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FOREST PALMS AS TROPICAL CROPS

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A Progress Report to the U.S.
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Part I of II

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INTRODUCTION

Amazonian palms of the genera *Jessenia*, *Oenocarpus*, and *Orbignya* are potential oilseed and biomass crops that boast established markets in their native areas. *Jessenia bataua* (Mart.) Burret, for instance, is an understory palm native to the northern half of South America. The fruit is collected throughout its natural range, and is eaten and processed for the production of edible oil. The oil content is as high as 50% of the mesocarp, and is similar in composition to olive oil (Balick 1984). *J. bataua*, which grows naturally in some of the poorest soils to be found anywhere, is an example of a potential crop for agriculturally marginal lands in the tropics. In spite of the desirable qualities of the fruit, virtually all commercial production comes from wild-grown trees.

The current project has been operating in both North and South America since 1984. The overall objectives, as expressed in the original proposal, are:

Collect suitable genetic material in the Amazon region

Develop and improve shoot proliferation techniques for palm propagation and cryobiological storage of palm germ plasm

Experimentally determine the role of mycorrhizal association in the growth rate and survival of these palm models

Develop nursery procedures that allow establishment and maintenance of the mycorrhizal association

Continue the existing NYBG program for training young LDC scientists in economic botany techniques, both in laboratory and through field exploration

Publish a multilingual document on the proposed and ongoing U. S. A. I. D.-funded research on forest palms as tropical resources

In the following sections we describe the specific actions and progress to date in relation to each major objective.

COLLECT SUITABLE GENETIC MATERIAL IN THE AMAZON REGION

Trip reports, publications and other documents generated in connection with germplasm collection are included in appendices I through V. Among these are some publications that begin to unravel some of the taxonomic problems necessary for the proper domestication of these groups.

In table 1 is a summary of germplasm material collected for use by the mycorrhizal and tissue culture studies. This material was collected in a variety

of habitats through the Amazon region. In most cases the collections emphasized production and other desirable traits. Other information on germplasm collection is to be found in the various appendices submitted with this progress report.

Table 1
Germplasm collections to date

Species	Accession number	Location
J. bataua	Rury 314	Peru
Orbignya sp.	Balick 1432	Bolivia
B. gasipaes	S.N.	Colombia
B. gasipaes	S.N.	Colombia
J. bataua	Balick 1647	Colombia
J. bataua	Balick 1647	Colombia
J. bataua	S.N.	Colombia
Euterpe sp.	Balick 1660	Colombia
J. bataua	Forero 110	Colombia
J. bataua	Forero 111	Colombia

It has been the intent of this project to study in the field material that has been studied in laboratory and nursery settings. An example is found in the mycorrhizal determinations done on field-collected roots, treated below.

Table 2 shows soil properties of 14 samples from germplasm collection sites. These soils are of low pH and very low in phosphorus. Other properties vary somewhat. This emphasizes the remarkable ability of these palms to grow and produce in some of the worst soils anywhere.

Table 2
Soil properties from a native habitat of tropical American palms: Bolivian and Mexican sites

Sample	O.M. %	pH	P	K	Mg	Ca	Mn	Fe	Al	Zn
			PPM in soil							
#1	5.4	5.4	1.5	315	345	500	20	510	29	0.5
#2	ISA	5.3	4.0	145	325	1450	43	<2.5	16	0.25
#3	2.1	5.9	4.5	245	200	350	9.0	<2.5	10	0.25
#4	0.4	5.3	0.5	210	110	250	5.5	<2.5	30	0.25
#5	3.4	6.2	1.5	205	145	1050	16	<2.5	<5.0	<0.25
#6	3.8	6.3	3.5	55	185	1250	13	<2.5	<5.0	<0.25
#7	2.4	4.9	1.0	50	25	350	30	8.5	42	<0.25
#8	2.9	5.9	2.5	230	125	400	14	<2.5	7.5	0.25
#9	5.5	5.2	5.5	290	190	600	20	900	17	0.5
#10	ISA	7.9	5.5	290	925	53800	9.0	3.0	<5.0	<0.25
#11	4.5	8.0	2.0	95	390	53800	6.5	3.5	5.0	<0.25
#12	3.9	8.0	1.5	110	350	53800	6.5	3.0	<5.0	<0.25
#13	1.8	6.6	10	110	145	900	9.5	3.0	<5.0	1.5
#14	2.3	6.5	12	120	170	1000	10	<2.5	<5.0	1.5

#1, #2, #9: San Joaquin, Boliva
#3-#8: Ascencion, Bolia
#10-#14: Mexican collections

A new germplasm nursery has been established at the Lemos Maia Experiment station, Una, Bahia, Brazil by our collaborator Dr. Ronald Alvim of CEPEC-CEPLAC. Some of the material has also been sent to an existing germplasm nursery in Yurimaguas, Peru.

DEVELOP AND IMPROVE SHOOT PROLIFERATION TECHNIQUES FOR PALM PROPAGATION AND CRYOBIOLOGICAL STORAGE OF PALM GERM PLASM

This objective was met by a subcontract let to Twyford Plant Laboratories, Somerset, England. Their report is attached as appendix VIII.

EXPERIMENTALLY DETERMINE THE ROLE OF MYCORRHIZAL ASSOCIATION IN THE GROWTH RATE AND SURVIVAL OF THESE PALM MODELS

Palms, like most tropical plant species, form the mutualistic root-fungus association known as vesicular-arbuscular mycorrhiza (VAM). Palms may be among the most dependent of plant species upon the nutrition-enhancing qualities of the symbiosis (St. John, in press). Janos (1977) demonstrated experimentally that growth of the palm *Bactris gasipaes* can be substantially improved by inoculation with mycorrhizal fungi.

A first step in the examination of mycorrhizal palms has been the determination of mycorrhizal status in field and nursery material. Table 3 summarizes samples examined in this study and in earlier work in the literature.

Table 3
Mycorrhizal status of palm species

This study:

Species	VAM	Origin
Bactris gasipaes	+	greenhouse
Cocos nucifera	-	nursery
Euterpe oleracea	+	field
Euterpe oleracea	+	greenhouse
Euterpe edulis	+	field
Jessenia bataua	-	field
Jessenia bataua	+	greenhouse

Other work:

SpeciesVAM	Origin	Authority	
Areca catechu	-	arboretum	Alwis & Abeynayake, 1980
Arecastrum romanzoffianum	+	field	Hood, 1964
Arenga engeleri	+	field	Asai, 1934; Maeda, 1954
Bactris gasipaes	+	field	Janos, 1977
B. gasipaes	+	greenhouse	St. John, unpubl.
Calamus sp.	+	field	Janse, 1897
Caryota urens	+	arboretum	Alwis & Abeynayake, 1980
Chamaerops humilis	+	greenhouse	Kryuger, 1970
C. nucifera	+	field	Johnston, 1949
C. nucifera	+	field	Lily, 1975
Elais guianensis	+	field	St. John, unpub.
Livingstonia chinensis	+	field	Asai, 1934; Maeda, 1954
Oenocarpus bacaba	+	field	St. John, 1980
Phoenix dactylifera	-,+	field	Trappe, 1981
P. roebelenii	-	greenhouse	Stanczak-Boratynska, 1954
Rhapis excelsa	+	greenhouse	Stanczak-Boratynska, 1954
R. humilis	+	greenhouse	Maeda, 1954
Roystonea elata	+	field	Barada & Halos, 1980
Sabal palmetto	+	field	Hood, 1964; Meador, 1977
Syagrus sp.	-	field	St. John, 1980
Washingtonia filifera	+	field	St. John, unpubl.

Mycotrophy in palms

Several experiments have been done, or are in progress, on the dependence of palms on vesicular-arbuscular mycorrhizae. Some have been in the U. S., and there have also been experiments in each of the host countries

U. S. work

Response of *Jessenia bataua*

Early in this project (in part before the grant initiation date) an experiment was carried out when a few seeds of *Jessenia bataua* (Mart.) Burret became available. The experiment was a test for this species of its relative development under mycorrhizal and non-mycorrhizal conditions.

At the time the experiment was initiated, only ten seeds of *J. bataua* were available, of these, only eight germinated. Because of the small number of plants, the experiment was designed as a simple comparison of growth rate of mycorrhizal and non-mycorrhizal plants, with a single harvest date.

The plants were grown in fritted clay, a material sold commercially as a grease absorbent and as pet litter. The advantages of using fritted clay as a growth medium were detailed by Van Bavel et al. (1978). Its application as a substitute for tropical soil was described by Pohl (1977). The material was washed thoroughly in tap water to remove the fine particles, which exert an overriding influence on its pH and otherwise reduce its suitability as a plant growth medium.

Inoculation was carried out on September 28, 1983, after the slow and uneven germination had taken place and the plants had used up their seed reserves. At the time of inoculation, considered day 0 in this experiment, the plants were placed in individual white 19 cm diameter plastic pots, each provided with individual drainage trays. Inoculum consisted of soil, roots, hyphae, and spores of a culture of the VA mycorrhizal fungus *Glomus fasciculatum*, which had been isolated from field collections near Fort Collins, Colorado. Inoculum for control and mycorrhizal pots was prepared at the same time by separating five ml portions into individual beakers. Control batches were randomly selected and autoclaved 15 minutes at 121^{0}C. An additional five ml of live inoculum was shaken in 300 ml of distilled water, allowed to sit 2 hours, and filtered twice through Watman number 1 filter paper to remove propagules of mycorrhizal fungi, but allow other microorganisms to pass. Twenty-five ml of the sievings were added to each beaker of inoculum, including live inoculum, and poured into the pots at the time the inoculum was added.

The plants were left in the dark for the first 24 h after inoculation to aid in adjustment to transplanting. They were then placed under low light intensity (quantum flux density approximately 120 microeinsteins.m-2s-1) with 24 h daylength under plant growth lights. The temperature range was approximately 20-22^{0}C. A plastic curtain enclosed the plants to help retain humidity.

After several months in the above conditions a growth chamber became available. The plants were thereafter maintained at a temperature of 25^{0}C, relative humidity at 70%, and a daylength of twelve h. The quantum flux density was approximately 600 microeinsteins.m-2s-1

The first non-destructive evaluation took place approximately twenty days after moving the plants, on day 161. The second non-destructive evaluation was on day 353. The final harvest was on day 357 of the experiment.

Roots and shoots were separated for drying at 70°C and weighing. Ten percent by fresh weight of the root system of each plant was reserved for determination of mycorrhizal colonization, and the remaining roots were dried and weighed.

At the time of non-destructive evaluation, the number of newly emerging and expanded leaves was counted on each plant. The longest leaf on each plant was also measured.

The roots reserved for the determination of mycorrhizal condition were cleared and stained (Phillips and Hayman 1970) and examined under a compound microscope. When characteristic VAM structures had been positively identified, the amount of colonization was quantified under a dissecting microscope. The prepared roots were placed in glycerin in a petri dish and superimposed on a grid (Marsh 1971). Mycorrhizal colonization was expressed as the number of grid intercepts bearing mycorrhizal structures divided by the total number of intercepts. Since each sample represented ten percent of the fresh weight of the root system, a crude estimate of total root length was obtained by multiplying the length of root in the subsample by ten.

Statistical analyses were carried out by Wilcoxen's Two-sample Rank Test (Hollander and Wolfe 1973).

The number of leaves tended to be higher, but not significantly so, on mycorrhizal plants at day 161. By day 353 the difference was significant. The longest leaf was significantly longer on mycorrhizal plants at both day 161 and day 353 (table 4).

Above ground and below ground portions of the four mycorrhizal plants weighed significantly more than those of non-mycorrhizal plants (table 5). Total root length was also significantly greater in mycorrhizal plants. Root shoot ratios (not shown) did not differ significantly.

Ten percent of the fresh weight of each root system was examined for VAM. Three of the four inoculated plants were mycorrhizal (two with 16% of the root length colonized and one with 10%). The fourth showed no colonization in the root subsample examined, but hyphae and spores in the preparation indicated that parts of the the root system that were not subsampled must have been mycorrhizal. None of the four control plants showed any indication of VAM.

In spite of the small number of seeds available at the time this experiment was established, the dramatic response of *J. bataua* to VAM was statistically significant. This response is especially noteworthy in the case of a plant species that is intrinsically a slow grower. Plant species that are genetically slow growers are usually native to nutrient-poor soils and make very modest demands on the soil's nutrient supply (Chapin 1980). Slow growth and the resulting low nutrient requirement mean that mycorrhizal responses can be difficult to detect in a species like *J. bataua*.

The differences in the number of leaves and the length of the longest leaf widened over the course of the experiment (table 4). These differences were apparent at a somewhat earlier age than the *Bactris gasipaes* seedlings tested by Janos (1977), even though *B. gasipaes* is normally a much faster-growing species than *J. bataua*. However, mortality of uninoculated seedlings was high

in the experiment with *B. gasipaes*, a factor which may complicate direct comparison of the results.

By harvest date, almost one year after inoculation, the dry weight of the mycorrhizal plants was almost twice that of the controls. This substantial advantage of mycorrhizal plants indicates that nursery palm seedlings, which may often remain non-mycorrhizal until outplanting, could potentially be held a shorter time in the nursery, planted at a larger size, or both, with appropriate mycorrhizal inoculation at an early stage.

TABLE 4
Number and length of leaves at two sample dates

	Day 161		Day 357	
	NUMBER OF LEAVES	LENGTH OF LONGEST LEAF (CM)	NUMBER OF LEAVES	LENGTH OF LONGEST LEAF (CM)
MYCORRHIZAL				
MEAN	1.8	16.1	5.5	19.8
n	4.0	4.0	4.0	4.0
SD	0.5	1.1	1.0	1.3
NONMYCORRHIZAL				
MEAN	1.3	12.9	3.3	14.5
n	4.0	4.0	4.0	4.0
SD	0.5	1.6	1.0	1.9

TABLE 5
Weight and mycorrhizal colonization of
Jessenia bataua seedlings at harvest.

	TOP WEIGHT	ROOT WEIGHT	TOTAL ROOT LENGTH
MYCORRHIZAL			
MEAN	8.82	3.55	1046
n	4	4	4
SD	1.51	1.52	283
NONMYCORRHIZAL			
MEAN	4.86	2.08	480
n	4	4	4
SD	0.64	0.27	134

On October 21, 1985, a second experiment was established with *Euterpe oleracea*, *Jessenia bataua*, and *Bactris gasipaes*. The objective was similar to the first

experiment: determination of the dependence of these species on mycorrhizal symbionts.

Fifty-one seedlings of *E. oleracea*, 36 seedlings of *J. bataua*, and 14 seedlings of *B. gasipaes* were available for the experiment. In the case of *E. oleracea* and *J. bataua* the plants were divided equally between three treatments: Low phosphorus (only that occurring in the potting medium plus 1/4 strength Hoagland's solution less phosphorus), high phosphorus (1/4 strength Hoagland's solution with phosphorus), and mycorrhizal (nutrient solution as for low P treatment). The mycorrhizal plants were inoculated with the same fungal symbiont used in the first experiment. Both low P and high P treatments received a steamed soil material which had supported host plants similar to those that produced the live inoculum. The steamed control inoculum received sievings from approximately 500 g of unsterilized control inoculum; the sievings had been passed through a 45 micrometer sieve and then Watman # 1 filter paper, a procedure known to remove viable mycorrhizal propagules but pass many non-symbiotic microorganisms that may influence plant growth and soil properties. The numbered pots were allocated randomly to treatments by means of a computer program.

At the beginning of the experiment certain parameters were assessed in a non-destructive evaluation. The initial evaluation included number of leaves per plant and height, measured from the base of the plant to the tip of the longest leaf. In no case were the treatment groups for any species significantly different at the beginning of the experiment.

Because contamination from mycorrhizal to control plants would be likely if the pots had been randomly intermixed, the palms were sorted into plastic trays. There were slightly more than two trays for each treatment. The trays were intermixed so that each treatment was spread throughout the growing area. The plants were grown under a metal halide lamp in a greenhouse. The photoperiod included nine hours of artificial lamp followed by approximately nine hours of daylight.

By January, 1986, it was clear that growing conditions were not satisfactory. A large number of the plants had died of causes that were not immediately evident. One possibility was that the temperature in the greenhouse had gone too low on one or more occasions. Monitoring with a maximum-minimum thermometer indicated that nighttime temperatures stayed above about 16°C except for a few brief intervals. Such temperatures are occasionally encountered within the natural range of these species. While growth might have been slowed by these temperatures, they are unlikely to have been fatal. The most likely problem was with the metal halide lamp, which seemed to burn the leaves under the conditions of the experiment. It is also possible that the long photoperiod was physiologically unsuitable for these tropical palms, which normally receive 12 hr photoperiods. The long photoperiods were used because in most plant species they greatly hasten growth rate and thus shorten the experiments, and because the use of the metal halide lamp at night was the main means of temperature control. A final possibility was that the nutrient solution, which has to be adjusted by trial and error for each plant species and each set of growing conditions, was not correct. The high phosphorus treatment was abandoned at this point as there were too few plants per treatment to allow meaningful conclusions.

At that time a second non-destructive evaluation of the experimental plants was carried out in the same way as described above. Length of leaves of mycorrhizal *E. oleracea* and *B. gasipaes* were shorter than those of control plants, but not significantly so, indicating the possibility that the fungus had assumed a parasitic rather than symbiotic role in the conditions of the experiment. Parasitism has been known under both temperature and nutrient conditions outside the optimal ranges (Hayman 1983, Hays et al. 1982). Mortality rates of the treatments had not been different.

At that time the nutrient solution was modified to include a higher nitrogen level. In March of 1986 it was necessary to move the plants to new facilities. Soon after the move a failure in the temperature control resulted in a single low temperature event that destroyed the meristems of almost all *E. oleracea* and *J. bataua*. Because the mature leaves were not killed outright, it took several more weeks for the extent of the damage to become fully apparent. By May 1986 it was clear that the number of viable plants was insufficient and that the experiment would have to be abandoned. A final evaluation of the plants, this time including top dry weight, indicated again no significant differences between treatments. However, the non-significant depression of mycorrhizal plants had essentially disappeared between mid January and the cold event in March when new growth ceased. This observation suggests that the change in composition of the nutrient solution had quickly removed the parasitic function of the mycorrhizal symbiosis and allowed the mycorrhizal plants to catch up to controls.

It is worthy of mention that no *B. gasipaes* were lost in the cold event, indicating the greater tolerance of that species for more temperate conditions.

Test of soil amendments

In both U. S. experiments the potting medium has been fritted clay (see methods for experiment one), a substitute for tropical soil. In the first experiment it worked well for the test of mycorrhizal dependency. Unfortunately different batches have unpredictable kinds of variability in chemical properties and it is necessary to separately test the suitability of each batch. In addition to experiment two above, several other failures of experimental plants were attributable to problems related to the soil or nutrient solution. In most cases plants were being held for experimental use pending the germination of sufficient seeds. In one early experiment not reported here in detail, virtually all plants died of unknown causes in a new batch of fritted clay. In a set of experimental plants kept at the New York Botanical Garden, differences in mycorrhizal and non mycorrhizal plants failed to develop, either because the plants received too much phosphorus from the soil or other contamination in the NYBG greenhouse, or because the control plants became mycorrhizal.

These problems have indicated the need for a means of separately testing the potting soil for either toxicity problems or high nutrient levels that would complicate a mycorrhizal experiment. The approach used for these tests is a bioassay procedure using maize as a test plant. A fast-growing test plant is preferred because nutrient relations become apparent much more quickly than with palms. The experimental test of four potential substrates is still in progress, but will be described with initial results.

The four substrates tested were a field soil from California, two kinds of fritted clay sold as pet litter, and a similar absorbent material of dolomitic rather that clay origin. Soils from this area are much higher in bases than most tropical soils but the pH (6.3) is within a range encountered in some Amazonian soils. It is not a likely substitute for tropical soil if one of the more uniform materials is suitable, but serves as a base for comparison in the bioassay. The materials are designated in the tables as "C" (Cat-sorb), "Q" (Susie Q), and "F" (Floor-dry). This last is dolomitic.

Because some of the past difficulties have been caused by soil fertility that is too high, the trial includes tests of some amendments that may reduce the availability of phosphorus. If any of the amendments can be successfully used for this purpose, it will be possible to bring soils with almost any desired properties into a range of P concentration that makes them suitable for use in a mycorrhiza experiment. The amendments are:

> Iron hydroxides: this mixture of insoluble iron hydroxides was prepared by reacting ferrous sulfate with potassium hydroxide. The precipitate is similar to the material used by Bolan et al. to reduce P availability. Its action depends on dry diffusion.
>
> Ferrous sulfate: a readily available agricultural chemical that should lower soil pH and take P out of circulation by complexing with iron.
>
> Lime: raising pH also can reduce P availability.
>
> Nitrogenated wood chips: organic materials stimulate microbial growth, usually resulting in Nitrogen deficiency. However, by adding N with the organic substrate a P deficiency may be induced by a parallel mechanism.

The experiment was established with newly germinated maize seedlings (Illini Xtra-sweet) in folding plastic plant containers, with four replicates of each treatment in adjacent cells. The amendments were added as 0, 0.05%, 0.5%, and 5.0% w/w in each medium, except that lime was added in amounts expected to bring the pH to 8, 8.5, and 9 as determined by preliminary standard curves. The pH after mixing of each treatment is shown in table 5.

Table 5
pH of four substrates given 13 treatments

Treatment	soil	C	Q	F
Control	6.3	7.5	7.5	7.1
Hydroxide 0.05	6.2	7.6	7.6	6.6
Hydroxide 0.5	6.1	7.6	7.8	6.5
Hydroxide 5.0	7.0	7.8	7.9	7.3
Sulfate 0.05	5.8	7.2	7.7	6.2
Sulfate 0.5	4.5	6.3	7.5	4.3
Sulfate 5.0	4.1	4.2	6.2	3.7
N-wood 0.05	6.3	7.5	7.7	7.1
N-wood 0.5	6.3	7.7	6.8	6.7
N-wood 5.0	6.2	7.7	7.5	6.0
Lime pH 8	7.4	7.7	7.8	7.2
Lime pH 8.5	7.8	8.1	7.9	7.4
Lime pH 9	9.2	8.2	7.9	8.0

Fifty days after planting a non-destructive evaluation was carried out, in which survival, number of leaves, and height from ground to tip of longest leaf was determined. The mean height of surviving plants (out of four originally) is shown in table 6.

Table 6
Mean height of surviving bioassay
plants in four test soils

Treatment	Soil	C	Q	F	Average
Control	48.7	22.7	31.2	33.8	34.1
Hydroxide 0.05	56.7	28.7	24.3	33.0	35.7
Hydroxide 0.5	54.8	32.0	24.0	34.8	36.4
Hydroxide 5.0	32.8	32.0	17.2	18.0	25.0
Sulfate 0.05	55.0	24.8	25.2	24.0	32.2
Sulfate 0.5	47.5	29.5	26.0	22.4	31.4
Sulfate 5.0	24.7	26.0	29.6	12.0	23.1
N-wood 0.05	53.6	25.1	28.5	29.1	34.1
N-wood 0.5	77.3	21.6	27.5	44.0	42.6
N-wood 5.0	64.0	29.6	31.3	34.5	39.8
Lime pH 8	66.8	24.7	15.0	38.8	36.3
Lime pH 8.5	70.9	26.0	30.0	41.2	42.0
Lime pH 9	62.8	27.0	24.4	31.7	36.5
Averages	51.2	26.9	25.7	30.6	

Table 7
Mortality and leaf counts of bioassay
plants in four test soils

	Soil	C	Q	F
Mortality (%)	11.5	26.9	23.1	21.1
Number of leaves	4.0	2.4	2.4	2.7

Mortality was higher in the three coarse-grained substrates (C, Q, and F) than in soil, in part because some seed dried out during germination (table 7). The number of leaves was also higher in soil. The analysis of height in table 6 shows that soil is the most favorable for plant growth, although F is superior to C and Q. All plants are being watered with a nutrient solution that lacks P but supplies other elements, thus only amendments that influence P availability or produce some toxicity should affect plant growth. Iron hydroxides and ferrous sulfate both suppressed growth rate in soil and F but not in C and Q, indicating that some sort of inherent toxicity may have had an overriding effect in the later two. Nitrogenated wood chips had little effect in any substrate, and lime influenced only soil and F, and those only at the highest addition. These results are still preliminary because no deficiency symptoms have yet developed, even though plant growth is clearly suppressed in some treatments. After deficiency symptoms have developed, the plants will be weighed and a final interpretation made. At this point, it appears likely that the F substrate with 5% iron hydroxides could be a suitable substitute for tropical soil, in which mycorrhizal growth response could be investigated.

Work in host countries

Response to inoculation

The most elaborate variant on this objective is being pursued at the Brazilian site, by our colleagues Rogerio Dias and Roberto E. Lima Borges.

Their experiment is referred to as "Effect of VAM fungi on the development of palms in nursery conditions." It is a factorial nutrient/inoculation experiment being repeated with four species of palms: two under utilized natives (*Jessenia bataua*, and *Orbignya oleifera*) and two accepted crop species (*Euterpe oleracea*, and *Bactris gasipaes*). The VAM fungal symbiont is *Gigaspora margarita* Becker and Hall. [illegible]d fungi native to the nursery potting soil. The work is being conducted [illegible] the Lemos Maia experiment station at Una, Bahia.

For each p[illegible]lm the experiment was a 4x4x3 random factorial design. The four substrates were: 1. Humus that was sterilized and inoculated with *Gigaspora margarita*; 2. humus that was sterilized and not inoculated; 3. humus that was not sterilized and was inoculated with *Gigaspora margarita*; 4. humus that was not sterilized and not inoculated. There were four harvest dates, at 60, 90, 120, and 150 days after planting. There were three levels of phosphate fertilization incorporated into the substrate. The levels were: 0, 90 ppm phosphorus, and 1/4 the full dose. Each treatment was replicated four times.

The soil used for humus was from the station and is the same material being used routinely in palm production in the nursery. The soil was sterilized with methyl bromide. The inoculation with *Gigaspora margarita* was carried out with 3 grams of soil containing spores, hyphae, and roots of infected corn, added at the time of planting. The native VAM fungi were those present normally in the unsterilized humus.

The plastic bags in which were planted three of the experimental species, *Euterpe oleracea*, *Jessenia bataua*, and *Bactris gasipaes*, were kept on wooden palettes 10 cm in height, and were irrigated daily.

The seeds of *Jessenia bataua*, sent by Dr. Bruce W. Nelson of the New York Botanical Garden, were put in the oil palm germinator at ESMAI in early June 1986, where they had already germinated by the time of the installation of the experiment on August 28 of 1986. The losses through germination were considerable.

The seeds of *Euterpe oleracea* and *Bactris gasipaes* were planted within hours after they were picked and depulped. The fruits of *Orbignya oleifera*, sent by Dr. Claudio U. B. Piniero, IMAPA Sao Luis, Brazil, last August, and placed for germination on November 9, 1986, remain in the vermiculite seed bed awaiting germination. Germination thus far has occurred in less than 40% of the fruits.

Because of the different stages of germination and development of the species, the experiments will proceed separately for the species.

The development of *Jessenia bataua* at this time is quite satisfactory. However, this is not true of *Euterpe oleracea* and *Bactris gasipaes*, where the stand is

visibly non-uniform. This fact has brought the Brazilian collaborators to abbreviate the experiments with those species, with the intention of investigating P fertilization and harvest date effects in a new experiment.

The measurements: fresh and dry weight of roots and shoots, concentrations of macronutrients in the shoot, percentage of infection by VAM in the roots, and leaf production were to be determined in January or February of 1987, or at five to six months after planting. As of this writing the first results are not yet available to the New York Botanical Garden collaborators.

Native inoculum in nursery potting mix

In considering the fate of the mycorrhizal symbiosis in a nursery setting, it is important to understand the source of the mix used for potting. Any native inoculum must come with the mix, and several aspects of soil handling can be expected to influence the inoculum.

Potting soil used in a Manaus, Brazil palm nursery (per C. R. Clements, pers. comm.) consists of 2/3 is upper sandy forest soil, 1/3 is B horizon, and 1/10 is chicken litter; the chicken litter is composted with a 1:5 mixture of sawdust. The soil is seived and stored no more than 1 month. All but the first stage of the rearing of palm seedlings is in the sun, indicating the likelihood of temperature-induced difficulties in the root zone.

Potting soil used in Una, Bahia, by Brazilian collaborators consists of the top (humus) layer of forest soil. In larger scale nurseries it is unlikely that sufficient humus will be available and it will become necessary to use the lower soil horizons were VAM inoculum is rare. At the Una nursery they use a product called MAFA-6 as fertilizer. 660 kg/ha (the dose recommended for cacau) is used as fertilizer. It consists of pressed soybean with cocoa butter extracted with solvents: 199 kg; urea: 60 kg; bone meal: 420 kg; KCl: 80 kg. This gives an N-P-K ratio of 5-14-8. This material is considered expensive and chicken litter would probably be preferable in most nursery operations.

The fungal symbionts of the VAM mutualism are found naturally in most native soils; thus no special attention is required to assure that field-grown specimens are mycorrhizal. When palms are reared in a nursery before planting, however, the potential lack of fungal propagules is a serious concern. Seedlings of palms and other crop species are often non-mycorrhizal in Brazilian nurseries (unpublished observations). The soil used as a potting medium at a large Brazilian palm nursery was very low in inoculum even when freshly collected, and deteriorated further with handling and storage (Sr. Rogerio Dias, CEPEC-CEPLAC, Ilheus, Brazil; pers. comm.). *Bactris gasipaes* seedlings at a Peruvian palm nursery were also found to be non-mycorrhizal (Sr. Pedro Ruiz, Yurimaguas Experimental Station, Peru, pers. comm.). The plants produced at these nurseries may suffer slow growth during the nursery phase, and may be at a considerable disadvantage when transplanted to the field. Slow and uneven growth in a California Citrus nursery was traced to a lack of VAM in a classic study by Kleinschmidt and Gerdemann (1972).

Our Brazilian colleagues carried out a test to investigate the effects of soil collection and treatment on native VAM inoculum in the substrates utilized normally in the culture of palm seedlings at the Lemos Maia experiment station in Una, Bahia. The test was conducted in a greenhouse of DIGEO, CEPEC, with the following treatments: 1. Humus that was recently collected and sieved though a screen with openings of 4mm; 2. humus that was recently collected and not sieved; 3. humus that was collected and stored for 30 days in black plastic bags in the open sun, then sieved; 4. humus that was collected and stored as above and not sieved. These four treatments were in a completely randomized experimental design with ten replications per treatment.

Corn (Zea mais) was used as an indicator plant, in an initial density of seven plants per pot. After one week they were thinned to a single plant per pot. The material was harvested after 30 days. The roots were removed intact and carefully washed under running water to remove adhering particles. They were then cleared and stained (Phillips and Hayman 1970), and the incidence of VAM colonization quantified by the grid line method (Giovannetti and Mosse 1980).

The percentage of VAM infection in the roots of corn was very small (table 8), independent of the management of the substrate, indicating a very low infection potential of the propagules of VAM present in these substrates.

The analysis of variance showed a very high coefficient of variation (table 8), probably because we left only one plant per pot after thinning. This left no easily supported explanation for the differences between the treatments.

Table 8
Percentage of infection for VAM fungi in roots of corn 30 days of age under different management treatments of the substrates. Means of 10 replicates.

Treatments*	Infection, %
1	3.62b=
2	8.03a
3	2.20b
4	1.31b
C.V. (%)	88.34

*1. Humus that was recently collected and sieved though a screen with openings of 4mm; 2. humus that was recently collected and not sieved; 3. humus that was stored for 30 days in black plastic bags in the open sun, then sieved; 4. humus that was stored as above and not sieved.

= Means followed by the same letter are not significantly different following Tukey at the 5% level of probability.

Native inoculum in field soil

In some soils subjected to disturbance or heavy use of agricultural chemicals, mycorrhizal inoculum may become scarce. In such cases, nursery inoculation is

not only important for survival of transplanting, but for continued long-term growth in the field.

A pot experiment was conducted in 1986 by our Peruvian colleague and trainee, Mr. Pedro O. Ruiz Cabillas of CIP, Yurimaguas, Peru. The objective of the experiment was to determine the occurrence of VAM fungi in soils for which palms are alternative crops.

The soils studied in this experiment had been subjected to several different types of management. Soils were collected from: 1) secondary forest (10 years old); 2) shifting cultivation (1 year); 3) low input continuous cropping (1 year); and 5) high input continuous cropping (14 years). Maize plants were used as indicator species in a modified greenhouse bioassay. The experiment had a completely randomized design with five replicates. After thirty days the maize plants were harvested and plant height, dry weight, and P content determined. Roots were stained in trypan blue-lactophenol for determination of mycorrhizal colonization (Phillips and Hayman 1970).

Mycorrhizal colonization was high in all treatments except high input continuous cropping (Table 9). The difference could be due to inhibitory effects of high phosphorus input, or to the disappearance of fungal propagules from the soil. Proliferation of non-mycorrhizal weed species, such as *Commelina duffusa* and *Portulaca oleracea*, was also observed. The abundance of these species could have helped reduce the population of VAM fungal propagules. A survey of VAM in all species present under continuous cropping could be helpful in interpreting the relative importance of fertility and weed populations in suppressing VAM inoculum.

Table 9
Plant height, dry weight, percent colonization, and shoot P content of maize plants grown under different management practices (thirty days after planting).

Management type	Plant height, cm	Dry weight, g	Shoot P, %	VAM colonization
1	55.2b	39.6b	0.21b	74b
2	45.8c	34.0b	0.21b	92a
3	43.3c	33.8b	0.19b	94a
4	62.3a	74.8a	0.64a	100a
5	60.1ab	68.7a	0.19b	10c

1 Secondary forest
2 Shifting cultivation
3 Low input (1 year)
4 High input (1 year)
5 High input (14 years)

Means with the same letter are not significantly different ($p<5\%$)

Collection of symbiont propagules

Tropical forest soils ofter have very few endogonaceous spores (St. John and Uhl 1983), and when spores are found most of them are dead and decomposing. Thus far our field sites have yielded few identifiable spores. However, our Brazilian collaborator, Rogerio Dias, has an ongoing program of spore collection, identification, and multiplication. His collection includes a number of VAM fungal species of the genera *Acaulospora*, *Gigaspora*, and *Glomus*, from Brazil and from other tropical and subtropical parts of the world. His work to date has indicated that his best isolates, in terms of plant growth response, are an unidentified *Acaulospora* and *Gigaspora margarita* from international sources. Mr. Dias has assumed responsibility for spore propagation in the Brazilian portion of the project.

An agreement has been reached with Dr. Chris Walker, a noted systematist from the U. K., to identify material collected in Peru and brought into culture. Our Peruvian collaborator, Mr. Pedro O. Ruiz, has assumed responsibility for culturing spores found there. Identifications by Dr. Walker will be an outgrowth of this project but will not occur during its term, since collection and culturing of a significant number of spore collections is two or more year's work. If permits can be arranged collections will be deposited in the international Endogonaceous culture collection of the University of Florida, maintained by Dr. Norman Schenck.

Comparison of fungal endophytes

A comparison of fungal endophytes with a single palm species is part of the ongoing program of our Brazilian colleagues. We have been unable to import tropical fungal species into the United States, and the facilities and sophistication at the Peruvian site are not yet sufficient. For now we must rely on the Brazilians to carry on this work.

DEVELOP NURSERY PROCEDURES THAT ALLOW ESTABLISHMENT AND MAINTENANCE OF THE MYCORRHIZAL ASSOCIATION

Temperature

During our early site visits it became clear that the most probable cause of a lack of mycorrhizal colonization in nurseries is high temperature. Not only the potting soil, but the seedlings are often kept in full sunlight. It is known that the temperature at plant level in cacau can be 42°C. However, soil temperature is almost certainly much higher in pots or black plastic bags containing plants growing in the full sun, at least until the plants reach sufficient size to shade the pots. Soil temperatures as high as 77°C occur in similar conditions in U. S. nurseries, according to a California nursery owner. Such temperatures are easily

high enough to kill mycorrhizal inoculum; even 40°C can prevent mycorrhizal colonization.

An experiment to test the effects of shading was carried out earlier this year by Mr. Pedro Ruiz in Peru. A series of palm seedlings was divided into two portions. One half were shaded with palm leaves arranged in such a way that the pots, but not the shoots were shaded. The others got no shade, and both sets of palms were grown in full sunlight. As of the most recent report final results were not yet available, but the progress of the shaded palms was so dramatic that the nursery manager immediately adopted the technique as a standard procedure. Only at the end of the experiment, when the roots have been cleared and stained, will we know whether the improved performance was associated with improved mycorrhizal colonization.

Miscellaneous factors

Several factors were proposed for study initially. Discussions with both Brazilian and Peruvian collaborators indicated the importance of temperature and the minor role of some of the other factors. These later include:

Toxicity of pesticides: pesticides are rarely used with palms since there are very few insect problems.

Effects of fertilization: this factor has been incorporated into Rogerio Dias's large experiment.

Inoculum source

Inoculum source: pot cultures are in use in Brazil, and field-collected grass roots are being used in Peru. These choices were based on availability and collaborator preference as well as considerations outlined in the proposal.

CONTINUE THE EXISTING NYBG PROGRAM FOR TRAINING YOUNG LDC SCIENTISTS IN ECONOMIC BOTANY TECHNIQUES, BOTH IN LABORATORY AND THROUGH FIELD EXPLORATION

Collaborative agreements

Field sites

Our official field sites were determined through correspondence with Drs. Paulo de Tarso Alvim and Pedro Sanchez. With their help we fixed the field sites at Una, Bahia, Brazil, and Yurimaguas, Peru.

Site visits

We made site visits in 1985 and 1986, during which many details of the work were agreed upon, and during which field work and experiments were carried out. The 1985 visit yielded much information, especially in conversations with Dr. Ronald Alvim and his staff. We discussed current methods, origins of soil, and variants for different palm crops. On the basis of information gained during these visits and site tours, some of the project objectives were refined to make them more realistic in view of the procedures in use at those sites. Among the important points bearing on the project, pesticides are rarely used because no insect problems have developed. We decided that because of the need for CEPLAC to internally justify participation it would be necessary to include established crop species in some of the experiments. Those are *Euterpe oleracea* and *Bactris Gasipaes*.

We also discussed the germplasm nurseries at the Una station, and the problem of coordinating planting of experiments with times of seed availability.

Paulo Alvim, Ronald Alvim, M. Balick, T. St. John and T. Whitmore visited the agroforestry projects at the Una field station in January, 1985. The projects include several palms, among them *J. bataua*. The palms were used as both shade and crops. Some were doing very well, but *J. bataua* showed notably slower growth than the other species. It is now clear that this slow growth is an inherent property of the species and will not be easily changed by cultural practice. The best prospects for *J. bataua* are genetic improvement and its use as an understory crop. In that application it would not be expected to produce well until the senescence of overstory crops.

Joint publications

The director of CEPEC, Joao Manuel de Abreu, talked to use for an hour or so. A major concern was that CEPLAC researchers get due credit in the publications. He was assured on this point.

Babassu workshop

On March 10-15, 1986, Dr. Balick co-hosted a workshop on progress in babassu research, organized by some of our collaborators in Brazil (CENARGEN/EMBRAPA; UEPAE de Teresina). Funds contributed by New York Botanical Garden were raised from private sources- no AID funds were used to support the workshop, but it was actually first suggested by personnel from the Science Advisor's Office as a way to strengthen the research program and collaboration. The symposium agenda and list of participants is submitted as appendix III.

TRAINING IN MYCORRHIZAE

The selection and training of a Peruvian collaborator is of prime importance in this project. Mr. Pedro O. Ruiz Cabillas, and employee of the International Potato Center, was chosen by Peruvian and North Carolina State University officials to cooperate with us. He has been a most fortunate choice for the project, both for his enthusiasm and competence to carry out the work. He spent four weeks in Ilheus, Brazil, in July of 1986, where St.John and the Brazilian collaborators worked with him in numerous aspects of mycorrhizal technique. An outline of the training course is given in appendix X.

PUBLISH A MULTILINGUAL DOCUMENT ON THE PROPOSED AND ONGOING U. S. A. I. D.-FUNDED RESEARCH ON FOREST PALMS AS TROPICAL RESOURCES

This will include our results as well as those of the NYBG from other projects on related topics. Most of our results and our collaborators' results to date are described in this report. The technical portions of this report may be a starting point for organization of the final document.

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APPENDIX I

Inventory and preliminary characterization of *Orbignya* germplasm collected during 1981-1984

APPENDIX I

INVENTORY AND PRELIMINARY CHARACTERIZATION OF ORBIGNYA GERMPLASM COLLECTED DURING 1981-1984

A JOINT PROGRAM OF THE CENTRO NACIONAL DE RECURSOS GENETICOS (CENARGEN) AND THE NEW YORK BOTANICAL GARDEN INSTITUTE OF ECONOMIC BOTANY (IEB)

MAY, 1986

Figure I. Expeditions undertaken as part of the babassu palm domestication program during 1981-85.

28'

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. I.LOCAIS DE COLETA E QUANTIDADES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) A.B.ANDERSON (INPA) J.M.F.FRAZAO & C.U.B.PINHEIRO (INEB) J.JANGOUX & N.A.ROSA (MPEG)
PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN PERIODO DA COLETA: 231191 A 121291 FAMILIA: PALMAE

REGISTRO	IDENTIFICACAO DO ACESSO/ LOCAL DA COLETA	MUNICIPIO	ESTADO OU TERRITORIO	PAIS	LAT	LONG	ALT (M)	QUANT	UNID
BRA-000060/01	M.J.BALICK ET ALII 1304 L.COL: MARGEM ESQUERDA DO RIO TOCANTINS A 20 KM DE ITUPIRANGA PROXIMO AO IGARAPE CAJAZEIRINHA	ITUPIRANGA	PARA	BRASIL	0505S	04920W	0100	54	FTS
BRA-000060/02	M.J.BALICK ET ALII 1304 L.COL: MARGEM ESQUERDA DO RIO TOCANTINS A 20 KM DE ITUPIRANGA PROXIMO AO IGARAPE CAJAZEIRINHA	ITUPIRANGA	PARA	BRASIL	0505S	04920W	0100	54	FTS
BRA-000060/03	M.J.BALICK ET ALII 1304 L.COL: MARGEM ESQUERDA DO RIO TOCANTINS A 20 KM DE ITUPIRANGA PROXIMO AO IGARAPE CAJAZEIRINHA	ITUPIRANGA	PARA	BRASIL	0505S	04920W	0100	54	FTS
BRA-000060/04	M.J.BALICK ET ALII 1304 L.COL: MARGEM ESQUERDA DO RIO TOCANTINS A 20 KM DE ITUPIRANGA PROXIMO AO IGARAPE CAJAZEIRINHA	ITUPIRANGA	PARA	BRASIL	0505S	04920W	0100	54	FTS
BRA-000060/05	M.J.BALICK ET ALII 1304 L.COL: MARGEM ESQUERDA DO RIO TOCANTINS A 20 KM DE ITUPIRANGA PROXIMO AO IGARAPE CAJAZEIRINHA	ITUPIRANGA	PARA	BRASIL	0505S	04920W	0100	54	FTS
BRA-000060/06	M.J.BALICK ET ALII 1304 L.COL: MARGEM ESQUERDA DO RIO TOCANTINS A 20 KM DE ITUPIRANGA PROXIMO AO IGARAPE CAJAZEIRINHA	ITUPIRANGA	PARA	BRASIL	0505S	04920W	0100	54	FTS
BRA-000060/07	M.J.BALICK ET ALII 1304 L.COL: MARGEM ESQUERDA DO RIO TOCANTINS A 20 KM DE ITUPIRANGA PROXIMO AO IGARAPE CAJAZEIRINHA	ITUPIRANGA	PARA	BRASIL	0505S	04920W	0100	54	FTS
BRA-000060/08	M.J.BALICK ET ALII 1304 L.COL: MARGEM ESQUERDA DO RIO TOCANTINS A 20 KM DE ITUPIRANGA PROXIMO AO IGARAPE CAJAZEIRINHA	ITUPIRANGA	PARA	BRASIL	0505S	04920W	0100	54	FTS
BRA-000060/09	M.J.BALICK ET ALII 1304 L.COL: MARGEM ESQUERDA DO RIO TOCANTINS A 20 KM DE ITUPIRANGA PROXIMO AO IGARAPE CAJAZEIRINHA	ITUPIRANGA	PARA	BRASIL	0505S	04920W	0100	54	FTS
BRA-000060/10	M.J.BALICK ET ALII 1304 L.COL: MARGEM ESQUERDA DO RIO TOCANTINS A 20 KM DE ITUPIRANGA PROXIMO AO IGARAPE CAJAZEIRINHA	ITUPIRANGA	PARA	BRASIL	0505S	04920W	0100	54	FTS
BRA-000060/11	M.J.BALICK ET ALII 1304 L.COL: MARGEM ESQUERDA DO RIO TOCANTINS A 20 KM DE ITUPIRANGA PROXIMO AO IGARAPE CAJAZEIRINHA	ITUPIRANGA	PARA	BRASIL	0505S	04920W	0100	54	FTS
BRA-000060/12	M.J.BALICK ET ALII 1304 L.COL: MARGEM ESQUERDA DO RIO TOCANTINS A 20 KM DE ITUPIRANGA PROXIMO AO IGARAPE CAJAZEIRINHA	ITUPIRANGA	PARA	BRASIL	0505S	04920W	0100	54	FTS
BRA-000060/13	M.J.BALICK ET ALII 1304 L.COL: MARGEM ESQUERDA DO RIO TOCANTINS A 20 KM DE ITUPIRANGA PROXIMO AO IGARAPE CAJAZEIRINHA	ITUPIRANGA	PARA	BRASIL	0505S	04920W	0100	54	FTS

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. I.LOCAIS DE COLETA E QUANTIDADES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

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PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN PERIODO DA COLETA: 231181 A 121291 FAMILIA: PALMAE

REGISTRO	IDENTIFICACAO DO ACESSO/ LOCAL DA COLETA	MUNICIPIO	ESTADO OU TERRITORIO	PAIS	LAT	LONG	ALT (M)	QUANT	UNID
BRA-000078/07	M.J.BALICK ET ALII 1309 L.COL: FAZENDA DO MOCAMBO A 11 KM DE	TOCANTINOPOLIS TOCANTINOPOLIS	GOIAS	BRASIL	0620S	04728W	0130	54	FTS
BRA-000078/08	M.J.BALICK ET ALII 1309 L.COL: FAZENDA DO MOCAMBO A 11 KM DE	TOCANTINOPOLIS TOCANTINOPOLIS	GOIAS	BRASIL	0620S	04728W	0130	54	FTS
BRA-000078/09	M.J.BALICK ET ALII 1309 L.COL: FAZENDA DO MOCAMBO A 11 KM DE	TOCANTINOPOLIS TOCANTINOPOLIS	GOIAS	BRASIL	0620S	04728W	0130	54	FTS
BRA-000078/10	M.J.BALICK ET ALII 1309 L.COL: FAZENDA DO MOCAMBO A 11 KM DE	TOCANTINOPOLIS TOCANTINOPOLIS	GOIAS	BRASIL	0620S	04728W	0130	54	FTS
BRA-000078/11	M.J.BALICK ET ALII 1309 L.COL: FAZENDA DO MOCAMBO A 11 KM DE	TOCANTINOPOLIS TOCANTINOPOLIS	GOIAS	BRASIL	0620S	04728W	0130	54	FTS
BRA-000078/12	M.J.BALICK ET ALII 1309 L.COL: FAZENDA DO MOCAMBO A 11 KM DE	TOCANTINOPOLIS TOCANTINOPOLIS	GOIAS	BRASIL	0620S	04728W	0130	54	FTS
BRA-000078/13	M.J.BALICK ET ALII 1309 L.COL: FAZENDA DO MOCAMBO A 11 KM DE	TOCANTINOPOLIS TOCANTINOPOLIS	GOIAS	BRASIL	0620S	04728W	0130	54	FTS
BRA-000078/14	M.J.BALICK ET ALII 1309 L.COL: FAZENDA DO MOCAMBO A 11 KM DE	TOCANTINOPOLIS TOCANTINOPOLIS	GOIAS	BRASIL	0620S	04728W	0130	54	FTS
BRA-000078/15	M.J.BALICK ET ALII 1309 L.COL: FAZENDA DO MOCAMBO A 11 KM DE	TOCANTINOPOLIS TOCANTINOPOLIS	GOIAS	BRASIL	0620S	04728W	0130	54	FTS
BRA-000078/16	M.J.BALICK ET ALII 1309 L.COL: FAZENDA DO MOCAMBO A 11 KM DE	TOCANTINOPOLIS TOCANTINOPOLIS	GOIAS	BRASIL	0620S	04728W	0130	54	FTS
BRA-000078/17	M.J.BALICK ET ALII 1309 L.COL: FAZENDA DO MOCAMBO A 11 KM DE	TOCANTINOPOLIS TOCANTINOPOLIS	GOIAS	BRASIL	0620S	04728W	0130	54	FTS
BRA-000078/18	M.J.BALICK ET ALII 1309 L.COL: FAZENDA DO MOCAMBO A 11 KM DE	TOCANTINOPOLIS TOCANTINOPOLIS	GOIAS	BRASIL	0620S	04728W	0130	54	FTS
BRA-000078/19	M.J.BALICK ET ALII 1309 L.COL: FAZENDA DO MOCAMBO A 11 KM DE	TOCANTINOPOLIS TOCANTINOPOLIS	GOIAS	BRASIL	0620S	04728W	0130	54	FTS

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. I.LOCAIS DE COLETA E QUANTIDADES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) A.B.ANDERSON (INPA) J.M.F.FRAZAO & C.U.B.PINHEIRO (INEB) J.JANGOUX & M.A.ROSA (MPEG)
PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN PERIODO DA COLETA: 231181 A 121281 FAMILIA: PALMAE

REGISTRO	IDENTIFICACAO DO ACESSO/ LOCAL DA COLETA	MUNICIPIO	ESTADO OU TERRITORIO	PAIS	LAT	LONG	ALT (M)	QUANT	UNID
BRA-000086/12	M.J.BALICK ET ALII 1342 L.COL: CALDEIRAO 25 KM A OESTE DE BALSAS. FAZENDA DO SR.DAMIAO	BALSAS	MARANHAO	BRASIL	0735S	04605W	0270	54	FTS
BRA-000086/13	M.J.BALICK ET ALII 1342 L.COL: CALDEIRAO 25 KM A OESTE DE BALSAS. FAZENDA DO SR.DAMIAO	BALSAS	MARANHAO	BRASIL	0735S	04605W	0270	54	FTS
BRA-000086/14	M.J.BALICK ET ALII 1342 L.COL: CALDEIRAO 25 KM A OESTE DE BALSAS. FAZENDA DO SR.DAMIAO	BALSAS	MARANHAO	BRASIL	0735S	04605W	0270	54	FTS
BRA-000086/15	M.J.BALICK ET ALII 1342 L.COL: CALDEIRAO 25 KM A OESTE DE BALSAS. FAZENDA DO SR.DAMIAO	BALSAS	MARANHAO	BRASIL	0735S	04605W	0270	54	FTS
BRA-000086/16	M.J.BALICK ET ALII 1342 L.COL: CALDEIRAO 25 KM A OESTE DE BALSAS. FAZENDA DO SR.DAMIAO	BALSAS	MARANHAO	BRASIL	0735S	04605W	0270	54	FTS
BRA-000086/17	M.J.BALICK ET ALII 1342 L.COL: CALDEIRAO 25 KM A OESTE DE BALSAS. FAZENDA DO SR.DAMIAO	BALSAS	MARANHAO	BRASIL	0735S	04605W	0270	54	FTS
BRA-000086/18	M.J.BALICK ET ALII 1342 L.COL: CALDEIRAO 25 KM A OESTE DE BALSAS. FAZENDA DO SR.DAMIAO	BALSAS	MARANHAO	BRASIL	0735S	04605W	0270	54	FTS
BRA-000086/19	M.J.BALICK ET ALII 1342 L.COL: CALDEIRAO 25 KM A OESTE DE BALSAS. FAZENDA DO SR.DAMIAO	BALSAS	MARANHAO	BRASIL	0735S	04605W	0270	54	FTS
BRA-000086/20	M.J.BALICK ET ALII 1342 L.COL: CALDEIRAO 25 KM A OESTE DE BALSAS. FAZENDA DO SR.DAMIAO	BALSAS	MARANHAO	BRASIL	0735S	04605W	0270	54	FTS
BRA-000094/01	M.J.BALICK ET ALII 1351 L.COL: MARGEM DO RIO PARNAIBA 32 KM SUL DE TERESINA ESTRADA PARA PALMEIRAS	TERESINA	PIAUI	BRASIL	0522S	04250W		54	FTS
BRA-000094/02	M.J.BALICK ET ALII 1351 L.COL: MARGEM DO RIO PARNAIBA 32 KM SUL DE TERESINA ESTRADA PARA PALMEIRAS	TERESINA	PIAUI	BRASIL	0522S	04250W		54	FTS
BRA-000094/03	M.J.BALICK ET ALII 1351 L.COL: MARGEM DO RIO PARNAIBA 32 KM SUL DE TERESINA ESTRADA PARA PALMEIRAS	TERESINA	PIAUI	BRASIL	0522S	04250W		54	FTS
BRA-000094/04	M.J.BALICK ET ALII 1351 L.COL: MARGEM DO RIO PARNAIBA 32 KM SUL DE TERESINA ESTRADA PARA PALMEIRAS	TERESINA	PIAUI	BRASIL	0522S	04250W		54	FTS

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. I.LOCAIS DE COLETA E QUANTIDADES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) A.B.ANDERSON (INPA) J.M.F.FRAZAO & C.U.B.PINHEIRO (INEB) J.JANGOUX & N.A.ROSA (MPEG)
PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN PERIODO DA COLETA: 231181 A 121281 FAMILIA: PALMAE

REGISTRO	IDENTIFICACAO DO ACESSO/ LOCAL DA COLETA	MUNICIPIO	ESTADO OU TERRITORIO	PAIS	LAT	LONG	ALT (M)	QUANT	UNID
BRA-000094/18	M.J.BALICK ET ALII 1351	TERESINA	PIAUI	BRASIL	0522S	04250W		54	FTS
	L.COL: MARGEM DO RIO PARNAIBA 32 KM SUL DE TERESINA ESTRADA PARA PALMEIRAS								
BRA-000094/19	M.J.BALICK ET ALII 1351	TERESINA	PIAUI	BRASIL	0522S	04250W		54	FTS
	L.COL: MARGEM DO RIO PARNAIBA 32 KM SUL DE TERESINA ESTRADA PARA PALMEIRAS								
BRA-000094/20	M.J.BALICK ET ALII 1351	TERESINA	PIAUI	BRASIL	0522S	04250W		54	FTS
	L.COL: MARGEM DO RIO PARNAIBA 32 KM SUL DE TERESINA ESTRADA PARA PALMEIRAS								
BRA-000108/01	M.J.BALICK ET ALII 1353	UBAJARA	CEARA	BRASIL	0350S	04055W	0850	54	FTS
	L.COL: SITIO AMAZONAS PROXIMO AO PARQUE NACIONAL DE UBAJARA								
BRA-000108/02	M.J.BALICK ET ALII 1353	UBAJARA	CEARA	BRASIL	0350S	04055W	0850	54	FTS
	L.COL: SITIO AMAZONAS PROXIMO AO PARQUE NACIONAL DE UBAJARA								
BRA-000108/03	M.J.BALICK ET ALII 1353	UBAJARA	CEARA	BRASIL	0350S	04055W	0850	54	FTS
	L.COL: SITIO AMAZONAS PROXIMO AO PARQUE NACIONAL DE UBAJARA								
BRA-000108/04	M.J.BALICK ET ALII 1353	UBAJARA	CEARA	BRASIL	0350S	04055W	0850	54	FTS
	L.COL: SITIO AMAZONAS PROXIMO AO PARQUE NACIONAL DE UBAJARA								
BRA-000108/05	M.J.BALICK ET ALII 1353	UBAJARA	CEARA	BRASIL	0350S	04055W	0850	54	FTS
	L.COL: SITIO AMAZONAS PROXIMO AO PARQUE NACIONAL DE UBAJARA								
BRA-000108/06	M.J.BALICK ET ALII 1353	UBAJARA	CEARA	BRASIL	0350S	04055W	0850	54	FTS
	L.COL: SITIO AMAZONAS PROXIMO AO PARQUE NACIONAL DE UBAJARA								
BRA-000108/07	M.J.BALICK ET ALII 1353	UBAJARA	CEARA	BRASIL	0350S	04055W	0850	54	FTS
	L.COL: SITIO AMAZONAS PROXIMO AO PARQUE NACIONAL DE UBAJARA								
BRA-000108/08	M.J.BALICK ET ALII 1353	UBAJARA	CEARA	BRASIL	0350S	04055W	0850	54	FTS
	L.COL: SITIO AMAZONAS PROXIMO AO PARQUE NACIONAL DE UBAJARA								
BRA-000108/09	M.J.BALICK ET ALII 1353	UBAJARA	CEARA	BRASIL	0350S	04055W	0850	54	FTS
	L.COL: SITIO AMAZONAS PROXIMO AO PARQUE NACIONAL DE UBAJARA								
BRA-000108/10	M.J.BALICK ET ALII 1353	UBAJARA	CEARA	BRASIL	0350S	04055W	0850	54	FTS
	L.COL: SITIO AMAZONAS PROXIMO AO PARQUE NACIONAL DE UBAJARA								

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LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. I.LOCAIS DE COLETA E QUANTIDADES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) A.B.ANDERSON (INPA) J.M.F.FRAZAO & C.U.B.PINHEIRO (INEB) J.JANGOUX & N.A.ROSA (MPEG)
PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN PERIODO DA COLETA: 231181 A 121231 FAMILIA: PALMAE

REGISTRO	IDENTIFICACAO DO ACESSO/ LOCAL DA COLETA	MUNICIPIO	ESTADO OU TERRITORIO	PAIS	LAT	LONG	ALT (M)	QUANT	UNID
BRA-000116/04	M.J.BALICK ET ALII 1354	IPU	CEARA	BRASIL	0420S	04045W		54	FTS
	L.COL: VARZEA DO JILO. RODOVIA UBAJARA-IPU KM 62. FAZENDA DO SR.ANTONIO PEREIRA								
BRA-000116/05	M.J.BALICK ET ALII 1354	IPU	CEARA	BRASIL	0420S	04045W		54	FTS
	L.COL: VARZEA DO JILO. RODOVIA UBAJARA-IPU KM 62. FAZENDA DO SR.ANTONIO PEREIRA								
BRA-000116/06	M.J.BALICK ET ALII 1354	IPU	CEARA	BRASIL	0420S	04045W		54	FTS
	L.COL: VARZEA DO JILO. RODOVIA UBAJARA-IPU KM 62. FAZENDA DO SR.ANTONIO PEREIRA								
BRA-000116/07	M.J.BALICK ET ALII 1354	IPU	CEARA	BRASIL	0420S	04045W		54	FTS
	L.COL: VARZEA DO JILO. RODOVIA UBAJARA-IPU KM 62. FAZENDA DO SR.ANTONIO PEREIRA								
BRA-000116/08	M.J.BALICK ET ALII 1354	IPU	CEARA	BRASIL	0420S	04045W		54	FTS
	L.COL: VARZEA DO JILO. RODOVIA UBAJARA-IPU KM 62. FAZENDA DO SR.ANTONIO PEREIRA								
BRA-000116/09	M.J.BALICK ET ALII 1354	IPU	CEARA	BRASIL	0420S	04045W		54	FTS
	L.COL: VARZEA DO JILO. RODOVIA UBAJARA-IPU KM 62. FAZENDA DO SR.ANTONIO PEREIRA								
BRA-000116/10	M.J.BALICK ET ALII 1354	IPU	CEARA	BRASIL	0420S	04045W		54	FTS
	L.COL: VARZEA DO JILO. RODOVIA UBAJARA-IPU KM 62. FAZENDA DO SR.ANTONIO PEREIRA								
BRA-000116/11	M.J.BALICK ET ALII 1354	IPU	CEARA	BRASIL	0420S	04045W		54	FTS
	L.COL: VARZEA DO JILO. RODOVIA UBAJARA-IPU KM 62. FAZENDA DO SR.ANTONIO PEREIRA								
BRA-000116/12	M.J.BALICK ET ALII 1354	IPU	CEARA	BRASIL	0420S	04045W		54	FTS
	L.COL: VARZEA DO JILO. RODOVIA UBAJARA-IPU KM 62. FAZENDA DO SR.ANTONIO PEREIRA								
BRA-000116/13	M.J.BALICK ET ALII 1354	IPU	CEARA	BRASIL	0420S	04045W		54	FTS
	L.COL: VARZEA DO JILO. RODOVIA UBAJARA-IPU KM 62. FAZENDA DO SR.ANTONIO PEREIRA								
BRA-000116/14	M.J.BALICK ET ALII 1354	IPU	CEARA	BRASIL	0420S	04045W		54	FTS
	L.COL: VARZEA DO JILO. RODOVIA UBAJARA-IPU KM 62. FAZENDA DO SR.ANTONIO PEREIRA								
BRA-000116/15	M.J.BALICK ET ALII 1354	IPU	CEARA	BRASIL	0420S	04045W		54	FTS
	L.COL: VARZEA DO JILO. RODOVIA UBAJARA-IPU KM 62. FAZENDA DO SR.ANTONIO PEREIRA								
BRA-000116/16	M.J.BALICK ET ALII 1354	IPU	CEARA	BRASIL	0420S	04045W		54	FTS
	L.COL: VARZEA DO JILO. RODOVIA UBAJARA-IPU KM 62. FAZENDA DO SR.ANTONIO PEREIRA								

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. II. CARACTERIZACAO AMBIENTAL E MATERIAL COLETADO
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) A.B.ANDERSON (INPA) J.M.F.FRAZAO & C.U.B.PINHEIRO (INEB) J.JANGOUX & N.A.ROSA (MPEG)
PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	AMBIENTE GERAL/SUBSTRATO/OBSERVACOES	RELEVO/ FREQUENCIA RELATIVA	REGIAO GEOPOLITICA/ MATERIAL COLETADO	DATA DA COLETA
BRA-000060/01	AMB:FLORESTA PRIMARIA COM PRESENCA DOMINANTE DE BABACU SUB:LATOSSOLO VERMELHO AMARELO/SERA INUNDADA POR TUCURUI OBS:BABACU ASSOCIADO A MATA PRIMARIA COM OCORRENCIA DE CASTANHEIRAS (B.EXCELSA). GERMOPLASMA OBTIDO DE 20 ARVORES	LEVEMENTE ONDULADO FR: COMUM	NORTE MAT:EXSICATAS FRUTOS	231181
BRA-000060/02	AMB:FLORESTA PRIMARIA COM PRESENCA DOMINANTE DE BABACU SUB:LATOSSOLO VERMELHO AMARELO/SERA INUNDADA POR TUCURUI OBS:BABACU ASSOCIADO A MATA PRIMARIA COM OCORRENCIA DE CASTANHEIRAS (B.EXCELSA). GERMOPLASMA OBTIDO DE 20 ARVORES	LEVEMENTE ONDULADO FR: COMUM	NORTE MAT:EXSICATAS FRUTOS	231181
BRA-000060/03	AMB:FLORESTA PRIMARIA COM PRESENCA DOMINANTE DE BABACU SUB:LATOSSOLO VERMELHO AMARELO/SERA INUNDADA POR TUCURUI OBS:BABACU ASSOCIADO A MATA PRIMARIA COM OCORRENCIA DE CASTANHEIRAS (B.EXCELSA). GERMOPLASMA OBTIDO DE 20 ARVORES	LEVEMENTE ONDULADO FR: COMUM	NORTE MAT:EXSICATAS FRUTOS	231181
BRA-000060/04	AMB:FLORESTA PRIMARIA COM PRESENCA DOMINANTE DE BABACU SUB:LATOSSOLO VERMELHO AMARELO/SERA INUNDADA POR TUCURUI OBS:BABACU ASSOCIADO A MATA PRIMARIA COM OCORRENCIA DE CASTANHEIRAS (B.EXCELSA). GERMOPLASMA OBTIDO DE 20 ARVORES	LEVEMENTE ONDULADO FR: COMUM	NORTE MAT:EXSICATAS FRUTOS	231181
BRA-000060/05	AMB:FLORESTA PRIMARIA COM PRESENCA DOMINANTE DE BABACU SUB:LATOSSOLO VERMELHO AMARELO/SERA INUNDADA POR TUCURUI OBS:BABACU ASSOCIADO A MATA PRIMARIA COM OCORRENCIA DE CASTANHEIRAS (B.EXCELSA). GERMOPLASMA OBTIDO DE 20 ARVORES	LEVEMENTE ONDULADO FR: COMUM	NORTE MAT:EXSICATAS FRUTOS	231181
BRA-000060/06	AMB:FLORESTA PRIMARIA COM PRESENCA DOMINANTE DE BABACU SUB:LATOSSOLO VERMELHO AMARELO/SERA INUNDADA POR TUCURUI OBS:BABACU ASSOCIADO A MATA PRIMARIA COM OCORRENCIA DE CASTANHEIRAS (B.EXCELSA). GERMOPLASMA OBTIDO DE 20 ARVORES	LEVEMENTE ONDULADO FR: COMUM	NORTE MAT:EXSICATAS FRUTOS	231181
BRA-000060/07	AMB:FLORESTA PRIMARIA COM PRESENCA DOMINANTE DE BABACU SUB:LATOSSOLO VERMELHO AMARELO/SERA INUNDADA POR TUCURUI OBS:BABACU ASSOCIADO A MATA PRIMARIA COM OCORRENCIA DE CASTANHEIRAS (B.EXCELSA). GERMOPLASMA OBTIDO DE 20 ARVORES	LEVEMENTE ONDULADO FR: COMUM	NORTE MAT:EXSICATAS FRUTOS	231181
BRA-000060/08	AMB:FLORESTA PRIMARIA COM PRESENCA DOMINANTE DE BABACU SUB:LATOSSOLO VERMELHO AMARELO/SERA INUNDADA POR TUCURUI OBS:BABACU ASSOCIADO A MATA PRIMARIA COM OCORRENCIA DE CASTANHEIRAS (B.EXCELSA). GERMOPLASMA OBTIDO DE 20 ARVORES	LEVEMENTE ONDULADO FR: COMUM	NORTE MAT:EXSICATAS FRUTOS	231181
BRA-000060/09	AMB:FLORESTA PRIMARIA COM PRESENCA DOMINANTE DE BABACU SUB:LATOSSOLO VERMELHO AMARELO/SERA INUNDADA POR TUCURUI OBS:BABACU ASSOCIADO A MATA PRIMARIA COM OCORRENCIA DE CASTANHEIRAS (B.EXCELSA). GERMOPLASMA OBTIDO DE 20 ARVORES	LEVEMENTE ONDULADO FR: COMUM	NORTE MAT:EXSICATAS FRUTOS	231181
BRA-000060/10	AMB:FLORESTA PRIMARIA COM PRESENCA DOMINANTE DE BABACU SUB:LATOSSOLO VERMELHO AMARELO/SERA INUNDADA POR TUCURUI OBS:BABACU ASSOCIADO A MATA PRIMARIA COM OCORRENCIA DE CASTANHEIRAS (B.EXCELSA). GERMOPLASMA OBTIDO DE 20 ARVORES	LEVEMENTE ONDULADO FR: COMUM	NORTE MAT:EXSICATAS FRUTOS	231181

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. II. CARACTERIZACAO AMBIENTAL E MATERIAL COLETADO
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) A.B.ANDERSON (INPA) J.M.F.FRAZAO & C.U.B.PINHEIRO (INEB) J.JANGOUX & N.A.ROSA (MPEG)
PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	AMBIENTE GERAL/SUBSTRATO/OBSERVACOES	RELEVO/ FREQUENCIA RELATIVA	REGIAO GEOPOLITICA/ MATERIAL COLETADO	DATA DA COLETA
BRA-000078/01	AMB:AREA DE PASTAGEM CULTIVADA SUB:LATOSSOLO VERMELHO AMARELO OBS:GERMOPLASMA OBTIDO DE 21 ARVORES. FRUTOS EXCEPCIONALMENTE GRANDES	LEVEMENTE ONDULADO FR: COMUM	CENTRO-OESTE MAT:EXSICATAS FRUTOS	281181
BRA-000078/02	AMB:AREA DE PASTAGEM CULTIVADA SUB:LATOSSOLO VERMELHO AMARELO OBS:GERMOPLASMA OBTIDO DE 21 ARVORES. FRUTOS EXCEPCIONALMENTE GRANDES	LEVEMENTE ONDULADO FR: COMUM	CENTRO-OESTE MAT:EXSICATAS FRUTOS	281181
BRA-000078/03	AMB:AREA DE PASTAGEM CULTIVADA SUB:LATOSSOLO VERMELHO AMARELO OBS:GERMOPLASMA OBTIDO DE 21 ARVORES. FRUTOS EXCEPCIONALMENTE GRANDES	LEVEMENTE ONDULADO FR: COMUM	CENTRO-OESTE MAT:EXSICATAS FRUTOS	281181
BRA-000078/04	AMB:AREA DE PASTAGEM CULTIVADA SUB:LATOSSOLO VERMELHO AMARELO OBS:GERMOPLASMA OBTIDO DE 21 ARVORES. FRUTOS EXCEPCIONALMENTE GRANDES	LEVEMENTE ONDULADO FR: COMUM	CENTRO-OESTE MAT:EXSICATAS FRUTOS	281181
BRA-000078/05	AMB:AREA DE PASTAGEM CULTIVADA SUB:LATOSSOLO VERMELHO AMARELO OBS:GERMOPLASMA OBTIDO DE 21 ARVORES. FRUTOS EXCEPCIONALMENTE GRANDES	LEVEMENTE ONDULADO FR: COMUM	CENTRO-OESTE MAT:EXSICATAS FRUTOS	281181
BRA-000078/06	AMB:AREA DE PASTAGEM CULTIVADA SUB:LATOSSOLO VERMELHO AMARELO OBS:GERMOPLASMA OBTIDO DE 21 ARVORES. FRUTOS EXCEPCIONALMENTE GRANDES	LEVEMENTE ONDULADO FR: COMUM	CENTRO-OESTE MAT:EXSICATAS FRUTOS	281181
BRA-000078/07	AMB:AREA DE PASTAGEM CULTIVADA SUB:LATOSSOLO VERMELHO AMARELO OBS:GERMOPLASMA OBTIDO DE 21 ARVORES. FRUTOS EXCEPCIONALMENTE GRANDES	LEVEMENTE ONDULADO FR: COMUM	CENTRO-OESTE MAT:EXSICATAS FRUTOS	281181
BRA-000078/08	AMB:AREA DE PASTAGEM CULTIVADA SUB:LATOSSOLO VERMELHO AMARELO OBS:GERMOPLASMA OBTIDO DE 21 ARVORES. FRUTOS EXCEPCIONALMENTE GRANDES	LEVEMENTE ONDULADO FR: COMUM	CENTRO-OESTE MAT:EXSICATAS FRUTOS	281181
BRA-000078/09	AMB:AREA DE PASTAGEM CULTIVADA SUB:LATOSSOLO VERMELHO AMARELO OBS:GERMOPLASMA OBTIDO DE 21 ARVORES. FRUTOS EXCEPCIONALMENTE GRANDES	LEVEMENTE ONDULADO FR: COMUM	CENTRO-OESTE MAT:EXSICATAS FRUTOS	281181
BRA-000078/10	AMB:AREA DE PASTAGEM CULTIVADA SUB:LATOSSOLO VERMELHO AMARELO OBS:GERMOPLASMA OBTIDO DE 21 ARVORES. FRUTOS EXCEPCIONALMENTE GRANDES	LEVEMENTE ONDULADO FR: COMUM	CENTRO-OESTE MAT:EXSICATAS FRUTOS	281181

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. II. CARACTERIZACAO AMBIENTAL E MATERIAL COLETADO
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) A.B.ANDERSON (INPA) J.M.F.FRAZAO & C.U.B.PINHEIRO (INEB) J.JANGOUX & N.A.ROSA (MPEG)
PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	AMBIENTE GERAL/SUBSTRATO/OBSERVACOES	RELEVO/ FREQUENCIA RELATIVA	REGIAO GEOPOLITICA/ MATERIAL COLETADO	DATA DA COLETA
BRA-000078/21	AMB:AREA DE PASTAGEM CULTIVADA SUB:LATOSSOLO VERMELHO AMARELO OBS:GERMOPLASMA OBTIDO DE 21 ARVORES. FRUTOS EXCEPCIONALMENTE GRANDES	LEVEMENTE ONDULADO FR: COMUM	CENTRO-OESTE MAT:EXSICATAS FRUTOS	281181
BRA-000036/01	AMB:CERRADO SUB:AREIAS QUARTZOZAS DISTROFICAS OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	041281
BRA-000036/02	AMB:CERRADO SUB:AREIAS QUARTZOZAS DISTROFICAS OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	041281
BRA-000036/03	AMB:CERRADO SUB:AREIAS QUARTZOZAS DISTROFICAS OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	041281
BRA-000036/04	AMB:CERRADO SUB:AREIAS QUARTZOZAS DISTROFICAS OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	041281
BRA-000036/05	AMB:CERRADO SUB:AREIAS QUARTZOZAS DISTROFICAS OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	041281
BRA-000036/06	AMB:CERRADO SUB:AREIAS QUARTZOZAS DISTROFICAS OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	041281
BRA-000036/07	AMB:CERRADO SUB:AREIAS QUARTZOZAS DISTROFICAS OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	041281
BRA-000036/08	AMB:CERRADO SUB:AREIAS QUARTZOZAS DISTROFICAS OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	041281
BRA-000036/09	AMB:CERRADO SUB:AREIAS QUARTZOZAS DISTROFICAS OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	041281

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. II. CARACTERIZACAO AMBIENTAL E MATERIAL COLETADO
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) A.B.ANDERSON (INPA) J.M.F.FRAZAO & C.U.B.PINHEIRO (INEB) J.JANGOUX & N.A.ROSA (MPEG)
PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	AMBIENTE GERAL/SUBSTRATO/OBSERVACOES	RELEVO/ FREQUENCIA RELATIVA	REGIAO GEOPOLITICA/ MATERIAL COLETADO	DATA DA COLETA
BRA-000036/20	AMB:CERRADO SUB:AREIAS QUARTZOZAS DISTROFICAS OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	041291
BRA-000094/01	AMB:FLORESTA DE BABACU COM PASTAGEM SUB:PODZOLICO VERMELHO AMARELO DISTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. AREA COM GRANDE DOMINANCIA DE BABACU	LEVEMENTE ONDULADO FR: DOMINANTE	NORDESTE MAT:EXSICATAS FRUTOS	081291
BRA-000094/02	AMB:FLORESTA DE BABACU COM PASTAGEM SUB:PODZOLICO VERMELHO AMARELO DISTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. AREA COM GRANDE DOMINANCIA DE BABACU	LEVEMENTE ONDULADO FR: DOMINANTE	NORDESTE MAT:EXSICATAS FRUTOS	081291
BRA-000094/03	AMB:FLORESTA DE BABACU COM PASTAGEM SUB:PODZOLICO VERMELHO AMARELO DISTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. AREA COM GRANDE DOMINANCIA DE BABACU	LEVEMENTE ONDULADO FR: DOMINANTE	NORDESTE MAT:EXSICATAS FRUTOS	081291
BRA-000094/04	AMB:FLORESTA DE BABACU COM PASTAGEM SUB:PODZOLICO VERMELHO AMARELO DISTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. AREA COM GRANDE DOMINANCIA DE BABACU	LEVEMENTE ONDULADO FR: DOMINANTE	NORDESTE MAT:EXSICATAS FRUTOS	081291
BRA-000094/05	AMB:FLORESTA DE BABACU COM PASTAGEM SUB:PODZOLICO VERMELHO AMARELO DISTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. AREA COM GRANDE DOMINANCIA DE BABACU	LEVEMENTE ONDULADO FR: DOMINANTE	NORDESTE MAT:EXSICATAS FRUTOS	081281
BRA-000094/06	AMB:FLORESTA DE BABACU COM PASTAGEM SUB:PODZOLICO VERMELHO AMARELO DISTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. AREA COM GRANDE DOMINANCIA DE BABACU	LEVEMENTE ONDULADO FR: DOMINANTE	NORDESTE MAT:EXSICATAS FRUTOS	081291
BRA-000094/07	AMB:FLORESTA DE BABACU COM PASTAGEM SUB:PODZOLICO VERMELHO AMARELO DISTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. AREA COM GRANDE DOMINANCIA DE BABACU	LEVEMENTE ONDULADO FR: DOMINANTE	NORDESTE MAT:EXSICATAS FRUTOS	081281
BRA-000094/08	AMB:FLORESTA DE BABACU COM PASTAGEM SUB:PODZOLICO VERMELHO AMARELO DISTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. AREA COM GRANDE DOMINANCIA DE BABACU	LEVEMENTE ONDULADO FR: DOMINANTE	NORDESTE MAT:EXSICATAS FRUTOS	081291
BRA-000094/09	AMB:FLORESTA DE BABACU COM PASTAGEM SUB:PODZOLICO VERMELHO AMARELO DISTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. AREA COM GRANDE DOMINANCIA DE BABACU	LEVEMENTE ONDULADO FR: DOMINANTE	NORDESTE MAT:EXSICATAS FRUTOS	081291

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. II. CARACTERIZACAO AMBIENTAL E MATERIAL COLETADO
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

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PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA — COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN — FAMILIA: PALMAE

REGISTRO	AMBIENTE GERAL/SUBSTRATO/OBSERVACOES	RELEVO/ FREQUENCIA RELATIVA	REGIAO GEOPOLITICA/ MATERIAL COLETADO	DATA DA COLETA
BRA-000094/20	AMB:FLORESTA DE BABACU COM PASTAGEM SUB:PODZOLICO VERMELHO AMARELO DISTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. AREA COM GRANDE DOMINANCIA DE BABACU	LEVEMENTE ONDULADO FR: DOMINANTE	NORDESTE MAT:EXSICATAS FRUTOS	081291
BRA-000108/01	AMB:FLORESTA SECUNDARIA SUB:SOLO LITOLICO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	111291
BRA-000108/02	AMB:FLORESTA SECUNDARIA SUB:SOLO LITOLICO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	111291
BRA-000108/03	AMB:FLORESTA SECUNDARIA SUB:SOLO LITOLICO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	111291
BRA-000108/04	AMB:FLORESTA SECUNDARIA SUB:SOLO LITOLICO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	111281
BRA-000108/05	AMB:FLORESTA SECUNDARIA SUB:SOLO LITOLICO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	111291
BRA-000108/06	AMB:FLORESTA SECUNDARIA SUB:SOLO LITOLICO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	111281
BRA-000108/07	AMB:FLORESTA SECUNDARIA SUB:SOLO LITOLICO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	111291
BRA-000108/08	AMB:FLORESTA SECUNDARIA SUB:SOLO LITOLICO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	111281
BRA-000108/09	AMB:FLORESTA SECUNDARIA SUB:SOLO LITOLICO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	111281

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. II. CARACTERIZACAO AM·'ENTAL E MATERIAL COLETADO
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

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PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	AMBIENTE GERAL/SUBSTRATO/OBSERVACOES	RELEVO/ FREQUENCIA RELATIVA	REGIAO GEOPOLITICA/ MATERIAL COLETADO	DATA DA COLETA
BRA-000108/20	AMB:FLORESTA SECUNDARIA SUB:SOLO LITOLICO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	111281
BRA-000116/01	AMB:FLORESTA DE BABACU COM AREAS ABERTAS DE CULTIVO SUB:PODZOLICO VERMELHO AMARELO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	121281
BRA-000116/02	AMB:FLORESTA DE BABACU COM AREAS ABERTAS DE CULTIVO SUB:PODZOLICO VERMELHO AMARELO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	121281
BRA-000116/03	AMB:FLORESTA DE BABACU COM AREAS ABERTAS DE CULTIVO SUB:PODZOLICO VERMELHO AMARELO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	121281
BRA-000116/04	AMB:FLORESTA DE BABACU COM AREAS ABERTAS DE CULTIVO SUB:PODZOLICO VERMELHO AMARELO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	121281
BRA-000116/05	AMB:FLORESTA DE BABACU COM AREAS ABERTAS DE CULTIVO SUB:PODZOLICO VERMELHO AMARELO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	121281
BRA-000116/06	AMB:FLORESTA DE BABACU COM AREAS ABERTAS DE CULTIVO SUB:PODZOLICO VERMELHO AMARELO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	121281
BRA-000116/07	AMB:FLORESTA DE BABACU COM A[illegible]TAS DE CULTIVO SUB:PODZOLICO VERMELHO AMARELO [illegible]ICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	121281
BRA-000116/08	AMB:FLORESTA DE BABACU COM AREAS ABERTAS DE CULTIVO SUB:PODZOLICO VERMELHO AMARELO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	121281
BRA-000116/09	AMB:FLORESTA DE BABACU COM AREAS ABERTAS DE CULTIVO SUB:PODZOLICO VERMELHO AMARELO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	121281

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. II. CARACTERIZACAO AMBIENTAL E MATERIAL COLETADO
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) A.B.ANDERSON (INPA) J.M.F.FRAZAO & C.U.B.PINHEIRO (INEB) J.JANGOUX & N.A.ROSA (MPEG)
PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	AMBIENTE GERAL/SUBSTRATO/OBSERVACOES	RELEVO/ FREQUENCIA RELATIVA	REGIAO GEOPOLITICA/ MATERIAL COLETADO	DATA DA COLETA
BRA-000116/20	AMB:FLORESTA DE BABACU COM AREAS ABERTAS DE CULTIVO SUB:PODZOLICO VERMELHO AMARELO EUTROFICO OBS:GERMOPLASMA OBTIDO DE 20 ARVORES. BABACU OCORRE EM POPULACOES ISOLADAS	ONDULADO-CHAPADA FR: COMUM	NORDESTE MAT:EXSICATAS FRUTOS	121281

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. III. DADOS COMPLEMENTARES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) A.B.ANDERSON (INPA) J.M.F.FRAZAO & C.U.B.PINHEIRO (INEB) J.JANGOUX & N.A.ROSA (MPEG)
PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA — COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN — FAMILIA: PALMAE

REGISTRO	HABITO DE CRESCIMENTO/ DESTINO(S) SUGERIDO(S)	COR DA FLOR/ COR DO FRUTO	DETERMINADOR E DATA/ NOME COMUM NO LOCAL
BRA-000060/14	ERETO	FL:AMARELO CLARO FR:MARROM ESCURO	DET:M.BALICK-A.ANDERSON 231181 NC:BABACU
BRA-000060/15	ERETO	FL:AMARELO CLARO FR:MARROM ESCURO	DET:M.BALICK-A.ANDERSON 231181 NC:BABACU
BRA-000060/16	ERETO	FL:AMARELO CLARO FR:MARROM ESCURO	DET:M.BALICK-A.ANDERSON 231181 NC:BABACU
BRA-000060/17	ERETO	FL:AMARELO CLARO FR:MARROM ESCURO	DET:M.BALICK-A.ANDERSON 231181 NC:BABACU
BRA-000060/18	ERETO	FL:AMARELO CLARO FR:MARROM ESCURO	DET:M.BALICK-A.ANDERSON 231181 NC:BABACU
BRA-000060/19	ERETO	FL:AMARELO CLARO FR:MARROM ESCURO	DET:M.BALICK-A.ANDERSON 231181 NC:BABACU
BRA-000060/20	ERETO	FL:AMARELO CLARO FR:MARROM ESCURO	DET:M.BALICK-A.ANDERSON 231181 NC:BABACU
BRA-000078/01	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 281181 NC:BABACU
BRA-000078/02	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 281181 NC:BABACU
BRA-000078/03	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 281181 NC:BABACU
BRA-000078/04	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 281181 NC:BABACU
BRA-000078/05	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 281181 NC:BABACU
BRA-000078/06	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 281181 NC:BABACU

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. III. DADOS COMPLEMENTARES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

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PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA
CURADOR: LIDIO CORADIN

COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
FAMILIA: PALMAE

REGISTRO	HABITO DE CRESCIMENTO/ DESTINO(S) SUGERIDO(S)	COR DA FLOR/ COR DO FRUTO	DETERMINADOR E DATA/ NOME COMUM NO LOCAL
BRA-000078/20	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 281181 NC:BABACU
BRA-000078/21	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 281181 NC:BABACU
BRA-000086/01	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 041281 NC:BABACU
BRA-000086/02	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 041281 NC:BABACU
BRA-000086/03	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 041281 NC:BABACU
BRA-000086/04	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 041281 NC:BABACU
BRA-000086/05	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 041281 NC:BABACU
BRA-000086/06	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 041281 NC:BABACU
BRA-000086/07	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 041281 NC:BABACU
BRA-000086/08	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 041281 NC:BABACU
BRA-000086/09	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 041281 NC:BABACU
BRA-000086/10	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 041281 NC:BABACU
BRA-000086/11	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 041281 NC:BABACU

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. III. DADOS COMPLEMENTARES
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PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	HABITO DE CRESCIMENTO/ DESTINO(S) SUGERIDO(S)	COR DA FLOR/ COR DO FRUTO	DETERMINADOR E DATA/ NOME COMUM NO LOCAL
BRA-000094/05	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 081281 NC:BABACU
BRA-000094/06	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 081281 NC:BABACU
BRA-000094/07	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 081281 NC:BABACU
BRA-000094/08	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 081281 NC:BABACU
BRA-000094/09	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 081281 NC:BABACU
BRA-000094/10	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 081281 NC:BABACU
BRA-000094/11	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 081281 NC:BABACU
BRA-000094/12	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 081281 NC:BABACU
BRA-000094/13	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 081281 NC:BABACU
BRA-000094/14	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 081281 NC:BABACU
BRA-000094/15	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 081281 NC:BABACU
BRA-000094/16	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 081281 NC:BABACU
BRA-000094/17	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 081281 NC:BABACU

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. III. DADOS COMPLEMENTARES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) A.B.ANDERSON (INPA) J.M.F.FRAZAO & C.U.B.PINHEIRO (INEB) J.JANGOUX & N.A.ROSA (MPEG)
PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	HABITO DE CRESCIMENTO/ DESTINO(S) SUGERIDO(S)	COR DA FLOR/ COR DO FRUTO	DETERMINADOR E DATA/ NOME COMUM NO LOCAL
BRA-000108/11	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 111281 NC:BABACU
BRA-000108/12	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 111281 NC:BABACU
BRA-000108/13	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 111281 NC:BABACU
BRA-000108/14	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 111281 NC:BABACU
BRA-000108/15	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 111281 NC:BABACU
BRA-000108/16	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 111281 NC:BABACU
BRA-000108/17	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 111281 NC:BABACU
BRA-000108/18	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 111281 NC:BABACU
BRA-000108/19	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 111281 NC:BABACU
BRA-000108/20	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 111281 NC:BABACU
BRA-000116/01	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 121281 NC:BABACU
BRA-000116/02	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 121281 NC:BABACU
BRA-000116/03	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 121281 NC:BABACU

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. III. DADOS COMPLEMENTARES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) A.B.ANDERSON (INPA) J.M.F.FRAZAO & C.U.B.PINHEIRO (INEB) J.JANGOUX & N.A.ROSA (MPEG)
PATROCINADOR(ES) DA COLETA: EMBRAPA(CENARGEN) INPA MPEG NYBG FUN.LINDBERGH & US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	HABITO DE CRESCIMENTO/ DESTINO(S) SUGERIDO(S)	COR DA FLOR/ COR DO FRUTO	DETERMINADOR E DATA/ NOME COMUM NO LOCAL
BRA-000116/17	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 121281 NC:BABACU
BRA-000116/18	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 121281 NC:BABACU
BRA-000116/19	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 121281 NC:BABACU
BRA-000116/20	ERETO	FL:CREME FR:MARROM	DET:M.BALICK-A.ANDERSON 121281 NC:BABACU

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. I.LOCAIS DE COLETA E QUANTIDADES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) ET ALII
PATROCINADOR(ES) DA COLETA: NYBG & USAID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN PERIODO DA COLETA: FAMILIA: PALMAE

REGISTRO	IDENTIFICACAO DO ACESSO/ LOCAL DA COLETA	MUNICIPIO	ESTADO OU TERRITORIO	PAIS	LAT	LONG	ALT (M)	QUANT	UNID
BRA-000159/01	M.J.BALICK ET ALII 1359	MARBAN	DEP.BENI	BOLIVIA				44	FTS
	L.COL: VILLA ALBA 10 KM SUL DE SACHOJERE. 35 KM SUL DE TRINIDAD								
BRA-000159/02	M.J.BALICK ET ALII 1359	MARBAN	DEP.BENI	BOLIVIA				41	FTS
	L.COL: VILLA ALBA 10 KM SUL DE SACHOJERE. 35 KM SUL DE TRINIDAD								
BRA-000159/03	M.J.BALICK ET ALII 1359	MARBAN	DEP.BENI	BOLIVIA				33	FTS
	L.COL: VILLA ALBA 10 KM SUL DE SACHOJERE. 35 KM SUL DE TRINIDAD								
BRA-000167/01	M.J.BALICK ET ALII 1367	RIBERALTA	DEP.BENI	BOLIVIA				230	FTS
								230	FTS
	L.COL: 25 KM SUL DE ASCENSION DE GUARAYOS								
BRA-000167/02	M.J.BALICK ET ALII 1367	RIBERALTA	DEP.BENI	BOLIVIA				25	FTS
								25	FTS
	L.COL: 25 KM SUL DE ASCENSION DE GUARAYOS								

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LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. I.LOCAIS DE COLETA E QUANTIDADES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) ET ALII
PATROCINADOR(ES) DA COLETA: NYBG & USAID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA COHUNE STANDL.
CURADOR: LIDIO CORADIN PERIODO DA COLETA: FAMILIA: PALMAE

REGISTRO	IDENTIFICACAO DO ACESSO/ LOCAL DA COLETA	MUNICIPIO	ESTADO OU TERRITORIO	PAIS	LAT	LONG	ALT (M)	QUANT	UNID
BRA-000175/01	M.J.BALICK ET ALII 1466 L.COL: KOHUNLICH FLORESTA DE BABACU		DP.QUINTANA-ROO	MEXICO				63	FTS
BRA-000175/02	M.J.BALICK ET ALII 1466 L.COL: KOHUNLICH FLORESTA DE BABACU		DP.QUINTANA-ROO	MEXICO				47	FTS
BRA-000175/03	M.J.BALICK ET ALII 1466 L.COL: KOHUNLICH FLORESTA DE BABACU		DP.QUINTANA-ROO	MEXICO				35	FTS
BRA-000175/04	M.J.BALICK ET ALII 1466 L.COL: KOHUNLICH FLORESTA DE BABACU		DP.QUINTANA-ROO	MEXICO				31	FTS
BRA-000175/05	M.J.BALICK ET ALII 1466 L.COL: KOHUNLICH FLORESTA DE BABACU		DP.QUINTANA-ROO	MEXICO				46	FTS
BRA-000183/01	M.J.BALICK ET ALII 1466 L.COL: SAYOLITO CAMPO ABERTO 30 KM NORTE DE PUERTO VILLARTA	PUERTO VILLARTA	DEP.JALISCO	MEXICO				40	FTS
BRA-000183/02	M.J.BALICK ET ALII 1466 L.COL: SAYOLITO CAMPO ABERTO 30 KM NORTE DE PUERTO VILLARTA	PUERTO VILLARTA	DEP.JALISCO	MEXICO				35	FTS
BRA-000183/03	M.J.BALICK ET ALII 1466 L.COL: SAYOLITO CAMPO ABERTO 30 KM NORTE DE PUERTO VILLARTA	PUERTO VILLARTA	DEP.JALISCO	MEXICO				35	FTS
BRA-000191/01	M.J.BALICK ET ALII 1466 L.COL: TEPIC	PUERTO VILLARTA	DEP.JALISCO	MEXICO				19	FTS

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. II. CARACTERIZACAO AMBIENTAL E MATERIAL COLETADO
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.BALICK (NYBG) ET ALII
PATROCINADOR(ES) DA COLETA: NYBG & USAID

PRODUTO: ORBIGNYA
CURADOR: LIDIO CORADIN
COD.PROD.:03212 NOME CIENT.: ORBIGNYA COHUNE STANDL.
FAMILIA: PALMAE

REGISTRO	AMBIENTE GERAL/SUBSTRATO/OBSERVACOES	RELEVO/ FREQUENCIA RELATIVA	REGIAO GEOPOLITICA/ MATERIAL COLETADO	DATA DA COLETA
BRA-000175/01	OBS:GERMOPLASMA OBTIDO DE 5 ARVORES (1-5)	FR: COMUM	MAT:EXSICATAS SEMENTES	
BRA-000175/02	OBS:GERMOPLASMA OBTIDO DE 5 ARVORES (1-5)	FR: COMUM	MAT:EXSICATAS SEMENTES	
BRA-000175/03	OBS:GERMOPLASMA OBTIDO DE 5 ARVORES (1-5)	FR: COMUM	MAT:EXSICATAS SEMENTES	
BRA-000175/04	OBS:GERMOPLASMA OBTIDO DE 5 ARVORES (1-5)	FR: COMUM	MAT:EXSICATAS SEMENTES	
BRA-000175/05	OBS:GERMOPLASMA OBTIDO DE 5 ARVORES (1-5)	FR: COMUM	MAT:EXSICATAS SEMENTES	
BRA-000183/01	AMB:CAMPO ABERTO (PASTAGEM) OBS:GERMOPLASMA OBTIDO DE 3 ARVORES (1-3)	FR: COMUM	MAT:SEMENTES	
BRA-000183/02	AMB:CAMPO ABERTO (PASTAGEM) OBS:GERMOPLASMA OBTIDO DE 3 ARVORES (1-3)	FR: COMUM	MAT:SEMENTES	
BRA-000183/03	AMB:CAMPO ABERTO (PASTAGEM) OBS:GERMOPLASMA OBTIDO DE 3 ARVORES (1-3)	FR: COMUM	MAT:SEMENTES	
BRA-000191/01	AMB:CAMPO ABERTO (PASTAGEM) OBS:GERMOPLASMA OBTIDO DE 1 ARVORE (1). INDIVIDUOS PRECOCES. FRUTOS PRODUZIDOS A NIVEL DO CHAO	FR: FREQUENTE	MAT:SEMENTES	

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. III. DADOS COMPLEMENTARES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): P.J.BALICK (NYBG) ET ALII
PATROCINADOR(ES) DA COLETA: NYBG & USAID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	HABITO DE CRESCIMENTO/ DESTINO(S) SUGERIDO(S)	COR DA FLOR/ COR DO FRUTO	DETERMINADOR E DATA/ NOME COMUM NO LOCAL
BRA-000159/01	ERETO		
		FR:MARROM	NC:BABACU
BRA-000159/02	ERETO		
		FR:MARROM	NC:BABACU
BRA-000159/03	ERETO		
		FR:MARROM	NC:BABACU
BRA-000167/01	ERETO		
		FR:MARROM	NC:BABACU
BRA-000167/01	ERETO		
		FR:MARROM	NC:BABACU
BRA-000167/02	ERETO		
		FR:MARROM	NC:BABACU
BRA-000167/02	ERETO		
		FR:MARROM	NC:BABACU

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. I.LOCAIS DE COLETA E QUANTIDADES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.G.HOPKINS & H.PHIPPS III (NYBG) L.E.FORERO & N.HERNANDEZ (U.NAC.COLOMBIA) S.BECK (UNIV.DE LA PAZ) H.WOLF
PATROCINADOR(ES) DA COLETA: US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN PERIODO DA COLETA: 260783 A 130883 FAMILIA: PALMAE

REGISTRO	IDENTIFICACAO DO ACESSO/ LOCAL DA COLETA	MUNICIPIO	ESTADO OU TERRITORIO	PAIS	LAT	LONG	ALT (M)	QUANT	UNID
BRA-000256/01	HOPKINS ET ALII 153 E1	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1535S	06302W		64	FTS
	L.COL: 5 KM SUDESTE DE URUBICHA. RODOVIA PARA ASCENCION DE LOS GUARAYOS								
BRA-000264/01	HOPKINS ET ALII 153 H	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1557S	06308W		132	FTS
	L.COL: 5 KM LESTE DE YOTAU. RODOVIA PARA LAGUNA BLANCA								
BRA-000272/01	HOPKINS ET ALII 153 E2	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1535S	06302W		46	FTS
	L.COL: 15 KM LESTE DE ASCENCION DE LOS GUARAYOS. RODOVIA PARA URUBICHA								
BRA-000302/01	HOPKINS ET ALII 153 I1	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1545S	06258W		50	FTS
	L.COL: 15 KM LESTE DE ASCENCION DE LOS GUARAYOS. RODOVIA PARA ASERADERO 'NUNEZ'								
BRA-000302/02	HOPKINS ET ALII 153 I2	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1545S	06258W		70	FTS
	L.COL: 15 KM LESTE DE ASCENCION DE LOS GUARAYOS. RODOVIA PARA ASERADERO 'NUNEZ'								
BRA-000311/01	HOPKINS ET ALII 153 J1	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1539S	06305W		50	FTS
	L.COL: CHACARA DE DON LUIS OLIVARRIA. 3 KM NORTE DE ASCENCION DE LOS GUARAYOS								
BRA-000329/01	HOPKINS ET ALII 112 B1	VELASCO	SANTA CRUZ	BOLIVIA	1538S	06057W	0320	33	FTS
	L.COL: 135 KM NORTE DE SAN IGNACIO. CERCA DE 22 KM SUL DE SAN SIMON PROXIMO A CHACARA BONANZA								
BRA-000329/02	HOPKINS ET ALII 112 B2	VELASCO	SANTA CRUZ	BOLIVIA	1538S	06057W	0320	84	FTS
	L.COL: 135 KM NORTE DE SAN IGNACIO. CERCA DE 22 KM SUL DE SAN SIMON PROXIMO A CHACARA BONANZA								
BRA-000329/03	HOPKINS ET ALII 112 B3	VELASCO	SANTA CRUZ	BOLIVIA	1538S	06057W	0320	50	FTS
	L.COL: 135 KM NORTE DE SAN IGNACIO. CERCA DE 22 KM SUL DE SAN SIMON PROXIMO A CHACARA BONANZA								
BRA-000329/04	HOPKINS ET ALII 112 B4	VELASCO	SANTA CRUZ	BOLIVIA	1538S	06057W	0320	42	FTS
	L.COL: 135 KM NORTE DE SAN IGNACIO. CERCA DE 22 KM SUL DE SAN SIMON PROXIMO A CHACARA BONANZA								

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. LOCAIS DE COLETA E QUANTIDADES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.G.HOPKINS & H.PHIPPS III (NYBG) L.E.FORERO & N.HERNANDEZ (U.NAC.COLOMBIA) S.BECK (UNIV.DE LA PAZ) H.WOLF
PATROCINADOR(ES) DA COLETA: US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN PERIODO DA COLETA: 260783 A 130883 FAMILIA: PALMAE

REGISTRO	IDENTIFICACAO DO ACESSO/ LOCAL DA COLETA	MUNICIPIO	ESTADO OU TERRITORIO	PAIS	LAT	LONG	ALT (M)	QUANT	UNID
BRA-000418/05	HOPKINS ET ALII 159 F5 L.COL: 2-7 KM SUL DE YAGUARU. RODOVIA PARA ASCENCION DE LOS GUARAYOS	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1530S	06305W		44	FTS
BRA-000418/06	HOPKINS ET ALII 159 F6 L.COL: 2-7 KM SUL DE YAGUARU. RODOVIA PARA ASCENCION DE LOS GUARAYOS	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1530S	06305W		56	FTS
BRA-000418/07	HOPKINS ET ALII 159 F7 L.COL: 2-7 KM SUL DE YAGUARU. RODOVIA PARA ASCENCION DE LOS GUARAYOS	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1530S	06305W		35	FTS
BRA-000418/08	HOPKINS ET ALII 159 F8 L.COL: 2-7 KM SUL DE YAGUARU. RODOVIA PARA ASCENCION DE LOS GUARAYOS	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1530S	06305W		45	FTS
BRA-000442/01	HOPKINS ET ALII 159 K1 L.COL: 3-10 KM NORTE DE EL PUENTE. RODOVIA SANTA CRUZ - ASCENCION DE LOS GUARAYOS	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1610S	06258W		50	FTS
BRA-000442/02	HOPKINS ET ALII 159 K2 L.COL: 3-10 KM NORTE DE EL PUENTE. RODOVIA SANTA CRUZ - ASCENCION DE LOS GUARAYOS	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1610S	06258W		50	FTS
BRA-000442/03	HOPKINS ET ALII 159 K3 L.COL: 3-10 KM NORTE DE EL PUENTE. RODOVIA SANTA CRUZ - ASCENCION DE LOS GUARAYOS	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1610S	06258W		50	FTS
BRA-000442/04	HOPKINS ET ALII 159 K4 L.COL: 3-10 KM NORTE DE EL PUENTE. RODOVIA SANTA CRUZ - ASCENCION DE LOS GUARAYOS	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1610S	06258W		50	FTS
BRA-000442/05	HOPKINS ET ALII 159 K5 L.COL: 3-10 KM NORTE DE EL PUENTE. RODOVIA SANTA CRUZ - ASCENCION DE LOS GUARAYOS	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1610S	06258W		50	FTS
BRA-000442/06	HOPKINS ET ALII 159 K6 L.COL: 3-10 KM NORTE DE EL PUENTE. RODOVIA SANTA CRUZ - ASCENCION DE LOS GUARAYOS	NUFLO DE CHAVES	SANTA CRUZ	BOLIVIA	1610S	06258W		61	FTS

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LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. II. CARACTERIZACAO AMBIENTAL E MATERIAL COLETADO
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.G.HOPKINS & H.PHIPPS III (NYBG) L.E.FORERO & N.HERNANDEZ (U.NAC.COLOMBIA) S.BECK (UNIV.DE LA PAZ) M.WOLF
PATROCINADOR(ES) DA COLETA: US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	AMBIENTE GERAL/SUBSTRATO/OBSERVACOES	RELEVO/ FREQUENCIA RELATIVA	REGIAO GEOPOLITICA/ MATERIAL COLETADO	DATA DA COLETA
BRA-000256/01	AM3:FLORESTA TROPICAL OBS:TRONCO DE 4M. 3 INFLORESCENCIAS MASCULINAS E 2 FEMININAS. FRUTOS: COMPRIMENTO MEDIO 8.04CM. LARGURA MEDIA 5.71CM. PESO MEDIO 105.2G. EXSICATAS DEPOSITADAS NOS HERBARIOS NY E LPB	FR: COMUM	MAT:EXSICATAS SEMENTES	030833
BRA-000264/01	AM9:FLORESTA TROPICAL OBS:FRUTOS: COMPRIMENTO MEDIO 8.97CM. LARGURA APRIXIMADA 6.32CM. PESO MEDIO 177G. EXSICATAS DEPOSITADAS NOS HERBARIOS NY E LPB	FR: COMUM	MAT:EXSICATAS SEMENTES	060833
BRA-000272/01	AM3:FLORESTA TROPICAL OBS:3 INFLORESCENCIAS MASCULINAS E 2 FEMININAS. FRUTO: COMPRIMENTO MEDIO 3.04CM. LARGURA MEDIA 5.46CM. PESO MEDIO 96.2G. EXSICATAS DEPOSITADAS NOS HERBARIOS NY E LPB	FR: COMUM	MAT:EXSICATAS SEMENTES	030833
BRA-000302/01	AM8:FLORESTA TROPICAL OBS:NENHUMA INFLORESCENCIA MASCULINA E 3 FEMININAS. FRUTOS: COMPRIMENTO MEDIO 9.45CM. LARGURA MEDIA 5.71CM. PESO MEDIO 123.5G. EXSICATAS DEPOSITADAS NOS HERBARIOS NY E LPB	FR: COMUM	MAT:EXSICATAS SEMENTES	100833
BRA-000302/02	AM8:FLORESTA TROPICAL OBS:NENHUMA INFLORESCENCIA MASCULINA E 4 FEMININAS	FR: COMUM	MAT:SEMENTES	100833
BRA-000311/01	AM8:FLORESTA TROPICAL OBS:FRUTOS: COMPRIMENTO MEDIO 9.03CM. LARGURA MEDIA 6.26CM. PESO MEDIO 168.4G. EXSICATAS DEPOSITADAS NOS HERBARIOS NY E LPB	FR: COMUM	MAT:EXSICATAS SEMENTES	110833
BRA-000329/01	AM9:FLORESTA TROPICAL OBS:1 INFLORESCENCIA MASCULINA E 3 FEMININAS. FRUTOS: COMPRIMENTO MEDIO 8.32CM. LARGURA MEDIA 5.57CM. PESO MEDIO 135.2G. EXSICATAS DEPOSITADAS NOS HERBARIOS NY E LPB	FR: COMUM	MAT:EXSICATAS SEMENTES	260733
BRA-000329/02	AM8:FLORESTA TROPICAL OBS:3 INFLORESCENCIAS MASCULINAS E 1 FEMININA. FRUTOS: COMPROMENTO MEDIO 8.51CM. LARGURA MEDIA 5.55CM. PESO MEDIO 129.4G. EXSICATAS DEPOSITADAS NOS HERBARIOS NY E LPB	FR: COMUM	MAT:SEMENTES	260733

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. II. CARACTERIZACAO AMBIENTAL E MATERIAL COLETADO
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.G.HOPKINS & H.PHIPPS III (NYBG) L.E.FORERO & N.HERNANDEZ (U.NAC.COLOMBIA) S.BECK (UNIV.DE LA PAZ) M.WOLF
PATROCINADOR(ES) DA COLETA: US-AID

PRODUTO: ORBIGNYA — COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN — FAMILIA: PALMAE

REGISTRO	AMBIENTE GERAL/SUBSTRATO/OBSERVACOES	RELEVO/ FREQUENCIA RELATIVA	REGIAO GEOPOLITICA/ MATERIAL COLETADO	DATA DA COLETA
BRA-000418/01	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:EXSICATAS SEMENTES	030893
	OBS:8 INFLORESCENCIAS MASCULINAS E 4 FEMININAS. FRUTO: COMPRIMENTO MEDIO 10.21CM. LARGURA MEDIA 6.33CM.PESO MEDIO 202.5G. EXSICATAS DEPOSITADAS NOS HERBARIOS NY E LPB			
BRA-000418/02	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:SEMENTES	040893
	OBS:6 INFLORESCENIAS MASCULINAS E 3 FEMININAS. FRUTOS: COMPRIMENTO MEDIO 8.57CM. LARGURA MEDIA 5.36CM. PESO MEDIO 106.2G			
BRA-000418/03	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:SEMENTES	040893
	OBS:8 INFLORESCENCIAS MASCULINAS E 5 FEMININAS. FRUTOS: COMPRIMENTO MEDIO 8.92CM. LARGURA MEDIA 5.70CM. PESO MEDIO 123.4G			
BRA-000418/04	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:SEMENTES	040893
	OBS:7 INFLORESCENCIAS MASCULINAS E 5 FEMININAS. FRUTOS: COMPRIMENTO MEDIO 8.39CM. LARGURA MEDIA 7.02CM. PESO MEDIO 181.4G			
BRA-000418/05	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:SEMENTES	040893
	OBS:3 INFLORESCENCIAS MASCULINAS E 7 FEMININAS. FRUTOS: COMPRIMENTO MEDIO 8.60CM. LARGURA MEDIA 5.77CM. PESO MEDIO 113.2G			
BRA-000418/06	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:SEMENTES	040893
	OBS:FRUTOS: COMPRIMENTO MEDIO 9.26CM. LARGURA MEDIA 5.66CM. PESO MEDIO 121G			
BRA-000418/07	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:SEMENTES	040893
	OBS:FRUTOS: COMPRIMENTO MEDIO 9.15CM. LARGURA MEDIA 6.39CM. PESO MEDIO 153.6G			
BRA-000418/08	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:SEMENTES	040893
	OBS:FRUTOS: COMPRIMENTO MEDIO 8.37CM. LARGURA MEDIA 5.53CM. PESO MEDIO 101.8G			
BRA-000442/01	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:EXSICATAS SEMENTES	120893
	OBS:5 INFLORESCENCIAS MASCULINAS E 9 FEMININAS. FRUTOS: COMPRIMENTO MEDIO 9.37CM. LARGURA MEDIA 6.34CM. PESO MEDIO 166.3G. EXSICATAS DEPOSITADAS NOS HERBARIOS NY E LPB			

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. III. DADOS COMPLEMENTARES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. III. CARACTERIZACAO AMBIENTAL E MATERIAL COLETADO
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.G.HOPKINS & H.PHIPPS III (NYBG) L.E.FORERO & N.HERNANDEZ (U.NAC.COLOMBIA) S.BECK (UNIV.DE LA PAZ) H.WOLF
PATROCINADOR(ES) DA COLETA: US-AID

NOME DO COLETOR(ES): M.J.G.HOPKINS & H.PHIPPS III (NYBG) L.E.FORERO & N.HERNANDEZ (U.NAC.COLOMBIA) S.BECK (UNIV.DE LA PAZ) H.WOLF
PATROCINADOR(ES) DA COLETA: US-AID

PRODUTO: ORBIGNYA
CURADOR: LIDIO CORADIN

PRODUTO: ORBIGNYA
CURADOR: LIDIO CORADIN

COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
FAMILIA: PALMAE

COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
FAMILIA: PALMAE

REGISTRO	HABITO DE CRESCIMENTO/ AMBIENTE GERAL/SUBSTRATO/OBSERVACOES	COR DA FLOR/ COR DO FRUTO/ FREQUENCIA RELATIVA	DETERMINADOR E DATA/ REGIAO FITOGEOGRAFICA/ NOME COMUM NO LOCAL/ MATERIAL COLETADO	DATA DE COLETA
BRA-000353/03	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983	05088
BRA-000507/01	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:EXSICATAS SEMENTES	
BRA-000353/04	ERETO OBS:3 INFLORESCENCIAS MASCULINAS E 2 FEMININAS. FRUTOS: COMPRIMENTO MEDIO 9.07CM. LARGURA MEDIA 6.56CM. PESO MEDIO 184.4G. EXSICATAS DEPOSITADAS NOS HERBARIOS NY E LPB	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983	
BRA-000507/02	AMB:FLORESTA TROPICAL			
BRA-000361/01	ERETO	FL:AMARELO FR:MARROM FR: COMUM	DET:M.J.BALICK AGOSTO 1983 MAT:SEMENTES	05089
	OBS:4 INFLORESCENCIAS MASCULINAS E 4 FEMININAS. FRUTOS: COMPRIMENTO MEDIO 3.46CM. LARGURA MEDIA 5.30CM. PESO MEDIO 153.4G			
BRA-000418/01	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983	
BRA-000418/02	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983	
BRA-000418/03	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983	
BRA-000418/04	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983	
BRA-000418/05	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983	
BRA-000418/06	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983	
BRA-000418/07	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983	
BRA-000418/08	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983	
BRA-000442/01	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983	
BRA-000442/02	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983	

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. III. DADOS COMPLEMENTARES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.G.HOPKINS & H.PHIPPS III (NYBG) L.E.FORERO & N.HERNANDEZ (U.NAC.COLOMBIA) S.BECK (UNIV.DE LA PAZ) H.WOLF
PATROCINADOR(ES) DA COLETA: US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	HABITO DE CRESCIMENTO/ DESTINO(S) SUGERIDO(S)	COR DA FLOR/ COR DO FRUTO	DETERMINADOR E DATA/ NOME COMUM NO LOCAL
BRA-000353/03	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000353/04	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000361/01	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000418/01	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000418/02	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000418/03	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000418/04	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000418/05	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000418/06	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000418/07	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000418/08	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000442/01	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000442/02	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. III. DADOS COMPLEMENTARES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): M.J.G.HOPKINS & H.PHIPPS III (NYBG) L.E.FORERO & N.HERNANDEZ (U.NAC.COLOMBIA) S.BECK (UNIV.DE LA PAZ) H.WOLF
PATROCINADOR(ES) DA COLETA: US-AID

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA PHALERATA MARTIUS
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	HABITO DE CRESCIMENTO/ DESTINO(S) SUGERIDO(S)	COR DA FLOR/ COR DO FRUTO	DETERMINADOR E DATA/ NOME COMUM NO LOCAL
BRA-000442/03	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000442/04	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000442/05	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000442/06	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000442/07	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000442/08	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000469/01	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000507/01	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983
BRA-000507/02	ERETO	FL:AMARELO FR:MARROM	DET:M.J.BALICK AGOSTO 1983

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LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. I.LOCAIS DE COLETA E QUANTIDADES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): MICHAEL J.BALICK (USA/NYBG) STEVEN KING (USA) LUIZ E.FORERO & NELLY HERNANDEZ (COLOMBIA/UNIV.NAC.)
PATROCINADOR(ES) DA COLETA: US-AID & FUNDACAO JOYCE MERTZ-GILMORE

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA CUATRECASANA DUGAND
CURADOR: LIDIO CORADIN PERIODO DA COLETA: JULHO 1984 FAMILIA: PALMAE

REGISTRO	IDENTIFICACAO DO ACESSO/ LOCAL DA COLETA	MUNICIPIO	ESTADO OU TERRITORIO	PAIS	LAT	LONG	ALT (M)	QUANT	UNID
BRA-000574/01	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	16	FTS
BRA-000574/02	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	8	FTS
BRA-000574/03	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	4	FTS
BRA-000574/04	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	9	FT
BRA-000574/05	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	5	FT
BRA-000574/06	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	4	FT
BRA-000574/07	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	4	FTS
BRA-000574/08	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	8	FTS
BRA-000574/09	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	11	FTS
BRA-000574/10	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	20	FTS
BRA-000574/11	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	35	FTS
BRA-000574/12	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	20	FTS
BRA-000574/13	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	10	FTS

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LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. I.LOCAIS DE COLETA E QUANTIDADES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-96.

