

# Food and fruit-bearing forest species

3: Examples from Latin America

Forest Resources Development Branch  
Forest Resources Division  
FAO Forestry Department

FAO  
FORESTRY  
PAPER

**44/3**



FOOD  
AND  
AGRICULTURE  
ORGANIZATION  
OF THE  
UNITED NATIONS  
Rome, 1986

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

M-32  
ISBN 92-5-102372-7

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying or otherwise, without the prior permission of the copyright owner. Applications for such permission, with a statement of the purpose and extent of the reproduction, should be addressed to the Director, Publications Division, Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla, 00100 Rome, Italy.

© FAO 1986.

ABSTRACT

These monographs of 74 food and fruit-bearing forest species were prepared under the auspices of FAO, by the Instituto Nacional de Pesquisas da Amazonia (INPA), Manaus, Brazil. Besides botanical and vernacular (South American and Caribbean) nomenclature and detailed descriptions, the illustrated monographs provide information, where possible, on the ecology, distribution, nutritional value and main uses of the species described.

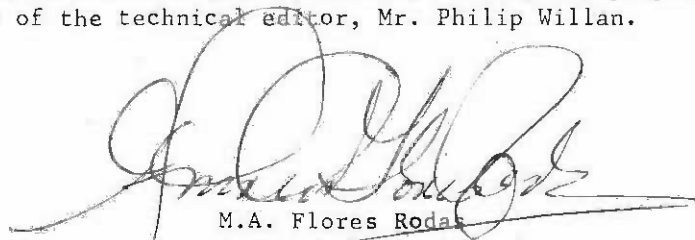
FOREWORD

In many developing countries rural populations derive a significant part of their food and energy requirements from trees. The variety and nature of food and food products obtained from trees are not fully appreciated. Many of these fruit-bearing species occur naturally in forest environments, and better knowledge of the potential of these species and of their capacity to contribute to food production will enhance efforts to conserve forests or woodlands and make them more productive.

The introduction of forest food and fruit species to agricultural areas and their possible domestication and improvement through breeding offer considerable possibilities, not only in the improved nutrition of rural populations but also in economic terms through the provision of cash incomes from the sale of raw fruits or processed products.

Monographs on forest food and fruit species are a useful aid to government extension agents, workers and specialists in programmes dealing with forest management and forestry for local community development, as well as to those interested in the conservation of natural resources.

These species descriptions are the third in a series of three entitled "Food and Fruit-Bearing Forest Species" covering the major tropical regions of the world. FAO acknowledges the work of Messrs. D.B. Arkcoll, C.R. Clement and P.B. Cavalcante of the Instituto Nacional de Pesquisas da Amazonia (INPA), Manaus, Brazil, who prepared the monographs with the assistance of the technical editor, Mr. Philip Willan.



M.A. Flores Roda  
Assistant Director-General  
and  
Head of the Forestry Department

TABLE OF CONTENTS

	<u>Page</u>
ABSTRACT	iii
FOREWORD	v
LIST OF PLATES	ix
INTRODUCTION	1
SPECIES MONOGRAPHS	
<u>Acrocomia aculeata</u>	3
<u>Alibertia edulis</u>	7
<u>Ambelania acida</u>	11
<u>Anacardium giganteum</u>	15
<u>Anacardium occidentale</u>	19
<u>Ananas comosus</u>	25
<u>Annona montana</u>	29
<u>Annona muricata</u>	33
<u>Antrocaryon amazonicum</u>	37
<u>Astrocaryum aculeatum</u>	41
<u>Bactris gasipaes</u>	45
<u>Bactris maraja</u>	49
<u>Bertholletia excelsa</u>	53
<u>Borojoa sorbilis</u>	57
<u>Byrsonima crassifolia</u>	61
<u>Campomanesia lineatifolia</u>	65
<u>Carica papaya</u>	69
<u>Caryocar brasiliense</u>	73
<u>Caryocar glabrum</u>	77
<u>Caryocar villosum</u>	81
<u>Caryodendron orinocense</u>	85
<u>Cassia leiandra</u>	89
<u>Couepia bracteosa</u>	93
<u>Couepia edulis</u>	97
<u>Couepia longipendula</u>	101
<u>Couepia subcordata</u>	105
<u>Couma utilis</u>	109
<u>Elaeis oleifera</u>	113
<u>Endopleura uchi</u>	117
<u>Erisma japura</u>	121
<u>Eugenia stipitata</u>	125
<u>Eugenia uniflora</u>	129
<u>Euterpe oleracea</u>	133
<u>Euterpe precatoria</u>	137
<u>Genipa americana</u>	141

	<u>Page</u>
<u>Gnetum nodiflorum</u>	145
<u>Hancornia speciosa</u>	149
<u>Hevea brasiliensis</u>	153
<u>Hymenaea courbaril</u>	157
<u>Inga edulis</u>	161
<u>Inga macrophylla</u>	165
<u>Jessenia bataua</u>	169
<u>Lecythis usitata</u>	173
<u>Malpighia puniceifolia</u>	177
<u>Manilkara elata</u>	181
<u>Mauritia flexuosa</u>	185
<u>Mauritiella armata</u>	189
<u>Maximiliana maripa</u>	193
<u>Mouriri apiranga</u>	197
<u>Myrciaria dubia</u>	201
<u>Oenocarpus bacaba</u>	205
<u>Orbignya barbosiana</u>	209
<u>Pachira aquatica</u>	213
<u>Platonia esculenta</u>	217
<u>Poraqueiba sericea</u>	221
<u>Pourouma cecropiifolia</u>	225
<u>Pouteria caimito</u>	229
<u>Pouteria macrocarpa</u>	233
<u>Pouteria macrophylla</u>	237
<u>Pouteria pariry</u>	241
<u>Pouteria speciosa</u>	245
<u>Pouteria ucuqui</u>	249
<u>Psidium angulatum</u>	253
<u>Psidium guajava</u>	257
<u>Psidium guineense</u>	261
<u>Quararibea cordata</u>	265
<u>Rheedia macrophylla</u>	269
<u>Rollinia mucosa</u>	273
<u>Scheelea martiana</u>	277
<u>Spondias mombin</u>	281
<u>Talisia esculenta</u>	285
<u>Theobroma bicolor</u>	289
<u>Theobroma cacao</u>	293
<u>Theobroma grandiflorum</u>	297
 BIBLIOGRAPHY	 301

LIST OF PLATES

BOTANICAL DESIGN/PHOTO CREDITS

Plate I	<u>Acrocomia aculeata</u> (Jacq.) Lodd.	
I <sub>1</sub>	Mature palm tree	Arkcoll D.B.
2	Fruit whole and section	Arkcoll D.B.
3	Flowering parts	
	1. Part of empty male flowering branchlet	
	2. Male flower	{ Pomona College
	3. Male flower showing stamens and sterile ovary	{ Journal of Economic Botany. USA 1911
	4. Female flower	
	5. Section of corolla	
	6. Detached ovary during anthesis	
Plate II	<u>Alibertia edulis</u> (L. Rich) A. Rich	
II <sub>1</sub>	Flowering branch	INPA (Instituto Nacional de Pesquisas de Amazonica, Manaus, Brazil)
2	Fruiting branch	
Plate III	<u>Ambelania acida</u> (Aubl.)	
III <sub>1</sub>	Flowering branch	INPA
2	Fruit whole and section	INPA
Plate IV	<u>Anacardium giganteum</u> Hanc. Engler	
IV <sub>1</sub>	1. and 2. Fruit whole and section	Cavalcante P.B.
	3. Flower	
	4. Leaves	
	5. Inflorescence	
	6. Male and female flower parts	
2	Fruit	Cavalcante P.B.
Plate V	<u>Anacardium occidentale</u> L.	
V <sub>1</sub>	Fruiting branch	Cavalcante P.B.
2 & 3	Bisexual and male flowers	
4	Fruit	
5	Leaves	
Plate VI	<u>Ananas comosus</u> (L.) Merrill.	
VI <sub>1</sub>	Fruiting plant	Clement C.R.
2	Mature fruit. Manaus, Brazil	Clement C.R.
3	Flower	Purseglove J.W. Tropical crops: Monocotyledons

- Plate VII     Annona montana Macf.
- VII<sub>1</sub>     1. Fruit     Cavalcante P.B.  
          2. Flower  
          3. Male and Female flower parts a), b)  
          4. Internal Petal  
          5. Stamen  
          6. Seed  
          7. Leaf
- 2 Six year old tree in production.     Clement C.R.  
                  Height 4 m.
- 3 Nearly mature fruit, split to show seeds.     Clement C.R.  
                  Manaus, Brazil.
- Plate VIII     Annona muricata L.
- VIII<sub>1</sub>     1. Flowering branch     Cavalcante P.B.  
          2. Seeds  
          3. 4. Internal and external petals  
          5. Fruit  
          6. Male and female flower parts a), b)  
          7. Stamens
- 2 A six year old tree in production     Clement C.R.
- 3 Mature fruit and split fruit showing     Ferreira S.A.N.  
                  borer attack - a serious problem in  
                  Soursop. Manaus, Brazil.
- Plate IX     Antrocaryon amazonicum (Ducke) B.L. Burtt & A.W. Hil.
- IX<sub>1</sub>     1. Leaves     Cavalcante P.B.  
          2. Fruit  
          3. Stone
- 2 Leafless tree     Arkcoll D.B.
- Plate X     Astrocaryum aculeatum G.F.W. Meyer
- X     1 Mature palm tree  
          2 Fruit whole and section     Arkcoll D.B.  
          3 Fruit on sale in a market in Brazil
- Plate XI     Bactris gasipaes Kunth
- XI<sub>1</sub>     1 Mature palm tree  
          2 Fruit whole and sections     Arkcoll D.B.  
          3 Fruit on sale in a market in Brazil
- Plate XII     Bactris maraja Martius
- XII<sub>1</sub>     1 Mature palm tree, left along roadside after     Costa J.T.M.  
                  cutting surrounding forest. Conceição de Angina,  
                  Para, Brazil



Plate XIII Bertholletia excelsa Humb & Bonpl.

- XIII<sub>1</sub> 1. Cross section of ovary  
2. Corolla and male flower  
3. Scale  
4. Flower showing stamens  
5. Longitudinal section of ovary  
6. Section of petiole  
7. Stamens  
8. Flowering branch  
Cavalcante P.B.
- 2 Mature tree  
Arkcoll D.B.
- 3 Fruit and nuts [Brazil nuts]  
Arkcoll D.B.

Plate XIV Borojba sorbilis (Huber) Cuatrec.

- XIV<sub>1</sub> 1 Leaves  
INPA
- 2 Fruit whole and section

Plate XV Byrsonima crassifolia (L.) Kunth

- XV<sub>1</sub> 1. Fruiting branch  
2. Flowering branch  
3. Flower  
4. Fruit  
5. Nut  
Cavalcante P.B.

Plate XVI Campomanesia lineatifolia Ruiz & Pavon.

- XVI<sub>1</sub> 1. Leaves  
2. Flower  
3. Fruit  
INPA
- 2 Mature fruits  
Cavalcante P.B.

Plate XVII Carica papaya L.

- XVII<sub>1</sub> 1 Fruiting plants  
Clement C.R.
- 2 1. Section of fruit  
2. Leaf  
3. Fruiting apex  
Purseglove J.W.  
Tropical crops:  
Dicotyledons 1976
- 3 Fruit of sunrise solo cultivar,  
Collected Belem, Brazil.  
Clement C.R.

Plate XVIII Caryocar brasiliense Cam.

- XVIII<sub>1</sub> 1. Section of fruit  
2. Fruiting branch  
3. Inflorescence and leaves  
Ribeiro J.F.

Plate XIX Caryocar glabrum (Aubl.) Pers.

- XIX<sub>1</sub> 1. Detail of flower  
2. Inflorescence and leaves  
3. Fruit  
Loureiro A.

- Plate XX Caryocar villosum (Aubl.) Pers.
- XX<sub>1</sub> 1 Mature tree along roadside after felling forest. Height 30 m. Manaus, Brazil Clement C.R.
- 2 1. Leaf Cavalcante P.B.  
2. Section of mesocarp and endocarp  
3. Whole fruit  
4. Fruit section
- 3 Mature fruit. Several fruit cut open to show mesocarp. Market "Vero-o-peso" Belem, Brazil. Clement C.R.
- Plate XXI Caryodendron orinocense Karst.
- XXI<sub>1</sub> 1 1. Leaves and fruit INPA  
2. Female flower  
3. Male flower  
4. Fruit section to show seed
- Plate XXII Cassia leiandra Benth
- XXII<sub>1</sub> 1 1. Fruit pods Cavalcante P.B.  
2. Leaves  
2 Tree Arkcoll D.B.  
3 Leaves, pods and seeds Arkcoll D.B.
- Plate XXIII Couepia bracteosa Benth
- XXIII<sub>1</sub> 1 1. Leaves Cavalcante P.B.  
2. Seed section  
3. Seed whole  
4. Fruit  
2 Tree Arkcoll D.B.  
3 Fruit. One partly cut to show seed Arkcoll D.B.
- Plate XXIV Couepia edulis (Prance) Prance
- XXIV<sub>1</sub> 1 Mature tree at Costanha di Côtia Brazil  
2 Leaves and fruit Arkcoll D.B.  
3 Fruit sections
- Plate XXV Couepia longipendula Pilger
- XXV<sub>1</sub> 1 1. Fruit Cavalcante P.B.  
2. Leaves and flowering branch  
2 Young tree Arkcoll D.B.  
3 Fruits sectioned to show seeds  
4 Fruiting branch
- Plate XXVI Couepia subcordata Benth ex Hook f.
- XXVI<sub>1</sub> 1 Tree Arkcoll D.B.  
2 1. Seed Cavalcante P.B.  
2. Fruit  
3. Leaves  
3 Fruits. Section of fruit to show seed Arkcoll D.B.

Plate XXVII Couma utilis (Mart.) Muell. Arg.

- XXVII<sub>1</sub> 1. Stigma Cavalcante P.B.  
2. Gynaecium  
3. Flora  
4. Fruiting branch  
2 Mature tree Arkcoll D.B.  
3 Leaves, flowers and fruit

Plate XXVIII Elaeis oleifera (Kunth) Cortéz

- XXVIII<sub>1</sub> 1 Young palm tree Arkcoll D.B.  
2 Fruiting bunch and split fruit to show mesocarp and endocarp

Plate XXIX Endopleura uchi (Huber) Cuatrecasas

- XXIX<sub>1</sub> 1. 2. Fruit whole and with part of pericarp removed Cavalcante P.B.  
3. Endocarp  
4. Section of endocarp  
5. Flower  
6. Stamen  
7. Section of ovary  
8. Flowering branch  
2 Tree FAO

Plate XXX Erisma japura Spruce ex Warm

- XXX<sub>1</sub> 1 Leaves INPA  
2 Fruit

Plate XXXI Eugenia stipitata McVaugh

- XXXI<sub>1</sub> 1. Leaves Cavalcante P.B.  
2. Fruit  
3. Flowers  
4. Seed  
2 Tree 4 years of age, in production. Height 2 m. Clement C.R.  
3 Mature fruit. One fruit sectioned to show mesocarp and seeds. Manaus, Brazil

Plate XXXII Eugenia uniflora L.

- XXXII<sub>1</sub> 1. Flower Cavalcante P.B.  
2. Fruit  
3. Seed  
2 Young tree Arkcoll D.B.  
3 Leaves and fruit

Plate XXXIII Euterpe oleracea Martius

- XXXIII<sub>1</sub> 1 Young palm tree 5 year old. Height 4 m. Clement C.R.  
2 Fruit on sale in the market "Vero o peso" Belem, Brazil.

Plate XXXIV Euterpe precatória Martius

- XXXIV<sub>1</sub> 1. Mature tree in production, left standing when the area was cleared for housing. Height 10 m.

Clement C.R.

Plate XXXV Genipa americana L.

- XXXV<sub>1</sub> 1. Fruit  
2. Seed  
3. Section of fruit  
2 Tree  
3 Fruit on sale in the market

Cavalcante P.B.

Cavalcante P.B.

Plate XXXVI Gnetum nodiflorum Brongn

- XXXVI<sub>1</sub> 1. Female flower  
2. Male flower  
3. Flowering branch  
4. Fruit

INPA

Plate XXXVII Hancornia speciosa Gomez

- XXXVII<sub>1</sub> 1. Flower  
2. Leaves  
3. Fruit

Cavalcante P.B.

Plate XXXVIII Hevea brasiliensis (Willd. ex A. Juss) Muell Arg.

- XXXVIII<sub>1</sub> 1. Fruiting branch  
2. Inflorescence  
3. Seed  
2 Seeds collected at Curupa, Brazil  
3 Mature tree being tapped for rubber

Purseglove J.W.  
Tropical crops:  
Dicotyledons

Clement C.R.

Plate XXXIX Hymenaea courbaril L.

- XXXIX<sub>1</sub> 1. Seed pod  
2. Flowering branch  
2 Tree  
3 Seed pods opened to show powdery pulp around seeds and germinated seed

Cavalcante P.B.

Arkcoll D.B.

Plate XXXX Inga edulis Mart.

- XXXX<sub>1</sub> 1. Fruit  
2. 3. Seed  
4. Leaves  
5. Flower  
6. Anther  
2 Pods and seeds  
3 Tree

Cavalcante P.B.

Arkcoll D.B.

Plate XXXXI Inga macrophylla Kunth

- XXXXI<sub>1</sub> 1. Leaves and inflorescence  
2. Seed pod

Cavalcante P.B.

- Plate XXXXII Jessenia batava (Martius) Burret  
XXXXII<sub>1</sub> 1 Mature palm tree  
2 Fruit whole and split  
3 Fruit on sale in the market  
Arkcoll D.B.
- Plate XXXXIII Lecythis usitata Miers  
XXXXIII<sub>1</sub> 1 1. Leaves  
2. Ovary  
3. 4. Stamens  
5. Androecium  
6. Fruit and operculum  
7. Section of ovary  
8. Seed  
2 Tree  
3 Fruit operculum and seeds  
4 Seeds  
Arkcoll D.B.
- Plate XXXXIV Malpighia punicifolia L.  
XXXXIV<sub>1</sub> 1 1. Leaves  
2. Flower  
3. Fruit  
4. Seeds  
INPA
- Plate XXXXV Manilkara elata (Fr. Allem ex Miq.) Monachino  
XXXXV<sub>1</sub> 1 1. Seed  
2. Leaves and inflorescence  
3.4. Fruit  
Cavalcante P.B.
- Plate XXXXVI Mauritia flexuosa L.f.  
XXXXVI<sub>1</sub> 1 The palm tree  
2 Fruit in the market  
Arkcoll D.B.
- Plate XXXXVII Mauritiella armata (Martius) Burret  
XXXXVII<sub>1</sub> 1 The palm tree  
2 Fruit in the market  
Cavalcante P.B.
- Plate XXXXVIII Maximiliana maripa (Correa da Serra) Drude  
XXXXVIII<sub>1</sub> 1 Palm tree  
2 Fruit bunches on palm  
3 Harvested fruit bunch with spathe  
4 Fruit ready for harvest  
Cavalcante P.B.
- Plate XXXXIX Mouriri apiranga Spruce ex Triana  
XXXXIX<sub>1</sub> 1 1. Leaves  
2. Fruiting branch  
INPA

Plate L Myrciaria dubia (Kunth) McVaugh

- L<sub>1</sub> 1. Leaves Cavalcante P.B.
- 2. Fruit
- 3. Flower
- 2 Tree { Clement C.R.
- 3 Fruit. Section to show edible pulp

Plate LI Oenocarpus bacaba Martius

- LI<sub>1</sub> 1 Young palm tree Arkcoll D.B.
- 2 Palm tree showing flowers and long bracts FAO
- 3 Fruit on inflorescence. Inflorescence up to 2 m length. Arkcoll D.B.

Plate LII Orbignya barbosiana Burret

- LII<sub>1</sub> 1 Palm tree with fruit Arkcoll D.B.
- 2 Fruit whole and in section

Plate LIII Pachira aquatica Aubl.

- LIII<sub>1</sub> 1. Fruit and leaf Cavalcante P.B.
- 2. Seeds
- 2 Tree { Levingstone R.
- 3 Leaves and immature fruit
- 4 Mature fruit { Cavalcante P.B.
- 5 Section of fruit and seeds

Plate LIV Platonia esculenta (Arruda da Camara) Richet and Starfleu

- LIV<sub>1</sub> 1. Flower without perianth Cavalcante P.B.
- 2. Flower buds
- 3. Flower
- 4. Leaf branch
- 5. Seed
- 6.7. Whole and sectioned fruit
- 2 Tree along road. Height 20 m. { Clement C.R.
- 3 Fruit on sale. One fruit parted to show mesocarp and seeds. "Vero o peso" Belem, Brazil

Plate LV Poraqueiba sericea Tulasne

- LV<sub>1</sub> 1 Young tree { Arkcoll D.B.
- 2 Fruit

Plate LVI Pourouma cecropiifolia Mart.

- LVI<sub>1</sub> 1. Leaf Cavalcante P.B.
- 2. Seed
- 3. Fruit branch
- 2 Tree { Clement C.R.
- 3 Flower and fruit branch

- Plate LVII Pouteria caimito (Ruiz & Pav.) Radlk
- LVII<sub>1</sub> 1. Flowering branch Cavalcante P.B.  
2. Seed  
3. Fruit  
4. Leaves
- 2 Tree in production. Six years old. Height 3 m {  
3 Mature fruit. Section of fruit to show mesocarp {  
and seed. Manaus, Brazil Clement C.R.
- Plate LVIII Pouteria macrocarpa (Huber) Baehni
- LVIII<sub>1</sub> 1. Fruiting branch INPA  
2. Flower  
3. Seed
- 2 Fruit Cavalcante P.B.
- Plate LIX Pouteria macrophylla (Lam.) Eyma
- LIX<sub>1</sub> 1. Flowers Cavalcante P.B.  
2. Fruiting branch  
3. Fruit  
4. Seed
- Plate LX Pouteria pariry (Ducke) Baehni
- LX<sub>1</sub> 1. Leaves INPA  
2. Fruit  
3. Seed
- Plate LXI Pouteria speciosa (Ducke) Baehni
- LXI<sub>1</sub> 1. Leaves Cavalcante P.B.  
2. Flower  
3. Ovary  
4. Open corolla  
5. Fruit  
6. Seed
- Plate LXII Pouteria ucuqui Pires & Schultes
- LXII<sub>1</sub> 1. Leaves INPA  
2. Seed  
3. Flower  
4. Ovary  
5. Fruit
- Plate LXIII Psidium angulatum D.C.
- LXIII<sub>1</sub> 1. Leaves INPA  
2. Flower  
3. Fruit
- 2 Four year old plant in production {  
3 Fruit sectioned to show mesocarp and seeds {  
Clement C.R.

Plate LXIV Psidium guajava L.

- LXIV<sub>1</sub> 1. Leaves  
2. Section of fruit  
3. Flower
- 2 Six year old tree in production. Height 2 m.  
3 Yellow fruited guava. Tefe, Amazonas, Brazil

Purseglove J.W.  
Tropical crops:  
Dicotyledons 1976  
Clement C.R.  
Pinedo M.H.

Plate LXV Psidium guineense Sw.

- LXV<sub>1</sub> 1. Flowering branch  
2. Floral bud section  
3. Section of fruit  
4. Fruiting branch
- 2 Four year old tree in production. Height 2 m.

Cavalcante P.B.

Clement C.R.

Plate LXVI Quararibea cordata (Humb & Bonpl) Vischer

- LXVI<sub>1</sub> 1. Leaf  
2. Flower  
3. Cut away section of fruit
- 2 Twenty year old tree in production. Height 21 m.  
"Terra preto do indio" Tefe, Amazonas, Brazil
- 3 Mature fruit. Average weight 400 g. From tree  
in 2 above.

Clement C.R.

Plate LXVII Rheedia macrophylla (Mart.) Planch & Triana

- LXVII<sub>1</sub> 1. Male flower  
2. Female flower  
3. Stamen  
4. Stamenoid  
5.6. Fruit  
7. Sectioned fruit  
8. Seed  
9. Leaves
- 2 Four year old tree. Height 3 m.
- 3 Fruit. One sectioned to show mesocarp  
and seeds. Market "Vero-o-peso"  
Belem, Brazil

Cavalcante P.B.

Clement C.R.

Plate LXVIII Rollinia mucosa (Jacq.) Baill.

- LXVIII<sub>1</sub> 1. Fruit  
2. Seed  
3. Flowering branch
- 2 Six year old tree in production. Height 6 m.
- 3 Mature fruit. Weight 4 kgs. Collected near  
Iquitos, Brazil

Cavalcante P.B.

Clement C.R.

Ferreira S.A.N.

Plate LXIX Scheelea martiana Burret

- LXIX<sub>1</sub> 1. Mature palm tree  
2. Trunk with fruit bunches  
3. Fruit bunch

FAO

Cavalcante P.B.



Plate LXX Spondias mombin L.

- LXX<sub>1</sub> 1. Flowering branch  
2. Leaves  
3. Fruit  
2 Mature tree  
3 Fruiting branch  
4 Fruit

{ Arboles communes de  
Puerto Rico y les  
Islas Virginias

{ Arkcoll D.B.

Plate LXXI Talisia esculenta (St Hil.) Radlk.

- LXXI<sub>1</sub> 1. Flowering branch  
2. Fruit  
3. Seed  
2 Fruiting branch

{ Cavalcante P.B.

Plate LXXII Theobroma bicolor Humb & Bonpl.

- LXXII<sub>1</sub> 1. Leaves. Smaller leaf, adult leaf  
2. Fruit  
2 Four year old tree in full sun -  
the reason for its poor growth.  
Height 2 m.

INPA

Clement C.R.

Plate LXXIII Theobroma cacao L.

- LXXIII<sub>1</sub> 1. Leaf  
2. Fruit  
2 Six year old tree in production. Height 2 m.  
3 Mature fruit in the market. Manaus, Brazil

INPA

{ Clement C.R

Plate LXXIV Theobroma grandiflorum (Willd ex Spreng) Schum.

- LXXIV<sub>1</sub> 1. Flower from top  
2. Flower from side  
3. Fruit  
2 Eight year old tree in full sun. Height 3 m.  
3 Mature fruit sectioned to show mesocarp and seeds.

Cavalcante P.B.

{ Clement C.R.

## INTRODUCTION

The Amazon basin, the drainage area of the Amazon river, covers 7 million square kilometres and contains one third of the world's remaining tropical rain forest. Within these forests there is a remarkable diversity of plants - more than in any comparable rain forest elsewhere in Africa or Asia. Many of these plants have great promise for food, fibre, fuel, drugs and chemicals.

It is a disturbing fact that the majority of the world's population rely for their food upon fewer than two dozen plant species. Scientists have realised that this narrow food base should be widened. Amazonian plants have a great potential as new food sources. Rubber, cocoa and pineapples originated in Amazonia and have been among the region's most important contribution to the world's economy. Other species could make an equally great contribution under cultivation both within Amazonia and elsewhere in the tropics. However, rapid destruction of the rainforest is threatening the extinction of many species before their potential can be realised. Increased efforts are needed to conserve and wisely utilize the forest habitat in which these species occur.

These species monographs with their descriptions and illustrations cover the natural distribution; forest type and occurrence in natural stands; collection and processing of edible parts; nutritional value; natural and artificial regeneration and where possible economic importance. The botanical descriptions and illustrations will assist in identifying the species and promoting an appreciation of their usefulness - both factors of immediate interest to the immigrant settler, extension worker and the forest manager who may not possess the knowledge of forest species and their uses held by local inhabitants of long standing.

Many of the species provide a supplement to largely starchy diets based on subsistence crops. When other means fail local inhabitants can often rely for survival on the presence of these forest species.

The selection and promotion of species for private growing or community plantations must always consider the nutritional value of the produce in relation to the needs of the community. Different parts of the plant will yield more calories and vitamins than others and national institute nutritionists should be consulted on how to incorporate these plant parts into the diets and needs of the local populations.

It should be remembered that impoverished rural dwellers often do not have the means to convert food into sophisticated preparations, which may not, in any case, form part of their normal diet. Fruits or plant products requiring this type of preparation may not therefore be of much local value unless included in a cooperative scheme which could organize and finance the necessary processing and thereby provide income opportunities for local communities. The arrangement of practical courses and demonstrations in this aspect may form a key part of the species introduction effort, following establishment of demonstration plots of the various species or the collection of products from natural food and fruit bearing plants.

1. ACROCOMIA ACULEATA

- 1.0 NAMES: Family Palmae  
Botanical Acrocomia aculeata (Jacq.) Lood (and closely related species).  
Synonyms See notes under ecology and distribution  
Vernacular macaya oil, butter tree, Paraguay palm, macaw palm (English); macaúba, macaiba, macajã, ubã, grou grou, noz do paraguai, mbocaya, bacaiuva, coco-baboso, coco de catarro (Brazil); coyol, palma de viño (Central America); corozo (Venezuela); gru gou, catey (Dominican Republic); mbocaiã, cayiete, ocori, coquito (Paraguay and Argentina); totai, cayara (Bolivia); palmiste epineux (Martinique); orotaiç, mbocaya (Amerindian).

2.0 ECOLOGY AND DISTRIBUTION

Acrocomia aculeata (including closely related taxa) is tolerant of very poor soils but grows better in more fertile areas. It is very common in savanna regions as it resists fire and can tolerate 4-6 months drought; it does not tolerate waterlogging. It does not occur in high forest but becomes increasingly abundant in cleared areas in the humid tropics of the Amazon. It is usually associated with a rainfall of between 1000 and 2500 mm and will tolerate occasional frost. Usually it occurs scattered at densities of up to 20 trees per hectare over large areas, but can occur locally in dense groves of 100 or more trees.

It and very closely related (probably not distinct) species occur from Mexico to Argentina. A. aculeata itself was described from Martinique and Dominica; A. lasiospatha Mart. from the Guyanas; A. totai Mart. from Paraguay and Argentina; A. mexicana Karw. ex Mart. from Mexico, and numerous other taxa from elsewhere in South America. The genus is greatly in need of a revision.

3.0 DESCRIPTION

Single stemmed, moderate, spiny, monoecious palm. Stem erect to 15-20 m tall, often less, 30-50 in diameter, closely ringed with leaf scars and densely armed with spines; root system often much greater in diameter than the crown. Leaves reduplicate pinnate, c. 20-40 in the crown, grey-green, 3-5 m long, + curved; sheath c. 40 cm long, brown hairy, armed with black spines; petiole to 60 cm long, armed with black spines, rachis also spiny; leaflets c. 100-120 on each side of the rachis, c. 30-70 cm long, 3-5 cm wide, unarmed, held in various planes giving the leaf a plumose appearance. Inflorescence interfoliar, up to c. 150 cm long; peduncle c. 60 cm long, densely armed with long, black spines; first bract (prophyll) c. 50 cm long, + hidden, bristly and hairy; second bract to 130 cm, boat shaped, woody, beaked, brown woolly hairy and spiny, the inner surface cream-coloured, smooth; rachillae numerous, bearing female and male flowers near the base, male flowers only near the tip; flowers creamy-yellow, strong smelling (earthy smell), male c. 7 mm long, female c. 10 mm long. Fruit rounded, 3-6 cm in diameter, rarely up to 9 cm, dull green to brown; epicarp smooth, thin, rather hard but brittle; mesocarp 3-7 mm thick, green, cream-coloured, yellow or orange, mucilaginous, fibrous, oily; endocarp 3-4 mm thick, blackish-brown, very hard, with 3 pores; seed rounded, endosperm homogeneous.

Flowering usually occurs towards the end of the dry season; fruiting usually occurs between December and May.

4.0 MAIN USES

The mesocarp pulp is eaten after cutting or chewing off the exocarp. Edible oils can be extracted from both the pulp and the kernels. Trees can also provide palm hearts and it is also claimed that they may be used to produce a sago-like starch and palm wine; some tribes use the fruit pulp and others the stem starch and sugar, to make fermented drinks. Flavour: the pulp is slightly sweet and pleasant smelling but the mucilaginous and oily texture is only attractive to those very familiar with the fruit.

The mesocarp oil rancifies rapidly, soon after ripe fruit fall from the tree. They ripen unevenly. Oil is usually extracted with primitive cooking methods or presses for making soap after fermentation and drying in the sun for a few months. Pulp and kernel are often extracted together. About 2000t of dried fruit are processed each year in Brazil and rather more in Paraguay. Fruit are often eaten by cattle who use the pulp and then pigs who are able to get at the kernel. So they are considered a useful source of animal food on remote farms. The trunks are used for posts and buildings and the leaves for forage and fibre for baskets and hats.

#### 5. METHOD OF COLLECTION OF THE EDIBLE PART

Fruit drop to the ground when ripe and rot rapidly due to attack by saprophytic fungi. This leads to very high acid levels in pulp oils. Pulp oil contents are only high when fruit are ripe and this, together with their uneven ripening and the position of most bunches deep within the trees crown, makes harvesting of many fresh ripe fruit difficult. So all commercial production depends on very cheap labour collecting mainly old, rotten fruit from underneath trees. Wild trees with 8 and even 12 bunches have been reported and estimates of oil yields of over 5 t/ha have been made. Yields of 40 to 80 kg of fruit from wild trees, giving a potential oil yield of about 15 kg, are common. Yields are said to be cyclical, being high every third year.

#### 6.0 NUTRITIONAL VALUE

Composition varies considerably however a typical fruit weighs 40 g of which 26 g; is dry matter. The latter consists of 20% exocarp, 34% mesocarp, 39% endocarp and 7% kernel. These contain 5 to 10%, 56 to 70%, and 55 to 58% oil respectively. Total oil varies from 16 to 23% of fresh fruit weight and 25 to 34% of dry weight with about a sixth coming from the kernel. The pulp dry matter has 3.4% protein and there is often a small amount of sugar and carotene. So the fruit can be considered a good source of calories and some varieties supply reasonable amounts of vitamin A.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds germinate well after six months dormancy and then grow slowly for the first few years. They start to fruit between 4 and 6 years, depending on soil fertility, and are about 4m high at this time. No pests or disease problems have been reported so far from wild trees. A few very small experimental plantations have been installed, however trees are commonly left when clearing secondary regrowth and this, together with their ability to withstand fire, has increased their numbers in many areas.

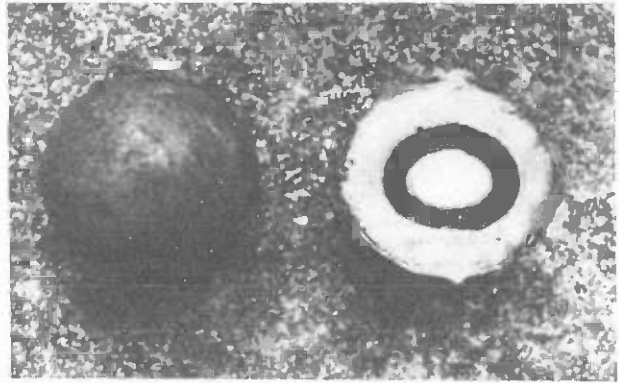
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

The fruit of this species has been, and still is in certain areas, an important item of the diet of some tribes. It is unattractive as a fruit but high oil content and potential yields are very interesting. Several research programmes are now in progress to improve current collection and extraction techniques in an attempt to make better use of the pulp oil. This is about 6 times that of the kernel oil but apart from the problems of harvesting ripe fruit and avoiding their rapid deterioration, the separation of pulp from the exocarp and endocarp and oil from mucilage and fibre is difficult unless the pulp is dry. Rapid blanching, specially developed de-pulpers, enzymic breakdown of mucilage and solvent extraction have been suggested and are now being examined. Resolving these processing problems together with the selection of high yielding precocious trees with longer harvesting periods and exposed bunches of uniformly ripening fruit, could lead to a very useful plantation crop over a very wide area too dry for Elaeis guineensis. The tree's production of stem starch and palm wine also deserves attention.

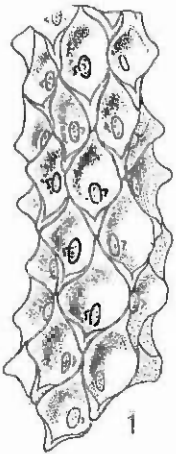
PLATE I. *Acrocomia aculeata* (Jacq.) Lodd.



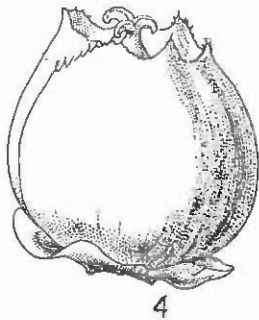
1



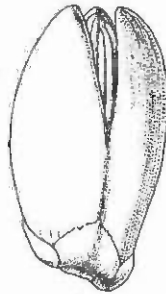
2



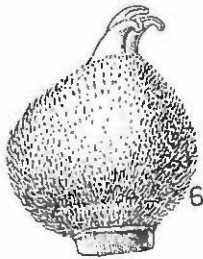
1



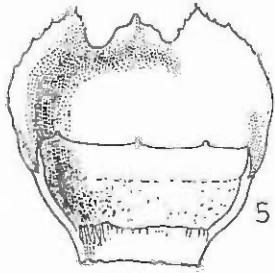
4



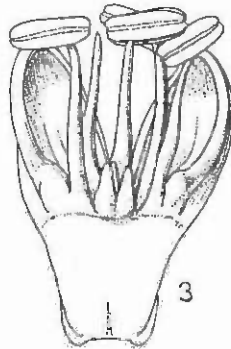
2



6



5



3

- I
- 1 - Mature palm tree
  - 2 - Fruit whole and section.
  - 3 - Flowering parts
  - 1. Part of empty male flowering branchlet
  - 2. Male flower
  - 3. Male flower showing stamens and sterile ovary
  - 4. Female flower
  - 5. Section of corolla
  - 6. Detached ovary during anthesis.

3

## 2. ALIBERTIA EDULIS

- 1.0 NAMES: - Family Rubiaceae  
Botanical Alibertia edulis (L. Rich.) A. Rich.  
Synonyms Genipa edulis L. Rich.  
Vernacular puruf, puruizinho, apuruf, marmelada (Brazil);  
goyave noire (French Guyana).

### 2.0 ECOLOGY AND DISTRIBUTION

Alibertia edulis occurs on nutrient poor oxisols and ultisols of the savannas, cerrados, open secondary growth and open forests that are periodically flooded but not waterlogged. Its rainfall requirements range between 1400 mm to over 3000 mm; the mean annual temperature throughout most of its range is c. 26°C but it can be as low as 13°C at Acre or 9.6°C at Belém. It has not been found fruiting about 800 m. In parts of its range it can occur in densities of 10-20 plants/ha over large areas; it is more commonly found in densities of 1-2 plants/ha.

The species appears to have originated in eastern Amazonia. It is now widely distributed throughout Amazonia, from east to west and southwards into Maranhão and Goiás states of Brazil and extending northward into French Guyana.

In the Amazonian region there are other edible species of A. edulis: A. acuminata (fruits red); A. concolor (fruits yellow); A. hispida and A. latifolia.

### 3.0 DESCRIPTION

Medium to large shrub 2-4 m high, rarely a small tree 6-8 m high; trunk usually straight with numerous, opposite and decussate branches; tap-root poorly developed, lateral roots extending to a depth of more than 1 m. Leaves opposite, simple; stipules triangular-acute or -acuminate, 6-8 mm long; petiole short; blade oblong-lanceolate, 8-25 cm long, 2-10 cm wide, apex acuminate, base cuneate to rounded, margins entire, subcoriaceous, smooth, glossy dark green above, dull below. Inflorescence: plant dioecious. Male flowers sessile, 6-8 in the axils of the terminal pair of leaves; calyx tubular, c.4 mm long, shallowly lobed; corolla salverform, white, c.25 mm long, sericeous; stamens 4-5, inserted in the upper part of the corolla tube, anthers sessile, 9 mm long, disk reduced, depressed, entire. Female flowers subsessile, 1-2, terminal; corolla 4 times the length of the calyx, lobes 4-5, equalling the tube; ovary ovoid-globose, 6 mm in diameter, smooth, 4-locular with numerous ovules, style exerted from the corolla tube. Fruit a globose berry 2.5-3.5 (-5) cm in diameter, skin leathery somewhat rough turning smooth, medium brown at maturity, tubular calyx persisting; mesocarp brown, smooth to very slightly gritty, somewhat juicy pulp enveloping numerous seeds; seeds small, lens-shaped, 4-8 mm long, with fine stripes.

Flowering July to November with a second season in some areas from February to April; fruiting August to December and a possible second season from March to April.

### 4.0 MAIN USES

The soft mesocarp is the only edible product. The strong sub-acid flavor is quite agreeable to most palates and is very similar to the Borojoa patinoa of Colombia which is in a closely related genus. The mesocarp is occasionally eaten fresh. However, usually it is made into a weak juice sweetened to taste.

### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit may be collected directly from the bush as it ripens. Because of its acidity it can easily last a week before becoming over ripe. A 5-year old plant may produce 60 to 80 fruit during the 2 production seasons. A hectare at 5 x 5m spacing produces enough to supply a large village or small town.

#### 6.0 NUTRITIONAL VALUE

About 30% of the fruit is usable pulp. No information is available on its nutritional value but it is thought to be very high.

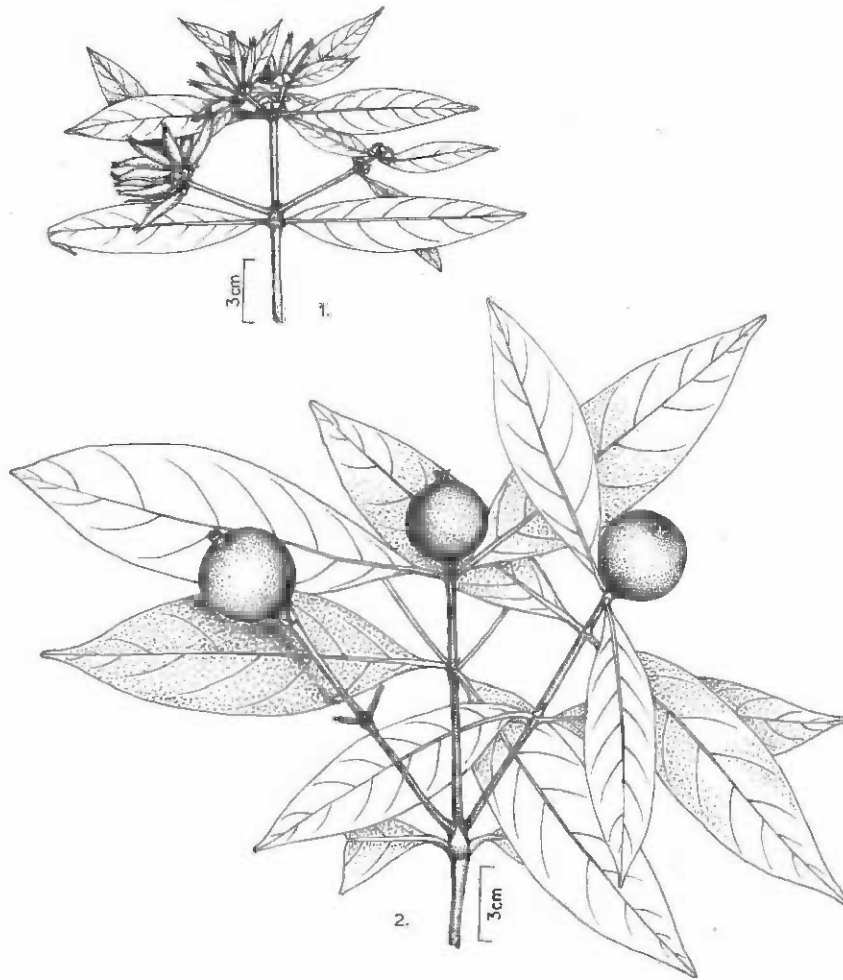
#### 7.0 CULTIVATION AND PROPAGATION METHODS

The seeds germinate rapidly (30 to 50 days) if sown soon after removal from the fruit. Initial growth in the nursery is slow as seed reserves are small. After some root development it starts to grow faster and may be hardened after 3 months. When the plant attains 50 cm in height it may be transplanted to the field. Initial field growth is rapid if planted with some manure. The first year may give 1 meter in height although it then grows less in height than in diameter. Five year old plants may be only 2 to 2.5 m tall but 1.5 to 2 m in diameter. Fruiting will begin in the second or third year in the field. No pests have been observed.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Fruits collected from the wild occasionally reach market. Because of its agreeable flavour, precocity and good production the puruf would appear to have some potential. For it to be developed extensive germplasm collection is necessary to find fruit with good flavour and a higher percentage of useable pulp. Agronomic and agro-industrial research will also be necessary to take this species beyond its present semi-wild, occasional-use status.

Plate II. *Alibertia edulis* (L. Rich) A. Rich



II  
1 - Flowering branch  
2 - Fruiting branch



### 3. AMBELANIA ACIDA

- 1.0 NAMES: Family Apocynaceae  
Botanical Ambelania acida Aubl.  
Synonyms Ambelania sagotii Muell. Arg.  
Ambelania tenuiflora Muell. Arg.  
Vernacular pepino-do-mato (Brazil, Amazonia); paraveris,  
quienbiendent (French Guyana).

### 2.0 ECOLOGY AND DISTRIBUTION

Ambelania acida occurs on moist, sandy clay soils with a thick humus layer or in semi-flooded areas as an understory shrub or small tree of the open high rain forest or high secondary vegetation known as "capoeirão". It is widely dispersed, generally present as isolated individuals but can occur in densities up to 3-4 plants/ha.

The pepino-do-mato is native to Amazonia, most frequently found in the estuary, but with a somewhat disjunct distribution within the northern part of the Amazonian region, with some penetrations into the Guyanas.

### 3.0 DESCRIPTION

Small shrub 1-3 m high or small tree up to 7 (-10)m; monopodial, trunk straight, slightly tapering towards the apex, bark thick, soft, lenticulate, and when cut emits copious, white, viscous latex; branches opposite, relatively thin and almost horizontal, forming a subpyramidal crown commencing half way from the ground; root system shallow, horizontal. Leaves opposite, arranged in 2 opposite rows, simple; stipules absent; petiole 1-2 cm long, grooved; blade elliptic to oblong-lanceolate, up to 24 cm long, 8.5 cm wide, apex shortly acuminate, base acute, margins entire, membranous, lateral nerves 7-24, parallel, delicate, inconspicuous. Inflorescence axillary, corymbose, 3-4 cm long, 2-10 flowered. Calyx lobes 5, ovate-acute, 1.5-2.8 mm long, 1-2 mm wide; corolla white, tube narrow, 10-15 mm long, lobes 5, 10-12 mm long, 2-2.5 mm wide; corolla white, tube narrow, 10-15 mm long, lobes 5, 10-12 mm long, 2-2.5 mm wide; stamens 5, inserted in the upper half of the tube; ovary 2-locular, ovules numerous. Fruit an oblong-ellipsoid berry 10-12 cm long; resembling a cucumber (Cucumis sativus), yellow when ripe, mesocarp sweet, slightly acid, seeds numerous, dark brown. Flowering August to October, with intensive flowering in September, occasionally some plants flower in December; fruiting begins in January.

### 4.0 MAIN USES

The edible part is the fleshy mesocarp, about 1 to 1.5 cm in thickness. The flavor is sweet, slightly acid, and agreeable. Before eating the fruit should be skinned and placed in water for a few minutes to remove the milky juice. The fruits of Ambelania acida are frequently consumed fresh, sometimes they are used to make salad mixed with other fruits. Some people cook the fruits before eating them.

There is information that the fruit is used as a remedy against coughing. According to Pio Correa (1974) the fruit contains 80% edible oil.

### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit may be collected directly from the tree when it becomes yellow. The yield is relatively small, considering that a tree produces only 15 to 20 fruits each crop.

### 6.0 NUTRITIONAL VALUE

No information is available.

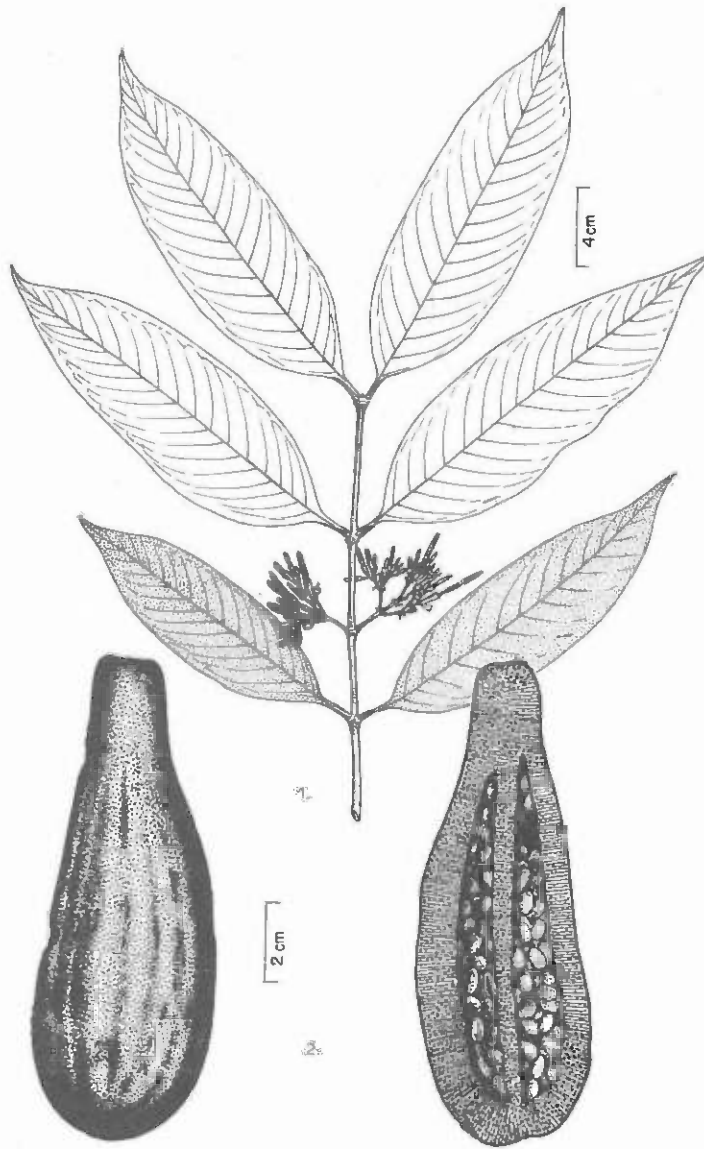
#### 7.0 CULTIVATION AND PROPAGATION METHODS

The pepino-do-mato is known only in the wild and there is no information concerning its cultivation. The only known way of propagation is by means of seeds, dispersed by forest animals. No information is available on the growth.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

It may not be possible to attain short-term satisfactory results with research on Ambelania acida as a marketable fruit, but at long or medium-term, agronomic studies on cultivation and selection to increase fruit production could warrant its commercialization. Despite the usual scarceness of the pepino-do-mato in local markets, this fruit is well known and reported as an excellent food.

Plate III. *Ambelania acida* (Aubl.)



III  
1 - Flowering branch  
2 - Fruit whole and section

#### 4. ANACARDIUM GIGANTEUM

1.0 NAMES      Family      Anacardiaceae  
                 Botanical Anacardium giganteum Hanc. ex Engler  
                 Vernacular cajui, cajuacu, caju-da-mata, oloi (Brazil, Tiriyo Indians).

#### 2.0 ECOLOGY AND DISTRIBUTION

Anacardium giganteum occurs mainly in the nonflooded areas of the rainforest but may sometimes be found on the high flood plains where the soils are only briefly waterlogged. It prefers clay soils but is not restricted to them. It thrives best in regions receiving about 2000 mm annual rainfall and with a mean annual temperature of 28°C. The species has not been found above 300 m.

The cajui is native to Amazonia and probably originated in the eastern part. It is now widely dispersed throughout the whole of the Amazon region, reaching the Guyanas in the north, Maranhão in the east and Mato Grosso in the south. The trees are quite common in Pará, especially in the estuary, in the lower Tocantine and Bragantina regions. It is also important to the indians in the Tumucumaque National Park, along the Paru de Oeste river.

The genus Anacardium contains over two dozen species most of which are found in Brazil. Only A. microcarpum and A. occidentale have edible fruit, besides A. giganteum.

#### 3.0 DESCRIPTION

Large, forest tree, 25-30 m high; trunk straight, up to c.1 m in diameter, bark thick, slightly rough; crown wide; root system large and deep. Leaves alternate, simple clustered at the branch tips; stipules absent; petiole up to 1.5 cm long; blade obovate, up to 20 cm long, 12 cm wide, apex rounded, base cuneate, margins entire, coriaceous, glabrous. Inflorescence a spreading, terminal panicle, the numerous secondary and tertiary branches arising at 90°; flowers fragrant. Calyx lobes 5, ovate-lanceolate, 2 mm long, 1 mm wide; petals 5, greenish-white or pink, turning red, oblong-lanceolate, 6-7 mm long, 2 mm wide, reflexed at anthesis; stamens 8 in male flowers, 1(-2) fertile with filaments 7-8 mm long, remainder shorter and sterile; ovary obliquely aoid, ovules 1, style robust, subulate. Fruit a kidney-shaped drupe 2.5 cm long with a resinous mesocarp and attached to and slightly immersed in an enlarged, reddish, succulent pedicel (false fruit) 7 cm long, 5 cm in diameter.

Flowering November to February, when the rains are beginning; fruiting December to April, the rainiest period in Amazonia.

#### 4.0 MAIN USES

Both the kernel and the enlarged peduncle (pseudofruit) are eaten as with the common cashew. The kernel resembles a small cashew nut and the acid-sweet red pseudofruit has a very pleasant smell and taste reminiscent of strawberries. The pseudofruit is used more than the nut, the latter roasted, and the pseudofruit fresh or as a juice. The Tiriyo indians from the Tumucumaque also ferment the juice to prepare a drink mixed with cassava, very appreciated.

The wood is sometimes used for interior building but is not considered to be of high value.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Ripe fruit are collected off the ground rapidly as they ferment fast. Yields: trees often fruit profusely but no details are available.

## 6.0 NUTRITIONAL VALUE

The pulp is very moist and succulent having less than 10% dry matter. Being seet, it provides some calories and will probably be a good source of vitamin C like A. occidentale. The kernels are a rich source of fat, calories and protein.

## 7.0 CULTIVATION AND PROPAGATION METHODS

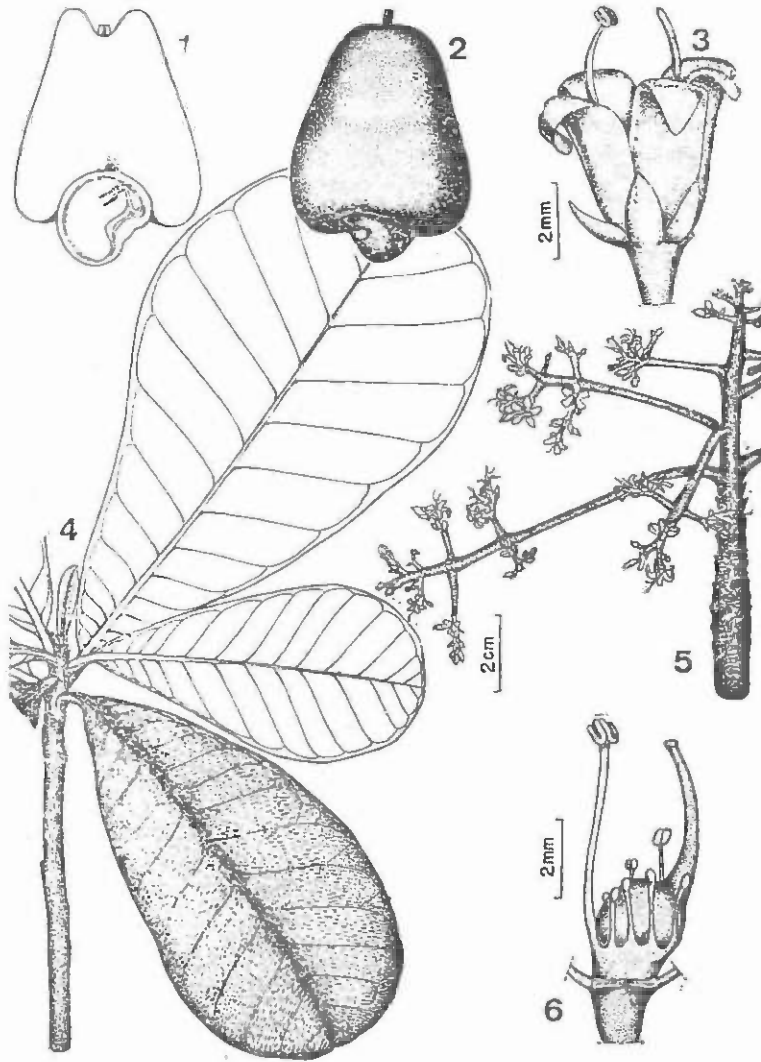
This species is rarely cultivated and so little information is available. Propagation is only by seeds which germinate rapidly in 6 to 8 days. Ducke (1939) reports some cultivated trees fruiting when small. An individual tree in the garden of Museu Goeldi fruited after 15 years when it was 20 m tall.

## 8.0 POTENTIAL ECONOMIC IMPORTANCE

The slow growth of the tree and late fruiting hinders the potential of this attractive fruit. It might be worth grafting good varieties onto precocious A. occidentale.

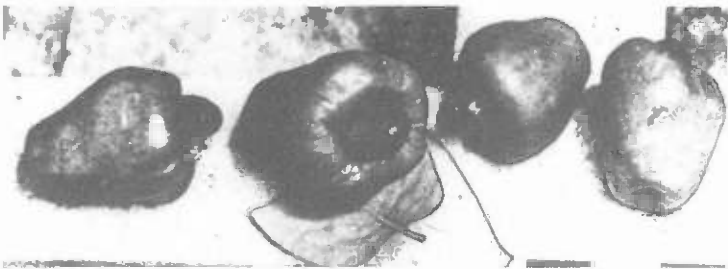
The tree is pretty in shape and colour with a Christmas tree appearance when fruiting, so it might make a useful ornamental.

Plate IV. *Anacardium giganteum* Hanc. Engler



I

IV 1 - 1 and 2. Fruit section and whole  
 3. Flower  
 4. Leaves  
 5. Inflorescence  
 6. Male and female flower parts



2 - Fruit

2

5. ANACARDIUM OCCIDENTALE

- 1.0 NAMES: Family Anacardiaceae  
 Botanical Anacardium occidentale L.  
 Vernacular caju, cajueiro (Brazil); cashew, cashew-nut, cashew-apple (English); cajuil, maranon (Spanish); Acajou (German); acajou à pomme, anacardier, noix d'acajou, pomme d'acajou (French); jocote marañon (Guatemala, Honduras, El Salvador); merey (Colombia, Venezuela); caju, casu (Peru); cashu, palu di cashupete, kasjoe, cashew, cherry (Dutch West Indies); kasjoe, boschkasjoe, mereke, orvi (Surinam); balubar, kasui (Philippines); caju-gaha, mundiri-maram (Sri-Lanka); kaju, hidglibadan (India).

## 2.0 ECOLOGY AND DISTRIBUTION

Anacardium occidentale prefers deep, fertile, sandy soils but will grow well on most soils except pure clays or soils that are otherwise impermeable, poorly drained or subject to periodic flooding. It grows well under a wide range of tropical and sub-tropical climates but is sensitive to low temperatures and freezing. It occurs under a wide range of rainfall conditions, from 500 to 4000 mm per annum, and according to Peixoto (1960), warm, humid climates favour normal growth and development. The cashew possesses considerable drought resistance and can grow on denuded hill slopes where no other form of viable cultivation is possible. The most favourable altitudes are from 0 to 500 m, although limited production is possible at altitudes of 1000 m.

The cashew is a native of tropical America and there is a strong indication that its centre of origin is the coastal strip of northern and north-eastern Brazil. It was introduced into India and probably Africa in the 16th century and is now found cultivated or naturalized in many tropical areas and on the numerous islands of the Pacific. It is cultivated in practically every country on the American continent. There is an estimated population of 50 million adult trees in northeast Brazil alone and it is suggested that this population would be even greater were it not for cutting for fuel or destruction by bush fires. The largest plantations and spontaneous stands are to be found in Africa, especially Mozambique, and India.

## 3.0 DESCRIPTION

An evergreen shrub or tree up to 15 m high; trunk usually tortuous and poorly developed, with loose branching, some lower branches rooting when in contact with the ground and sometimes resulting in large thickets. Leaves alternate, simple, clustered at the branch tips; stipules absent; petiole 1-3 cm long; blade broadly obovate to oblong-obovate, 6-25 cm long, 5-15 cm wide, apex obtuse, rounded or emarginate, base cuneate or rounded, margins entire, subcoriaceous, glabrous, lateral veins 9-17 pairs arranged almost at right angles to the midrib. Inflorescence a spreading, terminal panicle 10-25 cm long, bearing male and bisexual flowers; female and asexual flowers but with an abundance of male flowers have been reported by Alves (1971). Calyx lobes 5, lanceolate to oblong-ovate, 4-5 mm long, 1-2.2 mm wide; corolla greenish-white, red within, petals 5-6, linear-lanceolate, 7-13 mm long, 1-1.7 mm wide, reflexed at anthesis; stamens 7-10 in male flowers, 1-2 fertile with filaments 6-9 mm long, remainder sterile and filaments 2-3 mm long; ovary in bisexual flowers obliquely obovoid, ovules 1, style stout, 4 mm long. Fruit a greenish-yellow bean- or kidney-shaped drupe - 3-5 cm long with a resinous mesocarp and attached to an enlarged pedicel (false fruit) 6-8 cm long, 4.5 cm in diameter, yellow or red and with a somewhat spongy, juicy flesh when mature.

In the Amazon region flowering commences towards the end of the rainy season in May or June, bearing only male flowers at first, bisexual flowers appearing after some weeks; fruiting according to Calzavara (1973) varies from place to place in accordance with the dry season, in the coastal region of Brazil from September to December and from July to October further inland. The true fruit (drupe) attains its full size a few days after fertilization, the false fruit (pedicel) requiring 3 months to develop and mature.

#### 4.0 MAIN USES

There are two food products of the cashew: the peduncle or pseudo-fruit which is yellow or red, and contains an abundant sweet-astringent juice with a pronounced aroma and excellent flavour if consumed within three days of harvesting (the flavour alters after this period if the fruit is not properly stored under refrigeration). The edible part of the fruit, or nut, is the embryo, which is whitish in colour and practically odourless, with a sweet flavour reminiscent of the European chestnut or the hazelnut. Various products can be made from the cashew, the two best-known and most important being the pseudofruit and the nut. The former may be used as a natural fresh fruit or as jelly, compote, syrup or dried, either alone or "crystallized" with sugar. It is, however, best known and most commonly commercialized in the form of natural juice. The pasteurized and filtered juice produces a non-alcoholic home-made drink known as "cajuina", which is much appreciated. Through fermentation a fine, delicious wine may be obtained. The other product of the cashew, the nut, is considered more important due to its widespread acceptance and demand in the international market. The nuts, after roasting and processing, may be consumed alone, and are traditionally served as appetizers. They are also widely used in the bakery industry as a complement or filling in cakes, sweets and other products containing chocolate. The nut can be transformed into flour for pies with a high concentration of protein, or can be processed to produce an edible oil of high quality. The shell of the nut produces a caustic oily resin known as "cardoil" or "cashew nut oil" which is widely used in industry for the production of varnish, plastics, electrical and thermal insulation, brakes, insecticides and a range of other products.

In addition to the products already mentioned which come from the peduncle, nut and pericarp, the cashew produces a gum resin (cashew-gum), which exudes from the trunk. It has properties similar to gum arabic, for which it is a perfect substitute in book-binding, with the advantage that it protects against insect attack. This resin, dissolved in water is a home remedy against severe coughs. The bark from the trunk and branches is frequently used to make a solution which is used for swelling and throat irritation. The bark contains 3 to 5% tannin and is employed in the tanning industry. The wood is white and of good quality, but, given its tortuous and twisted growth habit, can only be used to make small items.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The harvest is done manually and requires a certain amount of care when the fruits are well ripe. It is sometimes necessary to use short ladders to reach all the fruits. The fruits may be picked slightly before fully ripening, which makes it easier to handle them without damage.

#### 6.0 NUTRITIONAL VALUE

The peduncle or pseudofruit contains approximately 86% juice, with 6.76% protein. The composition of 100 grams of juice, according to Dutra (cited in Peixoto) is as follows:

water .....	80 g
sugar .....	8.7 mg
fat .....	0.39 mg
calcium .....	18.00 mg
phosphorus .....	11.00 mg
iron .....	3.00 mg
protein .....	0.27 mg

Rabelo measured the level of vitamin C and tannins in green and ripe cashew and concluded that the mature fruits have greater content of vitamin C (4.224) and lesser content of tannin (1.622). Due to the high level of vitamin C and other components, the cashew has an excellent reputation in nutrition. R. Braga claims that weak, thin, exhausted or rheumatic people flock to the natural stands of cashew on the beaches of Sergipe during the summer in order to consume cashews in all of the available forms. When these people leave the area they are strong, well-fed and appear to be transformed.



Thus the cashew has a reputation as an excellent tonic and reconstituent. Feijao (1960) states that the nut, in addition to being nutritive, is endowed with invigorating properties and is efficient in treating impotence, weak minds, etc., and that the fruit, which is also invigorating, is a diuretic and aids in digestion.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

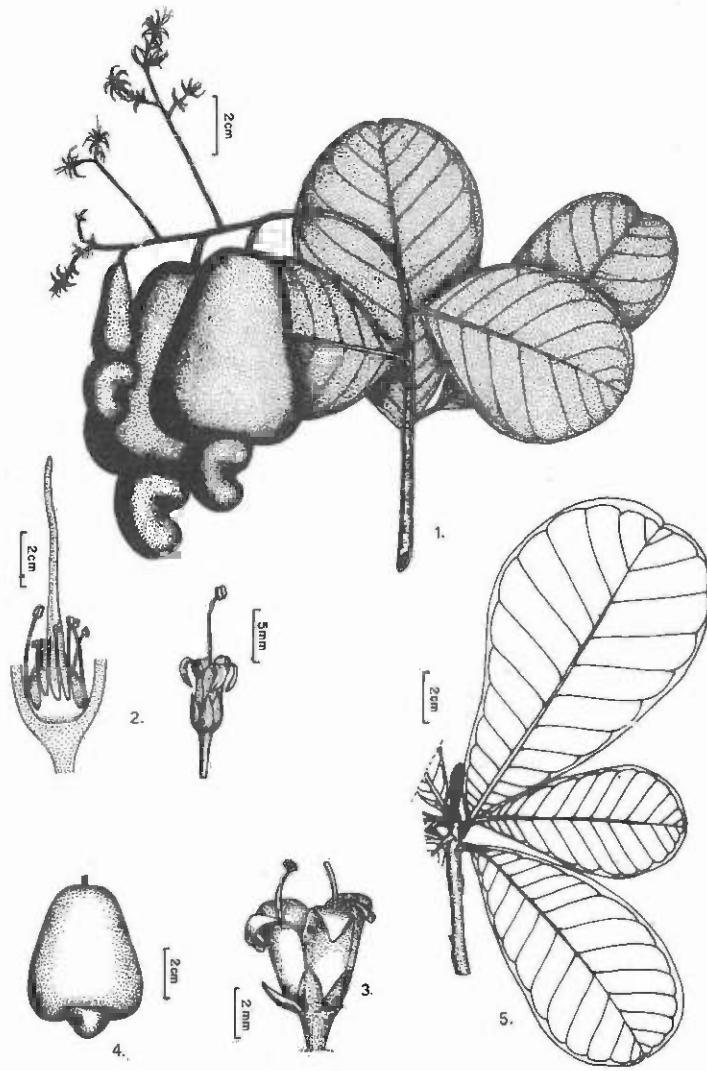
The cashew is a plant of relatively easy cultivation. Given its hardiness it does not require special or expensive treatment and is adapted to low fertility soils as long as they are well drained. Propagation is basically accomplished from seeds, although vegetative reproduction from cuttings can be practised with some success, with the advantage of avoiding inbreeding problems within a stand. Spacing within plantations depends on a number of factors. For homogeneous plantations, spacing of 5-6 m is recommended, provided that protection of the soil from excess insolation is taken care of. Greater spacing, for example every 10 m, permits interplanting with other, short-cycle crops, such as maize, potatoes, beans, etc.. In general terms, to form a plantation of cashews from seed, the first step is the selection of seed from vigorous, healthy, productive plants. The largest and best formed seeds available on such trees should be chosen to ensure vigorous seedlings. Before planting it is advisable to place the nuts in water for three days, which will permit germination two or three days later (Peixoto, 1960). If this is not done, germination will be delayed until the 15th to 20th day after planting (Calzavara, 1970). Experience indicates that individual recipients should be used for planting, and that these should be placed in the shade. The recipients should be made of material which decomposes easily so that they may be placed directly in the soil without damaging the roots. Two or three seeds should be placed in each recipient. The recipient should contain a mixture of earth with manure, and, if possible, a little ash. The seeds should be planted with the largest part uppermost at a depth of 3 cm. The holes for the final planting of the seedlings should be 40 to 50 cm wide and deep containing a good mixture of rich soil, preferably mixed with cattle or chicken manure. The best time to transplant is the rainy season (December to June in Amazonia), after the seedlings are about 50 cm tall. At this time selection should be made among the seedlings, leaving only the most healthy and vigorous. To protect and conserve humidity, mulch should be placed around the base of the seedling. Although a hardy wild plant, the cashew responds very well to culture techniques, such as weeding, at least at the initial phase of growth, pruning of branches below 1 m height, and thinning. In rich soils or those chemically fertilized the cashew grows rather rapidly, reaching up to two meters in height in the first year. In open areas with plenty of space, growth is primarily horizontal, and the width of the canopy of the tree may be twice the height. The cashew begins to produce commercially by the third year after planting, increasing gradually until the tenth. According to Calzavara (1970), production per plant is estimated at 70 to 80 kilos (peduncle and nut), of which 10% of the weight is nuts. Peixoto (1970) cites one adult tree of 12 to 15 years of age as having produced more than 4000 fruits with a total weight around 60 to 80 kilos. Johnson (1974) reports data for the production of nuts alone, stating that the majority of references estimate a production of 5 to 20 kilos. The Experimental Station of Pacajus, Ceará, has 13 selected trees under study which have an average annual production of 17.4 kilos. One tree at this station produces 48 kilos of nuts per year according to Pudine (1967) and Parente et al. (cited in Johnson).

Although its resistance is well-known, the cashew sometimes falls victim to plagues and diseases. Insects known as "white flies" (Aleurodicus cocois) damage the leaves; the "fruit beetle" (Hoplopyga sp.) attacks the peduncle when green; the "drill" or larva (Anthistarcha binocularis) attacks the end of the branches, diminishing flowering. Of the diseases, the most severe is "antracnose", which is caused by the fungus Colletotrichum gloesporioides which attacks the leaves, flowers and fruits. These diseases have greater incidence during prolonged rainy seasons.

## 8.0 POTENTIAL ECONOMIC IMPORTANCE

Domestic and international demand for cashew products is great. These products, including the nut, juice from the peduncle, and oil from the pericarp (cardoil) have large acceptance in the international market when they come up to the quality demanded. From what can be perceived, this demand, at least for nuts, still has a growth potential. It is necessary, therefore, to augment the plantations of cashew "until we have cashew nut harvests which are abundant and regular enough to supply industry, to satisfy the domestic demand, which will always grow, and to satisfy the overseas market, whose capacity for absorption is difficult to predict". (Peixoto, 1960).

Plate V. *Anacardium occidentale*. L.



V  
1 - 1. Fruiting branch  
2. 3. Bisexual and  
male flowers  
4. Fruit  
5. Leaves

## 6. ANANAS COMOSUS

- 1.0 NAMES: Family Bromeliaceae  
Botanical Ananas comosus (L.) Merril  
Synonyms Bromelia ananas L.  
Bromelia comosa L.  
Ananassa sativa Lindley, nomen.  
Ananas sativus (L.) Schultes  
Ananas ananas (L.) Voss.  
Vernacular pineapple (English); abacaxi, ananas (Brazil); pomme de pin (French); piña (Spanish); pina de agua, pina azucarada (El Salvador); pina blanca (Colombia).

### 2.0 ECOLOGY AND DISTRIBUTION

Ananas comosus is a cultigen not known in the wild. It prefers light, permeable soils rich in organic matter, with a pH between 5.5 and 6.0, although it will also grow in heavier, poorer, more acid soils; bad drainage will inhibit growth. The pineapple is very resistant to drought and grows best with an annual rainfall between 1000 and 1500 mm but will grow well with as little as 600 mm or as much as 2500 mm. Fruit quality is poorer in areas of excessive rainfall unless fruiting occurs during the dry season. Favourable temperatures range from 21° to 28°C; temperatures in excess of 32°C will result in leaf damage due to excessive transpiration. It is susceptible to cold, growth stopping at temperatures below 20°C. The most favourable altitudes for growth are below 400 m; it may grow but not fruit at 1000 m.

The species appears to have originated in south-central South America, in an area circumscribed by 15° to 30° South and 40° to 50° West. This includes southern Brazil, northern Argentina and Paraguay. Others argue that the area should extend further north, perhaps to include the southern fringes of Amazonia.

From its centre of origin the pineapple was distributed in pre-Colombian times throughout tropical and subtropical America. By the time of the arrival of Columbus it had spread to central America, Mexico, the Caribbean, all of Amazonia and northern South America. Europeans distributed the pineapple around the world, to central and especially south-eastern Africa, Madagascar, India, Indonesia, Malaya, the Philippines, Papua New Guinea and Australia. In many of these countries it has become an important crop and in some cases has escaped into disturbed habitats.

The genus Ananas is very small and includes only 4 species besides the A. comosus; these are: A. bracteatus (Lindl.) Schultes; A. fritzmuelleri F.C. Camargo; A. erectifolius L.B. Smith; A. ananassoides (Bake) L.B. Smith.

### 3.0 DESCRIPTION

A semi-perennial, herbaceous monocotyledon, up to 1.2 m high and crown spreading for 1.3-1.5 m in diameter; stem very short to nearly absent; root system mainly superficial, extending beyond the crown, except in very dry regions or in very sandy soils, where the roots will mainly extend vertically. Leaves congested, spirally arranged, in either a right - or lefthanded 5/13 phyllotaxis, arising from an apical meristem from which the inflorescence later develops. Leaves long, grooved, sword-shaped, the upper and lowermost being shorter and broader than those in the middle, margins spiny, semi spiny or smooth, depending upon the variety, upper surface smooth, medium green with greyish to reddish hues with a dull to almost brilliant sheen, lower surface light green or with a silvery-whitish sheen. Vegetative buds occasionally develop in the leaf axils, especially amongst the shorter leaves immediately below the inflorescence and are used for vegetative propagation. Inflorescence unbranched, strobiliform, elongated spike crowned by a dense tuft of foliaceous bracts; flowers 100-200, bisexual, sessile, each in the axil of a bract. Sepals 3, reddish to yellowish, fleshy; petals 3; stamens 6, in 2 planes; ovary with 3 carpels, ovules 14-20 per loculus, style with 3 stigmas. Fruit a syncarp formed by the ovaries coalescing with each other and with the bracts and axis to form a fleshy, compound fruit, crowned by a dense tuft of foliaceous bracts, known as the crown, which can also give rise to a new plant, occasionally forming a multiple crown; seeds rarely formed.

In central Amazon flowering during the dry season, July to October; fruiting from October to January, but with some fruits of inferior quality being found throughout the year.

#### 4.0 MAIN USES

The edible part of the pineapple is the juicy pulp formed by the walls between the fruitlets and the parenchymous tissue of these, as well as the fleshier external part of the central stem. The juicy sweet acid pulp has a distinctive aroma and flavour that has become a basis for comparison. Acidity ranges between 3,5 and 4,3 pH with a Brix level between 11 and 19. In regions that produce pineapple the ripe fruit is generally used fresh, cut in slices or chunks or made into a juice. For all of these uses the tougher part of the central core and the fruit skin are removed. Processed products include jellies and preparations similar to marmalade, chunks in syrup, canned juices that are made from the pulp, skin and central core, fruit salads sugar crystalized chunks, wine and the remains can be made into animal ration.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The precise timing of the harvest will depend upon the final utilization of the fruit. For industrial uses the fruit is normally collected ripe, while for the fresh fruit market it should be collected in such a way as to have it ripen upon arrival at the market. If flower induction is forced by chemical means the harvest may occur within 15 days, if not it may extend over 2 months. Because of varying fruit maturity the fruit must be collected by hand. Packing methods for fresh fruit depend upon the destination. In Brazil yields vary between 10 and 35 tons/hectare, while in Australia there are reports of 25 to 50 tons/ha and in Hawaii 60 to 80 tons/ha have been attained.

#### 6.0 NUTRITIONAL VALUE

The pulp contains about 85% water, 13 to 15% carbohydrates including fibre, 0.4 to 0.9% protein, 0.2% fats and oils, 0.04 ash which contains 17 to 40 mg/100 g calcium, 8 to 19 mg/100 g phosphorus, 0.5 to 1.2 mg/100 g iron, 1 to 2 mg/100 g sodium, 146 to 344 mg/100 g potassium and 13 mg/100 g magnesium.

It also contains 70-170 U.I. vitamin A, 0.09-0.21 mg/100 g thiamin, 0.03 to 1.06 mg/100 g riboflavin, 0.2 to 0.6 mg/100 g niacin and 17 to 40 mg/100 g ascorbic acid. The pulp contains about 52 to 123 calories/100 g. The pineapple is a good source of energy and some vitamins, especially vitamin C, but a poor protein source, thus its nutritional value is rather low.

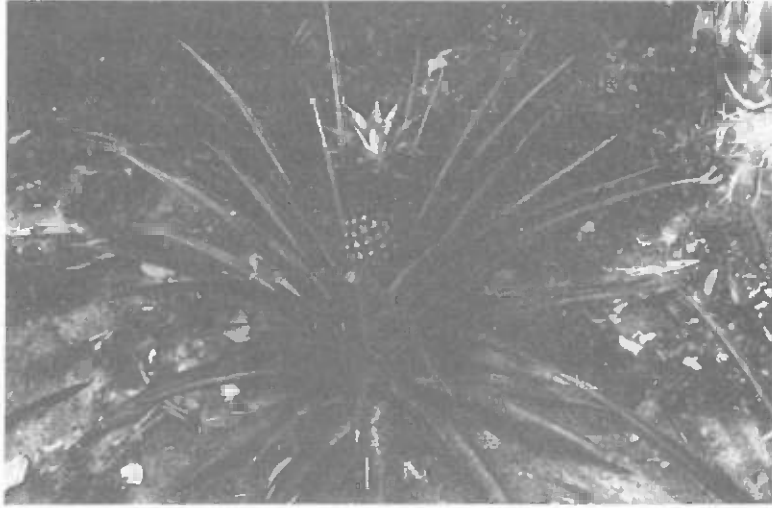
#### 7.0 CULTIVATION AND PROPAGATION METHODS

The pineapple is vegetatively propagated because the few seeds take a long time to develop to the fruiting stage. The vegetative parts used come from 4 parts of the plant: 1. the crown, which gives good size fruit, but take longer to fruit and are more susceptible to root rot; 2. slips from immediately below the fruit, which give uniform fruit and take less time to produce; 3. side slips from the region above but near to the trunk which take the least time to produce; 4. side slips from the trunk which vary greatly in size and consequently in reaching production, and also fall over easily. The slips are dried in the sun for about a week, the lower, smaller dried leaves are removed; slips that show any disease problems are eliminated, disinfected with insecticides and fungicides, stock for quarantine purposes for 2 to 3 months to verify the absence of gomosis. The slips can then be field planted at varying spacings, normally in double rows, at a density of 13,000 to 77,000 plants/hectare depending upon the variety used, fertilization, soil type, natural rainfall and irrigation, and fruit size desired. The pineapple requires large quantities of potassium and nitrogen for good growth and production. The first harvest will occur between 18 and 24 months after planting, depending upon variety, vegetative material used, fertilization and spacing. In Brazil there are numerous pests, some of the most serious are fungal, including *Fusarium* sp., *Ceratocystis* sp., *Phytophthora* sp., or insects including scale insects, fruit borer (*Thecla basildes* (Geyer, 1837)).

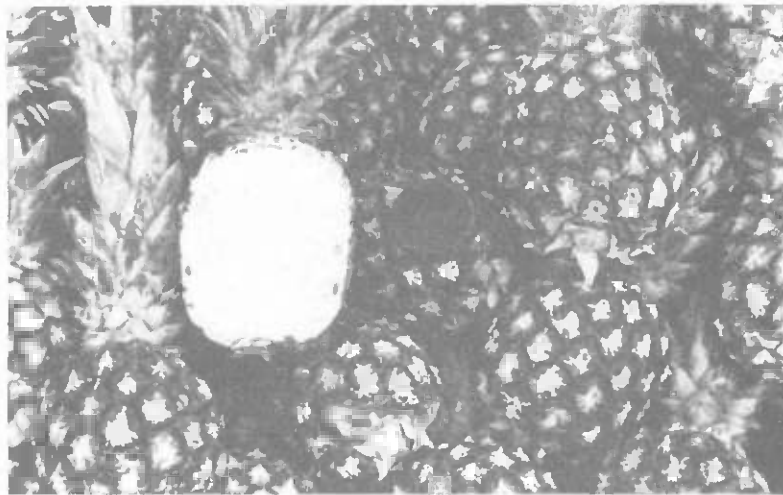
## 8.0 POTENTIAL ECONOMIC IMPORTANCE

The world market for pineapple can still be expanded, especially for fresh fruit. Private research has supposedly developed several excellent table pineapples but they have not been marketed, so that public research groups will have to redo this work. Other limitations include finding and developing disease resistant germplasm, a project that seems to be well started in Brazil, and better, more economical packing methods, so as to reduce costs when exporting.

Plate VI. Ananas comosus (L.) Merrill



1



2



3

- VI  
1 - Fruiting plant  
2 - Mature fruit. Manaus, Brazil  
3 - Flower

7. ANNONA MONTANA

- 1.0 NAMES: Family Annonaceae  
Botanical Annona montana Macf.  
Synonym Annona marcgravii Mart.  
Vernacular araticum, araticum-açu (Brazil); mountain soursop (English);  
guanabana cimarrona (Cuba); guanabana (Peru, Venezuela).

2.0 ECOLOGY AND DISTRIBUTION

Annona montana occurs in the lowland humid tropics in secondary forest, abandoned as well as cultivated farmland and in some city backyards. It is capable of growing on relatively poor clay oxisols provided there is good drainage; its climatic requirements are an annual rainfall of 2400 mm and an annual temperature of 26°C.

The species is believed to have originated in the Amazon basin, its natural distribution is now obscured through cultivation and the species is now widely distributed throughout the lowland humid tropics of the Americas.

