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CHAPTER 19

Useful Plants of Amazonia: A Resource of Global Importance*

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CONTENTS

19.1. INTRODUCTION

Innumerable explorers and adventurers have searched the Amazon Valley in an intensive hunt for its treasures — minerals, oil, and precious metals were and are still the objects of this much publicised quest. Sometimes the results are successful. Brazil is currently developing a $60 billion project in the

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Amazon, 'Programa Grande Carajás' designed to, among other things, export 15 million tons of iron ore annually by 1985 and 35 million tons by 1987. In addition, some 14,000 kilos of gold have been mined from a nearby location (Ulman, 1982). However, upon the frustrating realisation that such treasures are not easily found and extracted, often man has taken out his anger on the forest itself — mechanically cutting and burning it, attempting to release the reservoir of nutrients contained within the forest ecosystem through their conversion to develop intensive agricultural activity. Once again when crop yields decrease after only a few harvests, people grasp the reality that a simple and expedient way of exploiting this green kingdom does not exist.

Indeed, the great treasure to be found within the Amazon is the most obvious — the vast biological array of living organisms. There are many tens of thousands of plant, insect, fish, and mammal species that inhabit this great tropical forest. Realistically accurate estimates of all the different kinds of organisms that live in the Amazon cannot be made, as many still remain to be discovered. Unfortunately, too few of us realise and appreciate this kind of wealth.

Numbering among its treasures, the Amazon forest contains a plethora of plants that have great promise for economic utilisation. Many of these plant species could be scientifically domesticated and used in agricultural programs within the Amazon Valley and elsewhere in the tropics. Some possess specific advantages for cultivation, such as the ability to grow under harsh conditions with minimal care, current acceptability as a food, construction, or fuel source by local peoples, and superior content or quality of oils, proteins, drugs, insecticides, waxes, or other products of importance to an industrialised society. Without such a verdant and diverse flora the ability of humans to survive and indeed flourish in the Amazon Valley would be greatly diminished.

The plants outlined in the following pages represent a selection of those Amazonian native species which were important in the past, are currently in use, or have much greater potential for future benefit. A complete treatise on the range of economic plants of the Amazon Valley would fill many volumes, and even then would be lacking. Thus, in this chapter, I will focus on only a few of the important species, to substantiate the theme that the Amazonian flora is a resource of global importance.

19.2. SOME ECONOMIC PLANTS OF AMAZONIA

19.2.1. *Astrocaryum aculeatum* Meyer; *A. murumuru* Mart.; *A. vulgare* Mart.

Regional names: 'Murumuru,' 'Tucumã,' 'Tucum' (Brazil) (Figs. 19.1 – 19.3).

Heavily spined trees, up to 20 m in height, these palms are common in many areas of lowland Amazonia, found in both moist and dry habitats. Among the commercial products obtained are palm heart and edible oil. One study of *Astrocaryum vulgare* reported the following proximate analysis of the fruit: water, 50%; carbohydrate, 19.1%; protein, 3.5%; fat, 16.6%; fibre, 3.5%; minerals, 1.3%; other, 6.0% (Chaves and Pechnik, 1947). This same study also reported that the Vitamin A content of 'Tucumã' is an astonishing 52,000 i.u./per 100 g of pulp, three times higher than that of the carrot, which is usually considered one of the best sources of Vitamin A. 'Tucumã' oil is calculated to have some 313,000 i.u. Vitamin A per 100 g. Analysis of the fatty acid composition of the oil reveals it to be similar to the coconut: Lauric acid, 48.9%; Myristic acid, 21.6%; Oleic acid, 13.2%; Palmitic acid, 6.4%; Capric acid, 4.4%; Linoleic acid, 2.5%; Stearic acid, 1.7% and Caprilic acid, 1.3%.

Fruits of these species are steamed and served in restaurants as appetizers in the major cities of the Amazon. Presently the entire crop is harvested from the wild stands. These stands are endangered due to the destructive nature of palm heart production as well as widespread habitat extinction.

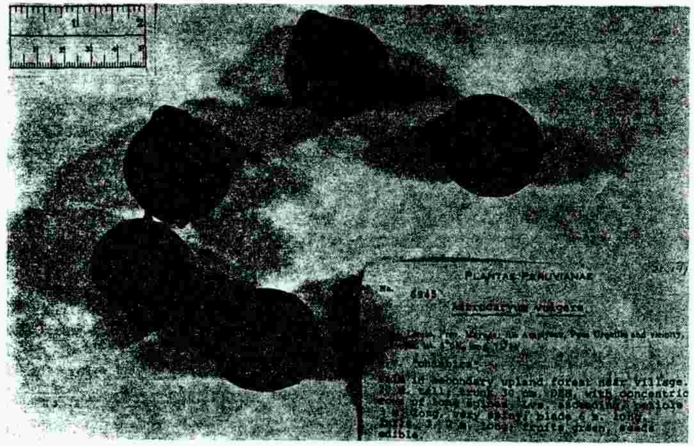

Fig. 19.1. Seeds of *Astrocaryum vulgare* collected from the Peruvian Amazon. Collection shown is *Plowman 6945*.

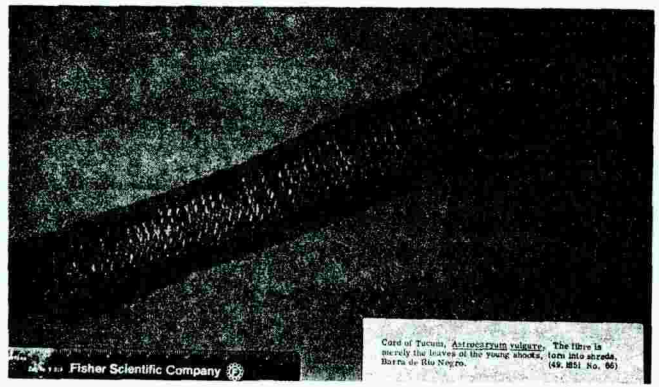

Fig. 19.2. Rope made from *Astrocaryum* fibre, collected by Richard Spruce in 1851. From the collections of the Economic Museum, Royal Botanic Garden, Kew.

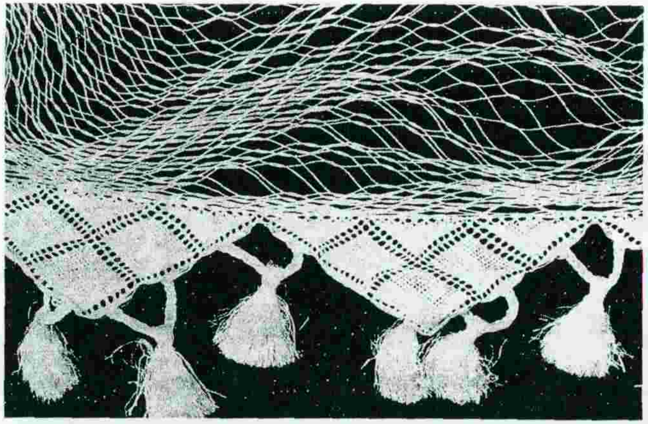

Fig. 19.3. Fibre from two palm species was used to produce this hammock, the edge of which is shown here. The fringes are made from *Mauritia flexuosa* while the main section of the hammock is woven from *Astrocaryum chambira*. Reprinted from *Economic Botany* 33(4) 1980.

