Angew. Bot. 68, 47 - 52 (1994), © 1994, Vereinigung für Angewandte Botanik, Göttingen

EMBRAPA - Centro de Pesquisa Agroflorestal da Amazônia, Manaus-AM

Native Fruit Species of Economic Potential from the Brazilian Amazon*

Vicente H. de F. Moraes, Carlos Hans Müller, Aparecida G.C. de Souza, and Isaac Cohen Antônio

(Received April 18, 1994)

Summary

A brief account of geographic distribution, ecology, breeding, cultivation, post-harvest handling and processing is given for 7 selected indigenous amazonian fruit species (out of 76 species cited in the literature): *Theobroma grandiflorum*, *Byrsonima crassifolia*, *Platonia esculenta*, *Eugenia stipitata*, *Spondias lutea*, *Genipa americana* and *Myrciaria dubia*. These species are considered as having a possible increase in their economic importance through cultivation, which is already occurring with *T. grandiflorum*, or from more intensive extraction from natural stands. Taste peculiarities have long been a serious constraint for the widespread acceptance of many Amazonian fruits. Difficulty in cultivation is also a constraint for some species. On the other hand, a few lesser known species, not considered in detail in this paper, may eventually become important fruit crops.

1. Introduction

Native Amazonian edible fruits are described in several publications that include many wild or sub-spontaneous species (Cavalcante, 1972, 1974, 1976, 1979; Clement, 1982, 1989; Fao, 1987; Le Cointe, 1947; National Academy of Science, 1975; Van der Pahlen et al., 1979; Correa, 1952; Rehm and Espig, 1976). The pre-colombian Amazonian fruit-crops were described by Ducke (1946). A recent germplasm collection of pre-colombian crops, covering all of the Amazon, has been introduced at CPATU (EMBRAPA), Belém, including important fruit species (Lima and Costa, 1991).

Some Amazonian species occurring in higher densities in the forest, such as Brazil nuts (*Bertholletia excelsa*) and açai-palm (*Euterpe oleracea*, *E. precatoria*) are exploited already on a large scale, perhaps almost to their full potential as extractive products. In this paper we shall focus our attention into the underexploited species that gives good indication that may become important sources of income, based on the present state of knowledge.

A critical evaluation of the possibilities to increase the limited amounts of local production and consumption of most Amazonian fruits are presented in only a few cases, for instance in the Fao (1987) monograph, which nevertheless still consider species such as "mapati" (*Pouroma cecropiaefolia*), "sapota" (*Quararibea cordata*), "bacuri-pari" (*Rheedia macrophylla)* and "piquiá" (*Caryocar villosum*), among others.

Taste peculiarity is certainly a serious constraint to the general acceptance of most Amazonian fruits. The fruits of the "açai" palm-tree (*Euterpe oleracea*) are a very important food source in the State of Pará where around 108.000 tons of fruits (with 10 % pulp) are consumed annually. Smaller amounts of fruits of *E. precatoria* are also consumed in Western-Amazonian States. Nevertheless attempts to export "açai" in large amounts to southern Brazilian states have failed. Even after the ease to handle freeze-dried powder became available (Melo et al., 1988) the acceptance of "açai" remained limited mainly to regional consumption.

Peach-palm (*Bactris gasipaes*) fruits are another example. Despite the intensive studies carried out at the Interamerican Institute of Agricultural Sciences in Turrialba, Costa Rica, since the 1960's, the acceptance of peach-palm fruits is practically restricted to some Latin-American countries mostly as fresh cooked fruits, produced by small farmers on a reduced scale.

On the other hand dense native populations of *Euterpe oleracea* of the Amazon low lands are the most important source of palm-hearts in Brazil (195.000 tons per year) and *Bactris gasipaes* is probably the most suitable species for cultivation and production of palm-hearts.

Excluding the species not native to the Amazon taken from publications previously quoted, 76 fruit species of genuine Amazonian origin are still left. It may appear disappointing to be concerned here with only 7 species. This is however a necessity for the purpose of providing brief but more detailed informations on the species that are little known outside the Amazon but have already shown good prospects of becoming important economic crops. The fact of being already cultivated was taken into account as it reflects the farmer's experience both from the choice of species and the feasibility of cultivation. "Camu-camu" (*Myrciaria dubia*) is an exception as in the first trials it has shown unthrifty growth out of its natural habitat but it has outstanding flavour, an extremely high vitamin C content and its dense native populations are practically unexploited.

2. The species selected for Discussion

Complete botanical description of the species are found in the cited literature, as well as the vernacular and latin synonyms. For the sake of brevity only the more relevant descriptive aspects will be presented here.