3.0 DESCRIPTION

Tree up to 10-15 m high; trunk straight, bark smooth, dull grey at first, becoming rough and fissured with age; branches ascending, the crown at first forming an inverted cone, becoming spreading and spherical at maturity due to loss of apical dominance. Root system extensive and superficial, extending well beyond the diameter of the crown; young plants with strong taproot but it is not known whether this persists. Leaves alternate, simple; stipules absent; petiole short, up to 1 cm long; blade elliptic to elliptic-lanceolate, 10-25 cm long, 4-8 cm wide, apex rounded and shortly acuminate, base rounded to cuneate, margins entire, glabrous, glossy dark green above, duller and paler below. Flowers solitary, on the younger parts of the branches, bisexual. Calyx small, green, lobes 3, triangular, 5-6 cm long; petals 6, in 2 whorls of three, fleshy, outer 4.5-5.5 cm long, 3.5 cm wide, strongly thickened to c. 5 mm at the apex, inner petals up to 4.5 cm long, 2.5 cm wide, concave and more or less closed when in flower and regulating the entry of pollinating beetles; stamens numerous, up to 6 mm long, forming a compact ring around the gynoecium, the pollen in tetrads held together by a viscous substance; carpels numerous, each with 1 ovule and a contracted style. Fruit a syncarp, composed of many united carpels, spherical to ovoid, up to 26 cm long, 15 cm in diameter, weighing up to 4 kg; epidermis dark to yellow-green, with many short, fleshy spines lying over the carpels; pulp white to yellow, with a soft, fibrous and mucilaginous texture and strong aroma; seeds 1.5 cm long, 0.7 cm wide, yellow-brown.

Flowering April to September and pollinated chiefly by beetles; fruiting July to September.

4.0 MAIN USES

The abundant fleshy pulp surrounding the seeds is eaten. Although the strong aroma is relatively agreeable, in most cases the flavour is poor, being slightly sweet and acid. Occasional trees produce better fruit with a more agreeable flavour. They are normally consumed with a fair to heavy measure of sugar as a juice or fresh fruit after the extraction of the seed, which are bitter.

5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Some varieties have fruit which start to turn a yellowish green when ripe, although most will remain green and must be felt to determine if they are starting to soften. The fruit are then hand harvested by breaking the peduncle. A 5 year old tree may produce 35 fruit of about 1 kilogram each. Some mature trees (+ 20 years) have been observed to produce more than 100 fruit.



## 6.0 NUTRITIONAL VALUE

No information is available on the chemical and physical composition of the Araticum, although it is probably similar to the soursop (A. muricata L.), which it strongly resembles in many ways. Its nutritional value would appear to be as low as that of the A. muricata.

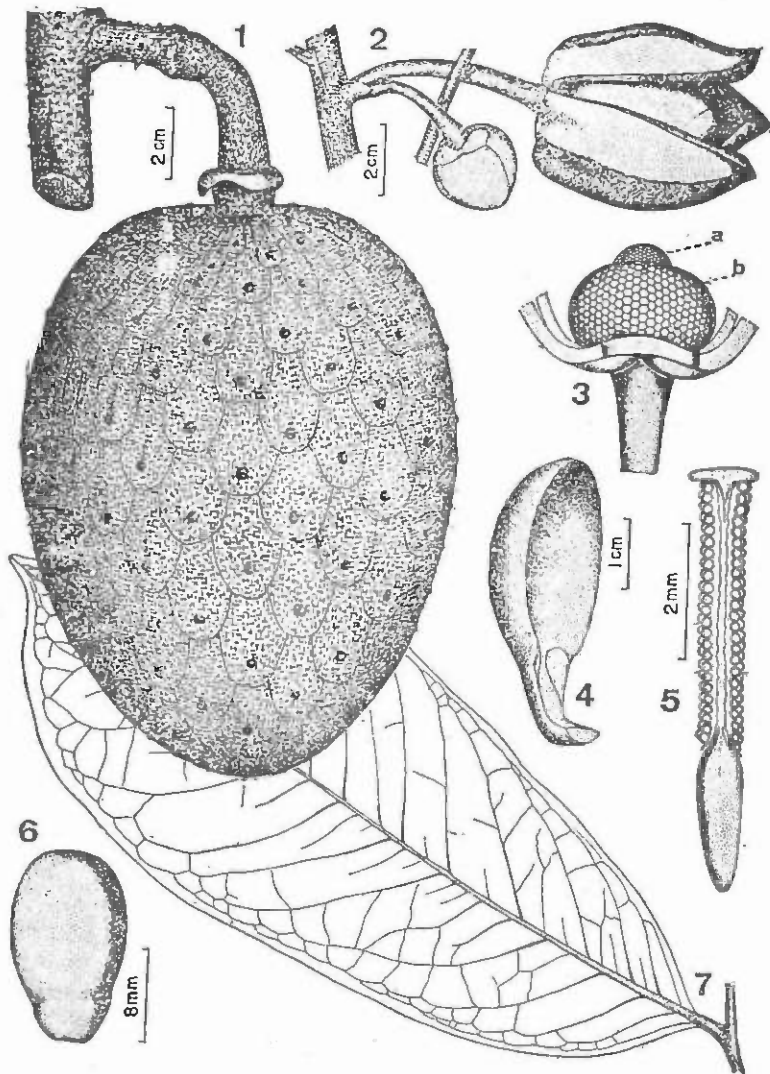
## 7.0 CULTIVATION AND PROPAGATION METHODS

Germination of fresh seed is rapid (3 to 6 weeks) and relatively good (60 to 80%) when sown in sand beds. Initial growth in the nursery is vigorous, with the young plants attaining graftable size in 4 to 6 months. A. montana has been used as a rootstock for A. muricata. Planted in the field growth is vigorous and continues strongly for at least 6 years. Fruiting starts after 2 years in the field and is quite good (35 fruit) by the fifth year. The trunk borer of the genus Cratasomus attacks the trees, but the tree's vigour appears to be reduced only slightly, if at all. The fruit are also attacked by various borers (Diptera, Lepidoptera and Coleoptera) although to a lesser extent than the soursop (A. muricata).

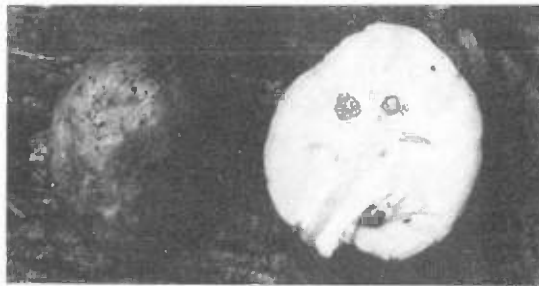
## 8.0 POTENTIAL ECONOMIC IMPORTANCE

The average Araticum would appear to have little or no economic potential, except as a root stock for soursop (A. muricata) and other Anonaceae. However, there are some varieties that have fruit with an agreeable taste and good size which might be worth collecting and evaluating.

Plate VII. *Annona montana* Macf.



2



3

- VII
- 1 - 1. Fruit
  2. Flower
  3. Male and female flower parts a), b)
  4. Internal petal
  5. Stamen
  6. Seed
  7. Leaf

2 - Six year old tree in production. Height 4 m.

3 - Nearly mature fruit, split to show seeds  
Manaus, Brazil.

8. ANNONA MURICATA

- 1.0 NAMES: Family Annonaceae  
Botanical Annona muricata L.  
Synonyms Annona bonplandiana Kunth  
Annona cearensis Barb. Rodr.  
Annona macrocarpa Werkl.  
Guanabanus muricata (L.) Gomez  
Vernacular soursop, guanabana, durian blanda (English); guanábana, guanaba, zapote agrio, anona, catoche, catuche (Spanish); cachiman-épineux, corossel, corosselier, corossol épineux, sappadillo, anone (French); anona, flaschenbaum, sauerapfel, stachel anone, stachliger (German); zuurzak (Dutch); araticu-ponhé, coração de rainha, graviola, jaca de pobre, jaca do pará, anona espinhosa, pinha azeda, anona, curassol (Brazil).

2.0 ECOLOGY AND DISTRIBUTION

Annona muricata prefers deep, well-drained, fairly rich loam soils but will also do reasonably well on deep, well-drained, nutrient poor oxisols in forest areas receiving more than 1200 mm rainfall per annum, where the dry seasons do not exceed 3 to 4 months - type "A" climate according to Koppen's classification. It is sensitive to low temperatures, failing to produce fruit at altitudes above 1000 m or where there are any cold periods during the year.

The species is reputed to have originated in the humid tropics of the Caribbean and northern South America and was later widely distributed by the Amerindians into most of the American humid tropics. Shortly after the Spanish conquest the soursop was widely distributed around the humid tropics of both the Old and New Worlds.

The genus Annona has many edible or marginally edible species: A. cherimola Mill.; A. reticulata L.; A. squamosa L.; A. diversifolia Saff.; A. purpurea Moç. & Sessé; A. aurantiaca Barb. Rodr.; A. cacans Warms; A. coriacea Mart.; A. crassifolia Mart.; A. furfuracea St. Mill.; A. longiflora S. Wats.; A. nutans Fries; A. paludosa Aubl.; A. salzmannii D.C.; A. scleroderma Saff.; A. spinescens Mart.; A. spraguei Saff.; A. testudinea Saff. and A. vepertonium Mart.

3.0 DESCRIPTION

Tree 5-10 m high; trunk straight, bark smooth, dull grey or grey-brown, later rough and fissured; branches at first ascending with the crown forming an inverted cone, later spreading and the crown at maturity spherical due to loss of apical dominance. Root system extensive and superficial, spreading beyond the diameter of the crown although shallow rooted; juvenile plants have a strong taproot which is eventually lost. Leaves alternate, simple; stipules absent; petiole up to 0.8 cm long; blade oblanceolate, 10-16 cm long, 5-8 cm wide, apex acuminate, base attenuate, margins entire, dark glossy green above, paler and duller below with fine, not prominent lateral nerves. Flowers solitary, usually in the area of the 2nd and 3rd previous flush of growth, bisexual. Calyx with 3 triangular lobes; petals yellow, 6, in two whorls of 3, outer petals larger, cordate with pointed apex, 4-5 cm long, 3-4 cm wide, thick and fleshy, inner petals thinner, concave within with finger-nail shaped base, not opening widely and restricting entry of the pollinating beetles; stamens numerous, shield-shaped, united below, anthers parallel and opening longitudinally; carpels numerous, overtopping the stamens, each with 1 ovule. Fruit a syncarp composed of many united carpels elliptic to ovoid, 14-40 cm long, 10-18 cm in diameter and weighing up to 7 kg, often asymmetric due to incomplete fertilization of the ovules; epidermis dark, often shining, dark green with short, fleshy spines covering each carpel; pulp white, fibrous and juicy. Seeds dark brown or black, up to 2 cm long, 0.7 cm wide, reputed to be toxic.

Flowering mainly in August to January; fruiting June to November, although sporadic flowering and fruiting can occur all year round in favourable conditions.

#### 4.0 MAIN USES

The abundant, fleshy pulp surrounding the seeds is eaten. The soursop's strong agreeable odour heightens appreciation of its delightful sweetish, sub-acid flavour. Some authors claim that the odour is reminiscent of pineapple but that the flavour is unique and best when well ripened. The fruit is most widely used for the preparation of a refreshing juice, but is also used as an ice-cream flavouring, purée, ingredient in fruit salads and to make jelly. Occasionally it is eaten as a fresh fruit but this is not its best mode.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit is generally harvested as it starts to soften, this point giving the best results for post harvest quality. However, as the fruit perishes easily, this method does not permit the shipment of fresh fruit over any great distance. A 5-year old plant may produce between 10 and 50 fruit, depending upon pollination efficiency and nutrient status. Hand pollination has proved effective in improving fruit production.

#### 6.0 NUTRITIONAL VALUE

The soursop is 83% water. One hundred grams of fresh pulp contains 1.0% protein, 0.4% oils, 1.1% fibre, 0.6% ash and 14.9% other carbohydrates. There is also 26 mg ascorbic acid, 5 mg vitamin A, 0.07 mg thiamin, 0.05 mg riboflavin, and 0.9 mg niacin. The soursop appears to be a reasonable source of calories and contains some vitamin C.

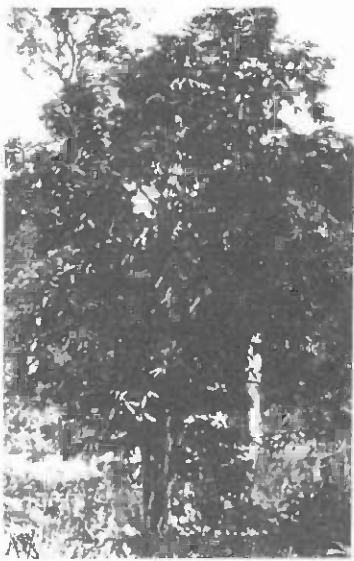
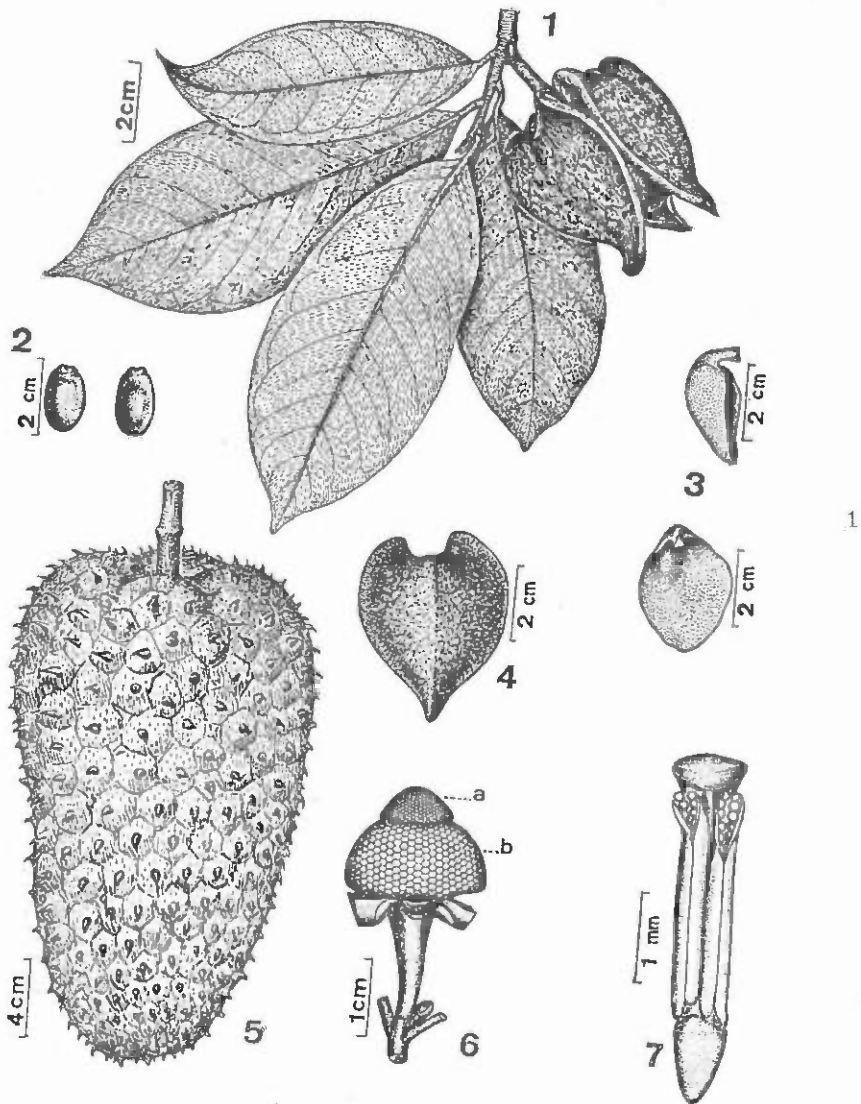
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Germination of fresh seed is rapid (2 to 4 weeks) and generally good (60 to 90%). Initial growth is rapid on a good substrate, with the young plants attaining graftable size in 4 to 6 months. Patch budding of several types have given good results on A. muricata and A. montana rootstock in most localities. A. glabra will occasionally give a dwarfing effect. A. reticulata and A. squamosa occasionally give good results as rootstocks. Planted in the field initial growth can attain 2 meters in the first year, remaining strong thereafter although height will not increase so fast, giving way to lateral growth. Fruiting is precocious, generally starting in the second year, although too heavy application of nitrogen has inhibited fruiting in some cases. In the Caribbean region the soursop is heavily attacked by Colletotrichum spp. and in the Manaus, Brazil region, a Pellicularia spp. is serious. The trunk borer, Cratasomus sp. is a serious pest as are many fruit borers in the Lepidoptera, Coleoptera and Diptera.

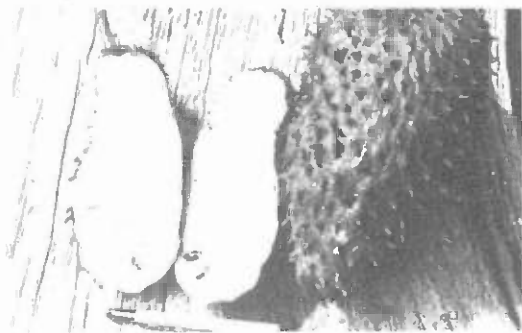
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Because of the fruit's flavour the soursop would appear to have excellent potential as an export or local crop, with potential markets in the USA and Europe for good quality juices and some other products. However, pollination, agronomy and the development of high quality, high production varieties needs research. Pollination biology and its relation to flower structure should permit increased yields. Insect and disease problems are serious limiting factors in many areas, especially in the Americas. The selection of high quality varieties with low fibre and flavours directed towards export markets is necessary.

Plate VIII. *Annona muricata* L.



2



3

VIII

- 1 - 1. Flowering branch
  2. Seeds
  - 3-4. Internal and external petals
  5. Fruits
  6. Male and female flower parts a) , b)
  7. Stamens
- 2 - A six year old tree in production
- 3 - Mature fruit and split fruit showing borer attack  
- a serious problem in soursop. Manaus, Brazil.

## 9. ANTROCARYON AMAZONICUM

- 1.0 NAMES: Family Anacardiaceae  
Botanical Antrocaryon amazonicum (Ducke) B.L. Burtt & A.W. Hill  
Synonym Poupartia amazonicum Ducke  
Vernacular jacaiacá, fruta-de-cedre, cedrorana, taperebá cedro,  
taperebá-acu, cedro (Brazil).

### 2.0 ECOLOGY AND DISTRIBUTION

Antrocaryon amazonicum is a rare tree of the primary forests of the humid and high terra firma. It prefers clay soils but will adapt readily to sandy soils if there is little competition. The annual rainfall in the area where it occurs is from 1600 to 2000 mm, with a mean annual temperature of 27°C. It has not been found at altitudes above 100 m. Although rare, it is widely dispersed in the lower canopy. In some areas it has become a semi-pioneer of secondary growth, occurring in small stands of 3 to 5, obviously the result of spontaneous growth from abandoned seeds.

The genus Antrocaryon like Poupartia in which it was originally placed, is an Old World genus and jacaiacá is the only known representative in the New World and was first discovered by Adolpho Ducke in 1922. It is only known from Brazil and occurs in the lower Amazon basin near Obidos, Pará and in the estuary of the Amazon river. It has recently been found in cultivation and semi-naturalized in the region of southeast of Belem, Pará.

### 3.0 DESCRIPTION

A medium to large, deciduous tree up to 30 m high; trunk frequently swollen, especially near the base, bark strongly fissured, as in "cedro", Cedrella odorata, hence the common name; branches few, long and orientated sharply upwards and forming an open crown; superficial roots few, long and voluminous, no information available on taproot. Leaves alternate, compound, stipules absent; rachis, including petiole 20-30 cm long in young plants, less in older; leaflets 2-3 pairs with an odd, terminal leaflet, broadly ovate, up to 12 cm long, 7 cm wide, apex rounded and shortly acuminate, base rounded. Inflorescences male or female, no information as to whether they occur on the same tree. Female inflorescence a terminal or subterminal raceme or panicle up to 12 cm long; flowers 5-merous; pedicels 2-4 cm long; sepals ovate, united at the base, petals yellow, ovate, 3-4 mm long, staminodes 10, inserted on a disc, ovary with 5 loculi and 5 short, stout styles. Male inflorescence larger, up to c 20 cm long; flowers with 10 stamens inserted on a crenate disc, ovary rudimentary. Fruit a somewhat flattened drupe c 4-5 cm in diameter, skin yellow, mesocarp fleshy, juicy and enveloping the hard, woody endocarp containing 5 loculi and seed.

Flowering January to March during the rainiest months; fruiting May to July.

### 4.0 MAIN USES

The mesocarp is the part consumed. The flavour is mildly acid but very pleasant, reminding one of Spondias lutea, the Taperebá. The pulp may be consumed fresh but it is most often made into juice or used as ice-cream flavouring. It has also been used to make a rather special alcoholic beverage.

### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit fall when ripe and should be collected immediately to avoid competition from wild and domestic animals. However, the fruit should be stored for 2 to 3 days to allow a perfect ripening of the flavour. No information is available on yields although it is reputed to be a poor producer.

### 6.0 NUTRITIONAL VALUE

About 30% of the fresh fruit is usable pulp and about 80% of this is water. No analysis has been done on its chemical composition. No information is available about its nutritional value.

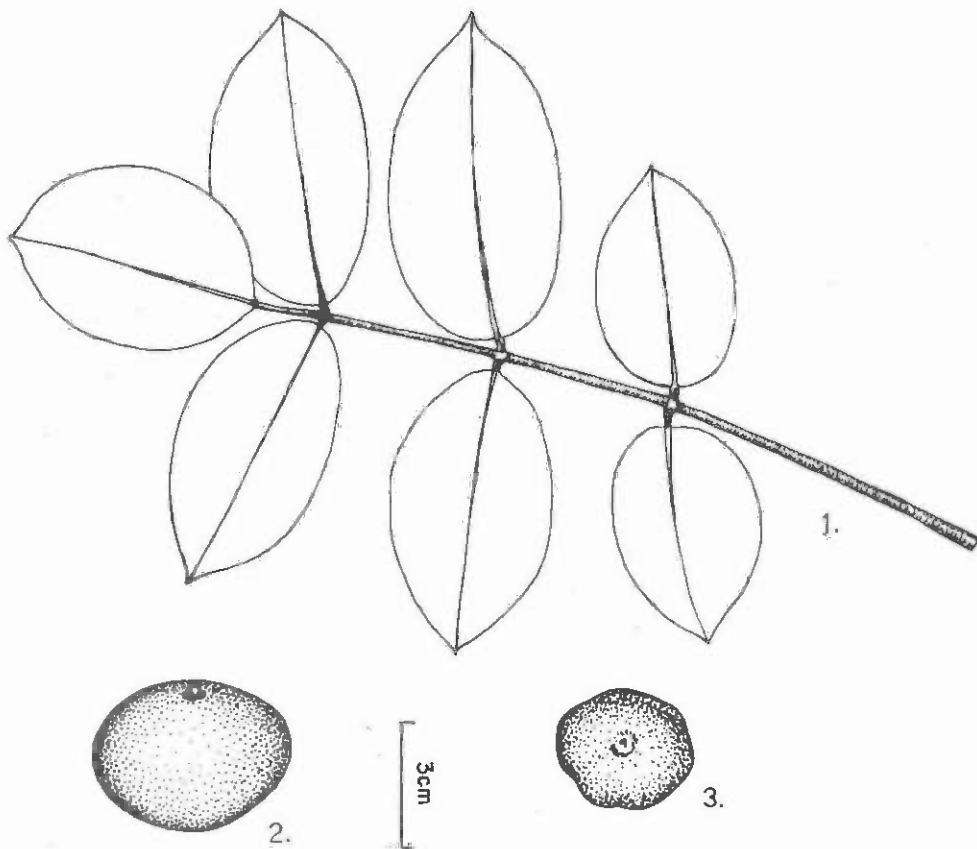
#### 7.0 CULTIVATION AND PROPAGATION METHODS

The seeds will germinate in 20 to 25 days, if scarified before sowing soon after being taken from the mesocarp. In these conditions the germination percentage is usually quite high. In the first two years growth is rapid. Later growth continues vigorous but not quite as rapid.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Given its excellent flavour the jacaiaçá appears to have some potential as a flavouring for ice-cream and popsicles, and perhaps as a fruit juice. However, because of poor production extensive germ plasm collection and agronomic studies are needed to find a high producing system.

Plate IX. Antrocaryon amazonicum (Ducke) B.L. Burtt and A.W. Hil.



- IX  
1 - 1. Leaves  
2. Fruit  
3. Stone  
2 - Leafless tree



10. ASTROCARYUM ACULEATUM

- 1.0 NAMES: Family Palmae  
Botanical Astrocaryum aculeatum G.F.W. Meyer  
Synonyms Astrocaryum tucuma Martius  
Astrocaryum aureum Griseb.  
Astrocaryum princeps Barb. Rodr.  
Vernacular star nut palm (English); tucumá, tucum verdadeiro, tucum do mato  
tucum do mato, tucumã-açu (Brazil); tackoeman, waran,  
amana (Surinam); hericungo (Peru); chambira (Colombia);  
tucumou (Guyana).

2.0 ECOLOGY AND DISTRIBUTION

Astrocaryum aculeatum is exceptionally tolerant of poor, degraded soils and can withstand periods of drought for a few months in areas receiving over 1600 mm rain each year. It is usually found in secondary forest and will invade savanna and pasture land, where it appears to be quite fire-resistant. It will grow at densities of up to 50 trees per hectare, but is usually less gregarious.

It is common in west and central Amazonia, where it may have originated; elsewhere it has spread through the whole of Amazonia, Guyana, Peru, Colombia and Pará and Mato Grosso in Brazil.

A. vulgare Mart., A. murumuru Mart., A. jauari Mart., A. ayri Mart. and about 40 other poorly described members of the same genus deserve more attention from economic botanists.

3.0 DESCRIPTION

Tall, single-stemmed, monoecious, spiny tree palm. Stem erect, to 25 m tall, c. 30 cm in diameter, bare of leaf sheaths, clearly ringed with leaf scars, and in the younger parts armed with whorls of black spines 1-10 cm long. Leaves usually 10-15 in the crown, reduplicate pinnate, held + erect and gently curving, 4-5 m long; leaf base + sheathing, densely black spiny and greyish hairy; petiole c.1.5 m long, black spiny; rachis c. 3.5 m long, spiny as the petiole; leaflets c.100 pairs grouped and held in different planes, linear, 60-100 cm long, 3-4 cm wide, dull dark green on upper surface, grey-white beneath, the margins spiny. Inflorescences up to 2 m long; peduncle c.50 cm long; prophyll mostly obscured by the leaf sheaths; 2nd bract very large, + thick, c. 2m long, acute, armed with long black spines; rachis c. 1.5 m long, bearing 200-300 rachillae 30-40 cm long; rachillae bearing 1-5 female flowers in the basal c. 10 cm and innumerable minute, densely packed male flowers along the remaining length. Male flowers c. 4 mm long, with cream-coloured sepals and petals and 6 stamens with purple filaments and white anthers. Female flowers cream-coloured, c. 15 mm long. Fruit usually 1-seeded, + globose or broadly ellipsoid, 4-6 cm long, 3-5 cm in diameter, green turning yellow-brown, often 200-400 in the infructescence or even up to 1000; epicarp smooth, hard; mesocarp 2-5 mm thick, fibrous, oily, orangey-yellow; endocarp very hard, woody, black, 2-3 mm thick, with 3 star-like pores; endosperm homogeneous, with a central hollow filled with fluid.

Flowering occurs between March and July; fruiting usually occurs between January and April, though a few fruit may be found throughout the year.

4.0 MAIN USES

The thin pulp is gnawed off the stone after cutting off the skin with a sharp knife. The flavour is typically bitter and nutty but may be sweet. The texture is often fibrous and pasty to oily, to very oily. Most newcomers find them repulsive until one of excellent quality is tried. The taste is acquired and most locals adore them so they are one of the most expensive items in the Manaus market. This is surprising as considerable effort is needed to peel them and get at the very thin (2 to 3 m usually) layer of pulp. The kernels are too hard to be considered edible. However, over 8000 t of tucum kernels are collected from several Astrocaryum spp. in the wild and processed for edible

oil and soap each year. The residue makes a useful cattle feed. A juice is made from the pulp of A. vulgare Mart. and palm hearts have been extracted commercially from A. jauari Mart. The wood is black, fibrous, extremely hard and flexible and is used by Amerindians for making bows. Strong long spines are used for arrow and dart points. A very high quality twine is made from the fibre of young leaves and is used for strong fishing nets and hammocks. About 100 tons of tucum fibre from this palm and A. ayri Mart. are processed each year in Brazil.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Bunches are pulled down with a hooked stick soon after the first fruit ripens and falls. Fruit must then be left about 3 days in sacks to ripen completely and for the pulp to soften slightly. They must then be eaten within 3 or 4 days after which they start to dry and rot where bruised. Bunches weigh 10 to 30 kg and there are usually 2 or 3 but occasionally up to 5 on each tree. A typical tree produces about 50 kg of fruit per year in the wild on poor soil. It is interesting to speculate what yields might be achieved with modern management, fertilizer and selection.

#### 6.0 NUTRITIONAL VALUE

Fruit vary in weight from 20 to 100 g although most weigh about 45 g. As the pulp varies considerably in thickness it accounts for 13 to 35% of the fruit weight with an average of 25%. Dry matter contents are around 50% with a range from 31 to 85%. There is 6 to 16% protein (average 9%) and 17 to 75% oil (average 55%) in the dry matter. The fresh pulp contains 3.5 mg of carotene/100 g although more must exist in very orange varieties. A. vulgare Mart. has been shown to have 31 mg/100 g. Kernel and shell each account for approximately 30% of the fruit weight. Kernels have 57% dry matter with 37% oil. The most oily fruit found so far had 21% pulp oil plus 6.4% kernel oil as a % of fresh fruit weight. High oil contents make the fruit an excellent source of calories. It also has useful amounts of protein and vitamin A.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds germinate very slowly from 8 months to 2 years even when free of their hard shells. This long dormancy can probably be reduced by a heat treatment and the precise conditions are now being studied. Initial growth is very slow with plants reaching a height of 50 cm after 2 to 3 years. Plants are not thought to fruit in the wild in less than 8 years when 5 to 6 m tall. They tolerate and may like strong shade when small. All collection is from wild trees and although not cultivated, people leave them when clearing secondary regrowth. No pests or diseases have been noted but wasp nests and termites are common on the trunks.

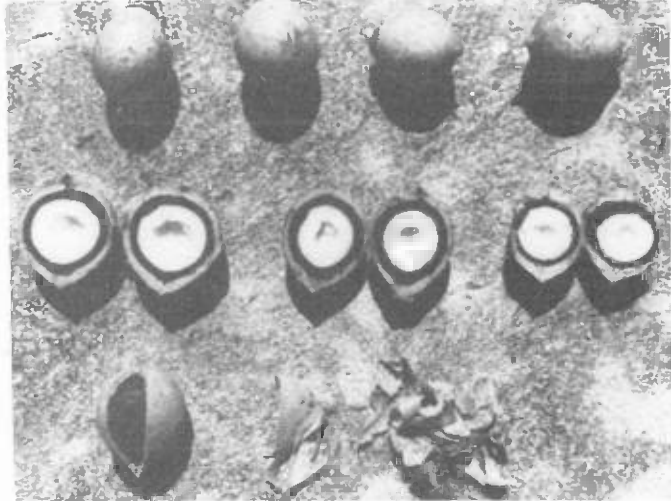
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Although wild trees are common and already exploited for their fruit pulp, kernels and fibre, this species deserves much more attention. As can be seen from the data on composition, there is 3 times more oil in the pulp than in the kernel of the best variety examined. This, together with the ability to exploit exhausted soils and apparent freedom from disease, suggest that it should be grown as an oil crop. Selection for oily varieties with thicker pulps, longer harvests, faster growth and precocity is needed to justify intensive plantations. Even if these characteristics cannot be found it would be worth the direct seeding of some of the vast areas of savanna and abandoned or poor pasture in the Amazon, to provide cheap oil with little input in 10 years time. Selection for better table fruit with sweet nutty flavour, medium oil, low fibre and thick pulps is needed to expand local markets.

Plate X. Astrocaryum aculeatum G.F.W. Meyer



1



2



3

- X  
1 - Mature palm tree  
2 - Fruit whole and section  
3 - Fruit on sale in a market  
in Brazil

## 11. BACTRIS GASIPAES

- 1.0 NAMES: Family Palmae  
Botanical Bactris gasipaes Kunth  
Synonyms Guilielma speciosa Martius  
Guilielma gaspaes (Kunth) Bailey  
Bactris speciosa (Martius) Karsten  
Vernacular peach palm, pewa nut (Trinidad); pupunha (Brazil);  
pejibaye (Costa Rica); chontaruro (Ecuador); gachipaes  
(Venezuela); macanilla, cachipay, chontaduro e chonta  
(Colombia); pejawo (Peru).

### 2.0 ECOLOGY AND DISTRIBUTION

Bactris gasipaes is rarely found in regions with more than 2 to 3 months summer drought and above 1000 m in the Andes. Growth is best in everwet conditions with temperatures well above 20°C. It will grow on poor sandy acid soils or heavy clay oxisols unless waterlogged. It can grow at considerable densities.

Wild specimens have been reported from the low eastern slopes of the Colombian Andes, in east Peru and northwest Brazil, but its distribution has been so much affected by man that it is difficult to be certain whether plants are truly wild. It is now spread throughout tropical South America and Central America.

Related species: B. major Jacq.; B. minor Jacq.; G. microcarpa Huber = B. dahlgreniana Glassman; B. matogrossensis Barb. Rodr.; B. maraja Mart.; B. ferruginea Mart.

### 3.0 DESCRIPTION

Moderate, clustering, spiny monoecious palm. Stems in clumps of up to 15, reaching heights of up to 25 m, 10-30 cm in diameter, usually very densely spiny, very rarely unarmed. Leaves reduplicate pinnate, c. 10-25 in the crown, 3 m long; sheath usually densely spiny; petiole to 1 m long, densely spiny, deeply channeled; rachis to 2 m long, densely spiny; leaflets c. 120 each side of the rachis clustered in groups of 3-7, held in different planes, the largest to 60 cm long, 3 cm wide, dark green, often covered in short bristles. Inflorescences interfoliar, to 80 cm or more long; peduncle unarmed, c. 50 cm or more long; first bract (prophyll) hidden by leaf sheaths; 2nd bract large, boat-shaped, c. 50 cm long, sparsely armed with short spines; rachis to 30 cm long, bearing 25-40 rachillae, 20-30 cm long, densely covered with intermingled male and female flowers; female flowers opening before the males, receptive for c. 24 hours only; flowers at anthesis visited by weevils and other beetles in large numbers, feeding on the male flowers and on swollen pustule-like bodies between the flowers. Fruit 1-7 cm in diameter when mature, very variable in shape, but usually + peach-shaped; epicarp green turning yellow, orange, brown or red, speckled with black lines; mesocarp dry and starchy or moist fibrous or oily, thin to very thick; endocarp woody, 3-pored; seed 1-2 cm long, endosperm homogeneous.

Parthenocarpic fruit sometimes present. Poor fruit set is due to poor pollination, drought and other factors. Fruiting may occur when the aerial stem is very short, but is much delayed on poor soils. As the stem grows taller, fruiting becomes more seasonal. Potentially 25 fruit bunches per stem can be produced each year, but 5-15 is more usual. Typical bunches weigh 3-7 kg; exceptionally they may weight up to 20 kg.

Main fruiting season in Manaus runs from December to March but varies from cultivar to cultivar.

### 4.0 MAIN USES

The fruit forms an important item of the diet in certain areas of the western Amazon, the Colombian Pacific coast and Costa Rica. Nomadic tribes are known to return long distances to abandoned settlements to collect fruit at harvest time. The mesocarp of the fruit is usually eaten after boiling for an hour or more and peeling off the fibrous epicarp. The texture is generally mealy but may be soggy, oily or fibrous. The flavour

is bland especially in the preferred slightly green and immature stage but may be strong and bitter later. It is enhanced by prolonged cooking in heavily salted water which can induce an attractive sweetness due to mild hydrolysis of the starch present. Cultivars with flavours and texture similar to potato and maize have been found. Starchy types are most common in the western Amazon, Colombia and Costa Rica and are often eaten as a cocktail snack with a mayonnaise filling. Oily varieties are more common and popular in the mid Amazon and often leave a thin layer of oil on the surface of the cooking water. However most of the oil is so well absorbed by the starch that its extraction by primitive means is difficult and pressing has not been observed.

The leaves may be used for thatching and the hardened stems of old trees are used for long bows and also make attractive black floor slabs.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Harvesting becomes progressively harder as bunches form higher up the tree and stems are frequently cut when they reach 15 m. Prior to this bunches may be cut down with knives on long poles although some indians can climb the dangerous spiny stems with ropes and ingenious x shaped sticks lashed to their feet. Trees are planted at 1  $\frac{1}{2}$  to 2 m for palmheart production and harvested initially at about 2 years of age and the regrowth at subsequent yearly intervals.

#### 6.0 NUTRITIONAL VALUE

Composition varies enormously: 19 to 93% mesocarp, 18 to 66% dry matter, 3.1 to 14.7 % protein, 2.6 to 61.7% oil, 1.8% ash, 1.6 fibre and 33.2 to 80.8% starch in the mesocarp dry matter. Nutritional value is consequently good in terms of energy but limited as a protein source. Carotenoid levels vary from 0 to 70 mg/100 g of fresh mesocarp so that some are extremely rich sources of vitamin A. Oxalate crystals are commonly found especially in and just under the epicarp. The importance of these and a report of an alkaloid (pupunharine) are as yet unknown. Oil composition is similar to that of the African oil palm and the amino acid profile looks reasonably balanced. Some indian tribes also ferment a slurry of the crushed fruit to a thick aromatic beverage smelling somewhat like peaches. Flours, gruels, and sweets are also made. Kernels may be eaten after cracking the thin shell between the teeth. They are like sweet coconut in flavour but often very fibrous in texture. The palm produces good flavoured thick and tender palmhearts that are a rich source of protein (30% of dry matter).

#### 7.0 CULTIVATION AND PROPAGATION METHODS

Propagation is usually by seeds that are easily stored in polythene bags and will germinate in 1 to 3 months in these bags or in sand. Germination may however take up to 18 months in some cultivars. Unfortunately, desirable characteristics have not yet been segregated and much inferior fruit can be produced. Some degree of segregation has however been achieved for dominant starchy types and recessive spineless stems by some indian tribes in certain areas of the western Amazon. Vegetative propagation of side shoots is difficult but possible, however the number that can be produced is limited. Tissue culture should be a promising technique for cloning in the future. Seedlings are ready for transplanting in 3 to 6 months and are able to tolerate several weeks of drought at this stage. Growth is slow in the first 6 months in the field and then becomes extremely rapid especially if adequate fertilizer is applied. Responses to heavy applications of N, P, K, and Mg are large on the poor oxisols of the Manaus region. Precocious fruiting at 1 to 2 years has been encountered although 3 to 4 years is more normal. Resistance to pests and diseases is marked. Mites, scale insects and defoliating lepidopteran larvae attacks have not been of economic importance, however it has proved necessary to spray against a fruit boring weevil and Anthracnose (*Collitotrichium* sp.). Various birds and animals are also troublesome. *Phyllosticta* sp., *Cercospora* sp. a crown rot, a lethal root rot and bacterial wilt have been observed occasionally. Trees are being tested in plantations and are then usually planted at about 4 to 5 m and only one stem developed. This can be cut when too high for harvesting and replaced by another. Wider spacing is needed if several stems are allowed to develop at the same time.

## 8.0 POTENTIAL ECONOMIC IMPORTANCE

The fresh fruit is a very common item of the diet and is actively marketed in the areas in which it is grown, generally by small-holders with 10 to 100 trees. Its value as a staple item of the diet suggests that it should be widely distributed across other areas of the humid tropics. Fresh fruit last about a week after harvesting so some form of preservation is needed for further storage. Canned fruit have been test marketed in Costa Rica but are probably not yet interesting and exotic enough to gain wide markets but there is much room for improvement and product development. There are however excellent prospects for commercializing palm hearts and several thousand hectares have now been planted for this purpose in Costa Rica. Rapid growth and regrowth together with good flavour and a lack of oxidative browning make this palm an outstanding source. Experimental yields of 1.5 t/ha have been obtained but costs are high and may not compete with wild collection in Brazil. As this becomes more and more expensive and quality control becomes more important, plantations can be expected to dominate new markets in the future. Spineless stems will make harvesting easier.

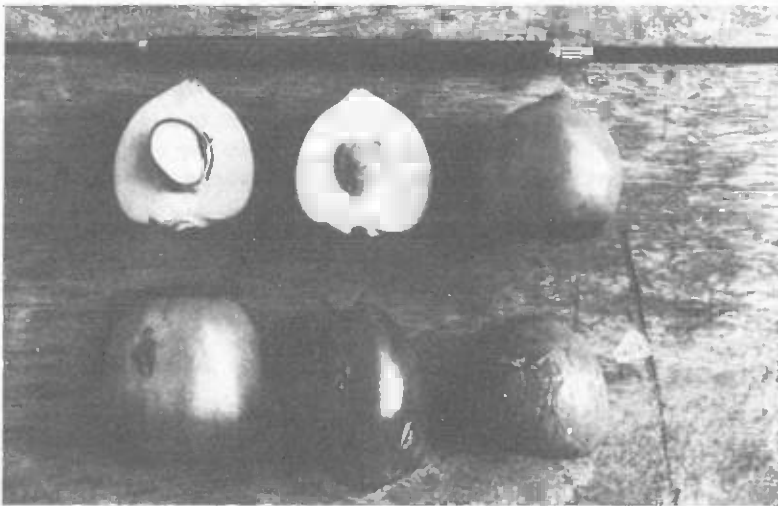
Fruit yields on solitary trees have been as high as 250 kg and yields of 30 t of bunches per hectare have been claimed for small areas. Initial results from young plantations tend to confirm this high potential especially once high yielding trees have been segregated. Combining these with those of high oil content looks and exciting prospect for the large vegetable oil market. Higher protein, starchy, extracted meals could then be used for animal rations. Combustible oil and alcohol from the starch offer another future prospect as an energy crop. Selection programmes are now underway in a number of countries to explore these prospects and also obtain better fruit for table use and flour production.

High yields, the enormous variability and the potential mentioned above, make it the most exciting species of the region. Finding dwarf varieties to solve the harvesting problem and the segregation and combination of desirable characteristics are the most urgent research needs.

Plate XI. *Bactris gasipaes* Kunth.



1



2



3

- XI
- 1 - Mature palm trees
  - 2 - Fruit whole and section
  - 3 - Fruit on sale in a market in Brazil

12. BACTRIS MARAJA

- 1.0 NAMES: Family Palmae  
Botanical Bactris maraja Martius  
Synonyms Pyrenoglyphis maraja (Martius) Burret  
Bactris brongniartii Martius  
Pyrenoglyphis brongniartii (Martius) Burret  
Bactris pallidispina Martius  
Pyrenoglyphis pallidispina (Martius) Burret  
Guilielma tenera Karsten  
Bactris tenera (Karsten) H.A. Wendland  
Bactris rivularis Barb. Rodr.  
Pyrenoglyphis rivularis (Barb. Rodr.) Burret  
Bactris piscatorum Drude  
Bactris strictacantha Burret  
Vernacular marajá, marajá-rana, marajá-açu, tucum bravo, tucum-mirim do do fruto doce (Brazil); chontilla, nieja, niejilla, taná (Spanish).

2.0 ECOLOGY AND DISTRIBUTION

Bactris maraja comprises many ecotypes which has resulted in the extensive synonymy. In the Brazilian northeast it prefers higher well-drained plateaux with nutrient poor, sandy to heavy clay soils, with 1000 to 2000 mm rainfall and a dry season of 4 to 6 months. In Surinam it is most often found in flood plains of rivers where, though the drainage is not good, soil fertility is better. In both areas it occurs within forest and in cleared areas. It may occur in densities of 20 to 50 clumps per hectare, but usually at much lower densities, e.g. 0.1 clump/ha.

The species occurs in the northeast of Brazil, the Amazon basin, and parts of Bolivia, Peru, Colombia and the Guyanas. It probably originated in northern tropical South America.

See Bactris gasipaes for related species.

3.0 DESCRIPTION

Moderate, clustered, spiny, monoecious palm. Stems erect, 4-8 m tall, 3-10 cm in diameter, densely armed with + flattened black spines 1-9 cm long borne in whorls between the leaf scars; internodes 7-16 cm long. Leaves reduplicate pinnate, c. 7-10 in the crown; sheath 30-40 cm long, densely armed with short spines c. 1 cm long and much longer brown spines, the sheath margins fibrous; petiole 40-60 cm long, deeply channelled, the lower face very densely-armed with spines 3-7 cm long, mixed with much shorter spines; rachis 100-210 cm long, armed as the petiole; leaflets 25-40 each side of the rachis, clustered in groups of 2-7, held in different planes giving the whole leaf a plumose appearance; leaflets 40-80 cm long, 3-6 cm wide, dark green above, paler beneath, the veins armed with short black spines. Inflorescence interfoliar, to c. 75 cm long, peduncle 25-45 cm long, densely armed in upper part with prickles; first bract (prophyll) short 15-25 cm long, sparsely armed or unarmed, hidden among leaf sheaths; second bract 25-50 cm long, boat-shaped, armed with short spines; rachillae 20-40 in number, 20-30 cm long bearing spirally arranged, intermingled male and female flowers. Male flowers yellowish, soon falling after the inflorescence opens. Female flowers c. 4 mm in diameter. Fruit at maturity rounded or somewhat depressed, c. 1-2.5 cm in diameter, purplish black, briefly beaked; epicarp smooth; mesocarp thin, white, juicy; endocarp c. 1 mm thick, woody with 3 pores; endosperm homogeneous.

Flowering occurs from November to January in Surinam, earlier in Brazil; fruiting extends from March to May.



#### 4.0 MAIN USES

The fibrous juicy mesocarp is the part consumed. The mesocarp has a semi-sweet somewhat acid flavour that is quite agreeable. Because there is little pulp the fruit is mostly consumed by children, fresh. The thinner trunks may be cleaned and used as walking canes.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

When the fruit are ripe the bunches are pulled from the tree. Occasionally they will then be sent to market where the bunch is sold entire. Some trees may produce 4 to 6 bunches of up to 5 kg each.

#### 6.0 NUTRITIONAL VALUE

No information on composition is available. Nutritional value would appear to be restricted to the provision of some calories.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

No information is available. Usually the marajã is not planted, rather it is left standing when clearing the land.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

The tree, although heavily spined, is ornamental. There is little demand for the fruit. The small stature of this species may be useful for crossing with B. gasipaes to reduce its height.

Plate XII. Bactris maraja Martius



1

XII.

1 - Mature palm tree, left along roadside after cutting surrounding forest.  
Conceição de Angina, Para, Brazil

13. BERTHOLLETIA EXCELSA

- 1.0 NAMES: Family Lecythidaceae  
Botanical Bertholletia excelsa Humb. & Bonpl.  
Synonym Bertholletia nobilis Miers  
Vernacular Brazil nut, para naut (English); noix du Brésil (French);  
castanha do par, castanha do Brasil (Brasil).

2.0 ECOLOGY AND DISTRIBUTION

Bertholletia nobilis is generally found in the warm, wet, lowland rainforest; it is also common in drier regions of transitional forest receiving only 1500 mm annual rainfall and with a noticeable dry period of 4 to 5 months. It is extremely well adapted to the heavy clay and low fertility oxisols and ultisols of the region but is not very tolerant of waterlogging. Dispersed groups of 50 to 100 trees are common, with individual trees often a kilometer or more apart; densities of 0.1 to 2.5 trees/ha have been recorded in forest inventories.

The species is now widely spread throughout much of the Amazon region, obscuring its precise centre of origin. Major areas of wild collections are in the southeast, centre and southwest of the Amazon; trees are also found in both the southern and northern Amazon and in the Guyanas.

Related species: Lecythis usitata Miers

3.0 DESCRIPTION

A large tree to 40-60 m high; trunk often reaching 2 m in diameter and occasionally over 4 m round in cross-section, very straight, often for 20 m or more, bark grey-brown, 1.5 cm thick, resinous, with deep, narrow, longitudinal fissures, reddish internally; open crown globose or umbrella-shaped, 10-20 m in diameter, often emerging 10-20 m above the forest canopy; seedlings and adult trees with deep, strong tap-root which may penetrate 3 m or more in heavy clays. Leaves alternate, simple; stipules absent; petiole 2-6 cm long; blade oblong to elliptic, 17-45 cm long, 6.5-15.5 cm wide, apex rounded and acuminate, base rounded, margins wavy, leathery, coppery to bright green, glabrous, veins prominent, especially below. Inflorescence terminal or axillary panicles 10-20 cm long; flowers 10-40, subsessile, bisexual, globose, 2-3 cm in diameter. Calyx envelops the flower except for a narrow slit at the apex, lobes subcircular-concave, c. 15 mm long; petals 6, yellow or cream, oblong, c. 30 mm long, curved over a thick, receptacle disc; stamens numerous, short; ovary inferior, 4-locular, ovules 4 or more per loculus, style short. Fruit a large, functionally indehiscent, woody capsule (pixidium), globose, 8-15 cm in diameter, weighing 500-1500 g; pericarp hard, woody, c. 1 cm thick, surrounded by a barklike pericarp; seeds 5-25, angular, 3-7 cm long, with hard, woody coat and thin, adhering testa, tightly packed within the fruit, kernel white, nutty texture.

Fruiting November to August, 14 months after flowering.

4.0 MAIN USES

Large quantities of fruit are collected from the wild for local consumption and for export. Nuts are removed with difficulty, by hacking out of the very hard fruit with an axe or machete. A large amount of nuts are exported from Brazil each year, mainly to Europe and the USA. Shells are difficult to remove with a knife or crackers and the trend is to increase the marketing of kernels that have been separated industrially. The process usually involves careful drying followed by a quick steam treatment which separates the kernels and softens shells, so that manual cracking becomes easy. This also has the advantage that rotten nuts, often contaminated with Aflatoxin, can be eliminated. Kernels are eaten raw, toasted or used in confectionary, often as a substitute for other nuts and grated coconut. A milk can be made from the kernels and is used in remote regions. Poor quality and waste kernels can be used for oil and soap production when enough are available and prices are low. The oil becomes rancid rapidly. The flavour is reminiscent of coconuts when the nuts are very fresh and they only develop the well known Brazil nut flavour after drying and oxidising slightly.

The wood is of good quality being straight grained, easy to work (density of 0.6 to 0.75 g/cm<sup>3</sup>), medium texture and lustre, with a light reddish brown heartwood and greyish sap wood. It takes a good smooth finish. Trees are being increasingly logged in many areas inspite of a Brazilian law which prohibits this because of the value of the fruit. Fruit pericarps are used for fuel and sometimes carved for sale in curio shops. The bark has been used for fibre production in remote regions and is also used in folk medicine for liver problems.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The large heavy fruit fall dangerously from a great height when ripe. Agoutis can chew through the woody pericarp and disperse some seed. Fruit are collected beneath trees usually within a few weeks of falling and are carried off for opening. Nuts are often stored and transported under precarious conditions for many weeks before drying, hence an Aflatoxin problem has arisen. *Aspergillus* spp. are able to slowly penetrate moist nuts so an attempt is being made by producers to improve the speed of collection and subsequent storage conditions. Dry nuts will store for a year or more in good conditions (70% R.H.). Sixteen-year-old trees produce 30 to 50 fruit and mature trees usually 200 to 400, although a yield of over a 1000 fruit has been reported. Fruiting is said to be heavy in alternate years only.

#### 6.0 NUTRITIONAL VALUE

Nuts represent about a third of the fruit weight and consist of half kernel and half shell. Kernels have 28% moisture when fresh and this falls to below 10% on dry storage. Dry nuts contain 63 to 69% oil, 14 to 17% protein, 4% fibre and 3% ash. So they are a good source of calories and protein. The latter is only slightly inferior to casein in nutritional value and is a very good source of sulphur amino acids. Because the species is able to extract nutrients from very poor soils there have been reports of dangerous accumulation of selenium and radioactive minerals in nuts from trees growing on soils rich in such elements.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

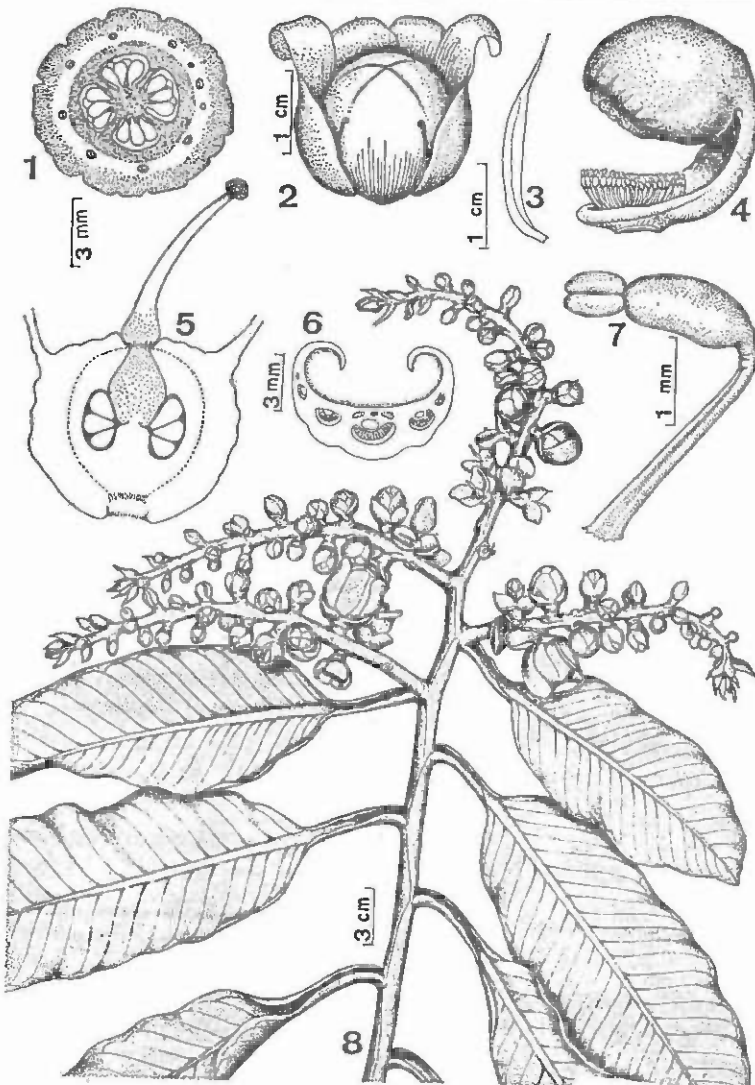
Seeds may take from 6 months up to 2 or 3 years to germinate unless their shells are well scarified or removed. This can reduce germination time to as little as 20 days. Lightly shaded seedlings grow to about 50 to 80 cm in the first year with as much as a metre of taproot. Growth continues at the rate of about a metre per year for 5 years and then slows a little with age. Forty-year-old trees are typically 20 m tall with a DBH of 0.5 m and 60-year-old trees 25 m by 0.8 m. Fruiting starts at 12 to 16 years in the forest and as soon as 8 years old if well managed in the open. Grafted trees (Forkert) fruit is about 6 years, although a record of 4 ½ years has been reported. Trees are very hardy and healthy although rodents and leaf cutting ants have attacked seedlings and *Cercospora* blight is sometimes seen, especially in older leaves. All commercial production is from wild trees as the few, small, known plantations yield poorly. This is probably due to the combination of poor pollination by wild bees away from their heterogeneous forest habitats and nutrient exhaustion of poor soils. Some new reforestation plantations are now being installed by logging companies planting at 20 to 30 m in 10 m wide lines cut in almost virgin forest. There are also some attempts to use the species in poor pasture, initially as a shade tree and eventually as a replacement.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

This species is extremely important to the economy of the Amazon region with many poor rural people depending partially on wild collection for their livelihood. It is also important in the rural diet and a common item in local markets. The export market of about 45,000 t per year is largely satisfied by Brazil with some nuts coming from Bolivia, Peru and Venezuela. International markets are relatively stable depending on the availability and price of other nuts, which they can frequently replace. However, local prices can fluctuate widely due to storage and over collection in some years. One can expect the market for deshelled kernels to expand as they avoid the problem of cracking and appeal more to the confectionary industry and consumer.

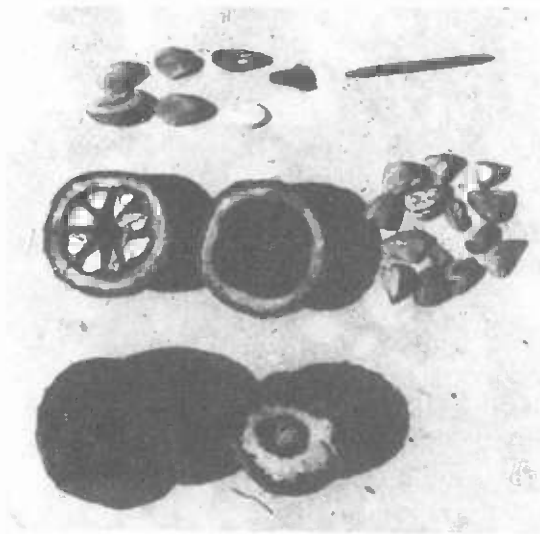
Plantations might create a social problem but would allow better quality nuts to be produced once the problems of pollination and fertilization have been overcome. Prospects for using the species in reforestation projects are good and the production of a valuable biproduct nut, during the 40 or more years needed, is obviously attractive. Some people feel that this might lower the cost of nuts to the point that they can be extracted to produce an edible oil and an animal ration. Selection for rapid growth, high production and kernels that separate from shell more easily, are research priorities.

Plate XIII. *Bertholletia excelsa* Humb & Bonpl.



2

1



3

- XIII
- 1 - 1. Cross section of ovary
  - 2. Corolla and male flower
  - 3. Scale
  - 4. Flower showing stamens
  - 5. Longitudinal section of ovary
  - 6. Section of petiole
  - 7. Stamens
  - 8. Flowering branch
- 2 - Mature tree
  - 3 - Fruit and nuts [Brazil nuts]

#### 14. BOROJOA SORBILIS

- 1.0 NAMES: Family Rubiaceae  
Botanical Borojoa sorbilis (Huber) Cuatrec.  
Synonyms Alibertia sorbilis Huber  
Thieleodoxa sorbilis (Huber) Ducke  
Vernacular puruf-grande (Brazil).

#### 2.0 ECOLOGY AND DISTRIBUTION

Borojoa sorbilis occurs on well-drained, nutrient poor, clay oxisols and ultisols as an understory element of the high forest of the terra firma. The annual rainfall varies from c. 2000 mm in the eastern part of its range to c. 2800 in the western part, with a mean annual temperature c. 26°C. It has not been recorded above 300 m. There are no records of its density from inventory records, however, it is frequently found in backyards.

The species appears to be restricted to the southwestern Amazon basin, where it probably originated. It is confined to the watersheds of the Madeira, Purus, Juruá, Javari and upper Amazon rivers as well as other minor tributaries of the upper Amazon between Madeira and Peru, thus ranging through all of southern Amazonas as well as parts of Rondonia, Acre and Peru.

Related species: T. stipulares and T. verticillata.

#### 3.0 DESCRIPTION

Large shrub or small tree 4-5 (-10) m high; trunk up to 10 cm in diameter, sub-angular or slightly fissured, bark thin, light brown; no information on the root system. Leaves opposite, simple; stipules persistent, triangular, 2 cm long; petiole 1.5-3 cm long; blade elliptic-ovate to oblong-ovate, 25-45 cm long, 15-21 cm wide, larger in sterile and generally juvenile leaves to 55 cm long and 20 cm wide, apex shortly acuminate, base cuneate, obtuse or subcordate, margins entire, membranous to subsoriaceous, glabrous, 16-18 pairs lateral nerves prominent below. Inflorescence terminal, species dioecious. Male flowers 5-merous, arising in the leaf axils on short pedicels between 2 stipule-like bracts; calyx campanulate, 3 mm long, truncate; corolla white, 25-30 mm long, lobes 5, oblong, 8-10 mm long; stamens 5, inserted in the tube, anthers linear, c. 12 mm long, base slightly emarginate; disc vestigial, with style c. 13 mm long with flattened apex and 2 minute, parallel stigmas. Female flowers subsessile, solitary, arising on short pedicels subtended by 2-stipule-like involucral bracts nearly as long as the corolla; calyx cylindrical, 5-6 mm long, 6-toothed; corolla 25 mm long, lobes 6, ovate-acute; anthers sterile, linear, inserted in the tube; ovary subglobose, 8-9 mm high, smooth, loculi 8, ovules numerous, style exceeding the corolla tube, stigma lobes 8. Fruit a depressed globose berry, 4.5-5 cm long, 6-8 mm in diameter; exocarp dark brown at maturity, smooth hard, leathery, 3-6 mm thick; mesocarp a dark brown pulp enveloping numerous, flattened, lens-shaped seeds 8-10 mm long.

Flowering September to December near Tefé, Amazonia; fruiting January to June.

#### 4.0 MAIN USES

The mesocarp is the only part of the fruit that is consumed. The fruit is very popular because it is reputed to be a good food. The pasty sub-acid to acid pulp has an agreeable flavour that frequently reminds one of tamarind (Tamarindus indica). The pulp may be consumed fresh or, more commonly, as a juice or made into candy. It is also very popular as a drink, mixed with rum.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruits are collected from the tree when ripe, either by hand or with a short stick. Because of the tough skin the fruit keeps well for a week or more. No information on yields is available.

#### 6.0 NUTRITIONAL VALUE

About 30% of the fruit is usable pulp, of which 80 to 90 % is water. There is some starch so the nutritional value may be restricted to furnishing some calories.

#### 7.0 CULTIVATION AND PROPAGATION

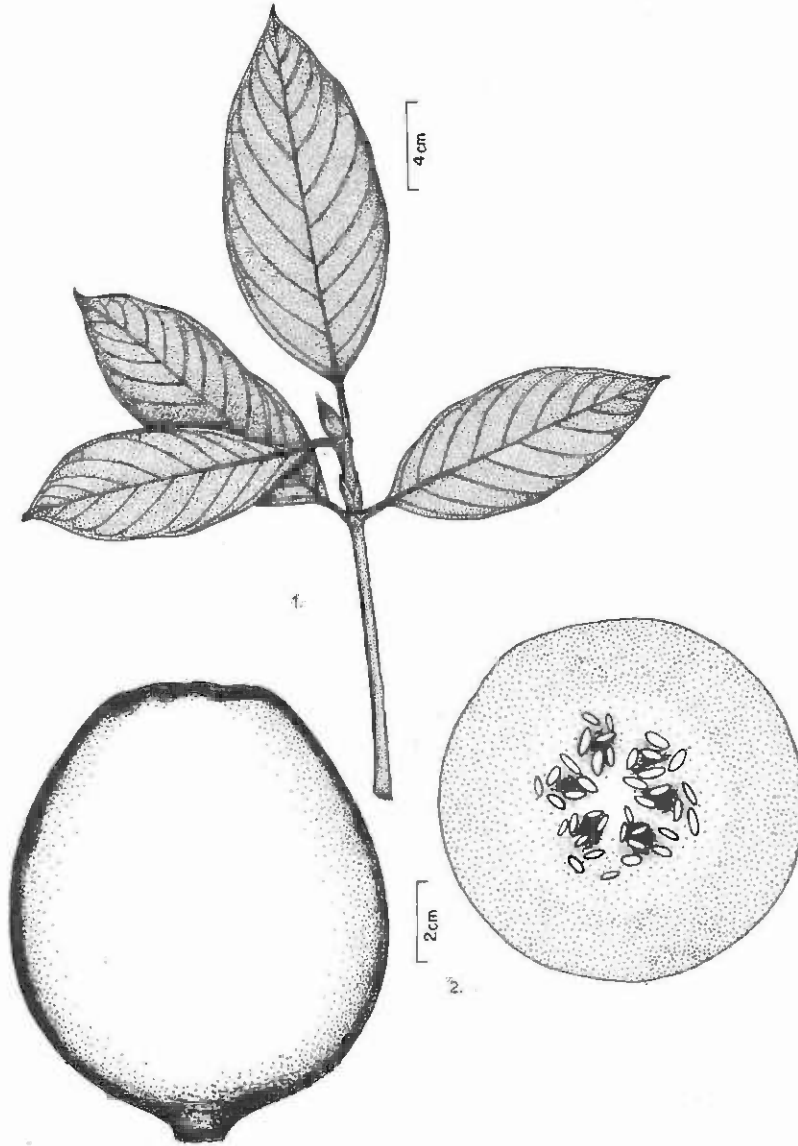
The percentage of germination is good if the seeds are sown soon after being removed from the fruit. Seedlings grow slowly. After 3 years in the field, on a yellow latosol (Oxisol), young plants vary from 1 to 2.5 m in height. Age at first bearing is unknown, as is the incidence of pests.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Because of its good flavour and popularity the puruf-grande occasionally reaches local markets. It would probably be able to find a wider market if good varieties could be found and selected. Thus germplasm collection is a first priority. Agronomic studies and the development of processed products are also needed. At the moment demand probably equals supply as many people have a plant in the backyard.



Plate XIV. *Borojoa sorbilis* (Huber) Cuatrec



XIV 1 - Leaves  
2 - Fruit whole and section

## 15. BYRSONIMA CRASSIFOLIA

- 1.0 NAMES: Family Malpighiaceae  
Botanical Byrsonima crassifolia (L.) Kunth  
Synonyms Malpighia crassifolia L.  
Byrsonima cinerea Dec.  
Byrsonima cotinifolia Kunth  
Byrsonima ferruginea Kunth  
Vernacular muruci, muruci-do-campo, muruci-da-praia (Brazil);  
maricas, cimarron (Cuba); chaparro manteca, sabanero  
(Venezuela); nancito (Honduras); nancé (Panama); nancite  
(El Salvador); yuco, nanci chaparro (Colombia);  
quinaquina des savanes (French Guyana); wild cherry  
(United States).

## 2.0 ECOLOGY AND DISTRIBUTION

Byrsonima crassifolia occurs spontaneously in open fields, open secondary growth and among coastal dunes. It prefers sandy soils but will adapt to well drained oxisols and ultisols of the terra firma. It appears to prefer an annual rainfall in excess of 2000 mm, unless growing near permanent water; throughout its distribution the mean annual temperatures are above 20°C. The muruci is most frequently found at altitudes below 100 m but may appear up to 300 or 400 m. It is most abundant in the lower Amazon basin and parts of the Bragantina region to the east of Belem, Pará. In some parts of this area, such as on the island of Marajó and in Salgado, Pará, it occurs in populations of 50 or more individuals/ha, and may cover many hectares.

The muruci and a number of related species occur in the Amazon basin, suggesting that this may well be its centre of origin. The present-day distribution extends from Minas Gerais and Mato Grosso in the south of Brazil northwards through Bolivia, Peru, Colombia, Venezuela and the Guyanas to Central America.

The genus Byrsonima contains many species with marginally edible fruit. However, only a few of these can be considered really edible, although all have a mediocre flavour. These are: B. crispa Juss., "muruci-da-mata"; B. lancifolia Juss., "muruci miudi"; B. verbascifolia (L.) Rich., "muruci rasteiro".

## 3.0 DESCRIPTION

Large shrub to small tree 2-6 m high; trunk crooked and gnarled, sometimes growing horizontally, bark soft, with lenticular markings; crown much branched and often touching the ground; extensive root system in the surface layer, deeper roots not known. Leaves opposite, simple; stipules lanceolate to ovate lanceolate, 2 mm long, densely pubescent; petiole up to c. 1 cm long; blade elliptic, 7-15 cm long, 3-7 cm wide, apex obtuse to acute, base rounded or cuneate, margins entire, coriaceous, green to yellow-green, often discoloured or mottled, glabrous or hairy, often densely so below, the hairs greyish or rusty-brown and sometimes soon deciduous. Inflorescence a terminal raceme at the end of the branches, up to 12 cm long; flowers bisexual, 5-merous. Sepals ovate-triangular, c. 2 mm long, tomentose, each with 2 large basal glands; petals 5, free, yellow, circular, concave limb with narrow, basal claw, c. 7-10 mm long; stamens 10; ovary superior, 3-locular, each loculus with 1 ovule, styles 3, subulate. Fruit a small, depressed-globose drupe 1.5-2 cm in diameter, skin delicate, yellow when ripe; pulp juicy, c. 5 mm thick, yellow with characteristic flavour and odour; stone globose or apex rarely pointed, containing 1, or rarely 2-3 seeds.

Flowering September to January or February; fruiting December to March or April.

## 4.0 MAIN USES

The mesocarp of the fruit is the part consumed and this may make up 40% of the fruit. The Musuci has an aroma and flavour that is extremely characteristic, somewhat sweet and acid, very agreeable once one is accustomed to it. The muruci was known and used by the Amerindians since before the "discovery" of the Americas. Today it is widely

used, especially in eastern Amazonia, in many forms: juice, pure or with cassava flour; flavoring for ice-cream and popsicles; prepared candies jellies; syrups, and as a fruit cocktail.

The bark, prepared as a strong decoction is reputed to help the human organism resist snake bites and lung inflammations.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit can be collected from the tree or from the ground. There is a preference for collecting from the tree while the fruit still have some green tints as this permits easier transport and allows a longer shelf life. At the markets the fruit are usually displayed in a bucket of water where they can be kept for a week or more. If kept in a dark container in a sugary solution they can be kept for more than 40 days in good conditions. Young plants attain economic production in the fourth fruiting season and may stabilize at about 15 to 20 kgs of fruit per season. At a 7 x 7 m spacing this gives potentially about 4 tons/hectare/year.

#### 6.0 NUTRITIONAL VALUE

A recent analysis gives the following results (Barbosa et al., 1978): 2.45% acidity, 4.8 BRIX, 2.8 pH, 25.86 mg % N (amino acids), 7.27 mg % vitamin C, 0.02% phosphorus, 0.08% calcium, 4.75% ether extract, 21.5% total solids, 77.5% H<sub>2</sub>O and 4.89% reduced sugars. Analysis of canned nectar after 14 months showed excellent results also. Because of its oil and sugar content, the muruci appears to be a good source of calories for human consumption.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

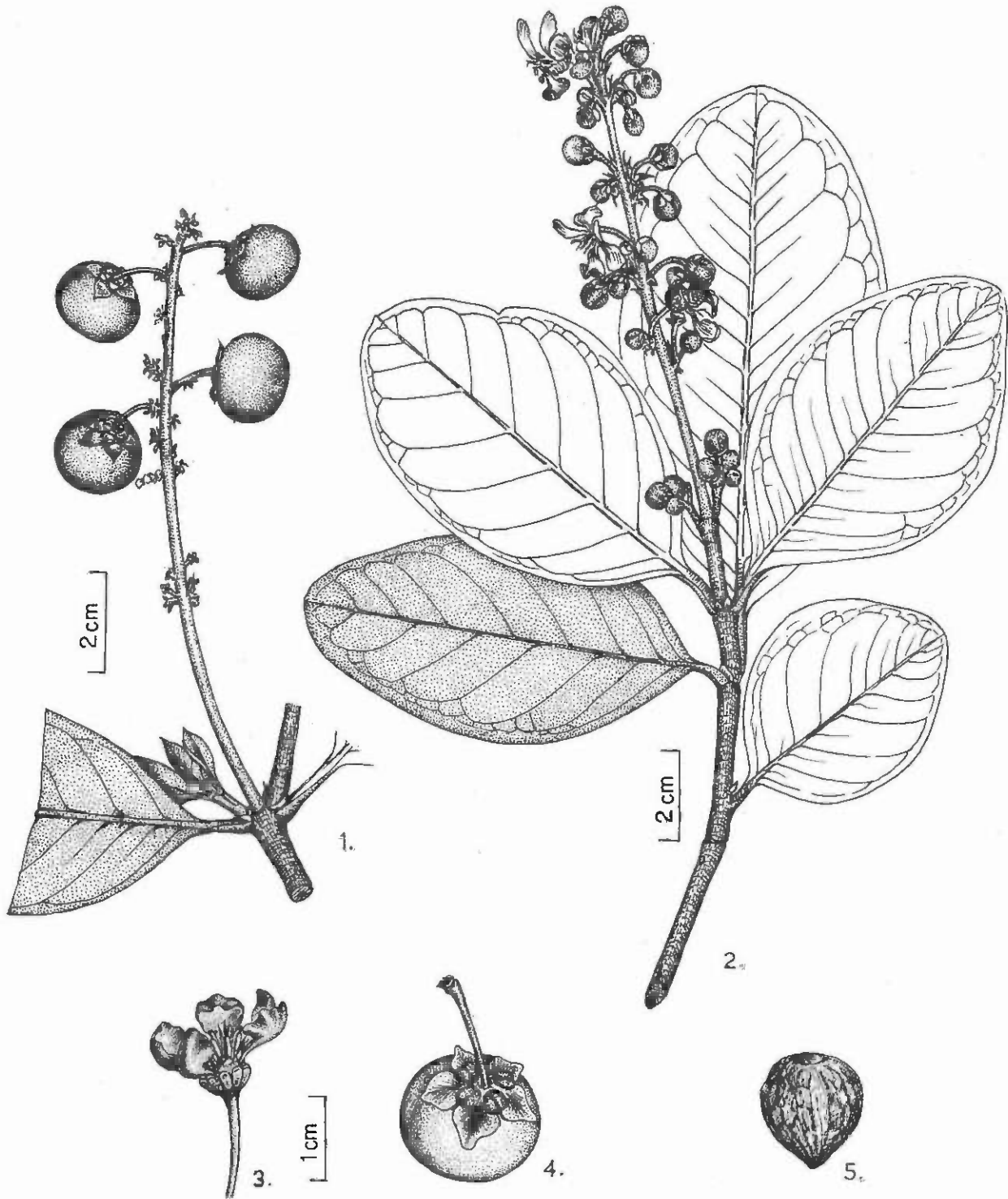
The muruci is generally propagated by seed, which starts to germinate in 12 to 14 days and gives good percentages if sown fresh after removal from the fruit. There are reports of grafting having given good results. The seedlings can be taken to the field after 100 to 120 days in the nursery, if raised in good substrates, when they reach 40 to 60 cm in height. After being established in the field initial growth is rapid. Flowering can be very precocious, frequently in the first season after one year in the field. Even the first flowering will generally set fruit. No insect or disease problems are known to reduce production seriously.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

The muruci is one of the most popular Amazonian fruits and appears to have great economic potential. It is a plant that grows well on poor soils, produces well and precociously, has a wide range of possible industrial products and is very popular.

Genetic collections for good flavour and high pulp/fruit ratio are needed, as well as research on agronomic practices that might increase production. In some parts of Pará state, Brazil, the muruci is already being planted on an agro-industrial scale and should produce good results.

Plate XV. *Byrsonima crassifolia* (L.) Kunth.



XV 1 - 1. Fruiting branch  
2. Flowering branch  
3. Flower  
4. Fruit  
5. Nut

16. CAMPOMANESIA LINEATIFOLIA

- 1.0 NAMES: Family Myrtaceae  
Botanical Campomanesia lineatifolia Ruiz & Pavon  
Synonyms Campomanesia cornifolia Kunth  
Campomanesia rivulare DC.  
Vernacular guabiraba, araca-lima (Brazil, Pará); guayaba de Leche,  
guayabo anselmo, guayaba de mono (Colombia); palillo (Peru).

2.0 ECOLOGY AND DISTRIBUTION

Campomanesia lineatifolia occurs on oxisols or sandy clay soils of the terra firma, under a hot, humid climate. There is no further information available. It is extremely rare and has only been found in the wild on three occasions.

The species is native to the western part of the state of Amazonas (Brazil) and in the eastern parts of Peru and Bolivia to Colombia. It is sometimes found either cultivated or growing spontaneously in other areas.

Related species: Pio Correa (1952) reports 29 species of Campomanesia found in Brazil, most of them with edible fruits, but only a few have flavourful fruits. There are shrubs of 1-2 m in height and trees between 10 to 15 m high. Campomanesia corymbosa Berg; C. fusca Berg; C. maschalantha Berg; C. martiana Berg; C. obversa Berg; C. reticulata Berg; C. rufa Berg; C. transalpina Berg; C. virescens Berg.

3.0 DESCRIPTION

Tree 4-6 (-10) m high; trunk slightly furrowed, bark pale brown, thin; crown densely branched; root system unknown. Leaves opposite, entire; stipules absent; petiole slender, 6-9 mm long; blade ovate to elliptic, 16-20 cm long, 8-10 cm wide, apex acuminate to cuspidate, base rounded, truncate or subcordate, margins slightly wavy, papery, subglabrous to sparsely hairy above, densely hairy below when young, soon becoming sparsely so, with pellucid glands, midrib and lateral veins conspicuous, prominent below, anastomosing near the margins and connected by numerous, slender, transverse veins. Flowers borne in fascicles of 3-4 on very short shoots in the leaf axils, bisexual, regular, 5-merous; pedicels 2-3 cm long. Sepals 5, rarely 4, oblong, c. 4-5 cm long, c. 3 mm wide, apex broadly rounded, densely tomentose, gland dotted; petals 5, white, rounded or obovate, c- 10 mm long; stamens very numerous, c. 10 mm long, on a disc surrounding the subulate style; ovary inferior, 4-7 locular, stigma peltate, flat. Fruit a depressed-globose berry up to 7 cm in diameter, with persistent calyx base, epidermis yellow, pulp abundant, soft, surrounding c. 10 discoid seeds, each weighing c. 1 gm.

Some cultivated trees in Belém, Pará flower from July to September, fruit until February.

4.0 MAIN USES

The edible part of the fruit is the abundant fleshy soft pulp. The flavour is sweet and slightly acid, scented and very agreeable. The pulp can be consumed fresh but it is most often made into juice or ice-cream.

5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The harvest consists of gathering the ripe fallen fruits on the ground under the tree. Commonly people climb trees to shake fruiting branches to hasten the falling of fruits. The yield can be estimated at 400-500 fruits per tree/year or 40-50 kg of fruits, as a rough calculation.

6.0 NUTRITIONAL VALUE

About 70% of the fruit is pulp, with the seeds and skin accounting for the rest. No information on nutritional value is available but probably it is a good source of vitamin C.

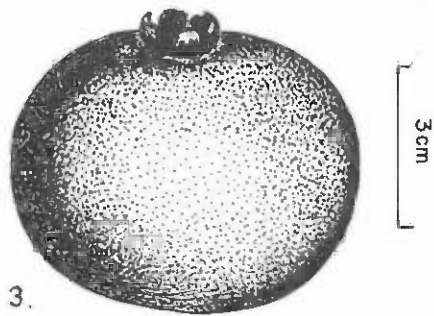
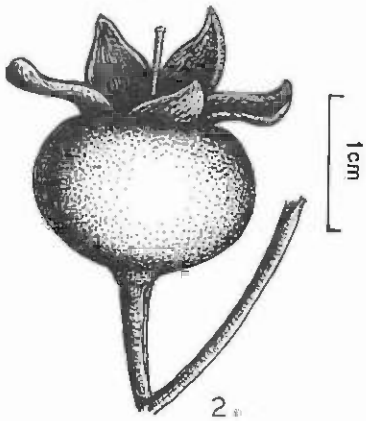
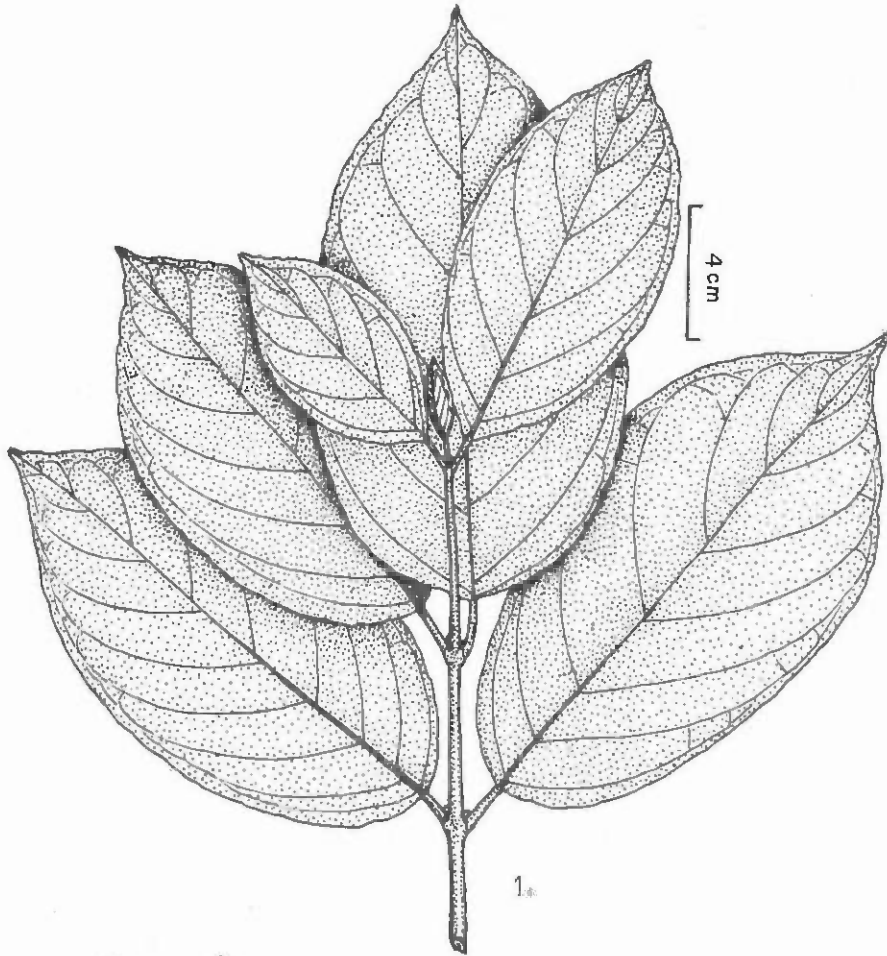
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Seemingly this species has never been studied agronomically. However, it is known that its propagation is by seeds which have a good germination percentage in the first days after collection. On the other hand, growth seems to be slow in the first three years, according to small experiments run in the Botanical Garden of the Museu Goeldi.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Although poorly known, this species has exceptional qualities that make it a strong competitor with other local market fruits. However, genetic and agronomic studies are necessary as well as research on the economic aspects and food value of the fruits. The abundant pulp and its agreeable flavour justify a research programme to make this species economically profitable.

Plate XVI. *Campomanesia lineatifolia* Ruiz & Pavon



XVI  
1 - 1. Leaves  
2. Flower  
3. Fruit  
2 - Mature fruits

17. CARICA PAPAYA

1.0 NAMES: Family Caricaceae  
Botanical Carica papaya L.  
Vernacular papaya, pawpaw, papaw (English); mamão (Brazil); papaya (Spanish); papaye (French); melonnenbaume (German); fruta-bomba (Cuba); papaya calentana, fruta bomba, árbol de melón (Colombia); papaya, lechosa (Venezuela); papaya, manón (Argentina); melon zapote, papaya cimarrona (Mexico); papao, papaya (Dutch Antilles); papai (Haiti); and many others.

