

PRINCIPES

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Contents for January

Hartrot or Fatal Wilt of Palms
I. Coconuts (*Cocos nucifera*)
M. V. Parthasarathy and
W. G. van Slobbe 3

Hartrot or Fatal Wilt of Palms
II. Oil palm (*Elaeis guineensis*) and other palms
W. G. van Slobbe, M. V. Parthasarathy, and J. A. J. Hesen 15

Temperature Elevation in Palm Inflorescences
C. A. Schroeder 26

The Names and Uses of Palms Among a Tribe of Yanomama Indians
Anthony B. Anderson 30

Regular Features
Natural History Notes 41
Letters 42
Photo Gallery 43
News of the Society 43

Cover Picture

Transverse section of a sieve tube plugged by trypanosomatid flagellates (Protozoa) in the inflorescence of a coconut palm affected by hartrot. Several flagella with their characteristic fine structure can be readily recognized. The dark fibrillar structures seen in four of the organisms are DNA-containing bodies known as kinetoplasts. Electronmicrograph ×28,000. Micrograph by M. V. Parthasarathy. See page 11 for details.

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JOURNAL OF THE PALM SOCIETY

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Hartrot or Fatal Wilt of Palms I. Coconuts (Cocos nucifera)

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Hartrot was first reported by Drost (1908) from the Coronie district of Surinam (South America), where even today several old coconut plantations (Fig. 1) are struggling to survive the disease. As we shall see later, the term hartrot is perhaps a misnomer since the disease is basically a type of wilt. The disease has also been called bronze-leaf wilt (Briton-Jones, 1940), lethal yellowing, and coronie wilt (Bor, 1969). Our preliminary study on hartrot (Partha-



1. Healthy coconut palms in an old plantation at Coronie, Surinam.

sarathy, van Slobbe, and Soudant, 1976) has indicated that the disease is associated with flagellates in the phloem and is quite distinct from lethal yellowing and the bronze-leaf wilt. The disease is now widespread both within and outside Surinam. Hartrot of coconuts has recently been reported from Trinidad* and that of oil palms in Surinam, Ecuador,** and Peru (Dollet, Giannotti, and Ollagnier, 1977). Since hartrot is a clear threat to the palm industries of South America and the Caribbean Islands, and a potential threat to the palms of Florida, we have described here in some detail the symptoms of the disease, and the organism associated with it. It is hoped that our report will clarify the differences between hartrot and lethal yellowing, with which it has often been confused.

Symptoms

The symptoms were studied in detail in the coconut cultivar 'Malayan Dwarf,' then in other cultivars such as 'Surinamese Dwarf' and 'Ceylonese Dwarf.' The description that follows, therefore, is chiefly based on the affected 'Malayan Dwarf' unless otherwise stated.

1) The earliest symptom, as far as we could determine, was the yellowing of oldest leaves, usually starting from the tips. The yellow color may vary in shade and intensity depending on the variety of coconut. Unfortunately the yellowing symptom by itself is not always helpful, since malnutrition and other deficiencies can produce a similar symptom.

2) The yellowing increases progressively to the younger leaves while the older ones start turning brown (Fig. 2). All of the unopened inflorescences and healthy-looking roots contain flagellates in the phloem. Rotting of the root tips of first-order (larger) roots is frequent.

3) Immature nuts, rather than the mature nuts, usually fall (Fig. 3). We found this phenomenon to be more common in the 'Malayan Dwarf' than any other cultivar. Some, but not all, mature nuts in 'Ceylonese Dwarf' and 'Surinamese Dwarf' may fall at this stage.

4) Female flowers of the most recently opened inflorescence turn black (Fig. 4). Spear rot starts.

5) The oldest unopened inflorescence at this time often will exhibit dark brown (coffee-brown) patches in the secondary inflorescence axes (Fig. 5). All young inflorescences always have flagellates in the phloem at this stage. Inner and outer bracts (spathes) of unexpanded inflorescences, basal (soft) portions of younger leaves, and differentiated vascular bundles below the shoot apex also contain flagellates.

6) Browning of the oldest unopened inflorescence increases until almost the entire inflorescence becomes brown (Figs. 6, 7). Younger inflorescences at this time may also start to become brown. Most vascular bundles in the inflorescences that start to, or have become, brown contain sieve tubes that are literally plugged with flagellates (cover picture).

7) Depending on the cultivar and growing conditions, all the other nuts may also drop at this stage. Recently opened inflorescences appear black (Fig. 3).

8) Most of the expanded leaves become yellow or brown, depending on their age. Some of the older leaves break near the base, and others at the middle of the petiole. Most nuts of all ages fall, leaving only naked stalks (Fig. 8). Spear rot accelerates and the spear

* Dr. R. Barrow, Centeno, Trinidad, and Dr. H. Waters, Kingston, Jamaica—personal communications, as Cedros Wilt.

** Dr. R. McCoy, Ft. Lauderdale, Florida, USA—personal communication.



2. Early symptoms in a coconut palm affected by hartrot. The oldest leaf has become yellow-brown (short arrow) and the next two younger ones have turned yellow (long arrows).

leaf topples over (Fig. 9), emitting a foul odor.

9) The apical region of the crown also rots with a foul odor. Rotting of the spear leaf and the apical region or "palm heart" is apparently due to the secondary infection of bacteria and other organisms. In the dwarf cultivars, stages 1 through 4 occur in two to three weeks depending on the cultivar, age, and



3. Many immature nuts have fallen off at this stage, while the mature nuts remain attached. Note that a recently opened (arrow) inflorescence is black instead of the normal pale yellow color.

growing conditions, and stages 5 through 9 take about the same time. Thus, as far as we could determine, the palm succumbs four to six weeks after the earliest symptoms begin to appear. In taller palms the symptoms are relatively slow to occur and the palm succumbs 12–16 weeks after the earliest symptoms begin to appear.

It is obvious from the symptoms de-



4. The most recently opened inflorescence of a palm affected by hartrot at a stage comparable to that in Fig. 3. Note that the pistillate flowers have turned black. Mature nuts appear normal. Spear rot starts at this stage.

scribed that the rotting of the spear leaf and ultimately the apical region, is not the primary symptom of the disease. Thus the term hartrot, which in English might be interpreted to mean heart rot, is perhaps not the best term to describe the disease. However, we have retained the Dutch name hartrot for its historical



5–7. The oldest unopened inflorescences of affected palms at stages comparable to Figs. 3 & 4. Note the darkened areas in the secondary inflorescence axes. 5. One of the earliest stages. 6 & 7. Same as in Fig. 5 but showing different amounts of darkning depending on the stage of the symptoms. In Fig. 6 the secondary axes have turned coffee-brown, while most flowers appear healthy. In Fig. 7 the inflorescence on the left is at a more advanced stage of browning than that in Fig. 6.

value in preference to a more appropriate name for the disease, such as fatal wilt.

Comparison with Symptoms of Other Diseases

It is obvious that hartrot exhibits some, but not all, of the symptoms exhibited by lethal yellowing. The yellowing of the leaves, blackening of inflorescences, and rotting of the palm heart that produces a foul odor are all symptoms comparable to lethal yellowing (Grylls and Hunt, 1971). However, one of the earliest and most common symptoms of lethal yellowing, which is the shedding of nuts in *all* stages of development, is normally not an early symptom in the case of hartrot. The so-called "flag leaf" symptom often present in coconuts affected by lethal yellowing in Florida, USA was also not observed in coconuts affected by hartrot. Minor



8. A relatively advanced stage of hartrot showing most nuts of all stages fallen. Most of the expanded leaves have turned yellow. Older leaves have turned brown.

variations in the symptoms of hartrot will no doubt be present in different cultivars, in age, and in different climatic and soil conditions.

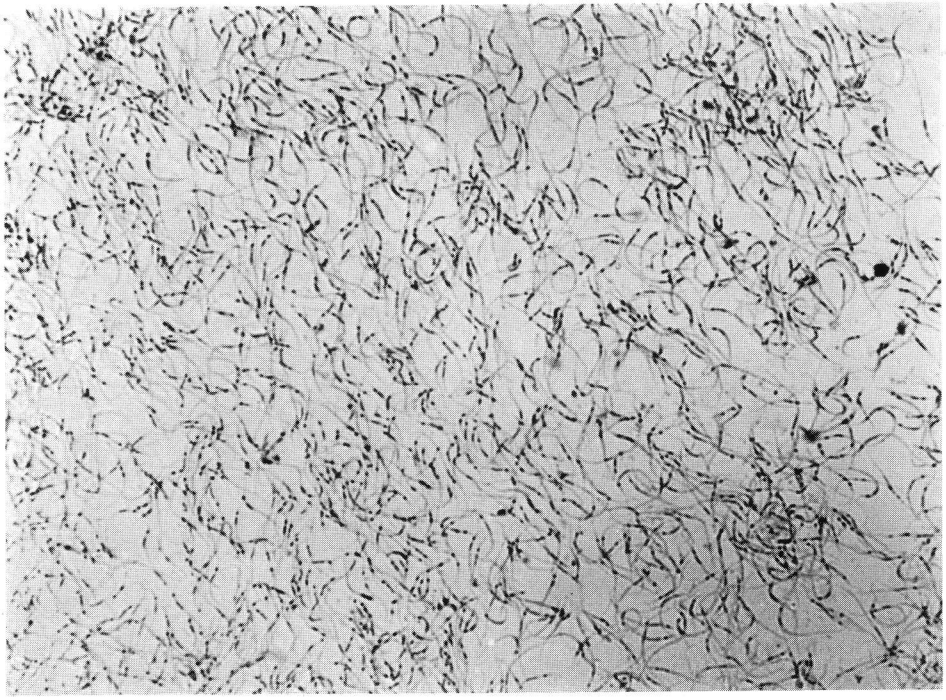
An important aspect of hartrot is that no known cultivar of coconut palm is immune to the disease, including the 'Malayan Dwarf.' On the other hand, lethal



9. Spear rot has progressed in this advanced stage of hartrot. The spear leaf has toppled over (arrow). The spear leaf base and the apical region at this stage emit a foul odor.

yellowing appears not to affect the 'Malayan Dwarf.' Furthermore, the disease progresses much more rapidly than lethal yellowing in dwarf cultivars. Also, the organism associated with lethal yellowing is a mycoplasmalike organism (Parthasarathy, 1974), whereas the one associated with hartrot is a flagellate.

