Current Status of Amazonian Oil Palms*

Michael J. Balick
Institute of Economic Botany, The New York Botanical Garden

One of the major teachings of Celestino Pesce's classic work *Oleaginosas da Amazônia* is that the Amazon forest comprises a vast storehouse of foodstuffs and other products and if properly managed, this verdant area could benefit a far greater number of people than it does at present. Impassioned pleas for the proper use of this resource and promises of its vast wealth have been made by many. To date, most appeals have not convinced the economic and governmental communities in the Neotropics who actually decide the fate of this region. With few exceptions, these influential people remain generally unconvinced that the plant resources within the forest can be developed and utilized through a sustainable system, one which will yield far greater riches than current systems of exploitation.

Thus, we in the research community must address the question of whether or not, in this era of agribusiness empires based on a single commodity and synthetic substitutes for most of societies' perceived needs, plants with unique chemical or nutritional properties are still necessary. If the product of the African oil palm is suitable for human consumption in the Neotropics and this species has become ubiquitious throughout this region, are the dozens of potential and presently used oil palms worth our attention?

What facts speak in favor of our continued interest in and research on native Amazonian oil palms? The most important perhaps, is the certainty that the laws of economics are in the long run subservient to the laws of nature. In this case, the trend towards reduced crop diversity and massive monoculture in tropical regions is no doubt more economical at present but will lead to a variety of complications in the future. In nature, diversity means security and a wide assortment of cultivated plants in a sustainable agricultural system is the best assurance of continued reliable production and therefore of human existence. One kind of sustainable agricultural system is known

---

* Presented as contribution 83-2 of The New York Botanical Garden Institute of Economic Botany

Reprinted From: Oil Palms and Other Oilseeds of the Amazon, by C. Pesce. Translated and Edited by D.V. Johnson. Reference Publications,Inc. 1985.

as agroforestry, the cultivation of "tree farms" of valuable species. Oil palms certainly will play an important part as researchers develop improved systems of tree cultivation for the tropics.

Another advantage of using native palms in agricultural systems is that local people already know how to utilize these plants to their maximum utility. For example, *Astrocaryum* species are used to produce many different products throughout their natural range in the Amazon Valley. People produce food (oil, protein, carbohydrate and drink), shelter, fiber for clothing, cordage, hammocks, bags, and a wealth of household products from the same tree. The same cannot be said for commonly introduced crops such as soybeans.

Native palms are far more adaptable to common Neotropical habitats. From an agronomic standpoint, many of the habitats available for cultivation are marginal, such as heavily inundated or very dry land, poor or compacted soil, etc. On the other hand, the palms already growing in these areas are well suited to thrive on such marginal lands and are thus reliable producers.

One indication of the continuing and increased role native palms play in regional economies is an increase in national and international programs focusing on this family as economic plants. A number of international foundations are supporting research efforts in both small and large scale programs in the Neotropics. This effort is augmented by the strong regional demand for palm products that still exist in this region combined with diminishing supplies of raw materials of these commodities in some cases, which is forcing local entrepreneurs and producers to cultivate several useful palm species or at least exploit the existing stands in a more rational manner. Another consideration in tropical countries is the high cost of petroleum which has made renewable sources of fuel such as charcoal from the babaçu palm fruit a very attractive alternative in poorer regions. Some of the palms mentioned in this book are playing an increasing role in breeding programs, producing hybrids with more conventional crop species. A common breeding technique is to cross *Elaeis oleifera,* a Neotropical palm, with *E. guineensis,* the African oil palm. The progeny yields higher quality oil in greater quantities with more resistance to disease than does the African oil palm. In the future, as genetic engineering provides us with the techniques to break down the barriers that currently limit plant breeding to closely related species, there is no doubt that other palms with particularly valuable characteristics—such as high protein values or unique oil composition—will be utilized to create superior crop plants.

Today there are a number of excellent public and private sector programs being undertaken in Latin America to exploit native palms as a commercial crop resource. Some are in the design stage or in their infancy while others are well developed.

The genus *Acrocomia* is an important source for oil production in South

American at present. *A. aculeata,* known as macaúba in Brazil, is an important source of kernel oil. In Brazil production is limited to three states, Maranhão, Ceará, and Minas Gerais, where a total of 195 tons was produced in 1980 (IBGE, 1982). This palm is found in some of the drier regions of Brazil, rather than the wetter lowland tropical areas more commonly considered as palm habitats. It is thus of advantage for production in areas where more conventional oilseed palms could not tolerate such a dry environment. Another species, *A. totai* is found in the savanna areas of Argentina, Bolivia, Brazil and Paraguay. A total of 7,400 tons of this oil was exported from Paraguay in 1971, up from 2,300 tons in 1964 (Hodge, 1975). Potential exists for increasing production of both these species. Interest is being shown in Brazil at the present time for investigating the possibilities of using this plant as a renewable source of fuel oil.

