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The Sago Palms

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[Reprinted with permission of the author and publisher, the original figures renumbered, from a longer article entitled "The Sago Palms and Other Food Plants of Marsh Dwellers in the South Pacific Islands," *Economic Botany* 13(2): 150-162. 1959.]

Marshes occupy wide areas in the continental islands of the South West Pacific. Among the vegetation types prevailing in such an environment are the swamp forests. These are composed of mangrove trees *(Bruguiera, Ceriops* and *Rhizophora* spp.) where the water is brackish and of sago palms *(Metroxylon* spp.) or other species, such as *Terminalia brassii* Exell in the Solomon Islands, where the water is fresh.

Needless to say, the possibilities of subsistence horticulture in these waterlogged surroundings are quite limited. Nevertheless, in some areas, for the most part in New Guinea, the marsh dwellers have evolved fairly elaborate techniques to grow the few edible plants which supplement their diet (Barrau, 1).

The purpose of the present article is to describe a few of the food plants characteristic of these swamp areas which are their natural habitat. As a matter of fact, some of these plants are the objects of foraging and not of proper cultivation.

The Sago Palms

The sago palms belong to the genus *Metroxylon* Rottböll. They are particularly abundant in the swampy lowlands of New Guinea where they form huge forests. The Papuans who live there use as a staple the starch which they extract from the stipe's pith.

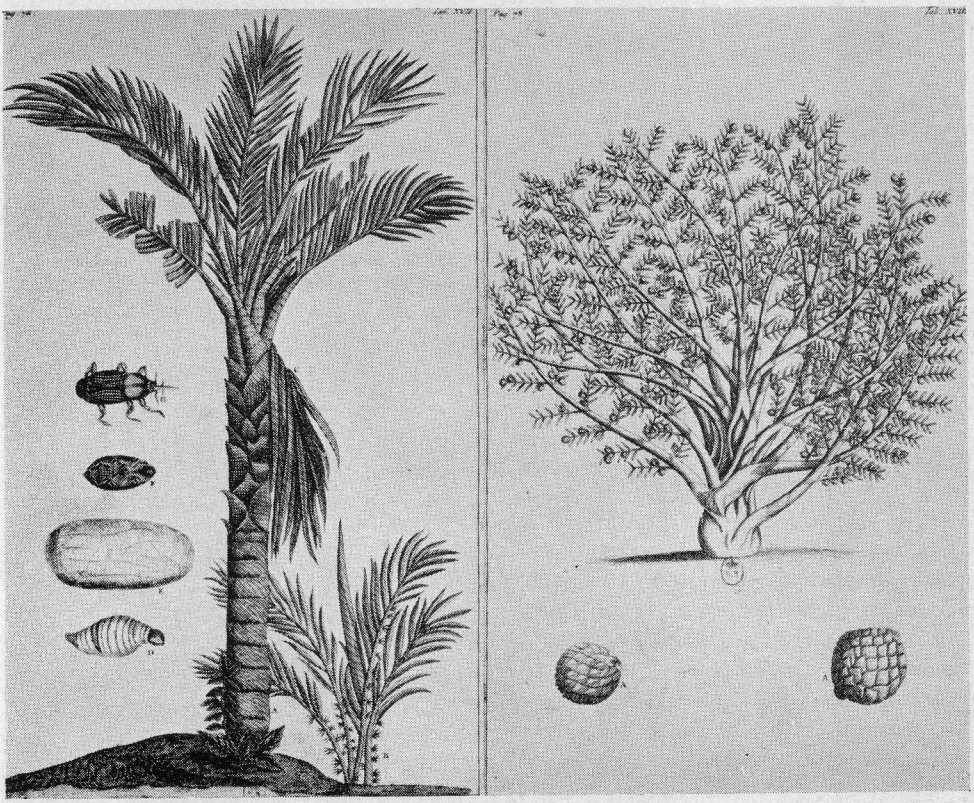
The species of the genus *Metroxylon* are arborescent, monoecious palms, often more or less thorny. The columnar stipe reaches generally from 25 to 30 feet in height; the leaf petioles have a widened base clasping the stipe without ensheathing it. These are strong and, according to the species and varieties, either inerm or thorny. The leaflets are straight, acuminate, ensiform, with acerate margins which, in some cases, are spinulous. The inflorescence