NOME DO COLETOR(ES): MICHAEL J.BALICK (USA/NYBG) STEVEN KING (USA) LUIZ E.FORERO & NELLY HERNANDEZ (COLOMBIA/UNIV.NAC.)
PATROCINADOR(ES) DA COLETA: US-AID & FUNDACAO JOYCE MERTZ-GILMORE

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA CUATRECASANA DUGAND
CURADOR: LIDIO CORADIN PERIODO DA COLETA: JULHO 1984 FAMILIA: PALMAE

REGISTRO	IDENTIFICACAO DO ACESSO/ LOCAL DA COLETA	MUNICIPIO	ESTADO OU TERRITORIO	PAIS	LAT	LONG	ALT (M)	QUANT	UNID
BRA-000574/14	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	11	FTS
BRA-000574/15	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	9	FTS
BRA-000574/16	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	5	FTS
BRA-000574/17	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	9	FTS
BRA-000574/18	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	9	FTS
BRA-000574/19	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	10	GTS
BRA-000574/20	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	10	GTS
BRA-000574/21	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	10	GTS
BRA-000574/22	BALICK;FORERO;HERNANDEZ & KING 1629 L.COL: PUERTO CALIMA. ESTACAO EXPERIMENTAL DEL BAJO CALIMA	BUENAVENTURA	VALLE DEL CAUCA	COLOMBIA	0350N	07630W	0035	2	FTS
BRA-000809/01	BALICK;FORERO;HERNANDEZ & KING 1630 L.COL: RODOVIA TUMACO-PASTO KM 75	TUMACO	NARINO	COLOMBIA	0145N	07845W	0010	12	FTS

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. II. CARACTERIZACAO AMBIENTAL E MATERIAL COLETADO
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): MICHAEL J.BALICK (USA/NYBG) STEVEN KING (USA) LUIZ E.FORERO & MELLY HERNANDEZ (COLOMBIA/UNIV.NAC.)
PATROCINADOR(ES) DA COLETA: US-AID & FUNDACAO JOYCE MERTZ-GILMORE

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA CUATRECASANA DUGAND
CURADOR: LICIO CORADIN FAMILIA: PALMAE

REGISTRO	AMBIENTE GERAL/SUBSTRATO/OBSERVACOES	RELEVO/ FREQUENCIA RELATIVA	REGIAO GEOPOLITICA/ MATERIAL COLETADO	DATA DA COLETA
BRA-000574/01	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:EXSICATAS SEMENTES	010784
	OBS:FRUTOS ARREDONDADOS. COMPRIMENTO MEDIO 12.3CM. LARGURA MEDIA 9.6CM. PESO MEDIO 618G. EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE			
BRA-000574/02	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:SEMENTES	010784
	OBS:FRUTOS ELIPTICOS. COMPRIMENTO MEDIO 13.9CM. LARGURA MEDIA 7.9CM. PESO MEDIO 474G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE			
BRA-000574/03	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:SEMENTES	010784
	OBS:FRUTOS ELIPTICOS. COMPRIMENTO MEDIO 14.1CM. LARGURA MEDA 8.3CM. PESO MEDIO 572G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE			
BRA-000574/04	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:SEMENTES	010784
	OBS:FRUTOS ELIPTICOS. COMPRIMENTO MEDIO 12.4CM. LARGURA MEDIA 7.5CM. PESO MEDIO 430G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE			
BRA-000574/05	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:SEMENTES	010784
	OBS:FRUTOS ARREDONDADOS. COMPRIMENTO MEDIO 13.9CM. LARGURA MEDIA 9.8CM. PESO MEDIO 707G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE			
BRA-000574/06	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:SEMENTES	010784
	OBS:FRUTOS ELIPTICOS. COMPRIMENTO MEDIO 14.7CM. LARGURA MEDIA 8.28CM. PESO MEDIO 581G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE			
BRA-000574/07	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:SEMENTES	010784
	OBS:FRUTOS ELIPTICOS. COMPRIMENTO MEDIO 14.7CM. LARGURA MEDIA 9.0CM. PESO MEDIO 682G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE			
BRA-000574/08	AMB:FLORESTA TROPICAL	FR: COMUM	MAT:SEMENTES	010784
	OBS:FRUTOS ELIPTICOS. COMPRIMENTO MEDIO 11.9CM. LARGURA MEDIA 8.1CM. PESO MEDIO 444G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE			

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. II. CARACTERIZACAO AMBIENTAL E MATERIAL COLETADO
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): MICHAEL J.BALICK (USA/NYBG) STEVEN KING (USA) LUIZ E.FORERO & NELLY HERNANDEZ (COLOMBIA/UNIV.NAC.)
PATROCINADOR(ES) DA COLETA: US-AID & FUNDACAO JOYCE MERTZ-GILMORE

PRODUTO: ORBIGNYA — COD.PROD.:03212 NOME CIENT.: ORBIGNYA CUATRECASANA DUGAND
CURADOR: LIDIO CORADIN — FAMILIA: PALMAE

REGISTRO	AMBIENTE GERAL/SUBSTRATO/OBSERVACOES	RELEVO/ FREQUENCIA RELATIVA	REGIAO GEOPOLITICA/ MATERIAL COLETADO	DATA DA COLETA
BRA-000574/09	AMB:FLORESTA TROPICAL			010734
	OBS:FRUTOS ARREDONDADOS. COMPRIMENTO MEDIO 11.2CM. LARGURA MEDIA 9.1CM. PESO MEDIO 450G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE	FR: COMUM	MAT:SEMENTES	
BRA-000574/10	AMB:FLORESTA TROPICAL			010734
	OBS:FRUTOS ARREDONDADOS. COMPRIMENTO MEDIO 12.9CM. LARGURA MEDIA 8.3CM. PESO 480G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE	FR: COMUM	MAT:SEMENTES	
BRA-000574/11	AMB:FLORESTA TROPICAL			010734
	OBS:FRUTOS ELIPTICOS. COMPRIMENTO MEDIO 11.2CM. LARGURA MEDIA 7.6CM. PESO MEDIO 336G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE	FR: COMUM	MAT:SEMENTES	
BRA-000574/12	AMB:FLORESTA TROPICAL			010734
	OBS:FRUTOS ELIPTICOS. COMPRIMENTO MEDIO 12.8CM. LARGURA MEDIA 7.7CM. PESO MEDIO 410G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE	FR: COMUM	MAT:SEMENTES	
BRA-000574/13	AMB:FLORESTA TROPICAL			010734
	OBS:FRUTOS ARREDONDADOS. COMPRIMENTO MEDIO 10.3CM. LARGURA MEDIA 7.9CM. PESO MEDIO 395G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE	FR: COMUM	MAT:SEMENTES	
BRA-000574/14	AMB:FLORESTA TROPICAL			010734
	OBS:FRUTOS ELIPTICOS. COMPRIMENTO MEDIO 15.4CM. LARGURA MEDIA 9.4CM. PESO MEDIO 717G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE	FR: COMUM	MAT:SEMENTES	
BRA-000574/15	AMB:FLORESTA TROPICAL			010734
	OBS:FRUTOS ARREDONDADOS. COMPRIMENTO MEDIO 13.5CM. LARGURA MEDIA 9.8CM. PESO MEDIA 725G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE	FR: COMUM	MAT:SEMENTES	
BRA-000574/16	AMB:FLORESTA TROPICAL			010734
	OBS:FRUTOS ARREDONDADOS. COMPRIMENTO MEDIO 10.7CM. LARGURA MEDIA 8.7CM. PESO MEDIO 436G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE	FR: COMUM	MAT:SEMENTES	

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. II. CARACTERIZACAO AMBIENTAL E MATERIAL COLETADO
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): MICHAEL J.BALICK (USA/NYBG) STEVEN KING (USA) LUIZ E.FORERO & NELLY HERNANDEZ (COLOMBIA/UNIV.NAC.)
PATROCINADOR(ES) DA COLETA: US-AID & FUNDACAO JOYCE MERTZ-GILMORE

PRODUTO: ORBIGNYA — COD.PROD.:03212 NOME CIENT.: ORBIGNYA CUATRECASANA DUGAND
CURADOR: LIDIO CORADIN — FAMILIA: PALMAE

REGISTRO	AMBIENTE GERAL/SUBSTRATO/OBSERVACOES	RELEVO/ FREQUENCIA RELATIVA	REGIAO GEOPOLITICA/ MATERIAL COLETADO	DATA DA COLETA
BRA-000574/17	AMB:FLORESTA TROPICAL			010784
	OBS:FRUTOS ARREDONDADOS. COMPRIMENTO MEDIO 12.5CM. LARGURA MEDIA 8.8CM. PESO MEDIO 591G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE	FR: COMUM	MAT:SEMENTES	
BRA-000574/18	AMB:FLORESTA TROPICAL			010784
	OBS:FRUTOS ARREDONDADOS. COMPRIMENTO MEDIO 12.7CM. LARGURA MEDIA 8.4CM. PESO MEDIO 438G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE	FR: COMUM	MAT:SEMENTES	
BRA-000574/19	AMB:FLORESTA TROPICAL			010784
	OBS:FRUTOS ARREDONDADOS. COMPRIMENTO MEDIO 15.1CM. LARGURA MEDIA 8.9CM. PESO MEDIO 632G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE	FR: COMUM	MAT:SEMENTES	
BRA-000574/20	AMB:FLORESTA TROPICAL			010784
	OBS:FRUTOS ARREDONDADOS. COMPRIMENTO MEDIO 12.8CM. LARGURA MEDIA 9.8CM. PESO MEDIO 704G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE	FR: COMUM	MAT:SEMENTES	
BRA-000574/21	AMB:FLORESTA TROPICAL			010784
	OBS:FRUTOS ARREDONDADOS. COMPRIMENTO MEDIO 16.3CM. LARGURA MEDIA 9.7CM. PESO MEDIO 879G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE	FR: COMUM	MAT:SEMENTES	
BRA-000574/22	AMB:FLORESTA TROPICAL			010784
	OBS:FRUTOS ARREDONDADOS. COMPRIMENTO MEDIO 14.9CM. LARGURA MEDIA 9.6CM. PESO MEDIO 710G EXPEDICAO REALIZADA COM SUPORTE FINANCEIRO DO US-AID E FUNDACAO JOYCE MERTZ-GILMORE	FR: COMUM	MAT:SEMENTES	
BRA-000809/01	AMB:FLORESTA TROPICAL			010784
		FR: COMUM	MAT:EXSICATAS SEMENTES	

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. III. DADOS COMPLEMENTARES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): MICHAEL J.BALICK (USA/NYBG) STEVEN KING (USA) LUIZ E.FORERO & NELLY HERNANDEZ (COLOMBIA/UNIV.NAC.)
PATROCINADOR(ES) DA COLETA: US-AID & FUNDACAO JOYCE MERTZ-GILMORE

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA CUATRECASANA DUGAND
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	HABITO DE CRESCIMENTO/ DESTINO(S) SUGERIDO(S)	COR DA FLOR/ COR DO FRUTO	DETERMINADOR E DATA/ NOME COMUM NO LOCAL
BRA-000574/01	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/02	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/03	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/04	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/05	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/06	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/07	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/08	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/09	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/10	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/11	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/12	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/13	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO

LISTA DE ACESSOS DE GERMOPLASMA OBTIDOS POR COLETA. III. DADOS COMPLEMENTARES
EMBRAPA/CENARGEN. BRASILIA-DF. 07-03-86.

NOME DO COLETOR(ES): MICHAEL J.BALICK (USA/NYBG) STEVEN KING (USA) LUIZ E.FORERO & NELLY HERNANDEZ (COLOMBIA/UNIV.NAC.)
PATROCINADOR(ES) DA COLETA: US-AID & FUNDACAO JOYCE MERTZ-GILMORE

PRODUTO: ORBIGNYA COD.PROD.:03212 NOME CIENT.: ORBIGNYA CUATRECASANA DUGAND
CURADOR: LIDIO CORADIN FAMILIA: PALMAE

REGISTRO	HABITO DE CRESCIMENTO/ DESTINO(S) SUGERIDO(S)	COR DA FLOR/ COR DO FRUTO	DETERMINADOR E DATA/ NOME COMUM NO LOCAL
BRA-000574/14	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/15	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/16	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/17	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/18	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/19	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/20	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/21	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000574/22	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO
BRA-000809/01	ERETO	FR:MARROM	DET:M.J.BALICK JULHO 1984 NC:COROZA. TAPARO

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APPENDIX II

Trip report: Expedition for collection of germplasm and botanical material of species of the babassu complex (Palmae Cocosoideae)

APPENDIX II
1986 Germplasm Expedition

EXPEDIÇÃO DE COLETA DE GERMOPLASMA E MATERIAL BOTÂNICO DE ESPÉCIES DO COMPLEXO BABAÇU (Palmae Cocosoideae)

ENTIDADES ENVOLVIDAS:

EMBRAPA/Unidade de Execução de Pesquisa de Âmbito Estadual de Teresina - UEPAE de Teresina

EMBRAPA/Centro Nacional de Recursos Genéticos - CENARGEN

The New York Botanical Garden - NYBG

Empresa Maranhense de Pesquisa Agropecuária - EMAPA.

RELATÓRIO DE VIAGEM

CLAUDIO URBANO BITTENCOURT PINHEIRO
Pesquisador da EMAPA

MARÇO/1986

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RELATÓRIO DE VIAGEM

1. NOME: Claudio Urbano Bittencourt Pinheiro
2. PERÍODO: 13/01 a 31/01/86
3. PROJETO: Caracterização e Avaliação de Germoplasma de Babaçu
4. ATIVIDADE: Coleta de Germoplasma e Material Botânico de *Orbignya* e *Attalea*.
5. PARTICIPANTES:
   Claudio Urbano Bittencourt Pinheiro (EMAPA)
   José Geraldo Alves Vieira (CENARGEN)
   Demétrio de Oliveira Neto (UEPAE de Teresina)
6. ÁREAS COLETADAS:

Orbignya sp - Fazenda do Sr. Joaquim, em frente a Fazenda Serra Negra - BR-242, município de Oliveira dos Brejinhos, 40 km à leste de Ibotirama-Bahia.

Attalea sp - À margem da BA-172, entre as cidades de Coripe e Cocos, à cerca de 10 km de Coripe-Bahia.

Orbignya cf *oleifera* - Fazenda Caraíba, 12 km à leste da Cidade de Cocos - Bahia.

Orbignya cf *Oleifera* - Fazenda Santa Rita, cerca de 10-12 km à oeste da cidade de Cocos, margem direita do rio Itaguari-Bahia.

Attalea sp - Br 135 km 91 - Brasilia de Minas-Minas Gerais.

Attalea sp - Br 135 12 km da cidade de Montes Claros - Minas Gerais.

Attalea sp - Br 135 12 km da cidade de Montes Claros - Minas Gerais.

Orbignya oleifera - Fazenda da Prata, cerca de 6 km à leste da cidade de Pirapora, margem direita do rio São Francisco - Minas Gerais.

Attalea sp - Br 020, cerca de 15 km da cidade de Posse Goiás.

7. TRABALHOS REALIZADOS

A primeira coleta botânica e de germoplasma de babaçu, foi realizada no dia 18.01.86, no lugar denominado pelos moradores locais, de Brejinho da Serra Negra, município de Oliveira dos Brejinhos, Estado da Bahia. O local de coleta foi a Fazenda do Sr. Joaquim, propriedade localizada à margem da Br-242, em frente à Fazenda Serra Negra, 40 km à leste de Ibotirama.

Esta área foi incluída no roteiro da excursão, em função de informações que indicavam haver ali uma formação de características especiais e que sugeririam, até mesmo, uma espécie nova.

A formação é isolada, pequena e relativamente jovem (em torno de aproximadamente 20 anos), ainda que tenham sido notados indivíduos remanescentes de uma população mais antiga. Segundo informação de morador da área, havia, muitos anos atrás, palmeiras muito mais velhas, as quais foram tombadas, para implantação de pastos e cultivos.

Os individuos dessa população apresentam características morfológicas idênticas ao babaçu típico (O. phalerata Martius), ainda que a análise realizada tenha sido "in loco", sem chegar a um maior detalhamento. Entretanto, alguns pontos chamam a atenção e determinam diferenças entre aquelas plantas e o babaçu conhecido como típico: 1) O número de estames das flores masculinas chega normalmente a 36-37; e, a cúpula do cálice dos frutos é bastante longa, atingindo, comumente, 2/3 dos frutos, o que, normalmente impede que os mesmos caiam mesmo depois de maduros, ficando assim presos nos cachos por período bastante longo, após a maturação.

A área de ocorrência era originalmente, uma caatinga, que cedeu lugar aos pastos e aos pequenos cultivos. O solo é de textura arenosa, com alguns pontos mais baixos, sujeitos à inundação periódica. Em função da pouca quantidade de palmeiras com frutos foram coletadas sementes de apenas 10 individuos e o número de frutos coletados variou de 30 a 100, por planta, segundo a disponibilidade. Foi efetuada uma coleta botânica, sob o nº 390 (J. G. Vieira e Claudio Pinheiro), coletando-se folhas, frutos, inflorescências e parte do caule. Foi retirada uma amostra do solo da

área, para análise laboratorial.

Seria interessante que essa população fosse revisitada, no futuro, para uma coleta mais completa, possivelmente, nos meses de outubro ou novembro, quando deve haver maior disponibilidade de frutos. Em virtude do seu isolamento e da sua pequena extensão é uma formação sujeita ao desaparecimento completo, em poucos anos.

A média de inflorescências masculinas por planta, obtida em 11 amostras, é de 8,7 e de femininas é de 5,5, o que corresponde à uma razão sexual média de 1,5 inflorescências masculinas para 1 feminina.

O número de cachos do ano/planta variou de 0 a 9 e a média (em 11 amostras) foi de 4 cachos.

Após a coleta de Oliveira dos Brejinhos, a equipe rumou para Cocos, também no Estado da Bahia, onde havia informações da ocorrência de babaçu, presumivelmente Orbignya oleifera Burr. No trajeto para Cocos, na BA-172, à cerca de 10 km da cidade de Coripe, foi localizada uma população de Attalea sp, onde foi efetuada a coleta botânica nº 396. Indivíduos frequentes ao longo da estrada, observando-se, também, a ocorrência abundante de Astrocaryum campestre. A Attalea ali encontrada não apresenta caule aparente, seus folíolos são agrupados em 2, 3 e 4 e crispados. Ocorrem em cerrado com latossolo vermelho amarelo.

Após a chegada à Cocos, foram mantidos os necessários contatos para realização da coleta e coleta geral de informações sobre a ocorrência do babaçu na região.

A primeira tentativa de coleta foi realizada na Fazenda Caraíba, à cerca de 12 km da cidade de Cocos, em estrada carroçável. Somente dois números foram coletados nesta área, em razão da grande dificuldade de trabalho, uma vez que o babaçu alí, localiza-se em capoeira alta, com partes da área bastante alagadas, além da escassez de frutos. A espécie ali encontrada, trata-se provavelmente de O. oleifera Burr.

Tratou-se, portanto, de seguir para a segunda área alternativa, a Fazenda Santa Rita, localizada à oeste de Cocos (10-12 km), à margem direita do rio Itaguari, trafegando-se em estrada de terra, em péssimas condições. Devido à problemas com

o veículo, a coleta foi efetuada em dois dias.

Orbignya cf. oleifera, Burr., bastante abundante às margens do rio Itaguari, ocorre em área de pastagem e mata modificada sobre solo arenoso. Nesta fazenda, foram coletados 21 números para o BAG, e efetuada uma coleta botânica sob o número 420 (sob este número, foram coletados frutos de 6 individuos, para distribuição). Apesar de apresentarem características gerais de O. oleifera, diferem no fato de apresentarem amêndoas pequenas, pouco comparáveis à O. oleifera conhecida pelo tamanho de suas amêndoas. Entretanto, as análises que deverão ser procedidas, posteriormente, confirmarão ou não, este fato.

Foram coletados cerca de 60-70 frutos, onde foi possível conseguir essa quantidade. Em geral, houve muita dificuldade na coleta dos frutos, uma vez que esta não é a época do pique de queda, exigindo que os frutos tivessem que ser derrubados com varas (em caso de palmeiras baixas) ou pelo arremesso de paus e pedras. Acredita-se que os frutos ideais para utilização como sementes, são aqueles recém-caídos, devendo-se se possível evitar a sua derrubada dos cachos. Contudo, não é aconselhável a coleta de frutos caídos que tenham permanecido no chão por mais de 1 mês, principalmente na época invernosa, pois, nesse caso, o processo germinativo já terá sido iniciado e não sendo, esses frutos postos, de imediato, em condições apropriadas para continuação da germinação, esta paralisar-se-á, inutilizando o fruto como semente.

Em 22 amostras, registrou-se a média, por planta, de 7,9 inflorescências masculinas e de 10,4 inflorescência femininas, o que leva a uma razão sexual média de 1,3 inflorescências femininas para 1 inflorescência masculina. De fato, trata-se de uma população bastante produtiva, apresentando número bastante pequeno de plantas improdutivas. O número de cachos do ano, por planta, variou de 2 a 11 a média por planta, foi de 4,49 cachos. (em 21 amostras).

Os moradores locais informaram que pouco utilizam este babaçu, salvo casos esporádicos, de uns poucos que extraem óleo para uso caseiro.

Na Br 135, km 91, município de Brasília de Minas, Esta

do de Minas Gerais, foi realizada coleta botânica em população de Attalea sp, abundante ao longo da estrada. Essa coleta recebeu o nº 421 (J.G. Vieira e Claudio Pinheiro). As plantas são bastante semelhantes àquelas coletadas em Coripe-BA e recebem o nome vernacular de Lobeiro, não tendo, entretanto, nenhuma utilização pelos habitantes locais. Não apresentam caule aparente e medem de 1 a 2,5m, ocorrendo no cerrado em latossolo.

Ainda na Br 135, à 12 km da cidade de Montes Claros foi observada nova população de Attalea sp, com características diferentes das anteriores. Foram efetuadas duas coletas sob os 422 e 423 (J.G. Vieira e Claudio Pinheiro), sendo que a de nº 422 registrou uma Attalea com caule e a de nº 423 foi dada a Attalea sem caule aparente. Esses individuos (com e sem caule) aparecem na mesma área, sendo em ambos os casos produtivos e não apresentam folhas crispadas. Fica a dúvida se serão espécies distintas ou individuos da mesma espécie, em fases distintas do seu desenvolvimento. As plantas sem caule são notávelmente mais numerosas que as com caule. Um exame morfológico mais detalhado dos espécimes botânicos, deverá elucidar a questão.

Após a coleta de germoplasma e material botânico realizada em novembro de 1984, em Pirapora, Minas Gerais, constatou-se a alta percentagem de amêndoas nos frutos, que, em termos médios, chega a 14%, o que representa o dobro do percentual dos frutos do babaçu típico (O. phalerata). Dessa forma decidiu-se incluir essa população no roteiro para uma nova coleta de sementes, mesmo porque, as manchas de ocorrência do babaçu naquela região desaparecem gradativamente, dando lugar à implantação de pastagens e cultivos.

Esta coleta foi efetuada no mesmo local da anterior, a Fazenda da Prata, à cerca de 6 km à leste da Cidade de Pirapora, na margem direita do Rio São Francisco. Não houve coleta botânica, pelo fato de que muito material botânico foi coletado na 1ª excursão àquela área, decidindo-se desta feita somente pela coleta de frutos.

Na Fazenda da Prata, o solo é de textura arenosa, nas partes mais baixas, onde ocorre a mancha de babaçu e latossolo, nas partes mais altas. É uma população relativamente pequena, mar

cadamente de ocorrência à margem do rio São Francisco e em geral, composta de palmeiras altas (em geral, mais de 8 metros). A espécie é descrita como Orbignya oleifera Burrett, cuja principal característica reside no fato de produzir amêndoas de grande tamanho e que representam percentual elevado em relação ao fruto inteiro e em comparação à outras espécies.

Nessa população foram coletados 20 números para o BAG (tomando-se, em média, 60 frutos por planta) e mais seis números adicionais coletados com o objetivo de destribuição de sementes para disseminação desse excelente material.

Tivemos que enfrentar o mesmo problema, já relatado, referente à escassez de frutos recém-caídos. Novamente foi preciso apelar para as varas e arremesso de paus e pedras para derrubada dos frutos dos cachos.

Em 26 amostras, a média de inflorescências masculinas, por planta, foi 4,7 e femininas ficou em torno de 9,3, representando uma razão sexual média de aproximadamente, 2 inflorescências femininas para uma masculina. O número de cachos do ano (também em 26 amostras) variou de 3 a 10, por planta, com média 5,8 . Esses dados só confirmam a constatação do ano anterior quanto à produtividade dessa população.

Para definição das áreas de ocorrência de O. oleifera (comumente chamada Coco Palmeira, pelos habitantes locais) às margens do rio São Francisco, no dia posterior à coleta, realizou-se viagem de barco, navegando-se cerca 20-25 km rio abaixo. Constatou-se o desaparecimento dos babaçuais às margens do rio, hoje, práticamente ocupadas pelas pastagens e em casos menos frequentes, pelos cultivos. A maior mancha nesse trecho, localiza-se na área da Fazenda da Prata e na área da Companhia de Desenvolvimento do Vale do Rio São Francisco - CODEVASF. No mais, a ocorrência é muito esporádica e reduzida, levando-nos a crer no desaparecimento completa dessa espécie, a curto prazo, naquela região.

A última coleta botânica foi procedida sob o número 452 (J.G. Vieira e Claudio Pinheiro) na BA-020, à cerca de 15 km da cidade de Posse, Estado de Goiás. Trata-se de uma população de Attalea sp. denominada vernacularmente "coco de caroço só" e que é, provávelmente a mesma espécie coletada em Coripe-BA e Brasília de Minas-MG.

Sugerimos que as próximas excursões sejam mantidas nos meses de outubro e/ou novembro, pelos problemas que já relatamos referentes à dificuldade na obtenção de frutos recém caidos, bem como pelo fato de que nos meses de férias escolares, é muito grande o fluxo de turistas, o que traz sempre problemas para alojamento da equipe.

ANEXO: 1

DADOS DO GERMOPLASMA COLETADO

Localização da população: Fazenda do Sr. Joaquim, em frente à Fazenda Serra Negra, BR-242, Município de Oliveira dos Brejinhos, 40 km à leste de Ibotirama - Estado da Bahia.

Ambiente geral: Caatinga modificada. Pastagem e cultivos-Solo arenoso.

Nº 385 Data da Coleta: 18.01.86

Nome Científico: Orbignya sp
Nome comum local: Coco Palmeira
Altura aproximada: 6,0m
DAP: 33cm
Nº de Cachos do Ano: 04
Nº de Cachos Velhos: 0
Nº de inflor. masc. velhas: 06
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 16
Razão sexual: 6M x 04F

Nº 386 Data da coleta: 18.01.86

Nome científico: Orbignya sp
Nome comum local: Coco Palmeira
Altura aproximada: 5,5m
DAP: 30cm
Nº de cachos do Ano: 02
Nº de cachos velhos: 02
Nº de inflor. masc. velhas: 07
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 15
Razão sexual: 07M x 04F
Obs: 01 bractea fechada.

Nº 387 Data da coleta: 18.01.86

Nome científico: Orbignya sp
Nome comum local: Coco Palmeira
Altura aproximada: 6,0m
DAP: 35,5cm
Nº de cachos do ano: 01
Nº de cachos velhos: 02
Nº de inflor. masc. velhas: 07
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 15
Razão sexual: 07M x 03F

Nº 388 Data da coleta: 18.01.86

Nome científico: Orbingya sp
Nome comum local: Coco Palmeira
Altura aproximada: 6,5m
DAP: 47,5cm
Nº de cachos do ano: 09
Nº de cachos velhos: 01
Nº de inflor. masc. velhas: 04
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 22
Razão sexual: 04M x 10F
Obs: Foram coletados 2 cachos deste indivíduo, sob os números 388-1 e 388-2.

Nº 389 Data da coleta: 18.01.86

Nome científico: Orbignya sp
Nome comum local: Coco Palmeira
Altura aproximada: 5,0m
DAP: 48cm
Nº de cachos do ano: 05
Nº de cachos velhos: 01

Nº de inflor. masc. velhas: 12
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 01
Nº de folhas: 18
Razão sexual: 12M x 07F

Nº 390 Data da coleta: 18.01.86

Nome científico: Orbignya sp
Nome comum local: Coco Palmeira
Altura aproximada: 4,0m
DAP: 61 cm (Caule ainda subterrâneo)
Nº de cachos do Ano: 0
Nº de cachos velhos: 0
Nº de inflor. masc. velhas: 06
Nº de inflor. masc. novas: 01
Nº de inflor. femin. novas: 0
Nº de folhas: 22
Razão sexual: 07M x 0F
Obs: Coleta Botânica - Folhas, flores, frutos e caule.

Nº 391 Data da coleta: 18.01.86

Nome cientifico: Orbignya sp
Nome comum local: Coco Palmeira
Altura aproximada: 5,0m
DAP: 44,7cm
Nº de cachos do ano: 08
Nº de cachos velhos: 01
Nº de inflor. masc. velhas: 13
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 19
Razão sexual: 13M x 09F

Nº 392 Data da coleta: 18.01.86

Nome cientifico: Orbignya sp
Nome comum local: Coco Palmeira

Altura aproximada: 6,5m
DAP: 42,6 cm
Nº de cachos do ano: 03
Nº de cachos velhos: 01
Nº de inflor. masc. velhas: 10
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 21
Razão sexual: 10M x 04F

Nº 393 Data da coleta: 18.01.86

Nome científico: Orbignya sp
Nome comum local: Coco Palmeira
Altura aproximada: 6,0m
DAP: 43,2 cm
Nº de cachos do ano: 04
Nº de cachos velhos: 02
Nº de inflor. masc. velhas: 11
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 23
Razão sexual: 11M x 06F

Nº 394 Data da coleta: 18.01.86

Nome científico: Orbignya sp
Nome comum local: Coco Palmeira
Altura aproximada: 4,0m
DAP: 47 cm
Nº de cachos do ano: 06
Nº de cachos velhos: 02
Nº de inflor. masc. velhas: 09
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 01
Nº de folhas: 23
Razão sexual: 09M x 09F

Nº 395 Data da coleta: 18.01.86

Nome científico: Orbignya sp
Nome comum local: Coco Palmeira
Altura aproximada: 5,0m
DAP: 52cm
Nº de cachos do ano: 03
Nº de cachos velhos: 01
Nº de inflor. masc. velhas: 10
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 01
Nº de folhas: 22
Razão sexual: 10M x 05F

Localização da população: À margem da BA-172, entre as cidades de Coripe e Cocos, à cerca de 10 km de Coripe-Estado da Bahia
Ambiente Geral: Cerrado com Latossolo Vermelho amarelo.

Nº 396 Data da coleta: 19.01.86

Nome científico: Attalea sp
Nome comum local:
Planta sem caule aparente:
Altura aproximada: 1m
Obs: Coleta Botânica (Folhas e inflorescências)

Localização da população: Fazenda Caraíba, 12km à leste da cidade de Cocos-Estado da Bahia.
Ambiente geral: Capoeira com solo areno-argiloso

Nº 397 Data da coleta: 20.01.86

Nome Científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 7,0m
DAP: 33cm
Nº de cachos do ano: 01

Nº de cachos velhos: 01
Nº de inflor. masc. velhas: 06
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 17
Razão sexual: 06M x 02F

Nº 398 Data da coleta: 20.01.86

Nome científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 6,0m
DAP: 33cm
Nº de cachos do ano: 01
Nº de cachos velhos: 01
Nº de inflor. masc. velhas: 02
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 15
Razão sexual: 02M x 02F

Localização da população: Fazenda Santa Rita, cerca de 10-12 km à oeste da cidade de Cocos, margem direita do rio Itaguari - Estado da Bahia.
Ambiente geral: Pastagem e mata modificada com solo arenoso.

Nº 399 Data da coleta: 20.01.86

Nome científico: Orbigyna cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 10m
DAP: 41cm
Nº de cachos do ano: 10
Nº de cachos velhos: 8
Nº de inflor. masc. velhas: 12
Nº de inflor. masc. novas: 01
Nº de inflor. femin. novas: 0

Nº de folhas: 20
Razão sexual: 13M x 18F

Nº 400 Data da coleta: 20.01.86

Nome científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 7,0m
DAP: 33cm
Nº de cachos do ano: 04
Nº de cachos velhos: 04
Nº de inflor. masc. velhas: 11
Nº de inflor. Masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 21
Razão sexual: 11M x 08F

Nº 401 Data da coleta: 20.01.86

Nome científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 7,0m
DAP: 35,5cm
Nº de cachos do ano: 05
Nº de cachos velhos: 04
Nº de inflor. masc. velhas: 10
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 19
Razão sexual: 10M x 09F

Nº 402 Data da coleta: 20.01.86

Nome científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 6,5m
DAP: 35,5 cm
Nº de cachos do ano: 04
Nº de cachos velhos: 03

Nº de inflor. masc. velhas: 08
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 20
Razão sexual: 08M x 07F

Nº 403 Data da coleta: 20.01.86

Nome cientifico: Orbignya cf. oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 8,5m
DAP: 34,7cm
Nº de cachos do ano: 11
Nº de cachos velhos: 06
Nº de inflor. masc. velhos: 04
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 19
Razão sexual: 04M x 17F

Nº 404 Data da coleta: 20.01.86

Nome científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 8,5m
DAP: 37cm
Nº de cachos do ano: 05
Nº de cachos velhos: 04
Nº de inflor. masc. velhas: 06
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 18
Razão Sexual: 06M x 09F
Obs: 01 bractea fechada.

Nº 405 Data da coleta: 20.01.86

Nome científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira

Altura aproximada: 7,0m
DAP: 37cm
Nº de cachos do ano: 08
Nº de cachos velhos: 06
Nº de inflor. masc. velhas: 05
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 18
Razão sexual: 05M x 14F

Nº 406 Data da coleta: 20.01.86

Nome científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 10m
DAP: 38cm
Nº de cachos do ano: 04
Nº de cachos velhos: 10
Nº de inflor. masc. velhas: 08
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 01
Nº de folhas: 20
Razão sexual: 08M x 15F
Obs: 01 bractea fechada.

Nº 407 Data da coleta: 20.01.86

Nome Científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 9,0m
DAP: 31,8 cm
Nº de cachos do ano: 04
Nº de cachos velhos: 10
Nº de inflor. masc. velhas: 08
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 17
Razão sexual: 08M x 14F
Obs: 01 bractea fechada

Nº 408 Data da coleta: 20.01.86

Nome científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 7,5m
DAP: 43,2cm
Nº de cachos do ano: 06
Nº de cachos velhos: 06
Nº de inflor. Masc. velhas: 10
Nº de inflor. Masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 21
Razão sexual: 10M x 12F

Nº 409 Data da coleta: 20.01.86

Nome científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 4,0m
DAP: 49cm
Nº de cachos do ano: 03
Nº de cachos velhos: 03
Nº de inflor. masc. velhas: 08
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 01
Nº de folhas: 16
Razão sexual: 08M x 07F

Nº 410 Data da coleta: 20.01.86

Nome científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 8,0m
DAP: 38cm
Nº de cachos do ano: 02
Nº de cachos velhos: 06
Nº de inflor. masc. velhas: 08
Nº de inflor. masc. novas: 01
Nº de inflor. femin. novas: 0

Nº de folhas: 20
Razão sexual: 09M x 08F

Nº 411 Data da coleta: 21.01.86

Nome científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 8,5m
DAP: 32,2cm
Nº de cachos do ano: 03
Nº de cachos velhos: 07
Nº de inflor. masc. velhas: 05
Nº de inflor. masc. novas: 01
Nº de inflor. femin. novas: 0
Nº de folhas: 20
Razão sexual: 06M x 10F

Nº 412 Data da coleta: 21.01.86

Nome Científico: Orbignya cf. oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 4,0m
DAP: 46,6cm
Nº de cachos do ano: 03
Nº de cachos velhos: 01
Nº de inflor. masc. velhas: 04
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 18
Razão sexual: 04M x 04F

Nº 413 Data da coleta: 21.01.86

Nome científico: Orbignya cf. oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 4,0m
DAP: 45,9cm
Nº de cachos do ano: 05
Nº de cachos velhos: 08

Nº de inflor. masc. velhas: 05
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 01
Nº de folhas: 24
Razão sexual: 05M x 14F

Nº 414 Data da coleta: 21.01.86

Nome científico: Orbignya cf. oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 6,0m
DAP: 47,8cm
Nº de cachos do ano: 09
Nº de cachos velhos: 07
Nº de inflor. masc. velhas: 09
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 01
Nº de folhas: 22
Razão sexual: 09M x 17F

Nº 415 Data da coleta: 21.01.86

Nome científico: Orbignya cf. oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 5,5m
DAP: 39cm
Nº de cachos do ano: 05
Nº de cachos velhos: 04
Nº de inflor. masc. velhas: 08
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 01
Nº de folhas: 22
Razão sexual: 08M x 10F

Nº 416 Data da coleta: 21.01.86

Nome Científico: Orbignya cf. oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 5,0m

DAP: 30,8cm
Nº de cachos do Ano: 03
Nº de cachos velhos: 02
Nº de inflor. masc. velhas: 09
Nº de inflor. masc. novas: 01
Nº de inflor. femin. novas: 0
Nº de folhas: 24
Razão sexual: 10M x 05F

Nº 417 Data da coleta: 21.01.86

Nome científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 5,0m
DAP: 34,6cm
Nº de cachos do ano: 02
Nº de cachos velhos: 04
Nº de inflor. Masc. velhas: 07
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 22
Razão sexual: 07M x 06F

Nº 418 Data da coleta: 21.01.8

Nome científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 9,0m
DAP: 32cm
Nº de cachos do ano: 03
Nº de cachos velhos: 06
Nº de inflor. masc. velhas: 08
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 18
Razão sexual: 08M x 09F

Nº 419 Data da coleta: 21.01.86

Nome científico: Orgignya cf. oleifera Burr.

Nome comum local: Coco Palmeira
Altura aproximada: 6,0m
DAP: 30cm
Nº de cachos do ano: 05
Nº de cachos velhos: 07
Nº de inflor. masc. velhas: 12
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 18
Razão sexual: 12M x 12F

Nº 420 Data da coleta: 21.01.86

Nome científico: Orbignya cf. oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 8,0m
DAP: 34cm
Nº de cachos do ano: 0
Nº de cachos velhos: 03
Nº de inflor. masc. velhas: 06
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 01
Nº de folhas: 18
Razão sexual: 06M x 04F
Obs: Coleta Botânica (Folhas, flores, frutos e caule). Sob este número foram coletados frutos de 6 plantas, para distribuição.

Localização da população: BR-135 km 91 - Município de Brasília de Minas - Estado de Minas Gerais.
Ambiente Geral: Cerrado com latossolo vermelho amarelo.

Nº 421 Data da coleta: 22.01.86

Nome científico: Attalea sp
Nome Comum local: Lobeiro
Altura aproximada: 1,0 a 2,5m (planta sem caule aparente)

Nº de cachos do ano: 01
Nº de cachos velhos: 01
Nº de inflor. masculinas: 1 - 3
Nº de inflor. femininas: 1 - 2
Nº de folhas: 5 - 10
Obs: Coleta Botânica (Folhas, flores e frutos)

Localização da População: BR-135 - 12km da cidade de Montes Claros - Estado de Minas Gerais.
Ambiente Geral: Cerradão modificado

Nº 422 Data da coleta: 23.01.86

Nome científico: Attalea sp
Nome comum local:
Altura aproximada: 3,0m
DAP: 21cm
Nº de cachos ao ano: 04
Nº de cachos velhos: 10
Nº de inflor. masc. velhas: 09
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 14
Razão sexual: 09M x 14F
Obs: Coleta Botânica (Folhas, Flores e Frutos)

Nº 423 Data da coleta: 23.01.86

Nome científico: Attalea sp
Nome comum local:
Altura aproximada: 2m (sem caule aparente)
Nº de folhas: 09
01 bractea fechada - inflorescência masculina.
Obs: Coleta Botânica (Folhas e flores)

Localização da população: Fazenda da Prata - cerca de 6km à leste da cidade de Pirapora, à margem di

reita do rio São Francisco - Estado de Minas Gerais.

Ambiente Geral: Pastagem e cerrado modificado com solo arenoso.

Nº 426 Data da Coleta: 24.01.86

Nome científico: Orbignya oleifera Burr.

Nome comum local: Coco Palmeira

Altura aproximada: 8,0m

DAP: 34,5cm

Nº de cachos do ano: 08

Nº de cachos velhos: 04

Nº de inflor. masc. velhas: 06

Nº de inflor. masc. novas: 0

Nº de inflor. femin. novas: 0

Nº de folhas: 16

Razão Sexual: 06M x 12F

Nº 427 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr.

Nome comum local: Coco Palmeira

Altura aproximada: 10,5m

DAP: 37,6 cm

Nº de cachos do ano: 07

Nº de cachos velhos: 05

Nº de inflor. masc. velhas: 04

Nº de inflor. masc. novas: 0

Nº de inflor. femin. novas: 01

Nº de folhas: 17

Razão sexual: 04m x 13F

Nº 428 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr

Nome comum local: Coco Palmeira

Altura aproximada: 8,0m

Nº de cachos do ano: 06

Nº de cachos velhos: 02

Nº de inflor.masc. velhas: 03
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 01
Nº de folhas: 21
Razão sexual: 03M x 09F

Nº 429 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 7,5m
DAP: 39cm
Nº de cachos do ano: 07
Nº de cachos velhos: 0
Nº de inflor. masc. velhas: 04
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 20
Razão sexual: 04M x 07F

Nº 430 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 6,0m
DAP: 37,2 cm
Nº de cachos do ano: 04
Nº de cachos velhos: 01
Nº de inflor. masc. velhas: 09
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 01
Nº de folhas: 19
Razão sexual: 09M x 06F

Nº 431 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 9,0m

DAP: 36cm
Nº de cachos do ano: 10
Nº de cachos velhos: 02
Nº de inflor. masc. velhas: 03
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 21
Razão sexual: 03M x 12F

Nº 432 Data de coleta: 24.01.86

Nome científico: Orbignya oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 15m
DAP: 45cm
Nº de cachos do ano: 06
Nº de cachos velhos: 06
Nº de inflor. masc. velhas: 04
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 21
Razão sexual: 04M x 12F

Nº 433 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 8,0m
DAP: 36,8cm
Nº de cachos do ano: 05
Nº de cachos velhos: 01
Nº de inflor. masc. velhas: 05
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 22
Razão sexual: 05M x 06F

Nº 434 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr

Nome comum local: Coco Palmeira
Altura aproximada: 14m
DAP: 40 cm
Nº de cachos do ano: 03
Nº de cachos velhos: 02
Nº de inflor. masc. velhas: 08
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 22
Razão sexual: 08M x 05F

Nº 435 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 10m
DAP: 38,4 cm
Nº de cachos do ano: 08
Nº de cachos velhos: 04
Nº de inflor. masc. velhas: 04
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 23
Razão sexual: 04M x 12F

Nº 436 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 6,0m
DAP: 44,2cm
Nº de cachos do ano: 06
Nº de cachos velhos: 04
Nº de inflor. masc. velhas: 03
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 19
Razão sexual: 03M x 10F

Nº 437 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 3,0m
DAP: 40,1 cm
Nº de cachos do ano: 05
Nº de cachos velhos: 04
Nº de inflor. masc. velhos: 02
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 20
Razão sexual: 02M x 09F

Nº 438 Data da coleta: 24:01.86

Nome científico: Orbignya oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 7,5m
DAP: 44,5cm
Nº de cachos do ano: 10
Nº de cachos velhos: 09
Nº de inflor. masc. velhas: 03
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 02
Nº de folhas: 24
Razão Sexual: 03M x 21F

Nº 439 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 8,0m
DAP: 42cm
Nº de cachos do ano: 05
Nº de cachos velhos: 07
Nº de inflor. masc. velhas: 02
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0

Nº de folhas: 19
Razão sexual: 02M x 21F

Nº 440 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 8,0m
DAP: 46,5cm
Nº de cachos do ano: 06
Nº de cachos velhos: 03
Nº de inflor. masc. velhas: 03
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 22
Razão sexual: 03M x 09F

Nº 441 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 7,5m
DAP: 37,2 cm
Nº de cachos do ano: 03
Nº de cachos velhos: 02
Nº de inflor. masc. velhas: 05
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 15
Razão sexual: 05M x 05F

Nº 442 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 6,5m
DAP: 32,3cm
Nº de cachos do ano: 06
Nº de cachos velhos: 03

Nº de inflor. masc. velhas: 06
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 01
Nº de folhas: 21
Razão sexual: 06M x 10F

Nº 443 Data da coleta: 24.01.86

Nome científico: Orbi_ya oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 7,5m
DAP: 40,2cm
Nº de cachos do ano: 07
Nº de cachos velhos: 07
Nº de inflor. masc. velhas: 03
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 22
Razão sexual: 03M x 14F

Nº 444 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 7,0m
DAP: 34cm
Nº de cachos do ano: 08
Nº de cachos velhos: 02
Nº de inflor. masc. velhas: 05
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 01
Nº de folhas: 25
Razão sexual: 05M x 11F

Nº 445 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 9,0m

DAP: 38cm
Nº de cachos do ano: 05
Nº de cachos velhos: 03
Nº de cachos masc. velhas: 06
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 01
Nº de folhas: 22
Razão sexual: 06M x 09F

Nº 446 Data da coleta: 24.01.86

Nome científico: Orbignya oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 9,0m
DAP: 42,5cm
Nº de cachos do ano: 06
Nº de cachos velhos: 04
Nº de inflor. masc. velhas: 05
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 26
Razão sexual: 05M x 10F
Obs: Germoplasma para distribuição

Nº 447 Data da coleta: 25.01.86

Nome científico: Orbignya oleifera Burr.
Nome comum local: Coco Palmeira
Altura aproximada: 14m
DAP: 31,5cm
Nº de cachos do ano: 03
Nº de cachos velhos: 01
Nº de inflor. masc. velhas: 05
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 23
Razão sexual: 05M x 04F
Obs: germoplasma para distribuição.

Nº 448 Data da coleta: 25.01.86

Nome científico: Orbignya oleifera Burr

Nome comum local: Coco Palmeira

Altura aproximada: 7,0m

DAP: 34cm

Nº de cachos do ano: 08

Nº de cachos velhos: 02

Nº de inflor. masc. velhas: 02

Nº de inflor. masc. novas: 01

Nº de inflor. femin. novas. 0

Nº de folhas: 20

Razão sexual: 03M x 10F

Obs: Germoplasma para distribuição.

Nº 449 Data da coleta: 25.01.86

Nome científico: Orbignya oleifera Burr.

Nome comum local: Coco Palmeira

Altura aproximada: 7,0m

DAP: 37,5cm

Nº de cachos do ano: 03

Nº de cachos velhos: 01

Nº de inflor. masc. velhas: 06

Nº de inflor. masc. novas: 0

Nº de inflor. femin. novas: 0

Nº de folhas: 19

Razão sexual: 06M x 04F

Nº 450 Data da coleta: 25.01.86

Nome científico: Orbignya oleifera Burr

Nome comum local: Coco Palmeira

Altura aproximada: 6,5m

DAP: 34,6cm

Nº de cachos do ano: 03

Nº de cachos velhos: 01

Nº de inflor. masc. velhas: 08

Nº de inflor. masc. novas: 0

Nº de inflor. femin. novas: 0
Nº de folhas: 23
Razão sexual: 08M x 04F
Obs: Germoplasma para distribuição.

Nº 451 Data da coleta: 25.01.86

Nome científico: Orbignya oleifera Burr
Nome comum local: Coco Palmeira
Altura aproximada: 8,0m
DAP: 36cm
Nº de cachos do ano: 05
Nº de cachos velhos: 03
Nº de inflor. masc. velhas: 07
Nº de inflor. masc. novas: 0
Nº de inflor. femin. novas: 0
Nº de folhas: 22
Razão sexual: 07M x 08F
Obs: germoplasma para distribuição

Localização da população: BA -020, cerca de 15 km da cidade de Posse - Estado de Goiás.
Ambiente geral: Cerrado

Nº 452 Data da coleta: 30.01.86

Nome científico: Attalea sp
Nome comum local: Coco caroço só
Altura aproximada: 1-2m
Nº de folhas: 2-6
Nº de frutos/cachos: 5
Obs: Coleta Botânica (Folhas, Flores).

COLETAS BOTÂNICAS

Orbignya sp

Nº 390

José Geraldo Vieira e Claudio Pinheiro

Data: 18.01.86

Local de coleta: Fazenda do Sr. Joaquim, próximo à Fazenda Serra Negra, município de Oliveira dos Brejinhos, 40 km à leste de Ibotirama, Estado da Bahia, Brasil.

Área de caatinga modificada com pastagem e cultivos. Formação isolada. Solo arenoso. Relevo plano. Cerca de 500m de altitude.

Nome comum local: Coco Palmeira

Planta Jovem: Altura - 4,0 metros

DAP - 61cm

Nº de cachos novos - 0

Nº de cachos velhos - 0

Nº de inflorescências masculina velhas - 06

Nº de inflorescências masculina novas - 01

Nº de inflorescências femininas novas - 0

Nº de folhas: 22

01 bractea fechada

Bainha da folha - 70 cm x 37 cm

Peciolo: 0 - 10cm

Folha nº 1 = Ráquis: 6,6m

Nº de pinas por lado = 175

Comprimento Base = 1,64m x 0,7cm
Meio = 1,39m x 4,5cm
Ápice= 47,6cm x 1,4cm

Folha nº 2 = Ráquis: 6,6m

Nº de pinas por lado: 176

Comprimento: Base = 1,27m x 0,7cm
Meio = 1,32m x 4,4cm
Ápice= 43,1cm x 1,3cm

Folha nº 3 = Ráquis: 6,5m

Nº de pinas por lado = 181

Comprimento: Base = 1,65m x 1,1cm
Meio = 1,32m x 4,7cm
Ápice = 41,9 cm x 1,1cm

Planta jovem: Inflorescência masculina:

Bráctea - 1,9m x 20cm

Bico - 15 cm

Pedúnculo - 86cm

Ráquis - 85cm

Rachillae - Comprimento = Base - 22,5cm
Meio - 19,0cm
Ápice- 16,0cm

Nº de rachillae -251

Planta adulta: Altura - 8,0 metros

Tomento branco na face abaxial da folha.

Flores amarelas

Inflorescência masculina:

Bractea = 2,5m x 25cm
Bico: 25cm
Pedúnculo - 74cm
Raquis= 1,28m
Rachillae - Base = 31 cm
Meio = 23,5 cm
Ápice = 20 cm

Nº de rachillae - 303

Cacho feminino com 103-114 frutos.

Cacho nº 2 - Pedúnculo - 1,05m

Ráquis - 1,07m

Nº de frutos - 85

Inflorescência masculina: Pedúnculo - 70cm

Ráquis - 86cm

Nº de rachillae - 297

Comprimento das rachillae:

da base: 27cm

do meio: 18,5cm

do ápice: 14,5cm

Bráctea (1) - 1,92 x 18,5cm

(2) - 2,00 x 29,5cm

Bico da bráctea (1) - 16cm

(2) - 14cm

Orbignya cf. oleifera Burrett

Nº 420

José Geraldo Vieira e Claudio Pinheiro

Data: 21.01.86

Local de coleta: Fazenda Santa Rita, 10-12 km à oeste de Cocos, margem direita do rio Itaguari, Estado da Bahia, Brasil.

Área de mata modificada com pastagem. Formação abundante às margens do rio. Solo arenoso. Relevo levemente ondulado - cerca de 600m de altitude.

Nome comum local: Coco Palmeira

Altura: 6,0m

DAP: 34cm

Nº de cachos novos: 0

Nº de cachos velhos: 03

Nº de inflorescências masculinas velhas: 06

Nº de inflorescências masculinas novas: 0

Nº de inflorescências femininas novas: 01

Nº de folhas: 18

Folha nº 1 - Ráquis: 6,7m
Pecíolo: 0-10cm
Bainha: 1m x 30cm
Pina - Base: 1,25m x 1,1cm
Meio: 1,14m x 3,8cm
Ápice: 46cm x 1,7cm
Nº de pinas por lado: 200

Folha nº 2 - Ráquis: 6,6m
Pecíolo: 0
Bainha: 1m x 30cm
Pina - Base: 1,17m x 1,1cm
meio: 1,17m x 4,2cm
Ápice: 58cm x 0,9cm
Nº de pinas por lado: 195

Cacho nº 1 - Pedúnculo - 78cm
Ráquis - 1,07m
Nº de frutos - 94

Attalea sp

Nº 421

José Geraldo Vieira e Claudio Pinheiro

Data: 22.01.86

Local de coleta: Rodovia BR-135, Km 91, município de Brasília de Minas, Estado de Minas Gerais, Brasil.

Área de cerrado em latossolo vermelho - amarelo - Formação abundate. Relevo ondulado.

Nome comum local: Lobeiro

Planta sem caule aparente.

Folhas maiores (1) Nº de pinas por lado: 102
Ráquis: 2,20m
Pecíolo: 25cm
(2) Nº de pinas por lado: 84
Ráquis - 1,20m
Pecíolo - 20cm

Folha menor - Nº de pinas por lado: 64
comprim. da pina - Base: 43cm x 2,0cm
Meio: 32cm x 3,0cm
Ápice: 14cm x 0,5cm

Bráctea (1) - Comprimento - 45cm
Circunferência - 13cm
Bico - 13cm
(2) - Comprimento - 60cm
circunferência - 18cm
Bico - 7cm
(3) - Comprimento - 69cm
Circunferência - 14,5cm
Bico - 8cm
/4) - Comprimento - 60cm
circunferência - 9,5cm
Bico - 9,0cm

Inflorescência feminina - comprimento: 35cm
Ráquis - 17cm
Pedúnculo - 18cm

Abaixo do pedúnculo - 9 brácteas, medindo 5cm x 3cm

Cacho com frutos - Comprimento: 49cm

Ráquis - 14cm

Pedúnculo - 35cm

Frutos: 7,5cm x 6,5cm

Albuns cachos com 2-3 frutos, somente - 01 cacho com 11 frutos.

cpt.

Attalea sp

Nº 422

José Geraldo Vieira e Claudio Pinheiro

Data: 23.01.86

Local de coleta: BR-135, 12 km da cidade de Montes Claros, margem direita da rodovia, município de Montes Claros, Estado de Minas Gerais, Brasil.

Área de cerradão modificado. Latossolo. Relevo ondulado. Formação pouco frequente - cerca de 1.100m de altitude.

Altura - 3,0m (Outros individuos na área com caule a partir de 0,5m)

DAP: 21cm

Nº de cachos novos -04

Nº de cachos velhos - 10

Nº de inflor. masc. velhas -09

Nº de inflor. masc. novas - 0

Nº de inflor. femin. novas - 0

Nº de folhas - 14

Folha - Bainha: 1,05m x 20cm

Pecíolo: 30cm

Ráquis: 2,10m - 2,00m

Nº de folíolos por lado - 124 - 105

Comprimento de pina (1) - Base: 80cm x 0,7cm

Meio: 75cm x 1,09cm

Ápice: 8,0cm x 0,2cm

(2) - Base: 42cm x 1,0cm

Meio: 55cm x 3,4cm

Ápice: 15cm x 0,2cm

Muitas folhas cortadas em quase todos os indivíduos

Inflorescência feminina - Pedúnculo - 25 cm

Ráquis - 25cm

34 fores.

Cacho - Pedúnculo - 25cm

Ráquis - 35cm

Nº de frutos - 68

Pequenas brácteas medindo 3-7cm x 3cm de largura no pedúnculo.

Bráctea de inflor. feminina - Comprimento: 60cm
Circunferência: 14cm
Bico: 10cm

Bráctea de inflor. masculina - comprimento: 70cm
Circunferência: 22cm
Bico: 10cm

Inflorescência masculina - Pedúnculo: 25cm
Ráquis: 30cm
Comprim. de rachillae - 7 a 9 cm
Nº de rachillae por lado - 78

Attalea sp

Nº 423

José Geraldo Vieira e Claudio Pinheiro

Data: 23.01.86

Local de coleta: Rodovia BR-135, 12 km da cidade de Montes Claros, margem direita da rodovia, município de Montes Claros, Estado de Minas Gerais, Brasil

Área de cerradão modificado. Latossolo - Relevo ondulado. Formação frequente. Cerca de 1.100m de altitude.

Planta sem caule aparente

Altura: 2,0m

Nº de folhas: 09

Folha (1) - Pecíolo - 50cm
Ráquis - 2,25m
Nº de pinas por lado - 72
Comprimento de pina - Base - 90cm x 1,02cm
Meio - 65cm x 4,0cm
Ápice- 12 cm x 4,0mm

(2) - Pecíolo - 40cm
Ráquis - 2,05m
Nº de pinas por lado - 86
Comprimento de pina - Base - 95cm x 2,0cm
Meio - 77cm x 3,3cm
Ápice - 15cm x 0,3cm

Inflorescência masculina - Pedúnculo - 15cm
Ráquis - 25cm
Comprimento - rachilla - 3-5cm
Nº de rachilla - 71

Brâctea - Comprimento - 40cm
Circunferência - 22cm
Bico - 8 cm

Attalea sp

Nº 452

José Geraldo Vieira e Claudio Pinheiro

Data: 30.01.86

Local de coleta: BR-020 - Cerca de 15 km da cidade de Posse, município de Posse, Estado do Goiás.

Área de cerrado. Formação abundante. Relevo plano.

Planta sem caule aparente

Altura: 1-2m

Nº de folhas: 2-6

Folha - Nº de pinas por lado - 73

Ráquis - 1,5m

Pecíolo - 10cm

Cacho - Nº de frutos - 5

Erythroxylum

Nº 424

José Geraldo Vieira e Claudio Pinheiro

Data: 23.01.86

Local de coleta: Rodovia BR-135, 12 km da cidade de Montes Claros, margem direita da rodovia, município de Montes Claros, Estado de Minas Gerais, Brasil

Área de cerradão modificado com pastagem. Latossolo. Relevo ondulado. Relativamente frequente. Cerca de 1.100m de altitude. Planta arbustiva, aproximadamente 1m de altura, frutos vermelhos. Hábito de crescimento ereto.

GERMPLASM TRIP Report 1984

Institute of Economic Botany
The New York Botanical Garden
Bronx, New York 10458-9980 (212) 220-8700

IEB

ORBIGNYA GERM PLASM COLLECTING TRIP TO COLOMBIA

JULY-AUGUST, 1984

TRIP REPORT

PARTICIPANTS: Michael J. Balick
Steven King
Luis E. Forero P.
Nelly Hernandez

Sponsored by: U.S. Agency for International Development
Joyce Mertz-Gilmore Foundation

5 September, 1984

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OBJECTIVES

The objectives of the trip made to Colombia during July-August 1984 were as follows:

1. Collection of germ plasm of *Orbignya cuatrecasana* (Corozo, Taparo Palm) on the Western Pacific Coast of Colombia. This is a trunkless palm which yields large panicles of oil-rich furit.

2. Documentation of the living collections with herbarium specimens and other preserved material.

3. Collection of plants associated with *Orbignya cuatrecasana* and other information to help understand the ecology of the habitats of the palms.

4. Collection of roots and other material associated with the rhizosphere for identification of mycorrhizae.

5. Strengthening of professional relationships between the United States - Colombian individuals and institutions.

6. Training of local counterparts in field methodology of palm germ plasm and herbarium collection.

PARTICIPANTS

Michael J. Balick/USA

Steven King/USA

Luis E. Forero P./COLOMBIA

Nelly Hernandez/COLOMBIA

IMPLEMENTATION

The team assembled in Medellin, Colombia during the first week of July, 1984. The New York Botanical Garden and Jardin Botanico Joaquin Antonio Uribe have recently signed a contract of collaboration which facilitates botanical fieldwork for NYBG scientists in that country. The arrangement includes, among other items, a commitment by visiting NYBG scientists to deposit one-half of their collections in Medellin, which serves to improve the local herbarium and strengthen its exchange program.

The group next went to Cali to meet with Victor Manuel Patiño, Director of INCIVA (Instituto Vallecaucano de Investigaciones Cientificas) who is a noted authority on the useful palms of Colombia. Dr. Patiño had recommended three sites for collection and study on the Pacific Coast: 1)Buenaventura, 2) Tumaco and 3) Quibdo.

Puerto Patiño

The group proceeded to Puerto Calima, (Puerto Patiño), a small town on the Rio Calima in the Buenaventura region. This site is also referred to as Bajo Calima. Thanks to local authorities, facilities were made available at a small agricultural research outpost 20 minutes upriver from Puerto Calima by motorized launch. The area is primarily tropical forest, approximately 35 meters above sea level. During the five days spent at this site 22 accessions of viable Orbignya germ plasm from 22 trees were made, totalling some 225 fruits. Data on fruit size and weight is included in this report. The palms (here called Taparo) are found in very moist muddy habitats such as along small streams or in swampy areas. Several herbarium collections were made of these palms, as well as the associated vegetation. There is a great variety in the fruits -- in size and weight -- in this region. Some germplasm accessions consisted of only a few fruits while others included a dozen or more. The Orbignya fruit is a prized food for forest animals, as well as people and it is thus difficult to locate large quantities of ripe fruit with epicarp and mesocarp intact, a condition essential for transport across borders, nutritional analysis and biometric evaluation.

All material was taken to Jardin Botanico Juan Maria Cespedes in Tuluá, El Valle for drying and packaging.

TUMACO

On July 18th we arrived in Tumaco, in the Department of Nariño and proceeded to the ICA (Instituto Colombiana de Agropecuaria) station "El Mira" near the town of Tangareal, some 40 kms from Tumaco along the Tumaco-Pasto Road. This is an area of heavy colonization, and the primary economic activities include extraction of wood and cultivation of African oil palm.

It soon became apparent that it would be most difficult to collect and document germplasm Orbignya in this area. Most of the available palms in the area are harvested prior to maturity by the people cutting wood, who open the fruits when the endosperm is still in a liquid stage and drink it as a thirst quenching beverage, similar to "milk" from unripe coconuts. Thus fruits are never allowed to ripen and the populations of palms are quickly declining in number. Some flowering palms were studied as well as some with immature fruit, and excellent herbarium and rhizosphere material taken. The palms in this area showed greater diversity in size and morphology than those found in the Bajo Calima area. We made arrangements with the ICA agronomists to engage the services of a

local person who knew where there was some ripe Orbignya fruit (here called "Corozo"), which would take a week to reach, collect and return. As this area is the personal property of the person whose services were engaged, and "Corozo" collection is apparently one of his many subsistence activities, he was not keen on having us collect on our own in his population. This material was later sent to New York via Cali, and then shipped to Brasilia, Colorado (for mycorrhizae experiments), the Palm Society Seed Bank; a few seeds were also retained in New York for mycorrhizae experiments.

The group then went to Quibdo, Department of Chocó, with the exception of Mike Balick, who went to Tuluá to process the collections from the two previous sites and begin to prepare the germplasm for shipment. Balick left for New York on July 27, 1984 and the fieldwork was continued by Forero, Hernandez and King.

QUIBDO

On July 26 the team arrived in Quibdo department of Chocó. This is the departmental capital of the Chocó which is connected to the city of Medellin, capital of Antioquia, by a 14 hour overland route. We made contact with Josefina Espinosa the director of the herbarium of the Universidad del Choco.

The area around Quibdo is heavily populated and this appears to have exhausted populations of Orbignya within a two day river travel radius of Quibdo. It was collected in this zone twenty years ago but the local population could not recall its presence within the past 15

years. A species of Attlea with a similar fruit and growth habit was collected. The region was however abundant in the protein rich oil producing palm Jessenia bataua which was being maintained in a state of semi-cultivation. The panicle is cut instead of the entire palm which is a common destructive method used in many other Jessenia areas. The people also recognize two varieties of J. bataua (here called mil pesos), one with mature fruits 60% green 40% purple producing a "white" palm milk the other with purple fruits which at maturity are said to yield more oil. Germplasm, specimens and material for mycorrhizae research were collected. Additional palms and associated plants were also collected. The material was dried in the herbarium of the Universidad with duplicates deposited there. Due to interest of local students and Josefina Espina a small project was designed to census the density, extent of use and varietal differences of J. bataua in this zone.

On July 31 the team proceeded to the Jardin Botanico of Medellin and deposited half of the Quibdo material and then went on to INCIVA in Cali, Colombia. In Cali the collections were prepared for shipment to New York and Brasilia. With the cooperation of Dr. Patino the material was treated with fungicide and the permits for export were obtained from ICA. On August 3, 75 kilos of Orbignya were shipped to Dr. Lidio Coradin at CENARGEN/EMBRAPA in Brazil via Avianca. The following day germplasm, herbarium speciments and mycorrhizae material was shipped to The New York Botanical Garden via Avianca. On August 6 Steven King deposited half of the remaining herbarium material at the Jardin Botanico de Medellin as part of the collaboration between New York and the Jardin Botanico.

RESULTS

Accessions of germ plasm were collected, as well as herbarium and other material which will add significantly to our understanding of this group of useful palms. Samples of mycorrhizae were also isolated and brought into laboratory culture, which will be used as innoculum for a program to be initiated shortly on the growth of Latin American native palm species. General collections were also made for distribution and study by scientists working on tropical forest ecosystems. Both Colombian and U.S. researchers received valuable experience on the recollection of forest palm germplasm and preparation of taxonomic vouchers. Many new contacts were made with local scientists not mentioned in this brief report, correspondence has begun and benefits will be derived in the future as a result of this contact and collaboration.

ACKNOWLEDGEMENTS

Financial sponsorship of the expedition was generously offered by the United States Agency for International Development (Grant No. DAN-5542-G-SS-1089-00) and the Joyce Mertz-Gilmore Foundation. Special thanks are offered to the staff of the Museu de Historical Natural and Jardin Botanico (of INCIVA), The Departmental Government of Cauca, The Jardin Botanico in Medellin, The Instituto Colombiano de Agricultura, and the staff of the ICA Research Station at Tangareal, as well as the many other individuals who were so helpful during this fieldwork.

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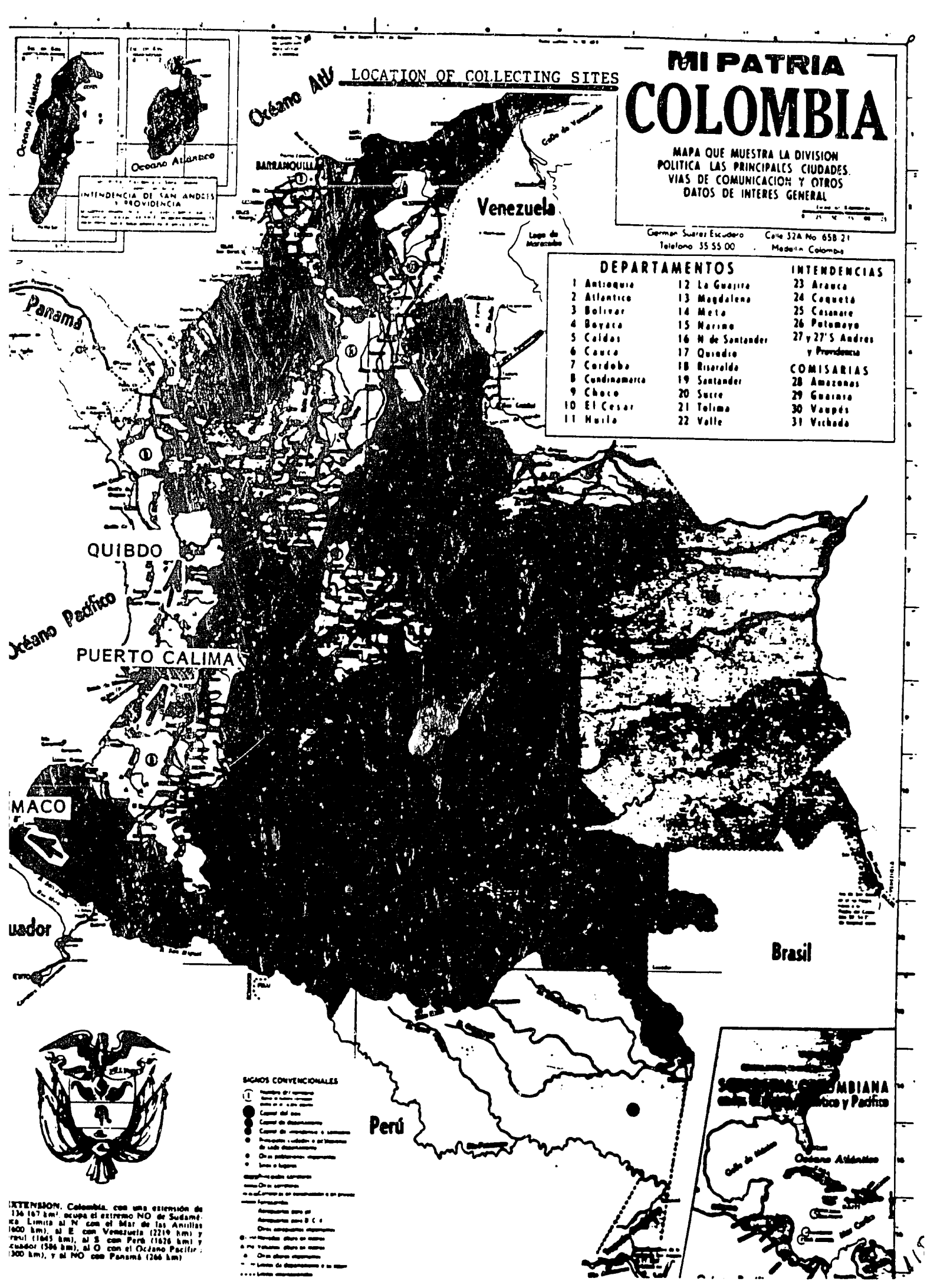
LOCATION OF COLLECTING SITES
MI PATRIA
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MAPA QUE MUESTRA LA DIVISION POLITICA LAS PRINCIPALES CIUDADES, VIAS DE COMUNICACION Y OTROS DATOS DE INTERES GENERAL
German Suarez Escudero
Telefono 35 55 00
Calle 32A No 65B 21
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Océano Pacífico
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MACO
uador
Brasil
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SIGNOS CONVENCIONALES
EXTENSION. Colombia, con una extensión de 1.136.167 km² ocupa el extremo NO de Sudamérica. Limita al N con el Mar de las Antillas (1600 km), al E con Venezuela (2219 km) y Brasil (1645 km), al S con Perú (1626 km) y Ecuador (586 km), al O con el Océano Pacífico (1300 km), y al NO con Panamá (266 km)
Océano Atlántico

ORBIGNYA CUATRECASANA GERM PLASM COLLECTION DATA

Accession Number	Fruit Length (cm)	Fruit Width (cm)	Fruit Weight (gm)
1629-1 (Round Fruits)			
1.	12.8	10.3	724
2.	13.2	10.1	698
3.	11.8	9.3	508
4.	12.2	9.7	598
5.	12.5	9.7	654
6.	13.3	10.1	706
7.	11.4	9.9	534
8.	13.0	9.3	616
9.	11.3	9.6	532
10.	12.5	9.1	566
11.	12.4	9.8	678
12.	12.1	9.3	604
Mean	12.3	9.6	618
1629-2 (Elliptic Fruits)			
1.	14.0	8.2	500
2.	12.5	8.2	458
3.	14.2	7.9	474
4.	13.8	7.6	458
5.	15.0	7.7	482
Mean	13.9	7.9	474
1629-3 (Elliptic Fruits)			
1.	16.5	8.8	722
2.	11.7	7.8	422
Mean	14.1	8.3	572

ORBIGNYA CUATRECASANA GERM PLASM COLLECTION DATA

Accession Number	Fruit Length (cm)	Fruit Width (cm)	Fruit Weight (gm)
1624-4 (Elliptic Fruits)			
1.	11.9	7.8	386
2.	12.4	7.7	428
3.	12.5	7.6	398
4.	12.7	7.6	424
5.	12.8	7.1	366
Mean	12.4	7.5	400
1629-5 (Round Fruits)			
1.	14.4	9.9	804
2.	13.8	9.8	678
3.	13.5	9.7	638
Mean	13.9	9.8	707
1629-6 (Elliptic Fruits)			
1.	14.8	8.0	550
2.	14.6	8.56	612
Mean	14.7	8.28	581
1629-7 (Elliptic Fruits)			
1.	15.0	9.5	754
2.	14.4	8.5	610
Mean	14.7	9.0	682
629-8 (Elliptic Fruits)			
1.	10.8	7.3	344
2.	12.6	8.4	524
3.	11.8	8.0	422
4.	12.0	8.3	444
5.	12.4	8.4	486
Mean	11.9	8.1	444

ORBIGNYA CUATRECASANA GERM PLASM COLLECTION DATA

Accession Number	Fruit Length (cm)	Fruit Width (cm)	Fruit Weight (gm)
1629-9 (Round Fruits)			
1.	11.1	9.0	452
2.	10.5	8.8	396
3.	12.3	9.0	526
4.	11.1	9.4	476
5	10.9	9.0	408
6.	11.6	8.9	438
7.	12.1	9.7	494
8.	10.6	9.0	412
Mean	11.2	9.1	450
1629-10 (Round Fruits)			
1.	12.6	8.2	458
2.	12.2	8.2	454
3.	13.5	8.2	502
4.	13.0	7.9	440
5.	12.3	8.4	476
6.	12.2	7.9	458
7.	12.5	7.8	466
8.	13.7	8.7	584
9.	12.8	8.1	526
10.	12.7	8.5	488
11.	12.3	8.7	482
12.	13.3	8.3	478
13.	12.6	8.0	456
14.	12.5	8.4	466
15.	13.3	8.7	536
16	12.7	8.2	462
17.	12.9	8.3	452
18.	12.9	8.1	462
Mean	12.8	8.3	480

ORBIGNYA CUATRECASANA GERM PLASM COLLECTION DATA

Accession Number	Fruit Lenght (cm)	Fruit Width (cm)	Fruit Weight (gm)
1629-11 (Elliptic Fruits)			
1.	11.3	6.5	264
2.	11.7	8.5	396
3.	10.9	7.0	286
4.	12.1	8.3	420
5.	11.2	7.4	296
6.	11.1	7.3	348
7.	11.2	7.4	304
8.	11.2	7.1	278
9.	12.1	8.0	408
10.	12.1	8.4	454
11.	12.2	8.1	400
12.	10.2	6.9	258
13.	11.6	8.0	368
14.	12.1	7.9	384
15.	11.9	8.3	390
16.	10.7	7.2	294
17.	10.7	7.0	264
18	11.0	7.3	286
19.	12.0	7.6	418
20.	11.7	7.1	346
21.	10.5	6.8	256
22.	10.6	7.4	288
23.	11.1	8.0	396
24.	11.3	8.2	362
25.	10.3	7.2	288
26.	10.5	6.8	264
27.	11.9	7.9	398
28.	10.9	7.7	322
29.	10.0	7.6	284
30.	10.3	7.6	354
31.	10.9	7.8	368
Mean	11.2	7.6	336

ORBIGNYA CUATRECASANA GERM PLASM COLLECTION DATA

Accession Number	Fruit Length (cm)	Fruit Width (cm)	Fruit Weight (gm)
1629-12 (Elliptic Fruits)			
1.	13.4	8.1	440
2.	13.3	7.8	468
3.	13.1	7.4	392
4.	13.3	7.5	412
5.	12.5	7.5	384
6.	12.9	8.0	460
7.	12.8	7.6	408
8.	12.5	8.0	422
9.	11.7	7.3	350
10.	12.6	8.2	428
11.	13.2	7.7	444
12.	13.4	8.0	440
13.	12.5	7.6	368
14.	12.6	7.2	368
15.	13.2	7.7	412
16.	13.2	7.7	422
17.	12.6	7.9	376
18.	12.5	7.9	400
Mean	12.8	7.7	410
1629-13 (Round Fruits)			
1.	11.2	8.3	440
2.	10.3	8.3	438
3.	11.8	7.6	350
4.	10.8	7.4	306
5.	11.0	8.2	430
6.	11.5	8.3	440
7.	9.8	7.9	382
8.	10.6	7.4	294
Mean	10.8	7.9	385

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oRBIGNYA CUATRECASANA GERM PLASM COLLECTION DATA

Accession Number	Fruit Length (cm)	Fruit Width (cm)	Fruit Weight (gm)
1629-14 (Elliptic Fruits)			
1.	16.3	10.0	830
2.	15.5	9.2	696
3.	14.5	9.4	658
4.	16.4	9.0	722
5.	15.4	10.0	818
6.	15.0	9.2	666
7.	15.0	9.2	620
8.	15.3	9.2	728
Mean	15.4	9.4	717
1629-15 (Round Fruits)			
1.	14.3	10.7	836
2.	14.75	10.4	908
3.	14.0	10.3	818
4.	12.2	8.4	512
5.	12.5	9.0	552
Mean	13.5	9.8	725
1629-16 (Round Fruits)			
1.	11.6	9.2	584
2.	11.4	9.0	528
3.	9.2	8.0	346
Mean	10.7	8.7	486
1629-17 (Round Fruits)			
1.	10.7	7.7	354
2.	11.4	7.7	440
3.	13.5	9.0	638
4.	13.0	10.0	708
5.	14.5	10.0	818
Mean	12.6	8.8	591

ORBIGNYA CUATRECASANA GERM PLASM COLLECTION DATA

Accession Number	Fruit Length (cm)	Fruit Width (cm)	Fruit Weight (gm)
1629-18 (Round Fruits)			
1.	12.9	8.5	494
2.	13.0	8.5	508
3.	12.3	8.4	442
4.	12.9	8.3	554
5.	12.7	8.2	444
Mean	12.7	8.4	488
1629-19 (Round Fruits)			
1.	15.0	9.1	662
2.	15.3	8.9	656
3.	15.0	8.5	592
4.	15.3	9.2	694
5.	15.4	9.2	672
6.	16.0	8.6	662
7.	14.5	8.8	624
8.	14.0	8.5	496
Mean	15.1	8.9	632
1629-20 (Round Fruits)			
1.	13.0	10.5	768
2.	12.7	9.7	698
3.	12.6	9.3	650
4.	12.6	9.5	670
5.	13.3	9.7	664
6.	12.2	10.2	780
7.	13.3	9.8	756
8.	12.5	9.3	644
Mean	12.8	9.8	704

ORBIBNYA CUATRECASANA GERM PLASM COLLECTION DATA

Accession Number	Fruit Length (cm)	Fruit Width (cm)	Fruit Weight (gm)
1629-21 (Round Fruits)			
1.	16.5	10.2	948
2.	16.5	10	890
3.	15	9.2	760
4.	16.6	9.7	906
5.	16.8	10	952
6.	16.8	10.3	948
7.	16.7	9	824
8.	15.5	9.4	804
Mean	16.3	9.7	879
1629-22 (Round Fruits)			
1.	15	9.8	740
2.	14.8	9.3	680
Mean	14.9	9.6	710

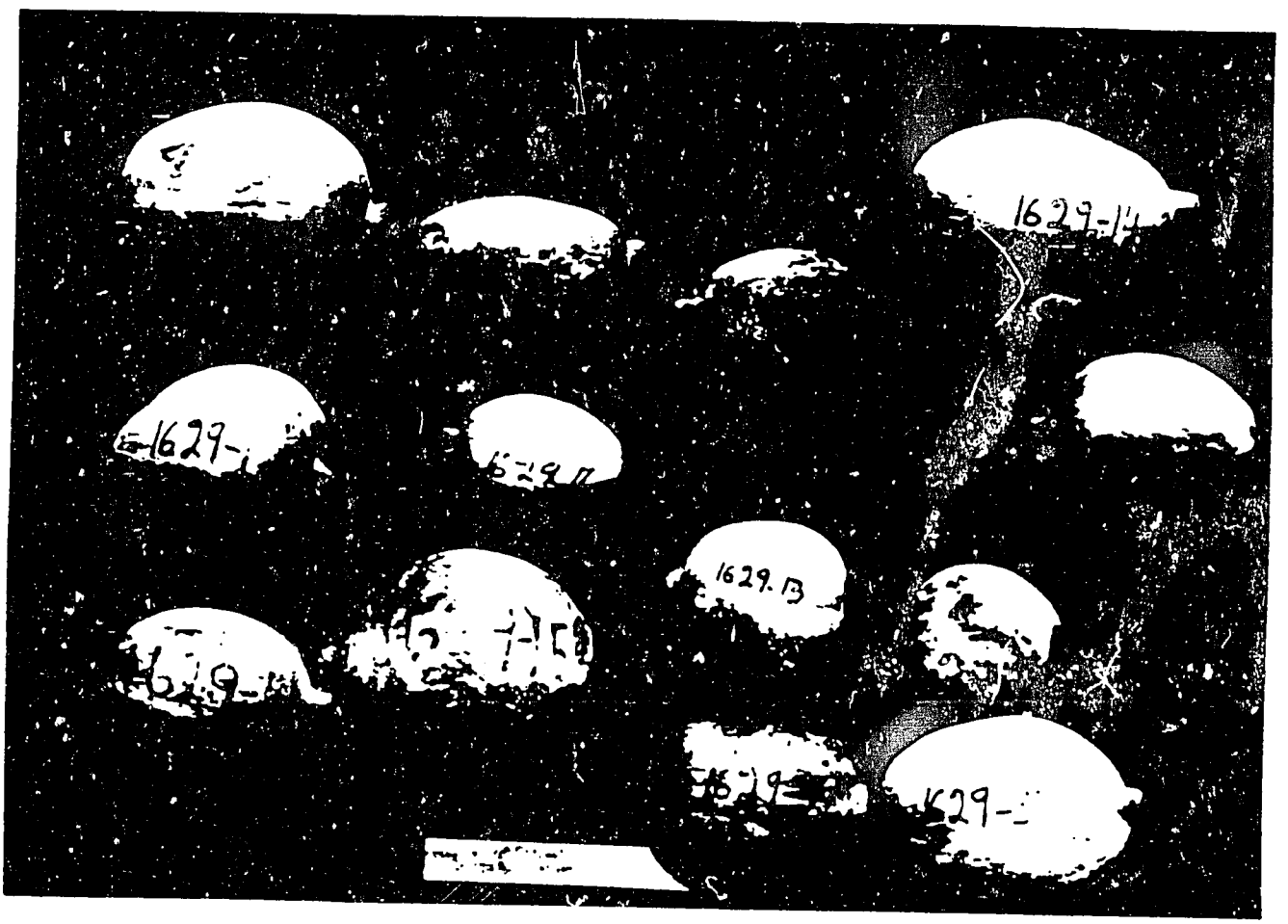

Figure 1. Variation in fruit size of Orbignya cuatrecasana.

Figure 2. Orbignya cuatrecasana in Bajo Calima, Colombia.

Figure 3. Fruiting panicle of Orbignya cuatrecasana .

GERMPLASM TRIP REPORT 1985

Institute of Economic Botany
The New York Botanical Garden
Bronx, New York 10458-9980
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IEB

JESSENIA/OENOCARPUS GERM PLASM AND MYCORRHIZAE COLLLECTING TRIP TO COLOMBIA JUNE/JULY, 1985

TRIP REPORT

PARTICIPANTS: Steven R. King
Luis E. Forero P.
Fabio Garcia Cossio
David R. Furth
Michael J. Balick

Sponsored by: U. S. Agency for International Development

17 July, 1985

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The Choco receives more rainfall then any other tropical forest of its size and supports signifigant amounts of useful palms, especially the oil rich Jessenia and Oenocarpus. The area is also unique because the previously mentioned palms (in this zone called Mil Pesos and Don Pedrito) are used but not cut down to harvest. These palms are in fact maintained in a state of semi cultivation and the regional population recognize the value of this wild resource.

Through discussions with Ms. Espina and CODECHOCO (Ministry of Agriculture National Development Corporation for EL Choco) it was decided that the team would best accomplish its goals by forming two separate groups each consisting of a Colombian botanist and a U.S. Counterpart. This also made the best use of the Entomologist who would focus on all insects associated with these palms. To coordinate the work all team memebers worked in the Quibdo area for 2 days focusing on multiple objectives. Germ plasm, roots for mycorrhizal study, benificial and harmful insects and soil were collected at several sites. A Census of the density of semi cultivated Jessenia as visible from the road was also conducted with extremely large numbers recorded, (+-1000) individuals 1.5 hours by car on one road from Quibdo. In addition interviews with local farmers and Jessenia consumers were conducted at each site. To further enhance the value of preserving Jessenia the team discussed the nutritional value of Jessenia with local health promoters and school teachers.

On June 14th the two teams separated, one group remaining in Quibdo and the other traveling by University bus 3 hours to the town of Istmina. Both groups sought to work all existing roads to collections, census the population density and gather data on use and managment. In each locality herbarium vouchers of germ plasm collections and any useful palms were prepared.

The Quibdo group concentrated on locating Jessenia in flower to discover the pollinators. A wide variety of entomofauna were found visiting both the inflorescence and the mature and imature fruits. We found panicles being visited by 2 species of wasps, 1 species of bee, at least 6 species of beetles and 4 species of weevils. These were collected from Jessenia in cleared fields and were found to be different from those collected from "wild" Jessenia collected in the forest with mixed native vegatation. In the forest 3 previously unrecorded weevils and 5 species of beetles were collected from the panicles.

In addition to insects and Jessenia/Oenocarpus material collected a number of useful palms in the following genera were documented with voucher specimens. Attlea, (local name Taparito) is both gathered and maintained in semi-cultivation for its edible endosperm, Wettinia, (local name Mame) is used for both flooring and walls, Mauritia, (local name Cabesi negro) used to make bags and sold as export craft, and a wild Bactris, (local name Corozo) for which no use was recorded.

The Istmina team followed the same strategy working on all accessible roads in the area, collecting germ plasm, roots, vouchers, soil, insects and managment data. It was observed that 1 hour out of Quibdo the density of Jessenia fell sharply and did not match the concentration in any other area visited. Germ plasm of Jessenia, Oenocarpus, Attlea and other useful palms was collected.

The regional managment of Jessenia in Istmina was similar to the Quibdo area. Individuals when asked why they cleared fields but left the Jessenia and Oencarpus standing replied that it was prohibited to cut them down and that they yielded a delicious beverage or "leche". It was also reported that this ("leche"=milk) is used also as a base to cook fish, meat, rice, and a soup of cheese. In addition the palm produces a rich "manteca" up to 5 liters per fruiting panicle, according to informants in Puerto Nuevo. Colonist new to the area also reported leaving the palm becuase it made the landscape atrractive, a reason that no local inhabitant offered. The land that was cleared except for Jessenia was used as pasture for cattle although very few cattle were observed. The farmers taking care of the land did report in numerous areas that very little would grow near the living palm because of its exstensive root system that appears to inhibit the penetration of any other root system near it. It was said to take up to 5 years for the roots to degrade enough to allow for the cultivation of fruit trees on the same land. In fact no other cultivar was observed growing within 3 to 5 meter radius of fields cleared of all but Jessenia.

Managment in both areas appears to be a combination of factors. When land is cleared useful palms especially Jessenia, and the others previously mentioned are left standing. In part because there food, construction and craft value is recognized and possibly because the main subsistance activity aside from house gardens for food is gold mining. There does not appear to be a large emphasis on agriculture in the area and the main exports by river and road are timber and fish. The Jessenia is harvested on a local scale by climbing the palm or if low enough striking the panicle with a stick. The main "harvest" of Mil Pesos is reported to be in October and November when individuals sell bowls full in the streets of Istmina and Quibdo for 20 pesos. A second "Harvest" is reported to be in January and Febuary. In June we found very few ripe individuals and observed many beggining to set fruit. The phenology of Mil Pesos in this area needs to established next.

On June 19 the team in Istmina returned to Quibdo and compared the data from the two areas as part of the first phase of the research. The Jessenia population density census yielded the following figures, in a one hour radius by car from Quibdo there were +-3500 individuals visible from the road in a state of semi-cultivation. In the area outside of this radius including the road to Tado, we recorded +-1500 Jessenia individuals within a 2 hour car radius of Istminia. The herbarium material was dried in Quibdo and duplicates of all collections left there.

On June 21, 1985 Steven King left Quibdo with all plant material from this phase of the research and sorted the herbarium vouchers leaving 50% of the material in Colombia as part of the cooperative research support. Export permits were obtained from ICA in Medellin and Mr. King left for New York on June 26, 1985. The team continued in Quibdo carrying out the second phase of the research.

PASSPORT DATA FOR GENETIC RESOURCES

1. **ACCESSION DATA**

1.1 ACCESSION NUMBER

VARA 665

1.2 SCIENTIFIC NAME

Jessenia bataua

1.3 DONOR NAME

Steven King & Luis Florero P.

1.4 DONOR NUMBER

665

1.5 ANY OTHER NAMES OR NUMBERS ASSOCIATED WITH ACCESSION

Milpesos

2. **COLLECTION DATA**

2.1 COLLECTING INSTITUTE

Institute of Economic Botany NY

2.2 ORIGINAL NUMBER ASSIGNED BY COLLECTOR OF THE SAMPLE

665

2.3 DATE OF COLLECTION OF ORIGINAL SAMPLE

June 15, 1985

2.4 COUNTRY OF COLLECTION

Colombia

2.5 LATITUDE OF COLLECTION SITE

2.6 LONGITUDE OF COLLECTION SITE

2.7 LOCATION OF COLLECTION SITE

Road from Quibdo to Yuto, 25 minutes by car from Quibdo right side of road.

2.8 ALTITUDE OF COLLECTION SITE

2.9 SOURCE OF COLLECTION

1 Roadside, wild vegatation
2 Shifting cultivation
(3) Farmland
4 Backvard
5 Market
6 Farm store
7 Agricultural institute
8 Seed company
9 Other (Specify)

2.10 POPULATION STRUCTURE

1 Continuous
(2) Subdivided

2.11 DENSITY OF STAND

(3) Sparse
7 Dense

2.12 AREA OF STAND

1 small less than 10 m^2
2 medium 10-100 m^2
(3) large greater than 100 m^2

2.13 STATUS OF SAMPLE

(1) Wild
2 Weedy
(3) Primitive cultivar
4 Advanced cultivar

2.14 LOCAL CULTIVAR NAME

2.15 PRIMARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
(5) Other (specify) Fruit eaten ("milk") and oil source

2.16 SECONDARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
5 Other (specify)

2.17 OTHER NOTE FROM COLLECTOR

See field notes from Luis E. Flores
the oil is produced only in ~~this~~ Harvest,
when there are ~~too much~~ many milpas fruits. In
other hand they make only "milk" and Drink
the Harvest will be at the end of August or
beginning September.

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PASSPORT DATA FOR GENETIC RESOURCES

1. ACCESSION DATA

1.1 ACCESSION NUMBER

666

1.2 SCIENTIFIC NAME

Tessenia batata

1.3 DONOR NAME

Steven King & Luis E. Forero P.

1.4 DONOR NUMBER

666

1.5 ANY OTHER NAMES OR NUMBERS ASSOCIATED WITH ACCESSION

Mil pesos

2. COLLECTION DATA

2.1 COLLECTING INSTITUTE

Institute of Economic Botany NY

2.2 ORIGINAL NUMBER ASSIGNED BY COLLECTOR OF THE SAMPLE

666

2.3 DATE OF COLLECTION OF ORIGINAL SAMPLE

June 18 / 1985

2.4 COUNTRY OF COLLECTION

Colombia

2.5 LATITUDE OF COLLECTION SITE

2.6 LONGITUDE OF COLLECTION SITE

2.7 LOCATION OF COLLECTION SITE

2.8 ALTITUDE OF COLLECTION SITE

Road from Guisbio to S. Francisco de Ichó, 1 Km. before reaching Ichó, left side of Road.

2.9 SOURCE OF COLLECTION

1 Roadside, wild vegatation
2 Shifting cultivation
(3) Farmland
4 Backyard
5 Market
6 Farm store
7 Agricultural institute
8 Seed company
9 Other (Specify)

2.10 POPULATION STRUCTURE

1 Continuous
(2) Subdivided

2.11 DENSITY OF STAND

(3) Sparse
7 Dense

2.12 AREA OF STAND

1 small less than 10 m^2
2 medium 10-100 m^2
(3) large greater than 100 m^2

2.13 STATUS OF SAMPLE

(1) Wild
2 Weedy
(3) Primitive cultivar
4 Advanced cultivar

2.14 LOCAL CULTIVAR NAME

2.15 PRIMARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
(5) Other (specify) to make "milk" for Drink or cosmetic
to extract oil

2.16 SECONDARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
5 Other (specify)

2.17 OTHER NOTE FROM COLLECTOR

the plant had two female inflorescences
the most of the fruits were "dry"

PASSPORT DATA FOR GENETIC RESOURCES

1. **ACCESSION DATA**

1.1 ACCESSION NUMBER

667

1.2 SCIENTIFIC NAME

Jessenia bataua

1.3 DONOR NAME

Steve King & Luis Florero P.

1.4 DONOR NUMBER

667

1.5 ANY OTHER NAMES OR NUMBERS ASSOCIATED WITH ACCESSION

Milpesos

2. **COLLECTION DATA**

2.1 COLLECTING INSTITUTE

Institute of Economic Botany NY

2.2 ORIGINAL NUMBER ASSIGNED BY COLLECTOR OF THE SAMPLE

667

2.3 DATE OF COLLECTION OF ORIGINAL SAMPLE

June 18, 1985

2.4 COUNTRY OF COLLECTION

Colombia

2.5 LATITUDE OF COLLECTION SITE

2.6 LONGITUDE OF COLLECTION SITE

2.7 LOCATION OF COLLECTION SITE

In forest cross the river Icho Sn Francisco de Icho, 20 minute walking into the forest.

2.8 ALTITUDE OF COLLECTION SITE

2.9 SOURCE OF COLLECTION

1. Roadside, wild vegatation
2. Shifting cultivation
3. Farmland
4. Backyard
5. Market
6. Farm store
7. Agricultural institute
8. Seed company
9. Other (Specify)

140

2.10 POPULATION STRUCTURE

1 Continuous
(2) Subdivided

2.11 DENSITY OF STAND

(3) Sparse
7 Dense

2.12 AREA OF STAND

1 small less than 10 m^2
2 medium 10-100 m^2
3 large greater than 100 m^2

2.13 STATUS OF SAMPLE

(1) Wild
2 Weedy
3 Primitive cultivar
4 Advanced cultivar

2.14 LOCAL CULTIVAR NAME

2.15 PRIMARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
5 Other (specify) to make "milk" for Drinking and Sometimes oil

2.16 SECONDARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
5 Other (specify)

2.17 OTHER NOTE FROM COLLECTOR

the plant had three female inflorescences, Collected also old and young roots and soil sample. All the fruits were completely ripe ~~the~~ people ~~Hope~~ the harvest is the last days of September.

PASSPORT DATA FOR GENETIC RESOURCES

1. **ACCESSION DATA**

1.1 ACCESSION NUMBER

669

1.2 SCIENTIFIC NAME

Attalea

1.3 DONOR NAME

Steve King & Luis E. Flores P.

1.4 DONOR NUMBER

669

1.5 ANY OTHER NAMES OR NUMBERS ASSOCIATED WITH ACCESSION

Téparo

2. **COLLECTION DATA**

2.1 COLLECTING INSTITUTE

Institute of Economic Botany

2.2 ORIGINAL NUMBER ASSIGNED BY COLLECTOR OF THE SAMPLE

669

2.3 DATE OF COLLECTION OF ORIGINAL SAMPLE

June 18, 1981

2.4 COUNTRY OF COLLECTION

Colombia

2.5 LATITUDE OF COLLECTION SITE

2.6 LONGITUDE OF COLLECTION SITE

2.7 LOCATION OF COLLECTION SITE

Road between Quibdó - El Veinte or to Medellín, 13 Kilometers from Quibdó
Site called "la recta" land tenant Luis Paulino, left side of road

2.8 ALTITUDE OF COLLECTION SITE

2.9 SOURCE OF COLLECTION

1. Roadside, wild vegatation
2. Shifting cultivation
3. Farmland
4. Backyard
5. Market
6. Farm store
7. Agricultural institute
8. Seed company
9. Other (Specify)

146

2.10 POPULATION STRUCTURE

1 Continuous
(2) Subdivided

2.11 DENSITY OF STAND

(3) Sparse
7 Dense

2.12 AREA OF STAND

1 small less than 10 m^2
2 medium 10-100 m^2
3 large greater than 100 m^2

2.13 STATUS OF SAMPLE

(1) Wild
2 Weedy
3 Primitive cultivar
4 Advanced cultivar

2.14 LOCAL CULTIVAR NAME

2.15 PRIMARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
5 Other (specify) to take OFF "almendras" pr estri

2.16 SECONDARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
(5) Other (specify) ⇒ When the fruits are unripe, th people used to drink the "water", ~~while~~ While they working in th forest hunting or cutting wood

2.17 OTHER NOTE FROM COLLECTOR

PASSPORT DATA FOR GENETIC RESOURCES

1. **ACCESSION DATA**

1.1 ACCESSION NUMBER
656

1.2 SCIENTIFIC NAME
Oenocarpus sp.

1.3 DONOR NAME
Steven R King Luis Fucero

1.4 DONOR NUMBER

1.5 ANY OTHER NAMES OR NUMBERS ASSOCIATED WITH ACCESSION
Don Petrito

2. **COLLECTION DATA**

2.1 COLLECTING INSTITUTE
Institute of Economic Botany

2.2 ORIGINAL NUMBER ASSIGNED BY COLLECTOR OF THE SAMPLE
656

2.3 DATE OF COLLECTION OF ORIGINAL SAMPLE
June 13, 1985

2.4 COUNTRY OF COLLECTION
Colombia

2.5 LATITUDE OF COLLECTION SITE

2.6 LONGITUDE OF COLLECTION SITE

2.7 LOCATION OF COLLECTION SITE
15 kilometers from Quibdo on road to Medellin
Site called la Recta land tended by Jorge Quitrago

2.8 ALTITUDE OF COLLECTION SITE
110 m

2.9 SOURCE OF COLLECTION

1 Roadside, wild vegatation
2 Shifting cultivation
3 Farmland
4 Backyard
5 Market
6 Farm store
7 Agricultural institute
8 Seed company
9 Other (Specify)

2.10 POPULATION STRUCTURE

1 Continuous
(2) Subdivided

2.11 DENSITY OF STAND

3 Sparse
(7) Dense

2.12 AREA OF STAND

1 small less than 10 m^2
(2) medium 10-100 m^2
3 large greater than 100 m^2

2.13 STATUS OF SAMPLE

(1) Wild → Semi cultivated
2 Weedy
3 Primitive cultivar
4 Advanced cultivar

2.14 LOCAL CULTIVAR NAME

Don Pedrito

2.15 PRIMARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
(5) Other (specify) beverage, Palm oil

2.16 SECONDARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
(5) Other (specify) to increase beauty of landscape

2.17 OTHER NOTE FROM COLLECTOR

Palms growing in cleared field. Not planted but undergrowth cleared. This stand dominated by Jessenia bataua

PASSPORT DATA FOR GENETIC RESOURCES

1. **ACCESSION DATA**

1.1 ACCESSION NUMBER
658

1.2 SCIENTIFIC NAME

1.3 DONOR NAME
Steven R. King Luis Forero

1.4 DONOR NUMBER

1.5 ANY OTHER NAMES OR NUMBERS ASSOCIATED WITH ACCESSION
Chaguaitero

2. **COLLECTION DATA**

2.1 COLLECTING INSTITUTE
Institute of Economic Botany

2.2 ORIGINAL NUMBER ASSIGNED BY COLLECTOR OF THE SAMPLE
658

2.3 DATE OF COLLECTION OF ORIGINAL SAMPLE
June 14, 1985

2.4 COUNTRY OF COLLECTION
Colombia

2.5 LATITUDE OF COLLECTION SITE

2.6 LONGITUDE OF COLLECTION SITE

2.7 LOCATION OF COLLECTION SITE
Road from Leguina to Pie de Pepe 5 kilometers from Leguina on left side of road

2.8 ALTITUDE OF COLLECTION SITE
110 m.

2.9 SOURCE OF COLLECTION

1. Roadside, wild vegatation
2. Shifting cultivation
3. Farmland
4. Backyard
5. Market
6. Farm store
7. Agricultural institute
8. Seed company
9. Other (Specify)

2.10 POPULATION STRUCTURE

1 Continuous
(2) Subdivided

2.11 DENSITY OF STAND

(1) Sparse
7 Dense

2.12 AREA OF STAND

(1) small less than 10 m^2
2 medium 10-100 m^2
3 large greater than 100 m^2

2.13 STATUS OF SAMPLE

(1) Wild
2 Weedy
3 Primitive cultivar
4 Advanced cultivar

2.14 LOCAL CULTIVAR NAME

2.15 PRIMARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
(5) Other (specify) Sweet fruit Eaten.

2.16 SECONDARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
5 Other (specify)

2.17 OTHER NOTE FROM COLLECTOR

Not cultivated but not cut down
Fruits orange when mature. Sweet sticky
liquid inside, especially valued by children.

PASSPORT DATA FOR GENETIC RESOURCES

1. ACCESSION DATA

1.1 ACCESSION NUMBER
660

1.2 SCIENTIFIC NAME
Jessenia bataua

1.3 DONOR NAME
Steven R. King Luis E. Forero

1.4 DONOR NUMBER
660

1.5 ANY OTHER NAMES OR NUMBERS ASSOCIATED WITH ACCESSION
Mil Pesos

2. COLLECTION DATA

2.1 COLLECTING INSTITUTE
Institute of Economic Botany

2.2 ORIGINAL NUMBER ASSIGNED BY COLLECTOR OF THE SAMPLE
660

2.3 DATE OF COLLECTION OF ORIGINAL SAMPLE
June 15, 1985

2.4 COUNTRY OF COLLECTION
Colombia

2.5 LATITUDE OF COLLECTION SITE

2.6 LONGITUDE OF COLLECTION SITE

2.7 LOCATION OF COLLECTION SITE

2.8 ALTITUDE OF COLLECTION SITE
115

2.9 SOURCE OF COLLECTION

1 Roadside, wild vegatation
2 Shifting cultivation
(3) Farmland
4 Backyard
5 Market
6 Farm store
7 Agricultural institute
8 Seed company
9 Other (Specify)

148

2.10 POPULATION STRUCTURE

1 Continuous
2 Subdivided

2.11 DENSITY OF STAND

3 Sparse
7 Dense

2.12 AREA OF STAND

1 small less than 10 m^2
2 medium 10-100 m^2
3 large greater than 100 m^2

2.13 STATUS OF SAMPLE

1 Wild
2 Weedy
3 Primitive cultiva
4 Advanced cultivar

2.14 LOCAL CULTIVAR NAME

2.15 PRIMARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
5 Other (specify) oil and Palm

2.16 SECONDARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
5 Other (specify)

2.17 OTHER NOTE FROM COLLECTOR

land cleared for cattle, Palm left standing. Considered useful for milk and food

PASSPORT DATA FOR GENETIC RESOURCES

1. **ACCESSION DATA**

1.1 ACCESSION NUMBER
661

1.2 SCIENTIFIC NAME
Cenocarpus

1.3 DONOR NAME
Steven R. King Luis Fuerte

1.4 DONOR NUMBER
661

1.5 ANY OTHER NAMES OR NUMBERS ASSOCIATED WITH ACCESSION
Don Pedrito

2. **COLLECTION DATA**

2.1 COLLECTING INSTITUTE
Institute of Economic Botany

2.2 ORIGINAL NUMBER ASSIGNED BY COLLECTOR OF THE SAMPLE
661

2.3 DATE OF COLLECTION OF ORIGINAL SAMPLE
June 15, 1985

2.4 COUNTRY OF COLLECTION
Colombia

2.5 LATITUDE OF COLLECTION SITE

2.6 LONGITUDE OF COLLECTION SITE

2.7 LOCATION OF COLLECTION SITE
Entrance to the Panamerican highway → forest behind
2 km from Animas

2.8 ALTITUDE OF COLLECTION SITE
110 m

2.9 SOURCE OF COLLECTION
1 Roadside, wild vegatatio
2 Shifting cultivation
3 Farmland
4 Backyard
5 Market
6 Farm store
7 Agricultural institute
8 Seed company
9 Other (Specify)

2.10 POPULATION STRUCTURE

1 Continuous
2 Subdivided

2.11 DENSITY OF STAND

3 Sparse
7 Dense

2.12 AREA OF STAND

1 small less than 10 m^2
2 medium 10-100 m^2
3 large greater than 100 m^2

2.13 STATUS OF SAMPLE

1 Wild
2 Weedy
3 Primitive cultivar
4 Advanced cultivar

2.14 LOCAL CULTIVAR NAME

2.15 PRIMARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
5 Other (specify) Milk, Pal, is extracted

2.16 SECONDARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
5 Other (specify)

2.17 OTHER NOTE FROM COLLECTOR

Said not to be used to extract

PASSPORT DATA FOR GENETIC RESOURCES

1. **ACCESSION DATA**

1.1 ACCESSION NUMBER

8622

1.2 SCIENTIFIC NAME

Indet

1.3 DONOR NAME

1.4 DONOR NUMBER

1.5 ANY OTHER NAMES OR NUMBERS ASSOCIATED WITH ACCESSION

None

2. **COLLECTION DATA**

2.1 COLLECTING INSTITUTE

Institute of Economic Botany

2.2 ORIGINAL NUMBER ASSIGNED BY COLLECTOR OF THE SAMPLE

622

2.3 DATE OF COLLECTION OF ORIGINAL SAMPLE

June 17, 1985

2.4 COUNTRY OF COLLECTION

Colombia

2.5 LATITUDE OF COLLECTION SITE

2.6 LONGITUDE OF COLLECTION SITE

2.7 LOCATION OF COLLECTION SITE

3 km kilometers from Istmina on road to Condoto
Bore River.

2.8 ALTITUDE OF COLLECTION SITE

120

2.9 SOURCE OF COLLECTION

1 Roadside, wild vegatation
(2) Shifting cultivation
3 Farmland
4 Backyard
5 Market
6 Farm store
7 Agricultural institute
8 Seed company
9 Other (Specify)

2.10 POPULATION STRUCTURE

1 Continuous
2 Subdivided

2.11 DENSITY OF STAND

3 Sparse
7 Dense

2.12 AREA OF STAND

1 small less than 10 m^2
2 medium 10-100 m^2
3 large greater than 100 m^2

2.13 STATUS OF SAMPLE

1 Wild
2 Weedy
3 Primitive cultivar
4 Advanced cultivar

2.14 LOCAL CULTIVAR NAME

Mana

2.15 PRIMARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
5 Other (specify) trunk used as building material very dense.

2.16 SECONDARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
5 Other (specify) Fruits Eaten by children

2.17 OTHER NOTE FROM COLLECTOR

Same path as King Forero #622
when struck with machette damaged the
machette bent the metal

PASSPORT DATA FOR GENETIC RESOURCES

1. **ACCESSION DATA**

1.1 ACCESSION NUMBER
656A

1.2 SCIENTIFIC NAME
Jessenia bataua

1.3 DONOR NAME
Stevin R. King Luis Forero P.

1.4 DONOR NUMBER
65A

1.5 ANY OTHER NAMES OR NUMBERS ASSOCIATED WITH ACCESSION
Mil Pesos

2. **COLLECTION DATA**

2.1 COLLECTING INSTITUTE
Institute of Economic Botany

2.2 ORIGINAL NUMBER ASSIGNED BY COLLECTOR OF THE SAMPLE
656 A

2.3 DATE OF COLLECTION OF ORIGINAL SAMPLE
June 13, 1985

2.4 COUNTRY OF COLLECTION
Colombia

2.5 LATITUDE OF COLLECTION SITE

2.6 LONGITUDE OF COLLECTION SITE

2.7 LOCATION OF COLLECTION SITE
15 kilometers from Quibdo on the way to Medellin

2.8 ALTITUDE OF COLLECTION SITE
110 m

2.9 SOURCE OF COLLECTION

1 Roadside, wild vegatation
2 Shifting cultivation
(3) Farmland
4 Backyard
5 Market
6 Farm store
7 Agricultural institute
8 Seed company
9 Other (Specify)

2.10 POPULATION STRUCTURE

1 Continuous
2 Subdivided

2.11 DENSITY OF STAND

3 Sparse
7 Dense

2.12 AREA OF STAND

1 small less than 10 m^2
2 medium 10-100 m^2
3 large greater than 100 m^2

2.13 STATUS OF SAMPLE

1 Wild
2 Weedy
3 Primitive cultivar
4 Advanced cultivar

2.14 LOCAL CULTIVAR NAME

Mil Pesos

2.15 PRIMARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
5 Other (specify) Palm Mill and oil

2.16 SECONDARY USE

1 Vegatable
2 Grain
3 Ornamental
4 Medicinal
5 Other (specify)

2.17 OTHER NOTE FROM COLLECTOR

large individual with numerous fruits on one Raceme

APPENDIX III

Report on the meeting for work on babassu

APPENDIX III

EMBRAPA
EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA
CENARGEN - CENTRO NACIONAL DE RECURSOS GENÉTICOS
UEPAE-TERESINA - UNIDADE DE EXECUÇÃO DE PESQUISA DE ÂMBITO ESTADUAL

"REUNIÃO DE TRABALHO SOBRE BABAÇU"

10 A 15 DE MARÇO DE 1986

LOCAL: EMBRAPA/UEPAE DE TERESINA
Av. Duque de Caxias, 5650
64.000 - Teresina-Piauí.

PROGRAMA

DIA 10 DE MARÇO - Segunda-feira

17:00 horas - **ABERTURA SOLENE**

Sr. Dr. Antônio Wall Ferraz
- Secretário de Agricultura do Estado do Piauí

Local: UEPAE/Teresina

18:00 horas - COQUETEL

DIA 11 DE MARÇO - Terça-feira

08:30 - 12:30 - SISTEMÁTICA E FITOGEOGRAFIA

Coordenador: Michael J. Balick
Secretário : Claudio U. B. Pinheiro

08:30 - 09:00 - TEMA: "TAXONOMIA DO COMPLEXO BABAÇU - ORBIGNYA/ATTALEA/MAXIMILIANA/SCHEELEA/MARKLEYA".