2.1 Cupuaçu - *Theobroma grandiflorum* Schum. - Sterculiaceae.

Cultivated *Theobroma grandiflorum* is a small - sized tree, up to 10m tall. Unlike *T. cacao* it flowers only on the later flushes of branches. The fruit is big, on average 1kg, with a hard pericarp shell. Plants producing long fruits weighing up to 4kg have been recorded (Ribeiro, 1992). The edible mesocarp is a white fleshy pulp with a very sour taste and a strong but agreable aroma. The seed coat is thicker and coarser than that of seeds of cacao. Due to the high acidity of the pulp it is not palatable to be eaten as fresh fruit.

a) Distribution and remarks on ecology

"Cupuaçu" is found sub-spontaneously in the understores of the non-flooding plateau and the floodplain forests in the southeast of the State of Pará, comprising the valleys of the rivers Tapajós, Tocantins, Xingú, and Guamá (Calzavara, 1970) where it reachs 15-20m. A more reduced area is given by Cavalcante (1979) for the true native occurrence of "cupuaçu", confining it to the upper Itacaiunas river, between Itaituba and Altamira. Having been cultivated since pre-colombian times it is now difficult to determine precisely if the specimens found are subspontaneous or not. For instance, Dubois (1992) found evidences that the Brazil nut trees found at high frequency in the valley of the Xingu river may have been planted by the indians. Cupuaçu is found cultivated in the whole of the Amazon, and also in the State of Bahia.

* Beitrag zu dem Symposium "Tropische Nutzpflanzen", Hamburg, 22.-24. September 1993; durchgeführt von der Vereinigung für Angewandte Botanik e.V.

Compared to its close relative *Theobroma cacao*, "cupuaçu" is less exacting in requirements of soil chemical conditions. A fair growth and yield of cupuaçu may be obtained in acidic Amazonian oxissols, where cacao fails to fruit without liming. This may be regarded as an indication of tolerance to aluminium toxicity. Heavy textured soils up to 80 % clay are not a constraint to cupuaçu, unless the soil becomes so compacted as to cause waterlogging. A good performance is also found on light-textured soils, but not in extremely sandy soils.
"Cupuaçu" has approximately the same degree of shade tolerance as cacao. Shade is needed for a better growth of young plants. Similarly as cacao, it may later be grown in full sun light, but it has not yet been determined how much of the extra cost of the higher quantities of fertilizer applied is compensated by a higher yield.
With well distributed rainfall throughout the year (Köppen Afi climate) "cupuaçu" blooms from November to January, the fruits being harvested 4 - 4,5 months later (Calzavara et al., 1984). Occasional moderate to severe dry spells are detrimental, to flowering and fruiting. Heavy losses of fruits may happen during periods of water stress due to splitting of the fruit shells following sudden rehydration after the first heavy rains. Shading reduces or prevents this kind of loss.

b) Breeding

Banks of germplasm collected in various locations of the Amazon are being evaluated at Belém (EMBRAPA-CPATU), Manaus (EMBRAPA-CPAA) and Porto Velho (EMBRAPA-CPAF - Rondônia). Selection for resistance to witches broom (*Crinipellis perniciosa*) is the main objective of breeding, together with higher pulp yield. This is a recent program and the first results are only indicative that there is good chance of obtaining better cultivars, based on the high genetic variability assembled already.
As a preliminary classification, Calzavara (1970) distinguishes three groups of plants: one with long fruits called "Mamorana", another with roundish fruits called "Redondo" and the clone of seedless fruits called "Mamau", obtained by propagation through grafting of a naturally seedless mother-tree.
It has been recently disclosed at the CPAA (Manaus) that the seedless cupuaçu is a triploid, with 30 chromosomes (unpublished) and this opens the possibility of obtaining new triploids, propagated by seeds, by crossing diploids with colchitetraploids. Addison and Tavares (1951) obtained a fertile hybrid of *T. grandiflorum* x *T. obovatum*, with small fruits and low pulp content. *T. canumanense*, a species very similar to *T. grandiflorum* not used by Addison and Tavares, might perhaps be interesting for crossing.