Astrocaryum is a multiuse genus of palms with dozens of subsistence and commercial applications. The most important oil-producing species are *Astrocaryum aculeatum* and *A. vulgare,* both known as tucum or tucumã. While the fruit pulp and kernel both yield oil, commercial production of oil is principally from the kernel. In Brazil production from these two species (and perhaps others) is primarily in Piauí and Maranhão (6,035 and 2,339 tons of kernels respectively) with almost negligible quantities reported from Bahia and Santa Catarina during 1980 (IBGE, 1982). Ten tons of *A. murumuru* seed, known in the industry as murumurú, were produced in Pará during that same year (IBGE, 1982). Production for local utilization also occurs in other states; I have eaten various *Astrocaryum* fruits served as appetizers in restaurants around Manaus, Brazil. There is some indication that this genus may be presently cut as a source of palm hearts in areas from which *Euterpe* species have been completely eliminated as a commercially exploitable wild plant.

The peach palm or pupunha as it is known in Portuguese (*Bactris gasipaes*) has become a crop of significant importance since the writings of Pesce. In Central and South America there are active projects involving the large scale cultivation of this species as a food source. In Brazilian Amazonia the major effort to improve pupunha has developed around a germplasm bank organized by CENARGEN (Centro Nacional de Recursos Genéticos)—EMBRAPA (Empresa Brasileira de Pesquisa Agropecuária). The germplasm bank is located in Manaus, Amazonas, on the grounds of a research station operated by INPA (Instituto Nacional de Pesquisas da Amazônia). At that location a large number of pupunha accessions collected from Central and South America have been assembled and are under study by local scientists. Special attention is being devoted to collecting unique individuals showing definite advantage for commercial cultivation and breeding including such traits as fruits with high oil content, reduced seed mass or seedless forms, spineless palms as well as those with exceptionally rapid growth rates. Recently this project has received financial support from the U.S. Agency for International Development as well as continued support from the Brazilian Government. At the same time a coordinated program of work on the peach palm has resulted in the achievement of *in vitro* vegetative propagation of this species, a better understanding of its taxonomy, and the development of economically feasible cultivation systems for this plant as a source of palm heart. Much of this work is being carried out at the Universidad de Costa Rica, San José, and CATIE-Centro Agronómico Tropical de Investigación y Enseñanza at Turrialba, Costa Rica. A number of research centers in other areas of the Neotropics, including Colombia, Panama, and Peru have smaller scale programs involving exploration and cultivation of this palm. Factories in Costa Rica process both the heart and fruit for regional sale and export.

Most of the utilization of *Elaeis oleifera* at the present time involves its role as a parent for breeding with *E. guineensis*. In the last few years a great deal of exploration has been undertaken to collect seed from the natural populations of *E. oleifera* which occur from Costa Rica southward to Brazil and Venezuela. The special qualities possessed by these hybrids have been previously noted. Because of the vast amount of resources that are being put into the development of the African oil palm as a commercial crop, it is certain that *E. oleifera* will continue to be an important plant for breeding, rather than being of much importance for utilization on its own.

The genus *Euterpe* is not a major oil-producing palm of the Amazon region. It does however play an important part in the local economy, as it is the source of a nutritious beverage and commercially important palmito. In 1980 almost 60,000 tons of fruit were produced from *Euterpe* species, primarily *E. oleracea*. That same year 114,408 tons of palmito were produced from *Euterpe* species mostly *E. oleracea*, but also including other species (IBGE, 1982). Palm hearts are an important commercial export crop from the interior of Brazil and will continue to remain so in the near term. Supply considerations have given rise to the development of palm heart plantations of *Euterpe* and other palms in the Neotropics.

In the local economies of Peru and Brazil *Mauritia flexuosa* has remained an important economic and subsistence crop. Local markets in Iquitos, Peru and Belém, Brazil are filled with fruits of this species during its harvest season. In addition to fruit this genus provides fiber and other construction materials for the commercial market. Industrial utilization of the oily fruits is primarily limited to production of sherbets, beverages and dried sweet paste sold throughout the year. This last product is eaten primarily as a dessert and is a nutritious food source. To the best of my knowledge there are no programs underway to develop major plantations of this tree for commercial use. Plantation cultivation is difficult because it is impossible to distinguish between "nonproductive" male and "productive" female trees prior to their flowering. In addition, *M. flexuosa* remains abundant throughout its natural range.