Judas Tadeu de Medeiros Costa
- Universidade Federal de Pernambuco - UFPe

09:00 - 09:15 - DISCUSSÃO

09:15 - 09:45 - TEMA: "O GÊNERO ORBIGNYA NA COLOMBIA; DISTRIBUIÇÃO E UTILIZAÇÃO"

Victor Manuel Patiño
- Instituto Vallecaucano de Investigaciones Científicas (INCIVA)

09:45 - 10:00 - DISCUSSÃO

10:00 - 10:15 - I N T E R V A L O

10:15 - 10:45 - TEMA: "ESTUDOS NO COMPLEXO BABAÇU EM MINAS GERAIS"

Edir Carvalho Tenório
- Fundação Centro Tecnológico de Minas Gerais-CETEC

10:45 - 11:00 - DISCUSSÃO

11:00 - 11:30 - TEMA: "ZONEAMENTO EDAFOCLIMÁTICO DO BABAÇU NOS ESTADOS DO PIAUÍ E MARANHÃO"

- Paulo Klinger Tito Jacomine
  Serviço Nacional de Levantamento e Conservação de Solos-SNLCS/Região Nordeste

11:30 - 11:45 - DISCUSSÃO

11:45 - 12:15 - TEMA: "SISTEMA DE CONSULTA E MANUTENÇÃO DE DADOS ATRAVÉS DE COMPUTADOR"

Aldemar de Araújo Santos
Eva Maria C. Girão
- Super. de Desenv. do Nordeste - SUDENE
Antonio Mariano de Campos Mendes
- Consultor IICA-UEPAE/Teresina/EMBRAPA

12:15 - 12:30 - DISCUSSÃO

DIA 11 DE MARÇO - Terça-feira (tarde)

15:00 - 19:00 - BIOLOGIA

Coordenador: Edir Carvalho Tenório
Secretário : Antônio Mariano de Campos Mendes

15:00 - 15:30 - TEMA: "ECOLOGIA DO BABAÇU"

Anthony B. Anderson
- Museu Paraense "Emílio Goeldi" - CNPq

15:30 - 15:45 - DISCUSSÃO

15:45 - 16:15 - TEMA: "POLINIZAÇÃO E BIOLOGIA FLORAL NO COMPLEXO BABAÇU"

Anthony B. Anderson
William Overal
- Museu Paraense "Emílio Goeldi" - CNPq
Andrew Henderson
- New York Botanical Garden-NYBG

16:15 - 16:30 - DISCUSSÃO

16:30 - 16:45 - I N T E R V A L O

16:45 - 17:15 - TEMA: "CITOGENÉTICA DO BABAÇU"

Marcos David F. de Carvalho
- UEPAE/Teresina/EMBRAPA

17:15 - 17:30 - DISCUSSÃO

17:30 - 18:00 - TEMA: "HIBRIDIZAÇÃO NO COMPLEXO BABAÇU"

Michael J. Balick
- New York Botanical Garden-NYBG

18:00 - 18:15 - DISCUSSÃO

18:15 - 18:45 - TEMA: "FENOLOGIA DO BABAÇU"

Eugênio Celso Emérito Araújo
- UEPAE/Teresina/EMBRAPA

18:45 - 19:00 - DISCUSSÃO

DIA 12 DE MARÇO - Quarta-feira

08:30 - 10:00 - BIOLOGIA (Continuação)

08:30 - 09:00 - TEMA: "INSETOS ASSOCIADOS AO BABAÇU"

Paulo Henrique Soares da Silva
- UEPAE/Teresina/EMBRAPA

09:00 - 09:15 - DISCUSSÃO

09:15 - 09:45 - TEMA: "ESTUDO PRELIMINAR DA ANATOMIA DE FOLHA DE ORBIGNYA PHALERATA, O. EICHLERI E O. TEIXEIRANA"

Claudio Urbano B. Pinheiro
- Empresa Maranhense de Pesquisa Agropecuária-EMAPA

09:45 - 10:00 - DISCUSSÃO

10:00 - 10:15 - I N T E R V A L O

10:15 - 12:30 - RECURSOS GENÉTICOS E MELHORAMENTO

Coordenador: Edurado Lleras Pérez
Secretário : Judas Tadeu de Medeiros Costa

10:15 - 10:45 - TEMA: "COLETA DE GERMOPLASMA DE ESPÉCIES DO COMPLEXO BABAÇU"

Lidio Coradin
- CENARGEN/EMBRAPA
José Mário Ferro Frazão
- UEPAE/Teresina/EMBRAPA
Eduardo Lleras Pérez
- Consultor IICA-CENARGEN/EMBRAPA

10:45 - 11:00 - DISCUSSÃO

11:00 - 11:30 - TEMA: "AVALIAÇÃO E UTILIZAÇÃO DE GERMOPLASMA DE BABAÇU"

João Roberto Pereira Oliveira
- UEPAE/Teresina/EMBRAPA

11:30 - 11:45 - DISCUSSÃO

11:45 - 12:15 - TEMA: "ORBIGNYA TEIXEIRANA: POTENCIAL PARA MELHORAMENTO"

Judas Tadeu de Medeiros Costa
- Universidade Federal de Pernambuco - UFPe
Antonio Mariano de Campos Mendes
- Consultor IICA-UEPAE/Teresina/EMBRAPA

12:15 - 12:30 - DISCUSSÃO

DIA 12 DE MARÇO - Quarta-feira (tarde)

14:30 - 18:00 - VISITA USINA DE CARBONIZAÇÃO DE CASCA DE BABAÇU
"INSTITUTO DE PESQUISAS TECNOLÓGICAS-IPT/SP"

- VISITA À FÁBRICA DE BENEFICIAMENTO DE AMÊNDOA
"USINA LIVRAMENTO"

DIA 13 DE MARÇO - Quinta-feira

08:30 - 10:00 - RECURSOS GENÉTICOS E MELHORAMENTO (Continuação)

08:30 - 09:00 - TEMA: "SELEÇÃO MASSAL NO BABAÇU"

José Soares Veloso
- Fundação CEPRO/Piauí

09:00 - 09:15 - DISCUSSÃO

09:15 - 09:45 - TEMA: "GERMINAÇÃO E FORMAÇÃO DE MUDAS DE BABAÇU"

José Mário Ferro Frazão
- UEPAE/Teresina/EMBRAPA
Claudio U. B. Pinheiro
- Empresa Maranhense de Pesquisa Agropecuária-EMAPA

09:45 - 10:00 - DISCUSSÃO

10:00 - 10:15 - I N T E R V A L O

10:15 - 12:30 - UTILIZAÇÃO

Coordenador: José Herculano de Carvalho
Secretário : Peter H. May

10:15 - 10:45 - TEMA: "POSSIBILIDADES DE ASSOCIAÇÃO DO BABAÇU COM CULTURAS TEMPORÁRIAS E PERMANENTES"

José Herculano de Carvalho
- UEPAE/Teresina/EMBRAPA

10:45 - 11:00 - DISCUSSÃO

11:00 - 11:30 - TEMA: "ETNOBOTÂNICA DO BABAÇU"

Michael J. Balick
- New York Botanical Garden-NYBG

11:30 - 11:45 - DISCUSSÃO

11:45 - 12:15 - TEMA: "ECONOMIA DE SUBSISTÊNCIA DO BABAÇU"

Peter H. May
- Universidade Federal do Ceará-UFC

12:15 - 12:30 - DISCUSSÃO

DIA 13 DE MARÇO - Quinta-feira (tarde)

14:30 - 18:00 - VISITA À ÁREA EXPERIMENTAL DA UEPAE/Teresina/EMBRAPA

DIA 14 DE MARÇO - Sexta-feira

08:30 - 10:00 - UTILIZAÇÃO (continuação)

08:30 - 09:00 - TEMA: "SITUAÇÃO ATUAL E PERSPECTIVAS DO APROVEITAMENTO INTEGRAL DO BABAÇU"

Wilson Milfont Júnior
- NATRON Consultoria e Projetos S.A.

09:00 - 09:15 - DISCUSSÃO

09:15 - 09:45 - TEMA: "LINHAS DE AÇÃO PARA ACELERAR A DOMESTICAÇÃO DO BABAÇU"

Gus Blaak
- Industrial Crops Group - FAO/Roma

09:45 - 10:00 - DISCUSSÃO

10:00 - 10:30 - TEMA: "US-AID: PROGRAMA AGROFLORESTAL"

Carl Gallegos
- United States Agency for International Development - US-AID

10:30 - 10:45 - DISCUSSÃO

10:45 - 11:00 - I N T E R V A L O

11:00 - 12:30 - COMUNICAÇÕES LIVRES

Coordenador: Afonso Celso Candeira Valois
Secretário : José Herculano de Carvalho

DIA 14 DE MARÇO - Sexta-feira (tarde)

14:00 - 17:00 - CONCLUSÕES E RECOMENDAÇÕES

17:30 horas - E N C E R R A M E N T O

20:30 horas - JANTAR

DIA 15 DE MARÇO - Sábado

08:00 - 18:00 - VISITA POPULAÇÕES NATURAIS DE BABAÇU

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REUNIÃO DE TRABALHO SOBRE BABAÇU

EMBRAPA
UEPAE/TERESINA - CENARGEN
TERESINA-PI - BRASIL - 10 - 15 DE MARÇO DE 1986

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APPENDIX IV

Jessenia and Oenocarpus: Neotropical palms worthy of domestication

APPENDIX IV

Jessenia and *Oenocarpus*: Neotropical Oil Palms Worthy of Domestication

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1987

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CHAPTER 1

SUBSISTENCE UTILIZATION

INTRODUCTION

Palms are a major contributing factor in the subsistence lifestyle of many Neotropical people, both Indians and peasant farmers (Balick 1979; 1984; Schultes 1977; Wilbert 1976). People obtain a wealth of products from these plants, including food, fuel, fiber, construction material, medicine, ornaments and weapons. Palms are also deeply involved with magic and mystical belief, and are common elements of regional or tribal folklore. In a survey of palm usage around the world, Balick and Beck (in prep.) catalogued 431 uses for this family.

As this chapter will show, palms in the *Oenocarpus-Jessenia* complex are heavily utilized by many of the subsistence-based people in the Neotropics.

FOLK TAXONOMY

A knowledge of the local names for the palms in each locality is important for locating and recollecting germplasm, as well as sampling the populations over as broad a range as possible. More then 100 names for species and subspecies in the *Oenocarpus-Jessenia* complex have been recorded. Table 1 lists the names, based on personal observation as well as citations in the literature.

Table 1A

Common Names For Species in the *Oenocarpus-Jessenia* Complex

Oenocarpus bacaba

Antilles: Cagua; Gagua
Brazil: Bacába; Bacaba verdadeira; Bacaba vermelha; Bacaba-açu; Bacabinha.
Colombia: Manoco; Milpesos; Milpesillo; Punáma (Tarianas).
French Guiana: Comon; Comou.
Guyana: Koomeri; Low (Arawak); Lu; Mapure (Waipisiana).
Peru: Ungurauy.
Surinam: Alata kaka; Koemboe; Koemoe; Lo; Man koemboe; Manni koemboe; Pikin koemboe.
Venezuela: Baniba; Bezi (Arawak: Guinau); Cudídi; Dzebé (Arawak: Guinau); Kuheri (Carib: Maquiritare); Kumú (Carib: Wayukomo); Kúnyeg (Carib: Taulipang); Kun, Kunuáza (Carib: Taulipang); Kunhuadayek (Carib: Pemón); Macaba (Waika); Seje chiquito; Seje finito; Seje pequeño; Sejito.

Oenocarpus circumtextus

Brazil: Bacába.
Colombia: Resina

Oenocarpus discolor

Brazil: Bacaba; Palmeira verdadeira; Pindó; Pindóba.

Oenocarpus distichus

Brazil: Bacaba; Bacaba assú; Bacaba branca; Bacaba de azeite; Bacaba de leque Bacaba de oleo; Bacaba de Pará; Iandi bacaba; Pacaba de azeite; Palmeira bacaba; Yandy bacaba.

O. macrocalyx

Brazil: Bacabinha.

Oenocarpus mapora

Brazil: Bacaba; Bacabai; Bacabay; Bacabao; Bacabi; Bacabinha; Ciambo.
Colombia: Corunto; Manaco; Milpesillo; Posuí; Posuy; Pusuy.
Panama: Black palm; Maquenque
Peru: Caima; Ciamba; Siamba; Sinami; Sinamillo.
Venezuela: Mapora; Palma mapora.

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Table 1 Cont'd.

Oenocarpus mapora subsp. dryanderae

Colombia: Don pedrito; Janana (Cholo); Maquenque; Milpesillo; Panama (Cholo); Piejcuró, Piejcurón (Cholo).

Oenocarpus minor

Brazil: Bacaba; Bacaba-miri; Bacaba-mirim; Bacabai, Bacabay; Bacabi; Bacabinha.

Oenocarpus tarampabo

Bolivia: Bacaba; Tarampabo; Trampabo.
Brazil: Bacaba; Coqueiro tarampabo.

Jessenia bataua

Brazil: Batauá; Koanani (Yanomama); Pacauá; Patawa; Segen.
Colombia: Aricaguá; Aricacuá; Batauá; Bocohañu (Cubeo); Boreyabeñu (Cubeo) Chapil; Cohañu (Cubeo); Cómee; Comeé (Huitoto and Muinane); Comenyá (Huitoto and Muinane); Cuperi Duebocohañu (Cubeo); Komaíhe (Witoto); Milpesa, Milpeso, Mil pesos; Obango; Oruta (Emberá-Chamí); Palma de leche; Palma resina; Patabá, Patahuá, Patauá; Patawa; Seje; Socorrong (Cholo); Trupa (Emberá-Chamí); Unamá; Unamo, Unamu; Uruta (Cholo); Yacohañu, Yaveecohañu (Cubeo).
Ecuador: Chapil
French Guiana: Palma patavona.
Guianas: Maripa de Monaña.
Guyana: Batawa (Carib); Mohee (Warrau); Tooroo, Toru; Turu (Arawak).
Peru: Cuuruhu (Bora); Hunguravi; Sacumana; Sinami; Tsitsihu (Bora); Ungurauv.
Surinam: Komboe; Pataka koemboe; Patauá.
Trindad: Jagua; Palma de jagua; Yagua.
Venezuela: Aricaguá, Aricacuá; Coroba; Curuba; Hunguravi; Jagua; Kuanamré (Carib: Wayunkomo Kuarámo (Arawak: Baré); Kuhéri (Carib: Maquiritare); Kunhua (Carib: Maquiritare); Kunùa (Carib: Pemón); Kunwada (Carib: Kamarakoto); Kunyek (Carib: Pemón); Kupéri (Guahibo); Pal de leche; Palma de jagua; Palma real; Palma seje; Palma zamora; Punáma (Arawak: Kurripako); Seje; Seje grande; Seje hembra; Unamá, Unamu; Yaro (Arawak: Baniva, Guarek).

Names in parenthesis are the linguistic group and/or tribe known to use that name.

[a]Locality is not necessarily an indication of the range of use of a common name; usage over a much greater geographic area may be made of a particular name. This list was compiled from published literature, herbarium specimens, and personal observation.

This table is not fully comprehensive. An example of its limitation was noted during a trip to the region around San Joaquín, Beni, Bolivia (ca. 13°S, 65°W), when I was trying to determine whether *Oenocarpus tarampabo* was still extant in the area. I queried local people using the two names I had taken from the literature, *tarampabo* and *trampabo*. No one knew of the existence of any type of palm with this name. On my way out from the region, I told someone that the general name for this palm group was *bacaba*, and there was instant recognition. Even though all of the available literature referred to *O. tarampabo* as *trampabo* or *tarampabo*, these names are no longer in current use.

It is interesting to note that in some locations the local people who utilize these palms have developed a system of folk classification that is much more complex than systems devised by botanists. Certainly, if the objective of the fieldwork is germplasm collection, a recognition and understanding of the local folk-taxonomic system is of great assistance in identifying local varieties of palms for further evaluation and utilization.

The usefulness of these kinds of observations became apparent to me during germplasm collection work with *Jessenia bataua* and *Oenocarpus bacaba* in the Vaupés of Colombia. In one region, six "types" of these two species were recognized by the Cubeo Indians. The first type, *cohañu* was said to have a normal seed, commonly harvested for oil and beverage production. The second type, *boécohañu*, was noted to be more flavorful than all the other types. It was of lower stature, with fruits that fall quickly to the ground when ripe. *Boécohañu* was said to be rarer than *cohañu*, and useful for oil and beverage production. The third type, *boreéyabeñu*, was a very tall type, to 17 m or more, with a smaller panicle and a very good crop valued for oil and beverage production. The first two-mentioned

types were identified as *Jessenia bataua*, and the third as *Oenocarpus bacaba*. The fourth type described was *hebücahañu*, a very tall (to 20 m) palm with a small panicle. Its use was not specified, and I never located a specimen in the field. The fifth type, *duecohañu*, grew in inundated areas. Neither its identity nor use were ever determined. The sixth type, *yaveécohañu*, known as the tiger palm, was the rarest and most desired. It had a larger trunk with a circumference greater than that of the others, but could be climbed. It grew on *terra firme* areas rather than in inundated sites. *Yaveécohañu* was only used for beverage production; it had a greater percentage of mesocarp than any of the others, and some people noted there was little oil. The tree is carefully guarded, never cut, and it was mentioned that this type was a "sacred" tree.

The reverence shown *yaveécohañu* intrigued me, as I was unable to distinguish this "special" tree from the rest. The Cubeo Indians insisted that the palm was unique, but I was not convinced. Only upon microscopic study of the trichomes on the abaxial surface of the pinnae did I find that these structures are intermediate in morphology between the peltate and sickle-shaped trichomes of *Jessenia bataua* and the needle-like trichomes of *Oenocarpus bacaba*. Using this and other morphological evidence, I became convinced that this was the first intergeneric hybrid in the *Oenocarpus-Jessenia* complex. This natural hybrid between the two aforementioned species possesses an important characteristic for domestication -- a smaller seed with no embryo, and a greater percentage of mesocarp in the fruit. This important discovery illustrates the value of studying local names, and collecting the different types of palms utilized by the people in the region.

FOOD

Thr *Oenocarpus-Jessenia* complex is most valuable as a food source. It provides oil, beverage, pulp, palm heart, and a medium for cultivating protein-rich insect larvae for human consumption. The fruits vary in size from ca. 1.6-4.0 cm in length, are globe shaped to ovoid, and deep purple in color (Fig. 1A). The oil is contained in the mesocarp, which is a few mm thick, and varies in color from cream to greenish to dark pink, depending on the species. In fact, local people often recognize 2 color forms of the same botanical species. For example, a single population of *Jessenia bataua* will sometimes yield fruits with either a whitish or reddish mesocarp. The local names for these "forms" in Peru are *blanco* and *morado*. Mesocarp color is said to be a stable characteristic, and does not vary from year to year. The reason for this variation is not known.

The mesocarp oil obtained from the *Oenocarpus-Jessenia* complex has physical and chemical properties nearly identical to olive oil (*Olea europaea*). An early observation on this oil by Richard Spruce noted the following:

> "The oil of these [various species of *Oenocarpus* and *Jessenia*]... is colorless and sweet tasted, not only excellent for lamps but for cookery... I can bear testimony that for frying fish, Bacaba [*Oenocarpus*] is equal to either olive oil or butter..." (Spruce, 1908, p. 479).

In the July 1972 issue of Brazilian Bulletin, the following description of the oil of *Jessenia bataua* (referred to as "pataua") is offered:

> "If U.S. gourmets ever tasted pataua oil, they would give up olive oil. Pataua oil ... is like an essence of olive oil and about the same color, though a little greener. It is prized as a salad and cooking oil and gives a taste to food which would be envied by Italian cognoscenti."

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Fig. 1. A. Fruits of *Jessenia bataua* with a portion of the epicarp removed to reveal oil-rich mesocarp. B. The *sebucan* or *tipi-tipi* basket press.

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The most effective method of traditional extraction involves the use of a cassava basket press, known as a *sebucán* or *tipi-tipi* (Fig. 1B). A detailed description of the process is presented in Balick (1986) and is summarized here.

A quantity of ripe fruit is harvested from the forest, placed in a pile, and covered with leaves or a plastic tarp and left overnight to ripen further. The next day a cauldron of water is heated to ca. 50°C, taken off the fire and the fruits are dumped into the water. After a few hours, the epicarp and mesocarp become soft, and the contents shifted to a smaller pot. The cauldron is filled with water and heated to just below boiling temperature. Fruits are transferred to the large cauldron, and the epicarp begins to split. These are put into a mortar and pounded with a club. The pulp (epicarp + mesocarp) separates from the seed (endocarp) and is sieved through a 1/2 inch screen. The pulp is quickly transferred to the basket press (*sebucán*, *tipi-tipi*) and pressure applied. Oil oozes through the weave on the press and is collected in a pan. As this oil contains a significant percentage of pigmented water, it is boiled off and the oil clarified. The clear light green or yellow oil (Fig. 2A) is then bottled. It has a shelf life of a year or more and, as any high quality oil, does not go rancid for many years.

A less effective method of processing oil involves breaking up the fruits in a pot of boiling water, letting the oil rise to the top and collecting it with a spoon or feather. This is a tedious and wasteful method, but said to be practiced in some parts of the Peruvian Amazon region.

The genus *Oenocarpus* literally means "wine fruit" in Greek. This is a name that truly reflects its use, as a good quality beverage is also made from the fruit of the *Oenocarpus-Jessenia* complex. While the beverage is not often fermented, it is still a drink that invigorates, and therefore the name is most appropriate.

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Fig. 2. A. Vial of oil from *Jessenia bataua*. B. Macerating the fruits of *J. bataua* to produce a beverage.

An early explorer, A. R. Wallace, considered the beverage of *Oenocarpus bacaba* to be "... of delicious flavour, somewhat resembling filberts and cream." (Wallace, 1853, p. 29). Although most of the species in this complex can be processed into a nutritious beverage, several species are preferred for this purpose: *Jessenia bataua*, *Oenocarpus bacaba*, *O. mapora*, *O. minor*, and *O. distichus*. Although the method for beverage production differs from place to place (as outlined in Balick 1986), it basically involves breaking up the mesocarp in water and filtering out the epicarp, endocarp and mesocarp fibers (Fig. 2B). The result is a dark, chocolate-colored oil-rich beverage. Whether it is called *chicha de seje* as in Colombia, or *vinho do patauá* as in Brazil, it is widely appreciated. In some areas it may be fermented, such as in the lowland forest region around Lago Agrio, Ecuador. A Quichua Indian explained to me that the Kofán in the region often let the drink ferment for 24 hours before mixing it with lightly fermented cassava or banana mash to consume after a few days of storage.

NUTRITIONAL VALUE

(Jointly Authored With S. N. Gershoff*)

During fieldwork in the Amazon Valley, it was observed that the daily consumption of *Oenocarpus* and *Jessenia* fruits had an important and visible effect on the local inhabitants. They gained weight, appeared healthier and reported fewer respiratory infections. A study was undertaken to ascertain the effects of eating these fruits on the people, and the results are reported in Balick and Gershoff (1981).

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Table 2 presents the data from an amino acid analysis of protein from *Jessenia bataua*. A comparison of the palm protein vs. the FHO/WHO provisional amino acid scoring patterns is presented, and only two amino acids are found to be limiting. These are tryptophan and lysine, but these are present at 90 and 96% of recommended levels. The data suggests that protein from *J. bataua* is comparable to that of animal protein and much better than most grain and legume proteins. Pulp from the species was mixed in a standard diet and fed to rats with the result that the biological value of the palm protein appears to be similar to that of casein. There were no abnormalities in the rats fed with either pulp or oil from *Jessenia bataua*.

Twelve samples of oil from *Jessenia bataua* were also analysed and compared with olive oil. The result of this analysis is presented in Table 3. The only significant difference was that olive oil has ca. 3 times more linoleic acid than *Jessenia bataua* oil. A small percentage of additional fatty acids were present in the *Jessenia bataua* oil; these are designated as "other" in the table. An analysis of *Oenocarpus* was also carried out with two mesocarp color forms of a single species, *O. distichus*. The result is presented in Table 4.

Although *Jessenia bataua* and *Oenocarpus distichus* are in the same complex, the oil they produce is remarkably different. *Oenocarpus distichus* has significant levels of pentadecanoic acid (25.3%), which is not found at all in *J. bataua*. In addition, linoleic acid is found at a level of 27.7%, more than ten times the percentage found in *J. bataua*. It is interesting to note that in the two "forms" of *O. distichus* -- the form with a whitish mesocarp (referred to as "branco") and the form with a yellow-green mesocarp (referred to as "amarelo") -- the fatty acid composition is quite similar. The only difference, therefore, appears to be the pigment.

Table 2. Amino Acid Analysis of *Jessenia bataua* Protein

Amino Acid Component	Mg of Amino Acid per Gram of Protein: mean ± standard deviation*	Amino Acid Scoring Pattern**	% of FAO/WHO Scoring Pattern
Isoleucine	47 ± 4	40	118
Leucine	78 ± 4	70	111
Lysine	53 ± 3	55	96
Methionine	18 ± 6		
Cystine	26 ± 6		
Methionine + Cystine	44 ± 9	35	126
Phenylalanine	62 ± 3		
Tryrosine	43 ± 5		
Phenylalanine + Tyrosine	105 ± 7	60	175
Threonine	69 ± 6	40	173
Valine	68 ± 4	50	136
Tryptophan	9 ± 1	10	90
Aspartic Acid	122 ± 8		
Serine	54 ± 3		
Glutamic Acid	96 ± 5		
Proline	75 ± 8		
Glycine	69 ± 4		
Alanine	58 ± 4		
Histidine	29 ± 4		
Arginine	56 ± 2		

*Values represent mean ± standard deviation for 7 separate samples with the exception of tryptophan, for which only 3 samples were analysed.

**FAO/WHO provisional Amino Acid scoring pattern. The scoring pattern represents an "ideal protein" containing all the essential amino acids to meet requirements without excess (Food and Agriculture Organization of the United Nations/World Health Organization 1973.

Table 3. A Comparison of the Fatty Acid Composition of *Jessenia bataua* Oil and Olive (*Olea europaea*) Oil.

Fatty Acid	*Jessenia bataua** Samples, %	Olive Oil Samples, %
Palmitic	13.2 ± 2.1	11.2
Palmitoleic	0.6 ± 0.2	1.5
Stearic	3.6 ± 1.1	2.0
Oleic	77.7 ± 3.1	76.0
Linoleic	2.7 ± 1.0	8.5
Linolenic	0.6 ± 0.4	0.5
Other	1.6 (range 0.2 - 4.6)	--

*Values given as the mean ± standard deviation of 12 separate samples.

Table 4. Fatty Acid Analysis of *Oenocarpus distichus* Pulp

Fatty Acid	Var. "amarelo" %	Var. "branco" %
Pentadecanoic	25.3	24.0
Palmitic	1.6	1.3
Palmitoleic	1.6	1.3
Stearic	2.5	2.6
Oleic	36.8	39.3
Linoleic	27.7	26.2
Linolenic	1.6	1.5

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Protein levels in the samples of the two forms of *O. distichus* ranged from 4.2-5.4% of total proximate composition. A very worthwhile research activity would be to characterize the oils found throughout the complex; this would assist in developing priorities for breeding by selecting for species with higher levels of polyunsaturated oils.

Because the major nutritional problem of people living in developing countries, most of which are tropical, is protein-calorie malnutrition, we have been particularly concerned with the oil and protein content and quality of this fruit. The protein, both by amino acid analysis and rat feeding trials, has a biological value equivalent to that of the best animal proteins. Unfortunately, the level of protein in the pulp following oil removal is relatively low. However, as shown from first-hand observations in the Amazon Valley, it is an excellent food for poultry and pigs.

A "milk" produced from the fruit pulp is widely consumed in the Amazon (Fig. 3A). Analysis of the caloric content of the beverage prepared in the laboratory--compared to human, cow and soybean milk--is presented in Table 5.

It is clear from data concerning the quality of the protein and oil that the beverage made from this plant is of high nutritional value. *Jessenia bataua* milk is most comparable in fat-protein-carbohydrate composition to human milk. Since the human protein requirement can be met by a diet containing less than 10% of its calories from high quality protein, the protein level in *Jessenia bataua* milk is more attractive than that supplied by soybean milk. Furthermore, the biological value of the *Jessenia bataua* protein is about 40% higher than that of soybean. On the basis of our very limited rat feeding studies and anecdotal information acquired during fieldwork in regions where *Jessenia bataua* oil and

Figure 3. Beverage produced from fruit of *Jessenia bataua*. B. Consuming the *J. bataua* beverage.

Table 5. A Comparison of Fat-Protein-Carbohydrate Content of Milk or Milk-Like Beverages

Approximate percentage calories from each	*Jessenia bataua* milk	Human milk*	Cow milk*	Soybean milk*
Fat	55.3	45.9	49.8	37.6
Protein	7.4	5.6	20.9	37.9
Carbohydrate	37.3	48.5	29.3	24.5

*Data from United States Department of Agriculture (1963).

milk are consumed by people and its pulp by animals, there is presently no evidence that this food contains toxic materials.

An increasing concern of nutritionists who have done studies among rice-, corn-, and wheat-eating populations in which approximately 70% of the calories are supplied by grain has been the low caloric density of the diets consumed. Even when adequate supplies of grain exist, children may not eat sufficient food to meet their caloric requirements. For this reason, a food with the high caloric density of *Jessenia bataua* is very attractive. Studies in man and animals indicate that the intake of essential fatty acids required to prevent deficiency lie within the range of 1-2% of total calories (National Academy of Sciences, 1980). *Jessenia bataua* milk contains approximately 1.5% of its calories from linoleic acid.

Those nutritionists who feel that a health advantage accrues from a high ratio of polyunsaturated fatty acids to saturated fatty acids may be slightly disappointed by the composition of *Jessenia bataua* oil, even though most of the fatty acid contained in the oil is the atherogenic neutral oleic acid. It may be possible that other species of palm fruit in the closely related genus *Oenocarpus* will provide oil with higher levels of polyunsaturated fatty acids.

OTHER FOOD PRODUCTS

Pulp residue is a by-product of beverage and oil production (Fig. 4). This is fed to domestic animals as a feed, as is the pulp beverage. People also consume the pulp by chewing on fresh fruits from the forest. This is said to be an excellent food while travelling in the forest. In one area (Chocó, Colombia), there was a report of the pulp being deep fried in oil and consumed, although this was never personally verified.

Figure 4. A. Pulp residue of *Jessenia bataua*. B. Pulp residue of *J. bataua* is fed to chickens.

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Heart of palm or *palmito* is a delicacy obtained from the immature growing tip of the palm. Most production for the commercial market is from two species of *Euterpe*: *E. oleracea* and *E. edulis*. In Brazil alone, the canning and export of palm heart is a multi-million dollar industry.

The heart of *Jessenia bataua* is a kilogram or more of edible material, with a slightly "nutty" taste not found in *Euterpe*. While of great value as a subsistence food it is probably of little value for cultivation, as the palm is much slower growing than *Euterpe oleracea*. Other species in the *Oenocarpus-Jessenia* complex, such as the caespitose *O. mapora*, may be competitive with *E. oleracea* in cultivation and should be tested. The young inflorescences of many palm species, including the *Oenocarpus-Jessenia* complex, are a delicious survival food and commonly eaten by local inhabitants.

Finally, the stems of the palms in the *Oenocarpus-Jessenia* complex are felled to attract weevil larvae (*Rhynchophorus palmarum*), which are then harvested for consumption. This is considered a first-class source of protein by many of the local people. For example, the Bora Indians of Peru actively fell palm trees to culture these larvae for eating, and ca. 1 kilogram of weevil larvae can be found in a single palm stem (Fig. 5). In my opinion, the weevils, when fried, have a mild ham and nutmeg flavor and are a perfectly acceptable food. Entomophagy, the consumption of insects, is a common practice among the Indians of the Amazon Valley of South America. Wallace (1853a) noted that 6 orders of insects were consumed by Indians in the Amazon Valley. Insects may some day become more acceptable as human food, because of their nutritional value and ubiquitousness in many regions.

MEDICINAL VALUE

These palms are important as elements of the native ethnopharmacopoeia of South America. The products are to be found in both the rural areas and in the herb markets of the capital cities (Fig. 6).

People use the oil of the *Oenocarpus-Jessenia* complex as a cure for bronchial and pulmonary afflictions. For a simple cough, the oil is taken, a tablespoon full at a time, 3-4x per day. It can be mixed with lemon or honey. Many people have mentioned this oil as a cure for tuberculosis. This use is discussed in the classic work on the medicinal flora of Colombia by García-Barriga (1974). Ranghel-Galindo (1945) discussed 3 studies on the medicinal value of *Jessenia bataua* oil in the treatment of tuberculosis. I observed the oil used in Peru with admixtures, such as sweet almond oil, for treatment of convulsive cough and bronchitis. The oil or green fruits can also be used as a purgative.

Jessenia bataua oil, when mixed with a liniment containing various anaesthetics and essential oils, is used to treat joint inflammation and pain. The oil is also used to prevent hair loss, by deeply massaging it into the scalp.

The Bora Indians of Peru use the germinating seedlings to prepare a drink taken for snakebite. Ten seedlings, each ca. 30 cm high are collected, the seeds removed from the plantlets, and soaked in water for a few minutes. Two cups of this liquid are reported to be consumed as a treatment of last resort when one is travelling in the forest and suffers a snakebite.

Figure 5. Wife of a Bora chieftain with a string of palm weevils prepared for eating.

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Figure 6. Plant and animal products (including seed of *Jessenia bataua*) used for a curative bath, sold in the herb market of La Paz, Bolivia.

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FIBER AND CONSTRUCTION

Rainforest peoples regard these palms as an important source of fiber and construction material. Wallace (1853) chronicled one of the more unusual uses of *Jessenia bataua*, the exploitation of its sheath fibers as the darts for Indian blowpipes. These darts, or "arrows" as he called them, were covered with curare and used in hunting. Figure 7, taken from his classic book, "Palm Trees of the Amazon and Their Uses," depicts the darts, a carrying quiver and sketch of the palm tree adorned with the sheath and petiole spines that always enclose the immature stem. The darts are made from these spines.

Actual preparation of the darts was observed at La Macarena, a Cubeo Indian village about one-half day by motor canoe upriver from Mitú, Vaupés, Colombia. Ample supplies of cotton-soft *Bombax* sp. (Bombacaceae) seed-fibers and 50 cm long spines of *Jessenia bataua* are collected. A small roll of string from the *cumari* palm, *Astrocaryum vulgare*, is also prepared. The kapok-like fiber, placed in a basket made from *Desmoncus* and *Ischnosiphon*, is whipped with the spines to separate the individual fibers. A number of the stoutest *J. bataua* spines are cut down to about 40 cm and sharpened to a slender point on one end. The other end, blunted and moistened with saliva, is inserted into a basket of fluffed fiber, and twirled. This end catches the first few hair-like fibers on the spine, and with further twirling, the base soon is covered with a loose mass of fiber. The mass is matted down by tightly spinning it against the inside of the hand and securing it to the shaft with a piece of *cumari* string. The finished darts are notched a few centimeters from the tip and covered with the arrow poison. The superbly accurate blowpipe, locally called *serbatana*, is here constructed from

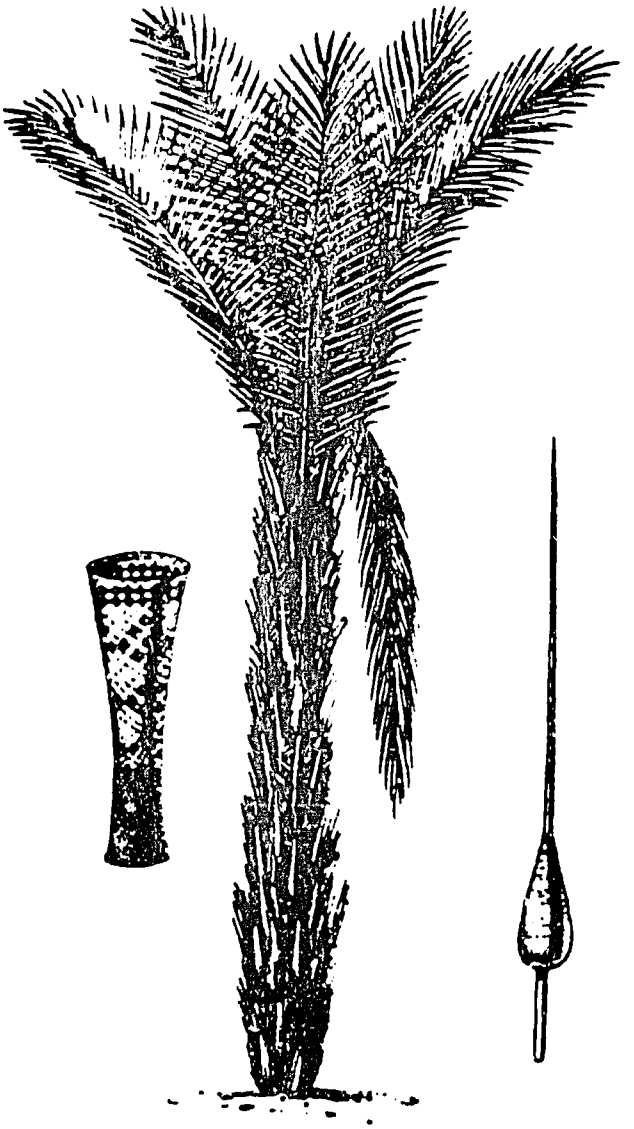

Figure 7. A drawing depicting a young spinose tree of *Jessenia bataua* (center); darts prepared from these spines (right); and a quiver used to carry the darts (left).

the trunk of another palm, *Iriartella setigera*. The example observed in use by the Cubeo was said to have been obtained from the Kuripako, a group expert in the manufacture of blowpipes and curare.

These weapons are a miracle of aboriginal engineering and craftsmanship. Light in weight, they can be transported and aimed with ease, operate silently and are deadly accurate. In addition, only locally available materials are used in construction, so manufacture or replacement is not difficult. In the field, darts fired from the blowpipe penetrate deeply into the quarry. If an animal attempts to remove the imbedded spine, the notched, poisoned tip breaks off and remains in the body. Subcutaneous exposure of the curare delivered by the dart causes paralysis of the voluntary muscles, resulting in death by asphyxiation or failure to escape from the waiting hunter.

Other implements for hunting and warfare are made from these palms. Anderson (1978) reported that the Xiriana-teri group of the Yanomama tribe in Amazonian Brazil occasionally still use *Jessenia bataua* wood for making fighting clubs. He observed that "...the dense wood of this palm must make such clubs terribly effective." This reference also described the manufacture of a hunting bow from the same wood.

The Guahibo in the Llanos of Colombia hold the wood of *Jessenia bataua* in high regard for the manufacture of bows and arrow points. They refer to a single folk cultivar of *J. bataua*, known as *ataito*, as specific for this task alone. The rare tree that yields *ataito* wood is a tall and robust individual. Bows and arrow points made from this wood are prized for hunting, although the latter are uncommon now, having been replaced by metal. Balick (1979) described the effectiveness of Guahibo arrows: "The point would enter the animal (or enemy?) and catch on the squared central portion. The arrow could then be neither pulled out or

pushed through, and thus impeded the victim's movement, leaving a trail of blood for easy tracking and capture."

Intertwined among the upright, durable sheath-petiole spines of *Jessenia bataua* is a mass of soft, hair-like brown fiber. I have never observed this in use by rain forest Indians. Dodge (1897), however, described its utility: "*Oenocarpus* [=*Jessenia*] *bataua* is found in the state of Pará, Brazil, where it is said "to furnish the strongest ropes for the navy."" In the same reference, *O. bacaba* is described to "...yield a piassaba-like fiber." Piassaba (*Leopoldinia piassaba*), although a much rarer species in the Amazon, produces fiber in far greater abundance than *O. bacaba*, which undoubtedly precludes any widespread commercial interest in the latter.

The large, arched pinnate leaves of *Oenocarpus* and *Jessenia* palms are used as shelter and thatch by various tribes in the Amazon Valley (Fig. 8). Common practice in many localities is to "cap" the uppermost portion of a thatched roof with leaves of *Jessenia* and *Oenocarpus* species, making it watertight, while still permitting smoke from cooking fires to escape. Among the Guahibo, *J. bataua* and *O. mapora* serve this purpose. The Xiriana-teri produce decorative mats from *J. bataua* (Anderson 1978). I have seen Cubeo living along the Río Vaupés in Colombia fabricating walls and other partitions from this species. At one village, a cone-shaped coop, fashioned from *Jessenia* leaves, served to protect chickens from nocturnal attacks by vampire bats. On the Río Yaguasyacu, the Bora employ both *O. mapora* and *J. bataua* for construction purposes. The trunk of the former species, known as *chicyora*, is used both as the main framework of the house and the roof crossbars, on which *Lepidocaryum* sp. thatch is woven. Temporary shelters of *chicyora* leaves are also made while traveling in inclement

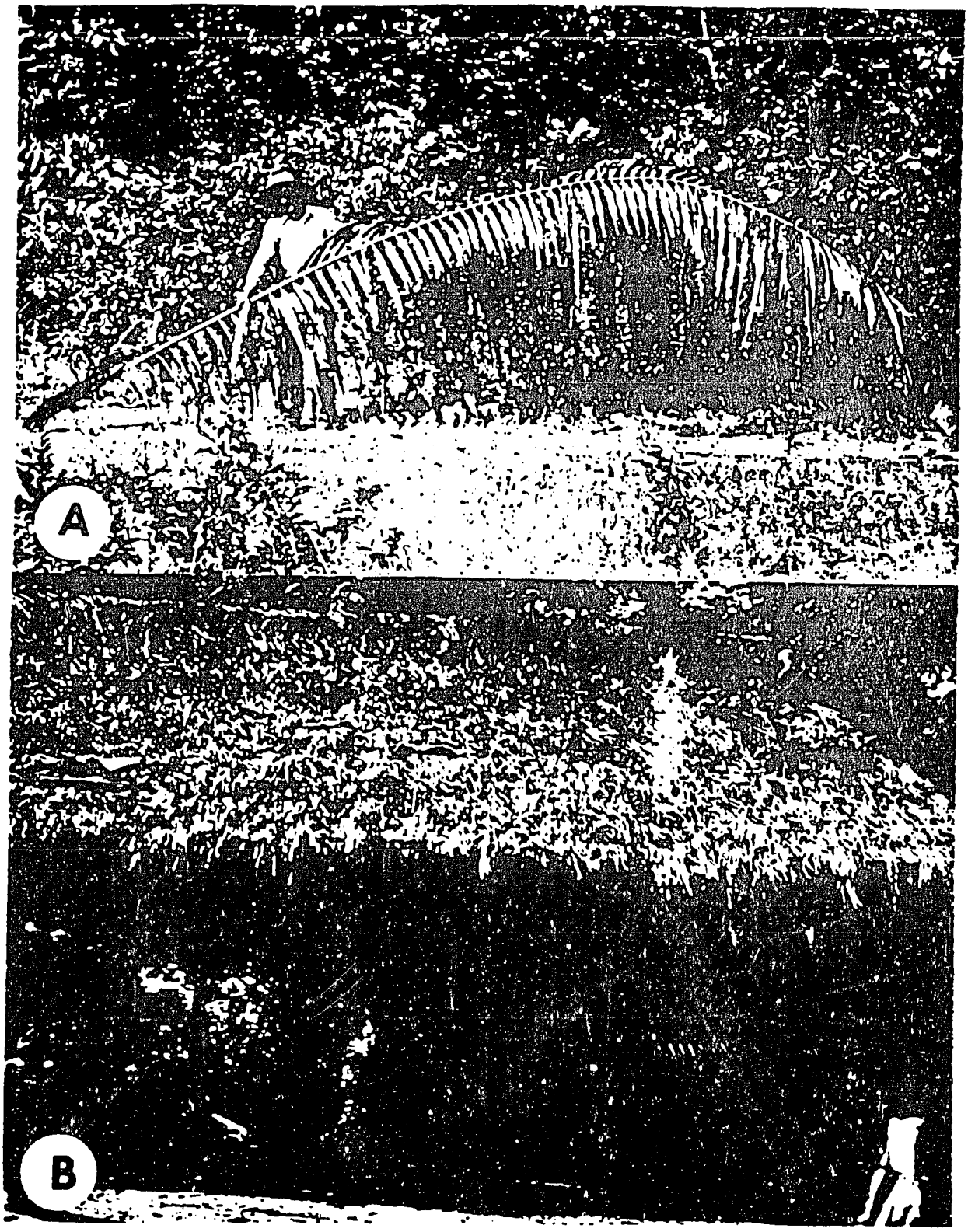

Figure 8. A. Pinnate leaf of *Jessenia bataua*. B. Indian house thatched with leaves of *J. bataua*.

weather. In Vaupés, these quick lean-tos are called *miatissabas*.

During a foraging trip with the Bora, a tree of *Jessenia bataua* was felled for fruit collection. The Bora told me that they rarely carried pack baskets into the forest; the reason soon became evident. Selecting a single long palm leaf, our guide folded it into a "U" shape, wove the pinnae into an interlocking sequence, and created a pack basket in about five minutes. After being filled with the fruit cache, it was secured to the head by a cord of twisted vine bark affixed to the upper sides of the basket. Upon seeing our interest, a second man quickly wove a smaller basket of two separate rachis pieces, in which a braid of the woven pinnae rests against the head for support. The larger basket easily accommodated a small child weighing 30-40 kg and was said to be able to carry the heavy carcass of a slain animal with no hardship to the bearer. Such provisional baskets are discarded after use, and my wish to take one back to the U. S. as a specimen was regarded as rather absurd.

Even the spent inflorescence of *Jessenia bataua* is not wasted by the Bora. After consuming the fruits, they salvage the large peduncle and rachis and carve it into the form of a small child. The clasping base represents the legs, and the apex with a few trimmed rachillae, a head with hair. Small children are given these training "toys" which, when placed on their hips, accustom them to carrying siblings later on. The *wa-wa*, as they call it, enables Bora children to become skilled at the task at an early age.

MISCELLANEOUS USES

A number of other uses have been reported for the palms in the *Oenocarpus-Jessenia* complex. These are detailed in Balick (1986) and include: oil for a meat preservative; oil as an engine lubricant and anti-rust agent for

firearms; the spine-like leaf fibers for torches; the fruits for dye; the dried seeds as a love amulet; the endocarps as beads for necklaces, the dried pulp as an edible food when reconstituted with water and; the young seedling as ornamental plants in terraria and dish gardens.

THE IMPORTANCE OF ETHNOBOTANICAL OBSERVATIONS

It is very important to acquire an understanding of the local uses for these palms, in order to assess the potential importance of the palms in other situations. Multi-use species are extremely valuable for agroforestry; the palms in this complex serve many functions and should be more widely cultivated.

Local market studies are important in domestication work on any plant. An example from the present study illustrates this point. Until recently, *Jessenia bataua* was not known in Bolivia. It is not mentioned in Balick's (1980) systematic study of this genus. While wandering through the herbal markets of La Paz, Bolivia a few years ago, I found seeds of *J. bataua* for sale in a mixture for an herbal bath remedy. In reply to my query as to the origin of these seeds, it was noted that the seeds were obtained from the lowland region of Bolivia. After a visit to the locality described, the genus was found to be quite common. This simple observation led to the discovery of a new record for this genus in Bolivia, which constitutes an important population and source of germplasm for future work. Ethnobotanical investigation is closely linked with germplasm collection and studies of palm distribution and biology.

CHAPTER 2

ECONOMIC UTILIZATION

EDIBLE OIL PRODUCTION IN LATIN AMERICA

This chapter discusses some of the economic aspects that must be considered before any attempt is made at commercializing *Oenocarpus* and *Jessenia* oils. Data and yield calculations involve a single species, *Jessenia bataua*. This is presumed to be the most productive species of the complex. Because there has never been a major attempt at plantation cultivation and scientific domestication of *Jessenia bataua*, some of the calculations and assumptions presented are based on extrapolation from educated guesses developed mainly from first-hand field observations or available literature studies. The ambiguous nature of these data is clearly indicated as such, and caution would be advised in developing long range economic forecasts using the figures mentioned.

The focus of this study is on Latin America, where the palms are presently located and immediately usable. The technology is transferrable to any tropical location--by planting the seeds elsewhere. Interest presently exists in commercializing the palms in both the Old World and New World. This chapter offers a summation of some of the current knowledge and seeks to encourage additional domestication efforts.

Edible fats and oils play a vital role in human nutrition. As appealing foodstuffs, they provide energy, serve as a carrier for certain fat soluble vitamins (A, D, E, K) and are used in the construction, repair and maintenance of body tissue.

Tropical America, as is true of other tropical areas, suffers from a serious edible oil shortage (Table 6), directly affecting both the health of the local

Table 6. Latin American Imports of Oils and Oilseeds[1]

	(100 Metric Tons) 1975	1976	1977	1978	% of World[2] Imports
Coconut Oil	196	184	1	50	0.5%
Cottonseed	27	1,081	403	446	30.0%
Cottonseed Oil	527	392	525	434	12.3%
Groundnuts[3]	484	210	200	20	0.3%
Groundnut Oil	358	530	1,284	523	12.3%
Olive Oil	97	111	112	80	5.0%
Palm Oil	0	104	110	84	0.4%
Soybeans	1,039	4,185	6,098	6,493	2.8%
Soybean Oil	947	1,705	1,990	2,311	11.4%
Total	3,675	8,502	10,723	10,441	

[1]If not included in the table, Latin America did not import in measurable quantities.

[2]1978.

[3]Shelled basis

Source: Food and Agriculture Organization of the United Nations 1979.

of edible oils are frequent in these areas, and prices often fluctuate wildly. Local governments allocate valuable foreign exchange to purchase such oils. The encouragement and development of local oilseed industries would lessen the outflow of currency, permitting the apportionment of funds for other necessities. Among the social benefits accruing from a local increase in oilseed production could be the creation of additional jobs, lessening of rural flight and migration to urban areas, an increase in the G.N.P., the stabilization of land ownership and the encouragement of agricultural programs in appropriate areas.

Animal fats and oils were once more popular than those from vegetable products. Presently, for health reasons and ease of production, interest has declined in such animal products. Edible vegetable oil output of both the United States and the world has grown at a greater rate over the past few years than has that for animal fats. It thus appears that we should turn to the plant kingdom for the solution of this Latin American "oil crisis."

The most important world oilseed crops are soybeans, cottonseed, groundnut (peanut), sunflower and rapeseed (Table 7). Of a 47,837,000 metric ton (MT) 1978 world production of oil crops (oil equivalent), Latin America produced 5,441,000 MT, a significant percentage for local consumption. The dollar value of these commodities is rather high. Venezuela alone imported U.S. $73,000,000 worth of fixed vegetable oils and fats and U.S. $36,400,000 worth of oilseed nuts and kernels in 1976. Clearly, there is room for increased local production of edible oils.

As discussed in the chapter on botanical classification, the *Oenocarpus-Jessenia* complex consists of nine species and six subspecies. Each taxon varies in height, form, size of fruits, yield and many other characteristics. The geographic range of this complex includes the Amazon Valley and much of northern South America, up to an altitude of about 1000 m, where the palms are found on the

Table 7. World Production of Oilseeds and Vegetable Fats

(1,000 Metric Tons)

	1982	1983	1984
Castor Beans	880	925	1,038
Copra	4,779	4,512	3,704
Palm Kernels	2,255	2,136	2,452
Palm Oil	6,384	5,894	6,809
Cottonseed	27,948	27,792	32,241
Olive Oil	2,158	1,764	1,917
Groundnuts	18,302	19,072	20,611
Linseed	2,842	2,234	2,574
Rapeseed	15,075	14,025	16,638
Sesame seed	1,911	2,110	2,113
Soybeans	92,277	79,407	89,893
Sunflower seed	16,223	15,495	15,941
Tung Oil	94	95	92
Total	191,136	175,461	196,023

Source: FAO 1985.

Andean foothills. The verdant rain forests of the Amazon Valley contain the highest density of exploitable plants.

Jessenia bataua, a massive palm in the rain forest environment, often attains a height of 20-25 meters. Fruits form in bunches, known botanically as panicles, and hang on the smooth trunk just below the tuft of leaves. This palm is primarily an inhabitant of wet areas. Thriving in heat and humidity and able to grow equally well on either seasonally flooded or upland areas, its ability to withstand inundations of water is certainly an advantage for exploitation. Dense stands of palms covering large areas are frequently found in the wild. These zones are immediately usable for commercial exploitation. Unfortunately, the practice of felling instead of climbing the plentiful trees for harvest and of burning forest land for colonization has eliminated useful palm populations in some areas.

MARKET POTENTIAL

Indigenous populations have long extracted the fruit pulp (mesocarp) oil for use as a food. Such a procedure is simple: the fruits are heated, pulp removed and oil expressed in a woven basket press. While requiring no elaborate equipment, the primitive methodology used cannot remove 100% of the mesocarp oil from the fruit. *Jessenia* oil also has medicinal qualities as discussed earlier in this work. Thus, in addition to its value as a food oil, it can command an even greater local price by marketing it as a curative.

The many uses and high prices (up to $15.00 per liter in Venezuela for medicinal purposes) now in effect for the limited production in the Amazon Valley give an

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indication of the value of the oil. The most widespread use, however, is as a high quality edible and salad oil. Chemically, the composition of this oil is surprisingly similar to that of olive oil. Similarities and differences can be seen by a comparison of the oil to other commercial species (Table 8; refer also to Chapter 1). The most striking similarity is the high percentage of oleic acid: 80.5% in olive oil and 76.5% in pataua (*Jessenia bataua*) oil. Under current marketing and trading laws pataua oil could never be surreptitiously labelled as olive oil and sold. However, with its similar, even superior flavor, the introduction, if properly managed and marketed, would undoubtedly be successful. For the economic aspects of this analysis, the substitutability of pataua and olive oils has been assumed. Given this similarity, some idea of the potential volume and value of the pataua oil industry can be obtained by examining statistical information available on olive oil.

Olive oil is obtained by crushing ripe olives, which yield 15-20% oil by weight. The first pressing releases the most valuable substance, known as virgin olive oil. Subsequent extractions yield a lower grade oil. Olive oil is used mostly as a salad and cooking oil, although other uses are in soap making and wool combing. As a high quality oil, olive oil commands a significantly greater price than other edible oils. Table 9 outlines comparative prices from 1972-1979.

Depending on the figures and the years, olive oil is approximately three or more times more costly than African Palm Oil, which in tropical American countries is being widely planted in many of the lowland areas.

A report by the World Bank shows a similar price differential in favor of olive oil, a spread projected to exist at least until 1990. Index calculations for 1977 and 1990 lead one to expect a stable fourfold difference during this time (Table 10).

Table 8.

A Comparison of Fatty Acids Contained in Selected Fats and Oils

Species:	Pataua (*Jessenia*)	Olive (Spanish)	African Palm	Soybean
Fatty Acid %				
Oleic	76.5	80.5	43.1	33.6
Linoleic	3.4	6.9	7.5	51.8
Palmitic	8.8	9.4	39.0	6.8
Stearic	5.6	1.4	3.5	4.4
Myristic	-	1.02	2.4	-
Linolenic	-	-	-	2.3

Source: Jamieson 1943.

Table 9. Wholesale Prices for Fats and Oils in the U.S.

Cents/Pound	Calendar Year 1972	Calendar Year 1977	March 1978	December 1979
Olive oil (imported f.o.b. N.Y.)	42.7	86.7	86.7	83.3
Coconut oil (imported f.o.b. N.Y.)	10.7	28.4	32.9	41.6
Soybean oil (refined N.Y.)	12.1	29.0	31.7	30.9
Palm oil (bulk U.S. ports)	--	24.3	27.4	30.1
Palm kernel oil (bulk U.S. ports)	--	33.3	36.9	42.8
Peanut oil (refined N.Y.)	20.4	36.3	41.2	36.2
Safflower oil (drums N.Y.)	31.4	52.0	52.0	-na-
Cottonseed oil (tanks N.Y.)	15.8	30.5	32.0	34.8
Corn oil (refined f.o.b. N.Y.)	19.3	36.5	49.5	34.8

Source: United States Department of Agriculture 1978, 1978a, 1980.

Table 10. Selected Fats and Oils--Actual and Projected Prices
(Current U.S. $ Per Metric Ton)

Year	Soybean	Olive	Palm	Palm Kernel
1960	$ 225	$ 585	$ 228	$ 317
1975	619	2,436	434	409
1977	576	2,234	530	620
1980	668	2,753	611	1,010
1985	1,089	3,778	882	1,298
1990	1,402	5,417	1,139	1,695
Index (1977)	26%	100%	21%	31%
Index (1990)	26%	100%	24%	28%

Source: World Bank 1980.

Because of the influence of the Spanish and Portuguese cultures, a strong tradition of olive oil use in Latin American cookery exists. None of these areas are important producers of olive oil, with the exception of Argentina. Table 11 lists olive oil imports by selected countries for this region.

There is a basic need and market for olive oil in Latin America, and pataua oil could successfully compete in this market.

The health factor also plays a part in trends of edible oil consumption. Those seeking to lower serum cholesterol in the diet may choose unsaturated oils such as safflower, sunflower and corn oil over saturated oils such as coconut, African palm, lard and cottonseed. Olive oil and probably *Jessenia* oil are most likely neutral in this regard because of their high concentrations of oleic acid, and have a comparative advantage for the producer in this portion of the market.

Current world producers of olive oil are for the most part European countries. Lesser amounts are also grown and exported from Asia, Africa and Argentina (Table 12, 13).

Because of the strong consumer demand for olive oil, there appear to be few short term effects on olive oil-producing countries resulting from the development of a pataua oil industry. A very small amount of pataua oil, relative to overall olive oil production, could be expected to be produced during the next decade if exploitation efforts were to begin immediately.

HISTORY OF PAST TRADING

A small international commercial market for pataua oil developed during the volatile trading years of the Second World War. With European sources cut off, the Amazon was able to supply moderate quantities of "olive oil" for commerce. The program in Brazil was limited and not well organized--at the cessation of

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Table 11. Use of Olive Oil by Selected Countries

(U.S. Tons)

	1973	1974
Brazil	17,365	30,000
Colombia	190	270
Ecuador	140	170
Guatemala	159	200
Costa Rica	56	58
Mexico	119	112
Venezuela	787	1,000
U. S. A.	32,705	41,240

Source: Wilkie 1977.

Table 12. World Production of Olive Oil*

(1,000 Metric Tons)

	1969-71	1976	1977	1978
Africa	173	154	213	184
Libya	8	11	21	26
Morocco	41	41	32	36
Algeria	21	11	21	26
Tunisia	103	91	139	96
North and Central America	2	2	2	3
Mexico	1	1	1	1
U.S.A.	1	1	0	1
Other	0	0	1	1
South America	18	13	12	11
Argentina	17	12	12	10
Other	1	1	0	1
Asia	128	282	143	264
China	1	1	1	1
Cyprus	2	3	3	2
Iran	1	1	1	1
Israel	1	1	1	2
Jordan	3	5	2	7
Lebanon	11	11	7	10
Syria	23	58	42	60
Turkey	86	201	86	181
Other	0	1	0	0
Europe	1228	1067	1434	1312
Albania	4	7	7	7
Greece	178	251	259	262
Italy	553	325	737	496
Portugal	70	40	33	33
Spain	419	442	395	510
Other	4	2	3	4
Total	1549	1518	1804	1774

*As some figures are unofficial or estimates, the data do not necessarily total correctly and, in addition, may represent minor production from other sources.

Source: Food and Agriculture Organization of the United Nations 1979.

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Table 13. Olive Oil--Percentage of World Production by Area

	1969-71	1976	1977	1978
Africa	11.0%	10.1%	11.8%	10.3%
North and Central America	0.1	0.1	0.1	0.2
South America	1.1	0.9	0.7	0.6
Asia*	8.3	18.6	7.9	14.9
Europe	79.5	70.3	79.5	74.0
Total	100.0%	100.0%	100.0%	100.0%

*Includes the Middle East.

Source: Food and Agriculture Organization of the United Nations 1979.

hostilities, production dropped and imports and the widespread use of olive oil began once again. The reason for this decrease is not known but could be based on supply and price of pataua oil, the desire to rebuild war-ravaged European economies or other factors. Table 14 illustrates the pataua export figures for Brazil. Since most of the oil produced was said to have been for the export market, these figures are also a general approximation of total commercial production. There is, of course, no way to know the entire annual volume for any single year or at present, as bottles are continually being produced for individual use or barter.

Records exist for some instances of the importation of pataua oil into the United States, contained in the following document: U.S. Court of Customs and Patent Appeals, No. 4614, filed December 7, 1948. The Nylos Trading Company of New York imported 63 drums of pataua oil from Brazil for use by the Conti Products Corporation in the manufacture of soap. A dispute arose over the classification of oil for import tax purposes. The Tariff Act of 1930 (paragraph 1732) provides for the free importation of palm oil. However, the U.S. Customs claimed that this oil was not "palm oil" but "patava oil" (semantically equivalent to "pataua oil") and thus assessible for duty at 20% *ad valorem*, according to the provision in paragraph 53 of said Act, providing duty "for all other expressed or extracted oils, not specifically provided for."

Various authorities in the field, including a botanist, chemist and oil trader offered testimony during the case. The Court ruled that "palm oil" was specifically to refer to the product of *Elaeis guineensis*, the African Oil Palm. Even though "patava oil" was an oil from a palm tree, its commercial classification was to be, from that time on, distinct from "palm oil." Thus, the precedent was established for excluding "patava oil" from the legal and commercial category of "palm oil." This distinction might today be a useful one if "palm oil" projects are not acceptable to funding sources in the United States.

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Table 14. Exports of Brazilian Pataua Oil

Year	Amount in Kgs	Cruzeiros Value
1939	14,870	70,000.70
1940	71,265	364,107.00
1941	70,914	571,632.00
1942	121,934	1,297,568.00
1943	103,849	1,336,897.70
1944	214,674	2,845,232.00
1945	150,109	2,002,107.80
1946	95,503	1,970,082.50
1947	26,727	661,587.70
1948	29,891	538,436.00
1949	24,656	408,260.00

Source: Pereira-Pinto 1951

Several assumptions can be made concerning the short-lived production of pataua oil for the export market. Because of the crisis situation involving the loss of traditional supplies of olive oil, the pataua oil "industry" developed quickly and with no real organization. It is likely that most of the trees were felled during oil collection, to obtain as many fruits as possible in the least amount of time, without regard for future production (once a palm tree is cut down, it does not grow back in the manner of dicotyledonous trees). Hence, large areas of palms were destroyed, explaining the absence today of this once widespread tree near many rural villages. Consequently, future attempts must require a more rational exploitation such as cultivation of plantation trees, in a system comparable to that used for the African Oil Palm, or the sustained management of existing palm stands.

Oil extraction during this short period of production was accomplished by primitive methods, owing to the isolated location of the palms. An efficient and economical procedure was not used. For the proper development of an industry today, mechanical presses are vital for removing all of the mesocarp oil possible.

Summarizing lessons learned from this wartime experience, several objectives and requirements may be stated for a proposed pataua domestication project:

1. A good organization and infrastructure is required. Sites for exploitation must be situated near rivers, roads or other means of economical transport. Semi-skilled labor is required for operation of the extraction facility, overall project organization and supervision. As fruits deteriorate rapidly when ripe, the flow rate from the field to press must be uniform and carried out in a minimal amount of time.

2. Existing palms in the wild must be conserved by prohibiting the felling of trees for harvest. This will assure no decline in the number of productive trees; rather, overall total will increase through natural propagation, e.g. seed production and dispersal. In addition, germplasm will be preserved in the wild until such time as large scale collection and preservation can be undertaken. Future domestication work will rely upon the available variation in palms for genetic manipulation.

3. Additional areas should be replanted with *Oenocarpus* and *Jessenia* palms. The replacement of forests and other tracts now devoid of exploitable products (e.g. wood, latex, nuts, etc.) with economic species such as pataua palms will increase the value of the land. The palms thrive in swampy or wet sites not suitable for most other species, and best use of such zones might be made through a massive reforestation program using *Oenocarpus* and *Jessenia* species.

4. Extraction must be done mechanically. Use of the basket press does not remove enough mesocarp oil for maximum financial return. A simple hydraulic hand unit can express a far greater percentage of oil.

CURRENT YIELD LEVELS

As stated before, present utilization of the *Oenocarpus-Jessenia* complex is on a very limited basis, with oil extracted at the request of an individual for use as food or medicine. In 1950, two agronomists, Luciano Sirotti and Gino Malagutti, undertook a study of the feasibility of the exploitation of Venezuelan populations

of "seje" (*Jessenia bataua* and *Oenocarpus bacaba*). Their detailed field observations provide an idea of what a grove of these palms is able to produce.

The "*sejales*"--almost pure stands of these palms--are composed of plants in various life cycle stages: seedlings, young, mature (fully productive) and senescent (dying or non-productive) individuals. This kind of forest is a dynamic system, with inputs from young plants adding to the overall population, and losses from senescent plants dying out. The rate of population flow and changes over a certain period are unknown. The mature (producing) palms as compared to the mature senescent or sterile non-productive *Jessenia bataua* trees were estimated by Sirotti and Malagutti (1950) in terms of productive and non-productive plants. Of the populations studied in the Venezuelan Amazon, it was found that 71.6% of the mature plants were productive and 28.4% were not. Of these, the average fruiting panicle weighed 14.5 kgs (range 12-18 kgs), of which 10.43 kgs (range 8-15 kgs) was pure fruit. Of the 71.6% productive plants, 29.9% produced 1 panicle, 42.1% produced 2 panicles and 36.8% produced 3 panicles. In a natural grove then, from 100 mature plants, an average of 154.6 panicles with approximately 10.43 kg of fruit each can be obtained--a total of 1612 kg of fruit.

According to the observations of these two agronomists, the number of plants per hectare in an exploitable *sejal* was as follows:

Seedlings (under one year)	1000
Young plants (1-4 years)	400-500
Bearing Plants	400-500

Variable percentages of oil composition are listed for the fruit of this palm, ranging from 5-10%. At 8%, the amount of oil that could be expected from these 100 plants would be 129 kg annually (282.8 lbs.). At 7.63 pounds per gallon, a

production of 37.2 gallons of oil might be expected from each 100 trees of *Jessenia bataua* growing under wild conditions. With a current wholesale price of 83.3 cents/lb for olive oil, the total return per 100 wild forest plants would be $236 each year. Taking an average of 450 bearing plants per hectare, a yield of 580.5 kg of oil is extractable each year, assuming a reasonable consistency in the forest structure and the integrity of the original calculations. At the wholesale price mentioned, 83.3 cents/lb, a return of $1064.00 per hectare can be obtained for the oil extracted. While this is not by any means a large sum of money, it must be remembered that great numbers of these palms exist today in many areas of the Amazon, although not all at the stated 400-500 trees per hectare density. These calculations were not able to take into account the harvest of *Oenocarpus bacaba* growing in the same areas as *Jessenia bataua*, and yielding equivalently oleaginous fruits, but ripening at a different season and thus also adding value to the land. Based on my own field measurements, a density of 450 bearing trees per hectare in the wild seems rather high, although these is no real reason to consider the calculations of Sirotti and Malagutti as suspect.

As has been mentioned, many areas where these palms were formerly abundant no longer exist. At present, clearing is proceeding at lightning speed, for colonization, local use and for whatever rationale is involved in peoples' destruction of their own habitat. Consequently, the feasibility of plantation cultivation must be considered for this palm, initiated at first by government, private sector and international agencies, perhaps in combination with other agricultural projects.

Agronomists often cite the high yields of *Elaeis guineensis* as good reason not to begin exploitation of *Jessenia bataua* or other oilseed crops. The current value of the African palm is praised as if it had always been a domesticated plant, especially as recent United States Department of Agriculture estimates show

yields of 3480 kg of palm oil and 421 kg of palm kernel oil respectively per hectare (U.S.D.A., 1976). Those skeptical of the value of *Oenocarpus* and *Jessenia* would be well advised to study the history of *Elaeis* domestication and consider what it once was, before making a quick decision regarding the utilization of other oil palms. To present fairly both cases, we must go back to the native locations of the African Oil Palm and also investigate its original production.

Elaeis guineensis is of African origin. Zeven (1967) supported this origin with fossil pollen evidence from the Miocene and younger (25 million years ago) in the Niger Delta. Early explorers and traders mention these palms in their journals as being useful for food. Much movement of the plant has continued, through domestication and use by man, and it is now common in tropical regions worldwide.

The habitat of many jungle palms is similar. While they can survive in the rainforest, through competition with other plants, they thrive in swampy and waterlogged areas because of a physiological ability to adapt to the low degree of soil aeration. In Africa, *Elaeis guineensis* is found in great stands on areas too moist to support the typical, diverse dicotyledonous vegetation of the rainforest. Zeven lists its habitats as fresh water swamps, sources and banks of water courses, moist valleys, banks of lakes, swamps, alluvial plains, and low-lying islands in rivers and forest fringes, especially in savanna areas. In these latter zones, palms can develop and multiply as they are not cut off from the sun by overhanging trees. The phenotype of the wild oil palm is thought to be thin-trunked with a covering of epiphytes and old leaves, and very small fruit bunches in comparison with those known today from plantation cultivation.

The biology and life cycle of the wild palm groves is most revealing. In a semi-wild environment, it may take 20-30 years for the palms to reach a fruiting age. In contrast, only four years are presently required until fruiting begins in

the domesticated African Oil Palm. For wild groves of *Jessenia bataua*, 8-12 years is cited as the time required for first fruiting. The percentage of bearing trees of *Elaeis guineensis* in wild stands in Africa is also of interest. Zeven (1967) noted that the number of mature palms bearing fruit in any one year varied from 54-63% in an Abak grove in eastern Nigeria. This compares to the 71.6% found for *J. bataua* in Venezuela. Examining the size of African Oil Palm bunches from the wild in Benin, Nigeria, Zeven calculated the average number of all stemmed palms per hectare as 59.6, each producing 1.9 bunches of fruit, weighing an average of 27.8 kg, or 14.3 kg for each bunch. Of this, the fruit:bunch ratio was a mean of 58:42, or an average calculated value of 16 kg fruit, of which 6.72 kg was mesocarp (pulp) and 2.24 kg kernel. In the same reference, an assumption is made of the oil: bunch ratio as 16%, which gives about 4.45 kg of oil per palm present. The yields of a grove near Abak range between 12.0 kg of bunches per plant (at 254 plants per hectare over an observation period of 1949-52 to 28.2 kg per plant (at 175 plants per hectare during 1949-59). Using the same oil:bunch ratio, yields range from 1.9-4.5 kg of oil per tree. Our previous calculation with *Jessenia bataua* gave a value of approximately 1.3 kg per tree, much lower than these values. However, keeping in mind the higher price of olive oil, a return of 3-4 times that of *E. guineensis* oil may be expected per kg. Using the pre-domestication biological data for the African Oil Palm, the great increase in oil production over time can be seen (Table 15). The African Oil Palm is a low yielding plant in the wild, with small fruits and few bunches. Under cultivation, Bunting *et al.* (1934) estimated fruit yields of 7-8 year old African palms at 6,287 kg/hectare, with 1527 kg of palm oil obtainable. Recent U.S.D.A. data for Malaysian palms suggest a yield of 3901 kg of oil (palm + palm kernel) per hectare. Highest yielding experimental results presented in Corley *et el.* (1976) list a maximum of 37,200 kg of fruit

Table 15. Present and Historical Yields of the African Oil Palm

	Kg Fruits/Hectare	Kg Palm Oil/HA	Oil:Bunch (%)
Wild State (Zeven, 1967)			
Benin (per 125 plants)	2,000	556	ca. 16
Abak (per 125 plants)			
Minimum	870	240	ca. 16
Maximum	2,044	564	ca. 16
Malaysia (Bunting *et al.*, 1934) Ca. 1930, 7-8 year old palms, 136 per hectare	6,287	1,572	not noted
Malaysia 1971-75 av. (U.S.D.A., 1976) (density not noted)	ca. 15,604	3,480 (+ 421 kg palm kernel oil)	ca. 25
Malaysia, experimental high-yielding plantation (Corley *et al.*, 1976) (density not noted)			
Spacing trial	28,500	6,760	23.7
Fertilizer trial	37,200	6,280	16.9
Progeny trial	30,400	8,420	27.7

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per hectare in some trials with up to 8,420 kg of oil produced per hectare in others. This last reference represents a total increase of just under twentyfold for total fruit production over wild trees, resulting from the intensive program of domestication and selection of *Elaeis guineensis*. The reasons for this include improved pollination, selection for disease resistance and higher yields and proper cultural care--in short, creation of an ideal habitat for the reproduction of the palm through its seed productivity.

PRESENT STATE OF DOMESTICATION

At present, the *Oenocarpus-Jessenia* palms are not domesticated in the agronomic sense of the word, e.g. taken from the original habitat and cultivated for successive generations by man (Seibert, 1948). Diversity of these organisms is poorly understood, as no study has ever been made over their entire geographic range. This investigation represents the most inclusive work to-date, but many important localities remain to be investigated.

One indigenous achievement has been the partial, subconscious domestication of the pataua palm through its everyday use as a food. Indians in each area recognize a number of different "forms" of *Oenocarpus* and *Jessenia*, always assigning a hierarchal preference ranking to each. As foragers, these people have an extensive knowledge about the composition of their rainforest and collect only those "forms" considered superior in taste, oil content, coloration, ease of harvest, etc. Panicles from such trees are brought back to the village and the fruit is prepared for consumption. As discussed in Chapter 6, heating the seeds and removing their oily mesocarp increases germination percentage and actually hastens growth rate.

After preparation, the seed from the preferred palms is discarded in the area surrounding the house, where it germinates and grows. Within a few years, the forest around a settlement contains a high composition of pataua palms. Even after abandoning a site, people return to harvest fruits from this select group of trees. Today, disturbed forest areas having concentrations of these palms indicative of past settlement are, consequently, choice locations in which to collect germplasm of superior, subconsciously-selected variants.

THE LAS GAVIOTAS MODEL OF UTILIZATION IN COLOMBIA

Centro de Desarrollo Integrado "Las Gaviotas" is a non-profit development agency located in the Llanos of the Comisaría del Vichada. An area of savannah and gallery forest, the region is, in general, unsuitable for conventional agriculture, so alternative solutions for development are being sought. The original objective of Las Gaviotas was to select a poorly populated area of Colombia, colonize it and build a permanent settlement dedicated to developing low-cost technology and uses for the region. The rational exploitation of native plants from the gallery forests, specifically extracting fats and oils from palm trees, is a prime goal of the agricultural program.

Guahibo and other residents of the region commonly clear and destroy the forests for swidden agriculture. Under the model program developed, Las Gaviotas would purchase fruits of *Oenocarpus* and *Jessenia* palms as a raw material for its small-scale, mechanized processing and extraction facility. For the first time, a financial incentive would exist for an individual farmer to conserve palms on his land for long-term fruit production, instead of clearing them for several short-lived annual grain or legume crops.

As the press and extraction facilities have been constructed by international organizations, most of the costs involved in processing are variable, and these costs primarily constitute labor. Thus, an individual landowner would receive a fair price for his sacks of fruit sold to Las Gaviotas. The collection scheme involves the organization of fruit harvests on a specific day in each locality. Then, people would bring the harvest to their village center--perhaps on market day--for collection by the Las Gaviotas truck. The truck transports fruit back to the facility for processing. Mechanical extraction procedures and costs are discussed in the next chapter.

One constraint for increasing production in this area appears to be the total supply of *Oenocarpus-Jessenia* palms, which have traditionally been cut for harvest. According to G. Blaak (pers. comm.), local residents could climb the palm to collect fruit panicles, ensuring a yearly financial reward, instead of simply cutting them down. A requisite for implimentation of the project is repopulation of the gallery forests of the Vichada with *Oenocarpus* and *Jessenia* palms -- specifically *O. bacaba*, *O. mapora* and *J. bataua*. This demonstration that people can practically and economically harvest the products of their tropical forests, especially in such an impoverished area, is an excellent model on which to base further development of agroforestry in other zones presently being decimated.

PROPOSED PLANTATION CULTIVATION

If a plantation of *Jessenia bataua* or *Oenocarpus sp.* is well cared for, an immediate increase in yields can can be assumed. If all palms of a single species are grown under uniform conditions, each should yield during the same season, and calculations will not have to be adjusted for non-productive (senescent

or diseased) plants. I have seen individual plants under semi-cultivated conditions with as many as 5 panicles apparent at one time, in various stages of flowering and fruit. A small, single inflorescence develops in each leaf axil, and aborts only when there is an indication that environmental or physiological conditions will not support its production. Thus, it is felt that with proper conditions, the number of panicles could be increased from two per year to a higher number. For example, if it is assumed that the average is 2.5 panicles per year, then the yield of fruit will be increased somewhat. Another factor is reproductive efficiency, that is, the actual number of fruits formed versus the potential number (based on the number of pistillate flowers). Field studies have shown a reproductive efficiency of only 3-15% in *Jessenia bataua* on a heavily-fruited panicle. The total amount of fruits that could be formed would be about 6-8 times the present 10.4 kg. The reproductive efficiency could perhaps be increased through better pollination, disease control and physiological methods. This area of biology is poorly understood, and reasons for the relatively low efficiency are not now known; perhaps there is no way to increase it. However, in plantation cultivation, through the skills of the breeder and agronomist, it is more likely that there would be a rise in the percentage of fruit set. As simple a procedure as hormone sprays during floral anthesis--as is done with vegetable crops--might be the answer.

It might be helpful to recalculate some of the figures for the proposed *Jessenia bataua* plantation, using the field observations of Sirotti and Malagutti (1950). On the scale of 100 well grown plants, the annual fruiting based on observations in the wild would be approximately as follows:

1 panicle	21%
2 panicles	42%
3 panicles	37%

Total: 216 or 2.16 panicles per plant

In the triangular spacing method of Hartley (1967), about 216 African Oil Palms are planted per hectare at an approximate spacing of 7.32 x 6.34 meters. Judging from the size of *Jessenia bataua*, this spacing could be possible, especially as the leaves are held upright on the palms during their early development and the first years of bearing. Only at full maturity do the leaves assume a horizontal orientation. This habit would allow for intercropping of the young plantation, adding a greater economic incentive to production.

An estimate of the oil yield per hectare from this planting, assuming no increase in reproductive efficiency or in the number of panicles produced, might be obtained as follows: 2.16 panicles x 216 palms x 10.4 kg of fruit per panicle = 4852.22 kg of fruit annually per hectare. At an 8% recoverable oil content, 388 kg (or 854 lb) of oil might be produced annually on a well managed planting of 216 trees per hectare. At 83.3 cents/lb the value would be $711.4 per hectare. It must be remembered that Latin American prices for olive oil are far higher than world market prices because of the duties and transportation costs involved. Therefore, a much greater price could be expected from sales of pataua oil in this region.

If an increase to 2.5 panicles annually produced is calculated, the total fruit harvested per hectare would rise to 5616 kg, yielding 449.3 kg (988.4 lb) of oil, or $823 per hectare. Finally, if reproductive efficiency is increased, and palms produced 12 kg of fruit per panicle, the per hectare yield becomes 6480 kg of fruit, 518.4 kg of oil (1140.5 lb) and a value of $950 (Table 16).

Admittedly, the previous calculations on a proposed plantation involve much speculation on unknown factors. Because there has never been a real attempt at cultivation, these figures are the only ones available. The census of 500 trees per hectare by Sirotti and Malagutti is an extremely high density of palms with a lower per tree production but an overall higher dollar yield. Whether these stands can be

Table 16. Forecasted Yields and Values of *Jessenia bataua* in a Domesticated State, Based on Values Calculated for Wild Palms

	# Palms/ Hectare	Kg Fruit Yield/ Hectare	% Oil	Kg Oil/ Hectare	Price/ Kg (cents)	Value/ Hectare ($)
Low Estimate	216	4852	8%	388	83.3	711
Medium Estimate	216	5616	8%	449.3	83.3	823
High Estimate*	216	6480	8%	518.4	83.3	950

*But still a conservative estimate, as increases in yield due to domestication and selection are unknown and not accurately predictable.

maintained and produce fruit over a long period of time in such a high density is questionable. As mentioned, my own experience in *Jessenia* palm groves shows the number of bearing trees to be much lower than the Sirotti and Malagutti figures. Furthermore, not taken into account here is the cyclical nature of pataua fruit production over a period of years. The tree begins yielding in great quantities, but, as it approaches senescence, yields begin to taper off. Sirotti and Malagutti use a lifespan of 50 years in their calculations, with the first few plants (density of 200 per hectare) bearing at years 7-10; 100% production being achieved during years 15-42; 60% production during years 43-46; and 25% production during years 47-50. Their estimate of 50 viable years may or may not be accurate and can only be investigated through long-term ecological studies.

A calculation of 22 kg of oil per tree is often cited in the literature (see for example National Academy of Sciences, 1975) but no sources or methods are ever given as to how this number has been ascertained. I have traced these calculations to a publication by the well known Colombian botanist Armando Dugand. Upon re-examining the figures, they appear to be incorrect, and the actual figures should be a maximum of 2.22 kg per tree per year, using his given variables. Because of their importance, the paragraph in which these calculations appear is reproduced at the end of chapter along with the re-calculations. In the Dugand figures, there was a probable misplacement of the decimal point, but it has since come to have been accepted, unfortunately, as fact.

In addition to *Jessenia bataua*, other species within this complex could be exploited. The genus *Oenocarpus* is also characterized by an oily mesocarp. *Oenocarpus minor* and *O. mapora* might be of value as, according to anecdotal information, they begin to fruit within 3-4 years of planting, a substantially shorter period than in *Jessenia bataua*. These two species of *Oenocarpus* are

smaller in stature, and caespitose. *Oenocarpus distichus* has a higher percentage of pulp in relation to kernel than *Jessenia* and, furthermore, develops its leaves along a single vertical plane, allowing for more intensive spacing per hectare. *Oenocarpus bacaba* is a species highly esteemed throughout the Amazon Valley for its oil production.

One additional use of *Oenocarpus* and *Jessenia* is for possible crossing with different groups of palms, using biotechnological methods now being developed for other crops. If a palm with high levels of oleic acid could be crossed with a high-yielding African Oil Palm, perhaps a clone could be developed of high-yielding palms yielding "olive oil." Although at present this technology does not exist, one should be aware of the possibility that one important role of the palms in the *Oenocarpus-Jessenia* complex would be for use in hybridization, in the same way as *Elaeis oleifera* is of most value when used in breeding work.

Present technology would allow for the conventional crossing of *Oenocarpus* and *Jessenia* as a first step. As is discussed in Chapter 7, natural hybrids between *O. bacaba* and *J. bataua* have been found in the wild. The resultant progeny produces a seed with a relatively higher mass of fleshy mesocarp to seed. When Indians in the Vaupés of Colombia locate trees of such parentage, they climb rather than cut the palms for harvest, as the hybrids are recognized and highly esteemed for good quality fruit production.

The only mature experimental plantation of species in this complex to my knowledge is at the EMBRAPA agricultural research station in Belém, Brazil. I had the opportunity of visiting the site, where *Oenocarpus distichus* is planted on sandy soil in the very high density spacing of 4 x 4 meters. Unfortunately, the experiment was abandoned for an unknown period of time, and the usual growth rates under normal plantation cultivation could not be calculated. After 16 years

however, with adverse conditions and poor soil, some trees were producing their first crop. The plants looked healthy and bore low enough to the ground to be harvested easily. There is no way of knowing the amount of secondary growth allowed to flourish in the planting and how this affected the experiment. A need remains for monitored repetitions with all species. Because various species fruit at different seasons, perhaps a year-round or extended harvesting scheme could be worked out--another aspect necessitating further study.

A singular problem noted in the *Oenocarpus distichus* plantation was weevil larvae found boring into the fleshy parts of palm, e.g. the leaf sheath and inflorescence. This pest was identified as *Rhynchophorus palmarum*, an injurious predator found also in the wild palm populations and deemed a possible insect threat to cultivation. The weevil attacks both coconut and African Oil Palm plantations in Tropical America, burrowing into the trunk and crown, especially on young trees. Techniques have been developed to help prevent and control infestations.

Other plantations that will yield information of value in further understanding the growth of these palms are near Itabuna, Bahia, Brazil and at CEPATU in Belém, Brazil. The first planting of *Jessenia bataua* is at the CEPLAC station (Una) outside of Itabuna. The second planting is at CEPATU in Belém, a germplasm bank coordinated by CENARGEN/EMBRAPA, the Brazilian National Germplasm Conservation Program. Both of these have been started only within the past five years and will be extremely useful research tools for understanding this complex.

In summary, utilization of this palm complex for oil production might proceed in two directions:

1. The existing stands of palms in Latin America are immediately exploitable.

2. Greater opportunity is through rational domestication, as *Oenocarpus-Jessenia* palms hold much promise as oilseed crops for tropical regions. Low yields at present and no knowledge of what future production rates could be are needlessly preventing the widespread domestication and use of this plant. However, it has been shown through the example of *Elaeis guineensis* that palm fruit yields increase greatly when selected for superior characteristics and given good agronomic conditions. There is no reason to doubt that an increase in production would occur when *Jessenia bataua* is grown in plantations, although perhaps not so dramatically as has happened with the African Oil Palm. Only consistent, scientifically based trials will provide the answer. If successful, such an increase in the number of oilseeds cultivated and the areas under cultivation will provide both economic and social benefits to producer countries and their inhabitants.

CONCLUSION

Oneocarpus and *Jessenia* are at present such a high risk crop that peasant farmers should not be expected to initiate cultivation on a large scale. Primary efforts, concomitant with the small-scale exploitation of extant populations in the Amazon Valley and elsewhere, should be directed towards the selection and domestication of desirable forms for plantation agriculture. Because of the high demand and rate of return that could be expected for pataua oil, it appears to be a potentially important crop for the tropics. No great short-term results or returns may be expected. A serious commitment of capital and research talent should be made by a major international organization which can utilize the most up-to-date genetic and agronomic techniques for the production of an acceptable crop meeting the

criterion necessary for domestication--high growth rate and yield, rapid maturation, low stature, thicker mesocarp. etc. To foster success, special marketing and support mechanisms could be set up by each local government, perhaps as a tax imposed on imported olive oil, while at the same time, offering a subsidy to those developing pataua plantations. If properly domesticated, the *Oenocarpus-Jessenia* complex could represent a substantial contribution as an important oilseed crop for tropical regions. The next chapter presents an analysis of the costs of installing a mechanical processing mill in a region containing wild *Jessenia* palms. Some of the numbers on which financial assumptions are based differ from those in this chapter. This is due to the fact that the industrialization and marketing are as yet still being proposed, and there is little historical data to draw upon. Nevertheless, any proposed project must be based upon an economic analysis, and so both sets of numbers are presented in this book, along with their underlying assumptions, to aid in the formulation of any future plans in a variety of settings.

ADDENDUM

The original text from Dugand's publication "Las Palmeras y El Hombre," (1972) in which the mistaken annual calculation of 22 kg of oil produced per pataua palm (here called *milpesos*) is presented in the following paragraph.

> "A los que gusten de números les interesará saber que la pulpa oleosa del fruto de la palmera colombiana llamada unamo o milpesos (*Jessenia polycarpa*), separada la semilla, constituye entre 36 y 39% del peso del fruto entero, una vez evaporada la mayor parte de la humedad. De tal cantidad el 18% o 19% es aceite aprovechable. Por lo tanto, de cada kilogramo de frutos enteros, tales como se recogen de la támara, resultan entre 65 y 70 gramos de aceite por término medio. El peso promedio de los frutos támara, excluído el del racimo mismo (o sea el pedúnculo y ramificaciones) es de 13 a 16 kilogramos, siendo el de cada fruto moderadamente seco, 8 a 9 1/2 gramos. Cada palmera adulta produce por término medio dos racimos anualmente (a menudo hasta tres), o sea unos 30 kilogramos de frutos, de los cuales se pueden extraer 22 kilogramos de aceite que equivalen a 24 litros, estimando la densidad en 0.915 (ver G. Pereira Pinto 1951:71). Dejo a los entendidos en economia la aplicacion de valores comerciales a estos simples datos numéricos."

Using his variables, the numbers should appear as follows: 30 kg fruit x 36-39% mesocarp content = 10.8-11.7 kg pure mesocarp; 10.8-11.7 kg mesocarp at 18-19% oil content = 1.944-2.223 kg pure oil from 30 kg fruit.

FOREST PALMS AS TROPICAL CROPS

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CHAPTER 3

MECHANICAL EXTRACTION AND PROSPECTS FOR DEVELOPMENT OF A RURAL INDUSTRY

(G. Blaak*)

OIL PRICE AND QUALITY

As discussed elsewhere in this volume, the mesocarp oil from the fruit of the seje** palm *Jessenia bataua* (Martius) Burret and *Oenocarpus bacaba* Martius is highly appreciated in Colombia and neighboring countries such as Brazil, Venezuela and Peru.

The yellow-green oil is used for consumption and by the Indians also for medical purposes. The chemical composition of the oil is very similar to olive oil (*Olea europaea* L.) and very different from the pericarp oil of the African oil palm (*Elaeis guineensis* Jacq.), as is indicated in Table 17.

The unrefined seje oil develops a unique, fragrant, resin-like scent during frying. The oil price varied from US$ 3.75/kg in 1980 in the production areas to US$ 8.25 in Bogotá as compared with US$ 0.65/kg for African palm oil. This high price justifies an economic analysis of the exploitation of wild seje palms and an analysis of the prospects of seje palm grown as a small-holder plantation crop.

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**Note that in this chapter the *Jessenia bataua* palm is referred to by its local name in Colombia, seje, as this is where the author's research has been carried out.

Table 17. Chemical Composition of Mesocarp Oil from Seje, Olive and African Oil Palm

Fatty acid	Seje oil	Olive oil	African Palm oil
Oleic acid	81.9%	83.1%	45.5%
Linoleic acid	3.4%	3.9%	8.2%
Palmitic acid	12.0%	9.4%	38.7%
Stearic acid	0.6%	2.0%	4.3%

Relevant information was obtained from a small seje oil mill that was designed and put in operation by the staff of the Royal Tropical Institute in Amsterdam for the Centro de Desarollo Integrado "Las Gaviotas," which is situated in the Llanos 500 km east of Bogotá. The pilot mill can process approximately 1000 kg fruit per 8 hours.

SEJE BUNCH COMPOSITION

The fruit bunch consists of a rachis to which numerous, long, fruit bearing rachillae are attached. The bunches may weigh 30 kg or more. The fruit to bunch ratio (total fruit wt/total bunch wt) is around 76% but can be as high as 83%. The fruits are round and green when unripe and purple/black when ripe. Each fruit contains a hard kernel surrounded by a fibrous white, pink or purple mesocarp. The outer layer of the fruit (epicarp) is purple colored and fairly hard when ripe. A summary of fruit analyses of individual bunches from different palms is presented in Table 18.

The mesocarp (pulp) to fruit ratio is on average 41.4% with a range from 25.5-44.7%. The oil content was determined by solvent extraction of the mesocarp and ranged from 14.5-22.6% oil in fresh mesocarp. The percentage oil to fruit ranges from 6.6-8.1%. The composite mill sample (Table 18) is an average of 3 analyses from a large quantity of mixed fruit including some underripe fruit.

It is obvious that only a low yield can be expected from any processing method. This is in contrast with published figures by the National Academy of Sciences (1975), discussed elsewhere in this volume.

Table 18. Fruit Analyses of 8 Seje Bunches at Las Gaviotas[1]

Bunch	F1	F3	F4	F5	F7	F8	F29	F30	Composite Mill Sample
Average fruit weight - gm	9.6	7.1	5.1	9.4	13.5	6.1	6.8	6.2	8.5 %
kernel/fruit	58.1	55.3	57.8	62.5	64.4	57.0	58.6	55.4	59.3
% pulp/fruit	41.9	44.7	42.2	37.5	35.6	43.0	41.4	44.6	40.7
% oil/pulp	17.1	14.5	-	19.3	22.6	18.9	-	-	15.0
% oil/fruit	7.1	6.6	-	7.2	8.1	8.1	-	-	6.1
% fiber/pulp	40.5	42.7	-	42.5	42.5	39.7	-	-	46.8

[1]All data are based on fresh weight.

In view of the variability it should be possible to breed in 1 or 2 generations a fruit type with 50% mesocarp, 25% oil to mesocarp and 12.5% oil to fruit.

INDIGENOUS PROCESSING

The native oil production method is very simple. Fruit is boiled and the mesocarp subsequently separated from the kernels by pounding in a mortar. Steaming hot pulp is placed in an elongated, woven, aboriginal "basket," the sebucán. The oil is obtained by stretching the sebucán. The oil extraction efficiency is about 35%.

CONSIDERATIONS FOR A LARGER SCALE SEJE OIL PRODUCTION

It is obvious that the sebucán method of oil extraction is inefficient in spite of the very low investment cost in processing equipment made from forest products. However, with better pressing equipment the extraction efficiency can be improved and the investment in a better press may repay itself in a short time.

A different argument to promote a small scale seje industry concerns socio-economic factors in Venezuela and Colombia. There are very few crops which can be considered for remote rural areas. However, the price of the seje oil is very high and the profit margins are sufficient to warrant the high transport costs from remote areas to the cities. An oil transport cost of 4% of the sales value in Bogotá is acceptable and would amount to US $ 330 per ton. In the case of palm oil from the African oil palm such a transport cost would be prohibitive, because it

adds 50% to the price of US $ 650 per ton. The advantage of the present situation is the existence of wild seje palms. Initially there is only a need to invest in better processing equipment. Small plantations can be considered at a later stage. The selection of parent palms for seed to establish small plantations will be easy as the indigenous people are aware of the fruit quality differences between various seje palms. When the seje palm becomes a cultivated crop, advisory services will be needed for nursery procedures, planting distance, choice of land, maintenance and improved harvesting techniques. However, the considerable experience in the cultivation of other palm crops such as African oil palm, coconut palm, arecanut palm and date palm may be usefully applied to seje palm cultivation.

THE SEJE OIL PILOT MILL AT LAS GAVIOTAS

Origin of the Seje Oil Mill Concept

The idea of a seje oil mill originated from a visit of the directors of the Centro de Desarollo Integrado Las Gaviotas to the Royal Tropical Institute in Amsterdam during March 1977. The construction of a small seje oil mill similar to the successful village palm oil mill in West Africa was considered (Blaak, 1980).

Processing

The first mill was designed to obtain experience in larger scale processing and to formulate from that experience a concept of a mill suitable for remote areas (Fig. 9). The equipment discussed in this section is obtainable from International Technological Assistance B.V., P.O. Box 242, Winschoten, The Netherlands. The processing pathway is indicated in Table 19.

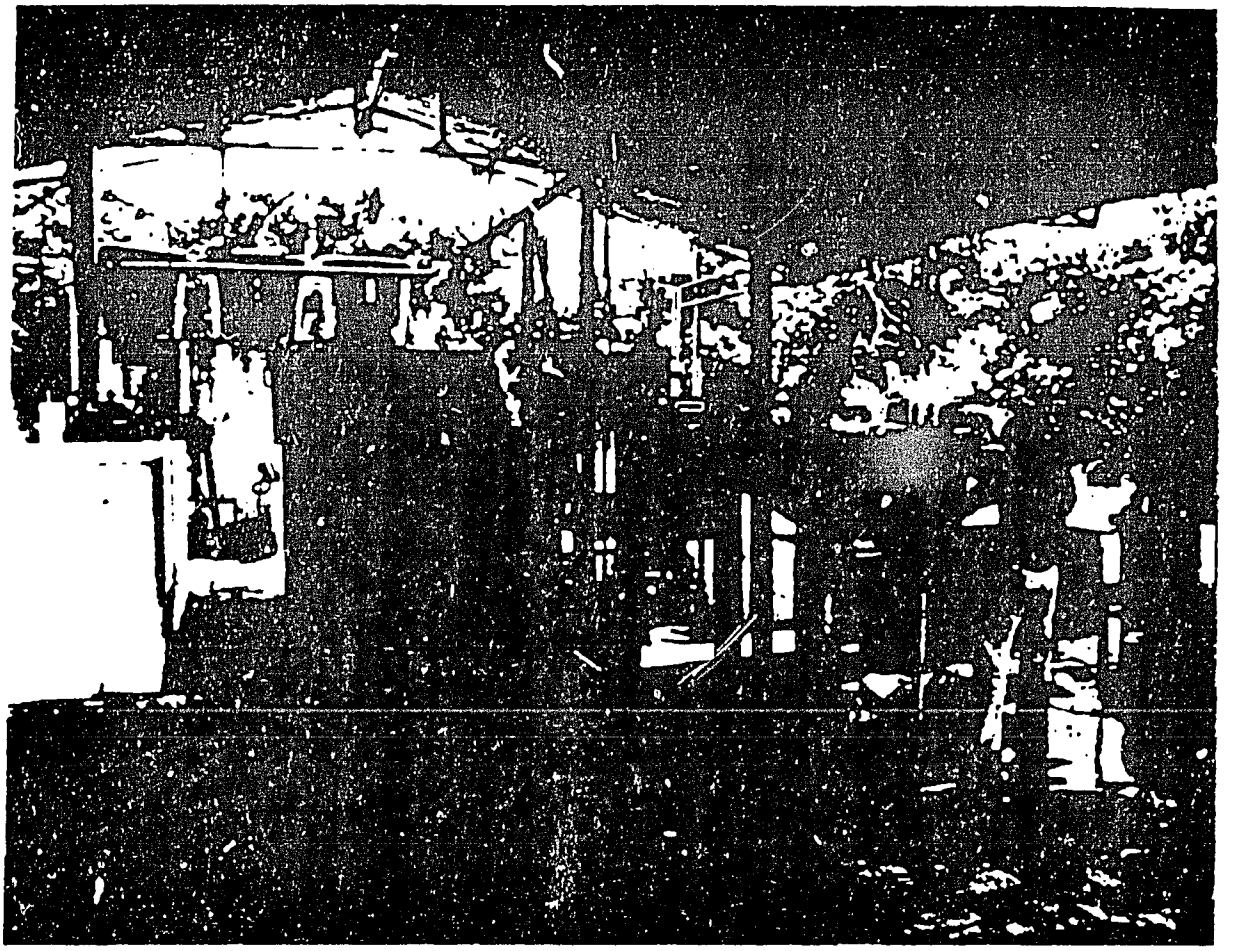

Figure 9. The processing mill at Las Gaviotas.

Table 19. Processing Pathway For Seje Oil Production

Fruit stripping from bunches

↓

Fruit steaming

↓

Digestion

↓

Sifting of nuts → Nuts are used as fuel or pigs food

↓

Pressing of the pulp

↓

Reheating of the pulp → Press cake is used as mill fuel

↓

Clarification of oil

↓

Drying of oil

↓

Filtering of oil

750

Fruit Stripping

Because of the often substantial distance from the mill, fruits are normally stripped from the bunches in the field. Complete bunches have to be carried in containers, otherwise too much fruit will be lost.

Fruit Steaming

Fruit is steamed in large kettles measuring 1 x 1 x 2 m made from ordinary 3 mm mild steel plate. The kettles are fitted with a perforated plate at 20 cm from the bottom and a lid to contain the heat. About 1100 kg fruit can be steamed at a time. Steam from a small boiler is blown under the perforated plate and passes the fruit mass on top of the perforated plate. The fruit is steamed during the night for 8 hours. This means that digestion and pressing can start at the beginning of the working day.

Digestion

The fruit is placed in a digester with the aim of loosening the mesocarp from the kernel and breaking the oil-bearing cells. The digester is a horizontal kettle of about 50-60 liters content fitted with a central shaft on which a mixing device is mounted. The mixing device requires considerable power and is driven by a 5 horsepower aircooled diesel engine. The engine requires 6-8 l fuel per day. The digester is charged with 11 kg steaming hot fruit through a funnel at the top and discharged after 5 minutes through a gate at the bottom of the kettle. The digested mesocarp is a dark brown-purple, damp, fibrous powder. (Figure 10A) The digested kernels remain undamaged and are completely devoid of mesocarp.

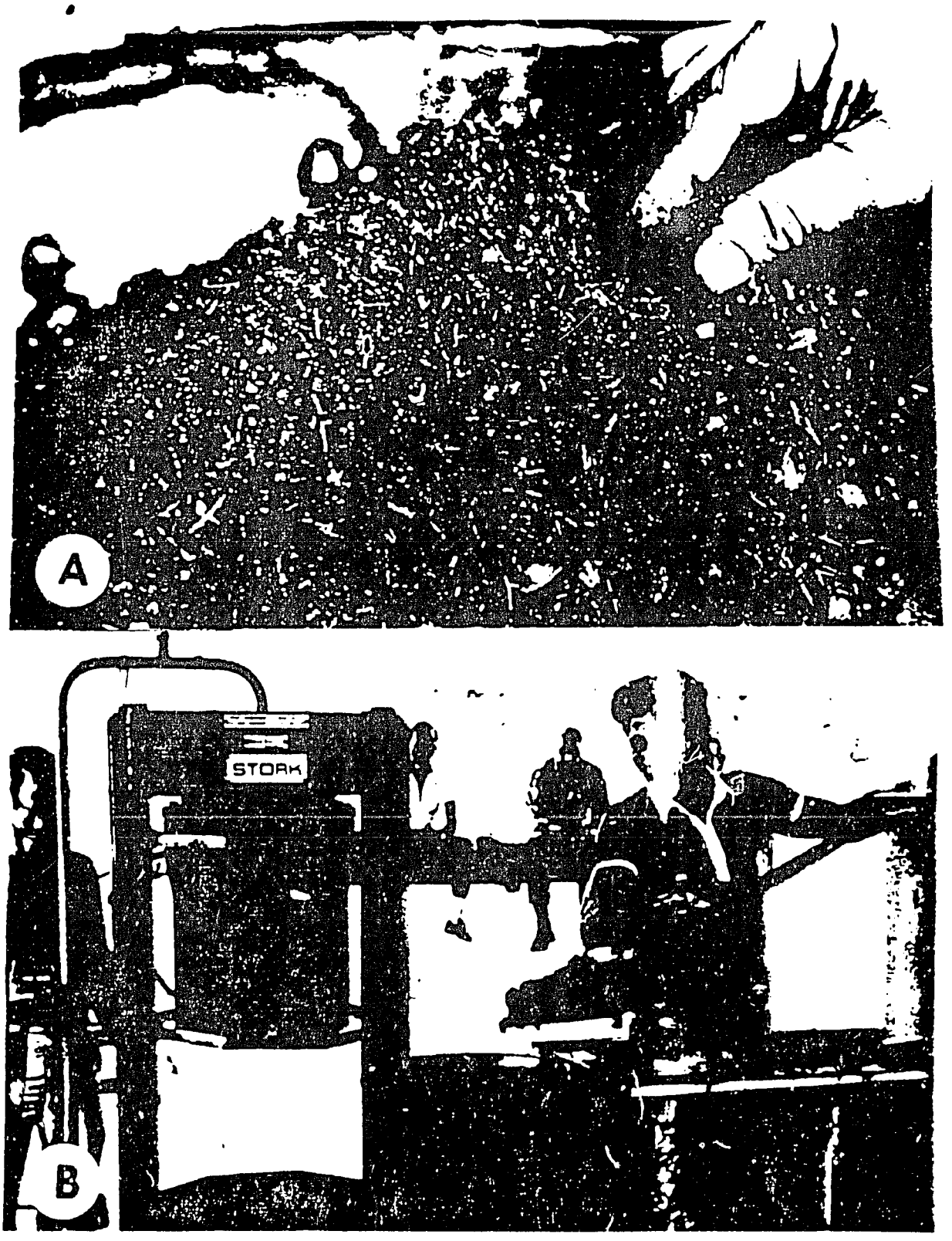

Figure 10. A. The digested mesocarp before digested kernels (endocarps) are sifted out. B. Loading the steamed, digested mesocarp into the press.

Sifting

The ratio of pulp to kernel is 40/60. Such a mixture cannot be pressed efficiently, because the oil-containing pulp is partly pressed in between the kernels. However, it is very easy to remove the large, round kernels (5 g average weight) from the pulp by sifting through a sieve with 0.5 cm openings. The additional advantage of sifting is the increased oil production from the press because less useless material is pressed.

Pulp Reheating

The sifted pulp is reheated by steam in a small kettle similar to the fruit-steaming kettle before it is placed in the press cage. The viscosity of the oil is reduced at a high temperature and this results in a better press efficiency.

Pressing

The hot pulp is pressed in a manually operated hydraulic press (Fig. 10B). The press cage holds about 40 l. Pressing is continued up to 70 atmospheres (1000 psi). The temperature of the press cake after pressing is about 80-90°C. One press charge can be handled in 20 minutes. Two press cages are used alternately to allow better use of the press, i.e., one cage is discharged and filled during the pressing of the other cage. The pressing efficiency as measured over a quantity of 157 kg pulp is 89%.

Clarification

Clarification is the process of oil separation from the press liquid. An excellent oil separation was obtained at 75°C, when using the large clarification tank as a waterbath for the containers with the crude oil from the press. A total of 57 l of press juice was obtained from 157 kg pulp. From 57 l of press juice, 26.5 kg crude seje oil could be obtained within a few hours.

Drying of the Crude Oil

The crude oil is translucent and light green. It is essential to remove the water from the oil to prevent hydrolysis of the oil during storage. The oil temperature remains constant (105°C) during drying and increases rapidly after evaporation of the last emulsified water. The oil becomes transparent after drying. Seje oil can contain a surprisingly large quantity of emulsified water. Only 22 kg oil was left after drying from 26.5 kg clarified oil. This is 17.0% water in crude oil. The quality of the seje oil from this milling process was highly rated by the aboriginal milling personnel. Part of the well-drained oil was stored in a large glass container. This oil was sampled again after storage for three years and still had an excellent flavor indicating its stability of at least its organoleptic properties.

Steam

A small boiler was used to generate steam for steaming of the fruit and reheating of the pulp.

Experience with the Seje Oil Pilot Mill

The experience with the pilot plant indicated that seje oil production on an intermediate scale is feasible with very simple equipment. The oil extraction efficiency could be improved from 35% (sebucán method) to 89% (pilot plant). A much smaller oil clarification tank than in a village palm oil mill should be used. A small tank of 100 liters will suffice. The best oil separation is obtained by static separation without addition of water to the press juice. The capacity of the digester could be increased by installing a stronger engine of 7-8 horsepower. The press cake is suitable as mill fuel without any further drying and can largely replace firewood. The processing of 1000 kg fruit per 8 hours requires 5 laborers

RURAL SEJE OIL MILL

Area to be Served by a Rural Seje Oil Mill

A concept for a rural seje oil mill can be formulated from the experience gained from the pilot plant. A throughput of 1000 kg seje fruit per 8 hours should be considered a minimum in view of the overhead costs. Fifty tons of fruit can be processed on a 2 shift system during the peak month of production. This means an annual throughput of 143 tons of fruit, when 35% of the annual production has to be processed within one month.

The productivity of the forest palms should not be overestimated. A production estimate of 30 kg fruit per annum per mature palm (1 - 2 bunches) seems realistic. This means that the mill can serve an area with about 4500 - 5000 palms. A rural seje oil mill (RSOM) is justified when at least 2300 palms are available to reach a break even point of the mill (Table 20). This means that a seje palm grove of 90 ha with 25 seje palms per ha will be needed to justify a mill.

Equipment and Mill Shed

The equipment should be constructed or assembled preferably from locally available standard materials. The cooking kettle should hold sufficient fruit to serve 2 shifts, i.e., 2 tons. One kettle measuring 122 x 122 x 244 cm (standard 4' x 8') made from 1/8" mild steel plate, will hold this quantity. It is not justified to buy a boiler for this small mill. A brick fireplace has to be installed under the kettle.

Table 20. Annual Income and Expenditure of a Rural Seje Oil Mill Processing 1 Ton Fruit Per Shift at Optimal Use (143 Tons), 100 Tons and Break-Even Point Estimated Under Colombian Conditions in 1980

Expenditure	143 tons/yr.	100 tons/yr.	Break-even point 65 tons/yr.
Wages $ 31.25/ton fruit processed	US $4,469	US $3,125	US $2,031
Diesel fuel 8 l/ton processed	572	400	260
Fruit transport $ 20/ton	2,860	2,000	1,300
Fruit purchases at $ 62.50/ton	8,937	6,250	4,062
Maintenance at 5% of $ 29,080	1,454	1,454	1,454
Loan repayment (10 yrs., 10% interest)	4,750	4,750	4,750
Total Expenditure	US $23,042	US $17,979	US $13,857
Income			
Extraction rate 5.7%, oil sale price at mill gate $ 3.75/kg	US $30,566	US $21,375	US $13,893
Profit	US $ 7,524	US $ 3,396	US $ 36
Profit on Mill Investment	25.9%	11.7%	0.1%

The digester and 5 horsepower aircooled diesel engine should be imported. The unit requires very little maintenance, and this can be done with locally available means. The hydraulic ITA-press has to be imported as well. These presses are very reliable as has been proven in West Africa. Spare parts and tools are delivered with the press.

The nut sifter, pulp reheating kettle, clarification tank and water tank can be made from local materials. The mill building could be an open shed of 8.5 x 8.5 m. Hardwood, bricks or construction metal can be used for the building, depending on which of these options is the least expensive. The roof can be covered with galvanized iron or tiles. A concrete tile floor is convenient but not essential. A layer of compacted laterite is also suitable as has been observed in practice. The two fireplaces, one for the kettle and one for the pulp reheating and clarification, can be connected to one chimney.

Costs of a Rural Seje Oil Mill

The costs of an RSOM depend on many factors. However, a realistic breakdown (1980 costs) would be as follows:

Imported equipment cif (press and digester plus engine)	US$17,000
Locally produced or obtainable equipment (fruit steaming kettle, kernel sifter, reheating kettle, clarification tank, water tank and a simple 200 kg bascule)	4,500
Foundation for equipment	750
Bits and pieces	500
Local transport costs for equipment and building materials	1,000
Open mill shed of 8.5 x 8.5 m at $ 3/sq. ft.	2,330
Supervision by local personnel	3,000
TOTAL COST	US$ 29,080

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Personnel Requirements of an RSOM

The personnel requirements for an 8 hour shift are:

Supervisor (supervision and clarification of press juice)	US$12.50
Fireman	3.75
Filling and emptying of digester	3.75
Sifting and reheating of pulp	3.75
Filling and emptying of press cages	3.75
Pressing	3.75
TOTAL MILL WAGES PER SHIFT	US $31.25

Total number of employees per shift is 6. Wages are according to Colombian rates.

ECONOMIC ANALYSES

General Considerations

It is assumed that mill employees are only employed in milling as part of their means of existence as is also the case in the village palm oil mills in West Africa. The following studies are based on figures valid in the rural areas of Colombia. A conversion rate of 40 Colombian pesos to 1 US dollar has been used in the analyses presented in Table 20.

Income and Expenditure

Optimal use will be made of the mill when 143 tons of fruit can be processed per year. During the peak season of production 2 tons fruit will be processed per day, i.e., 50 tons per month when milling takes place on 25 days. However, it is not expected that the mill will be used optimally. An analysis has been presented when

using the mill at 70% capacity, i.e., 100 tons/yr. A third analysis has been done to determine the break-even point. The mill can also be used for the production of pericarp oil from the cucurita palm (*Maximiliana maripa* (Correa de Serra) Drude) and the oil palm (*Elaeis guineensis*). However, loan repayment is fully charged against the seje oil production (Table 20).

The purchase price of the fruit could be raised from $62.50 to $75 per ton when the mill is used at full capacity. In that case, the profit on mill investment will drop from 25.9 to 19.7% and from 11.7 to 7.4%, when milling at 70% capacity.

Prospects of a Seje Palm Plantation

As discussed in Chapter 2, there are various reasons to consider the establishment of small seje palm plantations. The fruit quality could be improved by using the best forest palms as seed parents. The harvest and transport costs can be reduced because the wild palms are frequently very tall and widely scattered. By good agronomic practices it should be possible to double the yield as has been observed in other palm crops.