c) Cultivation

Details of cultivation are given by Calzavara (1979); Calzavara et al. (1984), and Ribeiro (1992). The general recomendation is to plant seedlings, raised in polybags under shade, at the spacing of 7 x 7m but farmers are adopting closer spacings, as 5 x 5m or 4 x 5m. The planting in the field should be made under provisional shade of a semi-perennial such as papaya, planted the previous year and *Inga* spp. should be planted as a permanent shade tree. Instead of using *Inga* as a shade plant it is certainly more profitable to use another dominant crop such as coconut. The seeds are recalcitrant and must be planted as soon as extracted or kept on moist sawdust untill germination is started.
Small farmers usually plant pre-germinated seeds directly under the shade of cassava at much closer spacing, sometimes even around 2 x 2m and leave the "cupuaçu" plants unshaded after harvesting the cassava. Eventually a closed canopy is formed. The yield per plant is very low, but partially compensated for by the higher plant density and the complete weed control due to the dense shade and the litter formed by the fallen leaves.
There is no data available yet based on experiments to give support to fertilizer recommendations. The doses of fertilizers found in the technical manuals are based on common sense. It is recognised however that in the poor Amazonian soils economic yields can only be obtained with fertilizers. The quantities of fertilizers recommended for "cupuaçu", in technical publications e.g. Calzavara et al. (1984), are smaller than that commonly used for cacao.
"Cupuaçu" is a precocious species. A first small crop is obtained within 3 years, and economical harvests start from the fourth year on, up to around 2 tons of pulp per ha in the seventh year (Calzavara et al., 1984). Much higher yields can however be obtained with moderately high manuring as illustrated by two japanese farmers in Tomé-Açu (Pará). With a yearly application of 500g of bone meal plus 500g of castorbean cake or 5kg of chicken manure supplemented by 200g of NPK mixture (10.28.20), 3 times per year, the yield is increased to 7.200 kg/ha of pulp per year.
Fruits collected from trees just a few days before complete maturation don't reach full taste and flavour. In practice the fruits are harvested after having fallen to the ground which implies in several rounds of collection.

d) Post-harvest and processing

Fruits fallen to the ground must be gathered within 3 days to reduce contamination with soil microorganisms and the pulp must preferably be extracted immediately and frozen. This procedure is impossible for many small farmers who usually sell their fresh fruits weekly, with a post harvest loss of spoiled fruits.
Fruits kept at ambient temperatures maintain good quality for 5 days if collected soon after falling. By keeping the fruits around 10° C in a refrigerator this period can be extended to 15 days (Lima, 1993), but this is also unapplicable to poor farmers. Easier procedures, such as treatment with hypochlorite or thiabendazol are being tested. The frozen pulp can be kept for 7 month without loss of quality (Miranda, 1989).
According to Calzavara et al. (1984) the mechanical extraction yields 20-28 % of pulp and 14-22 % of seeds in a weight basis. The shells comprise 38-58 %. The manual separation of pulp, with scissors yield 30-42 % of pulp, 16-23 % of seeds, and 38-48 % of shells.
Chocolate can be obtained from the seeds but mechanical separation of the seed tegument should be devised for this purpose. Instead of caffein, theobromin and theophyllin found in cacao seeds, cupuaçu seeds contain only the purine derivative 1, 3, 7, 9 - tetra methyluric acid (Vasconcelos et al., 1975). Comparative data of chemical composition of cacao and cupuaçu seeds are presented by Campos (1951) and Vasconcelos et al. (1975). Due to the difficulty of extracting the tegument the seeds of cupuaçu remain predominantly a waste product.
According to Ribeiro (1992), up until 1992, 2000 ha have been planted with "cupuaçu" in the State of Rondônia, mostly by small farmers. Based on his estimation of a potential yield of 2.000 tons of pulp in Rondônia, which would correspond to 25 % of the production of the whole of the Brazilian Amazon, 8.000 tons is presumably the current production in this region, which falls however very short of supplying the demand.
The pulp is used in ice-creams, refreshments, jams, jellies and several kinds of homemade confections. Data concerning the nutritive value are presented in Tab. 1.

e) Pests and diseases

The major phytossanitary problem of "cupuaçu" is witches broom caused by the fungus *Crinipellis perniciosa*. The strains of this pathogen isolated from "cupuaçu" have low virulence against cacao. A seed borer of cacao (*Conotrachellus humeropictus*, Curculionidae) (Trevisan, 1989) is a potential threat (Ribeiro, 1992) but until now only localized attacks on "cupuaçu" have been reported (Pamplona, 1993).

2.2 "Murici" - *Brysonima crassifolia* (L.) Kunth. - Malphigiaceae

Is a shrub 2-6m tall. The fruit is a small yellow drupe 1,5 - 2,00cm diameter with a 5mm thick pulp.

a) Distribution and remarks on ecology

Byrsonima crassifolia and other related species originated in the Amazon basin, but are presently found from southern Brazil to Central America (FAO, 1987). It is found more abundantly in the State of Pará, in the micro-regions of Bragantina and Salgado, as sub-spontaneous or cultivated plants. On the island of Marajó, natural populations of around 50 plants/ha are found.