2.0 ECOLOGY AND DISTRIBUTION

Carica papaya is rare in the primary forest but may become the dominant pioneer species in disturbed areas; it also occurs in secondary forest and clearings. Although it will grow well on most soils, provided they are well drained, it prefers deep, well-structured, sandy loams with high levels of organic matter and good drainage. Drainage is a limiting factor, likewise salinity, which can damage the root system. A high rainfall, 1800 mm or more, is necessary for good, sustained growth and production. Relative humidity in excess of 60% and temperatures between 21° and 33°C are preferred for optimum growth and production. Being a species of the humid tropics, the papaya does not produce well at altitudes above 1500 m and grows best from sea level to 200 m.

The Vavilov centre of origin for this species is in the foothills and lower mountain slopes of the eastern Andes, in the northwestern Amazon basin, in Peru, Ecuador and Colombia, where a number of other Carica species also occur. It is one of the most popular and widespread species introduced from the humid American tropics into the Old World tropics.

Related species: the genus Carica contains 22 species, of which the following are used occasionally: Carica quercifolia (St. Hil.) Hieron.; C. pubescens Lenné et Koch; C. candicans A. Gray; C. goudotiana Solms; C. parviflora Solms.

3.0 DESCRIPTION

Evergreen, semi-herbaceous, rapidly growing, short-lived, dicecious, or occasionally hermaphrodite tree 3-10 m high; trunk usually unbranched, up to 30 cm in diameter, with large, nearly horizontal leaf scars; latex thin, milky; root system radial, profusely branched, exploiting most of the surface area and also extending down to 1 m, roots creamy white, very flexible. Leaves alternate, simple; stipules absent; petiole cylindrical, 50-100 cm long; blade palmately lobed, up to 70 cm in diameter, lobes 7-13, and themselves frequently lobed, pale, uniform green above, pallid whitish-green below. Male inflorescence axillary, composed of indeterminate, multi-branched and multi-flowered clusters, generally 50-100 cm long on peduncles 10-20 cm long. Male flowers mildly perfumed, calyx small, 5-lobed; corolla creamy-white to greenish-yellow to yellow, tubular to funnel-shaped, up to 5 cm long, 5-lobed; stamens 10, yellow, in 2 rows around the throat of the corolla. Female flowers solitary in the leaf axils, on pedicels 1-2 cm long. Calyx small, 5-lobed; corolla creamy-white to pallid yellow or yellow, lobes fleshy, nearly free, lanceolate, 50-70 mm long, 15-25 mm wide; pistil pallid yellow, c. 2-3 mm long, ovary large, ellipsoid to globose, 1-celled with numerous ovules, stigma 5-branched. Hermaphrodite flowers are also often present. Fruit variable, spherical to ovoid or obovoid, 10-40 cm in diameter, smoothly rounded to somewhat 5-angled, skin yellow, with milky sap; pulp yellow to orange or reddish, juicy, soft, aromatic, sweet to insipid, 2.5-5 cm thick, surrounding a large central cavity containing numerous, black, nearly globular seeds,

Flowering and fruiting nearly all the year round in regions with a constant rainfall.



#### 4.0 MAIN USES

The fruit of the papaya is much appreciated everywhere that it is found and this has led to it becoming one of the most common species throughout the tropics. The juicy, soft pulp of the fruit generally has an attractive distinctive aroma and a sweet agreeable flavour. The flavour is appreciated more with experience but is generally liked when tried for the first time. The principle use of the papaya is as fresh fruit at breakfast or dessert, often with sugar and lemon juice. It also makes good juices, either alone or mixed with other fruits, and is also commonly used in fruit salads. There is some industrialization of the fruit and products canned in syrup, crystalized pieces of green and ripe fruit and stems; jams, jellies and purées have developed good markets in some areas.

Papain is a widely used product for meat tenderizing, among other uses, extracted from the immature fruit or the stem of the papaya. The collection of this product is incompatible with the production of fresh fruit but can be compatible with the production of fruit for industrial purposes. Depending upon the extraction technology used to obtain papain it is possible to obtain other by-products, such as pectin seed oil, carotene and an animal ration for ruminants.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Since this is a thin-skinned, relatively delicate pulped fruit care must be taken when harvesting for the fresh fruit market so as not to blemish the fruit. Many techniques have been developed, such as small baskets on poles, ladders in carts, etc.. For fresh fruit post-harvest technique is important, especially hot water/fungal and wax dips to protect against post-harvest fungal attack. The papaya can produce an enormous yield when well grown. A plant can produce between 20 and 160 fruit/year, depending upon variety and age. At 3 x 2.5 m spacing, 1.300 trees/hectare, yield can approach 25 tons/hectare/year, although as much as 30% of this may be unuseable for the fresh fruit market.

#### 6.0 NUTRITIONAL VALUE

The moisture content ranges from 84.8 to 89.3% and fresh pulp contains 10-20% sugars, 0.39 to 0.81% protein; 0.05 to 0.56% fats; 0.24 to 1.02% fibre; a pH of 5.20 to 6.25; 0.19 to 0.21 mg iron, 1093 to 2034 mg vitamin A 74 to 84 mg Ascorbic acid. There are also traces of Thiamin, Riboflavin and Niacin. As can be seen the papaya has low levels of protein but has useful levels of sugar and vitamins A and C.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

Papaya is propagated largely from seed. Vegetative propagation, although possible, is not economically viable. The breeding of the papaya has been highly developed during this century, taking advantage of the self-fertile hermaphrodite flowers found on some plants. Seeds are sown in plastic bags or directly in the field at a depth of 2 to 3 cm. Germination is rapid and early growth is favoured by good soil preparation and fertilization, especially animal manures or compost. Field planting is usually at a spacing of 1.8 to 2.7 m within the line and 1.8 to 3.3 m between lines, depending upon the variety used, climate, soil, location, incline and degree of mechanization. Because the papaya can produce very heavily and continuously if the climatic conditions are right, the heavy application of fertilizers is used commercially. Precise formulas and quantities depend on the soil. Organic fertilizers have given very good results. Given adequate water and nutrients the papaya will grow rapidly to flowering (5 to 7 months) and fruiting (9 to 14 months). Growth and production may be inhibited by a wide variety of fungal, bacterial and viral pests of the roots, trunk, leaves and fruit. Many insects and arachnids also attach the papaya. However, since the papaya is already an important agricultural crop, most of these pests have been studied and control techniques developed.

## 8.0 POTENTIAL ECONOMIC IMPORTANCE

The papaya is a species with a large, well developed market in the tropics and subtropics. However there is still much room for expansion. The European and American markets are just beginning to open up. There are also many tropical areas where disease problems, especially viral diseases, have prohibited cultivation, so that the fruit must be imported from other areas.

Research is especially needed on disease resistance, selection of good flavoured varieties, and post harvest handling. The production of papain is also a market with good potential.

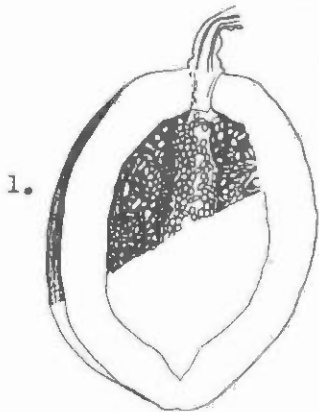
Plate XVII. *Carica papaya* L.



1



2.

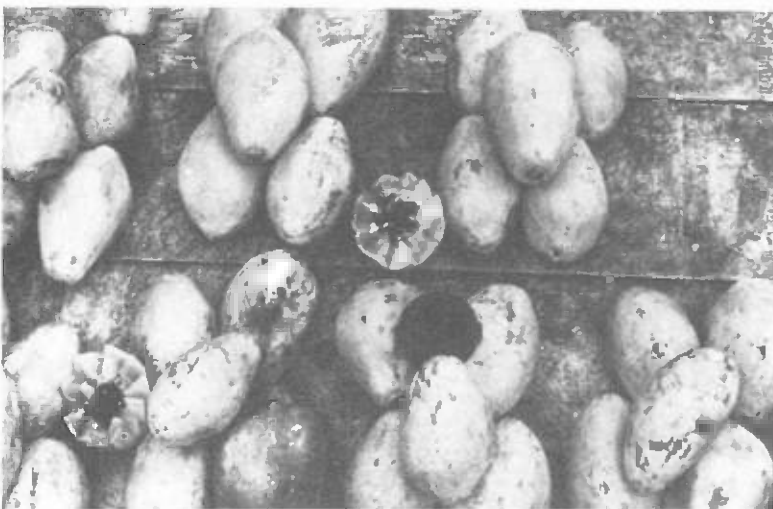


1.



3.

2



- XVII
- 1 - Fruiting plants
  - 2 - 1. Section of fruit  
2. Leaf  
3. Fruiting apex
  - 3 - Fruit of sunrise s cultivar. Collect Belem, Brazil.

3

## 18. CARYOCAR BRASILIENSE

- 1.0 NAMES: Family Caryocaraceae  
Botanical Caryocar brasiliense Cam.  
Synonym Caryocar intermedium Witt. - now subsp. intermedium (Witt.)  
Prance & Silva  
Vernacular pequi, piquí (Brazil)

### 2.0 ECOLOGY AND DISTRIBUTION

Caryocar brasiliense occurs in almost pure groves over large areas of the cerrado (savannas) of central Brazil, on both the plateaux and in the valleys, elsewhere usually as scattered individuals. The species is well adapted to nutrient poor, heavy clays, especially those rich in iron and aluminium. The species is restricted to areas with 4 or more months dry season, Aw climate according to the Köppen classification.

The species is believed to have originated in the cerrados of central Brazil, its northern limits being the fringes of the Amazonian rainforest, extending southwards through central Brazil, eastern Paraguay to northern Argentina, and extending westwards from the state of Maranhão to Bolivia.

See C. villosum for related species.

### 3.0 DESCRIPTION

A twisted, small tree or sometimes a shrub or even a suffrutex, rarely exceeding 10 m in height; trunk gnarled, rarely more than 30 cm in diameter; crown large, sometimes up to 10 m in diameter; an extensive and deep taproot system reaching down to the water table and supporting the tree in high winds, superficial roots also present. Leaves alternate, 3-foliate; stipules absent; petiole 1-10 cm long, densely pilose when young; leaflets elliptic-ovate, laterals often markedly asymmetrical, terminal leaflet 10-18 cm long, 8-12 cm wide, apex and base rounded, margins coarsely crenate, densely pilose with fine hairs, at least when young. Inflorescence a terminal raceme, peduncle 4-10 cm long, flowers 6-20; pedicels 1-5 cm long. Calyx broadly cup-shaped, 10-13 cm long, lobes 5-6, rounded; corolla white to yellow, sometimes orange-red outside, lobes 5-6, oblong, 18-25 mm long; stamens 270-330, outer filaments yellow, up to 50 cm long, inner grading down to 15 mm long; ovary globose, 4(-6) locular, styles filamentous and similar in appearance to the stamens, the inflorescence habit and positioning, combined with flower form, facilitate pollination by bats. Fruit irregular ovoid-globose, usually 1-locular and 4-5 cm in diameter or occasionally 2-locular and larger; exocarp smoother than in other Caryocar spp. with few or no lens-shaped markings; pericarp thick, fleshy and generally remains attached to the mesocarp, from which it will separate on cooking; mesocarp and endocarp enveloping the seed to form an ovoid stone about 2.5-3 cm in diameter; mesocarp smooth on the surface, its interior full of hard, thin and woody endocarp spines up to 2 or 3 cm long; kernel white and oily.

Flowering June to October; fruiting November to March.

### 4.0 MAIN USES

The fruit, and to a lesser extent the kernel, have played an important part in the diet where it occurs. As with the piquiá (C. villosum) it is the mesocarp that is most frequently used, the kernel often being ignored because of the spiny endocarp. The oily textured mesocarp is very rich and fatty, but one acquired has an agreeable odour and sweet taste. The piquí is most commonly used after cooking. The mesocarp can be gnawed or scraped off. The stone with mesocarp is often used to flavour rice or stews. Though it is most commonly eaten cooked, the piquí is also famous as a liqueur. The mesocarp is grated and mixed with alcohol and set aside to age, after which it is strained and mixed with sugar to make a very sweet, agreeably piquí flavoured liqueur. The kernel of the piquí is also prized by those with the patience to separate it from the spiny endocarp. Oil is extracted by crushing and boiling and used for cooking and soap manufacture in some remote regions.

The wood is occasionally used for furniture making in some areas. The tree, with its wide crown and beautiful large white or yellow flowers is often used as a street ornamental in the drier regions of Brazil.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

As with the piquiá (*C. villosum*), harvesting consists of collecting fallen fruit. Even though the tree is low enough to facilitate harvesting from the tree, this is not usually practised because of difficulty in determining ripeness. By waiting for fruit fall one obtains perfectly ripe fruit. Because of oil content, rancidity may be a problem if the fruit are not used soon after harvesting. Large trees are said to be capable of producing as much as 2000 fruit, but no reliable data on average yields are available.

#### 6.0 NUTRITIONAL VALUE

In 100 g of fresh mesocarp there are 81% water, 2.7% protein, 8% oils and fats, 1% ash, 6.7% carbohydrates, 120 mcg carotene and several other vitamins, among which vitamin C, thiamin, riboflavin and niacin. So there is about 42% oil in the dry pulp. Generally the piqui is reputed to have more oils and fats than in the above data, however precise information was unavailable. The piqui mesocarp is a good source of calories and its carotene level is relatively high. The carotene level suggests that there may be some validity to the old-wives' tale that it can be used to treat several eye diseases related to vitamin A deficiency.

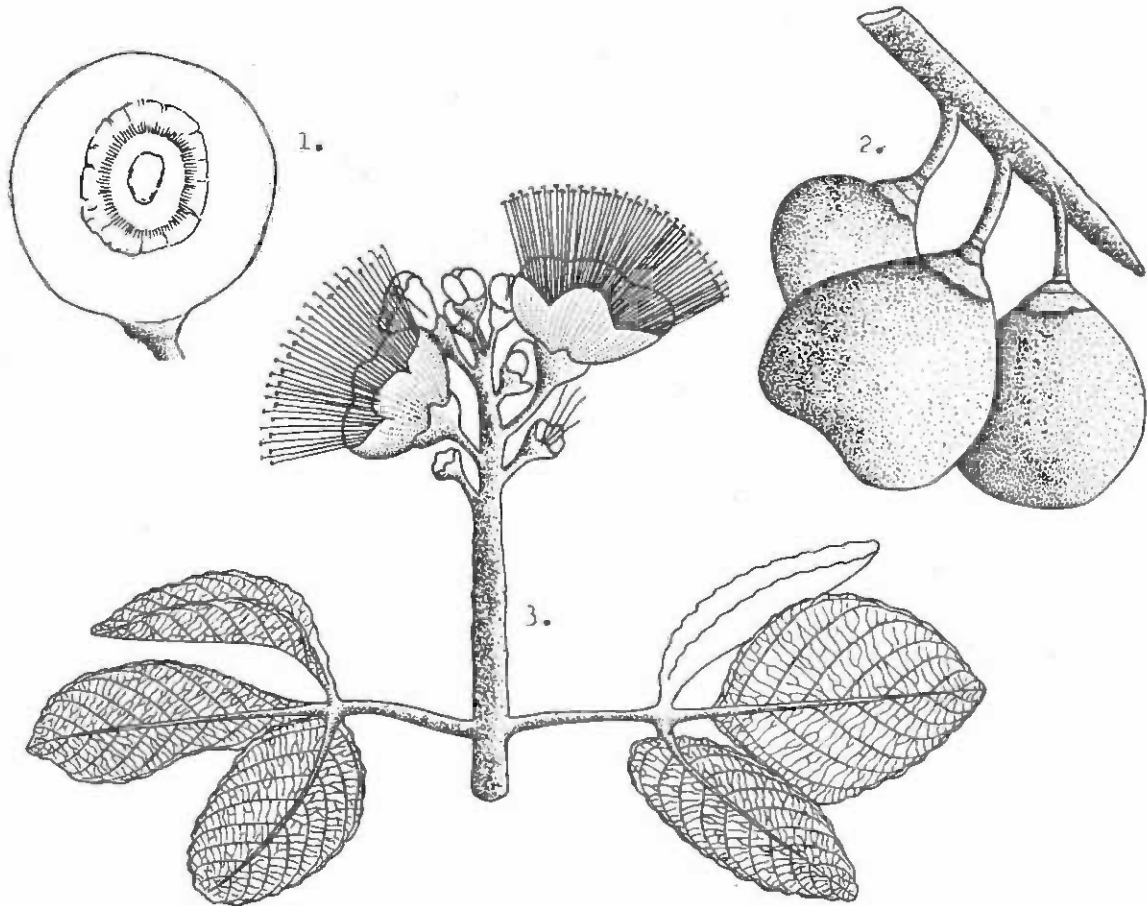
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Not much has been written about the reproductive biology of the piqui, however, there is mention of the fact that the seed may take more than a year to germinate. Stratification of the seed, still within the endocarp, has been suggested. Another source suggests that grafting and marcottage will give good results for vegetative propagation of selected material. Being native to the drier regions of Brazil, the piqui is a slow grower. Fertilizer is said to produce very good responses. There is no data available to suggest disease or insect pests.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Because of its local popularity and high oil content the piqui may have some potential as a tree crop for the drier regions of the world. It is well adapted to the nutrient poor soils and long dry seasons of the Brazilian savannas where few other crops can be grown without irrigation, fertilizer and other technical inputs. Large natural groves and slow growth have inhibited the systematic planting needed to establish yield potential. Genetic collection and selection are needed to identify high yielding, precocious germplasm with larger fruit, more mesocarp to total fruit, higher oil content and high production. The high melting point of the kernel oil may be attractive for cocoa butter substitution.

Plate XVIII. Caryocar brasiliense Cam.



XVIII 1 - 1. Section of fruit  
2. Fruiting branch  
3. Inflorescence and leaves

19. CARYOCAR GLABRUM

- 1.0 NAMES: Family Caryocaraceae  
Botanical Caryocar glabrum (Aubl.) Pers.  
Synonyms Caryocar taxiferum Barb. Rodr.  
Caryocar coccineum Pilg.  
Caryocar tessmannii Pilg.  
Caryocar parviflorum A.C. Smith  
Vernacular Piquia-rana (Brazil); almendra, almendro (Peru); chawari, kassagnan, agougagui (French Guyana); sawarie, sopohoedoe, aloekoemarirang (Surinam); tiqua (Venezuela); kōn, E-ko (Colombia); soapwood (Guyana).

2.0 ECOLOGY AND DISTRIBUTION

Caryocar glabrum appears to be restricted to the heavier, well-drained, nutrient poor clays, heavy clay oxisols and ultisols of the humid tropical rainforests on terra firma. Climatic conditions range from dryish Aw through Am to very humid Af on the Köppen scale. Thus, in some areas it tolerates up to 3 months of drought, and in others more than 3000 mm rainfall per annum. The altitudinal limits are not known.

The species appears to have originated in western Amazonia, perhaps in the Solimões-Amazonas West and Southwest phytogeographical regions of Prance (1973).

The three subspecies recognized are distributed as follows: - subsp. glabrum has the widest distribution. It occurs along the Atlantic coast of Brazil from near Belém, Pará Province to Surinam in the non-flooded humid forests and extends westwards along the major river basins, appearing on the Guyana shield in Guyana; in the Amazon basin as far inland as Manaus, Amazonas and along the Rio Negro into Venezuela. It is apparently absent from Roraima. It also occurs along the Rio Solimões westward into Peru and along the Rio Juruá and Rio Madeira into Acre and Rondonia Provinces in the southwest of the Amazon basin. Subsp. parviflorum (A.C. Smith) Prance & M.F. Silva occurs in the area between Manaus and the southern central part of the Brazilian Amazonia, along the Rio Solimões to Tefé and the Rio Puras and Rio Madeira. Subsp. album Prance & M.F. Silva is known only from the Upper Mazaruni River in Guyana.

For related species see C. villosum.

3.0 DESCRIPTION

A forest tree to 50 m, frequently emergent from the canopy and similar to C. villosum but with a more slender trunk; roots also as in C. villosum. Leaves alternate, 3-foliolate; stipules minute and early deciduous or rarely larger and persistent; leaflets + subequal, broadly ovate 7.5-15 cm long, 3.5-7 cm wide, apex acuminate, base rounded to subcuneate, margins entire to slightly crenate, thinly hairy at first, soon glabrous except sometimes for a few hairs on the midrib and the bearded vein axils below; petiole 3-10 cm long. Inflorescence of clustered racemes with 10-30 flowers on pedicels 1-3 cm long. Calyx broadly cup-shaped 7-12 mm long, lobes 5, rounded; corolla yellow, sometimes tinged with orange, lobes 5, oblong, 17-25 mm long; stamens very numerous, up to c. 300, the outer 30-60 mm long; ovary globose, 4-locular, styles 4, filamentous. Fruit 1 - or 2-locular, irregularly ellipsoid-globose, 5-6 cm long, 5-8 cm in diameter, glabrous with crusty exocarp, mesocarp indehiscent, fleshy and surrounded by a thick, fleshy pericarp and enclosing the easily separated, woody, spinose endocarp. Seeds 1-2, kernel white, large and oily; germination hypogeal.

Flowering June to November, pollinated by bats; fruiting March to May.

4.0 MAIN USES

The endosperm or kernel is widely consumed locally. It is oily and has a sweet taste similar to piquiá (C. villosum) and souari (C. nuciferum). After the extraction of the kernel from the endocarp the kernel may be eaten fresh or toasted or boiled. It is occasionally ground and made into small cakes.

The epicarp is used as a fish poison in the upper Amazon in Colombia, Brazil and Venezuela. The wood of the piquiá-rana is of good quality, although not as good as piquiá (*C. villosum*) and is used for the same purposes, except not for railroad ties, as it is not quite as resistant to rotting.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Because the fruit falls when ripe there is no special harvest technique needed, except speed, as the oily kernel may turn rapidly rancid. No information is available on yields.

#### 6.0 NUTRITIONAL VALUE

The kernel is reputed to have the same composition as the piquiá. Its nutritional value is probably relatively good, as with most nuts.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

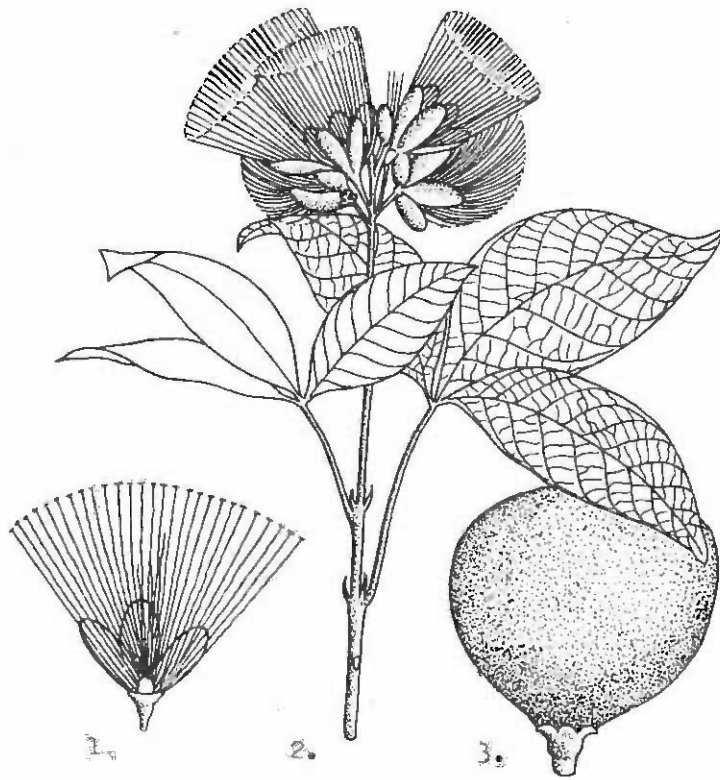
Seed propagation has been used for forestry experiments with good results. Initial growth is rapid, but slower than piquiá. It does not reach 10 m in ten years, except perhaps on very good soils, and has a more apically dominated crown.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Except in areas where it is already popular, the economic potential of the piquiá-rana appears to be limited. Like the piquiá it has heavy spines in the endocarp, though these do not separate easily, so that it would be a difficult nut crop to handle. Germ-plasm collection and selection would be necessary to increase nut size and perhaps improve flavour enough to overcome the endocarp drawback. This species may be more promising for silvicultural purposes than for its nuts.



Plate XIX. Caryocarp glabrum (Aubl) Pers.



XIX 1 - 1. Detail of flower  
2. Inflorescence and leaves  
3. Fruit

20. CARYOCAR VILLOSUM

1.0 NAMES: Family Caryocaraceae  
Botanical Caryocar villosum (Aubl.) Pers.  
Synonym Caryocar butyrosom (Aubl.) Willd.  
Vernacular piquiá, pequi, pequiá, ruamahi (Brazil).

2.0 ECOLOGY AND DISTRIBUTION

Caryocar villosum appears to be adapted to the heavier, poor but well-drained clay soils of the humid rainforest on terra firma. Climatic conditions range from Am to Aw on the Köppen scale, with from 1300 to 2500 mm rainfall with 1 to 4 months dry season; temperatures are uniformly constant. Within its natural distribution the species does not occur above 300 m altitude.

The species appears to have originated in eastern Amazonia. Its present distribution extends along the Atlantic coast from São Luis in Maranhão Province of Brazil to Cayene in French Guyana and westwards within the major river basins but failing to reach either the Guyanan or Brazilian shields. It occurs along the Amazon river as far as Manaus in Amazonas, and along the Rio Negro and Rio Branco of Roraima, ceasing only when the rainfall becomes excessive; it also occurs along the Rio Solimões up to Tefé in Amazonas, the Rio Purus up to the Afre border, and the Rio Madeira into Rondonia.

Throughout most of its range the average population of piquiá varies between 0.4 to 1 specimen per hectare; there are also records of some relatively dense stands of 4 to 5 specimens per hectare and of others with less than 0.4.

Related species: the genus Caryocar contains 15 species most of which have an edible nut, a few also having an edible mesocarp. Besides the 2 species also presented in this volume the genus contains the following species: C. coriaceum Wittmark; C. nuciferum L.; C. cuneatum Wittmark; C. gracile Wittmark; C. amygdaliforme G. Don; C. montanum Prance; C. pallidum A.C. Smith; C. edulis Caserotto; C. costaricense D. Smith; C. dentatum Gleason; C. amygdaliferum Mutis; C. microcarpum Ducke.

3.0 DESCRIPTION

One of the largest forest trees of the Central and Eastern Amazon basin, up to 40-50 40-50 m high under forest conditions and often emergent from the canopy; trunk up to 2.5 m in diameter, bark grey-brown, rough and fissured, remaining unbranched up to the canopy and supporting an open, leafy crown. In more open conditions, individual trees are normally smaller, with lower branches and more spreading crowns. Taproot large and deep; superficial feeder roots also present. Leaves alternate, 3-foliate; stipules absent; petiole 4-15 cm long; leaflets sessile, the terminal slightly larger than the 2 laterals, broadly elliptic, 8-22 cm long, 6-12 cm wide, apex acuminate, base cuneate, margins serrate or crenate, villous at least when young. Inflorescence of clustered racemes with c. 24 flowers, on pedicels 2-4 cm long. Calyx broadly cup-shaped, c. 1.5 cm long, lobes 5, rounded; corolla pale yellow, lobes 5, oblong, 25 mm long; stamens very numerous, up to 300, yellow, the outer up to 70 mm long, inner up to 15 mm long; ovary globose, 4-locular, styles 4, filamentous. Fruit irregularly oblong-globose, 1- or 2-locular, 6-8 cm long, 7-9 cm in diameter, glabrous or slightly hairy with small lenticels; pericarp thick and fleshy, mesocarp indehiscent and with the spinose endocarp forming a hard, kidney-shaped stone c. 5 cm at its widest point. Seeds 1 or 2, kernel white, large and oily, 2 cm long, 1 cm wide; germination hypogeal.

Flowering July to November (drier season), pollinated chiefly by bats; fruiting March to May. Leaves shed annually at the start of the dry season.

4.0 MAIN USES

The fruit and its nuts have played a relatively important part in the diet of the region, when in season. Some of the Indian tribes still rely upon it heavily. Though the nut is edible and has a good flavour it is normally ignored because of the difficulty

of removing it from the spiny hard endocarp. Thus the mesocarp is the main food source. The butter textured mesocarp is very rich and has a sweetish agreeable taste if cooked when still fresh. Rancidity sets in several days after the fruit has fallen from the tree. The nut is also very oily and has a sweet taste, reputedly very similar to the Souari nut (*C. nucifera*). The normal process is to collect the fruit freshly fallen from the tree (not more than one week) and cook it in slightly salted water for an hour or so. The thick pericarp, rich in tannins, is discarded. A layer of oily mesocarp of 3 to 11 mm thick can be cut or chewed off before reaching the points of the endocarp spines. If the fruit were to be industrialized steel scrubbing brushes could remove more useable mesocarp from between the spines. If the nut is to be consumed, either fresh or cooked, it must be removed from the endocarp, a rather prickly business to say the least, which is the principal reason that it is seldom used.

The heavy wood (0.8-0.85 g/cm<sup>3</sup>) of the piquiá is of excellent quality and wide use. Its colour is a very light, whitish beige with a rough grain that is quite compact because of its interwoven fibers. The wood does not rot, hence its main use is in ship-uilding and civil construction. It was used for railway ties in the Bragantina region.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Because the piquiá fruit falls upon reaching ripeness there is no special harvest technique needed, except speed, as forest and domestic animals also appreciate the fruit and the oil will turn rancid in about a week. Le Cointe has mentioned trees that produce 6000 fruit, however, this cannot be considered a realistic figure for unimproved, unfertilized trees. In the forests near Manaus some of the emergents produce 300-500 fruits per year, with quite a lot of year to year variation. One might expect a horticultural yield of about 1000 to 1500 fruits after some genetic selection, grafting and fertilizing.

#### 6.0 NUTRITIONAL VALUE

An average size fruit weighs about 300 grams fresh weight, of which about 65% is epicarp. This is especially rich in tannins of the pyrogallol type (hydrolysable), (34% on a dry weight). The fresh kidney stone is composed of about 30% mesocarp, 62% endocarp and 8% nut. On a dry weight basis (50% H<sub>2</sub>O) the mesocarp contains 72% oil, 3% protein, 14% fibre and 11% other carbohydrates. The nut contains 30% H<sub>2</sub>O and 62% of the dry weight is oil. The piquiá mesocarp is a good source of calories but low in protein.

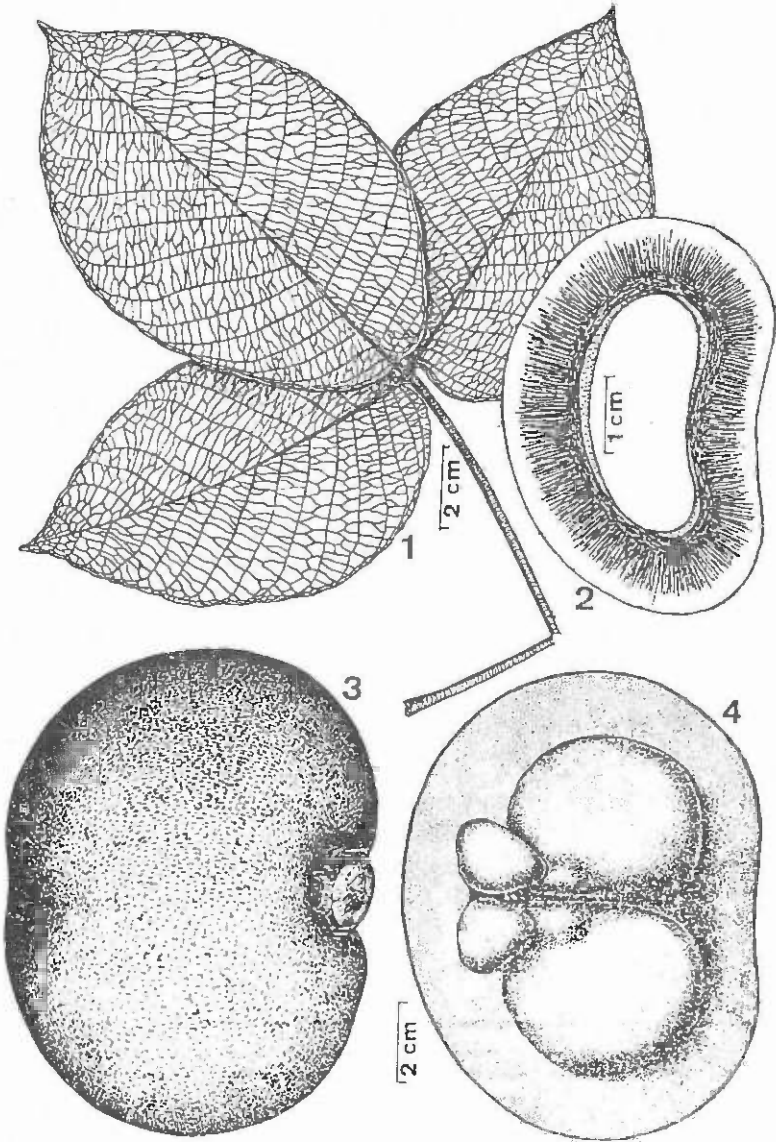
#### 7.0 CULTIVATION AND PROPAGATION METHODS

The seed is slow to germinate taking from 2 months to more than a year. This may be due to the difficulty of the leaching of germination inhibitors through the thick meso/endocarp stone. Marcottage has given good results as a vegetative propagation technique, but is very time consuming. Both budding and grafting work well with this species. For budding it is essential that the bark be slipping. The side veneer graft works well when bark is not slipping. Initial growth is rapid, being of the order of one meter per year during the first ten years. However the crown will also grow about one meter in diameter per year if grown in the open. The piquiá appears tolerant of many of the fungus diseases of the Amazon. There are some shoot-boring insects that may be responsible for the apparent lack of apical dominance noted in the field experiments in Manaus. Fruiting is reputed to start after 10 to 15 years in seedling trees. No information is available for grafted trees.

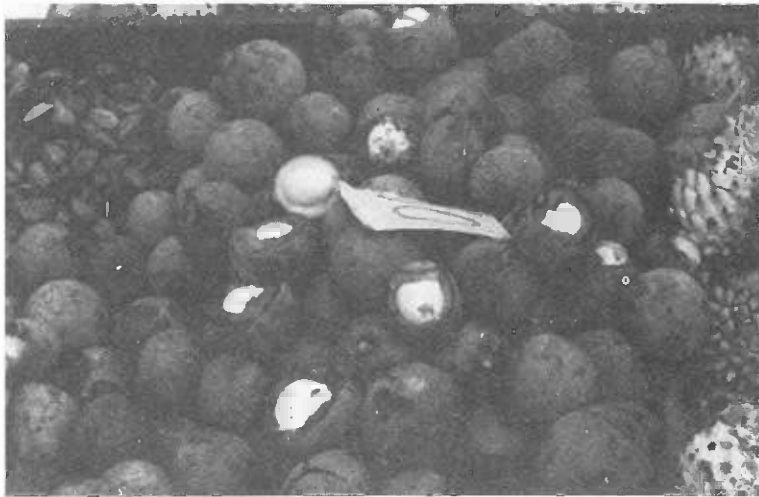
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Although the potential of piquiá as an oil crop has been appreciated since the time H. Wickham took seed to Malaysia with rubber, no practical attempts have been made to exploit it. Data on yields, reducing the time to first harvest, together with collection and selection of desirable characteristics are needed. Oils are said to have high melting points suggesting a use as a cocoa butter substitute. Dual purpose plantations for fruit and eventually hardwood seem worth considering.

Plate XX. *Caryocar villosum* (Aubl.) Pers.



2



- XX
- 1 - Mature tree along roadside after felling forest. Height 30 m. Manaus, Brazil
  - 2 - 1. Leaf  
2. Section of mesocarp and endocarp
  - 3. Whole fruit
  - 4. Fruit section
  - 3 - Mature fruit. Several fruit cut open to show mesocarp. Market "Vero @ peso" Belem, Brazil.

3

21. CARYODENDRON ORINOCENSE

1.0 NAMES: Family Euphorbiaceae  
Botanical Caryodendron orinocense Karst.  
Synonym Dioicia tetrandria L.  
Vernacular inchi (Colombia); palo de nuez (Venezuela); togay taque, taqui, caycay, kasepache, cumará, nambi, almendro del Peru, Ninacuru inchi, nuez de barinhas, huachanzo (Spanish and Amerindian).

2.0 ECOLOGY AND DISTRIBUTION

Caryodendron orinocense occurs on poor soils in the high forest, transitional forest and along waterways in the savanna in areas receiving between 2000 and 5000 mm annual rainfall. It is fairly tolerant to a few months of mild drought and will also withstand brief waterlogging. It is restricted to hot, lowland areas and has even been found as high as 1100 m. Average densities of over 2 trees/ha have been reported in a 50 km<sup>2</sup> survey area in Guape, Colombia. Trees have also been seen fruiting 2 km apart. The species is common in Colombia, Venezuela and Peru, in the western Amazon basin, where it originated.

Related species: C. amazonicum; C. agustifolium; C. grandifolium.

3.0 DESCRIPTION

Forest tree to 35 m with a relatively small but dense, flattened crown 12 m in diameter or cultivated tree rarely more than 15 m high with large, dense, round crown; trunk often straight for 20 m before heavy, dense branching starts, up to 2.5 m in diameter, sometimes with small buttresses, bark brown to brownish-red, 2 mm thick, sloughing periodically to reveal light green patches, green and grey lichens present and colouring the trunk, sweet, watery, orange latex exuded when cut; large superficial root system with large roots often seen on the surface, tap root weak, rarely penetrating more than 1 m. Leaves alternate, simple; stipules soon falling; petiole 3-5.5 cm long; blade elliptic, 22-30.5 cm long, 6.5-10.5 cm wide, apex acute, base subcuneate, margins entire with a row of small glands not far from the margins, glabrous, glossy dark green above, paler below, veining light. Inflorescence - plants dioecious. Male inflorescence a terminal raceme with small, shortly pedicellate, greenish flowers 2.5-3.5 mm in diameter; sepals 3, membranous; petals absent; stamens 4, inserted around a thick disc, filaments long. Female inflorescence a terminal panicle, flowers greenish, 2.5-3.5 mm in diameter, with large, persistent bracts; sepals 5-6 small, caducous, ovate sepals; petals absent; ovary globose, 3-celled. Fruit woody, grey, dehiscent capsule 3.7-6.5 cm long, 3.2-4.5 cm in diameter; seeds 3, waxy, grey-brown, 3-sided, slightly convex, with dark brown testa and creamy white endosperm.

Flowering June to September; fruiting September to December.

4.0 MAIN USES

Capsules are collected from the wild and cracked open. The kernels are then removed from the leathery testa before eating either raw, roasted, fried or ground up to make a drink or sweets. An edible oil can be extracted and is said to rancify rapidly. The flavour is pleasant and reminiscent of peanuts. Unripe nuts are said to be toxic and some people find ripe nuts indigestible.

The wood is used for construction of carpentry. Male trees are being eliminated for this purpose in some areas because the importance of pollination is not appreciated. Oil from the nuts, latex from the bark and shells are all used for light in remote areas as they burn well.

5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Capsules are gathered off the ground beneath trees. This must be done quickly as the fruit ripen almost all at once and then either rot, germinate or are eaten by animals.

Nuts keep for about 30 days within the capsules if kept in dry environment. They rancify rapidly if removed or kept moist and warm. Fifty to ninety kilograms of capsules can be produced by 10-year-old trees, Large forest trees will produce over 200 kg although yield varies considerably from year to year.

#### 6.0 NUTRITIONAL VALUE

One hundred grams of capsules contains 42% seed and 29 to 36% edible kernel. The latter contain 54 to 60% of a clear, light, liquid, edible oil containing 73% linoleic acid, 4% moisture and about 18% protein. The nuts are consequently a very rich source of calories and protein.

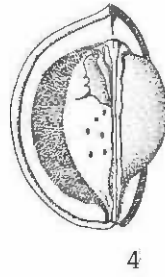
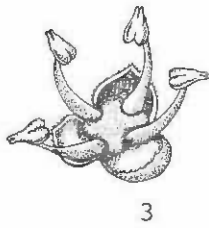
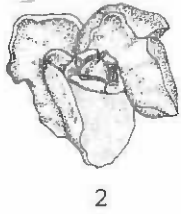
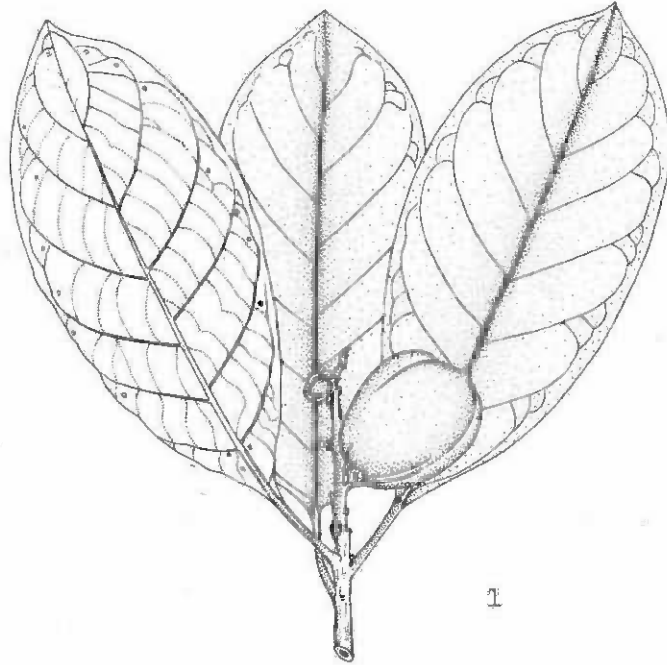
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds germinate well on the ground, one to two weeks after falling from the tree. They lose their viability rapidly. Growth is rapid with seedlings reaching 30 cm in 2 months and then gaining about a metre per year. Trees usually start to fruit when 7 m tall in about their seventh year. Fruiting at 4 to 5 years has been reported. Twenty-five-year-old trees are 12 to 15 m high and have 10 to 12 m crowns. Grafting is said to be difficult although few attempts have been made to test different techniques. Seedlings can suffer from leaf cutting ants and rodent attacks. Dieback has also been seen.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

The fruit of this species is attractive enough to reach local markets and these could obviously be developed. For example the species is unknown in Brazil. The excellent composition suggests that more careful thought should be given to exploiting it as a source of edible oil and animal ration. It is not clear if it is feasible to consider industrialization in areas of high concentration. If an effort is made to find higher yielding germplasm and to reduce the time to first harvest, the species could become an attractive proposition for plantations.

Plate XXI. *Caryodendron grinocense*, Karst



- XXI
1. Leaves and fruit
  2. Female flower
  3. Male flower
  4. Fruit section to show seed.

## 22. CASSIA LEIANDRA

1.0 NAMES Family Leguminosae subfamily Caesalpinioideae  
Botanical Cassia leiandra Benth.  
Vernacular marimari, seruaia, ingã, mari (Brazil)

### 2.0 ECOLOGY AND DISTRIBUTION

Cassia leiandra occurs both sporadically and gregariously along the banks of rivers on the fertile flood plains and on the infertile soils inundated for as long as 3 or 4 months by 'black water' and with the water table remaining high for some time after the flooding. The rainfall is more than 2000 mm per annum and the mean annual temperature above 25°C.

The species is assumed to have originated in the central Amazon region where it is most abundant. It is now distributed over a wide area, including the upper reaches of the Negro, Solimoes and Madeira Rivers.

Related species: C. fistulla Linn, C. grandis Linn.

### 3.0 DESCRIPTION

A small tree, rarely exceeding 12 m but can attain 20 m; trunk tortuous, seldom more than 50 cm in diameter, bark brownish-black, slightly rough and periodically sloughing off; branching starts very low down, crown usually open, up to 10 m in diameter; an extensive superficial root system observed in seedlings, no observations for mature trees. Leaves alternate, compound; stipules awl-shaped, 1-2.5 mm long, soon falling; petiole 3 cm long; rachis 12-22 cm long, leaflets 9-12 pairs, elliptic to obovate, 3-5 cm long, 2 cm wide, glabrous, thin, slightly reddish-purple when young, turning dark green above and greyish below, venation faint, petiolules 2-3 mm long. Inflorescence a terminal raceme 15-25 cm long, flowers 15-65, bisexual. Sepals 5, c 10 mm long; petals 5, yellow, elliptic, 20 mm long, 8 mm wide, thin and glabrous; stamens 4; style 2-3 cm long, slightly pubescent. Fruit a long, smooth, indehiscent, cylindrical, indented pod up to 80 cm long, 1.5-3 cm in diameter, green when unripe, turning yellow at maturity, divided internally by thin, transverse membranes into 50-100 1-seeded compartments; seeds brown, heart-shaped, 1 cm long, within a rough, leathery, elliptic but dented, seed coat, surrounded by a layer of pasty, green pulp.

Flowering from September to December; fruiting March to June to catch the rising flood.

### 4.0 MAIN USES

Pods are split by twisting them and the soft, sticky, green pulp sucked off the seeds in the mouth. The flavour is distinctive, subacid, sweet and pleasant to most people. Being leguminous the trees will probably fix nitrogen, the limiting nutrient in the flood plains.

### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Pods must be pulled off the tree when they start to turn yellow. They remain and rot on the tree at the time of the rising flood and are thought to be an important food for several fish that also aid in dispersing the seed. Fifty to 500 pods can be collected from a tree depending on the season and soil fertility.

### 6.0 NUTRITIONAL VALUE

The pulp constitutes about a third of the total pod volume but must be over 90% water. It is similar in texture to a weak starch gel and this together with the low sugar content will provide some calories.



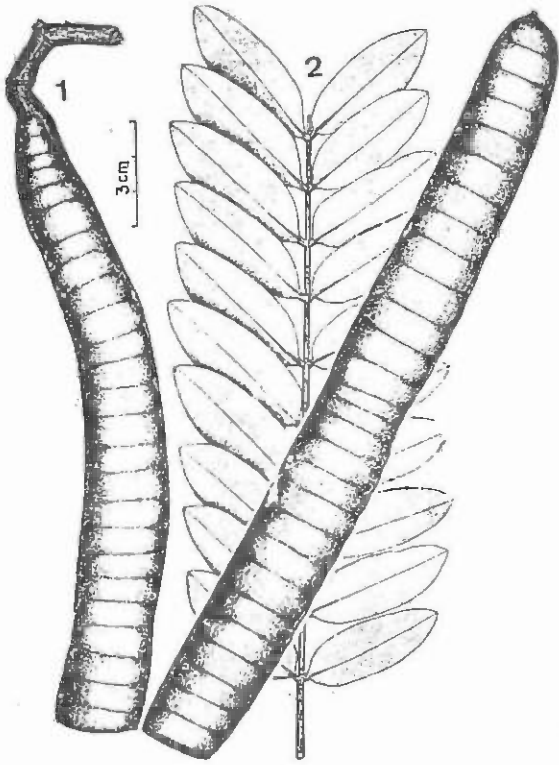
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds germinate in a month and seedlings then grow extremely slowly to a height of about 25 cm after a year. Subsequent growth is also slow and it is surprising that it withstands flooding as small plants must remain completely beneath the water often for months. It is thought to fruit between 6 and 10 years after germination when trees are 3 to 4 m high. Fruit flies are a common pest with their larvae eating and introducing disease to several individual sections in most fruit.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Planted trees have never been seen, although the fruit is a popular and cheap item in local markets for a short time each year. The slow growth appears to limit the trees potential and more research and perhaps some selection could turn it into a domestic crop. Its use in stabilizing river and fish pond banks, fixing nitrogen, providing shade and fish food, should all be considered.

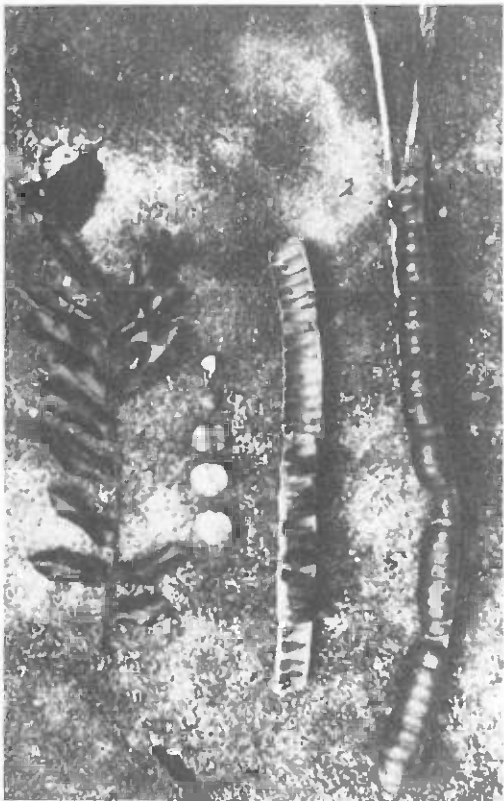
Plate XXII. *Cassia leiandra*. Benth



1



2



XXII

- 1 - 1. Fruit pods
- 2. Leaves
- 2 - Tree
- 3 - Leaves, pods and seeds

23. COUEPIA BRACTEOSA

- 1.0 NAMES: Family Chrysobalanaceae  
 Botanical Couepia bracteosa Benth.  
 Synonyms Couepia bracteosa var. grandifolia R. Ben.  
Couepia bracteosa var. minor Ducke  
 Vernacular pajurá (Brazil); aruadan (Guyana)

## 2.0 ECOLOGY AND DISTRIBUTION

Couepia bracteosa is well adapted to the poor, heavy clay oxisols of the hot lowland rainforest of the Amazon basin receiving more than 2000 mm annual rainfall with only a short period without rain. It has not been observed in flooded areas.

The species has originated in the Amazon basin and is now widely distributed throughout the central Amazon region of Brazil and the Guyanas. It is fairly common with up to several trees per hectare in some areas.

Related species: C. longipendula Pilger, C. edulis Prance.

## 3.0 DESCRIPTION

A tree up to 25 m high when fully grown, although rarely more than 10-20 m high in cultivation; trunk rarely more than 50 cm in diameter; bark rough, greyish; usually branched from below mid-height, with a rather narrow, dense crown. Seedlings with a deep taproot and superficial feeder roots. Leaves alternate, simple; stipules awl-shaped, 1.5-3.5 mm long, soon falling; petiole 1-2 cm long; blade ovate-elliptic, up to 35 cm long and 17 cm wide, apex short acuminate, base subcordate, margins entire, dark green and glabrous above, grey-brown and powdery below with prominent veins. Inflorescence in short terminal panicles, shortly silvery pubescent; flowers small, asymmetrical, bisexual; bracts ovate- 7-12 mm long, persistent. Receptacle subsessile, cylindrical 7-12.5 mm long; calyx lobes 5, acute; petals 5, white; stamens up to 40; ovary densely villous, style pubescent. Fruit a large, irregularly ovoid drupe up to 15 cm long; epicarp usually rough, mottled brownish-grey, 2 mm thick and adhering to the fleshy but firm mesocarp beneath; mesocarp usually 1 cm thick, yellow, with a gritty to pasty texture due to the presence of numerous fibre bundles similar to those in poor quality pears; endocarp with short fibres projecting into the mesocarp. Seed 1, large, bitter and inedible.

Fruiting December to May.

## 4.0 MAIN USES

The mesocarp is eaten after shaving off the epicarp with a knife. The flavour is peculiar and slightly attractive being vaguely reminiscent of walnuts, however the pasty and gritty texture make it difficult to eat a whole fruit unless one is very hungry or has acquired the taste.

The small volume of the trunk has failed to interest wood technologists and foresters.

## 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Harvesting is difficult as fruit are often high up the tree. They tend to shatter or bruise when knocked down or when they fall naturally. So they must be carefully picked with cutting poles. This is not easy as the stage of ripeness is difficult to judge and they fall when ripe. Fruit do not ripen well off the tree and only last a few days before the mesocarp turns mouldy. Yields are low with large trees seldom producing more than 30-100 fruit.

## 6.0 NUTRITIONAL VALUE

The mesocarp represents well over half the weight of the fruit. No analytical data are available but the mesocarp is very dry with a high fibre content. There is some oil and the yellow colour probably indicates the presence of carotene. The volume of the fruit and the dryness of the mesocarp make it a good source of calories.

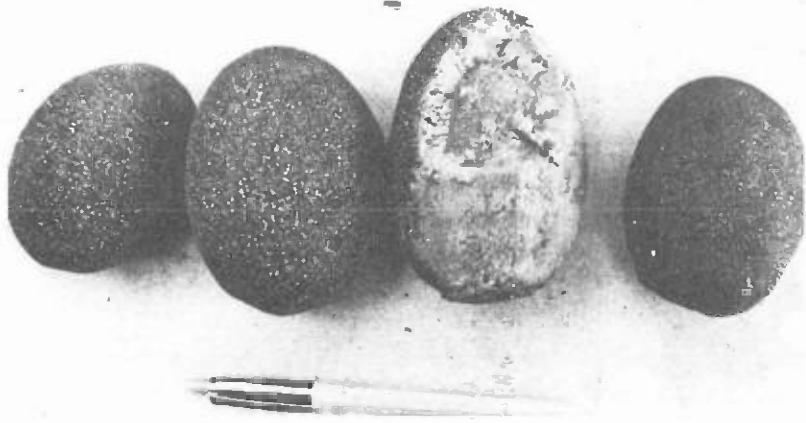
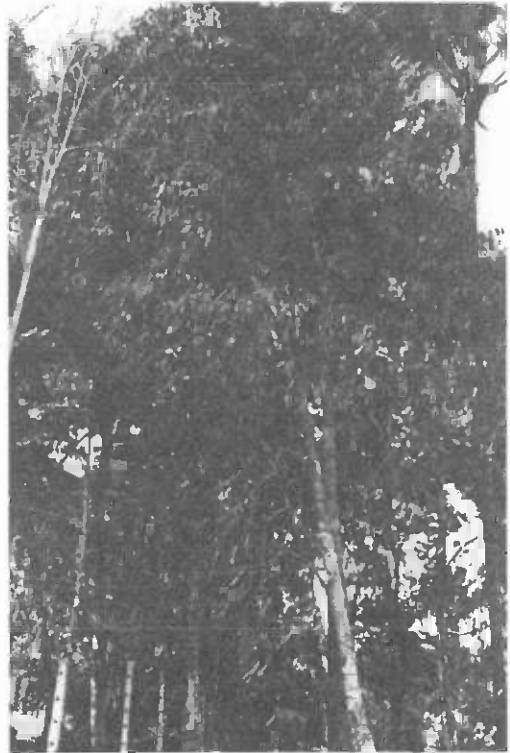
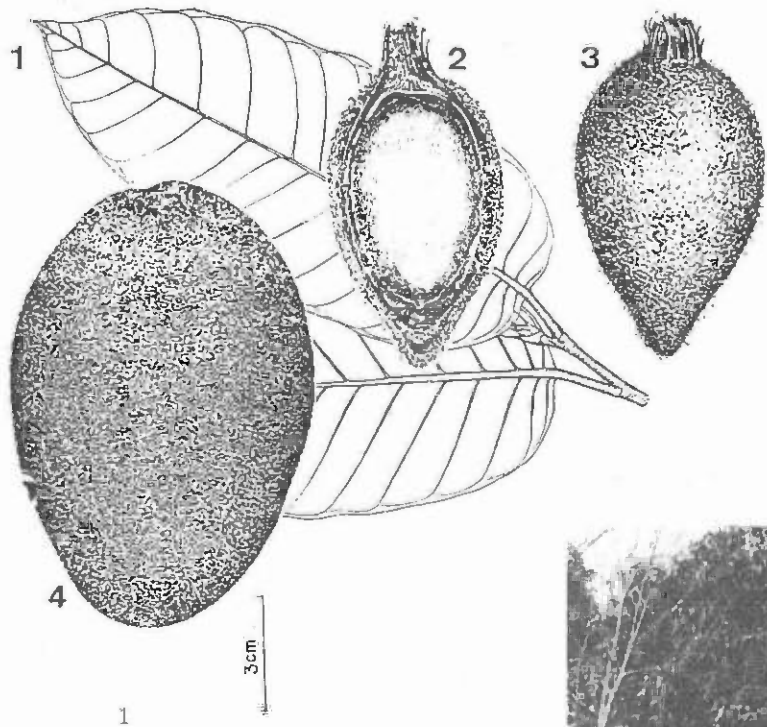
## 7.0 CULTIVATION AND PROPAGATION METHODS

Cleaned seeds will germinate after a few weeks and growth is good until the seed reserves are exhausted when the seedlings reach a height of 50 cm. Subsequent growth is fairly slow with trees reaching a height of 4-8 m in 7 years when they first start to fruit. A mild leaf blight attack has been seen, otherwise trees usually seem very healthy.

## 8.0 POTENTIAL ECONOMIC IMPORTANCE

The species is quite common in private gardens in Manaus. It occasionally reaches the local markets where it sells for a good price and is soon bought out. There is some scope for providing fruit for the local market in regions where the fruit is known and liked. However it is difficult to see any larger future for the species.

Plate XXIII. *Couepia bracteosa* Benth



XXIII  
 1 - 1. Leaves  
 2. Seed section  
 3. Seed whole  
 4. Fruit  
 2 - Tree  
 3 - Fruit. One partly cut to show seed.

## 24. COUEPIA EDULIS

1.0 NAMES Family Chrysobalanaceae  
Botanical Couepia edulis (Prance) Prance  
Synonym Acioa edulis Prance  
Vernacular Casianha de cutia (or cotia) Brazil)

### 2.0 ECOLOGY AND DISTRIBUTION

Couepia edulis is well adapted to the poor, heavy clay oxisols of the humid forest on terra firma, including areas that are occasionally flooded in the central Amazon lowland region receiving c. 2500 mm annual rainfall and no dry season. It is very common, often occurring in clumps of 6 or more trees per hectare.

The species is endemic to the central Amazon, between Tefé and Coari on the River Amazon.

Related species: C. longipendula Pilger.; C. bracteosa Prance.; C. subcordata Benth.

### 3.0 DESCRIPTION

A tree to 25 m high; trunk slender, up to 50 cm in diameter, seldom straight; bark brown, rough; crown open, 12-15 m in diameter. Seedlings with a strong taproot, large trees with small buttresses leading to superficial roots. Leaves alternate, simple; stipules 5-7 mm long, soon falling; petiole 1.5-2.5 cm long; blade ovate-elliptic, 7-17 cm long, 4.7-12 cm wide, apex rounded and acuminate, cumin 2-6 mm long, base rounded, margins entire, dark green, glabrous, shiny, lightly veined. Inflorescence a short, much-branched panicle 5-10 cm long; flowers c. 20, small asymmetrical, bisexual. Receptacle conical, 6-7 mm long; sepals 5, rounded, unequal, 3-5 mm long; petals white, soon falling; stamens long, 17-20 in 2 rows; ovary 1-locular, ovules 2. Fruit an elliptic, smooth, nut-like drupe 7-9 cm long, 4-5.5 cm in diameter; endocarp a hard, woody and fibrous shell 8-10 mm thick. Seed with a creamy white, elliptic kernel 4-5 cm long, 2-3 cm wide and covered by an adherent rust-brown testa.

Flowering and fruiting February to March, the newly formed fruit requiring a year to reach maturity.

### 4.0 MAIN USES

Nuts are collected in large quantities from the wild and the kernels, after being removed with a machete or axe, are eaten directly, roasted or mixed into cassava flour preparations. An attractive, clear, odourless oil is sometimes extracted from the nut and used for cooking. Like the nut of C. longipendula it is similar in flavour to a brazil nut but a little softer in texture. Nuts appear to store well with little change in flavour after several months in a dry environment.

The extracted oil is sometimes used to make soap. It is also said to dry well and so has been suggested as a substitute for tung and similar oils in the paint and varnish industry. The wood is so hard that a machete makes little impact on it.

### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Nuts fall to the ground when ripe, over a restricted period of a few weeks. They must be collected quickly and stored in a dry place as they rot quickly beneath the tree. Yields are often very large with adult trees being capable of producing over 200 kg of nuts.

### 6.0 NUTRITIONAL VALUE

Kernels weigh 15-20 g and represent about 29% of the nut weight. They are reported to contain 73% oil, 2.6% moisture, 9 or 16.6% protein and 6% ash. So they are a very rich source of calories and a good source of protein.

## 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds germinate after a few weeks and grow vigorously whilst obtaining nutrients from the large green cotyledons. Growth is thought to be slow after this stage although no data is available.

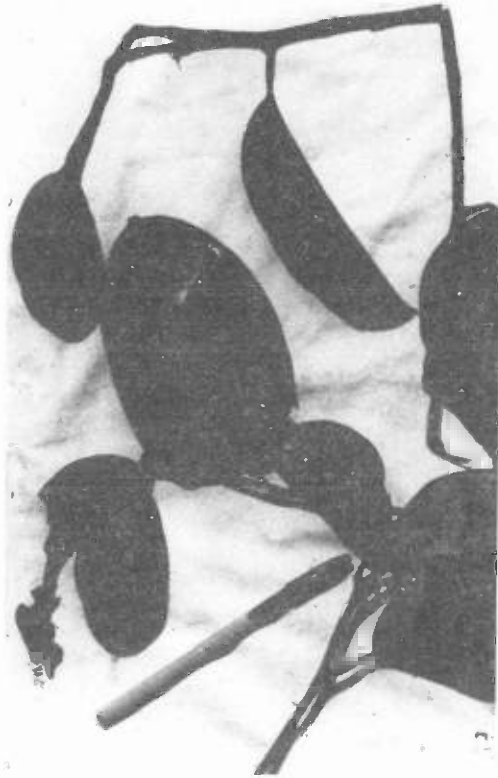
## 8.0 POTENTIAL ECONOMIC IMPORTANCE

Nuts have never been seen in markets but are well used in rural areas. It would be easy to create local and possibly even wider markets for the attractive nut. It is not yet clear if it has any advantages other than size over C. longipendula. The latter is said to be slightly better flavoured. Information on growth rates and production is now being collected and this will give a better indication of its potential as a plantation crop. Commercial oil extraction from nuts collected from the wild has been considered and is thought to be viable in certain areas where a high concentration of trees is found. The hard, fibrous briar-like (Erica arborea L.) shells of the nuts might be considered for pipe bowls.

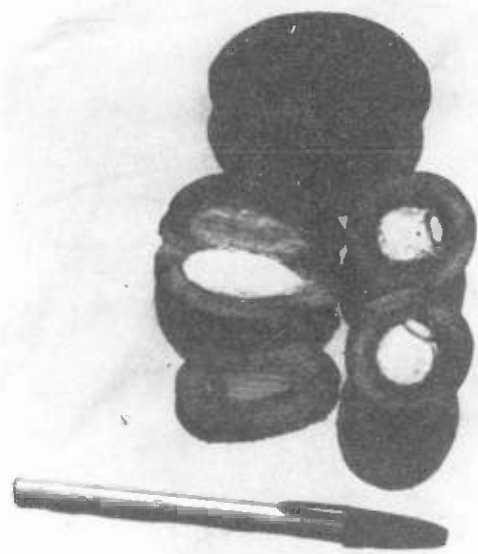
Plate XXIV. *Couepia edulis* (Prance). Prance



1.



2



3

- XXIV
- 1 - Mature tree at Costanha di Cotia Brazil
  - 2 - Leaves and fruit
  - 3 - Fruit sections



## 25. COUEPIA LONGIPENDULA

1.0 NAMES: Family Chrysobalanaceae  
Botanical Couepia longipendula Pilger  
Vernacular castanha de galinha, castanha pêndula (Brazil)

### 2.0 ECOLOGY AND DISTRIBUTION

Couepia longipendula is well adapted to the heavy, infertile, clay oxisols of the hot lowland forests of the Amazon basin receiving 2300 mm rainfall per annum and with a mild dry season. The species also occurs in low lying areas that are periodically inundated. It can tolerate dense shade, although growth is very slow under such conditions.

The species is endemic to Brazil, mainly in the central Amazon region around Manaus; it has also been recorded along the Rio Negro. It is reasonably common around Manaus, occurring in stands of 0.2 to 11 trees per hectare.

Related species: C. bracteosa Prance; C. edulis Prance; C. subcordata Benth.

### 3.0 DESCRIPTION

A tree 30 m or more high; trunk straight, up to 1.8 m in diameter, bark brown, rough, sometimes with superficial furrows and mottled with grey lichens; crown small, flat-topped, though on younger trees, 7 m high, the crown often with long, pendulous branches and leaves, giving a weeping appearance; seedlings with strong taproot, large tree fine, superficial feeder roots. Leaves alternate, simple; stipules lanceolate, 2-3 mm long, persistent; petiole 1 cm long; blade oblong-elliptic to lanceolate, 6-16 cm long, 3-7.5 cm wide, apex with acumen 10-15 mm long, base rounded to cuneate, margins entire, dark green, glabrous, lightly veined. Inflorescence of pendulous panicles on slender peduncles 30-60 cm long; flowers 10-20, bisexual, asymmetrical. Receptacle tabular-obconical, 10-15 mm long, calyx lobes rounded, with 2 sessile exterior glands, lobes obscure the 5 small, white petals, soon falling; stamens more than 30, pinkish purple, 1-2 cm long. Fruit obovoid to ellipsoid drupe, 6 cm long, 4 cm in diameter, shaped like a hen's egg, from which the common name is derived; pubescent with brown hairs up to 1 mm long; epicarp peeling to reveal a hard, woody and fibrous pericarp 6 mm thick. Seed with a white to light green kernel 3 cm long, 2 cm wide, with a thin pubescent testa surrounded by a thin membrane.

Fruiting February to March, usually very heavily, the newly formed fruit taking about 6 months to mature.

### 4.0 MAIN USES

The kernel is eaten after parting the hard nut with a strong blow from a machete or axe. Kernels are also eaten roasted or pounded and then mixed with sugar and cassava flour. The kernel has also been considered as a source of oil. The flavour is pleasant and like a cross between a brazil nut and pomegranate pips but softer in texture. This slightly raw flavour improves on storage as the high oil content oxidizes to become almost like that of a brazil nut. Further storage for a few weeks if moist, or months if dry, leads to a date-like flavour before going off.

The wood has a medium texture and attractive yellow to red-brown colour. It is hard (0.8 to 1.0 g/cm<sup>3</sup>) so a little difficult to work but takes a good finish and polish. Uses include building, general carpentry and roofing tiles as it is very resistant and long lasting. A rough fibre can be made from the bark. Extracts from bark and fruit pericarps are also used in folk medicine.

### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Nuts fall to the ground when ripe and must be gathered quickly before they germinate, rot or are carried off by small animals. They can also be picked off the long peduncles on small trees. Dry nuts will store for several months but deteriorate rapidly if kept moist at high temperatures. Small 7 m high and 12 m wide trees about 20 years-old give 300 to over 1000 nuts per year. Full grown trees will give over 100 kg.

#### 6.0 NUTRITIONAL VALUE

Kernels weigh 4 to 7 g and represent about 30% of the whole nut. They contain 18% moisture when harvested and 75% of a light greenish yellow liquid oil that rancifies quickly. Oil residues contain 32.5% protein, 10.6% fibre and 8.3% ash. So the nut is an extremely rich source of calories and provides plenty of protein as well.

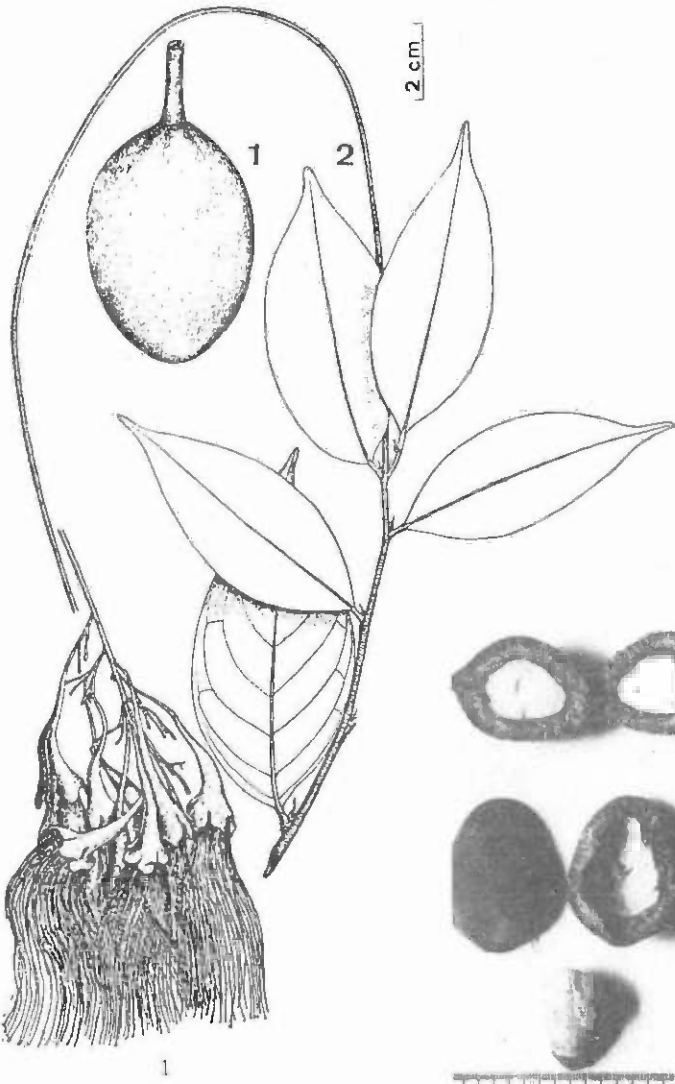
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds germinate within a few weeks on falling from the tree onto moist ground. They lose their viability rapidly and do not store easily. Early growth is rapid to 30 cm with the large cotyledons rising above the ground and supplying plenty of nutrients for root development. Later growth is slow with trees reaching about 2 to 3 m in 4 to 5 years when they produce their first flowers. Anthracnose can attack cotyledons soon after germination in very moist conditions otherwise no other diseases and pests have been noticed.

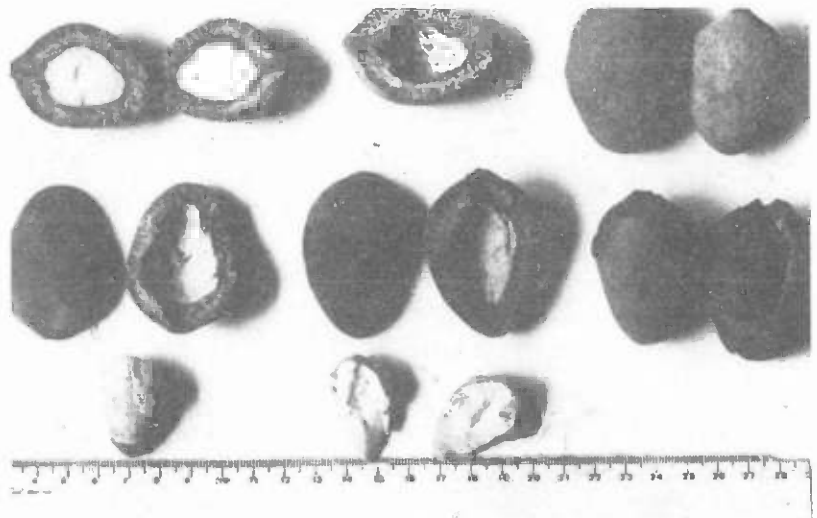
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Nuts are often collected from the wild and used in rural areas, however they are very rarely planted and have never been seen in markets. This is surprising as they are so common in the forests, yield well and are one of the best nuts of the region. A market could be created for them very easily once they are better known. Attempts are now being made to get over the slow early growth by shade and fertilizer applications. Grafting onto more aggressive rootstocks is also being considered to speed growth and reduce the time to flower. Foresters have also installed experimental plots to examine the species as a source of hardwood. The possibility of producing valuable nuts during the long period before the tree can be cut, is attractive. Production of oil can be considered once the nut market is satisfied.

Plate XXV. *Couepia longipendula*. Pilger



2



3



- XXV
- 1 - 1. Fruit
  - 2. Leaves and flowering branch
  - 2 - Young tree
  - 3 - Fruits sectioned to show seeds
  - 4 - Fruiting branch

26. COUEPIA SUBCORDATA

- 1.0 NAMES: Family Chrysobalanaceae  
Botanical Couepia subcordata Benth. ex Hock. f.  
Synonyms Couepia amazonica Fritsch  
Couepia inequalis Poeppig ex Fritsch  
Vernacular marirana, umarirana (Brazil)

2.0 ECOLOGY AND DISTRIBUTION

Couepia subcordata is well adapted to the infertile, heavy and medium textured oxisols in the hot, lowland forests of the Amazon basin in areas receiving over 2000 mm annual rainfall and only a short dry season.

The species is common in the central Amazon region of Brazil, also recorded from Belem. Rarely reported in the actual forests, it has become common in the towns, where it is often grown as a shade tree, especially along the streets.

Related species: C. longipendula Pilger, C. edulis Prance, C. bracteosa Prance.

3.0 DESCRIPTION

A tree up to 25 m high, usually less; trunk up to 50cm in diameter, rarely straight and usually branched from 2-4 m above ground level, bark pale grey, only slightly rough, up to 1 cm thick; crown dense, spreading, 10-15 m in diameter; seedlings with weak taproot, rapidly and extensively proliferating, large trees with dense and superficial root system. Leaves alternate, simple; stipules 2 mm long, soon falling; petiole 0.5-1 cm long; blade oblong-elliptic to oblong-lanceolate, 10-17 cm long, 4-8 cm wide, apex acuminate, base cordate to rounded, margins entire, thin, surfaces pale becoming dark green above, grey becoming brownish below, thinly pubescent when young with indumentum persistent on the midrib of the older leaves, veins prominent below. Inflorescence a dense terminal or axillary panicle 4-6 cm long, densely pubescent with grey to brown hairs; flowers bisexual, asymmetrical; pedicels 1-2 mm long, bracts and bracteoles ovate, 6-11 mm long, late deciduous. Receptacle cylindrical, c. 1 cm long, calyx lobes acute; petals 5, white; stamens 22-35; ovary villous, 1-locular, ovules 2. Fruit a fleshy, elliptic drupe 5-12 cm long, 3-5 cm in diameter, epicarp orange, thin, fragile; mesocarp orange, soft and pasty in texture, c. 1 cm thick; endocarp fibrous, thin. Seed with large kernel.

Flowering February to March, sometimes also at other seasons; fruiting June and July.

4.0 MAIN USES

The soft mesocarp is eaten without peeling off the thin epicarp. The flavour is strong, slightly sweet and unattractive to newcomers. The smell is particularly strong, sickly and unpleasant and the texture pasty, oily and sticky. Nevertheless they are eaten widely by children and the poor although with little enthusiasm, as many fruit are left to rot beneath productive trees.

The wood is said to be useful for carpentry and carvings, although the usual twisting of the trunks must limit its use for sawn timber. The tree is extensively used for shade.

5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Fruit drop from the tree when ripe and bruise easily. They must be collected rapidly as they rot within a few days and are also eaten by insects and small animals. The trees are extremely productive with large ones producing several thousand fruit.

## 6.0 NUTRITIONAL VALUE

The fruit is 50% mesocarp and this is 27.6% dry matter. Starch is the major component of the dry matter although there is some oil and protein. Thus it is a good source of calories. The strong orange colour may well be due, in part, to carotenes, so the fruit may well be a rich source of vitamin A.

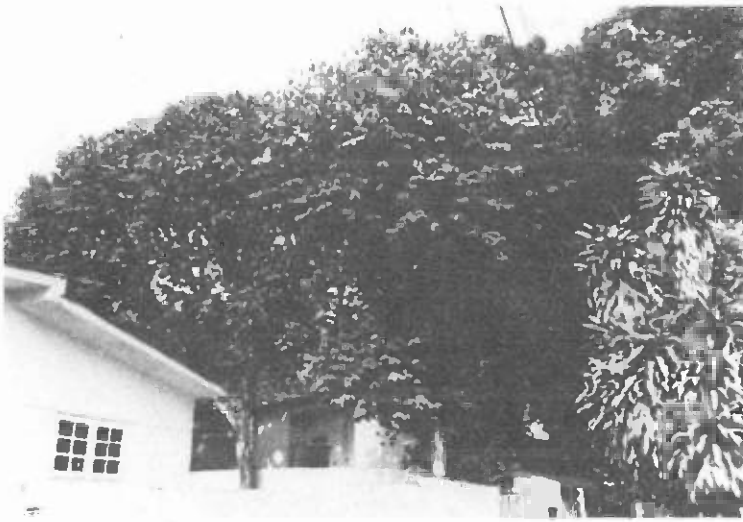
## 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds germinate rapidly and growth is fairly rapid, at the rate of about a metre per year. Fruiting starts in the fourth to fifth year. It is also hardy with few health problems, hence its use as a street shade.

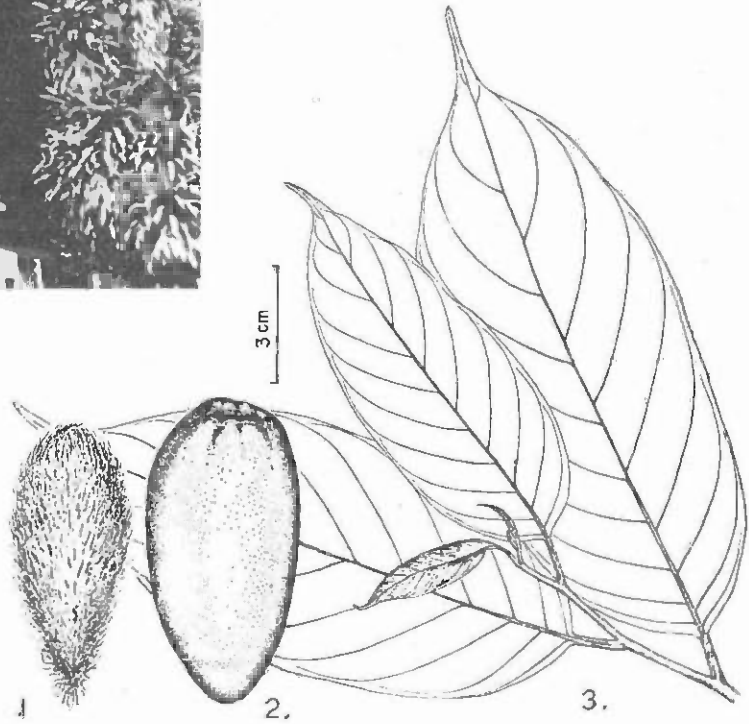
## 8.0 POTENTIAL ECONOMIC IMPORTANCE

The fruits are not attractive enough to reach market but might be considered for starch and oil production because of the high productivity and hardy growth. It may also be possible to take advantage of this species as a vigorous root stock for more attractive members of the same genus like C. longipendula and C. edulis.

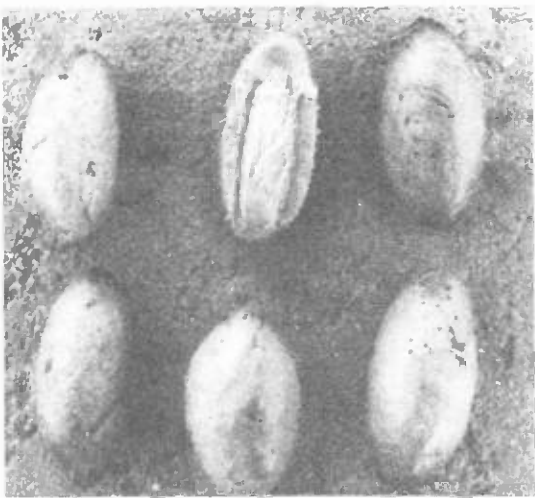
Plate XXVI. *Couepia subcordata*. Benth ex Hook f.



1



2



3

- XXVI
- 1 - Tree
  - 2 - 1. Seed  
2. Fruit  
3. Leaves
  - 4 - Fruits.  
Section of fruit to show seed.

27. COUMA UTILIS

1.0 NAMES: Family Apocynaceae  
Botanical Couma utilis (Mart.) Muell. Arg.  
Synonym Couma dulcis Spruce  
Vernacular sorva, cuma, sorvinha, saruvina (Brazil)

2.0 ECOLOGY AND DISTRIBUTION

Couma utilis occurs on the poor oxisols of the terra firma forest, preferably in low-lying areas where the water table is close to the surface, however, waterlogging is not well tolerated. The annual rainfall requirements are over 2000 mm with no marked dry season. It has not been found above 500 m.

The species originated somewhere in the western Amazon and is still largely confined to this and the central regions. It is extremely common in the Manaus region and the upper River Negro and Japurá despite extensive destruction for latex collection. Ten or more trees per hectare are not uncommon in some areas. It is rare in western Pará and in private gardens in Manaus.

Related species: C. macrocarpa Barb. Rodr. is a much larger tree, common in the same regions, that is a more important source of latex and produces similar but larger fruit. Its wood is of reasonable quality (density between 0.45 and 55 g/cm<sup>3</sup>) for light carpentry.

3.0 DESCRIPTION

Tree 5-15 m high, occasionally bushes 2 m high; bark fairly smooth, dark brown and often mottled with large, light grey patches of lichen, up to 2.5 cm thick, exudes copious quantities of white latex when cut; crown large, dense, dark green, with branching from 2-4 m above ground level in the open; tap root to 1-2 m or more in lighter soils, with extensive, superficial root system extending well beyond the crown. Leaves opposite, with 3 leaves at the end of branches, simple; stipules absent; petiole 5-10 mm long; blade elliptic, 5-10 cm long, 2-4 cm wide, apex rounded to subobtusate, base cuneate and decurrent into the petiole, margins entire, coriaceous, glabrous dark green above, light green below, lateral veins parallel, prominent. Inflorescences 1-3, axillary, corymbose, 2-4 cm long. Calyx cup-shaped, c. 3 mm long, lobes 5, obtuse, 2 mm long; corolla pink to purple, tube c. 8 mm long, lobes 4-5, 5 mm long; stamens 5, inserted in the tube; ovary with numerous ovules. Fruit a globose berry 1-4 cm in diameter hanging in bunches of 1-5 from long peduncles, dark green turning brown and soft when ripe with leathery exocarp c. 1 mm thick; seeds numerous, soft, flattened, 3-4 mm in diameter, evenly distributed in the creamy mesocarp.

Flowering April to June; fruiting August to September with some out of season fruiting.

4.0 MAIN USES

The soft creamy to brown mesocarp is usually squeezed out of the exocarp straight into the mouth and the seeds either swallowed or spat out. It is also used as an ice-cream flavour. Bunches of fruit collected from wild trees are often on sale in Manaus where they are much appreciated. Diluted latex is slightly sweet and sometimes used as a milk substitute in remote regions. Fruit are picked green when they are still firm and easy to carry. At this stage the mesocarp is insipid and the exocarp often exudes latex. Good flavour only develops when fruit are more mature and dark green brown in colour. At this stage they are very soft and start to drop off their peduncles and squash on the ground. The flavour is attractive, being sweet and reminiscent of raisins.