A seje plantation could be planted at 200 palms/ha (7 x 7 m^2 planting). The production per palm can possibly be raised to 60 kg/palm by the application of 1.5 kg fertilizer per palm per year. A plantation of 12 ha of palms will then produce about 146 tons fruit. This is sufficient to justify the construction of a small mill.

A dramatic improvement in oil production can be obtained without any extra costs in investment or processing by improving the percentage oil to fruit. An increase of the mill extraction from 5.7% to 7% almost doubles the profit, as can be verified by insertion in Table 20 an oil extraction of 7% instead of 5.7%. An improvement of

this order of magnitude should be possible without any problems in view of the high heritability of fruit characteristics in other palm species and the variability observed within the seje palm population.

DISCUSSION

It may be difficult to find many areas with large concentrations of wild seje palms that justify a rural seje oil mill. However, the seje palm seems an excellent cash crop for the more remote parts of the Llanos of Colombia. A seje palm plantation will provide a regular source of income in view of the perennial nature of the crop. The plantation and mill labor requirements are low. The high value of the oil permits high transport costs to the consumer areas. The technology involved in efficient oil extraction is relatively simple. The returns on the mill investment seem sufficiently high to ensure bank loans. The economic analyses contain a number of variables that cannot be estimated exactly. However, the approximate size of operations can be estimated. No big nucleus estates and large complicated oil mills are needed to enable large scale seje cultivation. Cultivation could be started by an individual farmer planting 12 ha or by a group of 5-7 farmers who plant 1-3 ha each. The rural seje oil mill can also be used for the production of the cucurita palm (*Maximiliana maripa*) which occurs in greater numbers than the seje palm in some areas. The cucurita pericarp can contain much more oil than reported in the literature (Hernandez, 1977). The palm is more productive than the seje palm and bears earlier in the season. The mill use could be extended over more days and this will spread the overhead cost over a bigger throughput and will also lead to a better exploitation of the forest.

Since cucurita oil would be a newcomer in the edible oil market, no price can be estimated for the oil. However, soap from cucurita oil is very easy to prepare and has excellent foaming properties. The orange oil has a peppery flavor.

ACKNOWLEDGMENTS

The author acknowledges the permission of the director of El Centro de Desarollo Integrado Las Gaviotas to use the experimental information from the pilot oil mill in this chapter.

CHAPTER 4. BOTANICAL CLASSIFICATION

TAXONOMIC HISTORY

The genus *Oenocarpus* was first described by Martius in *Historia Naturalis Palmarum* (1823). He included five species: *O. distichus*, *O. bataua*, *O. bacaba*, *O. minor* and *O. circumtextus*. The genus *Jessenia* was described by Karsten (1857), and a single species, *J. polycarpa*, was included. The two genera were maintained as distinct from each other through a number of publications in the nineteenth century, until Burret (1928) re-evaluated the two genera and studied the original material of Martius, as well as new material of *O. bataua* sent him from Manaus. He correctly concluded that *O. bataua* was really in the genus *Jessenia*, and made the new combination *Jessenia bataua* (Martius) Burret. The other species in *Oenocarpus* were left as originally place by Martius.

There has been much confusion as to the proper nomenclature of these palms. Despite recent taxonomic works by Balick (1980; 1986), it is not unusual to find past errors discussed in contemporary works. This chapter summarizes the most recent taxonomic information presented in the previously-mentioned citations. Table 21 indicates the major subdivisions and component taxa in this complex.

It is often difficult in the field and laboratory to distinguish between the two genera. Some workers use *Oenocarpus* to refer to the whole complex (e.g. Wessels Boer, 1965, 1971, 1972). Nevertheless, it is clear that major uniform differences between *Oenocarpus* and *Jessenia* can be found, and these are presented in Table 22 that follows.

Table 21. Major Subdivisions and Component Taxa in The *Oenocarpus-Jessenia* Complex

Oenocarpus

Subgen. I. *Oenocarpus*

1. *O. distichus*
2. *O. discolor*
3. *O. tarampabo*
4. *O. bacaba*
5. *O. macrocalyx*

6a. *O. mapora* subsp. *mapora*

6b. *O. mapora* subsp. *dryanderae*

7a. *O. minor* subsp. *minor*

7b. *O. minor* subsp. *intermedius*

Subgen. II. *Oenocarpopsis*

8. *O. circumtextus*

Jessenia

9a. *J. bataua* subsp. *bataua*

9b. *J. bataua* subsp. *oligocarpa*

Table 22. A Summary of Essential Morphological Differences

Between *Oenocarpus* and *Jessenia*

Oenocarpus	*Jessenia*
Solitary to caespitose, medium to large, slender to stout palms.	Solitary, always stout, large palms.
Pinnae regularly inserted along the rachis in a single plane to irregularly grouped and inserted at various angles to the rachis.	Pinnae regularly inserted along the rachis in a single plane.
Lower surface of pinnae slightly vestite or covered with whitish wax, trichomes, if any, few and hairlike	Lower surface of pinnae with peltate to sickle-shaped to doubly-sickle shaped trichomes.
Leaf sheath with strawlike or wiry fibers to ca. 30 cm long.	Leaf sheath with thin, short hairlike fibers and stout knitting-needlelike fibers to 1 m in length.
Staminate flowers with 6 stamens.	Staminate flowers with 7-20 stamens.
Anthers with connective not produced, filaments reflexed.	Anthers with connective produced, filaments not reflexed.
Endosperm homogenous.	Endosperm ruminate

TAXONOMIC KEY TO THE GENERA AND SPECIES

The taxonomic key that follows is modified from Balick (1986), and is based on fieldwork and herbarium studies of this complex throughout its entire range. Short descriptions of each species are intended to facilitate a determination of species. As the present volume is intended as a guide for the domestication of these palms, the botanical descriptions have been shortened considerably. More complete descriptions appear in Balick (1986). Localities of all known collections are included, as this information is vital for germplasm collection efforts. Distribution maps for the species are presented in Chapter 5.

Key To The Genera and Subgenera In the *Oenocarpus-Jessenia* Complex

1. Seeds with homogenous endosperm; staminate flowers with 6 stamens; pinnae lacking trichomes abaxially or trichomes, if present, needlelike or hairlike . (*Oenocarpus*) 2
   2. Trunk smooth in adults; pinnae linear-lanceolate to somewhat broadly linear-lanceolate at center of rachis and lacking a significant acumen; peduncle of inflorescence short and stout; peduncular bract opening along entire length and falling away (subgen. *Oenocarpus*). 3

2. Trunk covered with a fibrous reticulum, even in adult stage; pinnae ovate-oblong or oblong-lanceolate at center of rachis, terminating apically in a long narrow acumen 10-22 cm long by 2-3 mm wide; peduncle of inflorescence long and slender; peduncular bract opening along about one-half its length and persistent (subgen. *Oenocarpopsis*, consisting of a single species, *O. circumtextus*).

1. Seeds with ruminate endosperm; staminate flowers with (7-)9-20 stamens; pinnae covered abaxially with peltate to sickle-shaped or doubly sickle-shaped trichomes (*Jessenia*). . . . . .11.

3. Leaves distichously arranged; solitary palms. Brazil, Bolivia, and perhaps Venezuela.

4. Stems thick, 13-24 cm in diameter; central pinnae acute to acuminate, 0.7-1.15 m long, 3.5-5.5 cm wide. Brazil (Maranhão, Mato Grosso, Pará and possibly Minas Gerais), and perhaps Venezuela (Bolivar).

5. Pinnae lanceolate-acute, dark green abaxially, a small swelling present at insertion; petals of staminate flowers oblong-obtuse. Brazil (Maranhão and Pará) and perhaps Venezuela (Bolivar) . . . . . 1. *Oenocarpus distichus*.

5. Pinnae lanceolate-acuminate, glaucous abaxially, inserted directly into rachis with no swelling; petals of staminate flowers lanceolate-acute. Brazil (Mato Grosso, Maranhão and possibly Minas Gerais). . . . . .
. . . . . .2. *Oenocarpus discolor.*

4. Stems slender, less than 13 cm in diameter; central pinnae very narrowly acuminate, 40-50 cm long, 2 cm wide. Brazil (Rondônia) and Bolivia (Beni). . . . . .3. *Oenocarpus tarampabo.*

3. Leaves spirally arranged; solitary to caespitose palms. Costa Rica, Panama, Colombia, Guyana, Surinam, French Guiana, Ecuador, Brazil, Peru and Bolivia.

6. Axis of inflorescence distal to peduncular bract scar greater than 4.5 cm long; pinnae either grouped on the rachis or more or less regular with an occasional grouping of 2-3, usually at midleaf.

7. Rachillae 100-200 or more, usually longer than 80 cm; ripe fruit globose to globose-elongate; pinnae mostly in groups along much of the rachis, except near the apex. Much of the northern half of South America, to an altitude of ca. 1000 m. . . . . .
. . . . . .4. *Oenocarpus bacaba.*

7. Rachillae fewer than 100, 75 cm or less in length; ripe fruit ellipsoid-acute to subovoid; pinnae usually (although not always) regularly arranged except for a few and these often at midleaf.

8. Ripe fruit 1.5-1.7 cm long (not including cupule), by 1.1-1.2 cm wide, ellipsoid-acute. Brazil (Amazonas). . . . . .5. *Oenocarpus macrocalyx.*

8. Ripe fruit 1.8-2.9 cm long (not including cupule) by 1.4-2.25 cm wide, ellipsoid to ovoid. Much of the northern half of South America, Panama and Costa Rica, to an altitude of 1000 m . . . . . .9.

9. Abaxial surface of pinnae generally devoid of solitary and tufted, twisted trichomes between the intermediate veins, these, if present sparsely placed only on the intermediate veins; ripe fruits 1.8-2.5 cm long (not including cupule) by 1.4-2.0 cm wide. Costa Rica, Panama, and throughout much of the northern half of lowland South America . . . . . 6a. *Oenocarpus mapora* subsp. *mapora.*

9. Abaxial surface of pinnae densely covered with silvery, solitary and tufted, twisted trichomes between and on the intermediate veins; ripe fruits 2.3-2.9 cm long (not including cupule) by 1.75-2.25 cm wide. Colombia: Valle--Buenaventura and immediate vicinity. . . . . .6b. *Oenocarpus mapora* subsp. *dryanderae.*

6. Axis of inflorescence distal to peduncular bract scar less than 4.0 cm long; pinnae mostly regularly inserted along the rachis, rarely with an occasional grouping of 2-3. Brazil (Amazonas and Pará) and elsewhere?. . . . . 7. *Oenocarpus minor.*

10. Stems solitary; axis of inflorescence distal to peduncular bract scar 1.3-2.1 cm long, 0.9-1.9 cm wide at scar; rachillae 25-35. Brazil (Amazonas and Pará) and elsewhere?. . . . . .7a. *Oenocarpus minor* subsp. *minor*.

10. Stems caespitose; axis of inflorescence distal to peduncular bract scar 1.5-4.0 cm long, 1.8-2.4 cm wide at scar; rachillae 54-72. Brazil (Amazonas and Pará) and elsewhere? . . . . . 7b. *Oenocarpus minor* subsp. *intermedius*.

11. Pinnae covered with many trichomes on abaxial surface; rachillae uniformly tapering gently throughout; pistillate flowers usually 40-90, borne on proximal 40-60% of rachilla; staminate flowers ca. 4-7(-8) mm long, stamens (7-)9-20. Panama and the Amazon and Orinoco Valley, Andean foothills, and Pacific coastal territory. . . . . .9a. *Jessenia bataua* subsp. *bataua*.

11. Pinnae with whitish waxy covering on abaxial surface, trichomes generally few and scattered, rachillae thickened proximally on portion bearing pistillate flowers; pistillate flowers usually 3-54 in number, borne on proximal 10-25% of rachilla; staminate flowers ca. 4-5 mm long, stamens (7-)9-10(11). Restricted to northern and northeastern Venezuela, Trinidad, Guyana, and Surinam. . . . . 9b. *Jessenia bataua* supsp. *oligocarpa*.

CAPSULAR DESCRIPTIONS OF THE SPECIES

Brief descriptions of the species and subspecies in this complex are presented on the pages that follow. Note that as some of the palms are poorly known, certain descriptions are lacking information on essential characters. This volume is not intended to be a taxonomic work. To clarify some of the misunderstanding of the taxonomy, synonyms are listed under currently accepted names. Under the section on representative specimens, additional data is included as a guide to germplasm recollection. Whether a palm was collected in fruit, young fruit or inflorescences is indicated by fr, yfr or fl respectively. Herbaria from which the specimen was borrowed or where it was studied are indicated in parentheses following the collector and number. These codes conform to the abbreviations presented in *Index Herbariorum* (Holmgren et al., 1981), the standard guide to the world's herbaria.

1. *Oenocarpus distichus* Martius, Hist. Nat. Palm. 2:22-23, t. 22-23. 1823.

Trunk solitary, 10-20 m high, 13-25 cm in diameter. Leaves 9-15, distichous; sheath ca. 70-95 cm long; rachis 3.5-5 m long; pinnae 89-109 per side, inserted at regular intervals at apex, irregularly arranged towards middle and base either singularly or in groups of 2-7 at various angles to the rachis; middle pinnae 0.7-1.15 m long x 3.5-5 cm wide. Inflorescence with primary axis distal to peduncular bract scar 25-35 cm long, 2.6-3.5 cm wide at scar; rachillae 69-186, ca. 0.9-1.2 m long. Staminate flowers with ca. 4 mm long petals. Fruit globose to somewhat globose-elongate when mature, 1.8-2.1 cm long (including cupule), 1.4-1.6 cm wide, 2-3 gms when mature; mesocarp pulpy, greenish to purple.

Distribution: Known mainly from Pará and Maranhão, Brazil; possibly in Bolivia and Venezuela (Figs. 11, 12).

Representative Specimens: BRAZIL. Pará: Belém, rear of Instituto farm, fr, 26 Nov 1946, Bailey 341 (BH); Santarém-Cuiabá highway, BR 163, km 878 from Santarém, Cachoeira do Curua, Serro do Cachimbo, 4 Nov 1977, Balick et al. 910 (BH, ECON, MG, NY), km 876 from Santarém, fr, 6 Nov 1977, Balick et al. 915 (ECON, MG, NY), km 1231 from Santarém, 17 Nov 1977, Balick et al. 930 (ECON, MG, NY).
CULTIVATED. Brazil. Pará: Belém, EMBRAPA Station, 13 Dec 1977, Balick & Rosa 957 (ECON, MG).

2. *Oenocarpus discolor* Barbosa Rodrigues, Palm. Mattogrossenses, 8 t. 3. 1898.

Trunk solitary, ca. 8 m high, ca. 15 cm in diameter. Leaves ca. 10, distichous; petiole ca. 1.2 m long; rachis ca. 4-5 m long; pinnae inserted at regular intervals at apex, irregularly arranged towards middle and base in groups of 2-6 at various angles to the rachis; middle pinnae ca. 1.1 m long x 5.5 cm wide. Inflorescence poorly known; rachillae ca. 50 cm long. Staminate flowers with ca 3.25 mm(?) long petals. Fruits unknown.

Distribution: Mato Grosso, Maranhão, and possibly in Minas Gerais, Brazil.

Representative Specimens: No specimens are known to exist.

3. *Oenocarpus tarampabo* Martius, Palmet. Orbign. 12, t. 8, fig. 3, t. 18b. 1847.

Trunk solitary, 7-9 m high, 13-14 cm in diameter. Leaves 9-15, distichous; sheath ca. 60 cm long; rachis 2-2.5 m; pinnae ca. 60 per side, inserted at various angles to the rachis in groups of 2-5; middle pinnae 1-1.5 m long x 3.2-4.6 cm wide. Inflorescence with primary axis distal to peduncular bract scar ca. 10 cm long; rachillae ca. 30-40 cm long. Fruit subglobose when mature, ca. 1.5 cm in diam.

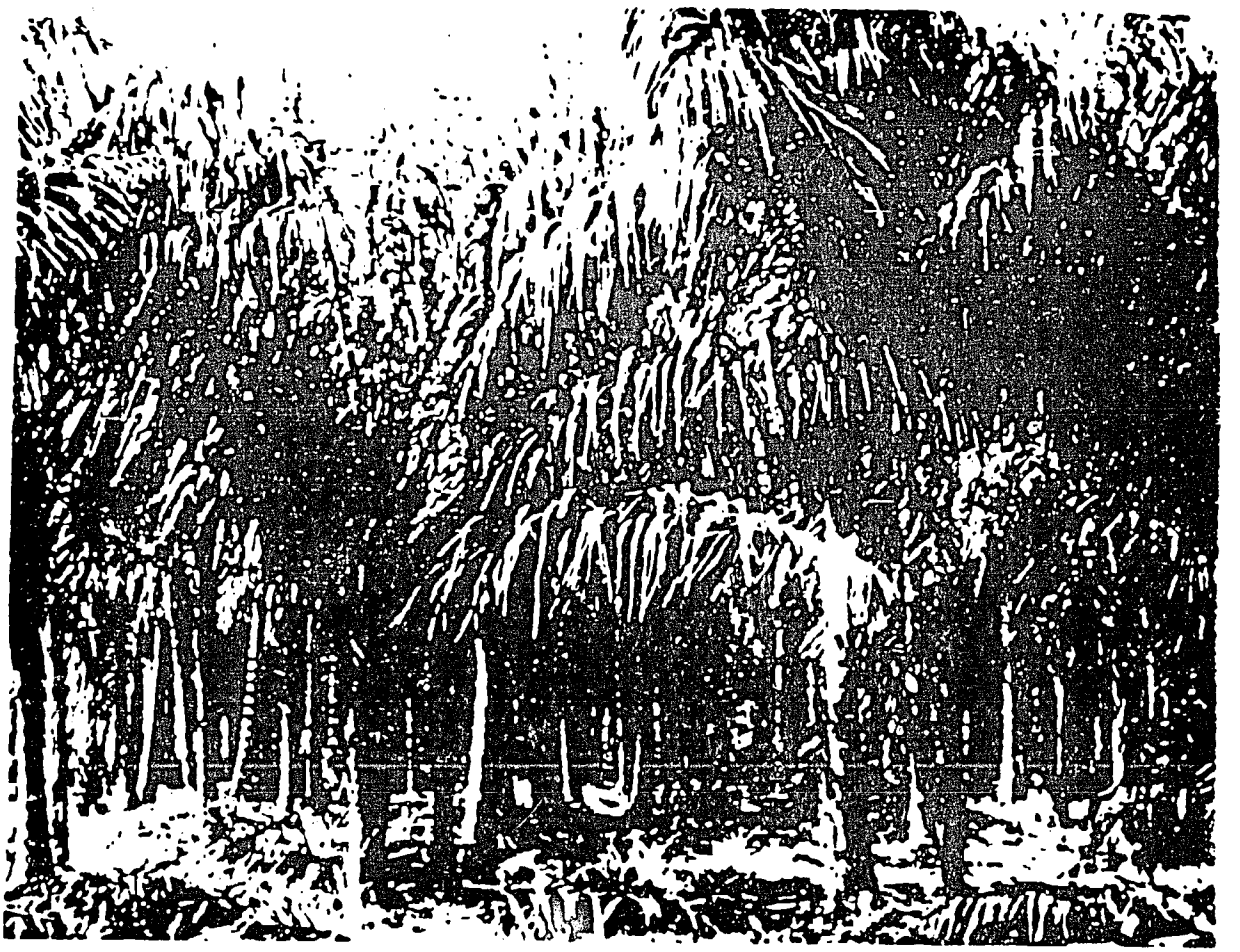

Figure 11. A stand of cultivated *Oenocarpus distichus* in Belém, Brazil.

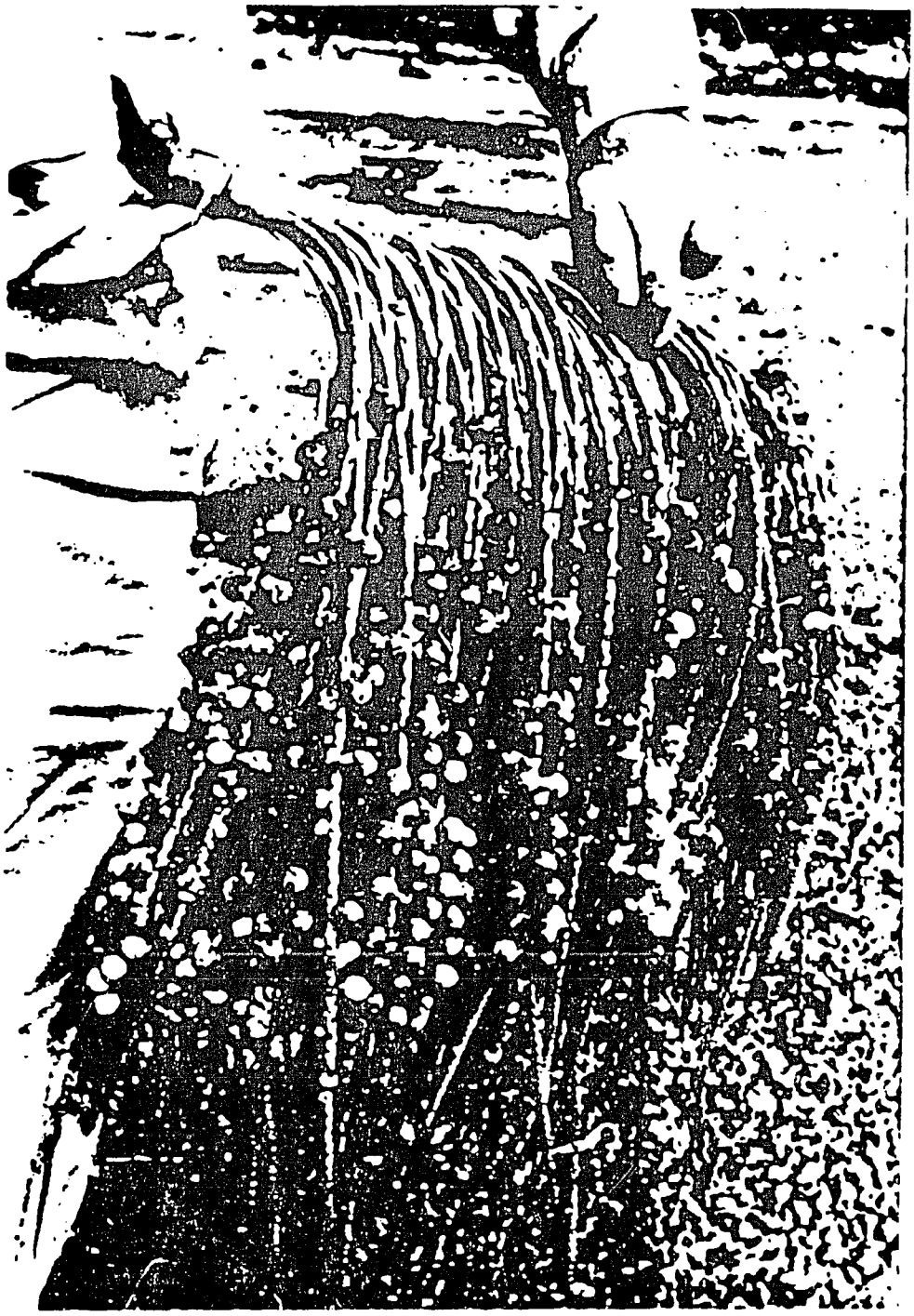

Figure 12. Panicle of *Oenocarpus distichus* with ripe fruit.

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Figure 13. *Oenocarpus tarampabo* in a primary forest remnant in Beni, Bolivia.

Distribution: Beni, Bolivia and Rondônia, Brazil (Fig. 13).

Representative Specimen: BOLIVIA. Beni, Prov. Mamore, Estancia Dolores, 4 km N of San Joaquin. 19 Aug 1982, Balick et al. 1451 (NY, LPB).

4. *Oenocarpus bacaba* Martius, Hist. Nat. Palm. 2:24-25. t. 26. 1823.

- = *O. bacaba* var. *xanthocarpa* Trail
- = *O. baccata* ex Cuervo-Marquez
- = *O. hoppii* Burret
- = *O. grandis* Burret
- = *O. bacaba* var. *bacaba* ex Wessels Boer
- = *O. bacaba* var. *grandis* (Burret) Wessels Boer
- = *O. bacaba* var. *parvus* Wessels Boer

Trunk solitary, 8-20(-25) m high, (12-)15-25 cm in diameter. Leaves 7-17, spirally arranged; sheath ca. 0.75-1.10 m long; petiole 0.6-1.0 m long; rachis 3.5-6.0 m long; pinnae 75-117 per side, inserted at regular intervals at apex, irregularly arranged towards middle and base either singularly or in groups of 2-6(7) at various angles to the rachis; middle pinnae (0.7-)0.9-1.6 m long x 3-7 cm wide. Inflorescence with primary ax s distal to bract scar (7.5-) 15-40 cm long, (2.4-) 3.5-10 cm wide at scar; rachillae 113-200(-230), (55-)80-120(172) cm long. Staminate flowers with ca. 3-5 mm long petals. Fruit globose to somewhat globose-elongate when mature, (1.5)1.6-2.1(2.2) cm long (including cupule), (1.2-) 1.4-2.1 cm wide, (1-)3-6 gm when mature, mesocarp pulpy, light purple.

Distribution: Amazon and Orinoco Valleys in Colombia, Venezuela, Guyana, Surinam, French Guiana, Peru and Brazil (Fig. 14).

Representative Specimens: COLOMBIA. Amazonas-Vaupés: Río Apaporis, entre los Ríos Kananari y Pacoa, alt. 250 m, fr, 1-15 Dec 1951, H. Garcia-Barriga 13914 (US). Meta: about 20 km SE of Villavicencio, alt. ca. 500 m, fr. 17 Mar 1939, Killip 34275 (US). Vichada: San Luis, 2 hours by car from Las Gaviotas, fr, 18 May 1978, Balick & Vargas 1201 (ECON, COL). Vaupés: Caño Cuduyari, tributary of Río Vaupés, alt. 200 m, fl, 15 Oct. 1939, Cuatrecasas 7221 (COL, US); across from La Makarena, Río Vaupés, upriver from Mitú, fl, 9 Jul 1976, Zarucchi et al. 1815 (ECON, COL).

VENEZUELA. Amazonas: near Macuruco, river above Santa Bárbara del Orinoco, fr, 29 May 1975, Berry 791 (BH, VEN); near Río Manapiare at camp at Caño Santo, fl, 7 Nov 1975, Berry 1655 (BH, VEN); Santa Barbara del Orinoco Experimental Station, 1-2 km S of Trapichote, alt. 130 m, 26 Feb-12 Mar 1976, Berry & Chesney 2118 (BH, VEN); Cerro Duida, SE slopes along Cano Negro, tributary of Cano Iguapo, alt. 260 m, fl, 28-29 Aug 1944, Steyermark 56066 (F); Sierra Parima, vicinity of Simarawochi, Rio Matacuni, 6-7 km W of Venezuela-Brazil frontier, 18 April-23 May 1973, Steyermark 107569a (BH, VEN); near Puerto Ayacucho between airport and Rio Cataniapo, young fr, 25 Jul 1967, Wessels Boer 1875 (U); near San Carlos de Rio Negro, fr, 18 Jan 1968, Wessels Boer 2276 (U); Brazo Casiquiare near Solano, 8 Feb 1968, Wessels Boer 2408 (U); Yavita, alt. 128 m, fr. 1942, Williams 14129 (F, VEN); San Carlos de Rio Negro, alt. 100 m, 28 Feb 1942, Williams 14521 (US, VEN); Capihuara, Alto Casiquiare, alt. 120 m, fr, 27 May 1942, Williams 15586 (US, VEN). Barinas: 20 km N of Barrancas, Mun. Cruz Paredes, Dist. Obispos, alt. 300-600 m, fr, 29 Mar 1972, Marcano-Berti & Torres-Lezama 3002 (VEN). Bolivar: near El Palmar, alt. ca. 75 m, yfr, 24 Jun 1967, Wessels Boer 2080 (U). Delta Amacuro: lower Orinoco, Catalina, May 1896, Rusby & Squires 414 (M, NY, US).

GUYANA. East Berbice-Corentyne: Corentyne River, Mataroo Swamp, fl, fr, 12 Oct 1880, Im Thurn 3 (K); Corentyne River, fl, Jul 1880, Jenman 521 (FDG, K). Mazaruni-Potaro: Mazaruni Station, 16 Aug 1940, For. Dept. Fld. no. F542 (K, NY), seedling, 25 Jan 1944 For. Dept. Fld. no. F1558 (K); Potaro Road, km 37, seedling, 28 Sep 1951, For. Dept. Fld. no. 3089 (K); basin of Cuyuni River, Essequibo tributary, about 240 km from mouth, fr, 21-26 Nov 1937, Smith 2584 (A, F, K, NY, P, U, US).

SURINAM. Brokopondo: village of Brokopondo, fl, 6 May 1965, van Donselaar 2365 (U); near Powakka, 8 Oct 1962, Wessels Boer 157 (U); Afobaka Road, km 81 S of Paramaribo, fr, 18 Dec 1962, Wessels Boer 361 (U); near Berg en dal, fr, 19 Dec 1962, Wessels Boer 390 (U); Brownsberg, Mazaruni top, 4 Feb 1963, Wessels Boer 620 (U). Marowijne: Apetina on Tapanahoni River, ca. 100 m, 5 Jul 1977, Moore et al. 10319 (BH); Gonini River, 1 Nov 1962, Wessels Boer 253 (U); Lawa River, 3 Nov. 1962, Wessels Boer 265 (U); Afobaka, without date, Wessels Boer 358 (U); Mapane region, Camp 8, fr, 9 Jan 1963, Wessels Boer 473 (U); Oelemari airstrip near Brazil border, fr, 16-19 Mar 1963, Wessels Boer 905 (U); near Oelemari, fr, 19-20 Mar 1963, Wessels Boer 1014 (U). Nickerie: Palaime Creek, fr, 19-22 Feb 1963, Wessels Boer 709 (U).

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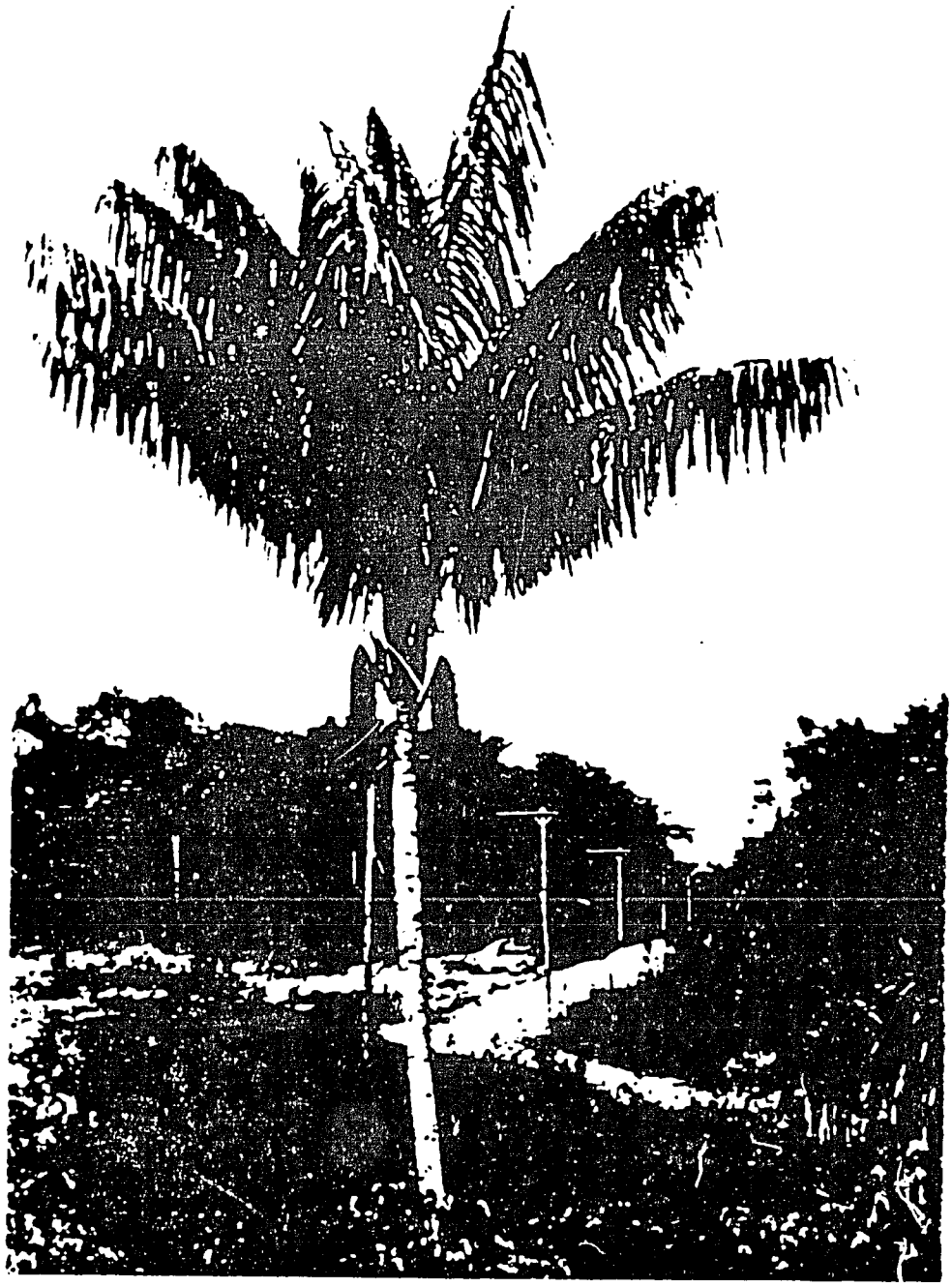

Fig. 14. *Oenocarpus bacaba* in Brazilian Amazonia.

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Saramacca: Stondansi, upper Nickerie, yfr, 9 Dec 1962, Wessels Boer 333 (U); hill near right branch of Coppename River, fl, fr, without date, Wessels Boer 1379 (U). Suriname: S of Paramaribo, Near Mijnzorgweg, fr, fl, 19 Nov 1962, Wessels Boer 283 (U).

FRENCH GUIANA. Charvein, fr, 28 Jan 1914, Benoist 693 (P); Karounany, fr, 1855, Sagot 851 in part (P).

BRAZIL. Amazonas: Tefe, fr, 25 Sep 1947, Black 47-1522 (IAN); Manaus, Campo Salles, fr, Oct 1926, Huebner 83 (B); Experimental Station at Mazagão, Ilha das Barreiras, fr, 17 Jan 1956, Ledoux 56-1502 (IAN); Reserva Florestal Ducke, km 26 on Manaus-Itacoatiara Highway, fr, 6 Sep 1966, Prance et al. 2187 (BH, INPA, NY). Pará: Bôa Vista on the Tapajós River, fl, May-June 1929, Dahlgren & Sella 131 (F); lower Trombetas, Achpicá Lake, fr, fl, 20 Sep 1910, Ducke 10973 (MG).

CULTIVATED: BRAZIL. Pará: Botanical Garden of Museu Paraense Emilio Goeldi, cult. pl. no. 108, Dec 1977, Balick 966 (ECON).

5. *Oenocarpus macrocalyx* Burret, Notizbl. Bot. Gart. Berlin-Dahlem 11:1043, 1934.

Trunk to 30 m tall, habit and stem diameter unknown. Leaves spirally arranged (?); sheath ca. 45 cm long; petiole and rachis ca. 2.9 m long; pinnae numerous; usually inserted at regular intervals and all in the same plane but some grouped in pairs and inserted at various angles to the rachis; middle pinnae to 75 cm long x 2.5 - 3.5 cm wide. Inflorescence with primary axis distal to peduncular bract scar 4.5-5 cm long x ca. 1.6-1.8 cm wide at scar; rachillae ca. 44, 26-44 cm long. Flowers unknown. Fruit ellipsoid-acute when mature, ca. 1.3-1.7 cm long (including cupule), 1-1.2 cm wide, weight unknown; mesocarp pulpy, color unknown.

Distribution: Known only from Amazonas, Brazil.

Representative Specimens: BRAZIL. Amazonas: Livramento near border of Mato Grosso, Jan 1932, Hopp 1155 (B-Type). Mun. Humaytá, between Rio Livramento and Rio Ipixuana, fr, 7-18 Nov 1934, Krukoff 7052 (CA, BH, F, K, LE, MO, NY, U, US).

6. *Oenocarpus mapora* Karsten, Linnaea 28:274. t. 55. 1857.

Trunk caespitose to more rarely solitary, 3-16(25) m high (2-12 per cluster), 9-15 cm in diameter. Leaves 6-8 per coma, spirally arranged, sheath 45-95 cm long; petiole 15-95 cm long; rachis (.95)2.8-5.5 m long; pinnae 60-71+ per side, inserted at rugular intervals and all in the same plane at apex, often more or less irregularly arranged towards center and base, either singularly or in groups of 2-4 at various angles to the rachis; middle pinnae 0.6-1 m long x 3.5-5.5(-7.8) cm wide. Inflorescence with primary axis distal to peduncular bract scar 6-20 cm long, 1.9-4.75 cm wide at scar; rachillae ca. 64-98, 36-73 cm long. Staminate flowers with 3-4 mm long petals. Fruit ellipsoid to ovoid when mature, 2.2-2.9 cm long (not including the cupule), 1.4-2.25 cm wide, weight unknown, mesocarp pulpy, lavender to purple.

6a. *Oenocarpus mapora* Karsten subsp. *mapora*

- = *Oenocarpus multicaulis* Spruce
- = *Oenocarpus huebneri* Burret
- = *Oenocarpus panamanus* Bailey

Distribution: A widespread subspecies occurring in Costa Rica, Panama, and throughout much of the northern half of South America, up to an altitude of about 1000 m (Fig. 15).

Fig. 15. A specimen of *Oenocarpus mapora* subsp. *mapora* growing next to a home in the Llanos of Colombia.

Representative Specimens: COSTA RICA. Puntarenas: S of Río Terraba, E of Palmar Sur near sea level, 11 Mar 1953, Moore 6541 (BH).

PANAMA. Darién: Uriti River, fr, without date, Duke & Bristan 219 (MO); vicinity of La Palma, alt. 0-50 m, Jan & Feb 1912, Pittier 5484 (US). Panama: Arraiján, 15 Jun 1923, Maxon & Cook 7034 (US); along El Llano-Carti Road, 16-18.5 km by road N of Pan American Highway at El Llano, alt. ca. 400-450 m, fr, 28 Mar 1974, Nee & Tyson 10979 (MO). Canal Zone: Barro Colorado Island, Shore S, 9 Jun 1931, Bailey & Bailey 75 (BH); Barro Colorado Island, fr, 2 Sep 1929, Bangham 554 (A, US); forest reserve near crossing of Cruces trail and Madden Dam Road, fr, 29 Jun-12 Jul 1940, Bartlett & Lasser 16407 (MICH); Juan Mina, fr, 22 Jun 1923, Cook & Martin 39 (US); Barro Colorado Island, Frijoles, seedlings, 13 Jul 1923, Cook & Martin 58 (US); Las Cascades plantation beyond Summit, seedlings, 14 Jun 1923, Cook 7101 (US), fl, 11 Apr 1925, Cook s.n. (US); Barro Colorado Island, Fred Miller Trail 360, fl, 6 Dec 1967, Croat 4119 (MO), Gross Trail 260, S side of trail, fl, 16 Dec 1967, Croat 4366 (MO), Snyder-Molino Trial 290, yfr, 9 Apr 1968, Croat 4537 (MO), shoreline from SW edge of Peña Blanca Point to W edge of first deep cove (central cove), young fr, 23 Apr 1968, Croat 5042 (MO), AVA Trail 1650, fr, 11 May 1968, Croat 5503 (MO), along sandy beach NW of Colorado Point, 13 May 1968, Croat 5527 (MO), in and around clearing, seedlings, 12 Sep 1968, Croat 5960 (MO), Snyder-Molino Trail 325, fl, 22 Feb 1969, Croat 8093 (MO), Armour Trail 2600, 14 Mar 1969, Croat 8646 (MO), forest across stream from Smith house, 26 Mar 1970, Croat 9126 (MO), Zetek Trail 195, seedling, 22 Jun 1970, Croat 10977 (MO), N of Snyder-Molino Trail 200, seedling, July 1970, Croat 11187 (MO); drowned forest of Río Puente, near junction of Río Chagres, alt. 66 m, fl, 7 Dec 1934, Dodge et al. 16827 (BH, US); Barro Colorado Island, fr, 18 Aug 1927, Kenoyer 169 (US); railroad relocation between Gorgona and Gatun, alt. 10-50 m, 7 Jan 1911, Pittier 2293, 2295 (US); around Las Cruces, alt. 20-100 m, 1 Feb 1911, Pittier 2628 (US); Barro Colorado Island, fr, 2 Sept 1929, Salvoza 954 (A).

COLOMBIA. Antioquia: Porcesito, Valley of Río Medellín, alt. 110 m, fl, 19 May 1946, Hodge 6863 (BH, GH); Peñas Blancas, fl, 29 Apr 1926, Juzepczuk & Woronow 4636 (LE), fl, 5 May 1926, Juzepczuk 4709 (LE), fl, 25 Apr 1926, Woronow & Juzepczuk 4537 (LE). Caquetá: Hetucha near Río Orgeguaza fl 30 Jul 1926, Woronow & Juzepczuk 6320 (LE). Chocó: Cabo Marzo, 13 Sep 1970, Moore et al. 9873 (BH). Meta: Cabuyaro, Jan 1937, H. García-Barriga 5103 (US); SE of Villavicencio, fr, without date, Killip 34275 (US). Nariño: delta of Río Mira, near Tumaco, sea level, fl, June 1966, Schulz & Rodríguez P. 492 (U), fr, June 1966, Schulz & Rodrigues P. 502 (U); Norte de Santander: Bellavista on pipeline fl, alt. ca. 830 m, 15 Sep 1946, Foster & Foster 1672 (GH); Petrólea, beginning of pipeline, ca. 60 m, fr, 24 Sep 1946, Foster & Foster 1785 (BH, GH). Vaupés: selve entre Calamar y San José del Guaviare, alt. 240 m, fl, 1 Nov 1939, Cuatrecasas 7368 (US). Vichada: Guacamayas, fr, 26 Jul 1976, Balick & Hoyos 76-19 (COL, ECON); Tropochera, Las Gaviotas, fr, 9 May 1978, Balick & Vargas 1199 (COL, ECON). Santander: Puerto Wilches and vicinity, alt. 100 m, 28 Nov-2 Dec 1926, Killip & Smith 14808 (GH, NY, US); km 16 between Puerto Wilches and Puerto Santos, alt. 110-115 m, 29 Nov 1926, Killip & Smith 14815 (A, NY, US); Puerto Wilches, between La Gómez and km 80 of Atlantic railroad, alt. 100-200 m, 19 Apr 1960, Romero Castañeda 8313 (MO, NY).

VENEZUELA. Apure: Reserva Forestal San Camilo, S of San Camilo (El Nula) to Río Sarare, yfr, 27 Mar 1968, Steyermark et al. 101380 (BH, VEN). Barinas: along Highway 5, between Río Acequia and junction with road to Ciudad Bolívia, 4 km SW of junction, alt. 175 m, fl, young fr, 25-26 Aug 1966, Steyermark & Rabe 96507 (BH, F, U, US, VEN); near Barinitas, alt. ca. 200 m, fl, 6 May 1967, Wessels Boer 1774 (U); near crossing of Barinas-San Cristóbal road and Río Bumbún, alt. ca. 250 m, yfr, 15 June 1967, Wessels 1855 (U), fl, 16 Jun 1967, Wessels Boer 1857 (U). Zulia: Sierra de Perija, near Quebrada Koshida (Kosida) S of Misión de Los Angeles de Tokuku (Tocucu), SW of Machiques, alt. 325-350 m, fl, 13 Aug 1967, Steyermark 99963 (BH, US, VEN); along Pan American Highway, 30 km N of Caño Zancudo, alt. ca. 100 m, 5 Dec 1967, Wessels Boer 2115 (U), fl, 5 Dec 1967, Wessels Boer 2117 (U).

ECUADOR. Napo: 16 km from Lago Agrio on road to Quito, fl, 10 Apr 1978, Balick & Allon 1188 (ECON, QCA).

PERU. Loreto: along road near Lake Quistachocha, Iquitos, fr, Feb 1978, Balick et al. 975 (AMAZ, BH, ECON, MO, USM); Maynas, Río Yaguasyacu, affluent of Río Ampiyacu, Brillo Nuevo and vicinity, fl, 30 Jan 1978, Balick et al. 987 (AMAZ, BH, ECON, MO, USM); Yurimaguas, lower Río Hullaga, alt. ca. 135 m, fl, 23 Aug-7 Sep 1929, Killip & Smith 27648 (F, NY, US); Coronel Portillo, 6-8 kms beyond Aguaytía on road to San Alejandro, alt. ca. 330 m, fl, 29 Apr 1960, Moore et al. 8376 (BH); Coronel Portillo, 6-10 kms from Pucallpa, fl, 7 May 1960, Moore et al. 8406 (BH) San Martin: Mariscál Cáceres, Tocache Nuevo, alt. 300 m, fl, 6 Mar 1978, Balick et al. 1157 (ECON, USM); near km 15, road from Tarapoto to Yurimaguas on Cerro de Escalero, alt. ca. 920 m, yfr, 26 May 1960, Moore et al. 8525 (BH).

BRAZIL. Acre: near mouth of Rio Macauhan, tributary of Rio Yaco, fl, 5 Sep 1933, Krukoff 5803 (K, NY); Amazonas: basin of Rio Madeira, Humayta near Tres Casas, fl, 14 Sep 11-Oct 1934, Krukoff 6402 (A, K, NY).

BOLIVIA. Pando: W bank of Río Madeira opposite Abuña, fr, 19 Nov 1968, Prance et al. 8677 (BH, INPA, NY).

CULTIVATED SPECIMENS: BRAZIL. Pará: Botanical Garden of Museu Paraense Emilio Goeldi, cult. pl. nos. 239-240, fr, Dec 1977, Balick 964 (ECON), cult. pl. no. 450, Dec 1977, Balick 965 (ECON), without cult. pl. no. fl, 30 Jun 1965, Cavalcante 1419 (MG).

DOMINICA. Dominica Botanical Garden, fr, 15 May 1968, Read 2012 (US).

PERU. Loreto: Coronel Portillo, in garden by Forestry Office, Pucallpa, 11 May 1960, Moore et al. 8412 (BH).

PHILIPPINE ISLANDS. Laguna Province, Los Baños College, College of Agriculture Campus, beside Language Building, 15 Sep 1966, Moore & Pancho 9398 (BH); Luzon, in College of Agriculture grounds, fr, 27 Aug 1958, Pancho 2036 (BH).

SRI LANKA. Peradeniya, Royal Botanical Garden, fl, 20 Nov 1963, Moore 9032 (BH).

6b. *Oenocarpus mapora* Karsten subsp. *dryanderae* (Burret) Balick, Adv. Econ. Bot. 3:110-111. 1986.

= *Oenocarpus dryanderae* Burret

Distribution: At present known only from Buenaventura, Valle, Colombia and vicinity (Fig. 16).

Representative Specimens: COLOMBIA. Valle: Station Bajo Calima, 4 km upstream from Bajo Calima (Pto. Patiño) on Río Bajo Calima, ca. 32 km NE of Buenaventura, fl, fr, 6 Mar 1975, Anderson 18 (INPA); Buenaventura, 3 May 1926, Cook 74 (US), fr, 26 May 1926, Cook 152 (US); Forests in concession of Carton Colombia, vicinity of Buenaventura, 10 Feb 1967, Moore et al. 9459 (BH); slope by road near Río Anchicayá, vicinity of Buenaventura, fr, 13 Feb 1967, Moore et al. 9479 (BH).

7. *Oenocarpus minor* Martius, Hist. Nat. Palm. 2:25-26. t. 27. 1823.

Trunk solitary to caespitose, 4-10 m high, 4.4-8 cm in diameter. Leaves ca. 6-10 per coma, spirally arranged; sheath ca. 30-60 cm long; petiole ca. 20-40 cm long; rachis 1.8-4 m long; pinnae 49-79 per side, inserted at regular intervals and all in the same plane or rarely with an occasional grouping of 2-3; middle pinnae ca. 40-72 cm long, 2.5-4.5 cm wide. Inflorescence with primary axis distal to peduncular bract scar ca. 28-68 cm long, 4-6 cm wide at scar; rachillae ca. 25-72, (17-)26-56 cm long. Staminate flowers with 3-4.5 mm long petals. Fruit globose-ovoid to ellipsoid when mature, ca. 1.6-2.3 cm long (including the cupule), 1-1.6 cm wide, weight unknown, mesocarp pulpy, light purple.

Figure 16. *Oenocarpus mapora* subsp. *dryanderae* growing in a recently cleared field near Buenaventura, Colombia.

7a. *Oenocarpus minor* Martius subsp. *minor*

= *Oenocarpus microspadix* Burret.

Distribution: Centered in Amazonian Brazil, although reported in the literature as occurring elsewhere (Fig. 17).

Representative Specimens: BRAZIL. Amazonas: Reserva Florestal Ducke, Manaus-Itacoatiara highway, km 26, fl, 25 Oct 1977, Balick et al. 903 (BH, ECON, INPA), fl, 27 Dec 1977, Balick et al. 969 (ECON, INPA), 4 Apr 1967, Byron & Elias 67-2 (INPA); Cuieiras-Manaus trail, km 1, fr, 6 Apr 1974; Campbell et al. P21875 (INPA, NY); Manaus, estrada velha da BR 17, km 40, fl, 11 Nov 1955, L. Coelho 2886 (INPA); Caviana, Rio Purus, fl, 29 Jan 1955, Ernani 765 (INPA); Manaus, Campos Salles, fl, Oct 1926, Huebner 81a (B); Manaus-Porto Velho road, km 245, 3 km S of Igapó Açu, fr, 13 Mar 1974, Prance et al. 20470 (BH, INPA); Manaus, Igarapé do Cachoeira, 1855, Spruce hb. palm 3 (K); Rio Tarumã near Manaus, fr, 1855, Spruce hb. palm 57 (K). Pará: Rio Jamundá, São Jorge, Faro, fl, 10 Nov 1950, Black & Ledoux 50-10686 (IAN). Rondônia: Basin of Rio Madeira, 8 km NE of Porto Velho, 9 Nov 1968, Prance et al. 8278 (BH, INPA, NY).

CULTIVATED. BRAZIL. Pará: Botanical garden of Museu Paraense Emilio Goeldi, Belém, cult. pl. nos. 27-28, Dec 1977, Balick 963 (ECON, MG), cult. pl. no. 880, Oct 1965, Cavalcante 1422 (MG).

7b. *Oenocarpus minor* Martius subsp. *intermedius* (Burret) Balick, Adv. Econ. Bot. 3, 1:140. 1986.

= *Oenocarpus intermedius* Burret.

Distribution: Known to-date only from Amazonas and Pará in Brazil, but perhaps wider ranging.

Representative Specimens BRAZIL. Amazonas: Reserva Florestal Ducke, Manaus-Itacoatiara highway, fr, 27 Dec 1977, Balick et al. 968 (ECON, INPA, MG, NY); Manaus, Campos Salles, Jan 1925, Huebner 1 (B-Type) Colonia Santo Antonio, Manaus-Itacoatiara highway, km 7, fr, 16 Mar 1967, Moore et al. 9540 (BH, INPA, NY). Pará: 1 km W of Ruropolis on BR 230, fl, 29 Nov 1977, Balick et al. 953 (ECON, MG, NY).

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Figure. 17. *Oenocarpus minor* subsp. *minor* growing in the Reserva Ducke near Manaus, Brazil.

8. *Oenocarpus circumtextus* Mart. Hist. Nat. Palm. 2:26, t. 26, figs. 3-4. 1823.

Trunk (solitary or caespitose?), ca. 3-6 m high, ca. 10-14 cm in diam. Leaves, quantity per coma unknown, spirally arranged; sheaths completely obscured by fibrous reticulum; petiole and rachis ca. 3 m long; pinnae per side unknown, but fewer in number than any other species, inserted at regular intervals and all in the same plane; middle pinnae ca. 50-70 cm long x 10-12 cm wide, last 10-22 cm forming a long narrow acumen ca. 2-3 mm wide. Inflorescence with primary axis distal to peduncular bract ca. 50+ cm long, ca. 1.4 cm wide at center; rachillae 21-32, ca. 28-38 cm long. Staminate flowers with ca. 3-4.25 mm long petals. Fruit oblong-cylindrical when mature, ca. 1.7 cm long (including cupule), 1.1 cm wide, weight unknown, mesocarp pulpy, color unknown.

Distribution: Known only from a single location in Amazonas, Colombia, although originally cited as in Brazil.

Representative Specimens: COLOMBIA. Amazonas: Cerro de La Pedrera, fl, 24 Nov 1912, Ducke 12305 (MG, US, U); alt. ca. 300 m, fl, Feb 1926, Huebner 41 (B).

9. *Jessenia bataua* (Martius) Burret, Notizbl. Bot. Gart. Berlin-Dahlem, 10:302. 1928.

Trunk solitary, 14-25(-28) m high, (12)19-25(-27) cm in diameter. Leaves 8-16, spirally arranged; sheath 0.6-1.4 m long; petiole 0.2-1 m long; rachis 3-8+ m long; pinnae 65-108 per side, inserted at regular intervals and in a single plane;

middle pinnae (0.75)1-1.7(-2) m long x (4.5)6-11(-14) cm wide. Inflorescence with primary axis distal to peduncular bract scar (15-)22-40(-50) cm long, (4.6-)7-11(-20) cm wide at scar; rachillae (116-)135-350(423) in number, (50-)70-120(-140) cm long. Staminate flowers with 4-7(8) mm long petals. Fruit ovoid-ellipsoid when mature, (2.3-)2.5-4(-4.75) cm long (not including the cupule), 2-2.75 cm wide, (5)6-15(-16+) gms when mature; mesocarp pulpy, purple or lavender-white.

9a. *Jessenia bataua* (Martius) Burret subsp. *bataua*

- = *Oenocarpus bataua* Martius
- = *Jessenia polycarpa* Karsten
- = *Jessenia repanda* Engel
- = *Oenocarpus seje* Cuervo Marquez
- = *Jessenia weberbaueri* Burret

Distribution: Panama and lowland areas over much of the northern half of South America (Figs. 18, 19).

Representative specimens: PANAMA. Darien: Río Uruti, yfr, without date, Duke & Bristan 218 (BH); without locality or date, Pittier 5678 (US).

COLOMBIA. Amazonas: 1 km E of Puerto Nariño, Río Loreto Yacu, alt. 100 m, 2 Feb 1973, Glenboski C-253 (US). Antioquia: Porce, Mun. Gomez Plata, fr, 1 Oct 1940, Ranghel Galindo 7, 23 (COL). Caquetá: Florencia, Cerros La Estrella, alt. 400 m, 30 Mar 1940, Cuatrecasas 8871 (COL); Hetuchá, Río Ortegaza, fl, fr, 21 Jul 1926, Woronow 6106 (LE). Chocó: 7 km W of Totenendo, on road to Quibdo, alt. ca. 100 m, yfr, 12 Aug 1976, Gentry & Fallen 17601 (BH); junction of Río Condoto and Río San Juan, alt. 100-150 m, seedling, 20 Apr 1939, Killip 35673 (BH, COL); Cabo Marzo, 13 Sep 1970, Moore 9872 (BH). Meta: Llanos Orientales, Caño Quenane, alt. 100 m, fl, fr, 22-23 Feb 1941, Dugand & Jaramillo 2897 (COL); Llano de San Martin, alt. 250 m, 1851-1857, Triana 716 (P). Norte de Santander: Petrolea, beginning of pipeline, alt. ca. 60 m, fr, 26 Sep 1946, Foster & Foster 1789 (BH). Vaupés: Mitú, fl, alt. 200 m, 18 Oct 1939, Cuatrecasas 7266 (BH (photo), COL, US); Río Guayabero, alt. 240 m, fl, 8 Nov 1939, Cuatrecasas 7539 (COL, US); Río Caraparana, between Las Bocas and

Figure. 18. *Jessenia bataua* subsp. *bataua* along the edge of the primary forest.

Figure 19. Mature fruiting panicles of *Jessenia bataua* subsp. *bataua*.

El Encanto, alt. 150 m, 22- May 1942, Schultes 3864 (BH); Río Apaporis, Jinogojé, at mouth of Río Piraparana, alt. ca. 230 m, 18 Jun 1952, Schultes & Cabrera 16754 (BH); Río Kubiyú, fl, fr, 30 Jun 1976, Zarucchi & Balick 1793 (ECON), fr, 1 Jul 1976 Zarucchi & Balick 1805 (ECON); Río Vaupés near stream across from Mitú, fr, 3 Jul 1976, Zarucchi et al. 1809 (ECON); along road S of Mitú, fr, 5 Jul 1976, Zarucchi et al. 1811 (ECON); Tukunaray, below Mitú on Río Vaupés, fr, 6 Jul 1976, Zarucchi et al. 1813 (ECON); Río Vaupés, La Makarena Village upriver from Mitú, fr, 9 Jul 1976, Zarucchi et al. 1814 (ECON), Río Kubiyú, fr, 12 Jul 1976, Zarucchi et al. 1838 (HUA, ECON), fr, 12 Jul 1976, Zarucchi et al. 1840 (COL, ECON), fr, 12 Jul 1976, Zarucchi et al. 1842 (ECON), fr, 15 Jul 1976, Zarucchi et al 1850 (ECON); Río Vaupés, La Makarena Village upriver from Mitú, fl, fr, 17 July 1976, Zarucchi et al. 1851 (COL, ECON); Río Vaupés, on trail that leads to Santa Lucia on Río Querari, fr, 7 Aug 1976, Zarucchi et al. 1874 (ECON). Valle: Buenaventura, 3 May 1926, Cook 73 (US), fr, 5 May 1926, Cook 79 (US), seeding, 7 May 1926, Cook 93 (US), 23 May 1926, Cook 135 (US), fl, 30 May 1926, Cook 178 (US); Río Naya, Puerto Merizalde, alt. 5-20 m, fl, fr, 20-23 Feb 1943, Cuatrecasas 13962 (COL, F. MO); Río Calima, La Trojita, alt. 5-50 m, 19 Feb - 10 Mar 1944, Cuatrecasas 16319 (COL); Río Cajambre, alt. 5-80 m, fr, 5-15 May 1944, Cuatrecasas 17379 (COL, F); 18 km E of Buenaventura, alt. ca. 50 m, yfr, 14 Feb 1939, Killip & García-Barriga 33255 (BH, US); Buenaventura, 9 Feb 1967, Moore et al. 9454 (BH); Agua Dulce, an island in Buenaventura Bay, 12 Feb 1967, Moore et al. 9476 (BH); Río Calima, Quabrada de la Brea, alt. 30-40 m, 19 May 1946, Schultes & Villarreal 7377 (BH). Vichada: Las Gaviotas, Topochera, fl, yfr, 25 Jul 1976, Balick & Hoyos 76-18 (ECON); Guacamayas, fr, 26 Jul 1976, Balick & Hoyos 76-20 (ECON); Las Gaviotas, 27 Jul 1976, Balick & Hoyos, 76-22 (ECON). Santander: 20 km S of Barrancas Bermeja, alt. ca. 100 m, fr, July 1966, Schulz & Rodríguez P. 509 (U).

VENEZUELA. Amazonas: along river 8 km above Santa Bárbara del Orinoco, fl, 28 May 1975, Berry 788 (BH, VEN); San Carlos de Río Negro, alt. 115 m, seedling, 18 Sep 1975, Berry 1421 (VEN); 4 km from San Carlos de Río Negro off road to Solano, seedling, 22 Sep 1975, Berry & Brünig 1506 (VEN); San Carlos de Río Negro, alt. 115 m, fr, 23 Sep 1975, Berry 1537 (BH, VEN); Santa Bárbara del Orinoco Experiment Station, 1-2 km S of Trapichote, alt. 130 m, 26 Feb-2 Mar 1976, Berry & Chesney 2100 (VEN); mouth of Río Ventuari between Macuruco and Santa Bárbara del Orinoco, alt. 130 m, fr, 24 Mar 1976, Berry 2133 (VEN); Piedra Blanca, Macuruco, Río Orinoco, alt. 130 m, fl, 25 Mar 1976, Berry 2155 (BH, VEN); 3 km S of Trapichote, alt. 130 m, fl, 29 Mar 1976, Berry 2196 (BH, VEN); Cerro Duida, SE slopes along Caño Negro, tributary of Caño Igapo, alt. 260 m, 28-29 Aug 1944, Steyermark 58065 (F); near Sanariapo, 26 Jul 1967, Wessels Boer 1891 (U); near San Carlos de Río Negro, 19 Jan 1968, Wessels Boer 2280 (U); near Santa Rosa de Amanadona, 30 Jan 1968, Wessels Boer 2369 (U); Puerto Ayacucho, alt. 100 m, yfr, 18 May 1940, Williams 12994 (F, US, VEN); Maroa, Río Guainía, alt. 127 m, 14 Feb 1942, Williams 14345 (F, US, VEN). Bolivar: Meseta de Jaua, Cerro Sarisariñama, Cumbre, alt. 700 m, seeds in cave, 12-15 Feb 1974, Steyermark et al. 109005 (VEN); around Las Paras encampment, vicinity of Salto Para, Río Caura, alt. 230-280 m, fr, 15-17 Jan 1977, Steyermark et al. 113113 (BH, VEN); near El Palmar, alt. ca. 75 m, 23 Nov 1967, Wessels Boer 2062 (U). Delta Amacuro: Atabuina, Caño Arature, to the foot of Sierra de Imataca, alt. 750 m, fr, 10 Apr 1959, Buza 304 (VEN). Merida: road from La Azulita to Caño Zancudo near Caño Zancudo, alt. ca. 250 m, 29 Aug 1967, Wesels Boer 2005 (U). Miranda: Parque Guatopo, seedling, 14 Mar 1976, Berry 2131 (VEN), several km N of the Junction of Río Santa Clara with the road, alt. ca. 300 m, 30 Apr 1976, Berry

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2202 (VEN), on steep slopes bordering Río Santa Cruz, between Santa Teresa and Altagracia de Orituco, 14.5 km from Los Alpes, 12 km from Rancheria Mi Querencia, 29 Nov 1971, Steyermark & Braun 104041 (BH, VEN). Monagas: Guácharo Cave, 6 km NW of Guácharo, alt, 950 m, seeding, 23 Apr 1945, Steyermark 62304 (VEN). Zulia: 1 km NW of Machiques-Colón Highway, between Río Tokuko and Río Aricuizá, ca. 90 km S of Machiques, alt. 50-100 m, fr, 22 Aug 1967, Steyermark & Fernández 99604 (BH, VEN); along Carretera Panamericana, ca. 30 km N of Caño Zancudo, alt. ca. 100 m, 5 Dec 1967, Wessels Boer 2112 (U).

FRENCH GUIANA. Charvein, 28 Jan 1914, Benoist 694 (P); Karounany, 1855, Sagot 851 in part (P).

ECUADOR. Imbabura: between El Pajon and Cachaco, alt. 600 m, without date, Acosta Solis 12742 (F); Lúrimagúa, alt. 600 m, fr, 10 Oct 1934, Heinrichs 787 (F, M). Napo: 16 km from Lago Agrio on Quito Road, fl, 10 Apr 1978, Balick et al. 1187 (ECON, QCA); Auca Territory, drilling site of Texaco Oil Company, 12 Apr 1978, Balick & Allon 1189 (ECON, QCA). Pichincha: Río Palenque Scientific Station, 56 km N of Quevado on Quito-Guayaquil Road, alt. 230 m, 19 Apr 1978, Balick & Allon 1190.

PERU. Húanuco: Leoncio Prado, Quebrada de Saugapilla, near Aucayacu, alt. 600 m, fl, 4 Mar 1978, Balick et al. 1148 (ECON); Tingo Maria, Naranjillo, 720 m alt., 10 Jul 1957, Ellenberg 2267 (U). Junin: La Merced, alt. ca. 700 m, 29 May-4 Jun 1929, Killip & Smith 23999 (BH (photo), F, NY, US), 24008 (F, NY, US). Loreto: Maynas, Río Yaguasyacu, tributary of Río Ampiyacu, Brillo Nuevo and vicinity, fr, Feb 1978, Balick et al. 1013 (AMAZ, ECON); El Sacremento, 89 km from Pucallpa, 240 m alt., 22 Jul 1957, Ellenberg 2462 (U); 40 km S of Pucallpa, 230 m alt., seedling, 24 Jul 1957, Ellenberg 2544a (U); Santa Rosa, lower Río Huallaga below Yurimaguas, alt. ca. 135 m, seedling, 1-5 Sep 1929, Killip & Smith 28845 (BH (photo), F, NY, US); Coronel Portillo, beyond vivero of Forestry Service toward Río Manatay, km 4, Pucallpa road, alt. ca. 220 m, 5 May 1960, Moore et al. 8402 (BH); Iquitos, alt. 120 m, seedling, Oct. 1929, Williams 3548 (F); Fortaleza, Yurimaguas, young fr, 1929, Williams 4963 (MO).

BRAZIL. Acre: near mouth of Rio Macauhan, tributary of Rio Yaco, fl, 3 Sep 1933, Krukoff 5758 (BH (photo), F, K, M, MICH, MO, NY, US). Amazonas: Yanomamu tribe at Tototobi, basin of Rio Denemi, 23 Aug 1975, Anderson 188 (BH): Reserva Florestal Ducke, Manaus-Itacoatiara Highway, seedling, 25 Oct. 1977, Balick 902 (ECON, INPA, NY); Manaus, Cachoeira alta do Tarumã, 28 Jun 1955, Chagas 1261 (INPA); Jutica, Varadouro, 16 Nov 1928, Luetzelburg 23043 (R); Reserva Florestal Ducke, fl, 15 Mar 1967, Moore 9532 (BH, INPA, NY); Rio Negro, Arivau, 1 Sep 1967, without collector, SPF herbarium no. 7 (IAN). Mato Grosso: Machado Angusturo, young fr, Dec 1931, Krukoff 1603 (BH, F). Pará: Santarém-Cuiabá Highway, BR. 163, km 1136 from Santarém, fl, fr, 16 Nov 1977, Balick et al. 929 (ECON, MG, NY), km 1234 from Santarém, yfr, 18 Nov 1977, Balick et al. 933 (ECON, MG, NY); 42 km E of Itaituba on Trans-Amazon Highway, fl, yfr, 28 Nov 1977, Balick et al. 952; EMBRAPA field station, Igapó de localidad Jogo, fl, 11 Dec 1977, Balick & Rosa 955 (ECON, MG, NY); without locality, fl, Jul 1923, Ducke 18615 (RB); Belém, fr, 5 Nov 1945, Pires & Black 571 (IAN), fr, 14 Oct 1950, Pires 2643 (IAN), seedling, 14 Oct 1950, Pires 2644 (IAN). Roraima: Bôa Vista, Jan 1933, Capucho 536 (F, IAN).

BOLIVIA. Beni, Prov. Vaca Diez, El Popeche, 22 km from Riberalta, fl, fr, 2 Aug 1982, Balick et al. 1368.

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9b. *Jessenia bataua* (Mart) Burret subsp. *oligocarpa* (Grisebach and Wendland) Balick, Adv. Econ. Bot. 3:126. 1986.

- *Jessenia oligocarpa* Grisebach and Wendland
- *Oenocarpus oligocarpa* (Grisebach) Wessels Boer
- *Oenocarpus oligocarpa* (Grisebach) Burret

Distribution: Trinidad, northern and northeastern Venezuela, Guyana and Surinam (Fig. 20).

Representative Specimens: VENEZUELA. Bolivar: Near El Palmar, alt. 75 m, fl, 23 Nov 1967, Wessels Boer 2062 (U). Delta Amacuro: Sur de Ibaruma, 23 Mar 1948, Tamayo 3562 (VEN). Miranda: San Pablo, cerca de Caripito, 9 Mar 1948, Tamayo 3563 (VEN). Monagas: Reserva Forestal de Guarapiche near confluence of Rio Guarapiche with Caño Colorado, fr, 25 May 1967, Wessels Boer 1825 (U).

TRINIDAD. Without locality, 17 Feb 1921, Bailey & Bailey s.n. (BH); Cumito, fr, 19 Jan 1946, Bailey 105 (BH); Valencia, fl, yfr, 19 Jan 1946, Bailey 105 (BH); Valencia, fl, yfr, 10 Jun 1978, Balick et al. 1231 (BH, ECON, TRIN), 25 Mar 1920, Britton et al. 1006 (K, NY, US); without locality, without date, Crueger s.n. (K); Aripo Valley, 13 Feb 1932, Loomis 49 (US); Valencia along road, 23 Aug 1963, Wessels Boer 1623 (U).

GUYANA. East Berbice-Corentyne: Corentyne River, fl, Nov 1879, Jenman 519 (FDG, K). East Demerara-West Coast Berbice: Essequibo River, Moraballi Creek near Bartica, sea level, fl, 28 Oct. 1929, Sandwith 528 (K). Mazaruni-Potaro: Essequibo, 1863-67, Appun 239 (K); Partang River, ca. 19 km above mouth, alt. 580 m, fl, Maguire & Maguire 43911 (U); Partang River, Merume Mountains, alt. 580 m, fl, 23 Jun 1960, Tillett et al. 43911 (NY).

SURINAM. Brokopondo: W slope of Emma Keten, alt. ca. 200 m, fl, May 1963, Wessels Boer 1433 (U); Kappel Savannah, fl, 8 Jun 1963, Wessels Boer 1514 (U); Taffelberg, 11 Jun 1963, Wessels Boer 1543 (U).

Figure 20. *Jessenia bataua* subsp. *oligocarpa* in Trinidad.

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CHAPTER 5

DISTRIBUTION AND ECOLOGY

DISTRIBUTION

The *Oenocarpus-Jessenia* complex is found throughout much of northern South America to an altitude of ca. 1000 m. *Oenocarpus* is also found in Panama and Costa Rica. Figures 21 and 22 illustrate the distribution of the collections listed in the previous chapter. The actual distribution is, of course, over a greater area than shown.

ECOLOGY

These palms are found in a wide range of habitats, from *terra firme* areas in primary forest to seasonally inundated sites along river margins and in disturbed forest. *Oenocarpus distichus* thrives in the sandy soils in the forests around Pará, and south into Goiás, Brazil.

The type locality of *Oenocarpus discolor* is a moist forest canyon in Morrinhos, across to the Serra da Chapada in Mato Grosso, Brazil. Another distichous-leaved species, *O. tarampabo*, is most abundant in the wet forest found along the river's edge in Rondônia, Brazil and Beni, Bolivia.

Oenocarpus bacaba is often found in large stands in the forest or in a high density swamp formation known as a "bacabal." Such swamps are reported in the literature (Pio Corrêa, 1926) but are not as common today, as they were recklessly

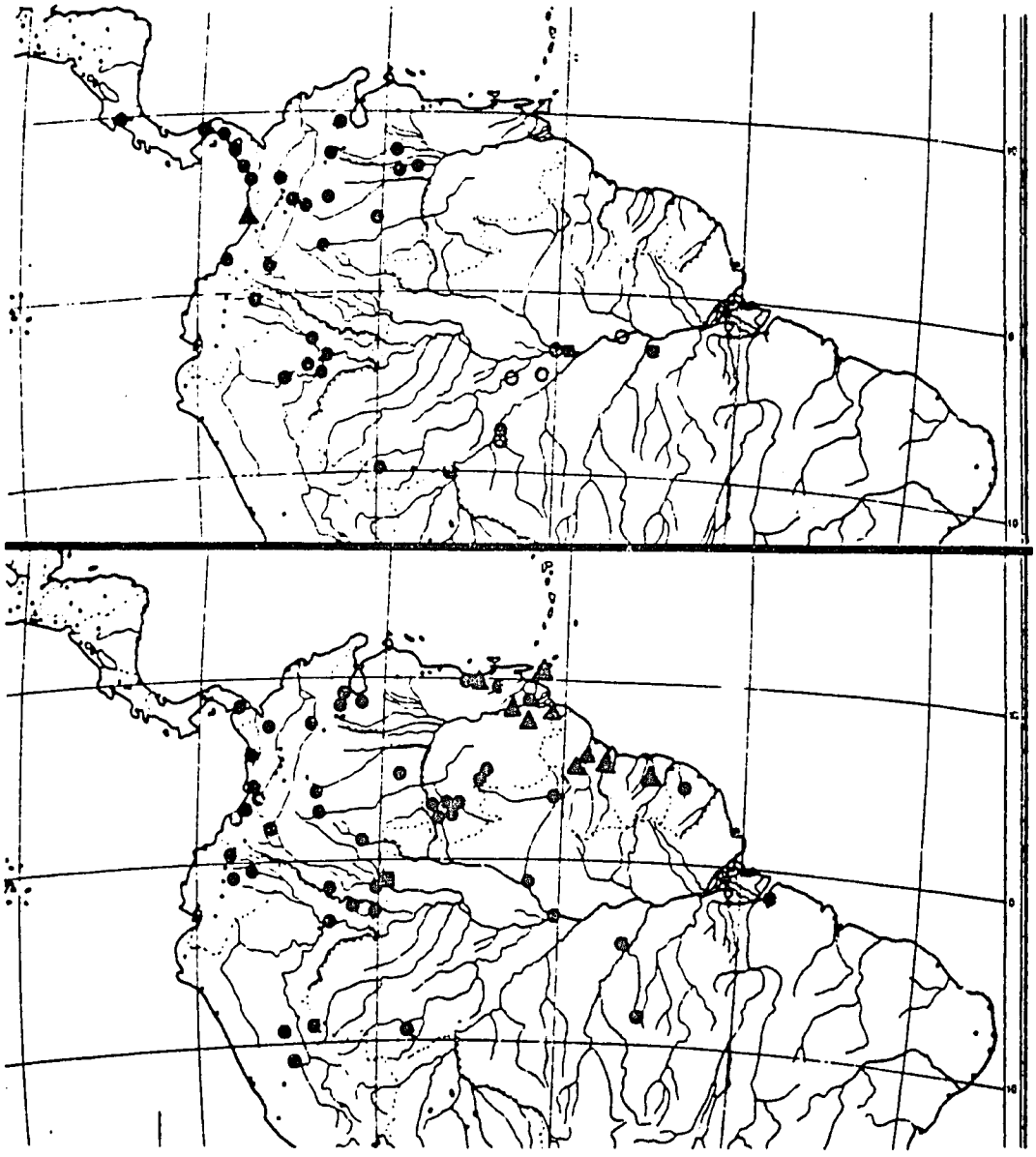

Figure 22. Top: Distribution of *Oenocarpus minor* subsp. *minor* (open circles), *O. minor* subsp. *intermedius* (squares), *O. mapora* subsp. *mapora* (closed circles) and *O. mapora* subsp. *dryanderae* (triangle). Bottom: Distribution of *Jessenia bataua* subsp. *bataua* (circles), *J. bataua* subsp. *oligocarpa* (triangles) and *Oenocarpus circumtextus* (square).

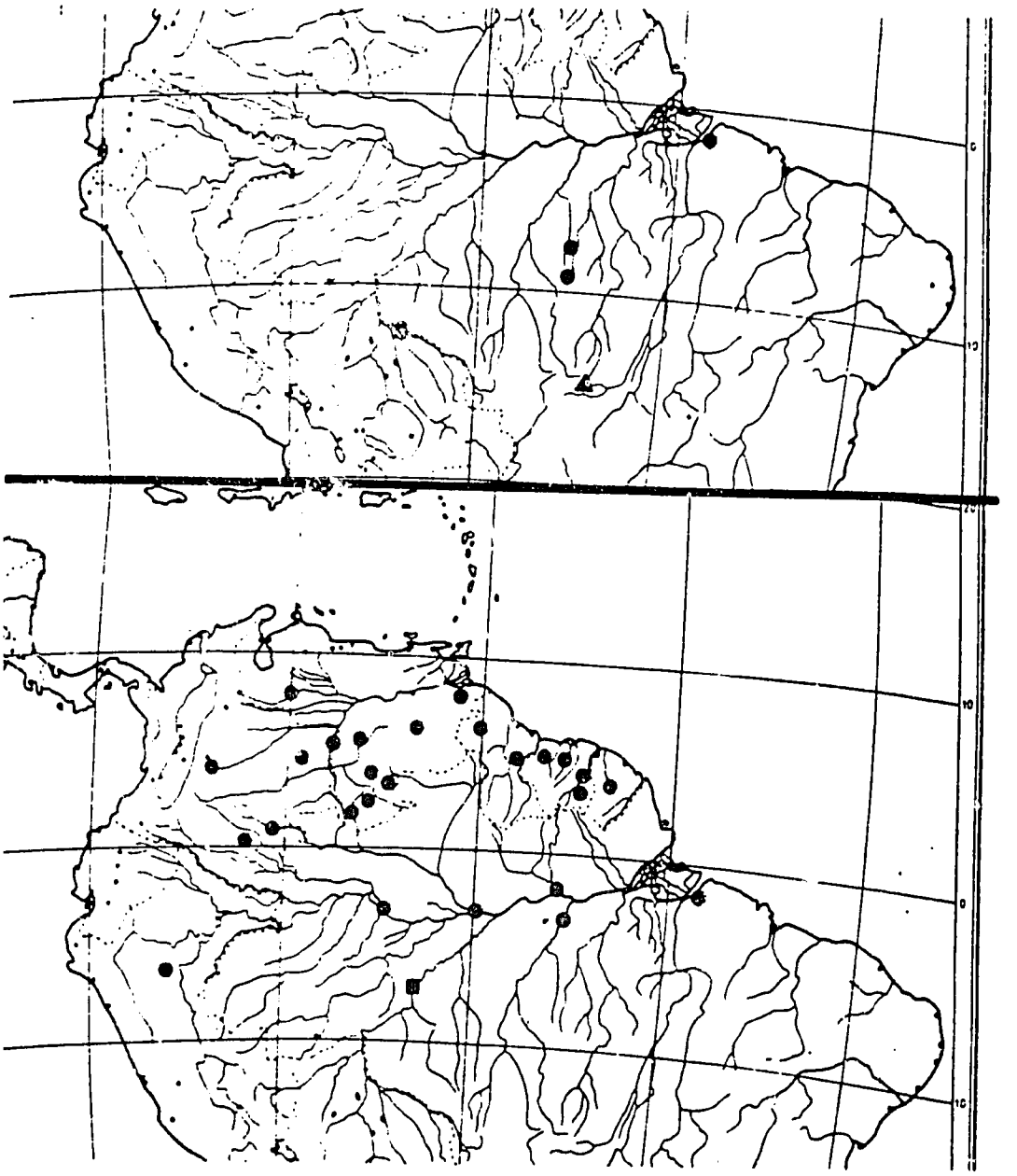

Figure 21. Top: Distribution of *Oenocarpus distichus* (circles), *O. discolor* (triangle), and *O. tarampabo* (square). Bottom: Distribution of *Oenocarpus bacaba* (circles) and *O. macrocalyx* (square).

CHAPTER 6. GERMINATION AND GROWTH

GERMINATION

Seeds in this complex have hypogeal, adjacent ligular germination. Tomlinson (1960a) speculated that this kind of germination was characteristic of palms inhabiting dark, moist environments where seedlings do not require protection by underground burial, a situation which is indeed true for *Oenocarpus* and *Jessenia*.

According to Braun (1968), *Jessenia bataua* requires 20-40 days to germinate. A high percentage of fresh seed germinates. Jordan (1970) found 80 and 99% germination after 79 and 83 days, respectively, in *J. bataua* and 88 and 97% after 74 and 67 days for *Oenocarpus mapora*. During my fieldwork, some seed lots collected in the Amazon Valley and sent to the Palm Society Seed Bank in Florida germinated in high numbers, while others appeared to suffer and deteriorate during transport and did not germinate. Well-packed *Oenocarpus* and *Jessenia* seeds (cleaned of the epicarp and mesocarp, wrapped in slightly moistened newspaper and sealed in plastic bags) were found to remain viable a maximum of six weeks after collection. As the usual habitat of the palms is a warm, constantly moist environment favorable to germination, there appears to have been no selection for the evolution of a complex or delayed system of germination.

During beverage making, fruits are placed in warm water (50°C+) for a half hour or so to soften and remove the epicarp and mesocarp. When fruits are not as ripe as desired, they may be soaked in water overnight at room temperature to make the epicarp pliant. While preparing the drink, the fibrous seeds are cleaned of

destroyed for short-term exploitation with little thought of the need for sustained utilization. The type collection of this species came from forest near the confluence of the Rio Solimoẽs and Rio Negro in Brazil. There is nothing known about the ecology of *Oenocarpus macrocalyx*.

Oenocarpus mapora is dimorphic in habit, either single-stemmed or caespitose. I have observed these two forms in the same population in Vichada, Colombia. This species is most commonly found scattered throughout the forest in upland or seasonally moist sites.

Oenocarpus minor is usually, in my experience, found scattered throughout the primary forest on *terra firme* sites. It does not appear to cover vast areas as is the case with some of the other species in this complex.

There is nothing known about the ecology of *Oenocarpus circumtextus*. It is found in the Cerro de La Pedrera, at an elevation of ca. 300 m. This is a region rich in endemic flora that deserves much closer attention.

Jessenia bataua grows in a variety of habitats from upland *terra firme* sites to high density stands in swampy regions or along river margins on seasonally inundated soils. In Trinidad it is found in the moist palm forest around Valencia.

In summary, very little is known about the ecology of these palms. Further studies about their soil, water and nutrient preferences in their native range would yield information of great value for domestication work.

Table 23. Germination and Early Growth of *Jessenia bataua* Following Various Treatments.

Seed Lot and Treatment	Percentage germination after 52 days	Percentage with first bifid leaf apparent
1. Control - no treatment, epicarp and mesocarp left intact.	42%	4%
2. Cool water soak for one week-epicarp and mesocarp left intact.	72	46
3. Cool water soak for one week-epicarp and mesocarp removed.	98	92
4. Warm water soak (ca. 50°C) for 1/2 hour-epicarp and mesocarp left intact.	22	0
5. Warm water soak (ca. 50°C) for 1/2 hour-epicarp and mesocarp removed.	98	90

their oily content, strained out of the mix, and discarded. Anecdotal information offered by Indians in the Vaupés and Vichada of Colombia revealed that this practice of soaking seeds (especially in warm water) hastens germination and growth, and results in an increase of the overall percentage of seed germination.

While various types of pre-treatments are known for palm seeds (Loomis, 1958, 1961), I was unable to find reference to such a positive effect from the combination of warm water and peripcarp removal. Clearly, any increase in germination and early growth rate of this slow-developing palm would have important implications for cultivation.

In an experiment devised to test this pre-treatment, five groups of 50 *Jessenia bataua* seeds were collected and planted in germination boxes in Manaus, after being given the following treatments: 1) control - no treatment, with epicarp and mesocarp left intact; 2) soaked in water at room temperature for one week, with epicarp and mesocarp left intact; 3) epicarp and mesocarp removed, seeds then soaked in water at room temperature for one week; 4) soaked in warm water (ca. 50°C+) for one-half hour, epicarp and mesocarp left intact; 5) epicarp and mesocarp removed and seeds soaked in warm water for one-half hour.

After 52 days the percentage germination and growth data were tabulated (Table 23). This simple in vitro test demonstrated indigenous observations to be correct. After a period of time when untouched seeds in the forest presumably would have shown a low germination rate with few seedlings leaves actually produced, seeds used in beverage production (or gnawed or passed through the digestive tract of an animal and subsequently discarded in the surrounding forest) would have an increase in both germination and early growth rate. It could be argued, therefore, that removal of the oily mesocarp layer, an attractive food, by humans or animals is of adaptive

Six major life stages, based on an easily recognizable stage of growth, were identified in *Jessenia bataua*. These were further divided into substages, for a total of 11 categories.

Certain difficulties arose when attempting to compile detailed quantitative data for the groups. Because of its size (often 25-30 m tall), the palm is rather awkward to work with, and thus it became necessary to estimate some parameters. While these may or may not be entirely accurate, they are nevertheless the best possible under existing circumstances. In studies of the adult root, it was impossible to dig beyond a depth of 0.75 m, due to the high water table. Consequently, little was learned about the adult root system in this species. Furthermore, a large accumulation of un-analyzed data and specimens was destroyed as the result of a plant press fire in Manaus. To determine weights, all materials were dried at 80°C in an oven of the type used in nutritional analysis for a minimum of 48 hours. The following life stages in *J. bataua* were delimited:

1. Seed. Seeds were collected from an adult palm. A single panicle yielded ca. 1650 seeds with an average dry weight of 5.5 g each.

2a. Seedling with only the bifid eophyll formed. Of ten collections made, 80% of the seedlings were still attached to the seeds, which, by this stage, weighed 1.4-2.6 g each ($\bar{x}$ = 2.0). The plants were 14-33 cm in height, with one-half the bifid eophyll measuring 14-17.5 cm long by 1.5-2.5 cm wide. Roots penetrated 7-22 cm below the surface and consisted of a single main root and one to three secondary roots. The aboveground portion of the seedling (excluding the seed) weighed 0.2-1.4 g ($\bar{x}$ = 0.7), while the root system totalled 1.0-5.0 g ($\bar{x}$ = 2.5). Figure 23 illustrates the range of leaf development from stages 2a-3b.

value by enhancing germination and growth.

The appearance of a small seedling leaf with a green lamina follows the production of the ligule and bladeless plumular sheath. Tomlinson (1960) used the term "eophyll" (from the Greek "early leaf") to describe this first blade and the similar few that follow. He assigned taxonomic importance to the morphology of the eophyll and classified them as entire, bifid, or compound. Seeds of *Oenocarpus* and *Jessenia* produce bifid or deeply emarginate eophylls. The two genera can be separated from each other on the basis of the abaxial surface of the eophyll: waxy-white in *Oenocarpus* or peltate to sickle-shaped trichomes in *Jessenia*, and distinguished from other Amazonian palms by the presence of the seed with its flattened fibrous cover and large embryo.

GROWTH

Palms in the wild exhibit variety in size and form, depending on age and environment. Natural populations of *Jessenia bataua* were carefully studied in the Reserva Florestal Ducke near Manaus, and a number of life stages delimited. These life stage classifications concern a species' whole lifetime, and conclusions are drawn on how biomass and measurements of various components (e.g., root, trunk, inflorescence, and leaf) vary with time. Bannister (1970) referred to "size classes" in her study of *Euterpe globosa* (=*Prestoea montana*), delimiting four such categories: seeds, seedlings (to 0.5 m tall), young trees (0.5-6.0 m tall), and mature trees (over 6.0 m tall). In view of the variation in growth of *Oenocarpus* and *Jessenia* and the inability to make absolute correlations regarding size and age, these groups are here called "life stages."

2b. **Seedling possessing several bifid leaves.** In only 50% of ten collections were seeds still attached to the seedlings. These seeds now weighed only 0.8-2.0 g each ($\bar{x}$ = 1.46), a significant drop from the first two stages. This is expected if the loss of epicarp, mesocarp, some of the nutritive tissue, and overall decomposition are considered. The young plants have a range of 30-47 cm in height, with one-half the bifid leaf measuring 20-30 cm long by 2.0-4.0 cm wide. The petiole bearing the rachis measured 14.5-33 cm, and the young sheath barely 5.0 cm long. Each plant had from 2-4 leaves. Roots, 3-4 per plant (those with a diameter ≥ 3 mm) measured 14-24 cm long and some were well branched. Excluding the attached seeds, aboveground mass was 1.9-5.4 g per plant ($\bar{x}$ = 2.78) while roots weighed 0.3-1.1 g ($\bar{x}$ = 0.68).

3a. **Sapling with leaves each bearing no more than four segments.** By this stage the seeds had completely separated from the young plants which now were 80-120 cm high (n = 5). Leaf segments, 34-40 cm long by 3.0-5.5 cm wide, were borne on a rachis measuring 3-15 cm, a petiole 44-74 cm, and sheath 10-12 cm long. There were 3-5 leaves per plant. Roots were 15-40 cm long, a measurement now subject to error due to breakage upon excavation from the ground. From this point on, the below-ground system became too complex to measure individual root lengths. Approximately 6-10 roots ≥3 mm thick were counted per plant. Aboveground biomass amounted to 16.6-33.6 g ($\bar{x}$ = 28.5), while that below ground amounted to ca. 1.9-5.7 g ($\bar{x}$ = 3.35).

3b. **Sapling with short, juvenile, pinnate leaves and no aerial trunk.** Of five specimens studied, heights ranged from 1.0 to 1.6 m. Petiole and sheath combined length was 63-103 cm and rachis length 33-70 cm. The three to five leaves per plant each carried 9-21 pinnae. No estimate of biomass or additional data were obtained for this sample due to the previously mentioned fire.

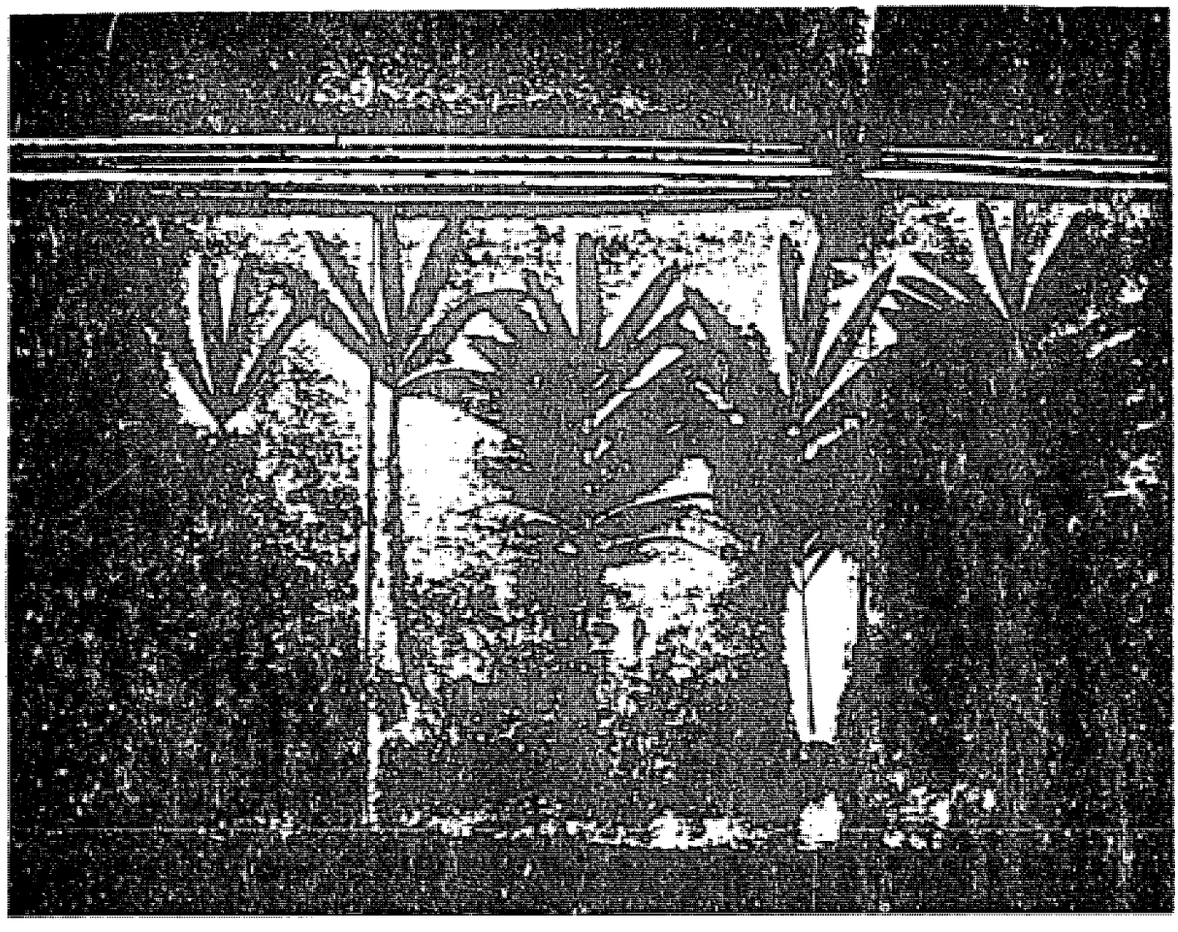

Figure 23. Range of leaf development in seedlings of *Jessenia bataua* from stages 2a-2b.

this point. Dissection of the 17 sheaths present revealed axillary inflorescences formed in two series of three and five inflorescences each, spaced between several axils having aborted inflorescences. Inflorescence production was thus not continuous. In specimens examined from other locations, axillary inflorescences were found to range from present in all axils to only in very few. The number of buds produced, as can be expected, appears dependent on the health and environment of a particular individual.

6. Senescent palm. The senescent palm showed a reduction in growth rate, reproductive potential and biomass generation, in contrast to the previous life stage. Only six, considerably shortened leaves were present in the crown, with a rachis only ca. 5 m, petioles 20 cm, and sheaths 95 cm long. Even the number of pinnae on an individual rachis showed a slight decrease from the seed-bearing adult, with 190 on the oldest and 181 on the newly emerging leaf. No young axillary inflorescence buds were found under the sheaths dissected. This palm had a strongly bent trunk measuring 16.25 m to the lowermost sheath, with 131 leaf scars present. From field experience in other areas, this individual was judged to have deteriorated unusually early in its life cycle, due to a hostile environment, physical damage to the stem, or other unexplained factors. The number of leaves produced on the aerial stem (131) was less than that on the previous specimen (133), a very healthy individual. Under more favorable conditions, the palm probably should produce more than 150 leaves on an aerial trunk during its lifetime.

No estimate of ages can be attached to any of the life stages as tagging and subsequent years of observation were not undertaken. However, measurements within the defined life stages reveal several growth trends. A comparison of above-and below-ground biomass over time reveals a decreased percentage of root biomass versus

3c. **Sapling with intermediate-sized pinnate leaves.** From this point on, as work was carried out in a forest reserve, we cut only one tree per category. The four leaves on this plant measured ca. 4.4 m each, including sheath, petiole, and rachis. Because of their graceful curve, the overall height of the plant was only 4.0 m. Central pinnae measured ca. 60 cm long by 5 cm wide. The aboveground weight of 6.88 kg was far larger than that below ground, 1.16 kg. None of the durable black spine-like fibers so characteristic of this species were formed by this stage - only a few soft green hair-like fibers arose from the sheath.

4a. **Adolescent palm, leaves expanded almost to full-size, beginning of aerial trunk formation.** This palm was 5 m tall with six leaves, each measuring ca. 8.5 m long. The 191-99 individual pinnae per leaf had reached adult size (ca. 1+ m long by 6-10 cm wide). The young trunk weighed 3.2 kg, bringing the aboveground biomass to 32.7 kg, while below-ground biomass comprised only 2.17 kg.

4b. **Adolescent palm with small fibrous trunk.** Reaching a height of ca. 12 m, the 4.5 m long apical trunk bore 18 leaf scars. Leaves were beginning to change from a more or less vertical orientation to one slightly less so.

4c. **Adolescent palm with fibrous covering completely dropped from the trunk.** At an overall height of ca. 17 m, the entire fibrous covering had abscised from the trunk. The stem measured 8.7 m long with 29 leaf scars. No axillary inflorescence buds were found. More commonly, such inflorescences are usually produced by this stage and, in fact, frequently are found mature enough to flower and fruit.

5. **Seed-bearing adult.** This specimen reached a height of 23 m, with 11 leaves in the crown oriented at an angle of ca. 45° relative to the stem. The aerial stem measured 14.7 m to the lowermost sheath, and had 133 leaf scars up to

CHAPTER 7.

NATURAL HYBRIDIZATION

The possibility of selection and/or creation of superior forms of these palms, from the standpoint of utilization, is greatly enhanced because of the vast amount of variation present in wild populations, as well as their ability to hybridize. Hybridization has been observed in wild populations at three sites, with two different sets of parents.

The most unusual hybrid found to-date in this complex was between *Jessenia bataua* and *Oenocarpus bacaba* in the Vaupés of Colombia. As discussed in Chapter 1, this palm is recognized by the Cubeo Indians as a distinct form, which they call "Yaveécohañu." It was found in the *terra firme* forest near Mitú, Vaupés, Colombia, where populations of *Jessenia bataua* and *Oenocarpus bacaba* intergraded. The hybrid possesses a unique characteristic -- an aborted seed with a greatly reduced quantity of endocarp relative to the oil-rich mesocarp. This is an extremely important characteristic if the aim of a selection breeding program is to increase the pulp/seed ratio of the fresh fruit, from its current rate of 40.7% as calculated from the composite mill sample discussed in Chapter 3. The aborted embryo and greatly reduced endocarp, along with intermediate-shaped trichomes on the abaxial surface of the pinnae are two distinctive elements of the morphology that characterize this hybrid. It has not been described botanically as yet. A second collection by Paul Berry (2100), from Santa Bárbara del Orinoco, Territorio Federal Amazonas in Venezuela, also documents the existence of this same intergeneric hybrid. A third collection of this hybrid, Balick et al. 76-20, was made in the Llanos of Colombia. Preserved mature fruits of this hybrid are depicted in Figure 24.

shoot biomass with age. In the seedling stage roots comprise 20-25% of total weight; in the sapling stage this drops to 10-15%, and in the adolescent stage (the last calculation believed to have any accuracy) it is only 6%. While Tomlinson and Soderholm (1975) used a final root biomass of 10% in their calculations of bioenergetics of *Corypha elata*, the trend shown here, should it be proven to hold throughout all stages, would appear to indicate a somewhat smaller percentage for *Jessenia bataua*. Unfortunately, I know of no way that this could be accurately calculated.

Leaf morphology is a good indicator of a palm's life stage. Seedlings and juvenile pinnae stages are easily recognized when contrasted to adult stages. In the senescent stage, slightly smaller and far fewer leaves are present in the crown than in the adult seed-bearing stage. Leaf orientation also varies with age. Leaves in a young adult often display a more vertical orientation, while a horizontal slant is indicative of an older specimen. Although bracts, inflorescences, fiber, and fruits are known to vary in size and number over time, I was unable to obtain any quantitative data for documentation. This would require felling entire populations of trees in a completely isolated area, a task which must be reserved for a later date.

The second natural hybrid identified in this complex is between *Oenocarpus minor* and *Oenocarpus bacaba*. It was seen growing in a disturbed primary forest site at the Estrado do Turumá. 1 km from its intersection with AM-010, the Manaus-Itacoatiara highway in Amazonas, Brazil. As can be seen in Figure 25, the two species are found in very close proximity to each other, in a mixed population with abundant specimens of both *O. minor* and *O. bacaba*. The result is a hybrid, also as yet undescribed, that produces a panicle intermediate in size between *O. minor* and *O. bacaba*, as seen in Figure 26.

From the standpoint of domestication, the advantages of being able to create hybrids between the species and genera in this complex are obvious. Field studies have proven the existence of at least two natural hybrids in the wild. It is likely that others would be found during additional fieldwork. The diversity available or created through hybridization is a valuable resource for improving the worth of the *Oenocarpus-Jessenia* complex as a domesticated tree crop. Studies are currently underway at The New York Botanical Garden Institute of Economic Botany to quantify the variation produced by hybridization in this complex.

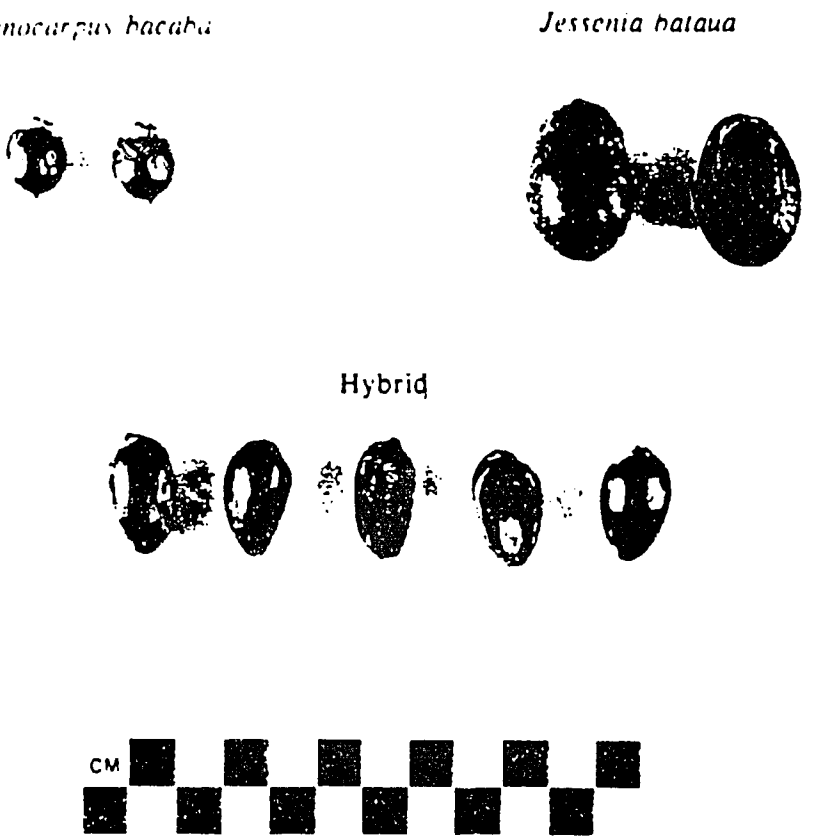

Figure 24. Fruits from the intergeneric hybrid *Oenocarpus bacaba* x *Jessenia bataua*.

Figure 26. The intermediate-sized panicle produced by the hybrid *Oenocarpus minor* x *O. bacaba*; panicles collected from the parent trees are also shown: *Oenocarpus minor* (L) and *O. bacaba* (R).

-3/2'

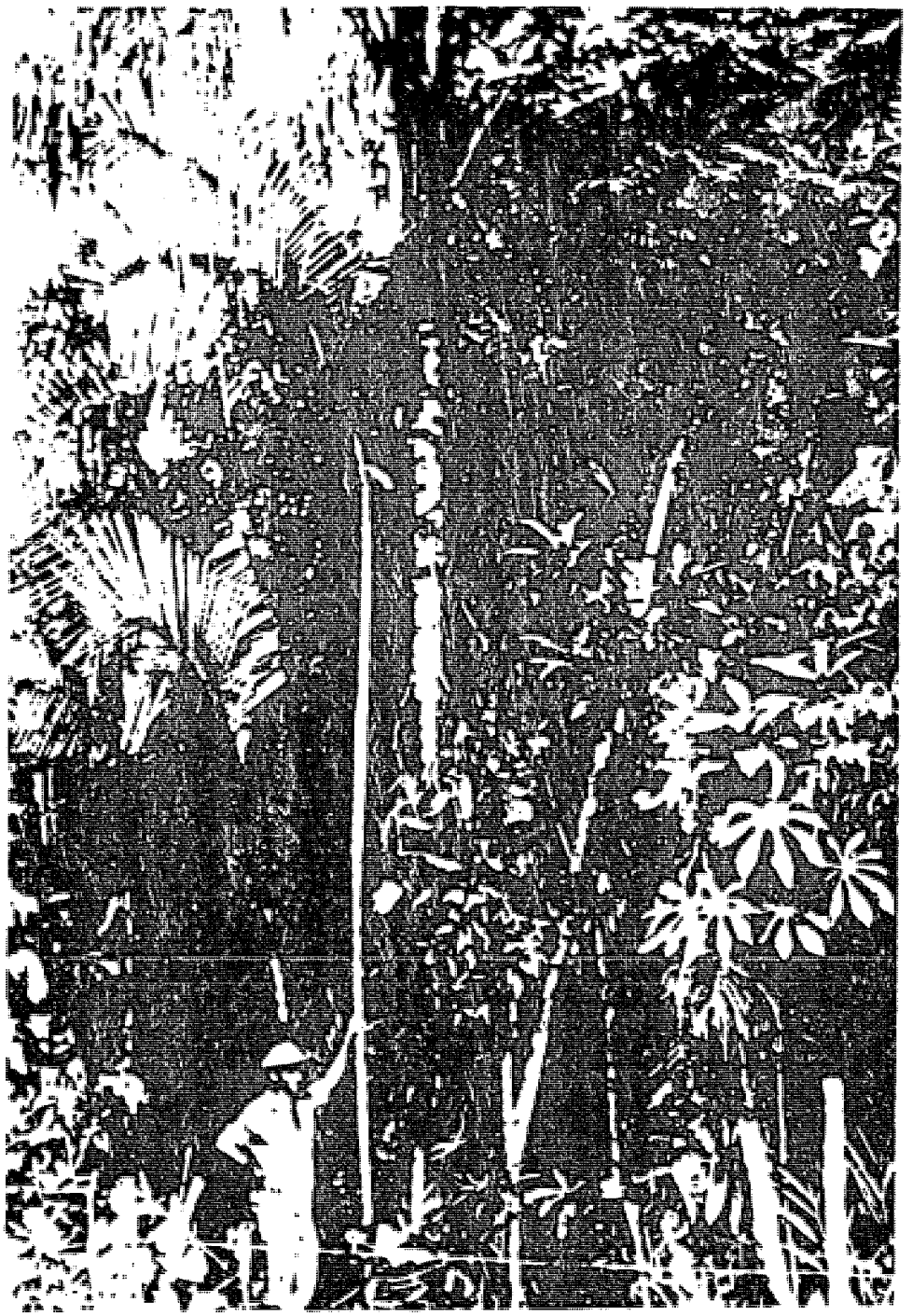

Figure 25. An example of *O. minor* growing in very close proximity to *O. bacaba*, along the Estrado do Turumá.

shortly after staminate anthesis. Some of this red color is due to a coating of pollen on the rachillae. Pistillate flowers reach anthesis several weeks after staminate flowers have passed anthesis.

As soon as the rachillae are free from the peduncular bracts many insects are attracted to the inflorescence. The closely bunched, pendulous rachillae seem to provide a temporary habitat for these insects. This suggests that both *Jessenia* and *Oenocarpus* may be insect pollinated, although the mechanism and pollinator are not known.

Collections from *Jessenia* and *Oenocarpus* inflorescences have revealed a quite remarkable diversity of insects and arachnids. For example, in the Chocó of Colombia, Furth collected approximately 80 different species of insect and arachnids from inflorescences of *J. bataua*. Clearly there are complex interactions involved, not only between the insects and palm, but also amongst the insects. Of the 80 species, the following are of interest. Eleven different species of Baridinae (Curculionidae) were collected. This large subfamily of weevils has been recorded many times from palm inflorescences, and may be pollinators. Thirteen other species of Curculionidae were collected, and these in sufficient numbers to suggest they could also be pollinators. Other potential pollinators, scarab and nitidulid beetles were also collected. Other groups, for example bees, ants and wasps are common visitors to all palm inflorescences. Bugs (Heteroptera) are generally not considered pollinators, since their sucking mouthparts are adapted for sap feeding. One bug of interest was *Discocoris drakei* Slater & Ashlock (Thaumastocoridae). This species is unusual among bugs in having bilaterally asymmetrical forewings and is apparently only known from palm inflorescences.

CHAPTER 8.

REPRODUCTIVE BIOLOGY

(Jointly with Andrew Henderson* and David Furth**)

Reproductive biology is considered here under three headings; pollination, predation and dispersal. Although there are no detailed studies of any of these for *Jessenia* or *Oenocarpus*, enough information is available to show certain trends. These are discussed below under each heading.

POLLINATION

In a recent review of palm pollination (Henderson, 1986), no information was given under either *Jessenia* or *Oenocarpus*. The following are observations made by the authors and allow a general idea of pollination to be given. However, there is still much room for further study.

During its development the inflorescence of both genera is enclosed by the woody peduncular bract. Just before anthesis the peduncular bract splits and falls away from the inflorescence. At this time the rachillae hang straight down and are closely bunched, giving the characteristic "horsetail" appearance. In both *Jessenia* and *Oenocarpus* the inflorescence is protandrous (i.e., the staminate flowers open before the pistillate). Rachillae and flowers are cream-colored at anthesis, and flowers have a slight, sweet odor. In both *Jessenia* and *Oenocarpus* the rachillae turn from cream-colored to red

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The following animals are recorded feeding on fruits of *Jessenia bataua*: *Tayassau tajacu*, *T. peccari*, *Steatornis caripensis*, *Cebus albifrons*; *Cebus apella*. *Ateles belzebuth*. *Ara macao*. *Ramphastos tucanus*, and *Pipile cumanensis* (Zona & Henderson in prep.). In particular, the oil bird, *Steatornis*, is probably an important disperser of *Jessenia* fruits. Both bird and palm are found in northern South America.

The following animals are recorded feeding on fruits of *Oenocarpus bacaba* and *O. mapora*: *Brycon* sp, *Gymonderus foetidus*, *Cebus apella*, and *Sciurus granatensis*.

Above all, man has probably been responsible for dispersing seeds of both genera throughout the neotropics.

ACKNOWLEDGEMENTS

Insects collected by Henderson were kindly loaned for determination by INPA Entomologia, Manaus, Brazil. Determinations of these were kindly provided by Charles O'Brien (Curculionidae) and by the USDA Biosystematics and Beneficial Insects Institute.

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Near Manaus, in Brazil, Henderson has collected insects from inflorescences of *Oenocarpus bacaba* and *O. minor*. Curculionids, scarabs, nitidulids and staphylinids were abundant. *Anchylorhynchus minimus* Bondar (Curculionidae Derelomini) was especially abundant on both species of *Oenocarpus*, and in view of what is known about derelomine weevils on other palms (Henderson, 1986), *A. minimus* is the probable pollinator

PREDATION

Seeds of *Jessenia bataua* are known to be predated on by termites (*Nasutitermes*) and an unknown genus of Cryptorhynchinae. Stems of *Jessenia bataua* are predated by stem boring weevils, *Rhinostomus barbirostris* and *Rhynchophorus palmarum* (Curculionidae, Rhynchophorinae). Quite a few of the insects collected during these pollination studies (mentioned in the previous section) are apparently feeding on the inflorescences and are actually phytophagous. In the process of feeding many of these plant feeders probably also pollinate the palms.

DISPERSAL

The following information has been taken from Zona and Henderson (in prep.). These authors have shown that most palm fruits are eaten, and the seeds dispersed, by animals. *Jessenia* and *Oenocarpus* are no exception.

The nutritious fruits of both *Jessenia* and *Oenocarpus* provide food for a variety of birds and mammals. While many of them may destroy the seeds, it is probable that many of them also act as agents of dispersal.

Bactris gasipaes seedlings at a Peruvian palm nursery were also found to be non-mycorrhizal (Sr. Pedro Ruiz, Yurimaguas Experimental Station, Peru, pers. comm.). The plants produced at these nurseries may suffer slow growth during the nursery phase, and may be at a considerable disadvantage when transplanted to the field. Slow and uneven growth in a California *Citrus* nursery was traced to a lack of VAM in a classic study by Kleinschmidt and Gerdemann (1972). The experiment reported here was undertaken in 1983 and 1984, when a few seeds of *Jessenia bataua* became available, as a test for this species of its relative development under mycorrhizal and non-mycorrhizal conditions.

METHODS

At the time the experiment was initiated, only ten seeds of *Jessenia bataua* were available; of these, only eight germinated. Because of the small number of plants, the experiment was designed as a simple comparison of growth rate of mycorrhizal and non-mycorrhizal plants, with a single harvest date. There were also two non-destructive evaluations.

The plants were grown in fritted clay, a material sold commercially as a grease absorbent and as pet litter. The advantages of using fritted clay as a growth medium were detailed by Van Bavel et al. (1978). Its application as a substitute for tropical soil was described by Pohl (1977). The material was washed thoroughly in tap water to remove the fine particles, which exert an overriding influence on its pH and otherwise reduce its suitability as a plant growth medium.

CHAPTER 9.