Bronze-leaf wilt can readily be distinguished from hartrot on the basis of



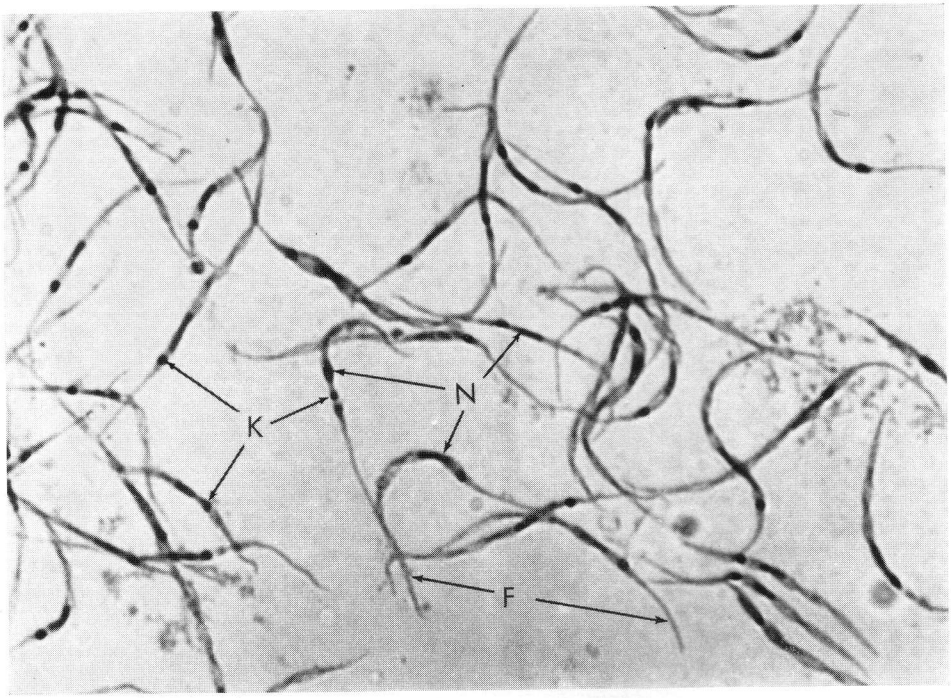
10. Trypanosomatid flagellates belonging to the genus *Phytomonas* present in a drop of phloem sap squeezed from a young inflorescence axis of coconut affected by hartrot. The nuclei and kinetoplasts are stained dark. Geimsa stain. ×480.

differences in nut fall, inflorescence blackening, and leaf discoloration. Leaves of palms affected by bronze-leaf wilt do not exhibit browning of the older leaves. Furthermore, bronze-leaf wilt is now thought to be due to a physiological cause, and recovery from the wilt commonly occurs (Grylls and Hunt, 1971). On the other hand recovery from hartrot has never been observed.

Flagellates Associated with Hartrot

If there is a single feature that distinguishes hartrot from all other known diseases of palms, it is the presence of flagellates in the phloem of differentiating organs. The flagellates are 12–18 μm in length and 1.0–2.5 μm in diameter. On the basis of size, morphology, and ultrastructure, they have been classified as a mastigophoran protozoon belonging to the order Kinetoplastida, family Trypanosomatidae, genus *Phytomonas* (Parthasarathy, van Slobbe, and Soudant, 1976). The flagellates are present in large numbers in sieve tubes, and are apparently confined to them. Samples of inflorescences from palms in advanced stages of the disease had flagellates in 10 to 100% of the mature sieve elements in *all* the vascular bundles examined. It thus seems likely that the flagellates, if they are the causative agents, literally plug the food conduit to growing regions in the crown and thus bring about the death of the palm. Further investigations are no doubt needed to resolve the host-parasite relationship.

We were able to check for the presence of flagellates in the inflorescences



11. Same as in Fig. 10 but at a higher magnification. Note that most of the flagellates appear twisted. F, flagellum; K, kinetoplast; N, nucleus. ×1,800.

or roots quite readily by the following method:

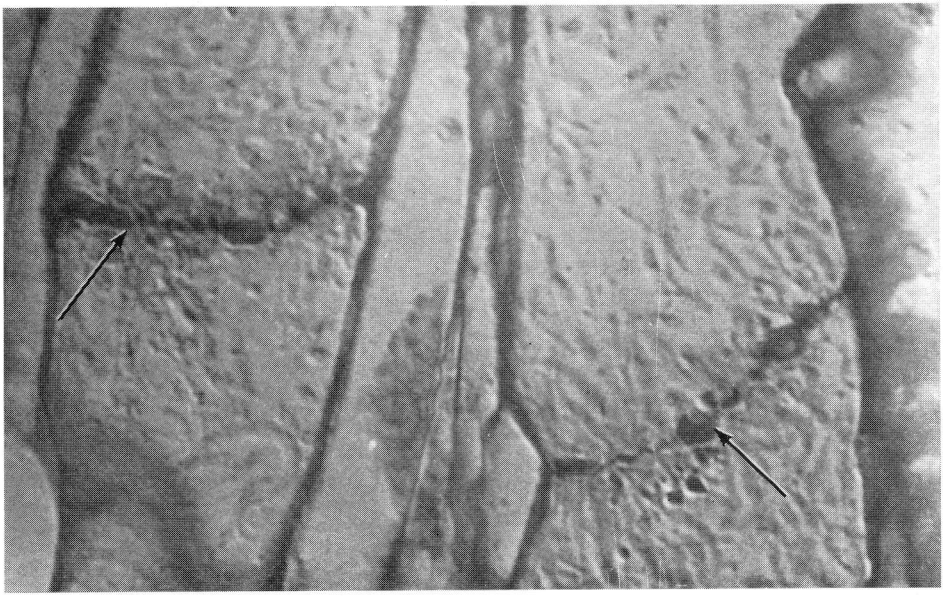
i) Collect the oldest or the next younger unopened inflorescence from a coconut palm between stages 1 and 6 and bring it to the laboratory or field station. If care is taken not to dessicate the inflorescence, the flagellates will remain alive up to *one week* in the inflorescence. The same is true of roots collected during stages 1 to 4.

ii) After splitting the unopened bract, remove a segment of primary or secondary axis of the inflorescence and cut a piece of the axis with a clean razor blade. Squeeze one or two drops of sap from the cut end of the axis onto a microscope slide and air dry.

iii) Place 2–3 drops of phosphate buffered Giemsa stain (Fisher Scientific Co.) on the slide and allow 15 minutes to elapse before placing a coverslip over the mixture of sap and stain. (There is no need to wash the stain.)

iv) Although the preparation will appear light blue in color, flagellates can be readily recognized even at 480× (Fig. 10). The kinetoplast can be recognized with this staining method. For a more permanent preparation, the dried sap containing the flagellates can be fixed in 100% methyl alcohol for 1 minute, and stained for 3 minutes in phosphate-buffered Giemsa before viewing (Fig. 11).

At the sacrifice of some resolution, one can also detect flagellates without staining by narrowing the condenser aperture or lowering the condenser position. Thus, excepting for a light microscope, very little equipment or chemicals are needed to determine the presence or absence of flagellates in trees suspected of being affected by hartrot. Observa-



12. Longitudinal section of sieve tubes in the primary axis of a young inflorescence infected with the flagellates. The flagellates are lodged near sieve plates. Some flagellates appear to be lodged within the sieve-plate pores. Phase contrast. ×1,900.

tions made under the electron microscope may be used to confirm the results at the light microscopy level.

Routine paraffin or plastic embedding of affected material can also yield useful information at the light microscopy level on the distribution of flagellates within a given plant organ or vascular bundle (Fig. 12).

Some Preliminary Observations on the Flagellates and the Host Phloem

Our preliminary attempts to culture the flagellates have not been successful. Further efforts to culture the organism are currently underway. However, we were quite successful in keeping the flagellates alive for various amounts of time for up to two hours in the sap squeezed out of the inflorescence stalk. The organism was considered "living" as long as the flagellum moved. It was interesting to note that although the flagellum exhibited a rapid sinuous movement, the organism itself exhibited no obvious locomotion. Flagellates commonly appeared to be twisted (Fig. 11). Our observations suggest that the flagellates are passively transported with the photosynthates in the sieve tubes to the sink regions of the palm, such as young inflorescences, immature leaves, and roots. Flagellates were not observed in the expanded leaves of the affected palms. The presence of flagellates did not seem to induce collapse of any phloem cell. Preliminary observations indicate that sieve tubes containing the flagellates are not greatly modified. Some sieve elements had electrondense material accumulated between plasmalemma and the cell wall (cover picture). Plastids with starch granules appeared to be fewer in the infected

cells as compared to the healthy ones. Further investigations are necessary to study the possible subtle structural changes in sieve tubes infected by the flagellates.

Preliminary Observations on the Effect of Drugs on the Flagellates

Effects of penicillin, streptomycin, oxytetracycline, tryparsamide, and Berenil (Hoechst A.G.) on the flagellates were tested by using 0.5 to 3% concentrations of the drugs both *in vitro* and *in vivo*.