The *Oenocarpus-Jessenia* complex of palms is one which appears to have great potential for future cultivation as an oil source. At the time *Oleaginosas da Amazônia* was published exports of this oil from Brazil reached almost 100,000 kilos annually. Such exports were primarily to the United States and Europe, where this oil served as an olive oil substitute in cosmetics and for other purposes. Exports of this oil from Brazil tapered off in the late 1940s probably because of the destructive way in which the trees were harvested, eg., by felling, as well as the increased availability of traditional sources of olive oil after the war. Recent research has shown this palm complex to be an excellent source of protein and edible oil (Balick & Gershoff, 1981). In 1975 the Centro de Desarrollo Integrado "Las Gaviotas" in the Orinoco Valley of Colombia launched an effort to prove that small-scale exploitation of *Jessenia bataua* and *Oenocarpus* species could be undertaken in remote regions of that country. In 1975, through a collaborative research program between "Las Gaviotas" and the Botanical Museum of Harvard University, I began taxonomic studies of this complex as well as collections throughout its distribution in the Neotropics. At the same time workers from the Royal Tropical Institute in Amsterdam, The Netherlands, began to develop a small scale prototype press to process locally collected palms fruits in this complex. The experiment was a success, showing that the oil could be produced with small-scale presses using fruits collected from the forest. Unfortunately, because of the lack of continued capital to establish plantations of these palms within existing native forest stands and to develop a basic infrastructure for collection procedures, proper implementation of the project has been delayed. The extraction facility is presently used at a level far below its actual production capacity. The palms in this complex could become a much more important oilseed crop, based on the possible economic analysis that has been carried out, the development of appropriate processing technology, and the fact that strong regional demand exists for the oil.

Production of the babaçu palm (*Orbignya* species) amounts to over 250,000 tons of kernel per year. This palm is common in the northeastern sections of Brazil and production is primarily in the states of Maranhão, Goiás and Piauí. Minor production also occurs in Ceará, Bahia, Minas Gerais and Pará. This palm is an important source of edible oil and charcoal. In 1980 a major project was established to domesticate the palm and begin to lay the groundwork for conversion of the industry from the collection of a wild source to a plantation crop. In 1981 CENARGEN-EMBRAPA created a germplasm bank in Bacabal, Maranhão, under the sponsorship of INEB—Instituto Estadual do Babaçu, The State Institute for Babaçu Research in Maranhão. At that time a collaborative research project between Brazil and the United States, sponsored by the U.S. Agency for International Development and carried out by the New York Botanical Garden was initiated. The aim of this project is to collect and evaluate germplasm of the babaçu palm throughout its distribution in the Neotropics, study its nutrition, taxonomy, ecology, as well as other aspects of domestication of babaçu. Another research group had been formed in Teresina, Piauí, —UEPAE, Unidade Experimental de Pesquisa de Ambito Estadual, a branch of EMBRAPA, which is at present a leading center for the study of this palm. The babaçu industry has been called the largest oilseed industry in the world entirely dependent on collection of a wild plant. This domestication program paves the way for the improvement of babaçu as a crop, especially in view of the increased role of multiuse plants which can provide a number of useful products such as food and fuel for local benefit. It is likely that babaçu will become even more important when facilities for what is known as "integral processing" increase in number. Integral processing is the use of the *entire* babaçu fruit to produce oil, charcoal and a wealth of other useful products such as animal ration, industrial chemicals, and alcohol.

In this brief epilogue I have attempted to show the current and potential importance of Amazonian palms in the cash economy to support the contention that continued research on these plants with conservation of their native habitats is essential. Indeed, the present day importance of palms in the South American economy is not widely appreciated. In 1979 Brazil reported over $100,000,000 of commerce resulting from the harvest and sale of products from six native palm genera: *Astrocaryum, Attalea, Copernicia, Euterpe, Mauritia* and *Orbignya*. Admittedly not all of these were for oil, such as the *Copernicia* palm so highly valued for wax. However, many of these palm species offer alternatives for agricultural production and economic return on lands which are today considered as marginal and for which no real productive use has been found. The bibliography that follows offers a selection of articles for those interested in pursuing further the subject of Amazonian oil palms. While these offer a good introduction to the subject, a great deal more information is available should one begin to investigate the complete body of literature on this important subject.

The following bibliography on native Amazonian useful palms was originally prepared in 1975 at the request of Paulo Lugari C., Director of the Centro de Desarrollo Integrado "Las Gaviotas," for use in their native oilseed utilization program. Since that time many additional materials have been gathered during my research on useful palms. Most recently the Rockefeller Foundation has generously supported this research through a grant to compile an expanded, annotated bibliography on the lesser-known useful palms of the world.

