Promising Structural Fiber Palms of the Colombian Amazon[1]

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We have . . . two natural groups of fibers—the commercial species with their substitutes, . . . and the vast group of the so-called native fibers. . . . These so-called native fibers are all interesting . . . and through our knowledge of some of them, or when a species finds its way to the outside world, a new commercial fiber now and then is brought to light. They are legion when taken collectively, and therefore in enumerating the many species found in the countries of the globe it is very easy to secure a list that can only be stated in four figures.

Charles Richard Dodge (2, p. 23)

A country like Colombia, with such a wealth of ecological sites and altitudinal localities, a broad spectrum of economic conditions and, above all, an unbelievably rich and varied flora, is blessed with the possibility of giving the tropical world useful products from a great variety of species. The rich flora of this country and its still viable indigenous knowledge of the properties and uses of the ambient vegetation have not yet fully been scientifically explored or exploited.

Colombia possesses some 50,000 species of plants in its richly varied ecological and geographical zones, yet little of its national wealth is based upon the exploitation of a plant of Colombian origin. In my many years of research on the flora of Colombia, I have felt for a long time that Colombian industrialists, like their counterparts elsewhere, have indicated a preference for the exploitation of introduced foreign plants—yes, even a prejudice against the study of the potentialities of native plants of promise. It should never be overlooked that there is great danger in allowing a national economy to be too heavily dependent on a monoculture, such as coffee in Colombia.

While great strides can and will be made in the production for local use and for exportation of fibers from *Furcraea*, *Agave*, and related genera, the time has come, I believe, to consider some of the lesser known but promising sources of other structural fibers.

Much of my botanical work has consisted in a search of the Plant Kingdom to the use and betterment of mankind. The palms have always interested me as one of the economically most important plant families but one that still offers many opportunities for new cultivated species.

Some of the promising fiber plants used by the natives of the Colombian Amazon may well deserve to be domesticated. They are exploited by man in aboriginal societies from purely wild stock and with primitive methods. The first step involved in modern domestication of a plant lies in the amassing of a living collection of as many wild strains as possible from wild populations—strains showing differing morphological or physiological characteristics that might prove to be valuable in programs of breeding or selection. This procedure has proven its worth

[1] Delivered at the Primer Simposio del Fique, el Sisál y Otras Fibras Duras in Medellin, Colombia, March 12–14, 1975.

in many modern plant improvement programs—rice, maize, wheat, potatoes, rubber, quinine, tung oil, to mention only a few.

A meticulous study and evaluation of the economic potentialities of the structural fibers in some of the species that I shall mention as promising should be carried out to decide which are most deserving of serious research. When the choice is made, it will be necessary to start building up living collections of wild strains, to engage in a physical study of the fibers, and to initiate an agronomic and ethnobotanical evaluation of the characteristics of the various strains.

As we consider the domestication of a new crop plant, the great importance of the multipurpose plant must nowadays be borne in mind. It will be much sounder economically to develop a plant that, in addition to fibers, may yield another useful product, such as a wax, an oil, food for humans or animals, or some medicinally valuable constituent. Even primitive societies have recognized the wisdom of this approach. We may cite a number of examples among our most ancient cultigens: *Cannabis*, the source of marijuana, with its five uses; *Linum usitatissimum* or linen, the source of flax fiber and linseed oil; the several species of *Agave* which, in Mexican cultures, yield not only sisal or ixtle but have a number of other locally important uses.

There are sundry plants that are promising sources of economically valuable structural fibers. They belong to several families. The most promising as potential new domesticates for specific ecological zones such as the humid tropics, however, belong to the palm family.

There are some 300 native species of palms known from the Republic of Colombia (3). At least seven species should demand our attention. They are: *Astrocaryum jauari*, *A. murumuru*, *A. tucuma*, *A. vulgare*, *Mauritia flexuosa*, *M. minor*, and *Oenocarpus bacaba*.

Astrocaryum

Botanists have recognized about 40 species of *Astrocaryum* G. F. W. Mey., native to tropical areas up to an altitude of 2,000 feet from Mexico to Brazil. Those species with trunks are usually tall and thickly beset with very long black spines. Wallace wrote in 1853 that they "have a rather repulsive aspect, from almost every part—stem, leaves, fruitstalk and spathe, being armed with acute spines in some cases a foot long." Several species yield fiber and oil.