is an enormous raceme protruding at the tree's top from the center of the leaf crown. It appears at the end of the tree's life. The lowest part of this inflorescence is ensheathed in a tubular spathe, as are the secondary ramifications which bear alternate catkin-like spikes on which are densely grouped the flowers set out by pairs—one male and one female—in a spiral. These flowers have membranous bracts and villous bracteoles, the latter being sometimes reduced to a tuft of hairs. The fruit—globulous, turbinate, egg-shaped or pyriform, according to the species and variety—is covered with scales set out in vertical series and contains a seed often hard enough to be used as a source of vegetable ivory.

The nomenclature presently used for the *Metroxylon* species is that of Beccari (2) who in 1918 described and classified all the then known forms of sago palms. If one follows this author, the *Metroxylon* species occurring in the islands of the South West Pacific are classified as follows:

A. Section *Eumetroxylon*: fruit covered with scales set out in 18 vertical series:

I. Petioles and spathes inerm: *M. sagus* Rottb. (syn. *M. inerme* Mart., *M. laeve* Mart., *Sagus genuina* Gisk., *S. inermis* Roxb., *S. laevis* Rumph.)



26. Two drawings from Rumphius' *Herbarium Amboinense*, 1741-1756. (left) A sago palm with the adult and immature stages of a weevil which frequently attacks this species. Larvae found in rotten sago palm stipes are frequently eaten by the natives. (right) The inflorescence and fruits of sago palm. (Photograph Bibliotheque Nationale, Paris).

II. Petioles and spathes more or less thorny: *M. rumphii* Mart. (syn. *Sagus genuina* Rumph., *S. rumphii* Willd., *S. spinosus* Roxb.)

B. Section *Coelococcus*: fruits covered with scales set out in 24-28 vertical series:

I. The inflorescence is not a raceme erected at the tree top, but axillary panicles appear between the petiole bases: *M. amicarum* Becc. (syn. *M. carolinense* Becc., *Coelococcus amicarum* Warb; *C. carolinensis* Dingl., *Sagus amicarum* Wendl.)

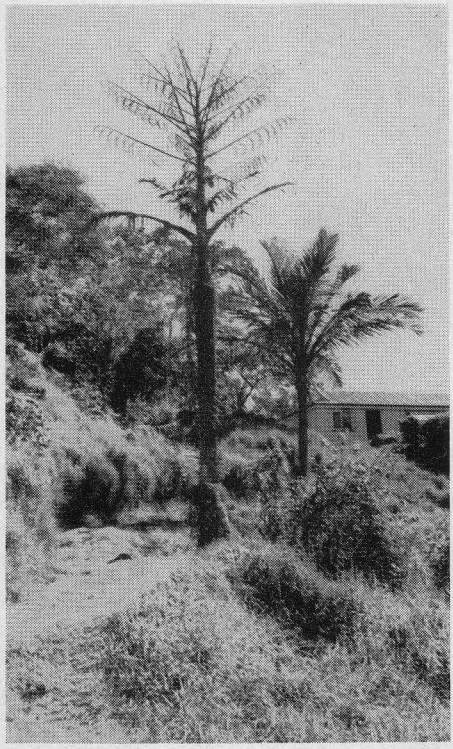
II. The inflorescence is a large raceme erected at the tree top.
   a) fruit obpyriform to turbinate
      i) 10-12 cm. in length, 7-8 cm. in width: *M. warburgii* Heim (syn. *Coelococcus warburgii* Heim).
      ii) 3-4 cm. in length, 2-3 cm. in width: *M. upolense* Becc.
   b) fruit globulous or egg-shaped, 5-6 cm. in length, 4-6 cm. in width: *M. vitiense* Benth & Hook. (syn. *Coelococcus vitiensis* H. Wendl., *Sagus vitiensis* H. Wendl.)