An excellent durable fibre is extracted from the young leaves of *Astrocaryum tucuma*, also referred to as *A. chambira* Burret. Individual leaf pinnae are selected, bent in half, and fibres peeled off. These are then crushed in water, cleaned and spun into cordage, for fish lines, bowstrings, nets, hammocks, ceremonial dress, and other products where strength and durability are of prime importance. An indigenous hammock made of *Astrocaryum* fibre is said to last many, many years, an impressive statement considering the humid environment of the Amazon Valley.

19.2.2. *Bactris gasipaes* H.B.& K.

Regional names: 'Cachipay' (Colombia); 'Pifuayo' (Peru); 'Pupunha' (Brazil): 'Tembé' (Bolivia) (Figs. 19.4, 19.5).

This species, known as the 'Peach palm' in English, is a caespitose palm of up to 20 m tall, with a crown of incurved crispate leaves, each about 2 m long. The stem and leaf are variably spined. Panicles of globose-rounded, glabrous fruits, to a maximum of up to 300 per inflorescence are produced just below the crown. This species yields up to 13 bunches of fruit annually (MacBride, 1960; National Academy of Sciences, 1975). The fruits are orange to red on the exterior, and inside contain a yellowish, somewhat mealy flesh and hard seed. The flesh, when boiled, tastes like 'something between a chestnut and potato in flavour and superior to either' (MacBride, 1960).

'Pupunha' is an extremely valuable palm which has not yet truly been documented in a wild state. It is commonly cultivated, and is a good indicator of a former habitation site.

Over time, a number of forms have been selected and domesticated by Amazonian Indians who utilise the palm to the fullest: the trunk for house construction, bows, and arrow points, fruits for human food and when fermented for 5 days as an alcoholic 'chicha,' dried mesocarp as an edible, storable carbohydrate product, and the entire fruit as an animal feed. This palm can also be cultivated for 'heart of palm' and will yield a marketable product in 2.5 – 4 years from seed. Success in cultivation with minimal spacing per tree at the Las Cruces Tropical Botanical Garden, San Vito, Costa Rica was reported by Balick (1976) who also noted that researchers at Turrialba Tropical Research and Training Center had planted 2,200 palms per hectare which could be expected to yield thousands of hearts for harvest. In addition, the 'pupunha' is a suckering palm which still offers the same advantage as the *Euterpe* species usually harvested from wild sources — multiple stems providing many 'hearts' per tree.

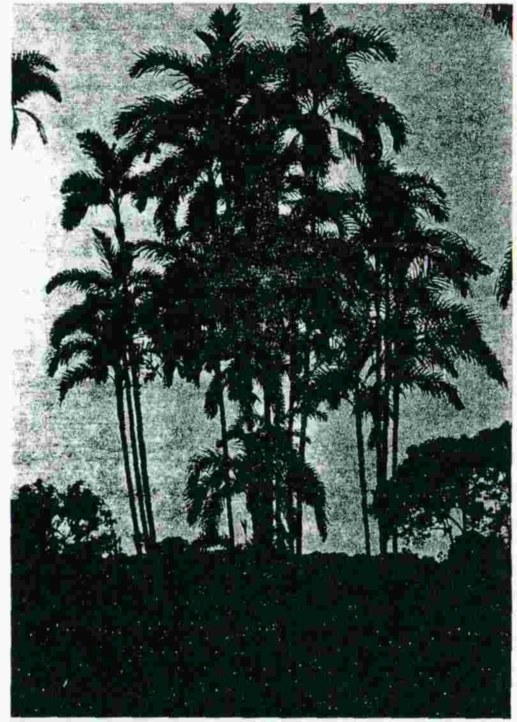

Fig. 19.4. A planting of *Bactris gasipaes* growing at the edge of a cultivated field.

Fig. 19.5. Removing the 'heart' from *Bactris gasipaes* in an experimental planting in Costa Rica. Reprinted from *Principes* 20(1) 1976.

The fruit of this species has twice the protein content of banana, and in cultivation will produce more carbohydrate and protein per hectare than maize (National Academy of Sciences, 1975). One study of nutrient composition of the fruits revealed the following ranges in 100 g of fresh fruit: fat, 1.61 – 9.45 g; protein, 1.37 – 2.85 g; Carotene, 70 – 603 μg; Niacin, 0.07 – 0.19 μg; Vitamin C, 0.10 – 2.38 mg (Johannessen, 1967).

The future challenge of 'pupunha' is not only to promote its widespread use as a staple food and commercial crop, but to introduce into wider cultivation its special forms, such as spineless trees or those with large parthenocarpic fruits, traits known to exist in isolated areas of the Amazon Valley. Already one company has introduced tinned fruits in Costa Rica, and living collections of genetic variants are being developed. This is an ideal tree for sustainable agronomic systems in the lowland tropics.

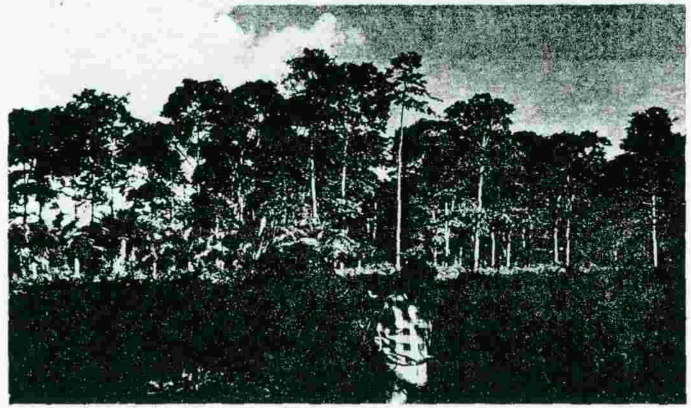

Fig. 19.6. Experimental plantation of Brazil Nuts (*Bertholletia excelsa*) in the Bolivian Amazon.

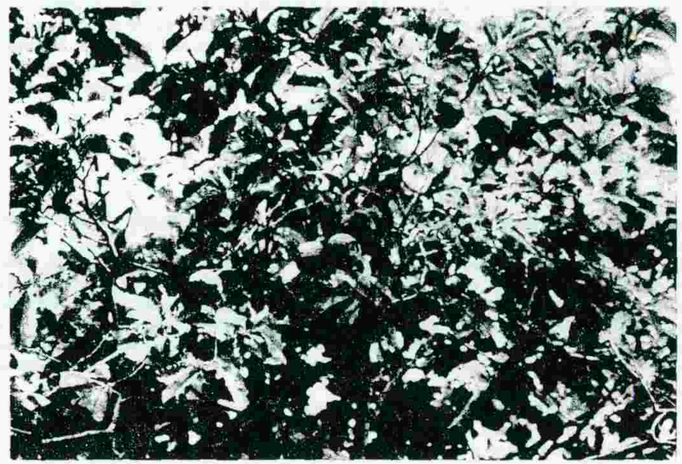

Fig. 19.7. Fruits of Brazil Nuts as they appear on the trees. (Photo by G.T. Prance).

19.2.3. *Bertholletia excelsa* Humb. & Bonpl.

Common names: Brazil Nut; 'Almendra' (Venezuela); 'Castanha-do-Pará' (Brazil); 'Castana' (Peru) (Figs. 19.6 – 19.9).

