Oil-Producing Palms of the World – a Review

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Oil palms, as the name implies, are sources of vegetable oils. The latter, by definition, are oils of plant origin and they are of major economic importance to man. Vegetable oils are mainly of two sorts, those that are volatile—the aromatic essentials oils (familiar examples are the numerous oils used in perfumery)—and the various kinds of nonvolatile or fixed oils. The latter are composed of glycerin combined with a fatty acid and are commonly termed fatty oils because of their close chemical relationship with animal fats. Fatty oils are found in oil-yielding palms, which are one of the major sources of the world's vegetable fats.

Unlike essential oils, which are believed to be mainly by-products of plant metabolism, fatty oils occur in all protoplasm where they serve as important sources of the high energy required for metabolic processes. A fatty oil is considered a true oil if liquid, but if it solidifies at ordinary temperatures, as in palm oils, it is termed a fat. Fatty oils in plants occur in greatest quantity in tissues of fruits or in seeds where they serve as food reserves. These oils may sometimes be useful as attractants to animals which effect seed dispersal, but more fundamentally they provide the energy required for germination and early growth of the seedling until it becomes self-sustaining with its own roots, stems, and leaves. In palms, the fatty oil is located chiefly in the endosperm of the seed. The amount of seed oil or so-called kernel oil depends on the quantity of endosperm; bigger palm seeds usually have larger oil reserves. The coconut, a fruit with one of the largest seeds known, has an abundance of fatty endosperm (i.e., coconut meat) which, when dried, is the important copra of commerce. The seed is surrounded by a thick endocarp and a fibrous fruit coat (pericarp or "husk") which are devoid of oil tissue but are highly useful in the dispersal of the maritime species by flotation in seawater. Many other palms depend upon animals for seed dispersal and each of their fruits contains not only an oil-rich seed but a colorful outer layer full of oily pulp (mesocarp) which attracts animals as food. Such palm fruits, exemplified by that of the African oil palm (*Elaeis guineensis*), may yield two distinct types of oil—mesocarp ("pericarp") oil plus seed or kernel oil. In world commerce, the term palm oil refers to mesocarp oil, while oil from the endosperm is traded as palm kernel oil. Coconut oil, actually a palm kernel oil, is often considered separately from other palm kernel oils.

Both types of palm oil are increasingly important as major sources of vegetable oils used as foods and in industrial products. A major reason for this is demonstrated in Table 1 which shows average factory yields of oil from some of the principal sources of commercial vege-

*Based on a presentation in the Symposium entitled "The Natural History and Utilization of Palms" at the annual meeting of the Society for Economic Botany, Ithaca, N. Y., June 14, 1973. Photos by the author except where otherwise indicated.

Table 1. Average factory yields from important oilseeds.

Species	Kilograms of oil/ hectare
Elaeis guineensis (mesocarp & kernel oil)	2790
Cocos nucifera	818
Sesamum indicum	420
Brassica spp.	392
Helianthus annuus	308
Arachis hypogaea	230
Linum usitatissimum	193
Glycine max	190

table oils. The oil palms are the highest yielders, far outstripping the soybean, which nonetheless is the chief source of the world's tonnage of vegetable oil (see Table 3). High quality or refined palm oil (i.e., mesocarp oil, primarily from *Elaeis*) has major uses in margarines and cooking fats and in the manufacture of such food products as bakery goods and ice creams; it is also essential in the manufacture of soaps, detergents and shampoos. Because of its slow oxidation rate, palm oil is also used by industry as a flux in plating tin and in the cold rolling of sheet steel. Palm oil contains valued fatty acids and yields stearic acid of high quality through hydrogenation. It contains a large amount of carotene, a precursor of vitamin A, and is also a source of proteins and antibiotics obtained through selective fermentation. Palm kernel oil (the oil derived from seeds of several genera discussed below) also has a number of uses in edible and inedible products which include cooking oils, margarines, shortenings for the bakery industry, ice cream, cosmetics, shampoos, soap, additives for lubricating oils, detergent foam boosters, biodegradable detergents, and the like.

Although the fruits and/or seeds of many palms may be oleaginous, the species yielding quantities of oil sufficient to be attractive in commerce are relatively few, about ten of the estimated 2780 kinds of palms presently known in the world. Thus about one of every 278 species of palms can be regarded as a commercial oil-yielding palm. The more important of these oil-yielding species were recognized as useful by man centuries ago when he first utilized them for domestic purposes, either for food or for edible or otherwise useful oil. Primitive man did a remarkably good job on a trial-and-error basis in selecting the useful plants from the nonuseful. He had a long time span in which to work, but his early needs did not always match those of modern man and his sophisticated industries. Thus it may be that genera and species of palms exist today which have fruits with oleaginous properties not recognized as potentially useful. Apparently no systematic survey has been made to evaluate the oil content of the fruits of all palms likely to be useful.