MYCORRHIZAL ENHANCEMENT IN GROWTH RATE OF *Jessenia bataua* SEEDLINGS

(Theodore V. St. John*)

INTRODUCTION

Palms, like most tropical plant species, form the mutualistic root-fungus association known as vesicular-arbuscular mycorrhiza (VAM). Palms may be among the most dependent of plant species upon the nutrition-enhancing qualities of the symbiosis (St. John, in press). Janos (1977) demonstrated experimentally that growth of the palm *Bactris gasipaes* can be substantially improved by inoculation with mycorrhizal fungi. St. John (1980) reported that VAM was found in *Oenocarpus bacaba* and other palms growing in a rainforest environment in Brazil.

The fungal symbionts of the VAM mutualism are found naturally in most native soils; thus no special attention is required to assure that field-grown specimens are mycorrhizal. When palms are reared in a nursery before planting, however, the potential lack of fungal propagules is a serious concern. Seedlings of palms and other crop species are often non-mycorrhizal in Brazilian nurseries (unpublished observations). The soil used as a potting medium at a large Brazilian palm nursery was very low in inoculum even when freshly collected, and deteriorated further with handling and storage (Sr. Rogerio Dias, CEPEC-CEPLAC, Ilheus, Brazil, pers. comm.).

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The first non-destructive evaluation took place approximately twenty days after moving the plants, on day 161. The second non-destructive evaluation was on day 353. The final harvest was on day 357 of the experiment.

Roots and shoots were separated for drying at 70^0C and weighed. Ten percent by fresh weight of the root system of each plant was reserved for determination of mycorrhizal colonization, and the remaining roots were dried and weighed.

At the time of non-destructive evaluation, the number of newly emerging and expanded leaves was counted on each plant. The longest leaf on each plant was also measured.

The roots reserved for the determination of mycorrhizal condition were cleared and stained (Phillips and Hayman, 1970) and examined under a compound microscope. When characteristic VAM structures had been positively identified, the amount of colonization was quantified under a dissecting microscope. The prepared roots were placed in glycerin in a petri dish and superimposed on a grid (Marsh, 1971). Mycorrhizal colonization was expressed as the number of grid intercepts bearing mycorrhizal structures divided by the total number of intercepts. Since each sample represented ten percent of the fresh weight of the root system, a crude estimate of total root length was obtained by multiplying the length of root in the subsample by ten.

Statistical analyses were carried out by Wilcoxen's Two-sample Rank Test (Hollander and Wolfe, 1973).

Inoculation was carried out on September 28, 1983, after the slow and uneven germination had taken place and the plants had used up their seed reserves. At the time of inoculation, considered day 0 in this experiment, the plants were placed in individual white 19 cm diameter plastic pots, each provided with individual drainage trays. Inoculum consisted of soil, roots, hyphae, and spores of a culture of the VA mycorrhizal fungus *Glomus fasciculatum* (Thaxter sensu Gerd.) Gerd. & Trappe, which had been isolated from field collections near Fort Collins, Colorado. Inoculum for control and mycorrhizal pots was prepared at the same time by separating five ml portions into individual beakers. Control batches were randomly selected and autoclaved 15 minutes at 121°C. An additional five ml of live inoculum was shaken in 300 ml of distilled water, allowed to sit 2 hours, and filtered twice through Watman number 1 filter paper to remove propagules of mycorrhizal fungi, but allow other microorganisms to pass. Twenty-five ml of the sievings were added to each beaker of inoculum, including live inoculum, and poured into the pots at the time the inoculum was added.

The plants were left in the dark for the first 24 h after inoculation to aid in adjustment to transplanting. They were then placed under low light intensity (quantum flux density approximately 120 microeinsteins $m^{-2}s^{-1}$) with 24 h daylength under plant growth lights. The temperature range was 20-22°C. A plastic curtain enclosed the plants to help retain humidity.

After several months in the above conditions a growth chamber became available. The plants were thereafter maintained at a temperature of 25°C, relative humidity at 70%, and daylength of twelve h. The quantum flux density was approximately 600 microeinsteins $m^{-2}s^{-1}$.

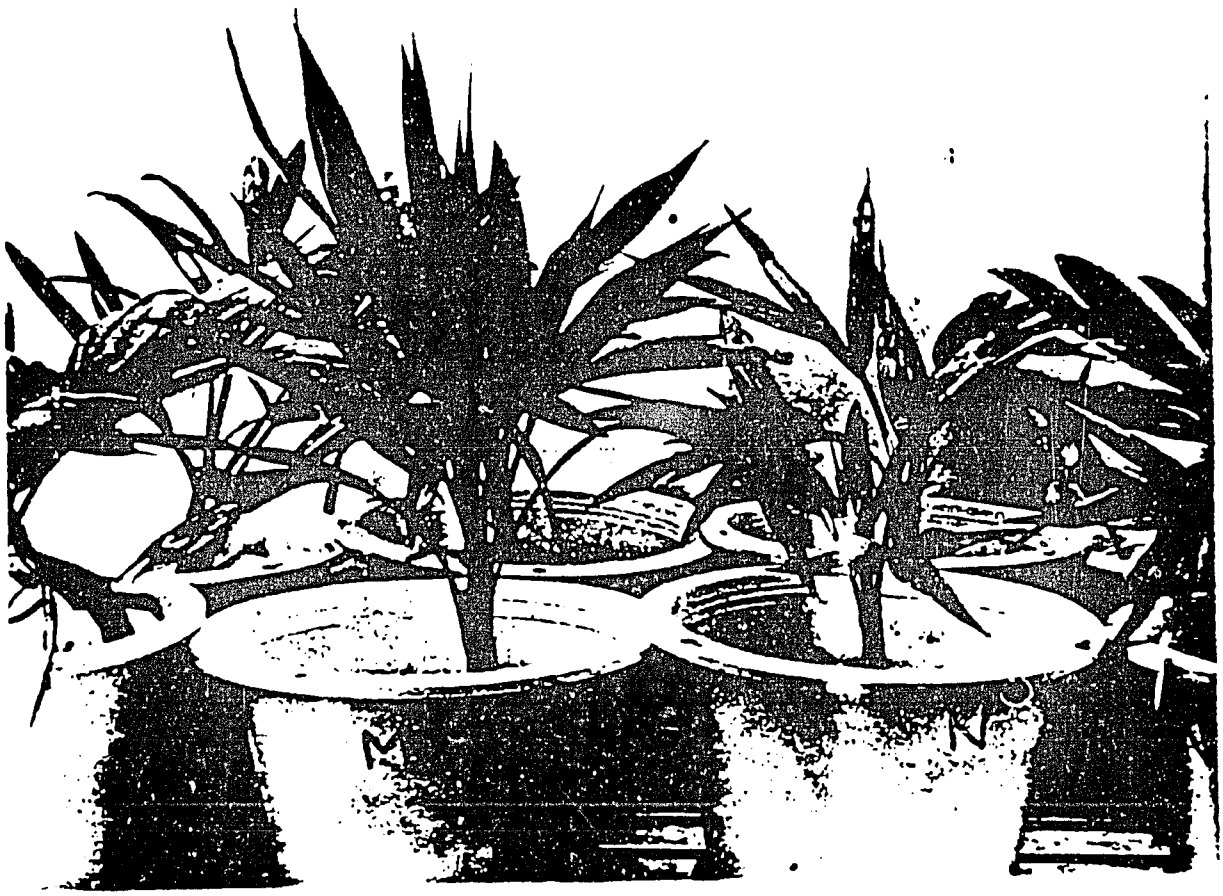

Fig. 27. Experimental *Jessenia bataua* plants, showing the size difference between mycorrhizal (left) and non-mycorrhizal plants (right).

RESULTS

The number of leaves tended to be higher, but not significantly so, on mycorrhizal plants at day 161. By day 353 the difference was significant. The longest leaf was significantly longer on mycorrhizal plants at both day 161 and day 353 (Table 24).

Above ground and below ground portions of the four mycorrhizal plants weighed significantly more than those of non-mycorrhizal plants (Table 25). Total root length was also significantly greater in mycorrhizal plants. Root/shoot ratios (not shown) did not differ significantly.

Ten percent of the fresh weight of each root system was examined for VAM. Three of the four inoculated plants were mycorrhizal (two with 16% of the root length colonized and one with 10%). The fourth showed no colonization in the root subsample examined, but hyphae and spores in the preparation indicated that parts of the root system that were not subsampled must have been mycorrhizal. None of the four control plants showed any indication of VAM.

DISCUSSION

In spite of the small number of seeds available at the time this experiment was established, the dramatic response of *Jessenia bataua* to VAM was statistically significant (Fig. 27). This response is especially noteworthy in the case of a plant species that is intrinsically a slow grower. Plant species that are genetically slow growers are usually native to nutrient-poor soils and make very modest demands on the soil's nutrient supply (Chapin, 1980). Slow growth and the

Table 25

Weight and Mycorrhizal Colonization of *Jessenia bataua* Seedlings at Harvest

	TOP WEIGHT (GM)	ROOT WEIGHT (GM)	TOTAL ROOT LENGTH (CM)
MYCORRHIZAL			
MEAN	8.82	3.55	1046
n	4	4	4
SD	1.51	1.52	283
NONMYCORRHIZAL			
MEAN	4.86	2.08	480
n	4	4	4
SD	0.64	0.27	134

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Table 24

Number and Length of Leaves at Two Sample Dates

	Day 161		Day 357	
	NUMBER OF LEAVES	LENGTH OF LONGEST LEAF (CM)	NUMBER OF LEAVES	LENGTH OF LONGEST LEAF (CM)
MYCORRHIZAL				
MEAN	1.8	16.1	5.5	19.8
n	4	4	4	4
SD	0.5	1.1	1.0	1.3
NONMYCORRIZAL				
MEAN	1.3	12.9	3.3	14.5
n	4	4	4	4
SD	0.5	1.6	1.0	1.9

CHAPTER 10. AGROFORESTRY

(Jointly with Steven R. King* and Luis E. Forero P.**)

Earlier sections of this volume have pointed out the great number of uses for the palms in this complex. It is truly a multi-use complex, providing a wealth of subsistence and commercial products, and therefore would be valuable for use in agroforestry systems, both within and outside of its natural range.

In 1984 and 1985 we undertook two expeditions to the Chocó of Colombia, to study *Oenocarpus*, *Jessenia*, *Orbignya* and related species. Surveys were carried out in the primary forest rich in *Jessenia bataua*, and it was noted that current local utilization of this species is substantial. These uses include beverage and oil production, thatch, wood, as well as for other purposes. There is also a small market for the fresh fruit; this is sold by the bag and bowl in the Quibdo area.

The primary forest has been modified radically in many parts of the Colombian Chocó. The region around Quibdo is no exception. The primary forest has been cut to create pasture and to demarcate an individual's holdings (consistent with the philosophy that "a cleared field is a useful field"). As a result, the removal of the primary forest cover has led to the degradation of the ecosystem, and a reduction in species diversity per unit area. Vast areas of swampy pastures are all that remain of what was once some of the richest tropical forest on earth.

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resulting low nutrient requirement mean that mycorrhizal responses can be difficult to detect in a species like *J. bataua*.

The differences in the number of leaves and the length of the longest leaf widened over the course of the experiment (Table 24). These differences were apparent at a somewhat earlier age than the *Bactris gasipaes* seedlings tested by Janos (1977), even though *B. gasipaes* is normally a much faster-growing species than *J. bataua*. However, mortality of uninoculated seedlings was high in the experiment with *B. gasipaes*, a factor which may complicate direct comparison of the results.

By harvest date, almost one year after inoculation, the dry weight of the mycorrhizal plants was almost twice that of the controls. This substantial advantage of mycorrhizal plants indicates that nursery palm seedlings, which may often remain non-mycorrhizal until outplanting, could potentially be held a shorter time in the nursery, planted at a larger size, or both, with appropriate mycorrhizal inoculation at an early stage. Further experiments currently underway are aimed at obtaining more complete information about the influence of mycorrhizae on the growth of these palms.

The palm/pineapple combination is also used in seasonally inundated sites. In the areas where this combination is used, the soil is not particularly rich in organic material, and the roots of the *Jessenia* palms form a very dense network in the upper 2-3" of the soil surface. As a result, farmers feel that the only crop that will grow in a soil so densely covered with the thick roots of *Jessenia* is pineapple, *Ananas comosus*. Farmers estimated that it would take five years for the *Jessenia* roots on the soil surface to rot and allow other crops to be put in.

Pineapples are planted in the field using two spacing techniques. In some areas, pineapple suckers are planted in rows spaced 2 m apart with individual plants set in holes 6" apart in the row (Fig. 28). No roguing of plants is carried out during the 20-24 months it takes for the plants to yield.

The second system observed involves planting rows of pineapples 1.2 m apart and spacing the pineapples 1.2 m apart in the row (Fig. 29). It appears that some farmers are of the opinion that, given greater spacing, the pineapples will provide more prolific yields.

Inventories were carried out at four farms to determine the number of trees per hectare and the total productivity of the palms in the system. The results are presented in Table 26. *Jessenia bataua* is the primary tree species of economic value in the fields. It is interesting to note that the density of palms measured at the four different farms ranged from 71-84 per hectare, and that varying amounts of palms were cut from the plot to achieve this density. Although the number of farms inventoried is too small to analyse statistically, the data suggest an optimum density in this area of 70-85 palms per hectare. Since we carried out this

In the half-dozen or so farms that we visited, the local people reported that they preserved the *Attalea allenii*, *Euterpe cuatrecasana*, *Jessenia bataua*, *Oenocarpus mapora* subsp. *dryanderae* and *Wettinia quinaria* palms that grew on the land. Only when the (absentee) owner ordered his farmhands to cut these palms were they cleared. Interestingly enough, there were several reports of absentee owners who, after ordering their men to cut the palms along with the other woody vegetation, later admitted this to be a mistake. Owners and workers we spoke to all noted these palms to be attractive on the landscape, and that this too was an important consideration in sparing them during clearing of the forest.

Three systems of land use employing palms in agroforestry were identified during our studies:

1. Palm/pasture combination;
2. Palm/pineapple/pasture combination and;
3. Palm/mixed crop combination.

The palm/pasture combination is very common in the lower elevation stands of forest that are inundated during a portion of the year. As the forest is cleared the palms in this complex are spared and not killed by the subsequent burning integral to this type of land management. The area is planted with grass and cattle are introduced. The palms provide shade and forage for the animals. For example, cows were observed eating young palm inflorescences. In general, the cattle we observed in this system were not particularly healthy, but were thin and weak. In this system, people continue to harvest the palm fruits. It was noticed that, in this region, many of the palms are low enough to be climbed for harvest. Therefore, cutting the palm to obtain panicles of fruit is not necessary.

Figure 28. Young pineapples planted under *Jessenia bataua* near Quibdo, Colombia.

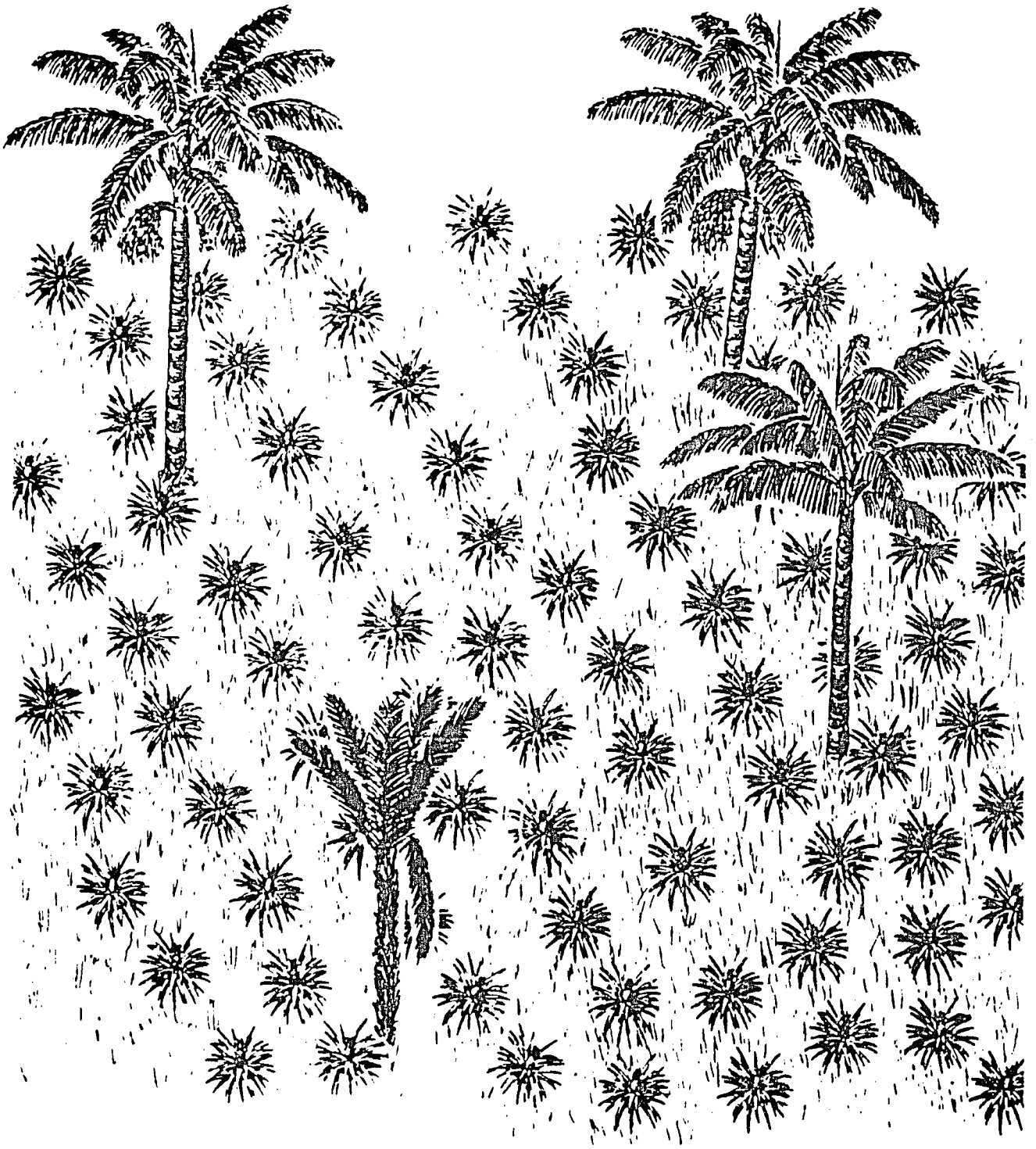

Figure 29. Depiction of a palm/pineapple agroforestry combination discussed in the text.

Table 26. Number and Condition of *Jessenia bataua* Palms on One Hectare Cleared Farm Plots Near Quibdo, Chocó in June 1985.

	Farm 1	2	3	4	Average
Total *Jessenia* Palms Cut Out Per Hectare	58	56	46	73	58.75
Total *Jessenia* Palms Still Standing	84	71	74	80	77.5
No. of Flowering Panicles	6	6	11	14	9.25
No. of Panicles with Young Fruits	45	35	7	16	25.75
No. of Panicles with Mature Fruits	0	8	1	0	2.25
No. of Palms with no Inflorescences Apparent (Mostly Young Palms)	49	42	57	51	49.75
No. of Dry Inflorescences	0	6	2	1	2.25

inventory prior to the time of maturity of the fruits, we found few mature panicles. However judging from the number of panicles with immature fruits, a range of 7-45 panicles of fruit per hectare could be expected to be produced during the year.

A related aspect of productivity in this system is the reproductive efficiency of palms. Balick (1986) reported that in a population of *Jessenia bataua* palms studied in the primary forests of the Vaupés of Colombia 7.2-14.5% of the pistillate flowers developed into ripe fruits. A range of 59-1143 mature fruits were produced per panicle. In the Chocó region, a number of panicles were studied, and the number of ripe fruits counted. Table 27 compares fruit production of inflorescences sampled in primary forest versus cleared pasture sites. A very interesting phenomenon can be observed from this data. Palms growing in the open plot areas have inflorescences with many more fruits than those found in the primary forest. One possible reason for this increased fruit set is more effective pollination by the vectors associated with this process. Based on our sample, it is likely to expect that fruit yields can be increased in plantation-grown palms, given a proper understanding of the pollination biology of this species.

The third system of agroforestry identified in this region utilizes a far more complex assortment of plants, is much more sensitive to the need to maintain a stable environment, and probably, over the long term, is more productive. This system was observed at a farm ca. 15 km from Quibdo, on the Medellin-Quibdo road. The farm is in an upland area that is not flooded during the seasonal rains. A portion of the farm is on a steep hillside, while the balance (including the dwelling) is on a flat area. When the land was cleared, ca. 10 months prior to our visit, the palms (*Jessenia bataua*, *Oenocarpus mapora* sub. *dryanderae*,

Table 27. Quantities of Mature Fruits Farmed on Individual Panicles of *Jessenia bataua* in the Colombian Chocó

Site No.	Tree In Open Plot	Tree In Primary Forest
1	4,322	
2	-	1,585
3	2,165; 5,315	1,926
4	4,582	1,906
5	4,553	2,256
Average	4,185	1,918

and *Euterpe cuatrecasana*) were preserved, along with *Cespedesia* sp. This latter plant is a dicotyledonous tree used to provide timber and poles for construction. Soil preparation prior to planting the crops is an essential element of this system. Composted wood chips obtained from a local poultry farm are mixed liberally into the soil. These chips were used to line the pens of the animals and, when composted, are a rich source of nutrients. The farmer at this site obtains truckloads of this material and deposits it in large (ca. 1 m high) piles scattered throughout the farm. As the material decomposes into rich organic matter, seedlings and saplings of economic species are planted into the dark mix. We observed a great variety of crops under cultivation, many of which were already yielding. These crops included: *Ananas comosus*, *Annona muricata*, *Bambusa* sp., *Borohoa patinoy*, *Colocasia esculenta*, *Canavalia* sp., *Carica papaya*, *Citrus* sp., *Cucurbita pepo*, *Lycopersicon esculentum*, *Manihot esculenta*, *Matisia cordata*, *Musa paradisiaca*, *Saccharum officinarum*, and *Solanum sessiliflorum* (Fig. 30). A small nursery is close to the house, and young plants are tended carefully before being transplanted into the field.

The third system was most impressive and, although only 10 months old, appears to be sustainable over the long term. The farmer is expanding into the surrounding vegetation, and piles of composted wood chips and saw dust were being placed throughout the new fields. By maintaining the palm/*Cespedesia* sp. canopy, proper shade and protection is provided for the young crops. It would seem a most worthwhile endeavor to inventory and observe this farm over a period of years to confirm our suspicion as to its sustainability. Certainly, this combination is far preferable to the palm/pasture combination, which appears to be a very ineffective use of the land.

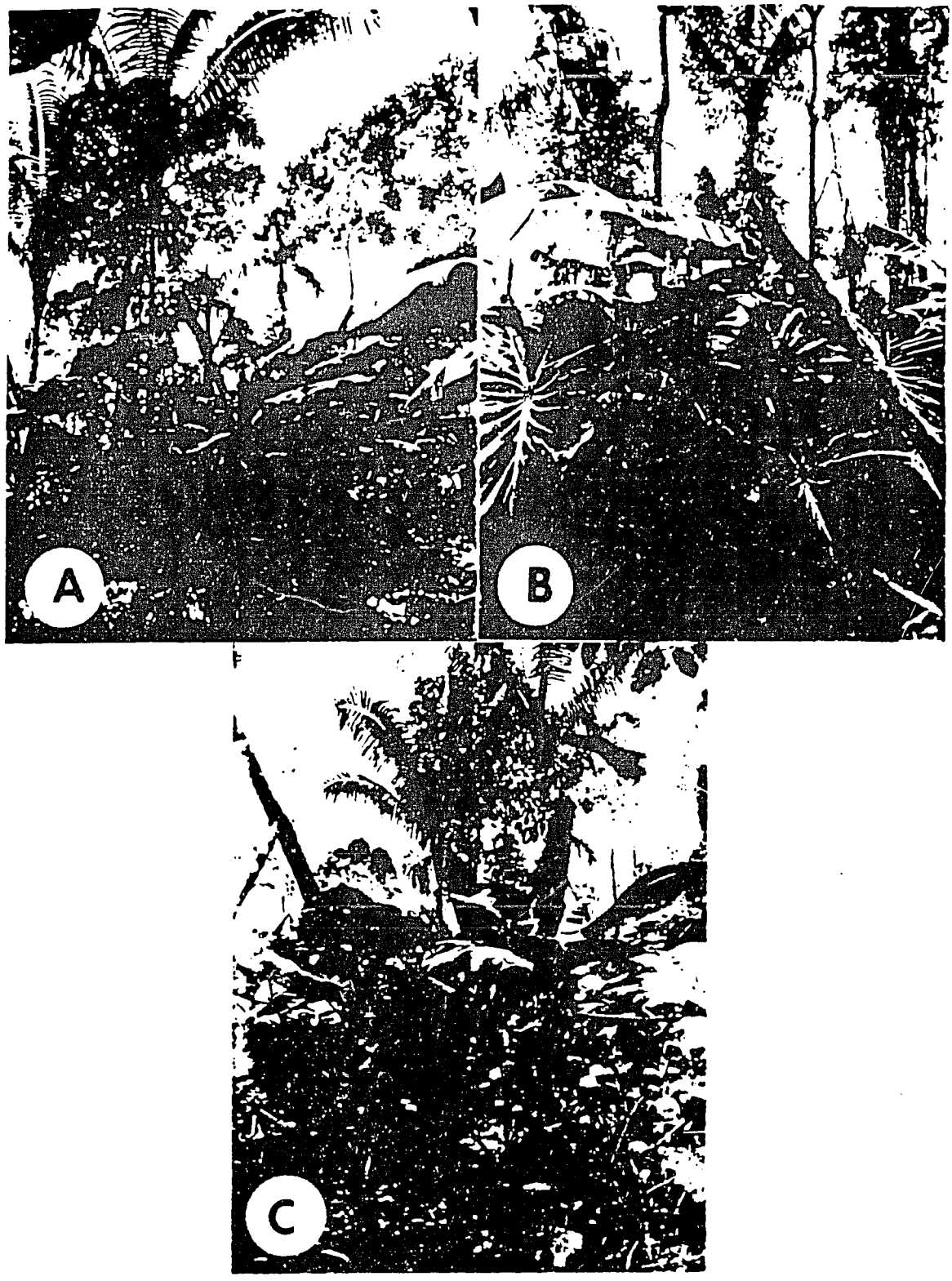

Figure 30. Some of the crops grown in the agroforestry system at a farm ca. 15 km from Quibdo, Chocó, Colombia. A. *Musa paradisiaca; B. Colocasia esculenta; C. Solanum sessiliflorum.*

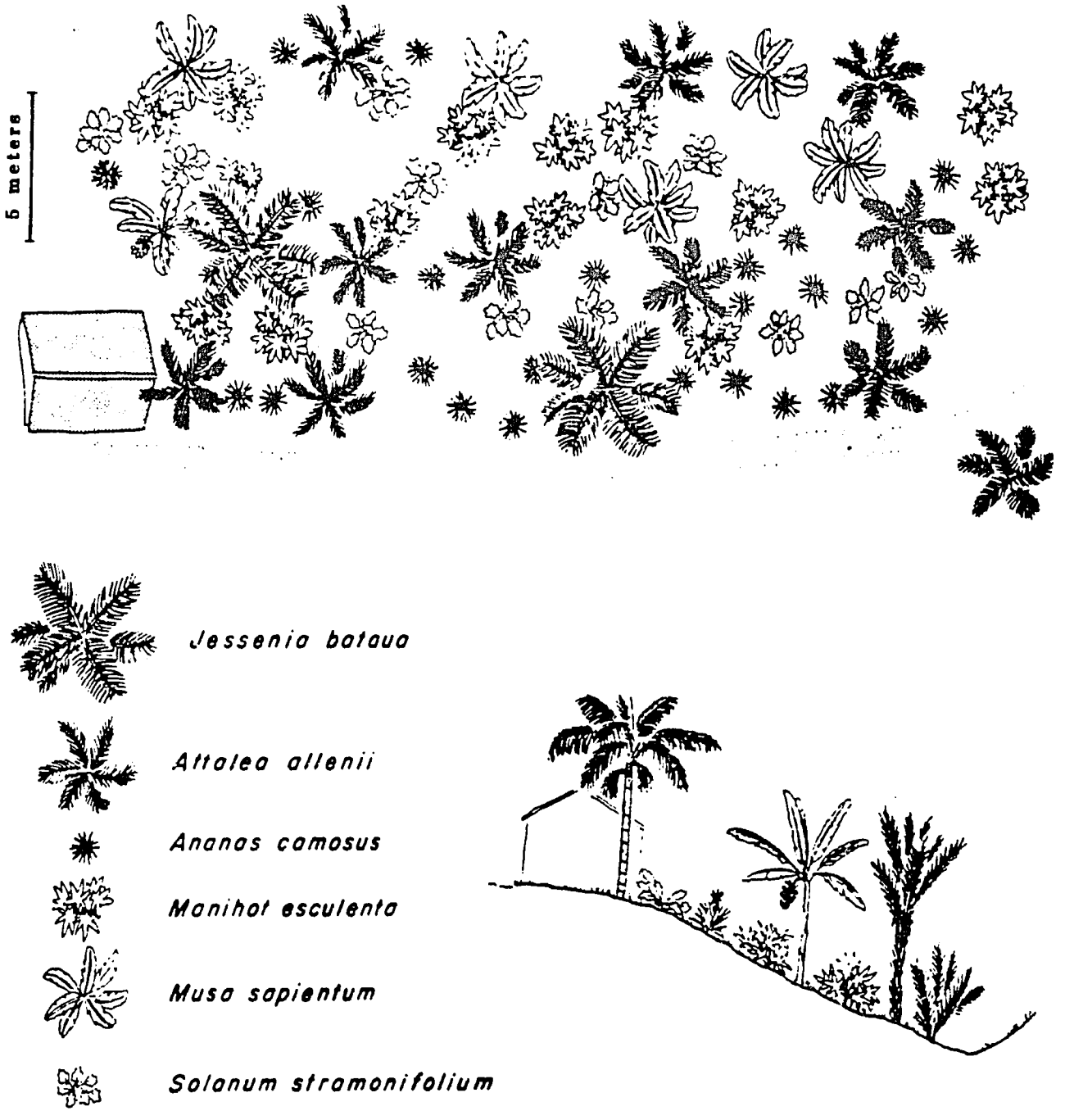

Figure 31. Depiction of the *Jessenia bataua/Attalea allenii* palm/crop agroforestry system discussed in the text.

A variation on this third system was observed at a farm on the road to Pie de Pepe, about 25 minutes by truck from Istmina. The crop mix was more limited and no pre-preparation of the soil was evident. Figure 31 is a depiction of this site, and shows the placement and number of the crop species. At this site another local species of palm, *Attalea allenii*, was preserved when the forest was cleared. *Attalea allenii* is an acaulescent palm to ca. 2 m tall which yields small panicles of fruit valued for its endosperm, which tastes somewhat like coconut. This endosperm is rich in oil and, presumably, protein.

Agroforestry may be viewed as an intermediate stage in the utilization of the *Oenocarpus-Jessenia* palm complex. It appears to be more stable than the often-destructive utilization (where large stands of trees are cut for harvest) of these palms by some of the indigenous groups in the Amazon valley. It is not, however, a case of agronomic domestication, as a palm monoculture would be. A better understanding of the three agroforestry systems should be obtained, both to foster the use of *Oenocarpus-Jessenia* palms elsewhere in similar situations, and as a precursor to full-scale domestication where economic and social conditions would justify such an investment in time, energy and capital.

CHAPTER 11.

BREEDING PROSPECTS

The *Oenocarpus-Jessenia* complex exhibits a great deal of variation in morphology and other aspects, offering a wide range of prospects for future programs aimed at crop improvement. Table 28 presents a capsule description of all the species in this complex, as well as an indication of their productivity and potential use. Of these species, *O. distichus*, *O. discolor*, *O. bacaba*, *O. mapora*, and *J. bataua* are best suited for immediate cultivation. This is due to a combination of factors, including habit, productivity and fruit size. The remaining species in Table 28 should be collected and studied for their value in breeding.

During studies of wild palms, it has been noticed that up to 7.5% of the fruits from certain trees, those which recently shed their fibrous coverings, contained two seeds (Fig. 32). This results in a seed with a larger mass and a greater quantity of oil-rich mesocarp per fruit. There is no apparent explanation for this tendancy to produce double fruits, and it was never observed on middle-aged or older trees. If a way could be developed to stimulate development of additional ovules in the fruits, and retain this trait over the life of the tree, yields would be increased.

Another characteristic of value for breeding is the apparent low-growing nature of the trunks of *Jessenia bataua* palms near Tumaco, in the Chocó of Colombia. The distinct nature of the trunk of this species was first pointed out to me by Dr. Victor Manuel Patiño who has made extensive studies in the region. These palms appear quite different in their habit from those in the Amazon Valley (Fig. 33).

TABLE 28

AGRONOMIC POTENTIAL OF PALMS IN THE Oenocarpus-Jessenia COMPLEX

Species	Range	Habit	Fruit Shape and Size	Productivity	Potential Use
Oenocarpus distichus	Brazil	solitary, tall (10-20 m); 2-ranked leaves	± globose; 1.8-2.1 cm long	high	plantation, cultivation breeding
O. discolor	Brazil	solitary, medium (8 m); 2-ranked leaves	unknown	unknown	plantation, cultivation breeding
O. tarampabo	Brazil Bolivia	solitary, medium (8-9 m); 2-ranked leaves	subglobose; ca. 1.5 cm diameter	unknown	breeding
O. bacaba	Amazon and Orinoco Valley	solitary, tall (8-20 m); spirally arranged leaves	globose; 1.6-2.1 cm long	high	plantation, cultivation; breeding
O. macrocalyx	Brazil	solitary(?); tall (30 m) spirally arranged leaves(?)	ellipsoid-acute; 1.3-1.7 cm	medium	breeding
O. mapora	Costa Rica Panama, and much of northern half of lowland South America	caespitose or solitary, short-medium (3-16 m); spirally arranged leaves	ellipsoid to subovoid; 1.8-2.9 cm long	high	plantation, cultivation; breeding

TABLE 28 CONTINUED

Species	Range	Habit	Fruit Shape and Size	Productivity	Potential Use
O. minor	Brazil	caespitose or solitary, short-medium (4-10 m); spirally arranged leaves	globose-ovoid to ellipsoid 1.6-2.3 cm long	low-medium	breeding
O. circumtextus	Colombia	solitary(?); short (3-6 m); spirally arranged leaves	oblong-cylindrical 1.7 cm long	unknown	breeding
Jessenia bataua	Panama, Trinidad and northern half of South America	solitary; tall (14-25 m); spirally arranged leaves	ovoid-ellipsoid, 2.5-4.0 cm long	high	plantation, cultivation; breeding

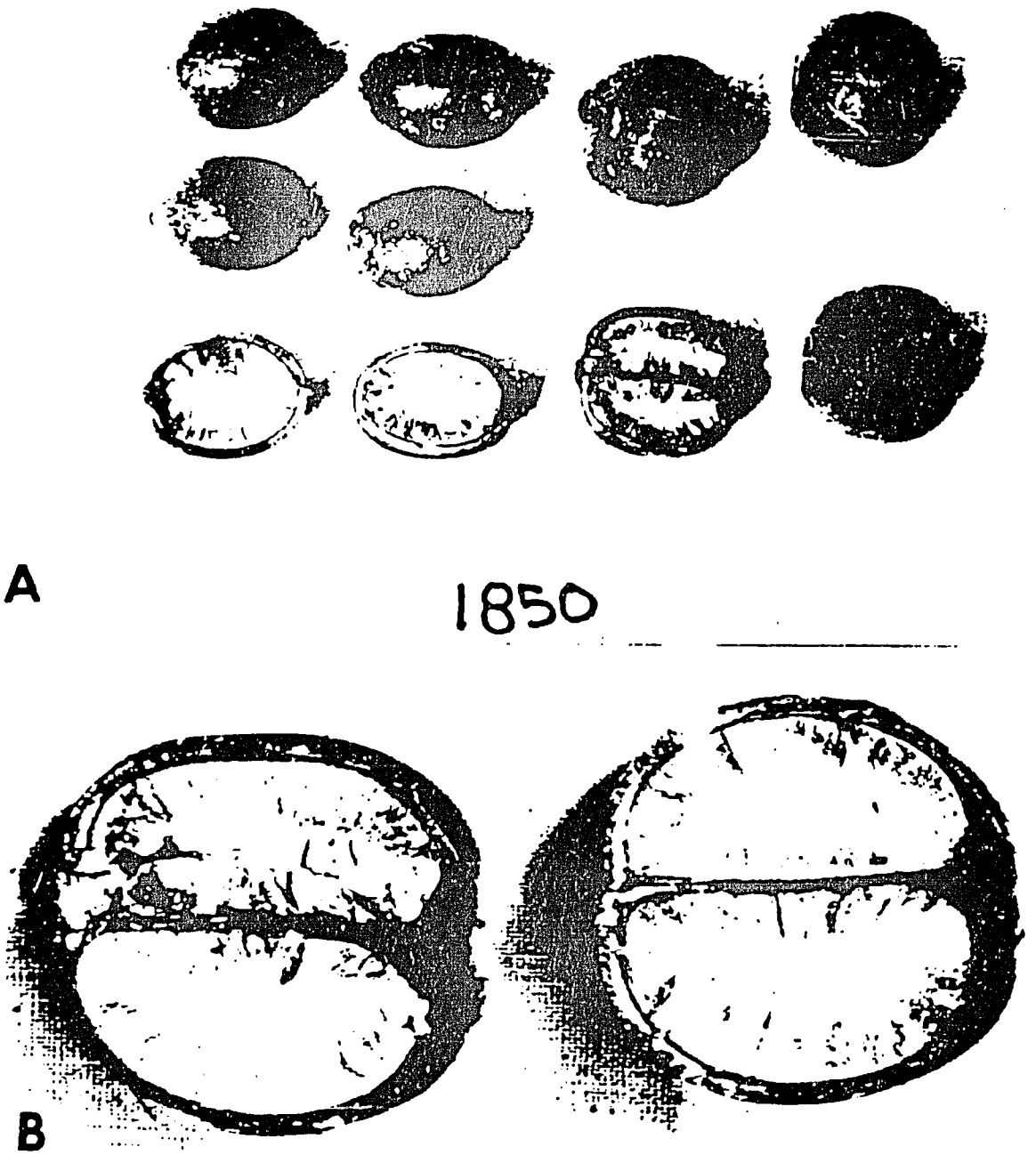

Figure 32. A. Double-seeded and single-seeded fruits of *Jessenia bataua* collected from the Vaupés of Colombia. B. Close up of double-seeded fruits of *Jessenia bataua*.

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In the Tumaco region, the trunk of the *Jessenia bataua* palm is somewhat swollen in the middle, and inflorescences begin to form a meter or so from the ground. This morphology is quite different from the uniform diameter of the trunk of *Jessenia bataua* throughout its entire range. Additionally, the first inflorescences usually develop several meters from ground level, except when the palm is grown in full sun. This "morphotype" deserves further study to understand its origin, and see if there is a way to "stunt" other palms, to hasten fruiting. This could be a valuable trait, much in the same way that the lower habit of *Elaeis oleifera* makes it of value for crossing with the African Oil Palm, *E. guineensis*.

One of the apparent disadvantages of *Jessenia bataua* in a plantation setting is its slow growth. For example, trees of this species observed at the INPA research station in Manaus, Brazil were ca. 50 cm tall after four years of growth. However, other palms in this complex grow at a much faster rate. *Oenocarpus mapora* observed at the same research station was ca. 3 m tall, and was planted at approximately the same time (Fig. 34). The reason for this differential in growth must be understood if these palms are to be domesticated. As the various genera and species hybridize so freely, crosses could be made between the larger-fruited, more prolific solitary species such as *Jessenia bataua* and the faster-growing *Oenocarpus mapora*.

Another trait that would be valuable for the domestication of this complex is precocity. If plants can be found that yield at an earlier age than usual, their economic returns from sales of the product (fruit) would be enhanced. In some cultivated trees, such as the African Oil Palm, seed collected from plants growing at higher elevators and planted at sea level will bear earlier than normal (G. Blaak, pers. comm.). In the case of *Jessenia bataua*, germplasm of the

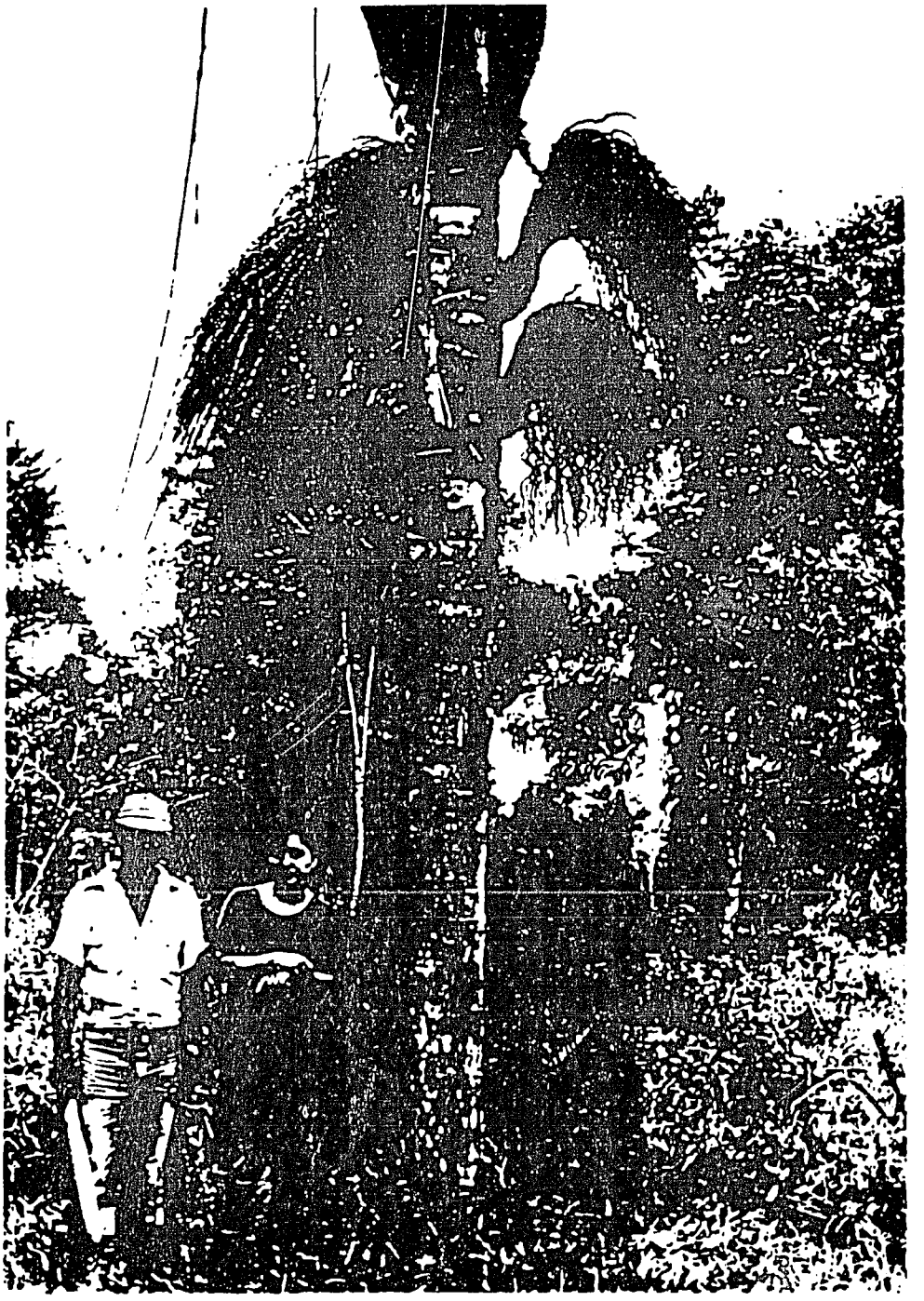

Figure 33. *Jessenia bataua* growing near Tumaco, Chocó, Colombia. Note swollen trunk and inflorescences (including remains of older panicles) that are low to the ground.

Fig. 34. Experimental planting of *Oenocarpus mapora* in Manaus, Brazil; age of tree is approximately four years.

populations growing at ca. 1000 m in the hills and Tingo Maria, Peru should be collected and incorporated into lowland nursery trials. This could be one way of reducing the non-productive period of a plantation.

As pointed out in earlier chapters, fatty acid composition of the oil varies in the different species in this complex. Breeding and selection activities should be influenced by these differences, and hybrids created according to greatest need and value.

Because of the variation in morphology, growth rates and chemical composition of the fruits, advances could also be made using the tools of modern biotechnology. In particular, somatic fusion could reduce the time necessary for the creation of hybrids desired. Advances in tissue culture work and cryobiological storage with *Jessenia bataua* have been made at the Twyford Plant Laboratories in Somerset, England.

In summary, because of the great variation in the species of this complex, as well as their ability to hybridize, prospects for selection and breeding are enhanced. As the next chapter discusses, broad-scale germplasm collection is one of the next steps towards utilizing this variation for agronomic domestication.

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CHAPTER 12

FUTURE RESEARCH LINES

To improve utilization and promote the domestication of this complex, a number of research lines are suggested. These include general studies of the palm's biology in the wild, as well as agronomic, technological and laboratory studies.

1. Inventory of species. A much better idea is needed of the contemporary distribution and diversity of species throughout the neotropical range of this palm complex. The information on precise distribution obtained from herbarium specimens is often no longer valid due to extensive cutting/exploitation of this group in some areas.

2. General biological studies. A much greater understanding is needed of the life history of these palms. Early growth in the rain forest, fruit and flower production, and the induction of senescence all need further understanding. From studies of the phenology of the different species throughout their range a better understanding can be obtained of the duration of yield, and a protocol for selecting species based on their ability to provide a year-round harvest would be feasible. In addition, general biological studies would allow the pulp-fruit ratio of all of the species to be analysed and the most prolific species or forms identified.

3. Agronomic Studies. It is essential that a series of stable germplasm banks for the *Oenocarpus-Jessenia* complex be developed. At present there are only a few efforts in the neotropics, and activity is proceeding at a slow pace. It is essential to stimulate the collection of genetic material from throughout the habitat of this complex, and curate this material in a variety of suitable

locations. It is also essential to begin comprehensive agronomic growth trials of this complex aimed at better understanding and increasing the slow growth rate of some of the species. In addition, a way of inducing the double-seeded trait occasionally found in the wild is of importance. A descriptor list should be developed for evaluating wild palms and characterizing germplasm that is collected.

4. Agroforestry systems. The agroforestry systems observed in Chocó, Colombia should be studied much more intensively. In particular, the third system discussed in Chapter 10 should be researched over a 5-year period to determine its level of sustainability and, if desirable, develop a strategy for introduction of this technology into other areas. Additional trials should be inaugurated in other areas of the tropics where *Jessenia* and *Oenocarpus* species are found, with the aim of determining the most suitable crop mix for agroforestry systems.

5. Biotechnology. Some advances have been made in tissue culture and cryobiological storage. Once promising genetic lines are identified, a system of rapid vegetative propagation would allow for the cloning of this line and hasten its introduction and use in broader cultivation. If somatic fusion could be developed, traits of some of the palms in this complex could be introduced into other common, more rapid growing palms such as the African Oil Palm, and production levels enhanced.

6. Oil composition. As the fatty acid composition of the oil varies in the different species, a much broader inventory of oil composition and quality should be undertaken. If unusual chemical constituents of these oils were found, this could help stimulate demand and thus promote more intensive cultivation of these palms.

7. Nutritional evaluation. Nutritional examination of the fruits of *Jessenia bataua*, undertaken by Balick and Gershoff (1981) revealed the importance of this species as a food source. Additional nutritional studies should be carried out of all of the species and subspecies in this complex, and components such as protein, oil, and carbohydrate should be studied.

8. Socioeconomic studies. The value of the palms in this complex depends on the social and economic structure of the area in which it may be used or introduced. The social component of the development of a new crop such as these palms must not be ignored. For example, the role of some of these palms in helping to develop extractive reserves should be investigated. Cooperatives of harvesters, perhaps based on the Las Gaviotas model, might prove to be one effective way of exploiting these palms.

9. Network of researchers. Finally, there should be increased communication between researchers and others interested in the use of the *Oenocarpus-Jessenia* complex. Researchers at individual institutions should be encouraged to publish results of their investigations, announcements of collecting programs, availability of germplasm, etc. The use of the newsletter "Useful Palms of Tropical America," published by CENARGEN/EMBRAPA in Brazil, is to be encouraged. Regular meetings of those workers interested in the domestication of this complex of palms, as well as other palm groups, should be held to keep up interest in these resources. Several meetings have already been held, such as that at CATIE, in Turrialba, Costa Rica, 1983, as well as PIRB, sponsored by the Interamerican Association, held in Bogotá, Colombia in 1985. Such meetings give the opportunity for personnel from institutions around the tropics to have contact with many other people and promote activity in research, agronomic and domestication efforts. The proceedings from these meetings should be published and widely disseminated.

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APPENDIX I.

BIBLIOGRAPHY ON THE USES OF THE OENOCARPUS-JESSENIA COMPLEX

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APPENDIX II.

THE PROPER COLLECTION OF PALMS FOR SYSTEMATIC STUDY

Given their relative abundance and importance as a part of the overall tropical and subtropical biota, palms are not well represented in the study collections used by biologists. For example, in Brazilian Amazônia where palms often dominate the landscape, there are minimal collections of this family in the local herbaria. As a result, local studies of domestication, ecology, population biology, floristics, pollination, ethnobotany, etc., are hindered by not having adequate and complete reference collections with which to compare material being brought in from the field. The lack of good palm collections in one important region was documented by Balick et. al. (1982) who found that only 37.5% of the 232 recognized palm species in Brazilian Amazônia were present in any of the three local herbaria within that zone. Of the species present, many lacked crucial information on their labels and others were in an unreasonable state of preservation.

With the new initiatives being taken in the domestication and utilization of native palm resources, it is important that good collections of these plants be made. These collections require a devotion of a great deal of field time in order to be made properly. If done correctly, these collections can serve future generations of biologists in their quest to understand the tropical ecosystem. A poor herbarium specimen of a palm is worse than no collection at all, in that it tends to give a misleading impression of the plant or creates too many unanswerable questions, thus adding only confusion to what could be a clear systematic picture.

This appendix summarizes some of the techniques and methods to follow for making a good palm collection, in the hope of encouraging field workers to devote more effort towards working with these important organisms. This information is presented in greater detail in Balick et. al. (1982). The interested reader should also see Fosberg and Sachet (1965), for additional discussion of this topic.

Because of the rather large size of many palms, it is difficult to try and collect entire organs, such as leaves, which may be up to 8 meters in length and weigh 20 kilos or more when fresh. Similarly, a fruiting panicle with 30 kilos of Cocosoid fruits would be extremely difficult to collect, dry, ship and curate in its entirety. It is, therefore, advisable to make collections with representative parts of each of the major organs, rather than making collections which encompass the complete organ. Through the use of photographs and very detailed measurements, in the herbarium one can subsequently reconstruct the general nature and habit of the palm. Ten elements of a good palm collection can be outlined:

1. The leaf apex in pinnate-leaved palms; leaf hastula in palmate- or costapalmate-leaved palms. The apical pinnae can be fused in a distinctive way or have dimensions altogether different from the middle pinnae. The hastula or ligula, as it is sometimes known, often varies in shape and size and can provide an element of distinction at the specific level.

2. Leaf pinnae and at least a portion of the rachis in pinnate-leaved palms. The pinnae are often crucial for making generic and specific determinations. For example, the presence or absence of peltate trichomes on the pinna can be used to separate the closely related genera, *Jessenia* and *Oenocarpus*. The pinna size and insertion (clustered versus regular) is very useful for separating out Cocosoid palms.

3. Flowers or fruits, or both. Flowers, and to a lesser degree fruits, usually contain the most essential criteria for systematic identification in palms, both at the generic and specific level. It is essential that collections include such fertile material. It is often possible to locate an individual plant in flower, while at the same time locating a similar individual of the same species having fruit in some degree of maturation. While it is preferable to obtain flowering and fruiting material from the same tree, it is also permissable to collect flowering and fruiting material from different individuals, if great caution is taken to collect from the same species. The herbarium label should note that sexual material was taken from different trees.

4. Flowering or fruiting axes, or both. The morphology of the flowering or fruiting axis often provides important information for taxonomic identification. Smaller axes should be collected in their entirety, while larger ones photographed and carefully measured.

5. Supplementary material: bracts, sheaths, spines, wood samples, stems, and seedlings. Such materials may be helpful in identification, depending on the taxon in question.

6. Quantitative and qualitative information on vegetative, reproductive and morphological characters not apparent on the specimen. As previously mentioned, it is essential to spend as much time as needed to properly document the presence, distribution and dimensions of vegetative, reproductive and morphological characters. In herbarium collections there are many important bits of information that cannot be faithfully discerned. For example, some palm fruits change color when dry. Another example would be the dimensions of a large leaf, which might be represented in the herbarium collection by only a sample of the apical, middle and basal pinnae and rachis. It is very important that proper measurements be made in the field, and faithfully transcribed on the herbarium label.

7. Information on habitat. This data should include comments on altitude, substrate, vegetation type and degree of habitat disturbance. Such data are especially useful in palms, as many species are limited to specific habitats and serve as ecological indicators.

8. Reasonably precise locale. As is the case in all herbarium collections, information on locale is essential, especially if the specimen represents an undiscovered, rare or endemic species.

9. Vernacular names and uses. Many palm species are referred to by vernacular names and many have local uses. Vernacular names are extremely helpful in relocating species populations in the field, and ethnobotanical uses may be indicative of species of potential economic value worth further consideration. It is surprising how many palm collections are lacking in such information.

10. Good quality black and white or color photographs. Even if they are not contained in the herbarium collection, it is extremely important that the collector take adequate pictures of the palm before and after it is collected. For example, these might include habitat photographs, a shot of the individual specimen(s) collected for harvest as well as

closeups of the reproductive, leaf, stem and other subsidiary organs. These photographs are often kept by the collector, and their availability indicated on the label. While useful, it is admittedly rather expensive to include original photographs in each herbarium collection.

Because the proper collection of a palm often results in sacrifice of the tree, it is important to make as many specimens as possible from that particular individual. In general, six specimens are sufficient, from one to three deposited in the country of origin as requested, and three duplicates sent to the home herbarium for distribution at a later date. More duplicates can be made, although drying these in the field is somewhat difficult, especially if more than one or two good collections are made each day, and the collecting activity lasts for several weeks or more. It is not uncommon for palm collectors to find that this material has filled up the field dryers and takes many days to process, resulting in a potential backlog of both palm and non-palm collections.

While seemingly difficult, palm collection becomes an interesting and rewarding endeavor, once the hurdle of the first few collections has been passed. The collector should be armed with a good ax, machete, clippers, measuring tape and a 35 mm camera with copious color slide and black and white print film. Strong cord and woven plastic sacks are important for carrying the collected material back to the location where it is to be pressed and otherwise processed. The fact that these plants have been somewhat ignored by collectors in the past provides an opportunity

for many significant discoveries in the form of new species and hybrids, country records, uses, distribution, and additional useful information for students of the tropical flora.

APPENDIX V

Balick, M. J., C. V. B. Pinheiro, and A. B. Anderson. 1987. Hybridization in the Babassu palm complex I. *Orbignya phalerata* x *O. eichleri* (Palmae). Amer. J. Bot. 74:1013-1032.

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have checked this proof. I have marked all changes or corrections I wish to be made
Signed
Telephone

HYBRIDIZATION IN THE BABASSU PALM COMPLEX: I. ORBIGNYA PHALERATA × O. EICHLERI[1,2]

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JUN 8 1987

ABSTRACT

The babassu palm (*Orbignya phalerata*) is an important source of oil and charcoal in Brazil. In some areas it grows in association with *O. eichleri*, and where their distribution is sympatric, a third palm is found. This taxon was described by Bondar in 1954 as *O. teixeirana*. As a result of intense fieldwork and subsequent morphological and anatomical studies, we conclude that *O. teixeirana* is a hybrid between *O. phalerata* and *O. eichleri* and propose a change in its status to reflect this new understanding of its origin.

MANY PALMS have long been poorly understood taxonomically. The frequently large sizes of their stems, leaves and inflorescences have impeded proper collections, with the result that critical parts of genera and species are under-represented in herbaria (Balick, Anderson and da Silva, 1982). Earlier in this century many new species were distinguished on the basis of quantitative morphological differences found on a limited number of specimens. More intensive collections in recent years have enabled taxonomists to appreciate the high degree of phenotypic plasticity in some characters formerly considered to be constant. Concomitant with this recognition is a realization that palms of some groups may frequently hybridize. Studies by Glassman in *Syagrus* (1968, 1970, 1971), Wessels Boer in *Bactris* (1971) and Dahlgren and Glassman in *Copernicia* (1963) have documented numerous new hybrids in palms, primarily in the Cocoeae. (For a definition of this group, see Dransfield and Uhl, 1986.)

Bondar (1954) described *Orbignya teixeirana* from a specimen he collected near the town of Caxias, in the Brazilian state of Maranhão. He presented a key that distinguished this new species from the widespread and common "babaçu" palm (spelled "babassu" in English), which he recognized as *O. speciosa* (Mart.) Barb. Rodr., and the acaulescent palm known as "piaçava" (spelled "piassava" in English), *O. eichleri* Drude. Bondar provided a brief description of the new species, as well as photographs of its inflorescence and fruit. In his description, Bondar wrote that *O. teixeirana*, known locally as "perinão," was found in the localities where babassu and piassava were also present, and was "probably a hybrid of the two." Despite his suspicion of the hybrid status of the perinão palm, Bondar described it as a new species. The types were reported to have been deposited in the Rio de Janeiro Botanical Garden (RB) and the Field Museum of Natural History (F), although no collection

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APPENDIX I

numbers or specific collecting locality were provided. According to Glassman (1977), the holotype is Bondar s.n. (RB-80813), and an additional collection is also found at the Field Museum of Natural History (F-405257). Bondar dedicated this species to Dr. Edgard Teixeira Leite in gratitude for his support of Bondar's studies.

In 1980 we began to investigate the genus *Orbignya* as part of a program to domesticate the babassu palm, which is widely used in Brazil as a source of oil and charcoal. In the Brazilian state of Maranhão alone over one million people collect babassu fruits and crack them to extract the oil-rich kernels for subsistence and market production of vegetable oil, the remaining woody endocarp provides the region's most important source of domestic fuel in the form of charcoal. Extraction of babassu kernels comprises the largest oilseed industry in the world entirely dependent on a wild plant for its raw material, with an annual cash value of over US $100,000,000 in oil produced (Pick et al., 1985). While collecting germplasm of these palms, we gathered extensive data on their ecology, ethnobotany, and taxonomy.

To determine the status of *Orbignya teixeirana*, we first had to resolve the taxonomy and nomenclature of its suspected parents, babassu and piassava. The taxonomic status of babassu, as well as its proper nomenclature, has been a prolonged topic of debate among botanists, and this debate has even spilled outside of the botanical community. For example, the Brazilian National Economic Council and the Association of Commerce in Maranhão took a stand on nomenclature, adopting *O. speciosa* as the official name of the babassu palm (Markley, 1971).

A detailed discussion of the taxonomic status and nomenclature of babassu is provided by Anderson and Balick (in press). They conclude that this complex is comprised of two distinct species. The most widespread and economically important is *Orbignya phalerata* Mart.; the second species, *O. oleifera* Burret, is apparently confined to the São Francisco river valley in Minas Gerais (with possible outlying populations in adjacent areas of Goiás and Bahia). Adoption of *O. phalerata* as the name for the predominant species in the babassu complex resolves nearly a century of nomenclatural debate. The palm referred to by Bondar (1954) as *O. speciosa* is now reduced to synonymy under *O. phalerata*. The original scientific name for the piassava palm, *O. eichleri* Drude, remains in good standing (Glassman, 1977).

This study describes the morphology and leaf anatomy in three taxa of *Orbignya*: babassu, perinão, and piassava. To date, the only published information on leaf anatomy in *Orbignya* (Tomlinson, 1961) is confined to the generic level. Determining the status of purported hybrids in palms has invariably been based on morphology, and this study represents the first such attempt that, to our knowledge, uses both anatomical and morphological comparisons. Tomlinson (1961) considered that palms cannot normally be distinguished at the specific level through the use of anatomical leaf characters. However, he believed that the latter were of value in systematic classification when combined with other lines of evidence such as morphology. Various workers have since used leaf anatomy coupled with morphological evidence to assist in distinguishing palms at the specific level (e.g., Glassman, 1972: *Syagrus*; Uhl, 1972: *Chelyocarpus* alliance; Read, 1975: *Thrinax*; Uhl, 1978: *Hyophorbe*).

MATERIALS AND METHODS—*Morphological studies*—Due to the lack of adequate herbarium specimens of *Orbignya*, we initiated an intensive field collecting program in 1980. Obtaining specimens of large palms, such as many of the species in this genus, requires a highly specific collecting methodology, the details of which are provided by Balick et al. (1982). Because it is often not possible to obtain a complete representation of each morphological component, collecting must be selective and accompanied by detailed field documentation.

Our overall collecting stategy was to obtain as wide a representation as possible of the variability within the species comprising the babassu complex. Specimens of *Orbignya phalerata* were obtained over widespread areas in Brazil and Bolivia (Fig. 1). Specimens of the purported hybrid described in this paper, as well as *O. eichleri*, were obtained at a total of four locations in Brazil, three in the state of Maranhão and one in the state of Goiás (Fig. 1). At each of these locales, we made repeated collections of the purported hybrid so as to obtain a better representation of its variability. Specimens were distributed among herbaria in Brazil (CEN, IAN, INPA, MG), Bolivia (LPB), and the United States (NY).

Detailed studies of the morphology and anatomy of these palms were carried out at the Lieberman Laboratory and Institute of Economic Botany of the New York Botanical Garden. Morphological comparisons were made over the full range of characters, from those apparent in the field to those only discernible in the laboratory. For quantitative comparisons, repeated measurements from numerous specimens were obtained, and the mean as well as the range of these measurements was usually determined, except in cases where the sample sizes were judged to be too small.

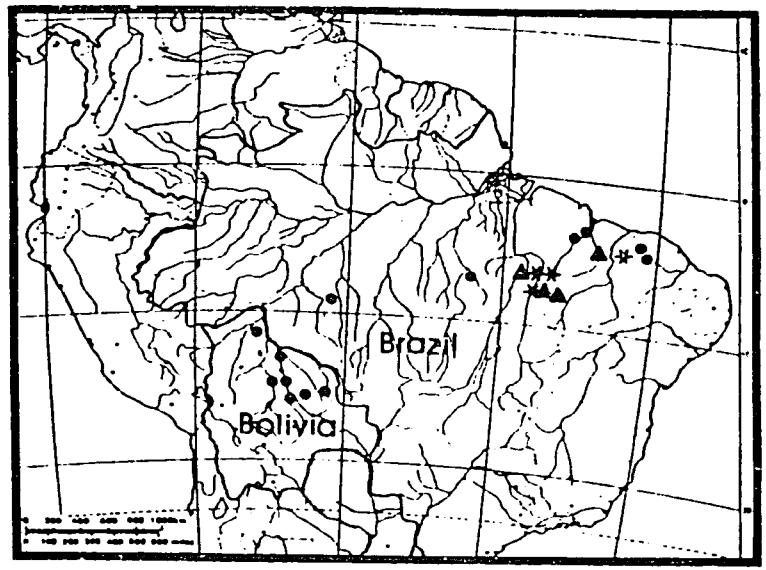

Fig. 1. Collections of the hybrid complex made for this study: circles = *Orbignya phalerata*, stars = *O. eichleri*, triangles = *O. teixeirana*.

Anatomical studies—For each of the three taxa, three collections considered to be representative were selected for anatomical studies. The material used in the preparation of anatomical sections was removed from the pinnae along the middle of the leaf and treated according to the methodology described by Martens and Uhl (1984) for the preparation of palm leaf cross-sections. Each of the sections comprised the entire width of the pinna, including the midrib. It was quite difficult to make these sections due to the presence of silica bodies and fibers, as well as the large size of the leaves. Preparation of the material included fixing, desilification, initial softening and dehydration. Each pinna was embedded in Paraplast Plus and cut with an A. O. Spencer 820 Rotary Microtome in 15 micron sections. Safranin and Fast Green were used as stains. It was discovered that best staining results were obtained by keeping the slides immersed five hours in the Safranin and 25–30 seconds in the Fast Green stains. Epidermal peels were made using the techniques described by O'Brien and McCully (1981). To make the peels, pinnae were removed, hydrated, cut in samples ca. 2 × 3 cm, mascerated and stained in Safranin. To analyze venation patterns in the leaves, pinnae samples were bleached and then stained in Safranin, according to the technique described by Martens and Uhl (1984).

RESULTS—Morphological and anatomical descriptions of the three taxa are provided below. To facilitate comparison, synopses of distinguishing morphological and anatomical characters are given in Tables 1 and 2, respectively.

Morphological descriptions (Fig. 2–5)

Orbignya phalerata Mart., Palm. Orbig. 126, t. 13, fig. 2, 32A. 1884. Type: d'Orbigny 20 (P, n.v.).

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TABLE 1. *Morphological comparison of* Orbignya phalerata *Mart.*, O. [illegible] *(Bondar) Balick, Pinheiro and Anderson, and* O. cohune *Dryde. Values indicate ranges, means in parentheses, except when sample size is too small*

Character	O. phalerata	O. [illegible]	O. cohune
STEM			
Length in adults (m)	5.0–30.0 (x̄ = 11.5)	0.5–7.1 (x̄ = 4.3)	0
DBH (cm)	19–50 (x̄ = 38)	19–25 (x̄ = 2)	0
LEAF			
Number per palm	10–23 (x̄ = 15)	10–13 (x̄ = 11)	3–8 (x̄ = 4)
Sheath:			
Length in adults (cm)	40–120 (x̄ = 98)	40–90 (x̄ = 54)	20–33 (x̄ = 27)
Maximum width (cm)	21–42 (x̄ = 32)	15–30 (x̄ = 21)	1.8–3.0 (x̄ = 2.2)
Striations on abaxial surface	Generally present	Present or absent	Absent
Petiole:			
Length in adults (cm)	8–42 (x̄ = 24)	21–30 (x̄ = 46)	30–80 (x̄ = 53)
Maximum width (cm)	5–30 (x̄ = 18)	3–8 (x̄ = 5)	1.5–2.3 (x̄ = 1.8)
Rachis:			
Length in adults (m)	5.6–8.6 (x̄ = 7.5)	2.0–6.4 (x̄ = 3.7)	1.2–2.1 (x̄ = 1.6)
Cross section	4-Sided	Usually 4-sided, rarely triangular	Usually triangular, rarely 4-sided
Abaxial surface	Weakly to strongly lepidote	Smooth to moderately lepidote	Smooth
Pinnae:			
Number per side	156–208 (x̄ = 196)	104–153 (x̄ = 130)	76–89 (x̄ = 84)
Orientation	In same plane	In same plane to crispate	Crispate
Arrangement	Regular	Clustered to regular	Clustered
Adaxial surface	Dull to lustrous	Dull	Dull
Abaxial surface	Weakly glaucous	Weakly glaucous to smooth	Mostly smooth
Length × width (cm)			
Basal pinna	83–185 (x̄ = 135) × 1.0–2.0 (x̄ = 1.5)	40–185 (x̄ = 95) × 0.5–2.5 (x̄ = 1.0)	45–70 (x̄ = 55) × 0.7–1.5 (x̄ = 0.9)
Middle pinna	88–168 (x̄ = 116) × 2.0–6.0 (x̄ = 4.4)	53–112 (x̄ = 85) × 2.2–4.0 (x̄ = 3.0)	37–81 (x̄ = 55) × 1.4–3.0 (x̄ = 2.1)
Apical pinna	22–139 (x̄ = 52) × 0.8–2.3 (x̄ = 1.6)	14–33 (x̄ = 26) × 0.2–1.5 (x̄ = 1.7)	14–42 (x̄ = 21) × 0.2–0.8 (x̄ = 0.4)
INFLORESCENCE			
Bracts:			
Length of prophyll (cm)	30–150	30–53	ca. 20
Length of peduncular bract (cm)	40–218 (x̄ = 154)	85–130 (x̄ = 113)	35–65 (x̄ = 46)
Length of acumen (cm)	16–40 (x̄ = 27)	3–20 (x̄ = 16)	3–12 (x̄ = 7)
Abaxial surface of peduncular bract	Tan to rust brown	Rust brown to blood red	Rust brown to blood red

TABLE 1. *Continued*

Character	O. phalerata	O. [illegible]	O. cohune
Primary Axis:			
Length of peduncle (cm)	56–185 (x̄ = 106)	44–88 (x̄ = 73)	5–57 (x̄ = 18)
Length of rachis (cm)	48–175 (x̄ = 97)	34–99 (x̄ = 66)	17–55 (x̄ = 24)
Curvature	Not curved	Weakly to strongly curved	Strongly curved
Rachillae:			
Number on staminate inflorescence	277–401 (x̄ = 339)	41–150 (x̄ = 84)	15–35 (x̄ = 23)
Number on androgynous inflorescence	323–475 (x̄ = 400)	20–70 (x̄ = 46)	10–20 (x̄ = 12)
Length on staminate inflorescence (cm)	8–28 (x̄ = 23)	1–20 (x̄ = 11)	2.3–15 (x̄ = 7.6)
Length on androgynous inflorescence (cm)	10–24 (x̄ = 16)	0.1–2.9 (x̄ = 1.0)	0.1–1.0 (x̄ = 0.4)
Disposition on rachis	Throughout	On abaxial side	On abaxial side
Length of subtending bracteole on staminate inflorescence (mm)	0.5–6.0 (x̄ = 3.2)	0.5–7.5 (x̄ = 2.5)	1.0–4.0 (x̄ = 1.6)
Length of subtending bracteole on androgynous inflorescence (mm)	2.0–14.0 (x̄ = 5.9)	0.5–30.0 (x̄ = 8.5)	3.0–45.0 (x̄ = 14.4)
STAMINATE FLOWER			
Sepals:			
Number per flower	3–4 (x̄ = 3.1)	3 (x̄ = 3)	2–4 (x̄ = 3)
Length (mm)	0.8–2.5 (x̄ = 1.3)	0.6–1.6 (x̄ = 1.1)	0.4–4.9 (x̄ = 1.1)
Width (mm)	0.5–2.3 (x̄ = 1.1)	0.6–1.3 (x̄ = 0.9)	0.5–2.0 (x̄ = 1.0)
Consistency	Coriaceous	Membranous to coriaceous	Membranous to coriaceous
Petals:			
Number per flower	2–3 (x̄ = 2.1)	1–2 (x̄ = 1.6)	1–4 (x̄ = 1.4)
Length (mm)	9.5–16.9 (x̄ = 13.0)	7.0–11.8 (x̄ = 9.3)	6.2–12.4 (x̄ = 9.2)
Width (mm)	2.8–7.5 (x̄ = 4.3)	3.0–9.0 (x̄ = 5.6)	1.5–11.6 (x̄ = 6.8)
Consistency	Coriaceous	Membranous to coriaceous	Membranous to fibrous
Stamens:			
Number per flower	21–30 (x̄ = 25)	18–26 (x̄ = 22)	14–20 (x̄ = 17)
Anther shape	Irregular	Irregular, semi-elongated	Irregular, elongated
Fusion of thecae	Separate	Separate or united	United
PISTILLATE FLOWER			
Number of bracteoles per flower	3	2–4	1–3
Sepals:			
Number per flower	3–6	3	3
Length (cm)	2.8–4.1	2.4–3.5	1.9–3.5
Shape	Triangular to deltate	Triangular to deltate	Triangular

TABLE 1. *Continued*

Character	*O. phalerata*	*O. teixeirana*	*O. eichleri*
Pistils			
Number per flower	3–5	3–4	3–6
Length (cm)	2.3–3.0	2.3–3.4	1.3–2.8
Margins	Dentate	Smooth	Smooth to slightly dentate
FRUIT			
Length (cm)	6.6–12.5 ($\bar{x}$ = 9.7)	5.4–9.1 ($\bar{x}$ = 7.9)	4.6–7.7 ($\bar{x}$ = 5.9)
Width (cm)	3.7–9.9 ($\bar{x}$ = 6.3)	3.4–5.9 ($\bar{x}$ = 3.1)	3.3–4.4 ($\bar{x}$ = 4.2)
Dry weight (gm)	40–480 ($\bar{x}$ = 176)	16–210 ($\bar{x}$ = 82)	10–50 ($\bar{x}$ = 22)
Height of calyx cupule (cm)	3.8–5.8 ($\bar{x}$ = 4.8)	3.4–5.9 ($\bar{x}$ = 4.2)	3.3–4.9 ($\bar{x}$ = 3.7)
Staminodial ring	Weakly to strongly defined	Weakly to moderately defined	Weakly defined
Number of seeds	1–11	3–7	4–7

Attalea speciosa Mart., Hist. Nat. Palm 2: 138, t. 96, fig. 3–6. 1826. Type: Martius s.n. (M, n.v.). *Orbignya speciosa* (Mart.) Barb. Rodr., Sert. Palm. Bras. 1: t. 52–53.

Orbignya martiana Barb. Rodr., Palm. Mattogross. 68, t. 22–23, fig. 1–14. 1898. Type: t. 22–23.

Orbignya macropetala Burret, Notizbl. Bot. Gart. Berlin-Dahlem 11: 690. 1932. Type: Schomburgk s.n. (B?, n.v.).

Orbignya barbosiana Burret, Notizbl. Bot. Gart. Berlin-Dahlem 11: 690. 1932. Type: published as a new name for *O. speciosa* (Mart.) Barb. Rodr.

Large, solitary, erect, pleonanthic, sometimes monoecious but commonly androdioecious, palm, stem columnar, frequently massive, 5–[illegible] m high, 19–50 cm in diameter, surface gray to brown, smooth, obscurely ringed with leaf scars, adventitious roots sometimes visible at base.

Leaves 10–25, fewer in young or senescent plants, spirally arranged in a suberect (when young) or erect-arching (when mature) crown; sheath 40–120 cm long, 21–42 cm wide, partially clasping, split opposite the petiole, thick, coriaceous, abaxial surface green, weakly white lepidote, usually with yellow, longitudinal striations that may extend to the rachis, adaxial surface brown; petiole 8–42 cm long, 5–30 cm wide, green, smooth, channeled adaxially, convex abaxially; rachis 5.6–8.6 m long, base trough-shaped in cross section, more or less 4-sided at center, becoming triangular toward apex, abaxial surface weakly to strongly orange-brown lepidote, vestiture especially apparent when young, becoming gray with age and falling away; pinnae 156–208 per side; regularly inserted along the rachis and in a single plane, rigid when young, becoming pliant with age, linear-lanceolate at center of rachis, plicate, acute, basally reflexed at attachment, 1-ribbed with preminent intermediate veins, glossy dark green and smooth adaxially, dull-glaucous abaxially, basal pinnae 83–185 cm long and 1.0–2.0 cm wide, middle pinnae 88–168 cm long and 2.0–6.0 cm wide, apical pinnae 22–139 cm long and 0.8–2.3 cm wide.

Inflorescences interfoliar, cream-white in bud, yellow at anthesis, finally turning greenish to brown, branched to 1 order, bearing a pliable, fibrous prophyll 50–150 cm long (usually disintegrating rapidly upon development of the inflorescence); peduncular bract 40–218 cm long, woody, longitudinally strongly-ribbed, brown, swollen in middle, opening lengthwise, persistent, with acumen 16–40 cm long, interior surface of bract white-to-yellow lepidote at anthesis, becoming tan to rust-brown over

TABLE 2. *Selective comparison of anatomical characters in leaves of* Orbignya phalerata *Mart.*, *O. teixeirana (Bondar) Balick, Pinheiro and Anderson and O. eichleri Drude*

Character	*O. phalerata*	*O. teixeirana*	*O. eichleri*
Abaxial hypodermis	2 Layers	Generally 1 layer but occasionally 2 layers	1 Layer
Adaxial fibers	Small strands or rows, scattered	Intermediate-sized strands or rows, moderately concentrated	Large strands without rows, heavily concentrated
Inner sheath of primary and secondary veins	Fibers completely surrounding veins	Fibers incompletely surrounding veins, lacking on adaxial side	Fibers incompletely surrounding veins, lacking on adaxial side
Buttresses	Absent	Rare	Usually present

time; peduncle 56–180 cm long, elliptic to ovate in cross-section; rachis 48–175 cm long; rachillae of staminate inflorescence simple, 277–401 in number, 18–28 cm long, linear to slightly undulate, slender, attenuate, arranged spirally along the rachis, each rachilla subtended by a bract 0.5–6.0 mm long, bearing 17–102 staminate flowers arranged in 2(4) longitudinal rows on the abaxial side only; rachillae of androgynous inflorescence 323–475 in number, 10–24 cm long, linear to undulate, slightly thicker than rachillae on staminate inflorescences, arranged spirally along the rachis, each rachilla subtended by a bract 2.0–14.0 mm long and bearing 1–2(3) pistillate flowers at base to middle and 1–several usually inviable staminate flowers at apex, or sometimes bearing staminate flowers only.

Flowers unisexual; staminate flowers yellowish, slightly fragrant, asymmetrical, subtended by 2 small bracteoles per flower, 1.0–4.0 mm long; sepals 3, free or basally connate, lanceolate to triangular, 0.8–2.5 mm long and 0.6–2.3 mm wide, coriaceous; petals 2(3), free, incurved, occasionally imbricate along the margins or apex, more or less similar in length but always with 1 petal wider than the other(s), the wider petal 9.6–16.8 mm long and 3.9–7.5 mm wide, obovate, dentate at apex, the narrower petal(s) 9.5–16.9 mm long and 2.8–5.2 mm wide, narrowly elliptic, acute or occasionally dentate at apex, all petals coriaceous with smooth margins; stamens free, (21–)24–26(–30); filaments slender, linear to slightly narrowed toward apex, straight to occasionally slightly undulate, 1.0–4.2 mm long, infrequently fused; anthers irregularly shaped, spirally twisted, thecae united, irregularly coiled and twisted, longitudinally dehiscent; pollen grains free; pistillode much reduced.

Pistillate flowers cream-yellow, partially covered with a rust-colored tomentum, bracteolate; sepals 3–6, free, imbricate, 2.8–4.1 cm long at anthesis, variably shaped but generally triangular, hooded-concave, margins smooth, inner sepals coriaceous; petals 3(4–5), free, imbricate, 2.3–5.0 cm long at anthesis, variably shaped but generally triangular to deltate, hooded-concave, coriaceous, margins dentate, apex acute or dentate with 2–3 teeth; staminodial cupule leaving a ring around the pistil; gynoecium syncarpous; ovary superior; carpels (1–)3–6(–11), stigmas (1–)3–6(–11), erect to more or less reflexed at anthesis.

Fruits broadly elliptic to oblong, 6.6–12.5 cm long, 3.7–9.9 cm wide, 40–480 g each (dry weight), lepidote, surface gray-white at apex, rust-brown beneath, apex delineated in mature fruits by a more or less distinct ring left by staminodial cupule; stigmatic residue persistent; a cupule of indurate perianth enclosing base of fruit, 3.8–5.8 cm long; epicarp 1.0–4.0 mm thick, fibrous; mesocarp 2.0–12.0 mm thick, mealy-dry at maturity, endocarp 35–76 mm in diameter, woody and very hard; seeds (1–)3–6(–11), ovate to elliptic, 3–6 cm long; endosperm white, oily, homogeneous; embryo cream-white.

Specimens examined—BOLIVIA. Dept. Beni: Prov. Marban, ca. 35 km S of Trinidad, 10 km S of Sachojere, Villa Alba, Jul 1982, *Balick et al. 1359* (LPB, NY); 30 km S of Riberalta, island in Lake Tumi-Chucua, 2 Aug 1982, *Balick et al. 1367* (LPB, NY). Prov. Mamoré, ca. 18 km S of San Joaquin, farm called "Barranquita," 18 Aug 1982, *Balick et al. 1432* (LPB, NY); Dept. Santa Cruz: Prov. Velasco, ca. 105 km N of San Ignácio and 22 km S of San Simon, near Finca Bonanza, 26 Jul 1983, *Hopkins et al. 112* (LPB, NY); Prov. Nuño de Chaves, on road between Yotaú and Ascerado La Luna, 6 Aug 1983, *Hopkins et al. 158* (LPB, NY). BRAZIL. Estado do Ceará: Mun. Ubajara, halfway between the town of Ubajara and Ubajara National Park, Dec 1981, *Balick et al. 1353* (CEN, IAN, INPA, MG, NY); Mun. Ipú, on road between Ubajara (62 km) and Ipú (11 km), 12 Dec 1981, *Balick et al. 1354* (CEN, IAN, INPA, MG, NY). Estado de Goiás: Mun. Tocantinópolis, 11 km from Tocantinópolis on Fazenda Mucamba, 28 Nov 1981, *Balick*

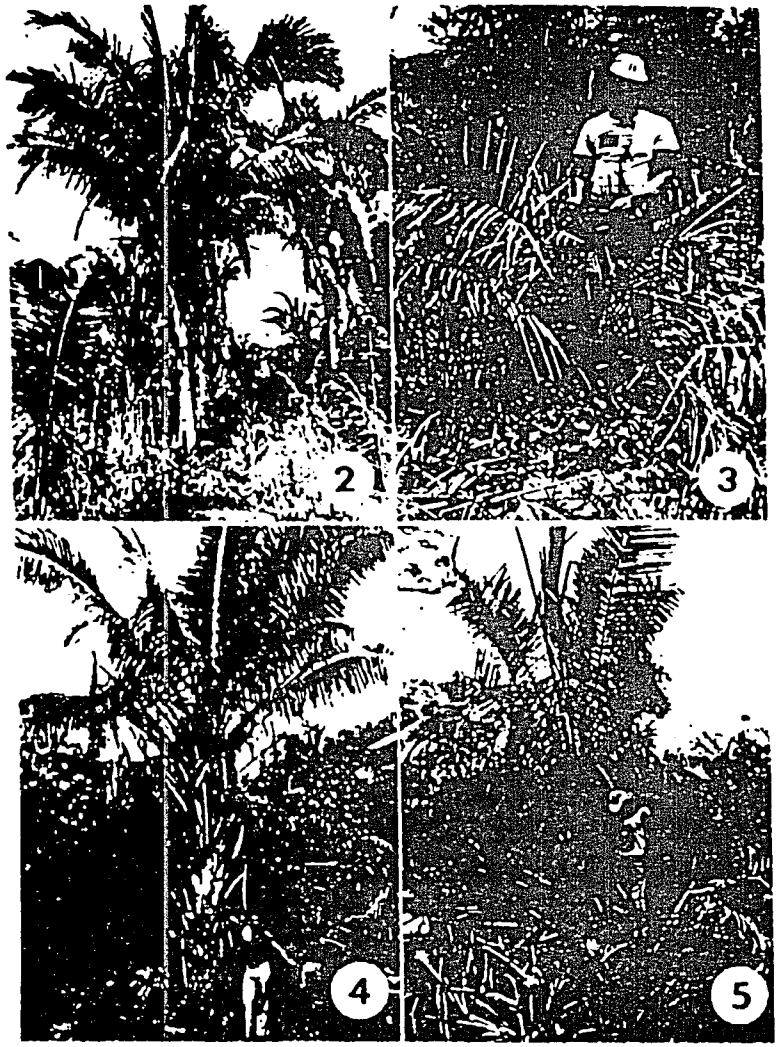


Fig. 2–5. 2. *Orbignya phalerata* (uncultivated population in Maranhão). 3. *O. eichleri* (Balick et al. 1597). 4. *O. tessmannii* with well-developed trunk (Anderson 395). 5. *O. tessmannii* showing acaulescent habit (Balick et al. 1604).

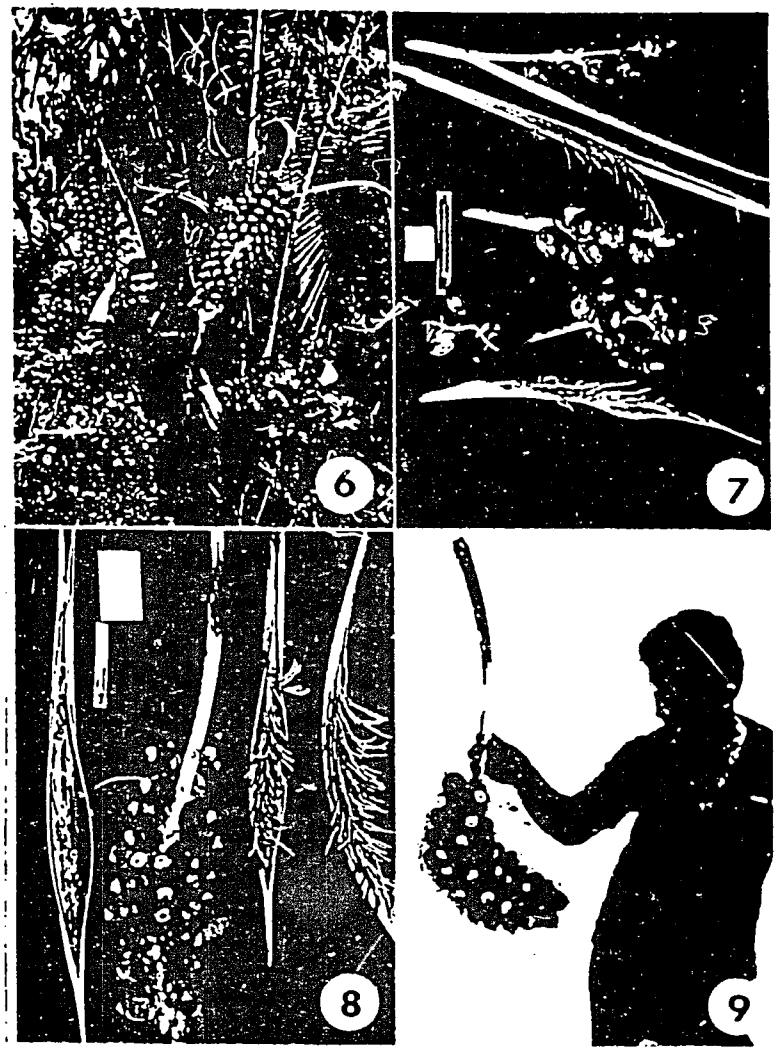


Fig. 6–9. 6. *O. phalerata*, a young palm with 2 fruiting panicles. Note fruits deposited in spirals completely around the rachis. 7. Fruiting panicle of *O. eichleri*. Note fruits form only along one side of the rachis, and fruit expansion during development causes the rachis to curl. 8. Fruiting panicle of *O. tessmannii* (Balick et al. 1604). Note that the fruits are not formed in a complete spiral around the rachis, one side, or at least a portion of it, is devoid of fruits. 9. Fruiting panicle of *O. tessmannii* (Balick et al. 1112). Note curved rachis caused by absence of fruit along one section of the rachis.

et al. 1309 (CEN, IAN, INPA, MG, NY). Estado do Maranhão: Mun. São Félix de Balsas, community known as "Poço," 4 Dec 1981, *Balick et al. 1342* (CEN, IAN, INPA, MG, NY); Mun. Bom Jardim, along Rio Pindaré at Posto Indígena Carú (FUNAI Post, Guajajara Indians), 28 Aug 1983, *Balick et al. 1468* (CEN, NY), and 1 Sep 1983, *Balick et al. 1528* (CEN, NY). Estado de Mato Grosso, Mun. de Aripuanã, in seasonally flooded forest adjacent to Rio Aripuanã, 17 Mar 1977, *Anderson 288* (MG, NY). Estado de Pará: Mun. Bragança, Village of Tracuateua, Nov 1981, *Balick et al. 1301* (CEN, IAN, INPA, MG, NY); Mun. Itupiranga, 20 km downstream on Rio Tocantins from Itupiranga at Cajazeirinha, 23 Nov 1981, *Balick et al. 1304* (CEN, IAN, INPA, MG, NY); Mun. São Félix do Estado de Piauí: Xingu, on banks of Rio Fresco ca. 50 km above confluence with Rio Xingu, 7 Jul 1980, *Anderson 391* (MG, NY). Estado do Piauí 32 km S of Teresina on road to Palmeiras along Parnaíba River, at locale called "Sumaré," Dec 1981, *Balick et al. 1351* (CEN, IAN, INPA, MG, NY).

Flesh with margin

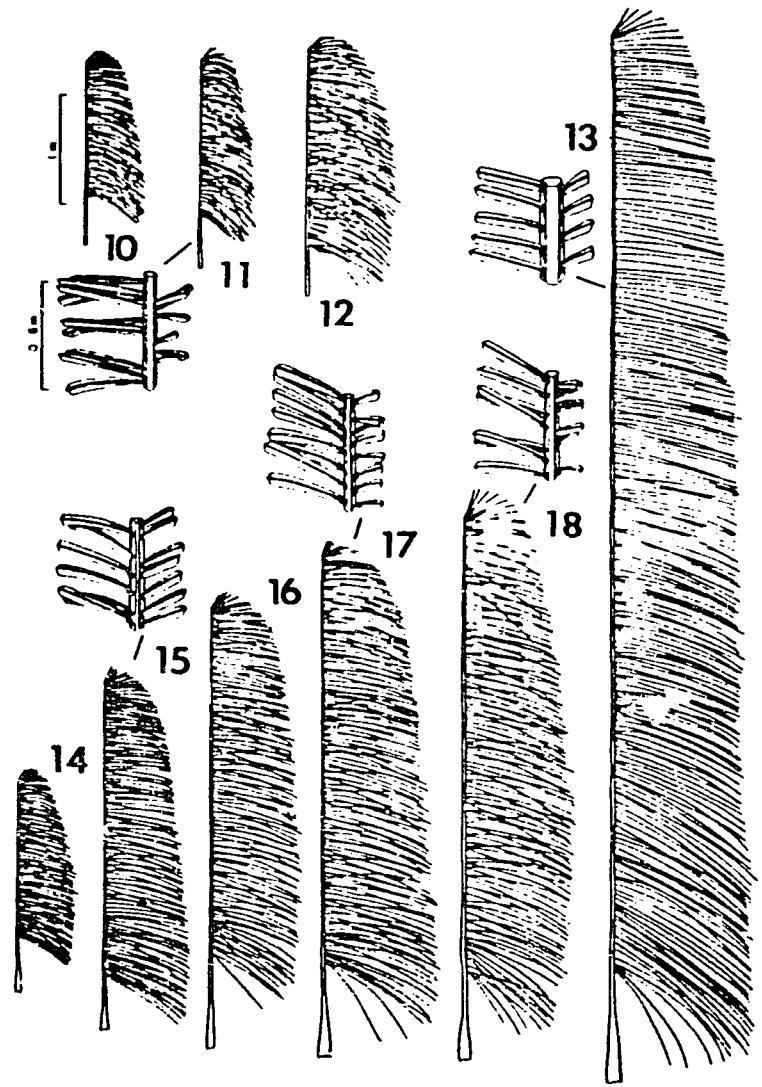
Orbignya eichleri Drude, Mart. Fl. Bras. 3: 449, t. 103. 1881. Type: Weddell 2705 (P, n.v.).

Small, solitary, stemless, pleonanthic, monoecious (or androdioecious?), palm. Leaves 3–8, spirally arranged in an erect-arching crown; sheath 20–35 cm long, thin, somewhat coriaceous, abaxial surface green, lacking striations, adaxial surface brown; petiole 30–80 cm long, ca. 1.5–2.3 cm wide, green, smooth, slightly channeled adaxially, flat to convex abaxially; rachis 1.2–2.3 m long, base trough-shaped in cross section, more or less triangular in cross section at center and toward apex, abaxial surface smooth; pinnae 76–[illegible]9 per side, irregularly inserted along the rachis in groups of 2–3(–7) per side, crispate, linear-lanceolate at center of rachis, weakly plicate, acute, basally reflexed at attachment, 1-ribbed with prominent intermediate veins, dull green and smooth adaxially, green and mostly smooth abaxially, basal pinnae 45–70 cm long and 0.7–1.5 cm wide, middle pinnae 37–81 cm long and 1.4–3.0 cm wide, apical pinnae 14–42 cm long and 0.2–0.8 cm wide.

Inflorescences interfoliar, cream-white in bud, yellow at anthesis, branched to 1 order, bearing a small fibrous prophyll ca. 20 cm long; peduncular bract 35–65 cm long, coriaceous, longitudinally weakly to moderately ribbed, brown, swollen in middle, opening lengthwise, persistent, with acumen 3–12 cm long, interior surface of bract reddish brown, whitish at anthesis, becoming rust brown over time; peduncle 5–37 cm long, elliptic to ovate in cross section; rachis 17–35 cm long, strongly recurved; rachillae of staminate inflorescence 17–35 in number, 2.3–15 cm long, linear to slightly undulate, slender, attenuate, attached to the abaxial side of the rachis only, each rachilla subtended by a bracteole 1.0–4.0 mm long and bearing 5–50 flowers on abaxial side only; rachillae of adrogynous inflorescence 10–20 in number, 0.1–1.0 cm long, much thicker than rachillae on staminate inflorescences, attached to the abaxial side of the rachis only, each rachilla subtended by a bracteole 3.0–45.0 mm long and bearing 1–2 pistillate flowers at base to middle and occasionally 1–several usually inviable staminate flowers at apex.

Flowers unisexual; staminate flowers cream-yellow, slightly fragrant, asymmetrical, subtended by 1 very small bracteole per flower, 0.4–1.5 mm long; sepals (2)3(4), free or basally connate, lanceolate to triangular or trullate, 0.4–1.7(–4.9) mm long, 0.5–2.0 mm wide, membranous to coriaceous; petals 1–2(–4), free, incurved, occasionally imbricate, more or less similar in length but always with one petal wider than the other(s), the wider (or solitary) petal is 7.1–12.4 mm long and 1.5–11.6 mm wide, ovate, obovate or elliptic, apex dentate, the narrower petal(s) 6.2–11.1 mm long and 1.5–7.2 mm wide, narrowly elliptic, acute or dentate at apex, all petals membranous to fibrous with smooth margins; stamens free, 14–18(–20); filaments slender, linear to slightly narrowed toward apex, straight to occasionally undulate, 1.0–4.5 mm long, infrequently fused; anthers irregularly shaped, spirally twisted, thecae united, longitudinally dehiscent; pollen grains adherent (?); pistillode much reduced.

Fig. 10–18. Variation in leaves of *O. eichleri*, *O. phalerata* and *O.* ≡*setzerana*. Leaves reconstructed from data gathered from herb. collections; pinnae depicted only along one side of the rachis. Enlargements of rachis sections show deposition and orientation of leaves, either regularly deposited along the rachis and in a single plane (*O. phalerata*), irregularly deposited in groups of 3–4 at various angles along the rachis (*O. eichleri*) and intermediate in pinnae deposition and orientation along the rachis (*O.* ≡*setzerana*). 10. *O. eichleri* (Balick et al. 1580). 11. *O. eichleri* (Balick et al. 1578). 12. *O. eichleri* (Balick et al. 1579). 13. *O. phalerata* (Balick et al. 1351). 14. *O.* ≡*setzerana* (Balick et al. 1597). 15. *O.* ≡*setzerana* (Balick et al. 1596). 16. *O.* ≡*setzerana* (Balick et al. 1559). 17. *O.* ≡*setzerana* (Balick et al. 1603). 18. *O.* ≡*setzerana* (Balick et al. 1604).



Pistillate flowers cream-yellow, partially covered with a rust-colored tomentum, bracteolate; sepals 3, free, imbricate, 1.9–3.5 cm long at anthesis, variably shaped but generally triangular, coriaceous, margins smooth; petals 3(4–6), free, imbricate, 1.3–2.8 cm long at anthesis, triangular to deltate, approximately same size, coriaceous, margins smooth or weakly dentate, apex acute; staminodial cupule leaving a ring about the pistil; gynoecium syncarpous; ovary superior; carpels 5–8; stigmas 6–8, apical.

Fruits elliptic, 5.5–7.7 cm long, 3.3–4.4 cm wide; 10–50 g each (dry weight), lepidote, surface gray-white at apex, rust-brown beneath, delineated in mature fruits by a weakly defined ring left by staminodial cupule; stigmatic residue persistent; a cupule of indurate perianth enclosing the base of fruit, 3.3–4.9 cm long; epicarp ca. 1.2–2.0 mm thick, fibrous; mesocarp ca. 0.4–2.7 mm thick, mealy-dry at maturity; endocarp ca. 12.5–18.2 mm in diameter, woody and very hard; seeds 4–7 (?), ovate to elliptic, 2.3–2.7 cm long, 0.6–0.8 cm wide, endosperm white, oily, homogeneous; embryo creme-white.

Specimens examined—BRAZIL. Estado de Goiás: Mun. Tocantinópolis, ca. 20 km N of town of Tocantinópolis at Posto Indígena São José (FUNAI Reservation, Apinajé tribe), 8–10 Sep 1983, *Balick et al. 1578, 1579, 1580,* and *1597* (CEN, NY). Estado do Maranhão: Mun. Carolina, ca. 10 km N of Estreito de Goiás on Belém-Brasília Highway, 1 Dec 1981, *Balick et al. 1313* (IAN, INPA, MG, NY), and ca. 20 km N of Estreito de Goiás on Belém-Brasília Highway, 2 Dec 1981, *Balick et al. 1315* (CEN, IAN, INPA, MG, NY); Mun. Coéo, 15 km N of Teresina-Belém Highway, Fazenda "Canto da Rosa," 19 Aug 1980, *Anderson 292* and *393* (NY, MG).

This should be italic

Orbignya teixeirana (Bondar) Balick, Pinheiro and Anderson stat. nov.

Orbignya teixeirana Bondar, Arq. Jard. Bot. Rio de Janeiro 13: 58, fig. 5, 6-3. 1954. Type: Bondar s.n., RB-80813 (RB, n.v.).

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Small to medium-sized, solitary, pleonanthic, monoecious (or androdioecious?) palm; stemless or stem 0.5–7.1 m high, 19–25 cm in diameter, brown, smooth or with some leaf sheaths persistent, obscurely ringed with leaf scars.

Leaves 10–13, fewer in young or senescent plants, spirally arranged in an erect-arching crown; sheath 4–90 cm long, 15–30 cm wide, partially clasping, split opposite the petiole, thin to thick, coriaceous, abaxial surface green, with or without striations, adaxial surface brown, petiole 21–80 cm long, 3–8 cm wide, green, smooth, channeled adaxially, convex abaxially, rachis 2.0–6.4 m long, base trough-shaped in cross section, more or less 4-sided or occasionally triangular at center, becoming triangular toward apex, abaxial surface smooth or weakly to moderately orange-brown lepidote, vestiture becoming gray with age and falling away; pinnae 104–153 per side, inserted either singly or irregularly in groups of 2–4 along the rachis and either in a single plane or in several planes, rigid when young, becoming pliant with age, linear-lanceolate at center of rachis, plicate, acute, basally reflexed at attachment, 1-ribbed with prominent intermediate veins, dull green and smooth adaxially, weakly glaucous to smooth abaxially, basal pinnae 40–185 cm long and 0.5–2.5 cm wide, middle pinnae 53–112 cm long and 2.2–4.0 cm wide, apical pinnae 14–33 cm long and 0.2–1.5 cm wide.

Inflorescences interfoliar, branched to 1 order, cream-white in bud, yellow at anthesis, bearing a small fibrous prophyll ca. 30–33 cm long; peduncular bract 85–130 cm long, coriaceous to woody, longitudinally strongly-ribbed, brown, swollen in middle, opening lengthwise, persistent, with acumen 3–20 cm long, interior surface of bract whitish at anthesis, becoming rust-brown over time; peduncle 44–88 cm long, elliptic to ovate in cross section; rachis 34–99 cm long; rachillae of staminate inflorescence 41–150 in number, 1–20 cm long, linear to slightly undulate, slender, attenuate, attached to the abaxial side of the rachis only, each rachilla subtended by a bract 0.5–7.5 mm long and bearing 10–60 staminate flowers deposited on abaxial side only; rachillae of androgynous inflorescence 20–70 in number, 0.1–2.9 cm long, much thicker than rachillae on staminate inflorescences, attached to the abaxial side of the rachis exclusively or occasionally arranged spirally from the base to the middle portion of the rachis and only on the abaxial side from the middle to the apex of rachis, each rachilla subtended by a bract 0.5–30 mm long and bearing 1–2 pistillate flowers at base to middle and 1–several usually inviable staminate flowers at apex.

Flowers unisexual, staminate flowers cream-yellow, slightly fragrant, asymmetrical, subtended by (1)2(3) small bracteoles 0.3–2.0 mm long; sepals 3, free or basally connate, lanceolate to triangular, 0.6–1.6 mm long, 0.6–1.3 mm wide, membranous to coriaceous; petals 1–2, free, incurved, occasionally imbricate, more or less similar in length but always with one petal wider than the other(s), when two or more petals present the wider petal 7.0–11.8 mm long, 4.1–6.8 mm wide, obovate or elliptic, apex dentate, the narrower petal(s) 7.0–11.5 mm long, 3.0–5.0 mm wide, narrowly elliptic to obovate, apex acute or dentate, all petals membranous; stamens free (18–)20–25(26); filaments slender, linear to slightly narrowed toward apex, straight to occasionally

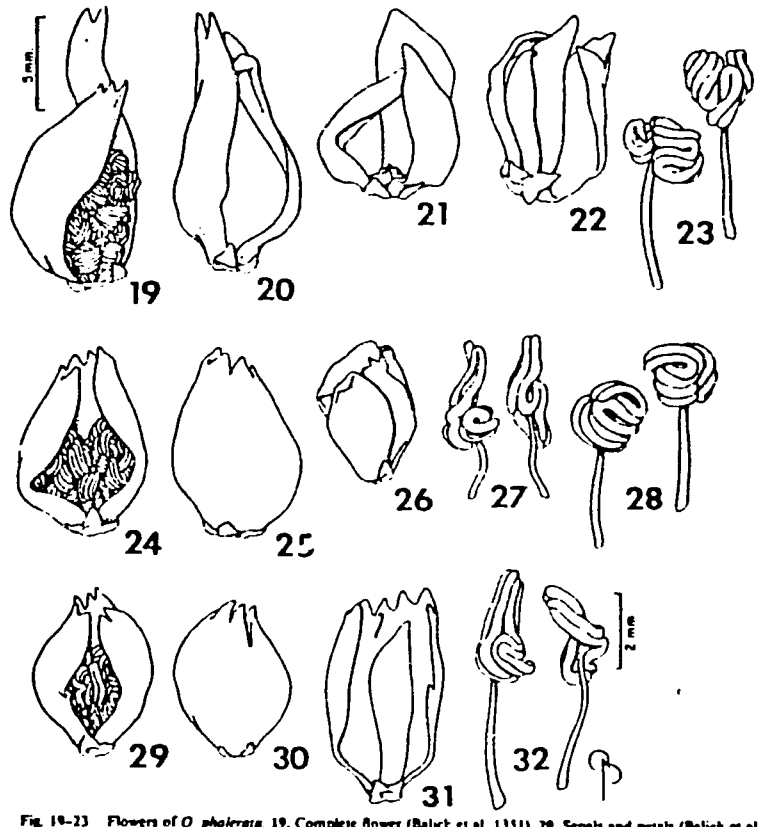
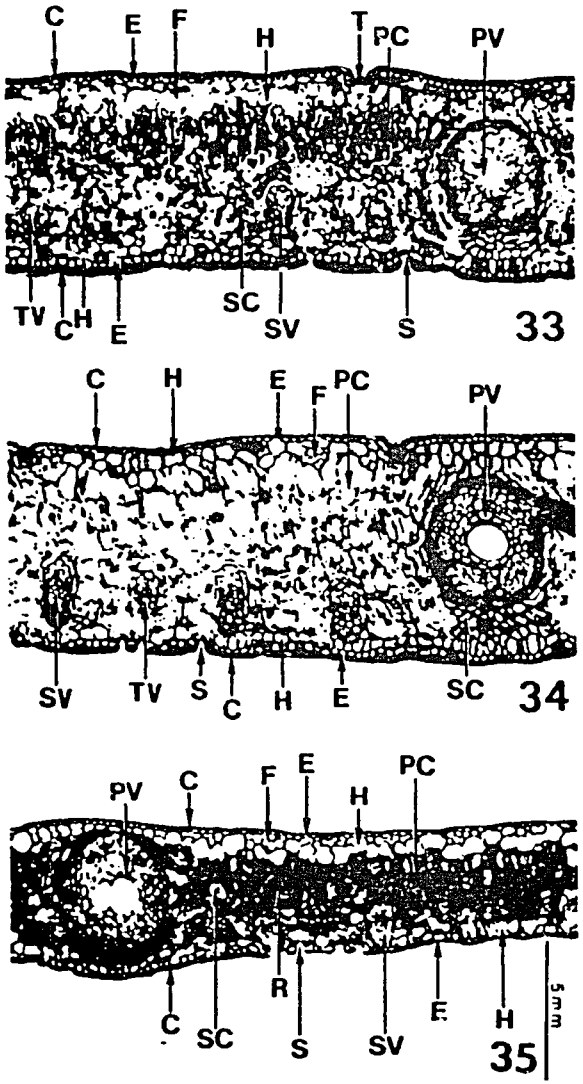


Fig. 19–23. Flowers of *O. phalerata*. 19. Complete flower (Balick et al. 1351). 20. Sepals and petals (Balick et al. 1351). 21. Sepals and petals (Balick et al. 1528); note that there are three petals in this flower. 22. Sepals and petals (Balick et al. 1354); note the rare occurrence of four petals on a single flower. 23. Stamens with inrolled anthers (Balick et al. 1351).

Fig. 24–28. Flowers of *O. teixeirana*. 24. Complete flower (Balick et al. 1348); note the single incurved petal. 25. Rear view of previous figure; note incurved petal. 26. Flower with one larger incurved petal and another smaller petal (Balick et al. 1559). 27. Stamens with loosely inrolled anthers similar to those characteristic of *O. eichleri* (Balick et al. 1559). 28. Stamens with tightly inrolled anthers similar to those characteristic of *O. phalerata* (Balick et al. 1348).

Fig. 29–32. Flowers of *O. eichleri*. 29. Complete flower (Balick et al. 1597); note single petal. 30. Rear view of previous figure. 31. Flower with stamens removed, showing two petals (Balick et al. 1313). 32. Stamens with loosely inrolled anthers characteristic of this species (Balick et al. 1580).



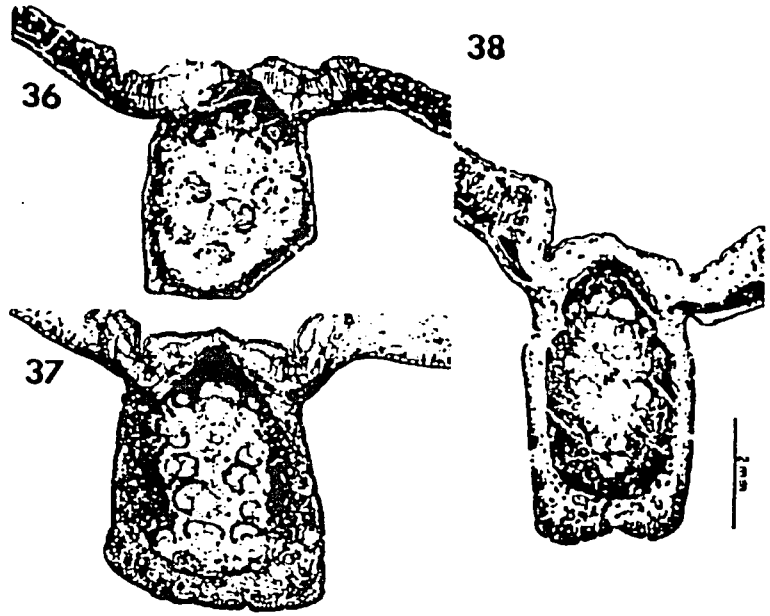


Fig. 36–38. Cross section of the leaf midrib. 36. *O. eichleri* (Balick et al. 1313). 37. *O. [illegible]* (Balick et al. 1347). 38. *O. phalerata* (Balick et al. 1351).

undulate, 1.0–4.0 mm long, infrequently fused; anthers irregularly shaped, spirally twisted, roundish or elongated, thecae united, longitudinally dehiscent, pollen grains free, pistillode much reduced.

Pistillate flowers cream-yellow, partially covered with a rust-colored tomentum, bracteolate, sepals 3, free, imbricate, 2.4–3.5 cm long at anthesis, triangular to deltate, coriaceous, margins smooth, petals 3(4), free, imbricate, 2.2–3.4 cm long at anthesis, triangular to deltate, approximately the same size, coriaceous, margins smooth, apex acute or dentate; staminodial cupule leaving a ring about the pistil; gynoecium syncarpous, ovary superior; carpels 5–6, stigmas 5–6, apical.

Fruits elliptic, 5.4–9.1 cm long, 3.4–5.9 cm wide; 18–210 g each (dry weight), lepidote, surface gray-white at apex, rust-brown beneath, delineated in mature fruits by a weakly to moderately defined ring left by the staminodial cupule; stiginatic residue persistent; calyx a cupule of indurate perianth enclosing the base of fruit, 3.4–5.9 cm long, epicarp ca. 1.2–2.5 mm thick, fibrous; mesocarp ca. 3.2–5.7 mm thick, mealy-dry at maturity, endocarp ca. 18.5–30

Fig. 33–35. Transverse section of leaves in this complex. 33. *Orbignya phalerata* (Balick et al. 1351). 34. *O. [illegible]* (Balick et al. 1347). 35. *O. eichleri* (Balick et al. 1313). Legend: C = cuticle, E = epidermis, F = fibers, H = hypodermis, PC = palisade cells, PV = primary vein, R = raphide, S = stoma, SC = spongy cells, SV = secondary vein, T = trichome, TV = tertiary vein.

mm in diameter, woody and very hard; seeds 4–7, ovate to elliptic, 3.5–4.4 cm long, 1.0–1.6 cm wide; endosperm white, oily, homogeneous; embryo cream-white.

Specimens examined—BRAZIL. Estado de Goiás: Mun. Tocantinópolis, ca. 20 km W of town of Tocantinópolis at Posto Indígena São José (FUNAI Reservation, Apinajé tribe) 6–10 Sep 1983, *Balick et al. 1559, 1596, 1603,* and *1604* (CEN, NY). Estado do Maranhão: Mun. Carolina, ca. 10 km N of Estreito de Goiás on Belém-Brasília Highway, 1 Dec 1983, *Balick et al. 1312* (CEN, IAN, INPA, MG, NY); Mun. Codó, 15 km N of Teresina-Belém Highway, Fazenda "Canto da Rosa," 20 Aug 1980, *Anderson 395* and *396* (NY, MG); Mun. São Félix de Balsas, community known as "Poço," 4 Dec 1981, *Balick et al. 1347* and *1348* (CEN, IAN, INPA, NY, MG).