In vitro testing was accomplished by adding different concentrations of drugs to live flagellates that were squeezed out of the inflorescence. For *in vivo* experiments, young inflorescence axes previously tested for the presence of live flagellates were placed intact in beakers containing different concentrations of the five drugs for up to 24 hours for uptake of the drug through capillarity. None of the drugs tested appeared effective against the flagellates. Injecting the affected palms with the same drugs (except Berenil) by the Moget and gravity-feed methods have also proved useless thus far.

Although the causative agent of hartrot is yet to be proved according to Koch's postulates, there is sufficient circumstantial evidence to suggest strongly that the flagellate *Phytomonas* could be the agent (Parthasarathy, van Slobbe, and Soudant, 1976). Since the protozoon parasites of the family Trypanosomatidae are notoriously difficult to control in human beings and animals, one might expect the control of hartrot to be a slow and uphill task, assuming that the flagellates are the causative agents.

Acknowledgments

We are very grateful to Mr. F. A. van Amson, Director, Agricultural Experiment Station, Ministry of Agriculture, Surinam for the help and cooperation offered during this investigation, and to Drs. R. Power, Mycologist and Plant Pathologist, for the use of his laboratory facilities. Special thanks are due to Mr. M. A. Palmtak, Agricultural Experiment Station, Paramaribo for his invaluable help in the field, and to Dr. R. Barrow, Red Ring Division, Agricultural Experiment Station, Trinidad for his help and discussions on hartrot in Trinidad.

Technical help of Ms. Carole Daugherty is gratefully acknowledged. The cytological aspects of this study were supported by Hatch Project No. 407 (M.V.P.).

Literature Cited

Briton-Jones, H. R. 1940. The diseases of the coconut palm (Revised by E. E. Cheesman). Bailliere, Tindall & Cox, London.

Bor, N. 1969. Coronie wilt: the 'unknown disease' of the coconut palm in Surinam. Internal Report, Agricultural Exp. Station. No. 1.

Dollet, M., J. Giannotti, and M. Ollagnier. 1977. Observation de protozoaires flagelles dans les tubes cribles de palmiers à huile malades. C. R. Acad. Sci. Paris. 284, Série D: 643–645.

Drost, A. W. 1908. Hartrot ziekte in kokos. Jaarverslag over 1907. Insp. Landb. W. Indië: 19–20.

Grylls, N. E. and P. Hunt. 1971. A review of the study of the aetiology of coconut lethal yellowing disease. Oléagineux 26: 311–315.

Parthasarathy, M. V. 1974. Mycoplasma-like organisms associated with lethal yellowing of palms. Phytopath. 64: 667–674.

Parthasarathy, M. V., W. G. van Slobbe, and C. Soudant. 1976. Trypanosomatid flagellate in the phloem of diseased coconut palms. Science 192: 1346–1348.

Hartrot or Fatal Wilt of Palms II. Oil palm (Elaeis guineensis) and other palms

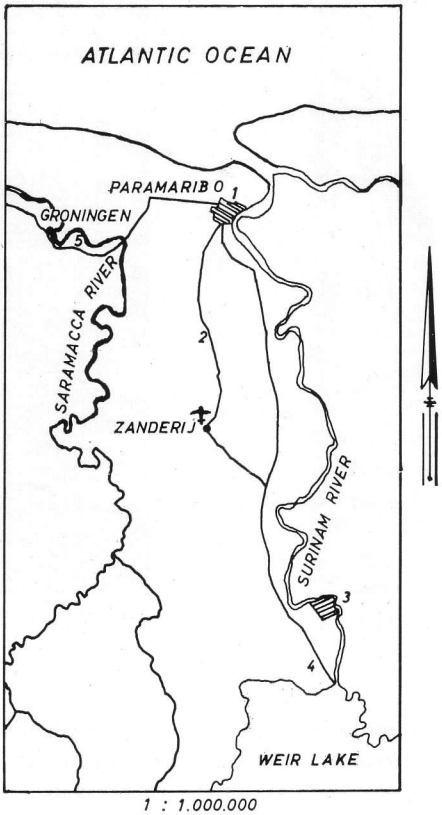
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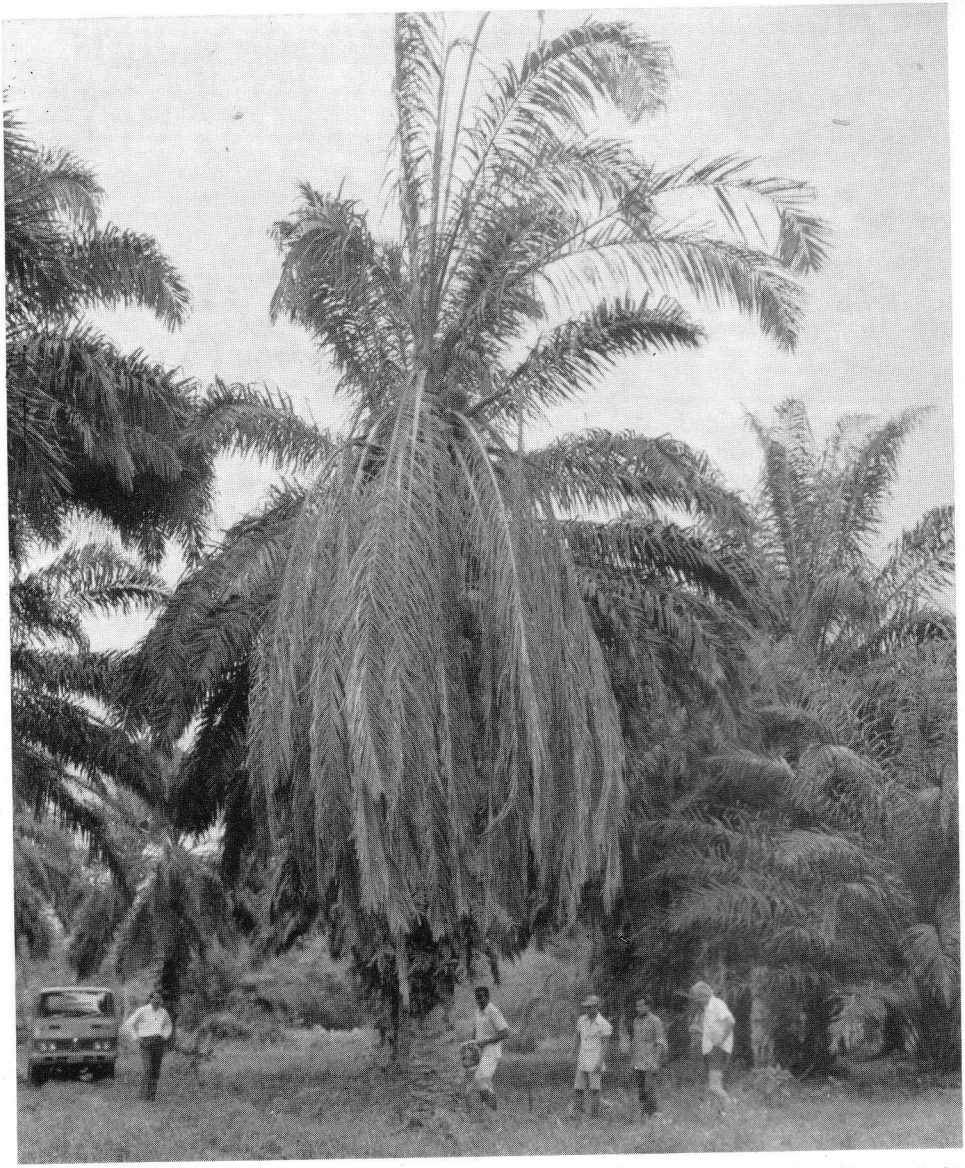
Preliminary investigations in August, 1976, on an oil palm at the plantation in Oema, Surinam (Fig. 1) indicated the presence of the flagellate *Phytomonas* in sieve tubes of young inflorescences. This prompted us to investigate more carefully some oil palms that were succumbing to a wilting disease at the Victoria oil palm estate and to trace the history of wilt diseases of oil palms in Surinam.

The first recording of a fatal wilting disease affecting oil palms in Surinam was made by Drost (1921). According to him, 47 of 130 palms planted at Cultuurtuin Agricultural Experiment Station (Fig. 1) in 1915 had succumbed to an unknown cause, while the following year 13 were left. He called this disease hartrot (Dutch for "heart or bud rot"), a disease similar to the one he observed in coconut palms (Drost, 1908). A second record of this wilting disease was published in a newspaper by Stahel (1938), who was the first to detect the plant-infecting *Phytomonas* flagellates in the sieve tubes of coffee plants affected by a wilt (Stahel, 1931, 1932). According to Stahel, of 140 African oil palms that were planted at Cultuurtuin in 1930, only three palms were left after seven years.