Astrocaryum jauari Mart.

Known in *lingua geral* in the Amazon region as *javarí*, this common tree grows along the flood banks of alluvial rivers, mainly in the western half of the Amazon Valley. In some localities that are under water more than half a year, it is extraordinarily abundant, occurring often for miles in dense stands, to the exclusion of any other plant.

Exploitation of this species as a major source of fiber, even locally by the Amazon native, has been hindered by the fierce spines protecting all parts of the plant and by its forbiddingly unfavorable natural habitat. It is, nonetheless, the source of a very strong, beautiful, white structural fiber which has found local use in the Río Negro of Brazil.

There is no agronomical reason to presume that *Astrocaryum jauari* might not—like *Hevea brasiliensis*—prosper better in a much drier habitat than that to which in nature it seems best adapted. Furthermore, the rapid growth of the plant and the quality of its fiber

1. *Astrocaryum murumuru* on the Río Putumayo, Amazonas, Colombia.

would seem to indicate the wisdom of a search for strains less fiercely armed with spines. Indians have informed me of "sports" with unarmed stems, and I have found in the Amazon several cultivated strains of the *pupunha* or *chontaduro* palm, *Bactris gasipaes* HBK. [*Guillielma gasipaes* (HBK.) L. H. Bailey], the trunks of which are devoid of spines. What we must do in our search for new economic plants is to examine nature—to see what nature itself has accomplished that we may bend to economic advantage.

Astrocaryum murumuru Mart.

A small tree that may attain a height of 12–18 feet, the *murumurú* palm grows along almost permanently flooded bog-banks of alluvial rivers and swamps. It is especially abundant in the eastern Amazon, but there may be a variety endemic in the westernmost part of the Amazon that prefers drier habitats (Fig. 1). The trunk, petiole, and sheathing bases are provided with strong spines, sometimes up to eight inches in length. The ovoid yellow fruit has a thin hard pulp around the endocarp. The fruit may be eaten by cattle, even though the stony endocarp enclosing the seed passes through the intestines of cows undigested. Swine are able to crush the endocarp and eat the seed.

The leaves are the source of a very strong white fiber. There is, however, little local production because of the fierce spines on the plant and the inhospitable habitat where it usually grows in nature.

In addition to its valuable structural fiber, *Astrocaryum murumuru* is economically interesting because of the oil content of its seed. The endocarp contains a seed with 44% of an edible white fat which is admirably suited for the making of oleomargarine. Its melting point is exceptionally high: 33–36° C; and its point of solidification is 32°. Its iodine index is 11–12.4 and its index of saponification is 241.6 (5).

As with *Astrocaryum jauari*, the *murumurú* palm deserves study to ascertain whether or not it might grow better on drier land than that of its native habitat and whether or not, in nature, one might find unarmed strains.

Astrocaryum tucuma Mart.

The fiber palm known as *tucúm* or *tucuma* in Brazil and *chambira* in Colombia and parts of Peru is native to the western part of the Amazon Valley, where it is one of the most useful of the native trees. Attaining a height of up to 50 feet, *Astrocaryum tucuma* has a stout trunk a foot in diameter covered with long strong black spines and growing singly in rather well-drained forests far above the level of high water.

Fiber from this species has long been recognized as one of the finest and strongest. Its strength has been compared with that of flax. The fiber is so fine that it has been called "vegetable wool." It has been produced in the Amazon by native labor from wild trees for a variety of purposes: the manufacture of cordage and rope, strings for bows, fish nets, carrying bags, hammocks, and other artifacts requiring great strength, durability, and resistance to decay.

The yellowish-white fiber is extracted from the leaves by maceration in water. An interesting description of the preparation by Siona Indians of the Colombian Amazon of chambira fiber states that both men and women gather the immature leaves. "The woman prepares the fiber from the palm heart, which consists of 20 to 40 blades about two to three feet long. The blade, three quarters of an inch wide at the base, tapers to a point at the other end. Starting at the base of the blade, the Siona woman strips off the inner surface, which is the usable fiber and discards the rest. The fiber is cooked in a metal kettle hung over a wood fire, until about one-third of the water has boiled away. Then the woman carries the kettle with its contents outside. With a stick, she removes the hot fibers from the kettle and hangs them over a line. She leaves them there to dry in the sun for a day or two, at which time they are ready to be twisted into string" (8).

