus Labill. subsp. globulus[1/]

SYNONYMS

Kirkpatrick (1974) grouped E. maidenii, E. bicostata, and E. pseudoglobulus together as subspecific forms of E. globulus

FAMILY

Myrtaceae (sub-family Leptospermoideae).

VERNACULAR NAMES

Tasmanian blue gum, southern blue gum, blue gum.

BOTANICAL DESCRIPTION

General

A medium to large tree, typically 30-50 m tall but up to 80 m high and 2.25 m in diameter.

Inflorescence

Flowers axillary, inflorescence usually only 1-flowered, occasionally 3; peduncles very short or absent. Buds top shaped, 4-ribbed, warty, the surface glaucous; 1.5-2.3 x 1-2 cm; opercula flattened with a very distinct central knob. Anthers very numerous spreading, creamy-white in colour.

Fruit

A woody "capsule", 2.5 cm diameter, broadly top shaped or globose, sessile, with a broad, flat or convex

1/ Based on the work of J.W.Turnbull (Seed Centre, Division of Forest Research, P.O.Box 4008, Canberra A.C.T. 2 600, Australia).

thickened disc extending over the valves. The capsule is warty, glaucous, 4-ribbed.

Seeds: small, black with reddish brown chaff, approximately 75 seeds per gram.

Foliage

Heterophyllous, the juvenile leaves opposite, sessile; the base cordate to amplexicaul; ovate or broadly lanceolate; margin entire; apex blunt or apiculate. Leaf surface covered with grey waxy bloom; 11-15 x 5-11 cm. Adult leaves alternate, petiolate, lanceolate or falcate-lanceolate; apex acuminate; margins entire. Upper surface dark, glossy green; 12-25 x 1.7-3 cm.

Bark

Rough and fissured to 3 m at the base of the trunk, expoliating in long strips from the remainder of the trunk and branches, leaving a smooth bluish-grey surface.

WOOD PROPERTIES AND PRODUCTS

General characteristics: heartwood pale yellow-brown; sapwood greyish-white. Grain usually interlocked; texture moderately coarse without distinctive odour or taste. It frequently contains gum veins that may detract from the appearance.

Moderately durable; air dry density about 900kg/m^3. The timber is used in both heavy and light construction work, and is highly regarded for purposes in which bending is necessary. It is used for poles, piles, sleepers and in the manufacture of pulp and paper.

Outside Australia it is one of the most widely planted of all eucalypts and forms the basis of forest industries in some countries. E. globulus is also a valuable fuelwood. The leaves are used for the extraction of essential oils. Honey production has also shown to be successful.

Other Uses

It is valuable for erosion control, amenity and roadside plantings, windbreaks and shelterbelts and other watershed and environmental purposes.

NATURAL DISTRIBUTION

The main occurrence is in eastern Tasmania from 0 m - 450 m above sea level. It also occurs on Flinders Island, King Island and Rodondo Island in Bass Strait. Isolated, very small relict stands, occur on the west coast of Tasmania. In Victoria there are small occurrences in the Otway Ranges and South Gippsland. The distribution of populations in Victoria is somewhat fragmented, the situation is complicated by the intermediate populations of E. globulus subsp. globulus grading into E. globulus subsp. pseudoglobulus in South Gippsland and into E. globulus subsp. bicostata (syn. E. st.johnii) in the Otway Ranges (Kirkpatrick 1971, 1973).

In early published references to the species in the more northern part of Victoria and southern New South Wales, there was confusion with the closely-related E. globulus subsp. bicostata.

CLIMATE

Mean maximum temperature of hottest month: 20-23°C. Mean minimum of coldest month: 0-8°C. Dry season up to 3 months, not severe. Total rainfall in the range from 600 to 1 400 mm. The rainy period differs from a primarily winter maximum to uniform rainfall throughout the year.

SOILS

It grows best on moderately fertile loams or rather heavy soils with good drainage and adequate moisture. Natural stands do not occur on poorly-drained sites or alkaline soils.

HABITAT

The Tasmanian blue gum is a dominant or sub-dominant species in moist temperate open-forest and tall open-forest. It is seldom found in extensive pure stands, usually being associated with at least one other species of eucalypt. Within a particular area it is closely tied to a restricted range of habitats and as a result a mosaic pattern is formed with local stands of E. globulus subsp. globulus being separated by stands of species occupying different habitats (Kirkpatrick, 1973).

SEED HANDLING

The seeds are not difficult to store, they can be held for several years if they are air-dried and then stored in sealed containers at a temperature of 1-4°C. An acceptable germinative capacity can be maintained for a year or two in unsealed containers at room temperature.

Dormancy is not usually a problem but if present can be broken by storing the seed in moist dark conditions for two weeks at 1-4°C.

SILVICULTURE

E. globulus is easily raised from seed. Germination usually takes 7-10 days and the seedlings may be potted after 6 weeks. Planting out may be done as soon as the seedlings have become established. Established trees coppice readily.

STATUS AND REASONS FOR DECLINE

The following two main areas can be identified:

A. Tasmania: A relatively large area of E. globulus subsp. globulus on the east coast, is well regenerated in the State Forest Reserves. The populations at the highest altitudes in Tasmania (c. 450 m) are on private land and cannot be considered safe. There are also some very small relict stands near the west coast of Tasmania. Before settlement, the forests of King Island were dominated by E.globulus subsp. globulus. They are partially included in a National Park. A small population on the uninhabited Rodondo Island is intact although its ability to regenerate itself appears to be related to the frequency of chance fires caused by lightning.

B. Victoria: There is threat to subsp. globulus in parts of Victoria. The Otway Range populations are relatively safe as some are included in Forest Commissions Parks but there is some clearing for pines on the inland slopes. In South Gippsland,

apart from in Wilson's Promontory National Park, the populations are not safe. Distinct populations intermediate between subsp. globulus and subsp. pseudoglobulus around Yarram and Neerim South are on private land with the hills to the north of the Latrobe Valley. On the northern slopes of the South Gippsland hills there is a threat to the populations as a result of forest clearing and replacement with other species. In the Crown Forests, clearing and progressive alienation pose a future threat. Within the South Gippsland area one population is conserved in the Morwell National Park.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

There are many populations of E.globulus subsp. globulus included in National Parks and Forest Parks and these will ensure the survival of the species and much of its genetic variation.

There are some disjunct populations in South Gippsland and Tasmania which are not well protected. Where these populations occur on Crown Land the local authority could create one or more reserves to ensure their survival. Where the trees are on private land their preservation in situ may not be possible and the collection of seed from a large number of individuals and the establishment of ex situ conservation stands in reserved areas may be a more practical measure to conserve the gene resource.

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Fagus longipetiolata Seemen[1/]

SYNONYMS

Fagus sylvatica var. longipes Oliver (1936)
Fagus sinensis Oliver (1936)
Fagus longipes Leveillé (1914)

FAMILY

Fagaceae

BOTANICAL DESCRIPTION

General

Tree up to 25 m in height.

Inflorescence

Staminate flowers in a spherical inflorescence up to 1.50 cm in diameter, pendulous on slender pedicels, up to 7 cm long; perigynous; corolla lobes 6, narrow, lanceolate, brown, externally piloses; stamens 8-12; filaments longer than the perigynous recaptacle; anthers ovate, the connective elongated to small point. Pistillate flowers erect, on pedicels up to 3 cm long; pedicels thickly piloses towards upper end only, grey-brown; bracts 2, linear lanceolate, up to 2 cm long, 1.5 cm broad, membranaceous, brown, sparsely pilosous, towards the point with long cilia; cupule capitate, approximately 1 cm long and 1.50 cm broad, surrounded

1/ Fao acknowledge the assistance of Pan Chih Kang. The Arboretum, Chinese Academy of Forestry, Beijing, China.

by subulate, piloses excrescences; per 2 flowers involucre; perigynous; bell-shaped, 5-6 segments, piloses, brown; style with 3 segments, piloses; stigmas 3, glabrous.

Fruit

Cupule erect, ovoid up to 2 cm long and 1.50 cm broad, thickly piloses,brown; petiolate, up to 5 cm, opening by 4 segments; with long-subulate excrescences, nutlets 2, ovate, pointed, triangular, up to 13 mm long, 6 mm broad, smooth, brown.

Foliage

Leaves ovate pointed or acuminate, narrow at the base, up to 8 cm long, and 4.5 cm broad, long-petiolate; up to 2.5 cm long; margin sharply-serrate; young leaves completely glabrous; leaf blade with the upper side dark,glossy green; lower side dull; midrib and lateral veins on the upper side of the leaf depressed, on the lower sharply raised; lateral veins 10-11, obliquely parting from midrib, straight and ending in a serration of the leaf margin.

Bark

Bark of old branches brown with grey dots; of young branches grey, sparsely pubescent.

NATURAL DISTRIBUTION

Although nowhere very abundant, this is the common beech of Central, Western China: (Upper Yangtze) and Southern China, Western Hupeh: Patung Hsien; Chang-yang Hsien; Eastern Szech'uan: Wushan Hsien,

south of Yangtsze River; Western Szech'uan: Mupin; west of Kuan Hsien ascent of Niu-tou-shan; Yunnan. Altitude: 1 000-2 600 m.

CLIMATE

Temperate

SOILS

Wet mountain, yellow soils.

HABITAT

In southwestern Hupeh it occasionally forms pure forests of limited extent, but it more usually grows in association with Quercus, Schima, Pasania and Castanopsis.

STATUS

Endangered in parts of its natural range.

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Gigasiphon macrosiphon (Harms) Brenan[1/]

SYNONYMS

Bauhinia macrosiphon Harms (1915)

Gigasiphon humblotianum sensu K.T.S.

FAMILY

Leguminosae subfam. Caesalpinioideae

VERNACULAR NAME

Mnondo (Tanzania)

BOTANICAL DESCRIPTION

General

Large, round-topped forest tree up to 20 m.

Inflorescence

Flowers with 5 slender, long-pointed sepals 5-8 cm long, alternating with 5 obovate to elliptic petals 9-13 cm long, pure white except for a yellow splash on one; or white flushed creamy-pink; stamens 10.

Fruit

Pod large and flattened, up to 30 cm long by 6-7 cm wide, containing 6 purplish-brown seeds each 2-3 cm across and almost encircled by the narrow U-shaped scar of attachement.

1/ Based on the work of J.A.Odera (Forestry Research Dept., Kenya Agricultural Research Institute, Kikuyu, Kenya) and Ms. C.Kabuye (East African Herbarium, National Museums of Kenya, Nairobi, Kenya).

Foliage

Leaves broadly ovate to subcordate 8-17 cm long and large.

Bark

Whitish or pinkish-grey.

WOOD PROPERTIES AND PRODUCTS

Sapwood white

Use

The large beautiful flowers makes it of potential use as an ornamental.

NATURAL DISTRIBUTION

In Kenya and Tanzania, it is known from only 4 localities:-

1. On Mrima Hill in Kwale District Kenya (where it was found in 1959 and 1960)

2. Between Msambweni and Lungalunga in Kwale District, Kenya (found there in 1964)

3. On the Rondo plateau in Lindi District, Tanzania (found there in 1951 and 1952)

4. At Amani in Tanga in the eastern Usambara Mountains, Tanzania (cultivated specimens found there in 1937).

The forest at Mrima Hill is a very good example of lowland evergreen forest, of a type probably once wide-spread along the coast but now nearly all destroyed.

The flora is of great interest, possessing as it does three distinct floristic elements and including several of the apparently quite endemic kenyan coastal species.

The Rondo plateau (c. 265 sq. km). is partly covered by what was the finest Chlorophora excelsa forest in East Africa before it was cut over in the late forties and early fifties. Although part has been cleared and replanted with various exotics, including teak and pine, a large part remains unchanged. The Rondo forest is by far the best representative of a number of dissected plateaux carrying forest in the coastal plain of southern Tanzania.

CLIMATE

Kenya: Lowland rain forest, 120 - 910 m. Tanzania: From dry lowland forest of coastal type to woodland.

SOILS

The Kenya population is associated with a deposit of rare earth elements, but there is no evidence at present that this association is causal.

HABITAT

In lowland, evergreen, tropical forest, 120-900 m.

SEED HANDLING

Seeds ripen between November and January, c. 3 seeds per pod. Seeds germinate easily. Around 200 seeds/kg.

SILVICULTURE

A few trees recorded cultivated at Amani, Tanzania in 1937. Cultivation not recorded elsewhere.

STATUS

Rare or endangered. A species of very restricted distribution.

It is known from the 4 scattered localities mentioned above and the populations, where found, tend to be very small.

REASONS FOR DECLINE

It has been affected in the long term by climatic changes decreasing the area of forests, but more recently by forest clearings for settlement and cultivation.

The site at Mrima Hill in Kenya is at risk from mineral exploitation (see also under distribution).

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

Conservation measures taken: part of the Rondo plateau (Tanzania) is a Central Government Forest Reserve.

Conservation Measures Recommended:

1. The Mrima Hill Forest (Kenya) should be urgently considered as a possible National Park.

2. Further protective measures should be considered for the Rondo Plateau.

3. Protection of the existing trees and possible re-introduction into conservation areas should be considered.

4. Detailed local surveys of existing sites are needed, in particular to assess the number of the remaining individuals on each site, so that protective measures can be formulated.

5. Further research should be done to bring the species into cultivation.

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Glyptostrobus lineatus (Poiret) Druce[1/]

SYNONYMS

Thuja pensilis Staunton (1798)
Thuja lineata Poiret (1817)
Juniperus aquatica Roxburgh (1824)
Taxodium heterophyllum Brongniart (1833)
Taxodium sinense Forbes (1839)
Glyptostrobus heterophyllus (Brongn). Endlicher (1847)
Glyptostrobus pensilis (Stamt.) K.Koch (1873)
Glyptostrobus sinensis Henry ex Loder (1919)
Glyptostrobus aquaticus (Roxb.) Parker (1924)

FAMILY

Taxodiaceae

VERNACULAR NAMES

Shui Sung, Cui Sung, Shui Ts'ung, Then-Tsong, Thon-Song, Water Pine, Chinese Deciduous Cypress, Chinese Swap Cypress, Chinese Water Pine.

BOTANICAL DESCRIPTION

General

The tree grows to a maximum height of 24 m, generally 8-10 m. It has a trunk which is strongly swollen below and can be buttressed and fluted. The swollen base is especially noticeable in old trees, and in specimens which are affected by the raising and lowering of the water level. It has an irregular growth habit with a

1/ FAO acknowledge the assistance of Pan Chih Kang (the Arboretum, Chinese Academy of Forestry, Beijing, China).

crown, which when young is pyramidal, but later becomes flat-topped and bushy. The branches are sparse, horizontally spreading, the upper ones ascending.

Inflorescence

Glyptostrobus is monoecious. Male cones are erect, terminal, short-lived; female cones are persistent, erect or on perennial short shoots. Male and female cones are borne on perennial short shoots which are covered with spirally cupressoid leaves. Male cones typically occur in clusters of 30-40 cones, while female cones tend to occur in clusters of 4-10. Just prior to the shedding of pollen the male cones are turbinate (shaped like an inverted cone) and flat topped, measuring 3.0-5.0 mm x 1.5-3.0 mm.

Before it is pollen receptive, the immature female cone is subglobose, flat topped, measuring about 2.0-3.0 mm x 1.5-2.5 mm. It consists of approximately 20 loosely imbricated, somewhat fleshy scales, approximately 6 outermost scales being in series with the cupressoid leaves and bearing white stomatal dots.

Fruit

The mature female cone tapers at base, with 4 woody scales which bear thin narrow bracts with the tip reflexed; 12 mm long, 5 mm across, greenish-brown in colour. The seeds stand erect with their micropyle upward, two seeds under each scale.

Seeds are ovoid to oblong, pointed at the lower, attached end, flattened adaxially and convex abaxially, with a terminal wing which is continuous over the whole

adaxial surface of the seed and covers nearly 1/2 the abaxial surface. The body of the seed is 5.5-7.5 mm x 3.0-3.5 mm, the free part of the wing being 5.0-7 x 2.0-3.5 mm.

Foliage

The foliage of the tree is heterophyllus, three types of leaves being produced. One type of leaf is linear and dorsiventrally flattened and resembles the normal foliage characteristic of Taxodium. This is referred to as 1 taxodioid leaf. A second type of leaf is pointed at the apex, quadrangular in transverse section and curved like a sickle. This type of leaf resembles the normal foliage of Cryptomeria and is referred to as a cryptomeroid leaf. A third type of leaf is scale-like, as a Cupressus and other members of the Cupressaceae, and this is referred to as a cupressoid leaf. The perennial branchlets bear cupressoid leaves or two kinds of leaves, cupressoid leaves at the base followed by cryptomeroid leaves. Annual branchlets bear taxodioid foliage if the tree is young, but bear cryptomeroid foliage on older trees.

Bark

The back has been described as fibrous and stringy and brown in colour, formed in irregular plates with the inner bark reddish brown.

WOOD PROPERTIES AND PRODUCTS

The wood is considered rot-resistant. Specific gravity 0.37-0.42. It is in general considered as a

good timber and has especially been used for boat-building and as fuelwood.

Other Uses

Fruit and seeds are used for extracting Indigo dye and the bark for making brushes. In some regions the tree is cultivated because it is an object of superstition in the local culture. It is believed to bring good luck. It has also been used for embankment along river banks.

NATURAL DISTRIBUTION

There is no known occurrence of the plant in the wild state. The tree may have been native in the marshes of the Heungshan district of Kwantung, an area east of Macao. A second area of cultivation is centered on Foochow, Fukien Province, but it is known to have been cultivated here only since 1890. The trees discovered by Hu in Southern Kiangsi, although tall (20m) are apparently cultivated there. The original report of G.lineatus was in a list of plants "collected in Shan-Tung and Kiang-nan" (i.e., Shantung and Anhwei Provinces). It has later been cited that the distribution of G. lineatus is in the vicinity of Canton and Foochow, and specifically noted is its absence in the intervening treaty port of Swatow and Amoy. It has been widely cultivated in the region of Yangtze river.

CLIMATE

The climate where G.lineatus occurs is warm and humid. Average annual rainfall varies from 1 200 - 2 000 mm

and mean annual temperature is 16-22°C. It is not a cold-resistant species.

SOILS

Soils are variable and include grey-brown podsols in the hills, red earths and non-calcareous alluvial soils in the coastal belt, and in other parts purple-brown forest soils and yellow laterites. It grows best in alluvial soils and prefers neutral to slightly alkaline soil (pH 7-8) but it is also found on acid soils.

HABITAT

There is no record of G.lineatus growing as a natural component of vegetation. It has been reported to have died out in the wild state. Apparently it is a plant which has survived solely because man has chosen to cultivate it. In China G. lineatus is cultivated in wet, swampy soil on the margins of fields, on the banks of canals and water courses, where it is significant in the prevention of soil erosion. It is also cultivated near monasteries and in gardens, but it is generally not clear whether these are situations with nonswampy soils. Some have suggested that the species has been cultivated longest in the vicinity of Canton, and that its introduction into the Foochow region probably only dates from approximately 1890.

SEED

18 000 seeds/kg; germination 50-60%.

SILVICULTURE

Normally 2 year old seedlings are used for outplanting. The extent of its cultivation in China indicate that it is usually propagated from seed, but it can easily be grown from cuttings. It is a tree that grows in wet soil and can stand periodic inundation and is therefore useful in the stabilization of soil in wet areas.

STATUS

Natural populations are extinct.

REASONS FOR DECLINE

The genus Glyptostrobus has played a conspicuous role in the forest vegetation of the northern hemisphere and also once extended into the southern hemisphere. As stated above, it is nowhere known to occur in the wild state. Presumably it was saved from extinction only because man revered it, found it useful, and cultivated it in south-eastern China.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

Cultivated by local villagers as described above. There are some suggestions that G.lineatus should be used widely in afforestation projects.

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Gossweilerodendron balsamiferum (Verm.) Harms[1/]

SYNONYM

Pterygopodium balsamiferum Verm. (1924)

FAMILY

Leguminosae subf. Caesalpinioideae

VERNACULAR NAMES

Agba, (trade name,Nigeria), Achi, Lósín-Erin, Emongi (Nigeria), Tola blanc (Congo), Tola branca (Angola), Nitola (Zaire).

BOTANICAL DESCRIPTION

General

An evergreen or deciduous forest tree, sometimes emergent, reaching as much as 60-70 m in height but more often around 40 m. DBH often reaches 1.5 or even 3 m. Crown spreading, hemispherical and rather open. Bole generally straight and cylindrical with no buttresses or other irregularities except for frequent, spiral grain. The length of the tree bole is generally 20-25 m, but may reach 35 m. Where the tree develops in open conditions, branching may be low.

1/ Based on the work of John B.Hall (Department of Forestry, University of North Wales, Bangor, U.K.) and F.O. Adewole, Nigeria . FAO also acknowledge the assistance of P.R.Kio (Director Forestry Research Institute of Nigeria).

Inflorescence

Finely pubescent, developing at the ends of the shoots, consisting of spikes 5-8 cm long arranged in panicles 5-15 cm long. Bracts small; 1-1.5 mm long and 0.5-1 mm wide, soon falling off. Flowers apetalous, borne on pedicels about 1 mm long. Bracteoles about 0.5 mm long, found only in newly opened flowers. Calyx of 4 or 5 broadly ovate, whitish sepals, 1.5-2 mm in length and width. Sepals slightly pubescent, pellucid-dotted, ciliate at the margins. Stamens equal, 8-10; filaments pubescent in the lower half, 3-3.5 mm long; anthers 0.5mm long. Ovary stalked, 0.5-1 mm long, hemispherical to elliptic in shape, villous, about 1.5 mm long, containing a single pendulous ovule. Style about 2 mm long. Flowering has been recorded in Nigeria during the dry season, with fruits developing two to four months later.

Fruit

Shortly pedicellate and samara-like but with the seed enclosed in the distal end; glabrous 9-17 cm long and at its broadest, in the distal half of the wing, 3-5 cm wide. Wing is oblong to ovate-lanceolate with one margin almost straight and the other markedly more rounded and less strongly thickened. Stipe, 10-15 mm long, separates wing from the remains of the calyx. Wing green when immature, at maturity yellowish-brown with a conspicuous lax reticulation of nerves. Distal end of fruit swollen , containing a solitary seed, terminating in a short, thick apiculus curved inwards. The surface of the swollen part of the adjacent part

of the wing is pustular. Integument thin and papery, remaining attached to the fruit wall.
The seed lies with part of its edge just inside the straighter margin of the fruit. Its point of attachment is close to the apiculus of the fruit and it is here that the seed is thickest; towards the ends of the cotyledons the seed becomes progressively thinner. Shape of seed roughly oval to elliptic, flattened;length 2-3 cm, breadth 1.5-2 cm.

Foliage

Leaves alternately arranged, compound (simply pinnate), entirely glabrous. The combined length of petiole and rhachis varies from 5-18 cm and the lowest leaflet is borne 5-25 mm from the base. Petiole and rhachis slender and shallowly grooved above, petiole swollen at the base. Leaflets alternate and one is terminal. Number of leaflets per leaf 6 to 9 but may be as low as 3 or as high as 11; uppermost leaflets slightly larger than those below. Petioles glabrous, 2-4 mm long and often slightly twisted. Lamina papery, both surfaces dull, although they contrast with the abaxial whitish and the adaxial green. Midrib prominent on both sides of the lamina and on the adaxial bears a shallow groove towards the leaflet base. Leaflets ovate-elliptic to oblong or oblong-lanceolate in outline and usually slightly asymmetrical, 2-13 cm long and 1.5-5 wide, with entire margins. Leaflets narrow to a blunt apex in most cases and although occasionally acuminate, the tip is always obtuse. Each leaflet bears about 20 irregular lateral nerves on

each side of the midrib. Numerous pellucid glandular dots are scattered over the lamina.