Meanwhile, oil palms that were planted in some coffee and cacao plantations also died of an unknown wilt disease. Stahel, who studied the wilt, decided that it was not hartrot, since he observed only the progressive browning of the leaves and not the rotting of



1. Map indicating important palm estates. 1, Cultuurtuin; 2, Oema; 3, Victoria; 4, Brokobaka; 5, La Poule.



2. Oil palm at Oema affected by hartrot. Flagellates were first detected in the phloem of this 22-year-old palm.

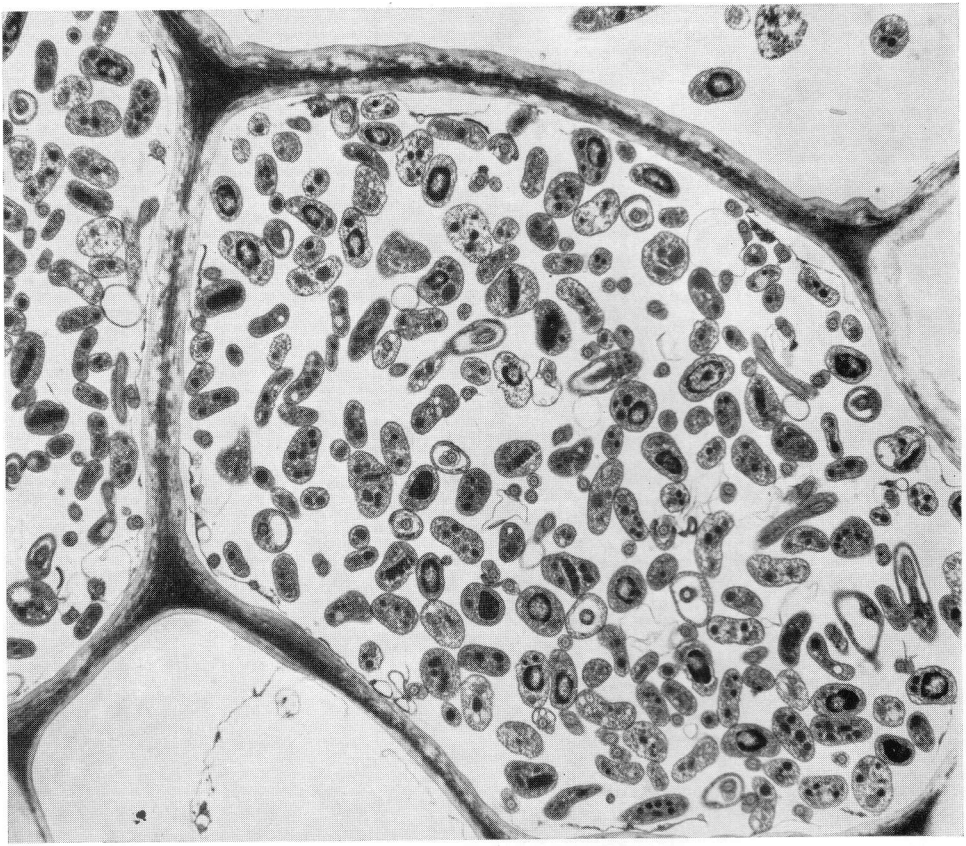
the spear leaves. It is not clear whether he actually dissected the crown to check the status of differentiating organs. A similar disease of oil palms was subsequently reported in 1940 (Anonymous, 1941) and again in 1950 (Anonymous, 1951). A thousand oil palms planted in 1956 died in the experimental garden at La Poule (Fig. 1) from an unknown disease between 1961 and 1966 (Schut, 1976). The symptoms were reported to be similar to those of the vascular wilt



3. A young but bearing oil palm affected by hartrot. Although not obvious in this photograph, the tips of pinnae in the older fronds have turned chocolate-brown.

(Wardlaw, 1950) that is thought to be caused by the fungus *Fusarium oxysporum*. Indeed, the fungus was found in some of the palms (Anonymous, 1967) and it is not clear whether it was a case of primary or secondary infection. It is of interest to note that in the same field, which was replanted in 1969–70 with 700 dwarf coconut cultivars such as 'Malayan Dwarf,' 'Surinamese Dwarf,' and 'Ceylonese Dwarf,' all had succumbed to hartrot between 1975 and 1976. La Poule is situated on the coastal plain where the soil is a poorly drained heavy clay. The next report of a similar oil palm disease was by van Hoof (1962) at Oema. He decided that the disease was the same as hartrot described by Drost (1908). It was at Oema, in September, 1976, that we first detected flagellates in the phloem of a 22-year-old diseased oil palm (Fig. 2).

The Victoria oil palm estate that was started in 1970 consists of 1600 hectares of oil palms. A wilting disease was first observed by us in May, 1976, and within nine months the wilt had killed scores of palms. The disease appeared to have started at two different loci in the estate. The soil at one locus is a poor to moderately drained silty clay alternated by heavy clay, while the soil in the other locus is a combination of well-drained sandy loam and sandy clays. The wilt occurs more commonly in palms growing along the rivers, creeks, and at the edges of fields. It appears to spread more slowly to trees growing in the



4. Electronmicrograph showing transverse section of sieve tubes in the root of an affected palm containing trypanosomatid flagellates of the genus *Phytomonas*. ×6,790.

heavy clay areas as compared to those growing in the sandy loam and clay combination. The significance of this is not yet clear.

Symptoms

External symptoms described here are based on observations made on diseased palms at Victoria oil palm plantation, Surinam. The disease appears to affect mostly bearing palms that are four years old or older. The external symptoms develop very rapidly on such palms. It takes about two weeks from the earliest leaf symptom to the time most of the crown turns brown.

1. The earliest symptom is the change in color of the tips of the pinnae in the oldest frond from green to chocolate-brown (Fig. 3). At this time flagellates are usually present in the phloem (Fig. 4) of healthy-looking roots of the first order (larger roots). Rotting of root tips is noticeable in a few of the larger roots. Most second order roots at this time are rotten.

2. Pushing apart the older spear leaves (the oil palm has more than one spear leaf) at this stage reveals the youngest spear leaf that has just started to rot.



5. Rotting fruits of immature infructescence in an affected oil palm. The fruits become dull and either fall or rot within three to four days after the appearance of the earliest symptom.

3. Fruits of the immature infructescences (fruit bunches) become dull (Fig. 5) and either fall or rot within three to four days after the appearance of the earliest symptom. The primary axis of such infructescences normally contains flagellates in the phloem before rotting. Staminate inflorescences do not rot as rapidly as the infructescence and also seem to lack flagellates. The oldest unopened inflorescence is often rotten and in the young ones the rot may be less advanced. Very few flagellates appear to be present in such unopened inflorescences.

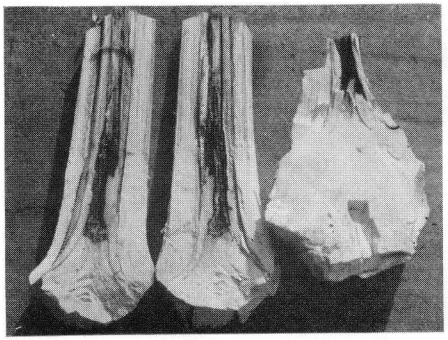
4. The browning of tips of pinnae progresses rapidly and sequentially from the oldest to the younger leaves so that all the leaves except a few young ones turn brown in about two weeks. Flagellates can still be detected in the healthy-looking parts of the larger roots. However, most root tips are rotten at this stage.

5. Remaining spear leaves start to rot and may topple over (Fig. 6). The younger leaves become yellow-green. Flagellates may be present at this stage in the basal parts of the spear leaf and in recently matured vascular bundles of the stem top. Although the spear leaves may rot completely, the rotting of the apical region itself has not been observed thus far (Fig. 7).

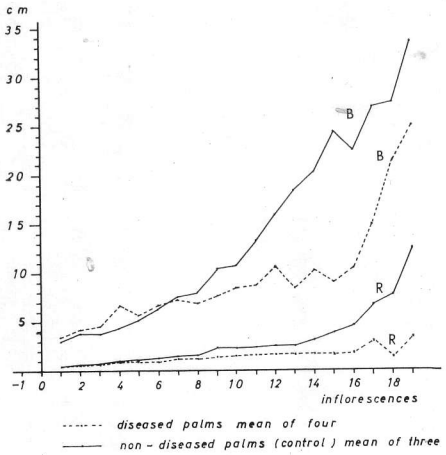


6. Spear leaves have started to rot in this oil palm affected by hartrot. One spear leaf has toppled over (arrows). Some of the older leaves are broken. Many leaves become yellow-brown by this stage.

The wilt advances very rapidly in four- to six-year-old palms but it is likely, as in coconuts, that the older and taller palms take a longer time to succumb to the disease. Again, as in coconuts, the disease is clearly a wilt, and the rotting of the spear is due to secondary infection.



7. Apical region of palms affected by hartrot showing the relatively healthy shoot apices. The rot appears not to proceed beyond the basal part of the spear leaves.



8. Length of the bract and rachilla in centimeters. Measured from the axil of leaf number 1 (youngest expanded leaf) to number 17 (normally that with the youngest expanded inflorescence in its axil). B, bract; R, rachilla.