Descriptions of Leaf Anatomy: Orbignya phalerata Mart.—*Trichomes* present on both surfaces, clavate, irregularly distributed, sunken, 0.035–0.055 mm long, more frequent on abaxial surface and also present on midrib. *Adaxial cuticle* ca. 0.007 mm thick; *abaxial cuticle* 0.005–0.015 mm thick. *Adaxial epidermis* one layer of rectangular cells, approximately equal, longitudinally oriented, walls undulate; *abaxial epidermis* also one layer of cells with alternate narrow bands of costal cells and wider bands of intercostal cells; costal cells approximately rectangular, narrow, longer than wide and longitudinally oriented, walls undulate; intercostal cells variable in shape and size, wider than long, walls slightly undulate and closely appressed. *Stomata* present abaxially only, irregularly distributed, not in definite rows, occurring among the intercostal cells, very rarely among the costal cells; guard cells sunken, 0.017–0.025 mm deep; subsidiary cells 6, comprising a pair of terminal cells and two pairs of lateral cells (inner pair sunken and outer pair superficial); terminal cells variable in shape but predominantly tetragonal. *Adaxial hypodermis* of two layers of cells, the upper layer of smaller cells than the lower, variable but usually rounded; *abaxial hypodermis* of one layer of cells of approximately same size and shape, but more elongated in the area of the base of trichomes and stomata. *Chlorenchyma* with two layers of palisade cells, abundantly tanniniferous; spongy mesophyll of several layers of closely appressed and variably shaped cells. *Fibers* near the adaxial surface longitudinally oriented, in strands or rows, but the strands more frequent, occurring below the epidermis or below the hypodermis (1)2–4 (–14) fibers per strand or row, fibers near the abaxial surface less frequent, isolated or in small strands of 2–3, above the epidermis and/or hypodermis. *Primary veins* located in the middle portion of the mesophyll, with an outer sheath incomplete abaxially and an inner fibrous sheath completely surrounding the veins; *secondary and tertiary veins* occurring in the spongy mesophyll, always above the hypodermal layer, buttresses lacking; the outer sheaths of secondary and tertiary veins also incomplete abaxially, the inner fibrous sheath completely surrounding the veins, fibers larger in the abaxial part of the sheath. *Midrib* approximately rectangular in cross section, elevated or raised adaxially, sclerotic sheath single, pointed abaxially, with 4–8 large vascular bundles and 6–7 small vascular bundles in the periphery of the sclerotic sheath and 3–7 among the central parenchyma cells, trichomes and stomata reduced in number; some strands of fibers among the parenchyma cells (2–20 fibers per strand); structure of midrib: epidermis (1 layer of very small cells), hypodermis (2 layers of cells varying in shape at different points of midrib), and centrally closely appressed parenchyma cells. *Expansion cells* present on both sides of midrib, with three layers on each side, these layers confluent or not below sclerotic sheath. *Silica bodies* spherical-spinulose, in the lamina. Specimens examined: *Balick et al. 1301, 1342,* and *135*.

Orbignya eichleri Drude—*Trichomes* present on both surfaces, clavate, irregularly distributed, sunken, 0.025–0.047 mm long, more frequent on abaxial surface and also present on midrib. *Adaxial cuticle* ca. 0.005 mm thick; *abaxial cuticle* 0.002–0.007 mm thick. *Adaxial epidermis* of one layer of longitudinally oriented rectangular cells, walls undulate, approximately equal; *abaxial epidermis* also of only one layer of cells with alternate bands of costal cells (narrower bands) and intercostal cells (wider bands); costal cells approximately rectangular, narrower than wide and longitudinally oriented, walls undulate; small intercostal cells, wider than long, variable in shape and size, walls undulate. *Stomata* present abaxially only, rarely among the costal cells; guard cells sunken, 0.012–0.022 mm deep; subsidiary cells 6, comprising a pair of terminal cells and two pairs of lateral cells (inner pair sunken and outer pair superficial); terminal cells variable in shape but mostly triangular; adjacent terminal cells frequently fused. *Adaxial hypodermis* of one layer of cells, longitudinally oriented and approximately same shape; *abaxial hypodermis* of one layer of cells, variably shaped, longitudinally oriented, a little smaller than the cells of adaxial surface, more elongated near the area of the bases of trichomes and stomata; abaxial layer of hypodermal cells always interrupted by the buttresses of the secondary and tertiary veins, the lower portions of the veins touching the abaxial epidermis. *Chlorenchyma* with 1–2 layers of palisade cells, abundantly tanniniferous; spongy mesophyll of several layers of closely appressed variably shaped cells. *Fibers* near the adaxial surface longitudinally oriented, in massive groups, regularly distributed, occurring below the epidermis, (1–)6–7(–22) fibers per strand; fibers near the abaxial surface less frequent, isolated or in small strands of 2–3, above the epidermis and/or hypodermis. *Primary veins* located in the middle portion of the mesophyll, independent of both surfaces, with an outer sheath incomplete abaxially and an inner fibrous sheath completely surrounding the veins; *secondary and tertiary veins* occurring in the spongy mesophyll extending through the hypodermal layer and touching the epidermis in well characterized and very frequent buttresses; an inner fibrous sheath of the secondary and tertiary veins present, the extended cells incomplete in their lower portions and the inner fibrous sheaths incomplete in their upper portions and not completely surrounding the veins; fibers larger in the abaxial part of the sheath. *Midrib* approximately square in cross section, elevated or raised adaxially, sclerotic sheath single, pointed abaxially, with 5 large vascular bundles and 1–4 smaller vascular bundles, 0–10 small vascular bundles in the periphery of the sclerotic sheath and 0–3 among the parenchyma cells; trichomes and stomata present; some strands of fibers in the upper portion of midrib, among the parenchyma cells and hypodermal cells (1–9 fibers per strand), structure of midrib: epidermis (1 layer of very small cells), hypodermis (2 layers of cells) and closely appressed parenchyma cells; *Expansion cells* present in layers on each side of midrib with 3 layers per side, these layers confluent or not below the sclerotic sheath. *Silica bodies* spherical-spinulose in the lamina. Specimens examined: *Balick et al. 1313, 1316,* and *1317*.

Orbignya ×teixeirana (Bond.) Balick, Pinheiro and Anderson—*Trichomes* on both surfaces, more frequent on abaxial surface, clavate, irregularly distributed, sunken, 0.040–0.047 mm long, present on midrib. *Adaxial cuticle* 0.005–0.007 mm thick; *abaxial cuticle* ca. 0.007 mm thick. *Adaxial epidermis* one layer of rectangular cells, walls undulate, approximately equal, longitudinally orientated, rather uniform; *abaxial epidermis* also of one layer of cells with alternate bands of costal cells (narrower bands) and intercostal cells (wider bands); costal cells rectangular, longitudinally oriented, walls undulate, intercostal cells closely appressed, variable but usually rounded. *Stomata* present abaxially only, irregularly distributed, not in definite rows, occurring among the intercostal cells and very rarely among the costal cells; guard cells sunken, 0.012–0.020 mm deep, subsidiary cells 6, comprising a pair of terminal cells and two pairs of lateral cells (inner pair sunken and outer pair superficial); terminal cells variable in shape but predominantly tetragonal. *Adaxial hypodermis* 1(–2) layer(s) of rounded cells; adaxially fibers replacing most cells of the outer layer of hypodermis, *abaxial hypodermis* a single layer of cells, longitudinally oriented, a little smaller than the cells of the adaxial hypodermis, more elongated near the base of the trichomes and stomata; the abaxial layer of hypodermal cells almost completely continuous but occasionally interrupted by the lower portions of secondary and tertiary veins. *Chlorenchyma* with 1–2 layers of palisade cells, spongy mesophyll of several layers of closely appressed and variably shaped, abundantly tanniniferous cells. *Fibers* near the adaxial surface occurring in longitudinally oriented, moderate strands and less frequently in rows; (1–)6–8(–14) fibers per strand; fibers near the abaxial surface less frequent, isolated or in small bundles of 1–4 in the spongy mesophyll. *Primary veins* in the middle portion of the mesophyll, independent of both surfaces, with an outer sheath incomplete abaxially and an inner fibrous sheath completely surrounding the veins; *secondary and tertiary veins* occurring in the spongy mesophyll; the lower portion of the secondary and tertiary veins extending part way through the hypodermis but only rarely touching the epidermis and forming buttresses; the outer sheath of the secondary and tertiary veins of extended cells incomplete in the lower portion of the veins, the inner sheath well developed in the lower portion but incomplete in the upper portion and not completely surrounding the veins; fibers larger in the abaxial part of the sheath. *Midrib* approximately square in cross section, elevated or raised adaxially, sclerotic sheath single, pointed abaxially with 2–3 large vascular bundles and 3–4 smaller vascular bundles, 5–12 small vascular bundles in the periphery of the sclerotic sheath and 2–4 among the parenchyma cells; trichomes and stomata on the midrib; some strands of fibers among the parenchyma cells (1–7 fibers per strand); structure of midrib: epidermis (1 layer of very small

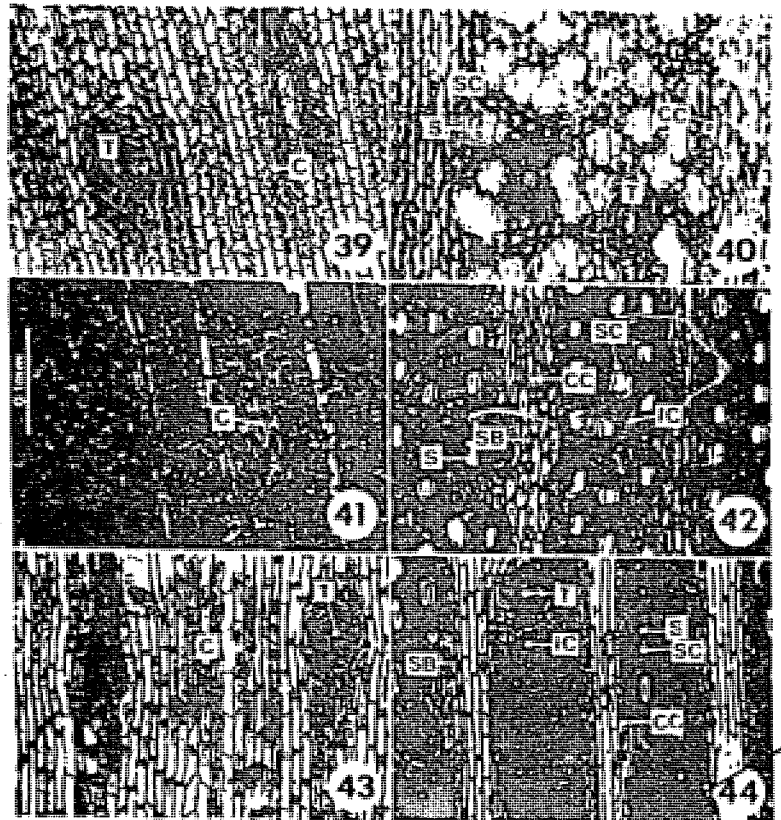


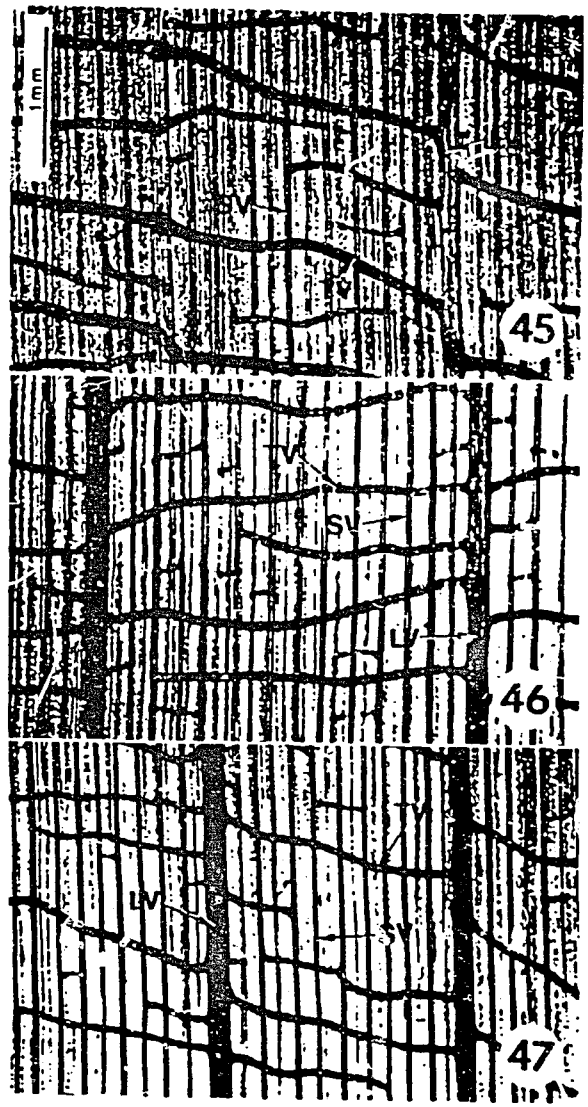
Fig. 39–44. Epidermal peels. 39. *Orbignya phalerata* (Balick et al. 1351), adaxial epidermis. 40. *O. phalerata* (Balick et al. 1351), abaxial epidermis. 41. *O. [illegible]* (Balick et al. 1347), adaxial epidermis. 42. *O. [illegible]* (Balick et al. 1347), abaxial epidermis. 43. *O. eichleri* (Balick et al. 1313), adaxial epidermis. 44. *O. eichleri* (Balick et al. 1313), abaxial epidermis. Legend: C = adaxial cells; CC = costal cells; IC = intercostal cells; S = stomata; SB = silica bodies; SC = subsidiary cells; T = trichomes.

O. ← as with other names in legend

(O. x teixeronae)

cells), hypodermis (2 layers in the upper portion and 1 layer in the remaining portion of midrib) and closely appressed parenchyma cells. *Expansion cells* present in layers on each side of midrib (3–4 layers per side), the layers confluent or not below the sclerotic sheath; sometimes some expansion tissue in the margins of pinnae. *Silica bodies* spherical-spinu-

Fig. 45–47. Leaf clearings showing venation. 45. *O. phalerata* (Balick et al. 1351). 46. *O. [illegible]* (Balick et al. 1347). 47. *O. eichleri* (Balick et al. 1313). Legend: LV = large vein; SV = small vein; TV = transverse vein.



lose in the lamina. Specimens examined: *Balick et al. 1312, 1347,* and *1348.*

DISCUSSION—As shown in Tables 1 and 2 and Fig. 2–9, a wide variety of quantitative and qualitative characters are intermediate in the purported hybrid. These intermediate characters range from morphology (e.g., stem length, leaf size, and structure of the flower) to anatomical features (e.g., thickness of abaxial hypodermis and presence of buttresses). In addition to the morphological and anatomical evidence, field observations revealed that the hybrid is apparently limited to areas where both *Orbignya phalerata* and *O. eichleri* occur (Fig. 1), thus providing further support for its hybrid status. Based on these considerations, we conclude that what was formerly known as *Orbignya teixeirana* Bondar is, in fact, a natural hybrid arising from the crossing of babassu, *O. phalerata* Mart., and piassava, *O. eichleri* Drude. We thus propose that the scientific name of the perinão palm be changed to *Orbignya* × *teixeirana* (Bondar) Balick, Pinheiro & Anderson. Within the natural populations of *Orbignya* × *teixeirana*, a great range of variation can be found, as is evident from Table 1. This variation has been studied in a population located in the basin of the Parnaíba and Itapecuru rivers of Maranhão and Piauí States, Brazil (Medeiros-Costa, de Campos Mendes, and de Castro Brito, 1985). On the basis of this study, three morphotypes were recognized, all intermediate in morphology between the two parent species. Recognition of these morphotypes was based on measurements of the rachis, number of pinnae, number and percentage of grouped and regular pinnae, percentage of rachis with regular pinnae and number of stamens in the flower. This exhaustive study of a single population provides further evidence that *Orbignya* × *teixeirana* comprises a highly variable hybrid swarm intermediate in size and structure between the parents. In future publications we shall propose hybrid status for other taxa in the babassu complex, based on various lines of evidence. The results of our research in this complex have convinced us that some proportion of the pronounced morphological variability in palms, especially in the subtribe Attaleinae (Dransfield and Uhl, 1986), can be attributed to their propensity to hybridize freely in the wild. The complexities of hybridization in palms will ensure decades of research problems for palm taxonomists, at least as long as native palm habitats remain intact. The current trend toward resolution of taxonomic questions in palms through extensive field work (Tomlinson, 1979) will produce an increased understanding of the extent of hybridization in some elements of the family, and, we feel, a considerable reduction in the number of valid taxa at the specific level within those groups where hybridization can be identified.

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APPENDIX VI

Balick, M. J., A. B. Anderson, and J. T. de Madeiros-Costa. 1987. Hybridization in the Babassu palm complex. II. *Attalea compta* x *Orbignya oleifera* (Palmae). Brittonia 39:26-36.

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HYBRIDIZATION IN THE BABASSU PALM COMPLEX. II. ATTALEA COMPTA × ORBIGNYA OLEIFERA (PALMAE)

MICHAEL J. BALICK, ANTHONY B. ANDERSON, AND JUDAS TADEU DE MEDEIROS-COSTA

Balick, Michael J. (New York Botanical Garden, Bronx, NY 10458-5126), Anthony B. Anderson (Museu Paraense Emílio Goeldi, Caixa Postal 399, 66.000, Belém, Pará, Brazil), and Judas Tadeu de Medeiros-Costa (UFPE—Departmento de Botânica, Rua Cons. Silveira de Souza, 1181, 50.721, Recife, Pernambuco, Brazil). Hybridization in the babassu palm complex. II. *Attalea compta* × *Orbignya oleifera* (Palmae). Brittonia 39: 26–36. 1987.—A new hybrid palm, ×**Attabignya minarum**, from the Rio São Francisco Valley of Minas Gerais, Brazil is described. It is a natural hybrid between *Attalea compta* Mart. and *Orbignya oleifera* Burret and is quite common in the area studied. Most of the morphological characters of the hybrid are intermediate between those of the parent species. A notable exception is the number of fruits produced: ×**Attabignya minarum** produces more fruits per panicle than either parent species. This is the first report of hybridization between *Orbignya* and *Attalea* and may shed light on the status of *Orbignya*, considered by some to be synonymous with *Attalea*.

The first paper in this series (Balick et al., in press) discussed the role of one hybrid complex in the genus *Orbignya*. This genus contains the economically important babassu palm complex, a group of palms in the tribe Cocoeae and subtribe Attaleinae (Dransfield & Uhl, 1986) widely distributed in lowland Brazil and Bolivia. The most important and widespread species is *Orbignya phalerata* Mart., the fruits of which are harvested to produce oil and charcoal. Approximately two million people collect the fruits of this species, manually crack them to extract the oil-rich seeds, and obtain charcoal from the remaining epicarp and endocarp. The taxonomy of *O. phalerata* is discussed in detail in Anderson and Balick (In press), along with that of another species, *Orbignya oleifera* Burret, which has a more restricted range. Together these two taxa comprise the palms commonly known as babassu ("babaçu" in Portuguese) or less commonly, "coco palmeira."

Orbignya oleifera is of great interest as a potentially useful plant, due to its abundant production of pistillate (fruit-bearing) inflorescences and higher percentage of oil in the seeds compared to the more widespread *O. phalerata*. Much of our botanical research in the last six years has been directed toward understanding this group and promoting its utilization through improved management practices and the selection of superior germplasm. Because of its unique characteristics, *O. oleifera* is of great importance to this work, and we have made several expeditions to its native range in Brazil to study variation in wild populations.

In 1984 we travelled to the Município of Santa Fe in Minas Gerais, Brazil (ca 165 km E of Montes Claros), where *O. oleifera* is common in the pastures and disturbed forests. The owner of the Fazenda Santa Maria, a farm some 11 km from the town of Santa Fe, granted us permission to collect palms on his property. There we found two palms dominating the landscape, *O. oleifera* and *A. compta* Mart. (Figs. 1, 2). These are known in this region as "coco palmeria" and "indaiá" respectively. We were informed that a similar palm, known as "indaiá mestiço," was also found in this area. Because the Portuguese word "mestiço" refers to someone of mixed blood, we were intrigued by the possibility that the plant called "indaiá mestiço" might be a hybrid between the local species of *Orbignya* and *Attalea*.

After a detailed survey of the population, three elements were identified. The

first two consisted of intermingled stands of *O. oleifera* and *A. compta*, each species exhibiting the morphological uniformity we had encountered in other populations during five years of fieldwork with this group. The third group consisted of a swarm of individuals with much morphological variation, most of which was in range intermediate between the two species mentioned above. During previous surveys of over 100 populations of *Orbignya*, we never found anything similar in morphology to this third group of palms. However, hybrid complexes were identified in several populations of *Orbignya* where these populations integrated with certain other species or genera in the Attaleinae. This was the first time we had ever found *A. compta* growing with a species of *Orbignya*, and we are convinced that, based on the propensity for natural hybridization within the Attaleinae as well as the intermediate (but still highly variable) morphology of the newly-identified palm, that it is indeed a hybrid and that the parents are *A. compta* and *O. oleifera*.

A search of the literature failed to reveal a previous report of this hybrid palm. We are giving it a nothogeneric name, according to Articles H.3 and H.6 (Appendix II of the International Code of Botanical Nomenclature (Voss et al., 1983).

The lack of accurate, published species descriptions, especially based on an understanding of variation in the wild, limits our understanding of these two genera. To help resolve this problem, detailed descriptions of the parent species based on our herbarium and field observations are included herein. The description of the new hybrid is based on the specimens cited as well as on observations and measurements of a number of other palms in the population.

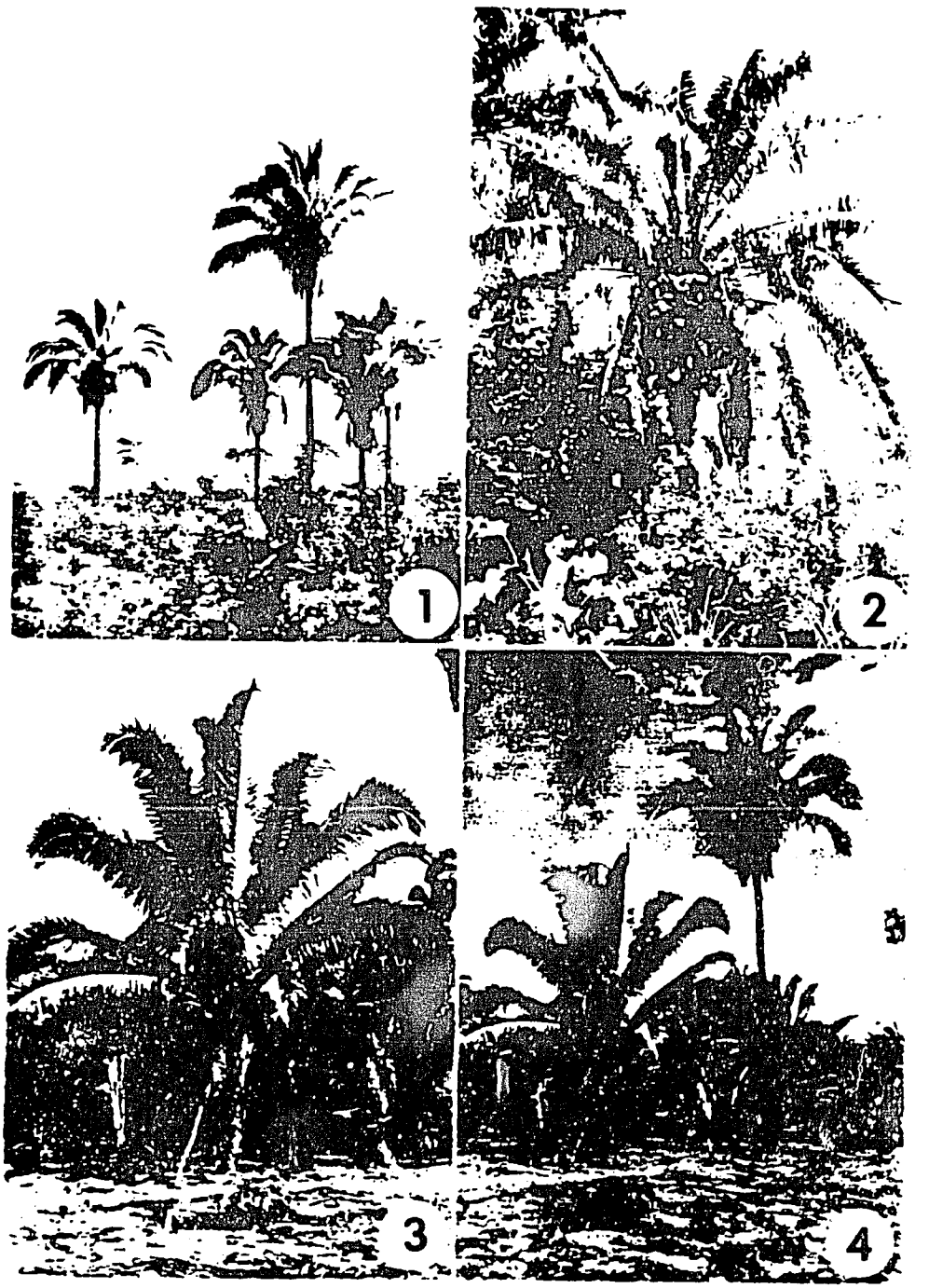
× **Attabignya** Balick, Anderson & Medeiros-Costa, gen. hybr. nov. (Figs. 3, 4)

Attalea H.B.K. × *Orbignya* Mart.

× **Attabignya minarum** Balick, Anderson & Medeiros-Costa, sp. hybr. nov. (Figs. 3, 4)

Notulis morphologicis plurimis inter *Orbignyam oleiferam* Burret et *Attaleam compiam* Martius intermedia et solum inter parentes obvia. Palma 7–11 m alta, trunco solitario 35–40 cm diam. Folia pinnata, pinnis ad racheos basin fasciculatis distaliter ordinatim dispositis; pinnae medianae ±98–110 cm longae, ad medium 4–7 cm latae. Inflorescentia androgyna, rachillis 9–12 cm longis; florum petala anguste elliptica vel ovata; stamina 11–20, thecis rectiusculis vel subtortis vel subcurvatis. Fructus elliptici 9.2–10 × 4.3–6.7 cm, semina saepissime 3–4.

Solitary, erect, pleonanthic, monoecious palm; stem 2–6 m high, 35–40 cm in diam. with pronounced, closely spaced internodes. Leaves 14–22, fewer in younger or senescent plants, spirally arranged in a broad, arching crown; sheath 70–74 × 31–33 cm, partially clasping, split opposite the petiole, thick, coriaceous, adaxial surface smooth and greenish, abaxial surface weakly gray-lepidote with yellow, longitudinal striations that may extend to the rachis; petiole 5–10 cm long, adaxial surface channelled and smooth, abaxial surface convex and glaucous; rachis 5.37–5.5 m long, base trough-shaped in cross-section, center more or less 4-sided, becoming triangular toward apex, abaxial surface glaucous; pinnae 181–191 per side, in groups of 2–5 at base of rachis, otherwise regularly spaced and in a single plane, rigid to pliant, linear-lanceolate at center of rachis, acute, plicate, basally reflexed at attachment, 1-ribbed with prominent intermediate veins, adaxially green and smooth, abaxially dull-glaucous; basal pinnae 135–152 × 1.2–2.1 cm; middle pinnae 98–110 × 4–7 cm; apical pinnae 14–22 × 0.9–1.4 cm. Inflorescences interfoliar, yellowish at anthesis, bearing a prophyll; peduncular bract 128–140 × 22–27 cm, woody, longitudinally ribbed, brown, swollen in middle, persistent, with acumen 17–20 cm long; peduncle ca 50 cm long; rachis 50–150 cm long; rachillae of staminate inflorescence simple or occasionally much branched.



FIGS 1–4. 1 *Orbignya oleifera*, from Mun. Santa Fe, Minas Gerais. 2. *Attalea compta*, from Mun. Santa Fe, Minas Gerais. 3. Type tree of ×*Attabignya minarum* growing in an open area behind farmhouse, from Mun. Santa Fe, Minas Gerais. 4. Type tree of ×*Attabignya minarum* (left) growing next to *Orbignya oleifera* (right).

103 cm long: rachillae of staminate inflorescence simple, 150–448 in number, 5–18 cm long, linear to slightly undulate, slender, attenuate, arranged spirally around the rachis and subtended by a membranous bract 2.5–4 mm long, bearing staminate flowers arranged in longitudinal rows on abaxial side only; rachillae of androgynous inflorescence simple, ca 230 in number, 5–15 cm long, arranged spirally around the rachis, each rachilla subtended by a bract 9–13 mm long and generally bearing 1 pistillate flower at middle (ca 5 cm above insertion on rachis) and 2 rows of ca 20 staminate flowers on abaxial side extending to apex, or rachilla at base of rachis commonly bearing staminate flowers only. Flowers unisexual; staminate flowers yellowish, slightly fragrant, subtended by 1 or 2 bracteoles 0.5–1.5 mm long; sepals 3, free or basally connate, triangular to deltate, ca 2 × 1.2 mm, membranous; petals 3 free, straight to curved, 1–1.8 × 4–5 mm, lanceolate, acute at apex, coriaceous, with smooth to slightly crenulate margins; stamens free, 11–12; filaments straight, linear; thecae united and longitudinally dehiscent; pistillode reduced. Pistillate flowers not seen. Fruits obovate, 7.8–9.4 × 4.9–5.3 cm, 76–96 g each (dry weight), brown-lepidote throughout, frequently channelled or grooved on sides, with a weakly defined ring left by staminodial cupule; stigmatic residue persistent, often slightly eccentric; fruiting perianth indurate, consisting of 3 sepals 2.5–4 cm long, 3 petals 4–5 cm long, and a staminodial ring; epicarp 2–3 mm thick, fibrous; mesocarp 2–3 mm thick, oily, bright orange at maturity; endocarp 3.7–4.1 cm in diam, woody and very hard; seeds generally 3–4, ellipsoid, ca 3–4 cm long; endosperm white, oily, homogeneous; embryo basal.

Specimens examined. BRAZIL. MINAS GERAIS: Mun. Uberlândia, 20 km E of city of Uberlândia, near BR-365, adjacent to Rio Araguari, 16 May 1981, *A. B. Anderson 399* (MG, NY); Mun. Santa Fe, 11 km from town of Santa Fe near stream called Logra do Rio, on Fazenda Santa Maria, 30 Nov 1984, *M. J. Balick et al. 1691* (CEN, NY), *1693* (CEN, NY).

ORBIGNYA OLEIFERA Burret

Orbignya oleifera Burret, Notizbl. Bot. Gart. Berlin-Dahlem 14: 240. 1938. TYPE: BRAZIL. MINAS GERAIS: Pirapora, 18 Dec 1937, *Burret & Brade 19* (HOLOTYPE: RB, n.v.).

Solitary, erect, pleonanthic, monoecious palm; stem to ca 20 m high, 31–53 cm in diam, leaf sheaths persistent just below crown, internodes inconspicuous. Leaves 13–20, fewer in younger or senescent plants, spirally arranged in a broad, erect-arching crown; sheath 100–125 cm long, split opposite the petiole, thick, coriaceous, adaxial surface smooth and brown, abaxial surface rarely with yellow, longitudinal surface striations that may extend to base of rachis, densely white-lepidote; petiole lacking or to 10 cm long; rachis 6.25–7.50 cm long, base trough-shaped in cross-section, center more or less 4-sided, becoming triangular toward apex, adaxial surface smooth, abaxial and lateral surfaces (at middle of rachis) densely white-lepidote; pinnae 156–186 per side, 2–3 basal pinnae grouped, otherwise regularly spaced and in a single plane, very rigid, acute, basally reflexed at attachment, 1-ribbed with prominent intermediate veins, adaxially dark green and smooth, abaxially glaucous; basal pinnae 152–182 × 1.5–2.5 cm; middle pinnae 140–168 × 4.5–6 cm; apical pinnae 49–69 × 0.5–1.5 cm. Inflorescences interfoliar; yellowish at anthesis, prophyll ca 75 cm long; peduncular bract 95–240 × 28–41 cm, woody, longitudinally ribbed, brown, opening longitudinally along a more or less distinct invagination, persistent, with acumen 28–52 cm long, interior surface tan to light orange at anthesis; all axes of inflorescences white- to yellow-lepidote at anthesis, peduncle 94–122 cm long; rachis 1–1.7 m long; rachillae of staminate inflorescence simple, up to 365 in number, 13–32 cm long, linear, erect, attenuate, arranged spirally around the rachis and subtended by a membranous bract ca 4 mm long, bearing 69–138 staminate flowers arranged

in 2 or 3 (4) longitudinal rows on abaxial side only; rachillae of androgynous (but functionally pistillate?) inflorescence simple, ca 277 in number, 2–3 × 3–4 mm, arranged spirally around the rachis, each rachilla subtended by a contorted bract 5–6 cm long and generally bearing 1–2 pistillate flowers at base to middle and 2–3 aborted staminate flowers at middle to apex, or more rarely bearing staminate flowers only. Flowers unisexual: staminate flowers yellowish, fragrant, asymmetrical, subtended by 1 or 2 bracteoles, 1–2 mm long on staminate inflorescences up to 1.5 cm long on androgynous inflorescences; sepals 3, free or basally connate, deltate, ca 1.5 × 1.2 mm, membranous to coriaceous, margins smooth; petals 2 (3), free, incurved, 10–12 mm long, 1 petal 6–7 mm wide and obovate with apex dentate or lobed, the other petal 4 mm wide and narrowly elliptic with apex acute with smooth margins coriaceous; stamens free, 28–32 (37); filaments slender, ca 2 mm long; thecae united, irregularly coiled and twisted; pistillode present. Pistillate flowers yellowish, subtended by a straight to curved or occasionally contorted bracteole 0.8–3.0 cm long; sepals 3–6, imbricate, triangular to deltate, 1–3 cm long at anthesis, coriaceous, margins smooth; petals 3 (5), imbricate, triangular to deltate, ca 2 cm long at anthesis, coriaceous, margins smooth, apex cuspidate; staminodial cupule leaving a ring around the pistil; stigmas typically 3–6, apical, erect. Fruits broadly ellipsoid to oblong, 13–14 × 7.5–8 cm, 152–404 g each (dry weight), brown-yellow-lepidote throughout; staminodial ring strongly defined; stigmatic residue persistent; fruiting perianth indurate, 7–7.5 cm long, containing a ca 1.4 cm long staminodial tube; epicarp 1–2 mm thick, fibrous; mesocarp 2–3 mm thick, mealy, dry, tan-white at maturity; endocarp 5.1–7.6 cm in diam, woody and very hard; seeds generally 4–6, ovate to ellipsoid, 4.3–6 cm long; endosperm white, oily, homogeneous; embryo basal.

Specimens examined BRAZIL MINAS GERAIS: Mun. Pirapora, ca 10 km from town of Pirapora on N side of BR-365, adjacent to highway, 14 May 1981, *A. B. Anderson 398* (MG, NY); ca 2 km from town of Pirapora on Fazenda da Prata, 26 Nov 1984, *M. J. Balick et al. 1684* (CEN, NY), 28 Nov 1984, *M. J. Balick et al. 1686* (CEN, NY). Mun. Santa Fe, ca 11 km from town of Santa Fe near stream called Logra do Rio, on Fazenda Santa Maria, 1 Dec 1984, *M. J. Balick et al. 1696* (CEN, NY).

×*Attabignya minarum* shows many characters intermediate between those of the two parent species (Table I), e.g., habit (compare Figs. 1–4), leaves (Fig. 5), inflorescence (Fig. 6), flowers (Fig. 7), and fruits (Figs. 8 & 9).

A number of intermediate characters can also be found in the size and shape of the fruit (Fig. 9). The apex of the fruit of *O. oleifera* (Fig. 9c) is quite prominent, that of *A. compta* (Fig. 9a) rather indistinct, while that of the hybrid (Fig. 9b) is intermediate. The cross-sections (Fig. 8) show a fruit of ×*A. minarum* (Fig. 8b) with two seeds, a rare condition (3–4 seeds per fruit is usual). Thus, hybridization does not always produce intermediate morphological characteristics.

One striking character that is not apparent from Figure 8 is the color and consistency of the mesocarp. In *A. compta* the mesocarp is bright yellow and oily, while in *O. oleifera* it is white, powdery, and relatively low in oil. ×*Attabignya minarum* has a light yellow mesocarp that is much more powdery than that of *A. compta*. The mesocarp of *Orbignya* is a commercial and subsistence product, used both for food and medicine (May et al., 1985); analysis of the mesocarp of ×*A. minarum* might reveal similarly useful products. Additional intermediate morphological features of the hybrid, not included in Table I, can be found in the descriptions of the three taxa.

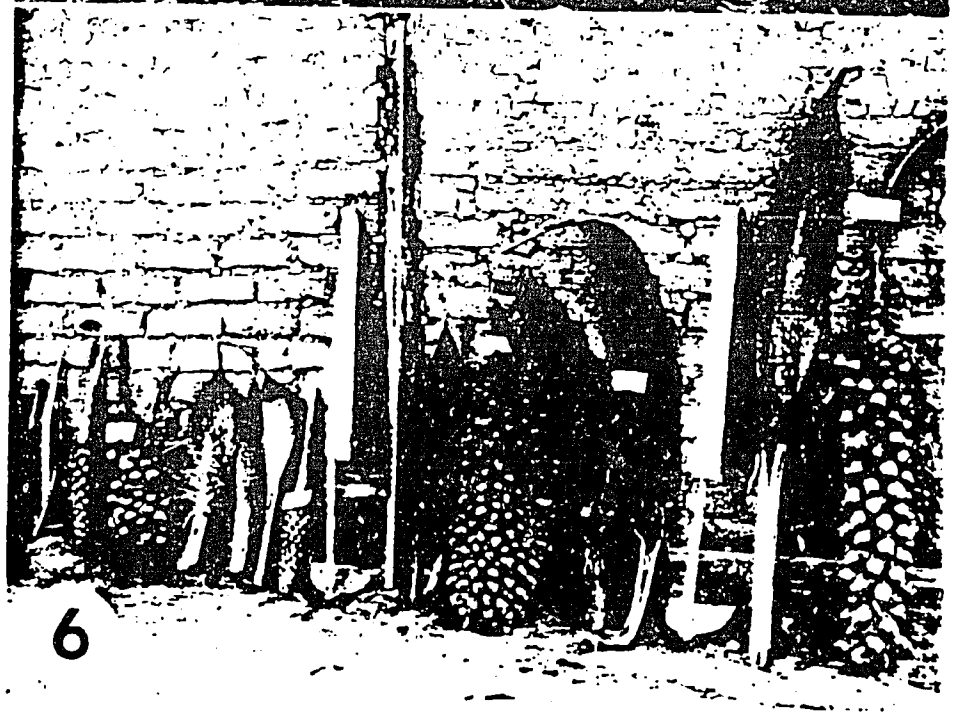
Some characteristics of the hybrid are radically different from the parents. For example, the number of fruits produced in the androgynous inflorescence of *A. compta* ranges from 81 to 120 while in *O. oleifera* the range is from 98 to 189. The type tree of ×*A. minarum* produced ca 298 fruits in the inflorescence, far

TABLE 1

A SELECTIVE MORPHOLOGICAL COMPARISON OF *Orbignya oleifera*, *Attalea compta*, AND THEIR HYBRID, × *Attabignya minarum*

Character	*Orbignya oleifera*	× *Attabignya minarum*	*Attalea compta*
Stem			
Diameter	31–53 cm	35–40 cm	20–32 cm
Leaf			
Length of petiole	0–10 cm	5–10 cm	10–20 cm
Arrangement of pinnae	regular except at extreme base of rachis	regular except in basal ⅛–1/10 of rachis	regular except in basal ⅛–1/6 of rachis
Length × width of middle pinnae	140–168 × 4.5–6 cm	98–110 × 4–7 cm	93–114 × 3.5–4 cm
Length of rachis	6.25–7.5 m	5.37–5.5 m	4.13–6.57 m
Inflorescence			
Length of acumen on peduncular bract	28–52 cm	17–20 cm	13–33 cm
Androgynous inflorescence			
Length of rachilla	2–3 cm	9–12 cm	5–15 cm
Position of pistillate flower on rachilla	0–2 cm above insertion on rachis	2.5–4 cm above insertion on rachis	ca 5 cm above insertion on rachis
Rows of pistillate flowers on rachis	9	17	13
Staminate Flower			
Texture of sepals	membranous to coriaceous	membranous to slightly coriaceous	membranous
Number of petals	2 (3)	(2) 3	3
Shape of petals	narrowly elliptic to ovate	narrowly elliptic to ovate	lanceolate
Number of stamens	28–32 (37)	11–20	11–12
Attachment of thecae to filaments	at midpoint	almost throughout length	throughout length
Orientation of thecae	irregularly twisted and coiled	more or less straight to twisted and coiled	straight
Fruit			
Length	13–14 cm	9.2–10 cm	7.8–9.4 cm
Width	7.5–8 cm	4.3–6.7 cm	4.9–5.3 cm
Shape	broadly ellipsoid to oblong	ellipsoid	obovate
Dry weight	152–404 g	110–176 g	76–96 g
Channelling on surface	absent	moderate	pronounced
Maximum length of calyx	7–7.5 cm	5.2–7.2 cm	4–5 cm
Color of mesocarp	white	yellow	orange
Consistency of mesocarp	dry	dry to oily	oily
Diameter of endocarp	5.1–7.6 cm	4–5.2 cm	3.7–4.1 cm

more than in either parent. Visual inspection of other hybrid plants confirmed that the androgynous inflorescences bore greater numbers of fruit than those of either *A. compta* or *O. oleifera*. A survey of palms in the Fazenda Santa Maria and adjoining farms carried out during our fieldwork indicated that the mean number of androgynous inflorescences produced by four hybrid individuals was 4.5, slightly greater than the 4.3 produced by ten individuals of *O. oleifera* and much greater than the 2.25 produced by four of *A. compta*. The larger number



FIGS. 5 & 6. 5. Comparison of leaves from this hybrid complex: *Orbignya oleifera* (left), ×*Attabignya minarum* (center), *Attalea compta* (right). Note the intermediate-sized rachis and pinnae of the hybrid. 6. Comparison of inflorescences from this hybrid complex: *Attalea compta* (left), ×*Attabignya minarum* (center) and *Orbignya oleifera* (right). Note the intermediate size of the bracts and panicle of the hybrid as well as the greater number of fruits per individual panicle in the hybrid than in either of the parents.

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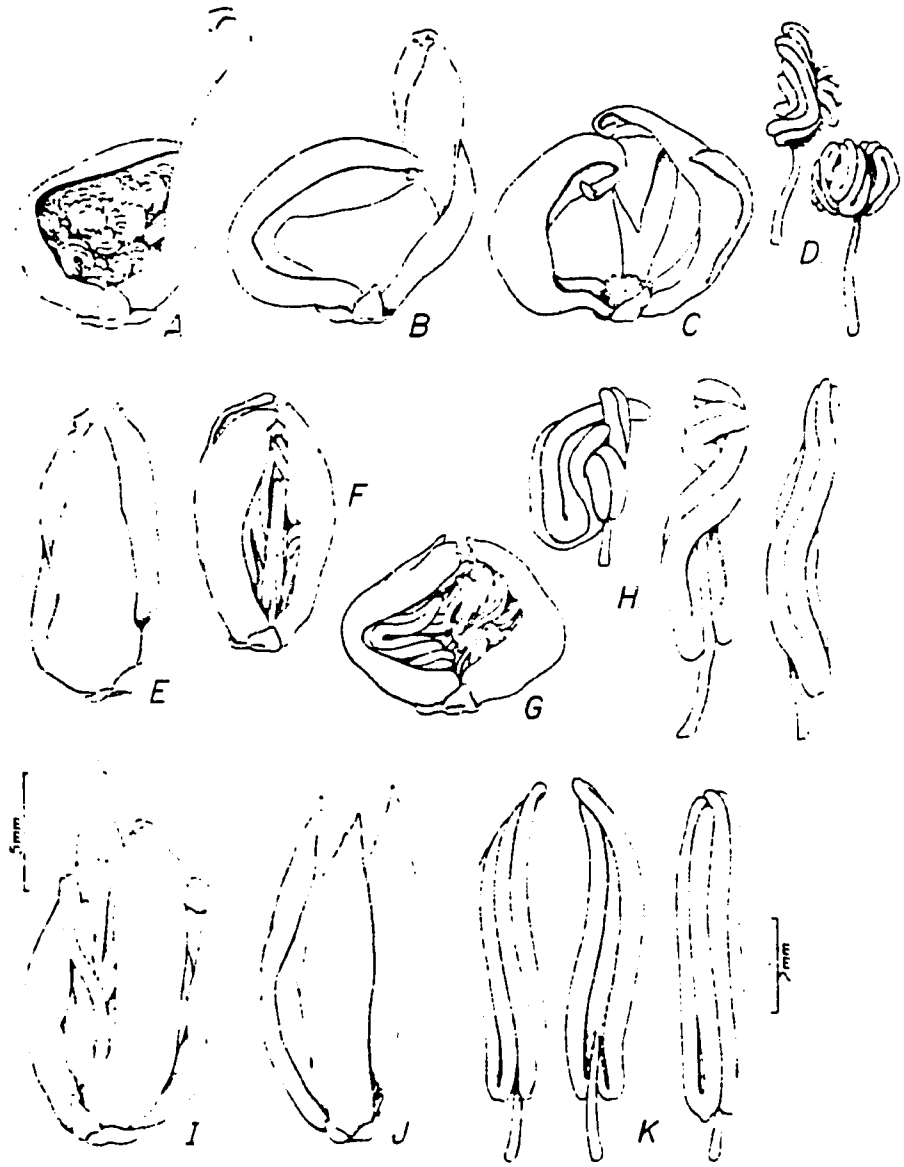
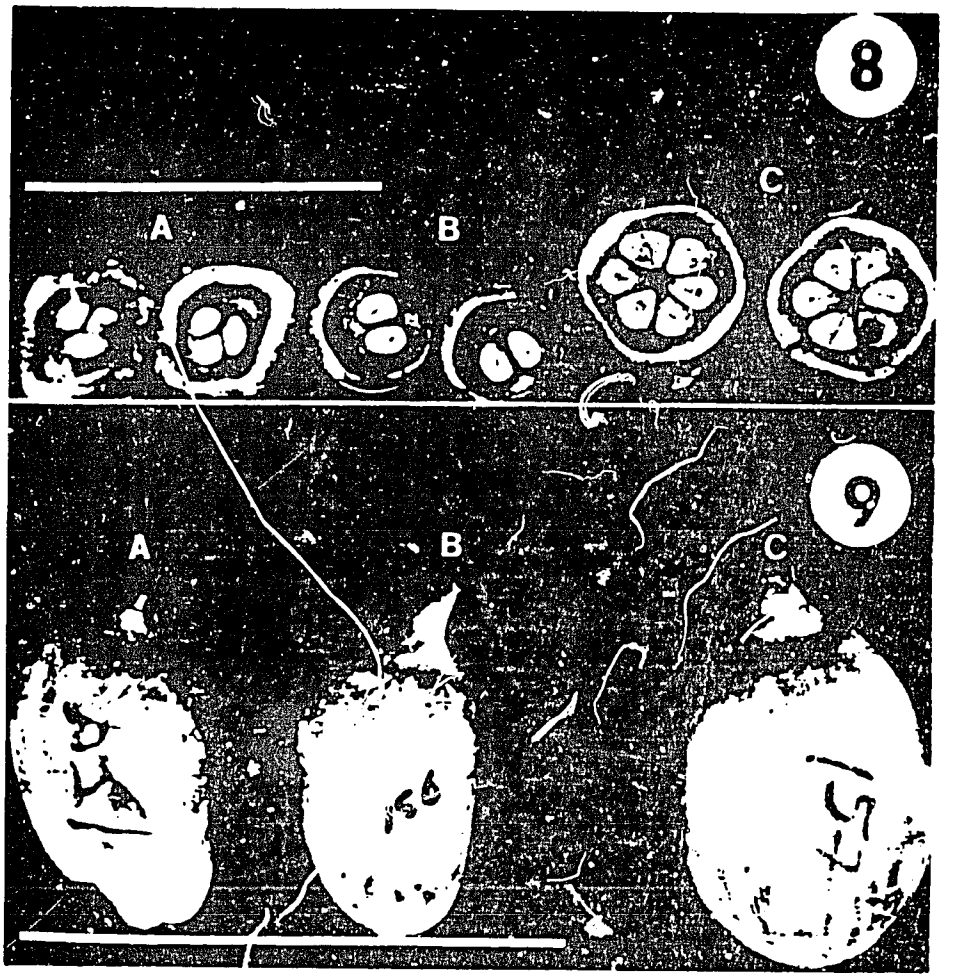


FIG. 7. Staminate flowers and stamens. A–D. *Orbignya oleifera* (*M. J. Balick et al. 1696*). *A*. Flower containing stamens. B. View of flower with stamens removed; note hooded petals. C. Flower with three petals. D. Stamens with inrolled thecae characteristic of this genus. E–H. ×*Attabignya minarum* (*M. J. Balick et al. 1694*). E. Flower with stamens removed; note three petals. F. Flower containing stamens. G. Complete flower with two hooded petals. H. Stamens illustrating variation in thecae shape from more or less linear to loosely inrolled. I–K. *Attalea compta* (*M. J. Balick et al. 1693*). I. Complete flower with three petals. J. Flower with stamens removed. K. Stamens with linear thecae.

of individual fruits per panicle and the larger number of androgynous inflorescences per palm appear to be an example of hybrid vigor, which could have important implications in the effort to select genetically superior forms of babassu and related palms for potential domestication. For example, based on observations at this site, approximate annual fruit production per tree in *A. compta* can be estimated at 34 kg. in *O. oleifera* at 150 kg. and in ×*A. minarum* at 169 kg.



Figs. 8 & 9. A comparison of fruits (scale bar = 15 cm). 8. Fruit cross-sections. A. *Attalea compta*. B. ×*Attabignya minarum*. C. *Orbignya oleifera*: note hole in one seed chamber caused by insect predation. 9. Fruits. A. *Attalea compta*. B. ×*Attabignya minarum*: note the intermediate nature of the fruit apex in the hybrid. C. *Orbignya oleifera*.

×*Attabignya minarum* appears to be quite common in the type locality, especially in lower-lying areas near streams. Its seeds produce viable embryos and the hybrid appears to be regenerating. The type tree (Fig. 3) has been protected for many years in a clearing behind a house as it is a source of food and other products for the household. It was not destroyed to make the type collection. Although the actual current distributions of the parent species are not known, it is reasonable to expect that ×*A. minarum* could be found in other sites where *A. compta* and *O. oleifera* are sympatric.

The existence of this hybrid provides evidence that could prove useful for evaluating the status of *Attalea*. This genus was considered by Wesseis Boer (1965) to include *Orbignya*, *Scheelea*, *Markleya*, and *Maximiliana*. Other workers (Dransfield & Uhl, 1986; Glassman 1977a, 1977b, 1978a, 1978b; Moore, 1973) maintained *Attalea*, *Scheelea*, and *Maximiliana* as separate genera. ×*Attabignya minarum* is the first reported hybrid between *Attalea* and *Orbignya* (sensu stricto). Another intergeneric hybrid in the Attaleinae is *Markleya dahlgreniana* Bondar, a hybrid between *O. phalerata* and *Maximiliana maripa* (Correa de Serra) Drude.

Given the propensity for hybridization between *Attalea*, *Orbignya*, and *Maximiliana*, with resultant fertile offspring (Wessels Boer, 1965; J. M. F. Frazão, unpubl. data), the recognition of separate genera is questionable. We are well aware that continued research may lead to a uniting of all genera in *Attalea*, but the resolution of such a longstanding question is beyond the scope of this paper. Through future field studies, including in-depth analyses at the population level, we hope to be able to understand better the complex interactions in the Attaleinae and contribute towards a taxonomic hierarchy based on true biological relationships.

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Taxonomy of the Babassu Complex (Orbignya spp; Palmae)

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ABSTRACT. The taxonomic identity of the economically important group of palms known in Brazil as babassu (Orbignya spp.) has been a source of confusion for well over a century, largely due to a proliferation of species described from incomplete specimens obtained at a limited number of sites. To resolve this confusion, we collected complete material over a wide part of babassu's distribution in Brazil and Bolivia; additional material was obtained from Surinam. Based on the literature, biological data obtained in the field, and detailed morphological comparisons of specimens in the laboratory, we conclude that the babassu complex is comprised of two principal species, each with a pronounced tendency to hybridize. The most widely distributed species is Orbignya phalerata C. Martius, originally described from Bolivia, which is identical to a number of subsequently described (and consequently synonymous) species from Brazil. A second species, O. oleifera Burret, appears to be restricted to the São Francisco River Basin in Minas Gerais, Brazil. The wide geographic range of this complex and its propensity to hybridize have probably contributed to its high morphological variability. We suspect

that this variability will prove to be a common theme in certain groups of palms currently thought to be comprised of many species.

Over widespread areas of Brazil, palms known locally as "babaçu" (spelled "babassu" in English) occur in pure stands that virtually blanket the landscape (fig. 1). Babassu stands form spontaneously on sites where the original forest cover has been cleared (Anderson and Anderson 1983). The total area of these stands in Brazil was recently estimated at 196,370 km^2 (STI 1979), roughly equivalent to the U.S. state of South Dakota. Babassu palms are an important source of vegetable oil in Brazil. In 1980, 250,951 metric tons of oil-rich kernels were sold to oil pressing facilities throughout the country (IBGE 1983); the manual extraction of these kernels is a source of livelihood for hundreds of thousands of rural families (May et al. 1985). In addition to vegetable oil, babassu fruits provide a host of market and subsistence products, including flour, alcohol, charcoal, coke, tar, combustible gases, etc. (fig. 2).

Despite its ecological and economic importance, the taxonomy of babassu has been a source of confusion since it was first described well over a century ago. The confusion begins on the generic level. Although babassu is generally assigned to the Cocoeae (Attaleinae) genus Orbignya (currently considered to comprise ca. 18 species), the status of this and the four other genera in the Attaleinae (sensu Dransfield and Uhl 1986) has been questioned by Wessels Boer (1965). These genera are

distinguished solely on the basis of staminate flower morphology. No correlation with other characters has been observed, and staminate flower morphology spans a separation based on other characters such as endocarp pores. Lines between genera in the Attalea alliance are further blurred by collections of intermediate flower types, which have prompted the description of two new genera; one of these, Markleya, was described by Bondar (1957) as a possible intergeneric hybrid involving babassu.

A classification based solely on staminate flower morphology is of little use in the field, as most species flower for a brief period of time. Thus it is no surprise that the species of babassu are often confused with other species or even genera, notably Attalea. Oil palms commercially referred to as babassu include Orbignya agrestis (Barb. Rodr.) Burret in the Brazilian state of Pará, Attalea oleifera Barb. Rodr. in the state of Goiás and Minas Gerais, A. geraensis Barb. Rodr. in Minas Gerais, and A. pindobassu Bondar in the state of Bahia (Markley 1971). Even botanists are not immune to generic confusion when dealing with the Attalea alliance. For example, the Brazilian botanist Mário Ferri (1974, 1980) evoked aboriginal dispersal to account for the apparently disjunct distribution of babassu near the town of Piraçununga in the southerly state of São Paulo; examination of male flowers collected from the local palm population has shown that it in fact pertains to the genus Attalea (J. T. de M. Costa, personal communication; A. B. Anderson, unpublished).

To resolve generic confusion in the Attalea alliance, Wessels Boer (1965) recommended reducing Orbignya and related genera to the single genus Attalea, but his suggestion has not been followed by other taxonomists (Dransfield and Uhl 1986; Moore 1973; Glassman 1977a). Countervailing arguments include the weight of taxonomic tradition and

the observation that Wessels Boer's scheme merely reduces the confusion to the specific level (H. E. Moore, pers. comm.). Final resolution of the confused generic limits within the Attalea alliance will require an exhaustive study of the entire group, which, like many large palms that occur in remote areas, is poorly represented in herbaria. In the absence of such a study, we shall consider the babassu palm to be part of the genus Orbignya, and thus maintain this as a distinct genus.

On the specific level, 9 names associated with babassu have been published (tab. 1). Most of this proliferation has resulted from species descriptions based on inadequate botanical specimens, a problem inherent to palm taxonomy in general (Tomlinson 1979). In the more recent taxonomic literature (e.g. Bondar 1954; Glassman 1977a, 1978b; Rizzini 1963), most of the names listed in table 1 are considered synonymous, and it is generally agreed that the babassu complex consists of a maximum of three species. The most commonly cited names are Orbignya martiana Barb. Rodr., O. speciosa (C. Martius) Barb. Rodr., O. barbosiana Burret, and O. oleifera Burret.

The confusion associated with the identity of the economically important babassu palm complex prompted us to undertake a long term field study of the group's taxonomy. In conjunction with this study, we are collecting germplasm of babassu as part of a domestication effort aimed at producing more desirable strains of the palm for introduction into cultivation. The study was thus undertaken not only to resolve longstanding taxonomic confusion but to provide a basis for intensifying the utilization of babassu.

MATERIALS AND METHODS

Lack of adequate specimens has been the principal impediment to resolving the taxonomy of the babassu complex. To help remedy this situation, we collected specimens of the complex over a substantial portion of its presently known range (fig. 3). Due to the large size and bulkiness of palms in the complex, complete botanical collections required extensive field documentation; recommended procedures are described at length in Balick et al. (1982). Specimens of all collections were deposited in herbaria in the U.S., Brazil, and Bolivia (e.g., NY, CEN, MG, INPA, CPATU, LPB, and others). Detailed morphological examination and comparisons of the specimens were subsequently carried out in New York.

A first-hand familiarity with the taxa in the field provided a solid basis for reviewing the extensive and often contradictory taxonomic literature on this group. Results pertaining to the nomenclature, morphology, and distribution of taxa in the babassu complex thus represent a synthesis of literature already published, data obtained in the field, and morphological comparisons of specimens in the laboratory.

RESULTS

Examination of data on specimens obtained to-date indicates that the babassu complex is comprised of two principal species, each with a pronounced tendency to hybridize with other species. In this section, we present data on the morphology and nomenclature of the two principal species. Preliminary data on putative hybrid complexes involving these species are also provided in Appendices 1-3; final results concerning the status of these complexes and definitive nomenclature for the purported hybrids will be provided in subsequent publications (Balick et al. in press; Balick et al. in press).

Orbignya phalerata C. Martius, Palm. Orbig. 126, t. 13, fig. 2, 32A. 1844. Type: Bolivia, Santa Cruz, Chiquitos and Moxos, n.d., d'Orbigny 20 (P).

Attalea speciosa C. Martius, Hist. Nat. Palm. 2: 138, t. 96, fig. 3-6. 1826. Type: Brazil, Maranhão and Pará, type not designated. Orbignya speciosa (C. Martius) Barb. Rodr., Sert. Palm. Bras. 1:t. 52-53. 1903. non O. speciosa Barb. Rodr. (1891).

Orbignya martiana Barb. Rodr., Palm. Mattogross. 68, t. 22-23, Fig. 1-14. 1898. Type: Published as a new name for O. speciosa. t. 22-23 (lectotype).

Orbignya macropetala Burret, Notizbl. Bot. Gart. Berlin-Dahlem 10: 507. 1929. Type: Guyana, on Rupununi River, n.d., Schomburgk s.n. (B?).

Orbignya barbosiana Burret, Notizbl. Bot. Gart. Berlin-Dahlem 11: 690. 1932. Type: published as a new name for O. speciosa (C. Martius) Barb. Rodr.

Stem solitary, columnar, to ca. 30 m high and 19-50 cm in diam.; leaf scars inconspicuous; leaf bases persistent just below crown.
Leaves 10-25, erect-arching; sheath 40-120 cm long, usually with yellow, longitudinal striations on abaxial surface that may extend to base of rachis, abaxial surface weakly white lepidote, adaxial surface smooth; petiole 8-42 cm long, channeled adaxially, convex abaxially; rachis 560-860 cm long, base trough-shaped in cross-section, middle more or less 4-sided in cross section, apex triangular in cross-section, abaxial and lateral (at middle) surfaces weakly to densely orange- to brown-lepidote, adaxial surface glaucescent; pinnae 156-208 per side, 5-6 basal pinnae grouped, otherwise inserted at regular intervals and in same plane, rigid

throughout when new, becoming pliant near apices with age, adaxial surface lustrous, smooth, dark-green, abaxial surface glaucous; basal pinnae 83-185 cm long and 1.0 - 2.0 cm wide; middle pinnae 88-168 cm long and 2.0 - 6.0 cm wide; apical pinnae 22-139 cm long and 0.8 - 2.3 cm wide. Inflorescences androdioecious, interfoliar; prophyll 50-150 cm long; peduncular bract woody, persistent, 40-218 cm long, bearing an acumen 16-40 cm long, adaxial (interior) surface white- to yellow-lepidote at anthesis, becoming tan to rust-brown over time; all axes of inflorescences white- to-yellow-lepidote at anthesis; peduncle 56-180 cm long; rachis 48-175 cm long; staminate inflorescences bearing 277-401 rachillae, the latter 10-28 cm long, erect, each rachilla subtended by a 0.5-6.0 mm long bract and bearing 17-102 staminate flowers arranged in 2-(4) longitudinal rows on abaxial side only; androgynous (but functionally pistillate) inflorescences bearing 323-475 rachillae, the latter 10-24 cm long, 3-4 mm in diameter, subtended by a bract 2-14 mm long, each rachilla bearing 1-2(3) pistillate flowers at base to middle and 1- several aborted staminate flowers at middle to apex, or more rarely bearing staminate flowers only. Staminate flowers yellowish, fragrant, assymetrical, subtended by 2 bracteoles 1-4 mm long; sepals 3, lanceolate to deltate, 0.8-2.5 mm long and 0.6-2.3 mm wide, coriaceous, margins smooth; petals 2(3), incurved, coriaceous, margins smooth, 9.5-16.9 mm long, one petal 3.9-7.5 mm wide and obovate with apex dentate, the other petal(s) 2.8-5.2 mm wide and narrowly elliptic with apex acute or occasionally dentate; stamens (21) 24-26(30); filaments slender, 1.0-4.2 mm long; thecae united, irregularly coiled and twisted; pistillode present. Pistillate flowers yellowish, subtended by 1-2 bracteoles ca. 2 mm long; sepals 3-6, imbricate, triangular to deltate, 2.8-4.1 cm long at anthesis, coriaceous,

margins smooth; petals 3(-5), imbricate, triangular to deltate, 2.3-5.0 cm long at anthesis, coriaceous, margins dentate, apex acute or dentate with 2-3 teeth; staminodial cupule leaving a ring around the pistil; stigmas (1)3-6(11), apical, erect to more or less reflexed at anthesis. Fruits broadly elliptic to oblong, 6.6-12.5 cm long, 3.7-9.9 cm wide, 40-440 g dry weight, lepidote, rust-brown at maturity, apex gray-white; stigmatic residue persistent; staminodial ring weakly to strongly defined; calyx a cupule of indurate perianth enclosing the base of the fruit, 3.8-5.8 cm long, containing a 2-4 cm long staminodial tube; epicarp fibrous, 1-4 mm thick; mesocarp mealy, dry, 2-12 mm thick; endocarp woody, 35-76 mm in diam.; seeds ovate to elliptic, (1)3-6(11), 3-6 cm long; endosperm white, oily, homogeneous; embryo creme-white.

Specimens examined: BOLIVIA. Dept. Beni: Prov. Marban, ca. 35 km S of Trinidad, 10 km S of Sachojere, Villa Alba, Jul 1982, Balick et al. 1359 (LPB, NY); 30 km S of Riberalta, island in Lake Tumi-Chucua, 2 Aug 1982, Balick et al. 1367 (LPB, NY); Prov. Mamoré, ca. 18 km S of San Joaquin, farm called "Barranquita", 18 Aug 1982, Balick et al. 1432 (LPB, NY). Dept. Santa Cruz: Prov. Velasco, ca. 105 km N of San Ignácio and 22 km S of San Simon, near Finca Bonanza, 26 Jul 1982, Hopkins et al. 158 (LPB, NY).

BRAZIL. Estado do Ceará: Mun. Ubajara, halfway between the town of Ubajara and Ubajara National Park, Dec 1981, Balick et al. 1353 (NY, MG, CEN, IAN, INPA); Mun. Ipú, on road between Ubajara (62 km) and Ipú (11 km), 12 Dec 1981, Balick et al. 1354 (NY, MG, CEN, IAN, INPA). Estado de Goiás: Mun. Tocantinópolis, 11 km from Tocantinópolis on Fazenda Mucamba, 18 Nov 1981, Balick et al. 1309 (NY, MG, CEN, IAN, INPA). Estado

do Maranhão: Mun. São Félix de Balsas, community known as "Poço," 4 Dec 1982, Balick et al. 1342 (NY, MG, CEN, IAN, INPA); Mun. Bom Jardim, along Rio Pindaré at Posto Indígena Carú (FUNAI Post, Guajajara Indians), 28 Aug 1983, Balick et al. 1468 (NY, CEN), 1 Sep 1983, Balick et al. 1528 (NY, CEN). Estado do Pará: Mun. Bragança, Village of Tracuateua, Nov 1981, Balick et al. 1301 (NY, MG, CEN, IAN, INPA); Mun. Itupiranga, on Rio Tocantins 20 km downstream from Itupiranga at Cajazeirinha, 23 Nov 1981, Balick et al. 1304 (NY, MG, CEN, IAN, INPA). Estado de Piauí: 32 km S of Teresina on road to Palmeiras along Parnaíba River, at locale called "Sumaré", Dec 1981, Balick et al. 1351 (NY, MG, CEN, IAN, INPA).

Nomenclature. The scientific name of this species has generated considerable confusion among taxonomists. Before initiating our fieldwork, the first taxonomic description that could definitely be attributed to babassu was that of Orbignya martiana Barb. Rodr., published in 1898 (tab. 1). A previously published name associated with babassu (Attalea speciosa C. Martius) was based on an incomplete collection, and its accompanying description was insufficient and could not be definitely attributed to babassu. Barbosa Rodrigues (1903) subsequently reduced O. martiana to synonymy under the new combination, O. speciosa (C. Martius) Barb. Rodr. Although widely accepted in Brazil, the latter name is invalid because the same combination (O. speciosa Barb. Rodr.) had been previously published by Barbosa Rodrigues (1891) in reference to another species (cf. Article 64, ICBN). Before initiating our fieldwork, then, Orbignya martiana was the earliest, validly published name definitely referable to babassu.

Martius (1844) published a relatively complete description of O. phalerata, which he designated as the type species of the genus. The collections were obtained in northeastern Bolivia in the region around Chiquitos and Moxos from a palm known locally as "cusi". Martius' published description and illustration provides no basis for distinguishing it from O. martiana. However, further collections of this species had apparently not been obtained.

During two expeditions to Bolivia in 1982 and 1983, we obtained collections of the cusi palm at seven localities in northeastern Bolivia (fig. 2). Comparison of this material from collections obtained of the babassu palm in Brazil revealed no consistent differences. We thus conclude that Orbignya phalerata C. Martius and O. martiana Barb. Rodr. are synonymous. The former has priority and the latter name is thus reduced to synonymy.

Hybridization. Orbignya phalerata is the most widespread, morphologically variable, and economically important species in the babassu complex. It is this species that forms extensive stands in the Brazilian states of Maranhão, Piauí, Goiás, and Mato Grosso (fig. 1), with outlying populations ranging from Bolivia to Surinam (Fig. 3). Contributing to its high morphological variability is its apparently pronounced tendency to hybridize. We tentatively propose that O. phalerata forms two hybrid complexes. One involves an intergeneric cross with Maximiliana maripa (Correa de Serra) Drude, producing a putative hybrid described by Bondar (1957) as Markleya dahlgreniana. We found this hybrid at two localities in the Brazilian state of Pará, and it has been reported at two other localities in Surinam (Wessels Boer 1965; see fig.

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3); in all cases it occurs in association with O. phalerata and M. maripa. A morphological comparison of the three taxa (Appendix 1) reveals the intermediate nature of the purported hybrid. The second hybrid involves a cross between O. phalerata and O. eichleri Drude, producing a putative hybrid described by Bondar (1954) as O. teixeirana. The intermediate morphology of this ~~species~~ taxon (Appendix 2), as well as its exclusive occurrence in association with O. phalerata and O. eichleri at four localities in the Brazilian state of Maranhão, support our contention that it represents a hybrid.

Orbignya oleifera Burret, Notizbl. Bot. Gard. Berlin-Dahlem 14: 240. 1938. Type: Brazil, Minas Gerais, Pirapora, 18 Dec 1937, Burret and Brade 19 (RB).

Stem solitary, columnar, to ca. 20 m high and 31-53 cm in diam.; leaf scars inconspicuous; leaf bases persistent just below crown.
Leaves 13-20, erect-arching; sheath 100-125 cm long, rarely with yellow, longitudinal striations on abaxial surface that may extend to base of rachis, abaxial surface densely white-lepidote, adaxial surface smooth; petiole 0-10 cm long; rachis 625-750 cm long, base trough-shaped in cross section, middle more or less 4-sided in cross section, apex triangular in cross section, abaxial and lateral (at middle) surfaces densely white-lepidote, adaxial surface smooth; pinnae 156-186 per side, 2-3 basal pinnae grouped, otherwise inserted at regular intervals and in same plane, very rigid, adaxial surface lustrous, smooth, dark-green, abaxial surface glaucous; basal pinnae 152-182 cm long and 1.5-2.5 cm wide; middle pinnae 140-168 cm long and 4.5-6.0 cm wide; apical pinnae 49-69 cm long and 0.5-1.5 cm wide. Inflorescences androdioecious, interfoliar; prophyll ca.

75 cm long; peduncular bract woody, persistent, opening longitudinally along a more or less distinct invagination, 95-240 cm long and 28-41 cm wide, bearing an acumen 28-52 cm long, adaxial (interior) surface tan to light orange; all axes of inflorescences white- to yellow-lepidote at anthesis; peduncle 94-122 cm long; rachis 100-170 cm long; staminate inflorescences bearing up to 365 rachillae, the latter 13-32 cm long, erect, each rachilla subtended by a ca. 4 mm long bract and bearing 69-138 staminate flowers arranged in 2-3(4) longitudinal rows on abaxial side only; androgynous (but functionally pistillate?) inflorescences bearing ca. 277 rachillae, the latter reduced, 2-3 cm long, 3-4 mm in diam., subtended by a contorted bract 5-6 cm long, each rachilla bearing 1-2 pistillate flowers at base to middle and 2-3 aborted staminate flowers at middle to apex, or more rarely bearing staminate flowers only. Staminate flowers yellowish, fragrant, assymetrical, subtended by 1-2 bracteoles, the latter 1-2 mm long on staminate inflorescences, up to 1.5 cm long on androgynous inflorescences; sepals 3, deltate, ca. 1.5 mm long and ca. 1.2 mm wide, membranous to coriaceous, margins smooth; petals 2(3), incurved, coriaceous, margins smooth, 10-12 mm long, one petal 6-7 mm wide and obovate with apex dentate or lobed, the other petal(s) 4 mm wide and narrowly elliptic with apex acute; stamens 28-32(37); filaments slender, ca. 2 mm long; thecae united, irregularly coiled and twisted; pistillode present. Pistillate flowers yellowish, subtended by a straight to curved or occasionally contorted bracteole 0.8-3.0 cm long; sepals 3-6, imbricate, triangular to deltate, 1.0-3.0 cm long at anthesis, coriaceous, margins smooth; petals 3(-5), imbricate, triangular to deltate, ca. 2 cm long at anthesis, coriaceous, margins smooth, apex cuspidate; staminodial cupule leaving a ring around the pistil; stigmas

typically 3-6, apical, erect. Fruits broadly elliptic to oblong, 13-14 cm long, 7.5-8.0 cm wide, 152-404 g dry weight, lepidote, brownish-yellow at maturity, apex brown; stigmatic residue persistent; staminodial ring strongly defined; calyx a cupule of indurate perianth enclosing the base of the fruit, 7.0-7.5 cm long, containing a ca. 1.4 cm long staminodial tube; epicarp fibrous, 1-2 mm thick; mesocarp mealy, dry, 1-2 mm thick; endocarp woody, 51-76 mm in diam.; seeds 4-6, ovate to elliptic, 4.3-6.0 cm long; endosperm white, oily, homogeneous; embryo creme-white.

Specimens examined: BRAZIL. Estado de Minas Gerais: Mun. Pirapora, ca. 10 km from town of Pirapora on N side of BR-365, adjacent to highway, 14 May 1981, A. B. Anderson 398 (NY, MG); ca. 2 km from town of Pirapora on Fazenda da Prata, 26 Nov 1984, M. J. Balick et al. 1684 (NY, CEN), and 28 Nov 1984, M. J. Balick et al. 1686 (NY, CEN); Mun. Santa Fe, ca. 11 km from town of Santa Fe near stream called Logra do Rio, on Fazenda Santa Maria, 1 Dec 1984, M. J. Balick et al. 1696 (NY, CEN).

Nomenclature. Burret (1938) provided an incomplete description of this species based on material collected from Pirapora, Minas Gerais. Before initiating our fieldwork, the status of this species was uncertain; Glassman (1977a) reduced it to synonymy under Orbignya barbosiana Burret. In 1981 and 1984 we visited the type locality and obtained several collections. The general aspect of O. oleifera is similar to that of O. phalerata (figs. 4, 5). However, detailed morphological comparisons between these species revealed numerous differences involving both vegetative and reproductive structures (tab. 2; fig. 6). We feel that these differences are sufficient to consider O. oleifera as a distinct

species from O. phalerata. Yet, collections of O. oleifera have only been obtained from two localities. According to local informants, the species occurs along the Rio São Francisco at a considerable distance from the type locality at Pirapora and may even extend into the neighboring states of Goiás and Bahia. Like O. phalerata, O. oleifera is likely to exhibit greater morphological variability than we have documented in collections from two localities, and it is possible that further collections will blur the distinctions between these two species.

Hybridization. At a single locality in the municipality of Santa Fe, Minas Gerais, we found a population of a putative hybrid resulting from an intergeneric cross between Orbignya oleifera Burret and Attalea compta C. Martius. This was seen only in the vicinity of these two species, and a morphological comparison (Appendix 3) reveals its intermediate status.

DISCUSSION

Our results show a high degree of morphological variability in the principal species of the babassu complex, Orbignya phalerata (tab. 2). This variability encompasses characters formerly considered relatively stable and utilized to differentiate species of Orbignya, such as the number of stamens or the dimensions of leaf pinnae and fruits (Glassman 1977a). There are probably three sources of this high morphological variability: the species' wide geographic range, its apparent propensity to hybridize, and ~~the~~ its intrinsic genetic variation. Each of these factors is discussed below.

Phytogeography. The wide distribution of Orbignya phalerata is especially noteworthy in view of the high weight of its fruits. During the course of our fieldwork, we found fruits with a fresh weight ranging from approximately 100 g to 900 g. Dissemination of these massive fruits has probably been exclusively by mammals (either living or extinct) or water. Among living mammals, rodents such as pacas (Agouti paca) and agoutis (Dasyprocta punctata) are effective, short-range dispersal agents (Anderson and Anderson 1983); humans and possibly monkeys disseminate the fruits over greater distances. Coevolution between hard-fruited palms such as babassu and large Pleistocene mammals such as mastodonts and gomphotheres seems likely (Janzen and Martin 1982), but a paucity of paleontological evidence makes it impossible to assess the potential contribution of these now extinct animals to the current distribution of Orbignya phalerata.

Markley (1971) argued convincingly that this species (which he referred to as Orbignya speciosa (Mart.) Barb. Rodr.) originated on the Central Brazilian Shield, a major center of diversity for the entire Attalea alliance (Glassman 1977a, 1977b, 1978a, 1978b). Since its origin during the Precambrian, the Brazilian Shield has undergone considerable erosion by numerous river systems. With few exceptions (discussed below), populations of O. phalerata from eastern Bolivia to the eastern portions of the Amazon Basin are connected by watersheds to the Brazilian Shield. Throughout its range, O. phalerata is largely confined to floodplains, river valleys, and former deltas, which lends support to the idea of dissemination by rivers. Although their high specific gravity (ca. 1.4 g fresh weight/cm^3) prevents the fruits from floating, they can be carried considerable distances by runoff and rivers in flood (Anderson and Anderson 1983).

There are three important exceptions to the links between the Brazilian Shield and the present range of Orbignya phalerata. The first is its disjunct occurrence in Surinam (fig. 3). Until the early Pleistocene, the eastern portions of the Brazilian and Guayana Shield were connected, which probably accounts for the close floristic ties between the two regions (Maguire 1970). The Guianas represent a second center of diversity of the entire Attalea alliance (Wessels Boer 1965).

A second exception is the occurrence of O. phalerata in the Brazilian states of Maranhão and Piauí (figs. 1, 3). Markley (1971) suggested that the Tocantins River may have once served as a link for dissemination of the palm to these states. The Tocantins has its headwaters in the Brazilian Shield and presently drains into the Amazon River. During the Cretaceous, however, it may have flowed across the northern part of Maranhão into the Atlantic and built up the huge delta that presently covers most of the northern third of the state. It seems unlikely that this delta could have been built by the relatively insignificant rivers of Maranhão that exist today (Pindaré, Mearim, Itapecuru, and Parnaíba), most of which have their headwaters only a short distance from the delta. Uplift of the Serra do Gurupí in western Maranhão (probably during the lower Tertiary) may have forced the Tocantins to change to its present course.

A final anomaly in the distribution of O. phalerata is its disjunct occurrence in the Brazilian state of Ceará (figs. 1, 3). Here the palm is confined to isolated and geologically very old uplifts, which are not connected by river systems with the Central Brazilian Shield. These uplifted areas have long served as favorable sites for human settlement and agriculture, due to their relatively cool temperatures, high rainfall,

and fertile soils. Markley (1971) argued that babassu's occurrence in Ceará is due to dissemination by humans from the Parnaíba valley 200-300 km distant.

Hybridization and intrinsic genetic variation The results of our study show that both *Orbignya phalerata* and *O. oleifera* each appear to have a strong propensity to hybridize. Probably as a result, both species exhibit high morphological variability.

In at least one character, this can be attributed to intrinsic genetic factors unrelated to hybridization, as illustrated in a comparison of the distribution of androgynous (but functionally female) inflorescences per palm in six populations of babassu (fig. 7). Five of the six sites represented populations of *O. phalerata*; the southerly site represented a population of *O. oleifera*. Despite a wide range of ecological conditions, the four contigous populations in Maranhão (forest and pasture at Lago Verde, wet site at Pindaré Mirím, and dry site at Caxias) showed no differences in the distribution of female inflorescences per palm, according to the Kolmogorov-Smirnov Test (Siegel 1956). However, distributions in the two geographically disjunct populations (northerly site in Goiás and southerly site in Minas Gerais) were significantly different from the first four populations, as well as from each other ($p \leq .01$ in all cases). These results suggest that the distribution of female inflorescences per palm in populations of babassu is governed by genetic factors.

Characteristics unique to the population of *Orbignya oleifera* in Pirapora, Minas Gerais, could have important implications for genetic improvement of babassu. The exceptionally high percentage of female (i.e.

fruit bearing) inflorescences in this population results in high fruit production, estimated at approximately 5 or more tons per hectare (Balick, unpublished data), compared to mean yields of ca. 1.5 ton per hectare for O. phalerata in Maranhão (STI 1979). In addition, kernels account for up to 18% of total fruit weight in the O. oleifera population (J. M. F. Frazão, pers. comm.), compared to a mean 7% in O. phalerata (see fig. 2). As a result, kernel and consequently oil yields of O. oleifera are potentially many times those of O. phalerata. Merely introducing the former into plantations could thus produce significant increases in yields, even in the absence of further selection or subsidies such as fertilizers and pesticides. In addition to higher yields, apparently precocious individuals have been observed that could attain maturity far more rapidly than the estimated minimal time span of 12 years usually required by babassu palms growing on open sites. One of the putative hybrids of babassu, the so-called Orbignya teixeirana (Appendix 2), is tolerant of soils that are infertile and relatively dry. While collecting taxonomic specimens, seeds from promising individuals and/or from representative populations have been obtained and subsequently introduced into babassu germplasm banks administered by the Centro Nacional de Recursos Genéticos (CENARGEN).

CONCLUSION

Coupling of taxonomic and agronomic research on babassu has provided a basis for genetic improvement of the complex. The direction that this improvement takes will probably be determined by babassu's unique characteristics. Because of its wide adaptability and capacity to form high density stands with little or no intentional human effort, the

babassu complex appears to be especially promising for extensive land use systems rather than intensive plantations, at least within its native range.

Elucidating precise relationships on the species level is the greatest challenge facing palm taxonomists today (Tomlinson 1979). Although babassu is singular in its capacity to dominate the landscape, we suspect that its high morphological, intraspecific variability will prove to be a common theme in groups of palms currently thought to be comprised of many species. In economic palms such as babassu, this variability provides a unique opportunity for combining basic and applied research, which can lead to deeper insight concerning the biology and utilization of these poorly known plants.

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PUBLICATION					
B. Rodrigues 1903	Burret 1929	Burret 1932	Burret 1938	W. Boer 1965	Glassman 1977a
.. = O. speciosa[1]	.....	O. barbosiana	.....	= A. speciosa...	= O. barbosiana
.....					
... = O. speciosa[1]	....= O. martiana	.....	= O. oleifera	.....	= C. barbosiana
= O. speciosa[1]..	= O. dammeriana...	= O. cohune	.....		Confused name
Described.....	Part = O. martiana	.....Part = O. barbosiana	... Part = O. oleifera	..... = A. speciosa ..	= O. barbosiana
	Described	.....		= A. speciosa...	= O. barbosiana
	Described	.....			Uncertain species
		Proposed	.....	= A. speciosa...	= O. barbosiana
		Described	.....		= O. barbosiana

speciosa Barb. Rodr., a name currently reduced to synonymy under O. cohune (C. Martius) Dahlgren ex Standley.

Table 2. A selective morphological comparison of *Orbignya phalerata* C. Martius and *O. oleifera* Burret.

Character	*O. phalerata*	*O. oleifera*
LEAF		
Abaxial Surface of Leaf		
-texture	smooth to moderately lepidote	densely lepidote
-yellow striations	usually present	rarely present
Petiole		
-length in adults (cm)	8-42	0-10
Pinnae		
-angle of insertion at middle of rachis	ca. 75-90°	ca. 45-60°
-thickness of midvein at base of middle pinnae (mm)	ca. 1.5	ca. 2.2
-adaxial surface	lustrous	glaucesent
-firmness	rigid to slightly pliant at tips	very rigid throughout
INFLORESCENCE		
Peduncular Bract		
-longitudinal invagination	absent	present
Staminate inflorescences	present in all adults (no adults with exclusively androgynous inflorescences)	present in most adults (some with exclusively androgynous inflorescences)
Androgynous Inflorescence		
-length of bract subtending rachilla (mm)	2-14	50-60
-length of rachilla (cm)	10-24	2-3
-bracteoles subtending pistillate flowers		
number	1-3	1
length (mm)	ca. 2	8-30
STAMINATE FLOWERS		
Number of Stamens	(21)24-26(30)	28-32(37)
FRUIT		
Color at Maturity	rust-brown, apex grayish	brown-yellow, apex brownish
Thickness of mesocarp (mm)	2-12	1-2

Appendix 1. A selective morphological comparison of *Orbignya phalerata*, *Maximiliana maripa*, and the putative hybrid, *Markleya dahlgreniana*.

Character	*O. phalerata*	Hybrid	*M. maripa*
LEAF			
Arrangement of Leaf Bases	spiralled	spiralled, in 5 vertical rows	spiralled in 5-7 vertical rows
Sheath			
-length in adults (cm)	560-860	603-817	420-490
-abaxial surface	usually with pronounced striations	usually with faint striations	without striations
Petiole			
-length in adults (cm)	8-42	64-110	90-240
Pinnae			
-number per side	156-208	208-264	209-473
-orientation	in same plane	in same plane to moderately crispate	crispate
-arrangement	regular	in groups of (1)2-5	in groups of (2)3-7(14)

Character	*O. phalerata*	Hybrid	*M. maripa*
STAMINATE INFLORESCENCE			
Peduncular Bract	slightly curved	moderately curved	strongly curved
Rachilla			
-length of subtending bract (mm)	0.5-6.0	1.5-2.5	0.5-1.0
-number of subtending bracts	17-102	142-190	107-273
-arrangement of staminate flowers	in longitudinal rows on abaxial side	in irregular rows on abaxial side	spiralled
ANDROGYNOUS INFLORESCENCE			
Rachilla			
-length (cm)	10-24	10-15	10.5-14.5
-length of subtending bract (mm)	2-14	3-4	6-12
-number of pistillate flowers per rachilla	1-2(3)	2.5	4-9
STAMINATE FLOWERS			
Sepals			
-shape	lanceolate to deltate	deltate	triangular
-length (mm)	0.8-2.5	0.6-1.2	0.4-1.5
-width (mm)	0.6-2.3	0.5-0.7	0.3-1.0
Petals			
-number	2(3)	3(-7)	3
-orientation	incurved	slightly incurved	straight
-length (mm)	9.5-16.9	3.4-6.8	2.1-3.7

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Appendix 1 (continued).

Character	*O. phalerata*	Hybrid	*M. maripa*
Stamens			
-number	(21)24-26(30)	6-11	6(8)
-orientation of thecae	irregularly coiled and twisted	straight to irregularly coiled and twisted	straight
PISTILLATE FLOWERS			
Corolla			
-length of sepals (cm)	2.8-4.1	1.9-2.5	1.2-1.5
-length of petals (cm)	2.3-5.0	2.5-3.0	1.8-2.3
FRUIT			
Shape	broadly elliptic to oblong	elliptic	elliptic to ovate
Length (cm)	6.6-12.5	6.5-7.0	4.0-4.5
Width (cm)	3.7-9.9	3.2-3.8	2.4-2.6
Length of Calyx (cm)	3.8-5.8	3.5-4.5	ca. 2.5
Length of Staminodial Tube (cm)	2.0-4.0	1.2-1.5	ca. 0.5
Thickness of Epicarp (mm)	1.0-4.0	1.0-1.5	0.5-0.8
Thickness of Mesocarp (mm)	2.0-12.0	2.5-3.0	0.5-1.5
Consistency of Mesocarp	mealy, dry	slightly oily	oily
Diameter of Endocarp (mm)	35-76	21-27	18-24

Appendix 2. A selective morphological comparison of *Orbignya phalerata*, *O. eichleri*, and their hybrid, *O.* × *teixeirana*.

Character	*O. phalerata*	Hybrid	*O. eichleri*
STEM			
Length in Adults (cm)	500-3,000	0-800	0
Diameter (cm)	19-50	19-42	0
LEAF			
Number per Palm	10-25	8-13	3-8
Sheath			
-length in adults (cm)	40-120	30-100	20-33
-striations on abaxial surface	generally present	present or absent	absent
Petiole			
-length in adults (cm)	8-42	17-80	30-80
Rachis			
-cross section in middle	4-sided	4-sided	triangular
-abaxial surface	weakly to strongly lepidote	weakly lepidote	smooth
Pinnae			
-number per side	156-208	96-190	63-128
-orientation	in same plane	in same plane to crispate	crispate
-disposition	regular	clustered to regular	clustered
-adaxial surface	dull to lustrous	dull	dull
-abaxial surface	weakly glaucous	weakly glaucous to smooth	mostly smooth

Appendix 2 (continued).

Character	O. phalerata	Hybrid	O. eichleri
INFLORESCENCE			
Bracts			
-length of prophyll (cm)	50-150	30-33	20
-length of acumen of peduncular bract (cm)	16-40	3-20	3-12
-abaxial surface of peduncular bract	tan to rust-brown	blood red	blood red
Peduncle			
-length (cm)	56-180	37-95	5-37
-curvature	not recurved	weakly to strongly recurved	strongly recurved
Rachilla			
-number on staminate inflorescence	277-401	41-50	15-35
-number on androgynous inflorescence	323-475	20-70	10-20
-attachment to rachis	throughout	on abaxial side only	on abaxial side only
-length of subtending bract (mm)	0.5-14	0.5-30	1.0-45
Staminate Flowers			
-stamens per flower	(21)24-26(30)	(18)20-25(26)	14-18(20)
Pistillate Flowers			
-length of sepals (mm)	2.8-4.1	2.4-3.5	1.9-3.5
-length of petals (mm)	2.3-5.0	2.2-3.4	1.3-2.8
FRUIT			
Weight (g)	40-410	18-210	10-50

-422'

Appendix 3. A selective morphological comparison of *Orbignya oleifera*, Burret, *Attalea compta* C. Martius, and their putative hybrid.

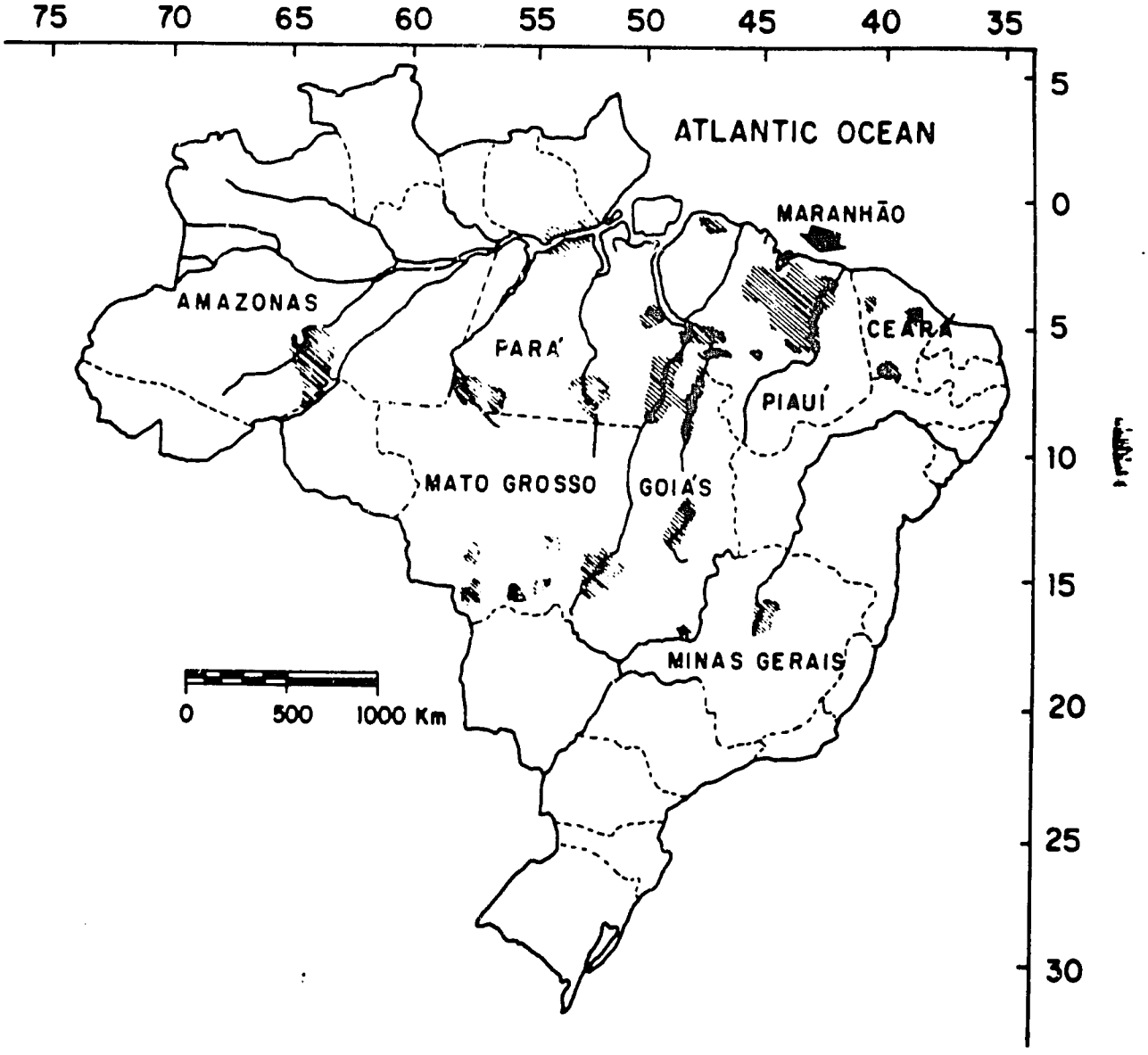
Character	*O. oleifera*	Hybrid	*A. compta*
STEM			
Diameter (cm)	31-53	35-40	20-32
LEAF			
Length of Petiole (cm)	0-10	5-10	10-20
Arrangement of Pinnae	regular except at extreme base of rachis	regular except at base of rachis	regular except at basal meter of rachis
Length of Rachis (cm)	625-750	537-550	413-657
INFLORESCENCE			
Length of Acumen on Peduncular Bract (cm)	28-52	17-20	13-33
ANDROGYNOUS INFLORESCENCE			
Rachilla			
-length (cm)	2-3	9-12	5-15
-position of pistillate flowers	0-2 cm above insertion on rachis	2.5-4 cm above insertion on rachis	ca. 5 cm above insertion on rachis
STAMINATE FLOWER			
Corolla			
-texture of sepals	membranous to coriaceous	membranous to slightly coriaceous	membranous
-number of petals	2(3)	(2)3	3
-shape of petals	narrowly elliptic to ovate	narrowly elliptic to ovate	lanceolate

Appendix 3. (continued).

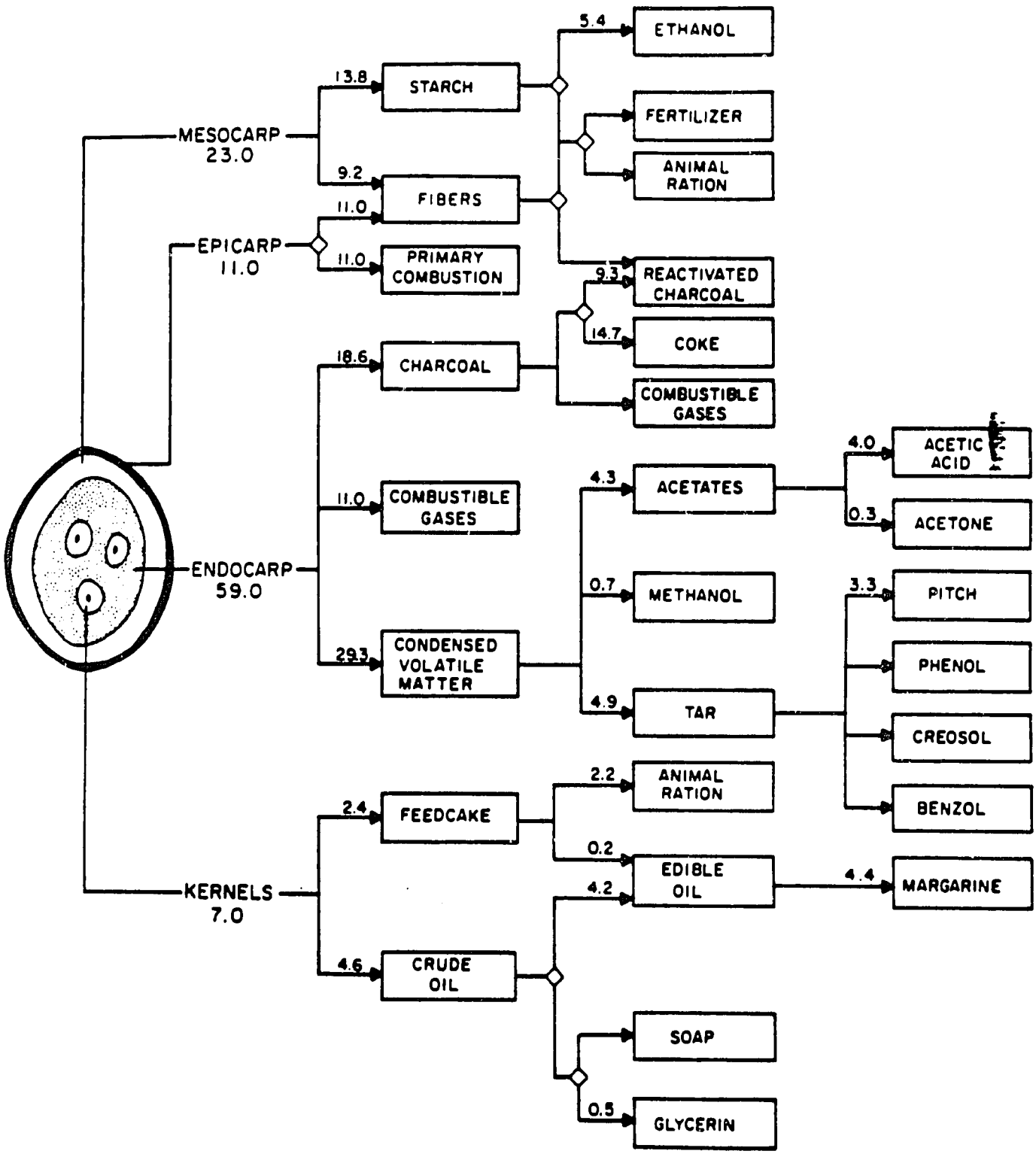
Character	*O. oleifera*	Hybrid	*A. compta*
Stamens			
-number	28-32(37)	11-20	11-12
-attachment of thecae to filaments	at midpoint	almost throughout length	throughout length
-orientation of thecae	irregularly twisted and coiled	more or less straight to twisted and coiled	straight
FRUIT			
Length (cm)	13-14	9.2-10.0	7.8-9.4
Width (cm)	7.5-8.0	4.3-6.7	4.9-5.3
Shape	broadly elliptic to oblong	elliptic	obovate
Dry Weight (g)	152-404	110-176	76-96
Channelling on Surface	absent	moderate	pronounced
Maximum Length of Calyx (cm)	7.0-7.5	5.2-7.2	4.0-5.0
Color of Mesocarp	white	yellow	orange
Consistency of Mesocarp	dry	dry to oily	oily
Diameter of Endocarp (cm)	5.1-7.6	4.0-5.2	3.7-4.1

Figure Legends

1. Approximate distribution of high-density stands of babassu (*Orbignya* spp.) in Brazil. States containing stands are labelled. Adapted from Anonymous (1981).
2. Flowchart of products derivable from babassu via current technology. Diamonds represent "either-or" options. Numbers are percentages of fruit weight. Adapted from Abreu (1940), Viveiros (1943), Escola Técnica Federal do Maranhão (1976), IPT (1979), and Mendes and Carioca (1981).
3. Distribution of specimens of the babassu complex examined in this study.
4. *Orbignya phalerata* C. Martius (*M. J. Balick et al. 1392*) from Ascención, Bolivia.
5. *Orbignya oleifera* Burret (*M. J. Balick et al. 1684*) from Pirapora, Minas Gerais, Brazil.
6. A comparison of fruit cross-sections in *Orbignya oleifera* (left) *M. J. Balick et al. 1684*) and *O. phalerata* (right) (*M. J. Balick et al. 1677*). Note striking difference in thickness of mesocarp.
7. Distributions of female inflorescences per palm in six populations of babassu in Brazil. Forest and pasture site = Lago Verde, Maranhão; wet site = Pindaré Mirím, Maranhão; dry site = Caxias, Maranhão; northerly site = Tocantinópolis, Goiás; and southerly site = Pirapora, Minas Gerais. N = number of palms observed per site. Source: Anderson and Anderson (1983).



Anderson & Balick Fig. 1


MESOCARP
23.0
EPICARP
11.0
ENDOCARP
59.0
KERNELS
7.0
13.8
STARCH
9.2
FIBERS
11.0
11.0
PRIMARY COMBUSTION
18.6
CHARCOAL
11.0
COMBUSTIBLE GASES
29.3
CONDENSED VOLATILE MATTER
2.4
FEEDCAKE
4.6
CRUDE OIL
5.4
ETHANOL
FERTILIZER
ANIMAL RATION
9.3
REACTIVATED CHARCOAL
14.7
COKE
COMBUSTIBLE GASES
4.3
ACETATES
0.7
METHANOL
4.9
TAR
2.2
ANIMAL RATION
0.2
EDIBLE OIL
4.2
SOAP
0.5
GLYCERIN
4.0
ACETIC ACID
0.3
ACETONE
3.3
PITCH
PHENOL
CREOSOL
BENZOL
4.4
MARGARINE

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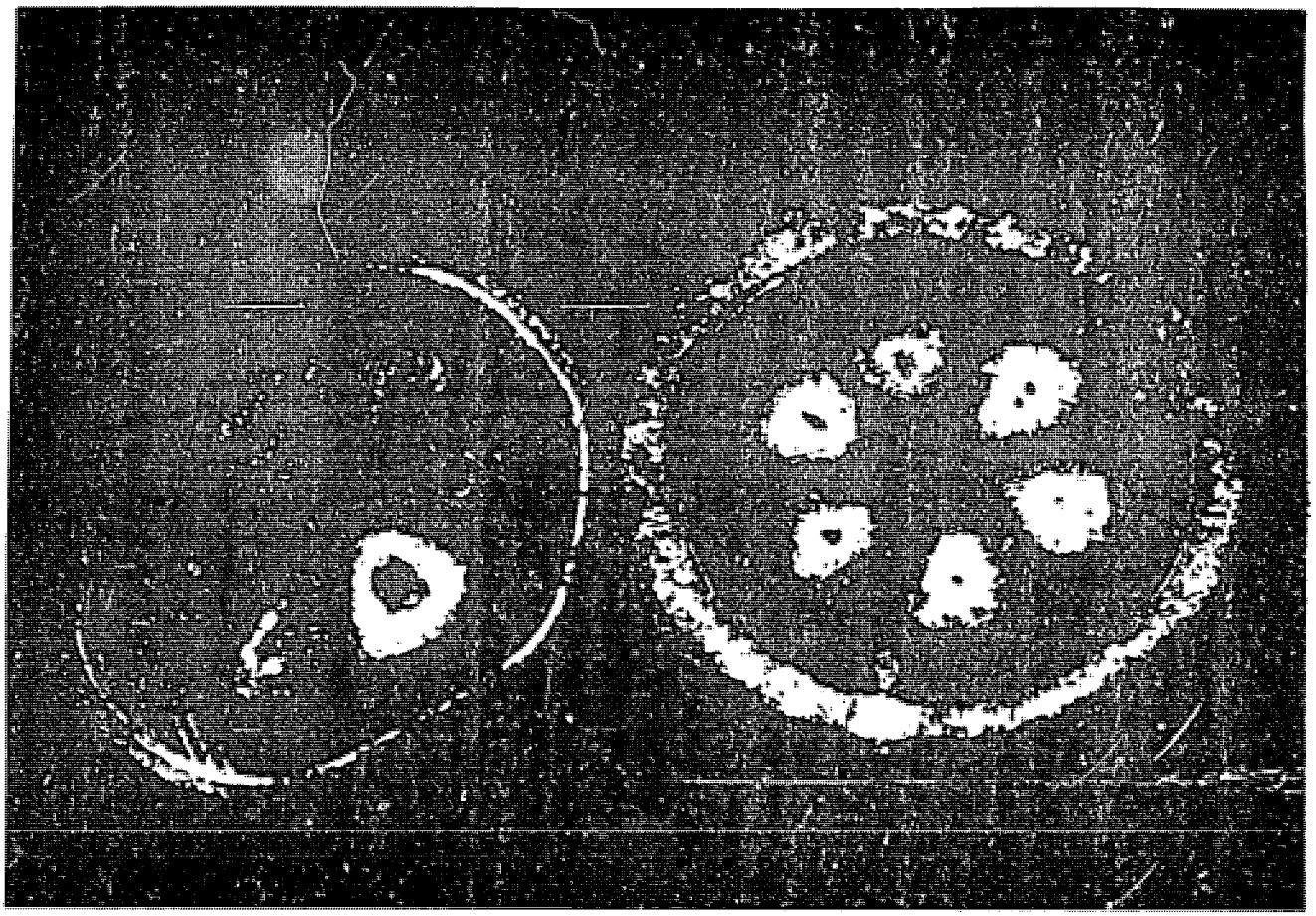
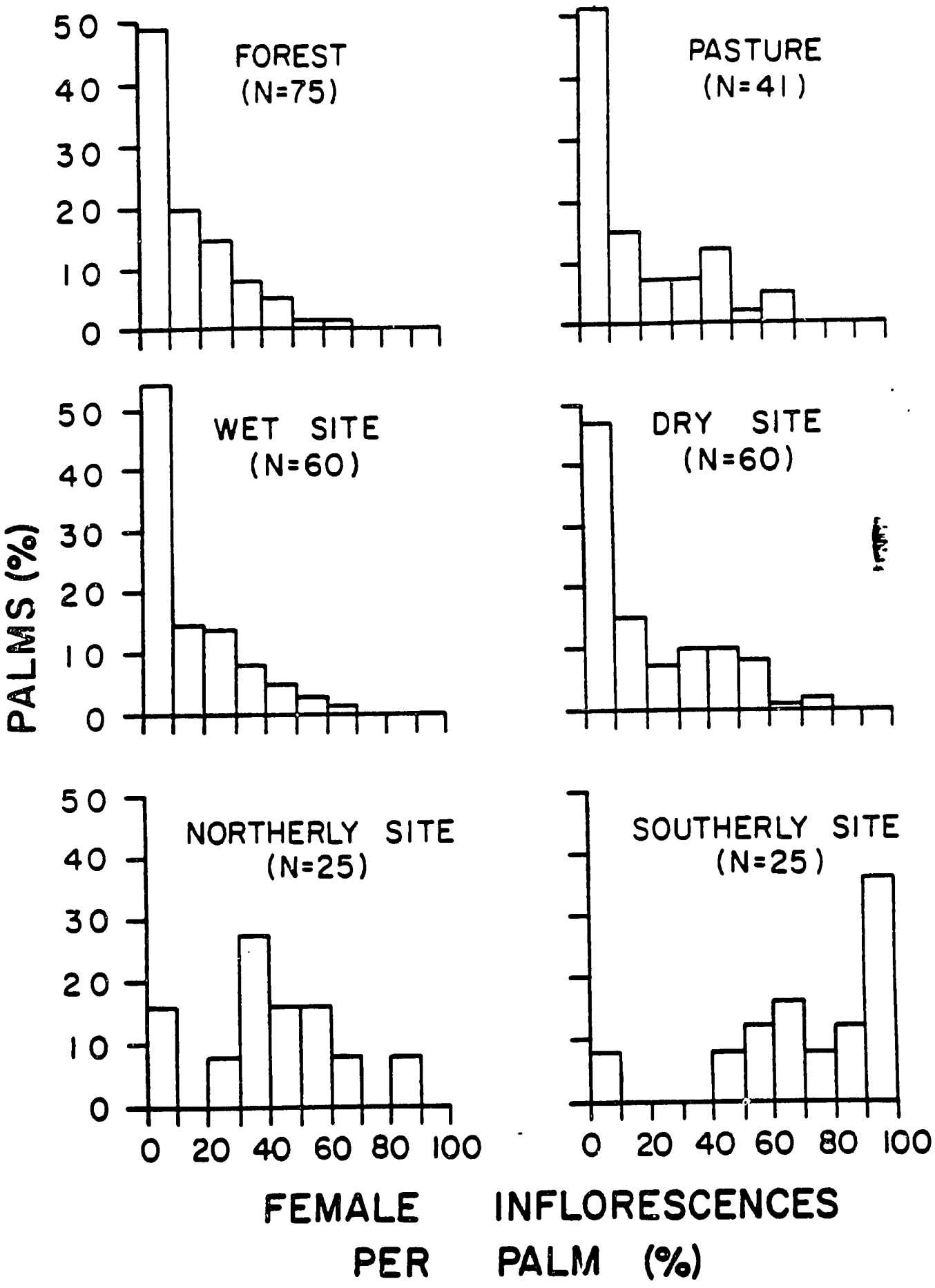
Orbignya phalerata
O. oleifera
Orbignya x teixeirana
Markleya
Orbigyna x Attalea
80
70
60
50
40
30
20
10
0
10
20
30

Anderson & Balick Figs. 4,5



Anderson & Pollick Fig. 6


FOREST
(N=75)
PASTURE
(N=41)
WET SITE
(N=60)
DRY SITE
(N=60)
NORTHERLY SITE
(N=25)
SOUTHERLY SITE
(N=25)
PALMS (%)
0
10
20
30
40
50
0 20 40 60 80 100
FEMALE INFLORESCENCES
PER PALM (%)

APPENDIX VIII

Report from Twyford Plant Laboratories

Section 1

Electron microscope studies of

ORBIGNYA SPECIOSA

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Electron microscope studies of *Orbignya speciosa*

Introduction

During initial attempts to excise zygotic embryos from the seed of *Orbignya*, the embryos were contaminated by accident. Since these embryos could not subsequently be used in culture they were prepared for scanning electromicrography.

The following electronmicrographs are of interest since they provide morphological detail not easily discerned with the naked eye.

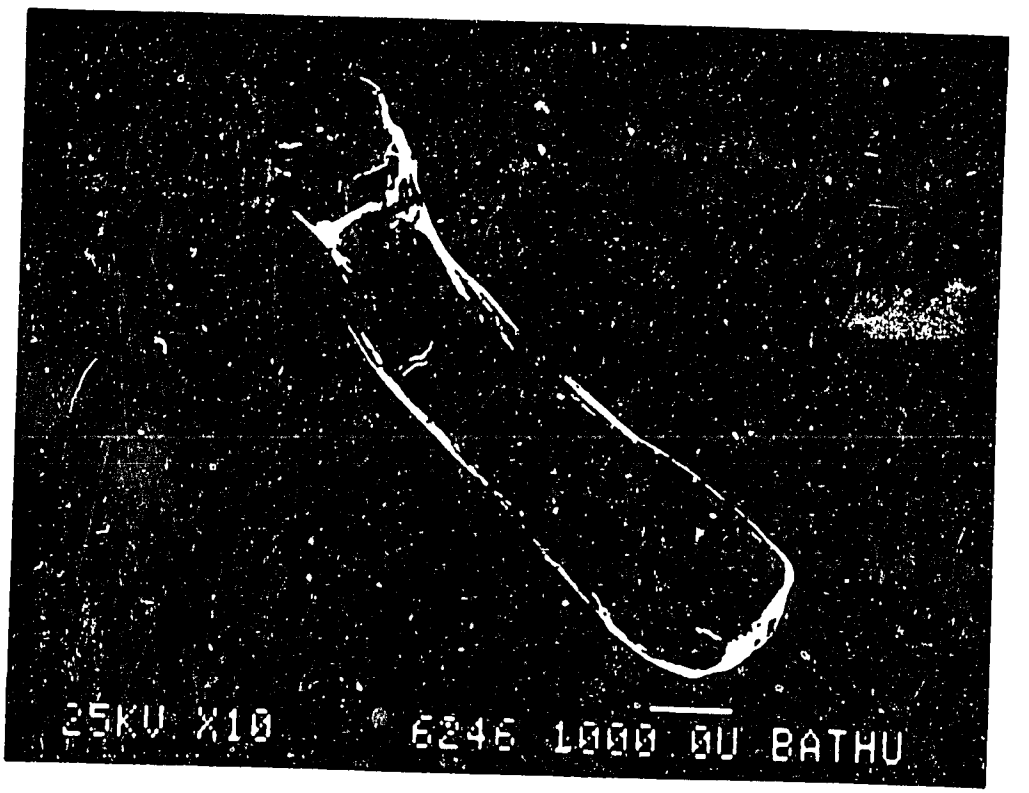

Plate 1: Entire zygotic embryo of *Orbignya speciosa* showing root pole end at the top of the photograph and haustorium at the bottom. The haustorium has collapsed, probably due to dehydration.