Bark

Thin (4-15 mm), generally dark grey but partly greenish. The surface features of the bark change as the tree ages, being somewhat wrinkled in young trees but later becoming smooth except in scattered patches where there are narrow longitudinal cracks. In old trees, where these cracks become deeper, roughly rectangular flakes of bark may become detached.

WOOD PROPERTIES AND USES

The timber is resistant to decay, easy to work and has good nailing, screwing and glueing properties. Its principal use is in plywood manufacturing, for furnishings, flooring and household fittings plus in light construction work.

NATURAL DISTRIBUTION

Gossweilerodendron balsamiferum occurs from the western border of Nigeria through the lowland forests further east as far as central Zaire. The northern and southern limits appear to be the boundaries of the main Nigeria/Zaire forest block. It is absent or rare in some parts of this range, such as the drier forests on basement complex rocks in Nigeria. Areas where high concentrations of the species have been reported are Temvo (5°30'S, 13°00'E) in Zaire (Vermoesen 1923) and the Owan (6°45'N, 5°45'E) and Sapoba (6°04'N, 5°50'E) areas of Nigeria (Kennedy 1936).

CLIMATE

The climate in the area of occurrence of the species is seasonal in nature with dry periods of up to 100 days, sometimes of up to 150-160 days in length (Mayumbe locality). Mean annual rainfall is generally 1 400 - 2 600 mm. Mean monthly minimum temperatures vary between 14 and 18°C, corresponding maxima between 28 and 32°C.

SOILS

The relationship with soils and geology is not particularly clear from the available records. However, there appears to be some tendency for the species to be associated with sedimentary rocks. In Nigeria, the concentration of the species is highest on ferrallitic soils derived from the tertiary coastal plains sands and on ferruginous tropical or ferrallitic soils derived from basement complex rocks. It is possible that the most influential of the edaphic factors involved is texture, the species being particularly favoured by deep sandy and free-draining soils. In Zaire, very high concentrations of the species have been reported from Mayumbe on sandy soils overlying basement complex rocks.

HABITAT

G.balsamiferum normally grows in mature, little-disturbed forest.

SEED HANDLING

There are about 280 de-winged seeds per kg. Seed viability is reported to be lost within two weeks.

SILVICULTURE

Although some studies have been made on the growth and development of the species under natural conditions only limited information is available on the behaviour of the species under plantation conditions.
As in most shade-tolerant species, early growth is slow during the first 10 years. Line-planting has been tried on an experimental scale. Using this method, heights of 18 m and girths (dbh) of 60 to 120 cm were achieved in 22 years.

STATUS

Further study needed, but likely to be endangered in parts of its geographic range, especially at the extremes. Ilaro, in Nigeria; Cabinda, at the southern limit; central Zaire at the eastern limit.

REASONS FOR DECLINE

The continued heavy exploitation of the species, the lack of a plantation programme and the rapid conversion of forests into plantations of other species.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

In addition to the endangered provenances listed above, the gene pools of the high density populations of the Sapoba area in Nigeria and of Mayumbe in Zaire also merit attention. The populations of these hilly districts - somewhat more secure, although less concentrated - may contain genetic material of interest for any future plantation programme. Both *in situ* and *ex situ* conservation of the species merit early attention.

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Gymnostemon zaizou Aubrév. & Pellégr.

FAMILY

Simaroubaceae

VERNACULAR NAMES

Zaizou, Zalé, Gouatoué

BOTANICAL DESCRIPTION

General

A very tall tree with Entandrophragma-like habit. Bole flared at the base, but with no buttresses. Thick, brittle, and yellowish-brown in cross-section. The tree exudes resin.

Inflorescence

Inflorescences in terminal panicles. Flowers small, downy; polygamous. Calyx short, 2 mm long with 5 small teeth. Petals 5, 4.5 mm long, 2 mm wide, slightly imbricate at the top, downy on both sides. Disc fleshy, lobed, thick and pubescent. Stamens 10, 3 mm long, broader at the base and pubescent; no basal scales present. Ovary with 5 free, villous carpels with united styles. Carpels uni-ovulate.

Fruit

A very large ovoid indehiscent drupe, the size of a fist, up to 10 cm long and 8 cm in diameter; borne on very thick, short peduncles, with a grey, pustulous, scaly surface. One very big seed in each fruit. Fruits are mature in April.

Foliage

Leaves grouped at the ends of thick branches; with 7 to 13 pairs of opposite or subopposite folioles. Rachis 20 to 45 cm long. Folioles oblong, acuminate, with an obtuse, asymmetric base; sub-sessile; 8 to 13.5 cm long and 2 to 4.5 cm wide, coriaceous, with slightly curved edges and 12 to 16 pairs of lateral nervures almost perpendicular to the median nervure, prominent on the under side. Tertiary nerves less marked, parallel to these. The apex and the upper part of the lamina are often dotted along the edges, on the upper surface, with small glandular points.

Bark

Smooth bark, with longitudinal cracks developing in very old trees.

NATURAL DISTRIBUTION

G.zaizou is a species endemic to the forests in the eastern part of the Ivory Coast (the forests of Sassandra and Cavally). It is located especially in the hinterland of Tabou. It only occurs as single individuals, the tree never growing in populations.

WOOD

Studies have not yet been made.

CLIMATE

Tropical rainforest, also semi-deciduous forest.

PROTECTIVE MEASURES TAKEN

Nothing has so far been attempted. It is only common in the two forests mentioned above.

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Ilex paraguaiensis St. Hilaire[1/]

SYNONYMS

Ilex mate St. Hil. (1824)
Ilex curitibensis Miers (1861)
Ilex domestica Reiss. (1861)
Ilex sorbitis Reiss. (1861)
Ilex theazans Bonpl. ex Reiss (1861)
Ilex vestita Reiss. (1861)

FAMILY

Aquifoliaceae

VERNACULAR NAMES

Erva congonha, congonha, congonheira, erva-mate, congoĩn, caaguaçu, congonha grande, orelha de burro, caá, erva periquita.

BOTANICAL DESCRIPTION

General

Medium to tall tree, up to 10 - 15 m in height, with a 20 - 40 cm diameter; trunk straight.

Inflorescence

Normally a clustered inflorescence, originating on the floral axis; female flowers, with a short peduncle, 5 - 7 mm in diameter. Flowers occurs from September to December. Flowers are dioecious with non-specialized pollinators.

1/ Based on the work of M.L.Marques, M.Tomazello and I.E.Pires. Forestry Department, ESALQ/USP, P.O. Box 9, Piracicaba, SP, Brazil.

Fruit

A drupe, black or a black-red when dry, globose or ovoid-globose, 4 - 5 mm in diameter, occurring from December to March.

Foliage

Leaves simple, alternate, spiral, obovate and attenuated at base, obtuse apex; crenate revolute margin, average size approximately 9.5 x 3.0 cm; peninerved, with petiole of approximately 1.0 cm; two small stipules, coriaceous.

Branches thin with no marked characteristics.

Clustered ramification, almost horizontal, forming an elongated crown.

Bark

Trunk: Generally straight, or somewhat twisted; bark dark greyish-brown; outer bark rough cracked, tending to separate into small scales. Internal bark of a yellow colour, which oxidizes and turns into a dark brown, sandy texture, with a compact heterogenous structure.

USES

The leaves are used for tonic and stimulant drinks.

NATURAL DISTRIBUTION

The tree occurs in subtropical and temperate regions of South America, between 18 to 30 degrees latitude South; is found in Brazil as well as Argentina,

Uruguay, Paraguay, Colombia, Bolivia, Peru and Ecuador. In Brazil it occurs in natural formations and in peculiar ecological environments formed by the large Parana, Paraguay and Uruguay Rivers, always in distinctly developed associations of Araucaria angustifolia.

SOIL AND CLIMATE

I. paraguaiensis grows between 500 and 1 500 meters in altitude on several soil types, often being of basaltic rock origin. It prefers compact land, humid and slightly hilly. The climate in the principal areas where this species occurs is humid temperate, and subtropical humid, with average annual temperatures varying between 12° and 21°C, with frosts during the winter. The average annual precipitation varies between 1250 and 2500 mm, evenly distributed, without water deficit.

HABITAT

It is a species of the mixed Araucaria and temperate hardwood forest, where it occurs in the intermediate stratum, frequently in association with Ocotea porosa, Sloanea lasiocoma, Ileve dumosa, Matoyoba eleagnoides and, less frequently, in association with Ocotea puchella. It is also found as cultivated stands.

SEED HANDLING

Seeds should be harvested from very ripe fruits. Ripening may be irregular on the same tree, causing a large heterogeneity in the germination percentage.

Dormancy is broken by natural "stratification" in the soil. The seeds presents tegumen dormancy and the artificial processes employed to break this have not to date rendered many results.

SILVICULTURE

The formation of production stands is made by thinning the other species in forests with Ilex paraguaiensis, or by enriching native "erva-mate" formations with new Ilex paraguaiensis seedlings; or by establishment of plantations. As there are some difficulties in producing seedlings from seeds, vegetative propagation has been used as the most economical and efficient method.

In a mixed cropping with corn, it has been observed that at 6 months of age, Ilex paraguaiensis reached greater heights in the more dense corn stands. No significant influences of the corn density on "erva-mate" survival (average 82%) were observed.
In a plant spacing experiment in Misiones - Argentina, the smaller spacings presented greater leaf production.

STATUS AND REASONS FOR DECLINE

Due to the properties of its leaves I. paraguaiensis was already exploited during the last centuries, and the distribution of this species was thus greatly reduced. The cultivation in pure artificial stands is not enough to fulfill the present demand, todays exploitation in areas of natural occurrence has further reduced the distribution of this species drastically.

PROTECTIVE MEASURES TAKEN

One of the priorities of the Unidade Regional de Pesquisa Centro-Sul (PNPF/EMBRAPA), is to improve the silvicultural technology for Ilex paraguaiensis. 1 research project on phenology, 2 on genetic conservation and 2 on genetic improvement have been set up.

In 1967, IBDF took over all the functions of the Institutio Nacional do Mate, promoting initiatives for protecting and expanding I. paraguaiensis, in view of its economic importance.

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Irvingia gabonensis (Aubry-Lecomte ex O'Rorke) Baill.[1/]

As a result of a recent taxonomic study of *Irvingia gabonensis*, two varieties have been recognized within the species by Okafor (in press), namely *I.gabonensis* var. *gabonensis* and *I.gabonensis* var. *amara*.

SYNONYMS

Mangifera gabonensis Aubry-Lecomte ex O'Rorke (1857)
Irvingia tenuifolia Hook. f. (1862)
Irvingia barteri Hook. f. (1862)

FAMILY

Irvingiaceae

VERNACULAR NAMES

Wild Mango; Duiker nut; Manguier sauvage; Bobo (Sierra Leone); Boboru; Wanini (Ivory Coast); Andok (Cameroon); Meba, Mueba (Zaire); Oro, Oba (Nigeria).

BOTANICAL DESCRIPTION

General

Evergreen forest tree, up to 25 m high and 2 m in girth, occasionally more; with dense compact, conical or umbrella shaped crown. The bole is usually fluted or with plank-like buttresses.

1/ Based on the work of J.C.Okafor, Forestry Research Institute of Nigeria, Ibadan, Nigeria.

Inflorescence

Flowers greenish yellow, small, profuse and fragrant, arranged in clusters on axillary panicles among the leaves and about as long as them, or on branchlets and younger branches; appearing mainly in January to February or in June and October. Floral parts pentamerous, with 5 free, greenish yellow sepals, 5 free,strongly reflexed cream petals, soon falling off, 10 free stamens with white filaments, and yellow anthers, and a green ovary surrounded by conspicuous bright yellow disk; pedicels slender about 5 mm long.

Fruit

Yellowish, broadly ellipsoid, 5-7.5 cm long, with sweet edible or bitter inedible, fibrous pulp, surrounding a large stone, the latter enclosing edible kernels with dark brown or tan or yellowish brown testa. The fruit ripens in the rainy season, April to July and September to October, or in the dry season, January to March.

Foliage

Leaves dark green and glossy above, leathery, 5-15 cm long by 2.5-6 cm broad, narrowly elliptic or broad and obovate, with one margin often a little more rounded than the other; base generally cuneate or rounded, apex acute or shortly acuminate, sometimes rounded or retuse; petiole 3-11 mm long, frequently varying on the same specimen; lateral nerves range from 7 to 13

on either side of the midrib, the lower ones running out vaguely to the margin, the upper ones looped; minor nerves more or less parallel and at right angles to the laterals; veins forming a close network. Stipules 4-27 mm long and curved, forming a protective sheath over shoot buds.

Bark

In young trees grey to brown and smooth, in older trees irregularly platy; slash yellowish-brown to light yellow, hard, fibrous and brittle, sometimes with a clear liquid.

WOOD PROPERTIES AND PRODUCTS

Heartwood pale green-brown or orange-yellow, fading on exposure to grey-brown, sometimes with dark grey streaks; sapwood lighter, not always differentiated. Basic specific gravity (oven-dry weight/green volume) 0.67-0.75. It is used in heavy construction, railroad crossties etc.

Other Uses

The pulp of the fruit is sometimes eaten, although it is bitter and gives off a strong smell of turpentine. The oily seed is edible and consumed in numerous parts of West Africa. The fruits are often left to ferment, which removes the smell that adheres to the seeds. The kernel of the seed is crushed, grilled and used to prepare a sort of butter: this is the dika, odika or pain de dika, also known as "chocolat du Gabon". One can also extract an oil used in soap making, and which is of some alimentary value. For cattle, the oil-cake has a food value equal to that of the oil-cake of coconut.

NATURAL DISTRIBUTION

This species occurs from the Casamance region of Senegal to Zaire and in Angola and Uganda. It is often found in towns or at the edge of villages.

CLIMATE

Tropical rainforest.

SOILS

The species is site demanding, growing well only on loamy to clayey soils which are moderately wet and well drained.

HABITAT

It is a species of dense, moist forests, in gallery forests and in semi-deciduous forests; often found near riverbanks and reaches its optimum in the dense evergreen rainforest.

SEED

No information available

SILVICULTURE

Propagation from seeds is not difficult. The species can also be propagated vegetatively by budding, thereby reducing its fruiting age to 3½ years instead of 10 years or more.

STATUS

Further study needed, but likely to be in danger of genetic impoverishment throughout its geographic range.

REASONS FOR DECLINE

Logging operations and settlement. Natural regeneration is scarse as the fruits are collected as soon as they ripen and fall from the trees.

PROTECTIVE MEASURES RECOMMENDED

There is a need to establish plantations and possibly *ex situ* conservation stands of the species.

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Joannesia princeps Vell.[1/]

SYNONYMS

Anda brasiliensis Raddi (1820)
Anda gomesii A. Juss. (1816)
Andicus pentaphyllus Vell. (1825)
Anda pisonis Mart. ex Stend. (1840)

FAMILY

Euphorbiaceae

VERNACULAR NAMES

Cotieira, andá-cu, oco de purga, purga de paulistas, fruta de arara, andá assú, castanha de arara, coco de gentio, fruta de cotia, indá assú, boleira.

BOTANICAL DESCRIPTION

General

Tree with dense, clustered, ramification that reaches a height of 20 m. When isolated, it develops a very open crown, growing less in height.

Inflorescence

Flowers white or purple in colour, monoecious, small, numerous, without petals, with 5 paniculate sepals and 7-10 stamens. Flowering occurs in the months of February, March, July and December.

1/ Based on the work of M.L.Marques., M.Tomazello F°, and I.E.Pires. Forestry Department, ESALQ/USP, P.O. Box 9, Pircacicaba, SP, Brazil.

Fruit

A dehiscent capsule, with a thick pericarp; up to 12cm in diameter, with 2-3 seeds. Fructification occurs in January to March.

Foliage

Leaves petioled, digitate, 3-7, elliptical with smooth petioled folioles, variable in size, up to 20 cm in length and 8 cm wide.

Branches: Circular, grey, with lenticels, which exude a water liquid, when injured.

Bark

Bark white coloured, almost smooth, trunk normally straight.

WOOD PROPERTIES AND PRODUCTS

White, slightly yellow or hay coloured; sapwood not distinct; with a slightly rough surface, and not very shiny; straight grain; rough texture; aroma and taste indistinct. It is light and has a low mechanical resistance. In laboratory trials it showed a low resistance to rot. Impregnation under pressure in the laboratory, revealed a high permeability to preservative solutions.

Chemical analysis of "boleira" wood gave a Cross & Beven level of celulose of 50.1%, and a lignin content of 21.8%.

"Boleira" wood may be used for cellulose production for high quality paper as well as for boxes.

NATURAL DISTRIBUTION

"Zona da Mata", eastern region of the state of Minas Gerais; valley of Rio Doce; and from the northern part of Espírito Santo to the south of the state of Bahia.

SOILS AND CLIMATE

As indicated by the wide geographical distribution of this species, it tolerates several soil and climate types. However, it does not withstand extremely dry conditions such as those of the arid and semi-arid regions. It withstands pronounced dry seasons and grows best in deep soil.

HABITAT

May be found isolated, as well as in association with other species in the forests. It prefers the more humid areas of the tropical rain forest.

SEED HANDLING

Seeds oval shaped, large, with a hard texture, presenting coat dormancy. One kg contains 180 to 340 seeds. An 80% germination rate was obtained with mechanical scarification, after 243 days storage in a cold chamber.

SILVICULTURE

In a trial set up in Marliéria - MG, a 15 m height and an 11 cm DBH was measured at five years of age. A

23.3 m height and a 50.9 cm DBH was observed, at 26 years of age in Santa Rita do Passa Quatro - SP. In-spite of the high growth rate and the excellent wood properties, this species is not planted on a commercial scale.

STATUS AND REASONS FOR DECLINE

The regions of natural occurrence of the species are among those that have undergone most severe devastation, due to clearence of the natural vegetation for development of agriculture, and livestock or plantation projects using fast growing species. Presently, the few remaining trees are being gradually cut down as a result of the high demand of this economic valuable species.

PROTECTIVE MEASURES TAKEN

J. princeps grows in the State Park of Rio Doce in Minas Gerais. However, this unit is not sufficient for conservation, as it does not represent its total natural distribution.

3 base populations, propagated from a total of 90 selected trees, have been implemented through a contract between the Conselho Nacional de Desenvolvimento Cientifico e Tecnologico (CNPq) and the Programa Nacional de Pesquisa Florestal (PNPF) in collaboration with the Sociedade de Investigacoes Florestais (SIF).

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Juniperus bermudiana L.[1/]

SYNONYMS

Juniperus barbadensis L. (1753)
J.fragrans Hort.
J.virginiana var. *australis* Endlicher (1846)
J. virginiana var. barbadensis Gordon (1858)

FAMILY

Cupressaceae

VERNACULAR NAMES

Bermuda cedar, Bermuda juniper, Red cedar, Southern red cedar.

BOTANICAL DESCRIPTION

General

An evergreen tree up to 20 m high and up to 1 m in diameter. Branching irregular, wide, giving the tree a conical outline when young, becoming round-topped with age. The spread of the branches is usually greater than the height of the tree.

Inflorescence

Staminate cores are yellow.
Male and female flowers on different trees (dioecious).

1/Based on the work of G.R.Groves. Dept. of Agriculture & Fisheries, Botanical Gardens, Paget, P.O.Box 834, Hamilton 5, Bermuda.

Fruit

Depressed, globular, about 0.6 cm in diameter, glaucous, each scale marked by a depression with a minute point; seeds 2-3, shining chestnut-brown, ovoid furrowed.

Foliage

Leaves linear-acicular, ascending, 5-15 mm long and about 1 mm wide, whitish above and light green beneath. Leaves of mature tree scale-like, closely appressed and imbricated.

Bark

Thin, grey, flaky.

WOOD PROPERTIES AND PRODUCTS

The Bermuda Cedar produces a good wood for furniture making and also for the manufacture of souvenirs. The finished article is highly polished and the reddish-brown hue of the wood adds dignity to the home in which it is used. It is also a valuable firewood which is burnt in open fire grates during the cool evenings from December to April.

Other Uses

Windbreaks

NATURAL DISTRIBUTION

Formerly abundant throughout the Islands of Bermuda. There is no sound evidence that the tree occurs in the wild elsewhere.

SOILS

Limestone-derived soil.

HABITAT

In the past forming almost complete forests on the hillsides and along marshes.

SEED HANDLING

The plants are easily propagated from seed, which is provided annually in the late autumn. The seed however, takes from 3-5 months to germinate.

SILVICULTURE

In some protected areas, patchy cedar regeneration was clearly visible among dead trees in 1960. By 1970 these same seedlings had grown to an average of about 1-2 m, but the sparseness of the foliage at their tops indicated that they had been attacked by the juniper scale (see below). Evidently the juvenile growth habit and vigour initially provides some degree of tolerance to the scale insect, but as the tree matures its resistance declines.

STATUS

Approximately one percent of the original Cedar has survived the scale outbreak.

REASONS FOR DECLINE

Approximately 90% of the trees died between the years 1944 and 1950 as a result of severe insect infestation. Two scale insects, the juniper scale (Carulaspis visci) and the oyster shell scale (Lepidosaphis

newsteadi) were responsible. A few of the old trees are still growing and young stands of the species are developing well in the undisturbed areas, but this species is no longer a dominant tree in Bermuda.

PROTECTIVE MEASURES TAKEN

The fact that the species has survived the insect infestation is probably due to the biological method of control adopted in the 1950's; this shows that with care, the species can be perpetuated. Pure stands are being established on Government land and particularly on a little island known as Nonsuch Island at the eastern end of the Bermuda Islands. Nonsuch Island, which was once devastated by goats, is now a living museum of Bermuda's flora and fauna with the Bermuda Cedar as the dominant tree.

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Juniperus procera Hochst. ex Endl.[1/]

Suggestions have been made (e.g. Lewis 1960, Kerfoot 1975) that this tree is not separable from *J.excelsa* Bieb., the range of which extends to Central Asia. Here the traditional view of the African taxon is retained, pending wider formal acceptance of the broader concept proposed for *J. excelsa*.

SYNONYMS

Juniperus abyssinica Hort. ex C. Kock (1853)
Sabina procera (Hochst.) Antoine (1857)

FAMILY

Cupressaceae

VERNACULAR NAMES

African Pencil Cedar; Mutarakwa (Kikuyu, Kenya), Ol-tarakwa (Masai, Kenya and Tanzania), Tarakwet (Nandi, Kenya), Tedh (Amharic, Ethiopia).

BOTANICAL DESCRIPTION

General

An afromontane tree, usually the tallest species present, reported to reach 50 m, though more commonly 30-35 m. Bole straight but sharply tapered, often with a pronounced twist; commonly heavily fluted; diameter

1/ Based on the work of John B.Hall, Dept.of Forestry, University College of North Wales, Bangor, U.K.

reaches 2 m, sometimes up to 2.9 m. Branching heavy, usually from near the ground. Crown pyramidal in youth, spreading in older trees, branchlets slender, terete, 0.5-1 mm in diameter, bearing sessile, scale-like leaves in decussate arrangement.

Inflorescence

Dioiecious. Male cones solitary, terminal on short branchlets, small (about 3 mm long), ellipsoid to subglobose, yellowish in colour, consisting of 5-6 pairs of decussate, subpeltate, obtuse or blunt apiculate scales, each with 2-3 pollen sacs. Female cones solitary, terminal, on short lateral shoots, consisting of 3-4 pairs of decussate fleshy scales, and bearing a solitary, erect ovule.

Fruit

Berry-like globose or subglobose, reddish-brown to blue-black in colour, waxy and composed of the confluent, swollen, fleshy scales of the female cone, the tips of the scales just distinguishable. When ripe, 4-8 mm in diameter, containing 1-4 seeds with a woody testa, each flattened or triangular, brown and about 5 mm long. Additional 1-3 smaller, aborted seeds common.