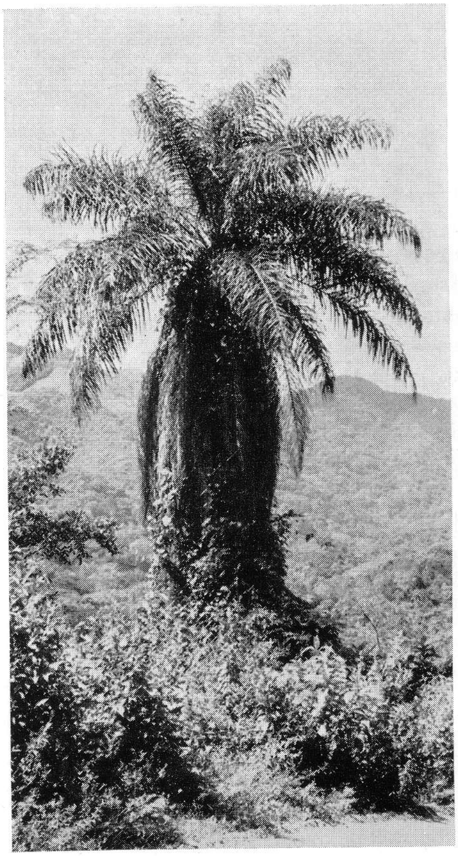
The presently recognized oil-yielding palms, representing eight genera, pertain to but two of the fifteen major groups of the Palmae, namely the arecoid and cocosoid groups. However only two genera, *Jessenia* and *Oenocarpus*, are arecoid taxa; the larger number of oil palms are cocosoid species belonging to the genera *Acrocomia*, *Astrocaryum*, *Cocos*, *Elaeis*, *Orbignya*, and *Syagrus*. Of interest also is the fact that of these eight genera only one, *Cocos*, is of Old World origin (probably Melanesia); *Elaeis* straddles the hemispheres with one species in tropical Africa and another in northeastern continental tropical America; all remaining genera are neotropical, the majority of species being South American.

The use of certain palms for oil by man appears to predate written history, at least in the case of the coconut palm, long considered not only the world's most important palm but one of the most useful of all trees as well. The endosperm of the coconut doubtless appealed originally to prehistoric primitive tropical man as a source of nutritious food, but the edible meat must soon have been found to yield a useful oil as well. Certainly the coconut had been widely disseminated as a cultigen and its oil was in universal domestic use throughout the coconut-growing areas of the Old World by the time of the pioneer voyages of Europeans. On the other hand, the use of the fruit of the African oil palm, the only other important source of palm oil in the Old World, appears to be of much more recent origin. Fruits of wild trees have long been collected for domestic use within its natural range in Africa, but *Elaeis guineensis* appears not to have been widely planted until very recent times, though apparently carried easterly across the African continent to Madagascar from its center of dispersal in tropical West Africa. Only within the past century has it been extensively cultivated, as *Cocos* has been for centuries.

The greatest variety if not the most important of the oil-yielding palms are natives of the New World from Mexico to Argentina, but with the greatest concentration in Brazil. Amerindians of the lowland neotropics apparently have utilized the oils derived from several different palms for a long time. Just how long is impossible to say, as written records for the pre-Columbian period are lacking and oil palms did not exist in the temperate highlands occupied by more highly developed cultures where archeological records have principally been available. However, there was no species of oil palm in the New World comparable to the coconut palm in the tropical Old World where, in its areas of distribution, it served as a primary source of food and edible oil.

Most of our early knowledge of oil-yielding palms in tropical America and their uses by aboriginals come from the accounts of various European naturalists travelling in South America, especially Amazonia, during the past century. Amerindian utilization of the oils obtained from palms, as recorded by these travellers, includes use as food and drink, cooking oils, illuminants, medicine, and as oil bases for the widely used insect-repellent and/or decorative body paints derived from the seeds of *Bixa* and the fruits of *Genipa*.

In a letter to Sir William Hooker from San Carlos del Río Negro, Venezuela [near the junction of the headwaters of the Orinoco and the Río Negro, a major tributary of the Amazon], the botanist Richard Spruce (6) wrote [March 19, 1854] "nearly all the palm fruits yield oil in greater or less quantity. . . . By allowing the liquid ["by triturating the fruit . . . in water"] to stand a short time . . . the oil rises to the top, and an idea is obtained of the quantity yielded by any particular palm fruit." Spruce noted that the greatest quantity of oil ("in appearance exactly like the oil of *E. guineensis*") is produced by what he erroneously called *Elaeis melanococca* [now known as *E. oleifera*], then adds, "but I have never heard of its being collected and put to any use [although] abundant all about the mouths of the Río Negro and Madeira . . . ." Certainly this is a strange commentary considering that its sister species, the African *E. guineensis*, is today one of the world's two most important oil palms. Spruce goes on to report that oil "of finer quality . . . colourless and sweet-tasted, . . . excellent for lamps [and] . . . cookery . . . [and] equal to olive oil or butter" is obtained from species of *Oenocarpus* ("*Oe. Ba-*



1. *Acrocomia mexicana* in the state of Oaxaca, Mexico. Photo by H. E. Moore, Jr.

caba, pataua, distichia, etc.".* The recognition of the excellence of *Oenocarpus* oil was even shown by "the shopkeepers of Pará [who] buy Pataua oil of the Indians, and mix it in equal proportions with olive oil, retailing the whole as 'olive oil', from which indeed even the best judges can scarcely distinguish it."