The Brazil Nut is one of the larger trees of the Amazon rainforest, growing to 40 m or more. Its crown of leathery leaves supports a mantle of erect panicles of yellow flowers. The so-called 'nuts' are produced in globose woody fruits, each containing some 12 – 24 seeds. In much of the Amazon, the fruits ripen in December and January after a full year of development and fall from the tops of the trees, scattering around the base where they are harvested. The 'nuts' are an important product of Amazonian Brazil, Peru and Bolivia.

Collectors split open the fruits in the field and sell them to local factories. 'Nuts' are then inspected and either shelled or shipped with their hard brown coating. Largest export markets are the United States, England and West Germany. The 'nuts' can be consumed raw, roasted or employed in confectionery. A recent report of the nutritional composition of Brazil Nuts offered ranges as follows: oil, 65 – 70%; protein, 13.9 – 17.0%; ash, 3.0 – 4.0%; crude fibre, 0.9 – 3.21%; water, 2.0 – 5.94%; carbohydrate, 3.83 – 10.1% (Prance and Mori, 1979). Attempts at plantation cultivation have not been particularly successful to date, because of the period needed to first fruiting (8 – 16 years) and poor fruit set. Accelerated studies on the taxonomic variation and pollination mechanisms currently underway (G.T. Prance, pers. comm. 1982) should shed new light on plantation possibilities. Brazil Nut would seem an ideal tree for use in agroforestry, especially in regions where it is already native — where the surrounding vegetation can be thinned out and additional Brazil Nut trees planted for harvest.

19.2.4. *Erythroxylum coca* var. *ipadu* Plowman

Common names: 'Coca', 'Ipadu', 'Yapadu' (Bolivia, Colombia) (Fig. 19.10).

This slight shrub, some 2 – 3 m in height and often with a scraggly appearance, has become the focus of international attention and debate, primarily because it contains the alkaloid cocaine. Two species of coca are cultivated for their alkaloidal content, Bolivian or Huanuco coca, *E. coca* Lam. and Colombian coca, *E. novogranatense* (Morris) Hieron. These are primarily cultivated in the Andean regions. Plowman (1979) described a variety of the former species, *E. coca* var. *ipadu*, identifying it as the characteristic coca cultivated in the Amazon Valley. Unlike the other kinds, Amazonian coca is only known in cultivation, and rarely produces seed. Indigenous peoples throughout the Amazon Valley appreciate the importance of coca, employing it as a masticatory, medicine, food, and in ritual ceremony. One important use in the areas where it is grown is to suppress hunger and fatigue, serving to ameliorate the rigours of a subsistence life-style.

Recent studies have shown the nutritional value of coca to be quite high. Duke *et al.* (1975) noted that consumption of 100 g of Bolivian coca leaves would meet the recommended dietary allowance for calcium, iron, phosphorus, Vitamin A, Vitamin B_2 and Vitamin E. Plowman (1980) estimated that an Andean coca user might consume up to 60 g of leaves per day, which would represent an important contribution to a rather poor diet. Alkaloids present in coca include cocaine, cinnamoylococaine, benzoylecgonine, and tropacocaine. By far the most important alkaloid is cocaine, present in quantities several times higher than the other alkaloids (Rivier, 1981). Burchard (1975) offered an interesting hypothesis linking coca-chewing to the control of blood glucose homeostasis and better carbohydrate utilisation.

The recent increased demand for cocaine has resulted in numerous illicit coca fields springing up throughout the Amazon Valley, along with 'factories' which produce a crude cocaine paste which is further refined elsewhere and smuggled into other countries for sale. It is unfortunate indeed that the many beneficial aspects of Amazonian coca will be overshadowed in the forseeable future by the intense controversy which surrounds it.

Fig. 19.8. Once the fruits of Brazil Nuts are located, they are split open in the field and the 'nuts' removed. (Photo by G.T. Prance).

19.2.5. *Hevea brasiliensis* (Willd. ex Adr. de Juss.) Muell. Arg.

Common names: Rubber; 'Caucho' (Colombia); 'Seringueira' (Brazil) (Figs. 19.11 – 19.14).

One of the most important species of *Hevea* from a commercial standpoint, *H. brasiliensis*, produces about 99% of the world's natural rubber. This is a fast-growing tree native to the lowland forests of the

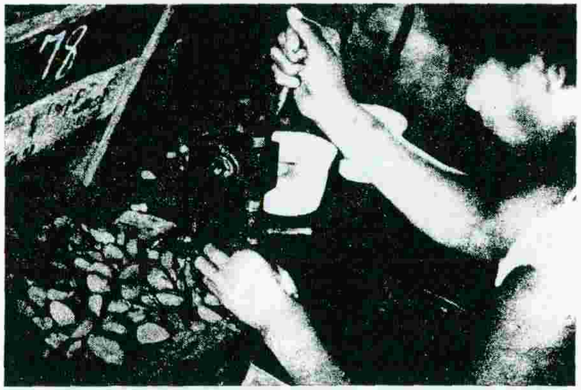

Fig. 19.9. Individual Brazil Nuts are cracked open with a small hand operated press, and the shells removed. (Photo by G.T. Prance).

Amazon Basin, common in seasonally inundated areas as well as in the drier uplands. In the wild, *Hevea* trees can reach to 40 m in height, but when in plantations the trees have a maximum height of 25 m. Whitish or yellow-whitish latex is obtained from the phloem cells which are tapped by cutting in as close to the cambium as possible without actually slicing through it. A knife with a V-shaped edge is used to cut channels into the tree at angles of 25 – 30°, beginning from the top left and extending to the bottom right. Increased yields and disease resistance are obtained by grafting bud wood on to nursery grown stock trees (Purseglove, 1974).

Some 9 species of *Hevea* are recognised. There are few comprehensive living collections of these species which could be used for breeding work — much fieldwork remains to be done. Incorporating genetic material of wild *Hevea* into currently existing agronomic stock would have important advantages. For example, certain interspecific hybrids between *Hevea brasiliensis* and *H. benthamiana* have shown resistance to *Phytopthora* leaf fall and die-back, as well as immunity to *Microcyclus ulei*, the South American Leaf Blight that has proven so fatal to New World plantations. Individual clones of *Hevea rigidifolia* have also shown resistance to leaf fall and die-back (Schultes, 1977). Other wild collections of *Hevea* have shown great promise for agronomic use. The forests of this region contain genetic material for an irreplaceable and unparalleled selection of variation in *Hevea* that must not be allowed to disappear. This important plant has not begun to reach the limits of its yields or cultural tolerance, and will do so only when the wide range of wild *Hevea* is properly collected, grown, analysed, and incorporated into existing stock. Although the great Amazonian empires based on the harvest of wild rubber collapsed with the introduction of cultivated rubber to the Old World at the beginning of this century, the harvest of this latex from wild and cultivated trees still is an important factor in the regional economy, especially in remote areas where so little else is produced. In addition, recent experiments in Venezuela cultivating *H. brasiliensis* in areas with a prolonged seasonal dry period have shown that incidences of disease are greatly reduced because the life cycle of the pathogen is interrupted and its ability to inflict injury to the trees is diminished (pers. obs.). Focusing on the agronomic manipulation of wild *Hevea* to better serve as a cultivated plant in its native range would seem a well-advised task of regional scientific and technical institutions throughout Amazonia.