The soil of sub-spontaneous or natural occurrences is very poor and sandy, supporting a small-sized vegetation with open canopy and a savanna-like physiognomy. It is a failure as a crop on soils of very high clay content, but on well drained sandy soils better results are obtained, with a rainfall above 2.000 mm/year (FAO, 1987). In the State of Pará it blooms from September to February and fruits are ripe from December to April.

b) Breeding

No attempt has been made yet to obtain improved cultivars, presumably because cultivated plants display a reasonable pattern of productivity and fruit quality.

c) Cultivation

The details of cultivations are described by CALZAVARA (1970b). Seedlings raised in polybags are planted with spacing of 7 x 7m. The economic yield starts in the fourth year, with 4-6 ton/ha of fruits with 64 % pulp, 11 % rind and 25 % seeds. Blooming starts in the second year, with a low yield. The small bunches with a few yellow fruits are picked by hand.

d) Post-harvest and processing

The maturation of fruits is completed at ambient temperature after harvesting. Dipped in an agueous sugar solution mature fruits keep well for up to 40 days (CALZAVARA, 1970).

The pulp is used in ice-creams, jellies, confections and refreshment mainly in the eastern-Amazon. Untasty products, however, are frequently found and this indicates the need of research to specify the best handling procedures to preserve the original taste and aroma of fresh fruits.

The pulp contains 20 % oil. Other nutritive value data are presented in Tab. 1.

e) Pests and diseases

No serious diseases have been reported. The beetle *Macraspis festiva* eats the ripe fruits. Another beetle, *Oncyderes dejeani* cuts the branches (CALZAVARA, 1970b).

2.3 "Bacuri" - *Platonia esculenta* (Arruda Câmara) Ricett & Staflen-Guttiferae.

Is a tree 15-25m tall. The fruit ranges 7-15cm in diameter and 200 - 1.000g with a thick yellow rind and big seeds. The white pulp is sweetish sour with a strong but very agreable aroma.

a) Distribution and remarks on ecology

Dense natural populations of the species are found in the pre-Amazonian open forests in the State of Maranhão (southeastern-Amazon). The characteristics of soil and vegetation in the locations of natural populations are similar to those described for "murici". There are also dense populations in the State of Pará in the micro-regions of Bragantina and Salgado and in the savanna-like areas of the island of Marajó. Incidentally the vegetative propagation of "bacuri" through gemminiferous roots is atypical of trees of the Amazonian primary forest but common in second-growth forest trees or the "cerrados" of central Brazil.

Like "murici", the growth of "bacuri" in heavy textured soils is disappointing. The trees bloom from June to September and fruits are ripe from December to May.

Tab. 1: Nutritive characteristics of the pulp of some amazonian fruits

Parameters (fresh weight)	fruits				
	Cupuaçu	Bacuri	Taperebá	Murici	Camu-Camu
Brix	10,8	16,4	10,2	4,8	-
acidity [%citric acid]	2,15	2,6	1,65	2,45	-
pH	3,3	3,5	2,1	2,8	-
etheric extracts [%]	0,53	0,6	1,03	4,75	-
pectins [%]	0,39	0,12	-	0,02	-
amino acids [mg/100g]	21,9	38,8	26,6	25,86	-
mineral residue [%]	0,67	0,4	-	0,52	-
P_2O_5 [%]	0,31	0,13	0,04	0,02	-
CaO [%]	0,04	0,31	0,001	0,08	-
reducing sugars [%]	3,03	3,98	6,74	4,89	-
vitamin C [mg/100g]	23,12	traces	45,0	7,27	3000 - 6000

Tab. 2: Nutritive characteristics of the pulp of "Araça-boi" (after PINHEDO et al., 1981; original data in dry weight, converted to fresh weight)

protein	0,8 - 1,07 %
fiber	0,5 - 0,65 %
other carbohydrates	6,9 - 7,2 %
Ca	0,016 - 0,021 %
Zn	1,0 - 1,2 ppm
vitamin A	7,75 mg/100g
vitamin B_1	9,84 mg/100g
vitamin C	7,68 mg/100g

b) Breeding

There is a great diversity of fruits concerning shape, size, content of pulp, taste and aroma as well as tree productivity, since 800 - 1.000 fruits have been reported for plants of 15-20 years old (FAO, 1987) but the average is between 400 - 600 fruits. Nevertheless this variability has not yet been exploited to select improved cultivars. The abundance in natural populations, supplying the consumption demand in the State of Pará may explain the lack of interest in genetic amelioration for cultivation. In fact, CALZAVARA (1970b) states that "bacuri" may become a weed due to the vegetative propagation by cut roots after felling the trees.