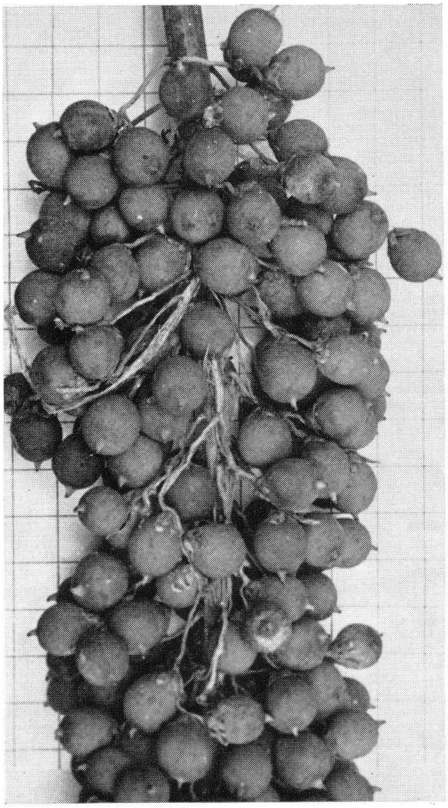
A number of palm genera are known to be sources of palm oil, either derived from the mesocarp and/or the endosperm. The records of some like *Rhyticocos* (2) and *Brahea* describe only minor local usually aboriginal use. Those genera that have been exploited commercially, either in the past or at present, are discussed briefly below in alphabetical order. It should be emphasized that these genera, despite their importance as economic plants, are poorly known biologically and, except for *Cocos* and *Elaeis*, also are in need of taxonomic study.

Acrocomia

Acrocomia, a genus of about 26 species of prickly cocosoid palms (Fig. 1) of the New World, occurs naturally in sites that are seasonally dry from Mexico and the West Indies to Paraguay and northern Argentina. The somewhat spherical druplike fruits (to 2 inches in diameter in some species) yield a kernel oil which at present is commercially valuable only from *A. totai*, a native of savannas in northeastern Argentina and Paraguay where it is locally abundant and of increasing importance in the export trade. Annual exports of this oil from Paraguay in 1971 were 7,400 metric tons, representing a gradual annual increase from the 2,300 metric tons recorded in 1964 (1). During the past decade this appears to be the only palm kernel oil exported from South America, and in 1971 it represented about three percent of the overall world export total of that commodity, the balance of which represents *Elaeis* oil (1). However, Brazil doubtless produces substantial palm kernel oil all of which is used domestically. In Paraguay, the kernel oil is obtained from the seed of wild trees. *Acrocomia totai* is of special interest in being a subtropical rather than a strictly tropical species. As such it may have potential as a cultivated species in similar latitudes where *Cocos* and *Elaeis* cannot be grown productively. Unlike the latter genera, which produce fruit continuously throughout the year but only under hot, wet, tropical conditions,

* Certain of these palms are now considered species of *Jessenia.*

2. *Astrocaryum tucuma* near Manaus, Brazil. Photo by H. E. Moore, Jr.



3. Fruits of *Astrocaryum standleyanum* in Panamá. Photo by Paul H. Allen.

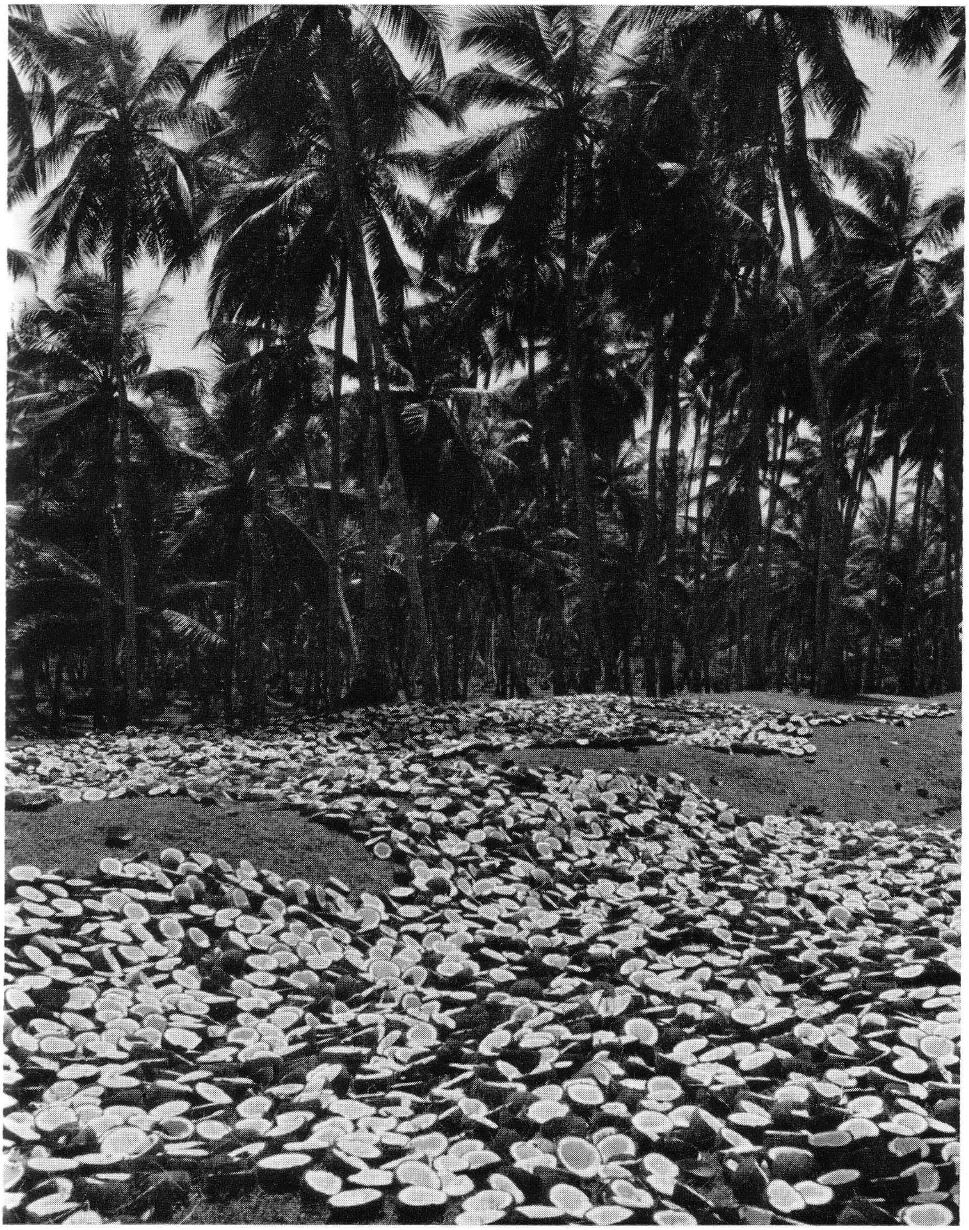
A. totai at its latitude produces seasonally and consequently is presumed to be less productive.