2. The crown of *Astrocaryum vulgare*, source of chambira fiber, on Río Apaporis, Vaupés, Colombia.

The Brazilian natives likewise employ the round yellow-green fruit in preparing a nutritious drink known as *vinho de tucuma.*

In Brazil, 50 tons of tucúm fiber were produced in 1958 (4). Its commercial production is on the increase, although all production still comes wholly from wild trees.

This species of *Astrocaryum* is perhaps one of the Amazonian palms of economic importance most deserving of serious attention as a potential domes-

3. The spinous leaf of *Astrocaryum vulgare*, Vaupés, Colombia. Photo by J. Zarucchi.

ticate. A principal disadvantage to commercialization in plantation form might be its spiny nature, but a search for spineless mutants and a program of selection undoubtedly could overcome this problem.

The fiber from *Astrocaryum tucuma* should not be confused with that produced in the eastern Amazon and coastal regions of Brazil from *Bactris setosa* Mart., also called *tucúm* and produced for the making of bags, cobbler's thread, twine and ropes, and fishing nets for use in sea water, to which it is extremely resistant (2).

Astrocaryum vulgare Mart.

A lofty tree attaining a height of 50–60 feet, *Astrocaryum vulgare* (Fig. 2) is commonly known in Brazil as *tucuma bravo, tucuma piranga*, or *cumare*. In Colombia, the most usual native name for the tree and its fiber is likewise *cumare*. The stout trunks, often up to 10 inches in diameter and heavily covered, especially in the higher parts, with rings of strong black spines, grow in clumps, not singly as in the closely related species *Astrocaryum tucuma*. The petioles and midribs of the leaves are similarly armed (Fig. 3). This species is native to the western part of the Amazon Valley, common especially in the Río Negro basin of Brazil and in the Amazonian parts of Colombia. Like *Astrocaryum tucuma*, it prefers high, drained forests away from flood banks of the rivers. It is such an important economic tree that often, where it does not occur wild, the natives cultivate a few individuals in their yuca fields near houses.

The undeveloped leaves are the source of an exceptionally strong fiber, prized locally for purposes similar to those for which the fiber of *Astrocaryum tucuma* is employed: cordage, lines, nets, hammocks, etc. This fiber will produce a small cord hardly 2 mm in thickness that will sustain a weight of three kilograms and, at the end of six hours, will have extended from 800 mm to only 809 mm—or 1.011% (2)!

The tender immature leaf blades (Fig. 4), occurring in tight bundles, are shaken apart and the epidermis of each one is carefully removed by stripping. This ribbon epidermis is hung up to dry, then each ribbon is rolled between the hand and thigh into a string (Fig. 5). The fiber is strong, durable and of a creamy-white color. In some tribes, the mature leaves may be boiled in water and the fibers then stripped free.

As with *Astrocaryum tucuma*, this species very definitely merits serious industrial consideration. Investigation of native knowledge of the palm is, however, strongly suggested.

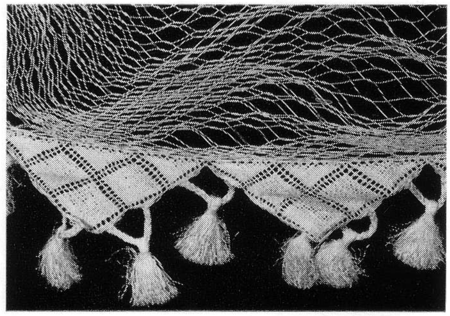
Both of these species might be adaptable to plantation practice in areas of the country covered with humid tropical forests, where little else can at pres-

4. Bundles of young pinnae of *Astrocaryum vulgare* ready for extraction of fibers, Río Apaporis, Vaupés, Colombia.

ent be cultivated and where hand labor is available. There is a very real possibility that simple machinery could be developed for the extraction of cumare fiber. There exists, naturally, the same hope that the wise application of agronomical procedures might develop strains with fewer or no spines—for these are a major disadvantage present in all species of *Astrocaryum*.