Plants producing completely seedless fruits have been found in the island of Marajó (CALZAVARA, 1970a). The possibility of triploidy should be investigated since the low pulp content is a constraint to cultivation. In seedy fruits it is common to find developed ovary locules without seeds.

c) Cultivation

The long period of economic immaturity of seed planting, at least 10 years, is another serious constraint. CALZAVARA (1970b) gives a general guidance for cultivation, stating that grafted plants begin to produce at 3-5 years, but "bacuri" fruits remain as an extractive product due to what has already been explained.

It is estimated (Fao, 1987) that in one hectare planted at 10 x 10m a yield of 2,2 tons of pulp per year can be obtained.

d) Post-harvest and processing

Ripe fruits are collected after falling to the ground and keep good quality during 10 days. The pulp may be damaged by exsuded resin, as in mangosteen. Nutritive characteristics of the pulp are presented in Tab. 1. A great part of the production is marketed and consumed as fresh fruits predominantly in Belém. The pulp is also extracted and frozen for use as ice cream. A small factory in Belém has for a long time used the seedless segments for canning in syrup, selling them at high prices to "delicatessen" shops.
The seedy fruit has on fresh weight basis 12 % pulp, 70 % rind and 18 % seeds. Fruits of seedless plants have 20-21 % pulp. The rind is used in a small scale in low quality confections. It is probably better for animal feeding than the shells of cupuaçu.
The availability of improved seedless cultivars with thinner rinds and a good pattern of quality should certainly be rewarding, as a precondition for cultivation.

e) Pest and diseases

No pest or diseases reported

2.4 "Araça-boi" - *Eugenia stipitata* Mc Vaugh - Myrthaceae

Is a shrub 2-3 m tall with profuse branching without apical dominance. The ripe fruit is a yellow oblate or spheric berry 2-10cm in diameter, 50-750g. A taller variety (or subspecies) is found in the State of Acre (Brazil) and Peru (Clement, 1989). "Araça-pera" *Psidium acutangulum* should also be considered, but in Manaus the heavy incidence of rust in the fruits makes its cultivation economically unfeasable.

a) Distribution and remarks on ecology

The natural habitat is the western border of the Amazon basin, with the center of dispersion in the Peruvian Amazon. The best varieties were selected by Peruvian indians in Iquitos. It is also found wild in Bolívia, Colômbia and in the State of Amazonas (Brazil). Natural populations of high densities are found along the river Ucayali (Peru).
It prefers rich, well drained soils but is also adapted to poor sandy or well drained clayey oxissols. On rich soils and with well distributed rainfall the flowering is continuous throughout the year, otherwise, for example, when cultivated on the poor heavy textured oxissols around Manaus, it blooms from November to April and fruits ripen from January to May. Preliminary observations in Manaus indicate a certain degree of shade tolerance of "araça-boi".

b) Breeding

Despite the great variability there is no breeding program being carried out in Brazil.

c) Cultivation

"Araçá-boi" is planted in a very small scale by small-farmers mainly in the State of Amazonas in Brazil, but it is more important in Peru. The spacing of 3 x 3m is provisionally recommended, with an expected yield of 3-5 tons/ha/year, on the third year. The seeds are recalcitrant but the emergence of seedlings occurs within 2-8 months. Seed layering in coal dust hastens germination.

d) Post-harvest and processing

The ripe fruits have a short shelf-life. Incompletely ripe fruits may be kept for 2-3 weeks in refrigerators. The pulp must be kept frozen. The very pleasant aroma is lost after cooking. Due to this the pulp is used only for ice-creams and refreshments. Nutritive data can be found in Tab. 2.

e) Pests and diseases

The fruits are attacked by the fruit fly *Ceratitis capitata*. An incipient incidence of rust (*Puccinia psidii*) has been recorded in Manaus (Gasparotto, 1993).