Bibliography on Oil Palms

Altman, R.F.A. 1958. A Exploração Industrial de Sementes Oleaginosas Amazônicas. Instituto Nacional de Pesquisas da Amazônia, Pub. No. 4, Química. Rio de Janeiro.

Anderson, A.B. 1978. The Names and Uses of Palms Among a Tribe of Yanomama Indians. *Principes* 22:30-41.

Anderson, A.B. & Anderson, E.S. 1983. People and the Palm Forest, Biological Utilization of Babassu Forests in Maranhão, Brazil. Final report to U.S.D.A. Forest Service, Consortium for the Study of Man's Relationship with the Global Environment. University of Florida, Gainesville.

Anonymous. 1952. *Babaçu Economia a Organizar*. Rio de Janeiro.

Anonymous. 1972. Vegetable Oils Beckon Investors. *Brazilian Bulletin* Jan. p. 8.

Anonymous. 1975. Extracción de Aceite del Fruto de la Palma de Moriche. Centro de Desarrollo Integrado "Las Gaviotas," Orinoquia, Colombiana. (manuscript)

Balick, M.J. 1979. Amazonian Oil Palms of Promise: A Survey, *Economic Botany* 33:11-28.

Balick, M.J. 1979. Economic Botany of the Guahibo. I. Palmae. *Economic Botany* 33:361-376.

Balick, M.J. 1981. *Jessenia bataua* and *Oenocarpus* Species: Native Amazonian Palms as New Sources of Edible Oil, pp. 141-155, In: Pryde, E.H., Princen, L.H. & Mukherjee, K.D. (eds.) *New Sources of Fats and Oils*. American Oil Chemists' Society, Champaign.

Balick, M.J. 1982. Palmas Neotropicales: Nuevas Fuentes de Aceites Comestibles. *Interciencia* 7:25-29.

Balick, M.J. Anderson, A.B. & Da Silva, M.F. 1982. Palm Taxonomy in Brazilian Amazônia: The State of Systematic Collections in Regional Herbaria. *Brittonia* 34:463-477.

Balick, M.J. & Gershoff, S.N. 1981. Nutritional Evaluation of the *Jessenia bataua* Palm: Source of High Quality Protein and Oil from Tropical America. *Economic Botany* 35:261-271.

Beckerman, S. 1977. The Use of palms by the Bari Indians of the Maracaibo Basin. *Principes* 21:143-154.

Bertoni, M.S. 1903. Le palmier "Mbocaya" du Paraguay et son exploi-

tation. *Journal d'Agriculture Tropicale* 23:156.
Bodley, J.H. & Benson, F.C. 1979. Cultural Ecology of Amazonian Palms. Reports of Investigations, No. 56, Laboratory of Anthropology, Washington State University, Pullman.
Bomhard, M.L. 1946. Brazil's Oil-Yielding Palms. *Agriculture in the Americas* 6:6-15.
Bondar, G. 1954. *O Babaçu e outras Palmeiras de Amêndoas Oleaginosas no Brasil.* Ministério da Agricultura, Serviço de Informação Agricola, Rio de Janeiro.
Bondar, G. 1964. Palmeiras do Brasil. *Instituto de Botânica Boletim* 2, São Paulo.
Braun, A. 1968. Cultivated Palms of Venezuela. *Principes* 12:39-103, 111-136.
Calvo, I.M. 1978. Segunda Reunión sobre Chontadura. Departamento del Valle del Cauca, Secretaría de Agricultura y Fomento, Sección Divulgación y Publicaciones.
Camacho, E. & Soria, J. 1970. Palmito de Pejibaye, *Proceedings of the Tropical Region, American Society for Horticultural Sciences* 14:122-132.
Campos, F.A. de M., Pechnik, E. & De Siqueira, R. 1951. Valor Nutritivo de Frutos Brasileiros. *Arquivos Brasileiros de Nutrição* 8:205-243.
Cárdenas, M. 1969. *Manual de Plantas Económicas de Bolivia.* Imprenta Icthus, Cochabama.
Cavalcante, P.B. 1977. Edible Palm Fruits of the Brazilian Amazon. *Principes* 21:91-102.
Chaves, J.M. & Pechnik, E. 1947. Tucumã. *Revista de Química Industrial* 16:1-19.
Classen, C.E., Jenkens, D.W. & Markley, K.S. 1949. FAO Oilseed Mission for Venezuela. Food and Agriculture Organization of the United Nations, Washington, D.C.
Clement, C.R. & Mora Urpi, J. 1982. The Pejibaye Palm (*Bactris gasipaes*) Comes of Age. *Principes* 26:150-152.
Cook, O.F. 1942. A New Commercial Oil Palm in Ecuador. *National Horticultural Magazine* 21:70-85
Criswick, J. 1970. *Jessenia* and *Maximiliana* in Guyana. *Principes* 14:34.
da Silva, S.A.F. 1971. *Catálogo Sistemático de Plantas Brasileiras Productoras de Oleo, Cêra e Resina. 1° parte, Monocotiledôneas.* Ministério da Agricultura, Rio de Janeiro.
De Civrieux, J.M.S. 1957. Nombres Folklóricos e Indígenas de Algunas Palmeras Amazónico – Guayanesas con Apuntes Ethnobotánicos. *Boletín de la Sociedad Venezolana de Ciencias Naturales* 18:195-234.