Retarded Growth of Unopened Inflorescences

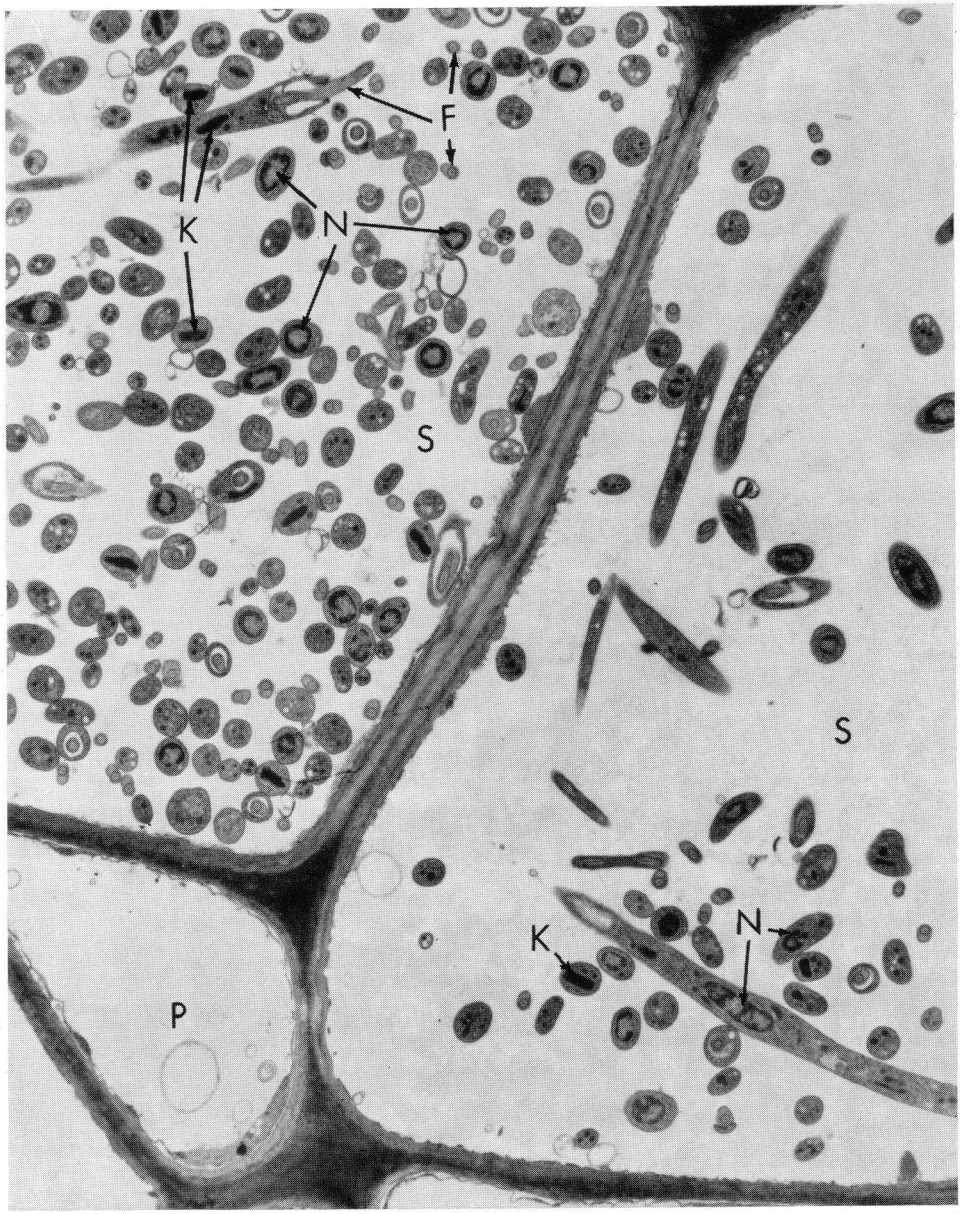
In addition to aborting and/or rotting, the length of the rachillae and bracts (spathes) of the unopened inflorescences are also retarded in growth. In Fig. 8 the development of the rachilla and peduncular bract is represented by means of the mean length of all rachillae and bracts of diseased and nondiseased palms.

Although the bracts of the nondiseased palms show a decrease in length at leaf 16, possibly due to drought, it is obvious that the decrease in length of the rachillae as well as the bracts of diseased palms has to be regarded as a symptom. A long bract does not always correspond to a long rachilla, especially when it concerns disorders, due to the fact that the rachilla is the first to become rotten and/or aborted.

The difference between the length of the rachillae and the bracts of the diseased and nondiseased palms suggests that the disease affects the development of the inflorescence before the external symptoms become visible.

Comparison with Other Diseases of Oil Palms

As noted earlier, although wilting diseases in oil palms have been often reported in Surinam, a detailed description of them is lacking. Consequently it is difficult to say that the disease now reported is identical to the disease reported from earlier recordings. A comparison of the disease with vascular wilt (Anonymous, 1967; Turner and Bull, 1967) shows that the two diseases are not identical, since we were unable to find the necrosed vascular strands characteristic of the vascular wilt. The wilting disease of oil palms in South America known as *la maladie de la pourriture des racines et de la flèche* (Corrado, 1970—Colombia, Brazil), *le desséchement des feuilles maladie* (Martin, 1971—Colombia), and *marchitez sorpresiva* (Lopez, Genty, and Ollagnier, 1975—Colombia, Peru, and Ecuador) are the only ones that appear to be similar to the wilt disease we are reporting. Furthermore, the presence of flagellates has been reported in the phloem of oil palms affected by wilt diseases in Ecuador (Dr. R. McCoy, personal communi-



9. Electronmicrograph showing flagellates in sieve tubes of differentiating inflorescence in a *maripa* palm (*Maximiliana maripa*) affected by hartrot. F, flagellum; K, kinetoplast; N, nucleus; P, parenchymatous cell; S, sieve tube. ×6,340.

cation) and in Peru (Dollet, Giannotti, and Ollagnier, 1977). The disease apparently has not spread to oil palm plantations in Africa and Asia.

On the basis of the symptoms exhibited by the oil palms affected by the disease in Victoria, and because of the association of flagellates with the dis-

ease, we feel that this wilt is the same as the hartrot of coconut palms (Parthasarathy and van Slobbe, 1978). It is thus likely that the wilt diseases associated with flagellates in Ecuador and Peru are also hartrot. Most cultivars of oil palms show no resistance to the hartrot. *E. oleifera* (*E. "melanococca"*), and the hybrid *E. oleifera* × *E. guineensis* appear to be the only ones that have thus far not been affected by the disease.

Wild Palms Affected by Hartrot

External symptoms comparable to hartrot were also observed in some wild palms including *pina* (*Euterpe precatoria* Mart.), *awara* (*Astrocaryum segregatum* Drude), *Mauricie* (*Mauritia flexuosa* L. f.), and *maripa* (*Maximiliana maripa* (Mart.) Drude). However, preliminary investigations have revealed the presence of flagellates only in *maripa* (Fig. 9). A more thorough study of species other than coconuts and oil palms that show external symptoms of hartrot needs to be undertaken.

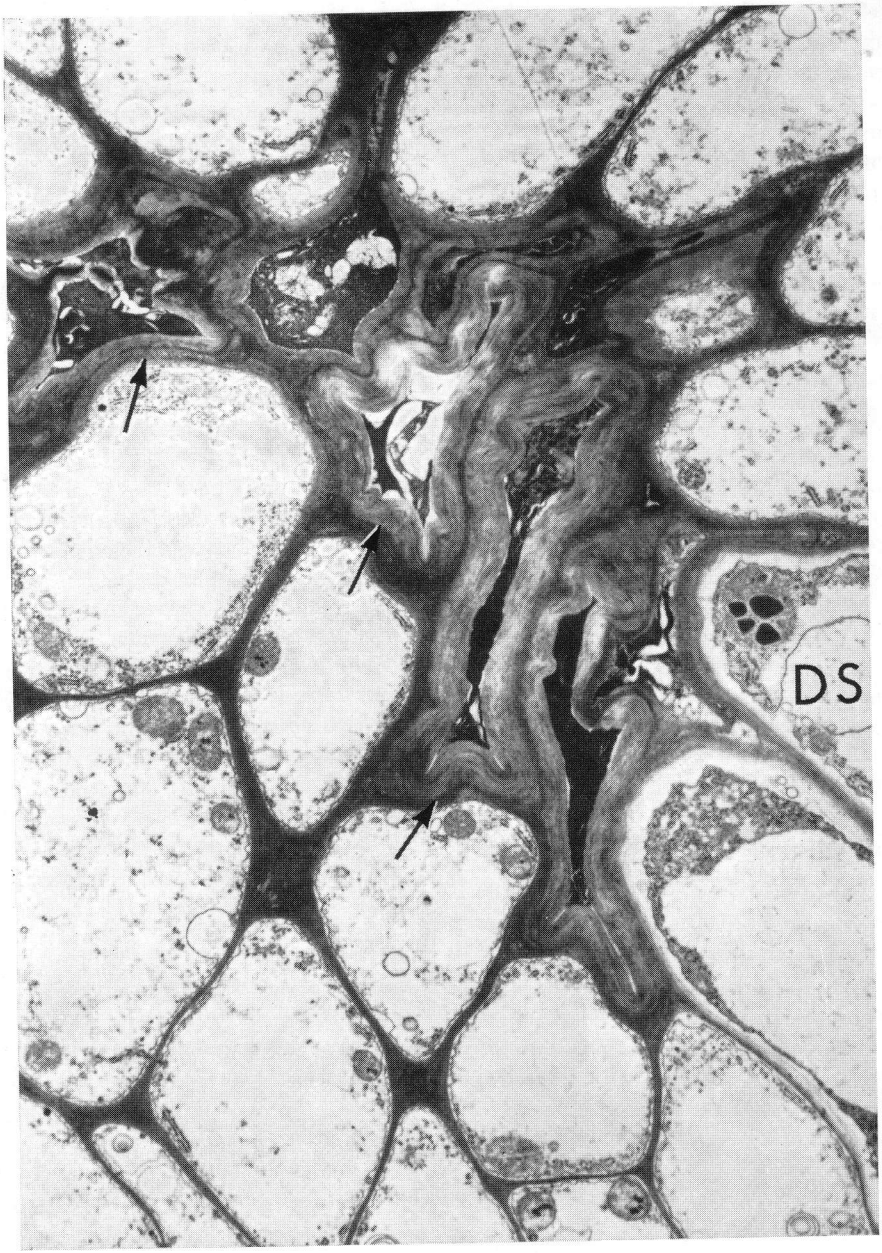
Flagellates Associated with Hartrot

As in coconuts affected by hartrot, flagellates belonging to the genus *Phytomonas* are associated with the hartrot of oil palms. In size and structure they are comparable to those present in the coconut palms affected by hartrot (Parthasarathy, van Slobbe, and Soudant, 1976). Although large numbers of flagellates are present in the primary axes of infructescences in affected oil palms, they appear to be scarce in the differentiating secondary axes of such organs. Sieve tubes in the differentiating secondary axes of affected inflorescences appear to collapse prematurely (Fig. 10). This could be one of the reasons why flagellates are not present in large numbers in the secondary axes as compared with coconut material. The reason for the apparent absence of flagellates in the primary axes of staminate inflorescences of affected oil palms is not clear. It could be that our sampling was insufficient, or that the sieve tubes in the pistillate inflorescence offer the right environment for the flagellates.