III. Fruit globulous, more or less flattened down:
   a) 7 cm. in diameter, base not concave: *M. salomonense* Becc.
   b) 5-6 cm. in diameter, base concave: *M. bougainvillense* Becc.

The map in fig. 28 shows the distribution of these species in the South Pacific area.

Probably this classification is not entirely valid.

In the section *Eumetroxylon* (to which belong the two species, *M. rumphii* and *M. sagus*, frequently used as sustenance plants) Jumelle (3) draws the attention to the following facts: the fruits of *M. rumphii* or of *M. sagus* can give birth to seedlings either thornless or thorny. As a matter of interest, the Marind Papuans, who live in the swamp, most southern part of Netherlands New Guinea where huge stands of these species occur, claim that in any of the



27. Flowering *Metroxylon vitiense* in the collection of Naduruloulou Plant Introduction Gardens, Viti Levu Island, Fiji Group. (Photo J. Barrau).

forests of thorny sago palm *(M. rumphii)* they have found thornless seedlings which they planted near the villages, thereby establishing groves of *M. sagus*. In this part of New Guinea, one can find among the wild sago palms all intermediate forms between a thorny *M. rumphii* and a thornless *M. sagus*. Beccari (2) himself wrote that the two species were "barely distinct."

Mention should be made that this author has at times described new species of *Metroxylon* on the basis of fragmentary specimens. Such was the case of his *M. upolense* of which, he wrote, he saw only *one* fruit.

Nevertheless, the sections he has erected on the basis of the number of

scale series covering the fruit seem to be sound. However, *M. amicarum* raises another problem. Should this sago palm be kept in the genus *Metroxylon* or segregated from it and placed under the old generic name *Coelococcus?* Some botanists such as Kanehira (4) and Glassman (5) were apparently in favor of this segregation. The point is that the peculiar inflorescence of this palm and the fact that it bears fruits during the tree's life differentiate this species from the others which have, as indicated above, an erected racemose inflorescence appearing at the top of the tree when it reaches the end of its life. Further investigation is needed to judge the exact value of this character as a possible criterion to segregate *M. amicarum* from the genus *Metroxylon.*

To complete this taxonomic discussion, one must mention that Burkill (6) suggested keeping in the old genus *Coelococcus* all sago palms growing in the South Pacific islands other than New Guinea. It is difficult to follow this proposal as the number of scale series of the fruit alone does not appear to be a sufficient criterion to do so.

Coming back to the distribution of the *Metroxylon* palms in the islands of the South West Pacific, it is of interest to underline the fact that species of the two sections *Eumetroxylon* and *Coelococcus* occur in New Guinea and the Bismarck Archipelago, where sago palms very similar to *M. salomonense* are found.

Beccari (2) was of the opinion that the *Metroxylon* has its center of origin in the Moluccas where another species, *M. squarrosum* Becc., occurs. It could very well be that this center includes the nearby sub-continent of New Guinea where huge natural forests of *Metroxylon* are found. Although we are far from knowing all the forms of *Metroxylon* occurring in this territory, present knowledge indicates that they are quite numerous and include a wide range of species and varieties (perhaps nearly all the species of *Metroxylon* described by Beccari).

In New Guinea, the sago palms are known under the following vernacular names: Abia, Aiasi, Akiri, Ambe, Api, Baiao, Balega, Barian, Da, Dou, Fi, Ipako, Na, Nafa, Ndana, No, Poi', Pu, Wariani. In the pidgin English used by the Papuans, they are called Saksak.

The natives of the New Hebrides called sago palms Natangora. On the island of Rotuma, its name is Ota or Oat, according to Bennett (7), while in the Fiji Islands, it is Soqo or Soqa. The last name could be a local modification of Sago.