This species is known principally for its latex which is repeatedly tapped from helical cuts down the length, of wild trees. Large trees that are difficult to climb are felled. The latex is coagulated and dried by boiling into large solid blocks of which about 5000 t are exported annually from Brazil for the manufacture of chewing gum. Fruit juice is said to be useful for curing worms. The tree also makes an attractive

ornamental that is frequently covered in small pink/purple flowers. Latex is also used for caulking boats.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Harvesting presents a considerable problem once the tree becomes tall and it is not unusual for collectors to lop off heavily laden branches. Ripe fruit that have fallen to the ground are often too squashed to eat unless there is a grass cover. So they are often marketed too green, tied together by their peduncles in bunches of about 20 fruit. Fruit last for 2 or 3 days once harvested but do not ripen well off the tree. Yields are extremely high with trees of 10 m crown diameter in the open giving 20-50 kg of fruit in one harvest.

#### 6.0 NUTRITIONAL VALUE

The mesocarp represents about 80% of the fruit weight with seeds and exocarp about 10% each. The fruit will be a reasonable source of calories as the pulp is usually very sweet and contains about 20% sugars.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

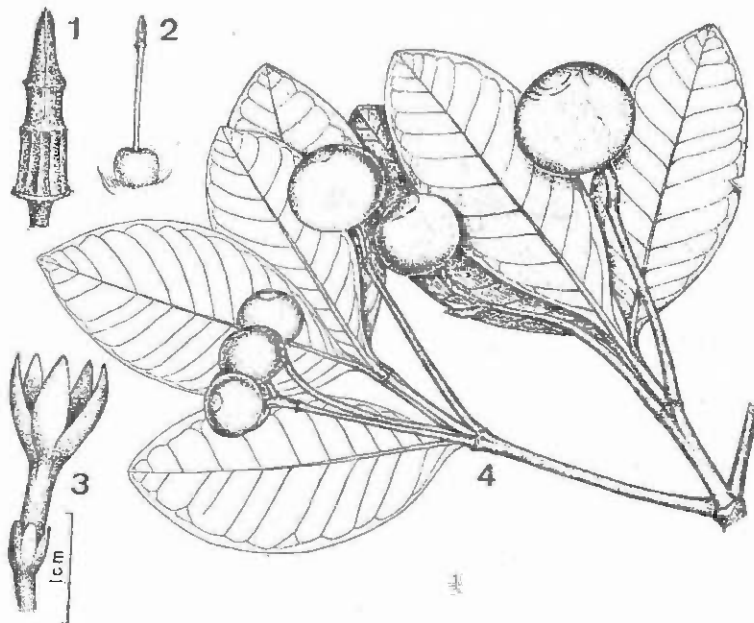
Seeds germinate well after a few months but seedlings are slow growing in the first year. Trees are said to reach a height of about 5 m in 4 or 5 years when they produce their first fruit. An experimental plot has now been established at a 5 m spacing which will be thinned later if necessary. No diseases have been noticed, in fact most trees look very healthy in the wild.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

There is a small local market in Manaus which is currently satisfied by collection of fruit from wild trees near the town. However the harvesting and storage problems just mentioned severely limit the economic potential of the tree for the marketing of larger quantities of good fresh fruit. Selecting dwarf varieties or developing grafting and pruning techniques should help and the development of attractive processed products like jams, purees, etc.. might overcome the problem of using squashed ripe fruit. Meanwhile the tree is very attractive for home gardens as a flowering ornamental producing edible fruit. Plantations for latex production are now being considered for the depletion of wild sources of chicle following destructive harvesting, the increased price of synthetic products and the comparatively slow growth of *Manilkara zapota* (*Achras sapota*). The fruit could form a useful biproduct.



Plate XXVII. *Couma utilis* (Mart.) Muell. Arg.



2



3

XXVII

- 1 - 1. Stigma
- 2. Gynaecium
- 3. Flower
- 4. Fruiting branch

2 - Mature tree

3 - Leaves, flowers and fruit

28. ELAEIS OLEIFERA

- 1.0 NAMES: Family Palmae  
Botanical Elaeis oleifera (Kunth) Cortés  
Synonyms Elaeis melanococca of many authors but not of J. Gaertn.  
Corozo oleifera (Kunth) Bailey  
Alfondia oleifera Kunth  
Vernacular american oil palm (English); Caiué, dendé do pará (Brazil);  
palma brasileira, noli (Colombia); carocito, colorada  
(Venezuela); palmiche (Central America)

2.0 ECOLOGY AND DISTRIBUTION

Elaeis oleifera occurs either individually or in groves in cleared and abandoned areas, preferably in open, low-lying areas along river banks and will tolerate short periods of flooding; occasional stunted palms with little or no fruit are to be found in the forest understory. It is well adapted to the low fertility of the heavy clay oxisols of the region. The climatic requirements are generally typical of the wet lowland tropics, although trees have been seen along rivers in regions of transitional forest with 3-5 month dry periods.

The species is found in the southern part of Central America, along the Colombian, Venezuelan and Guyanan coasts and down through the Orinoco basin to the central Amazon region. The species probably originated in Central America and the Amerindians may have been responsible for its southern extension.

Related species: E. guineensis Jacq.; E. madagascariensis Becc.

3.0 DESCRIPTION

Moderate, monoecious palm. Stem prostrate and rooting at the base for 1-5 m, 30-50 cm in diameter, upper part erect, 2 m tall, densely clothed with petiole bases and infructescences; root system profuse and extensive, several metres deep and extending many metres from stem, the basal part with many adventitious roots. Leaves c. 20-45 in crown, reduplicate pinnate, somewhat curved and twisted towards the apex; petioles 2 m long, with spiny margins; leaflets c. 120-200, 60-130 cm long, 5-8 cm wide, apex acute, rigid below but drooping towards apex, the leaflets remaining  $\pm$  in one place (unlike E. guineensis), dark green, glabrous, midrib and veins prominent. Inflorescence usually unisexual, the male and female often produced in alternate cycles, but mixed inflorescences occur occasionally, the relative proportion of female flowers increasing under better growing conditions, as in E. guineensis. Female inflorescence short, compact, held close to the trunk and borne among the leaves, enveloped by the thin, loose and fibrous remains of the peduncular bract; rachis 30-40 cm long with numerous rachillae 4-9 cm long; sepals and petals similar, 8 mm long, 6 mm wide; ovary c. 10 mm long with short style surmounted by 3 spreading stigmas. Male inflorescence 40-60 cm long, composed of narrow, cylindrical rachillae 4-9 cm long bearing very numerous, crowded, small flowers partly sunken in pits; sepals 3, very small; petals 3, larger than the sepals; stamens 6, partially fused. Fruit ovoid to rhomboid, 1-3 cm long, turning from yellow to orange when ripe, borne in compact clusters of 85-150 spikelets, the whole infructescence 20-50 cm long, c. 20-50 cm in diameter, weighing 2-18 kg, the peduncle accounting for 7-26%; epicarp shiny, c. 1 mm thick, mesocarp 2-4 mm thick, fibrous and oily; endocarp woody, 3-4 mm thick, the kernel white, hard.

Fruiting January to June, during the wet season, but fruiting can occur throughout the year in less seasonal areas.

4.0 MAIN USES

The fruit is not eaten fresh but is used in remote regions as a source of cooking oil and for the preparation of a drink. Oil is extracted in a primitive fashion by pounding and cooking of the fruit followed by the decanting of the floating oil. The residual emulsion may be drunk or, more commonly, fruit are softened by several hours cooking prior to squeezing off the pulp and mixing with water and sugar. The oil is

very similar in appearance and flavour to that of raw oil from E. guineensis. The emulsion is like thick creamy orange milk and although quite pleasant and mild in flavour, is too rich to be attractive. The flavour is reminiscent of Peach palm (Bactris gasipaes).

The fruit is fed to pigs in remote areas.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Fruit are ripe when they can be removed readily from their spikelets and the whole bunch is harvested by cutting through the peduncle after removing surrounding petioles. The low height of bunches (1 to 2 m) makes harvesting easy. Fruit can be shaken from their bunches after drying for a day or two but care must be taken to avoid damaging them and starting rotting and rancification of the oil. They cannot be stored for much longer than a week in the open before fruit rot within the bunch interior. Palm with 10 to 15 well developed bunches have been recorded so yields of over 100 kg per tree are possible. However such yields are less than a quarter of those from E. guineensis.

#### 6.0 NUTRITIONAL VALUE

Fruits vary in weight from 3 to 13 g and contain 31 to 62% pulp. The shell varies from 28 to 53% and the kernel from 10 to 24% of fruit weight. Pulp oil contents vary from 40 to 70% in the pulp dry matter and 35% of the kernel is oil. Fruit with up to 29% oil per bunch have been found although about 17% is more normal. The mesocarps are also rich in carotene so the fruit is a good source of calories and vitamin A.

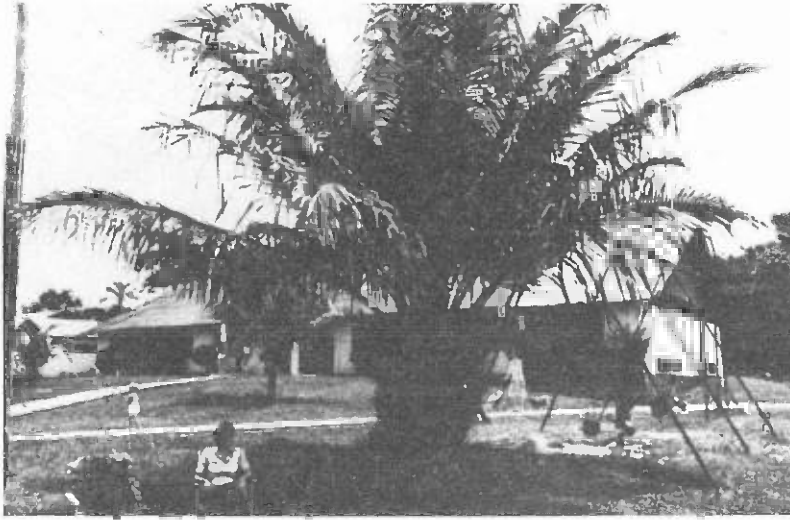
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds germinate in 2 to 4 months and grow slowly at first but then quite quickly. Fruiting starts in 4 to 5 years when the top of the trees has reached a height of about 6 m. Well fertilized trees may fruit earlier. Subsequent vertical growth is very slow because the older part of the trunk bends down and creeps along the ground. This creeping may complicate spacing management. Twenty-year-old trees may have 2 to 3 m of trunk along the ground and be no more than 8 m in total height. Mild Anthracnose spotting has been seen in old leaves, otherwise trees look very healthy and are known to be resistant to Machitez sudden wilt and possibly Ganoderma and Fusarium wilt.

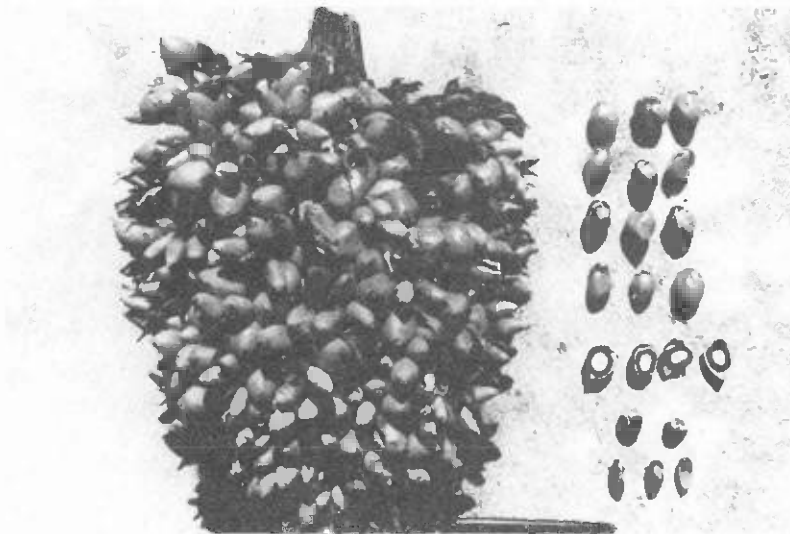
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

This species is of little interest in its own right, however it hybridizes readily with the important oil crop E. guineensis and has a number of desirable characteristics that would be worth incorporating into the latter. The fruit mesocarp oil has a higher content of unsaturated fatty acids which are considered to be of (dubious) nutritional advantage in the prevention of arteriosclerosis. Very high oil contents per bunch (29%) have also been found especially in parthenocarpic bunches. Another important characteristic is the low height of the tree which would avoid the need to renew E. guineensis plantations when they become too tall to harvest after about 25 years. Resistance to several lethal and troublesome diseases (Machitez sudden wilt, Ganoderma and Fusarium wilt) has been found in E. oleifera. Hybrid vigour results in increased fruit bunch production but unfortunately also in greater vegetative growth. Considerable research is in progress, but more is needed, to find and collect good germplasm and to combine all the desirable characteristics.

Platē XXVIII. *Elaeis oleifera* (Kunth). Cortés



1



2

- XXVIII
- 1 - Young palm tree
  - 2 - Fruiting branch and split fruit to show mesocarp and endocarp.

29. ENDOPLEURA UCHI

1.0 NAMES Family Humiriaceae  
Botanical Endopleura uchi (Huber) Cuatrecasas  
Synonym Sacoglottis uchi Huber  
Vernacular uxi, uxi pucu (Brazil, Amazon region)

2.0 ECOLOGY AND DISTRIBUTION

Endopleura uchi occurs on humid, well-drained soils of the high forests of the terra firma. It prefers a hot, humid climate and low altitudes. It is well distributed within the forests but there are no reports of any dense stands.

It is indigenous to Pará and Amazonas states of Brazil.

3.0 DESCRIPTION

Large, evergreen tree, 25-30 m or more high; trunk straight, cylindrical, up to 1 m in diameter, bark c. 2 cm thick, wood very hard, reddish; wide crown in open situations; root system very extensive but not very deep, the principal axial root disappearing in older plants. Leaves alternate, simple; stipules minute; petiole 1-2.5 cm long; blade elliptic-oblong or elliptic-lanceolate, 10-20 cm long, 2.5-8 cm wide, apex acuminate, base obtusely cuneate, margins serrulate, upper surface glossy, more or less glabrous, dull, glabrous below with thick midrib and 12-14 pairs of secondary nerves, thin, prominent, with the veinlets forming a conspicuous reticulum. Inflorescence a short, axillary cymose panicle, 3-4 cm long, shorter than the leaves, fragrant. Sepals 5, greenish, orbicular, united below, c. 0.5 mm long; petals 5, greenish to whitish, linear-oblong, 3-3.5 mm long, 1-1.4 mm wide; stamens c. 25, filaments up to 2 mm long, anthers with 4 thecae remote from each other; disk formed by 10 triangular scales, united at the base; ovary globose, c. 1 mm long, glabrous, 5-locular, each loculus with 1 ovule, style stout, longer than the ovary, stigma capitate. Fruit an oblong-ellipsoid drupe, 5-7 cm long, 4 cm in diameter, weighing 50-70 g, exocarp greenish-yellow or dark grey when ripe, smooth; mesocarp 5 mm thick, edible, fleshy to mealy and oily with a peculiar smell; endocarp woody, extremely hard, deeply grooved longitudinally, the grooves containing fibrous tissue; seeds 2-3, oblong, 2-3 cm long, c. 0.7 cm wide.

Flowering at end of rainy season, June to July; fruiting beginning regularly in December and extending until the following May or June.

4.0 MAIN USES

The utilizable part of the uxi is the mesocarp, which represents approximately 40% of the fruit. The pulp is highly aromatic, sweet, oily, with an agreeable flavour. The fruit is consumed in the natural state, either alone or with cassava meal, and is an important complement in the diet of the region's peasants. Recently it has come to be used extensively in the fabrication of ice-cream, liqueurs and sweets, especially the first.

A yellow-citrine oil can be extracted from the mesocarp of the uxi. It is transparent and limpid, with an aroma reminiscent of olive oil. Pinto (1956) determined the physicochemical characteristics of this oil and concluded that they were extremely close to olive oil; the organoleptic properties are practically identical. The wood of the uxi is relatively strong and heavy and is frequently used as beams, posts and rail-road ties.

5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The only known practical harvesting means is to gather the fruits after they have fallen to the ground. Often people climb trees to shake the limbs to encourage fruits to fall. This sometimes causes them to fall before fully maturing but in any case the fruits can be stored for considerable periods before consumption (15 to 20 days). No information is available on yields.

## 6.0 NUTRITIONAL VALUE

According to the analysis done by Campos (1951), the pulp of the uxi has the following composition: water: 40%; protein 0,9%; carbohydrate 12.2%; lipids 20.2%; mineral salts (ash) 1.0%; fibre 26.0%. There is no information on nutritional value but the above analysis shows a predominance of lipids, indicating a food rich in calories.

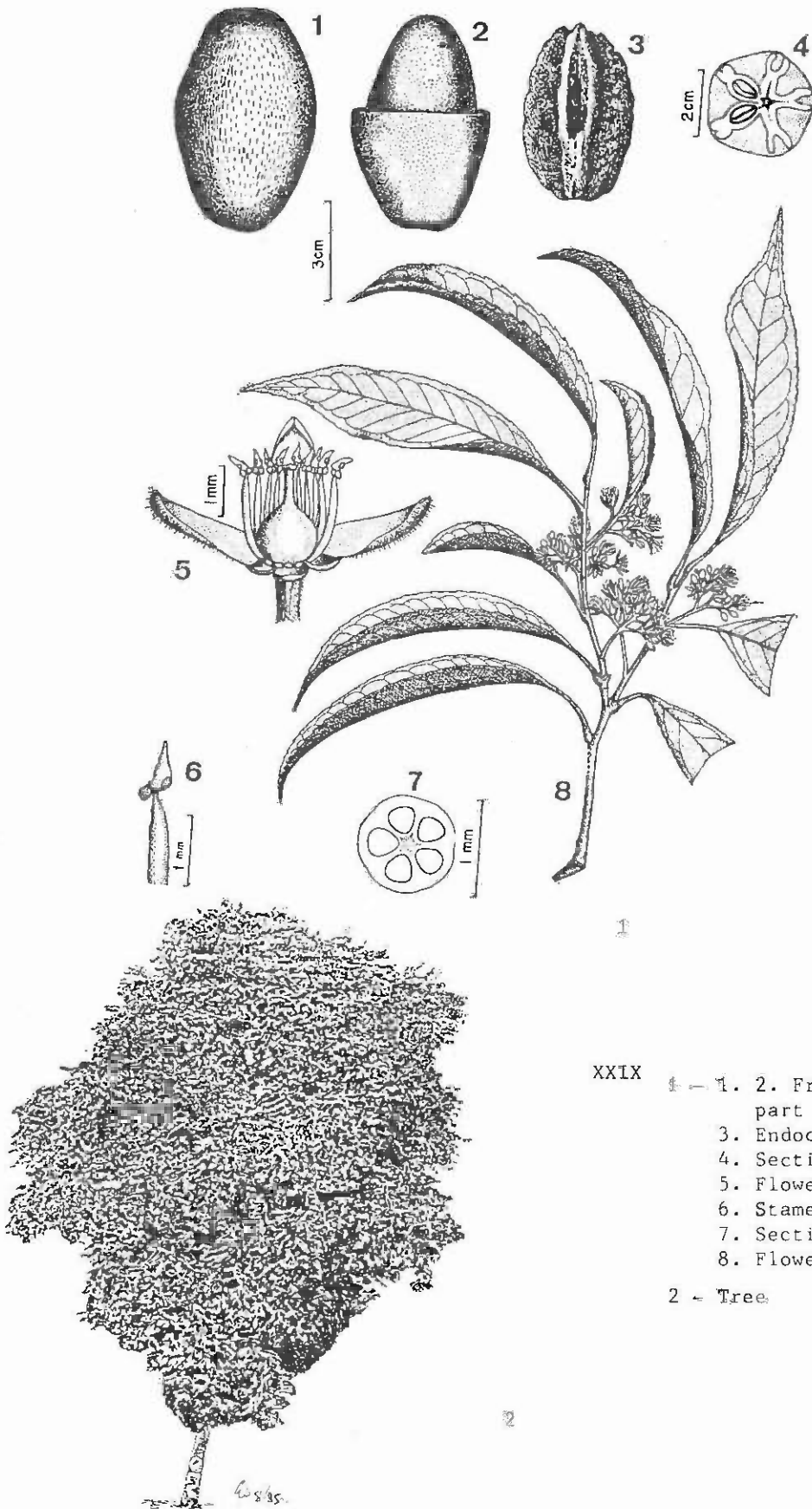
## 7.0 CULTIVATION AND PROPAGATION METHODS

There is no concrete information but it is known that propagation is accomplished from seeds and that germination is extremely delayed. In an experiment by one of the authors, germination took 10 months under normal conditions. It is believed that this period can be considerably reduced by partially destroying the endocarp or simply cutting it, obviously without damaging the seed. There are no available data on growth, but it appears that at the beginning it is relatively slow.

## 8.0 POTENTIAL ECONOMIC IMPORTANCE

The economic potential of the uxi does not appear specially promising, due principally to the long growth period required from planting to the first harvest. Modern agronomic techniques may change this picture.

Plate XXIX. *Endopleura uchi* (Huber) Cuatrecasas



XXIX 1 - 1. 2. Fruit whole and with part of pericarp removed  
3. Endocarp  
4. Section of endocarp  
5. Flower  
6. Stamen  
7. Section of ovary  
8. Flowering branch  
2 - Tree

30. ERISMA JAPURA

1.0 NAMES Family Vochysiaceae  
Botanical Erisma japura Spruce ex Warm.  
Vernacular japurá, quaruba branca (Brazil)

2.0 ECOLOGY AND DISTRIBUTION

Erisma japura grows in high, virgin rain forest on well-drained, sandy clay soils. According to Serra (1967), the annual precipitation is 3,275 mm, mean humidity 87.7%, mean temperature 28.8°C and the range of temperatures 22.4°C, varying from 14.6°C in July to 37.0°C in October.

The distribution of Japurá is restricted to the northwest of the state of Amazonas in Brazil, adjacent to the frontiers with Colombia and Venezuela.

Erisma megalophyllum Stfieu is another species with edible fruits, closely related to E. japura and occurring in the same area.

3.0 DESCRIPTION

Evergreen tree 20-25 m high; trunk up to 80 cm in diameter; young stems 4-angular in cross-section, the faces each with a longitudinal groove along the internodes; root system unknown. Leaves in 3-4-merous whorls, simple; stipules small, subulate, deciduous; petiole 2.5-4 cm long; blade oblong-ovate to broadly oblanceolate, 10-23 cm long, 4-10 cm wide, apex rounded or emarginate, base cuneate, margins entire, very coriaceous, glabrous or with very sparse stellate hairs below, lateral veins prominent below, 15-20 pairs, parallel and running into a marginal vein. Inflorescence a much branched panicle 20 cm long, with verticillate primary branches, other branches opposite; flowers showy, irregular; pedicels 3-6 mm long, bracts elliptic-ovate, 10 mm long, 5 mm wide. Sepals 4, unequal, the largest spurred, up to 14 mm long, 18 mm wide, spur bag-shaped, rounded, c. 3 mm long, 3 mm wide; petal 1, yellow, obcordate-reniform, c. 2-2.5 cm long, 2.5-3.5 cm wide, shortly clawed, glabrous, the margins undulate-crenate; stamens 1, c. 10 mm long, staminodes up to 4, c. 3.5 mm long; ovary inferior, 1-locular, stellate-tomentose, style c. 10-12 mm long, slender with capitate stigma. Fruit indehiscent, crowned by the persistent, accrescent, very unequal sepals, the largest 12-13 cm long, 4 cm wide, lanceolate and conspicuously veined; pericarp fibrous, enclosing 1 oblong seed 3-4 cm long, oily, edible.

Flowering October to April; fruiting February to March.

4.0 MAIN USES

Since this species occurs in a limited and isolated area very little is known about the use of its fruit. The natives are reported to eat the kernels, whether roasted, cooked or uncooked. According to Spruce (apud Stfieu, 1954) they prepare "japurá butter" which is eaten with meat and fish. Those who can endure the disagreeable and persistent odour of the butter find it very delicious.

Besides its fruits, japurá furnishes a soft and light-brown wood recommended for medium quality boards.

5.0 METHOD OF COLLECTION OF THE EDIBLE PART

No information available.

6.0 NUTRITIONAL VALUE

No information available.



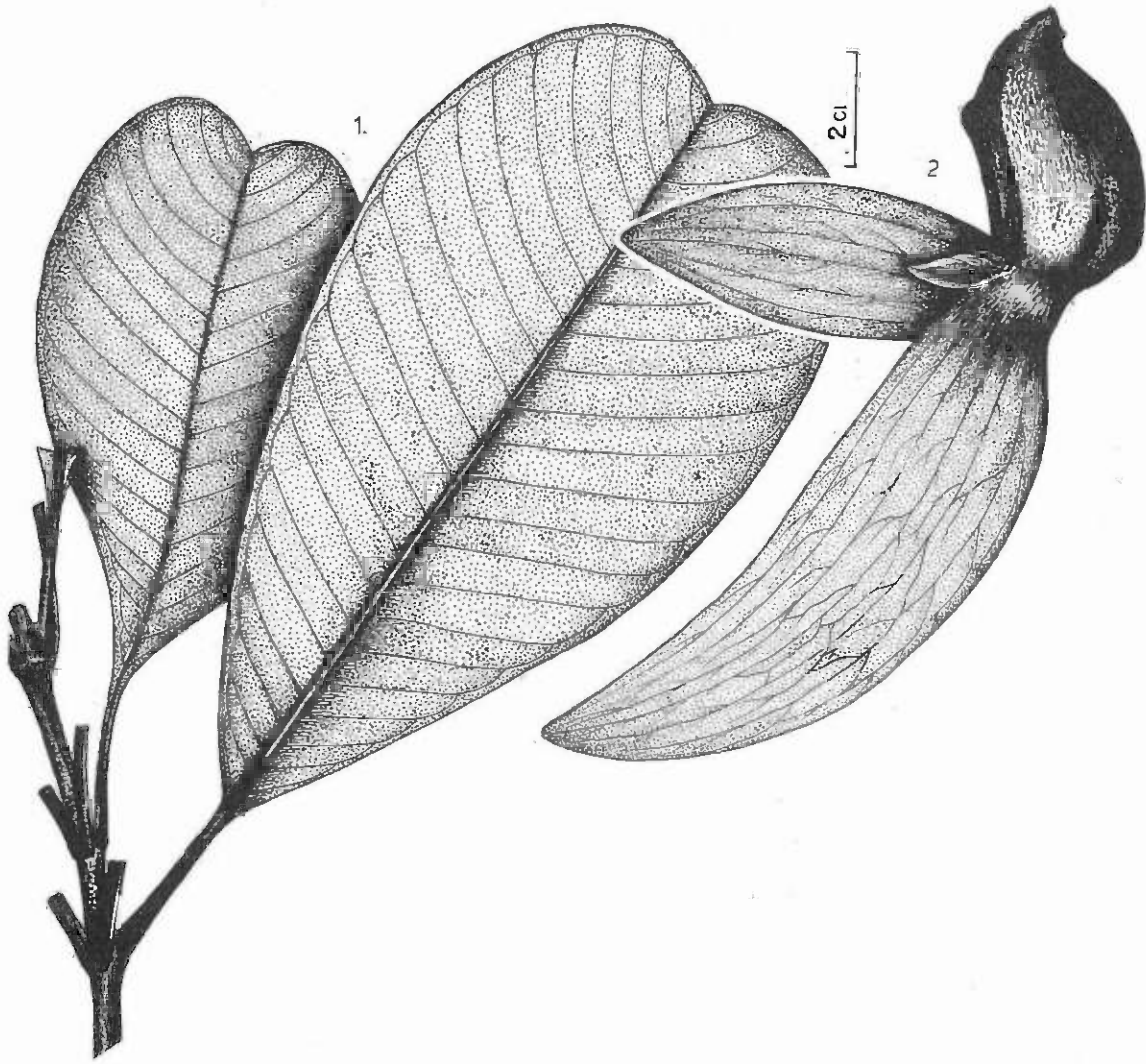
#### 7.0 CULTIVATION AND PROPAGATION METHODS

There is no technical information but propagation is by seeds, which demonstrate a high percentage of germination between 5 and 9 days. There are no available data concerning growth, harvesting and yield.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Although this species has been known and utilized for centuries, it has never been researched agronomically. Experimental plantings in new areas are needed as well as selection to reduce the plant size. The oily kernels require studies of chemical composition and food value. These are the initial steps towards realizing the economic potential of this species.

Plate XXX: Erisma japura Spruce ex Wärm



XXX  
1 - Leaves  
2 - Fruit

31. EUGENIA STIPITATA

1.0 NAMES: Family Myrtaceae  
Botanical Eugenia stipitata McVaugh  
Vernacular arazá, arazá-buey (Peru); araçá-boi (Brazil)

2.0 ECOLOGY AND DISTRIBUTION

Eugenia stipitata prefers well-drained, rich, loamy soils but will tolerate poorer clay oxisols, provided they are well drained, of the dense, humid, tropic high forest. In its natural habitat the rainfall averages 2800 mm, with a mean annual temperature of 26°C although in some areas where it has been introduced it grows well enough to withstand a drought of 2 months in an area with only 2000 mm annual rainfall. It is found in altitudes up to 650 m. There is little information regarding its abundance although great concentrations have been reported in the Rio Ucayali valley of Peru, especially near the city of Requena (Pinedo et al. 1981).

The species appears to have its origin in the extreme west of the Amazon basin, perhaps in the Peruvian Amazon. It is only found in the western Amazon and does not appear to have been widely spread by the indians although some of the best varieties appear to have been selected by the Peruvian indians in Iquitos. Herbarium specimens have been collected from Amazonas State of Brazil, Bolivia, Peru and Colombia. Samples of germplasm have recently been introduced into other areas of the American humid tropics.

Related species: Eugenia is a large genus restricted to the Americas. Many, or perhaps most, of the related species are edible. Some examples are E. vitoriana Cuatrec.; E. aggregata Kiarsk; E. dysenterica DC.; E. klotzschiana Berg.; E. ligustrina Willd.; E. luschaathiava Klotzsch; E. nhanica Berg.; E. pancens Berg.; E. selloi Berg.; E. supraoxillaris Spring; E. tomentosa Gamb.; E. uniflora L.; and E. uvalha Camb.

3.0 DESCRIPTION

Ornamental, leafy tree or shrub 3-15 m high, of densely branched habit, without apical dominance; stem with brown to reddish-brown, flaking bark; young branches covered with short, velvety brown hairs which are lost with age; root system unknown. Leaves opposite, simple; stipules absent; petiole short, 3 mm long; blade ovate to somewhat broadly elliptic, 8-19 cm long, 3.5-9.5 wide, apex acuminate, base rounded and often subcordate, margins entire, dull, dark green above, with 6-10 pairs of impressed lateral veins, pale green, shortly pilose with scattered hairs below. Inflorescence racemose, axillary, axis 4-10 mm long, with 2-5 opposite pairs flowers, the terminal flower absent, pedicels long, bracteoles linear, 1-2 mm long. Calyx lobes rounded, broader than long, overlapping in bud; petals 5, white, obovate, 7-10 mm long, 4 mm wide, ciliate; stamens c. 70, 6 mm long; ovary (3-)4-locular, each locule with 5-8 ovules, style 5-8 mm long. Fruit an oblate or spherical berry, 2-10 cm long, 2-12 cm in diameter, weighing 50-750 g, light green at first, turning pale or orange yellow when ripe, soft, with a thin, velvety skin enclosing a juicy, thick pulp which accounts for as much as 60% of the fresh fruit.

Flowering November to April; fruiting January to May. Plants growing in well fertilized soils can flower and fruit throughout the year.

4.0 MAIN USES

The pulp of the fruit is used, although the seeds may occasionally be incorporated in jellies. The fruit is slightly to extremely acid, so that the flavour can only be appreciated by mixing with sugar to mask this acidity. The fruit then has an agreeable refreshing flavour. The strong perfume of a ripe fruit is exquisite, but unfortunately does not carry over into juices or cooked products. Because of its acidity the fruit is not eaten directly. It is most popular as a strong or weak juice. Jelly made with the pulp and the seed is delicious. However excessive cooking destroys the attractive aroma and flavour.

## 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Fruit may be collected when they start to turn yellow, as they continue to mature off the plant. The fruit should be harvested at least once a week because they mature rapidly. Careful post-harvest handling is important because of the thin skin and delicate pulp. At a spacing of 3 x 3 m the first fruiting year can yield between 3 and 5 tons/hectare with adequate fertilization and rainfall.

## 6.0 NUTRITIONAL VALUE

The only published data (Pinedo *et al*, 1981) on composition does not include % H<sub>2</sub>O which must be of the order of 90%. The dry weight consists of 8 to 10.75% protein; 5 to 6.5 % fibre; 69 to 72% other carbohydrates; 0.16 to 0.21 calcium; and some phosphorus, potassium and magnesium. Also 10 to 12 ppm of zinc. In 100 grams of fresh fruit there are approximately 7.75 mg vitamin A; 9.84 mg vitamin B<sub>1</sub> and 7.68 mg of vitamin C. The surprisingly high protein content presumably comes from the inclusion of the seeds. The fruit has some value as a source of vitamins and minerals.

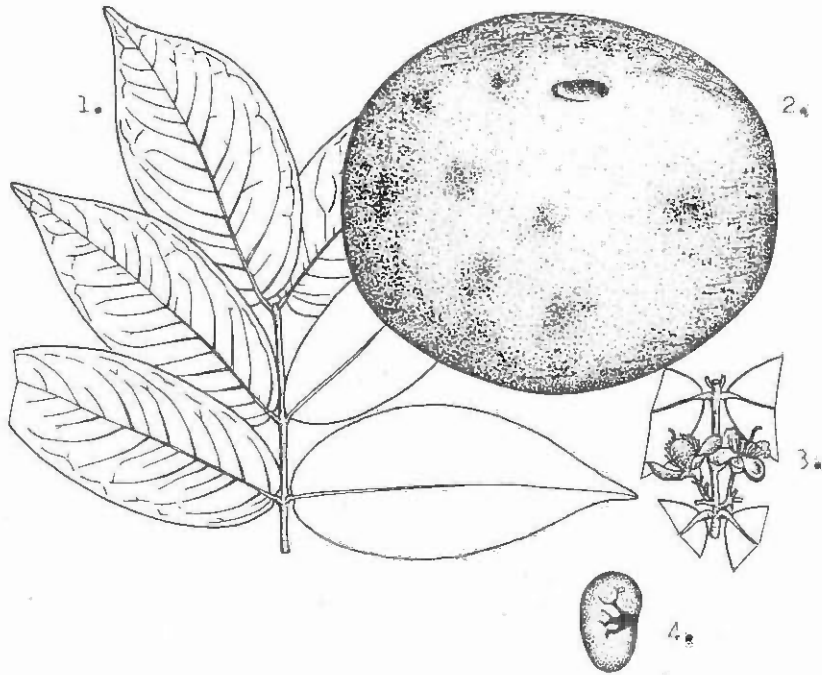
## 7.0 CULTIVATION AND PROPAGATION METHODS

Germination percentage is high (80 to 100%) when seeds are sown soon after removal from the fruit. However germination may take 2 to 4 months to start and 6 to 8 to finish. If seeds are stored in moist charcoal powder they will start to germinate in weeks. Early growth is slow, even in good substrate. The seedling needs about 12 months to attain a height 25 to 45 cm (in polyethylene bags) at which time they are ready for the field. No information is available about vegetative propagation. The seedling grows rapidly, although more in diameter than in height, when planted in the field with manure. Well fertilized seedlings can start to fruit after 18 months in the field. Potassium appears to be an especially important nutrient for the araçá-boi as it is for *P. guava* L. and many fruits. No pests have been yet registered as reducing growth or production of this species.

## 8.0 POTENTIAL ECONOMIC IMPORTANCE

The araçá-boi's delightful flavour and high yields suggest the fruit has economic potential. Little is known about agronomy for the species. No varietal selection has been made, thus germplasm collections are recommended as a first step, followed by more detailed agronomic studies with the best material. Food technologists should try to develop a way to retain the aroma and taste in industrialized products. Immediate potential appears to be limited to juice and jelly on a local scale.

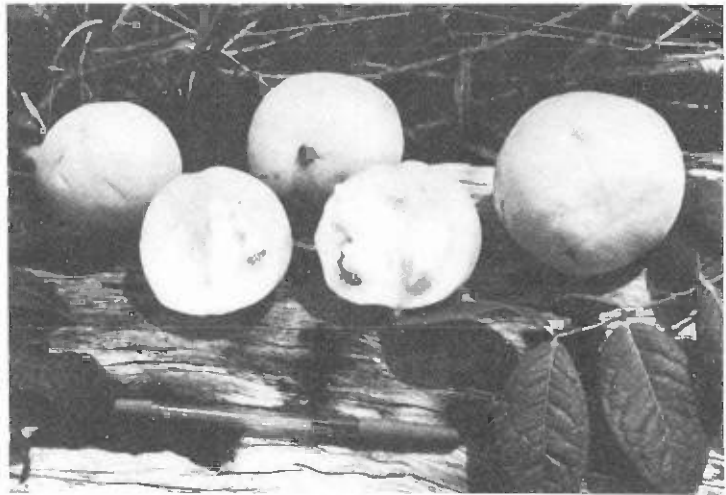
Plate XXXI. *Eugenia stipitata* Mc Vaugh



I



2



3

- XXXI
- 1 - 1. Leaves
  2. Fruit
  3. Flower
  4. Seed
- 2 - Tree 4 years of age, in production. Height 2 m.
- 3 - Mature fruit. One fruit sectioned to show mesocarp and seeds. Manaus, Brazil.

## 32. EUGENIA UNIFLORA

- 1.0 NAMES: Family Myrtaceae  
Botanical Eugenia uniflora L.  
Synonyms Eugenia michelii Lam.  
Stenocalyx pitanga Berg  
Stenocalyx michelii (Lam.) Berg  
Eugenia pitanga (Berg) Kiaerskov  
Vernacular surinam cherry (West Indies); cereza de cayenna (Spanish);  
ginja, pitanga (Brazil); cerise de cayenne (French Guyana)

### 2.0 ECOLOGY AND DISTRIBUTION

Eugenia uniflora appears to be adapted to the poor soils of the low scrub and transitional forest bordering the high forest in areas receiving 1500 mm rainfall with a 4 to 6 month dry period. It has been successfully introduced into Florida, consequently it is assumed to be able to withstand cold spells.

The Surinam cherry is believed to have originated in the eastern Amazon since it is common along the banks of the Xingu river where it has been reported as forming fairly dense stands. Wild trees are to be found in the Guyanas. It is now common in the gardens of northern Brazil and the West Indies and has now spread to many other parts of the tropics.

### 3.0 DESCRIPTION

Large shrub or small tree to 8 m high; trunk tortuous, bark smooth, dark brown; crown fairly dense, with many tortuous branches which are often slightly pendulous at the tips; root system unknown in adult trees, weak and superficial in seedlings. Leaves opposite, simple; stipules absent; petiole 2-4 mm long; blade ovate to ovate-lanceolate, 2-5 cm long, 1-3 cm wide, apex bluntly acuminate, base rounded, margins entire, glabrous, glossy coppery to dark green above, paler below with veins slightly prominent. Inflorescence axillary, flowers 1-2, bisexual, pedicels slender, 1-3 cm long. Sepals 4, persistent, oblong-elliptic, 2.5-4 mm long, 1.8-2 mm wide; petals 4, white, obovate, 7-8 mm long, spreading; stamens numerous; ovary inferior, 2-locular, ovules c. 20 per loculus, style subulate, 4.5-5 mm long. Fruit red or occasionally yellow, purple, blackish or white berry 1-4 cm in diameter, depressed-globose with 8 longitudinal ribs and crowned by the persistent calyx; skin very thin and enclosing a red, juicy pulp and usually 1 globose seed 0.5-1 cm in diameter, rarely up to 4 seeds present.

Flowering and fruiting in succession during much of the year.

### 4.0 MAIN USES

Fruit are eaten fresh or as a juice, jam or liquor. Concentrated juice is marketed in Brazil. The flavour is acid (pH 2.7 to 3), sweet and distinctive, usually but not always, with a bitter after taste. The fruit pulp is succulent and pleasant. However the fruits are frequently left to rot in gardens so they are not considered highly desirable. This species is often used as a hedge in the West Indies.

### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Fruit must be picked at the right stage as they are sour before and fall afterwards. They are difficult to transport as they bruise easily and deteriorate within a day or two. Yields are very high with small, 1.5 m bushes 3 years-old, giving 1 to 2 kilos of fruit several times a year. A yield of 8 t/ha has been recorded.

### 6.0 NUTRITIONAL VALUE

Fruit weigh 1 to 4 g, 71% of which is pulp. Considerably less is used in commercial juice preparation as a lot is lost with the separation of the exocarps. The pulp is 11% dry matter, 10.2% sugars, 0.4% protein, 0.05% fat, 0.33% fibre, 0.24% ash.

It contains a reasonable amount of tarmin (122 mg), vitamin C (62 mg) and vitamin A (1.1 mg) per 100g. So inspite of its low dry matter content it provides a useful source of calories and vitamins A and C.

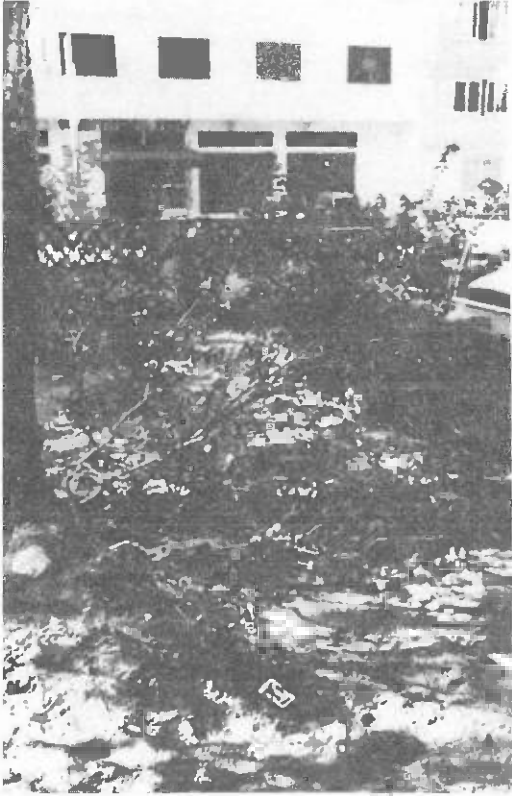
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds germinate readily and grow to about a metre in 2 to 3 years when fruiting starts. Cleft grafts can be used. Bushes are planted at 3 to 5 m in the few commercial plantations in the north-east of Brazil. It is said to be susceptible to attack by the fruit fly Ceratitidis capitata Wild in Peru. It is usually healthy in Brazil.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

The market for the juice in Brazil does not appear to be increasing very rapidly at present because few people are familiar with the fruit. Selection or processing to remove the bitterness might help. It should be used as a productive hedge in more gardens. The creeping variety requires research because it may be useful for stabilizing sand dunes and exploiting difficult habitats.

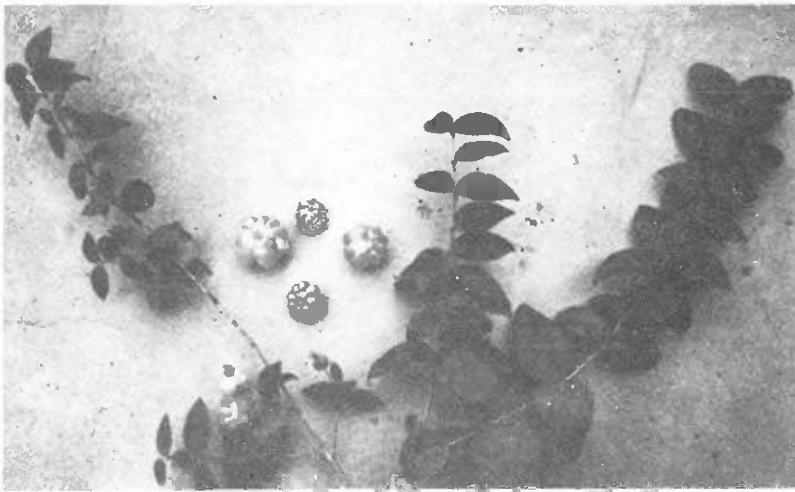
Plate XXXII. *Eugenia uniflora* L.



2



1



3

- XXXII 1 - 1. Flower  
2. Fruit  
3. Seed
- 2 - Young tree  
3 - Leaves and fruits



33. EUTERPE OLERACEA

- 1.0 NAMES: Family Palmae  
Botanical Euterpe oleracea Martius  
Synonyms Euterpe badiocarpa Barb. Rodr.  
Euterpe beardii Bailey  
Vernacular açai, açaf-do-Pará, açazeiro, palmitero, piriá, jaçara, jiçara (Brazil); pina, prasara, manaka, çasei, çapoe (Surinam); manaca (Venezuela)

2.0 ECOLOGY AND DISTRIBUTION

Euterpe oleracea grows best in rather open forests of the Amazon river flood plain, on humid clay floodplain soils which are nutrient rich because of periodic flooding. Optimum soil types are the lighter textured better drained soils ('varzea alta'); in the lower, heavier textured soils ('varzea baixa') with poor drainage it does not grow so well. Good drainage seems to be essential as it will not grow in areas where there is standing water. It does not occur above 500 m altitude. In its optimum habitat it receives a mean annual rainfall of about 2300 mm, and a mean annual temperature of 26°C. There is a short dry season of c. 2 months.

In the eastern Amazon basin it can grow in almost pure stands on the higher parts of the flood plain with as many as 9720 trunks (or c. 2000 clumps) per hectare. On the poorer drier soils density is less but may still reach 4000-7000 trunks or 800-1400 clumps per hectare (Calzavara 1972).

It is found throughout the Amazon basin where it has been planted for its fruit, cabbage (palm heart) or appearance. It has been spread into the Brazilian northeast, and northwards into the Guyanas and Venezuela. Its centre of origin would appear to be the extreme east of the Amazon basin-

This genus contains many species, of which E. edulis Mart. is used for palmito in the south of Brazil; E. catinga Wallace, reputed to have an excellent fruit; E. controversa Barb. Rodr.; E. jatapuensis Barb. Rodr.; E. longibracteata Barb. Rodr.; E. neblinensis Barret and E. montes Barret all occur in Amazonia.

3.0 DESCRIPTION

Slender, elegant, clustered, unarmed, monoecious palm. Stems to 12-18 m tall, 10-15 cm in diameter, clean, smooth, grey, ringed with leaf scars. Root system extending up to 5 m from the base of the clump. Leaves reduplicate pinnate, c. 8-14 in the crown, c. 2-4mm long, sheaths strictly tubular, c. 80-140 cm long, forming a conspicuous crownshaft, bright green colour; petiole 20-40 cm long; rachis 2-3.5 m long bearing very regularly arranged leaflets; leaflets c. 50-80 cm on each side, pendulous, 80-110 cm long, 3-4 cm wide, bright green. Inflorescence borne below the leaves, expanding soon after the subtending leaf sheath falls; peduncle short, 10-15 cm long; first bract entirely enclosing the bud, c. 1 m long, green; second bract lightly smaller, both neatly falling and exposing the rachis and rachillae; rachis to 50 cm long, bearing 80-130 spreading, straight, white-hairy rachillae. Flowers borne in 3's, a central female and 2 lateral males almost throughout the length of the rachilla. Male flowers c. 4-5 mm long, cream coloured; female flower c. 3 x 5 mm, cream coloured. Fruit ± globose, c. 1-1.5 cm in diameter, purplish-black, produced in large numbers; epicarp very thin, mesocarp c. 0.5-1.5 mm thick, purplish tinged; endocarp covered in longitudinal fibres; endosperm deeply ruminant.

Flowering and fruiting occurs throughout the year, producing 6-8 inflorescences per year.

#### 4.0 MAIN USES

The fruit is extremely popular among the people of eastern Amazonia. When prepared as a juice it has a distinctive nutty flavour, that may take some time getting used to. The ripe fruit are placed in a large receptacle to which is added warm water. After 15 to 30 minutes the skin and pulp are softened enough to be readily macerated, forming a thick, somewhat gritty juice, popularly called "wine" because of its reddish purple colour. The juice is consumed fresh, with sugar or without; mixed with cassava flour; used in cooking fish (with cassava flour) and recently has become popular as an ice-cream and popsicle flavouring.

The cabbage, or palmito, is especially appreciated in the region and has become the basis for a large industry based both on exploiting natural populations and on modern plantations, although the latter are still rare. The palmito of açai weighs 330 g on average and is about 41 cm long by 2 to 3 cm in diameter at the base. These are lightly cooked and then bottled or canned in a light brine solution. The trunk is used for posts or cut for burning, split for flooring and walling. It makes an excellent ornamental.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit are harvested when ripe. Usually a boy or young man will climb the smooth trunk and cut off the bunch, generally lowering it on a rope to avoid loosening the small fruit. The palmito may be extracted at any age where some trunk is visible above ground level. A single adult trunk produces between 4 and 8 bunches/year. Bunches produce on an average 4 kgs of fruit. Thus a trunk may produce about 24 kg/year. At a spacing of 4 metres (625 plants/ha) this gives a production of 15 t/ha. A single trunk also produces a palmito weighing on average 330 g. Thus 3 produce 1 kg of useable product. At a spacing of 1 m square this is a production of 3.3 t/ha.

#### 6.0 NUTRITIONAL VALUE

Mature pulp is 38 to 59% H<sub>2</sub>O. On a fresh weight basis there are between 7 and 13% fats; 2.5 to 3.5% protein; 1 to 25% sugars; up to 18% fibres and the ash contains 0.03 to 0.17% calcium; 0.05 to 0.26% phosphorus; some iron and sulphur oxides. The pulp has also been shown to contain β-carotene and thiamine. Caloric content ranges from 88 to 265 calories. The açai is a good energy source and appears to have some fat and protein value.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

The most common method of propagation is by seeds although separating side-shoots may give results. Germination is rapid (30 to 40 days) with enough humidity and percentages are good (70 to 90%) if sown soon after extraction from the pulp. Seedlings are generally transplanted from seed beds when about 5 cm tall and remain in the polibag nursery for 5 to 7 months with good substrate. They are planted out at about 50 cm in height. Except for germination all nursery growth is in full sun. Organic fertilizer is recommended for initial planting out with a 40 cm diameter planting pit. Spacing will depend upon desired product: for fruit 4 to 5 m square or triangular; for palmito 4 m if a large number of side-shoots are desired at once, or less than 4 down to 1 m square for no side-shoots. Growth is somewhat slow, the plants may attain 3 metres in 5 years on oxisols. However on "varzea" soils growth is more rapid. An aphid (*Ceratephis lataniae*) attacks all plant parts but is generally not a severe problem. The larva of the butterfly (*Brassolis astyra*) consumes leaflets at a great rate and can be a severe problem, but is easily controlled.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Because of its palmito the açai would appear to have an excellent economic potential. It is limited by relatively slow initial growth on oxisols, compared to fast growth of *Bactris gasipaes* for the same purpose. However, on the flood-plain it is unsurpassed. There is an urgent necessity of extensive germplasm collection as some of the natural stands are being devastated by over exploitation. More research is needed on the agronomic aspects of the açai. For fruit production the economic potential appears to be less good since its strong flavour is not immediately appreciated by all.

Plate XXXIII, *Euterpe oleracea* Martius



1



2

- XXXIII 1 - Young palm tree  
5 years old.  
Height 4 m.
- 2 - Fruit on sale in the  
market "Vero o peso"  
Belem, Brazil.

#### 34. EUTERPE PRECATORIA

- 1.0 NAMES: Family Palmae  
Botanical Euterpe precatória Maritus  
Vernacular açai de terra firma, açai solitario, açai molhe, açai o Amazonas (Brazil); palma de rosário (Bolivia); yuyu chonta (Peru).

#### 2.0 ECOLOGY AND DISTRIBUTION

In contrast to Euterpe oleracea, E. precatória is a species of the 'terra firma'. It occurs in rain forest on nutrient poor, well-drained oxisols and ultisols. Rainfall is in the range of 1900 to 4000 mm per annum, with mean annual temperatures of c. 26°C. It will grow well on the nutrient rich but lighter textured soils in the well-drained parts of the flood plain; it occasionally grows in the perennially poorly-drained stream bottoms of the terra firma. It does not grow in pure stands although occasional small groups of 10-20 palms occur; otherwise it may be no more abundant than 2-3 trees/ha. It does not appear to be planted, and, in the wild, occurs from the Amazon basin west of Santarém, Pará, Brazil to the foothills of the Andes in Bolivia, Peru, Ecuador and Colombia.

See E. oleracea for related species.

#### 3.0 DESCRIPTION

Slender, elegant, solitary, unarmed, monoecious palm. Similar to E. oleracea but larger in all its parts and differing in the single stem, 15-20 m tall, 10-20 cm in diameter, the leaflets only 2.5 cm wide, grey-green throughout, and the homogeneous rather than runcate endosperm. Fruit are usually somewhat larger than in E. oleracea.

Flowering occurs from July to October in the central Amazon region; fruiting from December to April.

#### 4.0 MAIN USES

The fruit is used like that of E. oleracea. When prepared as a juice it has a nutty flavour similar to that of E. oleracea, although not as rich. The ripe fruit are placed in a large receptacle to which is added warm water. After 15 to 30 minutes the skin and pulp are softened enough to be removed from the seed by being pounded. The juice is then consumed in the same manner as that of E. oleracea. Like the E. oleracea all parts of the palm are used. However, it is not as ornamental as the E. oleracea because of the single trunk habit and is not widely used for palmito for the same reason.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit is collected when ripe, generally by a boy or young man climbing the tree and lowering the bunch to the ground. A tree may produce 4 to 6 bunches per year. A bunch may produce 4 to 5 kg of fruit. Thus a tree may produce 16 to 30 kg. of fruit/year. If planted at 5 m spacing 6 to 12 t/ha may be expected from mature trees.

#### 6.0 NUTRITIONAL VALUE

No information on composition is available, although it seems reasonable to assume that it will be similar to that of E. oleracea. The E. precatória would appear to be a good energy source.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

Germination is rapid (30 to 60 days) and percentages are high (60 to 90%) if conditions are right. No other information is available about propagation although, again, this should be similar to that of E. oleracea. Although a native of the "terra firma" the young plant cannot withstand prolonged dry periods. No other information is available.

## 8.0 POTENTIAL ECONOMIC IMPORTANCE

Because of its single trunk habit the E. precatória does not have potential as a palmito crop, and because the E. oleracea is reputed to have better tasting fruit this potential also appears low. However it is an important element of the native diet extracted from the forest and germplasm should be collected for evaluation.

Plate XXXIV. Euterpe precatória Martius



XXXIV 1 - Mature tree in production, left standing when the area was cleared for housing. Height-10 m.

35. GENIPA AMERICANA

- 1.0 NAMES: Family Rubiaceae  
Botanical Genipa americana L.  
Synonyms Genipa oblongifolia Ruiz & Pavon  
Genipa excelsa Krause  
Vernacular bois de fer, marmalade box, yaguá (Antilles); nandipaguazú (Argentine, Paraguay); bigrande (Bolivia); jenipapo, jenipapeiro, jenipá, jenipaba (Brazil); keou tse, tou kio tse (China); jago (Colombia); guaifil (Costa Rica); irayol, tina-dientes (El Salvador); irayol (Guatemala); genipa (French Guyana); gêne-pas, genipayer (Haiti); Maluco (Mexico); Gigualti, tapaculo, ygualti (Nicaragua); guayatil blanco, jagua blanca, jagua de montaña, jagua negra (Puerto Rico); taproepa, tapoeripa (Surinam); genip, juniper (Trinidad); caruto, rebalseiro, kaguá (Venezuela).

2.0 ECOLOGY AND DISTRIBUTION

Genipa americana occurs preferably on clay or rich alluvial soils of the 'varzea'. rich soils are not essential, although it grows better on them, neither does it require good drainage provided the water is not stagnant. The jenipapo grows in the open forests and secondary regrowth of the 'varzea' as well as in the open forest/savanna transition zone. Throughout its distribution it appears to prefer a rainfall between 1200 and 4000 mm with mean annual temperatures between 18° and 28° C. There is no information available regarding its altitude limits. Although reasonably represented in all the above vegetation types, its presence is rather scattered, except where planted. Near Belém, Pará, the tree has been found in densities of 2-5 trees/10 hectares, most of them abandoned in secondary regrowth.

The species is probably of Amazonian origin, although not all authors agree. It had already been widely distributed throughout the humid American tropics and many parts of the American subtropics before the discovery of the Americas. It is growing spontaneously in the forest of Brazilian Amazonia, especially in the 'varzeas' of the clear and muddy waters, although not in the black water rivers. It is also found cultivated and abandoned throughout this region.

3.0 DESCRIPTION

A small to medium sized tree 5-15 m high, rarely to 30 m, usually 8-12 m; trunk usually straight, bark thick, smooth, greenish-grey; branching dense, lower branches generally horizontal; root system - no information available. Leaves opposite, simple, clustered at the ends of branches; stipules broadly triangular, 8-12 mm long; petiole c. 15 mm long, or more or less cylindrical; blade obovate to oblong-obovoid, 10-35 cm long, 7-10 cm wide, apex acute to acuminate, base cuneate, margins entire, subcoriaceous, glabrous, lateral nerves nearly parallel. Inflorescence terminal, racemose; flowers bisexual. Calyx tubular, 5-8 mm long, lobes inconspicuous; corolla white to yellowish, slightly fragrant, sericeous, 20-45 mm long, lobes 5-6, equalling the tube; stamens 5, inserted in the tube, filaments short, anthers linear; ovary 2-locular. Fruit an ovoid to subglobose berry 10-12 cm long, 7-9 cm in diameter, weighing 200-400 g, skin thin, mesocarp soft, yellow-brown, 1-2 cm thick with numerous flattened seeds arranged horizontally in the fibrous, pastey, inner mesocarp.

Flowering May to September in most of Amazonia; fruiting September to April.

4.0 MAIN USES

The pasty mesocarp is the part usually consumed, although the inner mesocarp may be consumed after straining the seeds. The jenipapo has a strong characteristic smell and flavour that is normally somewhat to very acid. It is unpleasant to newcomers but much appreciated by those familiar with the fruit over a long time. It must be diluted and sweetened to be appreciated. Although the jenipapo may be eaten fresh when well matured (the mesocarp becomes very soft at this stage), it is mostly used as a juice.

Compotes, jams and jellies, crystalized fruit, syrups and other sweets may be prepared. The fruit may also be used to make cocktails and liquors.

Historically the principal use for the jenipapo was for the extraction and preparation of a dark blue body paint based on tannins, by the pre-colombian Amerindians. It was believed to have magical properties. The wood is of good quality, with a fine grain, and is easy to work. It is widely used in cabinet making, civil and naval construction and has many other minor uses. The immature fruit is also reputed to be a good cure for small wounds and ulcers.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The mature fruit fall to the ground when ripe. They do not bruise because of their soft, spongy mesocarp. Harvesting thus consists of collecting the fallen fruit. Trees of 15 to 20 years have been seen with 400 to 600 fruits.

#### 6.0 NUTRITIONAL VALUE

The mesocarp is 73% H<sub>2</sub>O, 13% sugar, 8% cellulose, 1% ash and 0,35% essential oil which gives its characteristic flavour and smell. There is also 0,72% tartaric acid and 2.6% glucose. The jenipapo would thus appear to be a source of calories.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

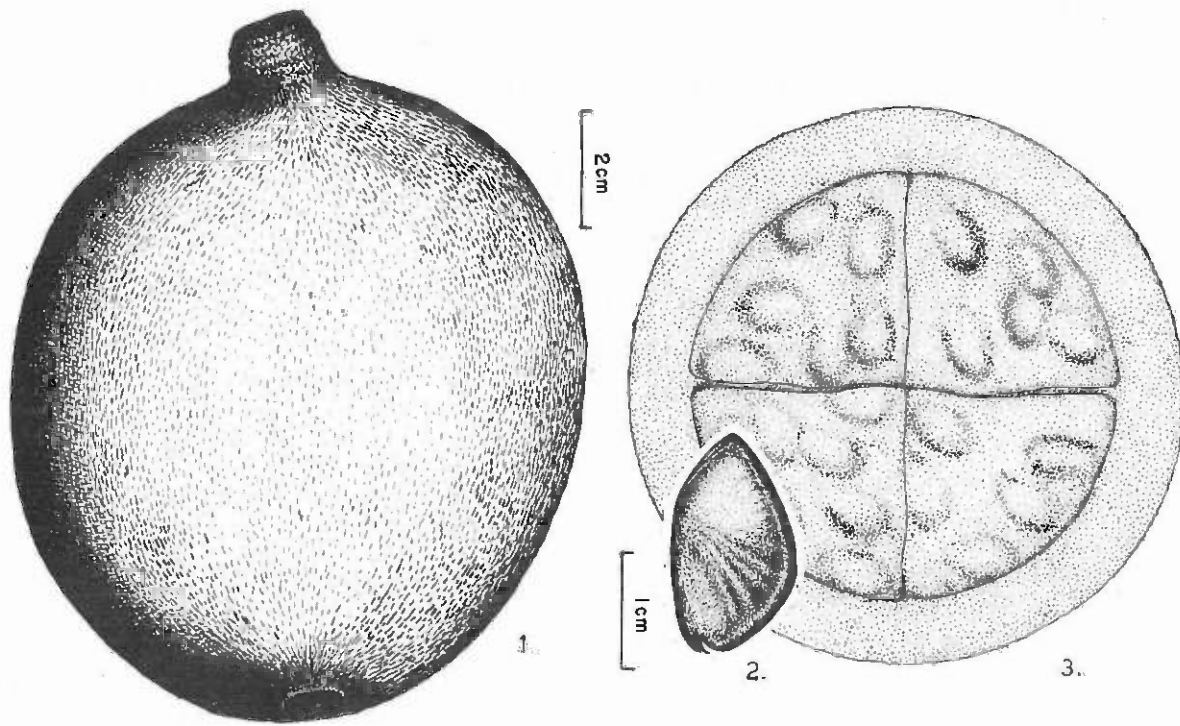
The seeds maintain their viability for at least 90 days. Germination will start after 25 to 30 days. Initial growth is slow, needing about 1 year to attain transplanting size of about 20 to 40 cm. At this size it may also be budded. Marcottage is also reputed to give reasonable results. The plants should be spaced at 10 x 15 m. Growth becomes more rapid as the plant grows. After several years it may grow at the rate of a metre per year. Seedlings plants may produce in 6 to 8 years. No disease or pest problems have been recorded..

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

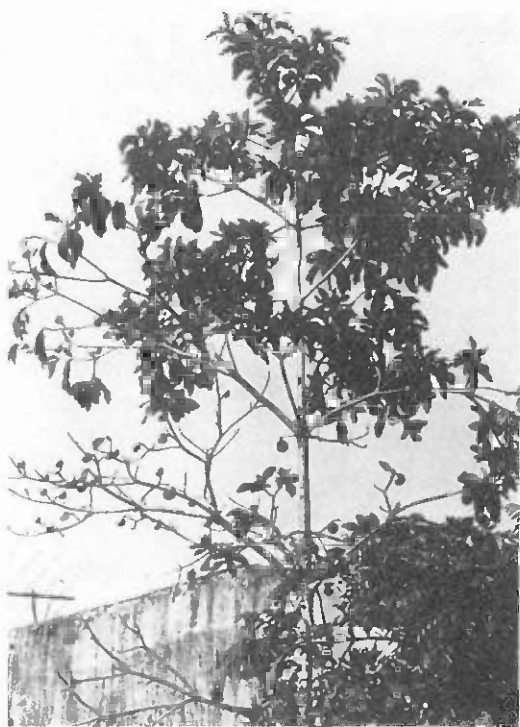
The jenipapo would appear to have a reasonable economic potential. It requires more research on industrial products to develop a wider market. Agronomic studies and germplasm collections are necessary. Local demand is adequately met because the trees are productive and because there are few industrial products at present. This is a species that merits more attention.



Plate XXXV. *Genipa americana* L.



☞



2



3

- XXXV
- 1 - 1. Fruit
  - 2. Seed
  - 3. Section of Fruit
- ☞ - Tree
- ☛ - Fruit on sale in the market

36. GNETUM NODIFLORUM

- 1.0 NAMES: Family Gnetaceae  
Botanical Gnetum nodiflorum Brongn.  
Synonyms Gnetum amazonicum Tul.  
Gnetum oblongifolium Huber  
Gnetum paraense Huber  
Vernacular itua; curucuda (indians of the Rio Negro, Amazonas, Brazil)

2.0 ECOLOGY AND DISTRIBUTION

Gnetum nodiflorum occurs on a wide range of soil types and in various habitats, generally along the forest margins, never in the high forest, along the flooded margins of rivers, the edges of 'campinaranas', along stream banks and in 'varzea'; drainage does not appear to be important. It appears to be adapted to all climatic variations within the Amazon basin, with a rainfall from 1500 to 4000 mm. It seems to prefer the lower altitudes. Of the 6 known species of Gnetum, the itua is the most abundant, albeit as an occasional plant, rarely occurring in groups of 3-5.

The species probably originated in the Amazon basin and is now distributed almost throughout the basin, being most plentiful to the north of the river, but extending southwards into Acre state.

Related species: those most closely related to itua are: G. leyboldii and G. schwackeanum, both of which have kernels similar to itua and which are used by the indians.

3.0 DESCRIPTION

A thick, woody vine growing to the tops of the taller trees; trunk and branches cylindrical, with pronounced, articulated nodes. Leaves opposite, simple; stipules absent; petiole short, c. 1 cm long, longitudinally grooved; blade ovate, oblong-elliptic or elliptic, 10-20 cm long, 6-10 cm wide, apex usually shortly acuminate, base rounded, subcordate or obtuse, sometimes asymmetric, margins entire; coriaceous, midrib slightly depressed above, prominent below, 4-5 lateral, upward curving nerves. Inflorescence - Plants dioecious. Male inflorescence a loose panicle up to 20 cm long with branches of variable length, internodes 15-20 mm long, male flowers grouped at the node and subtended by 2 opposite bracts forming a shallow dish 4-5 mm in diameter; male flower c. 0.7 mm high, consisting of 1 perianth part and 1 stamen with 2 micro-sponangias. Female flowers larger, c. 3-4 mm high, consisting of 3 perianth parts enveloping 1 ovule. Fruit red, ellipsoid, c. 4-5 cm long, 2.5 cm in diameter, epicarp thin, mesocarp absent, surrounding the large, hard seed.

Fruiting July to December, occasionally to January.

4.0 MAIN USES

The kernel is the part consumed, generally being roasted before consumption. After roasting the itua is reputed to have a flavour reminiscent of European chestnut (Castanea vesca), and is very much appreciated by the inhabitants of the upper rivers. After roasting the kernels may be consumed directly upon removal of the skin. It can also be ground into flour and is occasionally produced in such quantity that it must be stored in fibre baskets lined with leaves. In some localities it is used as bait for fruit eating fish.

The stem is very fibrous and these fibres are very strong and durable. Thus the vine may be used for tying or it may be pounded to separate the fibres to make rope. It may also be used as a cellulose base for some kind of paper.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Since most plants grow along the edges of rivers, fruit are generally collected from the water. Plants with crowns near ground level may also be harvested directly. No information is available on yields.

#### 6.0 NUTRITIONAL VALUE

No information is available.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

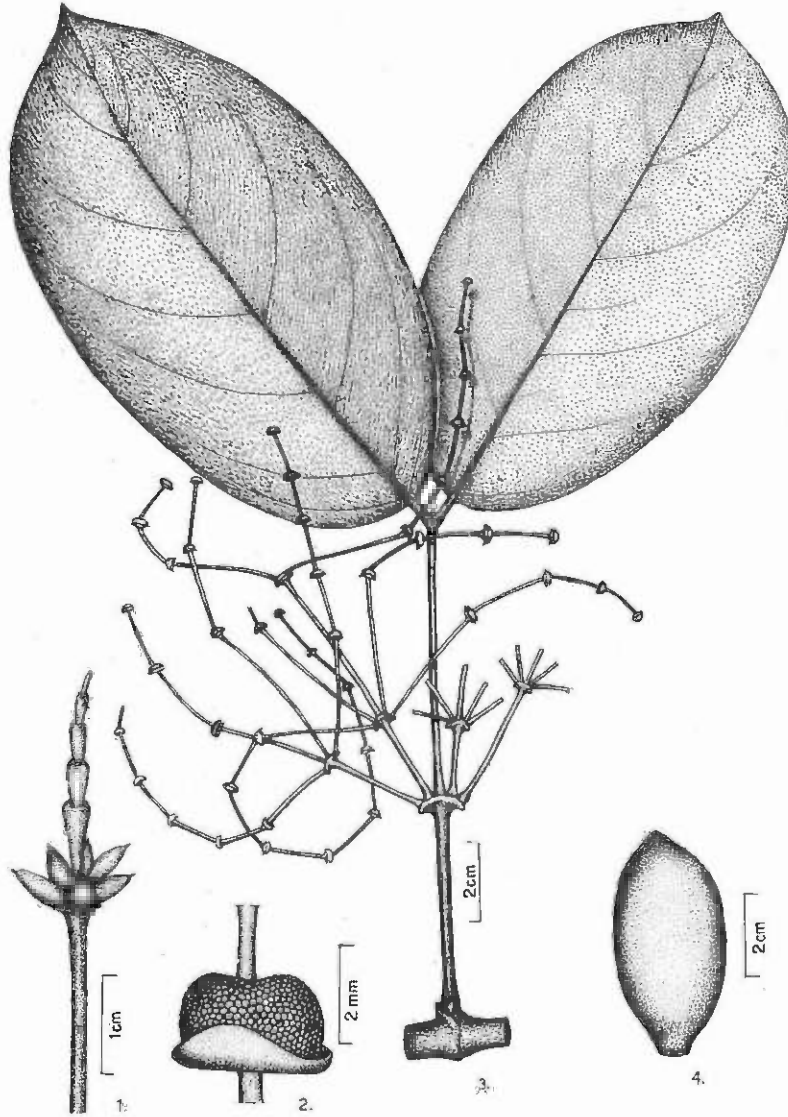
As far as is known, this species has never been cultivated, although plants are not destroyed when clearing land.

Since it is only found in the wild it must be propagated by seed, however, no information on germination or growth is available.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Given the quality of the kernel the ituaá deserves some research attention to determine possible economic potential. Collection of germplasm and nursery and field trials should not be difficult as the species prefers edges and can thus be interplanted with other species. Flour made from the kernel has the advantage that it keeps well in storage.

Plate XXXVI. Gnetum nodiflorum Brongn.



XXXVI  
1. Female flower  
2. Male flower  
3. Flowering branch  
4. Fruit

37. HANCORNIA SPECIOSA

- 1.0 NAMES: Family Apocynaceae  
Botanical Hancornia speciosa Gomes  
Synonyms Echitea glauca Roem. & Schultes  
Hancornia gardneri Muell. Arg.  
Hancornia lundii A.DC.  
Hancornia maxmiliana A.DC.  
Hancornia pubescens Muell. Arg.  
Ribeires sorbilia Arrud. Camara  
Vernacular mangaba, mangabeira, mangaiba, tembiú-ca tu (Tupi);  
manga-ice, mango jsu (Paraguay).

2.0 ECOLOGY AND DISTRIBUTION

Hancornia speciosa usually occurs on sandy soils in areas of open scrub known as 'campo', 'campo aberto', 'cerrado', 'sertão', 'caatinga', 'taboleiro' and 'chapada'; it is not found in forest areas, only in the humid savanna where it can survive many months of drought. In the central cerrado it is common at altitudes up to 600 m. It is present at both low and high densities, the latter are known as 'mangabais' and occur in the northeast of Brazil in Pará and Amapá.

The species is believed to have originated in the southern part of northeastern Brazil and is now found throughout Brazil as far south as São Paulo, Paraná and into Paraguay and possibly the Gran Chaco of Argentina (Monachino, 1945).

Related species: as there is much variation in the form of Mangabeiras, many species have been described. These have now been collected into 1 species with 5 varieties (Monachino, 1945).

3.0 DESCRIPTION

Deciduous shrub or small tree 3.5-7(-15) m high; trunk usually tortuous, 25-30 cm in diameter, bark soft dark brown, blotched, 1 cm thick; crown heavily branched with few leaves, somewhat pendulent, diameter of crown may exceed height of tree; all parts contain milky, white latex. Leaves opposite, uniformly spaced at the end of branches, simple; stipules absent; petiole 3-15 mm long, with minute axillary glands; blade narrowly elliptic, oblong or lanceolate, 3.5-10 cm long, 1.5-5 cm wide, apex acuminate, obtuse or rounded, base cuneate, margins entire, glabrous, dark green above, light green below with numerous, delicate, parallel lateral nerves. Inflorescence a terminal, few-flowered dichasium, pedicels 5 mm long. Calyx 2-3 mm in diameter, glabrous or sometimes pubescent, with 5 oval or obtuse lobes; corolla white or yellow, fragrant, tube 20-35 mm long, gradually expanding towards the apex and dilated at the insertion of the stamens, lobes 5, oblong-elliptic, asymmetric, somewhat reflexed, glabrous or pubescent outside; stamens 5, inserted in the corolla tube, anthers oblong-lanceolate; ovary 2-locular, ovules numerous in each loculus, of which only 1 loculus with a few ovules mature, style long, filiform, stigma cylindrical with a 2-lobed tip. Fruit an ovoid or globose berry 2.5-5 cm in diameter, yellow when ripe with pronounced reddish blotches and streaks, pulp soft, surrounding 8-15, flattened, discoid seeds c. 10 mm in diameter with a small, central hilum.

Flowering July to September, coinciding in northern Brazil with periods of light rain; fruiting September to March.

#### 4.0 MAIN USES

The fruit has a soft viscous pulp within a very thin exocarp. This is sucked off the inedible seeds in the mouth or separated in a sieve for pudding, juice, ice cream, jams, etc. The flavour is acid sweet and very pleasant, being reminiscent of pear.

About 20 tons of latex are extracted from wild groves each year and used to make a poor type of rubber with several industrial uses. Extracts from bark and roots are used in folk medicine against liver and menstrual problems.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Ripe fruit are picked off the tree or ground before they ferment. They can be picked slightly green to aid transport. No information is available on yields.

#### 6.0 NUTRITIONAL VALUE

About 80% of the fruit is pulp and 20% seeds. There is no data on nutritional value available but it will certainly provide some calories.

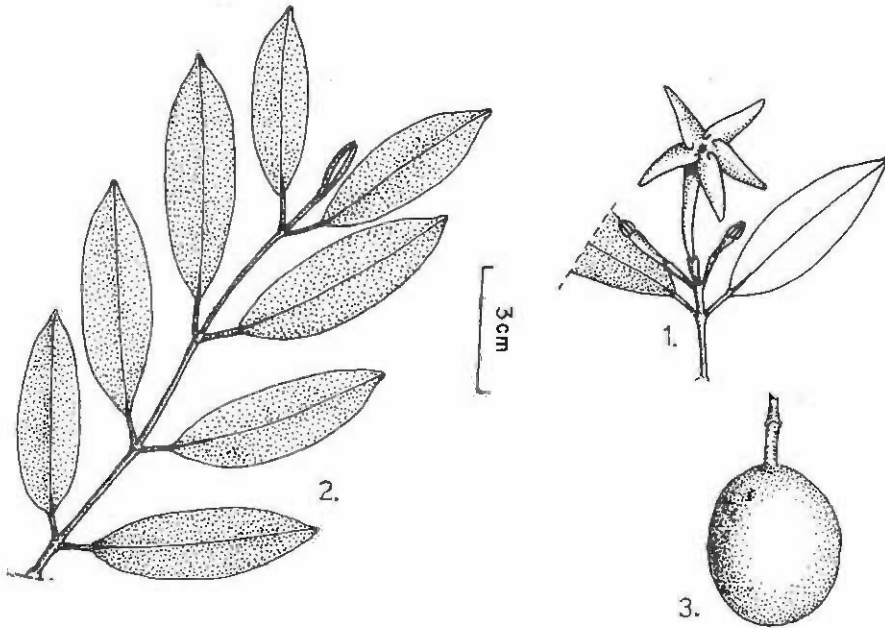
#### 7.0 CULTIVATION AND PROPAGATION METHODS

The *Hancornia speciosa* has only been propagated by seeds so far. These germinate in 18 to 20 days in sand. They should not be over watered and should be shaded for the first months. Growth is slow reaching a height of 2 m after 4 or 5 years, when fruiting starts.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

The fruit is marketed locally and much appreciated as one of the best flavoured of the north and northeast. Large natural groves have inhibited plantations to date but the fruit deserves the attention of industrialists. Plantations would provide rubber as well.

Plate XXXVII, *Hancornia speciosa* Gomez



XXXVII  
1. Flower  
2. Leaves  
2. Fruit

38. HEVEA BRASILIENSIS

- 1.0 NAMES: Family Euphorbiaceae  
 Botanical Hevea brasiliensis (Willd. ex A. Juss.) Muell. Arg.  
 Synonyms Siphora brasiliensis Kunth  
Hevea brasiliensis (Kunth) Muell. Arg.  
 Vernacular rubber, para rubber (English); seringa (Brazil); jebe,  
 caucho (Peru); caucho do Pará (Central America);  
 caoutchouc (French)

## 2.0 ECOLOGY AND DISTRIBUTION

Hevea brasiliensis is part of the mixed canopy of the humid tropical rainforest, usually occurring at densities of 1-2 trees/ha, but approaching 5 trees/ha in some areas of Acre and southwestern Amazonas states. It grows best on light textured clay loams to loam soils with good nutrient levels, although in most of its range it grows well on medium to heavy, deep, clay soils (oxisols and ultisols) with low nutrient levels. Drainage does not appear to be a limiting factor since although most trees are found on the dry plateau they will also grow on periodically or perennially inundated soils. Rainfall varies from 1600 to 4000 mm per annum, with dry periods from 0 to 3-4 months. Mean annual temperature is c. 26°C. Rubber grows well at altitudes up to 1000 m but will not fruit at 1000 m.

Most species of Hevea are indigenous to the northwest Amazon basin, although H. brasiliensis does not now occur in this region it seems reasonable to assume that it too originated there. It is widely distributed on the southern side of the Amazon basin from Pará state, Brazil, across Amazonas, Mato Grosso, Rondonia and Acre states into Bolivia and Peru. There is also a small area west of Manaus in Brazil where it occurs to the north of the River Amazon.

Related species: The genus Hevea contains 9 species, of which H. guineensis Auble is the most widely spread; H. pauciflora (Spr. ex. Benth) Muell-Arg.; H. nitida Mart. ex. Muell. Arg.; H. benthamiana Muell-Arg.; H. camporum Ducke; H. microphylla Ule; H. rigidifolia (Spruce ex Berth) Muelli-Arg. and H. spruceana (Benth) Muell-Arg. are the others. The related genus Micrandra has 12 species all of which produce seed that are similar to those of Hevea spp. Also the monospecific genus Vaupesia produces similar seed.

## 3.0 DESCRIPTION

A medium to tall forest tree which may attain the upper canopy (40m); bark relatively smooth, light grey with patches of darker brown or red-brown (6.5-) 9-11 (-15)mm thick; crown generally small and open, branching not dense, angling upwards; tap-root well developed, reaching 2.5 m at 3 years, augmented by an ample superficial system extending for 7-10 m at 3 years. Leaves spirally arranged, 3-foliolate; stipules minute, deciduous; petiole 2-70 cm long; leaflets elliptic to obovate, c. 15 cm long, 5 cm wide, apex acute, base cuneate, margins entire, dark green above, paler below, young leaves purple-bronze, becoming green on hardening; petiolules 5-25 mm long, with basal floral nectaries that secrete nectar only during the flush period. Inflorescences of several panicles borne below the tufts of leaves on each young shoot, 15-20 cm long, with many male and several female flowers (60-80 males to each female); flowers small, scented, unisexual, females slightly larger and borne terminally on the main and lateral branches of the inflorescence; pedicels short. Male flowers: calyx yellow, bell-shaped, lobes 5, narrowly triangular, c. 5 mm long; stamens 10, in 2 whorls of 5, on a slender, central column. Female flowers: calyx similar, 8 mm long, disc green, basal; ovary 3-celled, somewhat hairy, with 3 short, white stigmas. Fruit a compressed, 3-lobed capsule, 3-5 cm in diameter, seeds 1 per carpel. The fruit dehisces noisily and explosively, throwing the seed up to a distance of 15 m. Seed large, oval, slightly compressed, 2-3.5 cm long, 1.5-3 cm wide, shiny, grey to pale brown with irregular patches, dots and lines of dark brown; seed shape determined by capsule pressure and is characteristic for a given tree; endosperm white; seed weight 2-5 g.



Flowering sequence within an inflorescence commences with some male flowers, followed by the females and completed by the remaining males over a period of 2 weeks.

This process appears to favour cross-pollination, although there is excellent evidence for a high degree of self-pollination under forest conditions.

In central Amazon the flowering season is July to August. Only a small proportion of the female flowers set fruit, and of these between 30-50% fall after a month and more fall later. In central Amazon the fruiting season is October to November.

#### 4.0 MAIN USES

The seed is the part consumed, immediately after dehiscence from the fruit. After preparation the endosperm may be somewhat sweetish and has an agreeable flavour and odour. Because the seeds contain cyanic poisons, similar to those found in Manihot esculenta Crantz, they must be boiled for at least 24 hours. After removal of the seed jacket the endosperm may be washed underwater for several days, which is reputed to bring out any sweetness present. This cooked and fermented mass is then perfectly safe to eat. According to Schultes (1977) it may be eaten with fish, dried and conserved for later use or made into a bread. It is also used as a meal eaten with meat or poultry. It is interesting to note that, although Hevea spp. occurs throughout the Amazon basin and many parts of northern South America and all of them are edible if prepared as above, it is only the indians of northwestern Amazonia who value these seeds. In other parts of the region they are only consumed in emergencies.

H. brasiliensis is most important as the principal source of natural rubber. This is derived from the white latex present in the bark and has an infinity of uses. The wood of H. brasiliensis and related species may be used for making boxes and toys. When processed for cellulose it has characteristics similar to those of Eucalyptus spp.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The seed are harvested by collecting them from the ground. As they deteriorate rapidly, harvesting should be done twice a week and the seed used immediately. Tapping for rubber is done by cutting the bark at an angle to allow latex flow and then collecting the result. No information is available on seed yield of this species, although it is said that the indians in the northwest Amazon quickly fill a canoe.