Foliage

Mature leaf grey or glaucous, about 1 mm long, acute, hooded and keeled at the apex and with a narrow translucent margin and an elliptic oil gland on the back, near the base. Juvenile leaves in whorls of three on shoots, 1-2 cm long, linear and spine-tipped, the

lower part being decurrent on the branch. Oil gland on abaxial surface linear, extending three-quarters of the length of the leaf. Juvenile leaves deciduous. As plant ages the leaves gradually change until foliage characteristic of mature tree is produced. The term "intermediate" is used to describe leaves not reduced to the adult form but with the characteristic decussate adult arrangement.

Bark

Pale brown to reddish brown, thin and fibrous, with shallow longitudinal fissures, exfoliating in thin, papery strips.

WOOD PROPERTIES AND PRODUCTS

The wood of J.procera is fine-textured, straight-grained and of medium hardness. The heartwood is very resistant to termites and durable against rotting in the ground. It is easily worked, takes a good polish and glues and whittles well. The main use of the wood of J. procera is for construction, transmission and other poles, pencils, flooring and wooden structures exposed to the weather. The wood is also used for furnishings, and there are some prospects for its use in the manufacturing of hardboard and particle-board.

Other Uses

In addition to the above, Cedar Wood Oil was earlier distilled from the sawdust and used in the cosmetic industry.

NATURAL DISTRIBUTION

Widely distributed from Arabia southward to Zimbabwe. Range fairly continuous in Ethiopia and Kenya: outlying isolated populations extend the range of the species to the Horn of Africa in the East and Zaire in the West. Outlying populations are also found in the south of the species' range, south of latitude $4^{\circ}30'S$.

CLIMATE

The overriding restricting climatic factor seems to be temperature, J.procera being restricted to sites with a mean annual temperature of below $+19^{\circ}C$. In East Africa this corresponds to a minimum elevation of 1 350-2 000 m. Further from the equator the minimum temperature tolerated by the species is reduced, the lower limit of mean annual temperature for the tree being $+ 7^{\circ}C$ to $+ 10^{\circ}C$. A clear relationship exists between distribution of the species and rainfall, the optimum mean annual rainfall lying between 400 and 1 200 mm. The tree will grow in higher rainfall areas under plantation conditions, when competing species are artificially suppressed. In natural conditions, under rainfall regimes with 8 or more months receiving $\geq$ 50 mm of rain and with a mean annual rainfall of $\geq$ 1000 mm, J.procera is unable to compete with other species. Likewise, the species is not competitive under natural conditions in areas with a mean annual rainfall of 800-1000 mm and 7 or more months per year with over 50 mm rainfall. Where mean annual rainfall is below 800 mm, the tree seems to have become established in

all sites with suitable temperatures, it has reached. At 600 mm mean annual rainfall, or less, the competitive advantage over other species is strongest. However, in areas with less than 600 mm of rainfall, the areas where the species can be found receive additional moisture from mist and low-lying clouds.

SOILS

J.procera occurs on rocks as diverse as limestones, gneisses,and granites of the Basement Complex,and basalts, but especially on the latter. The concentration of the tree on areas of volcanic rocks is a consequence of the history of its entry and spread into Africa; there is no direct evidence that it is restricted to certain types of rock.

In terms of soil type, there is little information but it is clear that the drainage must be good, and that the species rarely grows in soil heavier than sandy clay. In other respects it appears tolerant of widely varying soils. Soil depth does not appear to be a critical factor.

HABITAT

The species occurs in highland and mountain areas, mostly at 1 750 m - 2 500 m altitude; in particularly favourable niches it may occur as high as 3 500 m. Details on elevational range are complicated by interactions of temperature, extent of high ground and site. On isolated mountains and in other places where low temperatures prevail at unusually low elevations, the species has been reported to occur at only 1 350-1 400 m.

SEED HANDLING

Seed is readily available but has short viability, 6 to 12 months. 1 kg contains c. 42 750 seeds; the germination 6 weeks after collection is around 40%. Phenological information is limited but seed is reported available at Shume in the Usambaras ($4^{o}42'S$, $38^{o}12'E$, 1 860 m) from January to May (i.e. the latter half of the rainy season) and on Mount Kilimanjaro, at Rongai ($2^{o}58'S$, $37^{o}27'E$; 2130 m) towards the end of July (i.e. the first half of the dry season).

SILVICULTURE

Early in this century a number of plantations were established especially in Kenya, until attention switched to faster-growing species during the 1960s. Recently, however, interest in J.procera has revived and new plantings are under way in Tanzania; unlike the earlier plantings, there is more interest today in trying to identify good provenances. Seedlings are ready to plant out after 1-2 years in the nursery. In the field, close initial spacing (2 m x 2 m) is advocated to limit low crown development, and form is further improved by a series of early prunings; in Tanzania these have been undertaken at 2.5 and 6 years. Initial thinning in Tanzania has been 50% at 5 years. It is essential that weedings be carried out at least once a year during the establishment phase.

STATUS

Outlying populations endangered. In Zimbabwe one single tree presently survives; in Zaire and Malawi the numbers of trees remaining in the populations are very low.

REASONS FOR DECLINE

Changing land use patterns, discontinuous distribution range of the species, coupled with wildfires hampering the establishment of regeneration; browsing pressure, particularly from buffalo and elephant; logging for both local use and for export; the gradual switch from local species to fast-growing exotics in plantation forestry, are all reasons for the decline of J. procera.

PROTECTIVE MEASURES RECOMMENDED

Exploration and evaluation through the establishment of internationally coordinated, range-wide provenance trials, which are likely to promote conservation measures and the increased use of J.procera in plantation forestry, are recommended. Ex situ conservation as a complementary practice is advocated. Improved management, protection of areas against fire and domestic and wild animals, is required for natural stands, to enable regeneration, and serve as conservation in situ.

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Khaya senegalensis (Desr.)A.Juss.[1/]

SYNONYM

Swietenia senegalensis Desr.

FAMILY

Meliaceae

VERNACULAR NAMES

Eri, Kirai, Mario, Tido (Uganda)
Acajou d'Afrique, Acajou du Sénégal, Kuka Caïlcédrat, Cail-Cédrat, Jallo, Khaya, Kuhi, Kaye, Senegal Mahogany, African Mahogany, Dry Zone Mahogany.

BOTANICAL DESCRIPTION

General

Caïlcédrat (Khaya senegalensis (Desr.) A.Juss.) is a very large tree, whose heavily branched and very developed crown may reach a height of 35 metres. The buttressed trunk is rarely very long; on deep, wet soil it is fairly straight and exceeds 10 metres, while under less favourable conditions the tree is low-branched, but nevertheless attains a very large diameter.

Inflorescence

Glabrous panicles of masses of small white flowers (about 5 mm long). Calyx with 4-5 imbricate sepals. 4-5 free white petals. White staminal corona, with 8-10 short lobes at the top; 8-10 alternate,

1/ FAO acknowledge the assistance of B.T.Styles (Oxford Forestry Institute,University of Oxford, OX1, 3RB, England)

serrated sessile anthers, completely enclosed. Red or orangey disc bearing a glabrous ovary with 4-5 multi-ovulate loculi. Discoid stigma. Flowering season: December to April.

Fruit

Globular capsules, borne above the top of the trees, which in the sun appear white before dehiscence. They are usually 5-6 cm in diameter, but these dimensions are not invariable. The capsules open into 4 valves, the flat, brown, suborbicular seeds with foliated edges are attached to a central columella with four or five sides and seem crammed together. There are 15-20 seeds per pile on each face of the columella. They ripen from March on.

Foliage

Oblong folioles, some extremely markedly narrow, with a short, obtuse acumen, grey underneath, 3-6 pairs, usually 3-4 pairs, 7-12 x 3-5 cm. 8-10 pairs of lateral nervures.

Bark

Dark grey, covered with small scales. The red cross-section exudes a little reddish liquid.

WOOD PROPERTIES AND PRODUCTS

The sapwood is not very distinct and is only slightly paler and browner than the pink-brown heartwood which darkens to deep red-brown, with a purplish tinge. It has a slight aroma when worked, and because of the resin it contains it stores well under water. It is

only moderately hard and heavy, yet is the heaviest of the African mahoganies (Khaya). Care is needed to prevent its warping and splitting, but little is, as yet, known about its seasoning. It was the first used of the African mahoganies, and was exported from the Gambia over a century ago, and used in Europe for furniture. It is durable, and has proved to be particularly resistant to termites in Sudan, but the sapwood is liable to attacks by Lyctus and Longhorn beetles. The Zande (Sudan) use it for drums (Culwick). It works well with all tools, though it is harder and less easy to work than K. ivorensis. It is used locally for temporary buildings, furniture, and railway carriages. It would be suitable for furniture and interior decoration, either solid or as veneer, and for most of the other purposes for which mahogany is used. The timber of K. senegalensis is not only heavier but also darker than the other species in the genus.

Other Uses

The tree contains a gum which is golden yellow and is semi-soluble in water. It is best collected in the dry season. The bark yields a brown dye (kuntunkuri) used for dyeing hunters' clothes. It is sometimes used in tanning and contains 10.2 percent of tannin. The leaves are used as fodder for cattle and camels. The dried and powdered bark found in markets is used for medicinal purposes.

NATURAL DISTRIBUTION

K. senegalensis is a native of tropical Africa along a band more or less parallel to the equator, stretching from the Atlantic to the Indian Ocean through tropical West Africa (Mali, northern Nigeria), northern Cameroon, northern Uganda, and southern Sudan. It is not known from any other areas in Africa.

CLIMATE

The natural distribution band corresponds to the Sudanian climate: rainfall 750 to 1 300 mm per annum with a dry season lasting 5 to 7 months.

SOILS

For good growth the species requires rich soil, rather wet, although it can withstand long periods of drying out.

SEED HANDLING

The collection time varies according to the locality. 3 000 - 7 000 seeds/kg. No pre-treatment is required. Good fresh seed will give a germination of 90% or more. Seed does not keep well. Germination occurs in 10 days, and reaches its maximum in 18 days. (Refrigeration for medium-term storage is required).

SILVICULTURE

Either one-year-old striplings or stumps may be used. In the first case (striplings) seeds are sown thickly in a shaded bed, at a depth of 1 to 2 cm. When 3 months old the young plants are pricked out into nursery beds, 20 x 20 cm apart. They are planted out some ten months

later, when 0.50 to 1 m high. The plants are more or less completely stripped (only 1 or 2 branches are left) and the main root is cut back to about 30 cm. In the second case (stumps), sowing is done directly in rows 15 cm apart and the young plants are left in place until they are one year old, though thinned out to bring them up to 10 x 15 cm. They are then prepared as stumps according to the usual method, leaving 2 to 3 cm of stem and 25 to 30 cm of roots. In both cases (striplings and stumps) the plants are planted out 2 x 2 metres apart, in holes previously loosened.

STATUS

Not under immediate threat but populations of best trees are in danger of genetic erosion (particularly in W.Africa).

REASONS FOR DECLINE

As the largest tree in the savanna flora with the most usable timber, the best individuals of K. senegalensis are being gradually cut down.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

K. senegalensis is best protected in gazetted forest reserves and natural parks (as in Uganda and Zaire) with strict supervision.

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Liquidambar styraciflua L.[1/]

SYNONYMS

Liquidambar macrophylla Oerst (1863)
L. styraciflua var. mexicana (Oerst.) Ndz. (1891)
L. styraciflua var. macrophylla (Oerst.) Ndz. (1891)

FAMILY

Hamamelidaceae

VERNACULAR NAMES

Ocozote; copalme; balsamo; estoraque; yaga-bizigui; ingamo; molá; suchete; icob; ko'ma; copalillo; quirambaro; somerio; copalome; cotoraque; komaliso; slu'to'nko; ien-gau-o; nijte-pijto; nite-biito; yaga-huille; xochicatscuahuitl; (in Mexico). Ocop; occob; ocom; quiramba; tzote; (in Guatemala). Liquidambar (throughout Central America).
Sweet gum; red gum; sycamore gum; satin walnut, yellow gum; starleaf gum; bilstead; alligator tree; hazel wood; hazel pine; (in USA).

BOTANICAL DESCRIPTION

General

A medium to large deciduous tree, capable of attaining heights of more than 50 m, and up to 1.5 m in diameter.

Inflorescence

A monoecious species, flowers are borne in terminal or axillary panicles on short, lateral, woody pubescent branchlets, 5-10 cm long; male flowers situated on the

1/ Based on the work of P.S.McCarter and C.F.Hughes (Oxford Forestry Institute, University of Oxford. OX1 3RD England).

upper part of the panicle, each bundle of flowers on a short branchlet 2-20 mm long, subtended by one or several ovate, papery, caducous, ciliolate bracts; perianth absent. Stamens numerous, free, with oblong, glabrous anthers; borne on a short thick stalk 5-10 long; ovary lacking. Female flowers in small heads 6-8 mm in diameter held on a short stalk up to 1 cm long; flowers regular; subtended by bracts similar to those in the male flowers; perianth very short with 4-6 acute or truncate fleshy, papillose lobes; stamens absent. Ovary semi-inferior with two partially free carpels, particularly in the upper part; bilocular with several ovules per loculus; each carpel with a thick glabrous, curved, basal style up to 4 mm long; stigmatic region papillose. Flowering occurs mid January to March.

Fruit

Grouped in small heads from 2.5-4 cm in diameter, on pendulous, glabrous, penduncles, 5-6.5 cm long; heads globose, spiky, woody, brown or shiny black. Fruit a bivalved capsule, dehiscing at the apex, containing many brown winged seeds from 6-8 mm long.

Foliage

Buds up to 1.5 cm long covered in acute or obtuse, brown, glabrous, shining scales; margin ciliolate. There are 2 stipules, approximately 5 mm long, lanceolate, glabrous and caducous. Leaves simple, 3-5 lobed; the lobes triangular with a serrated margin; spirally arranged, the laminas much broader than long:

from 4 x 5 to 11 x 15 cm; apex generally broadly acuminate, the base of the leaf truncated or weakly cordate; opaque dark green on the upper surface and light green beneath, changing to reddish or yellow when old and becoming glabrous; nervation palmate and prominent on the under surface,with a bunch of hairs in the nerve axils. The leaves have an agreeable resinous smell when crushed. The petioles range from 1.5-9 cm long, greyish-brown and glabrous. Young leaves bright green and soft. Trees loose their leaves completely between November and March/April in temperate regions, and this deciduous habit is maintained throughout the tropical part of the species' natural range, although this leafless period may be reduced to less than one month.

Bark

The bark on the main trunk is furrowed and greyish, and may be over 1 cm thick on old trees; younger branches red-brown in colour, often with corky ridges or thick wings.

WOOD PROPERTIES AND PRODUCTS

In the USA the wood of Liquidambar is widely used by the furniture and cabinet-making industries. The heartwood is a distinctive red-brown colour, sometimes beautifully figured with deep markings. Other major uses include boxes, crates, pallets, plywood, particleboard and pulp.

Other Uses

A balsamic exudate obtained from the sap of the tree is used by the medical and perfume industries.

NATURAL DISTRIBUTION

Liquidambar occurs widely in the southeastern states of the USA - the Carolinas, Georgia, Alabama, Maryland - extending northwards as far as Connecticut (41° N), westwards to Missouri, Arkansas and Oklahoma and southwards to central Florida. It is estimated that the species makes up some 30% of the hardwood growing stock of the Southern USA.

There is a gap of some 800 km from the most southerly of these US populations to the most northerly recorded site in Mexico, in the state of Tamaulipas. From here the species occurs in fairly small disjunct populations along the eastern Sierra Madre through the states of San Luis Potosi, Hidalgo, Veracruz, Oaxaca and Chiapas. The range continues sporadically through Guatemala and Honduras reaching its southern limit in central Nicaragua at a latitude of 13°N. The species has recently been reported from two additional locations. Firstly from the Mayan mountains in southwest Belize and secondly from Chihuahua and Durango States in northwest Mexico. These outlying populations are likely to be of particular interest genetically.

CLIMATE

Because Liquidambar spans such a broad latitudinal range (almost 30°) it is difficult to give general

climatic information. In the USA mean annual rainfall varies from approximately 1 000 mm in the north to 1 500mm in the south, whilst throughout the tropics slightly higher rainfall (1 500-1 800 mm) is recorded. Here, a dry season (any month with less than 60 mm rainfall) of between 0 and 6 months is reported.

On account of its broad distribution there are marked differences in the frost tolerance of provenances of the species. The northermost populations (Connecticut) regularly experience minimum temperatures of the order of $-24^{\circ}C$; those in Florida - $7^{\circ}C$. The Mexican and Central American populations probably never experience frost, and it seems unlikely that they would show any degree of tolerance of it.

SOILS

The species, whilst tolerant of a wide range of site conditions, does most certainly prefer and reach its best development on the richer, moister, well drained, acidic alluvial clay and loam soils of river bottoms.

HABITAT

Throughout its native range in north and middle America, Liquidambar is often found in mixed or "transition" forest, mainly associated with pine or oak, between the altitudes of 900 and 1 600 m. It has, however, been reported growing at elevations as low as 650 m in E. Honduras, where it occurs as a canopy species in lowland tropical broadleaf forest, and also, at over 2 000 m in Mexico. One of the most impressive

attributes of the tree from a forestry viewpoint is its excellent form, with straight stems, light branching and narrow crowns. It grows happily in very dense pure stands. The species coppices readily and also regenerates by means of root sprouts.

The deciduous habit of Liquidambar has been retained in the tropics, (to where it migrated, from temperate regions, during the last ice-age), although the leafless period is greatly reduced from over 6 months at the northern extreme of the natural range to 1 or 2 months in southern Central America.

SEED HANDLING

The seed is easy to collect: the fruit heads are collected when mature or almost mature, before seed dispersal. These fruit heads are spread out for 4-7 days to dry in the shade. One or two days in full sun should be sufficient to open them. Vigorous shaking will complete the extraction The seed can be stored in sealed bags at 2° - 7°C with a moisture content between 10% and 15% for several years without loss of germinative capacity. No pre-sowing treatment is necessary for the tropical provenances, (seed from US sources requires cold moist stratification of 15-90 days to achieve acceptable rates of germination).

SILVICULTURE

Because it has been managed extensively both in natural stands and in plantations in the USA, a wealth of information is available on the silviculture of Liquidambar. Field establishment is straight forward benefitting from effective weed control.

Liquidambar depends on an endomycorrhizal association for optimum growth. Suitable fungi are commonly found in tropical soils, and difficulties are only evisaged if, for example soil sterilents are used on nursery seed beds.

STATUS

Not endangered as a species, although endangered in some of the tropical parts of its natural range.

REASONS FOR DECLINE

Land clearance for agriculture is the main reason in Central America. The mid-elevation fertile sites where Liquidambar (and several species of pine e.g. P.patula subsp. tecunumanii, P.maximinoi) is often found, are under severe pressure by a rapidly expanding rural population. Subsequent grazing pressure prevents the regrowth of coppice shoots.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

With a financial contribution from FAO, the Oxford Forestry Institute, Oxford, England, in collaboration with the National Forest Seed Centres of Central America and the Instituto Nacional de Investigaciones Forestales (INIF) in Mexico, made seed collections of 13 provenances of Liquidambar from its southern limit in Nicaragua to just south of the Tropic of Cancer, Tamaulipas, Mexico, in September/October 1983. An average of 40 trees were sampled for each of these provenances with mild phenotypic selection for stem straightness and branching characters applied.

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Lovoa swynnertonii Bak.f.[1/]

FAMILY

Meliaceae

VERNACULAR NAMES

Nabulagala, Omukumbo Mukusu, Omukankoma (Uganda). Brown Mahogany (Zimbabwe). Mukonguro, Mutunguru, Nabolagala (Kenya). Mboto, Msau (Tanzania). Kilimanjaro Mahogany (English).

BOTANICAL DESCRIPTION

General

Tree up to 50 m tall, trunk only slightly buttressed at base, up to 2 m height, bole fluted.

Inflorescence

Panicles grey-pubescent when young; flowers white, paniculate; petals about 0.3 - 0.35 cm, staminal tube about 0.2 cm with 8 bifid lobes at the margin whose segments are narrowly elongate-triangular.

Fruit

Capsule ellipsoid, about 5.5 cm long; valves 4, semi-stiff, recurving first from apex, but remaining attached at the base for some time before falling. Seed 3.2 - 5.0 cm long including the wing.

1/ Based on the work of J.A.Odera (Kenya Agricultural Research Institute, Kikuyu, Kenya), Ms.C.Kabuye (East African Herbarium, Nat.Museum, Nairobi Kenya) and Dr.B.T.Styles (Oxford Forestry Institute, University of Oxford, OX1 3RD. England).

Foliage

Leaves 15-30 cm long, pubescent when young. Rachis angular; leaflets 6-16, subopposite or opposite, oblong, 5.0-14.5 cm long, apex subacuminate, base cuneate.

Bark

Bark grey-brown with rusty patches. New bark cinnammon coloured. Bark on branches and twigs silvery grey. Slash red, conspicuously layered, slightly scented.

WOOD PROPERTIES AND PRODUCTS

Sapwood dull white, heartwood dark grey-brown, handsome, frequently cross-grained and difficult to work; very durable, resistant to borers. When seasoned timber is dark reddish brown, producing beautiful furniture boards.

The timber is used for building bridges (Meru District, Kenya).

NATURAL DISTRIBUTION

Kenya: Kwale District (Mrima Hill) and Meru District. 300-1 300 m a.s.l.

Uganda: Mengo, Ankole (Kalinzu Forest), Toro (Kimbala Forest), Kigezi and Bunyoro (rare).

Tanzania: Mtibwa Forest Reserve, Turiani, Rau Forest (Morogoro District).

Mocambique: Garuso Forest.

Zimbabwe: Chirinda Forest (Chipinga Dist.), up to 300 m alt.
Also located in E. Zaire.

Although the area of distribution of this species is enormous, the occurrence of it in any one locality is very sparse. It was formerly fairly common in the Lake Forests of Uganda, but recent decline has been extending rapidly.

CLIMATE

In moist tropical forest, generally in wetter parts. In Kenya rainfall c. 1 250 mm.

SOILS

Kenya: On sandy or loamy soils

HABITAT

Kenya: Kwale district: lowland wet evergreen forest, with some dominant storey trees including Newtonia paucijuga, Chlorophora excelsa and Antiaris toxicaria. Meru District: Upland wet evergreen forest with Newtonia buchanannii and Ocotea usambarensis.

Uganda: wet, evergreen forest.

Tanzania: wet, evergreen forest.

SEED HANDLING

The seed which is winged may be carried away several metres from the mother tree. Germination is good, though, as with all Meliaceae (particularly Swietenioideae), viability declines rapidly if proper storage conditions are not followed.

SILVICULTURE

There are past records of enrichment planting in Meru forest. Natural regeneration is poor and cultivation in plantation uncertain due to damage by shoot borers. Establishment is easy, though saplings are often attacked by Hypsipyla.

STATUS

Rare. It is only known from a few sites and the populations on these sites are very small. The forests in which it grows are becoming depleted each year usually to give way for agricultural cultivation.

REASONS FOR DECLINE

1. Excessive exploitation of large specimens is occuring, reducing the number of seed trees, primarily the best ones.
2. Seedling establishment is difficult.
3. Natural regeneration is poor.
4. Prospects for cultivation in plantation are handicapped by shoot borers.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

Some enrichment plantings has been attempted on a limited scale in Uganda by line planting and the usual silvicultural practices of encouraging natural regeneration. Several of the best stands now occur in Protected Forest Reserves e.g. Rau Forest (Tanzania), Chirinda Forest (Zimbabwe), and Meru Forest (Kenya).

1. The Mrima Hill Forest (Kenya) should be considered as a possible National Park.

2. Germination studies and studies on possible control of shoot borers should be carried out to bring the species into cultivation.