Astrocaryum

Astrocaryum includes nearly 50 species of neotropical cocosoid palms (Figs. 2, 3) mostly native to hot areas of heavy rainfall in lowland South America. Several taxa are recognized sources of commercial palm oils but in all cases fruits are obtained from wild trees. Most important have been *A. murumuru* and *A. tucuma* of the lower Amazon basin, especially that part located within the Brazilian state of Pará. During World War II, and for a short period thereafter, substantial quantities of tucum palm kernels were exported (about 14,000 metric tons in 1949) but the total palm kernel oil production for domestic use in Brazil for these two species has seldom exceeded 1,000 metric tons (3). It should be noted that these palms occupy an area in Amazonia which is essentially the climatic analogue of the native range of *Elaeis guineensis*. Any consideration of the possible culture of *Astrocaryum* should therefore be made on the basis of its pros and cons vis-à-vis the African oil palm, a far more productive species.

Cocos

Cocos is the genus of the familiar monotypic cocosoid palm *C. nucifera* (cover), a cultigen widely planted along many humid tropical shores and adjacent lowland areas but probably of Melanesian origin. The coconut has been for many years the world's most important single source of a vegetable oil derived from a palm, the kernel oil (coconut oil) derived from copra (Fig. 4). Copra, containing about 65% oil, is the dried meat or endosperm of the familiar coconut seed. Unlike *Elaeis*, which produces both a mesocarp and seed oil, *Cocos* has a fibrous husk devoid of any oil (Fig. 5) and the collection of coconuts and preparation of copra which require much hand labor is not amenable to mechanization. The yield of coconut oil runs between 800–1,200 pounds per acre which is about one fourth the oil production of the African oil palm, a major reason why plantings of the latter palm are increasing dramatically at the present time. According to Purseglove (5), there are five million bearing palms on ten million acres planted to coconuts. This acreage is scattered throughout the lowland tropics but the Philippine Islands, Oceania, Indonesia, Malaysia, and Sri Lanka together produce over 90%

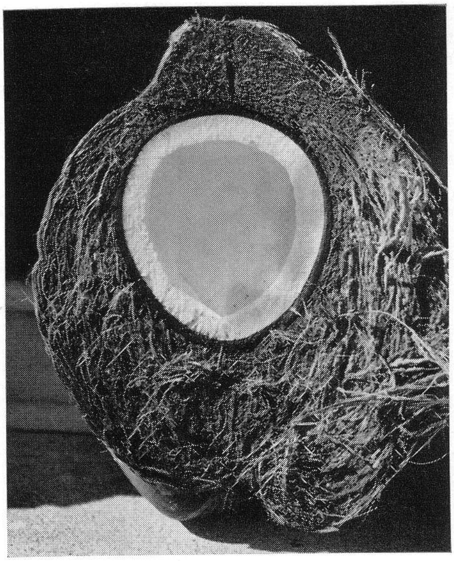


4. Copra drying at the edge of a coconut plantation in Sri Lanka.

of the copra and coconut oil entering world trade. India, Burma, and Thailand also have large plantings but utilize most of their production domestically.

Elaeis

Elaeis (including *Corozo*) is a small genus of two species of cocosoid palms. One, *E. guineensis* (Fig. 6), including