Fig. 19.10. Field of *Erythroxylum coca* in the Northwest Amazon Valley of Colombia.

19.2.6. *Jessenia bataua* (Mart.) Burret

Regional names: 'Majo' (Bolivia), 'Milpesos', 'Patauá' (Brazil), 'Seje' (Colombia and Venezuela), 'Unghuaray' (Peru) (Figs. 19.15 – 19.18).

This stately palm with feathery leaves up to 8 m long grows to 20 m in height. It is restricted to lowland regions up to an altitude of 1,000 m. 'Patauá' is social in habit, and in swamplands may occur in pure stands of almost uncountable individuals. It is common throughout the Amazon Valley, and is highly esteemed by local inhabitants. Each year these trees produce large panicles of dark purple, ovoid fruits weighing 10 – 15 g each. The mesocarp of the fruit contain a high quality oil and nutritious pulp, both of which are exploited on a regional basis. The oil, light green or yellow in colour, is almost identical to olive oil in its physical and chemical properties (Table 19.1).

An amino acid analysis of *Jessenia bataua* protein, using the FAO/WHO provisional amino acid scoring pattern for comparison, has revealed that the protein of this plant is comparable to that of good animal protein and substantially better than most grain and legume sources of protein. In comparison with the biological value of soybean protein, *J. bataua* protein is almost 40% higher (Balick and Gershoff, 1981).

The closely related palm genus *Oenocarpus* is also used as a source of oil and protein-rich foodstuff. These palms, like many other potentially important species in the Amazon, have never been domesticated and cultivated. Basic biological and economic studies by Balick (1980) suggest that the *Jessenia – Oenocarpus* palm complex would be an excellent crop for the lowland tropics, especially if hybrids between the individual species were developed. Utilising the traits found in this complex, high yielding plants of small stature with large fruit clusters could be selected as an ideal tree crop for tropical agriculture. In the past Brazil exported 'patauá' oil in substantial quantities — from 1939 to 1949 a total of 924,392 kilos (Pereira-Pinto, 1951). Over-exploitation with little regard to future production has resulted in the decimation of once large stands in many areas and action must be taken if this important food source is to be utilised for wider human benefit.

19.2.7. *Lonchocarpus utilis* Killip & Smith; *L. urucu* Killip & Smith; *L. nicou* (Aubl.) DC.

Common name: 'Timbó' (Brazil).

Fish poisons derived from plants are common in Amazonia. Indigenous peoples utilise these materials by soaking the leaves and stems in a dammed up body of water, temporarily paralysing the fish which then float to the surface and are easily caught. Fish not collected soon recover and swim off as the dose used is usually just enough to stun rather than kill. In this way the river ecosystem is not destroyed, but rather it is preserved through selective harvesting. Rotenone is the principal active component of *Lonchocarpus utilis*, *L. urucu* and *L. nicou*, three species of fish poison from the Amazon Valley.

Rotenone is a colourless, odourless, crystalline solid poison, with a chemical formula of $C_{22}H_{22}O_6$. It is very toxic to cold-blooded animals. Because of its selective toxicity, rotenone is of great value as an insecticide, as it kills insects but is relatively harmless to mammals. The best source of rotenone is from the roots of *Derris* species from Indonesia, up to 12% by weight. However, *Lonchocarpus* is a

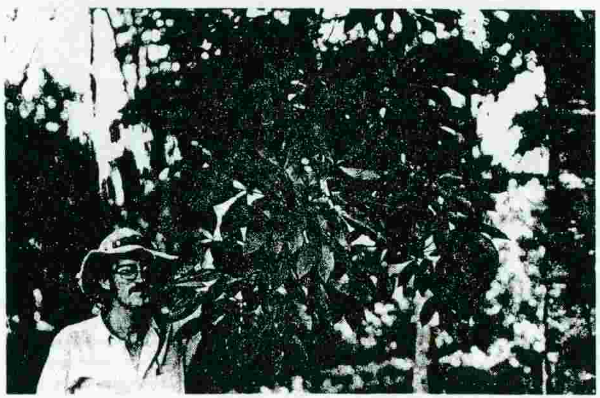

Fig. 19.11. Selection of wild rubber growing in a nursery in the Bolivian Amazon.

Fig. 19.12. Rubber tapper collecting from wild trees in the Bolivian Amazon. Harvest of rubber from wild trees still represents an important industry in the Amazon Valley, despite the advent of cultivated rubber elsewhere in the world.

commercially valuable source of rotenone, 2 – 4% by weight (Brady and Clauser, 1977). In 1946, the United States imported 11 million pounds of this product from Brazil and Peru (Purseglove, 1974). Brazil produced 30 tons of 'timbó' root in 1979, exclusively from the State of Pará (IBGE, 1979).

One interesting use of 'timbó' in Brazil was to eliminate or control populations of the 'piranha' fish in waters that could otherwise be filled with more valuable fish. It was discovered that 'timbo' in a proportion of three parts per million would totally eliminate the 'piranha' and its eggs within 15 minutes, causing minimal damage to other fish species. Between 1957 and 1961, 'piranha' was eliminated from some 48,000 km^2 of water systems, primarily in the State of Ceará. Apparently this technique was duplicated in the United States to restore balanced fish populations in waters affected by pollution (Rizzini and Mors, 1976). As the true lethal nature of more and more of the synthetically

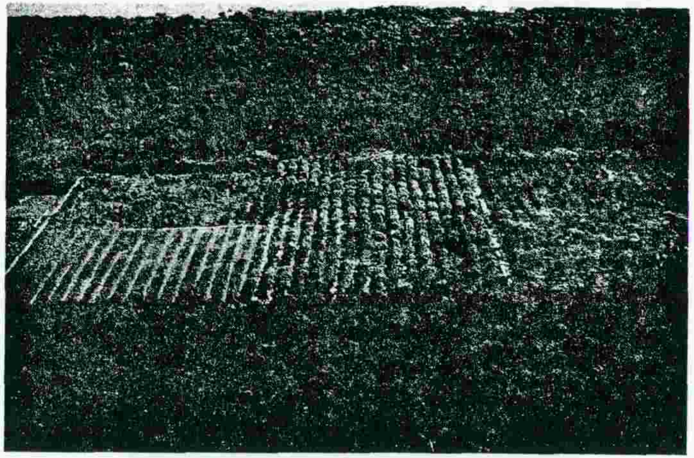

Fig. 19.13. Rubber germ plasm collection and experimental plantation in the Venezuelan Orinoco.

produced chemical pesticides is discovered it is important to realise that the Amazon Valley offers a wide spectrum of toxic plants whose derivatives could help fill an important role in our food production systems.

19.2.8. *Orbignya martiana* Barbosa Rodrigues; *O. speciosa* (Mart.) Barb. Rodr.; *O. oleifera* Burret; *O. phalerata* Martius.

Common names: 'Babaçú'(Brazil); 'Cusi' (Bolivia) (Figs. 19.19 – 19.21).

While this palm is native to the Amazon Basin, its major concentration occurs in areas somewhat peripheral to this region — in the states of Maranhão, Goiás, Piauí, Brazil and Santa Cruz, Bolivia. Here it forms the dominant vegetal cover over millions of hectares of dry grassland or 'cerrado' forest vegetation. No single specific epithet can be assigned to this palm as its present taxonomy is very unclear. Brazilian species have been called *Orbignya martiana*, *O. speciosa* or *O. oleifera*, while Bolivian populations are referred to as *O. phalerata*. Recent fieldwork in both countries leads me to suspect that the large, heavily fruited species in these two countries represent a single species or a very closely related group of species.