A potentially valuable secondary product from *Astrocaryum vulgare* could be the oils provided by the fruits, which ripen from February to June. The yellow-green pulp yields from 33% to 47% of its weight of an orange-colored oil or fat of the consistency of Vaseline and with properties very analogous to those of the oil of the African *Elaeis guineensis* Jacq.: it has an initial melting point of 27° C and melts totally at 35°; its iodine index is 46.4 and its index of

5. An Indian woman twisting chambira fiber of *Astrocaryum vulgare* into twine, Río Apaporis, Vaupés, Colombia.



6. Portion of a native hammock made in the Vaupés of Colombia. The fiber of the lower edge is of *Mauritia flexuosa*; that of the main part of the hammock is of *Astrocaryum vulgare*. Photo by M. J. Balick.

saponification is 220.2. The seed oil, solid at ordinary temperatures, has a slightly higher initial melting point (30° C), a higher saponification index (240–245), and much lower iodine index (12–14). These two oils are admirably suited for use in the soap industries (5).

In 1919, Correa stated that no fiber from any species of *Astrocaryum* could compete with *sisal, henequen* or *abacá* in the world market (1). Conditions have drastically altered in the past half century; needs have changed; secondary products from palm sources may have acquired new importance; and the obligation to find industrially valuable products for hinterland areas most certainly has developed. All of these considerations suggest a new critical technical look at *Astrocaryum* and its potentialities.

Euterpe

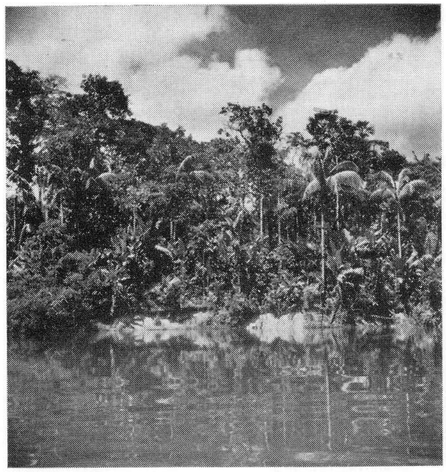
Approximately 30 species of *Euterpe* Mart., native to tropical America from Belize to South America and the West Indies, are recognized. They are usually extremely delicate and elegant palms with terminal leaves in a plumose arrangement. They occur all the way from swampy habitats to well-drained altitudes of some 4,000 feet. Many species occur in incredible abundance in nature.

Euterpe oleracea Mart.

This graceful tree up to 60 feet tall (Fig. 7) is known throughout the Amazon basin as *assaí.* In Colombia, the name applied to this or other species of the genus is *manaca.* At least 17 species are listed for the flora of Colombia, although many of the 17 are often included in the genus *Prestoea.*

Although I have never seen fiber extracted from any species of *Euterpe,* there are references to several species as the source of structural fibers useful for ropes and coarse textiles. Here is one point at which our botanical re-

7. A clump of *Euterpe oleracea* on the outskirts of Mitú, Vaupés, Colombia. Photo by J. Zarucchi.



8. *Euterpe precatoria* along banks of the Río Caquetá, Amazonas, Colombia.

search cannot, at the moment, help industry, and where industry should give heed to the vague reports that may be indicative of important economic characteristics of a group of plants.

This species, and the closely related *Euterpe precatoria* Mart. (Fig. 8), are the source of fruits from which are made a very popular drink and ice cream in many parts of Brazil and Peru.

Mauritia

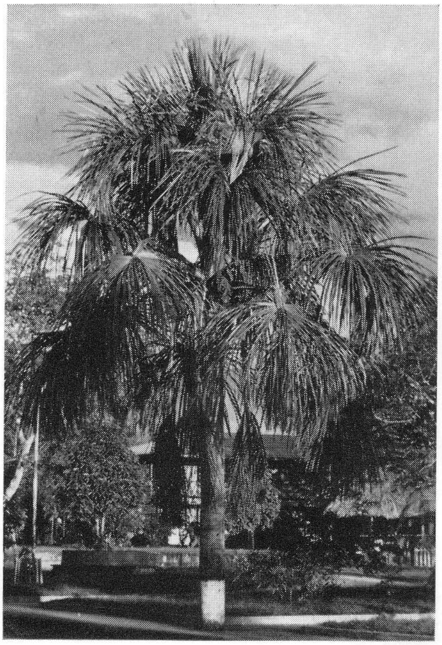
A genus native chiefly to the Amazon and Orinoco areas, to the Chocó, and to Trinidad, *Mauritia* L. f. prefers permanently swampy regions or localities at least periodically flooded. Nine or ten species are recognized. This genus may be potentially one of our most promising economic plants for domestication and deserves study.