3. An ecological study should be made to identify the requirements of the species and the factors limiting its distribution.

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Machaerium villosum Vog.[1/]

FAMILY

Leguminosae Subfam. Papilionoideae

VERNACULAR NAMES

Jacarandá-pardo, jacarandá-paulista, jacarandá-do-cerrado, jacarandá-do-mato, jacarandá-roxo, jacarandá-tá, jacarandá-pedra, jacarandá-escuro, jacarandá-una, jacarandá-amarelo.

BOTANICAL DESCRIPTION

General

Tree medium to tall, reaching a height of 12 m, with a bulgy crown, ascendent branches and cymose ramification.

Inflorescence

Flowers small, white in short axillary paniculate inflorescence with a cupuliform, pilose calyx, densely pilose standard, 10 stamens, forming a tube; filaments are varied and pilose, ovary pilose, with a very short style. Flowering occurs from October to December.

Fruit

An indehiscent samara, with a long wing, thin, smooth and curved, with a thick part that encases the seed. The fruit setting period is very irregular, sometimes not bearing fruit for up to 2 to 3 years. Fructification occurs from August to October according to some authorities.

1/ Based on the work of M.Tomazello, M.L.Marques, and R.Chiaranda. Forestry Dept., ESALQ/USP, P.O.Box 9, Piracicaba, S.P., Brazil.

Foliage

Leaves alternate, imparipinnate, 32 cm long, with 7 to 11 pairs of opposite folioles, sometimes alternate, petiole villous; petioled folioles, entire, lance-shaped, pointed, with a rounded base, rough and shiny on top and villous and opaque underneath.
Branches: Round, greenish-grey, rough due to lenticels, with swollen buds.

Bark

Straight trunk with cracked bark, sometimes the trunk is slightly crooked.

WOOD PROPERTIES AND PRODUCTS

Wood heavy (0.80 to 0.90 g/cm^3); the heartwood is light brown-yellow, grey-brown or dark dusky purple, with eventual purple-black highlights, stripes or shadows; irregular shiny surface; fibrous aspect, weak, pleasant odour, but somewhat pungent; indistinct taste, rough texture, undulated grain.
Used in the manufacture of fine furniture, balconies, lambrins, dowels, floor tiles, sashes, veneers, sleepers, etc.

NATURAL DISTRIBUTION

From Minas Gerais to Paraná. Common in the regions between affluents of Paranaíba and Rio Grande; also common in Southern Goiás and Western Minas Gerais.

SOIL AND CLIMATE

It is found on both poor and fertile soils, and sporadically in "terra roxa" (very fertile soil). As indicated by the wide area in which this tree grows naturally, it

is subject to the most diverse climate types, varying from tropical sub-humid to tropical and subtropical humid.

HABITAT

The tree is found in dry forest of the highlands of "Serra do Mar" and "Mantiqueira". Sometimes also found on the "cerrado".

SEED HANDLING

Seed winged, easily dispersed by the wind. One kilo gram includes about 3 500 seeds. When sown in the nursery, without pre-treatment, germination begins after 30 days. There is a large number of seeds per fruit.

SILVICULTURE

In a stand established in Santa Rita do Passa Quatro - SP an average height of 6.10 m and a dbh of 8.40 cm, at 22 years of age, were observed.

In Pederneiras - SP. an average height of 0.44 m at 2 years of age was obtained.
However, planted in the understorey of a Pinus elliottii stand, after the second thinning, an average height of 2.97 m, a dbh of 2.52 cm, and a 100% survival was obtained at the age of two years.

STATUS AND REASONS FOR DECLINE

This species is gradually disappearing due to the exploitation of its wood as well as to clearence of the natural vegetation for pasture development or plantation Projects using fast-growing species. The area in which this species grows naturally is one of the regions which has undergone the most severe forest devastation.

PROTECTIVE MEASURES TAKEN

Planting of 6 base populations from 49 selected trees, as a result of a contract between the Conselho Nacional de Desenvolvimento Cientifico e Tecnologico (CNPq) and the Programa Nacional de Pesquisa Florestal de Sao Paulo (IFSP), is reported. A trial in agreement with Instituto Florestal de Sao Paulo using 5 provenances and progeny from 25 trees per origin was established in 1981, in Pederneiras - SP by the IFSP. Variation among progeny from different trees and within progeny from the same trees was observed during the first year.

The above programmes have been implemented to evaluate the genetic variation and at the same time serve the conservation of the species.

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Mimosa caesalpiniaefolia Benth.[1/]

FAMILY

Leguminosae Subfam. Mimosoideae

VERNACULAR NAME

Sabiá

BOTANICAL DESCRIPTION

General

Tree which reaches up to 8 m in height, with branching from soil level, and a crooked trunk; the trunk when young, has few thorns that disappear when the tree reaches adult age. The rootsystem has nodules with nitrogen fixation capacity.

Inflorescence

A cylindrical spike of 5 to 10 cm in length, consisting of axillary and terminal panicules. Flowers are white, small, and in a capitulum, and are rich in nectar production. Flowering takes place from March to April and August to October; however, the seeds produced during this later period are the most healthy.

Fruit

The fruit is an articulated legume (pod), 7 to 10 cm in length by 10 to 13 mm in width, with a stipe of approximately 10 mm, segmented and held together by

1/ Based on the work of I.E.Pires & C.E. de S. Nascimento, EMBRAPA/CPATA, P.O. Box 23, Petrolina, Pernambuco, Brazil.

fibrous filaments that bears the petiole at the end of the legume; one seed in each segment.

Foliage

Leaves bipinnate with six opposite pinnae and six opposite folioles sometimes 4 to 8, with prominent ribs; petioles 2 to 5 cm in length, with winged stipules about 3 mm long with or without curved thorns. The leaves have a high forage value, containing approximately 17% protein.

Bark

The bark is 3 to 5 mm thick, light brown in colour, with parallel fissures that show lengthwise bands, which scale off slowly.

WOOD PROPERTIES AND PRODUCTS

It has a yellow-brown to dark purple coloured heartwood and a cream coloured sapwood; darkens with time to red-brown. The surface is shiny and smooth. Appropriate for external use for stakes, and pillars due to its high durability even when in contact with the soil; suitable also for the production of fuel wood and charcoal due to its high calorific value.

NATURAL DISTRIBUTION

The "sabiá" grows in Northeastern Brazil, in the State of Ceará, and is also found from Maranhão to Bahia.

CLIMATE

The dry climate of Northeastern Brazil is the most appropriate for the "sabiá". Climate varies however from dry subhumid tropical or subtropitcal to semi-arid tropical or subtropical, with average temperatures between 20 and 28°C, yearly average precipitation between 500 to 1 300 mm, with a dry period of 6 to 12 months, and water deficit varying between 200 and 1000 mm.

SOIL

Grows preferably in deep soils, principally in the aluvials, and in the deep sandy alluvials. Good performance in shallow soils is observed, in accordance with the low nutrient requirements of the species.

HABITAT

"Sabiá" developes naturally in association with other xerophytic species such as Anadenanthera sp., Tabebuia sp., Astronium sp., and Torresea sp.

SEED HANDLING

The seeds are tiny and light, with about 12,000 seeds/kg. Care must be taken with regard to the harvesting time, due to attack of the seeds by the Coleopteran, Bruchus pisorus L., while the seeds are still on the tree. In nature the seeds maintains viability till the first winter after the seed fall. Germination takes places 5 to 10 days after the first rains. Although the coat dormancy of the "sabiá" seeds is not a problem, it is recommended that they be treated in boiling water for 1 to 2 minutes to obtain the most uniform germination.

SILVICULTURE

Although this species is not intensively cultivated, existing experiments show its potential for afforestation for the production of wood for stakes, fuel-wood and charcoal. Results obtained in the swamp region of Paraíba, demonstrate that the most convenient planting spacings are 2.0 x 2.0 and 3.0 x 1.5 m, the latter being the most appropriate when planted with Vigna sinensis Endl. during the first year. On fertile soils, trees may be cut when three to four years old. In a coppice regeneration system, it is possible to carry out four cuttings (rotations). Natural regeneration after cutting from the stumps, as well as through root sprouting and seed germination is reported. The need for thinning in order to manage the stands for regeneration is stressed.

STATUS

The species is suffering a slow decline.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

No measures have been taken neither for ex situ nor in situ conservation of the original genetic pool. The studies underway on this species are limited to studying its behaviour in pure stands. In-situ preservation, is highly recommended. However, the fact that the geographical distribution of this species is widespread, along with the non-existence of homogeneous and/or continuous stands means that, this would require very vast areas. Studies of the reproductive system of this species and establishment of base populations are recommended, to preserve the original genetic variation and to provide reproductive material.

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Mimosa verrucosa Benth.[1/]

SYNONYMS

Pithecolobium diversifolium Benth. (1844)
Pithecolobium foliosum Benth. (1844)

FAMILY

Leguminosae Subfam. Mimosoideae

VERNACULAR NAMES

Jurema branca, jurema de oieiras

BOTANICAL DESCRIPTION

General

A bush tree with a height of 2 to 5 meters, with stem that is generally multiple; bark dark impregnated with thorns, with verrucose and tomentose branches. Crown relatively dense, providing 90% shade in the winter, and approximately 50% in the summer. Rapid growth.

Inflorescence

A spike of c. six flowers, each with four sepals, four petals and eight stamens. Calyx 1 mm in length, corolla c. 3mm, tomentose, whitish or pink in colour; stamens 10-12 mm long; ovary sessile with long hairs. flowering occurs from October to December.

Fruit

A small, thin, tegumented pod, articulated and spirally shaped, 10 cm or more in length, single.

1/ Based on the work of I.E.Pires and C.E.Nascimento, EMBRAPA/CPATA, P.O. Box 23, Petrolina, PE,Brazil.

Foliage

Leaves with 7 to 9 pinnae, each one with 10 to 12 pairs of folioles; petiole winged, 7.5 cm in length stipulate; dilated at the base. Folioles 4 to 6 mm long by 3 to 4 mm wide, ovate or oblong, oblique, obtuse and coarse.

Bark

Dark, with rigid thorns; smooth, greyish in colour, with lengthwise open stripes; has sedative, narcotic, astringent and bitter properties.

WOOD PROPERTIES AND PRODUCTS

Little is known about the wood characteristics. It is stated that it has great durability when in contact with the soil.

Used for stakes, fuel and charcoal.

NATURAL DISTRIBUTION

Occurs in the "caatinga", more commonly in the "Sertão" of Paraiba on midslopes. It is also found on the "Sertão" of Ceará and on the "Sertão" of Pernambuco and Rio Grande do Norte.

CLIMATE

The climate of the areas where the "Jurema" grows vary from sub-humid tropical to semi-arid tropical or arid, with a dry period of 6 to 12 months and a water deficit reaching 1 300 mm.

SOIL

The "Sertão" species prefers tableland soils.

HABITAT

The species is common in hills, with tableland soils, and on the humid midslopes. It is not as dominant as the Mimosa hostilis; it is always associates with the Bauhinia sp., and sometimes Anadenanthera sp.,Torresia sp. and Astronium sp.

SEED HANDLING

No studies have been carried out on seed technology. Seeds, when dispersed, germinate naturally within 5 days, if conditions are favourable. Direct sowing in clearings, soon before the rains commences is recommended.

SILVICULTURE

Enrichment plantings of natural forest through direct sowing and out-planting of seedlings are recommended; also through plantations.

STATUS AND REASONS FOR DECLINE

In view of the scarcity of wood in the arid and semi-arid regions of the Northeast, as well as in the Central and Southern regions of Brazil, each and every native forest species is subject to exploitation, especially those which produce timber for commercial purposes.

The species presented here is now suffering a slow decline. Till now the replacement of this species is by natural regeneration only.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

No measures have been taken at present, neither for bringing the species into cultivation nor for preserving the original gene pool. The studies underway on this species are limited to studying its behaviour in pure stands.

In-situ preservation is highly recommended. However, the fact that the geographical distribution of this species is widespread, along with the non-existence of homogeneous and/or continuous stands, means, that this would require very vast areas.

Studies of the reproductive system of this species and establishment of base populations are recommended, to preserve the original genetic variation and to provide reproductive material.

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Nesogordonia papaverifera (A. Chev.) R.Capuron [1/]

SYNONYM

Cistanthera papaverifera A.Chev. (1912)

FAMILY

Sterculiaceae.

In earlier taxonomic texts, and even as recently as 1959, (Aubréville 1959), this species has been considered a member of the Tiliaceae.

VERNACULAR NAMES

Kotibe (Attie, Ivory Coast); Danta (Twi and Wassaw, Ghana); Òpepe-ìra, 'Òró' (Yoruba, Nigeria), Danta (Trade name Nigeria).

BOTANICAL DESCRIPTION

General

A deciduous, secondary forest species capable of attaining a height of 45 m, though more frequently little over 30 m. Bole slender and fairly straight but often slightly angular, free of branches to 20 m or exceptionally to 25 m; above the buttresses the diameter of the bole may be as much as 1.2 m but 0.8 - 0.9 m is more common. The buttresses reach 3-4 m in height and are prominent though narrow, thin and steep. Crown small and irregularly rounded. Seedling germination is epigeal; hypocotyl 3-5 cm long, green and puberulous with simple hairs. Cotyledons

1/ Based on the work of John B.Hall, Department of Forestry, University College of North Wales, Bangor, U.K, and D.A.Ovat. Nigeria.
FAO also acknowledge the assistance of P.R.O. Kio, Forest Research Institute of Nigeria, Ibadan, Nigeria.

spreading, foliaceous and reniform, 7-10 mm long and 16-24 mm wide,with 5 faint, palmately arranged nerves, sparsely pubescent at the base; petioles 1-2 mm long and pubescent with simple hairs. First juvenile leaves elliptic, 16 mm long and 7 mm wide, borne on a petiole about 4 mm long; margin dentate, petiole and midrib pubescent, with simple and scattered stellate hairs. Subsequent leaves progressively larger with increasing numbers of stellate hairs.

Inflorescence

An axillary cyme, borne near the ends of the branches; peduncles densely stellate-puberulous, usually a little longer than the subtending leaf; bracts present but early caducous; 1-6 flowers per cyme; buds ovoid, 7-9 mm long and puberulous, on a pedicel up to 20 mm long, articulate 6-10 mm below apex. Flowers pentamerous; calyx slightly imbricate in bud, spreading at anthesis; sepals lanceolate and acute, 8-10 mm long and 3-4 mm wide, with a dense external reddish covering of small stellate hairs;corolla consisting of 5 free petals, contorted in the bud but later spreading; petals yellowish-white, glabrous, obovate and slightly longer than the sepals; stamens 15-20, separated into 5 bundles alternating with the petals; filaments short (0.5 mm), almost free; anthers 4 mm long and linear, opening extrorsely; opposite each petal is a strap-shaped staminode 7-8 mm long, its margin rolled slightly inwards; ovary 5 - angled, obconical, minutely puberulous, sessile and about 3 mm in length; adjacent faces separated by grooved ribs; top of ovary depressed

with a short style surmounted by 5 stigmas 3 mm long; stigmas lanceolate, fleshy, with a longitudinal range on the external face; there are 5 carpels; each locule contains 2 ovules.

Fruit

A yellowish-green, densely puberulous, pentagonal woody capsule, 20-28 mm long, bell-shaped, with a flattened apex about 18 mm across and tapered at the base where the diameter is about 2 mm. Capsules distinctly 5-ridged, splitting down the centre of each ridge at maturity into 5 valves, releasing up to 2 winged seeds from each of 5 compartments; valves remain attached to the tip of the pedicel.

The seed is attached to the central axis of the fruit close to the apex, elliptic in shape, flattened on one face, about 6 mm long, with a thin papery wing 10-15mm long and up to 7 mm wide, extending downwards from the seed's lower end to a point midway up its outer edge.

Foliage

Crown dense, the leaves borne in loose tufts at the ends of the branches. Branchlets densely covered with small stellate hairs and alternate, stipulate leaves; stipules paired, linear and pubescent, acutely pointed, 4-9 mm long, prominent around the terminal buds; petioles slender and densely puberulous, 10-50 mm long, with a pulvinus at each end, the lamina, medium green and glossy with the only pubescence confined to the impressed midrib on the upper surface; lower surface

paler and initially sparsely pubescent; midrib beneath prominent, remaining densely puberulous, with slightly-raised, lax reticulation of veins.

Leaves elliptic to obovate in shape, rarely ovate, 5-13 cm long and 2.5 - 6 cm broad; base obtuse or rounded (exceptionally cuneate or slightly cordate); apex acuminate with an apical mucro; leaf margin entire; lateral nerves in 5-10 pairs, with axillary tufts of long hairs; the basal pair of nerves ascending the lamina more steeply than those above, but rather short.

Bark

Yellowish-brown or grey, darker on trees growing in exposed conditions, and scaly; the scales form vertical lines and eventually flake off, leaving darker-coloured patches.

WOOD PROPERTIES AND PRODUCTS

Produces high-quality timber. The main uses of the species are in flooring, in boat and vehicle building and for tool handles; it is also an attractive but rather heavy furniture wood. The species is listed among the 20 main export species in Ghana; in Nigeria, it is mainly used locally for carcassing (shuttering), door and window frames,roof rafters and purlins.

NATURAL DISTRIBUTION

The species has two main areas of concentration; one across Ghana and the Ivory Coast, and the other one in the western part of Nigeria's forest zone. Outlying populations further west occur in Liberia and in central Sierra Leone. Towards the east, isolated

occurrences are found in northern Gabon and in western Central African Republic; there are also reports of isolated occurrences in Cameroon and Benin. The species occurs at altitudes up to 1000 m but occurrences above 500m are rare.

CLIMATE

Climatically, the species is found in areas with a mean annual rainfall of 1 200 to 1 800 mmm, with only some outlying populations occurring in higher rainfall areas (Liberia, 2 000 mm/an; Sierra Leone, 3 200 mm/an). Temperature variation is small over the range of the species. Monthly means of daily minima are almost continually above 20°C while the corresponding maxima are consistently below 35°C. The range between these means is as high as 8°C in the dry season but may be as low as 3°C in the rainy season.

SOILS

N.papaverifera grows principally on well-drained fertile ferruginous tropical soils derived from rocks of the basement complex, and on soils from cretaceous sediments which are rather similar in fertility where the mean annual rainfall is low or moderate ($<$ 2000mm) It is considered that the southern limit of the species' distribution in Nigeria reflects a change in soil rather than a change in climate. The low frequency of the species in Ghana in the dry semi-deciduous forest may also reflect a change in soil rather than in climate.

HABITAT

Present distribution of N.papaverifera suggests that it is almost confined to areas where savannas have in the past replaced forest: it does not appear to have penetrated older (> 20000 years old) forests that have withstood changes in climate in the last few thousand years. Density of the species in the forests is variable, but where best represented, concentrations are high, as in the Nesogordonia papaverifera/Khaya ivorensis zone of the Celtis spp./Triplochiton sclerocylon forest type in Ivory Coast. In these areas, the species accounts for 3-12% of the stems of over 60 cm in girth (dbh). In Ghana the species occurs throughout the moist semi-deciduous forest type but is less frequent in the dry semi-deciduous forest type.

SEED HANDLING

Flowers and fruits are found throughout the year, although the main period of flowering varies in different parts of the species range. Seed viability is short.

SILVICULTURE

Being a secondary, shade-tolerant species, N.papaverifera has not been used as a plantation species.

STATUS

Further study is needed. Endangered in parts of its geographic range, and subject to genetic impoverishment in outlying populations in Gabon, Central African Republic, Cameroon, Liberia and Sierra Leone.

REASONS FOR DECLINE

Logging and utilization

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

The frequently high density of populations, the tendency to grow in groups and the association with hillsides are all factors which favour the survival of the species. With legally gazetted forest reserves the importance of keeping disturbance minimal on slopes in order to enhance watershed protection also favours the species. Furthermore, the likelihood of such sites being used for plantation establishment is small as these do not have the most suitable growing utilisation conditions for the species normally used in plantations. However, special attention needs to be given to in-situ conservation of endangered provenances and of populations threatened with over-use and genetic impoverishment.

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Ocotea porosa (Nees and Mart.) Barroso[1/]

SYNONYMS

Phoebe porosa (Nees and Mart.) Mez (1889)
Cinnamomonum porosum (Nees and Mart.) Kostermans (1961)

FAMILY

Lauraceae

VERNACULAR NAMES

Imbuía, canela imbuía, imbuía amarela, imbuía clara, imbuía parda, imbuía rajada, imbuía preta, imbuía zebrina, canela imbuía escura, canela imbía vermelha.

BOTANICAL DESCRIPTION

General

Tall straight tree, 15-20 m heigh with a diameter of between 0.5-1.50 m; bole with evident nodal swellings; crown of ascending branches.

Inflorescence

Flowers borne in the form of pilose axillary panicles, with few flowers, white, pedicels articulate, small (3-4 mm in length); flowering takes place between October and February.

Fruit

A globose or ovoid-shaped drupe; calyx growing in the shape of a shallow goblet, pericarp thin, surface

1/ Based on the work of R.Chiaranda, I.E.Pires and M.Tomazello Fº. Forestry Department, ESALQ/USP, P.O Box 9, Piracicaba, SP. Brazil.

brown, 13-17 mm in diameter. Fructification takes place during the month of January.

Foliage

Leaves simple, alternate, elliptical, obtuse, acuminate and penninerved with two more developed ribs, having domatia on the underside, shiny on top, and opaque underneath, petiole flat. Commonly measuring 6-10 cm in length by 15-20 cm in width.
Branches round, thin, flexible, rough.

Bark

Trunk with a grey coloured bark, thin cracks, and scaly surface. On older trees the trunk is generally thick, crooked, with large globose excrescences.

WOOD PROPERTIES AND PRODUCTS

Moderately heavy wood (0.60 to 0.70 g/cm^3); heartwood, extremely variable from brownish yellow to grey-brown, and dark greyish brown; generally with parallel veins or dark spots; the surface has an irregular shine; a characteristic scent; taste is somewhat bitter and astringent; medium texture, uniform; grain straight, irregular to interlocked. Heartwood reported to be durable, it is easy to work, finishes very smoothly, and keeps well after manufacture.
Used for fine furniture, panels and interior decorations, lambrins, tiles, constructions, stairs, fences, etc.

NATURAL DISTRIBUTION

This species occurs naturally in the highlands of the States of Paraná and Northern Santa Catarina, Brazil.

SOILS AND CLIMATE

Ocotea porosa is uniformly distributed throughout several edaphic conditions, from the bottom of valleys to the tops of ridges. It is found between 500 and 1 200 meters in altitude, mainly in soils of basaltic rocks.

The predominant climate of the region is temperate sub-humid, with temperatures varying between 12° and 18°C with frequent frosts in the winter; annual average precipitation varies between 1 250 and 2 500 mm, evenly distributed; there is no water deficit.

HABITAT

O.porosa may be found evenly distributed and in high frequency as the dominant species of the understorey of the rain forest (mixed Araucaria and hardwood forest); associated with other species; or as a dominant species in later successional stages.
It also grows in isolated clusters in the coastal tropical forest. Here its behaviour is that of a pioneer species penetrating in the more open Ocotea pulchella forests.

SEED HANDLING

It was observed that the greatest seedling survival rate was obtained when seeds were sown at a depth of 0.5 cm in shade conditions.

SILVICULTURE

In a trial carried out in Santa Rita do Passa Quatro - SP, and average height of 7.81 m and a dbh of 9 cm were observed in a 23 years old stand. No significant differences in height and dbh were found in a spacing trial with this species at seven years of age in experiments set up in Angatuba - SP.
In a native forest of the highlands of Santa Catarina, a volume of 59 m^3 of imbuía wood/ha is reported.