2.5 "Taperebá" - *Spondias lutea* L. - Anacardiaceae

Is a tree that may reach 30m when propagated from seeds. The fruit is a small drupe 3-4cm long with low pulp content.
The fruit is not as appreciated in other Latin American countries as in the Amazon, presumably due to differences in taste (Fao, 1987).

a) Distribution and remarks on ecology

"Taperebá" is found spontaneously or is cultivated in home gardens throughout the Amazon region and also in the northeast of Brazil, in Central America and the West Indies. It is also found wild in nonflooded forests where the annual rainfall is above 1.500mm.
Heavy crops can be obtained, without fertilizer application, on poor oxissols. The main flowering period is during the dry season but sporadic flowering also occurs so that the fruit may be found discontinuously at any time of the year but more abundantly during the rainy season.

b) Breeding

The selection for higher pulp yields and lower acidity should be rewarding since there is a great variability of these characteristics, and the plant may be easily propagated by cuttings.

c) Cultivation and uses

"Taperebá" is not yet commercially cultivated. The fruits found for sale are obtained from home-gardens or sub-spontaneous plants. In some instances it has been used in living fences, planted as cuttings 1m long and 5-10cm in diameter.
Its popular use is in a fresh beverage. It is also largely used in ice-creams and can be used for jelly and liqueurs. Nutritive data can be found in Tab. 1.

d) Pests and diseases

Except the losses caused by the fruit-fly no other phytosanitary problem is recorded.

2.6 "Genipapo" - *Genipa americana* L. - Rubiaceae

Is a tree around 15m high but occasionaly may reach 30m. The fruit is a berry 10-15cm long, 7-9cm in diameter, 200 - 400g. It contains 73 % water, 13 % sugar, 8 % cellulose, 1 % ashes, 0,35 % essential oils, 0,72 % tartaric acid and 2,6 % glucose (Fao, 1987). The timber is of good quality and easy to work.

a) Distribution and remarks on ecology

Though considered of Amazonian origin it is found in all the tropically humid areas of the Americas. Probably disseminated as a precolombian crop. It is widely used in ritual body paintings by the indians (dark blue stem bark pigments).
In its wild or sub-spontaneous occurrence in the Amazon it is more frequently found in alluvial soils subject to annual floods. It can stand bad drainage and high rainfall (1.200 - 4.000mm) on heavy textured soils.

b) Cultivation and uses

It is found frequently in home-gardens. Fruits are sold fresh in street-markets but don't have a general appreciation due to the characteristics odour of the essential oils. The most popular use is as a flavourer of home-made or industrialized liqueurs. Semidried fruit preserved with sugar acquires a very good taste. Due to the very high fruit productivity on poor soils and its waterlogging resistance, better

forms of processing should be studied to increase the acceptance of "genipapo".

2.7 "Camu-camu" - Myrciaria dubia (Kunth) McVaugh. - Myrthaceae.

As an adaptation to flood the seedlings have a single upright stem without branching. Adult plants are small shrubs with long flexible branches. The fruits resemble a big grape with an acid pulp of excellent flavour and a vitamin C content as high as acerola (*Malpighia glabra*) also known as Barbado's Cherry (Tab. 1).

a) Distribution and remarks on ecology

It is essentially a plant adapted to flooding. It is a native to the basin of the Orinoco river and the western Amazon basin, being common in dense stands along the rivers near Manaus, both on fertile alluvial soils and on poorer soils, where it can stand 4-5 months of flood. The blooming near Manaus is from July to September and fruits ripen from November to June.

b) Cultivation and uses

The first attempts to grow "camu-camu" on nonfloodable oxissols in Manaus gave disappointing results. Grafting onto "jaboticaba" (*Myrciaria cauliflora*) could perhaps display a better performance. The pulp had a very good acceptance by the ice-cream industry which is apt to increase its use since the supply from native stands becomes more available. Nevertheless more effort for successful cultivation should be made as "camu-camu" has a better taste than acerola with an equally extremely high vitamin C content.

3. Concluding remarks

The choice of the species presented was based on the previous information. While there are reasons to believe that some species, like those previously mentioned, will never reach an important status as a crop or extractive product, some lesser known species may show better promise in the future. For instance, among the species cited by Fao (1987) and Cavalcante (1976), "pariri" (*Pouteria pariri*) is regarded as having an excellent taste but no attempt has been made for cultivation due to the very long immature period. In this case, propagation by grafting should be tried. Two other interesting fruit trees occur in the upper Rio Negro: "ucuqui" (*Pouteria ucuqui*) is prized locally, but, nothing is known about it outside the region it is native to; "caiu-tim" (*Anacardium negrense*) also must be better known as it occurs in a region of high rainfall, being certainly resistant to *Colletotrichum* and could perhaps be produced in the Amazon instead of cashew, for nuts. "Purui" (*Alibertia edulis*) also deserves more attention due to the uniqueness of its flavour. This species is more frequently found in home-gardens of small towns along the Madeira river.