Del Derrugia, J. 1955. Productions fruitières propres à la République de l'Equateur. *Fruits* 10:271-275.
Dierolf, C. 1978. Comentarios sobre Posibles Diseños de Equipo para Cosecha y Beneficio del Chontaduro. *Serie Informativa* No. 1, pp. 55-57. Secretaría de Agricultura y Fomento, Valle, Colombia.
Dugand, A. 1972. Las Palmeras y el Hombre. *Cespedesia* 1:31-101.
Duke, J.A. 1969. Ethnobotanical Observations on the Chocó Indians. *Economic Botany* 23:344-366.
Earle, F.R. & Jones, Q. 1962. Analyses of Seed Samples from 113 Plant Families. *Economic Botany* 16:221-250.
Galano, A.M. 1977. La noix babaçu. *L'Economiste du tiers monde* 20:61-62.
Galindo, A.R. 1945. La Palmera Milpes o Seje de la Amazonia Colombiana. *Agricultura Tropical* 5:40-43.
Glassman, S.F. 1972. *A Revision of B.E. Dahlgren's Index of American Palms.* J.Cramer, Lehre.
Gonsalves, A.D. & de Freitas, R.M. 1955. *O Babaçu, Considerações Cientificas, Técnicas e Ecônomicas.* Ministério da Agricultura, Serviço de Informação Agricola. Rio de Janeiro.
Grunwald, O. 1959. Contribución al Estudio de Diversas Palmeras Existentes en Venezuela Similares o Idénticas a la *Attalea* u *Orbignya cohune.* Ministerio de Agricultura y Cría, Dirección de Agricultura. Caracas.
Hodge, W.H. 1975. Oil-Producing Palms of the World—A Review. *Principes* 19:119-136.
Holmquist, J.D. & Popenoe, J. 1967. The Effect of Scarification on the Germination of Seeds of *Acrocomia crispa* and *Arenga engleri. Principes* 11:23-25.
Housing and Home Finance Agency, Office of International Housing. 1964. Palms—Their Use in Building. Publications and Technical Services Branch. U.S. Agency for International Development, Washington, D.C.
IBGE 1982. *Produção Extrativa Vegetal.* Fundação Instituto Brasileiro de Georgrafia e Estatística, Rio de Janeiro.
Janos, D.P. 1977. Vesicular-Arbuscular Mycorrhizae Affect the Growth of *Bactris gasipaes. Principes* 21:12-18.
Jenkins, D.W. n.d. Palms of Central America and Mexico as a Source of Vegetable Oil. Foreign Economic Administration, Bureau of Supplies, Office of Food Programs, Washington, D.C. (mimeograph)
Johannessen, C.L. 1967. Pejibaye Palm: Physical and Chemical Analysis of the Fruit. *Economic Botany* 21:371-378.
Johnson, D. 1982. Commercial Palm Products of Brazil. *Principes* 26:141-143.

Jordan, C.B. 1970. A Study of Germination and Use in Twelve Palms of Northeastern Peru. *Principes* 14:26-32.

Kitzke, E.D. & Johnson, D. 1975. Commercial Palm Products other than Oils. *Principes* 19:3-26.

MacBride, J.F. 1960. Flora of Peru: Palmae. *Botanical Series, Field Museum of Natural History* 13:321-418.

MacFarlane, N., Swetman, T. & Cornelius, J.A. 1975. Analysis of Mesocarp and Kernel Oils from the American Oil Palm and F_1 Hybirds with the West African Oil Palm. *Journal of the Science of Food and Agriculture* 26:1293-1298.

Markley, K.S. 1953. La Palma "Mbocaya." Ministerio de Agricultura y Ganaderia. Asunción.

Markley, K.S. 1955. The Mbocaya Palm: Economic Oil Plant of Paraguay. *The Journal of American Oil Chemists' Society* 32:405-413.