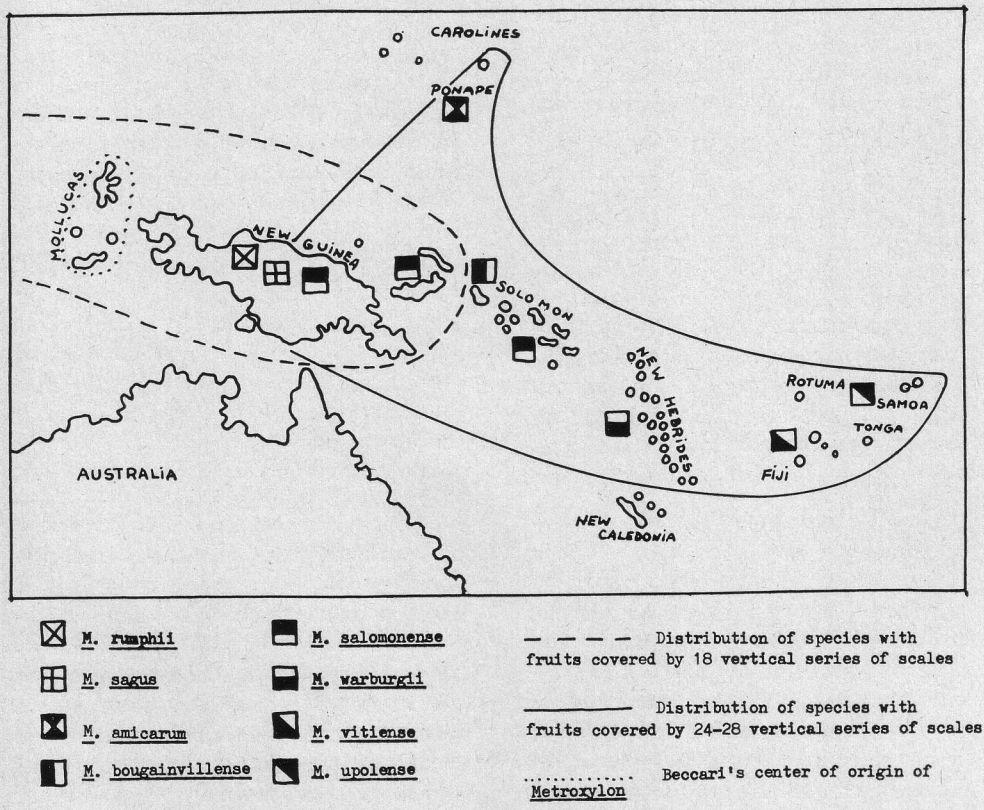
The sago palm is known as Lapia in the Moluccas, and as Rambia, Rembia, Rembi, Rumbia and cognates in Indonesia.

It is mainly in New Guinea and the neighboring islands that varieties of *Metroxylon* are used for their starch content. In other territories where these palms exist, for some unknown reason their use as a food was discontinued long ago. Guppy (8) believed that the use of *Metroxylon vitiense* as a subsistence food was thus lost in Fiji. In the New Hebrides, where the people know only through tradition of this use of sago as food, today one comes across varieties of *Metroxylon* valued for their leaves only, which are used in house building. It is possible that in some distant epoch species of the *Metroxylon* group, whose center of origin spreads from Indonesia to New Guinea, were transported by men right to the borders of what is at present known as Polynesia.

In New Guinea, the islanders use the natural groves and also grow sago palms propagated by seedlings and suckers. Eight to fifteen years are required before the palm tree is worth felling, as it is just before flowering that the reserves of starch stored in the trunk are at their maximum. To prevent flowering exhausting these reserves, the Papuans occasionally remove the bud. Naturally sterile palm trees which accumulate enormous amounts of starch in their trunks are also found, and as much as 900 lbs. of crude sago has been extracted from such palms. This, however, is exceptional and the average yield is very much lower.