'Babaçú' is truly a remarkable palm for many reasons. It yields an industrial raw material (fruits) that can be processed into a plethora of useful products. In addition, its aggressive nature and tolerance of stressed habitats makes it an ideal tree for use in degraded ecosystems. When established, 'babaçú' forms a cover not only providing useful products but offering a home for economically important animal species, including people. A myriad of products can be derived from its fruits (in per cent by weight): oil, 3.85%; feed cake, 3.15%; fertiliser cake, 2.9%; flour, 1.5%; animal ration, 3.5%; charcoal, 17.4%; methyl alcohol, 0.87%; tar, 4.64%, and acetic acid, 4.64% (Gonsalves, 1955). These numbers can vary somewhat, depending on the end use desired, e.g. through fermentation of starch in the mesocarp, increased yields of methyl alcohol can be obtained (Carioca *et al.*, 1978).

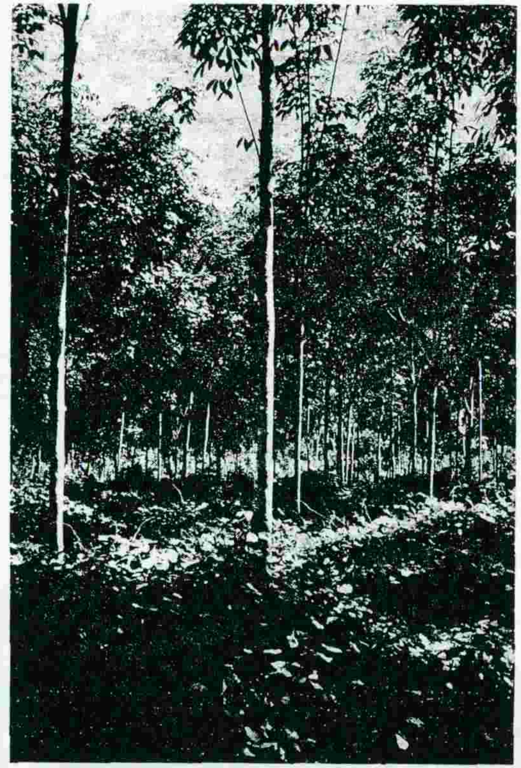

Fig. 19.14. Experimental plantation of rubber in the Venezuelan Orinoco, underplanted with legumes to control weeds and provide a source of nitrogen for the trees.

'Babaçú' fruits look like small coconuts, borne in clusters of a few dozen to several hundred. These fruits are hard, brown, vary in size from that of a plum to an orange, and weigh approximately 150 – 400 g each. Some *Orbignya* trees are recorded to yield one-half ton of fruits per year, but an average yield of ca. 15.6 tons per hectare of wild palms is sometimes cited (Carioca *et al.*, 1978). However, a study recently carried out by the State Babaçú Institute, offered evidence of much lower yields in a survey of 800 random points of babaçú distribution throughout Maranhão. According to that study, average production of babaçú in native stands in that state was about 1800 kg per hectare, with some sample plots yielding three times that amount (SUDENE/Estado do Maranhão, 1981).

'Babaçú's' special role may be yet to come — the reforestation of degraded tropical ecosystems with an economically important plant. When scattered on the soil surface, the fruits sprout and develop into seedlings which quickly and effectively establish themselves in the ecosystem. In fact, attempts at clearing 'Babaçú' forests with fire and machete usually result in the springing back to life of the younger trees as they are so hard to kill. In this era when resources are known to be finite, 'Babaçú' has potential as an inexhaustible source of a coal-like fuel (its charcoal is higher in volatile material and lower in ash

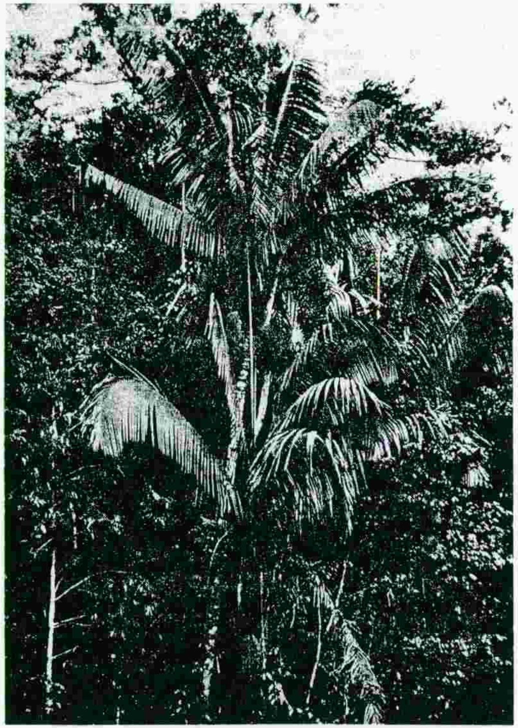

Fig. 19.15. *Jessenia bataua* growing along the river's edge in the Amazon Valley of Colombia. These plants stand about 15 metres tall. Reprinted from *Economic Botany* 35(3) 1981.

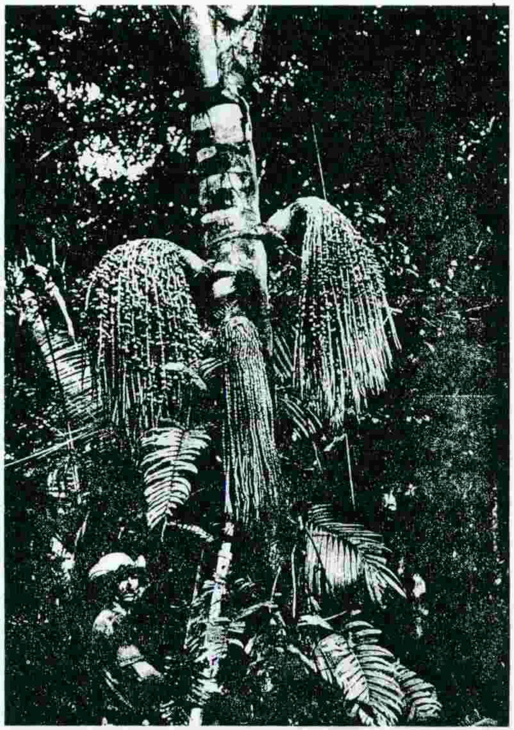

Fig. 19.16. Large fruiting panicles of *Jessenia bataua* are borne just below the leafy crown. Reprinted from *Economic Botany* 35(3) 1981.

than some mineral coals), methyl alcohol (from the mesocarp and endocarp), other industrial products (including plastics), food (edible oil, animal feed) and may be yet another important contribution from the tropical forest to our industrial society.

19.2.9. *Paullinia cupana* H.B.& K. and *P. cupana* var. *sorbilis* (Mart.) Ducke.

Common names: 'Cupana' (Venezuela and Colombia); 'Guaraná' (Brazil) (Figs. 19.22 – 19.24).