In some cases, studies of chemical composition have produced an unfounded expectation. Such is the case of the palm "patauá" (*Jessenia bataua*) whose fruits contain an oil similar to that of olives but the percentage of pulp is too low to justify the economic expectation. On the other hand, according to Lima et al. (1986) the oil productivity of "tacumã" (*Astrocaryum vulgare*) could reach the high level of oil palm productivity, through proper selection, but unlike the oil-palm, this species demands a definite dry season for flowering and the production is consequently seasonal. Such is also the case of piquiá (*Caryocar* sp) reported as rich in edible oil. The greatest world reservoir of unexploited fruit species (Clement, 1982) is in fact not so great if economic connotations are considered.

On the other hand it must be born in mind that the domestication of wild plant species may demand a greater research effort. As a matter of fact, only "cupuaçu" has so far received due attention from researchers and the results are still only barely visible.

It should be stressed that even most of the species here considered as valuable have some sort of constraint, such as the need for freezing the fresh pulp and the high cost of harvesting due to gradual flowering. These constraints act in opposite directions since freezing cannot be used by small farmers but the work of women and children can be employed for harvesting, thus alleviating the problem of extended harvesting periods.

To become crops planted by large scale farmers a more concentrated fruiting period should be pursued, which seems unfeasable. To avoid the middle-men's exploitation, small farmers need appropriate procedures to preserve the fruits on farms, otherwise they become discouraged by the low prices and the heavy losses of spoiled fruits.

Zusammenfassung

Wirtschaftlich bedeutende fruchtliefernde Pflanzenarten Amazoniens

Ein kurzer Abriß über geographische Verbreitung, Ökologie, Züchtung und Kultivierung, Nacherntebehandlung und Verarbeitung von sieben ausgewählten amazonischen Fruchtarten aus einer Liste von 76 in der Literatur zitierten amazonischen Fruchtspezies wird vorgestellt: *Theobroma grandiflorum, Byrsonima crassifolia, Platonia esculenta, Eugenia stipitata, Spondias lutea, Genipa americana* und *Myrciaria dubia*. Von diesen Arten wird angenommen, daß sie durch Kulturverfahren oder verstärkte Sammeltätigkeit an den natürlichen Standorten zu einer erhöhten wirtschaftlichen Bedeutung kommen können. Sowohl spezielle Geschmackseigenschaften als auch Schwierigkeiten in der Kulturführung von fruchtliefernden Pflanzenarten Amazoniens beeinträchtigen bislang die intensive ökonomische Nutzung. Es ist aber nicht ausgeschlossen, daß aus bisher wenig bekannten Fruchtarten wichtige Produkte Amazoniens entwickelt werden können.

References

Addison, G.O'N and Tavares, R.M., 1951: Observações sobre as espécies do gênero *Theobroma* que ocorrem na Amazônia. Belém. IAN., Boletim Técnico 25.

Barbosa, N.C., Nazaré, E.F.R., and Nagata, I., 1978: Estudo tecnológico de frutos da Amazônia. Belém, EMBRAPA-CPATU, Comunicado Técnico 3.

Calzavara, B.B.C., 1970: Fruteiras: abacaxizeiro, cajueiro, goiabeira, maracujazeiro, murucizeiro. Belém. IPEAN, Série Culturas da Amazônia 1, 3-42.

Calzavara, B.B.C., 1970b: Fruteiras: abieiro, abricozeiro, laranjeira, biribazeiro, cupuaçuzeiro. Belém. IPEAN. Série Culturas da Amazônia 1, 45-84.

Calzavara, B.B.C., Müller, C.H., and Kawage, O.N. da C., 1984: Fruticultura tropical. O cupuaçuzeiro. Cultivo, beneficiamento e utilização do fruto. Belém. EMBRAPA-CPATU, Série Documentos 32.

Campos, F.A. de M., 1951: Valor nutritivo de frutos brasileiros. Rio de Janeiro. Arq. Bras. Nutrição 8, 14-18.

Cavalcante, P.B., 1972: Frutas comestíveis da Amazônia I. Belém. Publ. Avul. do Museu Paraense Emílio Goeldi 17.

Cavalcante, P.B., 1974: Frutas comestíveis da Amazônia II. Belém. Publ. Avul. do Museu Paraense Emílio Goeldi 27.

Cavalcante, P.B., 1976: Frutas comestíveis da Amazônia. 3rd. ed., Belém. INPA/Museu Goeldi.

Cavalcante, P.B., 1972: Frutas comestíveis da Amazônia III. Belém. Publ. Avul. do Museu Paraense Emílio Goeldi 33.

Clement, C.R., 1982: Aspectos da fruticultura da Amazônia. Informativo SBF 1, 1-5.