5. A coconut split lengthwise to show husk and seed.

E. madagascariensis, is native to wet paleotropical Africa; the other, *E. oleifera* (Figs. 7, 8), occurs in the humid lowland neotropics of the lower Amazon, northern South America, and Central America. This is an unusual distribution among palm genera and one shared only with the genus *Raphia* (4). *Elaeis oleifera* has oleaginous characteristics similar to those of *E. guineensis* (see Spruce's comments above), but it is not cultivated, although it may be utilized locally for domestic purposes within its natural range. *Elaeis guineensis*, cultivated in extensive plantations mainly in the Old World, is the important commercial species and may soon displace *Cocos* as the most important source of palm oils (inclusive of both palm oil and palm kernel oil). In the decade 1962–1972 world exports of coconut oil increased 16% compared with a 75% increase in exports of *Elaeis* oils. The reason for this increase is obvious. The African oil palm fruit contains 45–48% of palm oil (mesocarp oil) in its fleshy coat (vs. none in the fibrous coconut husk) and another 56% of palm kernel oil in the endosperm of the seed (Fig. 9). And although the fruit clusters require hand harvesting, all subsequent operations including oil extraction (at the plantation) can be completely mechanized. Since *Elaeis guineensis* is a tree crop which fruits continuously in large, dense, many-fruited clusters (Fig. 10), it is not only the most efficient oil palm but apparently the most efficient of all oil-yielding plants as well. Certainly the majority of man's important oil plants (soybean, sunflower, peanut, cotton, and rapeseed) are herbaceous species of seasonal culture and hence do not produce crops the year around.

Most of the world's supply of palm oil and palm kernel oil has until recently originated in the native range of *Elaeis guineensis* in West African countries where the major source has been mostly wild or semiwild trees. However, commercial plantations, utilizing selected superior seedstock and with modern integrated extractive mills on the premises, have been developing rapidly elsewhere in the tropics both in the Old World and the New World wherever the necessary conditions of heat, humidity and high rainfall suitable for the best yields prevail. The high rate in development of new plantations of the African oil palm is illustrated dynamically in Malaysia where the species was first introduced in 1875. It remained unrecognized as an oil source but was grown as an ornamental for nearly 50 years. Its potential was finally recognized and in 1917 it began to be developed as a crop species. 12,548 acres had been planted by 1926, 186,680 acres in 1964, 660,000 acres in 1967, and over a million acres in 1973. This explosive recent growth of oil palm plantings is related directly to the world population explosion and

6. *Elaeis guineensis* in plantation culture, Honduras.

the greatly increased need for vegetable oils. The rationale for such success with this species is more than evident, for the productivity of this plantation palm, which begins to bear when plants are three years old, is two tons of vegetable oil per acre for mature trees (eight years old or more).

7. *Elaeis oleifera* in the former experiment station at Lancetilla, Honduras.

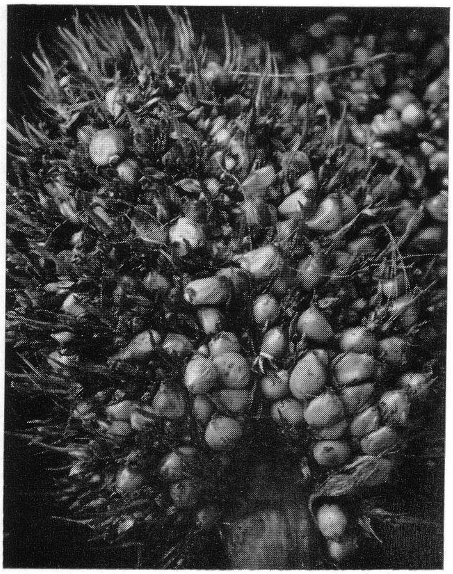
Jessenia

Jessenia is believed to include about five species of arecoid palms (Fig. 11) native to high rainfall areas of lowland tropical South America, including the river systems of the Amazon and Orinoco, and of the Atrato and San Juan in the Colombian Chocó. The drupaceous fruits produced abundantly by several Amazonian species, especially *J. bataua* (called *patauá* or *batauá* in Brazil and *seje* in Colombia and Venezuela), have long been utilized by Amerindians who relish the light greenish-yellow, edible, mesocarp oil. The edible oil of the *J. bataua* fruit is of high quality and practically identical in chemistry and utility with olive oil, a fact commented upon by Richard Spruce (see above, as *Oenocarpus pataua*). The *Jessenia* drupe is apparently unique among oleaginous palms in that there is scarcely any oil in the kernel (less than 1%) while the pericarp yields 18–24% oil (3). The very small commercial production of *pataua* oil, all obtained from wild trees, has been limited to Brazil where exports peaked in 1944 (215 metric tons) during the World War II scarcity of vegetable oil. Markley points out that the patauá palm occupies a natural range that would be ideally suited to plantation culture of *Elaeis guineensis*, a far more efficient palm oil producer.

Oenocarpus

Oenocarpus is an arecoid genus including about 16 species (Fig. 12) occu-

8. *Elaeis oleifera* in fruit at Lancetilla.