Mr. Zwollo, of the Department of Agriculture, Hollandia, Netherlands New Guinea, to whom I am indebted for much of my information on the sago palm, places the average yield at 250 to 350 pounds per tree. (Mr. Zwollo has produced for the Netherlands New Guinea administration a remarkable study, entitled "Sagoe Onderzoek," which is devoted to the sago palm and its uses. Unfortunately, this interesting work is unpublished.)

In a normal swamp forest grove there will be some 25 palm trees per acre per year which are worth felling. These will produce between 6,250 and 8,750 lbs. of crude starch, with a water content of between 35 and 40 per cent, which represents roughly food value of 7,000,000 to 10,000,000 calories. *Metroxylon* yields however, vary considerably; certain



28. Distribution of *Metroxylon* species in Oceania.

varieties are particularly poor in starch, and it is possible to find dense groves of *Metroxylon* containing only trees with a very low sago production.

In a given area of swamp forest, the local people recognize a number of varieties of sago palms; for example, the Marinds of Netherlands New Guinea distinguish at least eight smooth or more or less thorny varieties with added variations in size, color, growth, and starch yield.

The starch or sago is extracted from the palms in the following manner. After felling, the bark is removed from half of the sago trunk. The pith is removed by grating and crushing with a kind of adze of which the cutting section is made of rough stone, hard wood, or more often, from a piece of sharpened bamboo. Today, where there is contact with the Europeans, a section of metal piping with sharpened edges is frequently substituted for the stone or wood tools.

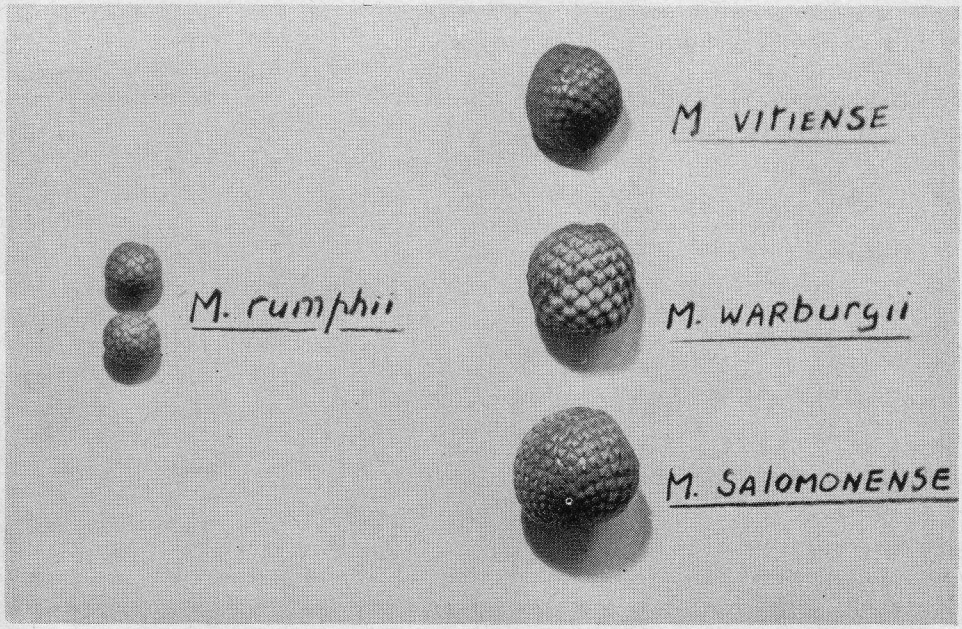
The crushed pith is washed in an inclined trough, made from a leaf of the sago palm. This process is accompanied by threshing with a lath or kneading by hand. The liquid containing the starch runs into the trough, filters through a fibrous spathe arranged for this purpose, and is collected in draining pans made from portions of the palm (leaves, leaf stalks, etc.).