Clement, C.R., 1989: A center of crop genetic diversity in Western Amazonia, a new hypothesis of indigenous fruit-crop distribution. Bioscience 39, 624-631.

Clement, C.R. and Flores, W.B.C., 1984: Considerações sobre o mapati *Pouroma cecropiaefoliae* Mart. Moracea, a uva da Amazônia. In: CONGRESSO BRASILEIRO DE FRUTICULTURA; 7. 1983. Florianopolis. Anals. Florianopolis. SBF/EMPASC, 1154-1165.

CORREA, M.P., 1952: Dicionário das plantas úteis do Brasil e das exóticas cultivadas. Rio de Janeiro, Serviço de Informação Agricola 3-5.

LE COINTE, P., 1947: Amazônia brasileira III. Árvores e plantas úteis (indigenas e aclimatadas), 2n. ed.. Editora Nacional, São Paulo.

DUBOIS, J.C.L., 1992: Os castanhais silvestres da região de Araras (Pará) como modelo de desenvolvimento sócio-econômico. Rio de Janeiro. REBRAF. Informativo Agroflorestal 4, 1-3.

DUCKE, A., 1946: Plantas de cultura pre-columbiana na Amazônia brasileira. Notas sobre as espécies e formas espontâneas que supostamente lhes teriam dado origem. Belém. IAN. Boletim Técnico 8.

FAO., 1987: Espécies forestales produtoras de frutas y otros alimentos. 3 - Ejemplos de la America Latina. Estudio FAO, Montes 44/3. Roma, Organizacion de las Naciones Unidas para la Agricultura y la Alimentacion.

GASPAROTTO, L., 1993: Personal comunication.

LIMA, H.C., 1993: Conservação pós-colheita do cupuaçu (*Theobroma grandiflorum* Willdenow ex. Sprengel) Schum) em condições ambiente e sob refrigeração. Manaus. INPA, MSc Thesis.

LIMA, R.R. and COSTA, J.P.C. da, 1991: Registro de Introdução de plantas de cultura pré-colombiana coletadas na Amazônia brasileira. Belém. EMBRAPA-CPATU, Série Documentos 58.

LIMA, R.R., TRASSUTO, C.C., and COELHO, V., 1986: O tucumã (*Astrocaryum vulgare* mart.) principais características e potencialidades agroindustriais. Belém. EMBRAPA-CPATU, Boletim de Pesquisa 75.

MELO, C.F.M. de, BARBOSA, W.C., and ALVES, S.M., 1988: Obtenção do açai desidratado. Belém. EMBRAPA-CPATU, Boletim de Pesquisa 92.

MIRANDA, R.M., 1989: Conservação de polpa de cupuaçu (*Theobroma grandiflorum* Schum) com o uso de frio. Manaus. INPA, MSc Thesis.

NATIONAL ACADEMY OF SCIENCES, 1975: Underexploited tropical plants with promising economic value. Washington DC.

PAMPLONA, A.M.S.R., 1993: Personal communication.

VAN DER PAHLEN, A., KERR, W.E., PAIVA, W. de O., REHMAN, F., YCUJAMA, K., VAN DER PAHLEN, E., and NODA, H., 1979: Introdução à horticultura e fruticultura na Amazônia, Manaus. CNPq/INPA, Divisão de Ciências Agronômicas.

PINHEDO, P.M., RAMIREZ, N.F., and BLANCO, L.M., 1981: Notas preliminares sobre el arazá (*E. stipitata*), frutal nativo de la Amazonia peruana. Lima, INIA/IICA-Publ. Mis. 229. (Cited in Fao, 1987).

REHM, S. and ESPIG, G., 1976: Kulturpflanzen der Tropen und Subtropen. Verlag Eugen Ulmer, Stuttgart.

RIBEIRO, G.O., 1992: A cultura do cupuaçuzeiro em Rondônia. Porto Velho. EMBRAPA/CPAF-Rondônia, Série Documento 27.

TREVISAN, O., 1989: O comportamento da broca dos frutos do cacau em Rondônia. Piracicaba. ESALQ/USP, M.Sc. Thesis.

VASCONCELOS, M.N.L., SILVA, M.L. da, MAIA, J.C.S., and GOTTLIEB, O.R., 1975: Estudo químico das sementes do cupuaçu. Acta Amazônica 5, 293-295.

Address of the authors:
V.H. de F. Moraes, A.G.C. de Souza, J.C. Antonio, EMBRAPA-CPAA, P.O. Box 319, Manaus-AM, Brazil. C.H. Müller, EMBRAPA-CPATU, P.O. Box 48, Belém PA, Brazil.