9. A fruit cluster of *Elaeis guineensis* in Honduras.

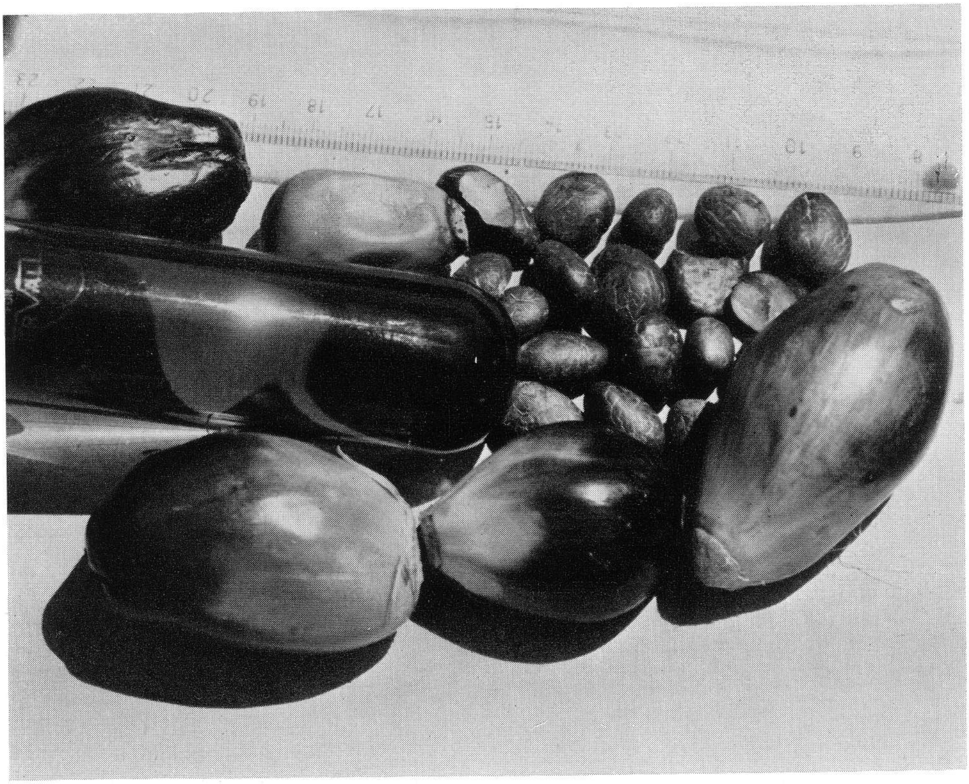
pying essentially the same geographical range in lowland tropical South America as the closely related *Jessenia*. Both genera are poorly known taxonomically and a comparative study of the two would seem desirable. The fruits of the two genera appear to be similar in general morphology and aboriginal use.

Orbignya

Orbignya includes about 24 species of often massive cocosoid palms native to the continental neotropics, mostly in South America. As is so frequently the case with large tropical plants, basic information on their biology and taxonomy is woefully inadequate. The genus includes what have been up to now the most important native oil-yielding palms of the New World. These are the Brazilian *curuá* (*O. sabulosa*) and *babassú* palms (*O. martiana* and *O. oleifera*) and the cohune palm (*O. cohune*, see Fig. 13) of lowland Central America. The potential of other species of *Orbignya* as oil producers is unknown as is the potential of species of the closely related genera *Attalea*, *Maximiliana*, and *Scheelea*.

Babassú and *cohune* palm fruits are produced abundantly in enormous pendant clusters (Fig. 14) with several hundred (each 3–5 inches long) in each giant infrutescence. The oil is derived from the kernels, for the pericarp in *Orbignya* is fibrous, not oleaginous. Each *babassú* fruit may have up to eight seeds, the endosperm containing about 65% oil. However the kernel oil represents, on an average, only about six percent of the total weight of the fruit. This fact, together with the physical difficulty of extracting the kernels (mostly a hand operation), have made *Orbignya* oil production relatively uneconomic when it is in normal competition in the world market with other seed oils, whether from palms or other plants, and primarily because of this the oil is no longer exported from Brazil.

Up to the end of World War II, most Brazilian *babassú* kernels were exported for oil extraction abroad, about 44,000 metric tons having been produced in 1945. Brazil's rapidly increasing pop-



10. Fruits, seeds, and mesocarp oil (in test tube) of *Elaeis guineensis.*

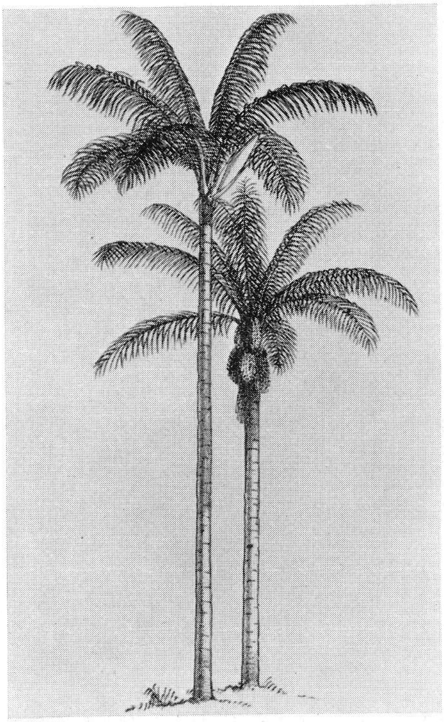
ulation and concomitant increases in domestic requirements for vegetable oil after the war have meant that *babassú*-derived oil has been used entirely in Brazil where the oil's large lauric acid content has made it of value primarily in the domestic soap industry (3). During a recent five-year period (1968–1972), production of *babassú* kernels increased from 177,000 to 190,000 metric tons, representing an increase in oil production from 65,000 to 107,000 metric tons (1).

Babassú fruits have always been obtained from wild trees, of which the largest stands are found in the Brazilian "campos" in the states of Maranhão, Piauí and northern Goiás. Although the wild stands of *Orbignya* apparently continue to be productive domestic sources of palm kernel oil, eventually they will be unable to hold their own economically with more efficient plantings of *Elaeis* which most certainly will be developed in favorable sites in Amazonia.