#### 6.0 NUTRITIONAL VALUE

No information is available, although there is information that oil may be collected while boiling the seeds and that there appears to be a reasonable protein content as well as carbohydrates. As in most seeds nutritional value may be expected to be good, both for energy and for some protein.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

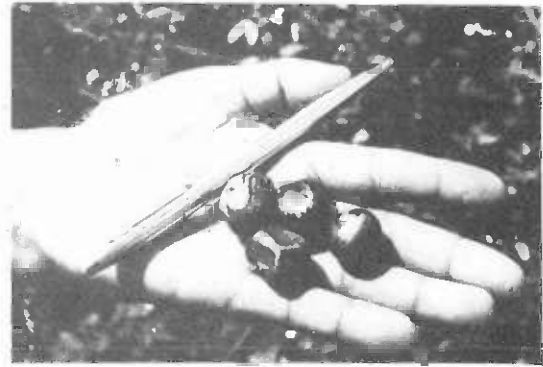
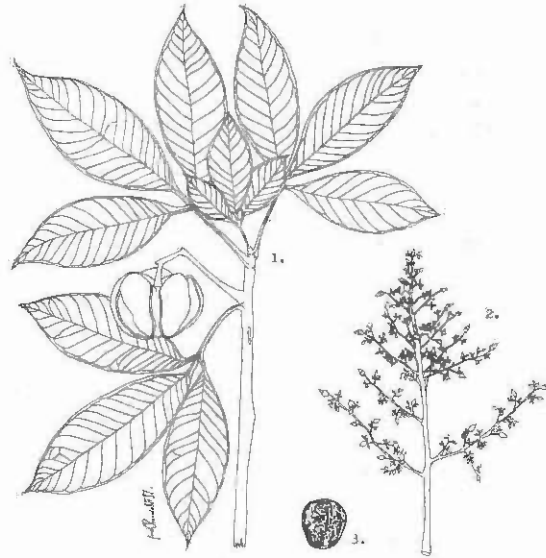
The seed of Hevea spp. loses its viability quickly so that sowing must be done as soon as possible after dehiscence from the fruits. After one month all viability is lost. Germination percentages are high if soon immediately and germination will start after 5 days and finish at about 20 days after sowing. Seedlings may be transplanted from shaded seed beds to shaded nursery after 2 weeks. The seedlings can then be hardened off immediately. Most Pará rubber is propagated vegetatively using the Forkert patch-bud method. In Amazonia the trees are grafted twice, once near ground level and once at about 2 metres to give a disease resistant crown. The H. brasiliensis is a fast grower; 2 meters/year during the juvenile phase is common. Tapping for rubber may usually start in the 5th to 7th year in the field. However fruit production may delay somewhat longer. The principal disease of para rubber in Amazonia is Microcyclus ulei (P. Henn.) v. Arx. which attacks the young leaves during flush at any period during plant growth. If an attack is serious during the annual leaf change the entire tree may lose all leaves or retain only a few severely deformed leaves. Spacing for rubber is usually 3 x 8 m. However a wider spacing might be indicated for seed production.

A lot of research has been done on fertilizer requirements for rubber production so it need not be mentioned here.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Although the economic potential of para rubber is well known there is scope for the use of the seed by smallholders. Chemical and nutritional analysis is necessary. A more efficient and easier method of preparation would also help expand the use of this potential food crop. Immediate potential appears extremely limited.

Plate XXVIII. Hevea brasiliensis (Willd ex A. Juss) Muell. Arg.



XXXVIII

- 1 - 1. Fruiting branch
- 2. Inflorescence
- 3. Seed
  
- 2 - Seed collected at Curupa, Brazil.
- 3 - Mature tree being tapped for rubber

39. HYMENAEA COURBARIL

1.0 NAMES: Family Leguminosae subfamily Caesalpinioideae  
Botanical Hymenaea courbaril L.  
Vernacular west indian or latin american locust, stinking toe (West Indies); jatobá, jataf, copal (Brazil); guapinol, algerrobo das antilhas (Central America)

2.0 ECOLOGY AND DISTRIBUTION

Hymenaea courbaril is widespread on the nutrient poor, light and heavy oxisols of the higher flood plains and dry transitional forests of the Amazon basin. Tolerating not only poor fertility and waterlogging but also 4 months or more of drought in areas receiving between 1500 and 3000 mm rainfall per annum, with temperatures typical of the wet lowland tropics.

The species occurs in Colombia, Venezuela, Brazil, Bolivia, Guyana, Surinam, British Guyana, Panama, Costa Rica, Nicaragua, Honduras, Mexico and the West Indies. In Brazil it occurs in densities of 0.2-2 trees per hectare.

Related species: H. stilborcarpa Hayne, H. altissima Ducke, H. reticulata Ducke, H. adenotricha Ducke, and about 10 other Hymenaea are found in Brazil.

3.0 DESCRIPTION

Tree, usually 30-40 m high, rarely to 50 m in the high forest; trunk up to 2 m in diameter, bark usually smooth, greyish, 1-3 cm thick and red internally; in the forest branching 10-20 m above ground level, much lower in exposed sites, crown wide and open or dense; root system fairly superficial with large roots often seen on the surface. Leaves alternate, compound, 2-foliolate; stipules soon falling; petiole 12-30 mm long; leaflets 2, ovate to lanceolate, curving slightly towards each other, 3-12 cm long, 1.5-7 cm wide, apex acute to obtuse, base oblique, margins entire, glabrous, shiny and leathery with small glands and prominent veins below, petiolules 2-8 mm long. Inflorescence a short, terminal panicle with few branches and flowers; flowers bisexual; pedicels 3-10 mm long. Sepals 4, concave, oblong-obovate, 12-22 mm long; stamens 10, filamentous, anthers 3-8 mm long; ovary 1-locular, ovules 6-18 or more. Fruit an indehiscent, oblong pod, 8-15 cm long, 3-5 cm wide, pericarp dull dark brown, hard, woody, c. 5 cm thick; seeds 1-6, light to dark brown, hard, flattened, obovoid to ellipsoid, 1-2 cm long, surrounded by a dry, creamy brown or greenish pulp.

Pods usually ripen between June and October, when the leaves fall; flowering about 6 months earlier.

4.0 MAIN USES

The powdery pulp around the seeds is eaten after cracking the pods open with a stone or hammer. It has its own peculiar smell and sweet flavour, slightly reminiscent of bananas and is generally considered pleasant but not very attractive. An indication of this is the large number of pods that are usually seen rotting under trees. The texture is like that of dry flour turning to a paste in the mouth and some people find this unpleasant.

This species is the source of the resin South American, Brazilian, Pará or Demerara Copal or Jutaicica. This hard resin exudes slowly from all parts of the tree when damaged. It trickles from holes drilled in the trunk and is also often dug up in a half fossilized form from the base of the tree where it collects. It is transparent to yellowish brown in colour and used to make poor quality varnish. About 35 tons per year are collected in Brazil for local use. The hard tough wood (0.8 to 1 g/cm<sup>3</sup>) is one of the best from the region and is known as West Indian Locust in international markets. The heartwood is reddish brown, sometimes with dark patches and the sapwood yellowish grey in colour. It is a little difficult to work as it is so hard but finishes well. Durable in moist soils, it is frequently used for heavy constructions, posts, boats and rail ties. It is also commonly used for furniture and for some

musical instruments. The thick bark is a source of tannin, has been used by Indians for canoes and is common in local folk medicine as a cure all, being especially useful for coughs.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Pods drop to the ground when ripe and must be collected within a few days before the edible pulp rots. Yields are large with some trees capable of producing several thousand pods.

#### 6.0 NUTRITIONAL VALUE

Pods weigh from 10 to 50 g and the pulp accounts for less than 20% of this weight. It is very dry and largely starchy so it is a good source of calories.

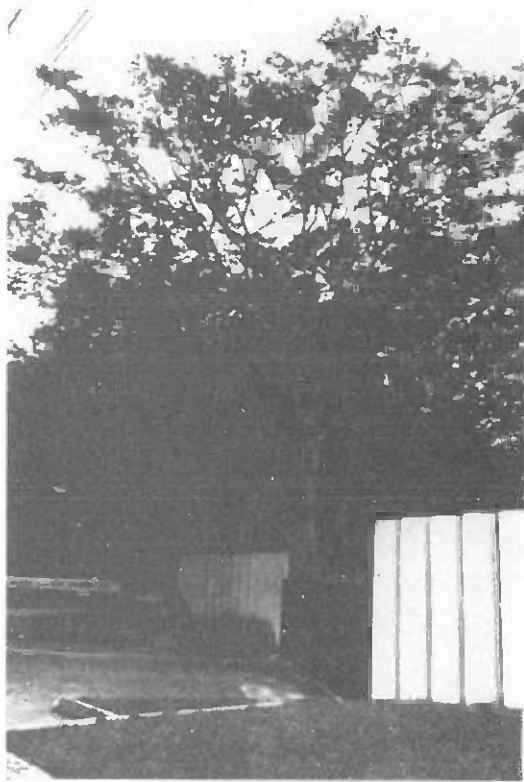
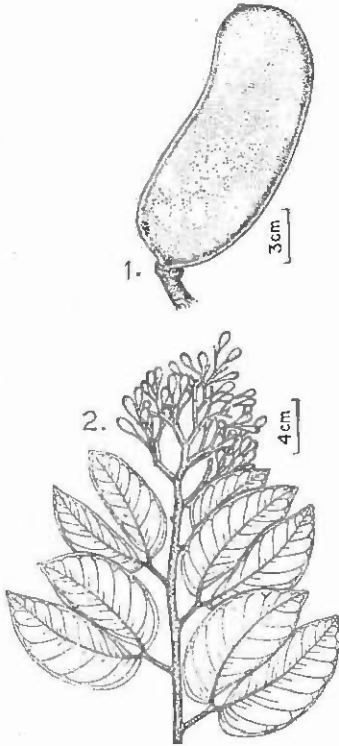
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds can be stored for as long as 12 months in dry conditions with little loss of viability. They germinate readily in about 3 or 4 weeks and grow rapidly for a hardwood. Trees may reach a height of 8 m in 5 years and 18.5 m in 16 years. They fruit at 8 to 12 years of age.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

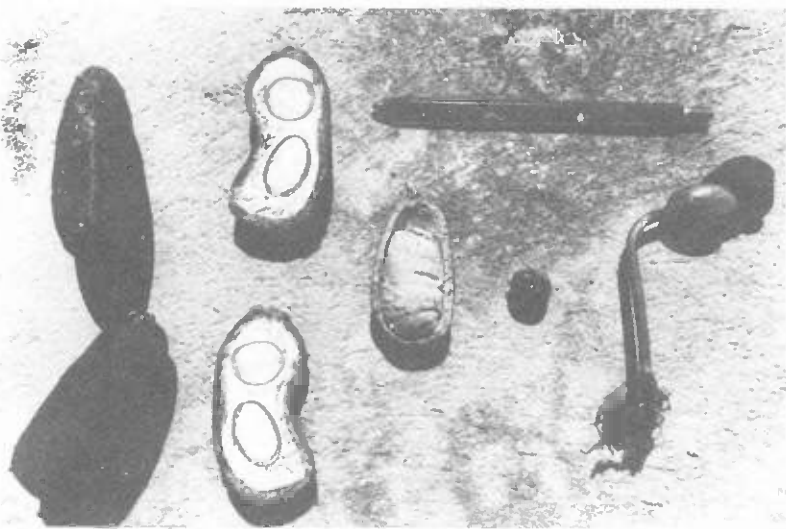
Foresters are beginning to show interest in this species as a fairly quick growing leguminous hardwood. The fruit is of little commercial value but it would be interesting to know if the seeds and pulp could be used as an animal feed to provide a byproduct from plantations.

Plate XXXIX. Hymenaea courbaril L.



1

2



3

- XXIX
- 1 - 1. Seed pod
  - 2. Flowering branch
  - 2 - Tree
  - 3 - Seed pods opened to show powdery pulp around seeds and germinated seed.

#### 40. INGA EDULIS

1.0 NAMES: Family Leguminosae subfamily Mimosoideae  
Botanical Inga edulis Mart.  
Vernacular Inga (Brazil); ice-cream bean (W. Indies); guabo (Peru);  
pois sucre (French Guyana); guano (Costa Rica).

#### 2.0 ECOLOGY AND DISTRIBUTION

Inga edulis grows rapidly on the poorest of oxisols and can also be found on floodplains that are water-logged for 2 to 3 months each year. Although generally associated with the warm, lowland, wet tropics, it is also remarkably resistant to drought and cold, occurring in regions with a 6 month drought and at altitudes of 1500 m in the Andes.

The species originated in tropical Latin America and is now very widely distributed throughout this region and also in Central America and the West Indies. It is frequently found in and around small dwellings in these regions.

Related species: Inga alba (Sw.) Willd., I. coriacea (Pers.) Desv., I. cinnamomea Spruce ex Benth, I. fagifolia (L.) Willd., I. falcistipula Ducke, I. heterophylla Willd., I. macrophylla H.B.K., I. thibandiana DC, I. velutina Willd., I. densiflora, I. feuillei, I. jinicuil, I. paterno and 100 or more wild species of Inga are found in central and southern tropical America.

#### 3.0 DESCRIPTION

A fast growing, evergreen forest tree 10-15 m high, with open, much branched crown often as wide as the height, and usually branching from just above ground level; bark thin, brownish-grey, slightly rough, pink within; seedlings with well-developed taproots. Leaves alternate, compound, pinnate; stipules awl-shaped, 1-2 mm long, soon falling; rachis 20-50 cm long, conspicuously and broadly winged between the leaflets and with a circular, cup-shaped, nectarial gland c. 2 mm in diameter on the upper side of the rachis between the point of attachment of each pair of leaflets; leaflets opposite, 4-6 pairs, elliptic to elliptic-oblong, 5-15 cm long, 2-8 cm wide, apex often long acuminate, base rounded to truncate or weakly cordate, margins often slightly undulate, sparsely pilose, smooth, mid-green above, slightly rough and paler below, midrib and veins often densely hairy and very prominent below. Inflorescence 1 or more axillary, short spikes 3-6 cm long; flowers sessile, bisexual. Calyx tubular, 4-7 cm long, greenish, hairy outside, with 5 deltoid teeth; corolla greenish-white, tubular, 10-15 mm long, with 5 deltoid teeth, hairy outside; stamens c. 80, with slender filaments exerted 20-40 mm beyond the corolla tube; carpel 1, ovules numerous. Fruit a cylindrical pod 50-100 cm long, 3-4 cm in diameter, shortly tomentose and with several, very deep longitudinal grooves, twisting and indehiscent; seeds 10-20, purple to black, 3-4 cm long, 1.5-2 cm wide, with a thin testa and embedded in a sweet, white, fibrous pulp 0.5 cm thick.

Flowering and fruiting 2-3 times every year, at different times on different trees; the ripe pods, which take 3 months to develop, being available from September to June.

#### 4.0 MAIN USES

The succulent testas are eaten off the seeds after removing them from the softened pod by twisting it open. The testas are sweet and soft but very full of fine fibres. They remind one of eating cotton wood soaked in sugar and it is consequently surprising that they are so popular. Lightly cinnamon flavoured varieties have been noted and these are considerably more attractive. Seeds are too bitter to eat although those are considerably more attractive. Seeds are too bitter to eat although those of I. paterno are said to be eaten roasted in El Salvador. Pigs eat seeds when hungry and cattle will even eat whole pods and leaves. The trees grow extremely fast and provide a light wood (0.3 to 0.4 g/cm<sup>3</sup>) that is frequently used for fuel. The open crown and rapid growth also provides an excellent shade and trees are widely used for this purpose around dwellings and in cocoa and coffee plantations.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Pods are either pulled off lower, or cut off higher branches when thick and soft. They may also yellow slightly at this stage. Pods will keep for almost a week after harvest and are easily carried. A tree with a 10 m crown will produce 20 to 100 pods at least twice a year.

#### 6.0 NUTRITIONAL VALUE

The testas are usually much heavier than the seeds but are over 70% water. The remaining dry matter is largely sugar and fibre. Brix levels up to 25% have been recorded so the sugar provides a useful amount of calories. The seed has 17% protein in its dry matter so may be a useful feed for pigs.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

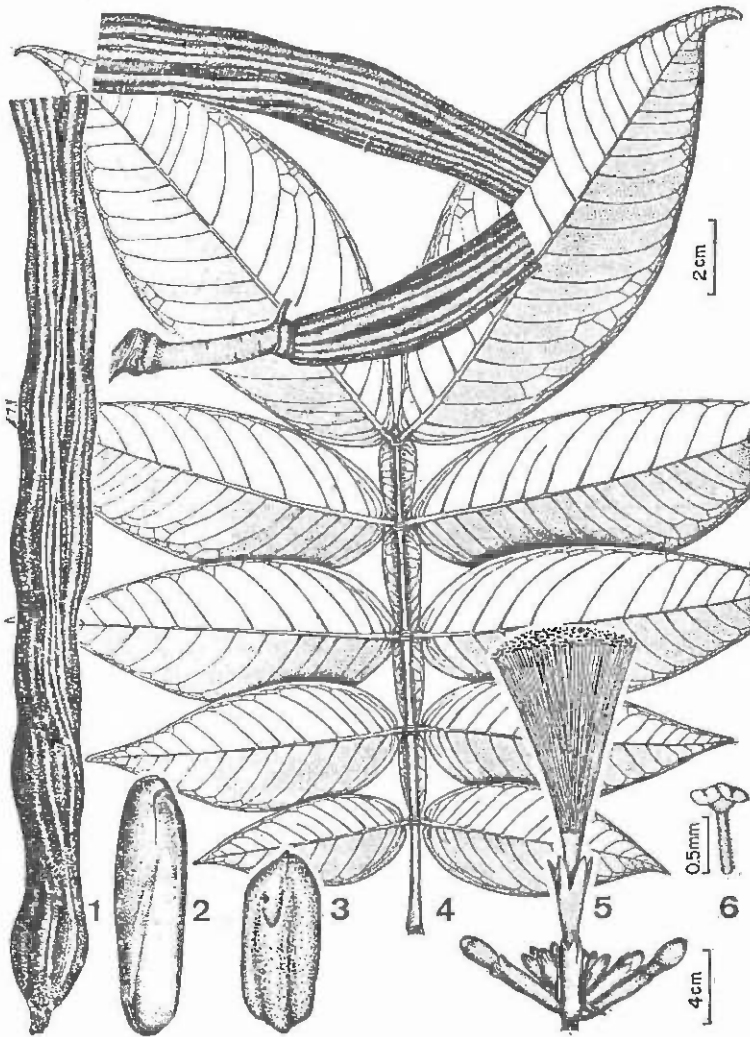
Seeds have usually started to germinate within the pods when the testas are ripe to eat. They are very hardy and root easily when thrown on top of moist soil. Thus most trees round dwellings have probably not been planted. They nodulate very well with nodules of over a centimetre being common. Growth is extremely rapid with branching occurring just above the ground to give a very open and untidy crown. Trees can reach a height of 5 metres in two years and will fruit soon after the first year in favourable conditions. They are short lived (20 years), frequently showing rotting in branches over 15 cm in diameter. Regrowth of cut trees is extremely vigorous reaching 4 metres in one year. Although trees are resistant to leaf cutting ants, complete defoliation by Lepidopteran larvae has been seen. Fruit fly larvae often damage testas especially in late maturity. Slight damage from fungal attack (*Rhizoctonia*) of seedlings has been noticed, otherwise the trees seem very healthy.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Fruit are frequently seen in local markets where they are low priced and well appreciated. Easy transport and storage are also important factors as the flavour is not attractive enough to justify commercial plantations. They are important economically as shade trees and supports in cocoa, coffee and vanilla plantations. The advantages of direct planting in the field, resistance to climatic extremes, pests and disease, very fast growth and regrowth and nodulation also make them an interesting option for woodlots, agroforestry systems and useful bush fallows. Biomass yields superior to those of *Eucalyptus deglupta* and *Leucaena* spp. seem probable on poor exisols when all these factors are considered. There is thus an urgent need to select varieties or species in the same genus for better form to awaken the interest of foresters. Cinnamon flavoured fruit and edible seeds should also be selected for.



Plate XXXX. *Inga edulis* Mart.



- XXXX
- 1 - 1. Fruit
  - 2. 3. Seed
  - 4. Leaves
  - 5. Flower
  - 6. Anther
- 2 - Pods and seeds
- 3 - Tree

41. INGA MACROPHYLLA

1.0 NAMES: Family Leguminosae subfamily Mimosoideae  
Botanical Inga macrophylla Kunth  
Synonym Inga quadrangularis Ducke  
Vernacular ingá-peuá, inga-peba (Brazil, Amazonia), pacaí amarilló (Bolivia).

2.0 ECOLOGY AND DISTRIBUTION

Inga macrophylla occurs in the relatively low profile, secondary growth known as "capoeira" and "capoeirinha", preferring non-flooded terra firma and grows well in fertile clay soils with some organic matter. Its distribution pattern within the Amazon basin suggests that it is not particularly sensitive to the variety of climates to be found in the region, although it does appear to prefer low altitudes not exceeding 250 m. Although frequent, the tree is not abundant and is encountered only as dispersed, isolated individuals, even when cultivated for shade or fruit production.

Ingá-peuá is native to the Amazon Basin and is distributed throughout the entire region, including Brazil, Bolivia, Peru and Venezuela.

Related species: the genus Inga includes some 200 species in tropical America, with 90 species in Amazonia (Ducke, 1949). The majority of the species produce edible fruits, but only a few have a pulp thick enough to be of economic interest. In addition to the species treated here, only four others deserve mention: I. edulis Mart., "Ingá-cipo"; I. cinnamomea Benth., "Ingá-açú"; I. capitata Desv. "Ingá costela"; I. ruiziana G. Don, "Ingá peba".

3.0 DESCRIPTION

A small tree to 5 m high, with a wide, low crown; root system unknown. Leaves alternate, 1-pinnate; stipules cordate, c. 12 mm long, deciduous, rachis, including petiole 9 cm or more long, broadly winged between the leaflets and with a raised, cup-shaped or cylindrical nectarial gland on the upper side between the junction of each pair of leaflets; leaflets 2-3 (-4) pairs, broadly elliptic, 12-18 cm long, 6-9 cm wide, apex acuminate or sometimes retuse, base sub-cordate, margins entire, glabrous. Inflorescence axillary or terminal, on a short peduncle up to 6 cm long; flowers subsessile, in a short, bracteate raceme. Calyx narrowly cylindrical, 15-25 mm long, with 5 deltoid teeth, glabrous or sparsely hairy; corolla white or yellowish, narrowly cylindrical, 20-40 mm long, densely hairy outside, with 5 lobes c- 5, long; stamens numerous, fused into a tube below, delicate; ovary elongate, stipitate, with 8-10 ovules, style long, filamentous. Fruit a stout, woody pod, rectangular in cross-section, straight or sometimes arcuate, up to 45 cm long, 4-5 cm wide, yellow, with 8-10 seed c. 3 cm long enveloped in a white, slightly fibrous pulp.

Flowering July to September and sporadically during the fruiting season; fruiting January to April.

4.0 MAIN USES

The only edible part of the fruit is the pulp, which is white and slightly fibrous and surrounds the seed. The seed and surrounding pulp are approximately equal in weight. The pulp is simply sweet with no aroma worthy to mention. It is consumed exclusively in natura. The tree is very suitable for shade.

5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruits only fall from the tree long after they are ripe and are unsuitable for consumption. The pods should be collected by hand using a cutting instrument. The fruits are ready to be collected when they are thick and the endocarp turns yellow. There is no precise information on yields but random observations of production fluctuate around 100 to 150 fruits per harvest.

#### 6.0 NUTRITIONAL VALUE

No information is available.

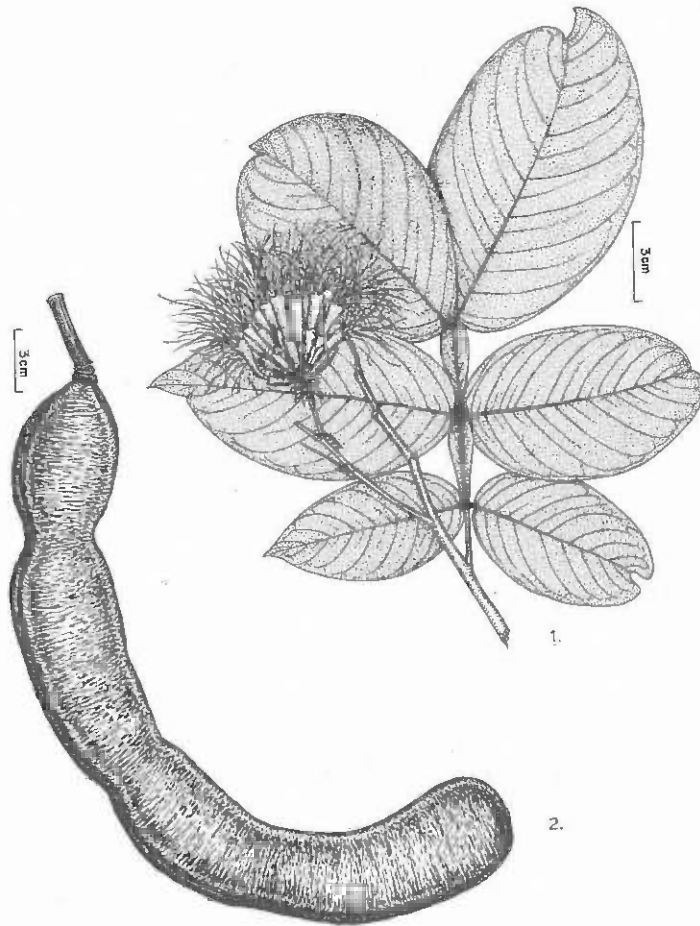
#### 7.0 CULTIVATION AND PROPAGATION METHODS

There are no technical reports on the cultivation of ingá-peua, but it is known that the plant propagates spontaneously from seeds and that monkeys are the principal dispersers. The seeds of well-matured fruits will germinate in 4 to 5 days. The seedlings grow rapidly if planted in soil with a significant amount of organic matter. The tree can begin to flower and fruit at 3 to 4 years of age.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Like the other species of Inga, principally I. edulis and I. cinnamomea, which are abundant in local markets, the ingá-peua could very well represent another option in the array of fruits offered to consumers. The plant's voluminous fruit with a large proportion of edible pulp rivals that of the other two species. All that is required is the selection of more productive varieties and the use of improved strains. The rest is easy, since the tree is a vigorous wild plant which does not require expensive culture techniques.

Plate XXXXI. Inga macrophylla Kunth



XXXXI 1. Leaves and inflorescence  
2. Seed pod

42. JESSENIA BATAUA

1.0 NAMES: Family Palmae  
Botanical Jeasenia bataua (Martius) Burret  
Synonym Oenocarpus bataua Martius  
Vernacular pataua (Brazil); ungurauy, sacumana (Peru); cuperi, obango, come, comenya (Colombia); batawo (West Indies); palma seje (Venezuela)

2.0 ECOLOGY AND DISTRIBUTION

Jeasenia bataua is a palm of low lying areas along riverbanks. Although it withstands temporary flooding, it is not often seen along 'varzea' floodplains, probably because slow seedling growth does not allow establishment. It can tolerate considerable deep shade when young and is usually associated with areas of high humidity (over 80%) and a mean annual temperature of about 25°C. It can grow on very poor sandy oxisols. It does not occur above 1000 m altitude. Commonly between 1 and 5 adult trees and many seedlings per 100 m can be seen along small rivers. Groves of several hundred hectares with 50-100 or more adult trees per hectare are found in some low lying areas, especially in the western and central Amazon.

The species is found throughout the Amazon, western Colombia, Ecuador, the Orinoco basin, Trinidad and the Guyanas.

Related species: J. polycarpa Karst, J. repauda Engel, J. weberbaueri Burret.

3.0 DESCRIPTION

Moderately robust, single-stemmed, unarmed, monoecious tree palm. Stem erect, to 25 m tall, c. 30 cm in diameter, smooth, mottled grey, ringed with leaf scars. Leaves robust reduplicate pinnate, c. 10-15 in the crown, c. 6-8 m long, stiff but bending and twisting near the tip; leafsheaths forming an ill-defined crownshaft, c. 2 m long, dark bluish green in colour, edged with thick, almost spine-like fibres 50-100 cm long; petiole to 50 cm long, deeply channelled; rachis bearing about 100 leaflets on each side; leaflets regularly arranged, held + horizontally, c. 50-100 cm long, 10 cm wide, dark bluish-green on the upper surface, grey-white beneath, with strong parallel veins. Inflorescences infrafoliar to 1.5 m long, shaped like a horse's tail; peduncle relatively short, held at 45°; first bract (prophyll) c. 60 cm long; 2nd bract shorter, both bracts deciduous; rachis c. 40 cm long, with c. 100 congested rachillae pendulous from the sides and lower surface; rachillae cream at first, later turning reddish brown, bearing flowers in 3's, a central female and 2 lateral males throughout their length. Flowers creamy brown, the male pointed, c. 5 mm long, with c. 9-12 stamens; female flower globose, c. 5 mm in diameter. Fruit usually produced in abundance, ovoid to ellipsoid, 3-4 cm long, 1.5-2.5 cm in diameter; epicarp smooth, dark purple to black with a waxy bloom; mesocarp fleshy, oily, c. 0.5-1.5 mm thick, white to purplish; endocarp covered in large dark fibres; endosperm ruminant.

Flowering occurs from December to July; fruit ripen 6-8 months later. It takes about 1 year between the emergence of the inflorescent bud and the production of ripe fruit.

4.0 MAIN USES

The fruit are usually used to make a drink although the oil is also extracted from them in remote regions, especially where large groves are found. Fruit are left to soak for about an hour in a little hot water to loosen the pulp (mesocarp and exocarp) enough for it to separate easily when pounded and scraped across a sieve. Water is added and the creamy brown emulsion drunk after filtering or decanting off and mixing with sugar and sometimes cassava flour. One kilogram of fruit gives about 1 litre of emulsion. Oil is obtained from the separated pulp usually by boiling it with water but occasionally with presses. An initial 2 to 3 days fermentation of moistened fruit may be used to break down the pulp and aid extraction. Good palm hearts can be obtained.

The drink is peculiar in flavour, being slightly bitter and sweet with the added sugar. It has the appearance and consistency of chocolate milk and the taste, rarely appreciated by newcomers, is acquired with familiarity. A high oil content also makes it too rich for most people to drink in any quantity. The freshly separated oil is very bland and quite similar in physical and chemical characteristics to olive oil so can be used as a substitute in salad dressing. However the primitive process usually employed in the Amazon only extracts about half the oil and often results in a poor, rancid, unrefined product.

The fruit or their waste from drink and oil production are sometimes fed to pigs and chickens. Leaves are used for thatching and some woven products. Long spines are important for arrows and darts. Both the drink and oil are used in folk medicine against respiratory diseases and worms.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Fruit are cut down when they turn black. Tall trees are often felled to harvest the fruit. Removing the thousands of fruit from the bunch is accomplished by shaking and laborious picking. Fruit only store for a few days before rotting or drying out. Only 1 to 2 bunches are produced each year as others often abort, presumably due to a lack of nutrient reserves, adverse climatic conditions and poor pollination. These also greatly affect fruit set and bunch size. A typical tree produces 2 bunches of about 15 to 20 kg each year although some regularly produce only 1 bunch of 8 kg and others as much as 2 bunches of 60 kg. If this very high yield were combined with the best fruit it would give a potential oil yield of 1.5 t/ha/year, only a third of that of Elaeis guineensis.

#### 6.0 NUTRITIONAL VALUE

Fruit represent about 70% of the bunch weight but it can be as low as 45%. Each usually weighs 8 to 9 g although some of 3.4 g have been seen and others of 15 g have been reported. The composition data in the literature is very variable and confused by a lack of clarity as to the dry matter content and the components of the pulp. This usually refers to the mixed exocarp and mesocarp and these are difficult to separate unless the fruit has been soaked and its dry matter content changed. The fresh pulp represents 15 to 52.7% varying with the size of the fruit and the thickness and moisture content of the mesocarp. Some fruit with thicker pulps are reported to give 7 to 10% oil (Pesce, Balick) and values for J. polycarpa vary from 1.8 to 13% (Beckerman, N.A.S. Dry seeds only contain 1% oil. Dried pulps also contain 5.1 to 5.6% protein, 30.6 to 49% fibre, 1.2 to 1.7% ash and 47.2 to 51.5% carbohydrates. The protein is well balanced with a nutritional value only a little below that of casein. As fibre will be filtered out during preparation, the milk-like drink, containing about 7.5% solids (55.3% fat, 7.5% protein, 37.3% carbohydrate) is of even higher value as a source of calories and protein. The bitterness and brown colour are due to tannins and their oxidation products.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds germinate after a month but seedlings grow slowly. They are ready for planting at about 18 months to 2 years, when 30 cm high. Growth in full light continues extremely slowly with well kept trees reaching a height of about 1 metre after 4 more years. This confirms the general impression that fruiting rarely occurs in less than 8 years and may take considerably longer in wild trees that start to fruit when 5 to 8 m tall. Greater attention to the trees exacting water requirements and partial shade may improve early growth. Abundant wild trees and slow growth explain why trees are never planted. No pests or diseases have been noticed so far but drought symptoms and deaths have been seen in young plants during dry spells.

## 8.0 POTENTIAL ECONOMIC IMPORTANCE

This tree provides an important and nutritious item of the diet for certain Amerindian tribes living in regions with large groves. Fruit are common in the Manaus market and these, together with all fruit from trees near dwellings, are used to make the much appreciated drink. Large groves have also been exploited commercially for oil during the scarcity of the two world wars and for a short time afterwards. As much as 200 t of oil per year was exported from Brazil in the 1940's. Oil extraction has now ceased, except for home consumption in remote regions, because of the harvesting and transport difficulties from high trees in swampy ground, the laborious and inefficient extraction techniques, the low yields and the availability of many other cheap alternative refined vegetable oils. Oil extraction industries in the major towns have shown little interest because of the additional difficulties of transporting fruit in bulk for any distance without deterioration, the low oil content of the fruit, the lack of suitable depulping equipment and the existence of many better options like Astrocaryum and Orbignya spp. Agronomists have shown no interest because of the slow growth of the tree, its large crown, the low oil content per bunch, the low bunch yield per area per year, its exacting moisture requirements, the difficulty of managing plantations in swampy soils, the possibilities of more attractive new crops like Bactris gasipaes and Astrocaryum aculeatum and the option of the lucrative and high yielding oil crop, Elaeis guineensis. In spite of all these difficulties there has been much recent enthusiasm about the crop's potential, especially because of the possibility of using it as a substitute for olive oil. This will only be justified if much better germplasm is found. For example, the reporting of very small seeded and thick fleshed sterile (parthenocarpic) fruit from hybrids with Oenocarpus bacaba and the faster growth and precocity of O. multicaulis deserve close attention. Meanwhile the feasibility of the rational exploitation of large natural groves with modern extraction methods, is being studied.

Plate XXXXII. *Jessenia bataua* (Martius). Burret



1



2



3

XXXXII

- 1 - Mature palm tree
- 2 - Fruit whole and split
- 3 - Fruit on sale in the market



43. LECYTHIS USITATA

- 1.0 NAMES: Family Lecythidaceae  
Botanical Lecythis usitata Miers  
Synonyms Lecythis paraensis Huber  
Lecythis amapaensis Ledoux  
Lecythis zabuxajo Aubl.  
Pachylecythis egleri Ledoux  
Vernacular paradise nut, monkey pot nut, cream nuts (English);  
sapucaia (Brazil): zabucajo, quatelé, marmite de singe  
(French Guyana).

2.0 ECOLOGY AND DISTRIBUTION

Lecythis usitata occurs in the hot, humid region, on the fertile floodplains as well as the drier oxisols of the terra firma, tolerating waterlogging for several months and also soils of low fertility. The species is rarely found in areas with less than 2000 mm annual rainfall. Forest inventory reports from the Manaus region of Brazil record densities of between 0.2 and 11 trees/ha, but greater concentrations are known to occur on the floodplains.

The species is distributed throughout the Brazilian Amazon and also in Colombia, the Orinoco basin and the Guyanas. The most likely origin of the species is believed to be the central or eastern Amazon, where it is most plentiful.

Related species: Bertholletia excelsa Humbolt and Bonpland.; L. ollaria Linn.; L. minor Jacq.; L. elliptica H.B.K.

3.0 DESCRIPTION

A large, deciduous tree, 30-40 m high; trunk 60-80 cm in diameter, straight for a considerable height when growing in the forest but branching profusely at 1 m or so when growing in the open, bark lightly fissured, greyish outside, yellowish inside; large, dense crown in the forest, round and 15 m or more in diameter in the open; seedlings with large taproot, large trees appear to be deep rooted. Leaves alternate, simple; stipules absent; petiole 6-10 mm long; blade elliptic, obovate or lanceolate, 6-20 cm long, 3-7 cm wide, apex acuminate, base rounded, margins slightly waxy and finely serrulate, thin, light green turning darker and coppery before leaf fall, glabrous, lightly veined. Inflorescence small, usually terminal raceme; flowers bisexual, globose. Sepals 6, unequal, ovate, c. 10 mm long, 5 mm wide; petals 6, unequal, broadly ovate to subcircular, c. 25 mm long, 20 mm wide; stamens in 2 rows and numerous staminodes within a hooded androecium; ovary inferior, 4-locular, ovules numerous. Fruit a large, functionally indehiscent, bell-shaped, woody capsule (pixidium) up to 25 cm long, pendent, pericarp woody, 1-2 cm thick; there is a large operculum which becomes detached from the mature fruit leaving nuts dangling by a slender, fleshy funicle which eventually rots and allows the nuts to fall, the empty pixidium remaining on the tree for many months. Fruit with 4 distinct loculi containing approximately 10 seeds; seeds elliptic, slightly angled, 5 cm long, 2 cm wide, testa brown, woody, with uneven, raised, lighter coloured ridges, aril large, fleshy and waxy, kernel creamy-white, 4 cm long, 1.5 cm wide.

4.0 MAIN USES

The nuts are cracked or cut open to reach the kernel. The testa is softer and a little easier to remove than that of the Brazil nut (Bertholletia excelsa) and the kernel is not attached so firmly. The kernels are similar in flavour and, being a little sweeter and moister, are considered superior by many people. They are sometimes roasted or used in confectionary.

The wood is of good quality having a density of 0.8 to 1.0 g/cm<sup>3</sup>. Heartwood is reddishbrown and the sapwood yellow. It is a little difficult to work but takes a good finish. Uses include railway ties, roofing shingles, construction and general carpentry. Infusions of bark and pericarp are used in folk medicine to cure liver problems.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The nuts are rarely obtained because once the operculum falls, both monkeys and bats rapidly eat or disperse them. Then nuts fall to the ground within a few days of maturity where rodents remove them. So harvesting requires cutting down fruit at the correct time, a difficult proposition. The kernels are rather moist and do not store well unless dried quickly. Flowering is sporadic with some trees bearing once every other year and some 5 years apart. Yields of 12 to 20 fruit in the first fruiting year and 81 fruit 2 years later have been reported. Less than 50 fruit per year is normal for adult trees although more may be produced on the fertile floodplains.

#### 6.0 NUTRITIONAL VALUE

Fruit weigh between 1 and 2.5 kg and contain 30 to 50 nuts, each weighing about 4 to 14 g. Kernels account for 60% of the nut weight and contain 60% dry matter. The latter contains 51 to 64% oil, 16% protein, 8% fibre and 42 % ash. So the nut is a good source of both calories and protein. Like Brazil nuts, they are also said to sometimes concentrate rare elements like selenium to toxic levels, when growing on soils rich in such minerals.

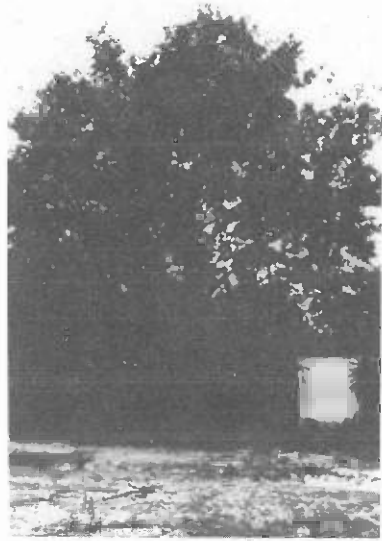
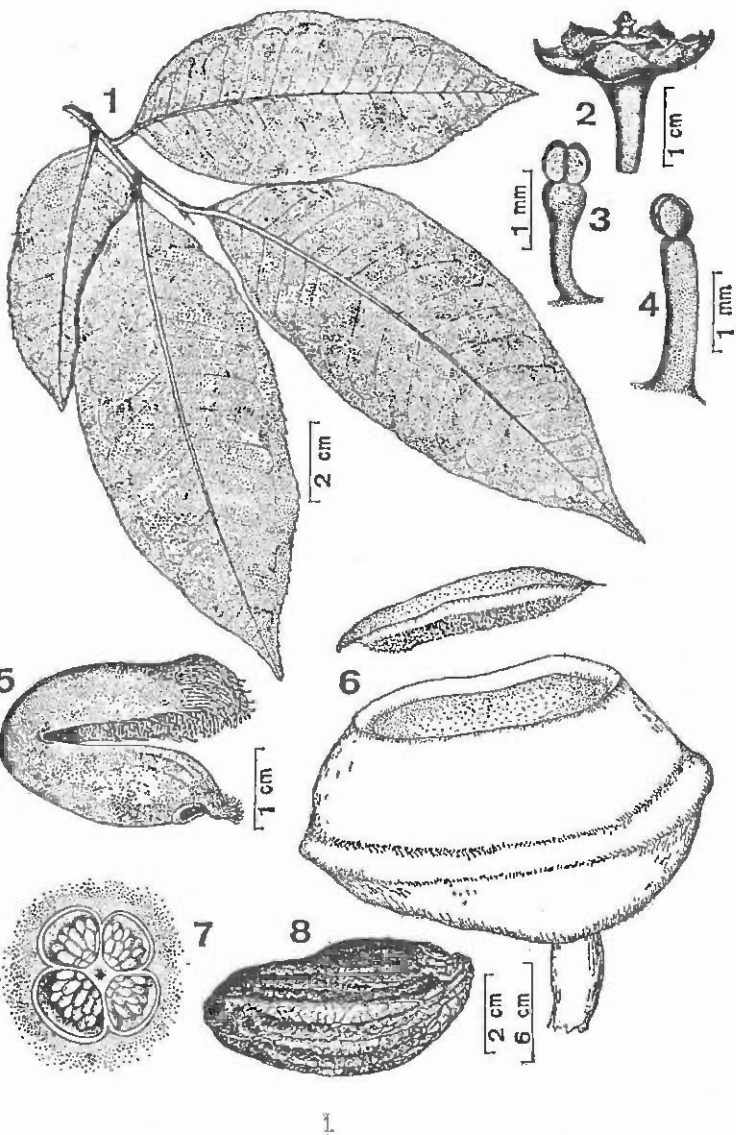
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds germinate easily within 2 to 6 weeks and seedlings grow to about 60 cm in the first year. Growth continues at about a metre per year with 10-year-old trees having a height of 12 m and crown diameter of 10 m. Fruiting starts between 10 and 18 years depending on the fertility of the soil. Growth on the fertile 'varzea' floodplains is said to be quite fast. No commercial plantings are known. A mild Anthracnose attack has been seen in aging leaves, otherwise trees look very healthy.

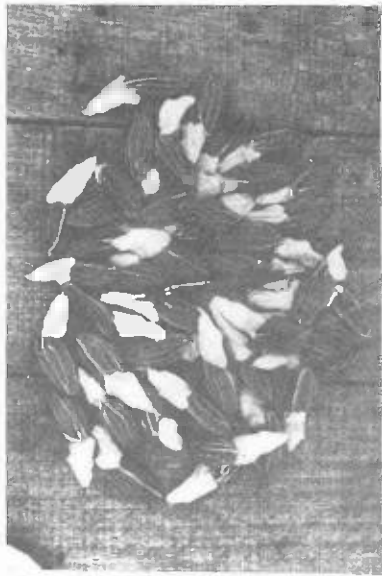
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Both the fruit and wood of this species are interesting. They have an advantage over B. excelsa in being able to grow on the floodplains but serious disadvantages with their difficult harvesting and storage. It would be interesting to know more about their growth rates and production on the floodplains. The possibilities of dual purpose plantations or use as a rootstock for B. excelsa on these rich soils should be examined.

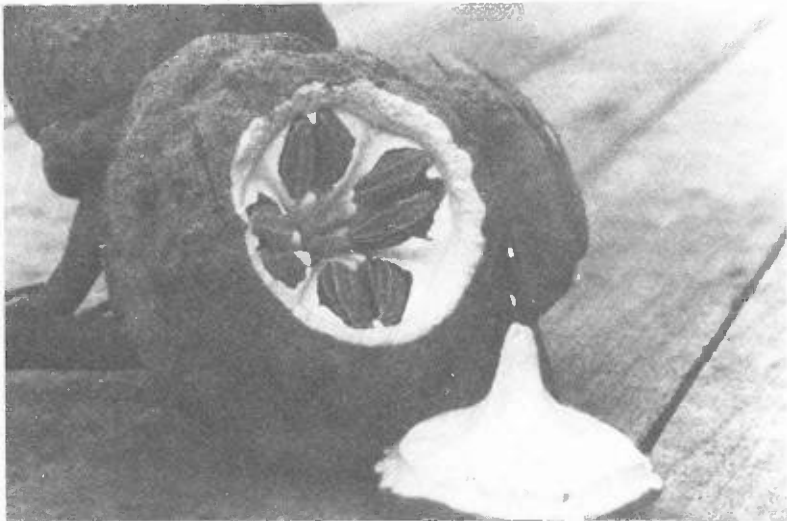
Plate XXXIII. *Lecythis usitata*. Miers.



2



4



3

- XXXIII
- 1 - 1. Leaves
  - 2. Ovary
  - 3. 4. Stamens
  - 5. Androecium
  - 6. Fruit and operculum
  - 7. Section of ovary
  - 8. Seed
- 2 - Tree
- 3 - Fruit operculum and seeds
- 4 - Seeds

44. MALPIGHIA PUNICIFOLIA

- 1.0 NAMES: Family Malpighiaceae  
Botanical Malpighia puniceifolia L.  
Synonyms Malpighia emarginata Moc. & Sessé  
Malpighia retusa Benth.  
Malpighia berteriana Spreng.  
Vernacular West Indian cherry, Barbados cherry, Antilles cherry,  
cerise ronde de Cayenne, semeruco (Venezuela); ceraja-do-Pará  
(Pará, Brazil); American cherry.

2.0 ECOLOGY AND DISTRIBUTION

Malpighia puniceifolia is now widely known as a cultivated tree and there appears to be little information on its natural habitat. It is tolerant of a variety of tropical climatic regimes. It is reported to grow and fruit well in the regions of Belem, Salgado and Bragantina in the Amazon estuary, where the temperatures and humidity are high and the altitude near sea level.

The West Indian cherry is originally from Central America or the Antilles, where it has been known since the 16th century. It is found both wild and cultivated in Central America and the Caribbean and extends from Mexico to the north of South Central America, including the whole of Amazonia, and extends to Rio de Janeiro and São Paulo in southern Brazil where it is cultivated apparently only on a domestic scale.

Related species: Malpighia glabra L. is a species closely related to M. puniceifolia, however its fruits are not as appreciated as the latter's. According to some botanists it is merely the wild form of M. puniceifolia.

3.0 DESCRIPTION

Small, much branched tree to 5 (-12) m high; trunk more or less cylindrical with discontinuous fissures, bark brown, thin with conspicuous lenticels; roots fairly deep. Leaves opposite, simple; stipules small, c. 2 mm long; petiole short, c. 3 mm long; blade elliptic to obovate, 1.5-7 cm long, 1-3 cm wide, apex rounded, mucronulate, base cuneate, margins waxy, more or less glabrous at maturity. Flowers solitary or up to 6 in sub-umbellate inflorescences; flowers irregular, bisexual; pedicels less than 1 cm long. Sepals 5, ovate, 2.5-3 mm long, each with 2 large, external, basal glands; petals 5, white to reddish, limb circular with narrow claw, 6-9 mm long, denticulate and slightly keeled; stamens 8, incurved; ovary superior, ovoid, styles 3. Fruit a depressed-globose, 3-lobed drupe up to 2.5 cm in diameter, skin red when ripe; mesocarp juicy, enclosing 3 angular seeds with endocarp sculptured with 3 dorsal crests connected by transverse ridges.

Flowering and fruiting during the first 6 months of the year, during the rainy season.

4.0 MAIN USES

The edible part of the fruit is the juicy mesocarp, slightly acid and very agreeable. The fruit may be eaten ripe or slightly green, fresh or made into juice, compote or a delicious jelly of excellent quality naturally rich in pectin.

Pio Correa (1931) mentions that the wood in spite of its short length, is of excellent quality for special cabinetwork and carving. The wood contains 20 to 30% tannin, and is used in the tanning industry. The bark gives a red colouring and yields a glue like gum arabic which has medicinal properties. M. puniceifolia is also recommended as a suitable plant for arborization of squares and avenues.

## 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The harvest should be done manually before the fruits attain full ripeness, in order to avoid damage during handling and transportation. Ripe fruit on the tree are eagerly sought by birds. Based on observation of an individual in good condition, the fruit production during a single harvest lasted 3 months, and was estimated at 1500 to 2500 fruits.

With an average weight of 5 g per fruit, this gives an estimated 7.5 to 12.5 kg of fruit per plant in one harvest.

## 6.0 NUTRITIONAL VALUE

The edible part accounts for 80-85% of the fruits weight. The fruit of M. puniceifolia are the richest in vitamin C of all known edible fruits. In a paper reporting a study in French Guyana by Floch & Gélard (1955) these authors conclude that a single American-cherry fruit weighing 4.5 g contains as much or slightly more vitamin C than 500 g of orange or 1000 g of lemon, the fruits most commonly used for scurvy prophylaxis. Leme Jr. (1951) has studied the vitamin C content of several tropical fruits, and gives special importance to M. puniceifolia because of its exceptional richness in this vitamin. According to this author three medium sized fruits (weighing 5.27 g each) are sufficient to provide 75 mg of vitamin C, which is the average daily requirement for a normal adult.

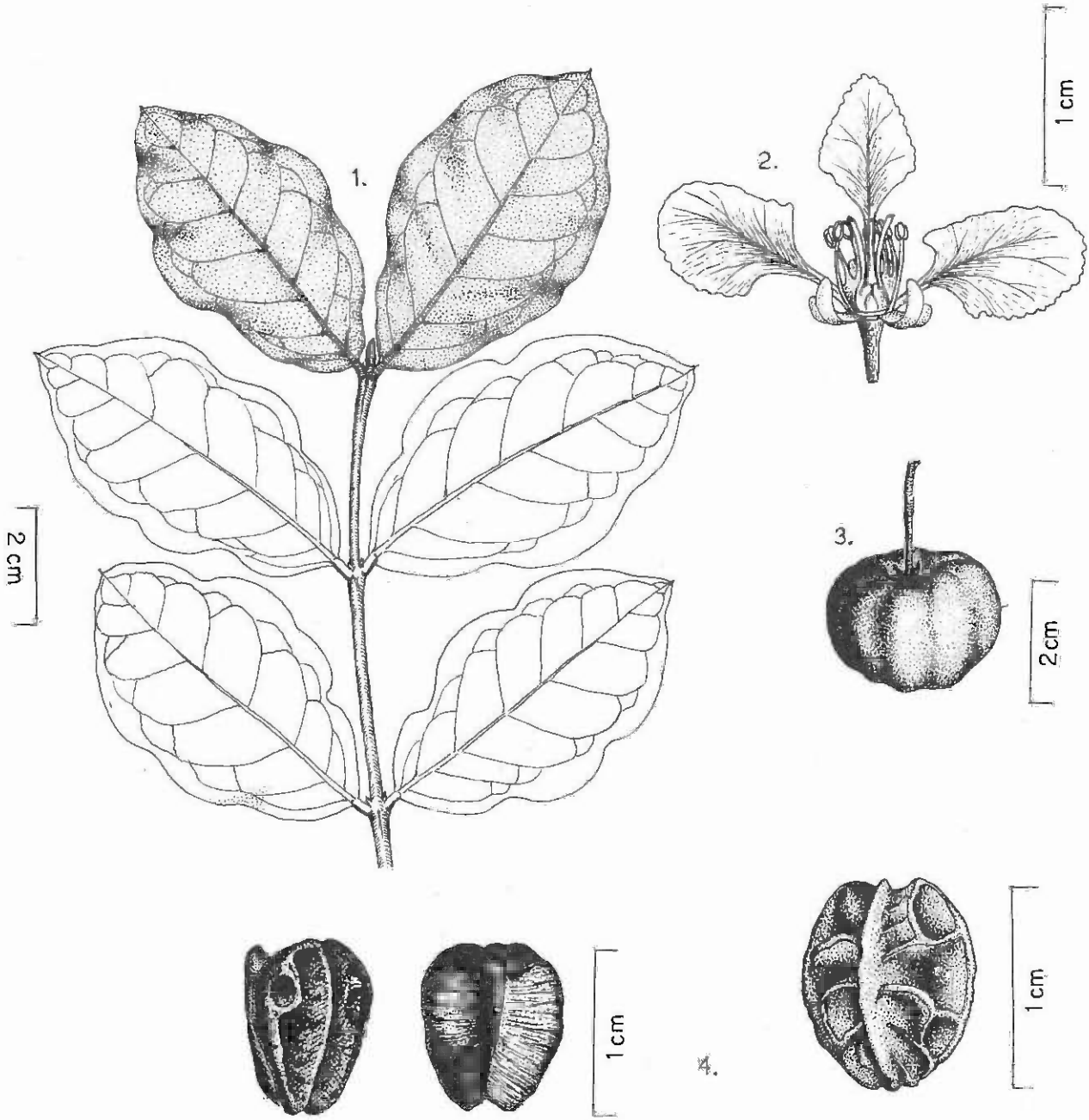
## 7.0 CULTIVATION AND PROPAGATION METHODS

The propagation of the American-cherry is by seeds or by vegetative means, the latter being the more advisable. Propagation by seeds may be practised when there is certainty that the fruits are products of cross fertilization; otherwise the germination percentage will be very low or nil. The method of propagation by layering gives excellent results, with rooting in 20 to 25 days. If planted in soils that are not too dry, with about 20 to 30% organic matter, the growth will be very good. Individuals cultivated from seeds attained 3 m in height and fruited in less than 3 years. Another individual reproduced by layering attained 1 m in less than a year.

## 8.0 POTENTIAL ECONOMIC IMPORTANCE

Large-scale American-cherry cultivation undoubtedly would provide new options to the food industry with products such as concentrated juice, canned fruit, jelly and others, not to mention its consumption in natura. The fruit's richness in vitamin C, its beauty and agreeable flavour justify intensive studies from every angle, with emphasis on cultivation.

Plate XXXIV, *Malpighia puniceifolia* L.



XXXIV 1 - 1. Leaves  
2. Flower  
3. Fruit  
4. Seeds

45. MANILKARA ELATA

1.0 NAMES: Family Sapotaceae  
 Botanical Manilkara elata (Fr. Allem ex Miq.) Monachino  
 Synonyms Mimusops huberi Ducke  
Manilkara huberi (Ducke) Chev.  
 Vernacular bullet wood (USA); maçaranduba, maçaranduba verdadeira (Brazil).

2.0 ECOLOGY AND DISTRIBUTION

Manilkara elata occurs on the well drained nutrient poor oxisols and ultisols in the dense high forest of the terra firme as well as the reasonably drained nutrient rich alluvial soils of the seldom flooded, high 'varzea'. Throughout its range it grows well with an annual rainfall between 1500 and 2500 mm and mean annual temperatures between 24° and 28°C. Nowhere has it been reported at altitudes above 500 m. Near Manaus, Amazonas, a frequency of 9 trees/ha of all age groups except seedlings, has been reported. In FAO inventories along the Belém-Brasília highway 5 trees/ha were reported.

The species is believed to have originated in the eastern Amazon basin. It is found throughout central and eastern Amazonia, being extremely common in Pará state, parts of eastern Amazonas, northern Mato Grosso, southern Rondonia, eastern Roraima and western Amapá. It has been reported from southern Surinam and may be present in French Guyana.

Related species: The genus Manilkara is widely spread throughout tropical and sub-tropical America. The most famous species is M. zapota (L.) P. von Royen = Achras zapota L., the sapodilla, which is a delicious fruit that has now been spread throughout the tropical world and which also produces a latex used in chewing gum. Other species of some use are: M. amazonica (Huber) Chev.; M. elata (Fr. All.) Monac.; M. excelsa (Ducke) Standl.; M. longifolia (A. d.C.) Dub.; M. rufula (Miq.) Lam.; M. triflora (Fr. All.) Ducke; M. floribunda (Mart.) Dubart.

3.0 DESCRIPTION

Evergreen, upper canopy, forest tree, 30-40 m high or occasionally emergent and 50 m or more; trunk long and straight for 25-30 m before reaching the crown, often 1 m in diameter, bark rusty brown, longitudinally fissured into rather straight, slightly rough strips, exuding a white latex when cut; root system unknown. Leaves alternate, simple, exuding a thin, white latex when cut; stipules absent; petiole 1.5-3 cm thick, 0.2-0.3 cm in diameter; blade oblong-obovate, 15-20 cm long, 4-7 cm wide, apex rounded, base cuneate, margins entire, coriaceous, pale green above, golden yellow below with a fine, densely appressed indumentum, midrib prominent, with numerous, fine, parallel, lateral veins almost at right angles to the midrib and with very fine anastomosing veinlets between them. Inflorescence at the ends of branches among the leaves, flowers in fascicles, bisexual; pedicels 3-4 cm long, densely covered with rusty brown, appressed hairs. Sepals 6, in 2 whorls of 3, ovate, 4-5 mm long, apex acute, densely hairy outside, glabrous within; petals 6, white, lanceolate, acute, united below, equalling or slightly shorter than the sepals, hairy outside, glabrous within; stamens 6, 2-locular; ovary superior, hairy, 10-12 locular, each loculus 1-ovulate, style terminal, subulate. Fruit a depressed-globose, apiculate berry, 3-4 cm in diameter, with persistent calyx; epidermis smooth, greenish-yellow when ripe, often slightly reddish-tinged; latex present in unripe fruit, disappearing at maturity except in the epidermis; seeds 1-5, small, dark brown and flattened, with a longitudinal stripe, similar to M. zapota and surrounded by a sweet, edible pulp.

Flowering October to November in central Amazon; fruiting February to April.

#### 4.0 MAIN USES

The pulp of the fruit is the part consumed, although humans seldom are able to compete with other forest animals who are able to collect the fruit from the top of the tall trees. The flavour is reminiscent of sapodilla (M. zapota (L.) P. von Royen) which are sweet and very agreeable in flavour. The fruit are consumed fresh. As so few become available for human consumption no other uses have been recorded.

The wood of the Maçaranduba is one of the best regional timbers. It is extremely heavy (0.9 to 1.0 g/cm<sup>3</sup>) with a regular grained heartwood that is reddish to dark red brown and outer wood that is whitish beige. The texture is medium and there is no taste or odour to the wood. It can be used for furniture and cabinet construction as well as many other functions in civil construction. The thin latex also makes an inferior "balata" that was once used in chewing gum. This latex is edible and is still used in folk medicine when mixed with honey as a treatment for tuberculosis.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit fall when completely ripe, if not first harvested by forest wild life. The fruit must then be collected from the ground and used immediately. No information is available on yields.

#### 6.0 NUTRITIONAL VALUE

No information is available.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

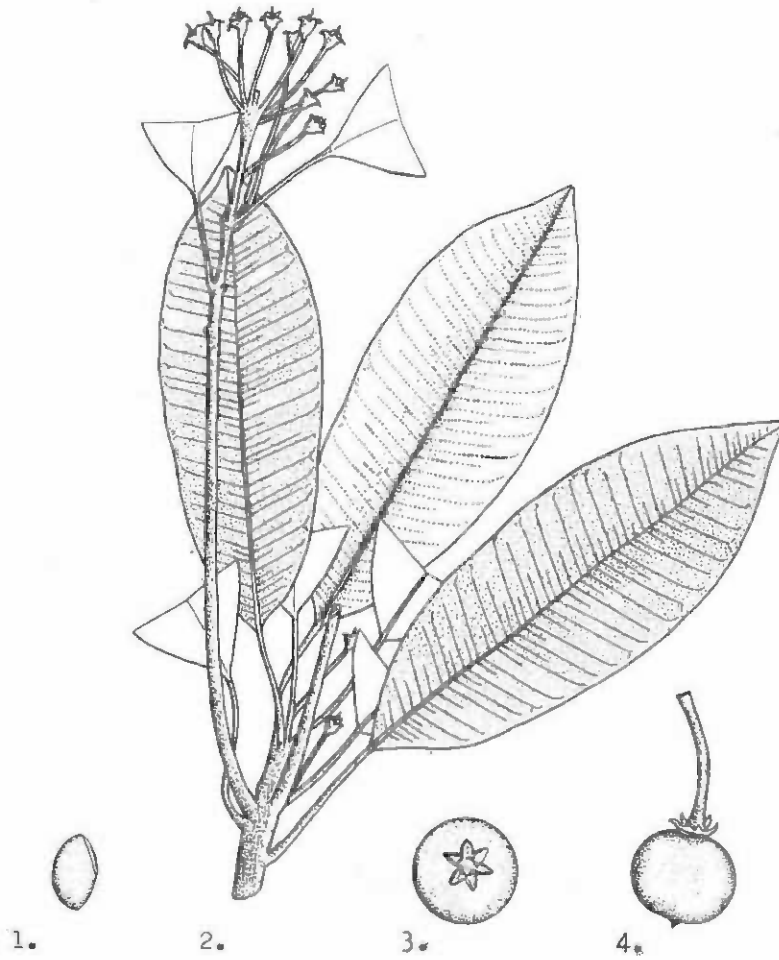
There are about 5000 seeds in a kilogram and if sown soon after extraction from the fruit may give 50 to 60% germination. The seedlings grow very slowly in the nursery, even in good substrate. Two or 3 years is often necessary to obtain plants for planting out or grafting. Grafting is difficult because of the latex but Maçaranduba has been used as rootstock for sapodilla (M. zapota). Growth continues to be extremely slow, both in semi-shade and full sun. A report of 6.2 m in height in 11 years in the field shows this slow growth in the central Amazon. However, there are no reports of insect or disease pests.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

This would appear to be extremely limited because of slow growth and similarity to its superior related species (M. zapota). However it deserves more attention from foresters because of its excellent wood.



Plate XXXV. Manilkara elata (Fr. Allem ex Miq.) Monachino



XXXV

- 1. Seed
- 2. Leaves and inflorescence
- 3. 4. Fruit

47. MAURITIA FLEXUOSA

- 1.0 NAMES: Family Palmae  
Botanical Mauritia flexuosa L.f.  
Synonyms Mauritia vinifera Martius  
Mauritia setigera Griseb.  
Mauritia minor Burret  
Mauritia sphaerocarpa Burret  
Vernacular miriti, merity, murity, muruty, bority (Brazil); aguaje (Peru);  
pibácho (French Guyana); moriche, muriche, gae-be (Venezuela).

2.0 ECOLOGY AND DISTRIBUTION

Mauritia flexuosa occurs often in great abundance, on poor acid soils in areas liable to flooding by running, not stagnant water in the lowlands; it will also occur in drier areas above 50 m. Extreme forms occur in dry sites or in hollows in the middle of savanna. It can grow at densities of 50-100 adults and many more juveniles per hectare, covering many thousands of square kilometres. Landsat pictures have been used to identify two large areas of M. flexuosa of 65 000 and 23 000 ha respectively.

It is found in northern South America, particularly in western Amazonia and around the mouths of the Amazon and in the Orinoco basin; it is also recorded for the Guyanas and Trinidad.

Related species: M. martiana Spruce.

3.0 DESCRIPTION

Robust, single-stemmed, dioecious tree palm, one of the largest of all Amazon palms. Stem erect to 35 m tall, c. 30-60 cm in diameter, eventually becoming bare, and marked with circular leaf scars, the internodes sometimes with short, adventitious roots, but these not spine-like; outer layer of stem extremely hard, enclosing much softer, creamy-white pith, this turning rusty-brown on exposure; root system very extensive with a wide range of root types. Leaves up to 20 in crown, reduplicate palmate; leaf base sheathing; petiole up to 4 m long, deeply channeled; blade with a costa up to 1 m long, and up to 100 or more segments, 1-2 m long, 5-10 cm wide, dark green, occasionally paler beneath. Inflorescence, the male and female superficially similar, interfoliar, up to 3 m long; peduncle to 1 m long bearing closely sheathing, tubular bracts; rachis up to 2 m long with numerous 2 ranked + pendulous branched, these in turn bearing tightly sheathing bracts subtending short, catkin-like branches bearing the flowers. Male catkin c. 6 cm long, bearing spirally arranged pairs of small flowers; female catkin very short, c. 1 cm long, bearing 1 or 2 flowers. Male flowers c. 10 x 7 mm in bud. Female flower + conical, c. 2 mm long. Fruit large, ovoid, barrel-shaped or oblate, 3-5.5 cm long, 4-7 cm in diameter; epicarp covered in vertical rows of orange-brown or dark red scales; mesocarp thick, yellow to reddish-orange, pulpy; endocarp scarcely differentiated. Seed solitary, very hard, with homogeneous endosperm.

Fruiting usually occurs once a year during the wet months, but some fruits are available throughout most of the year.

4.0 MAIN USES

The mesocarp of the fruit is widely used to make a very popular drink. Fruit are softened by soaking them in water and the pulp and scales are then squeezed off with the fingers and mixed with water. The cloudy orange emulsion is decanted or sieved off and drunk after adding sugar and sometimes fermenting or adding cassava flour. A compote is also made in some areas and the fresh mesocarp is sometimes chewed on. Fallen trunks are a very good source of large coleopteran larvae that are eaten raw or fried by certain Ameridian tribes. A number of authors claim that the palm can provide oil from the pulp and kernel produce palm hearts, give sago-like starch from the trunk and be tapped to provide palm sugar and wine. While the pulp contains some oil, the kernel contains practically none and we have been unable to find palm hearts or starch. We have only

recovered a very small amount of sweet exudate from freshly cut hollowed out stumps. It is not yet clear if these items are the result of earlier speculation or can be obtained from restricted varieties or with special techniques or timing. The orange emulsion varies in flavour from being pleasant, especially with familiarity, to being reminiscent of cough medicine. It tastes acidic and is milk-like in consistency. Softened fruit and the emulsion are popular items in local markets. The light trunks are used for making floating rafts and dug-out canoes. Cups for rubber collection and corks are sometimes carved from the pith. The leaves are used for thatching and their fibre for cord and hammocks. The roots are used for ornaments and in folk medicine.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The whole bunch is sometimes cut down or individual fruit knocked off with sticks or stones or picked off the ground as they drop when ripe. The pulp starts to rot within 2 or 3 days of falling on the ground, however if removed rapidly it will keep for many months either dried or after undergoing a natural acid fermentation. The latter is often encouraged by wrapping pulp in the waxy leaves of Calathea lutea and leaving under water. Trees produce 3 to 8 bunches with about 700 fruit each however 11,000 fruit have been removed from a tree with 7 bunches and an estimated yield of 60 t of fruit per hectare has been made in Peru. Ten to 20 t/ha is probably more normal.

#### 6.0 NUTRITIONAL VALUE

Fruit vary in weight from 15 to 120 g although most weigh about 50 g. The moisture content varies considerably depending on the length of time of contact of the dry ripe fruit with damp soil or water. A typical moist fruit contains 65% H<sub>2</sub>O and consists of 23% exocarp, 21% mesocarp, 12% pithy endocarp and 44% kernel. Dry fruit consist of 23, 13, 8 and 13% respectively. The dry mesocarp contains 31% oil, 5.5% protein, 38% sugar and starch, 23% fibre and 2.4% ash. Fresh pulp contains 30 mg of carotene, 52.5 mg vitamin C and 0.1 mg thiamine per 100 g. So although pulp dry matter only accounts for 13% of the dry fruit weight it is a rich source of calories and vitamins. The level of vitamin A is variable and claimed to be higher than in any other known fruit. However 70 mg of carotene has now been recorded for a variety of Bactris gasipaes.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

Seed germinate after a few months and the plant grows to a height of 20 to 30 cm fairly rapidly. Subsequent growth is slow but speeds up once the plant is well established. Fruiting starts when trees reach a height of about 6 m in 7 years under natural conditions. The presence of such large numbers of wild trees has inhibited detailed studies. Trees have been seen to suffer and die due to a lowering of the watertable. Bending of crowns is also occasionally observed, possibly due to Coleopteran larvae. However, in general the health of the palm in homogenous stands is remarkable.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

It is surprising that such an abundant palm that is so useful to Amerindians is poorly exploited commercially. An oil content of less than 5% of the fresh fruit weight explains why it is unattractive as an oil source. Further efforts should be made to find out if an how sugar exudates and trunk starch can be obtained. Tapping palms is notoriously difficult and we have yet to attempt techniques involving the inflorescence. The trunk and young petioles give a tasteless gel in copious quantities and this might be considered for use in the food industry. Hard kernels are said to be poor substitutes for vegetable ivory buttons. Pigs can be fattened on the fruit and swineherding would seem to be an excellent way to use the vast natural plantations.

Plate XXXXVI. Mauritia flexuosa L.f.



1



2

XXXXVI  
1 - The palm tree  
2 - Fruit in the market

46. MAURITIELLA ARMATA

- 1.0 NAMES: Family Palmae  
Botanical Mauritiella armata (Martius) Burret  
Synonyms Mauritia armata Martius  
Lepidococcus armatus (Martius) Wendland & Drude  
Vernacular carané, buritirana, buriti-bravo, buriti-mirim (Brazil)

2.0 ECOLOGY AND DISTRIBUTION

Mauritiella armata often occurs in almost pure stands, completely dominating the landscape; it prefers low, poorly drained soils of 'varzea' and estuaries of the Amazon river. It is also found on well-drained upland soils but growth is better in the low-land sites. In the Amazon it occurs in areas with a mean annual rainfall of about 2000-2800 mm, well distributed in some areas, but with a dry season of 2-3 months in others. The mean annual temperature is 26°C. It tends to occur in open and often low forest, and appears to be a high light demander.

The species is found throughout central and eastern Amazonia and throughout much of the northeast of Brazil where suitable conditions occur. The species probably originated in Amazonia.

3.0 DESCRIPTION

Moderate, clustered, dioecious palm occurring in clumps of many (10 or more), erect stems. Stems becoming bare, 10-20' m tall, c. 8-12 cm in diameter, armed with spinelike adventitious roots 2-3 cm long. Leaves c. 6-10 in the crown, reduplicate-palmate; petiole unarmed, c. 80 cm long, oval in cross section, channelled near the base, basally expanded to form a sheath c. 60 cm long, the sheathing part edged with fibres; blade with a radius of c. 80 cm, incompletely divided into 30-50 segments, dark green on the upper surface, chalky-white beneath. Inflorescence interfoliar, the male and female superficially similar, to 120 cm or more long, peduncle + elliptical in cross section, c. 40-50 cm long, bearing a basal, tubular prophyll and several tightly sheathing bracts; rachis bearing similar bracts, each bract subtending a branch to 40 cm long bearing similar but smaller bracts, each subtending a rachilla (flower-bearing branch); rachillae short, + catkin-like, the male much shorter and more slender than the female. Flowers very small. Fruit + ellipsoidal, c. 3 cm long; epicarp covered in neat vertical rows of rhomboidal, orangey-brown scales; mesocarp with a thin outer layer of oily orange pulp enveloping a spongy inner layer; endocarp scarcely developed. Seed single, ellipsoidal, endosperm homogeneous, white, very hard.

Flowering occurs from May to October; fruiting from November to May in eastern Amazonia.

4.0 MAIN USES

The mesocarp of the fruit is the only part consumed. It has an oily texture but a somewhat acid flavour (not due to rancidity) that is quite acceptable. The fruit is often eaten by first gnawing away the scaly skin and then gnawing the pulp which is only a few millimetres thick. It is more common to prepare a juice which is mixed with sugar or cassava flour before serving. This is prepared by soaking the fruit in warm water for several hours and then mashing the fruits together. Alternatively the fruits are wrapped in leaves and buried for 3 days to soften the pulp. This is reputed also to enhance the flavour.

The leaves are occasionally used for thatching. The trunk is frequently used for fence posts.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

When the fruits mature they fall to the ground and must be collected quickly to avoid competition from wild and domestic animals. However, because the plants frequently grow in the 'varzea' the nearly ripe bunch is pulled from the tree and hung in the house for a few days to ripen. The caraná produces 2 to 4 bunches/year. A bunch may weigh between 5 and 10 kgs.

#### 6.0 NUTRITIONAL VALUE

No information is available on composition but about 50% of the pulp is water, and there is some oil and appreciable amounts of carotene. The fruit would appear to be a good source of carotene and a reasonable source of calories.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

No information exists at all. One small experiment by the author suggests that vegetative propagation is possible using the small side shoots.

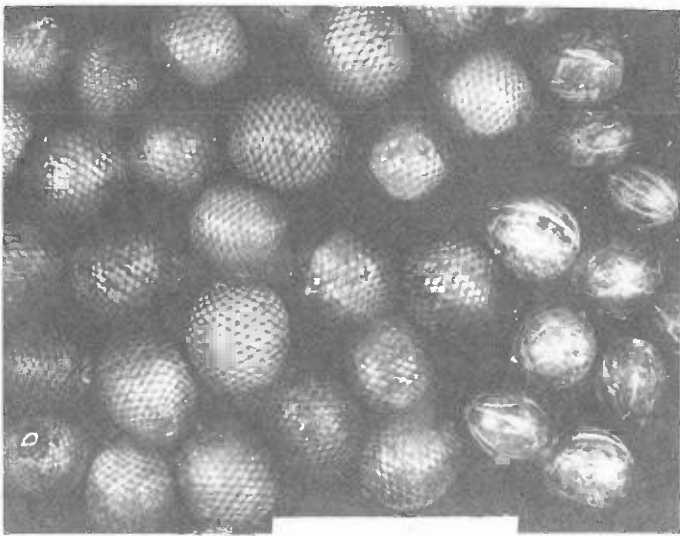
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

This would appear to be limited to supplying occasional food and vitamins to the peasant and wild and domestic animals in areas where no other cultures do very well.

Plate XXXVII. Mauritiella armata (Martius). Burret.



1



2

XXXVII 1 - The palm tree  
2 - Fruit in the market

48. MAXIMILIANA MARIPA

- 1.0 NAMES: Family Palmae  
Botanical Maximiliana maripa (Correa da Serra) Drude  
Synonyms Maximiliana regia Martius  
Maximiliana martiana Karsten  
Vernacular huacava (Bolivia); incham (Peru); cucurito (Venezuela);  
maripa (French Guyana); kokerit-palm (Guyana) inaja (Brazil);  
arítá, aritaire (Ameridian).

2.0 ECOLOGY AND DISTRIBUTION

Maximiliana maripa occurs on terra firma, in dry and sandy oxisols and ultisols poor in nutrients. It grows in natural savanna and will spread to artificial grasslands where the rainfall is above 2000 mm and the mean annual temperature is about 26°C. It is only rarely seen above 200 m. It occurs in great abundance, being one of the commonest palms of Amazonia; in places it may occur in densities of 50-70 trees per hectare, especially in cleared areas.

It is distributed throughout much of northern and central Brazil and neighbouring countries. It is thought to have originated in the northern part of South America, possibly in the land bordering the estuaries of the Amazon.

Related species: Maximiliana longirostrata B. Rodr. (Amazonas) and M. macrogyne Burr. (Maranhão).

3.0 DESCRIPTION

Robust, single-stemmed, monoecious tree palm. Stem erect, to 18 m tall, c. 20 cm in diameter, sometimes basally swollen, covered in petiole bases, eventually becoming bare, but marked with conspicuous leaf scars, at the base with a conspicuous cone of abundant adventitious roots. Leaves c. 15 in the crown, reduplicate pinnate, usually held + erect and curving; leaflets borne in groups of 3-5, held in different planes. Inflorescences usually several, either + entirely male or bearing flowers of both sexes, or rarely entirely female; peduncle to c. 1 m but mostly hidden among the leaf sheaths; first bract (prophyll) inconspicuous, tubular, hidden among the sheaths; 2nd bract very large, up to 100 cm long, 40 cm wide, + boat-shaped with a long beak to 80 cm long; rachis c. 40-80 cm long with 200-300 rachillae. Male flowers rather small, c. 1 cm long, creamy yellow, with minute sepals and petals and 6 (rarely more) very long conspicuous stamens. Female flowers c. 2 cm long, up to 12 on each rachilla, with + broadly triangular overlapping sepals and petals and large ovoid ovary. Fruit ovoid, c. 6 cm long, 3 cm in diameter, pale brown scaly; mesocarp with an outer fibrous layer and an inner pulpy, oily layer; endocarp very thick and woody, enclosing 1-3 seeds, and 3 basal pores; endosperm oily, homogeneous.

Flowering occurs between October and March; fruiting between January and March.

4.0 MAIN USES

The thin mesocarp is gnawed off the hard endocarp with one's teeth after stripping off the epicarp. It is also used to make a thickened gruel for the sick. The slightly mucilaginous and pasty pulp is subacid-sweet in taste. It is widely eaten in some areas but practically ignored in others as there is little pulp and the flavour and texture are not particularly attractive. Kernels are hard but may be eaten like those of Orbignya spp. A good cooking oil can be extracted from the kernels and an excellent sweet palm heart can be obtained, but only with considerable effort, from the thick meristem.

The leaves are widely used for thatching and for walls in simple rural homes. They are also woven into hats and baskets.



#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Mature fruit fall to the ground where they must be picked up quickly before they are eaten by wild animals. Ripe fruit are sometimes knocked off the tree especially during the first 4 or 5 years when they can be reached easily. Five to 6 bunches is a typical yield, each with 800 to 1000 fruits.

#### 6.0 NUTRITIONAL VALUE

Pesce (1941) found the following data for the mesocarp: 5.8% moisture, 37.2% oil, 14.3% protein; the kernels had 4.7%, 59.3% and 19.3% respectively. So both are good sources sources of calories and protein with the orange mesocarp probably also supplying vitamin A.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

This palm is not cultivated but the seeds are dispersed naturally by animals and man. Young plants are extremely well protected against fire by their deep and hidden meristem which remains below the ground for a long period. Growth is slow and trees are not thought to fruit in much less than 10 years.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

The pulp is not attractive enough for the fruit to reach local markets and the kernels are not used industrially for oil production in spite of their high content. This is mainly because they are hard to remove from the hard endocarp and represent a small portion of the fruit. Selection for thin endocarp and large kernels might be interesting as the palm seems free of pest and is so well adapted to poor soils.

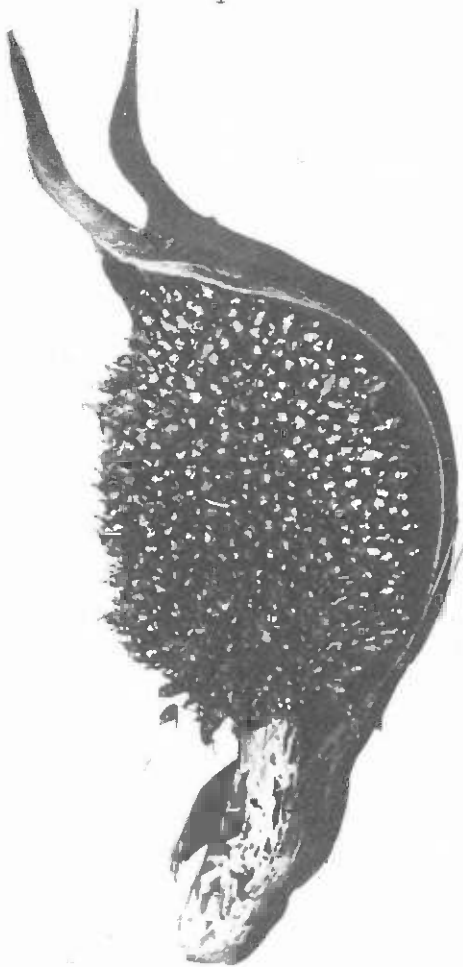
Plate XXXXVIII. Maximiliana maripa (Correa da Serra) Drude.



1



2



3



4

XXXXVIII

- 1 - Palm tree
- 2 - Fruit bunches on palm
- 3 - Harvested fruit bunch with spathe
- 4 - Fruit ready for harvest

## 49. MOURIRI APIRANGA

1.0 NAMES: Family Melastomataceae  
Botanical Mouriri apiranga Spruce ex Triana  
Vernacular apiranga, uapiranga, jaboticaba-do-cerrado (Brazil).

### 2.0 ECOLOGY AND DISTRIBUTION

Mouriri apiranga occurs in open areas, sandy or rocky banks of rivers in primary or secondary forest, including the low vegetation known as "capoeirinha", apparently growing best on sandy-clay soils containing some organic matter. It prefers a mean annual precipitation of 2300 mm and a mean annual temperature of 28°C. Apiranga is most commonly found at altitudes between sea level and 100 m, attaining 300-500 m in Rondonia state.

The apiranga is native to Amazonia and is dispersed throughout the region. Its principal areas of concentration are along the lower and middle Tapajós River, especially in the vicinity of Santarém, Pará, and Maués, Amazonas.

Related species: among the many species of the genus Mouriri found in South America, about 7 have edible fruits, but only two species have sufficiently good quality fruits to deserve attention. They are M. pusa Gard. Puça, or Mandapuçá, found from the south of Pará to Bahia and M. guianensis Aubl. Gurguri, with a wide distribution which includes most of South America, south to Rio de Janeiro.

### 3.0 DESCRIPTION

A tree to 11 m high, sometimes bushy; trunk slender, up to 11 cm in diameter; young branches lightly grooved, the crown relatively sparse. Leaves opposite, simple; stipules absent; petiole 1-4 mm long; blade elliptic to ovate-elliptic, 7.6-19.5 cm long, 3-7.2 cm wide, apex shortly acuminate to acute, base cuneate to nearly rounded, often abruptly attenuate nearly to the base of the petiole, glabrous, lateral veins obscure above and below. Inflorescence axillary or at leafless nodes, 1-7 flowered fascicles; flowers bisexual, 5-merous; pedicels minutely pubescent or glabrous, up to 6 mm long, bracts triangular, 0.8-2 mm long. Calyx, including inferior ovary, green, bell-shaped, 3-4.5 mm long, shallowly triangularly lobed; petals fugacious, rosy red or sometimes whitish, broadly ovate to subcircular, 4.2-6.5 mm long, 4-6.5 mm wide, shortly clawed; stamens 10, dimorphic, filaments 4-7 mm long, anthers 1.6-2.5 mm long, dehiscing by apical spores; ovary 3-4 locular, ovules 3 per loculus, style 10-14 mm long. Fruit a yellow to orange or vermillion globose berry, 1.5-2 cm in diameter, crowned by the remains of the calyx; mesocarp sweet, edible; seeds 1-3, medium to dark-brown, ellipsoid, 9.5-12 mm long, 6.5-8.7 mm wide, 5.5-7.5 mm thick.

Flowering and fruiting takes place 2 to 3 times a year at different times on different trees so that fruit is available from September to June; the fruit takes 3 months to develop.