The drained sago is then partially dried and wrapped in bundles with palm leaves. These bundles vary in form but are most often cylindrical or conical. If the sago is intended for family consumption only, the bundles are more or less shapeless. Those intended for barter, however, are prepared with particular care. In New Guinea, the natives hollow out cylindrical holes in the fibrous residue left from the washing process and line them carefully with green *Metroxylon* leaves. They then heap the fresh starch into the hole, using it as a mould; and after wrapping the leaves over the top, they remove the package and bind it fast.

Bartering of sago gave the marsh dwellers in New Guinea the opportunity to procure articles which they lacked, such as pottery, tools, smoked fish, and other foods, notably tubers. This trade entailed real sea-going expeditions, such as those made by the natives of the Port Moresby district travelling to the western deltas to acquire supplies of sago. Even today, intensive canoe traffic continues to ply between the islands in the Geelvinck Bay and the Waropen marshes in Netherlands New Guinea.

Industrialized cultivation and commercialization of sago might afford a desirable improvement in the living conditions of natives inhabiting the swamp forests, where economic possibilities are limited. Although the starch produced by native methods is impure, it might well become an export product. As a matter of fact, a sago factory for export has recently been established in the Radja Empat Islands, in the most western part of Netherlands New Guinea. Additional evidence that this product can be of considerable export value is shown by the fact that in 1950 the United States imported some 6,000,000 lbs. of sago from Malaya and Indonesia.

In order to preserve the sago they produce, the natives find it sufficient to keep it damp in a covering of leaves, sprinkling it with water from time to time. Where pottery is known, the fresh sago is merely placed in a large jar and covered with water. In some cases, a sago paste is made into briquettes, which are dried rapidly on the surface over a fire. These briquettes keep for about a



29. Fruits of four species of *Metroxylon* found in the South Pacific islands. Photo L. Devambez and J. Barrau.

month. As a general rule, the Papuans find that when sago is completely dried it loses its flavor. They consider the starch thus prepared by European methods as being practically inedible.

An examination of a number of food composition tables shows that sago consists almost entirely of starch and water (cf. Massal & Barrau, 9). The protein content is very low, in the region of 0.2 g. per 100 g.; fats are completely absent. Mineral salts are present only in very small quantities (ash, 0.35 mg. per 100; calcium, 10 mg.; phosphorus, 12.5 mg.; iron 1.5 mg.). There are practically no vitamins. Nevertheless, it is possible that the fermentation process which develops when sago is preserved in the wet state increases the vitamin B content. The water content of sago varies considerably depending on the methods of preservation used by the natives. The calorie value varies in relation to the water content and should be calculated according to the starch content of each sample.

In the South Pacific Commission laboratory in Nouméa, Mr. Frank Peters analyzed several samples of sago, or preparations made from sago, from Netherlands New Guinea. The results obtained and, in each case, the value of the constituent elements of the fresh and dried product, per 100 grams of the product are given below.

All the samples were collected in Netherlands New Guinea.

These results call for no particular comment. They indicate clearly the variations in water content of sago preserved according to native methods and coincide with results already known.

Sago can only supply energy needs. In swamp regions of New Guinea where sago is the staple food, the average daily

Analysis of Sago Samples made in the South Pacific Commission Biochemistry Laboratory by Mr. F. E. Peters:

Description	Water	Ash	Fibre	Starch (Acid Hydrol.)	Free Reducing Sugars	Ether Extract	Total Nitrogen	Nx625
Raw Sago	27.0	0.1	0.3	71.0	Nil.	Nil.	Trace	.....
Sago Senole[a]	23.0	0.5	1.0	59.0	0.5	16.5	0.30	2.0
Sago Ega[b]	37.5	0.5	1.8	53.0	0.5	Nil.	0.1	0.5
	52.5	0.5	0.6	40.0	0.5	Nil.	Trace	.....
Sago Lempeng[c]	12.0	0.3	0.2	84.0	Nil.	Nil.	Trace	.....
Sago Bulu[d]	55.0	1.5	1.0	39.0	1.0	1.0	Trace	.....
Sago Boengkoes[e]	42.0	0.5	0.5	53.0	0.2	2.0	Trace	.....