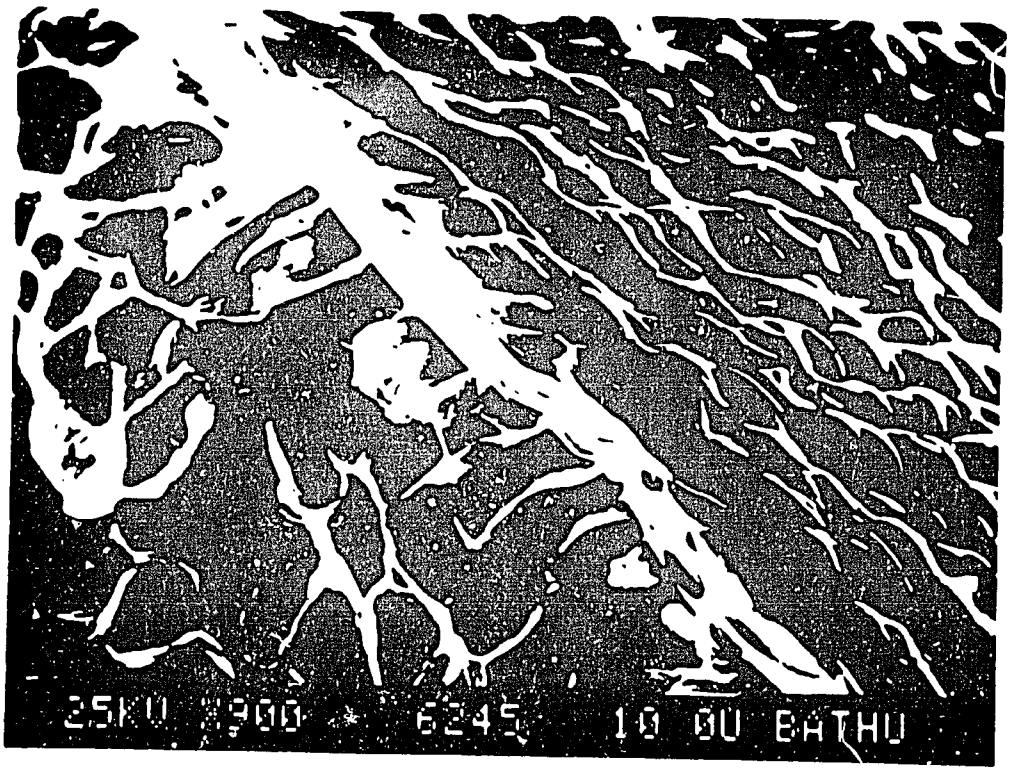

Plate 2: Broken edge of the embryo, revealing internal structure and cuticle

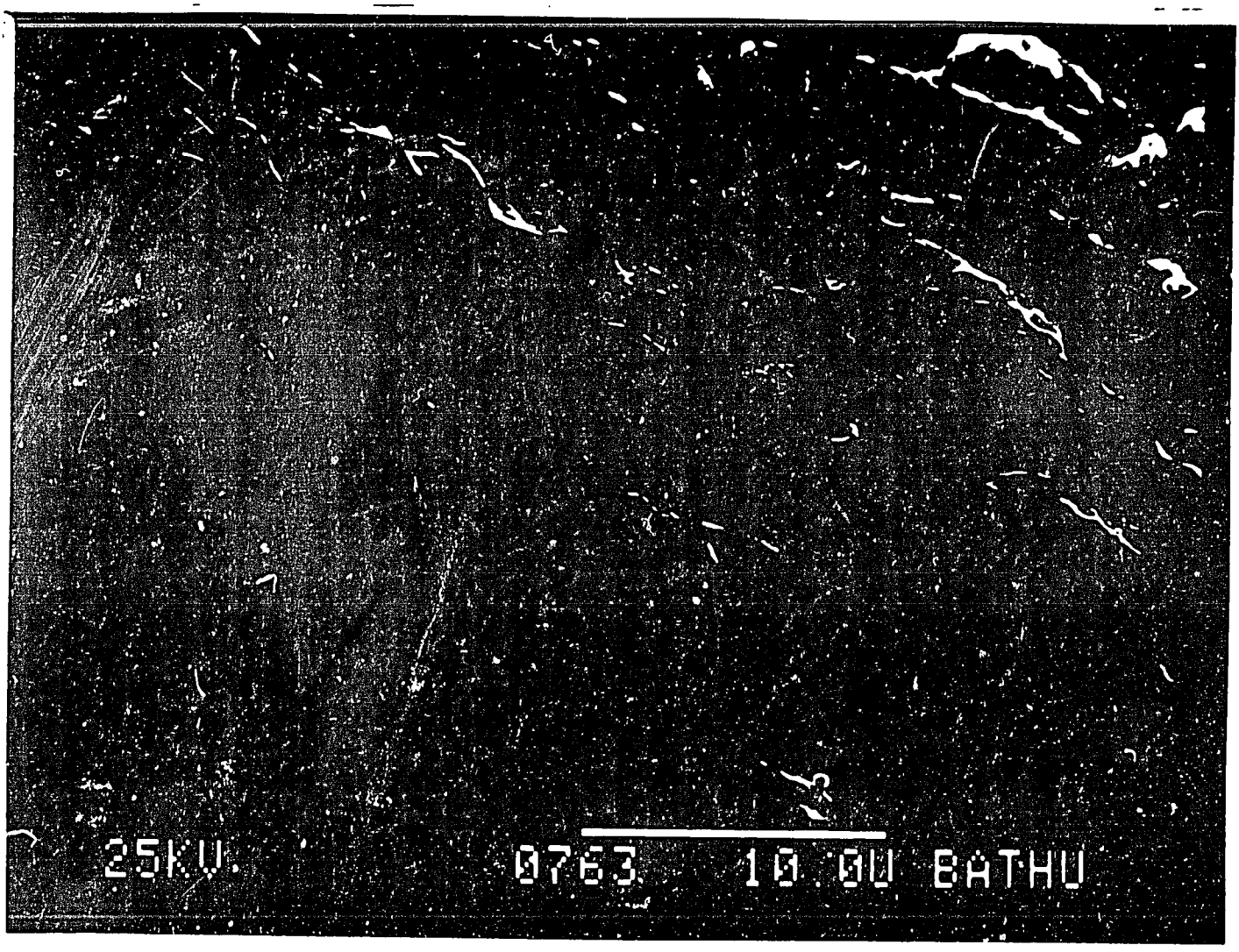

Plate 3: Cuticle surface of zygotic embryo of *Orbignya*. There are very few waxy bodies present on the cuticle surface, this is typical of an embryo of a tropical tree species which is characteristically dessication sensitive. Since under normal conditions, the seed will develop and germinate in a tropical forest environment of high rainfall, it has no requirements for a thick waxy cuticle. It has also not developed a dessication tolerant physiology for the same reason. This has implications in its cryopreservation as discussed in Section 3.

SECTION 2

Somatic Embryogenesis of *ORBIGNYA SPECIOSA*

Somatic embryogenesis of Orbignya speciosa

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1.3 Callus induction	5
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Somatic Embryogenesis of *Orbignya speciosa*

Abstract

Excised zygotic embryos of *O. speciosa* have been successfully induced to produce somatic embryos.

1. MATERIALS AND METHOD

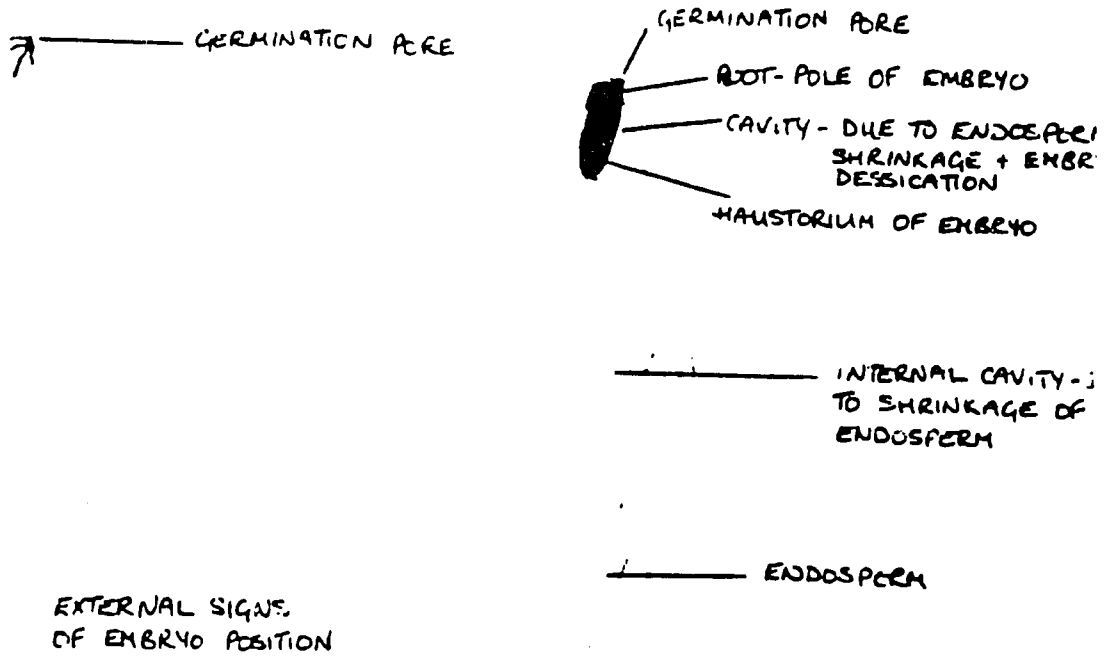
1.1 Surface sterilisation

Seeds were agitated for five minutes in full strength Sodium hypochlorite (12% a.i.) with 1 drop of wetting agent per 100ml of solution. This was followed by dipping in alcohol and flaming the seed.

1.2 Excision of Embryo

The embryo is positioned at the narrow end of the seed (Fig. 1). The root pole is just below the surface; its position is clearly indicated by a pore which is slightly raised at the surface.

Fig. 1



Position of embryo within the seed

Four seeds were devoted to the somatic embryogenesis programme. The seed was hand held at the end opposite the embryo, and the testa was carefully sliced away with a sterilised scalpel to expose the embryo. Most embryos were easily removed, once sufficient endosperm was cut away, by tapping the seed because the embryo had shrunk and was contained in a cavity in the endosperm.

1.3 Callus induction

Of the four seeds in the somatic embryogenesis programme, two were cut in half in an attempt to increase the number of cultures to six.

Proliferation media contained:
Murashige and Skoog salts
100 mg/l 2,4-D
2.5 mg/l 2iP
3 g/l activated charcoal

2. RESULTS

Within two weeks, zygotic embryos had swollen and turned a creamy yellow colour (except for one haustorium-end segment).

By the third week there was definite callus production at the root-pole ends of whole embryos and half segments, as well as some callus at the cut ends of segments.

Callus was subcultured on lower levels of 2,4-D when the tissue hadjust begun to look "watery", *i.e.*, after about 35 days. This first subculture caused organisation to begin within the callus. Plates 1 to 5 show the development of somatic embryos.

3. DISCUSSION

It is possible to induce somatic embryos from zygotic embryos of *O. speciosa*. However, this zygotic material is heterogeneous. Successful cryopreservation of date palm somatic embryos suggests that this may be a useful means of genetic conservation for *O. speciosa*.

If somatic embryos are to become part of a production procedure for *O. speciosa* it is necessary to obtain apical meristems of suitable palms to produce clonal plants. This procedure is well documented for *Phoenix dactylifera* and may require only slight modifications for *Orbignya*

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Plate 1: Secondary Callus

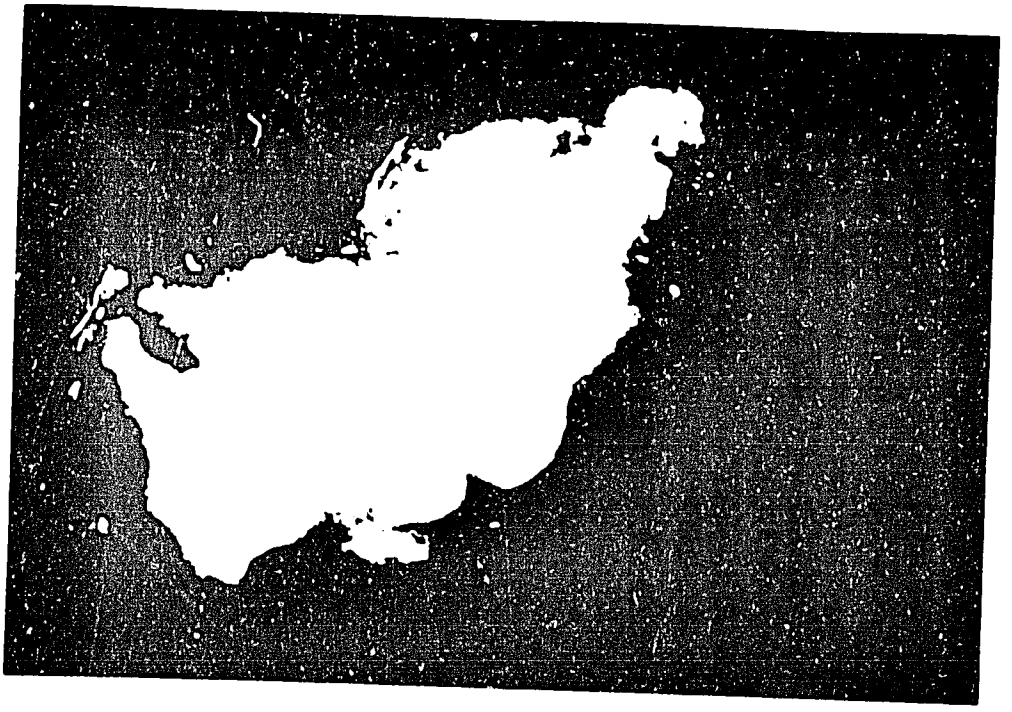

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Plate 2: Early Embryogenic callus

(mag 9.9x)

Plate 3a: Early embryogenic callus

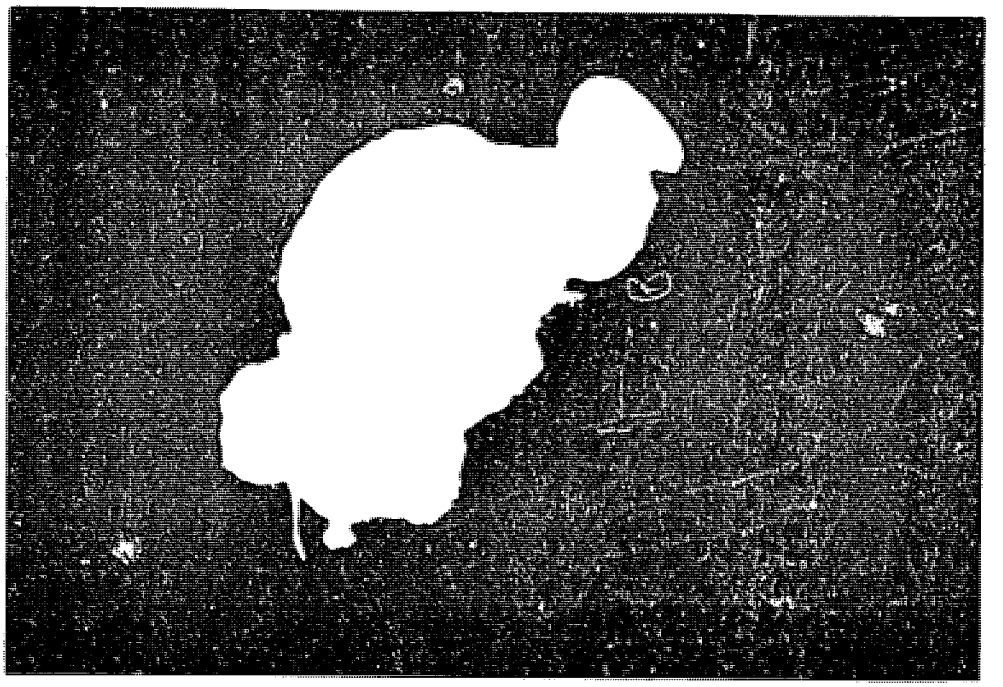

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Plate 3b: Early embryogenic callus

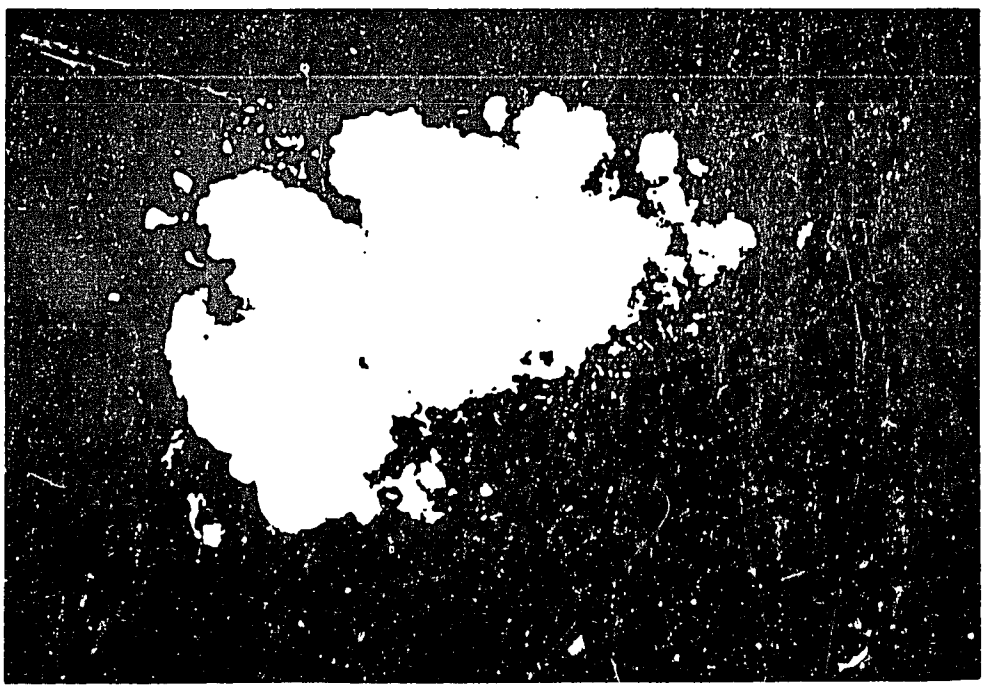

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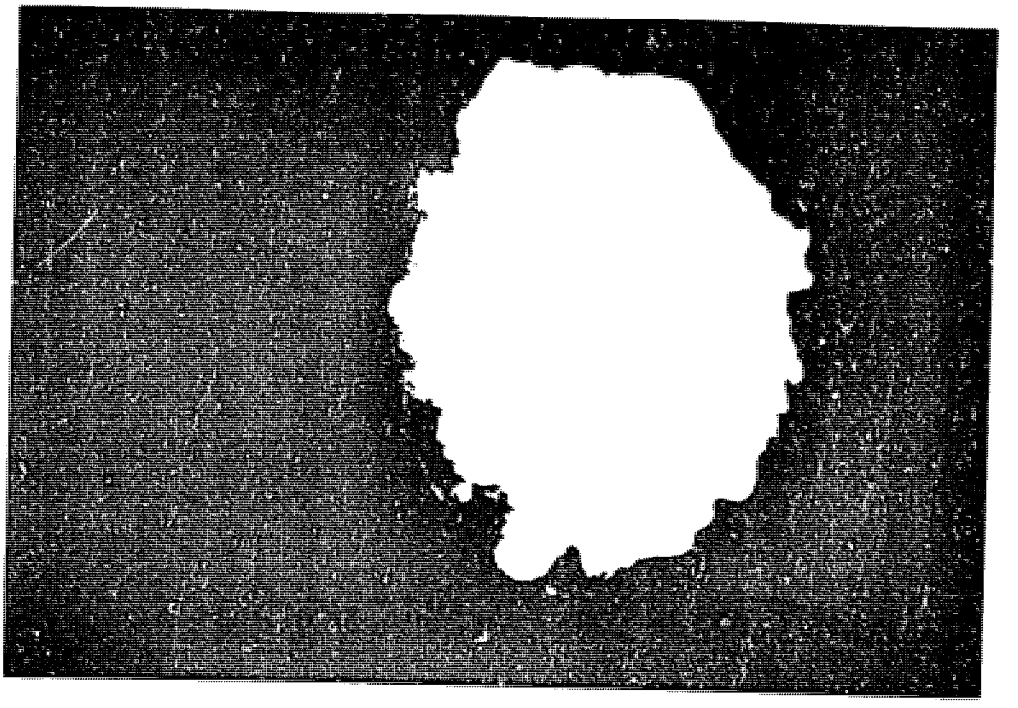
Plate 4: Early embryogenic callus showing globular embryos



(mag 9.9x)

Plate 5a: Germinating embryo

(mag 9.9x)

Plate 5b: Germinating embryo (close-up)

(mag 25.2x)

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SECTION 3

Cryopreservation of zygotic embryos and whole seed of *ORBIGNYA SPECIOSA*

Preliminary investigation of the cryopreservation protocol for *Orbignya speciosa* (Babassu palm)

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Preliminary investigation of the cryopreservation protocol for Orbignya speciosa (Babassu palm)

1. INTRODUCTION

The economic potential of babassu palm as a plantation crop has been reviewed (SHULTES 1979). The babassu fruit is produced abundantly, each palm yielding about 90 kg of kernels. Kernels contain up to 72% of an almost colourless oil which has uses similar to coconut oil, whilst the remaining seed-cake is composed of 27% protein and is of value as an animal feed.

Orbignya speciosa also grows wild over millions of acres of the Amazon Basin which makes germplasm collection for breeding programmes difficult. In addition, the seed is sensitive to dessication which makes conventional preservation impossible because this usually involves drying the seed. A stock of 20 seeds was obtained from New York Botanic Gardens and cryopreservation as a potential means of storage was assessed on a small scale.

Successful cryopreservation requires that material is frozen by one of two methods:- (a) ultra fast freezing to prevent the growth of large crystals within the cell, by direct immersion in liquid nitrogen (LN_2); or (b) in two stages, water being removed from the cells during the first stage (reducing the amount of water available for intra-cellular ice formation) before being immersed in LN_2.

Date palm seeds have been shown to survive cryogenic conditions following direct immersion in LN_2(MADENI and TISSERAT, 1986). A suggested protocol for two stage freezing of large tropical seeds has been proposed (KING and ROBERTS, 1979). The dilemma presented by two stage freezing is that it removes water from dessication-sensitive seeds. The degree of tolerance to dessication varies between species, varieties and even from seed to seed.

2. MATERIALS AND METHOD

2.1 Surface Sterilisation

Seeds (3) for whole-seed cryopreservation with cryoprotectant were sterilised by dipping in 70% ethanol and flaming. However, subsequent contamination was evident within 2 days of recovery of embryos from liquid nitrogen, hence the following experiments were preceded by more stringent sterilisation measures. The remaining seeds were agitated for 15 minutes in full strength sodium hypochlorite solution (12% available chlorine) containing 1 drop of Tween 20 per 100ml of solution. Seeds were then rinsed twice in sterile distilled water

and stored in disposable sterile jars before use. One embryo was excised and germinated successfully after surface sterilisation with full strength sterilant.

2.2 Cryopreservation of Whole Seed

2.2.1 Assessment of Embryo Quality

It was considered essential that a non-destructive means of assessing embryo quality be used to assist in the evaluation of whole seed cryopreservation experiments. X-ray radiography has been used to determine embryo quality (EL-LAKANY & HARIDI 1979; LONGDEN, JOHNSON and LOVE 1970) of *Auraucaria heterophylla*, leek and sugar beet seed, respectively.

An exposure of 3 milliamps at 15 K.V.P for 90 seconds was sufficient to produce a discernible image of the embryo and endosperm (Plate 1).

2.2.2 Cryopreservation of whole seed using Cryoprotectant

Seeds were imbibed in sterile water for 8 hours. Imbibed seeds were soaked in 10% (V/V) D.M.S.O. solution whilst being continuously aerated for 12 hours. Seeds were blotted free of superficial moisture and heat sealed inside a double layer tube of polythene (inner) and nylon (outer). Seed temperature was taken down to -51°C over a period of 10 hours in a controlled temperature methanol bath.

One seed was then thawed rapidly by immersion in sterile water at 35-40°C, the embryo excised under laminar flow conditions and placed on recovery media.

The remaining two seeds were removed as quickly as possible from the tubing, immersed in LN_2 and stored for 68 hours before rapid thawing.

All embryos were treated with 2% active sodium hypochlorite for 2 minutes, following signs of contamination after recovery from LN_2 and unsuccessful decontamination using 1% sodium hypochlorite for 30 seconds.

2.2.3 Cryopreservation of whole seed without cryoprotectant

Two seeds were enclosed in tubing as described above, and taken to -45°C in a methanol bath before immersion in LN_2.

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One seed was immersed directly in LN_2, where it exploded, releasing the embryo. All seeds were stored in liquid nitrogen for 18 hours before rapid thawing and excision of embryos. Excised embryos were immediately subjected to 2% active sodium hypochlorite for 5 seconds before planting on recovery media. This procedure has been used (TISSERAT 1979) successfully with date palm zygotic embryos which are difficult to de-contaminate.

2.3 Cryopreservation of excised embryos

Embryos were excised as described previously (see Somatic Embryogenesis).

Cryoprotectants:
(1) 10% DMSO (2 embryos)
(2) PGD (2 embryos)
(3) NO CRYOPROTECTANT (1 embryo)

Cooling rate:

(1) 1° per minute to $-45^{o}C$, followed by immersion in liquid nitrogen (10% DMSO + PGD)

(2) Direct immersion (no cryoprotectant)

Following freezing, embryos were thawed by immersing them in sterile warm water ($35-40^{o}C$) whilst frozen in the ampoules. Once thawed, embryos were dipped in 2% active sodium hypochlorite and planted on recovery media.

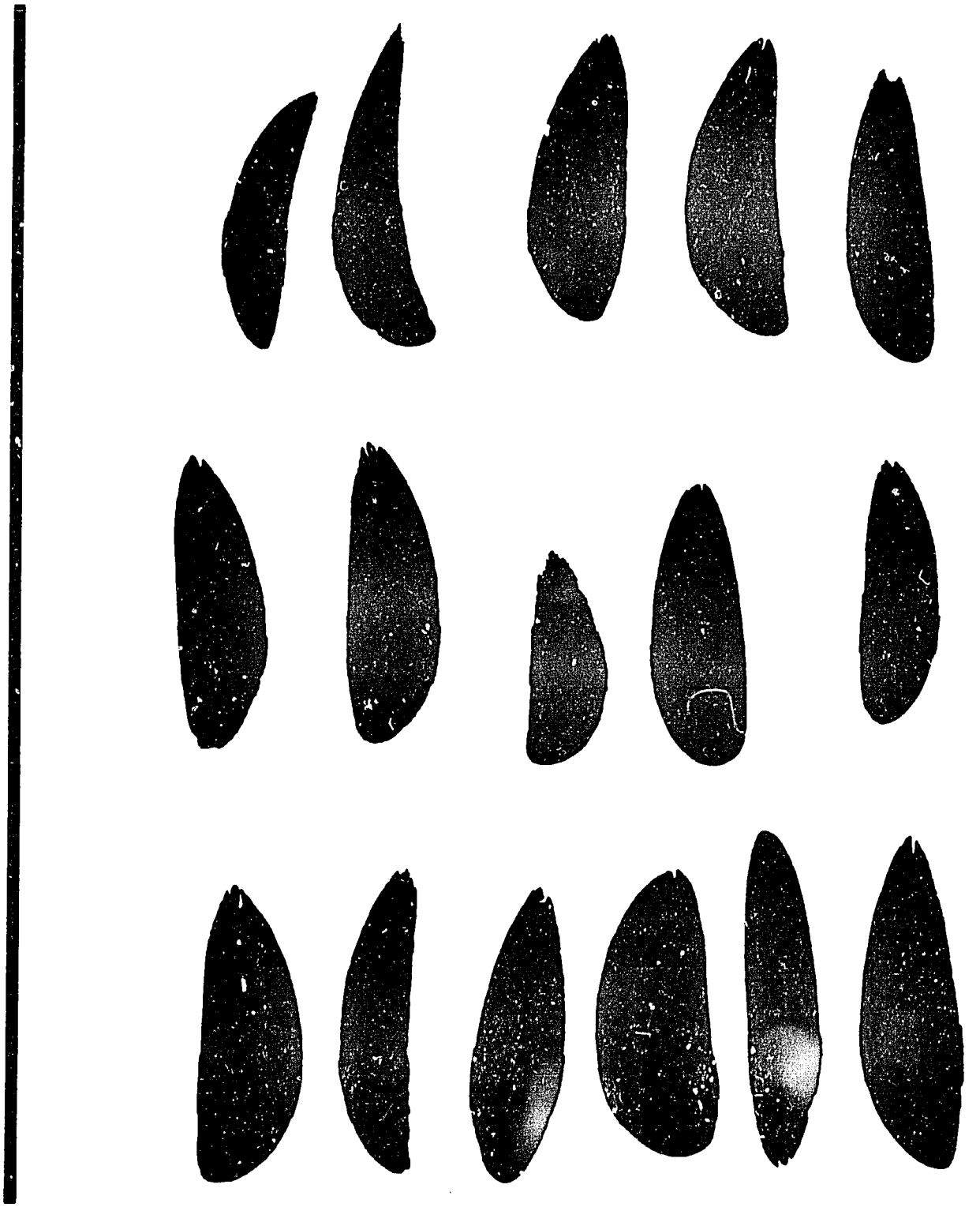
Two embryos which were excised and subjected to a pre-treatment phase on media containing 0.75M sucrose, developed excessive fungal growth within two days. These embryos had not been dipped in sodium hypochlorite solution prior to planting and the rapid fungal growth was an indication of the level of endogenous contamination in the seed. Hence other embryos were subjected to surface sterilisation as described above, before planting on recovery media.

3. RESULTS

Plates 1 - 5 show recovery from one embryo after immersion in liquid nitrogen. The only embryo to exhibit viability after freezing was the whole seed immersed in LN_2 without cryoprotectant, which exploded, as described above. The callus from the root pole of this embryo was sub-cultured onto media with a lower 2,4-D level and somatic embryos were induced after five months.

-450

Plate 1



Radiograph of *Orbignya* seed: Individual embryos are more easily discernable from the negative than the above photograph.

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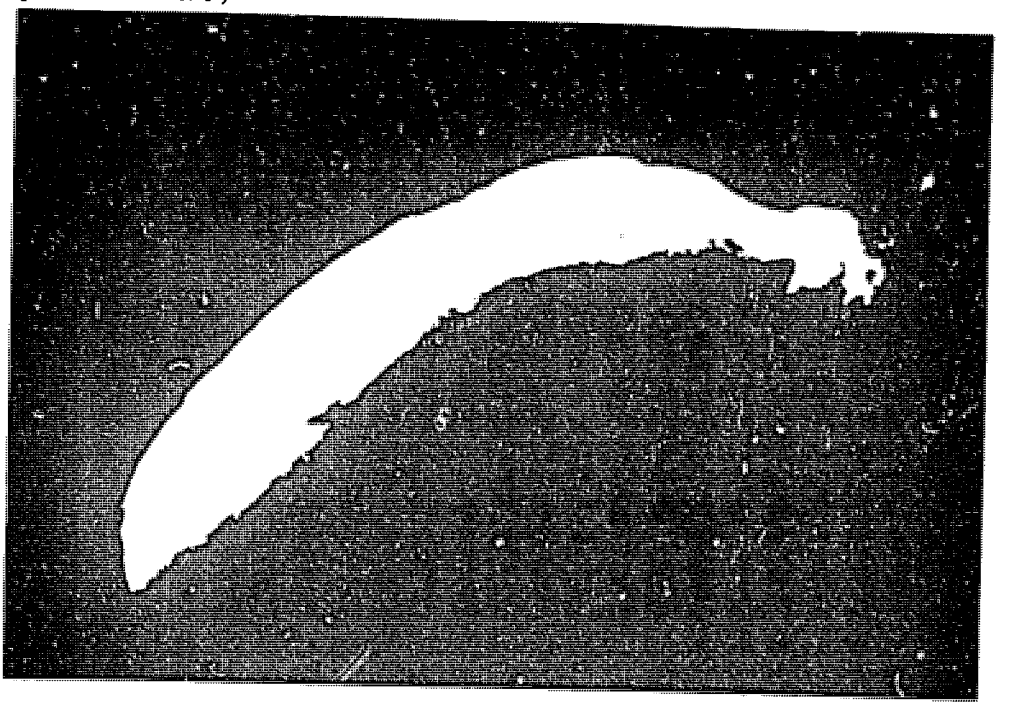
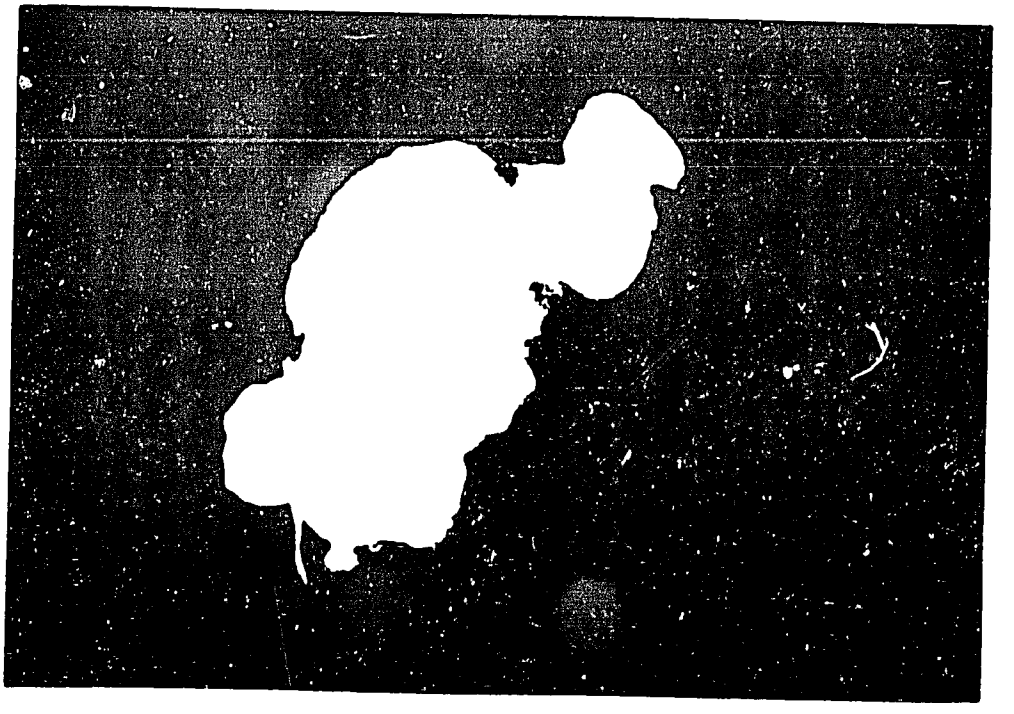
Plate 2: Callus proliferation at root pole of embryo recovered from LN_2 (whole seed [direct immersion] no cryo-protectant)



(mag 13x)

Plate 3: Callus sub-cultured onto lower 2,4-D media - somatic embryo



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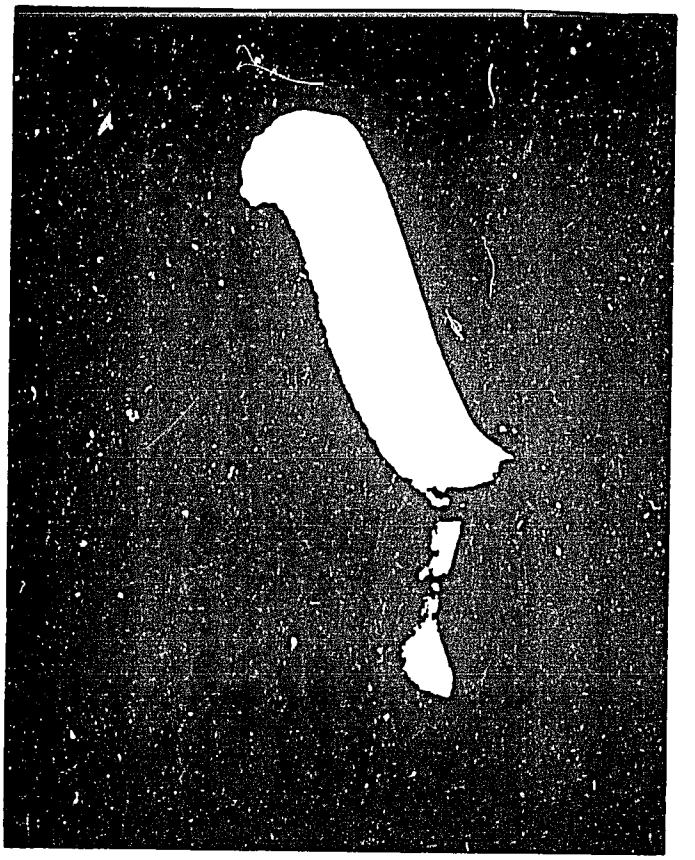
452

Plate 4: Whole embryo showing signs of colour change and enlargement after recovery from LN_2



(mag 13x)

Plate 5: Haustorium end of embryo - no colour change and a little enlargement

(mag 25.2)

Seeds varied in weight from 5.21g to 9.00g. Such a large variation in mass will result in different cooling rates within the seed. After excision of the embryos of these seeds, the endosperm was examined. Endosperm tissue differed in structure as shown in Plate 6 (overleaf).

4. DISCUSSION

A cryopreservation protocol is largely determined empirical by evaluating the optimum conditions for the following variables:

(a) type of experimental material (physiology and morphology

(b) pretreatments and cryoprotectants

(c) freezing rates

(d) thawing rates and recovery procedures.

The *Orbignya* seed stock was inadequate since it did not allow any replication within treatments. Often an interaction between variables such as freezing and thawing rates complicates the determination of an optimum protocol (WITHERS, 1979). It is necessary to have adequate plant material to explore all these interactions in order to obtain a satisfactory protocol for cryopreservation. This seed exploded on immersion in liquid nitrogen and the embryo was released into the LN_2 which makes the freezing rate of the embryo difficult to predict. Therefore, it may be difficult to repeat the result because the seed may have exploded due to a crack in the endosperm, allowing LN_2 to penetrate. However, it has been shown to be possible to recover viable material from whole seed immersed in LN_2.

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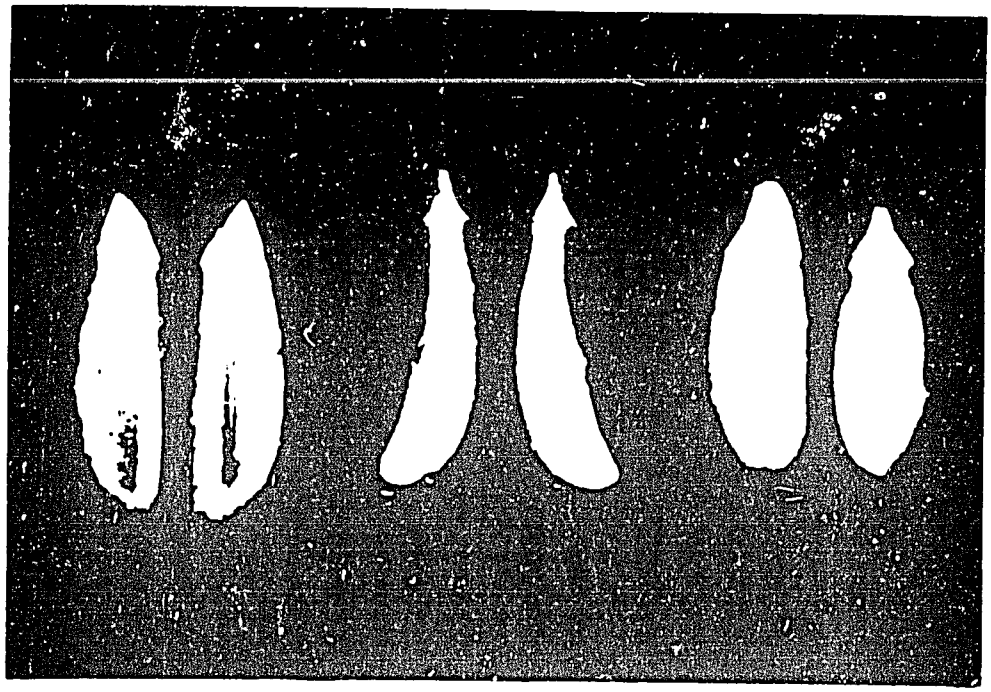

The white opaque tissue (right) perhaps indicates that cells have been ruptured by intracellular ice formation. The seed on the left has no white opaque tissue and the embryo recovered from this seed showed early signs of viability (swelling and colour change).

Differential Thermal Analysis (DTA)

This technique determines the moisture content to which seeds must be dehydrated to avoid intracellular freezing during immersion in liquid nitrogen (BECWAR et al 1982). The threshold moisture level beyond which water remains freezable, is identified using DTA, by the presence of an exotherm peak. The absence of an exotherm at a particular moisture content indicates the absence of freezable water and represents the moisture content at which the sample will avoid freezing injury. Germination tests of seeds, dehydrated to different moisture contents but not subjected to cooling will determine whether the seed is sensitive to dessication at this level (BECWAR et al 1983).

These preliminary studies suggest that cryopreservation is a feasible means of storage for *O. speciosa*.

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SECTION 4

Cryopreservation of seeds of

JESSENIA BATUA

Cryopreservation of seeds of *Jessenia batua*

1. INTRODUCTION

The cryopreservation of *Jessenia batua* seeds presents similar problems to those described for *Orbignya speciosa*, since this species is also a tropical oil palm from the Amazon. It was decided to use the same treatment for all seeds in order to provide reasonable replication.

2. MATERIALS AND METHOD

2.1 Plant material

The seed stock (20) was received from New York Botanical Gardens and stored in a polythene bag in the dark at room temperature at Twyford Plant Laboratories.

The structure of the seed of *J. batua* is very different from that of *O. speciosa*. The embryo is embedded in the endosperm and unlike the smooth cylindrical shape of *O. speciosa*, its surface is roughly grooved and difficult to extract from the endosperm without damage. The endosperm is enclosed in a hard shell which is surrounded by a husk. *Jessenia* is related to the coconut (*Cocos nucifera*) and although seeds are only about 30mm in length, their structure is very similar. Difficulties in embryo excision made it necessary to choose whole seed instead of zygotic embryos as plant material.

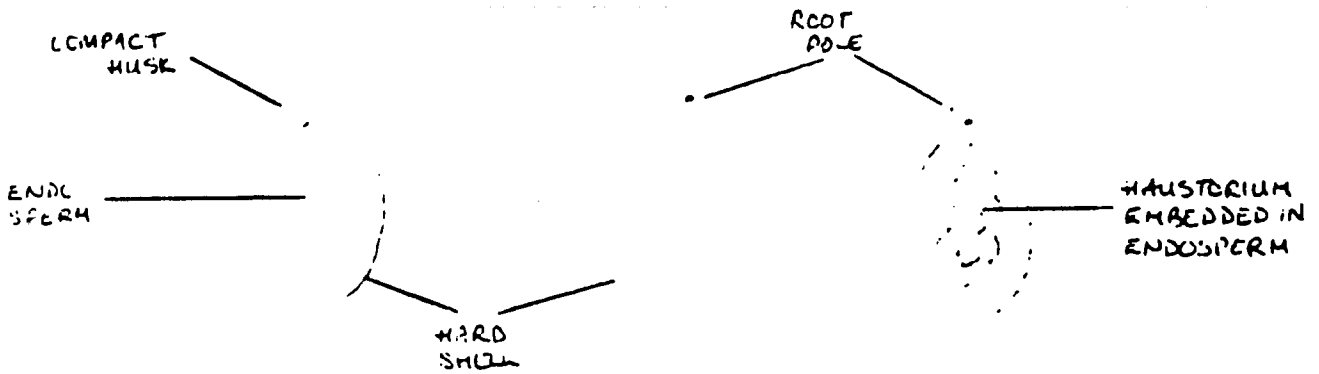
2.2 Surface sterilisation

Sterilisation had already been identified as a problem in a previous shipment of seeds to Twyford. Seeds had remained contaminated despite use of antibiotics.

It was thought that the outer husk would have provided a source of contamination to the embryo and it was removed under laminar flow conditions after dipping in alcohol and flaming.

Removal of the husk revealed that the root poles of some embryos were protruding from the hard shell which enclosed the endosperm, (see Fig. 1).

Figure 1



(a) CROSS SECTION JESSENIA (b) HUSK REMOVED (c) EMBRYO EXCISED FROM 'SHELL' (1.25x)

At this stage, the embryos of 3 seeds were identified as dead because the root poles were black and dehydrated. It was not known whether the exposed root poles indicated that germination had commenced or whether the embryo developed normally in this form by protrusion from the shell whilst protected by the husks.

Surface sterilisation requirements differed for those seeds with exposed root-poles from those still contained within the hard shell. Sterilisation needed to be sufficiently effective to eliminate contamination on the outer surface of the shell without damaging the exposed root pole. Seeds with exposed root-poles were dipped in 100% ethanol without immersing the root-pole, following this the whole seed was agitated for 2 minutes in 2% active sodium hypochlorite containing 1 drop of wetting agent per 100 ml of solution.

Those seeds without exposed root-poles were subjected to full strength sodium hypochlorite for 15 minutes. One embryo was successfully excised following this procedure and germinated *in vitro*.

2.3 Cryopreservation

Seeds were incubated on ice for one hour in a 2.5% (v/v) solution of DMSO, followed by direct immersion in liquid nitrogen.

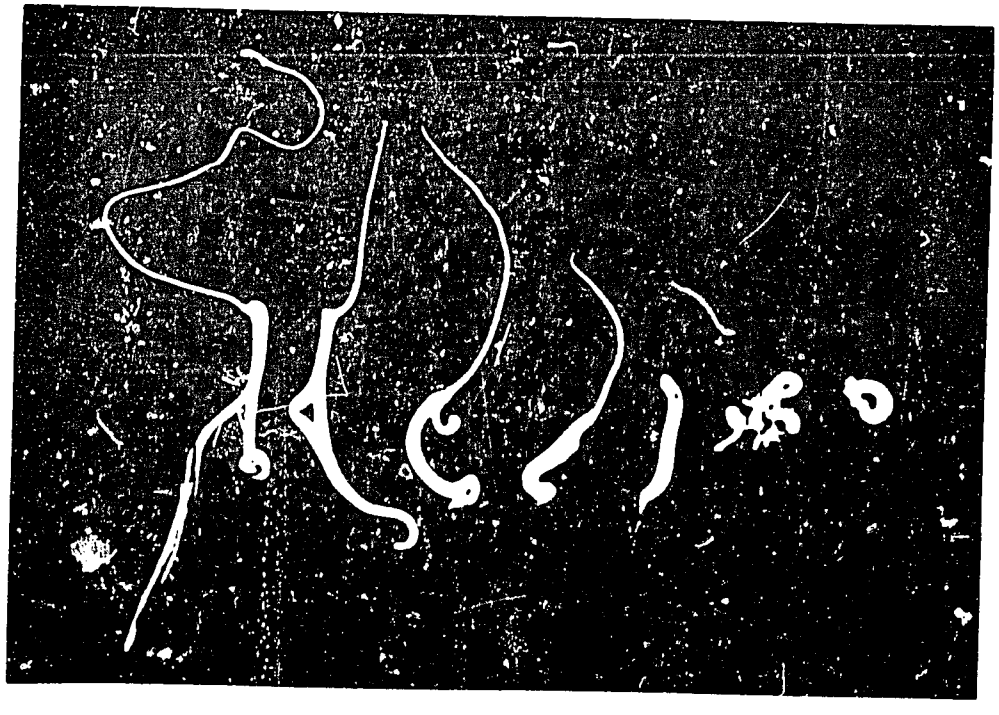
2.4 Storage in liquid nitrogen

Seeds are currently being stored in liquid nitrogen and will be thawed, embryos excised and cultured on media containing high levels of 2,4-D, in the hope of inducing callus on any surviving tissue. This experiment is in progress.

SECTION 5

Cryopreservation of Somatic Embryos of *PHOENIX DACTYLIFERA*

Development of somatic embryos and germination sequence



Cryopreservation of Somatic Embryos of Date Palm (Phoenix Dactylifera)

1. INTRODUCTION

Recent discoveries of aberrations in inflorescence morphology of oil palm derived from tissue which has been in long-term culture, has raised questions about the stability of tissue culture derived plants of date palm.

Cryopreservation of somatic embryos of oil palm (ENGELMANN *et al*, 1985) was described as "the first success in the application of cryopreservation to embryos originating from a tropical crop". However, success was limited to two clumps of embryos out of ninety-seven frozen; each of these clumps came from different treatments. No cryoprotectant was used, instead it was suggested that a pretreatment on growth media enriched with saccharose would sufficiently dehydrate the embryo before immersion in liquid nitrogen to prevent intracellular ice formation from damaging the cells. This protocol was attempted using date palm somatic embryos without any success.

Subsequent experiments were designed to determine the optimum cryoprotectant and cooling rates for successful freezing and recovery of date palm somatic embryos.

PRELIMINARY STUDIES

The aim was to determine the optimum cryoprotectant and concentration at several cooling rates. Survival (after thawing) was evaluated on a range of recovery media.

2. MATERIALS AND METHODS

2.1 Plant material

Multiplying clumps of somatic embryos (varying in size from 1mm - 5mm) previously cultured on a multiplication medium containing NAA.

2.2 Cooling rates

(a) 0.5°C per minute to -40°C then transfer to LN_2

(b) 1.0°C per minute to -40°C then transfer to LN_2

(c) direct immersion in LN_2

(d) CONTROL (no freezing)

2.3 Cryoprotectants

Incorporated into nutrient media as follows:-

a) DMSO at 2.5%; 5% and 10% v/v

b) PGD (Polyethyleneglycol 10% : Glucose 8% : DMSO 10%)

c) CONTROL - no cryoprotectant, liquid media only

2.4 Recovery media

a) Germination medium (3mg/l 2-IP)

b) Callus induction medium (100mg/l 2,4-D)

c) Sub-culture medium for somatic embryos (2.5mg/l 2-IP + 0.5mg/l NAA)

2.5 Cryopreservation Procedure

Multiplying clumps were harvested from cultures of date palm somatic embryos and stored on the same medium.

Cryoprotectants were prepared at double the required concentration in nutrient media then filter-sterilised. Embryonic clumps were immersed in sterilised nutrient media and chilled on ice before an equal volume of cryoprotectant was added. The embryos were then incubated on ice for one hour. Clumps were then removed from the solution and placed in cryotubes, using sterile forceps. An additional one or two drops of cryoprotectant were placed in the base of the cryotube and the plant material was positioned to ensure that it was in contact with the cryoprotectant.

Tubes were placed in the methanol bath at -5°C and allowed to stand for a few minutes to equilibriate at that temperature; ice was then seeded in the drop of cryoprotectant, by placing forceps cooled in liquid nitrogen on the meniscus. Once ice was seeded, the tubes were returned to the methanol bath, whether or not the ice-seed appeared to remain frozen. The cooling programme took samples to a transfer temperature of -40°C.

The tops were removed from the tubes containing the frozen embryos and immersed in liquid nitrogen. Embryos thus came into contact with liquid nitrogen and remained at -196°C for 1 hour.

Tubes were then removed, emptied of LN_2 before dipping the outside in ethanol followed by immersion in

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sterilised nutrient media warmed to approximately 35°C. The ice thawed quickly and embryos were shaken out into the media and gently agitated for 30 seconds. Prior to plating-out, clumps were blotted free of water on sterile filter paper.

RESULTS OF PRELIMINARY STUDIES (See Tables)

There was a high contamination rate in treatments, confined to indents in the media made by forceps. Cultures which showed signs of contamination are indicated in the margin. Viability was assessed using tetrazolium chloride staining.

One treatment showed successful recovery in all 4 replicates after cryopreservation.

Cooling rate: 1° per min. to -40°C then LN_2

Cryoprotectant: PGD

Recovery medium: Somatic embryo subculture medium

After 23 days, plants had started to green-up and there were indications of callus on the surface of embryos.

Other successful treatments were:-

i) 1.0°/min: 10% DMSO : sub-culture medium (2 replicates)

ii) 0.5°/min: PGD : callus induction medium (1 replicate)

iii) 0.5°/min: 10% DMSO : sub-culture medium (1 replicate)

iv) 0.5°/min: PGD : germination medium (1 replicate)

v) 1.0°/min: 10% DMSO : germination media (1 replicate)

This represented a survival rate of 10 embryogenic clumps out of 67 in LN_2. Therefore, it appears that cryopreservation of somatic embryos from date palm is more successful if a cryoprotectant is used. This agrees with the conclusions reached by Engelmann *et al* (1985) from oil palm (*Elaeis guineensis*).

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FURTHER INVESTIGATIONS

From the preliminary investigations it was decided to use PGD as the cryoprotectant and sub-culture medium as the recovery medium in further work.

3. MATERIALS AND METHODS

Cryopreservation procedures were carried out as described previously.

Cooling rate and transfer temperatures were varied to determine the optimum protocol for freeze preservation of date palm somatic embryos.

Cooling rates: 1° and 2°/min and direct immersion

Transfer temperatures: $-20^{o}C$; $-30^{o}C$, $-40^{o}C$ and $-50^{o}C$

Viability Assay

A revised viability test with tetra chloride (TTC) was used to assess viability of recovered material (STEPONKUS & LANPHEAR, 1967; TOWILL & MAZUR, 1974). As an indication of viability, the colourless solution of 2,3,5 triphenyl tetrazolium chloride forms the insoluble red triphenyl formazan.

Certain reductases in living tissue bring about the reduction of the tetrazolium salt (OBERLE & WATSON, 1953).

The test was carried out four days after recovery from LN_2, to avoid over-estimation of viability due to reduction of the dye by enzymes which were released by cells damaged by the cryopreservation procedure.

Tissue is weighed and placed in test tubes containing 0.8% TTC dissolved in a 2:1 solution of 0.05 M sodium phosphate buffer (pH 7.5): growth medium. The tissue is left in the dark for 18-20 hours, then transferred to 95% ethanol (5ml) and the red formazan extracted after 1 hour. The absorbance was read at 525nm with a spectrophotometer (Pye Unicam PU 8650).

4. RESULTS

Absorbance values and visual observations of the stained, viable areas of tissue are recorded in the Appendix (pages 13 to 17).

Successful treatments were:- 1°/min cooling to a transfer temperature of $-30^{o}C$ and 1°/min to $-38^{o}C$, which maintained viability of all and 50% of the tissue replicates, respectively.

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5. DISCUSSION

It appears to be feasible to cryopreserve somatic embryos of date palm. Further experiments are necessary to determine whether these results were reproducible. However, harvesting of suitable embryonic clumps is critical because it was observed that small embryos (<2mm) survived freezing better than large embryos (8mm). The vivid viability staining of some undifferentiated tissues is not surprising as embryos are known to bud from such tissue in culture. Not all undifferentiated tissues behave in this way. Initial success in freezing and recovery of date palm somatic embryos should encourage further work in this field since it may be a useful tool in plant production management.

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APPENDIX I

freezing rate	cryoprotectant	recovery media		visual observations...23 days after recovery condition of tissue...type of recovery growth						new embryos	fresh wt. (g) day 28	absorbance / 50mg.f.wt.
				growth	green	white	vitr-eous	brown	callus			
1°	NIL	S				***	*				0.0130	
1°	NIL	S				**					0.0282	
1°	NIL	S				***	*				0.0446	#
1°	NIL	S				**	*				0.0293	#
1°	2.5% DMSO	S				***	**	*			0.0643	
1°	2.5% DMSO	S				***	*				0.0343	
1°	2.5% DMSO	S				**	*	*			0.0188	
1°	5% DMSO	S				**	*	**			0.0181	
1°	5% DMSO	S				***	*				0.0405	#
1°	5% DMSO	S				**	*	*			0.0750	#
1°	5% DMSO	S				***	*	*			0.0280	#
1°	10% DMSO	S				*	***	**			0.0306	# POS.
1°	10% DMSO	S				***			***		0.0530	3.3
1°	10% DMSO	S				*	**	**			0.0213	#
1°	10% DMSO	S										
1°	PGD	S		***	*	***			***		0.0920	0.88
1°	PGD	S		***		***			*	(5)	0.0648	1.26
1°	PGD	S		***	*	**				(5)	0.1610	1.10
1°	PGD	S		**		**			***		0.0940	0.25

freezing rate	cryoprotectant	recovery media		visual observations...23 days after recovery condition of tissue...type of recovery growth						new embryos	fresh wt. (g) day 28	absorbance / 50.mg.f.wt.
				growth	green	white	vitr-eous	brown	callus			
[illegible]	PGD	G	CONT.	***	***	**			*	(25)	0.213	2.25
[illegible]	PGD	G		***		***	**				0.054	
[illegible]	PGD	G				***	**				0.066	
[illegible]	NIL	R				***					0.017	
[illegible]	NIL	R				***					0.016	
[illegible]	2.5% DMSO	R				**	*				0.047	
[illegible]	2.5% DMSO	R				**					0.025	
1°	5% DMSO	R				*	**	*			0.016	
[illegible]	5% DMSO	R				*	**	*			0.030	
[illegible]	10% DMSO	R				**					0.023	
1°	10% DMSO	R				**	*				0.156	
1°	PGD	R		**			**	***			0.043	
1°	PGD	R		**							0.019	
0.5°	NIL	G	CONT.	***	***	**			**	(5)	0.259	1.44
0.5°	NIL	G					***	***			0.061	
0.5°	2.5% DMSO	G	CONT.	***	****	**			**		0.303	#
0.5°	2.5% DMSO	G				**	***	*				

freezing rate	cryoprotectant	recovery media		visual observations...23 days after recovery condition of tissue...type of recovery growth						new embryos	fresh wt. (g) day 28	absorbance / 50mg.f.wt
				growth	green	white	vitr-eous	brown	callus			
).I.	NIL	R					**	**			0.0248	
).I.	2.5% DMSO	R				***	*				0.0291	
).I.	5% DMSO	R				*	**	*			0.0088	
).I.	5% DMSO	R					***	*			0.0209	
).I.	5% DMSO	R					***	*				
).I.	10% DMSO	R				**	*	*				
).I.	PGD	R					*	**			0.0061	#
1°	NIL	G	CONT.	*****	****	***				(40)		
1°	NIL	G					***	*			0.0112	#
1°	NIL	G				***		*			0.0118	#
1°	2.5% DMSO	G	CONT.	****	**	***			**	(16)	0.0403	1.32
1°	2.5% DMSO	G				**	*	**			0.060	
1°	2.5% DMSO	G				***	*				0.588	
1°	2.5% DMSO	G				***	*					
1°	5% DMSO	G				***		*			0.470	
1°	5% DMSO	G				***	**	*			0.025	
1°	10% DMSO	G	CONT.	***	*	***		*	**	(6)	0.132	1.56
1°	10% DMSO	G	CONT.	****	**	***			*	(20)	0.152	3.85
1°	10% DMSO	G		*		***	*		*		0.380	1.50
1°	10% DMSO	G				*	****	*			0.0610	#

freezing rate	cryoprotectant	recovery media		visual observations...23 days after recovery condition of tissue...type of recovery growth						new embryos	fresh wt. (g) day 28	absorbance / 50mg.f.wt.
				growth	green	white	vitr-eous	brown	callus			
[illegible]	NIL	S		*		****					0.0242	# POS
[illegible]	NIL	S				***	'	'			0.0177	#
[illegible]	NIL	S				*	*	*				
[illegible]	NIL	S				*	*	*				
[illegible]	NIL	S				****	*					
[illegible]	2.5% DMSO	S				*	**	**			0.0269	#
[illegible]	2.5% DMSO	S				**	*	'			0.0234	#
[illegible]	5% DMSO	S				*	**	**	*		0.0249	#
[illegible]	5% DMSO	S					**	**			0.0302	#
[illegible]	10% DMSO	S		*		**	*	*	*		0.0149	#
[illegible]	10% DMSO	S				*	**	***			0.0155	#
[illegible]	PGD	S				*	*	**	**		0.0444	# POS
[illegible]	PGD	S				**	'		*		0.0287	#

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freezing rate	cryoprotectant	recovery media		visual observations...23 days after recovery condition of tissue...type of recovery growth						new embryos	fresh wt. (g) day 28	absorbance 50mg.f.wt
				growth	green	white	vitr-eous	brown	callus			
0.5°	10% DMSO	S	CONT.	****		****			*		0.6755	0.62
0.5°	10% DMSO	S	CONT.	***		****			*		0.2470	0.66
0.5°	10% DMSO	S				*	***		*		0.0153	# POS
0.5°	PGD	S	CONT.	****		****				(26)	0.2761	1.56
0.5°	PGD	S				*	***	*			0.0229	
0.5°	PGD	S				*	***	*			0.0197	
0.5°	NIL	R	CONT.	***		**		*			0.1304	1.78
0.5°	NIL	R					***	*			0.0306	
0.5°	2.5% DMSO	R	CONT.	***		***			**		0.1271	1.40
0.5°	2.5% DMSO	R				**	*				0.0288	#
0.5°	5% DMSO	R	CONT.	**		*	*	*	**		0.1534	# POS
0.5°	10% DMSO	R				***			*		0.0268	#
0.5°	10% DMSO	R				*	**	*				
0.5°	10% DMSO	R	CONT.								0.0458	# POS
0.5°	PGD	R	CONT.								0.0429	# POS
0.5°	PGD	R									0.0221	# POS

freezing rate	cryoprotectant	recovery media		visual observations...23 days after recovery condition of tissue...type of recovery growth						new embryos	fresh wt. (g) day 28	absorbance / 50mg.f.wt.
				growth	green	white	vitr-eous	brown	callus			
0.5°	5% DMSO	G	CONT.	***	***	**			**		0.121	1.22
0.5°	10% DMSO	G	CONT.	***	***	**			*	(13)	0.157	1.18
0.5°	10% DMSO	G				**	***	*			0.0291	#
0.5°	PGD	G	CONT.	***	***	**			**			
0.5°	PGD	G				**	**				0.0463	# POS
0.5°	NIL	S	CONT.	****		****			**		0.2406	1.07
0.5°	NIL	S				*	***	*			0.0440	
0.5°	NIL	S					***	*			0.0520	
0.5°	NIL	S					***	*			0.0483	
0.5°	2.5% DMSO	S	CONT.	***		***			**	(2)	0.2937	0.89
0.5°	2.5% DMSO	S	CONT.	***		***			*	(6)	0.2872	0.99
0.5°	2.5% DMSO	S				*	***	*			0.0114	#
0.5°	2.5% DMSO	S				***					0.0254	#
0.5°	2.5% DMSO	S				**	**					
0.5°	5% DMSO	S	CONT.	***		****			*		0.3290	0.61
0.5°	5% DMSO	S	CONT.	****		***			*	(6)	0.3790	0.74
0.5°	5% DMSO	S				*	***	*			0.0159	#
0.5°	5% DMSO	S				**	**	*			0.0340	#

APPENDIX II

treatment	total no. of embryos	size of embryos mm <2	3-7	8+	fresh weight g.	absorbance 5mg.f.wt.	visual observations - stained areas
CONTROL	22	16	4	2	0.0734	0.1500	large & small emb. v. red; med. emb. pink (esp. base)
	20	12	6	2	0.1305	0.0828	small embryos & undif. tissue red
	25	13	8	4	0.1015	0.0654	small embryos & undif. tiss. red; med. emb. pink base
	6	5	1	-	0.1037	0.0551	undif. tissue red; small & med. emb. pink at base
	19	10	8	1	0.0996	0.0509	undif. tissue red; embryos pink bases
	57	50	4	3	0.0929	0.0225	undif. tiss. red; small emb. dk pink; med & lge emb. pink bas
	13	7	4	2	0.0496	0.0220	undif. tiss. v. red; small emb. & base lge emb. red
	24	4	20	-	0.0602	0.0164	brown tips, but dk. pink all embryos
	16	14	1	1	0.0563	0.0148	undif. tiss. red; embryos pink at bases
	10	7	-	3	0.0595	0.0117	undif. tiss. centre red, outside white; small embryo red
	6	3	-	3	0.0558	0.0089	small embryos & base of large embryo red
	6	3	-	3	0.0325	0.0072	undif. tissue v. red; base large embryo red
TOTAL	224	144	56	24			
AVERAGE	18	12	4	2	0.0763	0.0423	
1°/MIN TRANSFER -20°	8	2	6	-	0.0643	0.0124	
	19	14	2	3	0.0309	0.0103	small embryos & callus red
	24	14	10	-	0.0750	0.0030	callus + base of embryos red
	83	81	1	1	0.0640	0.0028	<2% small embryos red
	12	-	5	7	0.0646	0.0020	groove in one large embryo v. red
	23	13	3	7	0.0795	0.0006	base of one med. emb. red
	15	7	5	3	0.1792	NIL	
	16	4	9	3	0.0638	NIL	
	10	6	2	2	0.0340	NIL	
	16	-	15	1	0.0193	NIL	
TOTAL	226	141	58	27			
AVERAGE	23	14	6	3	0.0674	0.0031	

treatment	total no. of embryos	size of embryos mm			fresh weight g.	absorbance 5mg.f.wt.	visual observations - stained areas
		<2	3-7	8+			
1°/MIN TRANSFER -30°	37	35	2	-	0.0323	0.1150	all small embryos v. red
	37	35	2	-	0.0261	0.0247	10 small embryos v. red
	21	20	1	-	0.0302	0.0200	callus or embryo initials on indif. tissue v. red
	6	3	3	-	0.0284	0.0077	small embryos v. red
	50	45	4	1	0.0809	0.0059	14 small embryos v. red
	4	-	4	-	0.1216	0.0048	callus or embryo initials on indif. tissue v. red
	24	21	3	-	0.0250	0.0042	
	16	14	2	-	0.0518	0.0040	surface of small embryos v. red
	9	2	5	2	0.1441	0.0026	base of large embryo v. red
	35	27	5	3	0.0418	0.0019	small pieces undif. tissue v. red
TOTAL	239	202	31	6			
AVERAGE	24	30	3	1	0.0582	0.0190	
1°/MIN TRANSFER -38°	7	2	5	-	0.0072	0.0152	undif. tissue and base lge. embryo v. red
	75	68	6	1	0.1257	0.0084	undif. tissue v. red
	23	14	9	-	0.0960	0.0049	small area undif tissue (callus?) v. red
	18	10	6	2	0.0470	0.0048	3 small embryos v. red
	23	16	7	-	0.0153	0.0029	small area at base of 2 med. embryos pink
	31	14	17	-	0.0936	NIL	
	31	20	11	-	0.0819	NIL	
	13	6	5	2	0.0741	NIL	
	28	24	3	1	0.0450	NIL	
	16	8	8	-	0.0256	NIL	
TOTAL	265	182	77	6			
AVERAGE	27	18	8	1	0.0611	0.0036	

treatment	total no. of embryos	size of embryos mm			fresh weight g.	absorbance 5mg.f.wt	visual observations - stained areas
		<2	3-7	8+			
1°/MIN TRANSFER -50°	2	2	-	-	0.1213	NIL	
	4	1	1	2	0.1067	NIL	
	27	20	7	-	0.0918	NIL	
	11	9	-	2	0.0710	NIL	
	3	-	1	2	0.0626	NIL	
	9	4	5	-	0.0602	NIL	
	18	15	1	2	0.0430	NIL	
	21	18	2	1	0.0282	NIL	1 small emb. at base large emb. red; base 3 s. emb. red
	16	11	5	-	0.0250	NIL	
TOTAL	111	80	22	9			
AVERAGE	12	9	2	1	0.0677	NIL	
DIRECT IMMERSION LN_2	22	16	3	3	0.0879	NIL	
	10	6	3	1	0.0790	NIL	
	8	8	-	-	0.0774	NIL	
	11	4	6	1	0.0472	NIL	
	31	30	-	1	0.0464	NIL	
	62	60	2	-	0.0448	NIL	
	9	9	-	-	0.0392	NIL	3 small embryos v. red
	42	42	-	-	0.0348	NIL	
	8	4	2	2	0.0283	NIL	
	5	1	4	-	0.0281	NIL	
TOTAL	208	180	20	8			
AVERAGE	21	18	2	1	0.0513	NIL	

treatment	total no. of embryos	size of embryos mm			fresh weight g.	absorbance	visual observations - stained areas
		<2	3-7	8+		5mg.f.wt	
2°/MIN	28	24	2	2	0.0792		small areas at base of 2 large embryos red
TRANSFER	6	3	3	-	0.0341		
-30°	9	5	2	2	0.1183		
	30	12	11	7	0.1093		
	6	-	1	5	0.0620		
	10	10	-	-	0.0830		
	6	3	2	1	0.0230		small area at base of large embryo red
TOTAL	95	57	21	17			
AVERAGE	13.5	8	3	2.5	0.0698		
2°/MIN	4	-	1	3	0.1217		
TRANSFER	11	3	6	2	0.0954		
-40°	17	13	3	1	0.0913		
	6	-	2	4	0.0877		
	26	24	1	1	0.0586		
	3	-	2	1	0.0534		
	4	1	3	-	0.0450		
	4	3	1	-	0.0443		
	44	38	4	2	0.0383		
	3	-	3	-	0.0214		
TOTAL	122	82	26	14			
AVERAGE	12	8	3	1	0.0657		

treatment	total no. of embryos	size of embryos mm			fresh weight g.	absorbance 5mg.f.wt	visual observation - stained areas
		<2	3-7	8+			
2°/MIN TRANSFER -50°	13	5	6	2	0.0727		
	6	2	4	-	0.0634		
	20	15	5	-	0.0521		
	15	10	3	2	0.0334		
	9	5	2	2	0.0321		
	4	1	3	-	0.0216		
	21	20	1	-	0.0117		
	5	4	1	-	0.0110		
TOTAL	93	62	25	6			
AVERAGE	12	8	3	1	0.0372		

APPENDIX IX

Germination of palm seeds. Claudio U. B. Pinheiro. An earlier NYBG trainee who is now a collaborator on the current project.

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APRESENTAÇÃO

O estudo do processo de propagação das palmeiras é, sem dúvida, um grande passo para a domesticação de muitas espécies que apresentam potencial econômico como produtoras de óleo, alimento e como fonte alternativa de energia.

Gâmica ou agamicamente, as palmeiras podem ser multiplicadas, através da germinação das sementes, por intermédio de rebentos ou perfilhos, e mais recentemente, através de cultura de tecidos.

O presente trabalho, uma revisão bibliográfica sobre a germinação de sementes de 21 gêneros da família Palmae, é uma referência segura para os especialistas dessa área, facilitando assim, o acesso à bibliografia sobre o assunto.

Estamos certos de que este trabalho vem trazer uma grande contribuição àqueles pesquisadores que se interessam pelo estudo das palmeiras.

JOSÉ MÁRIO FERRO FRAZÃO
Coordenador, Programa Nacional de Pesquisa de Babaçu.

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GERMINAÇÃO DE SEMENTES DE PALMEIRAS
REVISÃO BIBLIOGRÁFICA *

Claudio Urbano B. Pinheir

RESUMO - Este trabalho consta de uma revisão sobre germinação de sementes de palmeiras e abrange desde os aspectos mais gerais, tais como métodos, períodos germinativos, viabilidade, acondicionamento e estocagem de sementes, além de informações sobre a germinação em 21 gêneros da família Palmae, tornando fácil o acesso à bibliografia sobre o assunto, como resultado da sua condensação.

ABSTRACT - This paper is a revision on seed palm germination and it treats of general aspects about the subject such as methods, periods, viability and storage of seeds as well as information about germination in 21 genera of palms through the bibliography compiilation and promoting its easier handling.

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*Pesquisa efetuada durante a participação do autor em Programa de Treinamento em Botânica Econômica, no New York Botanical Garden, Institute of Economic Botany, Bronx, New York, U.S.A. O referido treinamento foi patrocinado pela U.S. Agency for International Development - USAID. (1983 - 1984).

INTRODUÇÃO

A família Arecácea representa uma considerável parcela do reino vegetal, através de seus quinze maiores grupos de palmeiras, envolvendo 5 linhas evolucionárias, cerca de 520 gêneros e mais de 3.000 espécies, das mais evoluídas às mais primitivas. Dentro de tal considerável número, amplas são as variações, no tocante aos processos reprodutivos; nas diferentes linhas de evolução, diferentes serão, também, as formas de multiplicação das palmeiras.

Gâmica ou agâmicamente, as palmeiras podem ser multiplicadas, ainda que em proporções bastante diferentes, em relação à frequência dos processos.

A cultura de embriões de sementes de palmeiras, é defendida por Hodel (1977), pelo fato de que, tanto embriões resultantes de cruzamentos interespecíficos (onde são comuns os endospermas imperfeitos), quanto aos embriões destinados ao aborto, em condições naturais no fruto, podem ser cultivados com sucesso, desde que os mesmos sejam extirpados em um estágio inicial de seu desenvolvimento. Além disso, há a evidência de que embriões extirpados não apresentam inibidores físicos e/ou químicos, frequentes em frutos e/ou sementes. Exemplifica por Arenga engl-ri, Orbignya spp e Attalea spp. como palmeira de lento processo germinativo, devido a inibidores físicos, tal como um espesso e duro endocarpo no fruto ou inibidores químicos na semente. Hodel trabalhou em cultura de embriões de palmeiras, com Pritchardia kaalae Rock e Veitchia annis H. Wendl. Determinadas palmeiras podem ser multiplicadas por perfilhamento e utilização de rebentos formados na raiz ou base do caule, apresentando, entretanto, uma minoria, uma vez que por suas próprias características morfológicas e fisiológicas, as palmeiras não se multiplicam, por outros meios que não o de sementes. São relativamente poucos os gêneros que apresentam desenvolvimento de perfilhos e rebentos que, em determinados pontos de seu desenvolvimento podem produzir novas plantas. São: o grupo Actinophloeus de Ptychosperma, Arenga, Astrocaryum, Bactris, Calamus, Caryota, Chrysalidocarpus, Chamaedorea, Desmoncus, Guilielma, Licuala, Oncosperma, Paurotis, Rhapis e Phoenix (Kiel 1958).

A multiplicação por semente é, pois, mais frequente processo entre as palmeiras, justificando-se o uso de processos vegetativos, em alguns casos, seja pela dificuldade de obtenção de sementes, seja como forma de assegurar a manutenção de um cultivar. A germinação de sementes de palmeiras, às vezes caracterizada por grande dificuldades, que vão desde as características físicas das sementes até às peculiaridades fisiológicas do desenvolvimento do processo germinativo, é o tema a ser desenvolvido neste trabalho, que concentra os estudos efetuados por autores diversos, em diferentes épocas.

O tema segue em ordem cronológica de abordagem dos trabalhos, inicialmente, pelos aspectos mais gerais da germinação e, posteriormente por gêneros e espécies, segundo as publicações existentes e disponíveis, sobre o assunto.

A SEMENTE

Corner (1966), estuda as características gerais das espécies palmáceas, através de estudo de sua história natural e dedica parte do trabalho à descrição da semente e da plântula, em seus aspectos morfológicos e fisiológicos.

As sementes são ditas, em geral, arredondadas, podendo, no entanto, serem oblongas, achatadas ou mesmo cônicas e, menos frequentemente, curvadas; não suportam o ressecamento, motivo de debilidade ou mesmo falência total da germinação. É certo haver crescimento contínuo e vagaroso do embrião, havendo indícios de que esse crescimento nunca cessa, nem mesmo por ocasião da dispersão das sementes, ainda que as mesmas possam aparentar dormência. A aparente lentidão de crescimento da plântula, após a germinação da semente, é creditada à capacidade da plântula em armazenar nutrientes e dosar seu cresicmento, evitando o desgaste de suas reservas e consequente competição com as numerosas raízes integrantes dos povoados solos de floresta.

São sementes de relativamente fácil preservação, marcadas por características que as identificam em relação as espécies de que são oriundas. Por outro lado, a ausência de uma estrutura definida da capa da semente não ajuda o estudo botânico das palmeiras. A capa da semente promove o aparecimento de característica denominada ruminação do endosperma, sendo este chamado não-ruminado, quando duro, homogêneo, amarelado ou branco; ou, ruminado, quando mostra linhas marrons, placas ou rugas de tecidos procedentes da capa da semente.

O embrião, em terminologia de semente, pode ser basal, se está situado próximo à micrópila ou ao ponto de inserção da semente; ou apical, se situado no lado contrário; ou ainda, lateral.

Assim é que, segundo as características mais específicas das sementes de palmeiras, evi

denciam-se diferentes formas de germinação, em função das particularidades na morfologia e fisiologia das estruturas envolvidas no processo germinativo e no desenvolvimento da plântula.

A GERMINAÇÃO

Tomlinson (1960), partindo do reconhecimento da semente, em sua estrutura cotiledonária descreve algumas particularidades da germinação de sementes de palmeiras. Apresentando sómente um cotilédone e pelo fato da folha cotiledonária não emergir do solo, ficando nele, parcial ou totalmente contida durante a germinação, esta é denominada hipógea. O cotilédone, através do ápice, permanece preso no endosperma e funciona como uma espécie de haustório, suprindo a plântula com os nutrientes de reserva da semente. Esse haustório pode, segundo a estrutura do endosperma, assumir formas e ocupar espaços, tal como em palmeiras do grupo Cocosoide e algumas Borassoide, onde esse orgão de sucção preenche a cavidade central do endosperma; ou como em sementes de coqueiro, ao assumir considerável tamanho; ou ainda, substituir e adotar a forma do endosperma. Para que a plântula possa servir-se das substâncias de reserva das sementes, estas precisam ser solubilizadas, o que ocorre através da secreção de enzimas, pelas camadas superiores do haustório. Normalmente, as reservas nutricionais da semente são totalmente utilizadas, até que a plântula inicie o seu crescimento independente.

Segundo a extensão assumida pelas diferentes partes do cotilédone e a importância da função executada, Tomlinson (1960), reconhece três tipos de germinação em sementes de palmeiras (Remota tubular, Remota ligulada e Adjacente ligulada), havendo, no entanto, sugestões para um quarto tipo, dito de ocorrência em palmeiras do gênero Nypa e Phytelephas (a radícula formaria um órgão de sucção ou haustório), sendo que, es

te tipo é contestado por Gatin (1906) e considerado igual ao que ocorre em palmeiras do gênero Phoenix, descrito por Tomlinson (1960) e, conhecido como o melhor exemplo do primeiro tipo de germinação.

a) Primeiro tipo - Remota tubular:

Na germinação de Phoenix, das Palmeiras-leques e dos grupos Coryphoide e Borassoide, além de algumas Caryotoide e Cocosoide, todo o espaço no interior da semente é ocupado, pelo enlarguecimento do órgão de sucção. Na sequência, o pecíolo cotiledonário alonga-se e, em consequência, conduz a plântula para a superfície do solo. No embrião, existe uma espécie de fenda que corresponde à abertura da bainha; a princípio estreita, longa e oblíqua, enlarguece com o alongamento da bainha e da projeção da plúmula. Normalmente, as primeiras folhas da plântula apresentam crescimento acima da superfície do solo, assim ocorrendo, por intermédio da fenda. A radícula antecede a plúmula e ao crescer, provoca o rompimento da base do cotilédone, libertando-se. Persiste por um limitado período de tempo, sendo, então substituída por raízes adventícias, originadas na base do caule, o qual por sua vez, está iniciando o seu desenvolvimento. A primeira folha (plumular), não passa de uma bainha ponteaguda e rígida, que auxilia na penetração à superfície do solo, além da sua função de proteção. As folhas subsequentes, numa fase posterior, expandem seus limbos e iniciam seu processo independente de crescimento.

b) Segundo tipo - Remota ligulada:

No segundo tipo de germinação, ocorre desenvolvimento de um órgão adicional, a lígula, de estrutura tubular e presente em palmeiras do grupo coryphoide, tais como, Livistora, Sabal e Washingtonia, além de algumas Cocosoide, como Jubaea. O processo, em geral, é semelhante ao primeiro tipo, ocorrendo variação na estrutura

da lígula formada, principalmente, em função d desenvolvimento. Não é raro o desaparecimento lígula, a partir de determinado estágio de desenvolvimento da planta.

Lígula persistente, é comum em palmeira do tipo ascendentes (tipo cipó). Em certos sos, é visível somente em folhas novas, desorganizando-se com a maturação da folha.

c) Terceiro tipo - Adjacente ligulada

Gatin (1906), descreve o terceiro tipo d germinação, de ocorrência nas demais palmeiras O melhor exemplo deste tipo, é dito ser em Archontophoenix. O cotilédone não apresenta grande alongamento, ocorrendo o desenvolvimento d plântula adjacente à semente. Ao contrário d tipo anterior, a lígula é sempre desenvolvida proeminente, apresentando forma cilíndrica desenvolvendo-se nas margens da fenda, abertur final da bainha. O embrião é curvo e a projeçã da plântula, após o crescimento do cotilédone, efetuada através de uma estrutura em botão.

Algumas partes do cotilédone não são ev dentes, mas correspondem ao pecíolo e à bainha Uma espécie de lâmina cotiledonária permanec presa à semente, funcionando como um órgão d sucção. A plúmula é, normalmente, projetada através da lígula e, pelo fato de ser o embriã curvo, o crescimento da radícula procede-se e ternamente. Uma larga raiz, substitue a estre ta raiz inicial. Essa raiz larga, apresenta cre cimento restrito e funciona como uma raiz pri cipal, até que, eventualmente, seja substituíd por raízes laterais, oriundas do caule jovem. A tes que a folha com limbo apareça, a plúmula pr move o desenvolvimento de duas bainhas, sem l minas.

Os três tipos de germinação descritos, de tro de seus processos de desenvolvimento, dif rem, na verdade, em função do tipo particular d embrião apresentado pela semente. No primeiro t po, o embrião é reto e a plúmula e a radícula e

tendem-se em seu eixo; no segundo tipo, embora o embrião seja reto, a plúmula e a radícula estão situadas obliquamente a seu longo eixo; e, finalmente, o terceiro tipo, no qual o embrião é curvo (Gatin 1906).

MÉTODOS E PERÍODOS DE GERMINAÇÃO

Apesar do elevado número de espécies de palmeiras, poucas tem sido objeto de estudo voltado ao desenvolvimento de técnicas de germinação, que revelem-se práticas e econômicas, além de, óbviamente, eficientes. As palmeiras, em geral, começam a despertar o interesse de exploração, pelo muito que podem vir a representar e representam, social e economicamente, em um contexto relacionado.

A maioria dos trabalhos escritos sobre germinação de sementes de palmeiras, remontam de vários anos atrás e de modo geral, dizem respeito às palmeiras de conhecida e reconhecida importância econômica, atualmente exploradas.

Loomis (1958), expõe técnicas de preparação e germinação de sementes de palmeiras, além de tabela, na qual constam os resultados, em relação ao número de dias decorridos para germinação, nas espécies utilizadas em seu trabalho.

Reconhece três fatores prejudiciais às sementes de palmeiras:

1) Secagem excessiva da semente, que provoca o enrugamento do embrião e reduz a viabilidade;
2) Fungos, que formados à superfície, podem penetrar nos embriões, prejudicando a viabilidade;
3) Idade excessiva da semente.

No Apêndice I, constam os dados relativos ao número de dias para germinação de sementes de palmeiras, introduzidas na Estação de Introdução de Plantas dos Estados Unidos, Coconut Grove. Flórida. O trabalho está resumido nos seguintes

procedimentos, seguidos durante 12 anos de intr dução de sementes na estação da Flórida e acc panhados por aquele autor. Primeiramente, era as sementes limpas e plantadas, 24 horas após chegada, em recipientes que continham mistura d 1 parte de turfa-musgo e 3 partes de areia p neirada, mistura esta, esterelizada via calor Os recipientes eram colocados em casa de veget ção, com temperaturas mínimas nunca inferiore a 4,5ºC, no inverno. Loomis (1958) cita tra lho de De Leon, no qual foram utilizadas temp raturas controladas, em torno de 28ºC, sobre qu tro diferentes tipos de sementes de palmeiras não identificadas na citação. Segundo os crit rios de avaliação dos resultados do autor, é d to terem sidos obtidos excelentes resultados n germinação de duas das espécies; bons result dos, em uma; e, nenhuma germinação em 10 seme tes de Corozo oleifera.

De Leon (1958), procedeu a embebição da sementes em água por vários dias, antes do pla tio. As sementes foram plantadas em potes, o quais continham como estrato, uma mistura de pa tes iguais de turfa-musgo, areia e vermiculit sendo os potes mergulhados em canteiro de turfa musgo, acima de uma espécie de aquecedor, co temperaturas controladas. Um número de trinta três espécies foram utilizadas neste trabalh (Apêndice I).

Yocum (1961), preconiza um germinador pr vido de uma fonte de calor artificial, com lâ padas incandescentes (Fig. 1A). O germinado consta de uma caixa retangular, duas lâmpada nas partes extremas das caixas (40 watts cada) de maneira a manter uma temperatura em torno d 26,5ºC e, no fundo da caixa, uma lâmina de al mínio para reflexão do calor. Uma outra lâmin de alumínio é colocada sobre a caixa e, sobre ta lâmina, os potes.

As lâmpadas suprem de calor os potes co as sementes, através da condução uniforme po meio da lâmina de alumínio.

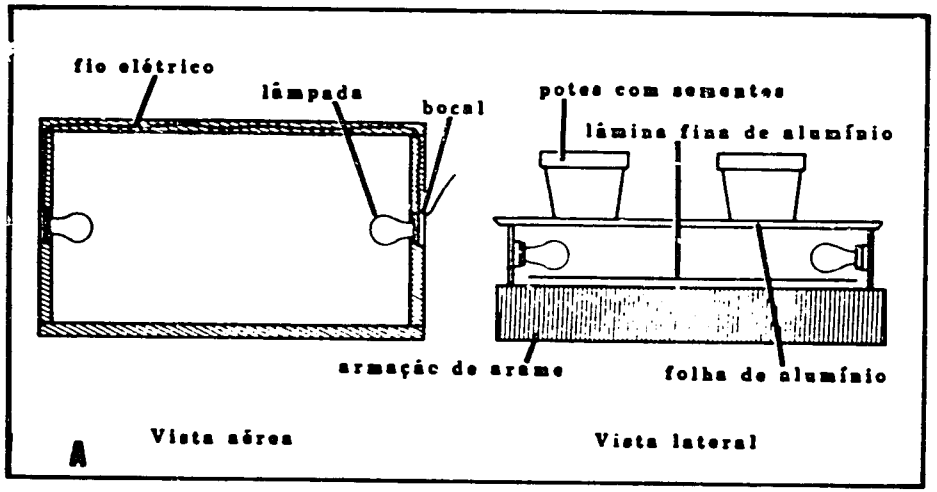

FIG. 1. Germinadores.
A. Fonte de calor para germinação(Yocum 1961)

No que concerne ao meio para germinação, Yocum tece referências à vermiculita, como livre de pragas e doenças, boa drenagem e ao mesmo tempo satisfatória capacidade de retenção de umidade. Seria a vermiculita, também, responsável por um bem formado sistema radicular, após a germinação, além da eliminação do risco de desenvolvimento de condições anaeróbicas no meio, o que poderia estimular o desenvolvimento de determinados microorganismos.

Convém ressaltar que, segundo observações do autor, a maneira conveniente de inserção das sementes (desprovidas dos seus pericarpos, preferencialmente) no meio, dependerá da forma das mesmas. Assim é que, sementes elipsóides ou ovóides, para melhores respostas germinativas, devem ser dispostas horizontalmente, enquanto que as sementes redondas não dispensam maiores cuidados. É importante o conhecimento da região da micrópila, variavelmente situada entre as espécies. Como recomendação final, deixar sempre a metade da semente exposta, acima da superfície do meio de germinação. Óbviamente que, este método com a utilização do germinador, é indicado para germinação em pequena escala.

Read (1962), sugere a observação de certos procedimentos para o êxito com a germinação de sementes de palmeiras; tais como:

1) Utilização, em primeiro lugar de sementes frescas;
2) Limpeza e tratamento anti-fúngico;
3) Plantio em estrato estéril, com boa aeração e drenagem (é recomendado Perlite);
4) Cobertura das sementes com fina camada de musgo Sphagnum, picado e granito, em pedaços
5) Manutenção do estrato quente e úmido, com temperatura nunca inferior a 25,5ºC;
6) Conservar as plântulas na sementeira, somente o tempo estritamente necessário;
7) E, finalmente, assegurar um estado de saúde às plântulas através de tratos adequados, que permita um bom crescimento.

Dentre esses procedimentos, considera-se de fundamental importância, a manutenção do nível adequado de umidade e a constância da temperatura, entre 26,5-29ºC. Para evitar a queda da temperatura abaixo de 26,5ºC, é aconselhada a construção de uma câmara de calor, com um cabo calorífico enterrado no estrato germinativo e, controlado por termostato. A câmara consta de uma rede de arame que sustenta uma cobertura de plástico, para manter altas a temperatura e a umidade relativa do ar (Fig. 1B). Em climas quentes, lógicamente, não é necessário o cabo calorífico, sendo suficiente, o calor de sol.

Rees (1963), utilizando um método de germinação bem sucedido em Dendê (Elaeis guineensis), alcançou relativo sucesso com algumas espécies de palmeiras, bem como fracassos com outras (Apêndice I).

O método é iniciado com a pré-embebição das sementes em água, por sete dias, efetuando-se a troca d'água a cada dia. Segue-se, então, secagem superficial das sementes com tecido absorvente e acondicionamento em sacos de polietileno. É importante a manutenção de um bom conteúdo de umidade na semente, sem que haja, entretanto, umidade superficial. Na sequência dos procedimentos, após 80 dias de alta temperatura (35ºC), as sementes são removidas para a temperatura ambiente (cerca de 27ºC). O autor ressalva que, esta medida alcança bons resultados com algumas sementes de palmeiras, mas não com todas.

A controvérsia em relação ao método, reside na quantidade de calor a ser aplicada, pois são diferentes as opiniões sobre o assunto. Os experimentos com Dendê sugerem temperaturas variáveis de 38 a 42ºC. Anteriormente, vimos o germinador concebido por Yocum (1961), o qual sugere cerca de 26,5ºC. Rees (1963), afirma que a metade das sementes utilizadas por ele, foram germinadas à temperaturas de 35ºC, (nível mais baixo que o recomendado para Dendê) em sementes

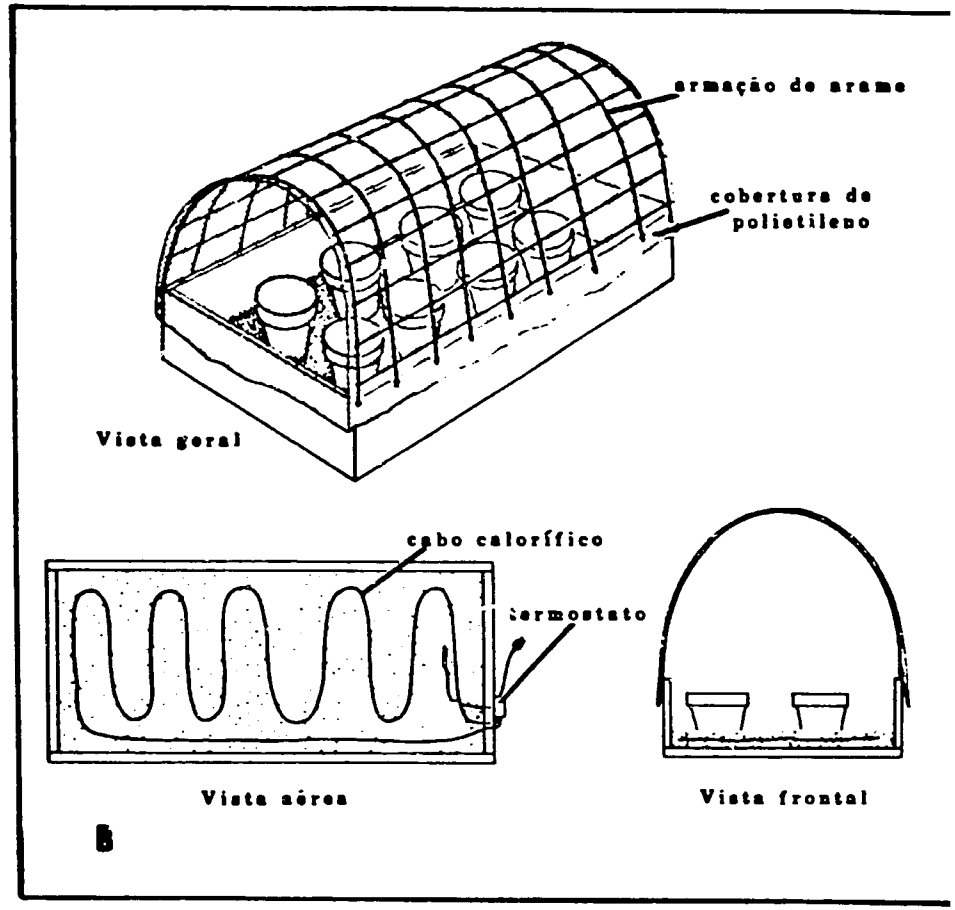

FIG. 1. Germinadores.
B. Câmara de calor, para manutenção de altas temperatura e umidade(Read 1962)

de espécies sensíveis à temperatura, sendo o restante das sementes mantido a temperaturas de 39,5ºC.

Braun (1968), após vários anos de pesquisa com palmeiras da Venezuela, orienta para a obtenção de bons resultados de germinação com uma série de recomendações. Acredita que as sementes de palmeiras não devem ser mantidas secas, mesmo por um curto espaço de tempo, pois perdem facilmente a viabilidade.

Para semeadura, sugere a construção de canteiros, em locais variáveis segundo a procedência das sementes: se procedentes de temperaturas baixas, local sombreado, com exposição à luz do sol somente até às 9 horas da manhã; por outro lado, se provenientes de temperaturas altas, local com exposição ao sol, todo o dia.

Quanto ao estrato, não faz restrições ao uso de preferência, desde que solto e friável. Utilizou, em seus estudos, mistura de serragem e esterco de cavalo, a qual julga bastante satisfatória, em termos de retenção de umidade e nutrientes, adequados. As sementes com polpa devem ser despolpadas, antes da semeadura e para isso, a fermentação por uns poucos dias permite a fácil remoção. Desaconselha a remoção das capas espessas e fibrosas, apresentadas por determinadas sementes.

Para sementes de maior valor, a cobertura com mistura de turfa e areia grossa, ou ainda Sphagnum, é material bem empregado, podendo as demais sementes serem cobertas com o meio utilizado em todo o canteiro. Em casos especiais, considera vantagem o plantio em local definitivo. No Apêndice I, constam dados do trabalho.

Jordan (1970), utilizando 12 gêneros de palmeiras, realizou observações quanto ao período e características do processo germinativo, em trabalho levado a efeito no Peru. Depois de coletadas, as sementes foram despojadas das suas capas e submetidas à secagem ao sol, por duas horas.

Grupos de 100 sementes foram, então, plantados em caixas de areia, as quais foram alojadas sob cobertura de plástico verde, transparente, a uma certa distância do solo, efetuando-se duas irrigações diárias. Jordan apresenta os resultados das observações, quanto à percentagem de germinação, número de dias (Apêndice I) e peso das 100 sementes limpas, além de desenhos representativos das sementes e suas plântulas.

Baseando-se nas descrições de Tomlinson (1960), considera, de um modo geral, a germinação como sendo do tipo característico de Archontophoenix (Adjacente ligulada), exceção para Roximiliana e Scheelea, que considera semelhante à germinação de Phoenix (Remota tubular) e Phytelephas, que germina como Washingtonia (Remota ligulada).

Koebernick (1971), reconhece quatro variáveis principais que afetam a germinação de sementes de palmeiras, abaixo enumeradas:

1) A temperatura;
2) O tipo do meio de plantio;
3) Umidade;
4) E, principalmente, a utilização de sementes novas.

Utiliza em seu trabalho de vários anos de observações, cerca de mais de 200 espécies de palmeiras (Apêndice I) e usa como estrato para germinação, material conhecido com o nome comercial de Perlite, obtido a partir da expansão via calor, de material proveniente de rocha vulcânica, tal como a vermiculita.

Uma questão levantada por Koebernick, refere-se ao fato de uma grande diferença registrado no período germinativo de sementes de Arenga engleri, obtidas da mesma inflorescência a diferença foi de 515 dias.

Relatando-se sobre este fato, Braun (1968) sugere a explicação de que, na mesma inflorescência encontram-se sementes de germinação precoce (em pequeno número) e os grupos de sementes

de posterior germinação, sendo estes, frequente mente, mas dependendo da espécie, a maioria. Sendo este, um fenômeno comum em palmeiras, dis to decorre benefícios ao habitat, uma vez que as plantas perdidas por um motivo ou por outro, são substituídas por aquelas oriundas das sementes de germinação retardada, que continua a ocorrer, em número reduzido, por determinado tempo.

Basu & Mukherjee (1972), publicam resulta dos de testes com períodos de germinação, leva dos a efeito no Jardim Botânico de Calcutá, na Índia. O método utilizado não apresenta novida des importantes em relação aos anteriores e con sistiu das fases abaixo:

1) Coleta de sementes maduras;
2) Remoção do pericarpo;
3) Lavagem em água;
4) Secagem ao ar;
5) Limpeza;
6) Plantio, em canteiros com areia lavada e se ca ao sol, decorridas 24 horas após a coleta. Foram utilizadas 100 sementes, cobertas com quantidade adicional de areia, de 0,5 a 1,5 cm;
7) Irrigação, suficiente para uma boa umidade, sem encharcamento.

Os autores consideram a areia como o es trato desejável, pelo fato de apresentar baixa capacidade de retenção de umidade e por melhor proteção das sementes, contra infestação fúngi ca.

Foram formados grupos de espécies, dentro de intervalos de período germinativo. O número de dias de germinação de cada espécie, isolada mente, está no Apêndice I.

V - VIABILIDADE DE SEMENTES

Sementes de palmeiras, como de todas as espécies vegetais que as apresentam, estão su

jeitas a períodos de tempo, que determinam e co dicionam a sua utilização, como forma de mult plicação. Esses períodos, definidos por fatore fisiológicos, inerentes à própria semente e f tores físicos e/ou químicos e ambientais, qua do em se tratando de palmeiras, não são, ainda bem caracterizados e definidos, exceção, talve a umas poucas espécies, objetos de maiores est dos. O conhecimento e entendimento do períod de viabilidade das sementes é, certamente, f tor de importância na busca de melhores result dos na germinação.

De Leon (1958), inicia-se nos estudos d viabilidade de sementes de palmeiras, inicialme te descrevendo a semente e caracterizando algu fatores de influência. Segundo ele, ao cont rio das dicotiledôneas em geral, as sementes d palmeiras não permanecem em dormência até qu advenham condições favoráveis à germinação. E condições desfavoráveis, o embrião, próximo a tegumento, inicia um processo de encolhimento constituindo este processo, se medido em di do seu início ao seu final, o período em que semente é viável.

Obviamente, a definição dos períodos viabilidade referentes às sementes das espé palmáceas, requer estudos específicos e, a assim, sujeitos à variação condicionada por tores diversos.

Adotando, naturalmente, padrões não muit rígidos referentes às condições ambientais d habitat das plantas, o autor em questão estab lece períodos de viabilidade para diferentes g pos de gêneros, segundo a procedência das seme tes.

Sementes procedentes de palmeiras de área sub-tropicais, com duas diferentes estações quente e fria, ou úmida e seca, com endocarp espesso, são viáveis por período de 2 a 3 meses Gêneros incluídos neste grupo: Acrocomia, Archo tophoenix, Arecastrum, Arikuryroba, Attalea, B rassus, Dictyosperma, Elaeis, Erythea, Howeia

Hyphaene, Jubaea, Mascarena, Nannorhops, Opsiandra, Orbignya, Paurotis, Phoenix, Pseudophoenix, Rhapis, Sabal, Scheelea, Serenoa, Syagrus, Thrinax, Trachycarpus e Thrinax.

Sementes de palmeiras de outras partes do trópico, onde as mudanças de temperatura e precipitação pluviométrica não são muito efetivas, além de palmeiras de áreas brejosas, apresentam viabilidade de 2 a 3 semanas. Incluídas neste grupo: Actinorrhytis, Areca, Balaka, Bentinckia, Bismarckia, Calyptrocalyx, Calyptronoma, Chambeyronia, Clinostigma, Cyrtostachys, Didymosperma, Drymophloeus, Eugeissona, Euterpe, Gronophyllum, Iguanura, Iriartea, Jessenia, Linospadix (Bacularia), Loxococcus, Mauritia, Metroxylon, Nenga, Normanbya, Nypa, Oenocarpus, Oncosperma, Orania, Pinanga, Podococcus, Ptychoraphis, Raphia, Rhopaloblaste, Roscheria, Salacca, Socratea, Stevensonia, Veitchia, Verschaffeltia e Wettinia.

Além dessas duas listas de gêneros, é apresentada uma classe intermediária de palmeiras de áreas tropicais, que produzem sementes com período de viabilidade de 4 a 6 semanas. São: Aiphanes, Arenga, Astrocaryum, Bactris, Caryota, Chamaedorea, Chrysalidocarpus, Corypha, Cryosophila, Diplothemium, Geonoma, Heterospathe, Latania, Licuala, Livistona, Phytelephas, Pritchardia, Ptychosperma, Reinhardtia, Rhopalostylis, Roystonea e Synechantus.

Naturalmente que não é esta, uma listagem exata de período de viabilidade, segundo gêneros e procedências, uma vez que as variações ocorrerão, segundo as espécies em questão. Certamente que as mais frequentes exceções aparecerão nos gêneros a apresentarem elevado número de espécies, que mostrarão ou não, comportamento diversos em relação ao período de viabilidade de suas sementes.

Ressalte-se que, o trabalho acima apresentado, foi efetuado através de observações procedidas em sementes introduzidas nos Estados Unidos, em sua grande maioria provenientes de re

giões tropicais, de condições ambientais sobre maneira distintas daquelas nas quais foram realizadas as observações. Alguns desses gêneros relacionados, apresentam períodos de viabilidade para as sementes que produzem, mais longos que os sugeridos pelo autor, como é o caso de Orbignya, cujas sementes podem conservar a viabilidade por períodos superiores a 1 ano.

Rees (1963), afirma ter conseguido germinar sementes de palmeiras, com um índice de 98% de germinação, após 15 meses de armazenamento, em método por ele concebido e baseado em experiências com Dendê.

ACONDICIONAMENTO E ESTOCAGEM DE SEMENTES

Frequentemente, a utilização de sementes destinadas ao plantio, não ocorre de forma imediata à coleta das mesmas; muitas vezes, são decorridos grandes períodos de tempo até que o plantio seja realizado, acarretando, muito provavelmente, a perda parcial ou total da viabilidade. Algumas técnicas, portanto, devem ser adotadas, no que se relaciona ao acondicionamento das sementes, com fins de transporte e/ou armazenamento.

De Leon (1958), para casos de demora, da coleta da semente ao plantio, recomenda a utilização de turfa-musgo seco, para proteção e como forma de evitar o encolhimento e secagem do embrião, cuidando-se, atentamente, contra o excesso de umidade, tanto no acondicionamento para transporte quanto no plantio.

Loomis (1958), tratando da preparação da semente para o plantio ou transporte, sugere como primeiro passo, a remoção da polpa, quando presente, através da lavagem, seguida de um ou dois dias de secagem ao sol. Para transporte grandes distâncias, utilização de sacos plásticos com uma mistura de igual quantidade de turfa-musgo ou sphagnum, com adequado teor de umidade. Para prevenir contra fungos, pulverização

as sementes com fungicida em pó.

Rees (1963), baseado em experiências com endê, concebeu os seguintes procedimentos para reparação e estocagem de sementes de palmeiras

) Secagem das sementes à temperatura ambiente, total ou parcialmente, sendo o último caso melhor recomendado;
) Estocagem das sementes a temperaturas mais reduzidas (22ºC), como forma de prevenir contra a germinação, durante o período de estocagem.

Balick (Comunicação pessoal, 1984), sugere algumas medidas práticas, para acondicionamento de sementes de curto período de viabilidade, tais como as de Jessenia, Oenocarpus, Euterpe, Bactris, Guilielma, Chamaedorea, etc.

Os procedimentos constam, de:

1) Remoção do epicarpo e do mesocarpo polposo;
2) Pulverização leve das sementes com fungicida + inseticida, como forma de prevenir contra a deterioração;
3) Acondicionamento em jornais, os quais tenham sido umedecidos levemente, sem contudo estarem completamente molhados;
4) Colocação das sementes envolvidas nos jornais úmidos, dentro de sacos plásticos, os quais devem ser postos em locais de pouca luz e frios, especialmente quando em trabalho no campo.

Além disso, é recomendada a abertura periódica dos sacos plásticos, para proporcionar aeração e assegurar-se contra o excesso de umidade.

Informa que, sementes conservadas por muito tempo através deste método, começam a germinar nos sacos plásticos, após o que, podem ser plantadas.

REVISÃO GENÉRICA

Gênero: Acrocomia

Palmeiras de rápido crescimento. Muitas espécies são importantes em economia local, pelos proveitosos frutos, material para construção e sementes oleíferas. Distribuição: América

Considerada uma das mais difíceis germinações entre as palmeiras, são poucos os estudos efetuados neste gênero.

Loomis (1958), faz referências a método aplicado por Edwin Johnston, Vero Beach Tropical Garden, Vero Beach, Flórida, em sementes de palmeiras de difícil germinação, entre elas, Acrocomia. As sementes foram plantadas em bandejas contendo areia grossa e úmida, dispostas uma sobre a outra, em abrigos sem iluminação e ventilação, com teto de ferro. As temperaturas diárias, foram de um mínimo de 48,8ºC, no verão. Não há dados referentes aos resultados do trabalho, apenas considerações sobre o sucesso da aplicação do método, nas sementes mais viáveis.

Um outro método foi tentado pelo autor utilizando altas temperaturas (65,5-71,1ºC) controladas com irrigações, durante um período de 2 a 3 semanas, após o que eram removidas e plantadas na casa de germinação. É citado como de 95%, o índice de germinação das sementes. Em relação a escarificação ou limagem das sementes, o autor afirma que tiveram pouco efeito sobre a germinação.

São comparados os efeitos da utilização de cabos caloríficos, acima ou abaixo do estrato de areia, concluindo-se que, os melhores resultados foram obtidos com os cabos acima da areia (2 a 3 meses), mas ainda assim, não tão satisfatórios quanto utilizando o abrigo com lhado de ferro (2 semanas).

spécie: A. crispa (HBK) C.F. Baker ex Beccari

Holmquist & Popenoe (1967), coletaram dois otes de frutos de A. crispa. O primeiro lote ra constituído de frutos maduros, começando a air e o segundo, de frutos não completamente aduros. Cem frutos de cada lote foram quebra os e as amêndoas examinadas. No lote de frutos aduros, 93% das sementes aparentavam bons em riões, havendo cerca de 7% de frutos vazios, em amêndoas. No lote de frutos não completamen e maduros, 23% estavam vazios e cerca de 50% a resentavam maturação incompleta, com amêndoas inda moles. Dessa forma, pela prévia quebra do esocarpo e descarte das sementes vazias, é eli inada uma das variáveis do experimento. Semen es de ambos os lotes foram tomadas separadamen e, em grupos de 25, recebendo os seguintes tra amentos:

) Testemunha - somente remoção do exocarpo;
) Quebra com martelo, remoção do mesocarpo e plantio da amêndoa;
) Remoção do mesocarpo com martelo e da pelícu la da amêndoa, com faca;
) Remoção do mesocarpo com martelo e embebição da amêndoa em água, por 12 horas;
) Remoção do mesocarpo com martelo e embebição da amêndoa em água, por 24 horas;
) Limagem do mesocarpo na região próxima ao hi lo;
7) Limpeza do hilo com faca;
8) Queima da semente envolvida em jornal;
9) Embebição das sementes em ácido sulfúrico concentrado, por 10 minutos;
0) Embebição das sementes em ácido sulfúrico concentrado, por 20 minutos;
1) Embebição das sementes em ácido sulfúrico concentrado, por 30 minutos;
2) Testemunha - sementes sem remoção do exocar po.

As sementes foram plantadas em potes com

mistura de partes iguais de turfa-musgo e verm culita, sendo colocadas em casa de vegetação.

Após 83 dias, foram os seguintes, os r sultados: no lote de sementes maduras, 15 seme tes germinaram no tratamento 4; 10 sementes, n tratamento 5; 4 sementes, na testemunha com exocarpo removido; 1 semente, no tratamento 7 e, 1 semente germinada, no tratamento 6. Ond as sementes não foram embebidas, mas plantada diretamente, 6 sementes germinaram. No grupo d sementes de frutos imaturos, somente duas seme tes germinaram, ambas no tratamento 2.

Não há aplicação de delineamento estatí tico, por falta de repetições nos tratamentos.

Espécies: A. lasiospatha Mart.

Braun (1968), para germinação das sement desta espécie, recomenda a utilização de cante ros aquecidos, além da embebição por três sem nas, em água morna. Em se tratando de viabilid de, é dito não haver perda da mesma, mesmo e períodos prolongados de estocagem, por um o dois anos

Gênero: Archontophoenix

Palmeiras largamento cultivadas como orn mentais nos trópicos e subtrópicos de ambos o hemisférios. São as de mais rápido cresciment entre as palmeiras cultivadas. Distribuição: A trális.

Espécie: A. alexandrae (F. J. Muell.) H. Wendl & Drude

Nagao & Sakai (1979), iniciaram estudo com esta espécie, para determinação dos efeito de pré-embebição com água e reguladores de cre cimento, na germinação.

O trabalho constou dos seguintes tratame tos: Pré-embebição das sementes em água destil

la por 24 e 72 horas; Pré-embebição das sementes
em água + reguladores de crescimento, por 72 ho
ras, sendo: solução aquosa de ácido giberélico
a 10, 100 e 1000 ppm, solução aquosa de ácido
naftalenoacético a 10 e 100 ppm e, solução aquo
sa de benziladenina a 10 e 100 ppm; além, de uma
testemunha. Foi utilizado delineamento experimen
l Blocos ao Acaso, com duas repetições. Para
cada tratamento foram tomadas 50 sementes. O es
trato de germinação utilizado foi a vermiculita
nº 2. As temperaturas foram controladas em máxi
ma de 26,1ºC e mínima de 19ºC, em casa de vege
tação.

Foi concluído que, a pré-embebição em água,
por 24 ou 72 horas (sendo este último mais efe
tivo), estimula a germinação e que o tratamento
por 72 horas, com ácido giberélico a 100 ou 1000
ppm aumenta esse estímulo. Não foi constatada
significância nos tratamentos com ácido naftale
noacético e benziladenina. É mostrado, em tabe
la, as percentagens de germinação, por tratamen
to, nos 30, 40, 50 e 70 dias.

Nagao et al. (1980), publicam novo estudo
com esta espécie, desta vez para avaliação dos
efeitos do Ácido Giberélico e da Escarificação,
na germinação das suas sementes. As sementes, ob
tidas de frutos maduros, depois de terem os exo
carpos removidos, foram limpas em água e hipo
clorito de Sódio, após o que, procedeu-se a se
cagem ao ar. Foram efetuados os seguintes trata
mentos: a) Escarificação; b) Escarificação e
Pré-embebição em solução aquosa de ácido giberé
lico 1000 ppm (72 horas); c) Escarificação e
Pré-embebição em água (72 horas); d) Não escari
ficação e Pré-embebição em água (72 horas); e)
Não Escarificação e Pré-embebição em ácido gibe
rélico 1000 ppm (72 horas); f) testemunha.

O estrato de germinação utilizado foi a
vermiculita nº 2 e as temperaturas foram manti
das, em máxima de 26ºC e mínima de 20ºC. O deli
neamento experimental utilizado foi Blocos ao
acaso, com 5 repetições. Cada tratamento utili

zou 20 sementes.

Os resultados, tomados semanalmente, lev
ram a conclusão, de que a germinação foi acel
rada nas sementes tratadas com ácido giberélic
1000 ppm e que, a escarificação aumenta o efe
to do ácido, estando pois, a atividade do ác
do, relacionada a sua penetração através da d
ra capa da semente.

Efeito significante, foi também observ
do, nos tratamentos com embebição em água, po
72 horas.

O efeito conjunto Escarificação/Ácido G
berélico foi significante, produzindo maior ac
eração do processo germinativo, entretanto, su
percentagem de germinação foi baixa. O trabalh
mostra as percentagens de germinação tomadas a
4, 5, 6, 7 e 12 semanas.

Gênero: Areca

Os frutos de A. catechu são importante
mastigatórios nos trópicos do Velho Mundo. Alg
mas espécies são cultivadas como ornamentais
Distribuição: Índia e Ceilão até as Filipinas
Ilhas Solomon.