### 4.0 MAIN USES

The only edible part of the fruit is the juicy mesocarp. The flavour is sweet and more agreeable than the fruits of any other species of the genus. The fruit is consumed for the most part in its natural state but is also used to make a tasty juice.

### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Harvesting is done manually directly from the plant since the fruits are within arm's reach. No information is available on yields.

### 6.0 NUTRITIONAL VALUE

Approximately 70% of the fruit is mesocarp; of this 40-50% is water. No information is available on nutritional value.

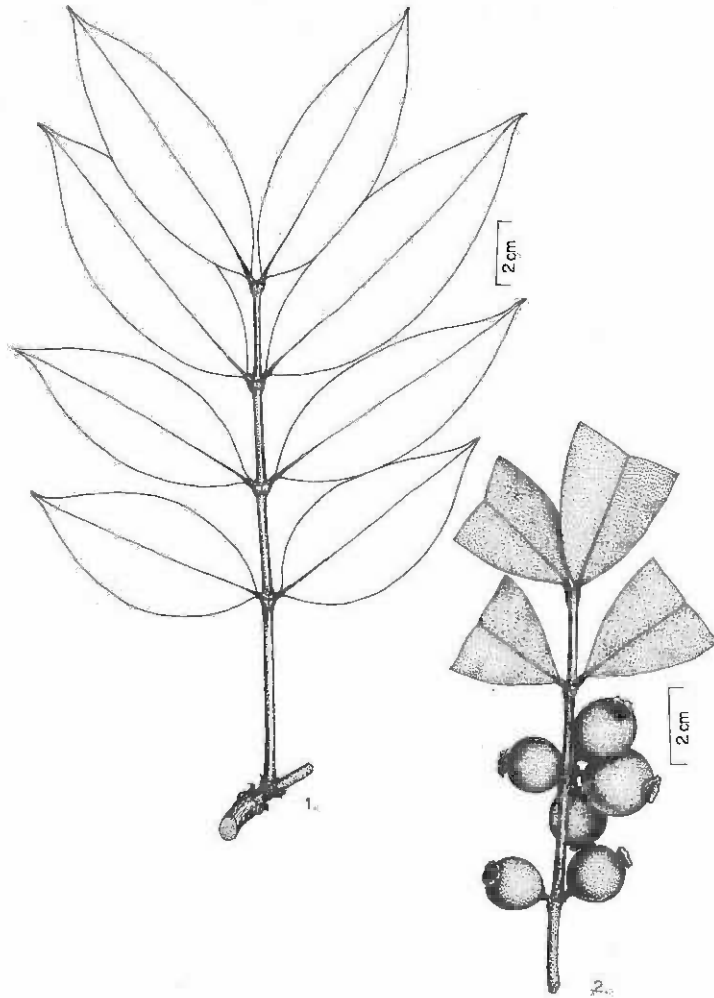
#### 7.0 CULTIVATION AND PROPAGATION METHODS

This species is only known in the wild or in spontaneous conditions, therefore, there is no information about its cultivation. Propagation is by seeds dispersed by frugivorous birds. All the species of the genus Mouriri have very hard wood and, consequently, slow growth. This is the only available information on the growth of apiranga.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

The handsome aspect and pleasant flavour of the fruits encourage agronomic studies of the apiranga to bring this wild fruit tree to the standards of those traditionally cultivated. The selection of good varieties and the introduction of modern cultivation techniques would be of value to local inhabitants who cannot acquire expensive imported fruits.

Plate XXXIX. Mouriri apiranga Spruce ex Triana



XXXIX  
1. Leaves  
2. Fruiting branch

50. MYRCIARIA DUBIA

- 1.0 NAMES: Family Myrtaceae  
Botanical Myrciaria dubia (Kunth) McVaugh  
Synonyms Psidium dubium Kunth  
Eugenia divaricata Benth.  
Myrciaria phylllyraeoides Berg  
Myrciaria divaricata (Benth.) Berg  
Myrciaria paraensis Berg  
Myrciaria caurensis Steyererm.  
Myrciaria spruceana Berg  
Vernacular caçari, camu-camu (Brazil); guayabo (Colombia);  
guayabato (Venezuela).

2.0 ECOLOGY AND DISTRIBUTION

Myrciaria dubia occurs naturally in the bushy, semi-open, low growth on the edge of rivers and lakes, where it is well adapted to the periodic flooding which may leave the roots and lower half to two thirds of the stem under water for up to 4 or 5 months. In some areas of Peru and along the Peru-Brazilian border it frequently forms extensive thickets on the river floodplain; the number of plants per hectare has not been recorded. It is only found in areas with more than 1500 mm annual rainfall and temperatures rarely below 20°C. It is known to occur on the rich clay loams of the Amazon river floodplain, as well as poorer sandy sites along black water rivers of the region. It also adapts well to the well-drained clay oxisols above the flood line and it would be reasonable to assume that it does not require good drainage. It has not been found naturally above 200-300 n.

The camu-camu seems to have originated in the western Amazon basin. It is widely distributed in the Amazon basin and upper Orinoco basin, in Peru, Colombia, Brazil and Venezuela. The species has only recently come to the attention of agronomists, so there has been little distribution by man.

Related species: the genus Myrciaria is best know for the jaboticaba (Myrciaria cauliflora Berg. and/or M. jaboticaba Berg.) from the south of Brazil. Some other species with edible fruit are: M. ibarrae Lundell.; M. trunciflora Berg.; M. baporeti Le Grand; M. floribunda Berg.; M. tenella Berg. and M. vismeifolia.

3.0 DESCRIPTION

Shrub or small tree to 8 m high; stems smooth, with thin, pale to bronzy-brown bark; much branched, with branches arising low down on the main stem; root system unknown. Leaves opposite, simple; stipules absent; petiole 3-6 mm long, c. 1 mm in diameter; blade gland-dotted, narrowly to broadly ovate or elliptic, 4.5-10 cm long, 1.5-4.5 cm wide, apex gradually to acutely acuminate, base rounded to sub-cuneate, margins entire, slightly glossy, dark green above, dull and paler below, midrib rather prominent with c. 20 pairs of obscure lateral nerves. Inflorescence axillary, axis 1-1.5 mm long and usually bearing 4 subsessile flowers in 2 opposite pairs; flowers regular, bisexual. Calyx lobes broadly rounded, 2.2 mm wide and almost as long, borne on a hypanthium which is circumscissile and deciduous after flowering; petals ovate, 3-4 mm long, ciliate; stamens c. 125, 7-10 mm long, with anthers 0.5-0.7 mm long; ovary inferior, style 10-11 mm long. Fruit reddish-brown to purple-black, globose berry 1-3 cm in diameter, with a circular, hypanthial scar at the apex; pulp fleshy, soft at maturity and enclosing 2-3 seeds.

Flowering July to September at Iquitos in Amazonian Peru; fruiting November to June.

#### 4.0 MAIN USES

The acid pulp of the fruit is edible. The flavour has been compared to lemon, but is also reminiscent of *Myrciaria cauliflora* Berg. The acidity is not pronounced that it dominates the flavour. There are reports of sweet varieties. Generally the fruits are mashed up with water and sugar to make a juice. In Iquitos (Peru) the juice is sold as a popular bottled carbonated drink. The juice is also exported to the USA for use in "organic" vitamin C tablets. It can also be used to make jelly or ice-cream.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The berries are picked when ripe and should be commercialized or processed within 3 to 4 days. Yields have been calculated at 10 tons/hectare, from a trial at 3 m square spacing given animal manure and NPK, in Iquitos.

#### 6.0 NUTRITIONAL VALUE

The camu-camu is an exceptional source of vitamin C, reputedly one of the richest known sources.

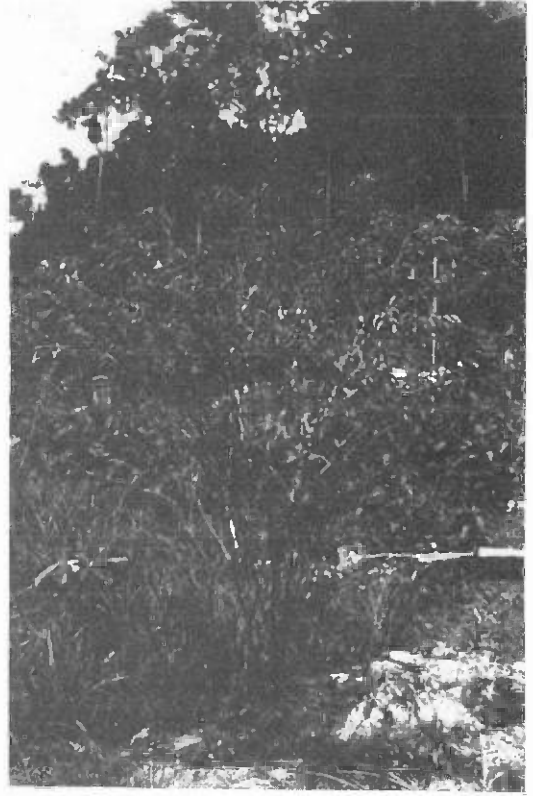
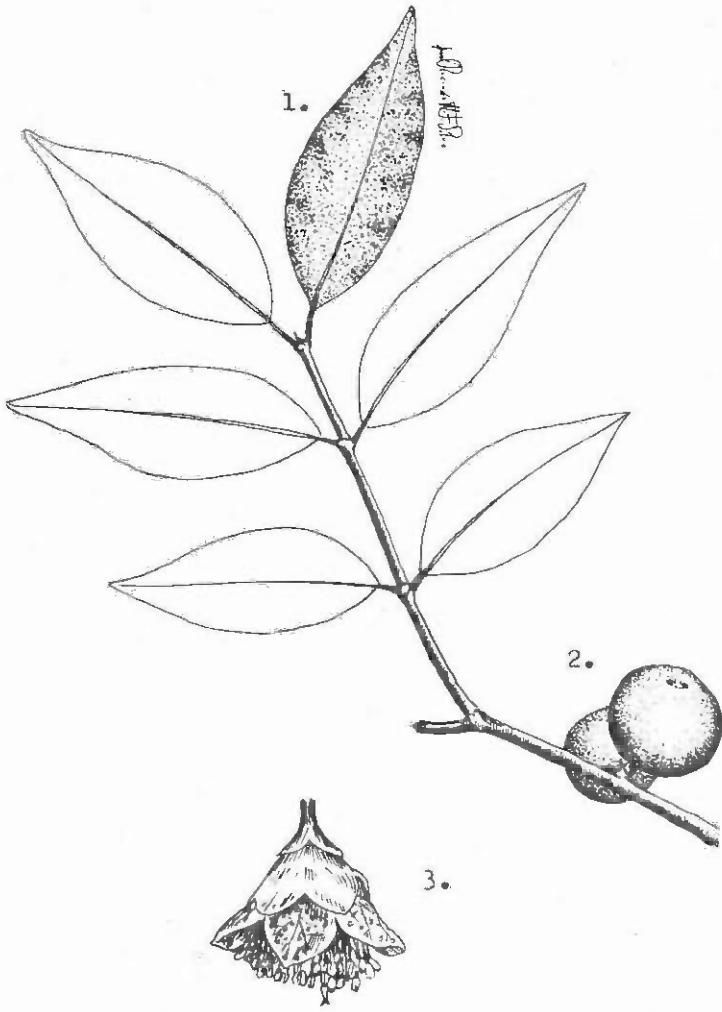
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Germination is rapid (14 to 21 days) if the seed is sown within 2 days after removal from the fruit. After 3 days the germination falls below 90% reaching 0% after 30 days out of the fruit in ambient conditions. Early growth is slow and the seedlings are not large enough to plant out (50 cm) until they have been a year in the nursery. When planted out on higher land, they rapidly extend one stem up to 1.5 to 2.5 m, probably as an adaptation to expected flooding. Later stages of growth include extensive branching near the soil and some branching above. Fruit production may start in the second or third year. Fertilizer appears to make little difference to the initial vegetative growth in Manaus (Brazil) although nitrogen has accelerated growth in Iquitos, Perú.

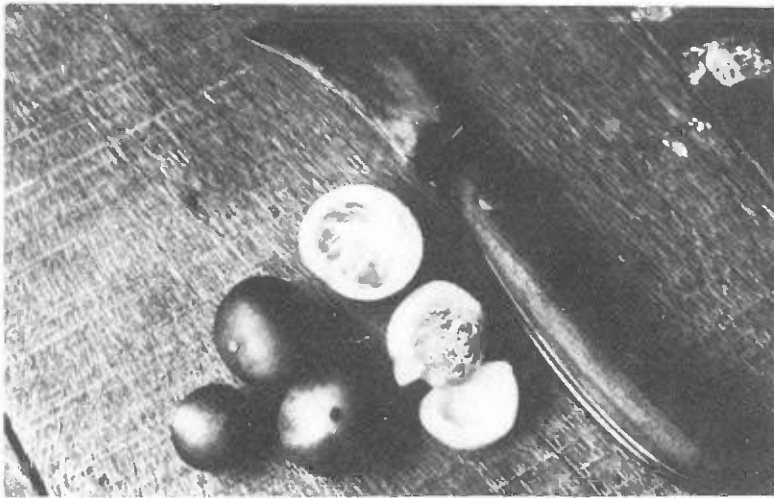
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

The high vitamin C of camu-camu gives it some potential as an exportable product for the "natural" or "health" food markets of the northern hemisphere. It would be a good option for cultivation by the small farmers who live along the banks of the major river systems of the tropics. The collection and selection of sweet and better flavoured varieties followed by agronomic studies and the development of attractive preserved products are now needed.

Plate L. *Myrciaria dubia* (Kunth) Mc Vaugh.



2



3

- L
- 1 - 1. Leaves
  - 2. Fruit
  - 3. Flower
- 2 - Tree
- 3 - Fruit. Section to show edible pulp.



51. OENOCARPUS BACABA

- 1.0 NAMES: Family Palmae  
Botanical Oenocarpus bacaba Martius  
Synonym Oenocarpus hoppii Burret  
Vernacular bacaba, bacaba-assu (Brazil); kuemboe, koemboe (Surinam);  
camon (French Guyana); ungurauy (Peru); manoco, milpe-sillo,  
milpesos, punama (Colombia).

2.0 ECOLOGY AND DISTRIBUTION

Oenocarpus bacaba is well adapted to high temperatures and poor, heavy clay oxisols of the Amazon region. It is found in regions with rainfall between 1500 and 3000 mm, fairly well distributed throughout the year. It can withstand 2-4 months dry season, but cannot tolerate waterlogging. Seedlings can tolerate deep shade, but grow better in higher light conditions. It seems to be fairly fire resistant, so becomes common in disturbed forest and newly made grassland. In undisturbed forest it grows at densities of a few trees and several hundred seedlings per hectare, but densities of 20-50 trees per hectare will develop in disturbed areas.

It is a very common palm in the central Amazon region, which may be its centre of origin. It is also found in western and southern Amazon, in the Orinoco basin and in the Guyanas.

Related species: 15 other Oenocarpus spp. many producing similar fruit are known, including O. distichus Mart., O. discolor Bar. Rodr., O. minor Mart., and O. multicaulis Spruce, O. caracasanus Mart.

3.0 DESCRIPTION

Moderate, single stemmed, unarmed, monoecious tree palm. Stem erect to 20 m, c. 30 cm in diameter, smooth, grey, ringed with leaf scars. Leaves reduplicate pinnate, 10-20 in the crown, 4-6.5 cm long, sheaths dark green, c. 1 m long, forming a well-defined crownshaft, the margins only sparsely fibrous; petiole 1-1.5 m long, deeply channelled; rachis 3.5-5.5 m long, bearing regularly arranged leaflets; leaflets c.100 on either side of the rachis. + pendulous, 30-100 cm long, 3-7.5 cm wide, dark green on the upper surface, paler and brown-hairy on the undersurface. Inflorescence infraloliar, shaped like a horse's tail, to 2 m long; peduncle short; first bract (prophyll) covering the inflorescence in bud, c. 2 m long, densely scaly; inner bract similar but slightly shorter both bracts soon falling; rachis c. 40 cm long, bearing c. 200 + pendulous, crowded rachillae; rachillae creamy-yellow at first, later reddish; flowers borne in 3's, a central female and 2 lateral males + throughout the rachilla length. Male flowers yellowish, + pointed, c. 6 mm long; stamens 6. Female flowers globose, c. 6-8 mm in diameter. Fruit globose, c. 1.3-2 cm in diameter, purplish black with a whitish bloom, produced in large quantities; epicarp very thin, smooth; mesocarp 1-1.5 mm thick, whitish, oily; endocarp fibrous, thin; endosperm homogeneous.

Trees usually flowering from June to August; fruit ripens 6-8 months later, however, out-of-season fruiting is not uncommon.

4.0 MAIN USES

The pulp of the fruit is used to make a drink and also occasionally an edible oil in remote regions. Good palm hearts can also be obtained. Fruit are left to soak in a little hot water for an hour or so to soften and loosen the pulp and skin which can then be smashed off with more water in a large wooden pestle and mortar. The brown chocolate colour emulsion is decanted off and filtered for drinking after mixing with sugar and sometimes thickening with manioc. One kilogram of fruit makes about a litre of emulsion. A little oil may be extracted in a similar way by adding the macerated pulp to boiling water. The oil rises and is poured off. The emulsion looks like chocolate milk and is rich, and only really appreciated with considerable familiarity. The oil is said to be similar to olive oil. The waste kernels and pulp left after making the drink are eaten

by pigs and chickens. Leaves are used for thatching and the hard wood for walking sticks and similar items.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Bunches are cut down by climbing the tree soon after the fruit turn from green to purple and black. Many fruit are lost when bunches crash to the ground unless their fall is broken. Tall trees are felled to get at the fruit. Fruit store for a few days only before rotting or drying out. One to 3 bunches a year is the normal production for wild trees, giving a total yield of less than 20 kg of fruit. More fertile trees may give 2 or more times this yield. However bunch weights vary enormously and as no phenological data are available, these yield estimates are bases on hearsay.

#### 6.0 NUTRITIONAL VALUE

Bunches typically weigh 2 to 8 kg although one of 19 kg has been seen and 35 kg has been reported. The peduncle is heavy and so fruit account for only 70% or less of bunch weight. Most fruit weigh 1.5 to 2 g although some may reach 4 g. Thirty five to 47% is fresh pulp (exocarp and mesocarp) of 54% dry matter containing 25 to 33% oil and 5% protein. There is usually about 5 to 8% oil in the whole fruit as the kernel contains less than 1% oil. However values as high as 12% have been reported. The extracted emulsion has about 7.5% solids representing about 5% of the fresh bunch weight. If large volumes are drunk, then it will provide a good source of fat, calories and protein. The bitterness and brown colour are due to tannins and their oxidation products.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds germinate after about 4 months and grow slowly. Fruiting starts when trees reach a height of 3 to 4 m in not less than 6 years. No pests and diseases have been noticed. Early growth should be shaded as small plants do not withstand the short dry season in Manaus when planted in the open. Drought or poor pollination may explain the poor fruit set sometimes seen. All fruit are collected from wild trees although they are often seen in private gardens because they have been deliberately left during the clearing of the land.

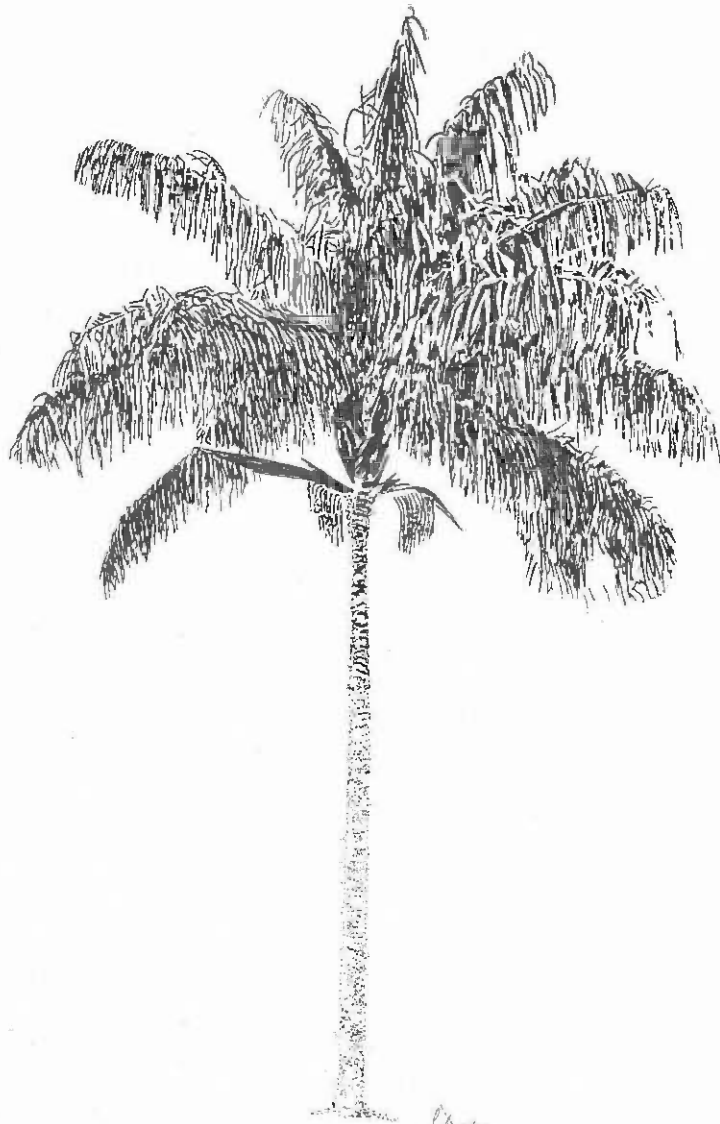
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

The fruit is rarely seen in markets but no bunches are wasted from wild trees growing close to dwellings. The drink is much appreciated and a useful addition to the diet of the region. An abundance of wild trees and slow growth inhibit cultivation of this palm in the Amazon and present oil yields are too low for commercial interest. However some trees of *O. distichus* Mart. are said to produce more oil than both *O. bacaba* Mart. and *Jessenia bataua* (Mart) Bur. in some areas. Considerable variations in composition exists and collectors should keep their eyes open for fruit with thick, oily mesocarps and trees with precocious production, fewer aborted bunches and high yields. *O. multicaulis* Spruce is said to fruit in 3 to 4 years and produces many more smaller bunches and hybridization with *J. bataua* has been reported to give fleshier sterile fruit. The faster growth, earlier production and adaptation to drier land may be other useful characteristic of *Oenocarpus* spp. for breeding programmes, should these ever become worthwhile in the future.

Plate LI. Oenocarpus bacaba Martius

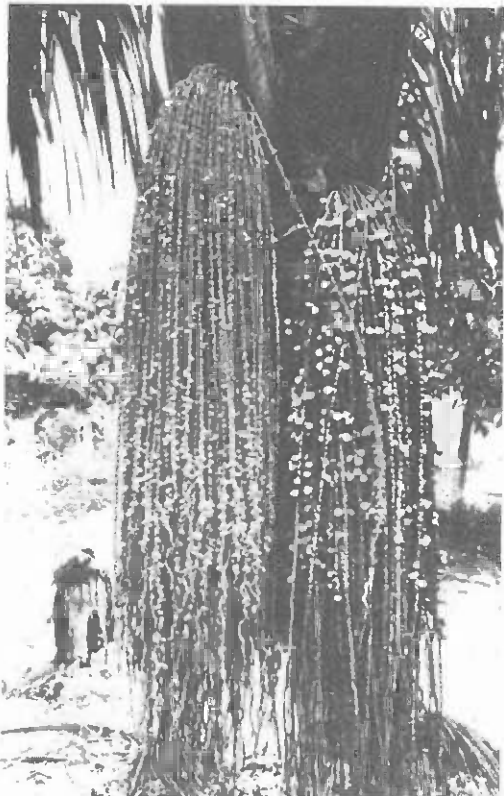


1



W. B. S.

2



3

- LI
- 1 - Young palm tree
  - 2 - Palm tree showing flowers and long bracts
  - 3 - Fruit on inflorescence. Inflorescence up to 2 m length.

52. ORBIGNYA BARBOSIANA

- 1.0 NAMES: Family Palmae  
Botanical Orbignya barbosiana Burret  
Synonyms Orbignya speciosa (Martius) Barb. Rodr.  
Orbignya martiana Barb. Rodr.  
(nomenclature much confused; genus in much need of a critical revision)  
Vernacular babassũ, babaçũ, uauaçũ, aguaçũ, багаçũ, guaguaçũ, coco de macaco, de palmeira e de rosario (Brazil).

2.0 ECOLOGY AND DISTRIBUTION

Orbignya barbosiana is a high light demander so only becomes dominant in disturbed, open areas. A few cycles of shifting cultivation may lead to pure stands. This is partly due to its considerable fire and drought resistance and its ability to grow in nutrient depleted savanna oxisols. Enormous groves now occur between savanna and forest and probably protect the forest and may even allow it to recolonize. Such areas receive between 1200 and 1800 mm of rain with 4-6 months dry season. This palm will tolerate only brief waterlogging. There are said to be 12-14 million hectares of babassũ groves in Brazil, 75% of them are in Maranhao. It may grow at densities of up to 1000 or more per hectare. The fruit is distributed by agoutis and is now found throughout the south-eastern edge of the Amazon basin. It also occurs in the Guyanas. Closely related species extend into drier areas. Several species are called babassũ and the taxonomy appears to be complex and not yet resolved.

Related species: O. oleifera Burret, O. huebneri Burret, Attalea speciosa Mart. (Syn. O. speciosa Mart.) are also known as Babassu O. microcarpa (Mart.) Burret, O. macrocarpa Barb. Rodr., O. cohune (Mart.) Dahlgren, O. eichleri Drude, O. phalerata Mart.

3.0 DESCRIPTION

Massive, single stemmed, unarmed, monoecious palm. Stem erect to 20 m tall, 25-50 cm in diameter, covered in persistent leaf bases and old inflorescences. Leaves reduplicate pinnate, c. 12-20 in the crown, erect but gently curving and twisting, 6-9 m long; petioles 1.5-2 m long; leaflets c. 150 or more on each side of the rachis, regularly arranged, 30-70 cm long, 3-4 cm wide, bright green. Inflorescences c. 4-8 produced each year, male, female or bisexual, in various ratios, 1.5-2 m long; peduncle c. 1 m long, first bract (prophyll) hidden among leaf sheaths; 2nd bract large, woody, deeply grooved, boat-shaped, with a long beak, the whole to c. 2 m long. Male inflorescence with several hundred rachillae covered in thousands of small cream-coloured flowers; male flowers with 12-24 stamens with curled and twirled anthers. Female inflorescence with short rachillae bearing female flowers, the rachilla tip bearing a few sterile male flowers, or in bisexual inflorescence, bearing fertile male flowers; female flowers c. 2 cm long. Fruit ellipsoidal, 5-15 cm long, 4-9 cm in diameter, brown, beaked, produced in abundance, c. 100-600 (usually 200); epicarp tough, covered in powdery brown scales; mesocarp comprising a fibrous outer layer and a dry, starchy inner layer 2-10 mm thick; endocarp very hard and stony, .5-1.5 mm thick, with 1-8 (usually 3-4) locules, each with an ellipsoidal but flattened seed, 2-5 x 1-2 cm; endosperm homogeneous. Large fruit tend to have more mesocarp and less kernel than the small ones.

Main fruiting season extends from August to January; fruit ripening occurs c. 12 months after fertilization.

4.0 MAIN USES

Kernels are sometimes chewed whole but in general are pounded for the cold extraction of a milk substitute or hot extraction of oil on boiling with water. The starchy mesocarp is also used as an emergency flour substitute in some regions. Kernels are difficult to remove from the hard endocarp shell. This is usually accomplished by cleaving the sun dried fruit on the edge of an upright axe by beating it with a heavy

wooden hammer. This species also produces an edible palm heart and it is said that the peduncle can be tapped to produce palm wine. Large edible Coleopteran larvae can be obtained from infected kernels. The oil is similar to copra oil but is usually much lower in acidity. It can be used as a cooking oil when fresh or after refining and also for the manufacture of margarine. Kernels are often a bit hard to eat whole. They are like very oily and fibrous coconut, and so are not attractive. The milk and mesocarp flour are mild in flavour and acceptable if well prepared.

The majority of the oil, is used to make soap because of its high content of lauric acid (45%). Kernels and waste after oil or milk extraction are sometimes used to fatten domestic animals. However most industrial meal is exported to Europe for making dairy concentrates. Nut waste may be used as fuel for cooking. Palm heart waste is often fed to horses. Nut harvests attract agoutis so that hunting is often good and groves are often a useful source of meat at this time.

Tree trunks are used for buildings and the leaves for thatch and sometimes for weaving into hats and baskets. Unfortunately, the reduviid or kissing bugs that transmit the grim trypanosome that causes Chagas disease have also moved from their natural habitat in the crevices behind the palm petioles to those in the house walls.

The low oil content has led to many suggestions for the industrialization of the whole nut. These generally include the use of the mesocarp as industrial starch or for producing glucose and alcohol.

The endosperm shell is said to make very high grade (low phosphorus and sulphur) charcoal suitable for making steel and will also give distillation byproducts like tar, acetic acid, methane, etc.. Process energy can come from the burning of the fibrous exocarp. Processing equipment has been developed and pilot plants have operated for some time. However the cost and transport problems involved in supplying a large factory with nuts of low value, and the risk capital needed have held investors back from what is claimed to be a viable process. In fact the problem of obtaining kernels at an attractive price has led to the failure of a number of oil extraction plants. The crop's potential as a source of biomass energy has also led to proposals to dry distil the whole or part of the nut for fuel oil or methane.

## 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Fruit start to fall to the ground when ripe and are usually collected off the floor after drying for a few weeks. They may also be dislodged from bunches with sticks or the whole bunch may be cut down. Fine silicate crystals falling off the fruit are said to irritate the eyes and may cause permanent blindness in collectors. Bunches and nuts are carried short distances to homes or to central points for the extraction of kernels. It is quite common for women to extract kernels from nuts gathered within a hundred metres or so by their children, moving to a new area from time to time. About 5 to 15 kg of kernels are harvested each day and sold at very low price, which is often halved with the landowner. About 230,000 t of kernels are processed in Brazil each year (mainly from soap) and something like a million people depend at least partly on their collection to eke out their miserably poor livelihoods. Whole kernels seem to keep well for a few weeks or even months without rancidifying badly. Yields of 1.5 to 2.5 t/ha are quoted for wild groves. However these are considered to be low because of the high density of trees and poor pollination. Thinning to about 100 trees per hectare is said to give yields of 7 to 30 tons with about a 16 t/ha average. Much higher yields have been predicted for well managed and fertilized plantations of selected trees. Palms usually produce 2 to 4 bunches each, with an average of 200 nuts weighing 25 kg. However trees with 7 bunches, bunches with 600 nuts and of up to 90 kg, and tree yields of almost a ton have all been reported, so there is considerable potential for selecting for high yields.

## 6.0 NUTRITIONAL VALUE

Fruit account for about 70% of bunch weight and vary tremendously in size and composition. They may be 40 to 490 g (mean of 110 g), have 75% dry matter and consist of 11 to 15% epicarp, 14 to 25% mesocarp, 50 to 67% endocarp shell and 0.5 to 17% (mean 6%) kernel. The kernel contains 1.2% water, 66.1% oil, 7.2% protein, 6% fibre, 2% ash and 14.5% N free extract. Thus although on average only about 4% of the total fruit weight is oil, some nuts have up to 11%. The mesocarp contains 14% water, 8% fibre, 2% protein, 4% ash and 2% N free extract including tannins. After extracting the oil an animal ration is left with about 20% protein and 17% fibre. The kernel and mesocarp are both good sources of calories and the milk and animal ration are also rich in protein.

## 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds have a very long viability within the nut if not attacked by Coleopteran larvae and may lie dormant for years. It is thought that fire or heat may be necessary to break the dormancy, however separated kernels germinate after a few months. They grow slowly producing a strong penetrating tap root while other roots and then a stem eventually arise. This may complicate nursery procedure and large bags must be used from the start. They are thought to fruit some 8 to 12 years later when about 8 m tall. All collection is from wild trees so available information is largely hearsay.

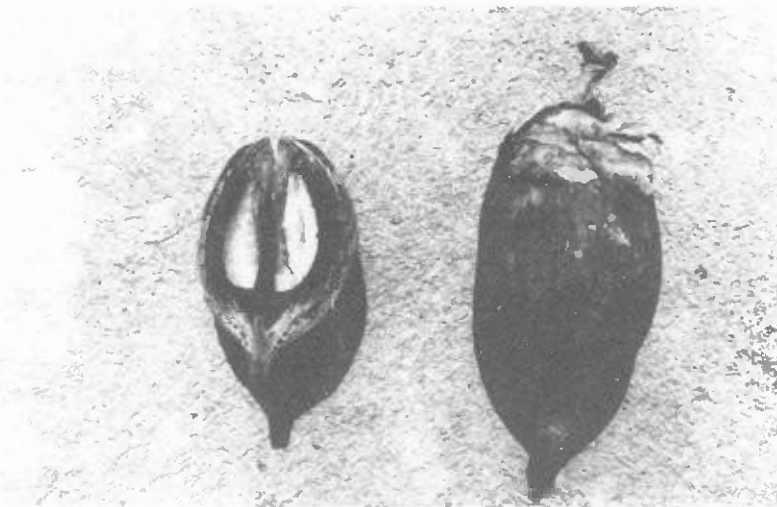
## 8.0 POTENTIAL ECONOMIC IMPORTANCE

The current collection and use of kernels from wild trees is a very important source of both income and food for about a million people. Future developments depend on income from collection compared to other activities and on world vegetable oil prices. As these prices are rising fast in relation to Brazilian salaries and employment, an increase in collection may occur in the short term. Larger and longer term exploitation of native groves depends on the viability of thinning to improve yields and of integrated whole nut processing. Higher yields per area would reduce the problems of transport and supply of low cost, low value nuts for factories. However problems of falling yields due to faster depletion of soil nutrients and the socio-economic impact on the major activity of a poverty stricken population both deserve careful attention. Agronomists have paid little attention to this species because of the presence of very large natural plantations, the very low oil content per bunch (< 5%), the low oil yields per area and the extremely slow growth. A search for precocity and high kernel content are the first priorities and then there may be a case for exploiting the ability of Orbignya spp. to grow on poor soils and degraded pastures in areas considered too dry for Elaeis guineensis, Bactris gasipaes or Astrocaryum aculeatum. The potential for tapping palms should be studied.

Plate LII. Orbignya barbosiana Burret



1



2

LII 1 - Palm tree with fruit  
2 - Fruit whole and in section

53. PACHIRA AQUATICA

- 1.0 NAMES: Family Bombacaceae  
Botanical Pachira aquatica Aubl.  
Synonyms Pachira grandiflora Tuss.  
Pachira macrocarpa (Schlecht.) Walp.  
Bombax aquaticum (Aubl.) Schum.  
Pachira pustulifera Pittier  
Vernacular memorana (Brazil, Amazonia); mulungu (Brazil, northeast);  
paineira de Cuba (Brazil, Rio de Janeiro); Castanha das  
Guianas (Brazil); castaño (Venezuela); zapoton, zapotolongo  
(Colombia); wild cocoa (Guyana).

2.0 ECOLOGY AND DISTRIBUTION

Pachira aquatica occurs naturally on the sparsely vegetated, marshy clay borders of rivers, streams and lakes; it will also grow well on the sandy or sandy-clay soils of the terra firma. It tolerates a wide range of temperature and humidity variations present in the tropics. It is reasonably frequent, especially where the vegetation is sparse.

The centre of origin of the species is uncertain but its ecological requirements suggest the Amazon estuary. It is now widely distributed through the whole of northern South America and the Antilles, either through spontaneous dispersal or by man. It is planted as an ornamental tree in many states of Brazil, from the northeast to Rio de Janeiro.

Related species: Pachira insignis Schum. Found in western Amazonia, it also has edible fruit but is less frequent.

3.0 DESCRIPTION

Small tree to 10 (-23) m high; trunk 25-60 (-90) cm in diameter, short, sometimes bowed and tortuous, bark lightly fissured, thick, soft with strong characteristic smell; roots rather few, near the surface. Leaves alternate, pedately compound, clustered towards the ends of branches; stipules lanceolate, soon falling; petiole up to 24 cm long; leaflets 4-6 (-9), elliptic-lanceolate 5-28.5 cm long, 2.5-14.5 cm wide, apex acuminate to rounded, base cuneate, margins entire or undulating, strongly coriaceous, glabrous. Flowers solitary or 2-3, terminal, narrowly cylindrical in bud, large and showy, scented; pedicels 1.5-3 cm long. Calyx entire, tubular, greenish-brown, 15-20 mm long; petals 5, yellowish or greenish, ribbon shaped, to 30 cm long, margins strongly incurved at anthesis; stamens c. 180-260, fused below into a thick tube c. 8 cm long, the free filaments 8-15 cm long, whitish in lower half, crimson in upper, anthers 3-4 mm long, reddish, vermiform; ovary conical, 5 mm long, 5-locular, ovules numerous, style thick, basal half whitish, up to 25 cm long. Fruit a large, oblong-ellipsoid capsule 20-30 cm long, 10-12 cm in diameter, weighing 1000-1500 g, pericarp rather thick, spongy and fibrous, scabrous on outer surface, dark brown and grooved; seeds 10-25 per capsule, irregularly shaped, c. 3 cm in diameter, the radicle and cotyledons forming the bulk of the seed, the cotyledons whitish, thick and tightly plicate with the consistence of the potato tuber, Solanum tuberosum.

Flowering and fruiting throughout the year, with maximum cropping at the end of the dry season and beginning of the rains.

4.0 MAIN USES

The only edible part of P. aquatica is the seed. The seeds are white and after cooking taste of European chestnut (Castanea vesca). Although a very well known plant and used for arborization, few people utilize it as an alimentary plant. Le Cointe (1947), states that the "almonds" (seeds) roasted on charcoal are good to eat, especially when not yet ripe. A white inodorous fat of good quality for industrial uses may be extracted from the seeds with a yield of 58%. The well ripened seeds may be eaten



sliced and fried in oil or simply cooked with salt. The seeds that fall in water are eagerly sought out by fishes and turtles.

According to Le Cointe (1947), the trunk bark furnishes a good material for calking boats and making ropes, and provides a dark red dye used to stain sails, lines and fishing nets. The wood, white and soft, is good for paper manufacture, with a yield of 36% cellulose paste.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The mature fruits open, liberating the seeds. When dropped in water the seeds float, and it is easy to collect them. However, it is better to gather the fruits before full ripening, making use of a pruning-hook. There are no concrete data on yields but in practice yield is estimated at 50 to 80 fruits per tree/year.

#### 6.0 NUTRITIONAL VALUE

The seeds are oily and when dried (humidity 30%) consist of 10% peel and 90% almond (Pesce, 1941). No information is available on nutritional value.

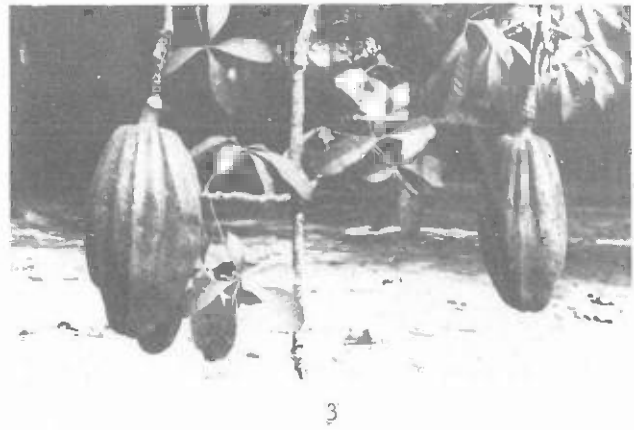
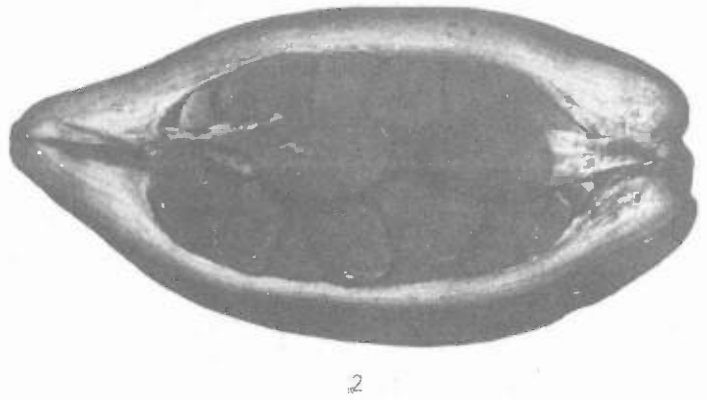
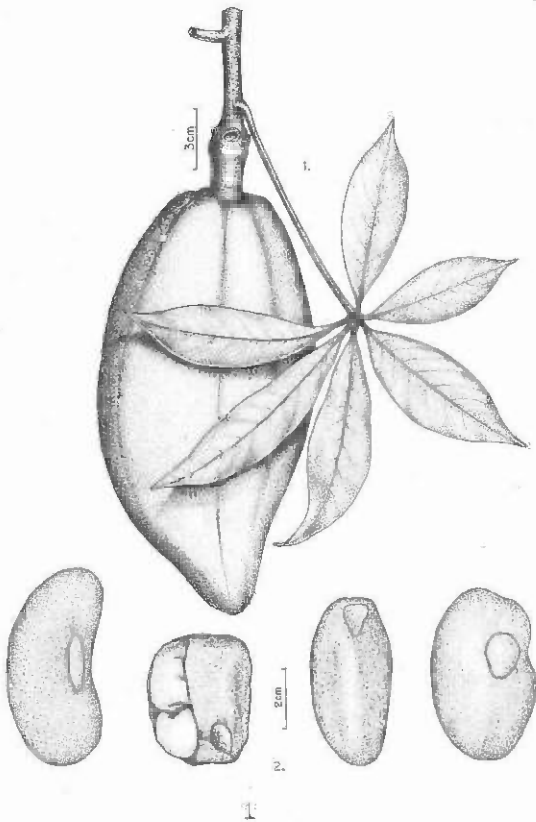
#### 7.0 CULTIVATION AND PROPAGATION METHODS

There are no studies on P. aquatica cultivation, but it is known that propagation is only by seeds with dispersal often by aquatic means. It is also known from a few experiments that germination takes about 6 to 8 days with very rapid growth in the beginning, such that seedlings may attain 60 cm in height within a fortnight after germination. The first flowering takes place in 4-5 years.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

P. aquatica is a species which is very common in the Amazonian region, and it has good alimentary possibilities. It is easily cultivated and has rapid growth, and early fruiting. Moreover, the palatable seeds supply a fat that can be utilized in the soap industry, and, properly refined, would be appropriate in cooking. These considerations justify research on its cultivation, improvement and propagation.

Plate LIII. Pachira aquatica Aubl.



- LIII
- 1 - 1. Fruit and leaf  
2. Seeds
  - 2 - Tree
  - 3 - Leaves and immature fruit
  - 4 - Mature fruit
  - 5 - Section of fruit and seeds.

54. PLATONIA ESCULENTA

- 1.0 NAMES: Family Guttiferae  
Botanical Platonia esculenta (Arruda da Camara) Rickett & Stafleu  
Synonym Platonia insignis Mart.  
Vernacular bacuri, bacury, bacurizeiro, bacuryseiro, bacuryuba,  
ibacopary, ibacury, pacoury grande, pacuru, ubacury (Brazil);  
bacury-guazú (Paraguay); pakooru (Guyana); pacouri (French  
Guyana).

2.0 ECOLOGY AND DISTRIBUTION

Platonia esculenta occurs in rather open transition forests, near areas of natural savanna, and in the states of eastern and southeastern Pará and southwestern Maranhão frequently occurs in almost pure stands of 30 to 100 trees/hectare known as "bacurizais", elsewhere the densities are in the order of 0.5-1.5 trees/hectare, extending as a non-emergent into the medium to high forest. It is always found on well-drained areas of terra firma. The bacuri does well on sandy to clay soils, frequently doing very well where other species have difficulty, thus indicating that it is not demanding of nutrient rich soils. It does not occur above 600 to 700 m. In this region the mean annual temperature is between 25 and 28°C, with rainfall that varies between 1500 and 2500 mm, generally with a pronounced dry season of 3 to 6 months.

The bacuri is probably indigenous to the eastern/southeastern Amazon basin, in about the same area as the centre of origin of Theobroma grandiflorum. In Brazil it occurs throughout Pará, parts of Maranhão, Piauí, Goiás and Mato Grosso states; it is rare in Amazonas, and then only in the extreme east and south. It also occurs in Para-Paraguay near Mato Grosso, as well as Guyana, Surinam and French Guyana.

Related species: the genus Platonia is generally considered to be monospecific. However a bacuri-preto (black bacuri) has been found on Marajá island with 6 seeds and thus may be a second species. There is also another species that may fit into Platonia or Rheedia which has not yet been adequately described.

3.0 DESCRIPTION

Often a very large evergreen or deciduous forest tree 15-25 m high; trunk straight, often over 1 m in diameter in 100 year old trees, bark thick, fissured, generally grey to grey-brown, becoming darker with age, exuding a copious yellow latex when cut; crown obconical, formed from branches which arise at an angle of 50-60° from the trunk; roots of mature trees forming an extensive, superficial, lateral system, it is not known whether the tap-root seen in seedlings persists at maturity. Leaves opposite, simple; stipules absent; petiole 1-2 cm long; blade ovate, 8-14 cm long, 4-8 cm wide, apex abruptly acute, symmetrical, base similar, margins often slightly undulate, glabrous, coriaceous, light to dark green with brilliant sheen on upper surface, lateral nerves numerous and closely parallel, blade exuding yellow latex when cut. Flowers solitary, bisexual, borne terminally on young branches at leaf-fall; pedicels c. 1 cm long. Sepals 5, suborbicular, 6-8 mm long, imbricate, the outer 2 smaller; petals 5, pale or mid-rose outside, white within, suborbicular, 3-4 cm long, contorted; stamens many, fused below into 5 bundles opposite the petals, anthers narrowly linear; ovary superior, 5-locular, ovules few, superimposed in each loculus, style slender, divided above into 5 subulate, spreading, stigmatic branches. Fruit ovoid to subglobose, 7-15 cm long, 5-15 cm in diameter, weighing 200 g to 1000 g. (mean weight 400-500 g), pale yellow turning brown, skin thick, 10-15 mm, tough and somewhat elastic and exuding a yellow latex when bruised; pulp white, mucilaginous, fibrous and in which 1-4 (-5) seeds are embedded. Seeds oblong-ovoid, angular, 4-6 cm long, 2-2.5 cm wide.

Flowering from the start of the dry season, June to September; fruiting December to May, with peak production in February to March. There is a pronounced leaf-fall, which may be complete, at the beginning of the dry season.

#### 4.0 MAIN USES

The pulp surrounding the seeds is the part consumed. The bacuri has a pleasant, though strong aroma and an agreeable, though strong, sweetish and slightly sour flavour. It is not always appreciated immediately when eaten fresh because of the strong flavour. It is rarely eaten fresh, except for the "filhotes". It is most often made into ice-cream and popsicles and the famous "marmellada (jam) de bacuri". Occasionally compotes, jams and jellies are produced. Less frequently the skin of the fruit is used to make a crystallized sweet.

The wood is a heavy (0.80 to 0.85 g/cm<sup>3</sup>), straight grained, easily worked timber with a rosy to clear beige colour, and takes a polish easily. It is used in civil and marine construction, general carpentry and for some kinds of furniture.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

In most trees the fruit will fall when ripe, so that harvesting consists of collecting from the ground. Because of the thick, durable skin the fruit do not bruise easily and can be transported over great distances. The pulp remains consumable for 5 to 10 days within the fruit. A vigorous adult tree (15 to 20 years old) will produce between 400 and 600 fruit/season. Some trees have been observed to produce 800 to 1000 fruit. At the recommended spacing of 115 trees/ha, one may expect about 22 tons/ha. However only about 10% of a normal 3-4 seeded fruit is useable pulp, so that pulp production is only about 2.2 tons/ha. There are also about 14 tons/ha of skin that is occasionally used and 5.7 tons/ha of seed. These last two may have potential as animal feed.

#### 6.0 NUTRITIONAL VALUE

About 10% of the fruit is edible pulp, which is 77% water. Because of its sweetness it must be a reasonable source of calories.

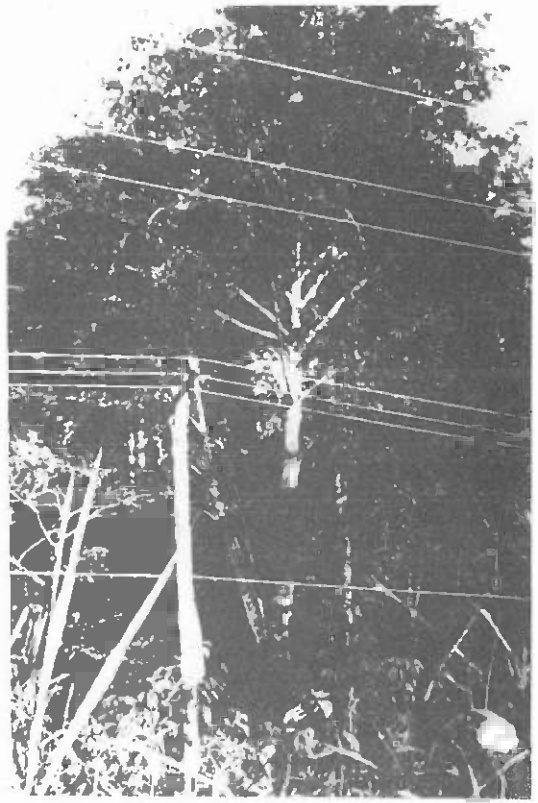
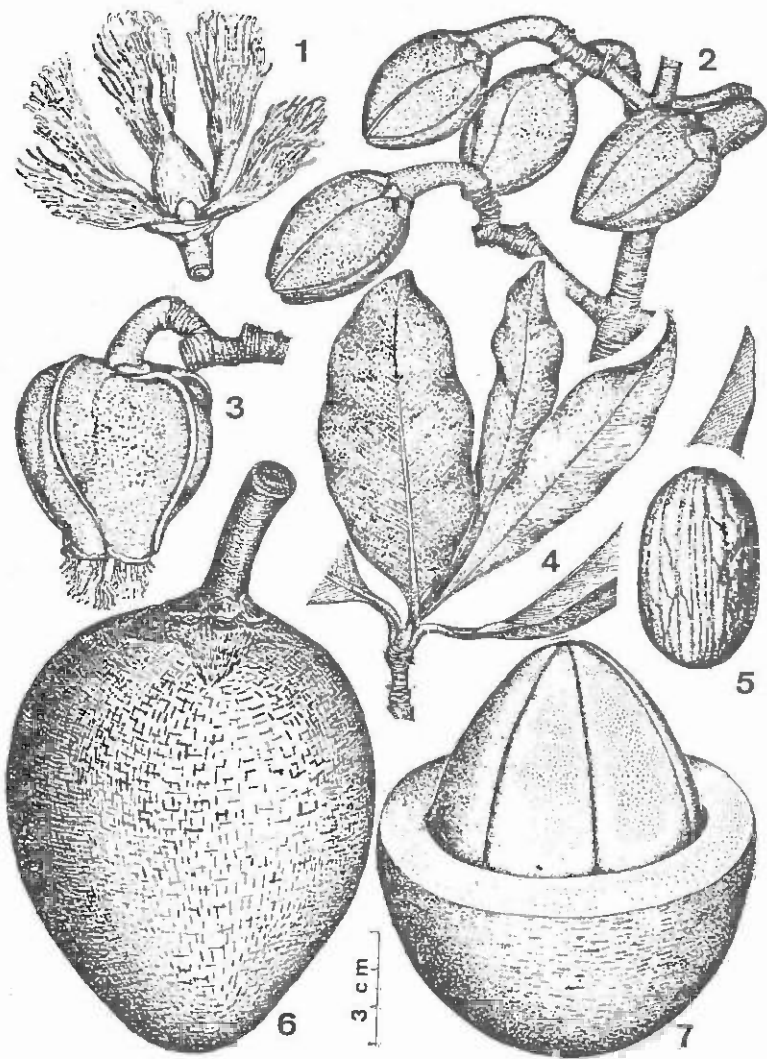
#### 7.0 CULTIVATION AND PROPAGATION METHODS

The seeds germinate easily when sown soon after removal from the fruit. Germination will start in 50 days and continue for another 50 days. Percentages vary from 40 to 80%. Seedlings are normally transplanted to 5 kg polyethylene bags for nursery development and are taken to the field when they attain 50 to 60 cm. Grafting (top cleft and side veneer) is reputed to give good take and is generally done in the nursery when the plants attain transplant size. Spacing should be equilateral triangular with 10 metres between plants, which will give 115 plants/hectare. Although the bacuri is very rustic it is advisable to plant with manure and bone meal and maintain a regular fertilization schedule with 10% ammonium sulphate; 50% simple superphosphate; and 40% potassium chlorate. Grafted plants may start production in 3 to 5 years, while seedlings will delay from 6 to 10 years.

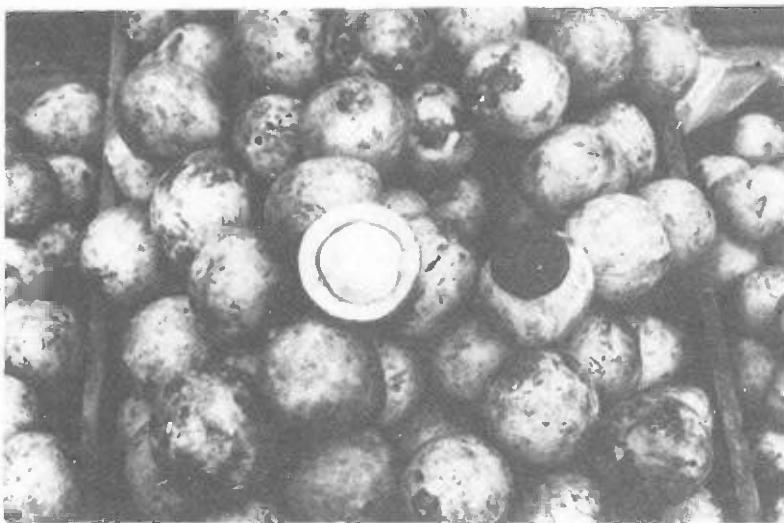
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

The bacuri is one of the most popular fruits of the Belém region. This suggests that the species should have a good economic potential if well marketed. Extensive germplasm collections should be carried out to find the best varieties. A seedless variety has already been found and propagated, and this surely deserves more study. More and better quality industrial products must be developed to insure good market acceptance. Because of its rusticity, ease of propagation and popularity this species would appear to have excellent potential.

Plate LIV *Platonia esculenta*. (Arruda da Camara) Rickett and Stafleu



2



3

- LIV
- 1 - 1. Flower without perianth
  - 2. Flower buds
  - 3. Flower
  - 4. Leaf branch
  - 5. Seed
  - 6. 7. Whole and sectioned fruit
- 2 - Tree along road, Height 20 m.
- 3 - Fruit on sale. One fruit parted to show mesocarp and seeds. "Vero o peso" Belem, Brazil

55. PORAQUEIBA SERICEA

1.0 NAMES: Family Icacinaceae  
Botanical Poraqueiba sericea Tulasne  
Synonym Poraqueiba acuminata Miers  
Vernacular umari, mari preto, mari, mary (Brazil).

2.0 ECOLOGY AND DISTRIBUTION

Poraqueiba sericea is well adapted to heavy and light clay oxisols that are of low fertility, preferably with a reasonably high water table but not waterlogged. It requires an annual rainfall of over 2000 mm with a short or no dry season and relatively high temperatures. It is extremely common around small-holdings and is often found growing spontaneously in secondary regrowth and abandoned settlements.

The species originated in the western or central Amazon region and is still confined to these areas of Brazil and Peru. It has been cultivated and spread by the Amerindians. A related member, P. paraensis Ducke is found in the eastern Amazon.

Related species: P. paraensis Ducke (may be a synonym), P. guianensis.

3.0 DESCRIPTION

Evergreen tree 8-12 m high; bark greyish-brown, smooth, c. 2 mm thick, greenish internally and with a characteristic smell when cut; crown dense, conical, 4-6 m in diameter, commencing 1-2 m above ground; tap root well developed in seedlings, mature trees with a superficial root system. Leaves alternate, simple; stipules absent; petiole stout, 0.5-3.5 cm long; blade elliptic-ovate, 10-35 cm long, 7-20 cm wide, apex rather abruptly long acuminate, base rounded to cuneate, margins entire, coriaceous, glabrous above, tomentellous to appressed-hairy below, at least when young, with 7-10 pairs of prominent veins. Inflorescence of terminal or axillary panicles 3-7 cm long; flowers bisexual, yellow, 1-2 mm in diameter, sessile, subtended by 3 bracts. Calyx 5-lobed, 2 mm long; petals 5, ovate-lanceolate, 3-4 mm long; stamens 5, 2.5-3.5 mm long; ovary superior, 2 mm long, 1-locular, ovules 2. Fruit an obovoid drupe 5-10 cm long, 4-6 cm in diameter, exocarp thin, delicate, smooth and shiny, yellow to orange or dark purple to blackish; mesocarp 2-5 mm thick, yellow with a greasy texture resembling cold butter; endocarp hard, woody and containing 1 large seed.

Flowering May to September; fruiting November to March with some trees flowering and fruiting at other times of the year.

4.0 MAIN USES

The greasy mesocarp is chewed off the endocarp with or without the epicarp. It is also eaten with cassava flour or cooked with rice. The flavour and smell are peculiar, very strong and sickly to the novice but delicious to people familiar with the fruit since childhood. The inedible seed dry matter contains 60% starch and 4.5% protein so may be useful for stock feed. It is said to be used for starching laundry in remote areas of eastern Peru. The wood is sometimes used for fuel.

5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Fruit must be gathered off the ground as they do not ripen well when picked from the tree. If not badly bruised they will keep for 3 or 4 days. Yields of 65 to 150 kg of fruit from unfertilized 4 year old, and 70 to 200 kg from 12-year-old trees, have been recorded. Fruits weigh about 70 g so these yields represent several thousand fruit.

6.0 NUTRITIONAL VALUE

The edible mesocarp varies considerably in thickness but usually accounts for about 20 to 30% of the fruit weight. It is 44% dry matter containing 40 to 50% oil, 3.5% protein, 17% fibre and 1% ash. Fresh mesocarp contains 3.9 mg of carotenoids/100 g so the fruit is a rich source of calories and vitamin A.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

Seeds germinate easily and young plants grow vigorously. Fruiting can occur at as early as 3 years when the tree is about 3 to 4 m tall. It is a hardy species that generally looks very healthy. Mild attacks of Anthracnose and woolly aphids have been seen.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Although the fruit is highly prized and common in local markets, the strange smell and flavour limit the creation of new markets. A plantation of 300 hectares has been seen near Iquitos to supply the local market there. The high oil content of the mesocarp together with the quick growth and high yields have resulted in the initiation of field experiments to examine the species as a source of vegetable oil. Germplasm with thicker mesocarp is urgently needed. The use of the large seed also requires research.

Plate LV. *Poraqueiba sericea* Tulasne



1



2

LV 1 - Young tree  
2 - Fruit



56. POUROUMA CECROPIIFOLIA

1.0 NAMES: Family Cecropiaceae  
Botanical Pourouma cecropiifolia Mart.  
Synonym Pourouma multifida Trécul.  
Vernacular Amazon grape, Amazon tree grape (English); uvilla, uva de monte (Peru); uvilla, uva de monte, uva caimarona, caimaron, caimurro (French Guyana), mapati, cucura, umbaüba de cheiro, umbaüba de vinho, amarten, imbaüba mansa, imbaüba de vinho, imbaüba rana, puruma, uva da mata, tararanga preta (Brazil).

2.0 ECOLOGY AND DISTRIBUTION

Pourouma cecropiifolia grows best on deep, fertile, loamy soils but will also do extremely well on relatively sandy to medium heavy, clay soils with low nutrient levels.

Good drainage is essential as 5 to 7 days of standing water will kill both juvenile and adult trees. The species does well in 2000 to 4000 mm rainfall; it is not known how well it will grow and produce with less. However a drought of 45 days can kill 2-year-old trees. The tree grape produces well at an altitude of 500 m; there is no information available about the effect of higher altitudes. Throughout its known occurrence the mean annual temperature is c. 26°C. There is one report from Florida, USA of the species being killed by frost.

There is general agreement that the centre of origin of the species is in the extreme west of the Amazon basin, perhaps in the foothills of the Andes in Peru, Ecuador and Colombia. However, there is some discussion as to whether the species may be a cultigen developed by the Indians, as is the case with Ananas comosus and Bactris gasipaes. Despite its popularity the species has not been widely dispersed since pre-colombian times, perhaps due to the short viability of the seed, although in recent years it has been more widely dispersed through the American humid tropics as a result of air transport.

Today it occurs in much of the Peruvian, Ecuadorian and Colombian Amazon as well as the extreme western part of the Brazilian Amazon. Irrespective as to whether the species is wild or a cultigen, there is no published information on its abundance.

Related species: Pourouma phaetricha Mildbr.; P. substrigosa Mildbr.; P. palmata Poepp. & Endl.; P. folleata Macbr.; P. Jussieuana Trécul.; P. guianensis Aubl.; P. mollis Trec.; P. acuminata Mart. and P. sapida Karst. are all reputed to have edible fruits. Some authorities affirm that all species in the genus have edible fruit.

3.0 DESCRIPTION

A small to medium size, dioecious, evergreen tree, 5-12 m high; trunk light grey-brown, slightly roughened, with copious leaf and stipule scars; of ornamental aspect, with an umbrella-shaped crown when growing in the open. Leaves alternate, simple; stipule large, large, solitary, up to 14 cm long, 4 cm wide, caducous, enclosing the leaf when in bud; petiole 10-30 cm long with a broad, clasping base extending about 1/3 of the distance around the stem; blade palmately lobed, often almost to the base, with 6-12 oblanceolate lobes 15-40 cm long, 10-20 cm wide, coriaceous, dark green, often slightly glossy above, pale green to greyish and densely felted below. Inflorescence a narrow erect, many-flowered, axillary panicle up to 10 cm long; flowers unisexual, the sexes borne on different plants. Male flowers with 4, free, dark brown, strap-shaped, hairy sepals, 3-4 mm long; stamens 4 or more, anthers basifixed on short filaments. Female flowers on panicles that soon deflex and increase in size as the fruit develops; perianth cup-shaped, up to 5 mm long, fleshy, shortly tomentose and closely investing the ovary and simulating the ovary wall; ovary 1-celled, narrowing to a short style with a terminal, obscurely lobed stigma. Fruit drupaceous, ovoid to spherical, 2-4 cm long, 1-4 cm in diameter, grape-like, with rough skin turning from green through violet to black when ripe; pulp juicy, gelatinous and sweet, slightly fibrous, surrounding a single, ovoid seed.

Flowering from March to June occasionally again from June to August, with a break in flowering of female plants of about a month when the second flowering period occurs; fruiting from September to February and also in March when a second flowering period takes place.

#### 4.0 MAIN USES

The juicy pulp is extremely popular and is the only part of the tree used. Most people who know both the common grape and the Amazon tree grape claim that the similarity in taste is very close. Commonly the fruit are eaten fresh by squeezing the pulp and seed from the skin directly into the mouth, later discarding the seed. Although the skin has good flavour it is generally not consumed because its surface roughness will irritate the lips and tongue. There is frequent mention of wine made from the fruit and in fact it ferments readily and has a pleasing flavour. Jams and jellies have been successfully produced.

No information is available on other uses, except that the wood is too light and weak for furniture or general construction. However it is a very nice ornamental with a thick umbrella-shaped crown suitable for shading.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit are harvested when ripe, or nearly so. Generally a long pole with a forked point is used to twist off the bunch stalk. Marketing must be immediate because the fruit do not store well, starting to ferment by the next day. The one published production figure shows a range of 13 to 45 kg/tree/season (Falcão & Lleras, 1980). This seems to be similar to, although somewhat lower, than unpublished work in the Manaus, Brazil region. At a spacing of 8 x 8 m (156 trees/hectare) this produces an upper estimate of 3,5 tons/hectare, assuming 50% male plants.

#### 6.0 NUTRITIONAL VALUE

100 g of fresh fruit contain between 82 and 92% water, 0.3 to 0.5% protein, 0.3% fat, 0.4% and 0.9% fibre, 6 to 16% carbohydrates of other types and 0.2% ash which may contain 10 to 34 mg of calcium, 4 to 10 mg of phosphorus and 0.2 to 0.6 mg of iron. There are traces of ascorbic acid, thiamin, riboflavin and niacin. The fruit may contain 64 calories/g. As may be observed the nutritional value of the Amazon tree grape is minimal, except as an energy source.

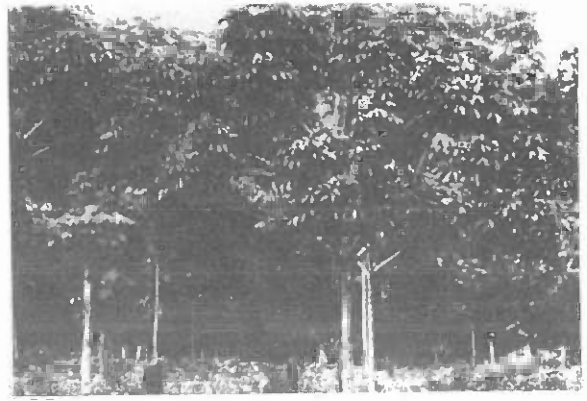
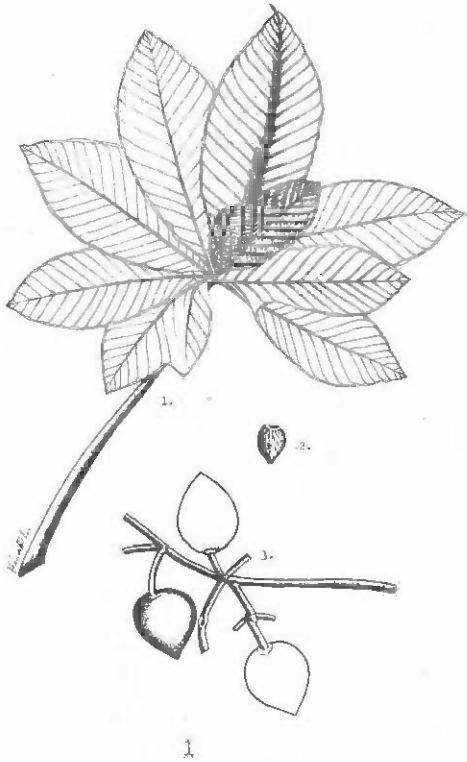
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Germination is very rapid (10 to 20 days if the seed are sown immediately after extraction from the fruit). However the seeds are of the type known as "recalcitrant" and lose their viability extremely rapidly. One afternoon in the sun will kill them and even protected in saw dust or charcoal powder they lose viability within days or a week at room temperature. Initial growth is rapid in a good substrate and they may be ready for field planting within 3 to 5 months. No information is available on vegetative propagation of this species. Growth is extremely rapid, cases have been found of 2.5 metres in the first year from seed. Branching will start between 1.5 and 3.5 metres, generally with a tight whorl of 4 to 6 followed by a space of a metre or two before the next group of branches. Fruit are only produced on the lateral branches. During the early juvenile stage the leaf cutter ant may be a problem, otherwise the species is surprisingly free of insect pests. A trunk borer has been observed near Leticia, Colombia. A root disease has killed some trees near Manaus, Brazil.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

The National Academy of Sciences (1975) recommends the testing of the Amazon tree grape because of its apparent potential. However little is known about the agronomy and genetic variability of the species. Research is thus necessary to select good quality high yielding varieties, determine the number of male plants needed to pollinate a hectare of female plants and to determine if it is possible to distinguish the sex of a tree by studying the seed, as natives in the region of Leticia, Colombia, claim. More study is also needed to determine the best methods for wine and preserve production.

Plate LVI. *Pourouma cecropiifolia* Mart.



2



3

- LVI
- 1 - 1. Leaf
  - 2. Seed
  - 3. Fruit branch
  - 2 - Trees
  - 3 - Flower and fruit branch

57. POUTERIA CAIMITO

- 1.0 NAMES: Family Sapotaceae  
Botanical Pouteria caimito (Ruiz & Pav.) Radlk.  
Synonyms Achras caimito Ruiz & Pav.  
Lucuma caimito Roem. & Schultes  
Labatia caimito Mart.  
Guapeba caimito (Roem. & Schultes) Pierre  
Vernacular egg fruit, abiu (English); abiu, abi. caimito (Brazil);  
caimito, caimo, cauje (Spanish); abiu (French).

2.0 ECOLOGY AND DISTRIBUTION

Pouteria caimito grows best in fertile, well drained soils but will grow reasonably well in nutrient poor, clay oxisols in the tropical rain forest receiving an annual rainfall in excess of 1500 mm and a mean annual temperature above 20°C. According to Castaneda (1961) it has been found at an altitude of 1900 m, but it is believed not to produce fruit at that altitude. Cavalcante (1976) claims that it is wild in Amazonia and in its wild state is often known by the common name "abiurana", a name which is also applied to other related species of Pouteria in the area. "Abiurana" is present in densities of up to 13 trees/ha and it seems reasonable to assume that abiu, P. caimito, may occur in densities of 1 to 3 trees/ha.

Although the abiu appears to be Amazonian in origin, there is no agreement among authors as to the region, although there is a general tendency towards the west of Amazonia. Fouque (1972) cites the forests of Peru to Brazil and Colombia; Prance & Silva (1975) suggest the Peruvian pre-andian region; Cavalcante (1976) records it as being found wild in all of Amazonia, while Castaneda (1961) claims that it is a cultigen, stating that it is only found cultivated and is found from Venezuela to Peru. In addition to the distribution stated above Tavares (1923) maintains that it is found throughout Brazil to as far south as the nearly temperate climes of Santa Catarina.

Related species: the genus Pouteria has many edible species, some of which are quite popular in their areas of occurrence: P. guianensis Aubl.; P. multiflora Eyma.; P. nitida Radlk.; P. arguacoensis Baehni; P. sellowii Engl. and P. suavis Hermsl. are just a few of these. Pouteria and related genera are poorly divided and disagreements as to name are extensive.

3.0 DESCRIPTION

Small to medium, evergreen, forest tree 9-10 m high; bark c. 2 mm thick, grey to brown, rough and cracking vertically with age, exuding a white latex when cut; crown narrow when young, becoming spreading at maturity, up to 20 m in diameter, branching very extensive and creating a dense crown, lower branches usually dying at maturity; roots spreading, superficial and penetrating the soil surface. Leaves alternate, simple, exuding a white latex when injured; stipules absent; petiole 5-15 mm long; blade obovoid to lanceolate, 11-15 cm long, 3-6 cm wide, apex acuminate, base cuneate, margins entire, slightly wavy, coriaceous, glabrous, mid- to dark green above, paler below. Flowers borne in clusters in the leaf axils and on the bare stem just below the leaves; unisexual or bisexual, usually both on the same plant; pedicels c.1 mm long or less. Sepals 4, ovate, 4-5 mm long, pale yellow to creamy white, with appressed hairs outside; corolla pale yellow or pink to creamy white, shortly 4-lobed, 6-7 mm long; stamens 4, alternating with 4 staminodes; ovary superior, 4-5-locular, each loculus with 1 ovule, hairy, style terminal, subulate with truncate stigma. Fruit an ovoid to spherical berry 4-12 cm in diameter, weighing 150-200 (-800) g; skin 2-5 mm thick, light green at first, turning yellow, mottled with green when ripe and, except in certain races, exuding a white latex when cut, even when ripe; pulp white to cream or yellowish, translucent and somewhat mucilaginous when ripe; seeds 1-5, oblong-ovate, smooth, black, with paler stripe along inner surface of testa.

Usually flowering several times a year but mainly from September to January in central Amazonia; fruiting mainly from February to May in the same region.

#### 4.0 MAIN USES

The mucilaginous pulp of the fruit is the part used. The flavour varies from insipid to an agreeable sweetness that is extremely popular. It is always eaten fresh, from the hand. No other information is available. The wood, of a rosy-brown colour, has medium durability ( $D = 0,89$ ), is easy to work and is especially useful for making handles for tools.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

When the fruit start to turn yellow they may be harvested and at this stage may be transported for several days. However fruit flavour is best when tree-ripened but this does not allow much transporting. Adult trees, in good production, may produce up to 500 fruit/year. At 7 x 7 m spacing (204 trees/ha) this gives a theoretical production of 102.000 fruit/ha, or about 15 t/ha.

#### 6.0 NUTRITIONAL VALUE

No information is available on composition. Given its obvious sweetness one may conclude that it is a good source of energy, while probably containing few vitamins.

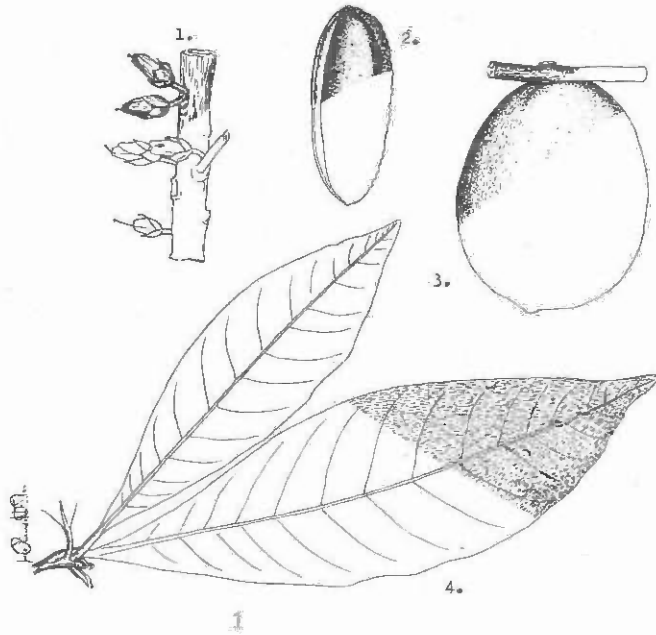
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Germination is rapid (15 to 45 days), if the seed are sown upon removal from the fruit, however, since these are "recalcitrant" they loose viability extremely rapidly. Immediate sowing gives 60 to 90% germination. Nursery growth is rapid in good substrate, the plants attaining size for field transplant within 3 to 5 months. Because the root system is sensitive polyethylene bags are recommended for seedling development in the nursery. Vegetative propagation is difficult because of the white latex, however some results are obtained using the side-veneer graft. Juvenile growth is rapid; as much as 1 metre per year, in the first 3 to 4 years, is common. Some of this species are extremely precocious (2 to 3 years) while others may take 6 to 8 years from seed. Fertilization with high levels of phosphorus and potassium has given reasonable results. Fruit flies (*Anastrepha* sp.) are considered to be the worst pest, sometimes affecting all fruit in a plantation. A trunk borer (*Cratasomus*) has been registered as causing damage, as have several leaf eating caterpillars (*Sibine* sp.). A small bee (*Trigona ruficus*) can damage the flowers to such an extent that production is reduced.

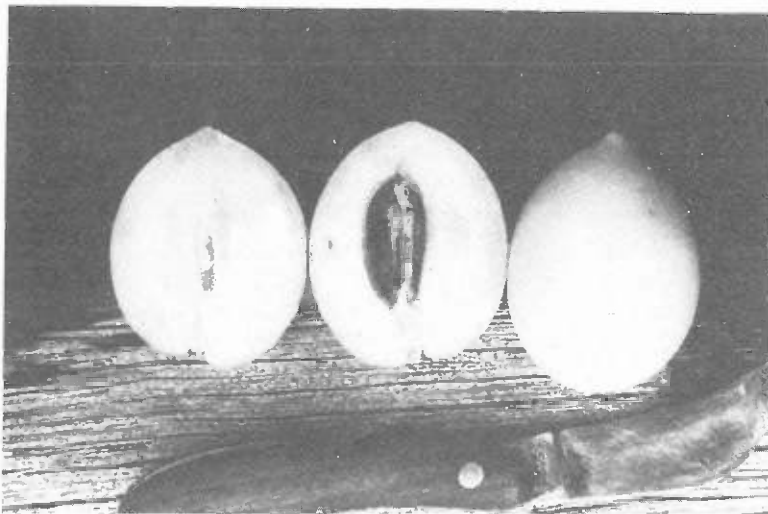
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Because the abiu is used exclusively as a fresh fruit and probably has a shelf life of less than a week, its potential appears limited to supplying local markets. There are areas in its distribution with extremely interesting germplasm and these should be extensively collected. Experiments in processing might produce saleable results. The immediate potential of the abiu appears limited, although it is very popular.

Plate LVII. *Pouteria caimito* (Ruiz & Pav.) Radlk.



2



3

- LVII
- 1 - 1. Flowering branch  
2. Seed  
3. Fruit  
4. Leaves
  - 2 - Tree in production.  
Six years old.  
Height 3 m.
  - 3 - Mature fruit. Section  
of fruit to show  
mesocarp and seed,  
Manaus, Brazil.

58. POUTERIA MACROCARPA

- 1.0 NAMES: Family Sapotaceae  
Botanical Pouteria macrocarpa (Huber) Baehni  
Synonyms Lacuma macrocarpa Huber  
Radkopherella macrocarpa (Huber) Aubrév.  
Vernacular cutite grande, cutitiribé grande (Brazil, Pará);  
nispero montanero, purguillo negro (Venezuela).

2.0 ECOLOGY AND DISTRIBUTION

Pouteria macrocarpa occurs on humid clay soils in the primary forests of the terra firme or in secondary vegetation, especially the 'capoeirão', i.e. high secondary growth tending towards forest. It grows under a wide range of Amazonian climatic conditions, generally at low altitudes.

The species is distributed throughout Amazonia, extending into Venezuela, although according to Huber (1902) it is believed to have originated in the coastal zone of Pará or Maranhão.

3.0 DESCRIPTION

Small tree up to 6-8 m high under cultivation or up to 30 m high in the wild; bark yellowish-brown, scaly, peeling in flakes, resembling that of Psidium guayava; crown thin. Leaves alternate, simple, clustered towards the branch tips; stipules absent; petiole 1.5-2 cm long; blade obovate-lanceolate, 7-25 cm long, 5-8 cm wide, apex shortly acute or obtuse, base decurrent-cuneate, margins entire, cartaceous or subcoriaceous, lateral veins 8-10 pairs. Flowers borne in clusters in the leaf axils or on the leafless portions of the branches. Sepals 6, broadly ovate, c. 6-7 mm long and wide; corolla greenish-white, 15 mm long, with 6 small, subcircular lobes; stamens 6, filaments subulate, staminodes 6, alternating with the stamens; ovary superior, flattened-globose, dark yellow, hispid, loculi 12, 1-ovulate, style thick, glabrous. Fruit a globose berry 8-10 cm in diameter, apex with an obtuse beak, base slightly concave, skin smooth, green at first becoming yellowish with a broken surface; pulp yellow, edible; seeds oblong-ovate, c. 3.5 cm long, apex mucronate, testa hard, glossy-brown.

Flowering March to August, fruiting September to December. Often some individuals anticipate this period by 1-2 months, others, start and finish the flowering periods later.

4.0 MAIN USES

The pulp of the fruit has a consistency ranging from that of cooked egg yolk to mealy and is consumed in the natural state. The flavour is considered somewhat insipid and many local people add sugar or molasses to improve the taste, as they do with many other regional fruits. The cutite grande is a little-known fruit tree, and its use is limited to exploitation of the fruits. Occasionally the wood is used for internal construction or on structures of short or medium duration.

5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit fall to the ground shortly before fully maturing. It is advisable to pick the fruits before they fall to avoid damage. Such care allows the fruits to be stored for up to 10 days. The individuals cultivated in the botanical garden of the Museu Goeldi, in Belém produce about 80-120 fruits per tree per harvest.

6.0 NUTRITIONAL VALUE

The average fruit contains about 70% pulp and 30% seeds. No information is available on its nutritional value.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

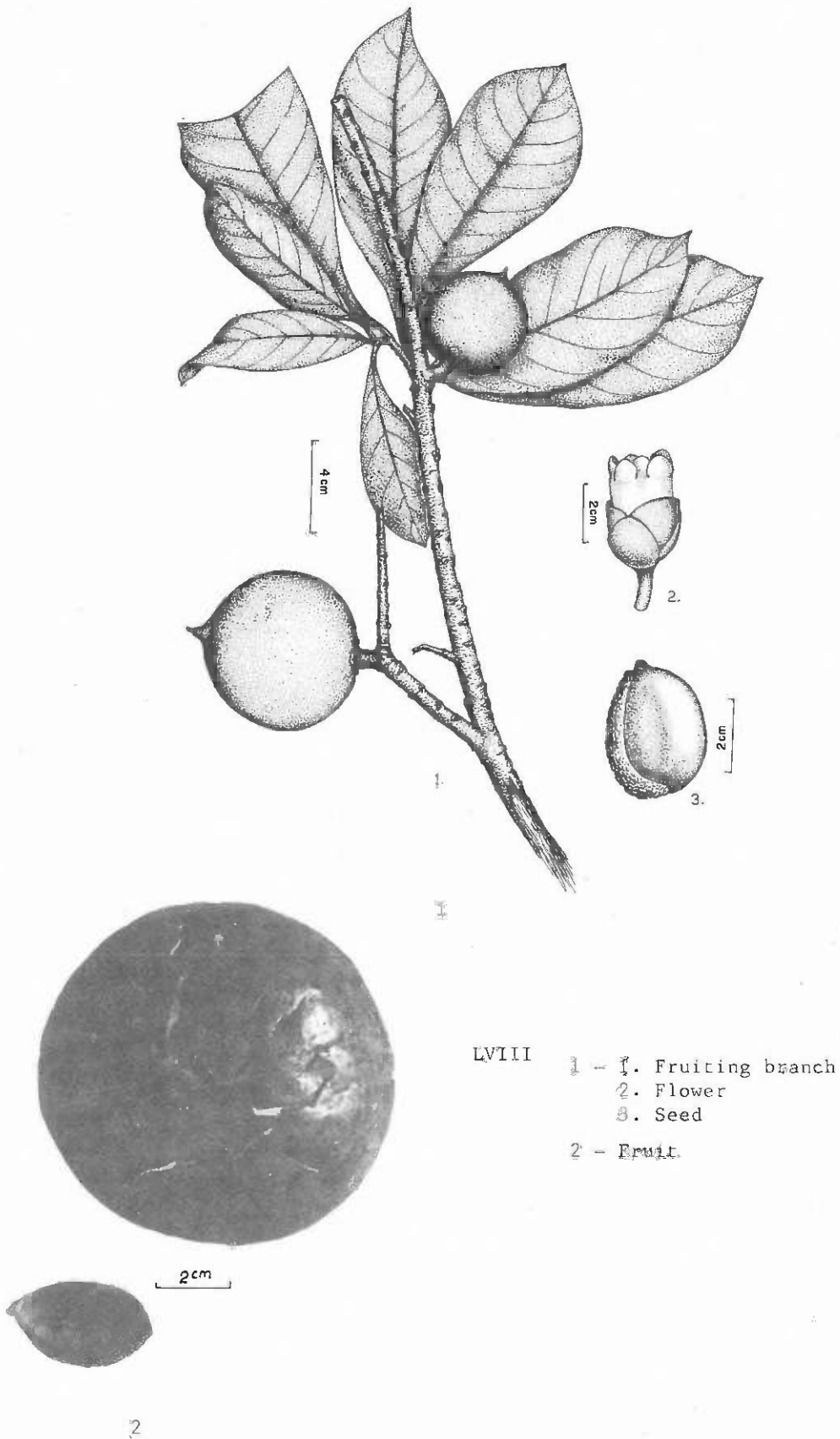
No precise data are available. The few specimens cultivated in home fruit groves are started from seeds, which is probably the only method of propagation of the species.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Cutite grande is a fruit tree with great potential as a food source even though the flavour of the fruit is not particularly attractive. The beauty form and volume of the fruit, as well as the quantity of exploitable pulp susceptible to improvement, undoubtedly make this species worthy of greater attention.