STATUS AND REASONS FOR DECLINE

The regions where this species occurs naturally are those that have undergone most intense clearing of the natural vegetation during this century, to give way for agriculture, livestock and plantation projects using fast growing species. Presently the last trees of Ocotea porosa are being gradually cut down, as a result of their economic value.

PROTECTIVE MEASURES RECOMMENDED

Reforestation trials are recommended in open woodland, mainly in the regions where this tree occurs naturally. This should be carried out along with attempts to conserve the genetic reserves in and ex situ.

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Pericopsis elata (Harms) van Meeuwen[1/]

SYNONYMS

Afrormosia elata Harms

FAMILY

Leguminosae Subfam. Papilionoideae

VERNACULAR NAMES

Kokrodua (Ghana), Assamela (Ivory Coast), Afrormosia (trade name).

BOTANICAL DESCRIPTION

General

A tall dominant tree in the moist semi-deciduous forest of Ghana, growing to a height of about 50 m and about 5 m in girth at breast height.

Crown fan-shaped.

Bole straight and fluted at the base, rather than buttressed.

Inflorescence

Flowers borne in short terminal panicles on slender, hairy raches, white, usually 15mm long and 13-14mm broad; calyx pubescent outside, finely-toothed. Ten free stamens, gynoecium of a subsessile or shortly stalked ovary.

1/ Based on the work of S.P.K.Britwum, FPRI, University of Science and Technology, Kumasi, Ghana.

Fruit

Pod about 17 cm long and 2.5 cm broad; flat, thin and light brown, usually with 1 to 3 seeds. Seed reddish brown, almost rectangular and about 15mm across. Flowering takes place in April to May. The pods are to be seen in May but they are not ripe until October to January.

Foliage

Leaf-rhachis glabrous, 8-15 cm long; leaflets 8-12, alternate, ovate elliptic, rounded at base, shortly acuminate, 3-7cm long, 1.5-3cm broad, upper leaflets longer than the lower, glabrous; stipels sublate, 3mm long. Leaves in juvenile trees are usually larger than those in mature trees.

Bark

Conspicuous, smooth brownish-grey to grey, peeling off readily and leaving bright red-brown patches hence "Kokrodua-red tree".

WOOD PROPERTIES AND PRODUCTS

Heartwood yellow-brown, turning to dark brown on exposure; sapwood narrow, lighter in colour and clearly demarcated. Texture moderately fine; grain straight to interlocked; some resemblance to teak. Basic specific gravity (oven-dry weight/green volume) 0.57. The species has been popular on the world timber market since 1948. The wood is a good substitute for teak (Tectona grandis) in ship decking and rails.

Other uses of the wood include cabinet making; furniture panelling and joinery. The species has been exported from West Africa either as log or sawn timber. It is important in the timber trade, and the species fetches higher prices than the world known African Mahogany on the world timber market.

NATURAL DISTRIBUTION

The species is known to occur in many West African countries and in Cameroon and Zaire. The West African countries are Ivory Coast, Ghana and Nigeria. In Ivory Coast, it occurs on the eastern frontier and is continuous with the range in Ghana where it is found in the west of the vegetation type described as the Antiaris-Chlorophora association. In Nigeria it is known that P. elata occurs in Ifon, Owo, Afi River and Eggua Forest Reserves.

The species occurs in the mid-west of Ghana between latitudes $6^{\circ}45'$ and $7^{\circ}30'$N and between longitude $3^{\circ}0'$ and 1° 30'W. It has a restricted distribution which occupies the general shape of a triangle with its base along the western frontier from about 7° 40'N to about 6° 45' north latitude. The apex of this triangle is in the Bounfum Forest Reserve, about 1° 30' west longitude and 7° north latitude. Two groups have been found in the Worobong Forest Reserve, about 0° 25' west and 6° 30'N. These trees are however shorter and poorer and are likely to be outliers. No specimens have been seen so far between the Bounfum and Worobong Forest Reserves.

CLIMATE

The area where the species is found lies in a tropical humid climate characterised by a two-peak rainy season from April to October, and a dry season from November to March. The annual rainfall ranges from 1 270 to 1 500 mm with two peaks occuring in May-June and September-October. Temperatures are uniformally high and range from 25° to 26°C. South-westerly moisture-laden winds prevail during the rainy season. In the dry season, the dry north-easterly Harmattan winds prevail.

SOILS

Clay soils in connection with two outcrops of acid igneous intrusions in the form of latholiths and consisting of gramites and veins of biotite schists which give rise to gritty sandy loams. On the summits and upper slopes, a red gritty light loam with clay subsoil containing varying quantities of quartz stones and iron concretions are found. Humus layer has a depth of 180-210mm. In the lowlands soils of colluvial or alluvial origin occur.

HABITAT

This species grows in restriced areas within the Antiaris-Chlorophora association of the moist semi-deciduous forest. It is sometimes semi-gregarious but generally scattered. It is a dominant tree in its locality.

SEED HANDLING

The species is presently not being planted on a large enough scale to warrant increased seed collection. However, small quantities of seed are collected every year for the establishment of small plantations and growth trials. Germination takes place on 8-10 days.

SILVICULTURE

It can be easily propagated from seed and also from rooted stem cuttings. In small direct plantations which have been established in Ghana, the trees branch at an early age and develop poor stem form. It has been tried in enrichment planting in a Forest Reserve where the species does not occur naturally and it has performed better in branching, stem form, and growth, and the incidence of attack by caterpillars of Lamprosema lateritialis Hampson, a defoliator, has not been severe (personal observation). Seedlings and saplings of the species are seriously attacked by the defoliator L. lateritialis. The entire set of leaves on a seedling may be attacked and bundled together in a loosely knit nest on which the caterpillars feed gregariously until the leaves are depleted. The defoliation has a marked effect on both height and girth increment of young P.elata trees.

STATUS

Endangered in parts of its geographical range. In danger of genetic impoverishment throughout the entire range.

REASONS FOR DECLINE

Lumbering and poor natural regeneration of the species are the reasons for the decline. The price of the wood is one of the highest among the tropical hardwoods of the world timber market with the result that the species is being heavily cut for export in the form of logs and saw timber.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

In forest reserves in Ghana where the species occurs, exploitation is on the basis of the "Modified Selection System" and trees of the species of 2.1m girth and above are exploited leaving the lower girth classes. It is recommended that in each of the forest reserves in which the species occur, an area of 60-250 hectares should be conserved *in situ* without exploitation. Establishment of plantations of the species is necessary to increase the resources.

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Pinus armandii Franchet var. *amamiana* Hatusima[1/]

This is recognized as a distinct species *P. amamiana* Koidzumi by some authorities.

SYNONYMS

Pinus amamiana Koidzumi

FAMILY

Pinaceae

VERNACULAR NAMES

Yakutane-goyo, Amami-goyo

BOTANICAL DESCRIPTION

General

Tree up to 25 m in height and 1 m in diameter, branches widespreading, horizontal and whitish. Branchlets brown or black, glabrous; buds oblong-ovoid with brown scales.

Inflorescence

Staminate flowers 2 cm long.

Fruit

Cones short stalked, oblong-ovoid, 5-8 cm long, peduncle c.1 cm long. Seeds about 12 mm long, wingless.

1/ Based on the work of H.Takehara and G.Asakawa. Forestry and Forest Products Research Institute, Tsukuba Morin Kenku, Ibaraki, Japan.

Foliage

Needles : five in a deciduous basal sheath, 5-8 cm long; resin canals 3. Needles of this variety are shorter than those of the P.armandii type and more rigid.

Bark

Bark of young tree greyish, smooth; scaly on older trees.

WOOD PROPERTIES AND PRODUCTS

The variety produces a good quality timber; however, because of its limited occurrence, its importance is minor.

Other Uses

It is an important source of genetic material for forest tree breeding of the white pine group and is also of phyto-geographical and taxonomical interest.

NATURAL DISTRIBUTION

Natural distribution of this tree is limited to Yaku-shima and Tanega-shima, two small islands off southern Kyushu, Japan. The original type of Pinus armandii is found in continental China and Formosa.

CLIMATE

Moist temperate zone: Average annual temperature: ca. 20°C. Lowest and highest average monthly temperatures are 7°C (January) and 28°C (July) Annual rainfall more than 3 000 mm.

SOILS

Drier types of brown forest soils and podzolized soil.

HABITAT

The variety grows in mixture with evergreen broad-leaved trees (Machilus thunbergii, Castanopsis cuspidata and evergreen Quercus spp.) or with deciduous broad-leaved trees (Alnus firma, Kalopanax pictum, Cornus kousa, etc.). It is scattered in the forest, but does not form pure forests. It is almost completely confined to hill ridges or rocky sites.

SEED

Around 5 000 seeds/kg.

SILVICULTURE

Propagation from seed is not difficult and nursery work is similar to that for other white pines.

STATUS

Endangered

REASONS FOR DECLINE

Lumbering has been a major reason for the decreasing population of this species.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

In Yaku-shima, Japan, the habitat of this variety is included in a national park. However, action is needed in other areas of the species' natural distribution

range. It is recommended that populations and individual specimens of the variety be protected by law in Japan. No information on action taken to conserve P. armandii and its variety is available from areas outside Japan.

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Pinus eldarica Medw.[1/]

Some authors have classified this pine as a variant of Pinus brutia.

SYNONYM

Pinus brutia Ten. (1815)

FAMILY

Pinaceae

VERNACULAR NAMES

Eldar pine, Mondell Pine, Eldar kiefer, Quetta Pine and Afghanistan Pine.

BOTANICAL DESCRIPTION

General

P.eldarica is conical in shape with a rounded crown at maturity. Branches occur in whorls on both the main-stem and laterals. Colour is deep green or blue green. The tree exhibits a modified taproot system.

Fruit

Cones spreading or pointing forwards, sometimes borne in whorls of 3-6; 5-6 cm long, and 4-5 cm wide.

Foliage

A two needle pine, needles slightly contorted, 10 to 15 cm long.

1/ FAO acknowledges the assistance of R.Morandini, Istituto Sperimentale per la Selvicoltura, Viale S. Margherita 80-82, Arezzo, Italy.

WOOD PROPERTIES AND PRODUCTS

The timber is useful for lumber and fuel, but is only considered of medium quality.

Other Uses

For environmental purposes it could be used for windbreaks, shelterbelts and the reclamation of desertified regions.

NATURAL DISTRIBUTION

The only documented naturally-occurring stands of P.eldarica are located in a geographically isolated area south of the Caucasus mountains (appr. latitude 41° N, longitude 45°E) near the border between the Russian republics of Azerbaydzhan and Georgia. The altitudinal range is from 200 to 600 m and the total area is about 550 ha. Natural stands in Afganistan and northern Pakistan, have been reported recently.

CLIMATE

Semi-arid, with hot summers and cold winters; the total precipitation is fairly even distributed throughout the year, and amounts to 250-300 mm.

SOILS

The tree thrives normally where soils are alkaline and not very rich in nutrients; it is also reported to show some resistance to salty soils.

HABITAT

Semi-arid, lower mountain region.

SEED HANDLING

11-25 000 seeds/kg; stratification has been used as pretreatment.

SILVICULTURE

Useful for afforestation in mountainous semi-arid zones, and has a tremendous potential to improve the economic and environmental conditions in arid zones. In the nursery P.eldarica shows excellent germination and very fast initial growth of the upper parts. Usually the trees are transplanted to the field after the second year. The growth is fast during 15-20 years, afterwards it slows down. In Iran it has been advised to clearcut after 20-25 years.

STATUS

Endangered in the URSS, only one native endemic stand is left in the Eliar-Ugi mountain range.

REASONS FOR DECLINE

It is considered to be an Oligocene relic.

PROTECTIVE MEASURES TAKEN

The last known natural stand in URSS has been declared a natural reserve. The species has been extensively planted as an exotic outside its natural site. International seed collections and provenance trials have been organized jointly by FAO and the Istituto Sperimentale per la Selvicoltura in Italy.

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Pinus koraiensis Scb. et.Zucc. 1/

SYNONYMS

Pinus mandshurica Ruprecht (1857)

FAMILY

Pinaceae

VERNACULAR NAMES

Chosen-goyo, Chosen-matsu (Japan),
Korean Nut pine .

BOTANICAL DESCRIPTION

General

Pyramidal tree of 20-25 m height and 40 - 70 cm diameter. Branchlets with yellow-brown tomentose pubescence. Buds oblong-ovoid, dark chestnut-brown.

Fruit

Cones short-stalked, 9-14 cm long, conic-ovoid or conic-oblong, yellow-brown, on short peduncles; scales with recurved, obtuse apex. Seeds wingless, obvoid, 10-18 mm long.

Foliage

Needles in fives, glaucous green 8-12 cm long, serru - late with 3 internal resin channels.

1/Based on the work of Takemara and G.Asakawa, Forestry and Forest Products Research Institute, Tsukula Norin, Kenkyu Ibaraki, Japan.

Bark

Scaly, grey-brown, thin, peeling off in irregular flakes; reddish-brown beneath.

WOOD PROPERTIES AND PRODUCTS

The species produces good constructional timber. In North Korea it is one of the most important timber species on the market. In Japan, where the amount of timber available is smaller, the species is of minor commercial importance.

Other Uses

It is widely used as an ornamental tree, and some special varieties have been developed for this use.

NATURAL DISTRIBUTION

The species is distributed through the mountainous areas of central Honshu (Nagano, Yamanashi, Tochigi, Gunma and some adjacent prefectures) and Shikoku in Japan, and extends to the Korean peninsula from the north-eastern part of South Korea to North Korea and to the border area between North Korea and China.

CLIMATE

Cool temperate zone, average annual temperature: c. 10°C. Annual precipitation: ca. 2 000 mm.

SOILS

Frequently, podsolized soils.

Similar to sites of Pinus pentaphylla, but slighly wetter.

HABITAT

In central Honshu, the species occurs from 1 050 m to 2 600 m a.s.l. In this area, it is found both in the sub-alpine conifer zone and in the higher parts of the broad-leaved zone. In the former, it is associated with Abies veitchii, Tsuga diversifolia and Picea jezoensis var. hondoensis. In the latter, it grows in mixture with Sciadopitys verticillata, Thuja standishii, Thujopsis dolabrata and Quercus crispula. The species does not form pure forests.

SEED HANDLING

Around 2 000 seeds/kg; warm stratification followed by cold is needed for germination. Air-dried seed can be stored at low temperature.

SILVICULTURE

The species is usually propagated by seed. Vegetative propagation of the species is also possible.

STATUS

Not endangered, but in danger of depletion in parts of its geographic range.

REASONS FOR DECLINE

Logging operations and cutting of the natural forest.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

The populations in central Honshu are represented in national parks and thus protected from logging operations. In addition, experimental plantations established in Iwate and Tokyo Prefectures by District

Forest Offices and the Forestry and Forest Products Research Institute will help ensure the conservation of the resource.

No information is available from N. & S. Korea on protective measures for the conservation of the genetic resources of the species.

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Pinus patula Schiede & Deppe subsp. *tecunumanii* (Eguiluz & Perry) Styles [1/]

SYNONYMS

Pinus tecunumanii Eguiluz & Perry (1983)
P. tecumunanii Schwerdtf. Nom. *invalid*. (1953)
P. oocarpa var. *tecumumanii* (Schwerdtf.) Aguilar (1962)
P. oocarpa var. *ochoterenae* Mart. (1948)

FAMILY

Pinaceae

VERNACULAR NAMES

Tecun Umán Pine, 'Tec' pine (Eng.)

BOTANICAL DESCRIPTION

General

Very large, straight-boled, evergreen tree reaching 50 m or more in height, usually 35-40 m; bole with a diameter of 40-80 cm or more. Crown light, conical or rounded, consisting of few slender ascending branches.

Inflorescence

Trees monoecious; male flowers yellowish, sometimes with a purplish tinge; quickly deciduous.

1/ Based on the work of B.T.Styles (Oxford Forestry Institute, University of Oxford, Oxford - OX1 3RD, England).

Foliage

Buds ovoid-cylindrical, brownish, 1-1.5 cm long, slightly resinous. Needles light green, spreading or pendulous, usually 4 per fascicle, but sometimes 3 or 5; from 12-25 cm long, sheaths slender, 10-25 mm long. Resin canals 2-3(-5), usually medial, rarely with one internal (never septal).

Fruit

Female cones strongly persistent, slightly asymmetrical small, hard, narrowly conoidal with a pointed apex and rounded base; from 4-9 cm long and 3-6(-8) cm broad; light brown, varnished; sometimes sessile, or with a peduncle up to 3.0 cm long; cone scales narrow, 15-25mm wide, opening quickly on ripening, apophysis raised, slightly ridged. Cones borne singly, in pairs or in clusters up to 8. In some localities the crop is always very sparse. Seeds light brown, up to 2.0 cm long (including wing). They mature between October and February.

Bark

Distinctive, rough at the base, but smooth above, reddish-brown or orange, exfoliating in thin papery scales or strips.

WOOD PROPERTIES AND PRODUCTION

This pine has the best form of any Latin American species. Its boles are among the straightest and largest yet encountered. This, plus the small crown, results in a maximum amount of convertible timber. It is important for industrial use in the form of general

constructional timber. Its mechanical characteristics have yet to be investigated.

Other Uses

It is recognized to be a better producer of resin than all of its closest relatives.

NATURAL DISTRIBUTION

This pine has a large but very scattered and disjunct distribution in S.Mexico and C.America. A few small stands occur in Oaxaca and Chiapas, but some of the best trees are seen in pure forests in Guatemala, Honduras and Nicaragua. The species also occurs in Belize and in El Salvador.

Its altitudinal range is very great, occurring at 550m alt. in the southern part of the range but can be found growing at altitudes of up to 2 700m in Guatemala.

CLIMATE

Areas with higher rainfall are preferred within the range of between 1 500-2 500 mm p.a.

SOILS

P. patula subsp. tecunumanii normally occurs on the richer and deeper fertile soils of upland valleys and plateaux.

HABITAT

It sometimes grows in association with other pines including P.ayacahuite, P.oocarpa, P. maximinoi, P.pseudostrobus and the broad-leaved Liquidambar styraciflua. Associated understorey vegetation is generally dense, reflecting the richer site conditions.

SEED HANDLING

Seed extraction is similar to that for other species of pine. However seed production per cone is generally very low. The number of cones per tree is frequently also low. Both factors are reasons for the high cost of seed on the commercial market.

SILVICULTURE

This is presumably similar to other related pine species for which abundant literature is available. Some difficulties with germination have apparently been encountered in Nepal.

STATUS

The species as a whole is under threat throughout its entire range and more so than any other Latin American Pine. Some populations have already been destroyed in C.America and others have been severely depleted and reduced in area.

REASONS FOR DECLINE

Because this pine grows on the most fertile sites, forests in which it occurs are being felled and cleared for agriculture (slash and burn). Such areas near centres of population e.g. Siguatepeque in central Honduras have now been totally deforested for maize cultivation. Forests in Guatemala have also suffered particularly from attacks by Dendroctonus sp. (Bark beetle).

PROTECTIVE MEASURES TAKEN

The Oxford Forestry Institute, Oxford, England, and CAMCORE, School of Forest Resources, N.Carolina State University, Raleigh, N.C., USA and National Seed

Centres of Central American Countries have made seed collections of many of the important provenances of the species throughout the entire natural range. These have now been planted as ex situ plantations, conservation stands and research trials throughout the tropics. Conservation of indigenous forests of the species will prove difficult, even impossible, for the reasons stated.

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Pinus pentaphylla Mayr[1/]

There is considerable disagreement about the classification nomenclature of the 5-needled pines of Japan. In this account we are following the work of O.Jisaburo (1972): Flora of Japan.

SYNONYMS

Pinus parviflora Sieb. & Zucc.var.pentaphylla Mayr (Henry) (1909) (northern type).
Pinus parviflora Sieb. & Zucc. (1842)
Pinus himekomatsu Miyabe & Kudo

FAMILY

Pinaceae

VERNACULAR NAMES

Himekomatsu, Goyoomatsu (southern type), Kita-goyoo (matsu) (northern type).

BOTANICAL DESCRIPTION

General

Tree up to 30m in height, 80 cm in diamter, with slender branches and dense, pyramidal habit. Branchlets greenish brown, puberulous when young. Buds ovoid, scarcely resinous, outer scales free at the tips.

FRUIT

Cones avoid to oblong-ovoid,(5) 6-10 cm long and 6-7.5 cm wide (northern type); nearly sessile; scales abruptly

1/Based on the work of H.Takehara and G.Asakawa. Forestry and Forest Products Research Institute, Tsukuba Morin Kenku, Ibaraki, Japan.

convex near the apex or irregularly warped, the umbo confluent with thin margin. Seed about 1-1.2 cm long, with the wing longer than seed itself. The original type found at Kyushu and Shikohu, is distinguished by a short wing (wing shorter than seed). Seeds/kg varies between 8 000 for southern type and 9000 for northern type.

Foliage

Needles in fours or fives, slender, 4-8cm long; finely serrulate; bluish green, conspicuously whitened on the ventral surface, with 2 external resin canals.

Bark

Bark of young trees smooth, of older trees fissured into thin flaky scales, red-brown underneath.

WOOD PROPERTIES AND PRODUCTS

The species produces good construction timber and is also used for long fibre pulp. However, its use in plantations is negligible, because of the existence of better alternative species.

Other Uses

It is used widely as an ornamental and in "Bonsai" cultivations, for which many varieties with special characteristics have been developed. The species has potential in hybridization work within the white pine group.

NATURAL DISTRIBUTION

The species including the northern type occurs from the Oshima and Hidaka districts of Hokkaido through the mountainous areas of Honshu, Shikoku, and Kyushu,

Japan. Outside Japan, the species is found on the island of Querpaert (Ullung-do), Korea.

CLIMATE

Cool temperate zone. The species occurs at a little lower elevation than Pinus koraiensis, meaning that the climate of the area where it occurs would be a little milder.

SOILS

Podzolized soil and sometimes drier types of brown forest soil. The tree is found at altitudes of 150 - 2 000 m a.s.l. (southern type) and 60 - 2 500 m a.s.l. (northern type), although variable due to latitude.

HABITAT

It generally grows in small groups in mixed stands on hilltops and rocky outcrops in the deciduous broad-leaved zone (Fagus zone) and the sub-alpine conifer zone (Abies picea). In the former it is associated with Sciadopitys verticillata, Thuja standishii, Thujopsis dolabrata and Chamaecyparis obtusa or alternatively with Quercus crispuls, Tilia japonica, Betula grossa, etc. In the latter zone, it grows in mixture with Abies veitchii, Tsuga diversifolia and Picea jezoensis var. hondoensis.

SEED HANDLING

8 000 - 9 000 seeds/kg. For germination, a warm stratification followed by a cold one is needed for the northern type and cold stratification alone is needed for the southern type.

SILVICULTURE

The species is propagated without difficulty by seed and grown in nurseries in the same way as other pine species. Vegetative propagation is often used for the varieties developed for amenity and ornamental purposes. Grafting has been successful using 2-4 year-old rootstocks of Pinus thunbergii.

STATUS

Not endangered, but in danger of depletion in parts of its geographic range, especially in its northern and south-western parts.

REASONS FOR DECLINE

Logging operations and cutting of the natural forest.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

The majority of the populations growing in Japan are represented in national parks and thus protected from logging operations. Systematic collections of germplasm should be undertaken in the northern and south-western limits of the species' distribution for conservation, utilization and breeding purposes.

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Pinus pseudostrobus Lindl.[1/]

SYNONYMS

Pinus orizabae Gord. (1846)
P.protuberans Roezl (1847)
P.pseudostrobus f. protuberans(Roezl) Mart. (1948)
P.pseudostrobus f. megacarpa Loock (1977)

FAMILY

Pinaceae

VERNACULAR NAMES

Pinabete (Honduras); pino blanco (Guatemala, Mexico); Pino ortiguillo (Mexico); False Weymouth Pine (England)

BOTANICAL DESCRIPTION

General

Medium size to large, evergreen tree up to 45 m tall, bole with a dimater of up to 80cm, normally less. Crown of several thick, whorled branches. Branches horizontal or ascending.