[a] Common preparation made from a mixture of sago and grated coconut, shaped into a flat cake and baked.

[b] Sago paste preserved in briquette form, wrapped in sago leaves.

[c] Sago biscuits.

[d] Sago paste cooked in a green bamboo.

[e] Roasted stick of sago paste.

ration for an adult is about two lbs. This ration varies, according to Zwollo, from between 1½ to 3½ lbs. of raw sago and represents 1,700 to 4,000 calories. It is considered that, in order to satisfy its needs, the average family must spend around ten days per month in sago groves. As sago is an unbalanced foodstuff, it must necessarily be supplemented.

Within the ecological environment of the New Guinea swamp forest, animal and vegetable protein, fats, minerals and vitamins are supplied mainly by foraging. *Ipomaea aquatica* Forsk. leaves and other greens take the foremost place, while the products of fishing and hunting are of secondary importance. Fresh vegetables are grown on platforms or in the gardens on the limited areas above water. On the edge of the swamp forest or in savannah districts dotted with sago swamps, the diet is supplemented by tubers, roots, greens, and pulses from the gardens and by coconuts and by hunting.

Sago is eaten in various ways. Where pottery is known, a sago porridge accompanied by condiments and greens, fish, shellfish, or wild meat is the most popular form. Where pottery is not known, a kind of cake is generally made by cooking a sago paste, occasionally mixed with grated coconut, greens, fish, or meat in an oven of hot stones. This paste is cooked either rolled in green leaves, in half a coconut shell, or in a section of bamboo.

In districts of Netherlands New Guinea where pottery is used, a kind of biscuit known in Malay as *sagoe lempeng*, which is easily preserved, is made in an earthenware mould which serves as an oven.

Thus by exploiting natural or cultivated plantations of sago palms, the dwellers in the swamp forests of New Guinea obtain this energy food which is the basis of their diet. Moreover, through barter sago makes it possible for them to acquire a limited quantity of goods, local or imported, which are becoming daily more necessary for their existence in this ill-favored area.

It is scarcely possible to increase the food value of sago; supplementing of the diet seems to be reasonably assured by the natural resources. The living con-

ditions of the swamp forest peoples of New Guinea could be improved by an industrialization and marketing of sago, as a source of revenue in these poverty-stricken areas.

The huge *Metroxylon* forests of New Guinea represent enormous potential resources in starch for export and industrial uses and deserve new research ranging from a botanical survey of the species and varieties to a study of the processing methods.

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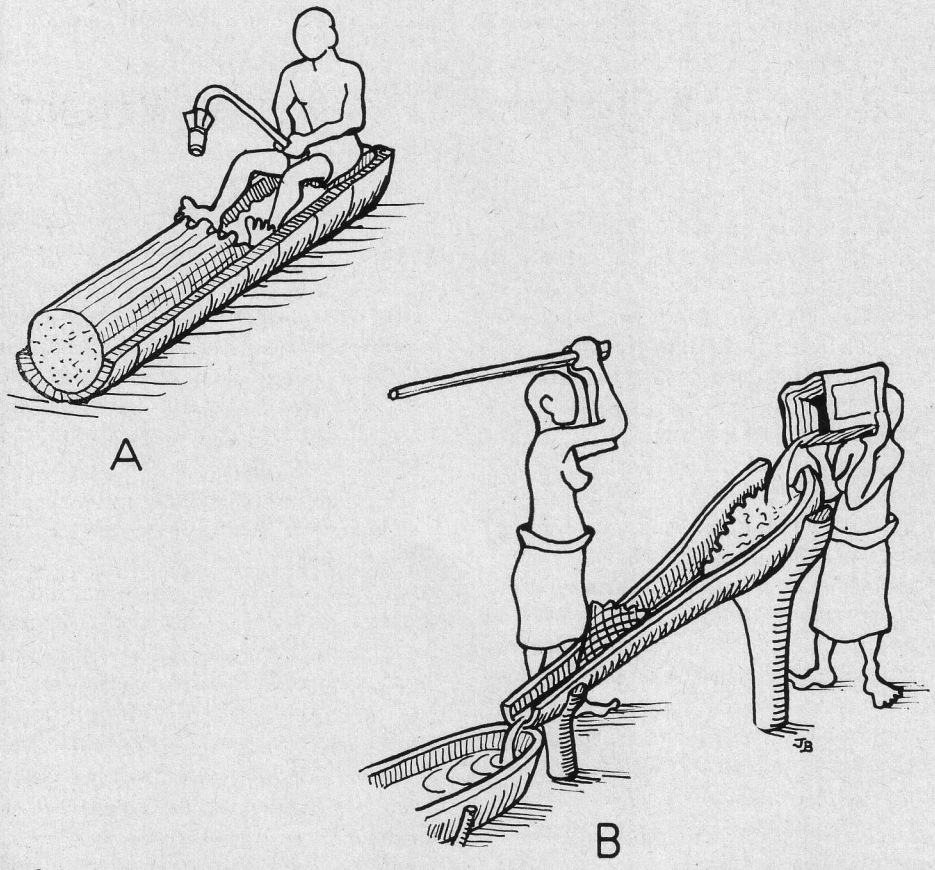