Plate LVIII. *Pouteria macrocarpa* (Huber) Baehni



LVIII  
1 - 1. Fruiting branch  
2. Flower  
3. Seed  
2 - Fruit.

59. POUTERIA MACROPHYLLA

- 1.0 NAMES: Family Sapotaceae  
Botanical Pouteria macrophylla (Lam.) Eyma  
Synonyms Chrysophyllum macrophyllum Lam.  
Lucuma rivicoa Gaertn.  
Vitellaria rivicoa (Gaertn.) Radlk.  
Richardella rivicoa (Gaertn.) Pierre  
Richardella macrophylla (Lam.) Aubrev.  
Vernacular canistel (English); jaune d'oeuf (French Guyana); caimo,  
canistel, siguapa, yema de huevo (Spanish); cutite,  
cutitiribá, tutiribá, uititiribá (Brazil).

2.0 ECOLOGY AND DISTRIBUTION

Pouteria macrophylla occurs on well-drained, nutrient poor oxisols and ultisols of the high forest, disturbed areas and transitional forest with an annual rainfall of between 1200 and 2800 mm and mean annual temperatures of about 26°C. It is widely dispersed in the forest, although there may be no more than 1 or 2 trees/ha.

The species appears to have originated in eastern Amazonia or northern South America and is found eastwards as far as Maranhão and parts of Ceará and southwestward to Mato Grosso. To the north it occurs in the three Guyanas, Venezuela, Colombia and through Central America to Guatemala. It is possible that the species has been introduced into Central America and possibly elsewhere.

Related species: the Richardella/pouteria/Lucuma complex is very confused taxonomically, so it is difficult to decide how many genera there really are and how many species in each. Many wild species of these genera are edible but are not as flavoured as the cutite.

3.0 DESCRIPTION

Small to medium forest tree up to 20-25 m; trunk straight, up to 50 cm in diameter, often with deep crevices near base; bark exuding abundant white latex when cut; crown dense, branches of juvenile trees sharply ascending, becoming more horizontal at maturity; mature trees with extensive superficial roots. Leaves alternate, simple; stipules absent; petiole 2.5-3.5 cm long; blade obovate-elliptic to oblanceolate, 10-18 cm long, 5-9 cm wide, up to 30 cm long, 10 cm wide on juvenile plants, apex rounded to acute, base cuneate to attenuate, margins entire, rather thin, papery, dark green, glabrous above, pale and often glaucous below, midrib and up to 15 pairs primary veins conspicuous, prominent below. Flowers borne in fascicles of 3-10 along the leaves or on the bare stems just below them; pedicels up to 1 cm long. Sepals 4-5, oblong-ovate, up to c. 7 mm long, densely hairy on outer surface with brownish, appressed hairs; corolla greenish, up to 10 mm long, broadly tubular with 4-6 lobes; stamens opposite the corolla lobes; ovary superior, globose, glabrous, 5-locular, each loculus with 1 ovule. Fruit an ovoid berry up to 6 cm in diameter, the seed long-ovoid with a dark brown, crustaceous testa embedded in a starchy, yellow, undifferentiated pulp.

Flowering June to October in eastern Amazonia; fruiting October to February.

4.0 MAIN USES

The starchy mesocarp is the part consumed. The cutite has a strong aroma that is not always immediately appreciated by those who do not know it. However the flavour is agreeable and generally sweet. The fruit is always eaten as a fresh fruit. It is most used by the poorer classes and peasants, as well as being widely consumed by children and domestic animals.

The wood of the cutite is frequently sawn for lumber, although it is of inferior quality.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit fall from the tree when ripe and must be collected from the ground quickly before wild animals arrive. As most production comes from the taller forest and the relatively soft fruit bruise or break easily, peasants will frequently pile leaves beneath the trees to avoid damage. Mature wild trees are known to fruit heavily, even to the point of breaking large branches. A case is reported of one large tree producing more than 5000 fruits, each weighing between 75 and 150 g.

#### 6.0 NUTRITIONAL VALUE

No information is available on its composition except the observation that there is about 70% H<sub>2</sub>O and the rest is largely starch. Because of the starch content the cutite must supply a reasonable amount of calories.

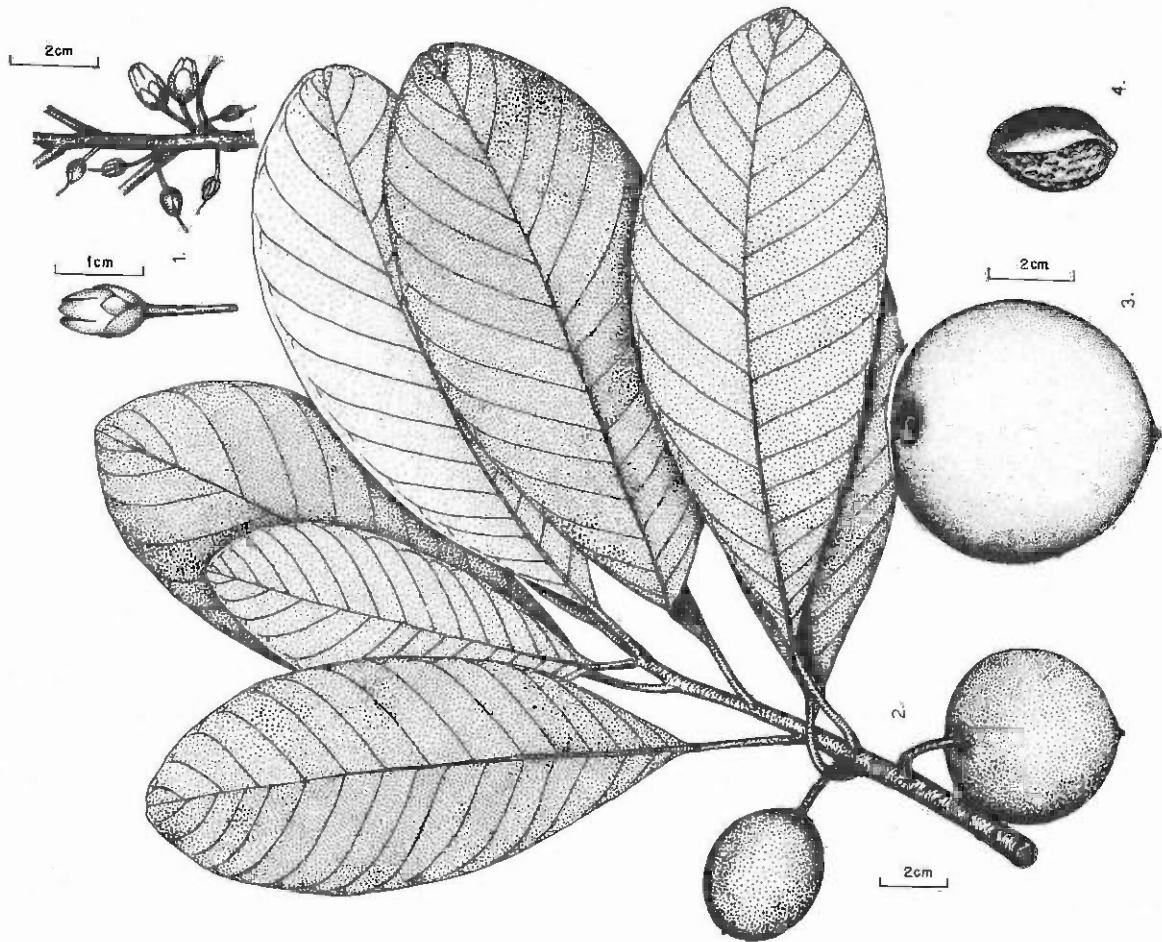
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Germination will start about 50 to 60 days after sowing fresh seed. In about one month the seedlings attain between 10 and 15 cm in height which suggests relatively slow propagation. No information is available about vegetative propagation. Although growth is slow the cutite is reputed to start producing in 7 to 10 years. No information is available about pests or special requirements.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

In some areas the cutite is very popular so that germplasm with good aroma and flavour exists. This must be collected and agricultural trials carried out to assess the potential of the tree. At the moment it would appear to be limited to supplying some local markets. High yielding trees planted rationally could give encouraging results.

Plate LIX. *Pouteria macrophylla* (Lam.) Eyma



- LIX
1. Flowers
  2. Fruiting branch
  3. Fruit
  4. Seed

60. POUTERIA PARIRY

- 1.0 NAMES: Family Sapotaceae  
Botanical Pouteria pariry (Ducke) Baehni  
Synonyms Lucuma pariry Ducke  
Eglerodendron pariry (Ducke) Aubrév. & Pell.  
Vernacular pariri, frutão (Brazil)

2.0 ECOLOGY AND DISTRIBUTION

Pouteria pariry occurs wild on the fertile clay soils of the primary forest but can also be cultivated on sandy clay soils in open situations. According to Le Cointe (1945) the annual precipitation of the lower Amazon where the pariri is most common is around 1592 mm with an average relative humidity of 76.25% and an average temperature of 27.2°C, with a maximum of 39.2°C in October and a minimum of 19.1°C in June. It is neither rare nor abundant in the wild. It is found under cultivation around riverine habitations of the lower Amazon (Monte Alegre, Santarém, and Obidos).

The pariri is considered to originate from the lower Amazon region, and is distributed along the southern tributaries of the Amazon from the Rio Tocantins in Pará to the Madeira river in Amazonas.

Related species: Pouteria acuqui is the most notable, and has already been treated in another chapter. P. dissepala Ducke, Abiurana grande, with edible fruits which are little utilized locally (Pará). P. parviflora, Muirapixi, with small sweet fruits.

3.0 DESCRIPTION

Large forest tree to 30 m high; trunk straight, columnar, bark dark grey, slightly scaly; root system not described. Leaves alternate, simple, clustered at the tips of the branches; stipules absent; petiole 3-5 cm long; blade oblanceolate to obovate, up to c. 25 cm long, c. 10 cm wide, apex acute to obtuse, base cuneate, margins entire, coriaceous, glabrous above, rusty appressed hairy below when young, becoming glabrous, lateral veins 10-14 pairs. Flowers clustered in the leaf axile, bisexual. Calyx 5-lobed, to 3 mm long, densely hairy; corolla greenish, 5-lobed, 3-4 mm long; stamens 5, alternating with 5 staminodes; ovary superior densely hairy, 5-locular, each loculus with 1 ovule. Fruit a large, depressed-globose berry to 10 cm in diameter, weighing up to 700 g, skin thin, green when ripe, pulp soft, fibrous and juicy, enclosing 2 narrowly ovoid seeds 4-5 cm long.

Leaves turning purple and shed in August and September as new leaves appear. Flowering season not constant, in one year flowering was observed from November to December and in the following year from March to April; fruiting occurs 5 months after flowering.

4.0 MAIN USES

The pulp of the fruit has a slightly acid taste and very pleasant odour. The fruit may be consumed in its natural state if sugar is added. It is most commonly used as a drink.

The tree also provides second quality lumber for a variety of uses, which can be obtained in large sizes.

5.0 METHOD OF COLLECTION OF THE EDIBLE PART

No direct harvesting from the tree is known; when the fruits mature they drop from the tree, ripe for eating. The mature fruits fall during a period of two to three months. The pariri normally fruits every year producing about 1200 to 1500 fruits per tree per year.

#### 6.0 NUTRITIONAL VALUE

About 65 to 70% of the fruit is represented by the pulp, with the seed and skin accounting for the rest. The pulp is 30 to 40% fibre and 60 to 70% liquid. No information is available on its nutritional value.

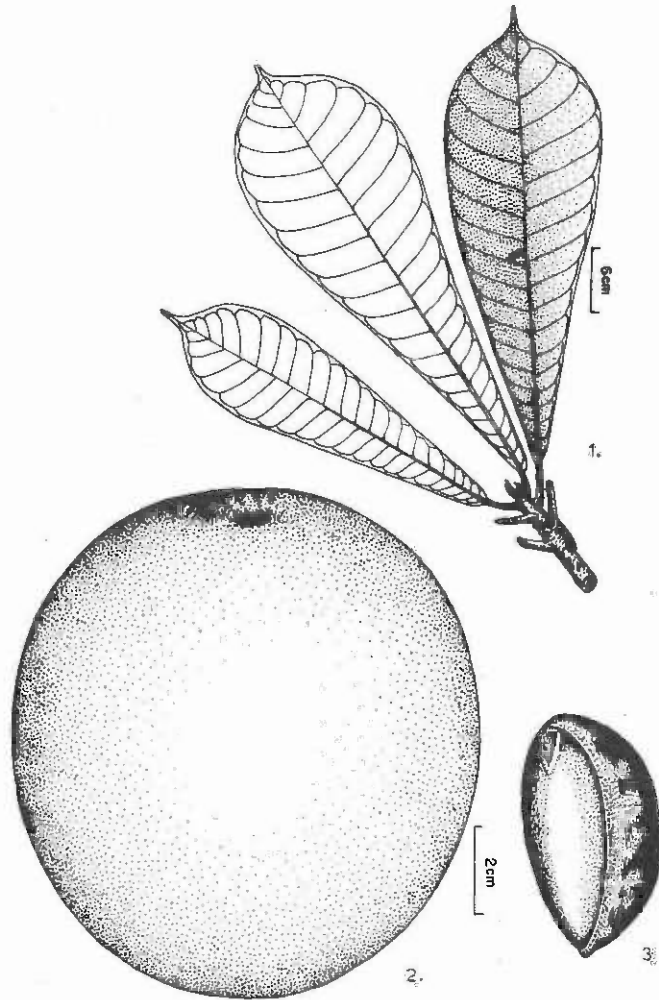
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Although nothing has been published, it is known that propagation is accomplished through seeds, which have a low rate of germination. Growth is slow, as evidenced by the growth of an individual planted as a seed in the Goeldi Museum Botanical Garden in 1960 and observed by one of the authors.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

It does not appear specially promising only because of the long period required to reach first fruiting. According to Ducke (1922), the cultivation of the pariri would be much more wide-spread, without question, were it not for the plant's reputation for fruiting only after 50 to 60 years of age.

Plate LX. *Pouteria pariry* (Ducke). Baehni



LX  
1. Leaves  
2. Fruit  
3. Seed

61. POUTERIA SPECIOSA

1.0 NAMES: Family Sapotaceae  
Botanical Pouteria speciosa (Ducke) Barhni  
Synonyms Lucuma speciosa Ducke  
Richardella speciosa (Ducke) Aubr.  
Vernacular pajurá-de-obodos (Brazil).

2.0 ECOLOGY AND DISTRIBUTION

Pouteria speciosa occurs on clay soils rich in organic matter on the high terra firma. According to Le Cointe (1945) the annual rainfall is c. 1592 mm and the mean annual temperature 27.2°C; altitude ranges from 100 to 500 m. According to Ducke (1922), the discoverer and author of this species, it is very frequent along the upper Paru river; densities are estimated at 5-6 trees/ha.

The species was first discovered on the little Rio Branco, northeast of Obidos, Pará, and later found along the upper Paru river, north of Obidos, which is probably the region where the species originated.

Related species: the most closely related species to P. speciosa is P. surumuensis, frequently found in the Roraima Territory, but the fruits are not so appreciated as the former.

3.0 DESCRIPTION

Evergreen forest tree to 25 m high; trunk straight, up to 60 cm in diameter, bark dark brown, thick and rough; crown elongated with drooping branches, the tips reaching 2 m from the ground; root system unspecialized. Leaves alternate, simple, clustered at the apices of the younger branches; stipules absent; petiole 1.5-2 cm long; blade oblong-obovate to oblanceolate, 15-35 cm long, 6-25 cm wide, apex rounded or acute to acuminate, base long-attenuate, margins entire, subcoriaceous, dark green, with prominent midrib above and below and 12-13 pairs of arcuate nerves, 1.5-2.5 cm apart, anastomising at the margin, prominent below, lower surface often with brown, caducous hairs when young. Flowers scented, borne in 3s in the leaf axils or leaf scars. Sepals 5, stiffly coriaceous, broadly ovate, outer 2-10 mm long, 3 internal 11-13 mm long, densely hairy with rusty, appressed hairs; petals 5, whitish, fused below to more than half way forming a barrel-shaped tube 1.5-2 cm long; stamens 5, opposite the petals and alternating with 5 subulate staminodes; ovary superior, with silky, appressed, reddish-brown hairs, 5-locular, each loculus with 1 ovule, style terminal, subulate. Fruit an ovoid or globose, 1-seeded berry up to 12 cm long, 8 cm in diameter, epidermis velvety, purple, tomentose; pulp thick and grainy, light yellow, sweet and with a flavour similar to "pajura" (Couepia bracteosa); seed up to 9 cm long, with a hard testa.

Flowering July to December; fruiting February to April.

4.0 MAIN USES

The only edible part is the mesocarp, which is considered the most tasty of the Sapotaceae of Pará. The mesocarp is commonly consumed in natura when completely ripe and can be used as a compote and to prepare a delicious liqueur. There is no information on other uses besides that the wood is utilized in rough structural works.

5.0 METHOD OF COLLECTION OF THE EDIBLE PART

There is no special method for harvesting; the ripe fruits fall on the ground and are gathered. In the wild fruit production is high, estimated at 500 to 600 fruits per tree/year. In single and isolated individuals fruit production is extremely low due to pollination problems; surely this species is allogamous.



#### 6.0 NUTRITIONAL VALUE

No information is available.

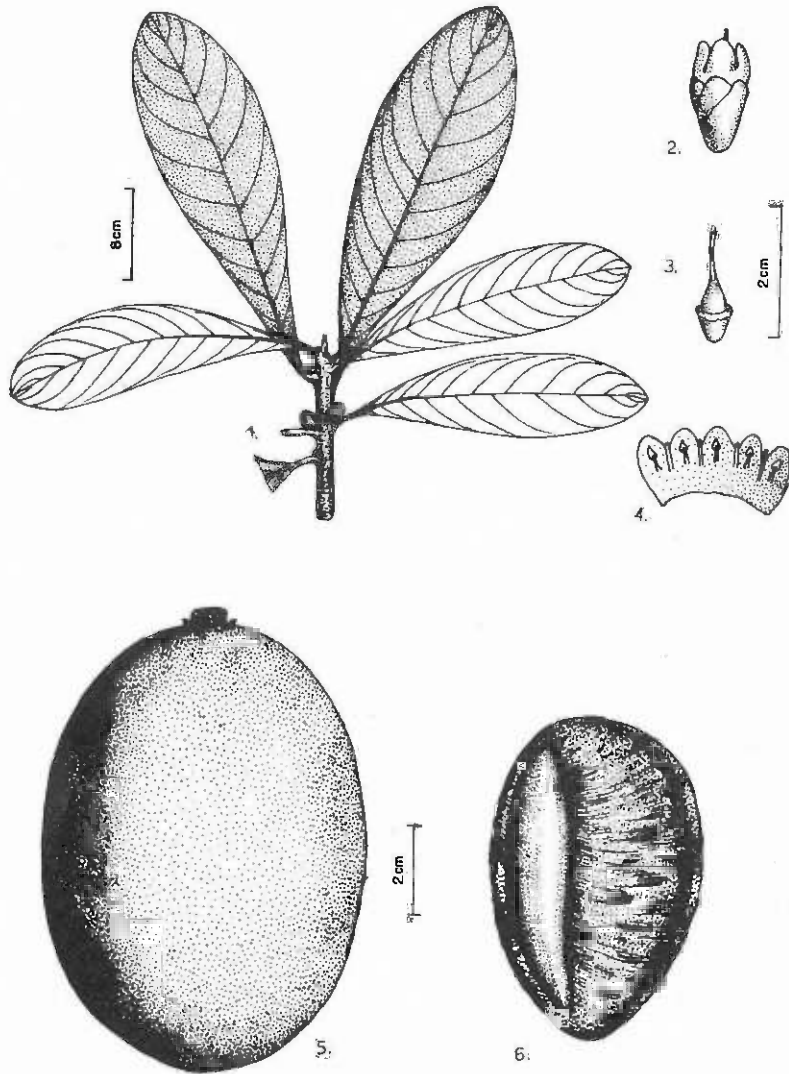
#### 7.0 CULTIVATION AND PROPAGATION METHODS

There is no information concerning the cultivation of this species. However, it is known that the propagation is by seeds. A single individual of P. speciosa was planted in the Museu Goeldi Garden in 1970. In the present year (1984) it is 7 m high, indicating a growth of 50 cm per year.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

P. speciosa is a little known fruit tree though it bears fruits of exceptional quality - sweet, tasty, with high pulp percentage. These attributes justify a research programme starting with its domestication. It is also important to know the pollenization agents and process and all details of its cultivation. This will take a long time but will be compensated by the high quality of the fruits.

Plate LXI. *Pouteria speciosa* (Ducke) Baehni.



- LXI
1. Leaves
  2. Flower
  3. Ovary
  4. Open corolla.
  5. Fruit
  6. Seed

## 62. POUTERIA UCUQUI

- 1.0 NAMES: Family Sapotaceae  
Botanical Pouteria ucuqui Pires & Schultes  
Synonym Peresodendron ucuqui (Pires & Schultes) Aubrev.  
Vernacular ucuqui (Amazonas); puch-poe-á, oo-lo-dá, ka he-pa coqui  
(Upper Rio Negro indians).

### 2.0 ECOLOGY AND DISTRIBUTION

Pouteria ucuqui occurs on well-drained sandy-clay soils of the high, virgin forests with a hot, humid climate. Climatic data from Uaupés, Brazil, the area where it is most abundant, the annual rainfall is 2823 mm with a mean annual temperature of 25.4°C; the altitude is 85 m (Serra 1967). The species is reported to be widespread throughout its entire range, especially common around habitations because the tree is usually spared when clearing land for habitation.

The species is native to the northwestern part of Amazonas state and is very common along all the tributaries of the upper Rio Negro, from Sta. Isabel (Tapuruquara), and also the basin of the upper Rio Japurá; it is also known from Colombia, along the rivers Guainia and Caquetá, as well as Venezuela, along the rivers Guainia and Cassiquiare.

Related species: the genus Pouteria (s. l.) encompasses a large number of species, but only a few produce fruits which are known to be edible, such as P. caimito (abiu), P. macrophylla (cutite), P. macrocarpa (cutite grande), P. pariry (frutao), P. speciosa (pajurá de Obidos).

### 3.0 DESCRIPTION

Large, evergreen forest tree up to 40 m high; trunk straight, columnar, 40-90 cm in diameter, bark thick, dark red, with blood red blaze and white, viscous latex; flat, buttress roots present, up to 2 m high, young branches with rusty, powdery indumentum. Leaves alternate, simple; stipules absent; petiole 3.5-5.5 cm long, covered with rusty, powdery indumentum; blade elliptic, 11-20 cm long, 5.5-10 cm wide, apex acute, base cuneate, margins entire, coriaceous, somewhat glossy above, glabrous, rusty brown below, midrib prominent below, with up to c. 12 pairs of prominent primary nerves, arcuate near the leaf margin; underside of young leaves covered with rusty, powdery indumentum. Flowers in dense clusters in the leaf axils, bisexual, covered with rusty, powdery indumentum. Sepals 5, rounded, c. 2 mm long; corolla 5-lobed, slightly longer than the sepals, c. 3 mm long; stamens 5.1 mm long; ovary 2-locular, surrounded by a hairy disc. Fruit a berry up to 12 cm long, epidermis yellow, thick, exuding a white latex when cut, enclosing a soft, whitish pulp; seed 1.7-9 cm long, with hard, glossy testa.

Flowering November to January; fruiting from April onwards.

### 4.0 MAIN USES

When completely mature the thick fleshy mesocarp of the fruit, which is very similar to avocado, is very pleasant; however, the fruit contains an extremely sticky, abundant latex when green. The pulp of the fruit can be consumed in natura or as a porrage which is prepared with "tapioca" or cassava meal over heat until it boils. This porrage is highly appreciated and has a reputation as a delicious and nutritive food.

In addition to the fruit, the only known products of the ucuqui are boards and large wood pieces for various construction uses, such as railroad ties, bridges, etc..

### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

When the fruits are ripe they fall to the ground where they are gathered. Sometimes strong winds cause the fruits to fall before they are completely mature; in this case some time must pass before they may be consumed. There are no data regarding fruit production, but it is known to be rather high, as evidenced by the observations of one of the authors during a visit to the upper Rio Negro during the fruiting season.

#### 6.0 NUTRITIONAL VALUE

The composition of the fruit is estimated at 40% seed and skin and 60% edible pulp. No information is available on its nutritional value.

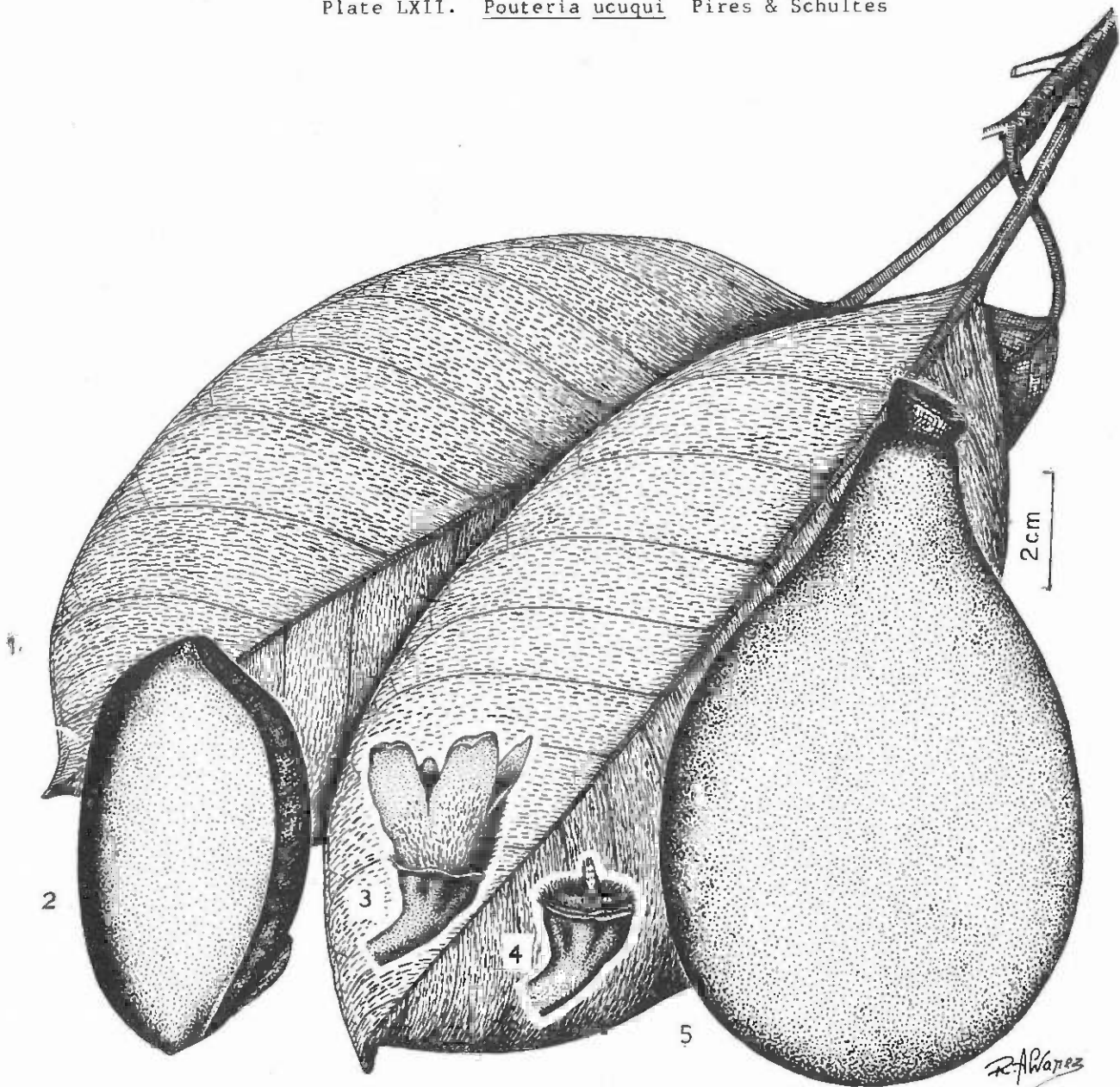
#### 7.0 CULTIVATION AND PROPAGATION METHODS

The ucuqui is a wild species which has not yet been cultivated, so there is no information on its behaviour outside natural conditions. Evidently propagation is by seed, as evidenced by the numerous seedlings found under parent trees after the fruiting season. All indications are that the growth of the tree is very slow, requiring around 25 years for the first fruiting under natural conditions.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

It can be inferred from the elevated number of husks and seeds found around habitations that human consumption of ucuqui is very high in the area where it is found. Therefore, a broader economic use of the plant requires only domestication and selection for precocious fruiting.

Plate LXII. *Pouteria ucuqui* Pires & Schultes



- LXII
1. Leaves
  2. Seed
  3. Flower
  4. Ovary
  5. Fruit

63. PSIDIUM ANGULATUM

- 1.0 NAMES: Family Myrtaceae  
Botanical Psidium angulatum DC.  
Synonyms Britoa acida Berg  
Britoa sellowiana Berg  
Psidium grandiflorum Ruiz & Pavon  
Vernacular araça-pera, araça do Pará, araça piranga, araçandiva,  
araçanduba, araçatinga, goyabarana, goiaba do Pará (Brazil);  
guayava del agua, aupi yacu, puca yacu (?) McVaugh (1958).

2.0 ECOLOGY AND DISTRIBUTION

Psidium angulatum occurs on poorly drained, nutrient poor oxisols but does best on well drained soils in the open, low forest to savanna transition forest areas of the Amazon and Orinoco Basin and parts of the Guyana Shield receiving 1500 mm to more than 3500 mm annual rainfall at altitudes below 300 m.

The araça-pera appears to be indigenous to the northern parts of South America and is found throughout the Amazon Basin in Brazil, Peru, Bolivia, Colombia, Venezuela, Surinam, Guyana and French Guyana as well as in the Orinoco Basin and parts of the Guyana Shield.

For related species see P. guajava L., P. araça Raddi.

3.0 DESCRIPTION

Large, evergreen shrub or small tree, 6-8 m high; bark greyish, red-brown, flaking, as in Psidium guajava; young branches 4-angled, with raised, almost wing-like ridges in the bark; root system unknown. Leaves simple, opposite; stipules absent; petiole 2-6 mm long; blade elliptic, 3-14 cm long, 2-6 cm wide, apex slightly acuminate, base rounded to attenuate, margins entire, smooth, often rather dark green above, dull green below, glabrous, conspicuously dotted with pellucid glands, veins impressed above, rather prominent below with up to 10 pairs of lateral nerves anastomosing between 1.5 to 3 mm from the margin and producing a characteristic pattern; young foliage with characteristic red flush. Inflorescence axillary, 1-3 flowered; flowers regular, bisexual, pedicels 2-4 cm long, 1 mm thick. Calyx splitting irregularly into 4-5 lobes, c. 7 mm long; petals 5, white, broadly obovate, 15-18 mm long; stamens numerous, over 300, up to 1 cm long, anthers 1-1.7 mm long, borne on slender filaments; ovary inferior, 3-locular, ovules numerous, style subulate, c. 0.5 mm across. Fruit a spherical or pear-shaped berry 3-10 cm in diameter, weighing up to 200 g. Two forms are known, the most frequent has a smooth, glandular skin, dark green at first, ripening to yellow, similar to P. guajava, the other form has a rough, light brown and rather tougher skin. Intermediate between these two forms have been recorded, and yellow-skinned plants can produce rough-skinned progeny, though this has not been studied in detail. Pulp acid, creamy white or yellowish, similar to P. guajava, 5-25 mm thick and enclosing numerous triangular seeds 7 mm long.

Flowering from August to October in Central Amazon; fruiting November to February with occasional fruits occurring at other times.

4.0 MAIN USES

The fruit is eaten. The acid to sub-acid pulp has a very agreeable and variable flavour, somewhat like that of P. araça. Many people consider it to be the best of the local Psidium sp. The araça-pera makes an excellent fruit juice. It has been used to make a delightful jelly and slices of pulp in a sweet sauce make an excellent dessert. In general it can be used in the same way as the P. guajava.

5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Harvesting is the same as in P. guajava. No precise information on yields is available. However large individual trees without special care may produce 50 kg of fruit in one harvest. At a 8m<sup>2</sup> spacing, this gives an estimate of 7.5 tons/hectare.

#### 6.0 NUTRITIONAL VALUE

No information is available but composition and nutritional value are very similar to guava.

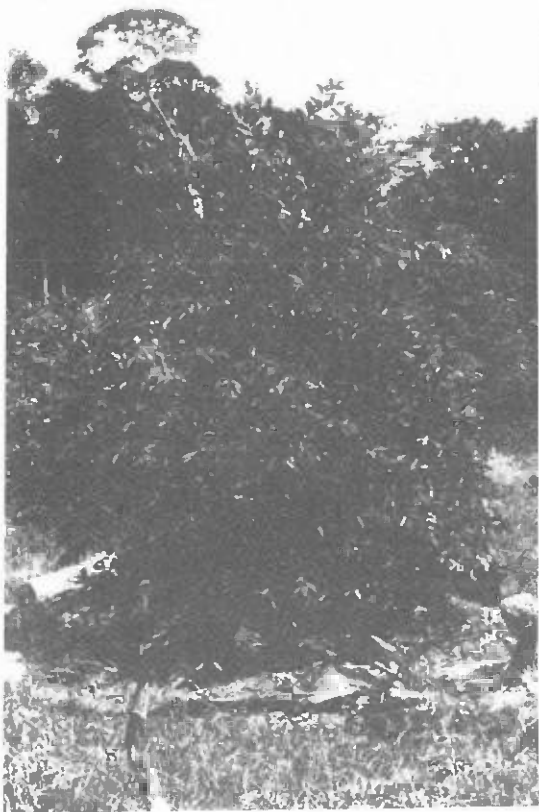
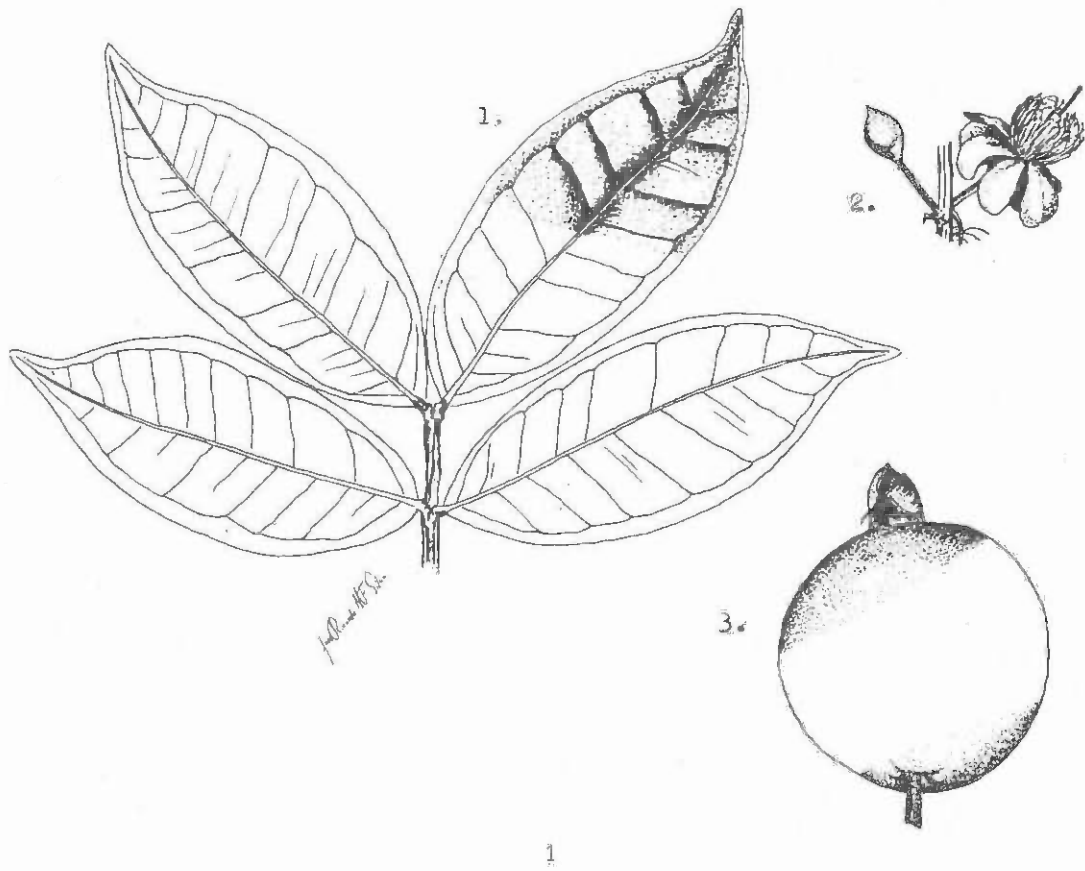
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Eighty to 90% of fresh seed will germinate within 2 or 3 months. Initial growth is good in a rich soil. No information is available about vegetative propagation. Initial field growth is good with organic fertilizer in clay oxisols, but weak with only NPK. Later growth responds well to NPK. No pests are known to cause serious production losses although it is susceptible to fruit flies.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Because of its excellent flavour the araçá-pera would appear to have good potential as a juice and for some processed products. However these will need to be developed. There is a need for germplasm collection, selection for flavour and agronomic yields. Immediate potential exists for small areas to supply the local markets in which it is rarely seen but much appreciated.

Plate LXIII. *Psidium angulatum* D.C.



2



3

- LXIII
- 1 - 1. Leaves
  - 2 - 2. Flower
  - 3 - 3. Fruit
- 2 - Four year old plant in production
- 3 - Fruit sectioned to show mesocarp and seeds



64. PSIDIUM GUAJAVA

- 1.0 NAMES: Family Myrtaceae  
Botanical Psidium guajava L.  
Vernacular guava (English); goiaba (Brazil); guayaba (Spanish);  
goyava, goyavier (French); guaiaba dulce (Colombia);  
guayaba blanca (Peru); araza-puitá (Argentina); guayaba,  
goejaba, guava (Dutch Antilles); guava, goejaba (Surinam).

2.0 ECOLOGY AND DISTRIBUTION

Psidium guajava appears to have evolved in relatively open areas, such as savanna/scrub transitional zones, or in frequently disturbed areas where it is a strong competitor in early secondary growth. In some areas it is found in large thickets with as many as 100 plants in an area of less than half a hectare, although it is more often found in densities of 1-5 plants/ha. As might be expected from a secondary growth colonizer it grows well on poor soils with reasonably good drainage, however growth and production are better on rich clay loams. The guava can tolerate high rainfall and withstand long periods of drought. A minimum of 1000 mm seems to be essential. The plant can withstand some cold, but freezing temperatures will kill back branches and eventually the whole plant. It fruits at altitudes up to c. 1500 m and can survive up to c. 2000 m.

De Candolle suggested that the guava may have originated in Mexico or the Colombian and Peruvian Amazon; more recent authors have not found any conclusive evidence to support this theory. The guava was widely distributed throughout tropical and most subtropical America well before the arrival of the Europeans so that its true origins have been somewhat obscured. It is now found throughout the tropics and subtropics of the world.

Related species: the genus Psidium is quite large. There are 233 species listed in the Kew Index. Almost all of them are very edible, some already being important regionally or locally. A few of the most important or with greatest potential are: Psidium friedrichsthalianum Niedenzu; P. cattleianum Sabine; P. molle Bertol; P. guineensis Sw. P. sartorianum (Berg.) Niedenzu; p. oerstedeanum Berg.; P. hypoglaucom Standl.; P. guayabita A. Rich and 2 other species described in this volume.

3.0 DESCRIPTION

A large shrub or small, evergreen tree, generally 3-10 m high, much branches; stems tortuous, bark light to reddish brown, thin, smooth, continuously flaking; root system generally superficial and very extensive, frequently extending well beyond the canopy, there are some deep roots but no distinct taproot. Leaves opposite, simple; stipules absent; petiole short, 3-10 mm long; blade oblong to elliptic, 5-15 cm long, 4-6 cm wide, apex obtuse to bluntly acuminate, base rounded to subcuneate, margins entire, somewhat thick and leathery, dull grey to yellow-green above, slightly downy below, veins prominent, gland dotted. Inflorescence axillary, 1-3 flowered, pedicels c. 2 cm long, bracts 2, linear. Calyx splitting irregularly into 2-4 lobes, whitish and sparsely hairy within; petals 4-5, white, linear-ovate, c. 2 cm long, delicate; stamens numerous, filaments pale white, c. 12 mm long, erect or spreading, anthers straw-coloured; ovary inferior, ovules numerous, style c. 10 cm long, stigma green, capitate. Fruit an ovoid or pear-shaped berry, 4-12 cm long, weighing up to 500 g; skin yellow when ripe, sometimes flushed with red; pulp juicy, creamy-white or creamy-yellow to pink or red; mesocarp thick, edible, the soft pulp enveloping numerous, cream to brown, kidney-shaped or flattened seeds.

Flowering September to December in central Amazon; fruiting 3 months after flowering, i.e. December to March in central Amazon.

4.0 MAIN USES

Either the whole of the fruit or just the thick mesocarp are consumed. The flavour varies from very acid to sweet with the best fruit being both sweet and mildly acid. Brix level varies between 9 and 11.30 in good varieties, The fruit has a pleasant aroma and is generally liked by everyone once the gritty seeds can be swallowed instead

of chewed up with the inner pulp. Table varieties with good taste, large size and high pulp to seed ratio, have been developed for the fresh fruit market in many countries. Other varieties have been developed for industrial purposes and the following wide variety variety of products are available: canned fruit or mesocarps in sweet syrup, puree, goiabada (a type of thick, sweet jam), jams and jellies, Juices and nectars, ice-cream and yoghurts. The leaves and bark may be used for dyeing and for tanning. They are also used in folk medicine as a cure for diarrhoea.

#### 5. METHOD OF COLLECTION OF THE EDIBLE PART

It is best to harvest in the early morning, because by mid-day fruit will be hotter and deteriorate more rapidly. Harvesting is done manually, usually from a ladder, although small baskets on poles have occasionally been used. Great care is necessary to avoid fruit damage, as when collected almost ripe, they will only store for about 2 to 3 days at room temperature. Fruit for industrial purposes do not need such care but greater speed is essential. Average yields are between 30 to 40 kg/plant in 5 year-old plants and will reach a maximum production of 50 to 70 kg at about 7 years if well managed. This is equivalent to 7 to 10.5 t/ha at 8 x 8 m spacing.

#### 6.0 NUTRITIONAL VALUE

One hundred grams of fresh pulp contains 83 to 88% H<sub>2</sub>O, 0.6 to 1.6% protein, 0.3 to 0.8% fat, 4.5 to 8% total sugars, 4 to 8% fibre, 0.3 to 0.6 ash (with calcium, phosphorus and iron making up most the the ash), pH 3.8 to 6.0, 23 to 492 mg vitamin C, 100 to 110 µg. Vitamin A, 0.9 to 1.05% pectin, and traces of thiamin, riboflavin and niacin. These results are from the analysis of 4 varieties and greater variation may exist. Some guavas are a better source of vitamin C than any of the citrus fruits and their sugars provide a source of energy.

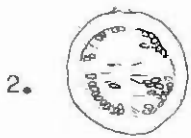
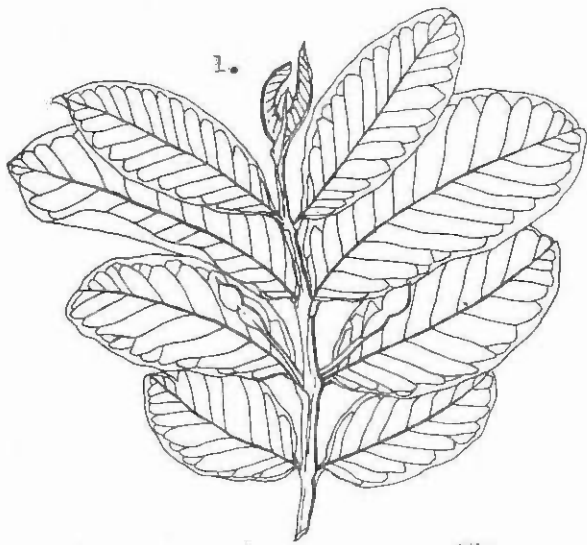
#### 7.0 CULTIVATION AND PROPAGATION METHODS

The guava is partially self-pollinated, levels from 60 to 75% selfing have been found in natural populations. This has been used to produce homozygotic varieties that can be propagated from seed. Even in areas where improved varieties are not available most plantings are from seed. A guava will supply over 50 seed, which should produce at least 25 good quality seedlings. The seed can be sown in beds, pots or directly in the field, at a depth of 1 cm. Seeds germinate after 20 days and seedlings are then thinned. They should be planted out when about 25 cm high. Plants should be about 1 metre tall for grafting. Several budding and grafting methods have given good results. Both branch and root cuttings can also be used. The seedling grows very rapidly, producing in 2 to 3 years on good soils. Branching is excessive and pruning is necessary to form good orchard trees. In Brazil "yellow rust" (Puccinia psidii) is an extremely serious fungal pest, as are leaf spot (Phyllosticha guajayae) and anthracnose (Colletotrichum sp.). Insect pests are numerous and in some cases severe. Fruit flies such as Anastrepa sp. and Ceratitidis sp. are especially troublesome.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

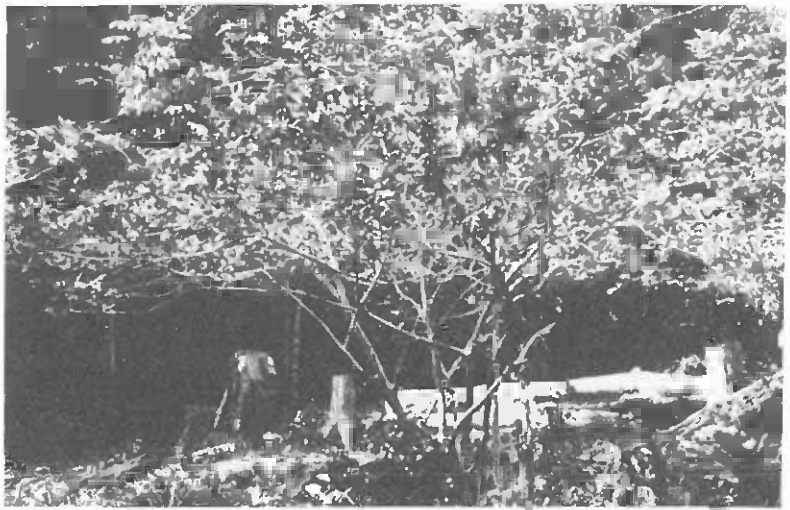
The guava is already one of the most important tropical fruits. Yet it is little known in the large markets of most of Europe and America. Although improved varieties have been selected and bred in some countries there is an urgent need to overcome the fruit fly problem.

Plate LXIV. Psidium guajava L.

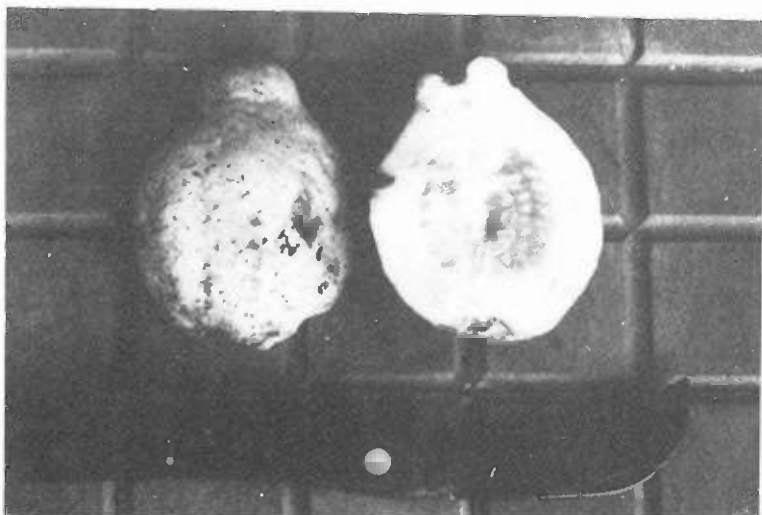


*Psidium guajava*

1



2



3

LXIV

- 1 - 1. Leaves
- 2. Section of fruit
- 3. Flower
  
- 2 - Six year old tree in production. Height 2 m.
  
- 3 - Yellow fruited guava. Tefe, Amazonas, Brazil

65. PSIDIUM GUINEENSE

1.0 NAMES: Family Myrtaceae  
Botanical Psidium guineense Sw.  
Synonyms Psidium araca Raddi  
Psidium molle Bertol.  
Psidium benthamianum Berg

Vernacular wild guava, Brazilian guava, sour guava, gûisara guava (English); araçá do campo, araçá-mirim, araçá-pedra, araçã-f. araçã-iba, araçã-verdaleiro, araçãzinho, awi, araçá (Brazil); goyavier acide, goyavier du Brésil, gouyava de "Afrique" (French); araza del Brazil, arrayán, diondan, guayaba acido, guayaba agria, guayaba de sabana, guayaba hedionda, guayabo sabanero, guayabito aseyan, chobo, guayabilla, guayabite de cerro, guayabito, guayabo, guayaba agria, guayaba cimarrón, orobua, guayaba silvestre, guayaba rajana, allpa guayaba (Spanish).

2.0 ECOLOGY AND DISTRIBUTION

Psidium guineense thrives on poor soils in the humid to semi-arid tropics and subtropics in areas receiving between 1000 mm and 2400 mm annual rainfall. There is no information about its drainage requirements. It is occasionally very abundant in areas of sparse vegetation, and appears very occasionally in disturbed areas, such as old pastures, abandoned agricultural areas and along roadsides, being distributed by birds or animals.

The wild guava is indigenous to the American tropics and sub-tropics and extends from the south of Mexico and parts of the Caribbean to the north of Argentina.

See P. guajava L. for related species.

3.0 DESCRIPTION

A very variable shrub or small tree, 1-9 m high, with the habit of P. guajava; bark smooth, 1 mm thick, flaky, pale to dark grey; root system unknown. Leaves opposite, simple; stipules absent; petiole 5-10 mm long; blade elliptic to oblong-obovate, 5-14 cm long, 3-6 cm wide, apex acute to broadly rounded, base rounded to cuneate, margins entire, glabrous to thinly pubescent, inconspicuously gland-dotted and green to dull green above, glabrous to thinly appressed-pubescent, densely gland-dotted and paler green below, midrib prominent, with 10-16 pairs of lateral nerves. Inflorescence axillary, usually 1, occasionally 2-3 flowered; flowers regular, bisexual, pedicel 1-2.5 cm long, terete. Calyx closed in bud, splitting irregularly into 5 lobes c. 9 mm long, appressed hairy, pale green; petals 5, white, concave-obovate, 10-12 mm long, spreading and eventually reflexed; stamens numerous, c. 200, anthers bilocular, ovoid, 0.8-1.2 mm long, borne on slender filaments as long as the style; ovary glabrous, ellipsoid to spherical, 3- to 5-locular, ovules numerous, style subulate. Fruit a yellow globose or ovoid berry, 2-6 cm long, 2-3.5 cm in diameter, crowned with the persistent calyx; skin thin, enclosing a yellow pulp 0.5-1 cm thick; seeds yellow, hard, kidney-shaped, flattened, 5-8 mm in diameter.

Flowering August to December and occasionally at other times in the year; fruiting October to March.

4.0 MAIN USES

The small acid fruit, especially its pulp, is the part consumed. The wild guava has a pronounced, very agreeable aroma often with an agreeable, though acid to very acid, flavour. The sweeter varieties may be eaten out of hand. Most commonly used for juices, sweets, jams and jellies, ice-cream flavouring. In general it may be used in the same way as P. guajava L., although many are much tougher and full of seeds. The wood is resistant and makes good tool handles, posts, firewood and charcoal. The leaves and

young shoots are astringent and may furnish colouring materials. The root is said to be diuretic and to have anti-diarrhetic properties. The bark can be used for tanning.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit are harvested when they start to turn yellow. No information is available on yields.

#### 6.0 NUTRITIONAL VALUE

The only analysis of composition available indicates 81 to 90% H<sub>2</sub>O, 0.8 to 1.1% ash, 1.5 to 3.8% malic acid, 4 to 5% sugar, 2.5 to 8% cellulose and 0.2 to 0.5% fats. The wild guava would appear to be a poor source of calories but is believed to be a source of vitamins A and C.

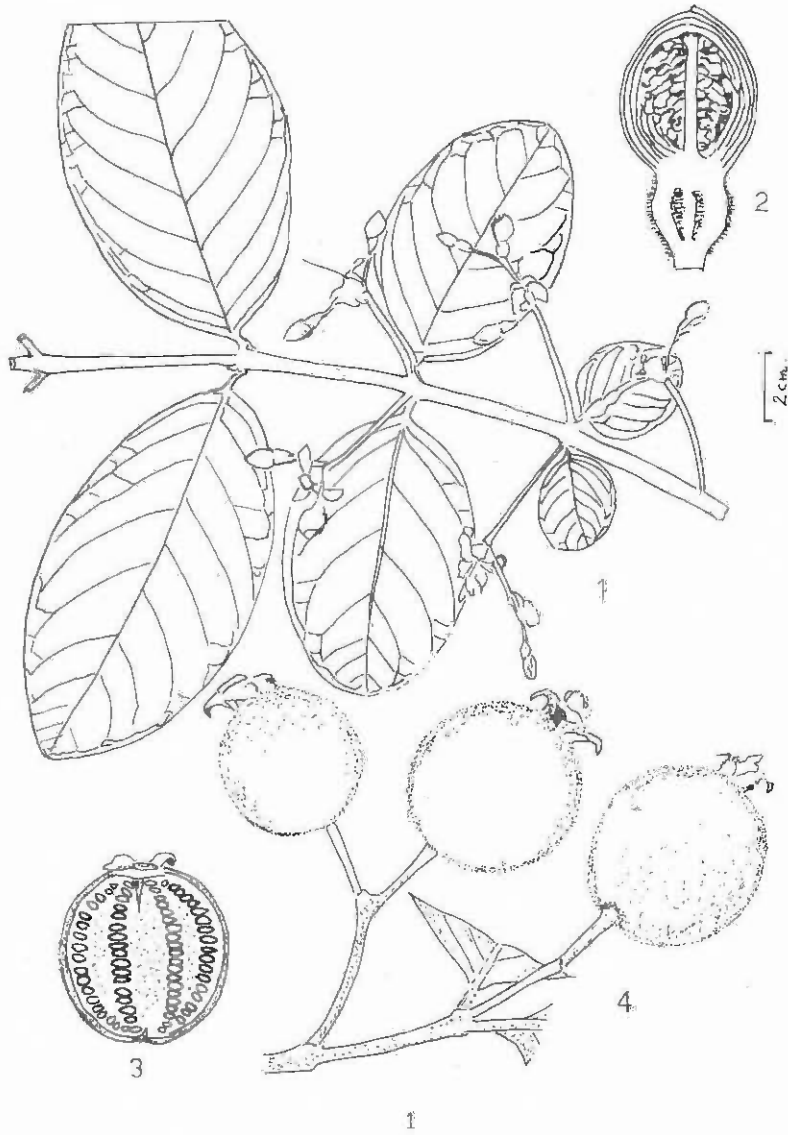
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Germination characteristics are unknown, but are probably similar to *P. guava*. The wild guava is generally propagated by seed, although there are reports of vegetative propagation by root cuttings. No information is available on growth.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Because of their agreeable flavour and wide adaptability certain wild guavas would appear to be an excellent choice for small gardens. The fruit could perhaps serve as a filler for other *P. guajava* products and may have some potential as a jam and/or jelly on its own. It may also be useful for the improvement of *P. guajava* L. Since little is known of the species' agronomic requirements or its genetic variability these deserve attention.

Plate LXV. *Psidium guineense* Sw.



- LXV
- 1 - 1. Flowering branch
  - 2. Floral bud section
  - 3. Section of fruit
  - 4. Fruiting branch
- 2 - Four year old tree in production. Height 2 m.

66. QUARARIBEA CORDATA

- 1.0 NAMES: Family Bombacaceae  
Botanical Quararibea cordata (Humb. & Bonpl.) Vischer  
Synonym Matisia cordata Humb. & Bonpl.  
Vernacular South American sapote (English); sapota, sapota do Peru,  
sapota do solimões (Brazil); zapote (Peru); zapote amarillo,  
zapote, chupa-chupa (Colombia).

2.0 ECOLOGY AND DISTRIBUTION

Quararibea cordata prefers deep, well-drained, non-flooding, clay soils, with good fertility for rapid growth and productivity. It occurs in the humid rain forest with an Af climate on the Köppen scale, with more than 2500 mm average rainfall per annum and no dry months; with less than 2000 mm rainfall growth is slow and productivity low. Although the species can tolerate short periods of near freezing temperatures, lower temperatures are fatal. The sapote flourishes at altitudes ranging from sea level to 1000 m; production declines between 1000 and 1400 m and growth is severely limited above 1600 m.

The species appears to be native in the foothills of the Andes, perhaps in the transitional region between what is now the Amazonia tropical rain forest and the sub-montane humid forests in the region of Colombia, Ecuador and Peru. It now extends from the western Amazonian rain forest into the sub-montane regions of Colombia, Ecuador and Peru, and in both Colombia and Ecuador extends over the mountains to the humid forests of the Pacific coast. It is uncertain whether or not man has contributed to this coastal extension.

The indigenous peoples and early colonisers have helped to spread the species elsewhere. In Brazil its semi-domesticated or domesticated occurrence extends as far east as Tefé in Amazonas, along the Rio Solimoes, with isolated specimens further east to Belém in Pará. The extent of the tropical humid forests restrict its southern limit in Peru, while to the north it occurs in the Magdalena region of Colombia, on or near the Caribbean coast.

Related species: none are considered to be edible.

3.0 DESCRIPTION

A forest tree to 40 m and reaching the upper canopy, with a relatively small, occasionally spreading crown; rarely exceeding 20 m under cultivation, with a pagoda-shaped branching system masked by a full crown; trunk slender, unbranched; bark smooth, light brownish-grey when not covered by lichens, slippery when wet, sap yellow, gummy; roots often very superficial, with some deeper, stabilizing roots, intolerant of a prolonged high water table. Leaves alternate, simple; stipules absent; petiole slightly shorter than the blade; blade cordate, those of vegetative shoots or young plants larger, up to 50 cm long, 40 cm wide, coriaceous, glabrous or thinly hairy, venation palmate. Flowers bisexual, slightly irregular, pale yellow, tinged orange, 5-7 cm long, pedicelled, produced on the branches, directly from the older wood. Calyx cup-shaped, 2-3 cm long, with 5 broad lobes; petals 5, obovate, 3 cm or more long; stamen filaments fused to form an elongate column protruding beyond the petals and branches above into 5 spreading arms, half the length of the column, each arm bearing a series of paired anthers, pollen viscous; style protruding above the staminal column. Fruit spherical to ovoid, 7-15 cm long, 5-15 cm in diameter, brownish-green with mealy surface, calyx persistent; rind (exocarp) thick, firm and somewhat elastic; pulp yellowish-orange to bright orange, soft, very juicy, often fibrous, edible; locules 5, each 1-seeded; seed angular, bean-shaped, 2-4 cm long, endosperm often absent.

Flowering late May to late July, pollinated by bats and humming birds; fruiting February to May (dates refer to records from eastern part of range only).

#### 4.0 MAIN USES.

The fruit is consumed with great relish by a large percentage of the population where it occurs. The fruit from wild trees obviously are smaller and weigh less than those from domesticated trees on good soil, where maximum fruit weights attain 1.3 kg. However the species average is probably near 250 grams. The pulp of the fresh fruit is juicy, though somewhat fibrous, and is the part consumed. A juice or nectar can be made from this pulp also. Some experiments with jam and jelly making have not given good results. The fruit is as avidly consumed by animals, both domesticated and wild, as it is by man. The sapote has a very sweet and agreeable flavour, appreciated immediately by most people who try it. Although it has its own flavour many people trying it for the first time claim to detect a similarity to papaya or mango or orange squash. The sapote has a symmetrical, full leaved form that makes an excellent large ornamental for gardens or parks.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit shows a light coloured ring around the calyx when it is ripe for human consumption, however it remains firmly attached to the branch. Therefore it is necessary for collector to climb up into the crown with a hook-knife on a long pole to identify the ripe fruit and cut them free. These then fall to the ground, occasionally bursting open, though the majority suffer no damage due to the thick, somewhat elastic, rind. The fruit are then easily gathered for market. On good soils with good climatic conditions, a mature tree can produce up to 6000 fruit, though these will be smaller than normal. These high yields only occur sporadically (and may be affected by hummingbird population fluctuations); an exceptional year will generally be followed by several poor years. This uneven yielding pattern may average out to 700 to 1000 fruit per year. Yield and fruit size will be smaller on poor soils or in dry climatic conditions.

#### 6.0 NUTRITIONAL VALUE

A sampling of sapote from a good soil in the eastern part of its distribution has this composition: 33% useable part in fruits averaging 420 grams; 22.5% dry weight in 100 g fresh; 22% fibre in d.w.; 3.5% ash in d.w.; 4.4% protein in d.w.; 1.7% fats and oils in d.w.; 67.3% carbohydrates in d.w.; 10.5 mg carotenoids in d.w.; 0.57 mg zinc in d.w. and 303 KCal of energy in d.w. Except for the relatively high levels of carotenoids the sapote has little nutritional value.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

As with most non-commercial species propagation is generally by seed, about 80% of which germinate if sown immediately upon removal from the fruit. In some areas (Colombia, Valle de Cauca) grafting has been in use for some years and has been experimentally tested in others (Brazil, Amazonas). The seedling does best in loose soil rich in organic matter. Seedlings transplanted to the field from a shaded nursery require hardening beforehand. Again organic material is important, not only for establishment but for future growth. In good soils with adequate water the sapote can grow as much as 2 metres/year coming into production in 6 to 8 years. In poor soils growth is slower and production will be delayed and diminished. Leaf-cutting ants are especially fond of sapote and pose a serious problem for young plants. Other insects have been observed to cause damage but not yet on a large scale. Several fungi attack the leaves and the terminal bud, in the latter case the plant may die.

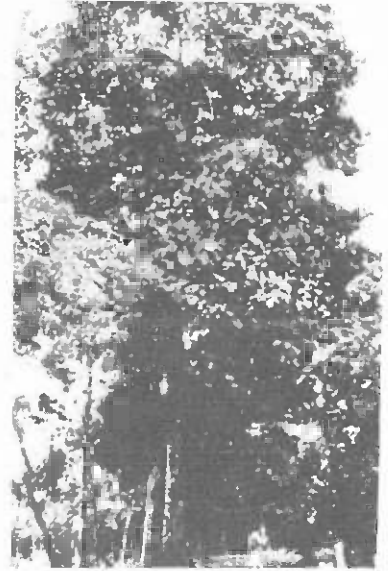
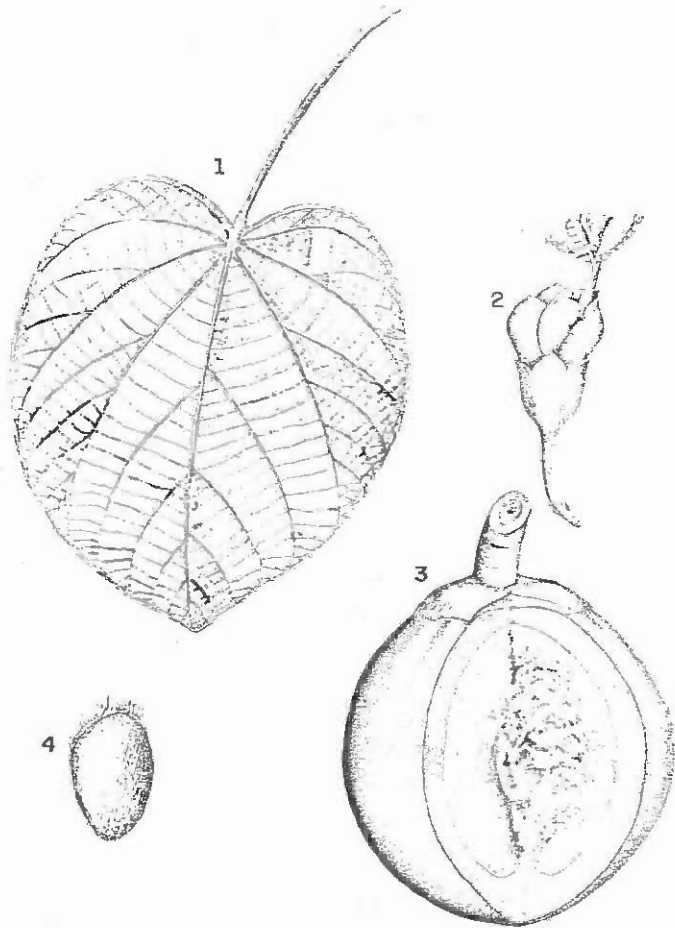
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

As a fruit from the forest or a few semi-domesticated plants the sapote is a pleasant variant for the diet of those that collect it. It is also sold in local markets for reasonably good prices. Widening its economic potential depends on creating new markets and overcoming some of the problems, like the variation in yield from year to year and apparent dependence on rich soils or high organic matter levels for good yield. Other research requirements include germplasm collection, selection for high pulp to total fruit weight ratio, reduction of fibre content in the pulp and of the long period to first harvest. Present use is limited to fresh fruit, so that preserved products need

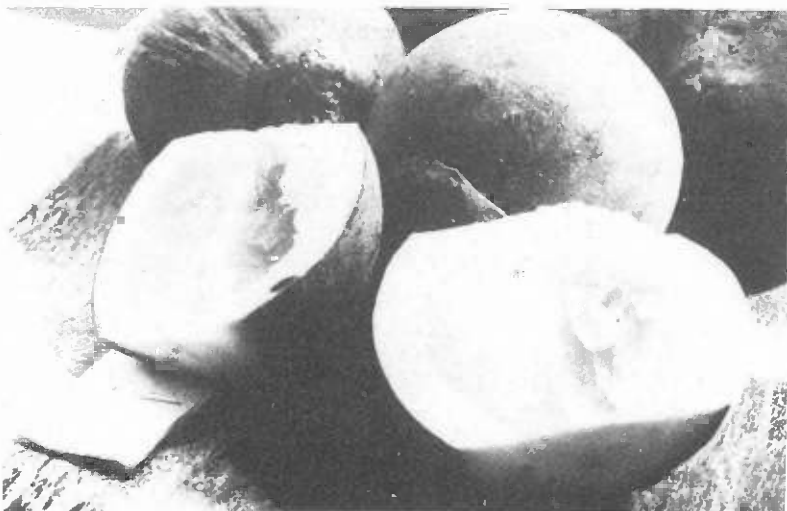


developing. However the fruit can be kept for up to 2 weeks in the tropics and the elastic rind would allow transport to distant markets. For areas of the humid tropics with the right climatic conditions and good soils the South American sapote has immediate potential to vary the diet of the small farmer and may even be developed for local markets that are not too demanding.

Plate LXVI. *Quararibea cordata* (Humb. & Bonpl.) Vischer



2



3

LXVI

- f - 1. Leaf.
  - 2. Flower
  - 3. Cut away section of fruit
- 2 - Twenty year old tree in production. Height 21 m. "Terra preto do indio" Tefe, Amazonas, Brazil.
- 3 - Mature fruit. Average weight 400 g. From tree in 2 above,

67. RHEEDIA MACROPHYLLA

1.0 NAMES: Family Guttiferae  
Botanical Rheedia macrophylla (Mart.) Planch. & Triana  
Synonym Garcinia macrophylla Mart.  
Vernacular bacuripari (bacuri + pari=close to), bacuri de cerca,  
bacuri (Brazil).

2.0 ECOLOGY AND DISTRIBUTION

Rheedia macrophylla grows well on the deep, well-drained, nutrient poor oxisols and ultisols of the high forest on the terra firma, although it prefers well-drained, nutrient rich soils. It is a component of the high understory to low canopy of these forests, where, like other species of Rheedia, it occurs in densities of 1 to 2 trees/hectare. It seems to flourish in all of Köppen's Amazonian climatic regimes with rainfall from 1500 to 4000 mm and a mean annual temperature of 26°C. No information is available about altitude limits, although within its natural distribution it is most common below 500 m.

The bacuripari appears to have originated in Amazonia and is now found throughout the Amazon basin, either in the forest or planted in backyards. Since the discovery of the Americas it has been spread around the world.

Related species: the genus Rheedia is rather large. Some of the more common species in the Amazon are R. benthamiana Pl. et Tr.; R. brasiliensis Pl. et Tr.; R. acuminata Pl. et Tr.

3.0 DESCRIPTION

A dioecious, evergreen, forest tree, 10-15 m high; bark rough, dark mottled with paler brown, 1-3 mm thick, exuding a yellow latex when cut; crown densely branched, semi-cylindrical to spherical, obconical in immature trees; adult trees with extensive, superficial root system, seedlings with a pronounced tap-root, but whether this persists at maturity is unknown. Leaves opposite, simple; stipules absent; petiole 10-15 mm long, 3-5 mm wide; blade elliptic to elliptic-oblong, 14-40 cm long, 5-12 cm wide, apex shortly acuminate, base rounded to cuneate, margins entire or sometimes slightly undulating, with prominent marginal vein, coriaceous, glabrous, smooth and glossy above, glabrous or sometimes sparsely hairy below, midrib prominent, lateral veins 45-50 or more. Inflorescence of 3-5 (-10)-flowered fascicles from the axils of fallen leaves and borne together on a thickened, woody pad; flowers white, unisexual, strongly scented. Male flowers on slender pedicels up to 4 cm long; sepals 2, broadly ovate, 3-5 mm long; petals 4, imbricate, obovate, 7-8 mm long; stamens many, inserted below a fleshy disc, anthers kidney-shaped, surrounding a central, nectariferous disc. Female flowers in fewer-flowered fascicles on shorter and thicker pedicels; sepals and petals as in male flowers; stamens fewer, smaller and with reduced, sterile anthers; ovary ovoid-spherical, inserted on a large disc, loculi 4, 1-seeded, style capitate, large and fleshy, weakly 4-lobed. Fruit yellow-brown, elliptic-ovoid, up to 10 cm long and 7 cm in diameter, smooth to rugose, exuding a yellow latex when cut; pulp white, mucilaginous and juicy, surrounding 1-4 elliptic seeds up to 2.5 cm long. The fruit is somewhat deformed if less than 4 seeds develop, although pulp partially fills the space left by aborted seeds.

Flowering June to August in Central Amazon; fruiting October to January in the same region.

4.0 MAIN USES

The thin layer of pulp around the seed is the part consumed. The bacuripari has a very agreeable sweet/sour flavour. The seed pulp segments are extracted from the fruit and may be eaten fresh, after discarding the seed. The seedless segments are preferred. Both seedless and seeded segments may be soaked in water and lightly mashed, to give an excellent juice. No other uses are known. The bacuripari makes a very nice ornamental with its well branched leafy crown. Its wood also makes an attractive cabinet wood, being easily worked and taking a nice polish.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit should be collected from the tree because when they fall they are over-ripe. No information is available on yields although some 10-year-old trees have been observed producing about 1000 fruits.

#### 6.0 NUTRITIONAL VALUE

No information is available, although one may expect it to be low, only supplying some calories.

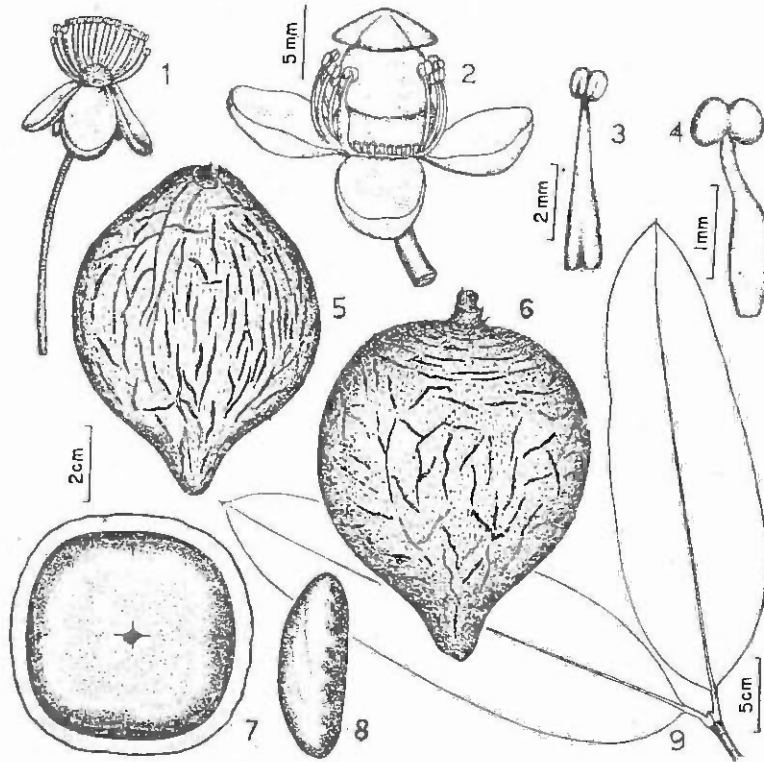
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Germination is rapid (about 30 to 50 days), as is early growth in the nursery. The seedling should be planted out before the tap-root becomes too twisted at the base of polyethylene bags. Field growth is slow, needing 4 to 5 years to attain 3 m. The leaf cutter ant appears to be fond of the bacuripari and other Rheedia sp. Production may start in the fifth year, although maximum yields probably only occur after the tenth year.

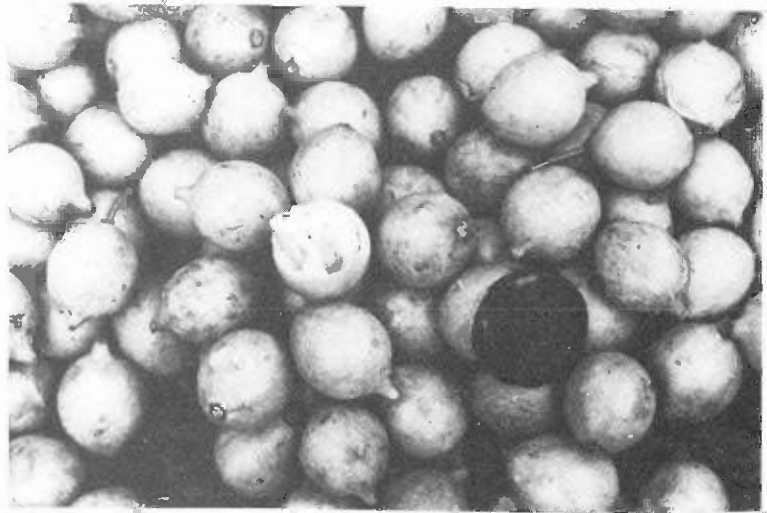
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Because of its excellent flavour for juices the bacuripari may have some potential although always as a minor fruit. However this will depend upon extensive germplasm collection and selection. Immediate potential appears to be limited to its use as an ornamental fruit species.

Plate LXVII, *Rheedia macrophylla* (Mart) Planch & Triana



2



3

LXVII

- 1 - 1. Male flower
- 2. Female flower
- 3. Stamen
- 4. Stamenoid
- 5. 6. Fruit
- 7. Sectioned fruit
- 8. Seed
- 9. Leaves
- 2 - Four year old tree. Height 3 m.
- 3 - Fruit. One sectioned to show mesocarp and seeds. Market "Ver-o-peso", Belem, Brazil.

68. ROLLINIA MUCOSA

- 1.0 NAMES: Family Annonaceae  
Botanical Rollinia mucosa (Jacq.) Baill.  
Synonyms Annona mucosa Jacq.  
Rollinia orthopetala A.DC.  
Vernacular biribá, beribá, biriba de Pernambuco, fruta da condessa,  
jaca de pobre (Brazil); anona (Peru).

2.0 ECOLOGY AND DISTRIBUTION

Rollinia mucosa is widely distributed through the lowland humid tropics of the Amazon basin, occurring in secondary forest, abandoned as well as cultivated farmland and in many city backyards. It prefers good, fertile soils but will grow reasonably well, albeit with diminished fruit production, on poor clay oxisols; good drainage is essential. The average annual rainfall requirements vary between 1800 to over 4000 mm, with average annual temperatures of 26°C. Altitudinal limitations are not known but are believed to be over 1000 m.

The species is believed to have originated in the extreme west of the Amazon basin and is now widely distributed throughout the low humid tropics of the Amazon basin with occasional records from the southern Orinoco basin. It occurs in San Domingo, Guadeloupe, Martinique, Trinidad, Peru, Colombia, Ecuador and Brazil.

Related species: Rollinia edulis Tr. & Pl.; R. pulchrinerva DC; R. silvatica Mart.; R. enarginata Schlecht; R. jimenezii Schlecht; R. laurifolia Schlecht; R. longifolia St. Hil; R. sieberi DC; and R. deliciosa are all related species from South America that have edible fruit. However it is not certain if all these mentioned are distinct species.

3.0 DESCRIPTION

Tree to 6-10 m high; bark c. 1 mm thick, greyish-brown with rose-coloured tissue beneath; crown conical at first with few branches ascending at an angle of 30-60°, becoming denser and more rounded at maturity. Root system of mature trees poorly known, superficial lateral roots usually present; seedlings with strong taproot and lateral branches. Leaves alternate, simple; stipules absent; petiole short, 5-10 mm long; blade oblong-elliptic, 15-25 cm long, 8-11 cm wide, apex acuminate, base shortly acute, margins entire, leathery, light to dark green, smooth and glossy above, hairy below with prominent midrib and 11-16 pairs of lateral veins; leaf replacement occurs rapidly after leaf-fall at the onset of the dry season. Flowers solitary, regular, borne on thick pedicels 2 cm long, widening above. Calyx lobes 3, broadly triangular, 3-4 mm long; petals 6, fused in 2 dissimilar whorls of 3, 2-3.5 cm in diameter, outer petals with conspicuous, wing-like, dorsal appendage, the inner small and scale-like; stamens numerous, c. 1 mm long; carpels numerous, 1-locular, style short, terminal, densely hairy. Fruit a syncarp composed of many united carpels, spherical to oblong, 10-20 cm long, 7-20 cm in diameter, and weighing up to 5 kg; epidermis medium to dark green at first, ripening to pale to medium yellow, with soft protruberances ending in a brown or black, fleshy point over each carpel; pulp white or cream with a soft, fibrous and mucilaginous texture, juicy and with a pleasant aroma; seeds dark brown to almost black. 1 cm long, 0.5 cm wide.

Flowering mainly August to September (until December in central Amazonia) which is the end of the dry season; fruiting January to June. Both flowering and fruiting can occur sporadically throughout the year.

4.0 MAIN USES

The abundant, fleshy pulp surrounding the seeds is eaten. The mild, agreeable odour combines with the equally mild and agreeable sweet flavour. When the fruits are eaten just before attaining the full yellow skin colour the flavour is bitter, somewhat acid, which acidness is lost upon full ripening. The fruit are normally consumed fresh, out of hand. No information or folklore exists about other uses.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Picking is recommended when the fruit loses its green tint and turns yellow. Picking completely ripe fruit does not permit transport over any distance because the fruit is too soft. A five-year-old seedling tree may produce 25 to 60 fruit that average 1 kg each. Some mature trees (over 15 years) have been observed to produce more than 150 fruit/year.

#### 6.0 NUTRITIONAL VALUE

This would appear to be as low as that of the Annona muricata, although it is a good source of energy. No information is available on composition.

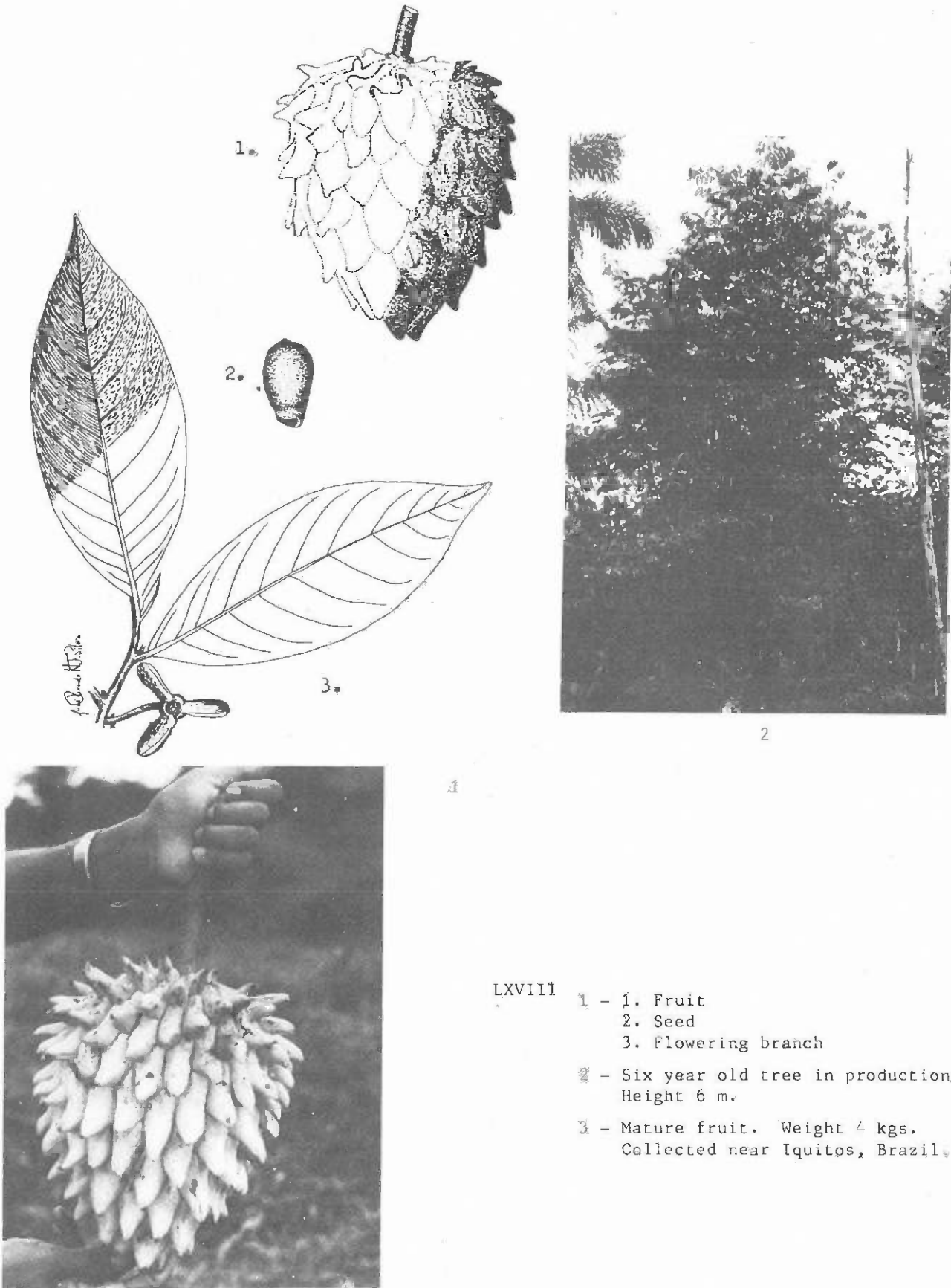
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Germination of fresh seed is rapid (3 to 6 weeks) and relatively good (60 to 80%) when sown in sandy loam beds. Initial growth in the nursery is vigorous, if the substrate is rich, with the young plants attaining graftable size in 4 to 6 months. Patch budding of several types has given reasonable results when the buds have received a week to ten days of preparation. Planted in the field in good soil growth is extremely vigorous for the first 3 to 5 years, with height increments of up to 1.5 metre/year. The trunk borer that attacks Annona muricata occasionally attacks biribá, although without apparent reduction in vigor of the affected plants.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

In general the biribá would appear to have a limited economic potential because its flavour, although agreeable, does not have any acidity or "tanginess" so that as a canned or bottled juice it would probably not attract as much interest as has Annona muricata. However, as a locally produced fresh fruit it is popular and may become more so if varieties can be found with good flavour.