Inflorescence

Trees monoecious; male flowers yellowish, 1-2.5 cm long; deciduous.

Foliage

Buds ovoid, with an acute apex; brownish-yellow, 1-2.0 cm long, resinous. Needles dark green, sometimes glaucous, pendulous or spreading, stiff; usually 5 per fascicle, very rarely 4 or 6; from 18.0-33.0 cm long

1/ Based on the work of B.T.Styles, (Oxford Forestry Institute, University of Oxford - OX1 3RD England).

and up to 1.25 mm wide. Sheaths persistent, scaly, 15-25 mm long. Resin canals 2-4 (rarely 5 or 6), usually medial, very rarely external, internal or septal. Hypodermal intrusions into chlorenchyma absent.

Fruit

Female cones persistent, ovoid to cylindrical, 7-14 cm long, 5-11 cm wide, robust and very woody; dark brown; sessile or with a peduncle up to 1.0 cm long; a few basal scales remain attached to it when the cone eventually falls; cone-scales broad, 1.0 - 2.2 cm wide; apoplyses flattened, sometimes raised and ridged. 15-20mm high. Cones are mature from November to February.

Bark

Thick, dark grey, platey; reddish-orange in the cracks. Bark of branchlets, distinctly pruinose.

WOOD PROPERTIES AND PRODUCTS

The timber is white and of good quality. It is used in industrial work for general construction and joinery.

Other Uses

The tree is very rarely tapped for resin.

NATURAL DISTRIBUTION

This pine has a scattered distribution in Mexico (particularly in the western states), on the Central plateau and further south in Oaxaca and Chiapas. It is fairly common in Guatemala, but is rare in El Salvador and Honduras. It does not occur further south.

CLIMATE

Growth is best where rainfall is between 1 000-1 600 mm per year.

SOILS

Frequently on poor, shallow soils on drier sites, especially exposed ridges.

HABITAT

It grows most commonly and best at altitudes between 2 000 - 2 500 m a.s.l. In Central America it sometimes occurs in a mixture with P. maximinoi and in Mexico with P.montezumae, P. douglasiana and P.oocarpa.

SEED HANDLING

As per related species e.g. P.oocarpa. Seed production is plentiful and there is normally a good yield from each cone. Seed extraction follows methods used for other pines.

SILVICULTURE

Straight forward; as for other pines.

STATUS

This pine does not normally have a good form since the tree often tends to have a large crown of many whorled, coarse branches; heavy branching occurs low down the bole, even when grown at close spacing in plantations. However, some provenances particularly from Oaxaca in south Mexico and Guatemala have trees with lighter crowns and longer, straighter boles of superb shape. These are being felled on a large scale, during commercial exploitation of the indigenous forest. A

variety of P. pseudostrobus var. oaxacana (as P. oaxacana) is listed as a taxon vulnerable to extinction by the International Dendrology Society Conservation Committee (Kew). It is fairly wide-spread in south Mexico, Guatemala and El Salvador. Only some provenances of better form are considered as endangered.

REASONS FOR DECLINE

Selective logging of best phenotypes as indicated above, particularly in Guatemala where population pressure is greatest.

PROTECTIVE MEASURES TAKEN

Seed collections of selected provenances have been made by the Oxford Forestry Institute, Oxford, England and the Instituto Nacional de Investigaciones Forestales, (INIF), Mexico. These will enable provenenace trials, conservation stands and ex situ plantations to be set up in tropical countries where conditions are suitable for the growth of this species.

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Pinus radiata D.Don[1/]

SYNONYMS

Pinus insignis Dougl. (1838)

FAMILY

Pinaceae

VERNACULAR NAMES

Insignis pine, monterey pine, radiata pine

BOTANICAL DESCRIPTION

General

A medium-sized tree up to 60 m in height, usually between 30 and 50 m. It is regularly branched, with long, actively-growing side branches and tip, producing a narrow crown. Old or mature trees usually develop an open or irregular crown with a few large branches,with the lower trunk and lower part of each branch quite bare of living foliage or side branches. Foliage dense near the ends of the living branches.

Inflorescence

Male yellow in spikes; female dark purple.

Fruit

Cone 5 to 21 cm long, 3.5 to 10 cm wide; apophyses generally rounded and protuberant; prickle on umbo 0.5 to 1.5 mm long, becoming partly or completely weathered away as the cone ages. Cones contain up to

1/Based on the work of W.B.Libby (School of Forestry and Conservation, University of California, Berkeley, California, 54720 USA).

200 seeds, 4.5 to 10.5 mm long and 2.5 to 6 mm wide. The cones remain on the tree for several years after maturity.

Foliage

Needles generally in clusters of 3 in the native American stands; mostly in clusters of 2 in the island populations; 7 to 12 cm long, 1 to 2 mm wide; dark bluish to yellowish-green in colour.

Bark

The bark of young trees or actively growing branches is dull grey, but mature trunks become reddish or very dark brown-black with narrow ridges and furrows.

WOOD PROPERTIES AND PRODUCTS

Fast-growing trees produce wood of excellent commercial quality. Wood variously used for pulp, plywood, building and packaging materials.

NATURAL DISTRIBUTION

Five natural populations of the species are known - 3 on the coast in California in the USA. 2 island populations off the coast of Baja California (Mexico).

CLIMATE

In its natural range the climate is temperate to mild with a rainfall of 330-457 mm, concentrated in winter and early spring. The summer fogs, however, play an important part in preventing any excessive drought. Mean annual temperature of about $13^{o}C$, absolute minimum $-1^{o}C$.

SOILS

In its natural range the tree thrives on almost pure sand, sandy loam, gravelly and sandy clays; elsewhere it grows in a great variety of soils - practically any deep soil. Friable soils are the best, as long as there is sufficient moisture.

HABITAT

Occurring in areas of fog where other factors are not limiting. Associates include live oak, mazanita, Ceanothus and Cupressus, and in the northern population, Douglas fir and redwood.

SEED HANDLING

Around 30 000 seeds/kg; no special pre-treatment recommended; germination high (more than 60%), normally good seed crops every year.

SILVICULTURE

Easily propagated from seed or via rooted cuttings. Hedged trees maintain juvenile characters and produce vigorous cuttings. The tree has been successfully planted as a timber species in many Mediterranean-climate countries. Especially successful in Chile, New Zealand and Australia.

STATUS

Guadalupe Island population -: endangered. Monterey and Cambria population -: genetic integrity endangered. Cedros Island and Año Nuevo -: populations are not presently endangered.

REASONS FOR DECLINE

Guadalupe Island: grazing of seedlings by goats introduced by sailors in mid 1800s. All regeneration has effectively been precluded; population is becoming extinct. Monterey and Cambria populations: highly urbanized. Ornamental planting of P.radiata derived from the other populations is contaminating the native gene pools.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

Cuttings from nine trees from each of 10 stands in each of the 3 mainland populations were rooted in 1962. Seeds were collected from 98 and 77 trees in Cedros and Guadalupe Islands in 1964. Collections were repeated by CSIRO, Australia in 1979. Replicate plantations have been established in a number of countries, using seed from these collections. A programme complementing the 1964 seed collections was started in the winter of 1973, when pollen was collected from several hundred trees. The pollen was used partly for controlled pollinations and partly placed in long-term storage. These activities will ensure that samples of the unselected, native gene pools are maintained for future use. With the possible exception of the Cedros Island, the native gene pools cannot be maintained via protection of in situ populations. Ex situ conservation as seed, pollen and ex situ conservation stands to maintain these gene pools seems the most logical alternative and is recommended.

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Piptadenia peregrina (L.) Benth.

SYNONYMS

Acacia angustifolia DC. (1825)
Acacia microphylla Willd. (1806)
Acacia niopa H.B.K. (1820)
Acacia peregrina Willd. (1806)
Mimosa niopa Poir. (1810)
Mimosa parvifolia Poir. (1810)
Mimosa peregrina L. (1753)

FAMILY

Leguminosae Subfam. Mimosoideae

VERNACULAR NAMES

Angico Branco, Angico, Angico de Curtume, Angico do Cerrado, Angico Niopo, Caubi, Curupaíba, Curupari, Niopo, Paricá da Terra Firme, Angico Vermelho.

BOTANICAL DESCRIPITION

General

A tree which reach up to 20 m in height and a diameter above 0.50 m.

Inflorescence

Inflorescence a globose capitulum consisting of many terminal panicules of white flowers. Flowers appear in the period from October to December.

Fruit

A dehiscent dry,long, legume, up to 16 cm in length. Fructification occurs from August to September.

Seeds: Circular, long, dark brown, shiny.

1/ Based on the work of M.Tomazello F°, R.Chiaranda and M.L.Marques. Forestry Department, ESALQ/USP , PO Box 9, Piracicaba, SP, Brazil.

Foliage

Leaves alternate, bipinnate, about 20 cm in length. Petiole with a wide base and sessile glands; pinnae, 10-30 jugate; opposite or sub-opposite, linear, glands between the five pairs of pinnas.
Branches: rough and lenticellate.

Bark

Trunk bark rough, thorny when young; with age the thorns are restricted to the base of the trunk.

WOOD PROPERTIES AND PRODUCTS

Moderately heavy, heartwood light pink, uniform, darkening on the surface; shiny finish, smooth; a medium to rough texture; straight grain; indistinct aroma, taste is slightly adstringent. It is considered highly durable under natural conditions. Fibers have reduced lumen and pores are clogged by resin oil and tyloses, with low permeability of preservative solution in experimental treatments under pressure.

Recommended for the construction of outside structures, stakes, poles, fence posts, sleepers, etc., as well as for civil construction, as rafters, door-posts, tiles and floor boards, etc., and for fuel wood and charcoal.

NATURAL DISTRIBUTION

This species is scattered throughout all of Southern Brazil, in the states of Minas Gerais ("Zona da mata"), Sao Paulo, Paraná, Santa Catariana and Rio Grande do Sul. It is also found in the Amazon region and on the coastal strip from the State of Rio Grande do Norte to the State of Espírito Santo.

SOILS AND CLIMATE

As indicated by its wide geographical distribution, it is found in several soil and climate types; however, more detailed information in this respect does not exist.

HABITAT

Occurs in several types of forest formations, from the coastal woodlands to the Amazon. Prefers swampy and riparian conditions.

SILVICULTURE

In the Parque Estadual do Rio Doce it showed an average height of 8 m at two years of age. Although a good development in pure stands is reported, reliable data is not yet available from the few existing experiments.

STATUS AND REASONS FOR DECLINE

There are no precise data as to the status of this species. However, the forests of the Northern region where it is found are being devastated for the expansion of agriculture and cattle rearing. This species is very rare in the South, and is being reduced further, due to its economic value.

PROTECTIVE MEASURES TAKEN

The species occurs in the Reserva Biológica da Mata do Acauá, in the Parque Florestal de Jaiba and in the Parque Florestal do Rio da Onça.

Planting of seven base populations from 75 trees, through a contract with the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and the Programa Nacional de Pesquisa Florestal (PNPF) in collaboration with the Sociedade de Investigaçoẽs Florestais (SIF), is reported.

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Platanus orientalis L.[1/]

Platanus orientalis hybridizes with P. occidentalis (the American sycamore) when they come in contact and produce vigorous and fertile hybrids, with normal meiosis. Fossils indicate that the two species were isolated for at least 20 million years.

FAMILY

Platanaceae

VERNACULAR NAMES

Chenar, Platanos (πλατανος)

BOTANICAL DESCRIPTION

General

A large deciduous tree up to 30 m tall, with large spreading crown, which can attain great age and diameter. In Greece the platanum of Hippocrates (400 b.C.) is still alive in the island Kos.

Inflorescence

Many minute greenish flowers, tinged with red, are borne in spring with the leaves, on long-stalked drooping balls or heads, male and female (monoecious).

Fruit

Drooping, ball-like fruits, maturing in September-October and shedding untill autum or spring. They are composed of many crowded, minute nutles surrounded by hairs.

1/ FAO acknowledge the assistance of K.Panetsos (Aristotelian University of Thessaloniki,School of Agric. and Forestry, Thessaloniki, Greece).

Foliage

The alternate, long-petioled leaves are palmately 3 to 9-lobed and palmately veined, usually broad, often toothed. A large, toothed stipule surrounds the twig of the leaf base and sheds early, forming a ring scar. The slender zig zag twigs without terminal buds bear short-pointed lateral buds covered by a scale and hidden inside the petiole base.

Bark

Platanus orientalis is easily recognized by the whitish bark which separates into large thin flakes. These fall irregularly and expose patches of brown, green and grey inner bark with a mottled appearance. Bark at the base of large trunks becomes thick, dark brown and deeply furrowed into broad, scaly ridges.

WOOD PROPERTIES AND PRODUCTS

General

The most important uses are for veneer, carpentry, box-making, door and window frames, and joinery. It also makes a good fuelwood.

Other Uses

Used for roadside plantings and as a shade tree.

NATURAL DISTRIBUTION

Platanus orientalis is the only species of Plane in the old world. Its distribution range embraces the East Mediterranean countries (viz.Balkan Peninsula, to 42° N, Crete, Turkey, Syria, Lebanon and Palestine) and some W.Irano-Turanian countries (viz.E.Turkey, Iraq, Iran, Pakistan and Afghanistan) as well as some

districts of the Himalayan Province and the S.E.Province of the Euro-Siberian region. This distribution pattern suggests that it is an element of the ancient E.Mediterranean and North African flora, but this is not fully understood.

CLIMATE

This species exhibits remarkable plasticity, with respect to temperature fluctuations, growing from sea level to high altitudes (1400 m). It seems that, at higher altitudes, the limiting factors are temperatures below - 25°C, and strong winds. It experiences extremely variable precipitation, but in Iran generally between 100 and 500 mm with a maximum in winter or spring. At least three summer months of total drought, extending up to nine months in the most arid regions, occur in some areas. In Greece it is not considered a drought resistant species.

SOILS

It can grow on soils derived from a variety of parent materials. Its occurence, however, is related directly to availability of soil moisture during the dry summer months. For this reason Platanus grows in small or large populations in areas where ground or surface water is available throughout the growing season.

HABITAT

Usually Platanus orientalis forms narrow bands along moist, ephemeral, stony or gravelly ravines. In Iran it is often accompanied by species of Salix, Tamarix, Elaeagnus, Fraxinus, Vitex and especially Nerium oleander. In Crete the other main species are

Populus nigra, P. nigra var. pubescencens, Alnus glutinosa and Populus alba.

SEED HANDLING

200-260 000 seeds per kg. Fruiting heads of oriental plane can be collected any time after they turn brown, but the task is easiest soon after leaf fall. Since the heads are persistent, collection can be made into the next spring. As heads begin to fall apart in the early spring, they may be stripped onto canvas sheets. Heads should be dried in well-ventilated trays until they can be broken apart. Seeds should be extracted by crushing the dried fruiting heads and removing the dust and fine hairs that are attached to the individual seeds. If the seeds are to be sown soon after collection, they may be stored in a cool, well-ventilated place in open-mesh bags or spread out on shelves. For storage longer than 1 year, seeds should be dried to 10 to 15 percent moisture and stored in air-tight containers at -6° to $+ 14^{\circ}$C. Pregermination treatments are not required. Normal germination of seeds from natural populations varies between 40-60 percent. Only 1-2 percent of seeds, however, from self-pollination germinated, indicating that the species is self-sterile.

SILVICULTURE

The seedlings grow slowly at first and it is preferable not to plant them out until they are at least two years old. The tree can be raised successfully from layers and cuttings, even large thick stakes rooting successfully. In irrigated commercial plantations in the Soviet Union, a planting density of

3 000 stems/ha is recommended. It is important to do deep soil cultivation before planting. In Iran, P. orientalis is pruned every year in such a way that 2/3rds of the crown is left. In Greece P.orientalis is considered as a species able to occupy any available niche, due to its advantage of wide seed dissemination by wind. Moreover, the seeds can be carried by water and are often deposited on mudflats or sandbars, where conditions are favourable for germination.

STATUS

Endangered in parts of its natural range.

REASONS FOR DECLINE

Perhaps the high mortality caused in Platanus plantations in Italy and France by Ceratocystis fibriata may be the reason to consider P.orientalis as an endangered species. It is also true that Platanus is continuously restricted in distribution, especially by changing water courses, in order to use the water for irrigation - also by the expansion of agriculture to river banks where it grows. A variety named cretica grows on the island of Crete. The variety is evergreen and grows together with typical trees of P.orientalis. This variety was known from the ancient times since it is described by Theophrastus in his book (Enquiry into Plants). Experiments have shown that it is sensitive to low temperatures and can not grow normally below - 5°C. In the north, when the temperature falls abruptly, it is severely damaged, losing leaves, twigs and even the whole part of the tree above ground. Depending upon the severity of the frost

it may regenerate from sprouts in the next spring. Under greenhouse condition it grows well all the winter. In Crete only 20-30 trees have been found of this variety, which shows that it is under great danger of becoming extinct.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

For the variety growing on Crete it is a matter of urgency to protect the last trees of the natural population. Preservation of this rare variety might be important in breeding programmes of the genus Platanus.

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Platymenia foliolosa Benth.[1/]

FAMILY

Leguminosae Subfam. Mimosoideae

VERNACULAR NAMES

Vinhático da mata, Vinhático Rajado, Vinhático Amarelo, Amarelinho, Amarelo, Pau Amarelo, Candeia, Paricazinho, Oiteira, Pau de Candeia, Acende Candeia, Vinhático do Campo, Vinhático, Candeia de Folha Grande, Vinhático Cabeleira, Vinhático pe dé Boi.

BOTANICAL DESCRIPTION

General

A tall tree, reaching a height of 30 m and a diameter of approximately 1 m.

Inflorescence

Flowers white or light yellow in rounded spikes, penduncles short, shorter than the leaves, about 10 - 13 cm in length; flowering occurs in November and December.

Fruit

Legume flat, redish brown, smooth, pointed, 15 to 25 cm in length by 3.5 to 4.5 cm in width; stipe 2 - 3 cm long. Fructification occurs in October and November. Seeds covered by the endocarp which is subcoriaceous and separated from the rest of the fruit; it has the appearance of an elliptical wing, measuring 3.5 - 4.5 cm in length.

1/ Based on the work of R.Chiaranda, I.E.Pires and M.Tomazello Fº. Forestry Department, ESALQ/USP, P.O.Box 9, Piracicaba, SP, Brazil.

Foliage

Leaves compound, alternate, bipinnate, with 8 to 14 opposite pinnae and 11-19 folioles, alternate, oblong-ovate to elliptical, membranaceous, emarginate, varying from glabrous to slightly pilose, 10-20 mm in length by 4 - 10 mm in width.

Branches: greyish, normally greenish with lenticels that are not easily distinguishable.

Bark

Trunk straight, cylinder-shaped with small expansions at the base. Bark hard, brownish, cracked in plates or sheets, somewhat rectangular, loose on the upper part of the tree.

WOOD PROPERTIES AND PRODUCTS

Wood light, the heartwood varying from a golden-yellow to burnt yellow or brownish yellow with a golden ton; sapwood well defined, whitish-yellow; a very shiny surface, moderate roughness to the touch, medium texture; straight or irregular grain. Presents a natural high resistance to rot.

The vinhatico wood, in experimental treatments using pressure, revealed a low permeability to preservative solutions. It has a low retractability and mechanical resistance.

It is recommended for veneer sheets for decorative covers, furniture, panels, topographic tripods, etc. In civil construction it may be used for internal

finishings, for panel, frames, shutters etc. It is still used in plywood production, naval constructions, and for wine barrels, etc.

NATURAL DISTRIBUTION

The tree occurs in the Fluminense coast, in the "zona da mata" of the State of Minas Gerais, in the valley of the Rio Doce, in the North of the State of Espirito Santo and Southern Bahia, where it is rare. It also sporadically appears in other regions more to the North, up to the State of Pernambuco.

SOILS AND CLIMATE

It occurs in the most diverse types of soil and climate, confer its wide geographical distribution. The climate varies from a dry sub-humid tropical type with periodical rains, to sub-tropical humid, with annual precipitation up to 2 000 mm.

HABITAT

The species is found in the more humid zones of the low altitude rainforest, as well as in the tropical riparian forest, and in the mountain ridges of the States of Pernambuco and Ceare, and on the "cerrados".

SEED HANDLING

Not recorded

SILVICULTURE

No results on growth are available from experiments carried out with this species. In a mixed stand of native species, planted in the State of Minas Gerais over 20 years ago, this species produces a straight trunk

with a diameter of over 20 cm, and a crown reaching the superior layer of the forest.

STATUS AND REASONS FOR DECLINE

Due to the selective exploitation of all the native species, and mainly those of economic value such as this one, as well as the inability of natural regeneration, this species is undergoing a slow extinction. This is evident in the coastal areas of the State of Espirito Santo.

PROTECTIVE MEASURES TAKEN

Five base populations have been established with seeds collected from a total of 115 selected trees. This work has been undertaken through a contract between the Conselho Nacional de Desenvolvimento Cientifico e Tecnologico (CNPq) and the Programa Nacional de Pesquisa Florestal (PNPF) in collaboration with the Sociedade de Investigacoes Florestais (SIF). A planting of a base population consisting of 403 trees in Aracruz - ES is reported.

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Populus ilicifolia (Engl.) Rouleu[1/]

Populus ilicifolia is the most puzzling species within the Salicaceae. At first it was classified in a totally different family, (Ulmaceae), and described as a species in the genus Celtis. Recently, there has been no doubt whatever that it belongs to the Salicaceae family. It has been recognized as a separate, monotypic genus Tsavo Jarm.

SYNONYMS

Celtis illicifolia Engl. (1895)
Populus euphratica Oliv. subsp. denhardtiorum Engl. (1898)
Populus denhardtiorum Dode (1909)
Turanga illicifolia (Engl.) Kimura (1938)
Balsamiflua illicifolia (Engl.) Kimura (1939)
Tsavo illicifolia (Engl.) Jarmol (1949)

FAMILY

Salicaceae

VERNACULAR NAMES

Kenya: Tana River Poplar; Malala; (Galla); Lalaftu (Pok.); Mugai, Makini (Kamba); Siricha (Boni.) Gucuba (Boran), Guduma (Boran).

BOTANICAL DESCRIPTION

General

Tall deciduous, riparian tree (7-) 15-27 m tall. Crown columnar when young, later conical. Stem rough, longitudinally fissured.

1/Based on the work of J.A.Odera (Forestry Research Dept., Kenya Agricultural Research Institute, Kikuyu, Kenya) and Ms.C.Kabuye (East African Herbarium, National Museums of Kenya, Nairobi, Kenya).

Inflorescence

Male catkins 8-10 flowers, up to 2.5 cm long, arising from previous year's growth: flowers with about 30 stamens and a deeply laciniate membranous disc. Female catkins 4-14 flowered, on terminate short 1-3 leaved shoots, up to 2.5 cm long, arising from previous year's shoots. Ovary grey, tomentose and sessile on the 2-3 partite or filiform segmented disc; stigmas 2-fid.

Fruit

A capsule, ovoid 7 - 15 mm long and 4 -8 mm wide with pedicel up to 7 mm, glabrous; surface rough with pale lenticels visible, longitudinally 4-furrowed; splitting along furrows into 2-4 valves. When the seed is ripe the whole branchlet with 2 leaves and 2-5 capsules is shed.

Foliage

Leaves ovate or elliptic (linear on seedlings, young plants and coppice shoots), deeply toothed up to 7.6 cm long (usually to 5.0 cm) and 3.2 cm broad, acute or rounded at apex, cuneate to truncate at base; margin coarsely and acutely toothed; lamina coriaceous, somewhat glaucous and with 2 glands at base; petiole slender to 3.8 cm long and usually twisted so that the leaves hang vertically.