Nambiar (1956), descrevendo as prática
mais frequentes no cultivo de Areca na Índia
tece algumas considerações em relação a proced
mentos levados a efeito, para germinação das s
mentes. As sementes, de preferência obtidas d
cachos médios da palmeira, são plantadas, gera
mente, após secagem à sombra, por período de
a 4 dias, acreditando-se que a secagem direta a
sol, diminue a viabilidade da semente. Mas, ne
sempre as sementes são plantadas diretamente, p
ra germinação. Algumas vezes, é utilizada a pr
tica da brotação, antes do plantio, através d
colocação das sementes em feixes de palha, molh
dos periodicamente, com água comum ou água
esterco. A brotação ocorre, entre 40 e 50 di
e dessa forma, as sementes não viáveis são de
cartadas. Após a brotação, são plantadas, inic
ando-se as práticas no viveiro.

Appaiah (1970), ao mesmo tempo que mostra a forma como são tratadas as sementes para germinação, sugere algumas mudanças práticas, para melhores resultados.

É recomendada, a coleta de sementes, a partir de plantas escolhidas e, preferencialmente, dos cachos médios, sendo estes, depois de cortados, baixados por meio de cordas. Em lugar do canteiro de areia, na qual as sementes eram germinadas, apresenta a sugestão de trincheiras rasas, de dimensões convenientes, preenchidas com areia até quase a sua total profundidade. As sementes são dispostas nas trincheiras, com os "talos" para cima e cobertas com areia ou solo, o bastante para cobrir as sementes. Seguem-se as irrigações periódicas. As sementes devem ser conservadas sombreadas, iniciando a germinação com cerca de 30 a 40 dias e prosseguindo por 90 a 100 dias.

Espécie: A. catechu Linn.

Pillai & Murthy (1973), investigando o fato de que, as sementes coletadas de plantas que ocorrem em grandes altitudes, não apresentam grande peso e possuem amêndoas moles, lançaram-se a um sistemático estudo do problema, uma vez que, sendo o endosperma o mais importante produto dessa espécie, tais irregularidades comprometem fatalmente, o comércio de tais sementes. A pesquisa foi conduzida na Índia, através da seleção de diferentes "stands" de Areca, em diferentes altitudes, variáveis de 350 a 1200 m. Os frutos foram coletados, periodicamente, por dois anos, para utilização nos testes de germinação.

Como conclusão, os autores desaconselham o cultivo de Areca catechu, em áreas superiores a 850 metros, uma vez que os resultados mostraram que, a partir dessa altitude para cima, as taxas de germinações decrescem consideravelmente e o peso da semente é bem menor que em mais baixas altitudes, além de se apresentarem moles, de excessivo encolhimento e quebra, portanto, im

próprias para a obtenção de um bom "chali" e, consequentemente, para o comércio.

É apresentada uma tabela, na qual constam as percentagens de germinação e percentagens de peso úmido da amêndoa, registradas para altitudes variáveis de 225 a 1200 metros.

Das & Baruah (1974), acreditando que, durante a germinação de A. catechu no solo, ocorram microorganismos envolvidos no apodrecimento da polpa que envolve a semente, pela produção de enzimas pectinolíticas, efetuaram estudo para determinação, se a utilização dessas enzimas in vitro, poderia afetar a germinação.

Os frutos, obtidos da mesma plantação e do mesmo tamanho, foram embebidos por 3 e 24 horas em 2% de extrato de enzima pectinase, extraído de fungo Trichoderma viride, isolado de polpa de Areca decomposta. Tanto as sementes tratadas com enzimas ativas e desativadas via calor, foram plantadas juntas com sementes tratadas com água destilada e não tratadas, utilizadas como controle. Foram tomadas cinco sementes por tratamento, cada um com duas repetições, em delineamento experimental Blocos ao Acaso. Foram registrados dados referentes ao tempo em dias requeridos para brotação e a taxa de crescimento das plântulas.

Segundo os resultados e análises estatísticas, os autores concluem que o tratamento de sementes com T. viride afeta a brotação e o crescimento das plântulas, indicando que um período de incubação se faz necessário para o início da ação das enzimas pectinolíticas sobre os tecidos da polpa, e que tais enzimas podem ser utilizadas justificadamente, desde que ajam como iniciadores ou ativadores do processo, para hidrolizar a polpa, facilitando, assim, o crescimento de microorganismos que produzem enzimas causadoras da degradação da polpa, que no caso de Areca, funciona como uma barreira à passagem de água e soluto.

São mostrados em tabelas, os dados refe

rentes a cada tratamento e análises estatísti cas dos resultados.

Gênero: Arenga

Diversas espécies ornamentais são, com fre quência, cultivadas. Há espécies economicamente importante, como fonte de amido, açúcar e Álco ol, nos trópicos do Velho Mundo. Muitas são pal meiras de touceiras, produzindo novos caules quando os velhos morrem. A polpa sucosa dos fru tos, apresenta substância bastante irritante à pele. Distribuição: Ásia.

Espécie: A. engleri Becc.

Holmquist & Popenoe (1967) testaram seis diferentes tratamentos sobre as sementes desta espécie. Os frutos utilizados, após a limpeza, foram separados em grupos, sendo um grupo subme tido a embebição em água por 15 dias e tratados, além de outro grupo, sem embebição prévia em á gua, apenas tratados. Os tratamentos constaram de: Lixação do mesocarpo com lixa de esmeril, no ponto em que se localiza o hilo; Limagem da semente, em ponto que não há hilo; Queima da ca pa da semente com jornal incendiado, por 30 se gundos; Embebição das sementes em ácido sulfúri co concentrado, por 5, 10 e 20 minutos; além do controle, sem tratamento adicional.

Foram utilizadas 25 sementes por tratamen to, após o que, foram colocadas em potes, um pa ra cada tratamento, os quais foram dispostos em casa de vegetação.

Após 80 dias, os melhores resultados fo ram conseguidos no tratamento onde as sementes foram lixadas no ponto do hilo (15 sementes ger minadas), sem embebição prévia. Neste mesmo tra tamento, com embebição prévia em água por 15 dias, 8 sementes germinaram. Houve germinação de 2 sementes no tratamento Ácido Sulfúrico por 10 minutos, sem embebição em água. No mesmo trata

mento com embebição prévia em água, ocorreu s mente uma germinação. Os demais tratamentos nã apresentaram germinação. Não houve tratamento tatístico dos resultados.

Gênero: Astrocaryum

Diversas espécies brasileiras constitue fontes consideráveis de sementes oleaginosas Distribuição: México até o Brasil.

Para germinação de sementes de palmeira deste gênero, Loomis (1958), refere-se ao mesm método empregado por Edwin Johnston, Vero Beac Tropical Garden, Vero Beach, Flórida, para ge minação de sementes de Acrocomia, já present do neste trabalho. Os procedimentos foram exat mente os mesmos, para as sementes dos dois gên ros, podendo-se dizer o mesmo em relação aos r sultados e conclusões.

Braun (1968), recomenda a semeadura em ca teiros aquecidos, embebendo-se as sementes, pr viamente, através de banhos de água quente, temperatura de 30 - 40ºC, por período de 2 a semanas. O autor apresenta período de germin ção a partir de quatro meses, sendo as semente mantidas a temperaturas, em torno de 40ºC.

Gênero: Bactris

Diversas espécies produzem frutos comes veis e sementes oleaginosas e o duro e fibr caule (chonta) tem sido a fonte comum de m rial para arcos, lanças e dardos, para os ind genas da América do Sul Tropical. Distribuição América Tropical.

Espécie: B. gasipaes Humboldt, Bonpland & Kunt

Fournier (1965) em trabalho no qual abo da vários aspectos sobre B. gasipaes, ainda c tado como Guilielma gasipaes, tece algumas co siderações sobre a propagação da espécie, cons

derando a utilização de sementes como o método de maior emprego, ainda que, sem descartar as possibilidades de sucesso através da multiplicação por rebentos, dentro de procedimentos adequados.

É citado como estrato para a germinação, de fibra de coco ou material similar e areia, além de um bom teor de húmus. Tomando afirmações de outros autores, aponta o Sphagnum, como outra alternativa para estratificação das sementes. A germinação é dita ocorrer em período de dois meses, após o que, segue-se transplante, desde que as plântulas tenham alcançado altura de 10 a 15 cm.

O autor considera que, como em diversas palmeiras, as sementes de B. gasipaes, perdem a sua viabilidade, se submetidas a longos períodos de insolação.

Braun (1968) como recomendado para todas as sementes de difícil germinação, preconiza o uso de canteiros aquecidos, contendo solo fértil e misturado com areia grossa, sombreados, em geral à tarde e expostos à luz do sol, pela manhã. O período de germinação é dito variável, segundo a espécie, mas em maioria requerem vários meses.

Gênero: Borassus

Palmeiras cujos frutos não apresentam valor comercial, exceto pela massa comestível, que consiste o endosperma em estágio tenro, uma vez que, com o envelhecimento do fruto, o endosperma torna-se seco, devido a acumulação de hemicelulose. Distribuição: África e Ásia.

Espécie: B. flabellifer Linn.

Dassanayake & Sivakadachchan (1973) relatam estudos sobre a germinação e a estrutura da plântula desta espécie. As pesquisas realizadas no Ceilão, tratam, inicialmente, da estrutura

do embrião da semente, que em estágio de matur dade, foi descrito pelos autores como, aproxim damente cilíndrico, tendo o seu volume complet do pelo cotilédone e, sendo a plúmula complet mente envolvida pela porção da bainha do cotil done. A plúmula e a radícula, situam-se ambas no eixo do embrião.

A germinação foi dita do tipo remota tub lar. A parte proximal do cotilédone, durante processo germinativo, cresce dentro do endospe ma e alarga-se, funcionando como se fosse u haustório. A região entre o haustório e a plúm la sofre alongamento, formando o pecíolo cotil donário que, em crescimento descendente, carr ga a plúmula e a radícula na sua extremidade, e terrando-as a uma profundidade de 30-40 cm, n solo.

A primeira folha (plumular), é laminada atinge cerca de 30-40 cm de comprimento e 3- cm de largura e contém, grande quantidade d amido de reserva em suas células, sendo assim comestível.

Acreditam que o tipo de germinação de B flabellifer ocorre em palmeiras das sub-família Borassoideae e Coryphoideae, além dos gênero Phoenix e Phytelephas e relaciona-se com a e trutura do embrião maduro.

Padmanabhan et al. (1978), ainda em pe quisa com B. flabellifer, reportam-se sobre a pectos que variam desde considerações sobre fr tos e sua utilização, germinação, estruturas d endosperma, do embrião e do cotilédone, até a conteúdo de amido das folhas plumulares da plã tula. Sobre a germinação, da forma em que é pr cedida pelos povos rurais na Índia, é dito que as drupas são, geralmente, germinadas em mont culos de terra, preparados com terra escavada. No topo desses montículos, de altura entre 1-1,5 metros, são enterrados os caroços, os quais são cobertos com húmus e folhas mortas. Os montícu los precisam de irrigações frequentes, de modo a manterem-se sempre úmidos. A germinação da se

mente ocorre em 45 a 60 dias, com o eixo embrionário crescendo fora do caroço e penetrando no solo solto do montículo.

A bainha cotiledonária é responsável pelo transporte do eixo embrionário, para o interior do solo. A primeira folha, acumula material de reserva, que é em forma de grãos de amido, acumulados em largo parênquima celular. Os caroços, cada um contém uma semente. As plântulas tuberosas, constituem um alimento sazonal para as camadas mais pobres da população.

Gênero: Ceroxylon

Inclue as mais altas palmeiras, algumas com até mais de 50 metros. Distribuição: Andes, da Venezuela e Colômbia até o Peru e a Bolívia.

Espécie: C. klopstockia Mart. = C. ceriferum (Karsten) Burret

Braun (1976), em trabalho que reune informações oriundas de observações, efetuadas durante 12 anos na Venezuela, volta-se sobre a germinação desta espécie, entre outros aspectos.

O autor não apresenta dados de experimentação com sementes, mas depois de afirmar que as mesmas desenvolvem lento processo germinativo, constitue dois intervalos de tempo, como sendo os mesmos mais comuns em germinação de Ceroxylon. O primeiro intervalo é de 6 a 9 meses, constituindo esta, pequena percentagem; o segundo intervalo é de 10 a 16 meses ou mais, que é dito de maior frequência e de maiores percentuais. Registra ainda, germinação retardada, após dois anos.

Para confirmação de que as sementes desta espécie são capazes de passar por longo período seco e, posteriormente, germinarem, mesmo em reduzido número, Braun diz poder o fato ser demonstrado, através da submissão de sementes a um grande período de tempo sem água, com

posterior plantio.

Das informações sobre a germinação, é to que, a maioria é proveniente de observaçõ das palmeiras cultivadas no Jardim Botânico Caracas, pois não foi possível o acompanhamen da germinação da espécie, em seu habitat na ral.

Gênero: Cocos

Uma das mais valiosas plantas dos trópic o Coqueiro é fonte principal de gordura veget obtida de óleo proveniente da prensagem do dosperma. Também fornece fibras, da casca fruto; açúcar e álcool, da seiva extraída da florescência; e, o endosperma e a "água" que p enche a cavidade, são utilizados frescos e cozinha. As palmeiras são, normalmente, culti das com fins comerciais mas são, também, lar mente usadas como ornamentais. Distribuição: toda a parte tropical das costas do Velho Mund entre as latitudes 26º Norte e Sul.

Espécie: C. nucifera Linn.

Decerto, atualmente, já existem sistem de produção definidos para a cultura de C. nucifera e são, hoje, métodos bastante difundidos de resultados bastante razoáveis. Obviament não é nosso propósito, ao tratar deste gêner apresentar novidades sobre métodos de germi ção da semente do Coqueiro, mas são agrupar sequência das práticas, a partir de cerca 15-20 anos atrás até os dias atuais, segundo que se tem publicado sobre o assunto, em di rentes partes do mundo.

Pieris (1955) tratava de procedimentos p ra o cultivo do Coqueiro, que constavam desde seleção da boa semente, construção de viveiro plantio. Recomenda, seguindo algumas prática das ilhas do Pacífico, a utilização da sement completamente madura e seleção por interessant

método, que consiste em sacudir o fruto e julgar qualidade do som feito pela "água" dentro dele, rejeitando toda semente com som "falso". São citadas algumas práticas comuns às Ilhas do Pacífico, àquela época, tais como a coleta de frutos caídos sob as palmeiras, ou mesmo plântulas já em início de desenvolvimento, também tomados de sob as palmeiras.

Na sequência, recomendações para a instalação do Viveiro, construção de canteiros, plantio das sementes e manutenção das plântulas.

Menon & Pandalai (1958), em trabalho sobre generalidades de cultura do Coqueiro, na Índia, apresenta variadas sugestões de procedimentos para uma boa germinação e consequente produção de mudas.

Os procedimentos iniciam-se com uma boa seleção de sementes, obtidas, preferencialmente, de plantas matrizes prèviamente escolhidas. Uma vez obtidas as sementes, estas não serão imediatamente plantadas, mas estocadas por um período de um mês. Baseado em outros autores, é recomendada a preservação das sementes em fina areia seca, como forma de evitar a secagem excessiva das mesmas. As sementes devem ser arranjadas com o pedúnculo para cima, sobre uma camada de areia de 7,5 cm e completamente cobertas com ela, até a época do plantio. Este arranjo deve ser efetuado sob abrigo, e é afirmado não haver efeitos prejudiciais na viabilidade da semente.

O autor cita diferentes práticas de germinação das sementes, seguidas em diferentes partes do mundo, embora consideradas defeituosas:

- As sementes são colocadas sobre os tetos de casas cobertas de palha, durante o monção, sendo diretamente plantadas, após a brotação;
- Algumas vezes, as sementes são permitidas germinarem no local onde caem, após o que são levadas ao plantio;
- As sementes são amarradas aos pares, com uma pequena rachadura, suspensas em galhos de árvores ou postes e borrifadas com água até a

brotação;
- As sementes são amontoadas na sombra e permitidas brotarem.

Sob suas recomendações, as sementes devem ser plantadas em viveiros, de solo arenoso e com boa umidade, ou ainda, podendo ser o solo original substituído por areia, depois de escavado, dispondo-se as sementes na posição horizontal, com o mais largo dos três segmentos para cima. A profundidade recomendada é de 15 cm deixando-se uma pequena parte da casca exposta.

É comentado sobre métodos de estimulação da germinação, tais como embebição em água, injeção de nutrientes ou de hormônios. A embebição em água, por 15 dias estimulou uma mais rápida e melhor germinação, sendo no entanto, que se o período for prolongado, haverá efeitos negativos. Não foram obtidos efeitos benéficos sobre a germinação pela injeção de nutrientes (N, P K) nas casca, sendo, pelo contrário, prejudicial.

A germinação é dita ocorrer, nas variedades gigantes, em 11 a 12 semanas, após o plantio.

Piggott (1963), trata da cultura de Coco nucifera, na Malaia. O processo germinativo descrito e dito iniciar-se o "brôto" cresce em direção a um dos três "olhos" da semente e a outra parte do embrião entumesce, desenvolvendo-se dentro de uma massa esponjosa ("a maçã"), que preenche todo espaço no interior da semente; por este meio, a plântula absorve material nutritivo, contido na "água" e na massa. Em continuação, o "brôto" cresce, atravessa o "olho mole" mais ou menos às 6 semanas do início do processo e as primeiras raízes desenvolvem-se da base do "brôto", fora do endocarpo, dentro ainda, da casca fibrosa.

Posteriormente, as raízes emergem, penetram no solo, ao mesmo tempo em que são formadas as primeiras folhas.

Em relação as práticas a serem seguidas para a germinação, o autor sugere a escolha, inicialmente, de uma área de solo solto e de boa drenagem, para instalação do viveiro. É afirmado que, as plântulas podem viver, no mínimo, por um ano, com as reservas da própria semente. Um bom teor de umidade é necessário, para evitar que as sementes rachem, retardando a germinação. Uma vez selecionadas, as sementes são dispostas em canteiros elevados, dentro de trincheiras escavadas com o lado que apresenta o "olho mole", para cima, e é dito que embora o mesmo não possa ser visto, é sempre oposto ao lado mais estreito da semente, devendo este lado, pois, ficar para baixo. O lado mais superior da semente não deve ser coberto, ficando, assim, exposto.

McPaul (1963) discorre sobre diversos aspectos relativos ao cultivo do Coqueiro, nas Ilhas Fiji. Suas primeiras considerações, no tocante à germinação, referem-se à seleção das sementes. Considera que, mesmo sendo método bastante empregado, a seleção de palmeiras matrizes para obtenção de sementes, baseado em critérios de produção, não tem base experimental, mas ainda assim, é reputado como uma boa prática, até resultados mais definitivos estarem disponíveis. Sugere a seleção prévia das sementes, obtidas de um bom bloco de produção, observando-se: 1) Maturidade dos frutos; 2) Conteúdo adequado de líquido (por sacudimento do fruto); 3) Ausência geral de danos; 4) Forma e tamanho; 5) Espessura da casca (não deve ser muito espessa). Uma vez definidas as sementes para utilização, estas são estocads em local arejado, seco, e é afirmado, por um período de 4 meses, sem afetar a germinação. Os autores, em geral, recomendam que esse período não ultrapasse um mês.

A seguir, é enfocada a importância da seleção de sementes, na produção da futura palmeira. É mencionado experimento, realizado no Ceilão, que confirmou, pelos seus resultados, a im

portância dessa prática.

As sementes são plantadas no viveiro, em trincheiras abertas nos canteiros, sendo estes distantes entre si, 45 cm. As sementes distam uma da outra, 30 cm e são dispostas com o seu lado mais largo para baixo, além de, cobertas com terra em somente 2/3, ficando, dessa forma 1/3 exposto. A cobertura morta, pode ser realizada, com folhas de Coqueiro ou grama morta.

As práticas seguintes referem-se à manutenção das mudas.

Whitehead (1966), em trabalho que registra pesquisa e coleta de germoplasma de *Cocos nucifera*, nas Ilhas do Pacífico, apresenta variadas considerações sobre o assunto e relata observações sobre a germinação.

O autor afirma que em muitas áreas, tem sido registradas germinações de sementes na palmeira, se as mesmas forem deixadas sem colheita e enfatiza que, em determinada área (Marlam Valley, Bubia), as sementes ainda inseridas aos cachos, apresentam "broto" de mais de um pé de comprimento. Essas observações foram efetuadas em plantas das variedades "Gigante" e "Anãs".

Notáveis diferenças na velocidade de germinação foram observadas para diferentes tipos de Coqueiros cultivados na Jamaica e é preconizada a influência genética para germinação precoce, além do incentivo reconhecido, proporcionado pelas altas umidades de certas regiões.

É relatado sobre a velocidade e taxa de germinação, em sementes com cascas e descascadas, para determinada variedade denominada "Niu Lekas". As sementes descascadas dispenderam 20 dias a mais que aquelas com casca, para alcançar a taxa de germinação de 60%. São apresentados gráficos da percentagem de germinação/número de dias, para sementes descascadas e com casca, de diferentes variedades.

Fremond et al. (1966), trata da cultura de *C. nucifera*, em vários países do mundo. Ao tratar do processo germinativo, acrescenta alguma

coisa mais às descrições anteriores. Diz que, após a elongação do embrião, no início da germinação, ocorre a formação de uma espécie de constrição, que delimita duas partes: uma parte que constitue o "broto" e que se encaminha para fora da casca; e, outra parte que permanece dentro da casca, desenvolvendo-se em massa esponjosa, denominada haustório, o qual digere da polpa da semente, as reservas que nutrem a plântula. Este haustório preenche completamente a cavidade interna da semente, onde aloja-se a "água". A polpa é completamente digerida, em aproximadamente 10 meses, após o início do processo.

É dito ter sido estudado o processo de assimilação do albúmen e mostrado que, a superfície de contato do haustório é uma ativa zona de secreção de enzimas, permitindo a absorção da polpa, incluindo suas reservas oleaginosas. É essa massa do albúmen e o considerável volume d'água contido na semente, responsáveis pelo vigor inicial da plântula.

Sobre as práticas para a germinação, são apresentadas algumas novidades, em relação ao anteriormente exposto. Em lugar do plantio em viveiro, é recomendada a utilização inicial de canteiros de germinação. É sugerida a estocagem por um mês, antes do plantio, em abrigo contra sol e chuva, para proporcionar um bom nível de maturação às sementes. Na falta de abrigo, é argumentado que, as sementes podem ser amontoadas, em montes de até 5 metros de altura.

Na preparação da semente para o plantio, recomenda o corte de uma parte da casca, na região do poro germinativo, como forma de ajudar o "broto" a atravessar o epicarpo e também, como de proporcionar maior umidade ao pericarpo.

O autor distingue dois estágios de desenvolvimento, antes do plantio em local definitivo: primeiro, a germinação propriamente dita (a qual é dita finalizada por ocasião do aparecimento da plúmula, fora da casca); e o segundo, correspondendo ao crescimento da plântula. Baseado nessa idéia, recomenda a utilização de

canteiros de germinação, em vez dos tradicionais viveiros, como etapa inicial. Os canteiros de germinação constam de trincheiras, nas quais as sementes são dispostas horizontalmente, com a área cortada da semente, para cima. Em seguida, são cobertas com terra em dois terços de sua altura, ficando o terço restante, com a parte cortada, exposto. Após a germinação, são removidas com ganchos e levadas ao viveiro.

Woodroof (1970), numa compilação de alguns autores, inclusive ele próprio, publica trabalho sobre produção, processamento e produtos de C. nucifera. O enfoque da propagação, é efetuado por Popenoe (Fairchild Tropical Garden, Miami, Florida, U.S.A), que considera o Coqueiro uma espécie diferente, pela divisão que apresenta em Variedades "Gigantes" e "Anãs" e enfatiza a propagação através de sementes, como sendo o único meio viável e inclusive, através do qual tem sido realizados os melhoramentos das variedades pela seleção de matrizes, ainda que, sem suficiente base científica. Nos procedimentos para germinação, o autor não apresenta novidades, em relação aos anterioes. Também recomenda o corte oblíquo ao redor do pedúnculo, removendo fatia de cerca de uma polegada de espessura para facilitar a emergência do "brôto". Afirma que, após o plantio, as sementes completamente maduras emitem raízes com cerca de 90 dias. Este autor, também preconiza a utilização de canteiros de germinação como primeira fase, sendo depois de brotadas, levadas ao viveiro.

Child (1974), também aborda, praticamente todos os aspectos de cultura desta importante espécie.

A casca do coco é dita possuir três "olhos", sendo que um é desenvolvido e os outros dois não são funcionais. Abaixo do olho desenvolvido, situa-se o embrião, marcadamente constante em seu tamanho, dentro de uma população. Foram examinados 2.500 embriões e encontrado média de peso de 0,119 g e conteúdo médio de umidade de 76-69%, além de valores médios para a

ercentagens do peso seco para N, P. K, Ca e Mg le, 3-45, 0-68, 2-14, 0-52 e 0-29, respectivamen te. Ao iniciar o processo germinativo, o embrião enlarguece e diferencia-se no cotilédone e no ápice do caule. As reservas nutritivas das se mentes são atacadas por enzimas secretadas pelo cotilédone, o que as torna solúveis, permitindo a sua mobilidade e nutrição da plântula. Na se qüência, pelo desenvolvimento do cotilédone, há a formação do haustório, cujo tecido esponjado é dito ser constituído por 85% de umidade, 10% de nutrientes solúveis e somente 5% de tecidos estruturais (em maioria, celulose). Os nutrien tes solúveis são ditos incluir notável propor ção de açúcares e aminoácidos, sendo os açúcares derivados do endosperma, por sucessivas reações enzimáticas, e os aminoácidos, sendo produto da hidrólise das proteínas da amêndoa. A cadeia de reações enzimáticas tem lugar sobre a enrugada superfície do haustório. A "maçã", é afirmado, presenta relativa constância em sua composição química, durante o processo germinativo e funcio na como o meio de transferência dos nutrientes solúveis, para as partes em crescimento da plân tula. São citadas três principais enzimas, par ticipantes no processo germinativo: a celulose (responsável pela quebra das paredes das células das amêndoas, liberando óleo); a lipase (que fen de a gordura em glicerol e ácido graxo); e a pro teínase (cuja presença é indicada pelo Nitrogê nio). Entretanto, várias outras enzimas tem si do citadas como presentes.

O autor registra a ocorrência, não rara mente, de sementes com dois e até, menos frequen temente, com três "brôtos" desenvolvidos. Nos casos de ocorrência de dois "brôtos", há a fu são dos haustórios, e em maioria, os pares são triplóides.

São apresentadas, também recomendações pa ra uma boa germinação, que iniciam-se pela esto cagem, após coleta das sementes, sendo dita des necessária e que retardará a germinação se exce

der os 6 meses. Em relação ao tratamento de cor te da casca, próxima ao pedúnculo, sugerido por Frémond et al. (1966), é considerado um desneces sário refinamento e que a sugestão para utiliza ção de canteiros de germinação não foi largamen te adotada, sendo preferido, o plantio inicial em viveiros. Estes seguem práticas similares aos anteriores e em relação à posição de plantio da semente, é sugerido que, aquelas plantadas hori zontalmente, produzem melhores plântulas e isto é explicável pelo fato de que, em sementes dis postas na vertical, a água do seu interior não permanece em estreito contato com o embrião, o que ocorre na semente plantada horizontalmente.

São apresentadas tabelas referentes aos seguintes itens, abaixo:

- Desenvolvimento do haustório em sucessivos es tágios quinzenais;
- Perdas de peso da amêndoa *pari passu* com o au mento do haustório, raízes e broto", mesmo a pós 30 semanas de semeadura;
- Média de peso de matéria-seca em diferentes partes da semente-seedling (amêndoa-"água"-ha ustório-"broto"-folhas-raízes), em sucessivos estágios de germinação, até 16 semanas.
- Média do conteúdo de potassa (MgK_2O) em dife rentes partes da semente-plântula (amêndoa-"á gua"-haustório-"broto"-folhas-raízes), em su cessivos estágios de germinação, até 16 sema nas.

Em geral, não foi encontrada grande dife rença em peso (se total ou matéria-seca somen te), entre uma plântula de 7 meses e a semente original; foi definido que, até acima de 16 se manas é auto-sufuciente em Nitrogênio; foi ob servado aumento no total de potassa contido nas partes em crescimento da planta e que, se o con teúdo original de potassa na casca não fosse li xiviado, seria suficiente para suprir essa ne cessidade crescente. Os experimentos foram rea lizados no Coconut Research Institute (Ceilão), com 800 sementes sendo postas em viveiro e 50,

tomadas para exame, a cada 15 dias.

Thampan (1981) cita vários experimentos efetuados sobre germinação de sementes de Coqueiro.

Inicialmente, referiu-se sobre experimentação nas Filipinas, a qual encontrou que, sementes com casca fina e espessura média de 2,9 cm para menos, brotaram mais cedo e produziram maior número de plântulas do que sementes com espessura média de casca de 3,0 cm para cima. Em relação ao peso, sementes pesando 0,95 a 1,35 kg germinaram mais tardiamente que sementes mais pesadas, de 1,85 a 2,45 kg, além de terem produzido plântulas menos vigorosas. Ao examinarem o conteúdo de massa da semente, foi encontrado que, a massa consumida pelas plântulas de sementes leves após 211 dias, foi muito menor que o consumido pelas plântulas de sementes mais pesadas.

Na Central Plantation Crops Research Institute, India, foi estabelecido que, sementes pesadas, com um bom conteúdo de copra flutuam verticalmente na água, com o pedúnculo para cima e que as plântulas oriundos de tais sementes são mais vigorosos que aqueles crescidos de sementes que flutuam obliquamente ou horizontalmente, na água.

Quanto à estocagem, é recomendado o método que utiliza areia, já mencionado em Menon & Pandalai (1956). Nestas condições, as sementes são ditas conservarem sua viabilidade por mais de 8 meses.

Na sequência de recomendações de procedimentos para germinação, que em geral, repete que já foi comentado, o autor menciona experimento nas Filipinas, no qual foram comparados cinco diferentes modos de posicionamento da semente no plantio e que, a posição horizontal apresentou média percentagem de germinação de 92% e 33 dias para emergência do "broto", enquanto que os números para o plantio vertical foram de 64% para a germinação média e 39 dias para a emergência do "broto". Em Papua-Nova Guiné, novos experimentos confirmaram o plantio horizontal como o melhor posicionamento: em 8 semanas, foi obtido 47% de germinação na horizontal contra 39%, da vertical. Na Tanzânia, é dito ter sido encontrado período de germinação de 81,1 dias para sementes embebidas préviamente em água, por duas semanas contra 142,9 dias para sementes não embebidas.

E, finalmente, o autor cita estudos na Índia, os quais demonstraram que as coberturas orgânicas promovem a germinação mais precoce, além de plântulas de maior vigor. As folhas secas, do próprio Coqueiro são recomendadas.

Gênero: Copernicia

As palmeiras deste gênero são formosas e ornamentais. As folhas são, comumente, utilizadas para a cobertura de casas e em especial as de uma de suas espécies, produzem a cêra de Carnaúba, a mais importante das cêras vegetais: Distribuição: Índias Ocidentais e América do Sul.

Kitze (1958) foi responsável por intensivo trabalho de pesquisa sobre a germinação de numerosas espécies deste gênero. Os estudos iniciais, voltaram-se para a indução da germinação, através da submissão das sementes a prolongados períodos de embebição em água fresca, trocada diariamente.

As sementes submetidas a esse processo, eram invariavelmente, livres do pericarpo e como forma de prevenir o aparecimento de limo, o apodrecimento da semente ou o desenvolvimento de micro-organismos, a troca diária da água é considerada altamente eficiente.

As sementes com aparentes sintomas iniciais de apodrecimento, foram descartadas, após dissecação que revelou, em muitos casos, infestação por insetos. É recomendada a fumigação com brometo de metila, antes da embebição, pois da mesma é dito não decorrerem prejuizos à viabili

dade das sementes.

Em se tratando de viabilidade, o autor preconiza método simples de verificação e, que se fundamenta na afirmação de que sementes que flutuam não são viáveis. Assim, é procedido o descarte das sementes que flutuarem na água, sendo apontadas como causas mais frequentes os danos provocados por insetos e menos frequentemente, por fungos, além de que, a idade da semente está relacionada com a sua viabilidade. Foi registrada a germinação em até dois dias, de sementes de colheita recente, enquanto sementes velhas chegaram a requerer muitas semanas de embebição para germinarem. As sementes brotadas, como consequência do tratamento da embebição, foram plantadas, de imediato, em potes, emitindo a primeira folha, em cerca de 35 dias. São apontadas como vantagens desta técnica, em relação ao plantio da semente sêca, as taxas mais altas de germinação e a fácil distinção das sementes viáveis (pela brotação) das não viáveis, com consequente economia de tempo, trabalho, material e espaço. O autor sugere a possível aplicação do método a outras palmeiras de sementes similares. Foram estudadas neste trabalho, 15 espécies de Copernicia, sendo uma do Brasil, uma do Paraguai, uma da Venezuela e doze de Cuba.

Espécie: C. australis Becc.

Kitze (1958), no mesmo trabalho, em função dos péssimos resultados alcançados na aplicação do método de embebição, na espécie do Paraguai (C. australis), aparentemente com sementes dormentes, submeteu-as a diferentes tratamentos, sendo: 1) congelamento, em bandejas com cubos de gelo (24 horas) e posterior degêlo, em água de torneira; b) Resfriamento em água, à temperatura de refrigerador (48 horas); c) Embebição em água quente (5 minutos a 70ºC); d) Banho em ácido sulfúrico a 10% (15 minutos); e) Aeração contínua em água (7 dias); f) Escarificação da capa da semente, em região próxima ao embrião; g) Controle: apenas trocas de água.

Os resultados, segundo os critérios do autor, foram excelentes no tratamento de Escarificação; bons, naquele do Banho em ácido sulfúrico; e, fracos para o de Aeração. Os demais não foram melhores que o controle. Sementes submetidas à embebição durante nove meses, mostraram-se ainda, viáveis e germinaram em quase 100%, após escarificadas.

Tecendo considerações sobre o habitat de C. australis, o qual por ser sujeito a inundações, produz encharcamento ao redor das palmeiras por longos períodos, Kitze (1958) relaciona a degradação microbial da capa da semente, sujeita ao encharcamento no seu habitat natural, como uma forma de estímulo à germinação, similar à escarificação. Entretanto, não foi tentado o tratamento de permitir a degradação por microorganismos, da capa da semente.

Convém ressaltar observações do autor sobre o posterior desenvolvimento de plântulas, após a extirpação da "aba" da capa da semente, sobre o embrião. Quando esta operação foi imperfeita, provocando corte na extremidade embrionária, houve invariavelmente, a formação de um atípico e fibroso crescimento da estrutura embrionária, que continuou atípico até que o endosperma estivesse exausto. Como consequência desse tipo de dano, os espécimes, raramente produziram plântulas normais.

Gêneros: Desmoncus

Palmeiras do tipo ascendentes, raramente cultivadas. Distribuição: América Tropical.

Braun (1968), tece curtas considerações sobre o cultivo dessas palmeiras, utilizando canteiros com aquecimento e sementes necessariamente frescas, pois é dito terem as mesmas grande facilidade em perder sua viabilidade. Ao mesmo tempo que registrou a germinação de sementes de

Desmoncus aos 40 dias, reporta-se a uma grande variação de tempo, que abrange de 2 até 29 meses, requeridos por algumas sementes para sua germinação.

ESPÉCIE: D. orthacantos Mart.

Braun (1968), mostra tabela, contendo percentagens de germinação ocorridas depois de 300, 540-660 e 730 dias, sendo as mesmas, respectivamente, de 20%, 70% e 2%.

GÊNERO: Elaeis

Um dos mais importantes gêneros da família Arecácea, juntamente com Cocos e a maior fonte de óleo comercial entre as palmeiras. Também crescem como ornamentais nos trópicos e subtrópicos. Distribuição: África tropical e América.

ESPÉCIE: E. guineensis Jacq.

A pesquisa com germinação no gênero Elaeis, remonta de muitos anos e são inúmeros os trabalhos realizados sobre o assunto. Obviamente que, não serão apresentados aqui todos os trabalhos, mas procurar-se-á a apresentação de uma sequência cronológica, que reveja desde os primeiros passos da pesquisa até o estabelecimento das técnicas e métodos mais modernos da germinação em larga escala de sementes de Elaeis.

Bunting et al. (1934) tratam da germinação entre muitos outros aspectos do cultivo do Dendê na Malaia e frisam que já nos primeiros estágios da pesquisa naquele país havia sido concluído que, a remoção do pericarpo da semente fresca retarda a germinação, obtendo-se índice de 50% em período de 9 meses, sendo as sementes plantadas em canteiros com solo comum.

É reportado sobre investigação levada a efeito na Estação Central de Experimentação, Serdang, no sentido de acelerar a germinação, utilizando-se: a) Plantio das sementes em canteiros abertos e úmidos; b) Fermentação das sementes em covas, com camadas alternadas de esterco e sementes; c) Embebição das sementes em água aquecida duas vezes ao dia, até 45ºC, com posterior esfriamento; d) Embebição das sementes em soluções de ácido clorídrico, em várias concentrações. Dependendo do agente de calor, o método mais eficaz, foi o plantio em canteiros de areia abertos (75% de germinação em 16 semanas). Experimentos adicionais mostraram que, a cobertura dos canteiros com armação de vidro, aumentaria a taxa de germinação para 80%, em doze semanas. Em termos práticos, esses experimentos vieram a confirmar o efeito da temperatura sobre a taxa de germinação, sendo este efeito ratificado nos diversos testes efetuados nesse sentido.

Os autores relatam sobre similar pesquisa realizada na Sumatra, a qual revelava bons resultados com o uso de ácido, em menores períodos de embebição, ocorrendo mesmo, decréscimo na taxa de germinação, pelo prolongamento do período de imersão no ácido. Os melhores resultados foram obtidos com sementes frescas imersas por dois dias em ácido e lavadas em água (também por dois dias), antes do plantio em canteiros de areia (77% em 14 semanas).

Era recomendado o uso de sementes frescas, maduras, pois é dito que os experimentos mostravam taxa de germinação de 23% para sementes estocadas por 14 semanas contra 52% das sementes frescas, no mesmo período de tempo. Em sequência, são sugeridas algumas práticas para preparação das sementeiras, as quais eram constituídas de canteiros com areia lavada, expostos ao sol e, construídos segundo dimensões convenientes. O plantio das sementes era realizado dispondo as micrópilas voltadas para o solo cerca de uma polegada abaixo da superfície. Técnica adicional, dita de resultados mais satisfatórios, era a cobertura dos canteiros com arma

ções de vidro, como forma de proporcionar calor adicional. Os primeiros sinais de germinação, são afirmados evidentes, após um período de oito semanas.

Grist (1936), praticamente reporta-se sobre os mesmos aspectos da germinação de Elaeis, enfatizados por Bunting et al. (1934) e não apresenta absolutamente nenhuma novidade, além do que foi anteriormente descrito.

Galt (1953), os métodos comerciais de germinação de sementes e métodos melhorados, os quais eram baseados já nesta época, na manutenção de temperatura relativamente alta e uniforme (cerca de 37ºC), durante todo o processo germinativo.

Rees (1960), discute a classificação do tipo de germinação da semente de Elaeis guineensis. Baseado nos padrões morfológicos adotados por Gatin (1906) e seguidos por Tomlinson (1960), para caracterização dos tipos de germinação que ocorrem em palmeiras, o autor descreve os principais pontos observados no processo germinativo do Dendê e procede uma análise das características observadas e aquelas adotadas pelos autores supracitados. É dito ser o embrião pequeno e reto ou quase reto, tornando-se curvo durante a germinação, aparentemente devido ao crescimento da plúmula. A radícula, persistente e desenvolvida, é produzida na parte final distal do embrião após a projeção da plúmula. Raízes adventícias desenvolvem-se regularmente na região da junção radícula-hipocótilo. A lígula é cilíndrica, persistente e bem desenvolvida e, duas bainhas, sem lâminas, são produzidos antes do aparecimento da primeira folha laminada.

Comparando essas características, o autor conclui que, a germinação em Dendê é, superficialmente, semelhante ao tipo adjacente-ligulada (embrião curvo, plúmula e radícula obliquamente localizados, radícula não persistente, pecíolo não alongado e bainha ligulada). Entretanto, ressalva que, pelo fato do embrião ser reto, pode ser considerada, também, semelhante ao tipo remota-ligulada (embrião reto, plúmula e radícula obliquamente localizados, radícula persistente, pacíolo alongado e bainha ligulada).

Finalmente, são argumentadas algumas considerações sobre a adaptação fisiológica da semente, a qual não germina durante a estação seca, embora necessite de temperatura em torno de 38-40ºC, para seus primeiros estágios germinativos. Nas condições naturais, a germinação é retardada, até que a umidade do solo seja suficiente, como consequência do estabelecimento das chuvas.

Kee (1972), em trabalho abrangente, que inclue cultura, manejo e utilização do Dendê, na Malaia, informa sobre método de germinação de desenvolvimento recente na época e que consistia, básicamente, no tratamento pelo Calor Seco, que veio a substituir os métodos anteriores de germinação em caixas ou canteiros de areia.

O despolpamento do fruto, inicialmente, era realizado por invento rotativo, desenvolvido pelo Instituto de Pesquisas para Oleaginosas (I.R.H.O.), com capacidade para despolpar 6.000 frutos/hora. Seguido ao despolpamento, era procedida a embebição em solução fungicida e bactericida (3 minutos). Para germinação das sementes, era utilizado germinador elétricamente aquecido, desenvolvido pelo West African Institute for Oil Palm Research. Antes de irem ao germinador, as sementes são submetidas à embebição por sete dias e secas à sombra por 24 horas, após o que, são colocadas em sacos de polietileno, os quais são dispostos em prateleiras de arame no germinador, onde permanecem por 80 dias à temperatura de 38-40ºC. São, então, re-embebidas em água (7 dias) e secas ao ar, como forma de alcançar conteúdo de umidade em torno de 21-22% (dura) ou 28-30% (tenera), sendo novamente ensacadas e mantidas à temperatura ambiente. As radículas emergirão cerca de 10 dias depois, sendo as sementes germinadas removidas dos sacos e

despachadas para plantio. A taxa de germinação é dita de 85-90%.

Turner & Gillbanks (1974), também tratando sobre aspectos gerais do cultivo e manejo desta importante palmeira, descrevem as técnicas de preparação e germinação da semente.

Após a obtenção dos frutos, estes devem ser despolpados. É citado um método mais antigo de despolpamento, que consistia na embebição dos frutos por duas semanas, com esmagamento regular da polpa com um largo pilão de madeira. Havia sempre tendência ao desenvolvimento de microorganismos nos restos do mesocarpo. Método mais moderno consiste na utilização do despolpador mecânico, que consiste de uma estrutura giratória, provida de escarificadores que raspam o mesocarpo. Após despolpadas, são as sementes embebidas em solução de Thiram e Estreptomicina, como forma de desinfecção e prevenção contra o desenvolvimento de microorganismos. Segue-se a secagem por dois dias (em sala para tal), até que a umidade seja reduzida para uma média de 17% sobre a matéria seca. Feito isto, as sementes são ensacadas e estocadas em salas com temperatura controlada em torno de 38-40ºC, por um período de 40 dias, após o que, são embebidas em água (2 dias) e novamente tratadas com fungicida e antibiótico, estando nessa ocasião, o conteúdo de umidade em 22%, sem umidade superficial, após o tratamento anti-microbia. Retornadas aos sacos de polietileno e estocadas à temperatura ambiente, as sementes germinam 7 a 10 dias depois, continuando por 30-40 dias, a taxa de 85-90% de germinação.

Mais tarde, foi utilizado o método do calor Umido, que difere do descrito pelo fato de que, as sementes não são primeiramente secas para um conteúdo de umidade mais baixo, com resultados, em geral, inferiores ao método do calor seco.

Para estocagem das sementes, é recomendado, inicialmente, a liberação do pericarpo e en

tão, secagem, antes de estocar em sacos de polietileno, em ambiente de ar condicionado, podendo assim permanecer sem considerável perda do poder germinativo.

Hartley (1977), aborda praticamente, todos os aspectos inerentes a germinação de *E. guineensis*. Inicialmente, são feitas importantes observações sobre a fisiologia da germinação do Dendê. É dito que, em condições naturais, as sementes germinam, aproximadamente, 60 dias após a primeira forte chuva e é mostrada tabela sobre a condição de sementes não germinadas, no fim de período de 2-2,5 anos, sob diferentes habitats, para determinação do nível de predação. É considerado que, embora amêndoas não possam ser convenientemente germinadas em larga escala, foram os experimentos com elas, que abriram caminho para o entendimento do processo germinativo e do valor das altas temperaturas, tanto para a germinação das amêndoas quanto dos frutos, germinando, ambos, à mesma velocidade, aproximadamente.

Foi mostrado que, as altas temperaturas (38-40ºC), aumentando a tensão do oxigênio, notavelmente aceleravam o processo, o que não acontece à temperatura ambiente, deixando patente a importância do suprimento de oxigênio e demonstrando, que a germinação sofria inibição, até que algum processo induzido pela alta temperatura, tomasse lugar.

Trabalho fisiológico subsequente estabeleceu os "ótimos" de umidade e temperatura para satisfatória germinação das sementes, sendo:

a) Umidade (peso seco) - semente dura : 21-22%
semente tenera : 28-30%

b) Temperatura - amêndoas, úmidas - : 40ºC
sementes, secas - : 42ºC

Em resumo, conclui-se que, o Dendê apresenta um certo requerimento de umidade, oxigênio e temperatura, para germinação de suas sementes.

A temperatura, pode ser considerada separadamente da germinação por si própria, e satisfeita com um pré-tratamento. Em relação à umidade, seu conteúdo ótimo foi definido, enquanto que o requerimento de oxigênio é satisfeito pelo suprimento de um ótimo de umidade para a germinação, depois que a semente tenha sido levada para a temperatura ambiente.

Numa etapa seguinte, o autor aborda variados aspectos, que vão desde a preparação da semente, sua estocagem, métodos de germinação e transporte, citando resultados obtidos por outros autores no estudo do processo germinativo do Dendê. Em relação à preparação da semente, uma vez colhida madura (manualmente), deve ser, então, despolpada, assinalando três diferentes métodos para tal. O primeiro método, impraticável em grandes quantidades de sementes, mas de bons resultados em pequena escala, consiste na raspagem à faca, o segundo, consta de Imersão das sementes em água, corrente ou parada, por período de 10 a 20 dias, com posterior socagem das sementes com areia, em recipiente de madeira, para remover o mesocarpo aderente; o terceiro método, é a utilização de despolpadores mecânicos, para grandes lotes de sementes. A secagem das sementes, etapa subsequente ao despolpamento, é objeto de discussão, uma vez que, existiam dúvidas em relação as condições de secagem: se à luz do sol ou à sombra.

Rees (1965), testou a germinação de lotes de sementes secas ao sol e à sombra. Os resultados mostraram germinação mais satisfatória nas sementes secas à sombra, por período não prolongado (máximo de 2 dias).

Sobre a estocagem das sementes, é efetuada uma sequência histórica dos estudos, que inicia com Vanderweyen (1952), falta referência no Zaire, e que observou diminuição da velocidade de germinação após 4 meses de estocagem das sementes, havendo drástica redução na germinação após 10 meses. Esses resultados foram contestados por Galt 1953, que observou efeito contrário e por experimentos posteriores realizados no Zaire, confirmando a germinação mais precoce de sementes estocadas. Trabalho de Rees (1963), testando o efeito sobre a germinação, da estocagem de sementes em larga escala à temperatura ambiente (27ºC) e ar condicionado (22ºC), quando estocadas em conteúdo de umidade, aproximadamente em torno do ótimo, após secagem à sombra por período de 2,5 dias, conclui que a viabilidade pode ser mantida a temperaturas ambientais, em conteúdos de umidade baixos demais para germinação ou à baixas temperaturas, sob mais altas condições de umidade.

A viabilidade manteve-se alta além de 12 meses, em todos os tratamentos. Outro experimento de Rees (1965) é citado, desta vez testando sementes acondicionadas em sacos de polietileno, expostos e não expostos ao ar, além de sementes não acondicionadas mas expostas, também, ao ar, usando baixa temperatura e temperatura ambiente. É afirmado ter sido obtida taxa de germinação entre 92 e 100%, após período de estocagem de 1 ano. Como conclusão final, pode ser dito que, a semente pode ser satisfatoriamente estocada à temperatura ambiente sem grande perda de viabilidade, se ela for, cuidadosamente, seca à sombra (em período máximo de 2 dias). A estocagem em tambores de 44 galões, providos de tampa de madeira, também tem sido satisfatória, ainda que muitos produtores optem por sacos de polietileno em temperatura de ar condicionado (22ºC).

Entre os métodos utilizados para germinação de sementes de Elaeis, são apresentados:

1) Caixas de fermentação - Constam basicamente, de caixas de dimensões convenientes, afundadas até 1/3 no solo, providas de telhado inclinado e supridas com material fermentável, no qual são colocadas as caixas que contém as sementes para germinação, misturadas com carvão úmido. O sistema não é plenamente satisfatório, uma vez que, a germinação exige 5 a

6 meses para completar-se; entretanto, pode ser recomendável onde não haja outros meios. (Fig. 2. A, B, C).

2) Germinadores tipo forno e aquecidos a água - Consistem de unidades com um número de câmaras mais latas e mais baixas, sendo estas últimas para produção do fogo com madeira, e as primeiras, para as caixas com carvão e sementes ou, sacos de polietileno colocados sobre prateleiras. As câmaras são separadas por folhas de metal, cobertas com uma camada de cimento.

3) Sistemas aquecidos a água - Constam, fundamentalmente, de um abrigo para a caldeira e uma sala de germinação, provida de canos para água quente. A caldeira é alimentada por lenha. As paredes podem ser em blocos de concreto, com duplo teto. Os canos de água quente situam-se abaixo do estágio onde são dispostas as caixas contendo os sacos de polietileno com sementes. A temperatura pode ser controlada termostáticamente.

4) Germinadores aquecidos e controlados eletricamente - Construção de concreto, segundo dimensões adequadas com paredes duplas e teto, também com dupla camada de asbestos, além de duplas portas, que cercam espaço fechado onde estão alojados os interruptores e controles. O germinador é aquecido por aquecedores de 500 watts, montados em frente a um ventilador de 1/6 HP e, situados no chão, contra a parede do fundo. A aeração é feita por exaustor, periodicamente, em um louvre, que abre quando o exaustor está em funcionamento; ambos são controlados por interruptor de tempo. Um ventilador oscilatório distribue a temperatura, evitando a formação de "ilhas" de diferentes temperaturas no interior da sala. Altamente recomendável para germinação de sementes em larga escala. (Fig. 2 D).

Em se tratando de técnicas de germinação de sementes de Dendê, duas são as mais importan

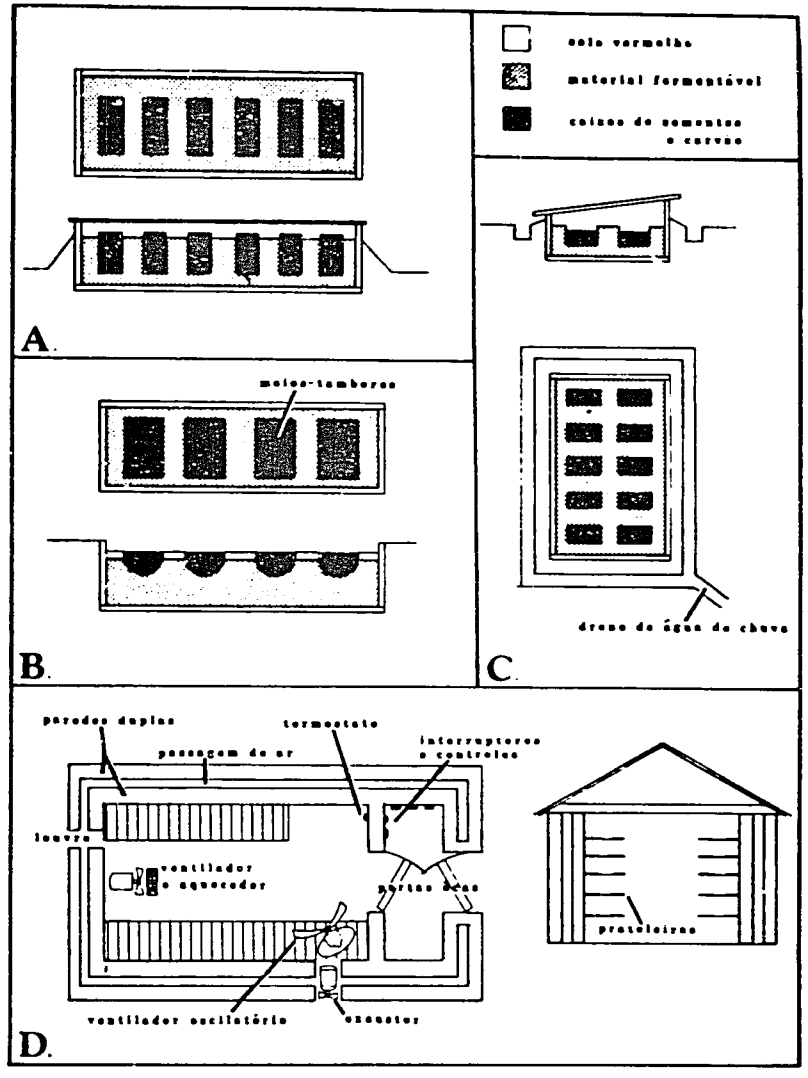

FIG. 2. Germinadores. (cont.)
A., B. e C. Caixas de Fermentação.
A. Caixa de Fermentação elevada com caixas de sementes enterradas. (Vanderweyen 1952)
B. Caixa de Fermentação abaixo do nível do solo (Desneux 1957)
C. Caixa de Fermentação coberta com dupla fileira de caixas de sementes (Marynen e Bredas 1955)
D. Germinador elétricamente controlado (Rees 1959)

tes: tratamento pelo Calor Úmido e tratamento pelo Calor Seco.

Utilizando a técnica do Calor Úmido, as sementes são embebidas em água por 5 dias, com troca diária da água, após o que, são secas à sombra (2 horas), para eliminação da umidade superficial. São, então, colocados em sacos de polietileno, que após lacrados, são dispostos em caixas, as quais são levadas ao germinador, cuja temperatura deve estar em torno de 39ºC.

Procede-se o exame das sementes duas vezes por semana, sendo na oportunidade, molhadas com jatos tipo spray, conservando o ótimo conteúdo de umidade. Após 80 dias, as caixas são removidas do germinador e postas em local conveniente para o esfriamento, sendo a germinação iniciada poucos dias após o esfriamento e completando-se, em 15-20 dias.

No tratamento pelo Calor Seco, após a embebição por 5 dias (também com troca diária da água), as sementes são submetidas à secagem à sombra (24 horas), para obtenção de um conteúdo de umidade, sugerido em 17%. São, na sequência, colocadas nos sacos de polietileno, sendo estes lacrados. Após 80 dias, remoção das sementes e re-embebição em água (5 dias), secas à sombra (2 horas), para remoção da umidade superficial e novamente, colocadas em sacos de polietileno, depois de tratadas com TMTD e Estreptomicina. Os sacos devem ser mantidos em lugar frio, sendo examinados duas vezes por semana e molhados com spray, mantendo-se, assim, sempre o conteúdo ótimo de umidade para germinação. Após 10 a 20 dias a germinação inicia-se, após o que, estará completada em 10 a 15 dias mais.

Na Malaia, para transporte, as sementes são colocadas em sacos de polietileno (200 sementes por saco), os quais são acondicionados em caixas com vermiculita (15 sacos por caixa).

As sementes podem ser, também, enviadas em sacos de polietileno ao fim do período de calor seco e o conteúdo de umidade pode ser ajustado

à um ponto ótimo para germinação na chegada ao destino.

GÊNERO: Euterpe

É este gênero, a maior fonte de palmito, o qual é consumido fresco ou processado por fábricas de conservas e comercializado, principalmente no Brasil. São palmeiras ornamentais, mas um tanto quanto frágeis e desenvolvem-se apenas nos trópicos. Distribuição: América Tropical.

Calzavara (1972) considera as espécies E. oleracea, E. precatoria, E. edulis, como as mais importantes do gênero, ao tratar dos aspectos gerais do açaizeiro. Para propagação, são vistos dois diferentes métodos: através de sementes ou por brotação da base do estípite. O método recomendado é o de sementes, que é dito mais vantajoso e de melhores resultados, uma vez que se disponha, óbviamente, de boas sementes. Como forma de acelerar a germinação, é sugerida a imersão dos frutos em água quente (tal como efetuado para o preparo do "vinho"). É afirmado que, devido ao choque térmico recebido, as sementes iniciam a germinação em 25-28 dias, enquanto que, quando não submetidas a tal tratamento, as mesmas somente germinam com 30-33 dias.

O Instituto Agronômico de Campinas (1974) publica estudos sobre o cultivo do palmiteiro, com especial ênfase para o gênero Euterpe, em duas espécies (E. edulis e E. oleracea), destacadas como principais produtoras de palmito.

Sobre germinação, é dito que as sementes são de germinação bastante lenta, apresentando período de dormência, variável segundo a estação do ano e que o seu poder germinativo é perdido muito facilmente. Como resultado de ensaios de germinação realizados, foi concluído que, para acelerar e uniformizar o processo germinativo, deve ser procedido o despolpamento da semente (procedimento para tal é sugerido), e que o

uso de cobertura morta retarda a germinação.

A conservação de sementes foi também enfocada e os estudos revelaram grande facilidade para a perda do poder germinativo. Sugere-se o armazenamento em sacos plásticos, pelos resultados observados, em períodos até cinco meses de armazenamento, sem grandes despesas. Em geladeira (5-10ºC), os resultados foram, também, satisfatórios, com conservação da viabilidade da semente pelo mesmo período (5 meses), impedindo a germinação no recipiente, o que ocorre em condições de alta umidade e temperatura ambiente.

A profundidade de semeadura foi objeto de ensaio, realizado com a espécie E. edulis, sem resultados publicados, uma vez que, não estavam finalizados. Na sequência, são sugeridas práticas para instalação de um palmital, que abrangem desde a semeadura até a colheita. Em relação à semeadura são dadas duas opções: em laminados, com a semente e 2 cm de profundidade, sendo considerado método seguro, mas pouco econômico, com a germinação ocorrendo em até seis meses; e, direta, menos onerosa, mas com maiores riscos de perdas de sementes.

ESPÉCIE: E. edulis Mart.

Mattos & Mattos (1976) abordam amplos aspectos de E. edulis e referem-se a técnicas para o cultivo, que envolvem a preparação da semente, armazenamento, semeadura e germinação, em sequência até o plantio.

Como preparação é sugerido o despolpamento (por maceração, após 24 horas em água fria) e secagem à sombra (2 dias), após o que, é procedido o armazenamento, por período nunca superior a um mês, pois há perda do poder germinativo.

A semeadura aconselhada é aquela realizada em canteiros, preparados segundo práticas adequadas. A semeadura é feita em sulcos, nos quais são dispostas as sementes. A semeadura direta é desaconselhada, a não ser em casos da im

possibilidade da semeadura em canteiros.

O processo germinativo é descrito, a partir de oito dias após a semeadura, época em que é notado o afloramento do embrião à superfície da semente. Aos 15 dias, é dito ocorrer o rompimento da parte dura da semente pelo embrião. Aos 30 dias, foi observado o cotilédone, com caulículo e radícula evidenciando-se, desenvolvendo-se aos 45 dias e, completando o processo germinativo aos 60 dias, quando, então, começam a surgir folíolos.

Na sequência, são consideradas algumas práticas, a partir da repicagem das mudas até o plantio.

ESPÉCIE: E. globosa Gaert. (= E. edulis Mart.)

Bannister (1970), em floresta de Porto Rico, estudou diferentes aspectos do ciclo de vida de Euterpe. A germinação foi observada em ocorrência natural, na floresta, além de, em câmara ambiental.

Foi concluído que, aparentemente, as sementes desta espécie, não apresentam dormência, pelo menos por grandes períodos de tempo. O processo germinativo completou-se em três meses, na câmara ambiental, em percentual de 30,9%. Após seis meses este percentual foi de 65%. Na floresta, as estimativas revelaram um índice de germinação de 53%, com 1,4 sementes/m² e 0,75 seedlings/m².

É sugerido que, as sementes de Euterpe devem perder rapidamente sua viabilidade, se as condições não se mostrarem favoráveis à sua germinação. Essa sugestão é proveniente do fato de que, os frutos secos examinados mostraram conteúdo de água de 72,8%, considerado alto e característico de sementes desprovidas de mecanismos de dormência, adaptadas para germinação imediata.

Em amostras de solo, foram encontradas fortes infestações por larvas e adultos de insetos

(Coleoptera), que não interferiram significativamente, nas percentagens de germinação.

ESPÉCIE: E. oleracea Mart.

Santos et al.(1973), utilizaram sementes obtidas do mesmo cacho e divididas em lotes, com acondicionamento em sacos plásticos, sendo um lote conservado com polpa e o outro despolpado manualmente, além de um terceiro lote formado a partir de sementes despolpadas à máquina, obtidas em posto de venda de "vinho". Os três tratamentos, com 6 repetições, foram locados em sementeiras, em delineamento experimental "Split plot", com sombra e sem sombra. O período de duração do experimento foi de 60 dias. É apresentado quadro que mostra a produção experimental, em número de sementes germinadas por 950m² (área útil de cada sub-parcela), aos 30, 40, 50 e 60 dias após a semeadura das sementes, além de gráfico que registra a percentagem de germinação aos 60 dias, em cada tratamento, com sombra e sem sombra.

Em geral, os resultados obtidos, levaram à conclusão de que o não sombreamento, em qualquer dos três tratamentos utilizados, retarda a germinação e provoca queda no seu percentual; o despolpamento das sementes antecipa o início da germinação e eleva o seu percentual. Pela aplicação de testes estatísticos teve-se que, não houve diferença significante entre os tratamentos de sombreamento com sementes despolpadas à máquina e sombreamento com sementes despolpadas à mão, em nenhum dos períodos de observação, mas que ambos foram, superiores aos demais. Finalmente, os autores recomendam o plantio à sombra, como forma de elevar a percentagem de germinação e reduzir o período do processo.

O trabalho foi realizado no Estado do Pará, Brasil.

GÊNERO: Livistona

Palmeiras largamente cultivadas como ornamentais nos trópicos e subtrópicos. São, também, utilizadas como plantas de jarros, em residências ou casas de vegetação. Distribuição: Ásia, Indonésia, Austrália, Nova Guiné, Filipinas e Ilhas Solomon.

ESPÉCIE: L. mariae F.J. Muell.

Lothian (1959) dispensa particular atenção à germinação desta espécie, após referências às condições de habitat das palmeiras e comportamento dos Seedlings no campo. A experimentação com germinação, teve lugar no Jardim Botânico de Adelaide, Austrália.

As sementes utilizadas nos estudos, oriundas de coletas no campo, foram classificadas por grupos, em função do estado físico de sua capa, sendo:

a) Exocarpo inteiro;
b) Exocarpo levemente rachado;
c) Exocarpo em início de degradação;
d) Sem exocarpo;
e) Sementes velhas, em péssimo estado de conservação.

A semeadura foi realizada em potes, com uma mistura de solo (dita baseada no padrão do John Innes), os quais foram enterrados em local com controlada temperatura, em torno de 26º C. Dez sementes de cada grupo foram plantadas, por pote. As primeiras observações foram efetuadas 5 semanas mais tarde, após o que, seguiram-se novas contagens, periodicamente. A contagem final teve lugar 15 semanas após o plantio, registrando-se, em termos gerais, os seguintes resultados:

1) No grupo a haviam quatro plântulas, sendo duas de germinações recentes. A plântula de maior

vigor, apresentava folha de cerca de 30cm de comprimento. Havia, também, cinco sementes germinativas, as quais não haviam, ainda, emitido folhas à superfície, além de uma semente não germinada, mas considerada viável, após dissecação;

2) No grupo b, quatro plântulas (duas morreram). No interior do solo, mais duas sementes germinadas. As quatro sementes restantes foram ditas viáveis;
3) No grupo c, foram registradas seis plântulas, sendo que quatro morreram, posteriormente. As sementes restantes estavam apodrecidas;
4) No grupo d, foram produzidas dez plântulas, consideradas vigorosas, sendo registrada a morte posterior de uma. As plântulas apresentavam folhas de cerca de 35cm de comprimento e algumas delas, já emitiam uma segunda folha;
5) Não houve germinação no grupo e. As sementes foram encontradas apodrecidas. É suposto já estarem mortas, antes do plantio.

Os resultados do grupo d, foram reputados a ausência do exocarpo, que é dito, possivelmente, abrigar agentes inibidores da germinação, em sua camada polposa.

GÊNERO: Lodoicea

Integrantes do grupo conhecido como palmeiras-leque. Raramente cultivadas e de crescimento muito lento, são notáveis pelas suas sementes, as maiores do reino vegetal. Adequadas para jardins nos trópicos. Distribuição: Ilhas Seychelles.

ESPÉCIE: L. maldivica (C.F.Gmel.) Pers.

Alguns autores propuseram-se à descrição do processo germinativo desta espécie, denominada maldivica pelo pensamento errôneo, de terem

seus frutos procedência das Ilhas Malvinas, ao serem encontrados flutuando no Oceano Índico. As descrições, na verdade, não são satisfatórias em completo, uma vez que, em geral, carecem de maior embasamento na caracterização morfológica e fisiológica das estruturas envolvidas no processo.

Cook (1917), considera que, após o desenvolvimento do cotilédone e posterior emissão de raízes, em sua extremidade (hipocótilo), ocorre a emergência da plúmula, através de fenda lateral, proporcionando a presença de uma bainha basal no cotilédone e nas folhas subsequentes. O embrião, depois do enterramento da base do cotilédone, encontra dificuldade para emergir à superfície do solo, forçando, assim, um processo de especialização nos internódios inferiores da plântula, os quais, em vez de produzirem folhas completas, produzem apenas folhas rudimentares, em forma de bainhas, sem lâminas.

Bailey (1942) reporta-se de forma mais completa, aos aspectos da germinação de L. maldivica. É dito que, o desenvolvimento da estrutura cotiledonária, é condicionado pelas condições, propícias ou não, para sua penetração no solo. Afirma que a estrutura "em cordão", não é o hipocótilo, e sim a base do cotilédone, bastante alongada, com a radícula em sua parte final e, contendo a plúmula.

Descrição de todo o processo germinativo é apresentada segundo o que escreveu Mr. Vesey-Fitzgerald, por Bailey publicado, segundo observações registradas nas Ilhas Seychelles. Foi escrito que, após um período de cerca de 5 anos na planta, após completamente desenvolvidos, os frutos caem ao chão e são, então, descascados, por pancada sobre pedra. As sementes a serem utilizadas na germinação são estocadas por seis meses, após o que, podem ser plantadas. O plantio consiste, em dispor as sementes, deitadas sobre solo úmido, devendo ser a umidade conservada, mas o encharcamento evitado. Situado em

um septo entre dois lobos na semente, há uma espécie de "olho". A germinação é iniciada com o crescimento de uma estrutura, a partir dos lobos da semente, que penetra o "olho" forçando o desenvolvimento em direção ao solo e penetrando-o até certa profundidade. Essa estrutura, derivada do haustório (que se encontra embebido no endosperma), entumesce para formar um corpo em forma de fuso, no qual o embrião está situado. A plúmula, então, cresce em direção à superfície do solo, atravessando o "fuso"; enquanto que, do embrião, cresce para baixo, uma raiz proeminente, da qual partem raízes laterais menores. Nesta fase, o haustório aumenta de tamanho dentro da semente, apresentando dois lobos. O endosperma apresenta uma zona mole (ao redor do haustório), enquanto o restante é branco e bastante duro. Por essa ocasião, já se passaram, mais ou menos, 9 meses, após o início do processo. A plúmula continua a crescer, até se projetar acima da superfície do solo. A primeira folha é produzida, emergindo protegida por envoltório da plúmula. A conexão da plântula com a semente apodrece em 3 ou 4 anos, tornando a planta independente.

GÊNERO: Orbignya

Palmeiras de lento crescimento, em geral, requerendo muitos anos para produzir um caule emergente. Produzem amêndoas oleaginosas o que as torna comercialmente importantes onde nativas. Cultivadas muito pouco frequentemente, como ornamentais, nos trópicos e subtrópicos. Distribuição: América do Sul e Central.

Frazão & Pinheiro (1981) e Frazão et al. (1981) efetuaram experimento exploratório com a germinação de amêndoas de Orbignya, fora do pericarpo do fruto. As amêndoas foram extraídas dos frutos inteiros e maduros, evitando-se, tanto quanto possível, ferimentos nas mesmas. A seguir, foram submetidas aos seguintes tratamentos:

1) Embebição, por 3 horas, em ácido giberélico;
2) Embebição, por 3 horas em ácido giberélico e tratamento anti-fúngico;
3) Somente tratamento anti-fúngico;
4) Controle - sem tratamento.

As amêndoas assim tratadas, foram dispostas em dois diferentes ambientes, para germinação, sendo: germinador, à temperatura na faixa de 20-20ºC e caixas com areia lavada e esterelizada em autoclave. Foram utilizadas 50 amêndoas, para cada tratamento. No germinador, as amênodas foram envolvidas em papel utilizado para germinação de sementes em laboratório, o qual foi umedecido sempre que necessário.

Os resultados mostraram uma mais alta percentagem de germinação nos tratamentos com ácido giberélico, nos dois ambientes. Os tratamentos com somente fungicida apresentaram as mais baixas taxas de germinação, tanto no germinador quanto em caixas de areia. Os autores concluem que, o ácido giberélico estimula a germinação de amêndoas de Orbignya, ainda que a germinação aconteça, também, em amêndoas sem tratamentos, sendo, a busca dessa evidência, um dos principais objetivos do trabalho. Em geral, a germinação ocorreu sem uniformidade e em percentuais baixos. O delineamento experimental utilizado foi o Qui-quadrado, havendo significância em ambos os casos (germinador e caixas de areia), ao nível de 5%. Este experimento foi o marco inicial dos estudos sobre a germinação de amêndoas, fora do pericarpo, neste gênero e, veio a mostrar a viabilidade desse método germinativo.

Frazão & Pinheiro (1982) continuando os testes com a germinação de amêndoas de Orbignya, concluiram que, existe uma pequena capa, na zona de localização do embrião, a qual situa-se externamente, sobre o tegumento e que funciona como uma barreira à emissão mais rápida, do eixo cotiledonário. A eliminação dessa capa pela

escarificação, estimula e uniformiza a germinação, alcançando-se percentagens de até 90%, com as primeiras germinações iniciando-se com cerca de 3 dias, enquanto que, sem a utilização de escarificação, as amêndoas começavam a germinar em cerca de uma semana e continuavam em total desuniformidade.

Note-se, entretanto, que alguns pontos devem ser atentados, para o sucesso da germinação de amêndoas de babaçu, pela utilização do método:

1) As sementes não podem ser muito velhas e/ou danificadas;
2) As amêndoas devem ser extraídas dos frutos, evitando-se, tanto quanto possível, os ferimentos;
3) A escarificação deve ser procedida, após embebição prévia em água, por período considerado satisfatório (7 dias);
4) A escarificação é feita de forma cuidadosa, assegurando-se contra a danificçaão do embrião (podem ser usadas facas, canivetes ou mesmo, as unhas);
5) Após a escarificação, as amêndoas são colocadas no meio de germinação (os autores utilizaram vermiculita), em posição horizontal.

Uma vez que as sementes tivessem emitido o eixo cotiledonário e que este alcançasse um comprimento razoável (cerca de 5-10cm), eram transferidas para sacos plásticos, com terra e esterco, para complementação do processo germinativo, até a emissão da primeira folha.

Frazão & Pinheiro (1982), trabalhando na implantação do Banco de Germoplasma de Babaçu, no município de Bacabal, Maranhão, Brasil, utilizaram a técnica da germinação de amêndoas, com relativo sucesso.

As amêndoas foram extraídas dos frutos, os quais foram, anteriormente, submetidos à secagem ao sol por aproximadamente 15 horas. A extração das amêndoas foi realizada por pessoas de grande prática nessa atividade, recomendando-se todo o possível cuidado, para evitar danos às sementes. As amêndoas extraídas foram postas a germinar em caixas (40 x 50cm), confeccionadas em compensado marítimo e preenchidas com vermiculita. As caixas foram dispostas sobre jiraus cobertos de palha da palmeira babaçu, à cerca de 80cm do solo; as amêndoas, dentro das caixas com vermiculita foram arranjadas horizontalmente. As irrigações eram feitas regularmente, segundo as necessidades d'água, observadas nas caixas; mas, de um modo geral, uma irrigação diária revelou-se suficiente.

As amêndoas, após a emissão do eixo cotiledonário, eram transferidas para sacos plásticos (40 x 50cm), contendo mistura de solo e esterco, na proporção de 1 : 3 e, alojados sob cobertura de palha. A época de transferência, era condicionada ao comprimento do eixo cotiledonário, o qual não deve tornar-se muito longo, pois dificultará o seu alojamento nos sacos com terra e esterco e, aumentará a possibilidade de provocar danos nos mesmos. Acredita-se que, o comprimento ideal para transferência, está em torno de 5-10cm.

Em relação às percentagens de germinação, pode-se dizer que foram bastante variáveis e isto é explicável, pelo fato de estarem sendo utilizadas diferentes sementes, oriundas de trabalho de coleta em seis diferentes populações, em cinco estados brasileiros e, sujeitas à variadas condições, além de, lógicamente, apresentarem variáveis idades. Em geral, a germinação foi bastante desuniforme, em quase todas as populações. O método da escarificação da região do embrião foi tentado, após determinado tempo de permanência das amêndoas na vermiculita, daquelas que não apresentaram germinação, revelando-se de grande auxílio, nas sementes ainda viáveis.

Após a transferência para os sacos plásticos, as amêndoas brotadas, emitiam a primeira folha em período variável de 2 a 4 semanas, pe

ríodo este, acreditado em função do estágio de desenvolvimento do eixo cotiledonário, por ocasião da transferência. Foram registrados casos de amêndoas que emitiram mais de um eixo cotiledonário (um caso de até seis), mas tais sementes não conseguiram desenvolver plântulas.

ESPÉCIES: O. martiana Barb. Rodr.

Anderson & Anderson (1983), trabalhando no interior do Estado do Maranhão, Brasil, estudaram diferentes aspectos da palmeira, localmente denominada Babaçu, entre os quais, a germinação e a viabilidade de suas sementes.

Para acompanhar o desenvolvimento da germinação no transcorrer do tempo e as prováveis variações, entre frutos de diferentes plantas, foram tomados 100 frutos por palmeira (em total de 10 palmeiras), os quais foram descascados e postos a germinar. As observações foram efetuadas mensalmente, em período de 5 meses. Os autores revelam que a germinação das sementes ocorreu regularmente durante três meses, finalizando no quarto mês e consideram como fator de grande influência, a condição de alta umidade, resultante da estação de chuvas. Sugerem um provável e parcial controle genético do processo germinativo, pela alta variação encontrada na germinação das 10 palmeiras tomadas no experimento.

Adicionalmente, sementes de babaçu foram submetidas a condições de queima pelo fogo (moderado e intensivo), remoção do mesocarpo e sombreamento. Foram utilizados 100 frutos por tratamento, obtidos de uma única palmeira e a germinação era observada semanalmente, quanto à emissão de eixos cotiledonários. Em relação ao fogo, é concluído que, moderadamente (tal como a queima anual de pastos), não influe na germinação, enquanto o fogo intensivo (tal como a queima da mata para instalação de cultivos temporários) a afeta negativamente. Por outro lado, a remoção do mesocarpo, é dita promotora da germinação, do mesmo modo que, melhores resultados foram registrados no sombreamento.

O tipo de germinação é dito criptógea. É em geral descrita, pela emergência de um ou mais eixos embrionários (plúmula, cotilédone e radícula), a partir da base do fruto. Tais eixos penetram no solo até profundidades variáveis, diferenciando-se em folhas e raízes. A sugestão desse tipo de germinação para Orbignya é baseada em descrição de Jackson (1974), e proposta como de ocorrência na aliança Attalea, além de em, vários grupos de palmeiras. Esse tipo de germinação habilitaria essas palmeiras a uma vigorosa regeneração em áreas sujeitas às queimadas e devastações frequentes, pelo fato de apresentarem o meristema apical subterrâneo em suas plântulas e plantas jovens pré-emergentes.

Os autores efetuaram, ainda, experimentação sobre a viabilidade das sementes do babaçu, em experimentos montados para acompanhar o estado da semente durante o transcorrer do tempo, em diferentes períodos. Os resultados foram registrados quanto ao número de sementes depredadas, defeituosas (abortadas ou estragadas), germinadas e dormentes. Um dos experimentos foi montado em áreas de pastagem, floresta secundária e campo, através da montagem de grupos de frutos, dos quais vinte eram retirados trimestralmente, para observações. O outro experimento utilizou sementes provenientes de áreas limpas e áreas que mantinham a vegetação de mata (ervas daninhas e arbustos). Também foram utilizados vinte frutos de cada área (10 áreas, em total). O primeiro experimento teve a duração de um ano e, o segundo, foi medido aos 18 meses. Os resultados, levaram os autores a concluir, finalmente, que os frutos de O. martiana conservam a viabilidade de suas sementes por período superior a um ano, mesmo quando sujeitos a forte predação.

GÊNERO: Phoenix

Espécies deste gênero são importantes como fonte de frutos e de açúcar, além de bastante utilizadas como ornamentais. São cultivadas e de ocorrência natural, havendo muita variação entre as espécies, ocorrendo hibridação entre elas e proporcionando a que muitas formas cultivadas, sejam de provável origem híbrida. Distribuição: África tropical e subtropical e Ásia.

ESPÉCIE: P. dactylifera Linn.

Swingle (1904) desaconselha a utilização de sementes como forma de propagação da Tamareira para fins comerciais, pelo fato de resultarem em metade das palmeiras masculinas, que não produzem frutos, enquanto que, das plantas femininas restantes, em média, não mais que dez produzem bons frutos.

Popenoe (1973), tratando do cultivo de Phoenix, dedica atenção à germinação e cita diversos autores arábes, os quais vêem diferentes causas para o problema da propagação por sementes e apresentam diferentes soluções, em geral bastante pitorescas, tais como:

- Embebição da semente em água, por 5 dias;
- Plantio em posição horizontal;
- Embebição por 2 dias e corte em duas partes, longitudinalmente, sendo então, enterradas lado a lado, com a superfície cortada para baixo, apontando para o Leste;
- Colocação da semente em água fervente, para que dela cresça uma palmeira fêmea;
- Aparência feliz e satisfeita do plantador, como forma de auxílio a uma boa germinação; além da fase da lua, que deve ser propícia.

A parte das folclóricas sugestões, o autor recomenda a embebição por uma semana em água, das sementes selecionadas e, plantio posterior, em caixas com solo úmido, em qualquer posicionamento; ou ainda, como muitos plantadores, no campo, em local definitivo. São acrescentados alguns pontos de vista, que em geral desaconselham a utilização de sementes, ainda que possam ser obtidas algumas vantagens, mas que, em geral, são sobrepujadas pelas desvantagens da aplicação de tal forma de multiplicação, com objetivos econômicos, os quais podem ser atingidos com menores riscos, pela utilização de rebentos para propagação.

Robbins (1931) considera que, a germinação de sementes da Tamareira, não é o melhor método de propagação, visto que, somente pequena percentagem das plantas obtidas por sementes produzem frutos de boa qualidade. É dito que, a germinação das sementes de P. dactylifera, processa-se em 2 a 4 semanas, obtendo-se, em geral, cerca da metade das plântulas, masculinas e, a outra metade, femininas. Para variedades, é considerado melhor forma, a propagação através de rebentos, que desenvolvem-se próximo a base do caule da palmeira, nos seus anos iniciais de vida.

GÊNERO: Phytelephas

Palmeiras acaules ou com caules muito curtos. O duro endosperma da semente, é fonte de "marfim vegetal", usado como substituto para o marfim verdadeiro. Distribuição: América do Sul e Panamá.

Cook (1910) considera a germinação de Phytelephas muito semelhante à de Attalea, considerando praticamente a mesma, e é em geral, descrita do seguinte modo: o embrião, não se desenvolve diretamente da semente, mas sim do cotilédone, o qual carrega o embrião, enterrando-se no solo, onde as primeiras raízes são emitidas. As duas ou três folhas mostradas pela plântula, são bainhas sem lâminas. Este comportamento é dito ser o mesmo em palmeiras do gênero Attalea.

GÊNERO: Pseudophoenix

Palmeiras ornamentais, de pouco frequente cultivo, que apresentam caule de forma interessante e vistosas flores. Distribuição: Região do Caribe.

Read (1961) testou a viabilidade e germinação de sementes de Pseudophoenix, em experimento que constou de estocagem das sementes por período superior a dois anos, em condições secas, após o que, foram colocadas para germinar. As sementes que tiveram seu endocarpo removido germinaram cinco meses antes que aquelas nas quais o endocarpo foi conservado. Em relação à temperatura, é dito que, as sementes conservadas em temperatura controlada, à constante 29ºC, germinaram à um percentual de 90%. As demais sementes, sem manutenção de uma constância de temperatura, apresentaram somente 10% de germinação.

Read (1968), em trabalho que reune informações de âmbito geral sobre este gênero, refere-se à germinação e, baseando-se em seu estudo anterior, afirma que as sementes de Pseudophoenix germinam satisfatoriamente, após longo período de estocagem seca, ao contrário da maioria das palmeiras, sendo como que, quando muito frescas, não germinam, segundo observações de plantadores. O autor vê como explicação provável para isso, o encolhimento do fruto a medida em que seca, deixando um espaço ao redor da semente, enquanto que em frutos frescos, a semente preenche todo o endocarpo. Quanto ao tipo de germinação, este é dito similar ao de Phoenix, baseando-se na descrição de Gatin (1906) e Tomlinsom (1960).

GÊNERO: Ptychosperma

Palmeiras entre as quais algumas espécies constituem-se como ornamentais. Distribuição: Nova Guiné, Austrália, Ilhas Solomon e micronésia.

ESPÉCIE: P. macarthurii (H. Wendl.) Nichols

Nagao et al. (1980), testaram os efeitos do ácido giberético, da escarificação e aplicação de calor na germinaçcao das sementes desta espécie.

Este trabalho foi realizado conjuntamente ao teste de Archontophoenix alexandrae, pelos mesmos autores. Os procedimentos iniciais e os tratamentos já foram relatados, acrescentando-se o fato de terem sido as sementes depois de tratadas, plantadas em canteiros aquecidos, com temperaturas mantidas em 27 ± 1ºC. Foram utilizadas 25 sementes por tratamento, com 3 repetições, em blocos ao acaso.

Em relação aos resultados, é concluído que o calor acelerou grandemente a germinação e que esta, foi mais rápida, quando ao calor estava associado o tratamento com ácido giberélico, em sementes escarificadas.

Dados referentes aos canteiros aquecidos revelaram melhores resultados que aqueles relativos aos canteiros não aquecidos, em relação à aceleração do processo germinativo. Entretanto, as taxas de germinação final em tratamentos com sementes escarificads foram baixas, tanto em canteiros aquecidos quanto não aquecidos.

Os autores concluem, finalmente, que combinando-se a Escarificação, a Pré-embebição em ácido giberélico e a aplicação de calor, são melhores os resultados, no que se refere à aceleração da germinação.

São apresentadas tabelas, com os dados referentes às percentagens de germinação por tratamento, tomadas as 7, 9, 11 e 16 semanas, em canteiros aquecidos e, 12, 15, 20 e 26 semanas, em canteiros não aquecidos.

GÊNERO: Roystonea

Palmeiras de rápido crescimento, ornamentais e de notável aparência. Muito plantadas

nos trópicos e particularmente presente, em inúmeras praças ou avenidas. Distribuição: Região do Caribe e América do Sul.

ESPÉCIE: R. venezuelana L.H. Bailey

Braun (1968) utilizou sementes frescas desta espécie em testes de germinação. Os resultados foram os seguintes: Após 60 dias, 15% das sementes germinaram; após 120 dias, 45%; após 150 dias, 29%; e, finalmente, após 165 dias, somente 11%.

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NÚMERO DE DIAS PARA GERMINAÇÃO

APÊNDICE 1

Palmeira	DE LEON (1958)	LOOMIS (1958)	REES (1963)	BRAUN (1968)	JORDAN (1970)	KOEBERNICK (1971)	BASU (1972)
Acanthophoenix rubra	71	-	-	-	-	-	-
Acoelorrhaphe wrightii	-	-	-	-	-	-	180
Acrocomia aculeata	-	-	-	180-300	-	-	-
Acrocomia mexicana	-	-	-	-	-	440(2)	-
Acrocomia sclerocarpa	-	-	-	-	-	878(3)	-
Actinorrhytis calapparia	-	-	-	-	-	71	-
Alphanesu aculeta	-	-	-	65	-	-	-
Alphanes acanthophylla	-	-	-	-	-	91,43,95(1)	-
Alphanes caryotafolia	-	-	-	-	-	71,60,61(1)	-
Alphanes erosa	-	-	4	-	-	58,110(1)	-
Allagoptera arenaria	-	-	31	-	-	-	-
Allagoptera campestre	-	-	-	-	-	62,62(1)	-
Archontophoenix cunninghaniana	-	-	-	-	-	90	-
Archontophoenix sp.	-	-	-	-	-	53	-
Areca alicia	-	-	-	-	-	41	-
Areca catechu	-	79	-	-	-	55,25,30(1)	-
Areca concinna	43	-	-	-	-	46,61(1)	-
Areca langlosiana	-	-	-	-	-	114	-
Areca latiloba	27	-	-	-	-	-	-
Areca sp.	-	-	-	-	-	31	-
Areca triandra	-	-	-	-	-	33,31(1)	-
Arenga engleri	-	-	-	-	-	111,506,626	-
	-	-	-	-	-	283,83(1)	-
Arenga microcarpa	-	-	-	-	-	261(1,4)	-
Arenga obtusifolia	-	-	-	-	-	374,232,238(1)	-
Arenga pinnata	-	-	-	-	-	189	-

Continuação Apêndice 1

Palmeira	DE LEON (1958)	LOOMIS (1958)	REES (1963)	BRAUN (1968)	JORDAN (1970)	KOEBERNICK (1971)	BASU (1972)
Arenga sp.	-	-	-	-	-	181	-
Arenga tremula	-	-	-	-	-	103	-
Arenga undulatifolia	-	-	-	-	-	268	-
Arenga wrightii	-	-	3	-	-	298	-
Arikuryroba schizophylla	-	-	-	-	-	51,107(1)	-
Aristeyera spicata	-	-	-	90	-	-	-
Astrocaryum aculeatum	-	-	-	-	-	104	-
Astrocaryum chambira	-	-	-	-	250	-	-
Astrocaryum mexicanum	-	38	-	-	-	-	-
Astrocaryum sp.	-	-	-	130-347	-	-	-
Astrocaryum sp.	-	-	-	-	-	65	-
Astrocaryum standleyanum	148	-	-	-	-	68,47,96(1)	-
Astrocaryum vulgare	-	-	-	-	-	413,334(1)	-
Bactris gasipaes	-	-	-	65-70	78,80	69	-
Bactris major	-	-	-	150	-	188	-
Bactris ottostapfeana	57	-	-	-	-	-	-
Bactris rhaphidacantha	-	-	-	-	-	197	-
Bactris sp.	-	-	-	-	-	150	-
Bentinckia conddapanna	30	-	-	-	-	-	-
Bentinckia nicobarica	-	75	-	-	-	85,82,74(1)	-
Bismarckia nobilis	39	-	-	-	-	-	-
Borassus flabellifer	-	-	35	-	-	-	-
Borassus sp.	-	-	-	-	-	283,265,273(1)	-
Brassiophoenix drymophloeoides	-	-	-	-	-	245	-
Butis capitata	-	142	-	-	-	149	-
Butia capitata var. capitata	-	-	-	-	-	161	-
Butia eriospatha	-	-	-	-	-	673,230(1)	-
Calamus sp.	-	-	-	-	-	107,408(1)	-

Continuação Apêndice 1

Palmeira	DE LEON (1958)	LOOMIS (1958)	REES (1963)	BRAUN (1968)	JORDAN (1970)	KOEBERNICK (1971)	BASU (1972)
Calyptrocalyx spicatus	-	-	-	-	-	19	-
Carpentaria acuminata	-	-	-	-	-	78	-
Caryota cumingii	317	-	-	-	-	142,114(1)	-
Caryota mitis	-	-	28	-	-	149	76
Caryota urens	-	-	-	-	-	-	30
Catoblastus praemorsus	-	-	-	270-330	-	-	-
Ceroxylon klopstockia	-	-	-	300-490	-	-	-
Chamaedores cataractarum	-	-	-	-	-	-	-
Chamaedorea costaricana	-	-	-	-	-	41	-
Chamaedorea elatior	-	-	-	-	-	118	-
Chamaedorea erumpens	-	222	-	-	-	235,194(1)	-
Chamaedorea glaucifolia	89	-	-	-	-	244	-
Chamaedorea metallica	-	-	-	-	-	197	-
Chamaedorea microspadix	-	-	-	-	-	105,98,65(1)	-
Chamaedorea monostachys	-	-	-	-	-	148	-
Chamaedorea oblongata	-	-	-	-	-	40,117(1)	-
Chamaedorea oreophila	-	-	-	-	-	214	-
Chamaedorea pinnatifrons	-	-	-	115-125	-	-	-
Chamaedorea seifrizii	-	-	-	-	-	138,203,220,69(1,5)	-
Chamaedorea schiedeana	44	-	-	-	-	-	-
Chamaedarea sp.	95	-	-	-	-	-	-
Chamaedorea tepejilote	-	-	-	-	-	41	-
Chamaedorea humilis var. arborescens	-	-	-	-	-	67	-
Chamaedorea humilis var. humilis	-	-	-	-	-	124	-
Chelyocarpus sp.	-	-	-	-	-	179	-
Chrysalidocarpus cabadae	-	-	-	-	-	127,78(1)	-
Chrysalidocarpus lutescens	-	31	20	-	-	-	38
Chrysalidocarpus lucubensis	150	-	-	-	-	-	-

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Continuação Apêndice 1

Palmeira	DE LEON (1958)	LOOMIS (1958)	REES (1963)	BRAUN (1968)	JORDAN (1970)	KOEBERNICK (1971)	BASU (1972)
Chrysalidocarpus madagascariensis	145	-	-	-	-	-	84
Clinostigma gronophyllum	-	-	-	-	-	113,127(1)	-
Clinostigma ponapensis	48	-	-	-	-	-	-
Coccothrinax acuminata	-	-	-	-	-	49	-
Coccothrinax alta	-	-	-	-	-	63	-
Coccothrinax argentata	-	-	-	-	-	76	-
Coccothrinax crinita	-	37	-	-	-	187,164(1)	-
Coccothrinax fragans	-	45,237*	-	-	-	240,241,201,59(1)	-
Coccothrinax martii	-	-	-	-	-	-	-
Coccothrinax miraguamo	-	104	-	-	-	-	-
Coccothrinax pseudorigida	-	48	-	-	-	-	-
Cocos nucifera	-	119	-	-	-	125,182(1)	-
Cocos nucifera var. Malay verde	-	-	-	-	-	76,151,153(1)	-
Cocos nucifera var. Malay dourado	-	-	-	-	-	184	-
Cocos nucifera var. Malay amarelo	-	-	-	-	-	88	-
Colpothrinax wrightii	-	55	-	-	-	-	-
Copernicia burretiana	-	37	-	-	-	-	-
Copernicia cerifera	-	-	28	-	-	-	-
Copernicia cowellii	-	37	-	-	-	-	-
Copernicia gigas	-	73	-	-	-	-	-
Copernicia glabrescens	18	-	-	-	-	32	-
Copernicia hospita	-	37	-	-	-	60,122(1)	-
Copernicia pauciflora	-	-	-	-	-	33	-
Copernicia prunifera	-	-	-	-	-	56	-
Copernicia sp.	-	-	-	-	-	174	-
Copernicia vespertilionum	-	14	-	-	-	-	-

Continuação Apêndice 1

Palmeira	DE LEON (1958)	LOOMIS (1958)	REES (1963)	BRAUN (1968)	JORDAN (1970)	KOEBERNICK (1971)	BASU (1972)
Copernicia torreana	-	22	-	-	-	-	-
Copernicia yarey	-	-	-	-	-	122	-
Copernicia yarey var. robusta	-	-	-	-	-	114	-
Corozo oleifera	-	-	-	-	-	379	-
Corypha elata	-	-	-	-	-	-	20
Corypha lecomtei	-	-	-	-	-	89	-
Corypha umbraculifera	-	52,108*	-	-	-	117,226(1)	-
Crysophia warscewiczii	-	-	-	-	-	68	-
Cyrostachys renda	-	-	-	-	-	114	-
Deckenia nobilis	-	-	-	-	-	257	-
Desmoncus horridus	-	-	-	-	-	161	-
Desmoncus orthacanthos	-	-	-	40-80	-	-	-
Desmoncus sp.	-	-	-	-	-	45	-
Desmoncus sp.	-	-	-	-	-	84	-
Dictyocaryum fuscum	-	-	-	112-160	-	-	-
Dictyosperma album	-	84	-	-	-	86,43(1)	-
Dictyosperma aureum	-	75	-	-	-	102	-
Didymosperma caudatum	65	-	-	-	-	-	-
Diplothemium maritimum	73	-	-	-	-	-	-
Drymophloeus beguinii	-	26	-	-	-	45,43,34(1)	-
Drymophloeus oliviformis	-	-	-	-	-	123	-
Drymophloeus sp.	-	-	-	-	-	104	-
Elaeis guineensis	-	64,147**	-	-	-	288	152
Elaeis madagascariensis	-	-	-	-	-	-	-
Erythea armatau	-	-	-	-	-	161	-
Erythea brandegeei	-	44	-	-	-	297,383(1)	-
Erythea brandegeei x edulis	-	-	-	-	-	238	-
Erythea edulis	-	-	-	-	-	78,186,141(1)	-
Erythea sp.	-	-	-	-	-	62	-

Continuação Apêndice 1

Palmeira	DE LEON (1958)	LOOMIS (1958)	REES (1963)	BRAUN (1968)	JORDAN (1970)	KOEBERNICK (1971)	BASU (1972)
Eugeissona sp.	-	-	-	-	-	144	-
Eugeissona triste	-	-	-	-	-	210	-
Euterpe edulis	-	-	-	-	-	53,77,41(1)	-
Euterpe longibracteata	-	-	-	-	-	24	-
Euterpe precatoria	-	-	-	-	89,83	-	-
Euterpe sp.	-	-	-	14	-	-	-
Gastrococo crispa	-	-	-	-	-	66,107,132,(1)	-
Gaussia attenuata	-	43	-	-	-	25,148,287(1)	-
Geonoma baculifera	-	-	-	-	-	209	-
Geonoma congesta	-	-	-	-	-	184	-
Geonoma longipetiolata	119	74	-	-	-	-	-
Geonoma longisecta	-	-	-	-	-	278	-
Geonoma membranaceae	-	-	-	-	-	48,141(1,6)	-
Geonoma pinnatifrons	-	-	-	80-90	-	-	-
Heterospathe minor	-	-	-	-	-	63	-
Heterospathe coriaceae	-	-	-	-	-	73,223(1)	-
Howeia belmoreana	-	-	-	-	-	-	40
Hyophorte indica	-	75	-	-	-	-	-
Hyphaene crinita	-	-	-	-	-	72	-
Hyphaene schatan	-	-	-	-	-	38	-
Hyphaene sp.	-	-	-	-	-	70	-
Hyphaene sp.	-	-	-	-	-	290,96(1)	-
Hyphaene sp.	-	-	-	-	-	96	-
Hyphaene sp.	-	-	-	-	-	74	-
Hyphaene sp.	-	-	-	-	-	207	-
Hyphaene thebaica	-	-	-	-	-	61,82,66(1)	-
Hyphaene turbinata	-	-	-	-	-	147	-
Iriartea sp.	-	-	-	90	-	-	-
Iriartea ventricosa	-	-	-	-	154,144	-	-

Continuação Apêndice 1

Palmeira	DE LEON (1958)	LOOMIS (1958)	REES (1963)	BRAUN (1968)	JORDAN (1970)	KOEBERNICK (1971)	BASU (1972)
Jessenia bataua	-	-	-	40	-	67	-
Jessenia policarpa	-	-	-	20-30	83,79	-	-
Jessenia sp.	-	-	-	-	-	37	-
Jessenia sp.	-	-	-	25	-	-	-
Jubaea chilensis	-	113	-	-	-	-	-
Kentiopsis oliviformis	-	-	-	-	-	317	-
Laccospadix australasica	-	-	-	-	-	71,53(1)	-
Latania loddigesii	-	-	-	-	-	57,64(1)	54
Latania lontaroides	-	-	-	-	-	100	-
Latania verschaffeltii	32	-	-	-	-	-	-
Licuala amplifrons	-	70	-	-	-	-	-
Licuala elegans	-	-	-	-	-	-	-
Licuala gracilis	-	-	-	-	-	363	-
Licuala grandis	-	122	-	-	-	53,85,80,168,107(1)	-
Licuala lauterbachii	-	-	-	-	-	220	-
Licuala muelleri	-	-	-	-	-	123	-
Licuala peltata	-	-	-	-	-	100,389(1)	-
Licuala sp.	-	-	-	-	-	303	-
Licuala spinosa	31	-	-	-	-	78,334,475,361(1)	280
Linospadix monostachya	-	-	-	-	-	54,110(1)	-
Livistona australis	-	-	-	-	-	122	
Livistona chinensis	-	-	-	-	-	62,32(1)	32
Livistona cochinchinensis	-	31	-	-	-	-	-
Livistona decipiens	-	-	-	-	-	233	24
Livistona humilis	-	-	-	-	-	48	-
Livistona jenkinsiana	-	-	-	-	-	130	-
Livistona muelleri	-	-	-	-	-	130	-
Livistona robinsoniana	-	-	-	-	-	129,175,141(1)	-
Livistona rotundifolia	-	-	-	-	-	67,62,199(1)	45
Livistona sp. (australia)	-	-	-	-	-	110	-

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Continuação Apêndice 1

Palmeira	DE LEON (1958)	LOOMIS (1958)	REES (1963)	BRAUN (1968)	JORDAN (1970)	KOEBERNICK (1971)	BASU (1972)
Manicariau saccifera	-	-	-	115-130	-	-	-
Manicaria sp.	-	-	-	-	-	80	-
Mascarena lagenicaulis	-	-	-	-	-	65	-
Mascarena revaughanii	-	-	-	-	-	106	-
Mascarena verschaffeltii	-	-	-	-	-	84,58(1)	-
Mauritia flexuosa (sem. velhas)	-	-	-	210-270	-	-	-
Mauritia flexuosa	126	56	-	65	-	199	-
Mauritia subnermis	-	-	-	75	-	-	-
Mauritia vinifera	-	-	-	-	100,125	-	-
Mauritiella sp.	-	-	-	-	94,105	-	-
Maximiliana elegans	-	147	-	160	-	-	-
Maximiliana martiana	-	-	-	-	-	361	-
Maximiliana stenocarpa	-	-	-	-	150,148	-	-
Metroxylon amicarum	-	94	-	-	-	-	-
Microcoelum weddelianum	-	-	-	-	-	86,174(1)	-
Neodypsis decaryi	-	-	-	-	-	52	-
Neonicholsonia watsonii	-	-	-	-	-	127	-
Nephrosperma vanhoutteanum	-	-	-	-	-	69,57,154 176(1)	-
Normambya normambyi	-	-	-	-	-	79	-
Oenocarpus caracasanus	-	-	-	-	-	-	-
Oenocarpus multicaulis	-	-	-	-	-	-	-
Oenocarpus panamanus	-	-	-	-	-	25,41	-
Oncosperma fasciculatum	46	-	-	-	-	-	-
Oncosperma ligillaria	44	-	-	-	-	-	-
Opsiandra maya	-	-	-	-	-	26,38,79(1)	-
Orania appendiculata	-	-	-	-	-	206	-
Orbignya cohune	-	67	-	-	-	-	-
Orbignya phalerata	-	71	-	-	-	-	-
Orbignya sp.	-	-	-	-	-	175	-

Continuação Apêndice 1

Palmeira	DE LEON (1958)	LOOMIS (1958)	REES (1963)	BRAUN (1968)	JORDAN (1970)	KOEBERNICK (1971)	BASU (1972)
Phoenix acaulis	-	-	59	-	-	-	-
Phoenix canariensis	-	-	-	-	-	34,39(1)	18
Phoenix dactylifera	-	-	-	-	-	78	-
Phoenix humilis	-	-	-	-	-	-	-
Phoenix x macrocarpa	-	-	-	-	-	30	-
Phoenix reclinata	-	42	-	-	-	67	25
Phoenix roebelenii	-	39	-	-	-	38	-
Phoenix rupicola	-	-	-	-	-	114	60
Phoenix sp.	-	-	-	-	-	12	-
Phoenix sp.	-	-	-	-	-	47	-
Phoenix sp.	-	-	-	-	-	57	-
Phoenix sylvestris	-	-	-	-	-	36	20
Phoenix zeylanica	-	-	-	-	-	25	-
Phoenicophorium borsigianum	-	-	-	-	-	21,42,81,59 124(1)	-
Phytelephas macrocarpa	-	-	-	-	240	376,192(1)	-
Pinanga kuhlii	-	-	-	-	-	45,66,36(1)	-
Pinanga sp.	-	-	-	-	-	183	-
Pinanga sp.	-	-	-	-	-	43	-
Polyandrococos caudescens	-	-	-	-	-	59	-
Prestoea montana	-	-	-	-	-	38	-
Prestoea sp.	-	-	-	-	-	26	-
Pritchardia hillebrandii	-	-	-	-	-	40	-
Pritchardia lowreyana	-	-	-	-	-	-	-
Pritchardia pacifica	-	-	-	-	-	46,77,44(1)	-
Pritchardia sp.	-	-	-	-	-	46	-
Pseudophoenix vinifera	33	23	-	-	-	178	-
Ptychandra glauca	-	-	-	-	-	49	-
Ptychococcus paradoxus	-	-	-	-	-	192,180(1)	-
Ptychoraphis augusta	-	29,68*	-	-	-	-	-

Continuação Apêndice 1

Palmeira	DE LEON (1958)	LOOMIS (1958)	REES (1963)	BRAUN (1968)	JORDAN (1970)	KOEBERNICK (1971)	BASU (1972)
Ptychosperma augustifolium	43	-	-	-	-	157	-
Ptychosperma elegans	-	-	-	-	-	-	59
Ptychosperma hospitum	-	-	-	-	-	61	-
Ptychosperma macarthurii	-	-	-	-	-	-	58
Ptychosperma hosinoi	39	-	-	-	-	-	-
Ptychosperma ledermannianum	60	-	-	-	-	-	-
Ptychosperma nicolai	-	-	-	-	-	94	-
Pritchardia sp.	-	-	-	-	-	370	-
Raphia gracilis	115	-	-	-	-	-	-
Raphia pedunculata	-	81	-	-	-	-	-
Raphia sp.	-	-	-	-	-	209,237,243	-
Reinhardtia gracilis	-	-	-	-	-	545,619(1)	-
Reinhardtia gracilis var. gracilior	-	-	-	-	-	95	-
Rhapis humilis	-	-	-	-	-	88,64(1)	-
Rhopaloblaste elegans	-	-	-	-	-	125,106(1)	-
Rhopalostylis baueri	-	-	-	-	-	35	-
Rhopalostylis cheesemanii	-	-	-	-	-	47,82,129(1)	-
Rhopalostylis sapida	-	73	-	-	-	137	-
Rhyticocos amara	-	62	-	-	-	-	-
Roystonea princeps	-	-	-	-	-	53,45(1)	-
Roystonea regia	-	-	-	-	-	34	-
Roystonea venezuelana	-	-	-	-	-	119	38
Sabal bermudana	-	-	-	60-165	-	-	-
Sabal blackburniana	-	-	-	-	-	137	-
Sabal causiarum	-	-	-	-	-	99	120
Sabal domingensis	-	-	-	-	-	82,43,107(1)	-
Sabal glaucescens	59	-	-	-	-	48	-
Sabal jamaicensis	-	-	-	-	-	-	-
Sabal mauritiaeformis	-	-	-	55-60	-	37	-

Continuação Apêndice 1

Palmeira	DE LEON (1958)	LOOMIS (1958)	REES (1963)	BRAUN (1968)	JORDAN (1970)	KOEBERNICK (1971)	BASU (1972)
Sabal mexicana	-	-	-	-	-	48	120
Sabal minor	-	-	-	-	-	123,122(1)	-
Sabal plametto	-	-	-	-	-	90	-
Sabal parviflora	-	-	-	-	-	22,51(1)	-
Sabal peregrina	-	-	-	-	-	48,49	-
Sabal texana	-	-	-	-	-	82,70,169(1)	-
Sabal yapa	-	-	-	-	-	82,127(1)	-
Salacca conferta	-	-	-	-	-	37	-
Salacca edulis	24	-	-	-	-	-	-
Salacca sp.	-	-	-	-	-	-	-
Salacca wallichiana	24	-	-	-	-	-	-
Satakentiau liukiuensis	-	-	-	-	-	70	-
Scheelea macrocarpa	-	-	-	-	60-120	-	-
Scheelea leandroana	-	-	-	-	-	151	-
Scheelea phalerata	-	-	-	-	-	466	-
Scheelea preussii	-	-	-	-	-	86,304(1,9)	-
Scheelea sp.	-	-	-	-	146	-	-
Siphokentia beguinii	-	-	-	-	-	117	-
Socratea durissima	55	-	-	-	-	137	-
Socratea exorrhiza	-	-	-	45-70	-	112	-
Socratea orbigniana	-	-	-	-	70,65		-
Strongylocaryum sp.	-	-	-	-	-	40	-
Syagrus campestris	-	-	-	-	-	135	-
Syagrus campicola	-	293	-	-	-	-	-
Syagrus comosa	-	99,316*	-	-	-	-	-
Syagrus orinocensis	-	-	-	30-40	-	-	-
Syagrus quinquefaria	-	-	-	-	-	63	-
Syagrus sancona	-	-	-	-	-	77	-
Syagrus sp.	-	-	-	-	-	51	-
Syagrus sp.	-	-	-	-	-	-	-

Continuação Sinonímias do Apêndice 1

Ptychoraphis augusta (Kurz.) Beccari	= Rhopaloblaste augusta (Kurz.) H.E.Moore
Ptychosperma hospitum (Burret) Burret	= P. macarthurii (H.Wendl.) Nichols,
Rhyticocos amara (Jacquin) Beccari	= Syagrus amara (Jacquin) Martius
Roystonea venezuelana L.H.Bailey	= R. oleracea (Jacquim) O.F.Cook
Sabal glaucescens Loddiges ex H.E.Moore	= S. mauritiiformis (Karsten) Grisebach & Wendl.
Sabal peregrina L.H.Bailey	= S. yapa Wright ex Beccari
Sabal texana (Cook) Beccari	= S. mexicana Martius
Salacca conferta Griff.	= Eleiodoxa conferta (Becc.) Burret
Socratea exorrhiza (Martius) Wendl.	= Iriartea exorrhiza Martius
Strongylocaryum Burret	= Ptychosperma Labill
Syagrus campestris (Martius) Wendl.	= S. flexuosa (Martius) Beccari
Syagrus quinquefaria (Barb. Rodr.) Beccari	= S. coronata (Martius) Beccari
Thrinax argentea Loddiges ex Schultes	= Coccothrinax argentea (Loddiges) Sargent
Thrinax argentea Grisebach	= Coccothrinax jamaicensis R.W.Read
Thrinax barbadensis Loddiges ex Martius	= Nomen confusum
Thrinax ekmanii Burret	= T. morrisii H. Wendl.

*Sinonímias extraídas das obras:
- A Revision of B.E. Dahlgren's Index of American Palms (Dahlgren, 1936), S.F.Glassman, 1972
- Hortus Third - A Concise Dictionary of Plants Cultivated in the U.S. and Canada, Liberty Bailey Hortorium, 1976.

Notas Explicativas do Apêndice I:

Koebernick:

(1) mais de um plantio
(2) Acrocomia mexicana - 440 dias; removendo casca dura - 138 dias
(3) Acrocomia sclerocarpa - 878 dias; removendo a casca dura - 373 dias
(4) Arenga engleri (111, 506, 626), todos os tos da mesma planta e inflorescência
(5) Chamaedorea seifrizii (203, 220) - meta plantada em esterco e metade em Perlite. dias (esterco) - 220 dias (Perlite)
(6) Geonoma membranaceae - 48 dias (semen frescas); 141 dias (sementes secas)
(7) Hyphaene sp. (290, 96) sementes frescas mesma planta
(8) Raphia sp. - Sementes velhas, plantadas tas, ao mesmo tempo
(9) Scheelea preussii (86, 304) - duas semen (86 dias); restantes (304 dias)

Loomis:

(*) Dois plantios seperados
(**) Três plantios separados

Rees:

Número de dias para 50% de germinação final

APÊNDICE 2 - GERMINAÇÃO DE SEMENTES DE 30 ESPÉCIES DE PALMEIRAS, EM GRUPOS FORMADOS SEGUNDO O INTERVALO DE DIAS PARA GERMINAÇÃO.

18-30	31-50	51-80	81-130	152-180
Caryota urens	Chrysalidocarpus lutescens	Caryota mitis	Areca catechu	Elaeis guineensis
Corypha elata	Areca triandra	Latania loddigesii	Chrysalidocarpus madagascariensis	Licuala spinosa
Dictyosperma album	Howeia belmoreana	Phoenix humilis	Licuala grandis	Acoelorraphe wrightii
Livistona decipiens	Livistona chinensis	Phoenix rupicula	Sabal blackburnia	
Phoenix canariensis	Livistona rotundifolia	Ptychosperma macarthurii	Sabal mexicana	
Phoenix reclinata	Roystonea regia	Ptychosperma elegans	Thrinax parviflora	
Phoenix sylvestris	Ptychoraphis singaporrensis			
Thrinax Barbadensis				

*Basu & Mukherjee (1972)

APPENDIX X

Outline of mycorrhiza training program for Peruvian colleagues

Review of classic literature
Baylis 1959, Mosse 1959, Nicolson 1959, 1960, Gerdemann and Nicolson 1963, Nicolson 1967, Gerdemann 1968, Phillips and Hayman 1970
other recent work
[illegible] books

Schema. Plan.
Directory of mycorrhiza researchers
Resources for finding the literature

Hoagland and Tompkins 1975. Salt
preparing roots (50% time)
clearing and staining
field collecting
clipping roots
chemicals for clearing staining
removal of cytoplasm (KOH)
bleaching
acidification
staining
destaining
identification of VAM structures
hyphae
arbuscules
vesicles
chlamydospores
Rhizobium
spores (10% time)
field collecting
herbing samples
extraction of spores
wet sieving and decanting
elutriator
centrifugation
sucrose gradient
quantification
identification
to genus
Preparing specimens for a taxonomist
setting up pot cultures (20% time)
growing conditions
soil
source of spores
methods of inoculation
fertilization
appropriate nutrient solutions
setting up experiments (10% time)
controls

high P controls
"washings"
choice of conditions
plant growth conditions
fertilization
appropriate nutrient solutions
soil
Supplies required
methods prep.
root preparation
safety equipment, electric hotplate, pan, wash bottles, chemicals, KOH, lactophenol, liquid phenol, lactic acid, trypan blue, ammonium hydroxide, glycerin, hydrogen peroxide, HCl
microscope supplies
scopes
dissecting scope
compound scope
materials
petri dishes, forceps, needles, pi-pumps, disp. pipettes, counting dish
quantification
spores
colonization
grids
sieving spores
sieves
about 45 microns, around 110, around 250-300, around 1000, around 2 mm
decanting
large graduates, funnels, misc containers
centrifuging
centrifuge with large vessels, 50% sucrose soln- prepare ahead of time, pipettes, sieve for washing spores
pot culture
materials
containers, bricks, basin, watering, wicks, funnels, soil
fertilization
experiments
soil
containers
fertilizers
greenhouse growth chamber
controls
filtering: "washings"