Markley, K.S. 1957. Fat and Oil Resources and Industry of Brazil. *Economic Botany* 11:91-125.

Markley, K.S. 1971. The Babassu Oil Palm of Brazil. *Economic Botany* 25:267-304.

Markley, K.S. & Jenkins, D.W. 1949. Oil Palm Resources of the American Hemisphere. *The Journal of the American Oil Chemists' Society* 26:257-267.

MIC/STI. 1977. Côco de Babaçu Matéria—Prima para Produção de Álcool e Carvão. Ministério da Indústria e do Comércio, Secretaria de Tecnologia Industrial. Brasília.

Monteiro da Silva, J.R. 1951. O Brasil e suas Possibilidades. Colectânea de Vários Artigos Publicados em alguns Jornais do Rio de Janeiro e de São Paulo. Rio de Janeiro.

Mora Urpí, J. & Clement, C.R. 1981. Aspectos Taxonómicos Relativos al Pejibaye (*Bactris gasipaes* H.B.K.). *Revista de Biologia Tropical* 29:139-142.

Moses, T. 1962. Palms of Brazil. *Principes* 6:26-37.

NAS. 1975. *Underexploited Tropical Plants with Promising Economic Value.* National Academy of Sciences, Washington, D.C.

Nogueira, J.B. & Machado, R.D. 1950. *Glossário de Palmeiras Oleaginosas e Ceríferas.* Instituto de Óleos. Rio de Janeiro.

Patiño, V.M. 1977. El Corozo o Noli (*Elaeis oleifera* (HBK) Cortes ex Wessels Boer), Recurso Natural Oleaginoso de Colombia. *Cespedesia* 6:7-122.

Patiño, V.M. 1977. Palmas Oleaginosas de la Costa Colombiana del Pacífico. *Cespedesia* 6:131-260.

Pérez Arbelaez, E. 1947. *Plantas Útiles de Colombia.* Imprenta Nacional, Bogotá.

Popenoe, W. & Jiménez, O. 1921. The Pejibaye—A Neglected Food Plant of Tropical America. *Journal of Heredity* 12:154-166.

Rizzini, C.T. 1963. Sobre a Distinção e Distribuição das duas Espécies de Babaçu (*Orbignya*). *Revista Brasileira de Geografia* 25:27-40.

Romero, C.G. & Luna M., n.d. Factibilidade de Explotación del Seje en los Llanos Orientales Colombianos. Centro de Desarrollo Integrado "Las Gaviotas," Universidad Industrial de Santander. Bogotá. (offset)

Schultes, R.E. 1977. Promising Structural Fiber Palms of the Colombian Amazon. *Principes* 21:72-82.

Spruce, R. 1871. Palmae Amazonicae. *Journal of the Linnean Society, Botany* 11:65-183.

Spruce, R. 1908. *Notes of a Botanist on the Amazon and Andes.* Macmillan, London.

Takeuchi, K. 1961. Amino Acids in the Endosperm of some Amazonian Palmae. *Chiba Daigaku Bunrigakubu* 3:321-325.

Velasco, A. 1978. Estudio Biométrico del Chontaduro. *Serie Informativa* No. 1, pp. 58-61. Secretaría de Agricultura y Fomento, Valle, Colombia.

Viana, V.R.C. 1977. Contribuição ao Estudo das Frutas Silvestres das Matas do Rio de Janeiro. *Leandra* 6-7:95-105.

Vivacqua, A. 1957. Exploitation rationelle du babassu au Brésil. *Oléagineux* 12:697-700.

Wallace, A.R. 1853. *Palm Trees of the Amazon and Their Uses.* J. van Voorst, London.

Wessels Boer, J.G. 1965. *The Indigenous Palms of Suriname.* E.J. Brill, Leiden.

Wessels Boer, J.G. 1972. Clave Descriptiva de las Palmas de Venezuela. *Acta Botánica Venezuélica* 6:299-362.

Wilhelms, C. 1964. Babaçu Riqueza Inexplorada. Carteira de Comércio Exterior do Banco do Brasil, S.A. com a Colaboração do Instituto Nacional de Óleos. (mimeograph)

Zapata, A. 1972. Pejibaye Palm from the Pacific Coast of Colombia. *Economic Botany* 26:156-159.

Zapata, A. 1978. Notas sobre el Valor Alimenticio del Chontaduro. *Serie Informativa* No. 1, pp. 12-17. Secretaría de Agricultura y Fomento, Valle, Colombia.

MICHAEL J. BALICK

Appendix II
Preliminary Checklist of Palms in the Brazilian Amazon Region*

Michael J. Balick, Anthony B. Anderson,
and Marlene Freitas da Silva

Acrocomia eriocantha Barb. Rodr.
A. microcarpa Barb. Rodr.
A. wallaceana (Drude) Becc.