'Guaraná' is a scandent shrub in the Sapindaceae growing to a maximum of 10 m in height. Its large, glossy green leaves form great contrast to the terminal panicles of fiery orange – red capsules containing

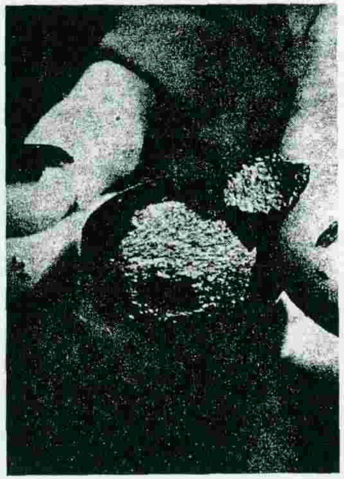

Fig. 19.17. Fruit of *Jessenia bataua* with the epicarp removed to reveal the oil-rich mesocarp. Reprinted from *Economic Botany* 35(3) 1981.

fleshy white arils and chocolate-brown seeds. When mature, these fruiting clusters seem like an aggregation of 'eyes'. The two varieties used to produce 'Guaraná' can be distinguished by their fruit size — those of *Paullinia cupana* var. *sorbilis* are about one-third the volume of the typical *P. cupana*. 'Guaraná' is considered native to areas around the Madeira, Maués and Ramos rivers, as well as the upper Orinoco and Negro rivers (Machado, 1946).

The seeds of this shrub are highly valued as a stimulant, due to their high caffeine content of 4.3% — some 3 – 5 times as much as coffee. Tannic acid content is also high with a range of 5 – 10% (Winton and Winton, 1939). Local people use this plant by harvesting the seeds and preparing them into thick sticks of dry, hardened paste which can be stored and transported. The ripe seeds are collected and sun-dried, their fleshy arils removed and the seeds baked. These are ground into a fine powder and with the addition of a small amount of water acquire a dough-like consistency. A few coarsely ground seeds are then mixed in and the mass kneaded into sticks approximately 5 – 8 inches long and 1 inch thick. Heat from the cooking fire ensures that the product will store well. Re-constitution involves simply rasping the stick against a rough object; in Brazil the tongue of the 'pirarucu' fish is used for this purpose. The resulting powder can be mixed with water and consumed either hot or cold.

'Guaraná' is a tremendously popular beverage in Brazil, sold as a carbonated, bottled beverage under a variety of names. Consumer demand is spreading into other countries in Latin America as well as the United States. In 1979, Brazilians consumed over 15 million bottles of 'Guaraná' soda per day. Coca Cola markets a 'Guaraná' product, known as 'Taí', and exports to Paraguay, Uruguay and the United States are envisioned. In the first 8 months of 1981, Coca Cola (Brazil) produced 51 million litres of 'Taí' and 3.8 million litres of 'Fanta – Guaraná' (B. Holder, pers. com.; Hoge, 1979). Folk-medicinal

uses for 'Guaraná' in the Amazon include as a powerful tonic for general well-being, analgesic, aphrodisiac, against diarrhoea, for conditions of the heart, and a myriad of uses. It is not uncommon for an Amazonian to begin his or her day with a drink of hot 'Guaraná' — a few teaspoons of this powder mixed into a cup of steaming water.

Literature reports from 1889 mention 'Guaraná' included in medical pharmacopoeias (Simmonds, 1889). Recent advertisements in the North American media have offered 'Guaraná' pills as both diet aids and as an exotic natural stimulant, providing that 'little something extra — whether its dancing till dawn or making it through those incredibly slow days at the office, you should try Guaraná!' (Cosvetic Labs, 1980). Such interest has stimulated demand beyond local capacity and shortages in the market have resulted in a large jump in wholesale and retail prices. From 375 – 500 kg can be produced per acre each year, and in 1980/81 Brazil had plans to be producing 1215 tons, up some 275% over the 1976/77 level of 324 tons (Anon., 1977). Increased consumer use in the Amazon and elsewhere is expected to make 'Guaraná' an extremely important crop plant.

19.2.10. *Pourouma cecropiaefolia* Mart. ex Miq.

Common names: 'Imbauba do vinho', 'Mapati' (Brazil), 'Uvilla' (Colombia, Peru) (Fig. 19.25).

'Uvilla' is a medium-sized tree 10 – 15 m in height found in Amazonian Colombia, Peru, and Brazil. Its habit and leaf shape are similar to *Cecropia*, a common second growth tree of the Neotropics. The leaves of this member of the Moraceae are cordate-rotund and radiately parted, with obovate to oblong-lanceolate segments green above and white-scurfy beneath (MacBride, 1937).

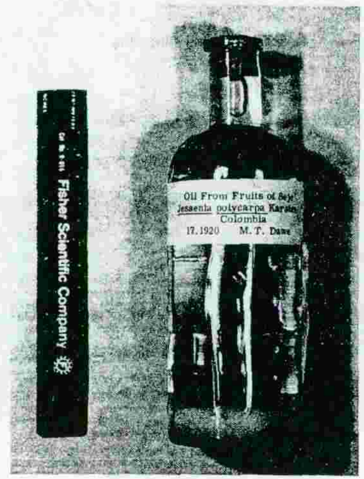

Fig. 19.18. A jar of *Jessenia bataua* oil collected in Colombia in 1920. From the Economic Museum, Royal Botanic Gardens, Kew.

TABLE 19.1. A comparison of the Fatty Acid composition of *Jessenia bataua* oil and olive (*Olea europaea*) oil.*

Fatty Acid	*Jessenia bataua*** samples, %	Olive oil samples, %
Palmitic	13.2 ± 2.1	11.2
Palmitoleic	0.6 ± 0.2	1.5
Stearic	3.6 ± 1.1	2.0
Oleic	77.7 ± 3.1	76.0
Linoleic	2.7 ± 1.0	8.5
Other	1.6 (range 0.2 – 4.6)	—

* (Balick and Gershoff, 1981).
** Values given as the mean ± standard deviation of 12 separate samples.

The most important product of this tree is its purplish, round, sweet, juicy fruits which are the size of a small plum. The fruits are borne in clusters of a few dozen each and begin to appear 3 years after planting. While the outer covering is somewhat bitter, the fruits are readily consumed by sucking the pulp and spitting out the seed. 'Uvilla' is often found cultivated near indigenous villages in the Amazon Valley and also harvested from the wild. In addition to its fruits, the leaves are burned to ash which is then used as an admixture to powdered coca.

While not difficult to grow, Indians have told me that seeds will not germinate if sucked into the mouth with the pulp. This has not been tested scientifically, but there is some indication that germination may be affected by certain as yet unknown factors. To-date there are no published results of agronomic trials, but domestication programs have been observed in Manaus, Brazil and Iquitos, Peru.

Perez Arbelaez (1947) pointed out that a related species, *Pourouma sapida* (Aubl.) Karst. yielded grape-like fruits which could be dried like raisins and also used to produce a fine wine. It would seem that 'uvilla' would make a good jam or an excellent fruit drink. Very little is known of the nutritional value of this fruit, chemistry of its flavouring, or overall industrial potential. Investigations on such aspects of 'uvilla' would certainly yield a wealth of new and valuable data on a plant which deserves far greater utilisation.

19.2.11. *Theobroma cacao* L.