Syagrus

Syagrus includes 34 species of cocosoid palms of tropical South America. Only one species, *S. coronata*, the *licuri* or *ouricury* palm (Fig. 15), has been utilized as the source of palm kernel oil, used domestically in Brazil's soap industry. Formerly, during World War II, *licuri* kernels were exported, peak production reaching about 15,000 metric tons, but utilization of this species has

11. *Jessenia bataua* near Pucallpa, Peru. Photo by H. E. Moore, Jr.



12. *Oenocarpus bacaba* as illustrated in Wallace, Palm Trees of the Amazon and Their Uses, plate IX.

apparently decreased greatly in recent years (3). Unlike other oleaginous palms, the majority of which require rainy lowland tropical conditions, *Syargus coronata* occurs in areas of low rainfall and inhabits poor, arid soils throughout its natural range in Brazil from Pernambuco to Minas Gerais.

Discussion

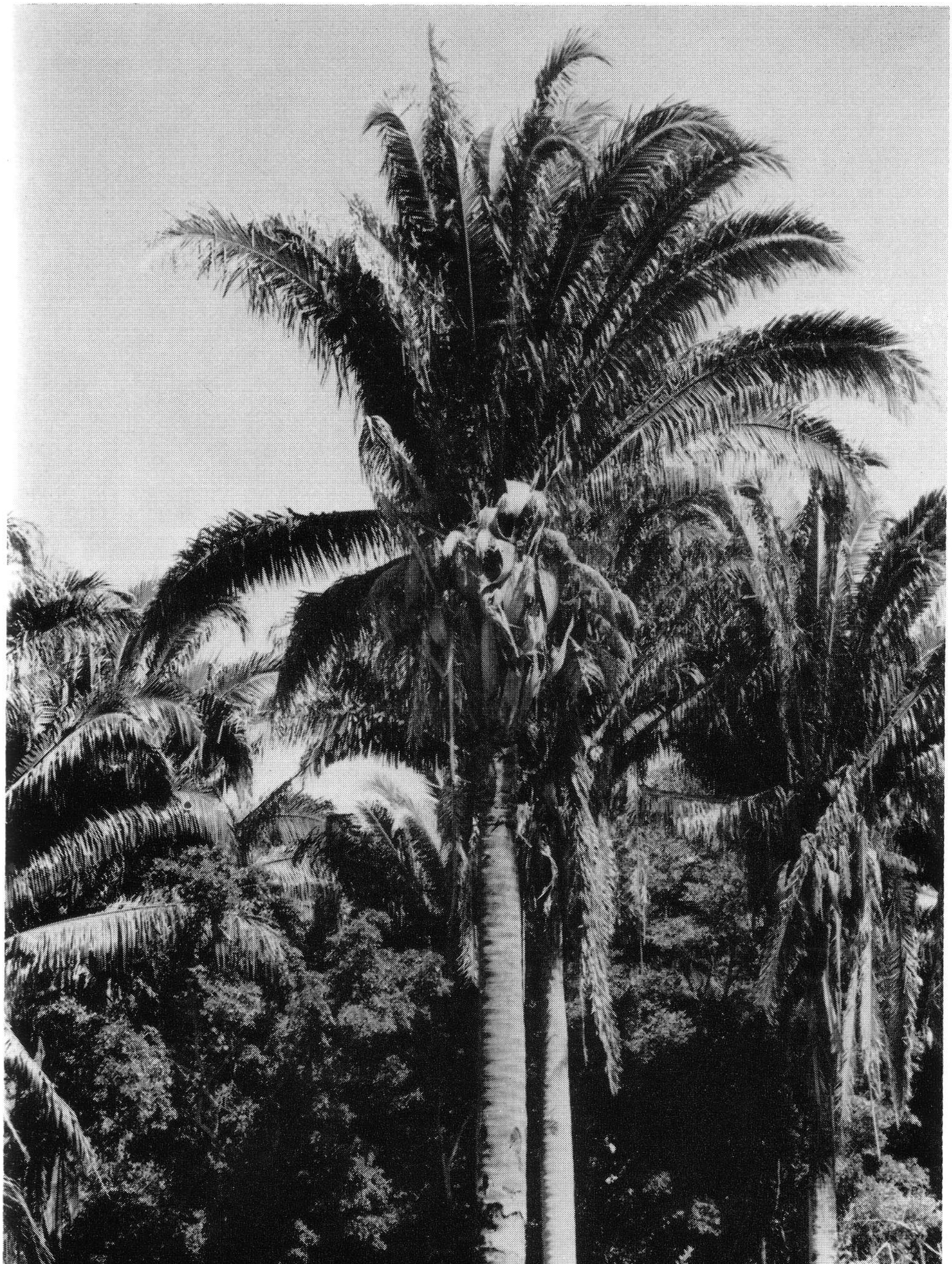
In this brief review of the world's oil-producing palms, it is clear why *Cocos nucifera* and *Elaeis guineensis* are the only two species of prime economic importance. Table 2, which compares the oil content of all the useful palm species, demonstrates that the African oil palm stands far above all the others in the total oil content of its fruit. Furthermore it can outproduce the coconut in oil production four to one on an acreage basis. It has lagged behind the coconut up to now simply because the development of *Elaeis* as a plantation crop is comparatively very recent. The combination in *Elaeis* of highest oil content and highest yield per acre—plus the fact that modern plantation culture of this species can involve automatic oil extraction plants as an integrated part of a year-round production-extraction plantation operation—promises that *Elaeis guineensis* will soon outstrip *Cocos* (which does not lend itself so easily to such integrated production) as the most important of oil-yielding palms.