Plate LXVIII. *Rollinia mucosa* (Jacq.) Baill.



LXVIII

- 1 - 1. Fruit
  2. Seed
  3. Flowering branch
- 
- 2 - Six year old tree in production. Height 6 m.
  - 3 - Mature fruit. Weight 4 kgs. Collected near Iquitos, Brazil.



69. SCHEELEA MARTIANA

1.0 NAMES: Family Palmae  
Botanical Scheelea martiana Burret  
Synonym Attalea excelsa Martius  
Vernacular urucuri, urucurizeiro, uricuri (Brazil); maripá (French Guyana); chopaja (Peru).

2.0 ECOLOGY AND DISTRIBUTION

Scheelea martiana is commonly found in the forest of the high 'varzea' or in areas subject to occasional flooding. In these areas it prefers partially drained to well-drained alluvial or sandy soils. Throughout the area the annual rainfall is between 1600 and 3000 mm and the mean annual temperatures vary between 24° and 28°C. It may occur in groups of 10-50 individuals but is usually more scattered.

It is found from Marajo Island at the mouth of the Amazon up river to the Peruvian frontier and along many of the tributaries. It has also been reported for French Guyana and the Mato Grosso.

Related species: the Orbignya/Scheelea/Attalea/Maximiliana complex is very confused taxonomically, so that it is difficult to decide how many genera there really are and how many species in each. Scheelea contains several marginally useful species: S. amylacea (Catoilé); S. goeldiana (inajarana); S. insignis (Curuaí); S. phalerata (Acuri); S. princeps.

3.0 DESCRIPTION

Massive, unarmed, single-stemmed, monoecious palm. Stem erect, 10-15 m tall, rarely to 30 m, 70-80 cm in diameter, covered in persistent leaf sheaths, eventually bare, grey, closely ringed with leaf scars. Leaves reduplicate pinnate, very large, 8-10 m long, 15-20 in the crown, held + erect, bent outwards towards the tips; sheath fibrous, opposite the petiole; apparent petiole (leaf base) c. 1.5-2 m long, rachis 5.5-8 m long bearing very numerous, regularly arranged, stiff, leathery leaflets c. 100 cm long, 4-6 cm wide, bright green. Inflorescences axillary, interfoliar, either male, female, or bisexual; first bract (prophyll) hidden among the leaf sheaths; second bract very large, woody, deeply grooved, boat-shaped, beaked, c. 2 m long; rachis 1.5-2 m long; flowers produced in large quantities. Male flowers small, with 6 stamens shorter than the + terete petals. Female flowers much larger, globose. Fruit produced in abundance, c. 500 per infructescence, the whole bunch weighing 20-25 kg; fruit ovoid, c. 10 cm long, 7 cm in diameter, dull brown; epicarp smooth, thick and woody; mesocarp oily, yellowish; endocarp very thick, enclosing 1-6 seeds.

Fruiting occurs from December to June.

4.0 MAIN USES

Both the starchy/oily mesocarp and the seeds are consumed. The mesocarp is sticky, sickly and slightly sweet while the seed is vaguely reminiscent of coconut (Cocos nucifera) in flavour. The starchy/oily mesocarp is generally consumed cooked and mixed with cassava flour. The seeds are frequently made into a rough flour. The woody pericarp of the fruit is often burned for the smoking of rubber in the interior of Amazonia.

5.0 METHOD OF COLLECTION OF THE EDIBLE PART

When ripe, the fruit fall from the bunch and may be easily collected. Occasionally a whole bunch will be collected as it starts to ripen. A tree may produce 3 to 6 bunches in a year, each weighing 20 to 25 kg.

#### 6.0 NUTRITIONAL VALUE

No information is available about the composition of the mesocarp. The seed contains about 66% of an edible, clear yellow, sweet oil, very similar to that of babaçu. Due to the starch and oil contents the urucuri would appear to be a good source of calories.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

No information is available, because the urucuri has never been cultivated. All production is from wild trees.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

If the babaçu industry becomes economic the urucuri could also become an interesting option in some areas. The urucuri also produces more seeds/fruit (on the average) than the babaçu, so that it might be useful in a breeding programme in babaçu.

Plate LXIX. Scheelea martiana. Buñret



1



2



3

- LXIX
- 1 - Mature palm tree
  - 2 - Trunk with fruit bunches
  - 3 - Fruit bunch

70. SPONDIAS MOMBIN

- 1.0 NAMES: Family Anacardiaceae  
Botanical Spondias mombin L.  
Synonyms Spondias myrobalanus L.  
Spondias lutea L.  
Vernacular hog plum, yellow mombin (West Indies); taperebá, cajá, cajá-mirim (Brazil); jobo colorado (Colombia); circuela (Mexico).

2.0 ECOLOGY AND DISTRIBUTION

Spondias mombin is generally found in the terra firma forests where the rainfall is above 1500 mm per annum; some trees may be found in drier areas as well as along the high, fertile floodplains where the trees are waterlogged for 2 or 3 months of the year. Growth is rapid on the heavy oxisols of the Amazon basin. Densities of several trees per hectare can be found in many areas.

The species probably originated in the Amazon basin since it is commonly encountered in most of the lowland forests of the region. It is also well known in the north east of Brazil, in Central America and the West Indies.

3.0 DESCRIPTION

Tree to 30 m high; bark greyish-brown, thick, rough, often deeply grooved, and with blunt, spine-like projections; trunk with branches arising 2-10 m above ground level to form a spreading crown up to 15 m in diameter and forming an open to densely closed canopy, depending on the vigour of the individual; seedlings with deep tap-root, probably persisting in mature trees, which also possess a shallower root-system near to the surface. Leaves alternate, once pinnate with an odd terminal leaflet; stipules absent; rachis 30-70 cm long; leaflets 5-10 pairs, elliptic, 5-11 cm long, 2-5 cm wide, apex long acuminate, base asymmetric, truncate or cuneate, margins entire, glabrous or thinly puberulous. Inflorescence a branched, terminal panicle with male, female and hermaphrodite flowers. Sepals 5, shortly deltoid, 0.5-1 mm long; petals 5, white or yellow, oblong, 3 mm long, valvate in bud, becoming reflexed; stamens 10, inserted beneath a fleshy disc; ovary superior, 1-2 mm long, styles 4, short, erect. Fruit an ovoid or ellipsoid drupe, 3-4 cm long, 2-2.5 cm in diameter, dull, light orange to yellow or brown, in clusters of 1-20; epicarp thin, enclosing a juicy orange or yellow mesocarp 3-6 mm thick; endocarp large, with a soft and fibrous, grooved coat surrounding 4-5 small seeds.

Flowering during the dry season, especially August and September around Manaus; fruit ripe between December and February, although some ripe fruit can be found during most of the year.

4.0 MAIN USES

The pulp of the fruit is sometimes eaten directly especially when found in the forest, but is too acid to be considered attractive. Consequently it is removed by squeezing fruit between the fingers and blending the loosened pulp into a sweetened juice. It is generally considered one of the best of the local fruits in Northern Brazil and is widely marketed and accepted in the form of fresh juice, iced lollipops or ice-cream. Fermented products are also good. Hog plums are not so well liked in other areas, so there is probably a difference in flavour between these and the Brazilian varieties. It is possible that S. lutea and S. mombin are distinct species as there are also colour differences ranging from yellow hog plums to orange taperebás. The latter have an attractive fragrance and the flavour is predominately acid sweet. Juices improve with keeping overnight as the mild astringency of the fresh juice disappears.

Pigs eat the whole fruit as they fall to the ground. The wood from this growing tree is light and could be used for boxes, pulp or fuel. Both bark and flowers are used in folk medicine to make cure-all teas. Branches can be planted close together to make live fences and leaves can be fed to cattle.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

Ripe fruit are usually collected from the ground but this must be done rapidly before they rot or are taken by animals. Large trees may yield well over 100 kg of fruit.

#### 6.0 NUTRITIONAL VALUE

About half of the fruit weight is pulp and this is 87% water, 10% sugars, 1-8% fibre and 0.4% ash. Vitamin C varies between 34 and 56 mg/g and carotenoids are presumably present in reasonable concentrations. The sugars give about 40 calories/100 g and the fruit is a good source of vitamins A and C.

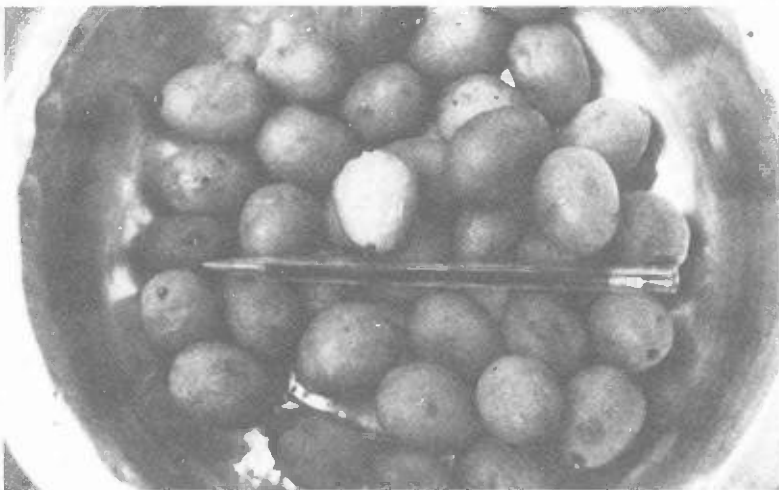
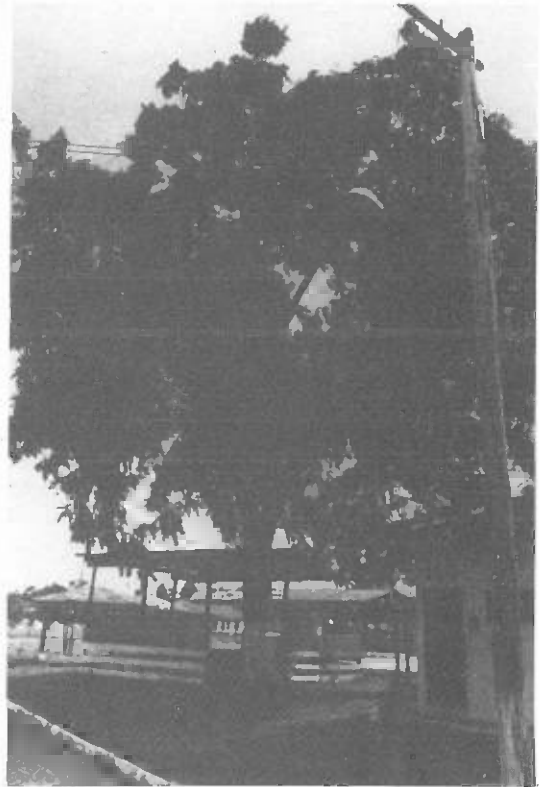
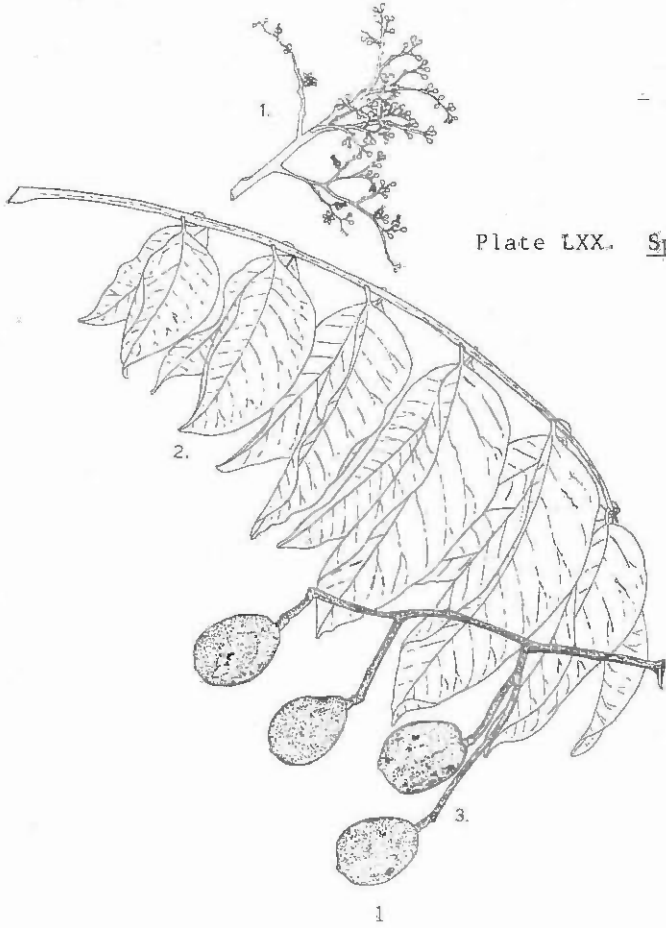
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Propagation is usually by large cuttings often 50-100 cm long and 5-10 cm thick. However the fresh seeds germinate quite well. Growth is good where soil fertility permits and trees can reach 7 m in under 5 years. Fruiting usually starts from about this age, although well kept large cuttings may produce earlier. Trees respond well to fertilizer on the poor Amazon oxisols. Little is known about pests and diseases except that some trees appear to suffer from root rots.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

This species is obviously worth studying further as good local markets already exist in areas like Manaus and Belém where good varieties are found. So far these markets have not been developed enough to put in plantations, although demand exceeds supply. As the most attractive products are quickly accepted processed products it should be easy to develop new export markets. Research is now underway to identify precocious varieties with greater yields of good flavoured pulp.

Plate LXX. *Spondias mombin* L.



3

2

4

- LXX
- 1 - 1. Flowering branch
  - 2. Leaves
  - 3. Fruit
  - 2 - Mature tree
  - 3 - Fruiting branch
  - 4 - Fruit

## 71. TALISIA ESCULENTA

- 1.0 NAMES: Family Sapindaceae  
Botanical Talisia esculenta (St. Hil.) Radlk.  
Synonyms Sapindus esculentus St. Hil.  
Sapindus edulis St. Hil.  
Vernacular pitomba, pitombeira (the tree), carayá-vola (Paraguay).

### 2.0 ECOLOGY AND DISTRIBUTION

Talisia esculenta occurs on a wide range of soils, except those that are seasonally flooded, substantially rocky or sandy, and under a wide range of climatic conditions. It is rarely found in the wild.

The species occurs throughout Brazil to the north of Rio de Janeiro, also in Paraguay and Bolivia.

Related species: Radlkofer in his monograph on the Sapindaceae includes 41 species of Talisia for South and Central America. Only 6 wild, little known species, of restricted distribution are referred to by Radlkofer as producing edible fruit. They are: T. ovaliformis (Kunth) Radlk., Mexico, Colombia and Venezuela; T. intermedia Radlk., Brazil: Minas Gerais; T. guianensis Aubl., French Guyana; T. cerasina (Benth.) Radlk., Peru, Brazil: Pará and Amazonas; T. acutifolia Radlk., Brazil: Amazonas; T. cupularis Radlk., Brazil: Amazonas.

### 3.0 DESCRIPTION

Medium sized tree 4-12 (-15) m high; bark brown, thick and rough; crown ample, much branched; root system deep, well developed. Leaves alternate, 1-pinnate; stipules absent; rachis, including petiole 12 cm or more long; leaflets 2-4 sub-opposite to alternate pairs, narrowly elliptic to oblong-elliptic, 7-13 cm long, 3-6 cm wide, apex long-acuminate to almost obtuse, base broadly acute, margins entire, membranous, glabrous above, glabrous or sparsely hairy below, lateral veins prominent, 7-10 pairs, delicate with a fine, rather prominent network of veinlets between them. Inflorescence a narrow, elongate, thyrsoid panicle 20-25 cm long, borne terminally on the branchlets; flowers bisexual. Sepals 5, elliptic, 3 mm long, joined near the base, densely tomentose outside; petals 5, white or pinkish, perfumed, ciliate in lower half and densely hairy within; stamens 8, filaments hairy, arising from within a glabrous disc at base of ovary; ovary ovoid, 3-locular, hairy. Fruit a subglobose or ovoid, apiculate berry, 3 cm long, 2.5 cm in diameter, yellowish-green with coriaceous exocarp; seeds 1-2, enveloped by a white, fleshy, edible aril, cotyledons thick, superposed.

Flowering August to September of October or sometimes extending to December; fruiting December to February.

### 4.0 MAIN USES

The edible part of the fruit is the whitish fleshy aril that covers the seeds. The flavour is sweet, slightly acid and very agreeable. The fruit (aril) is consumed only in natura but it can be used to prepare a pleasant drink. The seeds are very astringent and when cooked are used against chronic diarrhoea (Le Cointe, 1947). The tree is suitable for square and street arborization.

### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruits grow in compact bunches of 10 to 25 units and they must be collected like that to be sold in the market. It is common to use a ladder and a pruning hook or pruning shear to facilitate the harvest. Although there is no precise information, the production of an adult plant in good condition may be estimated at about 100 bunches.

#### 6.0 NUTRITIONAL VALUE

The fruit contains about 25 to 30% edible pulp; in this amount there is nearly 60% solid and 40% liquid. No information is available on its nutritional value.

#### 7.0 CULTIVATION AND PROPAGATION METHODS

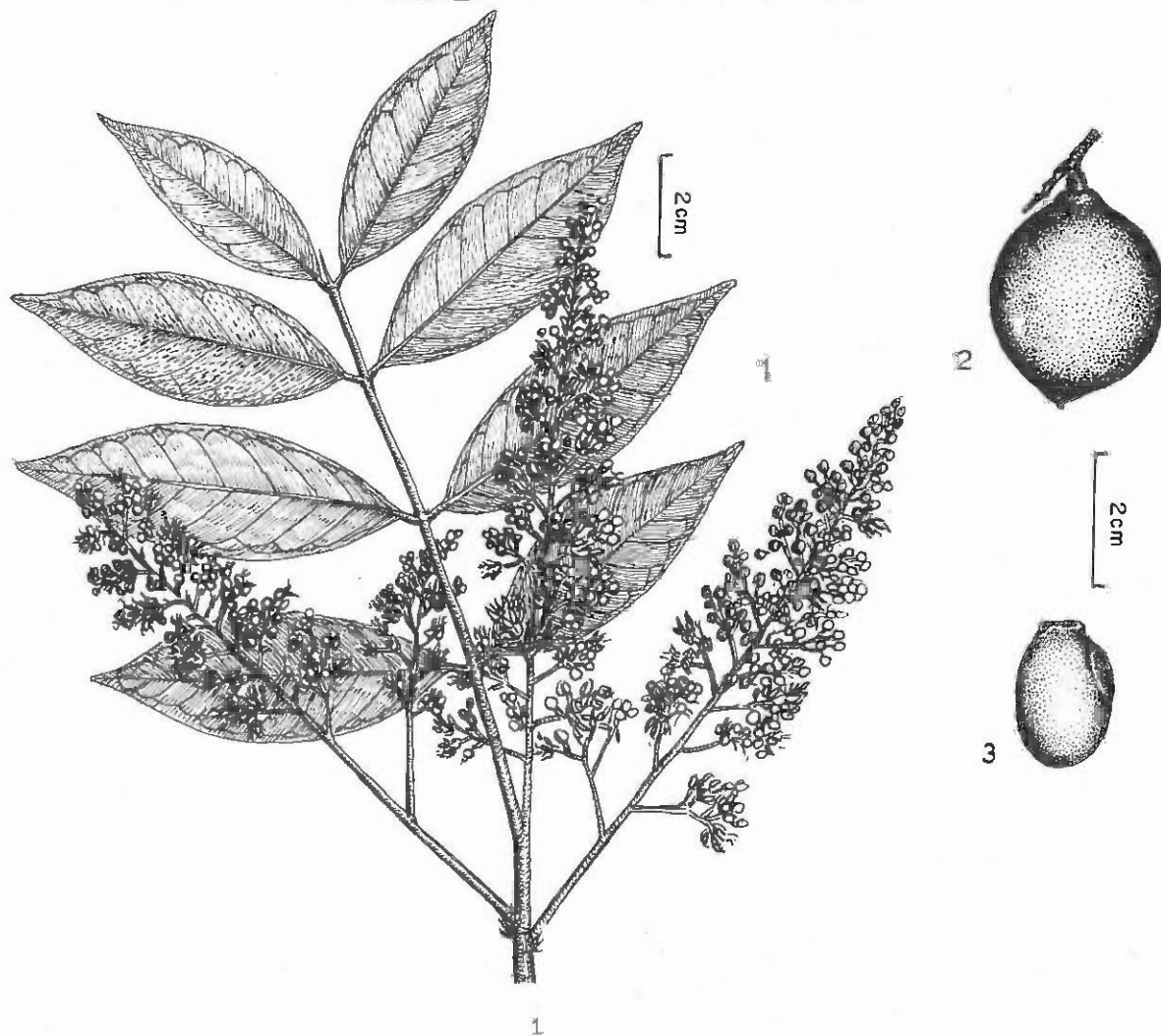
T. esculenta is cultivated occasionally and only on a small scale in gardens. There is no information about its cultivation. Propagation is only by seeds. The only available information about growth comes from a plant sown 15 years ago, now 10 m high but not yet flowering.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

In many Brazilian regions the consumption of the pitomba constitutes an old tradition mainly among the popular classes who eat fruits gathered in their own yards or acquired in the market. However, nothing is known about the practical methods of its cultivation and improvement, or its nutritional value or the potential uses of the fruits. Given the acceptance of the fruit in the markets the tree undoubtedly deserves a detailed study.



Plate LXXI. *Talisia esculenta* (St. Hil.) Radlk.



LXXI 1 - 1. Flowering branch  
2. Fruit  
3. Seed  
2 - Fruiting branch

72. THEOBROMA BICOLOR

- 1.0 NAMES: Family Sterculiaceae  
Botanical Theobroma bicolor Humb. & Bonpl.  
Synonyms Theobroma ovatifolia Moc. & Sessé ex DC.  
Cacao bicolor (Humb. & Bonpl.) Poir.  
Tribroma bicolor (Humb. & Bonpl.) Cook  
Theobroma cordata Ruiz & Pavón  
Vernacular patashte (English); patashte, pataiste, patashtle, patasht, pataxte, pataste, petaste, petaxte, patatle, balam, balamati, pataste de sapo, pataste simarron, cacao malacayo, cacao blanco, bacao, cacao silvestre, cacao marraco, macambo, majambo, najambu (Spanish); cacau do Perú, cupuassú, cupua-f, cacau bafu, cacao bravo (Brazil); and innumerable indian tribal names.

2.0 ECOLOGY AND DISTRIBUTION

Theobroma bicolor occurs throughout its range almost always on well-drained soils, most frequently on clay or loamy clay soils. In the central Amazon it grows well on nutrient poor oxisols, although in western Amazonia it grows better on the somewhat richer ultisols. It grows in both the dense and more open forests, in the latter it occurs in densities up to 1 tree/hectare. Where it occurs in the dense forests of Ecuador the rainfall is in excess of 3000 mm, with mean annual temperatures between 25° and 28°C. Most references indicate the altitude limit at about 1000 m, the one reference from Mexico of 1800 m is believed to be an error.

Some authors believe patashte to be indigenous to Central America, while others suggest the Amazon region of Colombia, Ecuador and Peru, which is considered the more likely. It occurs in the dense forests of eastern Ecuador and the more open forests of Peru, Brazil, Ecuador, Colombia and Central America. Its present distribution is very similar to that of Bactris gasipaes, ranging from Mexico and Guatemala in the north to Bolivia and Brazil in the south and being well distributed under cultivation in the humid tropic regions between these limits.

Related species: the T. bicolor is the only species in its section (Rhytidocarpus) of the genus Theobroma. For other species in the genus, see T. cacao.

3.0 DESCRIPTION

An evergreen tree 25-30 m high when present in the forest understory, though much smaller, 3-8 m in the open; trunk grey becoming fissured and rough with age, the older branches smooth; growth habit as in Theobroma cacao but with small, lax crown composed of few whorls of 3 branches on an otherwise naked stem; there is no information available about development of seedling tap-root, although extensive and extremely dense, lateral, superficial roots develop. Leaves alternate, simple; stipules oblong-lanceolate, 5-8 mm long, 1.2-2 mm wide, more or less persistent; petioles 1.2-2.5 cm long or 10-38 cm long, stout; blade dimorphic, those on main stem broadly ovate-cordate, 12-35 cm long, 6-18 cm wide, apex acuminate, venation palmate, those on lateral branches oblong- to elliptic-ovate, apex acuminate, base cordate, venation more or less pinnate, on younger plants blades 30-50 cm long, 20-40 cm wide, with petiole 10-40 cm long, upper surface pale green, lower surface silvery-grey-tomentose. Inflorescence axillary, on the leafy, juvenile branches. Sepals 5, lanceolate to ovate-lanceolate, 5-6 mm long, 2-2.5 mm wide, apex acute; petals 5, smaller, the blade oblong-ovate, pinkish-white to reddish; staminodes 5, c. 5 mm long, erect, ligulate, stamens 5, filaments compressed and recurved, each with 2 ellipsoid, bilocular anthers; ovary superior, oblong-obovate, 5-lobed, each loculus containing many ovules, styles 5, united, c. 1-2 mm long. Fruit very characteristic subglobose to oblong - or ovoid-ellipsoid, very large, 10-25 cm long, 9-15 cm in diameter, weighing 500-3000 g, greenish-grey when immature, ripening yellow or yellowish-brown; pericarp hard, longitudinally ribbed, the grooves prominently nerved; seeds arranged in 5 rows within the fruit and surrounded by a fibrous, juicy, cream to yellowish pulp; seeds 16-30 mm long, 14-25 mm wide, 8-13 mm thick.

Flowering July to September; fruiting November to March in the central Amazon region.

#### 4.0 MAIN USES

Both the pulp surrounding the seed and the seed itself are consumed. The pulp is juicy and has a sweet agreeable flavour, better than that of T. cacao. The seed has a flavour inferior to that of T. cacao. The pulp is eaten fresh, out of hand. The seed may be cooked or toasted before eating. It also may be made into a chocolate of inferior quality, although the fat (cocoa butter) that may be extracted from the seed is of good quality. The durable pericarp may be cleaned, dried and used as a bowl or container.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The fruit fall from the tree when ripe. The pericarp is more durable than of T. grandiflorum and so rarely breaks upon falling. Thus harvesting consists of collecting from the ground. No precise information is available on yields although 8-year-old plants have been observed to produce 20 fruit.

#### 6.0 NUTRITIONAL VALUE

No information is available although one may expect it to be similar to T. cacao both in composition and nutritional value.

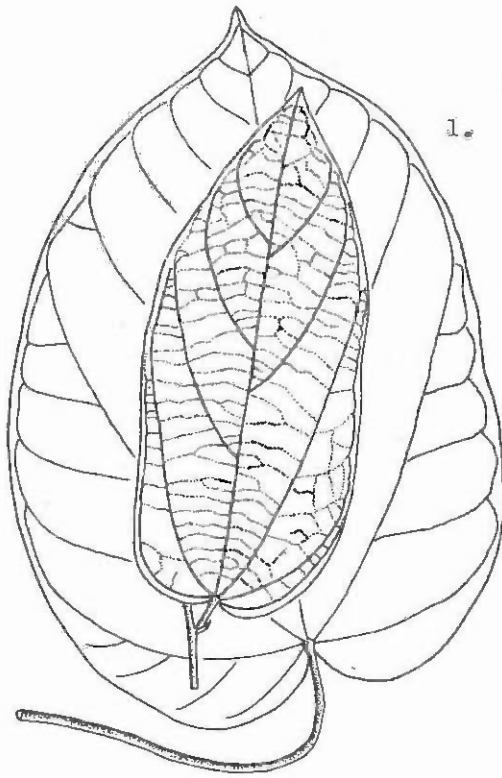
#### 7.0 CULTIVATION AND PROPAGATION METHODS

Germination is rapid and good if the seed are sown immediately after removal from the pod. In good substrate nursery growth is rapid. It requires semi-shade for the first few months. No information is available about vegetative propagation. In the field the T. bicolor grows rapidly, even on relatively nutrient poor soils, attaining between 50 and 100 cm/year. Production may start in the fifth year from planting out. The patishte is susceptible to Witches Broom disease (see T. cacao).

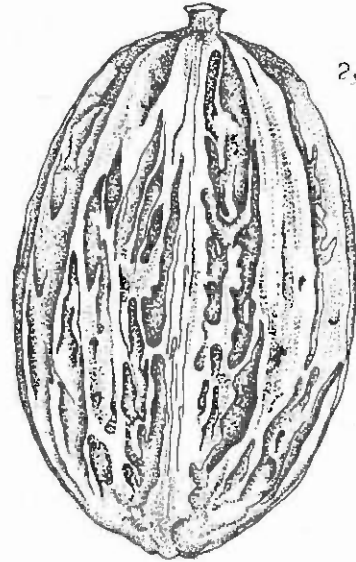
#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

In some areas the patishte is widely used and popular, so that there may be some potential as a local crop. More intensive study of the "butter" of this species may permit wider use on an industrial level. If so, extensive germplasm collection and agronomic studies will be necessary.

Plate LXXII. *Theobroma bicolor* Humb. & Bonpl.



1.



2.

1



2

LXXII 1 - f. Leaves. Smaller leaf,  
adult leaf.  
2. Fruit

2 - Four year old tree in full sun -  
the reason for its poor growth.  
Height 2 m.

73. THEOBROMA CACAO

- 1.0 NAMES: Family Sterculiaceae  
Botanical Theobroma cacao L.  
Synonyms Theobroma pentagona Bernoullii  
Theobroma leiocarpa Bernoulli  
Theobroma sativa (Aubl.) Lign. & Le Bey  
Theobroma sphaerocarpa Pittier  
Vernacular cocoa, chocolate tree (English); cacau, cacau verdadeiro,  
cacau comum (Brazil; cacao (Spanish); cacaoyer (French).

2.0 ECOLOGY AND DISTRIBUTION

Theobroma cacao is a native of the uplands and higher flood plains of the high forests of the western Amazon, growing in shaded situations on acid, nutrient poor soils in areas receiving at least 1200 mm to more than 4000 mm annual rainfall and average temperatures between 21° and 30°C. Cacao will withstand temperatures as low as 21°C but will not produce, while temperatures in excess of 30°C in full sun can be harmful. Seeds will die in less than 15 minutes at 40°C. In some areas of western Amazonia high concentrations of cacao with as many as 40 trees/ha can be found in the understory of the high forest; usually it is between 1 and 2 trees/ha.

All commercial cocoa plantations are located under 1000 m altitude, so this would appear to be the recognized limit. Until recently cocoa growing was only carried out in regions with good soils where fertiliser applications were unnecessary. Thus, nutrient rich, deep, well-drained soils with high levels of organic matter and a pH between 4.5-6.5 are considered optimum. However, cocoa is tolerant of soil pH as low as 3.9, and can thus be grown with the addition of fertilisers on most of the oxisols of the humid tropics. Because it is a plant adapted to the high flood plain it can withstand a month or so of flood but will not tolerate stagnant standing water.

Cacao probably originated in the forests of the western Amazon but in pre-colombian times spread widely throughout tropical America. This has resulted in the Central American populations being recognized as a distinct type, the 'Criollo' while the Amazonian populations are known as the 'Foresteiro' type; another type, probably of more recent development is known as the 'Trinitario'. The Spanish and Portuguese have spread the cacao throughout the humid tropics to such an extent that there are few countries in the humid tropics where cacao is not a common or relatively common plant.

Related species: All species of Theobroma are edible. Aside from those mentioned in this volume the following species have been described: Theobroma sylvestre Mart.; T. speciosum Willd.; T. velutinum Benoist; T. glaucum Karst.; T. bernouillii Pittier; T. gileri Cuatr.; T. microcarpum Mart.; T. angustifolium Moçino e Sessé; T. cirmolinae Cuatr.; T. stipulatum Cuatr.; T. chocoense Cuatr.; T. simiarum Donn. Smith; T. obovatum Klotz. ex Bern.; T. subincanum Mart.; T. hylaenum Cuatr.; T. nemorale Cuatr.; T. sinuosum Pavón ex Huber; T. canumanense Pires et Fróes; T. mammosum uatr. & León.

3.0 DESCRIPTION

Small tree to c. 10 m high; bark smooth, dark brown and somewhat scaly; rather open crown with characteristic branching, in which the apex of the main stem, after 1-2 m, aborts and forms a whorl of 3-5 spreading, lateral branches which fan out more or less horizontally. Further vertical growth continues by the development of a single, erect, adventitious shoot, initiated laterally just below the whorl of branches; this continues growth for 1-2 m before branching again, the process continuing with 4-6 levels of branching. Seedlings with a tap root with ramifying branch roots; the tap root seldom penetrates more than 2 m and the lateral roots are superficial, occupying the 20 cm soil level. Leaves alternate, simple; stipules absent; petiole dimorphic, 1-3 or 3-10 cm long; blade symmetrical and short petioled on erect shoots, asymmetrical and long petioled on lateral shoots, elliptic to obovate-oblong, 20-60 cm long, 4-12 cm wide

(depending on position and shading), apex acute, base rounded, margins more or less entire, light to mid-green, usually suffused with pink or purple when first unfolded, glabrous, midrib prominent below, with 9-12 pairs of lateral nerves. Inflorescence cauliferous, on the trunk and older branches on 'cushion-like', contracted, short-shoots; flowers borne in fascicles, regular, bisexual; pedicels 5-15 mm long. Sepals 5, free, whitish or pink, valvate, deltoid, 2.5-10 mm long; petals 5, each consisting of a basal, pouch-like region, white with red streaks, that enclose the stamens, and a narrow limb that widens upwards to form a yellow, spatulate blade 1.5-2.5 mm long; staminal tube short, 1.2-1.5 mm long, terminated by a whorl of 5, narrowly subulate, acute, erect staminodes opposite the sepals, alternating with a whorl of 5, spreading stamens, with short filaments, each bearing 2 bi-locular anthers and enclosed within the corolla pouch. Ovary superior, 5-locular, each loculus with 2 rows of ovules, style terminal, with 5 short branches. Fruit extremely variable in shape and size, oblong-elliptic to ovoid, often acuminate berry or 'pod', 10-30 cm long, 5-12 cm in diameter, with 5 or more longitudinal furrows and often irregular in shape, green, yellow, red or purple; pericarp tough, fleshy within and enclosing 20-60 seeds arranged in 5 rows, each enveloped in a sweet, white, mucilaginous, edible pulp; seeds dark brown, 20-40 mm long, 12-20 mm in diameter.

Flowering and fruiting throughout the year, but more seasonal in E. Brazil.

#### 4.0 MAIN USES

In the Amazon region the cocoa has been used extensively for its pulp. The pulp surrounding the seeds has a sweet, rather insipid flavour that is quite popular among Amazonians but not much appreciated by European palates for any length of time. Widely used as a fresh fruit, especially by children, the pulp can also be made into jams and jellies, filling for pastries and other sweets and fermented for alcohol or vinegar. In Bahia state, Brazil, all of these uses are widely found, however in other regions of Brazil they are less frequent.

The cocoa has become a major tropical perennial crop because of its seeds, which are used principally to make chocolate. The cocoa butter is the basis for the chocolate industry but it is also used in some cosmetics, and for other consumer industrial products.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

The pods are manually harvested when ripe. Pulp should be separated and used immediately, although it will stay useable inside the fruit for several days. For seed production for chocolate the fruits are opened and the entire contents are put into a large receptacle and left to ferment, which allows easy separation of the seeds after a few days. The seeds are then dried for packing and shipping to the factory. Rusticly grown cocoa under shade and without fertilizer may yield 500 kg/ha. With good agronomic practices and planting material shaded cocoa may produce 1500 kg/ha. With close-planted unshaded cocoa with good agronomic practices and planting material yields of 4000 kg/ha may be obtained.

#### 6.0 NUTRITIONAL VALUE

The pulp of the cocoa is similar to that of the cupuaçu (*T. grandiflorum*) while the seed has the following composition: 3.6% H<sub>2</sub>O, 12% protein, 46% fats and oils, 34% carbohydrates, 8% fiber and 3% ash. There are also about 15 mcg/100 g vitamin A, 0.17 mg/100 g thiamin, 0.14 mg/100 g riboflavin, 1.7 mg/100 g niacin and 3 mg/100 ascorbic acid. It also supplies about 430 calories/100 g. With 12% protein the cocoa has a good nutritional value as well as being a good source of calories.

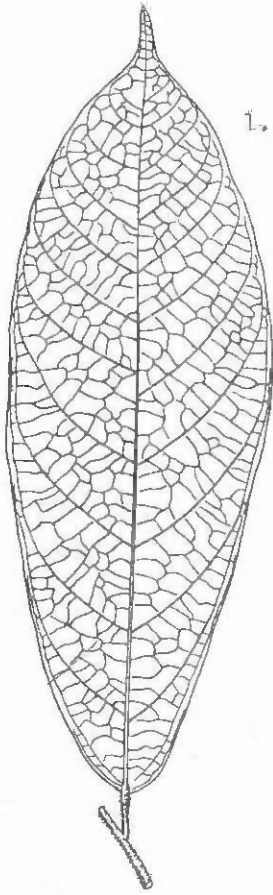
## 7.0 CULTIVATION AND PROPAGATION METHODS

The general practice is to raise cocoa from hybrid seed, although cuttings and grafting are also used. The hybrid seeds are produced from known crosses of superior high-yielding trees and are planted shortly after being collected because the seed viability is rapidly lost in storage, so much so that 10 days without special care will cause the loss of all viability. Seed may be planted directly in the field or in polythene bags in a nursery. Germination is rapid as is seedling growth and the seedlings are ready for planting out when they are between 30 and 50 cm tall. Cuttings are usually obtained from recently-matured flushes of fan branches. Both single leaf and several leaf cuttings are used. Sawdust mixed with compost and sand is widely used as a rooting medium because it drains well and has good aeration. The cuttings are generally raised in polythene bags under a close-fitting polythene cover to maintain humidity, which gives a high success rate. Cuttings are usually dipped in rooting hormone to improve take. Patch budding has been the most widely used grafting method, although other methods of budding, as well as side veneer grafting also work. One method has been to patch bud low on the trunk and then plant the grafted seedling deeply so that soil can be mounded around the scion. This method gives the plant a tap-root and adventitious roots from the scion. Rooting hormone is used to encourage adventitious roots on the scion. Because fan-branches are most widely used for cuttings and budding the resultant trees do not have a main stem and grow with a shape that is somewhat difficult to harvest. Spacing is rather variable, depending upon soil, climate, shade, type of plant (seedling or grafted) and variety (Criollo or Forasteiro). Close spacings (2.5 m square or 3 m square) are used for Criollo types and give higher initial yields but cumulative yields are less different from wider spacings (3.5 to 4 m square). Without shade the closer spacings are more generally used, except with the Forasteiro types. Shading has long been considered essential but this idea is now changing because plants that are well fertilized have been shown to resist sun scalding and produce as well or better than shaded cocoa. Shading is still widely used, especially with leguminous trees that may fix nitrogen or with other crops like coconut (Cocos nucifera L.) or rubber (Hevea spp.) that will give a second marketable product. As mentioned seedling growth is rapid and this continues through the juvenile stage to first production at about 2.5 to 4 years in the field. Pruning is frequently used to control plant shape as well as to remove dead, diseased or unproductive wood. The fungus Phytophthora palmivora causes a wide range of symptoms including pod rot, seedling wilt and damping-off and leaf fall. It can also attack the flower "cushion" and give rise to cankerous growth. The fungus Marasmius perniciosus is the causal agent of the "Witch's Broom" disease which is widely spread throughout the Amazon and causes the production of broom-like branching of the shoots with undeveloped leaves, enlarged branched flower "cushions" and pod rot. Trunk canker (Ceratocystis fimbriata) is becoming serious in South America, with Forasteiro types showing some resistance. In some areas of South and Central America the "monilia pod rot" or "watery pod rot" is serious. This disease is caused by the fungus Monilia rorei and develops internally until its latter stages when it causes brown spots. Other diseases, including viruses, are serious in other areas and insects occasionally cause damage.

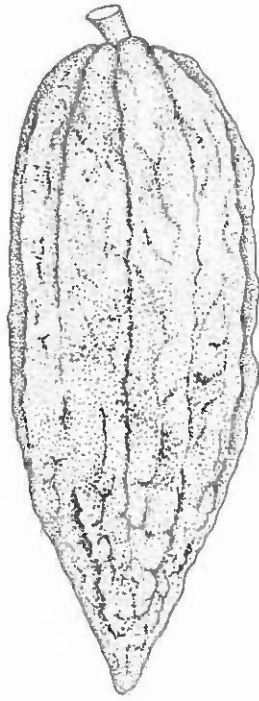
## 8.0 POTENTIAL ECONOMIC IMPORTANCE

At the present time world markets for cocoa products are nearly saturated which means soft and irregular prices. However this situation may change with the recuperation of the world economy, although there is now so much cocoa planted in Africa, South and Central America and tropical Asia that one would expect the market to remain saturated. There may be some possibility for market expansion of cocoa pulp products like jellies and jams. Disease is presently the most serious limiting factor to the cocoa industry, after the soft world market. This may be overcome by more extensive germplasm collecting, especially in western Amazonia where the cocoa is probably indigenous and where some resistant germplasm has already been found. Economic potential is still strong but market expansion seems to be unlikely, so that this potential rests upon higher production per hectare of better quality cocoa at lower prices.

Plate LXXIII. Theobroma cacao L.



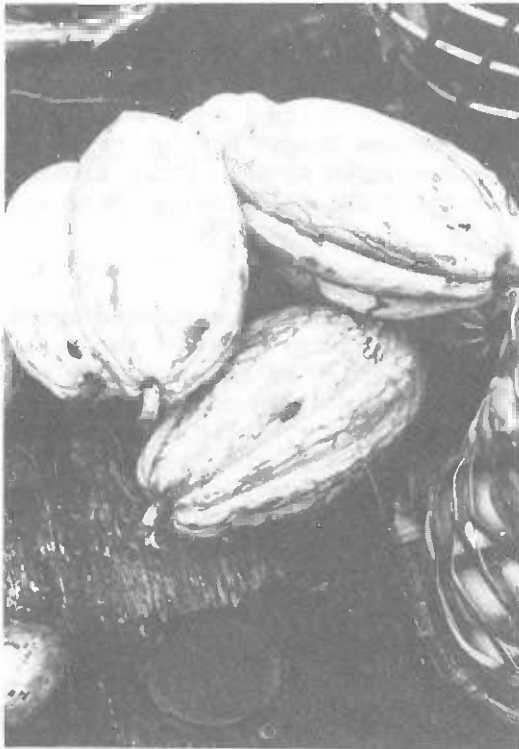
1.



2.



2



3

- LXXIII f - 1. Leaf  
2. Fruit
- 2 - Six year old tree in production.  
Height 2 m.
- 3 - Mature fruit in the market.  
Manaus, Brazil.



74. THEOBROMA GRANDIFLORUM

- 1.0 NAMES: Family Sterculiaceae  
Botanical Theobroma grandiflorum (Willd. ex Spreng.) Schum.  
Synonyms Bubroma grandiflora Willd. ex Spreng.  
Guazuma grandiflora (Willd. ex Spreng.) Don  
Theobroma silvestre Spruce ex Schum.  
Theobroma macranthum Bernoulli  
Vernacular large-flowered cocoa (English); cupuaçu, cupuassu, cupu do mato,  
cupu-assu, cacão de Peru, cacao de Nova Granada (Brazil);  
bacau (Colombia); cacão blanco, pataste (Mexico & Central  
America); cacau silvestre, pataiste, tete negra (Costa Rica);  
lupu (Surinam).

2.0 ECOLOGY AND DISTRIBUTION

Theobroma grandiflorum occurs in the low, open forests of eastern Amazonia in densities of up to 14 trees hectare, preferring rich, sandy clays and loam soils with good drainage, although it will withstand short periods of flooding. The tree grows best in semi-shade but withstands full sun when growing on good soils; it does not easily escape into areas of heavily shaded forest. The species is well adapted to Köppen's climatic types AW and Am, although it grows best under Af climatic regimes with rainfall above 1000 mm being essential and temperatures ranging from 21° to 30°C. In its natural range it does not appear above 400 m, however, there is no information available on its altitude limits although it is known to grow and fruit at 600 m in Turrialba, Costa Rica.

The cupuaçu seems to have originated in south-eastern Amazonia in what is now the south of Para state and western Maranhão, extending into the pre-Amazon transitional forests of Maranhão. It has now spread throughout Amazonia and into many areas of the humid tropics of South America, although it is only found in great abundance in eastern Amazonia. In most of its present range it is grown as a garden or small-farm fruit.

See T. cacao L. for related species.

3.0 DESCRIPTION

Small to medium-sized evergreen tree 6-10, rarely to 18 m high; bark dark brown to greyish, with granular, fissured texture; habit columnar, growth pseudo-apical, with lateral branches in 3s, the apical shoot aborting and replaced by development of bud above one of the lateral branches, older branches becoming horizontal or descending; seedling with central tap-root and ramifying branches, even in the mature tree the tap-root never exceeding 2 m long, the lateral roots mainly superficial. Leaves alternate, simple; stipules oblong to lanceolate-oblong, 10-20 mm long, 3-6 mm wide, persistent; petioles 7-14 mm long, densely floccose; blade oblong to elliptic-oblong, 15-60 cm long, 5-16 cm wide, apex acuminate, base rounded, margins entire or sinuate towards the apex, coriaceous, usually slightly glossy, dark green above, pale green to brown below, minutely tomentellous between the veins, veins 9-10 pairs directed forwards at an angle of 40°. Inflorescence axillary along the branches, few-flowered, with short peduncles bearing at the apex 3 small bracts 3-4 mm long, pedicels 5-20 mm long. Calyx divided almost to the base into 3-5, slightly boat-shaped, deltoid-acute lobes 14-15 mm long, 6-8 mm wide, c. 1.5 mm thick, fleshy, stellate-tomentose outside, greenish rusty or reddish within; petals 5, fleshy, the base fleshy, hooded, whitist, 7-nerved, 6-7 mm long, 4-6 mm wide, blade dark red or crimson, obovate, 4-9 mm long, 4.5-8.5 mm wide, abruptly contracted at the base; staminal tube short, 2.5 mm long, with 5 spreading, lanceolate-acute staminodes 9-15 mm long, dark red, pilose outside, alternating with 5 shorter stamens with filaments 1.7-2 mm long, each bearing at the apex 3 bi-ocular anthers; ovary pentagonal-obovate, 5-locular, each loculus with numerous ovules, style slender, 2 mm long. Fruit oblong- to obovoid-ellipsoid, 15-40 cm long, 10-15 cm in diameter, rounded at both ends, smooth, thinly brown-tomentose, falling at maturity; pericarp hard, c. 1 cm thick, mesocarp 5-7 mm thick, fleshy at maturity with a thin membrane surrounding the seed cavity; seeds 20-60, arranged in 5 rows, thin-skinned,

nut-brown to reddish, enveloped in a fibrous, creamy white to creamy yellow, rather juicy pulp with a strong aroma and slightly acid taste.

Flowering June to September, with some individuals flowering throughout the year; fruiting from December to April in the Central Amazon region.

#### 4.0 MAIN USES

The principal edible part is the thick, fleshy, fibrous pulp that surrounds the seeds. The agreeable sub-acid, aromatic pulp has its own rather strong flavour that is not always appreciated on first taste, generally requiring dilution to be acceptable to any palate. The pulp is almost never consumed directly. The most popular preparations are juices of varying strengths, ice-cream and charlotte puddings. It is also used for compotes, fillings for sweets, jellies and jams. The seed can be used as a cocoa substitute as they contain up to 48% of a white, aromatic fat that is closely analogous to that of cocoa (*T. cacao* L.). It is frequently used for making home-made chocolate. About 10 years ago the Nestlé's company of Switzerland was interested in using it for the fabrication of white chocolate, but regional production was too limited to supply the seed or cupuaçu butter.

#### 5.0 METHOD OF COLLECTION OF THE EDIBLE PART

As the fruit will fall when ripe harvesting consists of picking the fruit from the ground. Because of possible pod breakage due to the fall from the tree and resultant fungal attack, a daily harvest is suggested with immediate marketing. Recommended spacings permit about 170 trees/hectare. A young mature tree may produce as many as 40 fruit/year, although this can increase significantly with fertilization. Thus a yield of about 7,000 fruit/hectare may be expected in the 6th to 8th years. Average weight varies between 1 and 1.5 kg and about 30% is pulp and 20% seed, so that a yield of 2 tons of pulp and 1.5 tons of seed per hectare appears likely.

#### 6.0 NUTRITIONAL VALUE

About 40% of the fruit is uneatable pulp; this has a pH of 3.3 and a Brix value of 10.8. The pulp is about 89% H<sub>2</sub>O with small amounts of protein (1.2%), reduced sugars (3%), minerals (0.7%) with traces of vitamin C (4-21 mg) in total carbohydrates of 8%. Nutritional value appears to be low although the cupuaçu supplies some energy (67.9 cal/100 g. pulp).

#### 7.0 CULTIVATION AND PROPAGATION METHODS

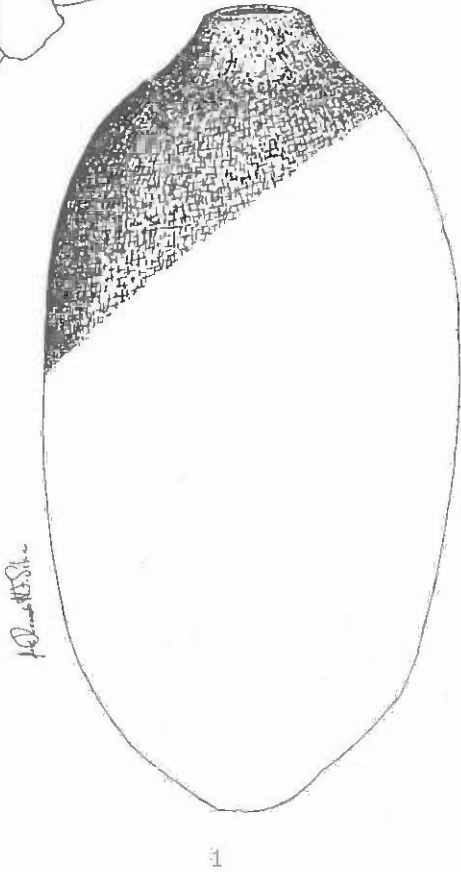
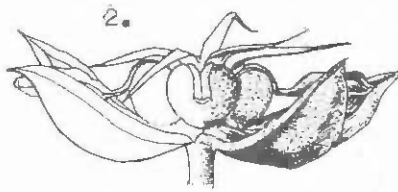
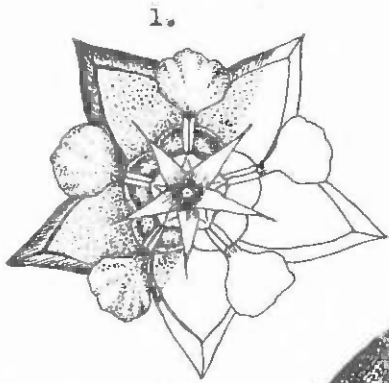
Seed propagation has been the norm in cupuaçu propagation. Like the cocoa (*T. cacao* L.) the viability of the cupuaçu seed is extremely limited, ranging from 2 to 3 days with no care to about 2 weeks with elaborate precautions. The seed are germinated in seed-beds at a depth of 1 to 2 cm with daily watering to maintain high humidity. Germination takes 10 to 20 days and initial growth is rapid and will continue to be if soil fertility is maintained. Light, sandy clay loams, rich in organic matter make the best potting or polythene bag substrate. When the seedlings are 50 to 60 cm tall they can be grafted. Side veneer grafts have given good results using terminal shoots as scion wood. Greater economy of vegetative material is attained using a patch budding method similar to that used in rubber (*Hevea* spp.), being preceded by removal of leaves and terminal point 8 to 10 days before budding to permit better bud elongation after removal of the tying material. The seedlings should be hardened-off before going to the field. Seedlings will have a normal growth habit and should be planted at 8 to 9 metre spacing, triangular or square. Grafted plants, usually produced from scions from the fan branches, will give non-erect growth habits and smaller plants. These can use closer spacing, 5 to 7 metres and need more careful orientation to allow for the non-erect growth habit to give uniform plantations. No fertilization trials have yet been done with cupuaçu but it is known to respond well to fertilizer. Well fertilized plants grow quickly and may flower in 2 years after planting out, although usually first fruiting will only occur in the third or fourth year. As fruiting becomes more regular the lower branches will be bent towards the ground by the weight of the fruit. It then becomes necessary

to prune these back. Pruning is also necessary to remove dead, diseased and non-productive wood. In the Amazon the principal disease is Witch's Broom (Marasmius perniciosus) which is so serious that it has wiped-out many plantations although in fact it is a disease that is relatively easy to control by mechanical and chemical means. Pruning and burning or burying of diseased plant parts followed by application of copper fungicides will control the disease. Other diseases of cocoa (T. cacao L.) besides Witch's Broom also attack the cupuaçu, the most serious being Phytophthora sp. which is controlled as in cocoa.

#### 8.0 POTENTIAL ECONOMIC IMPORTANCE

Because of fruit flavour and the possibility of using the seed as a sub-product the cupuaçu appears to have an excellent potential. A company of Belém, Pará, Brazil is exporting pulp to France and cannot meet demand because there are still no viable cupuaçu plantations on a large scale. The principal limitations are the Witch's Broom disease, although there appears to be some genetic resistance to the disease in some parts of the species, and heavy political resistance from the Cocoa Growers' Association which claims, on very weak, if not incorrect, evidence, that the cupuaçu is host to the Witch's Broom that attacks cocoa. Although cultural treatments are similar for both species this political resistance has not permitted the expansion of the cupuaçu culture, which would stimulate the necessary research. Thus research will have to be government sponsored and must include germplasm collection to find disease resistance, productivity and good quality fruit. A seedless variety has already been found in Pará and is being propagated. If disease and political barriers to cupuaçu culture can be overcome this species has excellent economic potential.

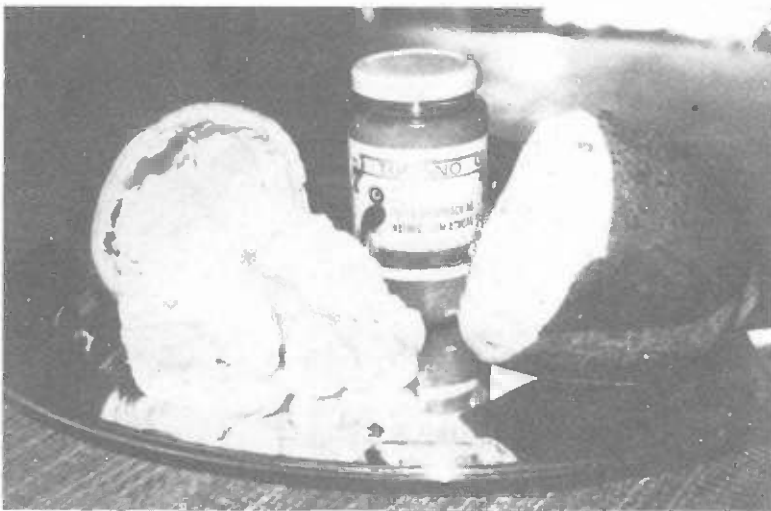
Plate LXXIV. *Theobroma grandiflorum* (Willd. ex Spreng.) Schum.



3.



2



3

LXXIV

- 1 = 1. Flower from top  
2. Flower from side  
3. Fruit

2 - Eight year old tree in full sun. Height 3 m.

3 - Mature fruit sectioned to show mesocarp and seeds.

BIBLIOGRAPHY

- Aguiar, J.P.L.; Marinho, H.A.; Rebêlo, Y.S. & Shrimpton, R. Aspectos nutritivos de algunos frutos da Amazonia. Acta Amazonica 10(4): 755-758. 1980
- Albuquerque, B.W.P. Contribuição ao conhecimento de Couma macrocarpa Barb. Rodr. e Couma utilis (Mart.) M. Arg. (Apocynaceae) da Amazônia. Acta Amazonica, 3(2): 7-15. 1973
- Altman, R.F.A.; De Oliveira, P.C.; De Oliveira e Silva, E.G.; Da Silva, M.L. & Da Silva Neves, M.C. Estudos sobre o fruto de Umari. INPA. Publicação Química no.8. 16 p. 1965
- Altman R.F.A. and Cordeiro M.M.C. de M. A industrialização do fruto do Buritf. INPA publ. Química no. 5. 20 p. 1964
- Alves, F.T. Biologia da flor do cajueiro - Anacardium occidentale L. Síntese global dos trabalhos apresentados na "1ª Semana do Caju". Fed. Agric. Est. Ceará. Fortaleza, 105 p. il. 1972
- Ansejo, C.F. & Gusman, A.F. The high ascorbic acid content of the West Indian cherry. Science 103. 1946
- Araujo Feio, P.L. Anacardium occidentale L. Cajueiro. Rev. Flor. Med. 8:1. 1941
- Argoviensis, J.M. Apocynaceae. in Martius, Fl. Brasiliensis 6(1): 23-25, 185-187. 1860
- Azambuja, D. Contribuição ao conhecimento das Apocinaceae encontradas no Brasil. Arq. Serv. Florestal, R. Janeiro, vol. 3: 9-112. il. 1947
- Bailey, L.H. The Standard Cyclopedia of Horticulture. New York, The Macmillan Co. vol. 2:1201 - 2422. il. 1929
- Balick, M.J. Jessenia bataua and Oenocarpus Species: Native Amazon Palms as new sources of Edible Oil. p. 141-155 in New Sources of Fats and Oils. Editors Pryde E.H. et al. American Oil Chem. Soc. 1981
- Balick M.J. and Gershoff S.N., Nutritional Evaluation of the Jessenia bataua Palm: Source of High Quality Protein and Oil from Tropical America. Econ. Bot. 35(3) 261-271 1981
- Balick, M.J. Palmas neotropicaes: nuevas fuentes de aceites comestibles. Interciencia 7(1): 25, il. 1982
- Barbosa, W.C., Nazare, R.F. et Nagata, I. Estudo tecnologico de frutas da Amazonia. Belem, CEPATU - EMBRAPA. Comunicado Técnico 3, 18 p. 1978
- Barros, R. da Costa. O. Dirigente Rural - Lavoura:20. 1965
- Beckerman, S. The use of Palms by the Bari Indians of the Maracaibo Basin. 1977
- Benza, J.C. 143 Frutales Nativos. Univ. Nac. Agraria "La Molina", Lima, Peru. 1980

- Bohórquez R., J.A. Monografia sobre *Mauritia flexuosa* L. et F. p. 233-245 in 1976 IICA Simposio Internacional sobre plantas de interes economico de la flora Amazônica. no. 93 Turrialba. Costa Rica 292 p.
- Bondar, G. Palmeiras do Brasil. Bol. Inst. Bot. Secr. Agric. S. Paulo. 2, 1964 159 p. il.
- Bourke, D. O'D. *Annona* spp. In: Garner, R.J., et al. The propagation of tropical 1976 fruit trees. Hort. Review 4. FAO/CAB. England. 566 p.
- Braga, R. Plantas do nordeste, especialmente do Ceará. Fortaleza, Imprensa 1960 Oficial, 2a ed. 540 p.
- Braun, A. Cultivated Palms of Venezuela 899. Reprinted from Principes J. 1968 of the Palm Soc. Vol. 12 nos. 2, 3 and 4.
- Calzada Benza, J. El "Arazá". Frutal de Gran Provenir para la Selva. INIA (Mimeografado).
- Calzavara, B.B.G. Fruteiras: Abieiro, Abricozeiro, Bacurizeiro, Biribazeiro, 1970 Cupuaçuzeiro. Série: Culturas da Amazônia. Vol. I, no. 2:45-84. IPEAN-Belém.
- Calzavara, B.B.G. Fruteiras. Inst. Pesq. Agrop. Norte. Belém, 42 p. 1970 (Culturas da Amazônia, 1).
- Calzavara, B.B.G. As possibilidades do açazeiro no estuário Amazônico. 1972 FCAP Bol. no. 5. Belém, PA; Brasil. 103 p.
- Calzavara, B.B.G. O. cajueiro (*Anacardium occidentale* L.) e suas possibilidades 1973 cultarais no litoral paraense. Esc. Agron. Amaz. Belém, Bol no. 2.
- Castañeda, R.R. Frutas Silvestres de Colombia. Vol. 2. 383 p. Universidad 1969 Nacional de Colombia. Bogotá.
- Cavalcante, M.C.P.B. Oleo de Castanha de Cotia. Inst. Nacional de Tecnologia. 1947 Rio de Janeiro. 40 p.
- Cavalcante, P.B. Frutas Comestíveis da Amazônia. 3a Ed. INPA-Belém. 166 p. 1976
- Cavalcante, P.B. Contribuição ao conhecimento das Gnetáceas da Amazônia 1978 (Gimnospermas). Acta Amaz. 8(2): 201-215, il.
- Clement, C.R. Considerações sobre a sapota da América do Sul, *Quararibea* 1982 *cordata* (Humb. & Bonpl.) Vischer. Proc. Trop. Reg. ASHS 25: 427-432.
- Correa, M.P. Dicionário das plantas úteis do Brasil e das exóticas cultivadas. 1926 Imprensa Nacional, Rio de Janeiro, Vol. I, 747 p. il.
- Cuatrecasas, J. A taxonomic revision of the Humiriaceae. Contr. United States 1961 Nat. Herb, Washington, 35(2), 214 p. il.
- Cuatrecasas, J. Cacao and its Allies: A Taxonomic Revision of the Genus *Theobroma*. 1964 Contrib. U.S. Nat. Herb. 35(6): 379-614.
- Dahlgren, B.E. Index of American Palms. Field Mus. Nat. Hist. Bot. Sér. 1936 Vol. 14, 438 p.
- De Souza, A.H. Castanha do Pará. Estudo Botânico, Químico, Químico e Tecnológico. 1963 Estudos Tec. no. 23. Min. da Agricultura. Rio de Janeiro, 69 p.

- Drude, O. *Palmae*, in *Mart. Fl. Bras.* 3(2), 610 p. il.  
1881
- Ducke, A. *Pajurá e oiti-coró*. *Arq. Mus. Nac. Rio de Janeiro* 22:61-68, il.  
1919
- Ducke, A. *Plantes nouvelles ou peu connues de la région Amazonienne II*.  
1922 *Arc. Jard. Bot. R. Janeiro*, 3:204.
- Ducke, A. *Espèces nouvelles de plantes de l'Amazonie Brésilienne*. *Bull. Nat.*  
1932 *d'Histoire Naturelle. 2ème Série* 4(6): 720-749.
- Ducke, A. *O genero Mouriri na Amazonia Brasileira* In: *Reunião Sul-Amer.*  
1938 *Bot. I. Rio de Janeiro, Anais Acad. Bras. Ci. Vol.* 3:67.
- Ducke, A. *O gênero Anacardium na Amazônia brasileira*. *An. Acad. Bras. Cienc.*  
1939 11(1):11-17, il.
- Ducke, A. *Plantas de cultura precolombiana na Amazônia brasileira. Notas sobre*  
1946 *as espécies ou formas espontâneas que supostamente lhes teriam dado*  
*origem. Bol. Tecn. Agro. Norte* 8, 24 p.
- Ducke, A. *Notas sobre a flora neotrópica - II. As Leguminosas da Amazônia*  
1949 *brasileira, 2d ed. Bol. Tecn. Inst. Agron. Norte, Belém*, 18, 249 p.
- Ducke, A. & Black, A. *Notas sobre a fitogeografia da Amazônia brasileira*.  
1954 *Bol. Tec. Inst. Agro. Norte*, 29 Belém, 62 p.
- D'Utra, G. *A mangabeira e sua cultura*. *Bol. Inst. Agro. Est. S. Paulo e*  
1899 *Campinas*, 10(8): 514-536.
- Eckey, E.W. *Vegetable Fats & Oils*, 836 p. Reinhold Publ. Corp. New York.  
1954
- Falcão, M.A. and Lleras, E. *Aspectos fenológicos, ecológicos e de produtividade de*  
1980 *umari. Acta Amazonica* 10(3) 445-462.
- Falcão, M.A. & Lleras, E. *Aspectos fenológicos, ecológicos e de produtividade do*  
1980 *Mapati (Pourouma cecropiaefolia Mart.). Acta Amazonica* 10(4): 711-724.
- Falcão, M.A. and Lleras, E. *Aspectos fenológicos, ecológicos e de produtividade*  
1981 *da sorva (Couma utilis Muell. Arg.). Acta Amazonica* 11(4) 729-741.
- Feijao, R.O. *Elucidário Fitológico. Inst. Bot. de Lisboa, 2v. vol. 1, 472 p.*  
1960 *(Artigo de Divulgação no. 8)*.
- Feitosa, J.C. & Feitosa, D.A. *Sintese global dos trabalhos apresentados na*  
1972 *"la Semana do Caju". Fed. Agric. Est. Ceará. Fortaleza*, 105 p. il.
- Ferreira, S.A.N. *Observação da germinação de sementes de Araça-pera (Psidium*  
*acutangulum D.C.). Acta Amazônica (in press)*.
- Ferreira, R. *El "Camu-Camu", Nueva Fuente Natural de Vitamina C. PCEA Informe*  
1959 *Mensal, Ano 33, no. 385. Lima, Peru*.
- Figueroa Z.R. *La Castaña (Bertholletia excelsa H.B.K.). p. 257-263. in I.I.C.A.*  
1976 *Simpósio Internacional sobre Plantas de Interes Económico de la*  
*Flora Amazonica. Turrialba, Costa Rica*.
- Floch, H. & Gélard, A.M. *La cerise ronde de Cayenne, Malpighia puniceifolia L.;*  
1955 *sa richesse exceptionnelle en vitamine C. Arch. Inst. Pasteur Guyane*  
*Française Terr. Inini*, 16(368): 1-6.

- Fonseca, E.T. Frutas do Brasil. R. Janeiro, Inst. Nac. do Livro, 281 p.  
1954
- Fougue, A. Espécies frutíferas d'Amérique tropicale: Famille des Anonacees.  
Fruits 27(1).
- Fougue, A. Espécies frutíferas d'Amérique tropicale: Famille des Moracée.  
1974 Fruits. 29(6).
- Glassman, S.F. A revision of B.E. Dahlgren's Index of American Palms,  
1972 Phanerogamarum Monographiae Tomus VI. Germany.
- Gomes, P. Fruticultura Brasileira. Bibl. Rural/Livraria Nobel, São Paulo.  
1977 448 p.
- Guimarães, F.A., Holanda, L.F.F. de, Maia, G.A., and Moura FÉ J. de A. Estudos  
1982 Analíticos e físicos em polpa e sementes de Pitanga, Cienc. Tecnol.  
Aliment. 2(2) 208-215.
- Guimarães, M.C. de F., Souza H.B. de, Melo C.F.M. de, and Ribeiro J.F.  
1970 Composição das tortas oleaginosas comercializadas no Pará. I.P.E.A.N.  
Serie Tecnologia 1(1) 6-18.
- Hoehne, F.C. Frutas indígenas. Inst. Botânica, São Paulo, 88 p.  
1946
- Huber, J. Duas sapotaceas novas do Horto Botanico Paraense. Bol. Mus. Goeldi  
1902 Hist. Nat. Ethnogr. Belem 3:54-59, il.
- Huber, J. Notas sobre a pátria e distribuição geográfica das árvores  
1904 frutíferas do Pará. Bol. Mus. Goeldi Hist. Nat. Ethnogr.,  
Belem, 4:375-406.
- Huber, J. Arboretum Amazonicum. Belem, Mus. Goeldi, 4a dec. il.  
1906.
- Hunter, J.R. The lack of acceptance of the pejibaye palm and a relative  
1969 comparison of its productivity to that of maize. Econ. Bot. 23(3):  
237-244.
- Johannessen, C.L. Pejibaye palm: Yields, prices and labour costs.  
1966 Econ. Bot. 20(3): 302-315.
- Johannessen, C.L. Pejibaye palm: Physical and chemical analysis of the fruit.  
1967 Econ. Bot. 21(4): 371-378.
- Johnson, D.V. O. caju no nordeste do Brasil - um estudo geográfico.  
1974 Depto. de Estudos Econômicos do Nordeste (ETENE). Fortaleza.  
169 p. il. (Tese de Ph.D.).
- Le Cointe, P. Apontamentos sobre as sementes oleaginosas, os balsamos e as  
1927 resinas da floresta Amazônica, 3a Ed. Belém.
- Le Cointe, P. O. Estado do Pará. A Terra, A Água e o Ar. S. Paulo,  
1945 Ed. Nacional, 305 p. il.
- Le Cointe, P. Amazônia Brasileira III, Arvores e plantas úteis (indígenas  
1947 e aclimatadas) 2ed. S. Paulo, Ed. Nacional 506 p. il (Brasiliana, 251).
- Leme Jr., J. A vitamina C em algumas plantas brasileiras e exóticas.  
1951 Piracicaba, Rev. de Agricultura 26 (9-10): 319-330.
- León, J. Fundamentos Botánicos de los Cultivos Tropicales. IICA/Costa Rica,  
1968 487 p.



- Llanos, L.A., Palmeiras Nativas de Bolivia de Valor Economica p. 87-97 in IICA  
1976 Simposio Internacional sobre plantas de interes economico de la flora  
Amazônica. No. 93. Turrialba. Costa Rica.
- Loureiro, A.A.; Silva, M.F. & Alencar, J.C. Essências madeireiras da Amazônia.  
1979 2 Vol. INPA, Manaus.
- Machbride, J.F. Flora of Peru. Field Mus. Nat. Hist. Bot. Vol. XIII. II (2).  
1937
- Maheshwari, P. & Vasil, V. Gnetum. New Delhi, Council of Scientific & Industrial  
1961 Research, C. 142 p. (Botanical Monography, 1).
- Maranca, G. Fruticultura Comercial - Mamão, Goiaba, Abacaxi. 2a Ed. Nobel -  
1981 S. Paulo, 121 p.
- Maravalhas, N.; Rodrigues, W. & Da Silva, M.L. Castanha Pendula ou Castanha de  
1965 Galinha - Valor Econômico. INPA. Publ. Quimica no. 9. 9-12.
- Markgraf, Fr. Monographie der Gattung Gnetum. Bull. Jard. Bot. Buitenz.  
1930 Ser. 3, 9(4): 448-455.
- Markley, K.S. Fat and oil resources and Industry of Brazil. Econ. Bot. 11.  
1957 91-125.
- Markley, K.S. The Babassú oil palm of Brazil. Econ. Bot. 25(3).  
1971
- Martin G. and Guichard P.H. A propos de quatre palmiers spontanés d'Amérique  
1979 Latine. Oléagineux, 34. 375-384.
- Martinez, S., J.B. El Inchi (Caryodendron orinocense Karst.). Manuscript.  
1970 52 p. Faculdade de Agronomia, Universidade de Nariño. Colombia.
- Martins H., Teixeira L.C., de Oliveira A.M. Macaúba Preliminary Report 50 p.  
1983 CETEC. Belo Horizonte, Brazil.
- Martius, C.F.P. Historias Naturales Palmarum.  
1826
- Mattar, H. Industrialization of the Babassú palm nut. in Proc. Conf. on  
1979 Ecodevelopment and Ecofarming. Science Foundation Berlin. 34 p.
- McVaugh, R. Flora of Peru. Field Museum of Natural History. 12 (pt. 4, no. 2):  
1958 812-13. Chicago, U.S.A.
- McVaugh, R. Myrciaria. Memoirs NY Bot. Gard. 18(2).  
1969
- McVaugh, R. Botany of the Guyana Highland. Part VIII. Mem. New York Bot. Gard.  
1969 18(2): 55-287.
- Medina, J.C. et alii. Série Frutas Tropicais - 2. Abacaxi - da cultura ao  
1978 processamento e comercialização. ITAL - S. Paulo. 200 p.
- Meulen, G.F. Vander. A real green Revolution, Agric. Consulting Bureau for the  
1977 Tropics. The Hague, 94 p.
- Monachino, J. Revision of Hancornia (Apocynaceae). Lilloa, Tucuman. 11:19-48.  
1945

- Mora Urfí, J. & Solis, E.M. Polinización en Bactris gasipaes H.B.K. (Palmae).  
1980 Rev. Biol. Trop. 28(1):153-174.
- Morley, T. Melastomataceae - Tribo Memecyleae. (Flora Neotropica, monograph 15)  
1976 New York Bot. Garden, 295 p.
- Moura Campos et al. Valor nutritivo de frutas brasileiras. Arq. Bras. Nutrição  
1951 (Maio, Junho), 220.
- Muller, C.H. Castanha-do-Brasil. Estudos Agronômicos. EMBRAPA/CPATU.  
1981 Doc. no. 1. Belém, 25 p.
- National Academy of Science. Under-exploited Tropical Plants with promising  
1975 Economic Value. 188 p. Washington D.C.
- Niedenzu, F. Malpighiaceae I. in: Engler, Das Pflanzenreich. Weinheim, H.R.  
1956 Engelman. B.4, h. 141.
- Ochse, J.J.; Soule, Jr., M.S.; Dijkman, M.S. & Wehlburg, C. Cultivo y mejora-  
1974 miento de plantas tropicales y subtropicales. Ed. Limusa, Mexico. 2 Vol.
- O.N.E.R.N./AID. Use of remote sensing systems. Evaluating the potential of the  
1977 Aguaje Palm tree in the Peruvian jungle. ONERN Lima 35 p.
- Ooi, S.C., Da Silva, E.B., Muller A.A., Nascimento, J.C. Oil Palm Genetic  
1981 Resources - native E. oleifera populations in Brazil offer promising  
sources. Pesq. Agropec. Bras. Brasilia. 16(3):385-395.
- Parente, J.I. & alii. Cajueiro: aspectos econômicos e agronômicos. Esc. Agr.  
1971 Univ. Fed. Ceará. Fortaleza.
- Patino, V.M. El cachipay o pijibay en la cultura de los indigenas de America  
1958 Intertropical. America Indigena 18 (3): 1-331. Ediciones Especiales  
Num. 39. Inst. Indigenista Interamericano. Mexico D.F.
- Patino, V.M. Plantas cultivadas y animales domesticos em America Equinocial.  
1963 Tomo I. Frutales. (Cali, Imp. Departamental, 549 p).
- Paula, J.E. Estudos sobre Vochysiaceae - IV. Contribuição para o conhecimento  
1969 dos gêneros Vochysia e Erisma na Amazônia. Bol. Mus. Par. Emílio  
Goeldi, n. ser. Bot. 31, 23 p. il.
- Pechnik, E. & Guimarães, L.R. Contribuição ao estudo dos alimentos da região  
1959 Amazônica. Arc. Bras. Nut. 15(1): 15-24.
- Peixoto, A.R. O. caju. Serviço de Informação Agrícola. Rio de Janeiro,  
1960 60 p. il. (Produtos Rurais, 13).
- Peixoto, A.R. Plantas Oleaginosas Arbóreas: Oliveira, Tungue, Dendê, Coqueiro,  
1973 Buriti, Balagu, Piquí, Oiticica, Pinhão. Bib. Rural, Liv. Nobel,  
Sao Paulo. 284 p.
- Pesce, C. Oleaginosas da Amazônia. of. Graf. de Revista do Veterinária. Belém,  
1941 Brazil, 164 p.
- Pimentel Gomes, F. Fruticultura Brasileira. 446 p. Livraria Novel S.A.  
1977 São Paulo.
- Pinhedo, P.M.; Ramirez, N.F. & Blasco, L.M. Notas Preliminares sobre el Arazá  
1981 (E. stipitata), Frutal Nativo de la Amazonia Peruana. INIA/IICA.  
Pub. Mis. no. 229, Lima.

- Pinto, G.P. O óleo de Patauá. Boletim Técnico do I.P.E.A.N. No. 23 p. 66-77  
1951 Belém, Brazil.
- Pinto, G.P. O óleo de uxi; seu estudo químico. Bol. Tecn. Inst. Agron. Belém 31,  
1956 309 p.
- Pires, J.M. & Schultes, R.E. The identity of Ucuqui. Bot. Mus. Leaf., Harvard  
1950 University 14(4): 87-93, il.
- Poliakoff, J. Le Macauba. Oleagineux. 16. 37-40.  
1961
- Popenoe, F.W. Manual of Tropical and Subtropical Fruits. New York,  
1974 Macmillan Publ. Co. Inc. 474 p.
- Prance, G.T. Flora Neotropica Mono. 9. Chrysobalanaceae. p. 227.  
1972
- Prance, G.T. New and Interesting Chrysobalanaceae from Amazonia. Acta  
1972 Amazonica 2(1) 7-16.
- Prance, G.T. The Correct Name for Castanha de Cutia. Acta Amazonica  
1975 5(2) 143-145.
- Prance, G.T. and Balick, M.J. Domestication of the Babassú Palm. Project  
1981 Proposal submitted to A.I.D. 26 p.
- Prance, G.T. & Mori, S.A. Lecythidaceae Part. I. Flora Neotropica. Mono  
1979 no. 21. 272 p.
- Prance, G.T. & Silva, M.F. Caryocaraceae. Monograph, Flora Neotropica.  
1973 Hafner Pub. Co. New York. 75 p.
- Prance, G.T. & Silva, M.F. Árvores de Manaus. INPA, Manaus, 312 p.  
1975
- Purseglove, J.W. Tropical crops: Dicotyledons. London, Longmans Group Ltd.  
1968 719 p.
- Radlkofer, L. Sapindaceae. In: Engler, A. Das Pflanzenreich.  
1956 Weinheim, H.R. Engelmann, B.l. H.4 (165), 1018 p. il.
- Ribeiro, J.F. A importância econômica do pequi. Cerrado, ano XI, no, 36: 24-26.  
1980
- Rizzini, C.I. Árvores e madeiras uteis do Brazil, Universidade de São Paulo.  
1971 294 p. Ed. Edgard Blucher Ltda. São Paulo.
- Robyns, A. Essai de monographie du genre Bombax s.l. (Bombacaceae).  
1963 Bull. Jard. Bot. Bruxelles 33(2): 231, il.
- Rodrigues, W. Castanha de Galinha, Simpósio Internacional sobre Plantas  
1976 de Interes Econômico de la Flora Amazonica. I.I.C.A. Trópicos.  
Informes no. 93 p. 229-230. Turrialba, Costa Rica.
- Romero Castañeda, R. Frutas silvestres de Colombia. Vol. 1. Bogotá.  
1961
- Rosenthal, F.R.T. Considerações sobre um projeto integrado de babaçu.  
1976 Informações de I.N.T. Rio de Janeiro 11. 22-28.

- Saénz Ch. A. Evaluacion cosecha de pejibaye Asociacion Bananera Nacional S.A.  
1978 Manuscript. 38 p.
- Schultes, R.E. Diversas plantas comestíveis nativas do Nordeste da Amazônia.  
1977 Acta Amazônica 7(3): 317-327.
- Serra, A. Climas da Amazonia. A lavoura, vol. 70.  
1967
- Stafleu, F.A. A monograph of the Vochysiaceae - IV. Erisma. Meded. Bot. Mus.  
1954 Herb. Rijksuniv. Utrecht, 3(4): 459.
- Standley, Paul C. Flora of Peru. Field Mus. of Nat. Hist. Bot. Ser. Chicago,  
vol. 13(6): 112 (Publ. 364).
- Tavares, J. da S. As Fruteiras do Brasil. Separatas da Revista Broteria.  
1912-1922 Série Vulgarização Científica. Vol. X-XX.
- Teixeira da Fonseca, E. Frutas do Brasil. MEC, Inst. Nac. do Livro.  
1954 Rio de Janeiro.
- Wallace, A.R. Palm trees of the Amazon (A facsimile reprint of the original  
1971 edition of 1853). Coronado Press, Lawrence, KA, USA, 129 p.
- Warburg, O. Les plantes à caoutchouc et leur culture. Le caoutchouc de  
1902 mangabeira. Paris, Augustin Challamel, p. 188-199.
- Warming, E. Vochysiaceae. in Mart. Fl. Bras. 13(2): 109.  
1875
- Wenkam N.S. and Miller, C.D. Composition of Hawaii Fruits. University of  
1965 Hawaii Bulletin no. 135. 87 p.
- Wessels Boer, J.G. The indigenous Palms of Suriname. Publ. E.J. Brill. Leiden.  
1965
- Whitman, W.F. The Camu-Camu, the "Wan" Maprang and the "Manila" Santol.  
1974 Proc. Florida St. Hort. Soc. Vol. 87.
- Wisniewski, A. and de Melo, C.F.M. Babaçu e a crise energética. C.P.A.T.U.  
1981 Documentos no. 2. 25 p. Belém.
- Zapata, A. Pejibaye Palm from the Pacific of Colombia (A detailed chemical  
1972 analysis). Econ. Bot. 26(2): 156-159.
- Zayas, J.C. La guayaba y otras frutas Myrtaceas. Inst. del Libro -  
1968 La Habana, 87 p.