Common name: 'Cacao'

The genus *Theobroma* is considered by Purseglove (1974) to have probably originated in the Amazon Basin. There are 22 species according to Cuatrecasas (1965), all of which are in the Neotropics. Ducke (1940) listed 9 species as Amazonian. While the cultivated forms of *Theobroma cacao* are primarily native to Central America and Mexico, one taxon, *T. cacao* L. subsp. *sphaerocarpum* (Chev.) Cuatrecasas is found in the Amazon Valley, and referred to as 'Amazonian Forastero'. This is the most widely cultivated cacao throughout the world.

Because of the early recognition of its economic importance long before the Spanish conquistadores set foot on the continent, cacao had been widely dispersed and cultivated in Mexico and Central and South America. The Spaniards were introduced to cacao in the court of Montezuma (Dahlgren, 1923). It is a commonly cultivated crop throughout the Amazon Valley, and provides substantial revenue for the countries in this region. Along the more remote rivers, 'semi-wild' cacao or that from small holdings is collected and sold.

There are a number of important cacao research programs in the tropics, with the goal of increasing yield, developing new cultivation systems, lessening disease problems, and improving flavour. The genetic base of this crop plant is not very great. Cacao is particularly susceptible to Black Pod Disease (*Phytophthora palmivora*) which among other things causes the pods to rot (Purseglove, 1974).

Fig. 19.19. *Orbignya* sp. in Bolivia.

Much remains to be accomplished in the collection and utilisation of all the wild and cultivated forms of cacao for commercial use. Germ plasm collecting projects have shown good results, such as the 1937 collections by Pound in Amazonian Ecuador and Peru which obtained clones resistant to Witches' Broom Disease. Exploration programs currently in Brazil and a number of Amazonian countries are collecting, cataloguing, and cultivating some of the great diversity within this genus. In addition to *Theobroma cacao*, *T. bicolor* H. & B. is grown for its seeds and edible, sweet pulp, *T. angustifolium* Moc. & Sessé seeds are sometimes mixed in the cacao for commercial use, and pulp from *T. grandiflorum* (Willd. ex Spreng.) K. Schum. is the source of a sweet beverage in Brazil known as 'cupuaçu'.

19.3. IDENTIFYING USEFUL SPECIES AND THE ROLE OF THE ECONOMIC BOTANIST

Much of the knowledge concerning the useful plants of the Amazon Valley is not available in books, professional journals, newspapers, or on film. This information is in the possession of the many indigenous peoples inhabiting this region. They do not catalogue their data in the traditional way; rather it is passed down from generation to generation, guarded by selected individuals who utilise it to benefit the entire community. In an ideal situation, that is without the influence of outsiders and other 'civilising' forces, the information is refined over generations, and the end product is an excellent panorama of uses for local plants. Most of the indigenous knowledge, in the early stages at least, is obtained through a system of trial and error. From the first trials some plants proved fatal, while others had a positive effect upon the person. With time, people came to know which plants had strong activity, such as against a disease or what was perceived to be an evil spirit lurking inside the body causing the disease or other affiliation. Those species of culinary value were also identified.

The study of plants either useful or harmful to people is known as economic botany. A subdiscipline of this field, known as ethnobotany, is the investigation of plants employed by people indigenous to a particular area. Thus it is through ethnobotanical inquiry that many useful plants from the Amazon have been identified and put to wider use. Curarine, an important alkaloid used to relax muscle tissue prior to surgical incision was discovered through analysis of the Amazonian Indian arrow poison known as curare.

But yet our modern utilisation of plants from the Amazon represents only the tip of a huge beneficial 'iceberg' of possibilities present in the Amazonian flora. Only through an accelerated program of field

Fig. 19.20. Low density stand of *Orbignya* sp. scattered in the forest. In some areas, *Orbignya* stands comprise almost 100% of the canopy vegetation.

Fig. 19.21. Grinding the kernels of *Orbignya* sp. to produce oil, in Bolivia.

inquiry, coupled with laboratory testing and agronomic domestication programs, will people directly benefit from the plants of this great forest. The current pace of research in this field is not proceeding with the sense of urgency needed to build up a program with inertial movement to achieve results. Far greater numbers of multidisciplinary studies must be initiated with the aim of identifying, evaluating and bringing into wider use the plethora of useful plants found in the Amazon.

19.4. PROGRESS IN GERM PLASM CONSERVATION OF AMAZON FOREST RESOURCES

The popular and scientific press has been all too full in the last decade with coverage of the 'problem' of the Amazon Valley. In analysing any dynamic system, whether it be a corporation, country, government, city or ecosystem, it is always easiest to speak of the problems. Indeed, it almost seems that human nature dictates an emphasis in this area. Far more difficult, but much more important, is a creative analysis of the possible solutions or actions relating to the 'problem'. In the case of the Amazon

Valley, the continued, even pedantic insistence by some scientists that nothing short of halting all human activity in that vast ecosystem tends to reduce the opportunity for creative analysis of possible solutions in the search for rational and sustainable systems of exploiting this resource. The current epidemic of negativism, especially in the First World media, only serves to demoralise scientists and policymakers actively working on developing sustainable resource systems and new plant introductions from the Amazon rainforest and to fragment and diminish their resources with which to do so. Emphasis must be shifted to covering the 'positive' research on sustainable rainforest utilisation, along with the realisation of the irreversibility of continued human impact at some level in the Amazon Valley, short of regional catastrophe.

Brazil, which contains much of the Amazon Valley within its borders, has made a serious commitment to inventory and preserve as much of the genetic diversity contained within the Amazon rainforest as possible, especially of currently and potentially useful plant species. Policymakers and

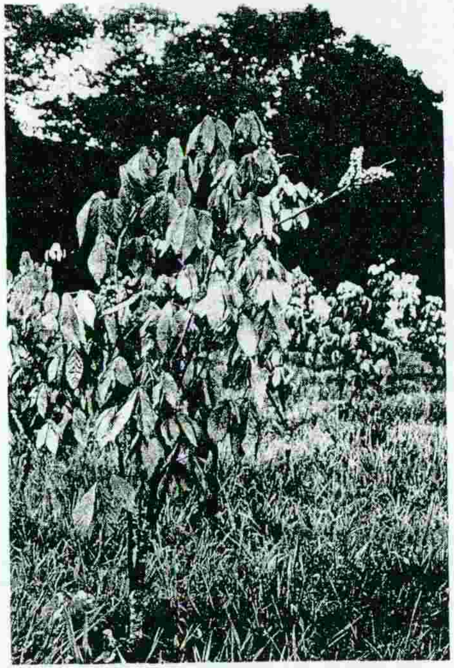

Fig. 19.22. *Paullinia cupana*, planted in an open field in Belém, Brazil. In this environment, 'Guaraná' becomes shrub-like in habit.

scientists in that country are undertaking a coordinated program of germ plasm collection, the creation of living germ plasm banks, and exchange programs designed to get new material into Brazilian agriculture and distribute existing stock to other countries.