Mauritia flexuosa L. f.

This species—or its very close relative *M. vinifera* Mart., which is often considered to be the same as *M. flexuosa*—is native from British Guiana to Colombia and Peru (Fig. 9). Described by Wallace (7) as one of the "most noble and majestic of the American palms," it is known in Venezuela and Colombia as *moriche*, as *aguaje* in Peru, and, in Brazil, as *burití* or *mirití*. It attains a height of 80 feet, with a stout unarmed trunk measuring up to two feet in diameter. *Mauritia minor* Burret, often considered as a separate species, is undoubtedly used for identical purposes.

This may prove to be one of the most important tropical economic plants ever to be domesticated in South America, once serious attempts are made to domesticate it. It is a multipurpose economic plant.

We are here interested in it as a fiber source. Since it apparently has never been cultivated, even by primitive peoples, we have no idea of the extent to which cultivation may alter the plant



9. *Mauritia flexuosa* growing in the center of the town of Mitú, Vaupés, Colombia. Photo by J. Zarucchi.

and render it more important as a potential domesticate, especially for ecological sites not usable for other cultigens.

Occurring widely in the Amazon and Orinoco valleys, the *moriche* holds a very important place in the life of native peoples in tropical South America. The sap is the source of a wine; another beverage is prepared from the leaves; a kind of sago starch is made from the inner pithlike parts of the stem; the fruits have an edible pulp from which also a fermented chicha is made; and the immature leaves yield a fiber.

The strong structural fiber is prepared from the epidermis, stripped from very young leaf blades and dried. It is threadlike and white. The fiber extracted from young leaf spikes appears to be much stronger than that taken from older material. Widely regarded as one of the best fibers for cordage, hammocks, and fishing nets, it has been rated even more durable than the fiber provided by *Astrocaryum vulgare*. *Mauritia* fiber has been classed as the most useful native fiber produced in British Guiana.

Because of interest in this fiber plant as a possible candidate for domestication, it will perhaps be valuable to mention some of its other economic potentialities. The quality and quantity of a sagolike starch from the stem of *Mauritia flexuosa* puts this palm in the same category with *Metroxylon sagu* Rottb. of the Old World. The Warao and other Indians of the Orinoco prepare great quantities of this starch from wild stands of *Mauritia flexuosa.* The production of starch from the *moriche* palm is, perhaps, a locally exploitable industry.

In addition to its importance as a source of starch, *Mauritia flexuosa* yields interesting oils. The pulp of the fruit comprises approximately 10% of an edible oil, valuable because of its high concentration of reddish carotenoids. The fruit kernel has up to 48% of an oil of a light yellow color with an iodine index of 25 and a saponification index of 246 (5). Little has been done, even in Brazil, about the industrialization of this oil, but it could, together with fiber production, become the basis for cultivation of extensive plantations of *Mauritia flexuosa* and its relatives. It most certainly demands the attention of modern science and industry as a neglected economic plant (6).

The interesting genus *Mauritiella*, a segregate of *Mauritia*, may well supply the same fibrous elements as does *Mauritia*, but I have never encountered its use. It is very similar to *Mauritia* but is of a slenderer and more graceful habit. Some 15 species of *Mauritiella*

10. *Oenocarpus bacaba* growing in forest, Vaupés, Colombia. Photo by J. Zarucchi.

have been recognized from tropical Americas. The species most commonly found in Amazonian Colombia is *Mauritiella aculeata* (HBK.) Burret. It is known in the Vaupés as *caranaí*.