Bark

Smooth and white becoming dark and rough with deep fissures.

WOOD PROPERTIES AND PRODUCTS

Timber dark brown, soft and white, somewhat coarse. It seasons well and is easy to work. The logs are favoured for dug-out canoes.

NATURAL DISTRIBUTION

Kenya: Tana, Athi and Uaso Nyiro River systems; from sea level to 1 200 m. Four large trees of unknown history have been reported along the Nyando river basin in western Kenya. In Tanzania it occurs in the Ruvu river systems.

CLIMATE

Annual rainfall c. 250 mm.

SOILS

(1) Alluvial, sandy

(2) Grey-brown, sandy mud.

HABITAT

Riparian, with Acacia, Ficus, Antidesma and Borassus spp. appearing in patches.

SEED HANDLING

Not recorded

SILVICULTURE

Reported cultivated in Tanzania, N.Kiria village, Ruvu rivers, Same District in the 1960's.

STATUS

Endangered, only known from a few very scattered localities.

REASONS FOR DECLINE

Clearing of vegetation. Most of the seeds get washed away during floods. Seeding is in October while the highest floods come in November.

In Kenya the irrigation and settlement programmes along the Uaso-Nyiro, Tana and Athi river basins pose a looming threat to this species.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

No recorded protective measures have been taken.

Protective measures proposed:

(1) Detailed local surveys of existing sites are needed to assess population sizes so that conservation measures can be formulated.

(2) Protection of the existing trees.

(3) Protection of the habitat.

(4) Bringing the species into cultivation.

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Prosopis cineraria (L.) Druce[1/]

SYNONYMS

Prosopis spicigera L. (1753)

FAMILY

Leguminosae subfam. Mimosoideae.

VERNACULAR NAMES

Jand, Khejiri, Shami (India); Thand, Kandi, Jandi (Pakistan); Ghaf (Arabia).

BOTANICAL DESCRIPTION

General

Small to medium-sized, deciduous, spiny tree, 5-9 m high, with crooked trunk up to 30 cm in diameter; thin, open crown of many irregular branches, and large very deep taproot; leafless for a short time before flowering or locally evergreen.

Inflorescence

Flower clusters (spikelike racemes) appearing after the new leaves, several along each stalk at the leaf base, 5-13 cm long. Flowers many, almost sessile, small, 5 mm long, yellow, glabrous, composed of a short cuplike calyx 1 mm long, corolla of 5 narrow petals 3.5 mm long, becoming reflexed; with 10 separate, threadlike, spreading stamens 5 mm long, and pistil with a cylindrical glabrous ovary, long threadlike style, and inconspicuous stigma.

Fruit

Fruits or pods (legumes) short-stalked, beanlike, narrow, almost cylindrical, 8-9 cm long, 4-7 mm diameter, slightly narrowed between seeds, long-pointed at apex; with thin brittle wall and mealy sweetish pulp, not dehiscing. Seeds several, bean-shaped, 6 mm long, flattened.

Foliage

Leaves alternate, bipinnately compound, glabrous or sparsely hairy, with main axis 0.5-4 cm long and 1-3 pairs of side branches (pinnae), 2-7 cm long. Leaflets 7-14 pairs on each side of axis, stalkless; narrowly oblong, 4-15 mm long, 2-4.5 mm broad, straight or slightly curved, ending in a short sharp point, with midvein on side and without side veins, grey-green.

Bark

Ash grey, rough thick, with deep long furrows and horizontal cracks.

WOOD PROPERTIES AND PRODUCTS

Wood with thick sapwood and smaller irregular masses of purplish-brown heartwood, heavy (sp.gr.1.15), fine-textured, straight-grained, with small to medium-sized pores and growth rings, very hard, tough. Easy to work but not durable, susceptible to dry rot and insects. An excellent fuelwood, preferred locally for cooking and heating. Used also in locomotives and river steamers. Produces high-quality charcoal. Wood is used for house construction, posts, tool handles, boat frames, and occasionally for furniture, though trunks often have poor form.

Other Uses

Gum exuding from wounds in bark not used. Pods are valued for fodder or forage. Branches also cut or lopped for forage. Species is locally classed among the best browse plants for cattle, sheep, goats and camels. Mealy nutritious pulp of immature pods is high in protein. It can be ground and eaten raw or boiled to enrich the diet.

NATURAL DISTRIBUTION

Arid regions of southwestern Asia from northwestern India (Punjab, West Rajasthan, Gujarat, Uttar Pradesh) to dry parts of central and southern India, also Pakistan, Afghanistan, Iran, Arabia. At low altitudes. Not widely introduced elsewhere.

CLIMATE

Dry tropical with long dry seasons and hot winds. Plants withstand both slight frost (-6°C minimum) and high temperatures (40-50°C maximum). Annual rainfall 75-850 mm.

SOILS

Soils vary from alluvial and course sands often alkaline (as high as pH 9.8) to moderately saline, dry stony, and black cotton soil.

HABITAT

Species is scattered in rocky uplands or found pure or mixed with other species in open groves in the tropical thorn forest. Where rainfall is less than 25 mm plants are confined to stream banks.

SEED HANDLING

About 25 000 seeds/kg. The seeds require soaking in water 24 hours prior to sowing. They remain viable for decades.

SILVICULTURE

P.cineraria reproduces freely by root suckers and establishes well from seed. The tree has been seeded directly in the field with success. However, it would be better to sow it in a nursery and transplant it to the field when 2-3 months old. Young trees should be planted in spring immediately after the last frost-free date or at the onset of the rainy season.

STATUS

Endangered in parts of its geographical range.

REASONS FOR DECLINE

Increasing human pressure and changing land-use patterns.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

Is one of the species included in the FAO/IBPGR Project on Genetic Resources of Arid and Semi-Arid Zone Arboreal Species for the Improvement of Rural Living. Seed collections for evaluation and conservation have been made in India and PDR Yemen. Action towards in situ conservation in PDR Yemen has been taken recently.

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Pseudotsuga gausseni Flous [1/]

SYNONYMS

Pseudotsuga sinensis auct. non Dode

FAMILY

Pinaceae

BOTANICAL DESCRIPTION

General

An evergreen coniferous tree, up to 40 m in height and 1 m in diameter.

Fruit

Cone globular, ovoid 4 to 5 cm long by 3 to 4 cm wide. Scales large. Bracts curved with a short median point, 3 to 4 mm long. Seed winged, rounded at the top. Cone matures in October.

Foliage

Leaf rounded, notched at the top, straight or slightly falcate, not persistent; 20 to 30 mm in length, on pubescent twigs.

Bark

Bark dark-grey, fissured into irregular plates.

WOOD PROPERTIES AND PRODUCTS

The wood is considered as rot-resistant and of a superior quality. Sapwood is light brown, heartwood is reddish brown, grain is straight. Normally used for construction and furniture.

1/ FAO acknowledge the assistance of Pan Chih Kang. The Arboretum, Chinese Academy of Forestry, Beijing, China.

NATURAL DISTRIBUTION

Localized in eastern China in the provinces of Chekiang and Ngan-Hoei (at elevations between 1 500-2 800 m in eastern Szechuan and north-eastern Yunan, 100 - 1 500 m in Anhwei and Chekiang Province).

SOILS

Normally found on acid, yellow mountain soils.

HABITAT

In mixed coniferous/broad leaved forests together with Pinus hwangshanensis, Fagus spp. and Tsuga spp.

STATUS

Endangered

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

In need of basic research programmes on distribution and genetical variation.

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Pseudotsuga sinensis Dode.[1/]

SYNONYMS

Keteleeria fortunei Carr. (1855)

FAMILY

Pinaceae

VERNACULAR NAMES

Chinese Douglas Fir

BOTANICAL DESCRIPTION

General

A tree about 50 m in height and 1 m in girth; young shoots reddish-brown at first, becoming grey with age, covered with minute hairs.

Fruit

Cone ovoid, cylindrical, composed of about 20 rounded scales, thick, woody and large, each subtended by a 3 - cleft exserted, reflexed bract. Seed 2-2.5 cm long, including the wing.

Foliage

Leaves, 2 - 2½ cm long, light green above and whitish beneath; upper surface furrowed from the base to apex, lower surface with a raised midrib.

Bark

Deeply furrowed bark, dark grey colour, twisted, fibrous, fissured.

1/FAO acknowledge the assistance of Pan Chih Kang, The Arboretum, Chinese Academy of Forestry, Beijing, China.

WOOD PROPERTIES AND PRODUCTS

The quality of wood is superior; sapwood is light brown, heartwood is reddish brown. The timber is used for construction, boat-building and furniture.
Specific gravity: 0.6.

NATURAL DISTRIBUTION

In China in the provinces of Chekiang and Anhwei. It is usually found at elevations between 800-1 200 m in western Hupeh, Hunan province; 1 500-2 800 m in south-west Szechuan and central Yunan.

CLIMATE

Warm and humid. P sinensis can endure drought during spring and winter.

SOILS

The tree normally grows on red mountain soils, yellow soils or brown forest soils, also on limestone formations.

HABITAT

Mixed coniferous broadleaved forest.

STATUS

This is a rare species, even in its nature habitat. No specimens are known in the west.

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Pterogyne nitens Tul.[1/]

SYNONYMS

Machaerium pseudotipe Griseb. (1879)
Tipuana pseudotipa Griseb. (1879)

FAMILY

Leguminosae Subfam. Caesalpinioideae

VERNACULAR NAMES

Amendoim bravo, candeirão, madeira nova, óleo branco, pau amendoim, pau de fava, madeira nova, carne de vaca, viraró, jacutinga.

BOTANICAL DESCRIPTION

General

Tree of medium size and crooked bole, with a grey rough, lenticellate bark, about 10 mm thick, and with a bitter taste; crown with round ascending branches.

Inflorescence

An axillary panicle made up of 3 racemes of small flowers, with yellow, pubescent peduncles, brown at the base, white on top, with a deciduous bract at the insertion of each pedicel. Flowering occurs from January to March.

Fruit

A winged achene with the pedicel on the seminiferous thick side; the wing is connate to the pericarp by an oblique slit. The back side of the seed has protruding

1/ Based on the work of M.L.Marques, M.Tomazello F° and I.E.Pires. Forestry Dept., ESALQ/USP, P.O Box 9, Piracicaba, SP, Brazil.

ribs; the wing also has curved ribs. Ripening takes place from May to June. It is generally recognized that seeds must be collected from April to May. According to some authorithies the best harvest season is, however, the month of August. Seed elliptical, long, dark yellow.

Foliage

Leaves alternate, pinnate, with 6 pairs of alternate folioles, petiole sulcate in the upper part, with a strong pulvinus at the base; short petioled folioles, oblong, entire, shiny above and opaque below, with protruding ribs and veins.
Branches: Grey, round, wrinkled and lenticellate.

WOOD PROPERTIES AND PRODUCTS

Wood heavy with a dark beige-pink or uniform light brown heartwood; distinct sapwood, slightly yellow to light beige; with a shiny uniform surface; grain straight to irregular; medium texture; slight odor in the sapwood layer; a slightly astringent taste. Moderate natural resistance to rot. As the heartwood of amendoim wood presents veins that are partially obstructed by oil-resin that reduce the lumen of the fibers, it probably has a low permeability to preservative solutions under pressure.

The amendoim wood is recommended for fine furniture, veneers for lambrins, interior decorating, etc., as well as in civil construction for beams, rafters, laths, tiles and boards for floors etc. It has a low retractibility, a handsome appearance and a medium mechanical resistance. It is also recommended for the construction of truck bodies, the interior of railway wagons,

agricultural implements, etc. It is widely used in the manufacturing of large barrels, water kegs and tanks for drinks, and also for tanks for acid solutions.

NATURAL DISTRIBUTION

This species occurs in Argentina, Paraguay and Brazil (from the state of Ceará to the state of Paraná, reaching the Central-eastern region).

HABITAT

P.nitens grows in the dry deciduous forests of the "sertões" where there is a well defined dry season. As indicated by its wide distribution, this species occurs in several soil and climatit conditions.

SEED HANDLING

The fruit stays on the tree for a long period. For time of seed collection, see above. When stored in the open it is frequently attacked by fungi and should be treated accordingly. A 75% germination after 45 days storage in the open has been observed. The germination period is from 3 to 47 days after sowing. Germination at 10 days after sowing without breaking seed dormancy is resported; and a 5% germination for untreated seeds. According to several authors 1 kg contains approximately 5 500 seeds.

SILVICULTURE

An average height growth of 0.68 m for a one year old provenance trial set up in Pederneiras - SP is recorded. In São Simão - SP a height growth of 9.02 m, a DBH of 10.71 cm and a survival of 94.7% for a stand established in 1968 was reported in 1982.

STATUS AND REASONS FOR DECLINE

The tree has been very much in demand, as its wood has characteristics that are very favourable for industrial use. The species is becoming rare, because of continued exploitation in the areas of natural occurrence.

PROTECTIVE MEASURES TAKEN

The CNPq/PNPF with the collaboration of IFSP, maintains 4 base populations and 100 selected trees. The "Instituto Florestal de São Paulo" (IFSP) established a trial in Pederneiras in 1981 using 4 provenances and 36 progenies, and has observed a high genetic variation.

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Schinopsis brasiliensis Engl.[1/]

FAMILY

Anacardiaceae

VERNACULAR NAMES

Barauna, brauna.

BOTANICAL DISCRIPTION

General

One of the largest trees found in the semi-arid region of Northeastern Brazil. There are trees from 12 to 20m in height and from 30 to 60 cm in diameter.

Inflorescence

In panicles of white, small flowers, occuring from November to December and November to February.

Fruit

A samara or drupe of light brown colour, measuring 30 to 40 mm in length.

Foliage

Leaf petiolate, subcoriaceous, dark green on the upper surface and light coloured on the under side, with 10 pairs of oblong folioles, tip obtuse and oblique-acute at the base.

Bark

The bark is approximately 17.0 mm thick with a dead external layer, rough, rigid, light grey to black.

1/ Based on the work of I.E.Pires and C.E.S.Nascimento, EMBRAPA / CPATSA, P.O.Box 23, Petrolina, PE, Brazil.

When injured it shows a resinous exudate, which is transparent and without odor.

WOOD PROPERTIES AND PRODUCTS

Hard and heavy, with a brownish-yellow colour, becoming dark brown with age and when exposed to air. The presence of resin and tannin renders a large durability when it is submitted to adverse conditions.
The wood is appropriate for construction, rafters, pillars, beams, sleepers, fuel, charcoal, etc.

NATURAL DISTRIBUTION

A species typical of the "Sertão" and "Agreste" of the state of Pernambuco and Bahia. It has been found in the states of Paraíba, Rio Grande do Norte, Ceará and Piauí. Trees are generally found in the "caatingas" of Northeastern Brazil.

CLIMATE

The climate where barauna grows is dry sub-humid tropical to dry tropical, where the dry period may reach up to 12 months, with a water deficit reaching a level of 1 300 mm.

SOILS

This species is found in all soil types with the exception of those that are deep and sandy; preference for deep and fertile soils has also been noted.

HABITAT

The tree thrives best in the high lands of the "caatinga", and does not appear in pure formations;

it is found mixed with species such as Astronium sp. Tabebuia sp. Caesalpinia sp. Ziziphus sp. and Bombax sp.

SEED HANDLING

Little information is available; however, it is known that the seeds are susceptible to borer attacks while stiil on the tree. Studies are required on the physiological maturation. The seeds present coat dormancy which will also need to be studied. The weight of 1000 seeds is about 106 g.

SILVICULTURE

This species is normally not planted. A review of the forest experiments in the Northeast and other studies under semi-arid conditions, show an average survival of approximately 60%, with a very slow growth.

The seedlings are raised by employing traditional methods. The seed dormancy causes delay and irregular germination.

STATUS

S. brasiliensis is suffering a slow decline. The studies underway on the species are limited to studying its behaviour in pure stands.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

In situ conservation is highly recommended. Studies of the reproductive system and the establishment of base populations should also be undertaken to preserve the genetic variation and to provide reproductive material.

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Stuhlmannia Moavi Taub.[1/]

S.moavi is the only known species of the genus.

FAMILY

Leguminosae Subfam. Caesalpinioideae

VERNACULAR NAMES

Tanzania: Mkwizingi

BOTANICAL DESCRIPTION

General

Tree 7.5 - 9 m high, apparently evergreen. Young branchlets tomentellous.

Inflorescence

Racemes 9 - 13 cm long (up to 20 cm in fruit); outside of calyx with a dense tomentellus brownish indumentum like that of the branchlets, also with some scattered round red sessile glands in addition. Petals yellow, unguiculate, obovate - spathulate, 1.6 - 2 cm long and 6 - 9 mm wide. Pods obliquely oblanceolate ± 5 cm long and 2 cm wide, olive-brown, glabrous and rather glossy. Seeds broadly obovate to elliptic, ± 14 mm long and 10 mm wide, brown and glossy.

Foliage

Leaves with a petiole (0.6 -)1-1.7 cm long, rhachis (3.5 -) 6 - 12 cm long, at first with a sparse indumentum like that of the branchlets. Leaflets

1/Based on the work of J.A.Odera (Forestry Res. Dept., Kenya Agric. Research Institute, Kikuyu,Kenya) and Ms.C.Kabuye (East African Herbarium,National Museums of Kenya, Nairobi, Kenya).

3 - 5 (-6) pairs, ovateelliptic to elliptic, usually with a subrhombic tendency. 2.5 - 9 (-12.5) cm long and 1.3 - 5 - 6.5 cm wide, obtuse to rounded at apex, asymmetric at base, glabrous (except on midrib when young); venation prominent on both surfaces.

NATURAL DISTRIBUTION

Pangani District in Tanzania (Mkwaja, Mkaramo, Wachenya, 23 Nov., 1955).

CLIMATE

The mean annual rainfall varies widely, from 32 - 240 cm a year. There is a long dry spell with rain restricted to the period from November to May.

HABITAT

Lowland dry evergreen and riverine forests of the Pangani area in Tanzania.

SILVICULTURE

Not recorded

STATUS

Endangered

REASONS FOR DECLINE

Settlement and clearing of forests.

PROTECTIVE MEASURES RECOMMENDED

The forests in which the species occurs are in the Central Government Reserve. Research is required to study and document:

1. the flora and ecology of the region,
2. the requirements of the species so that it can be brought into cultivation.

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Tabebuia impetiginosa (Mart.) Standl.[1/]

SYNONYMS

Tecoma impetiginosa Mart (1845)

Tebebuia impetiginosa (Mart. ex DC.) Tol. (1952)

FAMILY

Bignoniaceae

VERNACULAR NAMES

Pau d'arco, ipê-roxo, pau d'arco-roxo, ipê-una, ipê-preto, pau d'arco-rosa.

BOTANICAL DESCRIPTION

General

A tree which reaches 8 to 10 meters in height when isolated; in the forest it reaches a height up to 30m with a 100 cm diameter. The crown is long and irregular, always reaching the dominant stratum; the trunk is generally straight.

Inflorescence

In clusters of ordinate triads in sub-umbellate panicles the axes branch out dichotomously, and are thick and heavily covered with a yellow-white layer which also covers the pedicels and the calyx; bracts yellow-pilose, generally deciduous; calyx, bellshaped, scaly, tomentose, 5 to 8 mm in length; corolla pink-violet, 6 to 7 cm in length; ovary elliptical, 3 to 5 mm in length. Flowering begins in September; or earlier in July to August. Fructification occurs in September.

1/ Based on the work of I.E.Pires and C.E.S.Nascimento, EMBRAPA/CPATSA 23, Petrolina, PE, Brazil.

Fruit

A long linear, coriaceous, pointed, capsule measuring 25 to 30 cm in length and 15 to 20 mm in width.

Foliage

The leaves are opposite, digitate, large, with 5 pubescent folioles; coriaceous, oblong-ovate, with a rounded base and shortly wedged apex, margin entire, somewhat pubescent; lateral ribs 6 to 10 mm apart, measuring 8 to 22 mm in length and 4 to 12 in width.

Bark

2 to 3 cm in thickness, rigid, dark brown on the outside and inside, with lengthwise furrows and transverse fissures, with no detaching plaques. The bark is bitter, astringent and mucilaginous.

WOOD PROPERTIES AND PRODUCTS

Light brown to dark greyish-brown in colour, very heavy and hard, resistant to adverse conditions; the sapwood is light brown. The specific gravity is 1.083.
Wood is used for carved pieces, construction, hydraulic projects, sleepers, fence posts, pillars, etc.

NATURAL DISTRIBUTION

It grows from Piauí to São Paulo, and is found in the region of "Cariri" in Ceará and on the "cerrados" of central Brazil.

CLIMATE

This tree grows from a humid sub-tropical climate, with periodical rains, to an arid tropical climate subject to prolonged dry periods of up to 12 months.

SOILS

The tree has a preference for deeper aluvial soils in gallery forests, ridges and tablelands; it is rarely found in shallow rocky soils.

HABITAT

In Ceará and Rio de Janeiro it is found in the rain forest, while in Minas Gerais it is found in forest, as well as on pasture land, as solitary trees. There exists no pure natural stands and it is usually found among other species such as Astronium sp., Anadenanthera sp. and Torresia sp., etc.

SEED HANDLING

The seeds are winged and easily dispersed by the wind. This requires care in collecting them before the fruits open. When stored in the open germination percentage is reduced by 30% within 6 months. However, when stored in cold chambers, the germination percentage is maintained above 70% up to 7 months. Germination takes place during a period of 15 days.

SILVICULTURE

This species is normally not cultivated on a commercial scale but is frequently grown as an ornamental tree (for parks and avenues). Its growth in pure stands is slow, but satisfactory when compared to the majority of native species. It presents a high survival rate even in regions where there is a high water deficit e.g. in Petrolina - PE.

STATUS

The species is suffering a slow decline.

PROTECTIVE MEASURES TAKEN

No measures have been taken at present neither for ex situ nor in situ conservation. The studies underway on this species are limited to studying the behaviour of trees in pure stands. In situ preservation is highly recommended. Studies of the reproductive system and the establishment of base populations is also recommended, to preserve the genetic variation and to provide reproduction material.

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Taiwania cryptomerioides Hayata[1/]

This species strongly resembles Cryptomeria in its growth habit.

FAMILY

Taxodiaceae

VERNACULAR NAMES

Taiwan-Sah (Japan)

Taiwania (English in Taiwan)

BOTANICAL DESCRIPTION

General

An evergreen coniferous tree with a conical form, up to 60 m in height and 2-3 m in diameter, with a clear bole up to 20 m.

Fruit

Cones small, terminal on the young twigs, cylindrical, composed of 12-20 scales; mature cones 10-12 mm long and 3-6 mm wide, tapering at the base, brown in colour; seeds winged or samara-like, oblong, two under each scale.

Foliage

Leaves dimorphic, scale-like on the older branches, imbricate and incurved, and short needled, falcate or subulate, on young branches, with an acute apex and broad base; leaves arranged opposite in alternate pairs, pale green in colour.

1/ FAO acknowledge the assistance of Pan Chih Kang. (The Arboretum, Chinese Academy of Forestry, Beijing, China).

Bark

Bark greyish brown with very long longitudinal furrows, breaking off into long narrow strips.

WOOD PROPERTIES AND PRODUCTS

The wood is considered to be moderately strong and to some extent resistant to termites. The timber is very easy to operate with tools and machines and is principally used for general construction and furniture, it is especially good for products of saw-timber and veneer.

NATURAL DISTRIBUTION

A native of Taiwan, China, and possibly North Burma.

HABITAT

In Taiwan, China, it is found in the central mountain ranges. There it usually occurs at elevations between 1 800 m and 2 600 m and is usually found in scattered stands mixed with cypresses and hardwoods.

SEED HANDLING

Normally a low germination rate, ranging from 11 to 18% (Taiwan). Germination after 24-26 days.