30. Sago processing in New Guinea: (A) crushing the stipes' pith; (B) extracting the starch from the crushed pith. Drawings by the author.

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The Editor's Corner

Continued from page 39

them furnished information condensed by the editor. The flavor of Dr. Bondar's adventures cannot be caught in a brief sketch. Those who read Portuguese will find the autobiographical account in *Revista de Entomologia* for 1943 a stirring story.

The germination of palms is a subject fascinating to any grower. Dr. Tomlinson, who has written an earlier paper in PRINCIPES (vol. 1: 163-173. 1957), begins here a series of articles explaining something of the structure of palms. Following articles will discuss the structure of seedling leaves, stems, leaves, and other parts of palms.

Some members deplore the paucity of information on culture of palms in PRINCIPES. The editor regrets that this is due to a lack of proved information and articles. We attempt to achieve a balance of interest and will welcome contributions on the subject of culture.

The Cuban Belly Palm-Colpothrinax Wrightii

HAROLD E. MOORE, JR.

Cuba's belly palm (*Colpothrinax Wrightii*) is mentioned in this issue of PRINCIPES as a challenge to growers (page 66). It has not yet been successfully cultivated in South Florida and doubtfully elsewhere. The photographs provided by Nixon Smiley (cover) and Frank Gatteri (figs. 31-32) demonstrate the unusual swollen trunk of this palm which has caused it to be called belly palm, bottle palm, or *palma barrigona*. The species is unique in other less conspicuous characteristics. The trunk, however, is very striking. Brother Marie-Victorin has given his impression on first seeing this palm near Concepción del Sur, Pinar del Rió, in the delightful "Itinéraires Botaniques dans l'Isle de Cuba" [*Contributions de l'Institut Botanique de l'Université de Montréal* 41: 132. 1942] written by him and Brother Léon and here translated freely.

"The sun was touching the horizon. Suddenly Brother Léon touched my arm: 'Look! *Colpothrinax Wrightii!*' And I saw a strange palm, which one does not forget when one has seen it in its environment. An amateur palmologist, Captain Johnston, when he passed by there with Brother Léon, burst out laughing when he saw the big-bellied palm for the first time, for it is a name that it merits and bears, belly palm, *palma barrigona*."

Colpothrinax grows on the sandy plains of western Pinar del Río and on the Isle of Pines, Cuba, where it forms extensive open stands, often with pines. Even when the land is cultivated for tobacco, the palms are often left standing, exposing their obesity. The bellies of these palms are used to make casks, beehives, water troughs, and sometimes boats or canoes. The trunks are used for small buildings, the leaves for thatch, and the fruit for hog feed.