Table 2. Percentage of oil in the fruits of oil palms.

Species	% mesocarp oil	% kernel oil
Acrocomia totai	–	60
Astrocaryum spp.	–	?
Cocos nucifera	–	65
Elaeis guineensis	45–48	56
Jessenia bataua	18–24	1
Orbignya spp.	–	65
Syagrus coronata	–	60

The coconut has remained most important up to now because as a cultigen it has been grown for a far longer period. Moreover it can continue to be an important plantation crop in many extensive tropical low-island areas, such as in Oceania, where other industrially important crops cannot be grown and where it serves also in the domestic economy for food and other uses. Like *Elaeis*, the coconut tree produces the year around. However, far more hand labor is required in producing copra, for each fruit must be dehusked and the seed split to permit drying the kernel.

For reasons mentioned earlier, the



13. *Orbignya guacuyule* on the west coast of Mexico much resembles *O. cohune.* Photo by H. E. Moore, Jr.

14. Fruit of *Orbignya cohune* at Soledad, Cuba.

other oil-yielding palms will not prove to be serious economic competitors to *Elaeis* and *Cocos*. *Acrocomia totai* and several species of *Orbignya* are essentially equal to the coconut in the oil content of their seeds but as uncultivated palms they have other drawbacks and at best they can remain economically viable only as local domestic or special-situation sources of oil. However, the situa-

15. *Syagrus coronata*, the *licuri* or *ouricury* palm of Brazil. Photo by Eugene D. Kitzke. Reprinted from Principes 19: 9, 1975.

tion might change if serious disease problems were to develop with the primary palms—diseases to which these secondary species proved resistant.

In conclusion, it may be worthwhile to examine the relative importance of the palms versus other species that are also of major importance as sources of vegetable oils in the world export market. Table 3 lists world production of vegetable oil from the most important species for 1972. Four palms appear in the list of 13 species which, except for the palm genera *Orbignya* and *Acrocomia*, represent cultivated plants. The only other tree crop that produces oil is the olive. The soybean, *Glycine max*, dominates in oil production. It produces a general-purpose oil that, when hydrogenated, can be used in many different ways, the principal exception being that of a foaming agent in soap, where coconut oil is required. However palm

Table 3. World production of vegetable oils by plant species, 1972 (in 1,000 metric tons).

Glycine max	6,585
Cocos nucifera	4,265
Helianthus annuus	3,625
Elaeis guineensis	3,142
Arachis hypogaea	3,335
Gossypium spp.	2,580
Brassica spp.	2,575
Olea europaea	1,565
Sesamum indicum	635
Zea mays	305
Carthamnus tinctorius	300
Orbignya spp. (babassú)	107
Acrocomia totai	16

oils from both *Cocos* and *Elaeis* can be used in place of either soybean oil or the oil from other important species which are not palms. The palm-derived oils are used increasingly because they are produced the year around in an efficient manner which makes them far more competitive than oils from annual herbaceous species in yield and price. The supply of palm oil is far more dependable since it is produced under growing conditions which are essentially unvariable. Soybeans (and most other oilseeds) are highly susceptible to poor growing seasons.

Recent newspaper accounts in January, 1975 note that both palm oil (*Elaeis*) and coconut oil have been selling in the United States at as much as 13 cents per pound cheaper than soybean oil. Little wonder then that vegetable users such as the entire potato-processing industry of the Pacific Northwest have shifted during the year from use of soybean oil to palm oil. It is anticipated that increasing demand for use of palm oils will result in the continued expansion of *Elaeis guineensis* plantations. There are still substantial undeveloped natural areas available for the culture of this tree crop in the wet lowland tropics of the world, but the same situation does not exist for the annual oil crops, or for the olive tree.

The greatest potential threat to contemporary *Elaeis* plantations is disease. This species is increasingly grown in monoculture over extensive new areas. Past experience has shown what can happen suddenly to such crop monocultures as, for example, Arabian coffee, formerly an important plantation industry in Sri Lanka but wiped out by red rust (*Hemileia*). The endemic leaf disease (*Dothidiella*) of *Hevea* in Amazonia has barred profitable monocultural plantings of the Pará rubber tree in the New World. Tree crops require more time to be replaced than do annuals, which can be quickly replaced or rotated with another crop whenever serious disease threatens. Palms are more susceptible than most trees because of their unique growth from a single terminal bud. Once that bud is killed, the tree is dead. Standard horticultural techniques such as grafting on disease-resistant stock, used to combat disease in some woody plants, cannot be used with palms. Several serious but little known diseases already attack the coconut. One of these, "lethal yellowing," attacks some other palm genera as well. Is *Elaeis* also susceptible? What are the endemic diseases and pests of this genus within its natural range in Africa and tropical America? These are questions concerning the basic biology of these palms for which answers are largely unknown but for which answers should be obtained now, not after an epidemic strikes.

Acknowledgment

I would like to extend thanks for the generous aid provided by United Brands Corporation and its subsidiary, the Tela Railroad Company in Honduras. Without this help it would have been impossible to study at first hand present-day plantings of oil palm (*Elaeis*) in Central America.

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