CENARGEN, the Brazilian National Center for Genetic Resources (Centro Nacional de Recursos Genéticos) was created in 1974 as a unit of EMBRAPA, the Brazilian Enterprise for Agricultural Research (Empresa Brasileira de Pesquisa Agropecuária). Realising the paucity of genetic resources for use in improving Brazilian agriculture, CENARGEN was given the mandate to implement a continuing system of organisation for introducing, conserving, and documenting germ plasm. As part of this mandate CENARGEN is to collect and study germ plasm from forest plant species, both related to commonly cultivated crops and potentially useful new crop species. As of 1980 there were some 47 'active germ plasm banks,' or areas where genetically diverse collections of economic plant species were

Fig. 19.23. Close-up view of the ripe fruit of 'Guaraná'. Note the fleshy white arils which surround the shiny dark seeds.

being developed and expanded. These included commonly cultivated plants such as soybeans and rice to regional specialities such as 'Guaraná' (EMBRAPA, 1982). Priorities were established relating specifically to the Amazon Valley in 1981, with the addition or acceleration of activities in germ plasm collection and banking for 'Babaçú', *Elaeis oleifera*, rubber, and cashew to name a few (CENARGEN/EMBRAPA, 1981). Many of these programs are international in scope and involve the collaboration of scientists from a number of countries. For example, scientists from the New York Botanical Garden Institute of Economic Botany assisted in the creation of a germ plasm bank for 'Babaçú' in 1981, which is located in Bacabal, Maranhão. This external collaboration was supported by the Charles A. Lindbergh Fund and U.S. Agency for International Development. Through an agreement with CENARGEN, the 'Babaçú' germ plasm banks are managed by agronomists from the State Institute for 'Babaçú' (INEB — -Instituto Estadual do Babaçú) in Maranhão and the State Unit for Field Research in Teresina, Piauí (UEPAE de Teresina) and comprises germ plasm of this palm from many areas of Brazil, including that now in threatened ecosystems such as dam sites, as well as from other countries where 'Babaçú' is native, such as Bolivia. There is a great interest in conserving genetic resources in other Amazonian countries, although Brazil probably has the largest network of germ plasm banks at present.

Fig. 19.24. A stick of 'Guaraná' being grated against the tongue of the 'Pirarucu' fish, to produce a fine, water-soluble powder.

Fig. 19.25. *Pourouma cecropiaefolia* planted next to an Indian dwelling in the Northwest Amazon Valley of Colombia.

19.5. CONCLUSION

Many people derive their sustenance from the products of the Amazon rainforest. Although low in actual population density, this forest does support large numbers of inhabitants, dispersed along the many rivers and small cities of the region. Table 19.2 offers an interesting perspective on just how extensively used the native Amazonian flora is, outlining some of the many products derived from the forests of Amazonian Brazil (although not exclusively Amazonian in origin or distribution) and used in commerce. Many of the commercial products presently derived from this region are from forest trees which could be utilised on a far greater sustained basis. Policymakers and scientists from Amazonian countries and elsewhere must begin to address the options for sustained usage of this fragile resource. At the same time research on many broad fronts relating to the further utilisation of Amazonian economic plants must be intensified: basic biology, agronomy, anthropology, chemistry, ethnobotany,

TABLE 19.2. Native plants, primarily Amazonian, utilized commercially in Brazil* (harvested from the wild during 1979)

Commodity	*Tons*	*Value in 1000 Cruzeiros***
RUBBER		
Castilla ulei Warb. ("caucho")	994	32,445
Hevea (coagulated)	20,269	836,987
Hevea (liquid latex)	1,288	30,208
Hancornia speciosa Gomez ("mangabeira")	16	272
NON-ELASTIC GUMS		
Manilkara bidentata (DC.) Chev. ("balata")	358	10,913
Achras zapota L. ("chicle")	6	75
Manilkara elata (Fr. All.) Monac. ("maçaranduba")	435	8,855
Couma hileianas ("sorva")	5,197	72,543
Ecclinusa balata Ducke ("ucuquirana, coquirana")	1	13
WAXES		
Copernicia cerifera ("carnaúba")	19,920	695,717
FIBRES		
Mauritia flexuosa L.f. ("buriti")	394	9,546
Urena lobata L. ("guaxima")	27	191
Sida rhombifolia L. ("malva")	66	536
Attalea funifera Mart. ("piaçava")	55,186	551,770
Astrocaryum tucuma Mart. ("tucum")	95	1,657
Stryphnodendron barbadetiman (Vell.) Mart. ("barbatimão")	2,712	7,158
Rhizophora mangle L. ("mangue")	405	1,177
OILS		
Carapa guianensis Aubl. (kernel) ("andiroba")	277	469
Orbignya sp. (kernel) ("babaçu")	250,913	2,591,082
Copaifera spp. (oil) ("copaíba")	33	921
Dipteryx odorata (Aubl.) Willd. ("cumaru")	41	2,855
Astrocaryum murumuru Mart. (seed) ("murumuru")	24	24
Astrocaryum spp. (kernel) ("tucum")	11,724	88,688
Virola surinamensis (Rol.) Warb.; *V. sebifera* Aubl. (kernel) ("ucuuba")	84	374
FOODS		
Euterpe oleifera (seed) ("açai")	54,507	203,627
Bertholletia excelsa H. B. K. ("castanha-do-Pará")	43,242	460,298
Hancornia speciosa Gomez (fruit) ("mangaba")	1,101	3,645
Euterpe edulis Mart. and other palms (heart) ("palmito")	31,358	116,158
Hymenaea spp. (resin) ("jatoba," "jutaicica")	23	354
Lonchocarpus urucu Killip & Smith (root) ("timbo")	30	126
Bixa orellana L. (fruit) ("urucu")	538	10,452

* Source: IBGE, 1979.

** The approximate dollar value for the Cruzeiro during 1979 was CR$ 42.33/US$ 1.00 (personal communication, Bank of Brazil).

entomology, forestry, nutrition, pathology, zoology and other fields. Regional agencies must form networks to benefit not only from interaction with each other, but actively seek to increase collaboration of scientific and technical counterpart agencies throughout the world. One such network was recently established in the Amazon region — REDINAA (Red de Investigación Agraria para la Amazonia) a group comprising six Amazonian countries committed to strengthening agricultural research capabilities in this region.

A report by Boyer (1982) pointed out that while the genetic potential exists for high yields in today's conventional crops, actual yields fall far short of their potential. This is primarily due to the inability of traditional crop plants to adapt to the less than optimum environments which comprise 88% of U.S. agricultural lands. Among the major environmental limitations in the U.S. are drought, shallowness of soil profile, cold, and wet soils. He concluded that much more work needs to be done on adapting plants to environments that are less than optimal for growth. While this study was done in the temperate zone, the data and conclusions are equally valid for the tropics. Tropical ecosystems are less than ideal environments for conventional agricultural crops and work must proceed in identifying and developing plants able to tolerate such conditions, while still offering economic and sustainable yields. Many of the native Amazonian economic species are such plants. What is needed now is an increased commitment towards developing these multipurpose species to help feed, clothe, shelter, and provide fuel for our ever-growing global family. Indeed, as we are now coming to realise, the future is in the forest.

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This paper is fondly dedicated to my friends and colleagues in the Neotropics undertaking research involving the identification and utilisation of resources from the tropical forest. While they often work in relative obscurity, as this kind of research is not one of the most visible nor colourful of today's sciences, their contributions will be some of the most important to the future of both the developing and developed worlds. Dr. G. T. Prance kindly provided Figs. 6 – 8, Dr. J. L. Zarucchi kindly provided Fig. 15, and Mr. Rupert Hastings offered much-valued assistance in photographing Figs. 2 and 18. Figures 2 and 18 are reprinted with the permission of the Director, Royal Botanic Gardens, Kew.

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