Etiology

Although the flagellate *Phytomonas* is always associated with the hartrot of coconuts, oils palms, and *maripa*, there is no proof that the flagellate is indeed the causative agent. The absence of flagellates in healthy palms, and the absence of microorganisms other than flagellates in affected palms strongly suggest but do not prove that the flagellates are causative agents. More work no doubt needs to be done to prove the pathogenicity of the flagellates.

Phytomonas commonly infects the latex cells of many lactiferous plants without apparently affecting them. However, when the flagellate infects sieve tubes of the phloem, the host plant apparently suffers (see Parthasarathy *et al.*, 1976 for a review). The lygaeid hemipteran *Oncopeltus* is known to be the insect host that commonly transmits the flagellates to milkweeds (McGhee and Hanson, 1964). We do not know anything about the insect hosts of the phloem-infecting flagellates. Since hartrot appears to be widespread, we suspect that the vector must be a common one with a wide geographical range. It also appears that the vector(s) prefer conditions that follow disturbed vegetation. Obviously all lygaeid hemipterans, both adults and nymphs, are suspects. Screening for possible vectors is clearly one of the first tasks that must be undertaken if one hopes to control the disease. In tropical areas, however, this is no easy task since hundreds of species of in-



10. Electromicrograph of a differentiating vascular bundle in immature female inflorescence of oil palm affected by hartrot. Note the collapsed mature sieve elements (arrows). DS, differentiating sieve element. ×3,330.

sects will need to be screened for *Phytomonas*.

Since known antibiotics and drugs appear to be useless in killing the flagellates (Parthasarathy and van Slobbe, 1978), it may be worthwhile to see whether broad spectrum insecticides can play a part in controlling the unknown vector or vectors.

The Government of Surinam is currently engaged in the study and possible control of the disease with the cooperation of scientists from the United States, the Netherlands, and other counties. A substantial amount of basic research on the biology of the flagellates needs to be done before control of hartrot becomes a reality.

Acknowledgments

We are grateful to The Ministry of Agriculture, Surinam and HVA-International for the help rendered during the course of this investigation. Technical help of Ms. Carole Daugherty is gratefully acknowledged. The cytological part of this investigation was supported by Hatch Project #407 (M.V.P.).

Literature Cited

Anonymous. 1941. Jaarverslag over 1940. Dep. Landb. Econ. Zaken, Suriname. p. 48.

Anonymous. 1951. Jaarverslag over 1950. Dep. Landb. Veet. Viss., Suriname. p. 48–49.

Anonymous. 1967. Jaarverslag over 1966. Meded. Landbouwproefst., Suriname, no. 42: 74, 96.

Corrado, F. 1970. La maladie du palmier à huile dans les Llanos de Colombie. Conseils de l'I.R.H.O., no. 97; Oléagineux 25(7): 383–384.

Dollet, M., J. Giannotti, and M. Ollagnier. 1977. Observation de protozoaires flagellés dans les tubes cribles de palmiers à huile malades. C. R. Acad. Sci. Paris 284, Série D 643–645.

Drost, A. W. 1908. Jaarverslag over 1907. Insp. Landb. Suriname: p. 19–20.

———. 1921. Jaarverslag over 1920. Dep. Landb. Suriname: p. 64.

Hoof, H. A. van. 1962. Afsterving van oliepalmen. Sur. Landb. 10(4): p. 168.

Lopez, G., Genty, P., and M. Ollagnier. 1975. Contrôle préventif de la 'Marchitez sorpresiva' de la l'*Elaeis guineensis* en Amerique latine. Oléagineux 30(6): p. 243–250.

Martin, G. 1971. Le dessèchement des feuilles, maladie de palmier à huile dans la region du Nord Santander en Colombie. Oléagineux 26(1): p. 23–24.

McGhee, R. B. and W. L. Hanson. 1964. Comparison of the life cycle of *Leptomonas oncopelti* and *Phytomonas elmassiani*. J. Protozoology 11: 555–562.

Parthasarathy, M. V. and W. G. van Slobbe. 1978. Hartrot or fatal wilt of palms. I. Coconuts (*Cocos nucifera*). Principes 22: 3–14.

Parthasarathy, M. V., W. G. van Slobbe, and C. Soudant. 1976. Trypanosomatid flagellate in the phloem of diseased coconut palms. Science 192: 1346–1348.

Schut, B. 1976. Oil palm accessions of Surinam. Sur. Agr. 24(1): 42–47.

Stahel, G. 1931. I. Zur Kenntnis der Siebröhrenkrankheit (Phloëmnekrose) des Kaffeebaumes in Surinam. Phytopathol. 4: 65–83.

———. 1932. II. Zur Kenntnis der Siebröhrenkrankheit (Phloëmnekrose) des Kaffeebaumes in Surinam. Phytopathol. 5: 539–544.

———. 1938. De productie der oliepalmen op Zandery I. De West, 7-1-1938, Nr 3189, Paramaribo, Suriname.

Turner, P. D. and R. A. Bull. 1967. Diseases and disorders of the oil palm in Malaysia. Inc. Soc. Planters, Kuala Lumpur 1967: 228–234.

Wardlaw, C. W. 1950. Vascular wilt disease of the oil palm caused by *Fusarium oxysporum* Schl. Trop. Agric. (Trinidad) 27: 42–47.

Temperature Elevation in Palm Inflorescences

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The production of an inflorescence in palms precedes a marked increase in metabolic activity associated with the development and maturation of the complex floral structure. The concentration of floral structures on the palm spadix and the enclosure of these highly metabolically active tissues within the protective spathe result in the intensification of heat production associated with floral development. Indeed such is the case in the pejibaye palm, *Bactris gasipaes* HBK, one of the economically important palms grown from Honduras and Costa Rica southward to Brazil and Bolivia.

While observing the floral behavior of pejibaye palm in Turrialba, Costa Rica, it was noted that at certain stages the inflorescence was perceptibly warm to the touch. More accurate temperatures were then determined with the aid of a YSI telethermometer model 425F and the use of needle probes and an air temperature sensor. Temperatures within the spathe above the ambient air were most evident in early morning. Periodic readings were made at various hours especially in early morning and throughout the day. Several observations were made in the field on a group of seedling palms in the progeny collections at the Centro Agronomico Tropical de Investigación y Enseñanza, Turrialba, Costa Rica in July, 1976. These materials had been selected for comparative freedom from the spininess that characterizes the species. Temperature probes were inserted into the base of the intact spathe, into the approximate center of the flower mass and in some cases into the space between the apex of the rachillae and the bract before the latter split. In adjacent inflorescences, where the bract had split to expose the fresh flowers, which were not yet abscising from the rachillae, probes were placed in the basal, solid peduncle tissue or nested among the rachillae about midway in the floral mass. While a degree or two difference could be detected between temperatures of given inflorescences in comparable stages of development, the trends and magnitudes of heat emission are depicted by typical observations in Table 1.

The elevation of temperature in pejibaye flowers associated with their high rate of metabolic activity is indicated by the observation on the temperature of detached staminate flowers held in a paper sack about 20 cm × 12 cm and piled to the depth of 20 cm. These flowers had been stripped by hand from freshly opened, nonshedding inflorescences, counted, and merely poured into the bag where they remained for about 12 hours. The next morning at 9:00 A.M. in an ambient air temperature of 22.2°C the middle of the flower mass registered 28.8°C. A similar group of many thousands of flowers which had been held for three days in a hard-sided plastic bowl of comparable size to the paper bag, registered an interior temperature of 33.3°C. Another small open paper box of loosely placed rachillae with flowers attached had been standing

Table 1. Temperature differences between air and inflorescence tissue in Pejibaye

Inflorescence identity and condition	Ambient air temperature	Inflorescence temperature	Temperature difference
3–12 (intact)	21.5°C	22.2°C	0.7°C
3–10 (intact)	22.0	26.5	4.5
3–10 (open)	22.8	27.8	5.0
5–16 (intact)	20.9	25.0	4.1
3–16 (open)	21.3	26.2	4.9
3–17 (intact)	21.3	23.5	2.2
3–17 (open)	21.3	26.2	4.9

Intact—spathe unopened.
Open—spathe split.

overnight and developed an internal temperature of 25.8°C in ambient air temperature of 21.3°C.

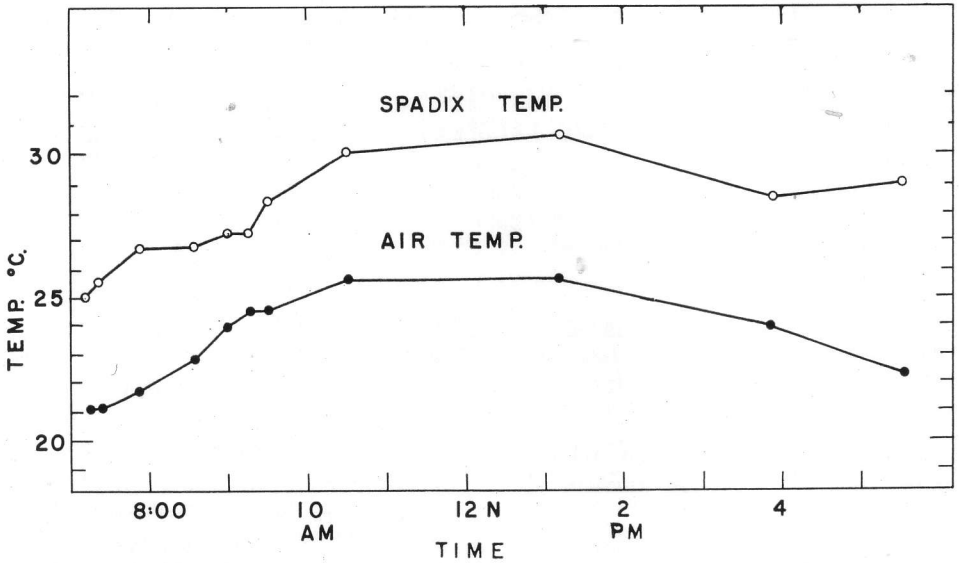
The phenomenon of temperature rise associated with floral development and maturation of floral parts is described by Meeuse (1975) who points out the response in plants that have hermaphrodite flowers and those with staminate and pistillate flowers or other structures associated with the inflorescence in *Arum*. It is indicated that the number of temperature maxima within an inflorescence varies from species to species from two in *Arum* and *Philodendron* to five in *Colocasia odora* Brongn. It is also indicated that the "heat serves as a 'volatilizer' for the odoriferous compounds . . . that attract pollinators . . . hence the maximum precedes the shedding of pollen by many hours." The heat development in the spadix of *Arum* is confined to a time period of less than 12 hours (Knutson, 1972). The postulation is made of a triggering hormone ("calorigen") in the staminate flower primordia which is present about 22 hours before the heating starts.