Aiphanes ernesti (Burret) Burret

Astrocaryum acaule Mart.
A. aculeatum Meyer
A. caudescens Barb. Rodr.
A. chambira Burret
A. giganteum Barb. Rodr.
A. gynacanthum Mart.
A. horridum Barb. Rodr.
A. huebneri Burret
A. jauari Mart.
A. javarense (Trail) Trail ex Drude
A. macrocarpum Huber
A. manaoense Barb. Rodr.
A. munbaca Mart.
A. murumuru Mart.
A. paramaca Mart.
A. rodriguessii Trail
A. sciophilum (Miq.) Pulle
A. tucuma Mart.
A. ulei Barret
A. vulgare Mart.
A. yauaperyense Barb. Rodr.

Attalea ferruginea Burret

Bactris acanthocarpoides Barb. Rodr.
B. acanthospatha (Trail) Trail ex Drude
B. actinoneura Drude & Trail ex Drude
B. amoena Burret
B. angustifolia Damm.
B. aristata Mart.
B. armata Barb. Rodr.
B. arundinacea (Trail) Drude
B. atrox Burret
B. balanophora Spruce
B. bella Burret
B. bicuspidata Spruce
B. bidentula Spruce
B. bifida Mart.
B. bijugata Burret
B. campestris Poepp. ex Mart.
B. capillacea (Trail) Trail ex Drude
B. capinensis Huber
B. chaetochlamys Burret
B. chaetospatha Mart.
B. chloracantha Poepp. ex Mart.
B. chlorocarpa Burret

B. concinna Mart.
B. constanciae Barb. Rodr.
B. curuena (Trail) Drude
B. cuspidata Mart.
B. dahlgreniana Glassman
B. elatior Wallace
B. elegans Barb. Rodr. & Trail ex Barb. Rodr.
B. ericetina Barb. Rodr.
B. erostrata Burret
B. eumorpha Trail
B. exaltata Barb. Rodr.
B. fissifrons Mart.
B. floccosa Spruce
B. formosa Barb. Rodr.
B. gasipaes H.B.K.
B. gastoniana Barb. Rodr.
B. gaviona (Trail) Trail ex Drude
B. geonomoides Drude
B. gracilis Barb. Rodr.
B. granariuscarpa Barb. Rodr.
B. hirta Mart.
B. hoppii Burret
B. huebneri Burret
B. humilis (Wallace) Burret
B. hylophila Spruce
B. incommoda Trail
B. inermis Trail ex Barb. Rodr.
B. integrifolia Wallace
B. interruptepinnata Barb. Rodr.
B. juruensis Trail
B. kuhlmannii Burret
B. lakoi Burret
B. lanceolata Burret
B. leptospadix Burret
B. littoralis Barb. Rodr.
B. longifrons Mart.
B. longipes Poepp. ex Mart.
B. macroacantha Mart.
B. macrocarpa Wallace
B. major Jacq.
B. maraja Mart.
B. maraja-acu Barb. Rodr.
B. megistocarpa Burret
B. microcalyx Burret
B. microcarpa Spruce
B. microspadix Burret
B. mitis Mart.
B. monticola Barb. Rodr.
B. multiramosa Burret
B. nemorosa Barb. Rodr.
B. oligocarpa Barb. Rodr. & Trail ex Barb. Rodr.
B. ottostapfeana Barb. Rodr.
B. paucijuga Barb. Rodr.
B. pectinata Mart.
B. penicillata Barb. Rodr.
B. piranga Trail
B. platyacantha Burret
B. platyspina (Barb. Rodr.) Burret
B. pulchella Burret
B. pulchra (Trail) Trail ex Drude
B. riparia Mart.
B. simplex Burret
B. simplicifrons Mart.
B. socialis Mart.
B. sphaerocarpa Trail
B. syagroides Barb. Rodr. & Trail emend. Trail
B. sylvatica Barb. Rodr.
B. tomentosa Mart.
B. trailiana Barb. Rodr.
B. turbinata Spruce
B. turbinocarpa Barb. Rodr.
B. umbraticola Barb. Rodr.
B. umbrosa Barb. Rodr.
B. unaensis Barb. Rodr.
B. vexans Burret

Barcella odora (Trail) Drude

Catoblastus drudei Cook & Doyle

Chamaedorea depauperata Damm.

C. *integrifolia* (Trail) Damm.
C. *pauciflora* Mart.

Chelyocarpus chuco (Mart.) H. Moore
C. *ulei* Damm.