SILVICULTURE

In Taiwan, China, it is recommended that a heavy grade first thinning should be carried out at about the age of 14 years, when the stands appear too dense in crown cover. Five years after first thinning, another thining of moderate grade should be carried out again. The rotation age ranges from 60 to 80 years.

STATUS

Endangered in certain areas.

REASONS FOR DECLINE

Large scale clear-cuttings during the past several decades (Taiwan).

PROTECTIVE MEASURES RECOMMENDED

In Taiwan, China, recommendations to preserve *T. cryptomerioides* have been made.

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Taiwania flousiana Gaussen[1/]

This species is doubtfully distinct from T. cryptomerioides.

SYNONYMS

Taiwania yunnanensis Koidz. (1925)

FAMILY

Taxodiaceae

BOTANICAL DESCRIPTION

General

An evergreen coniferous tree, up to 75 m (generally 30-40 m) in height and 2 m in diameter.

Fruit

Cone oblong, 14 to 21 mm long (17 mm being the most common length); usually with about twenty scales; purplish-grey in colour; edge of the scale fairly clearly marked; scales 9 mm long, with internal lateral edges slightly concave at the base, 7 to 9 mm wide. Winged seed 6 to 7 mm long.

Foliage

Leaves almost touching edge to edge when the branch is flattened; 4 to 5 mm long, fairly closely overlapping. On 1 cm of branch there are 12 to 14 leaves. Free end of the leaf a little bent, but heavily keeled up to the apex, giving a quadrangular general section.

1/ FAO acknowledge the assistance of Pan Chih Kang, The Arboretum, Chinese Academy of Forestry, Beijing, China.

Bark

Bark grey-brown, fissured into irregular long plates.

WOOD PROPERTIES AND PRODUCTS

Sapwood light reddish-yellow. Heart-wood purplish brown. Wood light and soft, with straight grain. The timber is easy to operate with tools and is used for general construction and furniture.

Other Uses

The tree has also been planted for ornamental purposes and watershed protection.

NATURAL DISTRIBUTION

In the mountain chains which separate the parallel courses of the rivers in Upper Burma and Yunnan: from west to east, the upper Irrawaddy, the upper Salween, the upper Mekong and the Kin-Cha-Kiang (upper Yang-Tse-Kiang). The species appears to have originated in this mountainous zone on the frontier between Burma, Tibet and Yunnan. Along the rivers the tree seems to have come as far south as Myitkyina. Elevations: 1 700 - 2 700 m in western Yunnan, 800 m in western Hupeh.

CLIMATE

The climate of the Taiwania flousiana range is warm and cool. Most rainfall occurs in summer and autumn. Spring and winter are normally dry.

SOILS

Prefers red soil, yellow mountain soil or brown forest soil.

HABITAT

Found in mixture with Chinese fir, Schima spp., Lithocarpus and Castanopsis spp.

SEED HANDLING

Seed weight is measured to 1 556 gram/1000 seeds. Germination around 38%.

STATUS

Endangered

REASONS FOR DECLINE

No information available

PROTECTIVE MEASURES RECOMMENDED

In need of basic research programmes on distribution and genetic variation.

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Tectona hamiltoniana Wall [1/]

FAMILY

Verbenaceae

VERNACULAR NAME

Dahat (Burma)

BOTANICAL DESCRIPTION

General

A moderate-sized, deciduous tree with clean bole up to 8 m tall and diameter up to 70 cm. Branchlets 6-8 angular, the younger parts shortly and densely tomentose.

Inflorescence

Flowers small, pale blue or white, indense tomentose corymbose panicles 15-30 cm long, borne at the end of the branchlets. Corolla 8 mm long very hairy in the throat. Flowering period June to August (Troup 1921), "... before the leaves are fully developed" (Hooker 1885), "March-May, with the young foliage" (Brandis 1921), July (Kurz 1877). The inflorescences are normally developed from axillary buds along the terminal parts of the tree branches.

Fruit

Fruit a small four celled drupe, between 4 x 8 mm and 6 x 20 mm. Fruit ripening period (in Lampang, Thailand) is between September-October. There are 4 000 - 4600 fruits per 1 kg. (1 litre = 0.1 kg.).

1/Based on the work of T.Hedegart (Saatvedt. Skollenborg, Norway) and A.Kaoza-Ard (Teak Imp. Centre, Royal Forest Department, Bangkok, Thailand).

Foliage

Leaves ovate, 10 to 20 cm long, 4-6 cm wide, mostly in whorls of 3, sometimes opposite, base rhomboid or obtuse, apex acuminate; white tomentose beneath, later softly hairy.

Bark

Smooth, in younger trees the outer-layer of the bark will peel off and shed naturally.

WOOD PROPERTIES AND PRODUCTS

T. hamiltonia is not an important timber species, but its potential value for plantations on dry sites and for teak breeding should be investigated. The timber has a different appearance from that of Tectona grandis. The wood is of good quality, uniformly pale brown or yellow, streaked, close-grained and finely fibrous. Heavier than Tectona grandis wood (oven-dry 0.90-0.95 as compared to 0.60-0.65 g/cm^3). It takes a fine polish. Natural resistance to fungi and termites has been observed.

Other Uses

Locally the bark is grinded with a stone and used as a drug, mainly against lung deseases.

NATURAL DISTRIBUTION

A limited natural distribution range (about 150 by 80 km) in the dry zone of Burma (Prome District and Upper Burma). Approximately 20^{o}N latitude, 95^{o}E longitude.

CLIMATE

Growing in dry localities (rainfall 400 to 800 mm).

SOILS

Often on poor, stony soil (calcareous sandstone).

HABITAT

A light demanding, drought resistant tree. In open stands, it is associated with Terminalia oliveri, Acacia catechu, Acacia leucophloea, Diospyros burmanica and other species of the dry open scrub forest. Seldom overlapping with Tectona grandis in its distribution.

SEED HANDLING

About 40 000 seeds/kg; no special pre-treatment is recommended.

SILVICULTURE

In Thailand, plants were easily grown from seeds harvested from a few specimens growing at the Forest Research Institute Dehra Dun, India. The resulting trees (approximately 100) are on a relatively poor site showing an initial development superior to that of Tectona grandis on the same site. Another seed sample obtained from Burma failed to produce any seedlings. It is believed that reproduction from seed should normally be easy. In Thailand grafting of T.hamiltoniana buds on to T. grandis root stocks has shown some success (approximately 50%).

STATUS

Further study is needed, but species is likely to be endangered.

REASONS FOR DECLINE

The wood is used locally for fuel and construction (house posts and parts of carts). Annual forest fires are also severely diminishing the existing populations.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

A few plantation plots have been established in Burma. One plot of 66 trees planted in 1940 is reported from Indonesia. It is recommended that a representative seed collection is arranged in the natural distribution range and that ex situ gene conservation plots are planted on sites under full control in Burma, India and Thailand.

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Tectona philippinensis Benth. & Hook. f. [1/]

FAMILY

Verbenaceae

VERNACULAR NAMES

Bunglas, Malapangit (Phil.)

BOTANICAL DESCRIPTION

General

A moderate sized tree reaching a height of about 15m.

Inflorescence

Flowers approximately 8 mm long and 10 mm in diameter, throat of corolla hairy inside. Cymes terminal, at anthesis rather dense, becoming rather diffuse in fruit.

Fruit

Drupe: about 8 mm long, enclosed in persistent calyx.

Foliage

Leaves elliptic-ovate to ovate-lanceolate, 8 to 15 cm long, 3 to 6 cm wide. The upper surface glabrous, rather densely white-verrucose, paler beneath and densely stellate-puberulent. Nerves 5 to 7 on each side of the midrib. Petioles densely puberulent, 5 to 7 mm long.

1/ Based on the work of T.Hedgart, Saatvedt, Skollenborg, Norway.

WOOD PROPERTIES AND PRODUCTS

The timber is of the same type as that of T.hamiltoniana, i.e. pale brown or yellow, close-grained and heavier than T.grandis wood. It is not an important timber species, but as for T.hamiltoniana, its potential value for plantations on dry sites and for teak breeding should be investigated.

NATURAL DISTRIBUTION

Endemic to the Batangas and the Iling Island near Mindoro, the Philippines, approximately 14°N latitude, 121°E longitude.

HABITAT

Occurs in dry, exposed ridges in thickets and secondary forests at low altitude.

SILVICULTURE

Reproduction from seed most probably easy

STATUS

Further study needed, but species likely to be endangered.

REASONS FOR DECLINE

The tree is not common even in its natural distribution range. The wood is sought after for house-posts and general constructions.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

Probably no protective measures have so far been taken. It is recommended that a representative seed collection is arranged in the natural distribution area, and that ex situ gene conservation plots are planted in the Philippines & Thailand.

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Ulmus wallichiana Planch.[1/]

Two different subspecies have been identified: subsp. wallichiana and subsp. xanthoderma Melville & Heybroek. Subsp. wallichiana has more or less roughly hairy leaves and fruits that are sparingly hairy over the seed. The var. tomentosa Melville & Heybroek has densely softly hairy leaves and branchlets, and uniformly hairy fruits. Subsp. xanthoderma Melville & Heybroek has smooth yellowish branchlets and hairless fruits. Related species, with similarities in ecology, are U.glabra Huds. in Europe, U. laciniata, U. bergmanniana and U. uyematsui in Central and North-eastern Asia.

SYNONYMS

Ulmus erosa sensu Wall. (1831)

FAMILY

Ulmaceae

VERNACULAR NAMES

Brare, himri, imroi, mair, marai.

BOTANICAL DESCRIPTION

General

A deciduous tree up to 30 m high and over 1.25 m in diameter. Branches several, ascending.

1/ Based on the work of H.M.Heybroek, Dorschkamp Research Institute, Wageningen, Netherlands.

Inflorescence

Flowers borne on leafless twigs in spring, with elongated axis 7-12 mm long, in groups of 15-30; perianth lobes 5-6, stamens 5-6, anthers red; ovary densely hirsute.

Fruit

Samara orbicular to broadly obovate; 10-13 mm in diameter, seed central; wing sparingly pubescent. For differences between subspecies see the introduction.

Foliage

Leaves elliptic-acuminate with unequal base 6-15 cm long and 2.5 - 6 cm wide (longer and broader on coppiceshoots); margin doubly-serrate.

Bark

Grey brown longitudinally furrowed or reticulate with the ridges ± interweaving.

WOOD PROPERTIES AND PRODUCTS

U. wallichiana produces a good quality timber with many uses.

Other Uses

The tree is being used in programmes to breed elms for city and landscape use in the temperate climates, as it exhibits a certain degree of resistance to Dutch elm disease. Its potential to produce a high quality fodder may still be utilized under certain conditions.

NATURAL DISTRIBUTION

The species extends from NE Afghanistan through Pakistan and India into Neapal, between 1 500 and 3 000 m above sea level.

HABITAT

The western part of the area is occupied by subsp. xanthoderma, the eastern half by subsp. wallichiana; var. tomentosa is rare and has been found in the upper Ravi valley only. The species occurs mainly as a specimen tree in mixed stands. It is a member of the Temperate Oak and Coniferous Mixed Forest, of the Temperate Coniferous Forest and of the Cedrus deodara forest zones in the Western Himalayas. In humid sites, it occurs mainly in mixture with many other deciduous species near streams; sometimes as an admixture of Abies forest.

SEED HANDLING

The seeds do not retain their viability for long and should be sown immediately; they germinate within a few days.

SILVICULTURE

Plants can easily be grown from seeds, which, however, are not available where trees are lopped regularly. Various methods of vegetative propagation are effective, such as grafting, layering, and rooted cuttings under mist in the summer.

STATUS

Endangered

REASONS FOR DECLINE

Elm is preferred over most other tree species for use as fodder for cattle, sheep, goats, and cows. Wandering shepherds lop every elm in the forest severely, which leads to their destruction, as they cannot reproduce, because the developing coppice-sprouts bear no flowers. This happens on a large-scale over the whole distribution area. Trees in game reserves and those at inaccessible places (cliffs etc.) are the only ones to escape distruction. This used to be counteracted, in part, by the fact that villagers planted elms near houses for a sustained yield of fodder, which was dried and kept for winter usage. For this purpose, however, hybrids are often used (U. x brandisiana); moreover, new types of fodder will mostly replace elm.

PROTECTIVE MEASURES TAKEN AND RECOMMENDED

The fact that the species flourishes and is able to complete its regeneration in the Dachigam Game Reserve near Srinagar, Kashmir, shows that protection from cattle may suffice to save the species. In establishing new game and forest reserves in the Himalaysa, attention should be paid to including elms and elm habitats. Small stands of elms could be planted near foresters' and wardens' homes, where they are protected from lopping. This would make their protected status clear to all, at the same time producing seed for forestry use.

Such plantings should consist of at least ten seedlings (clones) of local origin to provide possibility for sufficient cross-pollination. Special care should be taken to preserve a wide range of forms in the upper Ravi valley area, including the var. tormentosa. A small collection of clones of the two main sub-species is being maintained at the "Dorschkamp" Research Institute in Wageningen, Netherlands.

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Vepris glandulosa (Hoyle & Leakey) Kokwaro[1/]

Hoyle and Leakey placed this species in a new genus *Tecleopsis* which they did not compare directly with *Vepris*. By inference they probably thought it differed in the hermaphrodite flowers and the presence of only one ovule in each of the two locules of the ovary. The degree of dioecism is unstable throughout the *Toddalieae* and a single ovule per locule also occurs in *V. eugeniifolia* (Engl.) Verdoorn, while the ovary is further reduced in *V. arushensis* and *V. glomerat* (F. Hoffm.) Engl. to a single carpel. It seems preferable to retain all species in *Vepris* which is then distingulished from *Teclea* and *Diphasia* solely by the more numerous stamens and from *Toddaliopsis* Engl. by the smooth or bullate, not markedly verrucose fruits.

SYNONYMS

Tecleopis glandulosa Hoyle and Leakey 1932.

FAMILY

Rutaceae

1/ Based on the work of W.G.Dyson, U.K, †.

FAO also acknowledge the assistance of J.A.Odera (Forestry Research Department, Kenya Agricultural Research Institute, Kikuyu, Kenya) and Ms.C.Kabuye (East African Herbarium, National Museums of Kenya, Nairobi, Kenya).

VERNACULAR NAMES

Mũnderendũ-itu (Kikuyu). Mũnderendũ is the Kikuyu name for several species of Teclea. The suffix "itu" serves to distinguish Tecleopis glandulosa from Teclea simplicifolia which grows in the same locality and closely resembles it in general appearance and habit.

BOTANICAL DESCRIPTION

General

An unarmed, evergreen tree up to 6 m tall.

Inflorescence

Flowers clustered in axillary and terminal panicles, branches densely tomentose, hermaphrodite, sepals 4, united at the base or halfway, ± 1 mm long, broadly ovate to deltoid, glabrous, petals 4, broadly ovate - oblong or elliptic, 1.8 - 3 mm long, 1.5 - 3 mm broad, obtuse. Stamens (6-) 8, 2-3.8 mm long, anthers 0.8-1mm long, pistils densely glandular wooly; ovary 1-1.5 mm long, bilocular, with 1 ovule in each locule, style very short or absent, stigmas 2, obscured by simple and glandular hairs.

Fruit

A ± bilobed drupe (lobes sometimes different in size if one ovule is aborted), compressed elliptic to somewhat quadrate, 12 - 16 mm long and broad, glandular, pilose or strigose, bright crimson red or brown when ripe. The seed slightly compressed ellipsoidal, 5 mm long.

Foliage

Leaves opposite to subopposite, trifoliate; petiole 3.4 - 6.5 cm long tomentose but becoming glabrescent

with age, terete and longitudinally furrowed above. Leaflets subsessile or with a short petiolule up to 1 cm long, elliptic to elliptic-oblong 8-18 (-22) cm long, 3 - 6.5 cm broad, sometimes unequal-sided; acuminate or occasionally acute at the apex, cuneate and sometimes oblique at the base; entire to shallowly and broadly crenate; generally glabrous except the midrib which is pubescent or pilose beneath; pellucid gland dots numerous and conspicously dark beneath and furrowed above; lateral nerves 14-22 pairs.

Bark

Smooth grey bark.

WOOD PROPERTIES AND PRODUCTS

The tree is now too extremely rare to have any economic value. In the past it was presumably utilized together with Teclea simplicifolia, for walking sticks, spear shafts, bows and arrow shafts. The wood as judged from a small branch, is similar to that of T.simplicifolia and is suitable for such purposes and small turned tool handles.

NATURAL DISTRIBUTION & CLIMATE

Central Kenya (Muguga nature reserve). Dry sub-humid to semi-arid eco-zone, mean annual rainfall of 970 mm and mean monthly temperature of 16°C. Rainfall is bimodal but the 'short' rains (October to December) are less reliable.

SOILS

The soils are red, well drained, fertile volcanic loams but with high clay content at lower depths. The soils have mean organic matter content of 5.1 per cent throughout the profile to 6.0 cm depth and mean topsoil (0-30 cm) with pH of 5.6.

HABITAT

The tree is one amongst numerous species of small evergreen understorey trees occurring in the semi-deciduous forest of Central Kenya. This type of forest occurs in scattered patches at elevations of 1 550 to 2 150 m, between the lower edge of the montane conifer forest and the grass and open woodlands found at lower elevations. These forests were once abundant near Nairobi but many have now been cleared for settlement. In the Muguga area, the main overstorey species are Calodendrum capense, Croton megacarpus, Olea africana and Warburgia ugandensis. Juniperus procera was also common formerly, but has now mostly been felled. The trees are in dense shade in the wet season but are more exposed in dry weather when the Calodendrum and Croton of the overstorey are leafless. A small number of seedlings to 20 cm, can be found growing under the parent trees, but they are very sensitive to sun-scorch and apparently only a few survive to become adult.

SILVICULTURE

Raising seedlings is difficult. Germination and field regeneration are being studied. Measurements on growth are being taken on one plot in the Muguga Research Arboretum. Seedlings for another plot are being raised.

STATUS

Endangered.

REASONS FOR DECLINE

Settlement and clearing of forest.

PROTECTIVE MEASURES TAKEN

The species is presently known only from a part of Muguga Forest (Kenya), where 15.5 ha of indigenous forest has been retained as a nature reserve on the estate of the Kenya Agricultural Research Institute (1° 13'S, 36° 38'E, 2 100 m a.s.l.). Eight mature trees, over 4 m tall, are known and have been marked. Small seedlings can be found near the parent trees but do not appear to survive the dry season.

Gichuiro Forest (Kijueru), the typical locality, was situated 3 km to the South of Muguga but was cleared in 1941. The two type specimens from there, were the only known collections until 1967, and the species was thought to be extinct.

In 1967, a systematic collection was made by the East African Herbarium in the Muguga nature reserve, and the species was rediscovered.

A careful watch for ripe seed was maintained throughout 1972 and a collection made in June 1973 (E.A.A.F.R.O. Seed Batch No. 2412) from which 140 seedlings were raised. They are slow growing and very liable to sun-scorch. A preservation plot has been established in Muguga arboretum using this seed.

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Zeyhera tuberculosa Bur.[1/]

SYNONYMS

Bignonia tuberculosa Vell. (1835)
Zeyheria tuberculosa Bur. ex Ver. (1868)

FAMILY

Bignoniaceae

VERNACULAR NAMES

Ipê felpudo, bolsa-de-pastor, camaruçú, bucho-de-boi, ipê preto, ipê tabaco, ipê bóia, ipê combuca, ipê cabeludo, velame-do-mato.

BOTANICAL DESCRIPTION

General

Medium sized to large tree, 20 - 25 m in height and 50 - 80 cm in diameter; crown cone or pyramid shaped with ascendant branches and racemose ramification.

Inflorescence

A short, erect, pyramid-shaped, terminal panicle, dense, furry, formed of many tiny flowers 2 cm long, furry; calyx of two sepals, corolla funnel shaped, furry, furrowed, light brown outside and red-brown inside, with a yellow coloured throat; four stamens; flowering from December to February.

1/ Based on the work of M.Ferreira and H.F.Luz, Forestry Department, ESALQ/USP, P.O.Box 9, Piracicaba, SP, Brazil.

Fruit

A large woody, ovoid capsule, 15 x 10 cm; on the outside densely covered with short hairs, 1 cm thick, twisted, smooth inside; dehiscent, opening by two halves by a lengthwise split, exposing the septum or replum; dark and smooth where the seeds are fixed (more than 90), half on each side, in layers. Fructification is from July to October, and trees shed all leaves when the fruits are ripe, facilitating the dispersion of seeds by the wind.

Seeds: Winged, flat, heart-shaped, 2 cm in diameter, white, rough, surrounded by a thin and irregular circular wing, 4 to 5 cm in diameter, generally dark.

Foliage

Leaves terminal, opposite, digitate, with 5 folioles with petioles, large, 50 x 30 cm. Petiole thick, 25 cm long, round, furry. Folioles obovoid with a pointed apex and sinuous margins, sometimes serrated; upper side is dark green, opaque, rough, with ribs forming a dense network; beneath the leaves are a pale green, velvet-like, with protruding veins. Young leaves reach up to 90 x 50 cm.

Branches: Thick, cracked, rough; the younger branches covered with a brown-grey felt pubescence, which gradually becomes a tomentum that is dense, dark and rusty, covering all the extremities and the leaves.

Bark

Cylinder-shaped trunk, erect, long (more than 2/3 of each tree); very thick bark (5 cm), fissured, forming long lengthwise crests.

WOOD PROPERTIES AND PRODUCTS

Wood heavy (0.75 to 0.80 g/cm^3); burnt yellow heartwood, sometimes with green highlights, which changes, when exposed, to a brown-yellow; uniform; irregular surface, shiny, smooth; fibrous aspect, lessening in some samples; medium texture; grain straight, indistinct odour, a slightly bitter taste. Resistant and durable.

Commonly used in civil construction. As this is a tree with a very resistant wood with a long and very straight trunk, several other uses are recommended, such as for fence posts, sleepers etc. Is also used for tool handles, tiles, fuel wood etc.

Other Uses

Leaves of the young trees are eaten by cattle during dry periods. They are non-poisenous to animals.

NATURAL DISTRIBUTION

The tree occurs in the southeastern region of Brazil (States of Minas Gerais, São Paulo, Rio de Janeiro and Espírito Santo).

SOIL AND CLIMATE

It is found in various climates, such as tropical humid (rain forests), tropical hot and dry with rains only in the summer (dry forests and "cerrados"), and tropical at altitudes with frequent frosts (mountain ridge and meridional forests). Adapted to all soil types, but is generally found in poor shallow soils, such as lithosols and much eroded podzolic soils, almost always in granite rock regions.

HABITAT

It is a pioneer species in altered ecosystems (pastures, secondary forests), presenting abundant natural vegetation, forming large homogeneous stands (there are no known pests or diseases).

SEED HANDLING

Seeds last, at the most, 18 months, when stored in a cool and dry chamber (18°C and 60% of relative humidity). Do not have dormancy; germinate easily within 10-20 days, when placed on a shallow layer of soil and/or straw.

SILVICULTURE

As this species is not widely cultivated and studies are only in the initial phase, no information on silviculture is available.

STATUS AND REASONS FOR DECLINE

Stands are being cut down and even becoming extinct due to advancing agricultural, livestock and charcoal making activities, that are very intense in the region of natural occurrence of this species.

PROTECTIVE MEASURES TAKEN

Through a contract between the Escola Superior de Adgricultura "Luiz de Queiroz" ESALQ/USP, the Instituto de Pesquisas e Estudos Florestais (IPEF) and the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), 7 populations were located and registered in distinct

ecological regions of the States of Minas Gerais, São Paulo, Espírito Santo and Rio de Janeiro, with selection and identification of 80 trees.
A trial of 5 provenances with 55 progenies was established as a genetic conservation measure by ESALQ.

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