Discussion

The temperature rise in a palm inflorescence was noted by Martius who, according to Kerchove (1878), recorded the elevated spadix temperature of 34°R (n° Reaumur) (27.2°C) and the ambient air temperature of 29°R (23.2°C) in a *Bactris* palm inflorescence. This increased temperature was attributed to the emission of CO_2 by the flowers. Barbosa Rodrigues (1898) noted the production of heat by staminate flowers of *Guilielma speciosa* Mart. [= *Bactris gasipaes*] and Gatin (1912) mentions specifically that the male flowers of the same species elevate the temperature 14° above the ambient. Time of day and developmental stages of the spadix are not specifically noted. Skutch (1971) also has observed the elevated temperature of inflorescence tissue in the palm. Essig (1971) made a study of pollination in two species of *Bactris* but does not mention the temperature rise associated with the development and maturation of the inflorescence.

Pfeffer (1906) mentioned casually the rise in temperature of 5°–10°C in the inflorescences of cycads and palms and that the stamens are warmer than the carpels but gives no details of these observations. He also called attention to possibly the earliest report by Lamarck on heat production by the spadix of *Arum italicum* Mill. in 1778.

Heat developed in the spathe of skunk cabbage, *Symplocarpus foetidus* (L.) Salisb. (Knutson, 1972), during winter



1. Temperature relations in detached spathe (not split) of *Bactris gasipaes* and ambient air (Turrialba, Costa Rica).

months acts as a natural protection against freezing of the otherwise susceptible tissue. This high heat level of the spathe tissue immediately drops from approximately 25°C upon severance from the mother plant under conditions of 0°C ambient temperature.

Jost (1907) refers to the observations of Kraus (1896) that the inflorescences of palms and cycads not infrequently possess a temperature of 10°C or more above that of the air. Certain parts of the flower of *Victoria regia* Lindl. [= *V. amazonica* (Poepp.) J. & C. Sowerby] (Prance and Arias, 1975) show a similar temperature rise. The evolution of heat in *Arum italicum* was greatest at the opening of the spathe toward evening, increased rapidly to a maximum at midnight, and later in the night dropped to normal (Kraus, 1883). Goodale (1885) also noted that Caspary detected a noticeable rise of temperature in the opening flowers of *Victoria amazonica* and in the flowers of species of *Cactus*, melon, and tuberose.

The heat emission from pejibaye palm inflorescence possibly is directly related to the relative stage of floral development or maturation. This is noted in the observations in Table 1. Comparable inflorescences were monitored, one with the bract intact just prior to splitting and the second when the bract had been split possibly for a day or more. In both spadices the internal tissues were above the ambient air temperature at 8:00 A.M. The floral mass in the split spadix had attained 25.8°C in an ambient air temperature of 21.3°C. The flowers were in a state of anthesis but were not abscising from the rachilla. This state of high temperature in the floral mass is maintained until the flowers drop, at which time the ambient air temperature prevails.

The development of high tissue temperature was detected in a pejibaye spadix that had been severed from the palm on one afternoon and observed the following day starting in early morning (Fig. 1). It should be noted that the

floral mass within the intact (not split) spadix suspended on a palm trunk attained temperatures above the ambient air at all times during the day. This observation is at variance with that made by Knutson (1972) on the spathe temperature of *Symplocarpus foetidus* which immediately declined when the floral structure was severed from the parent plant. The ambient temperature in this latter case was 0°C.

The random set of observations made in intact and split spadices of *Bactris* (Table 1) indicates that there is a consistent trend in the development of elevated temperatures in both in respect to the ambient air temperature with the higher internal temperature prevailing as the floral development proceeds in time.

The significance of these preliminary observations is that elevation of tissue temperature is probably related to stages of floral development. More extensive correlations between these two parameters must be established before specific conclusions can be drawn. It is altogether possible that temperature fluctuations in floral tissue might provide an indication of periods of pollen shedding or stigmatic receptivity which could be useful in genetic and breeding investigations, or which could be developed into a practical indicator of pollination phenomena associated with fruit set and crop production.

It is noted that the amount of heat generated by the developing inflorescence probably is greater in the "open" spadix where the individual flowers are approaching anthesis just prior to abscission.

LITERATURE CITED

BARBOSA RODRIGUES, J. 1898. O calor das flores masculinas da *Guilielma speciosa* Mart. Pl. Nov. Cult. Jard. Bot. Rio de Janeiro 6: 29–31

ESSIG, F. B. 1971. Observations on pollination in *Bactris*. Principes 15: 20–24, 35.

GATIN, C. L. 1912. Les palmiers. Paris.

GOODALE, G. L. 1885. Gray's botanical textbook Vol. II. Physiological botany. American Book Co., N.Y.

JOST, L. 1907. Lectures on plant physiology. Clarendon Press, Oxford.

KERCHOVE, O. 1878. Les palmiers. J. Rothschild, Paris.

KNUTSON, R. M. 1972. Temperature measurements of the spadix of *Symplocarpus foetidus* (L.) Nutt. Amer. Midl. Naturalist 88: 251–254.

KRAUS, G. 1883. Ueber die Blüthenwärme bei *Arum italicum*. Abh. Naturf. Ges. Halle 16: 35–76.

———. 1896. Physiologisches aus den Tropen III. Über Blüthenwarme bei Cycadeen, Palmen und Araceen. Ann. Jard. Bot. Buitenzorg 13: 217–275.

MEEUSE, B. J. D. 1975. Thermogenic respiration in aroids. Annual Rev. Pl. Physiol. 26: 117–126.

PFEFFER, W. 1906. The physiology of plants, Vol. 3. Clarendon Press, London.

PRANCE, G. T. AND J. R. ARIAS. 1975. A study of the floral biology of *Victoria amazonica* (Poepp.) Sowerby (Nymphaeaceae). Acta Amazonica 5(2): 109–139.

SKUTCH, A. 1971. A naturalist in Costa Rica. University of Florida Press, Gainesville.

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The Names and Uses of Palms Among a Tribe of Yanomama Indians

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Abstract

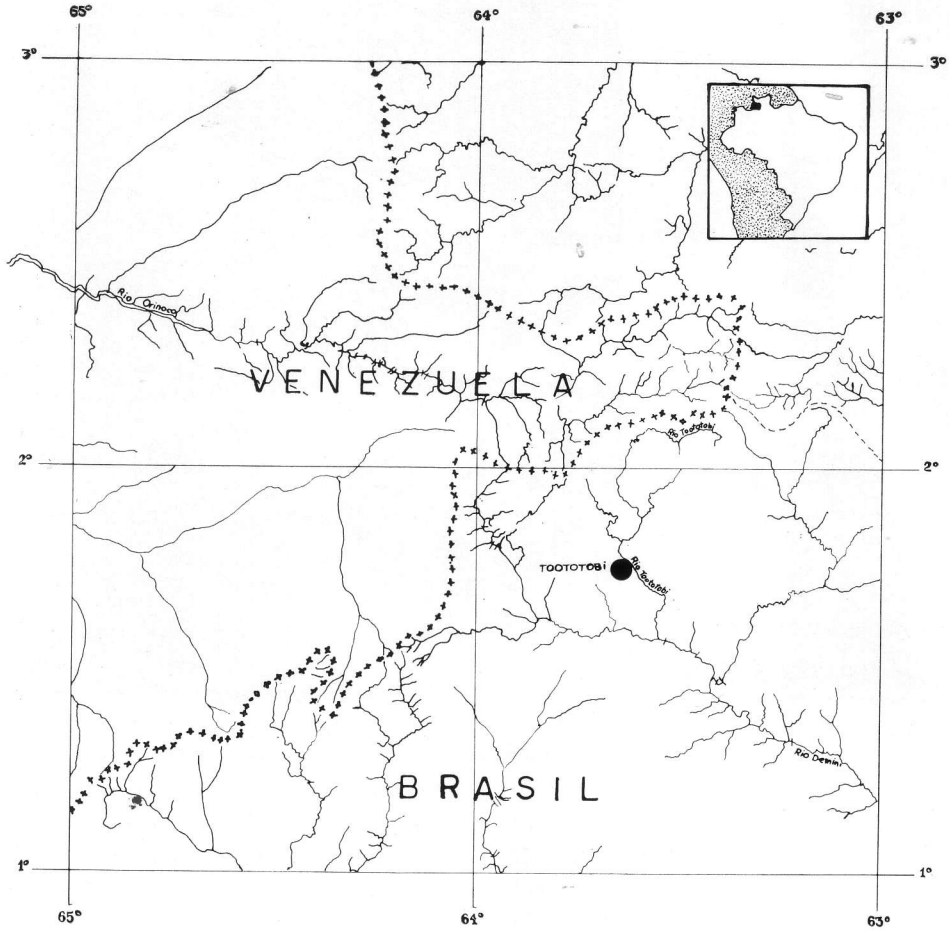
This paper presents an examination of 20 of the major palm species utilized by a tribe of Yanomama Indians, the so-called Xiriana-teri, in the north of Amazonas State, Brazil. The Indian, Brazilian, and scientific names for each species are provided. The Xiriana-teri's uses of palms are examined in detail, and it is found that they utilize palms to a far lesser degree than do many other South American tribes. To a large extent this is due to the material aspect of their culture, which is rudimentary in comparison with other forest tribes. But the author maintains that, to some extent, palms are utilized to a lesser degree by the Xiriana-teri due to past overexploitation of economically important species in the area adjacent to the village.