Copernicia prunifera (Miller) H. Moore

Desmoncus brevisectus Burret
D. *leptospadix* Mart.
D. *macroacanthos* Mart.
D. *macrodon* Barb. Rodr.
D. *mitis* Mart.
D. *nemorosus* Barb. Rodr.
D. *oligacanthus* Barb. Rodr.
D. *orthacanthos* Mart.
D. *philippianus* Barb. Rodr.
D. *phoenicocarpus* Barb. Rodr.
D. *polyacanthos* Mart.
D. *pumilis* Trail
D. *riparius* Spruce
D. *setosus* Mart.
D. *tenerrimus* (Mart. ex Drude) Mart. ex Burret

Elaeis oleifera (H.B.K.) Cortes

Euterpe catinga Wallace
E. *controversa* Barb. Rodr.
E. *jatapuensis* Barb. Rodr.
E. *longibracteata* Barb. Rodr.
E. *oleracea* Mart.
E. *precatoria* Mart
E. *roraimae* Damm.

Geonoma acaulis Mart.
G. *appuniana* Spruce
G. *arundinacea* Mart.
G. *aspidiifolia* Spruce
G. *baculifera* (Poit.) Kunth
G. *brongniartii* Mart.
G. *camana* Trail
G. *densiflora* Spruce
G. *deversa* (Poit.) Kunth
G. *juruana* Damm.
G. *laxiflora* Mart.
G. *leptospadix* Trail
G. *macrostachys* Mart.
G. *maxima* (Poit.) Kunth
G. *multiflora* Mart.
G. *oligoclada* Burret
G. *oligoclona* Trail
G. *pauciflora* Mart.
G. *piscicauda* Damm.
G. *poiteauana* Kunth
G. *pycnostachys* Mart.
G. *spixiana* Mart.
G. *stricta* (Poit.) Kunth
G. *tamandua* Trail
G. *triglochin* Burret

Hyospathe brevipedunculata Damm.
H. *elegans* Mart
H. *filiformis* H. Wendl. ex Drude

Iriartea ventricosa Mart.

Iriartella setigera (Mart.) H. Wendl.

Jessenia bataua (Mart.) Burret

Leopoldinia insignis Mart.
L. *major* Wallace
L. *piassaba* Wallace
L. *pulchra* Mart.

Lepidocaryum casiquiarense (Spruce) Drude
L. *gracile* Mart.
L. *guainiensis* Spruce
L. *macrocarpum* (Drude) Becc.
L. *tenue* Mart.

Manicaria atricha Burret
M. *martiana* Burret
M. *saccifera* Gaertn.

Mauritia aculeata H.B.K.
M. *campylostachys* (Burret) Balick
M. *carana* Wallace
M. *duckei* (Burret) Balick
M. *flexuosa* L. f.
M. *huebneri* Burret
M. *intermedia* Burret
M. *martiana* Spruce
M. *nannostachys* (Burret) Balick
M. *pumila* Wallace

Maximiliana maripa (Corr. Serr.) Drude

Oenocarpus bacaba Mart.
O. *discolor* Barb. Rodr.
O. *distichus* Mart.
O. *macrocalyx* Burret
O. *mapora* Karst.
O. *minor* Mart.
O. *tarampabo* Mart.

Orbignya barbosiana Burret
O. *pixuna* (Barb. Rodr.) Barb. Rodr.
O. *sabulosa* Barb. Rodr.
O. *spectabilis* (Mart.) Burret

Parascheelea anchistropetala Dugand
P. *luetzelburgii* (Burret) Dugand

Pholidostachys synanthera (Mart.) H. Moore

Phytelephas macrocarpa R. & P.
P. *microcarpa* R. & P.

Raphia taedigera Mart.

Scheelea huebneri Burret
S. *insignis* (Mart.) Karst.

Socratea exhorrhiza (Mart). H. Wendl.

Syagrus cocoides Mart.
S. *comosa* (Mart.) Mart.
S. *inajai* (Spruce) Becc.
S. *petraea* (Mart.) Becc.

* Originally published in: Palm Taxonomy in Brazilian Amazônia: The State of Systematic Collections in Regional Herbaria, *Brittonia* 34 (4), 1982, pp. 463-77. This checklist is confined to those species reported to occur within the Brazilian Amazon. The northern and western boundaries of this region are defined by international frontiers; the southern and eastern boundaries by the limits of the Amazon forest as determined by C. Soares in his article: Limites Meridionais e Orientais da Area de Ocorrência da Floresta Amazônica em Território Brasileiro, *Revista Brasileira de Geografia* 15 (1), 1953, pp. 3-95. Note: the taxonomy used in the Pesce text does not absolutely follow the nomenclature in this listing. Ed.