Oenocarpus

The genus *Oenocarpus* Mart. comprises up to 16 species of palms of northern South America and Central America. They are often lofty and majestic trees native to river banks that are not heavily flooded during the rainy season; some species, however, are lower and caespitose. They are tropical, no species ascending higher than 1,500 feet above sea level.

Oenocarpus bacaba Mart.

Widely known in the Amazon as *bacabá, Oenocarpus bacaba* occurs abundantly on high river banks of the Amazon and Orinoco drainage areas and is general in the dry virgin forests of the western Amazon (Fig. 10). With a strong trunk, usually devoid of spines, it may reach a height of 60–70 feet.

Although I have never seen *Oenocarpus bacaba* exploited by Indians for its fiber in Colombia, there are reports suggesting that the production of fiber of this species is worthy of study (2, 4). The literature can help us little in this respect, and it may be that the fibers supplied by this species represent not structural fibers but the remnants of persistent leaf bases, like those of *Leopoldinia piassaba* Wallace; they are, however, much stouter and stiffer than those of the *piassaba* palm.

The fruits, violet externally and greenish within, produce an oil (from 8–10% of the nutritive tissue) which has physical properties very similar to those of olive oil (5).

There are many other species yielding valuable structural fibers that Colombia ought to consider from the industrial point of view. Some are native Colombian plants; others are from far off foreign lands, but they could be easily adapted to Colombia's varieties of climate. I have mentioned only palms of the Colombian Amazonia—partly because I am personally acquainted with most of those plants. But I would be derelict if, in this brief and superficial report, I did not mention a few other plants to which Colombian fiber-producing operations should direct their attention. Some are well known plants; some are poorly known, but, as with the palms that I have discussed, they all merit research. Such a list might include *Ananas comosus* (L.) Merr., *Aechmea* spp., *Bromelia* spp. and *Karatas plumieri* E. Morr. of the Bromeliaceae or pineapple family; *Musa textilis* Nee of the Musaceae or banana family; and *Phormium tenax* Forst. and several species of *Sansevieria* of the Liliaceae or lily family. These, and others that might be mentioned, await proper exploitation or study as adjuncts to Colombia's future in an intensification of man's bending of the Plant Kingdom to human betterment.

In conclusion, I take the opportunity of dedicating this modest contribution to the late Professor Armando Dugand, outstanding Colombian scientist and expert in palms, under whose direction in 1941 I began my 35-year study of the economic potentialities of the Colombian flora.

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PALM LITERATURE

Recent Malaysian Studies on the Oil Palm

Turner, P. D. (ed.) *Oil Palm Developments in Malaysia: Proceedings of the First Malaysian Oil Palm Conference.* 164 pp. The Incorporated Society of Planters, Kuala Lumpur. 1968. Wastie, R. L. and D. A. Earp (eds.) *Advances in Oil Palm Cultivation: The Proceedings of the International Oil Palm Conference.* 469 pp. The Incorporated Society of Planters, Kuala Lumpur. 1973. Williams, C. N. and Y. C. Hsu. *Oil Palm Cultivation in Malaya: Technical and Economic Aspects.* 205 pp. University of Malaya Press, Kuala Lumpur. 1970. Turner, P. D. and R. A. Gillbanks. *Oil Palm Cultivation and Management.* 672 pp. The Incorporated Society of Planters, Kuala Lumpur. 1974. Khera, H. S. *The Oil Palm Industry of Malaysia: An Economic Study.* 354 pp. Penerbit Universiti Malaya, Kuala Lumpur. 1976.

These five books reflect the breadth of investigations carried out in Malaysia over the past ten years on the oil palm, during a period wherein Malaysia came to be the world's leading producer of palm oil.

Considered in the order listed above, the first item is an edited collection of fifteen papers presented at a conference held in Kuala Lumpur in 1967. The papers cover a broad range of agronomic subjects including land preparation, nursery operations, cover crops, and harvesting methods. These are complemented with single papers on industrial processing, economic aspects, and the future of the oil palm in Malaysia. Each paper is followed by a short summary of the points from discussion, and some include black-and-white photographs.

Advances in Oil Palm Cultivation represents the edited proceedings of another oil palm conference held in Kuala Lumpur in 1972. Although billed as international in scope, nearly all of the thirty contributions specifically concern cultivation in Malaysia. The intro-