The Yanomama Indians are a loosely defined tribal group occurring in the frontier region between Venezuela and Brazil. Their 150 or more villages are scattered throughout an area of roughly 150,000 sq. km., bordered by the equator and latitude 5° North, and by longitudes 61° and 66°30′ West (Spielman, Migliazza, & Neel, 1974). The Yanomama represent one of the least acculturated, relatively large tribal groups remaining in South America. Only in the past 20 years have permanent contacts with the outside world become established.

This study is concerned with one of the Yanomama tribes, the so-called "Xiriana-teri" in the State of Amazonas, Brazil, adjacent to the Venezuelan frontier (Latitude 1°44′ North, Longitude 63°39′ West). The village is located on the west bank of the Rio Toototobi,[1] a tributary of the Rio Demení, itself a major tributary of the Rio Negro. The area surrounding the village is less than 200 m above sea level and is covered continuously by tall tropical forest: aerial reconnaissance revealed no sign of savannas, which cover extensive areas some 250 kilometers to the East in the Brazilian Territory of Roraima. The Xiriana-teri have occupied their present location at Toototobi for at least 15 years, since the arrival of a Protestant missionary and his family. While contacts with the outside world have made some impression on the material and spiritual lives of the Indians, their traditional culture appears to have remained largely intact. Other than body painting, no pictorial art is practiced among the Xiriana-teri. Ceramic work is not produced, and weaving is relatively uncommon. In its material aspects, the culture of the Xiriana-teri is on a simple, predominantly subsistence level, an observation which holds true for virtually all of the Yanomama tribes (Chagnon, 1968).

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[1] The river and the village have been occasionally referred to as "Totobi" in the literature (e.g. Schultes and Holmstedt, 1968). However, "Tootobi" is the name encountered in the more recent literature (e.g. Spielman *et al.*, 1974), and it is utilized in reference to the river in the 1972 edition of the *Carta do Brasil ao Milionésimo* (I.B.G.E., Rio de Janeiro).



1. Map showing location of Toototobi.

Methods and Results

With the exception of studies by Schultes and Holmstedt (1968) and Cocco (1972), virtually no ethnobotanical work on the Yanomama appears in the literature. While there are a number of valuable references on the uses of palms among Amazonian Indians (e.g. Wallace, 1853; Levi-Strauss, 1950; Civrieux, 1957; Wilbert, 1976), only passing commentaries can be found concerning palm uses among the Yanomama (Chagnon, 1968; Cocco, 1972; Smole, 1976). Present lack of information on the role of palms in the lives of the Yanomama is the result of the relative isolation of this indigenous group, combined with the formidable difficulties involved in obtaining botanical specimens of palms for identification. The situation is hardly improved by the confused taxonomic state of a number of large palm genera that are typically Amazonian, such as *Astrocaryum*, *Bactris*, and *Euterpe*.

The lack of knowledge concerning ethnobotany and taxonomy of Amazon-



2. Aerial view of Xiriana-teri village at Toototobi. The large circular structure in the background is the *moloca*, a communal dwelling found in many Amazonian tribes.

ian palms prompted me to focus on palms during a short visit to Toototobi in August, 1975. I made intensive collections of botanical specimens in the vicinity of the village; due to time limitations, I only collected those species of palms that were unknown to me. The original botanical specimens have been deposited in the herbarium of the Instituto Nacional de Pesquisas da Amazônia (INPA); duplicates, when obtained, were sent to the L. H. Bailey Hortorium in Ithaca, New York, U.S.A.

One of the greatest problems which I experienced while collecting palms at Toototobi arose from the seemingly innocuous fact that the Indians have no word, and apparently no concept, equivalent to our notion of the word "palm." The Xiriana-teri divide plants into two major groups: one group, denoted by the suffix *-hiki*, represents dicotyledonous trees; the other group, denoted by the suffix *-siki*, represents cryptogams as well as phanerogams, and among the latter includes trees, vines, and herbs that are predominantly monocotyledons (e.g. Palmae, Gramineae, Marantaceae, Araceae, etc.), as well as some lianous or herbaceous dicotyledons (such as cotton). Undoubtedly the Xiriana-teri employ a sophisticated and complex scheme of plant classification, as is suggested by Taylor's study (1974) of animal classifications among a nearby tribe of the Yanomama.

In any case, time limitations prevented me from probing deeply into the complexities of Xiriana-teri plant taxonomy. Lacking a word for palms, I was forced to ask my Indian informants to show me every plant that fell into their *-siki* cate-

gory. My companion on the trip, Dr. Ghillean Prance of the New York Botanical Garden, adapted a more efficient scheme for amassing a formidable collection of mushrooms: he simply asked the Indians to obtain the specimens for him. Unfortunately, palms are not so easy to collect: upon my request to collect a number of plants in the *-siki* category, the Indians judiciously ignored the palms but managed to bring me a fine collection of bamboos and vines.

In addition to collecting the palms, I obtained as much information as possible concerning their names and uses among the Xiriana-teri. Although probably not all of the palms which occur in the vicinity of Toototobi are included in this article, certainly the species most important economically are. The results are summarized in Table 1.

Discussion

Food and drink.

Chagnon (1968) states that of all the vegetable foods gathered in the wild by the Yanomama, palm fruits are by far the most significant. This appears to be true for the Xiriana-teri, who depend on a large number of palm species to provide edible fruits. (The Xiriana-teri refer to fruits, seeds and seedlings as "*moki.*") Probably the most important is *Bactris gasipaes* (*Guiliema gasipaes*), a palm cultivated throughout tropical America. This particular species is not native to Amazônia and has not been found in the wild; it may have had its origin in the Andes of Colombia, where a strikingly similar species occurs (unpublished field observations, H. E. Moore, Jr., and A. B. Anderson, 1974). The fruits of *B. gasipaes* are boiled and have an excellent, starchy taste. The harvest occurs in February or March, and unfortunately there were no trees in fruit during the time of my visit (August).

Another popular fruit among the Xiriana-teri is provided by *Orbignya spectabilis*; during my visit, each family group had a sizeable supply which served for snacks throughout the day. The fruits of this species are eaten raw.

Mauritia flexuosa and *M. aculeata* also provide edible fruits that are especially sought after by the Indians. They soak the fruits of these species in water for a few days, after which the outer scales are easily scraped off, exposing a thin layer of flesh that tastes rather like cheese. The Xiriana-teri also prepare juices from the fruits of these species. However, *M. flexuosa* and *M. aculeata* have become somewhat depleted in the vicinity of Toototobi, apparently due to intensive exploitation by the Indians. The fruits of *M. flexuosa* are reported to be highly nutritious, along with those of *Astrocaryum tumuca*, which are also popular among the Xiriana-teri: the fruits of both species have a vitamin A content three times that of carrots (Pechnik, Mattoso, Chaves, & Borges, 1947).

Probably no month passes without a harvest of one or another of the many species of palms that the Xiriana-teri depend upon for edible fruits. Yet they are apparently less imaginative than other Amazonian tribes in their repertoire of food and drink derived from palm fruits. Wallace (1853) reported that in the Rio Negro region of Brazil, Indians extract a clear, inodorous oil from *Oenocarpus bacaba* fruits; the oil is used for cooking and also occasionally for lighting lamps. The use of palm oils appears to be a common phenomenon among Amazonian tribes according to Levi-Strauss (1950), who also found that, in addition to medicinal uses, palm oils are often mixed with pigments to

Table 1. The names and uses of palms among the Xiriana-teri.

INDIAN NAME	BRAZILIAN NAME	SCIENTIFIC NAME	USES						
			Edible Fruits	Edible Palm Hearts	Roof Thatching	Lumber	Bows	Arrow Points	Other Uses
Dorea-	Caraná or Caranaí	Mauritia aculeata H.B.K.	X						
Liõkoho-	Buritĺ	Mauritia flexuosa L.	X						
Manaka-	Paxiuba	Socratea exorrhiza (Mart.) H. Wendl.				X	X	X	
Bahanaki-	Ubím	Geonoma baculifera (Poit.) Kunth			X				X
Wanama-	Ubím	Geonoma deversa (Poit.) Kunth			X			X	X
Kunuana-	Palha vermelha	Orbignya spectabilis (Mart.) Burret	X			X		X	
Okolaxi-	Inajá	Maximiliana martiana H. Karst. (=M. regia Mart.)	X	X					
Yoi-	Urucuri	Scheelea martiana Burret	X	X					
Ai-amo-		Astrocaryum aff. aculeatum G.F.W. Meyer	X	X				X	X
Mahã-	Murumuru	Astrocaryum murumuru Mart.	X	X					
Uri-	Tucumã	Astrocaryum tucuma Mart.	X	X					
Xohomo-		Astrocaryum sp.	X	X					
Lasa-	Pupunha	Bactris gasipaes H.B.K.	X	X			X	X	
Mokamo-	Maraja	Bactris sp.	X	X				X	
Yarimo-	Marajá	Bactris sp.	X	X		X		X	
Yoroa-	Marajá	Bactris sp.	X	X		X		X	
Yoyoma-	Marajá	Bactris sp.	X	X					
Hokoma-	Bacaba	Oenocarpus bacaba Mart.	X	X			X	X	X
Koanani-	Patauá	Jessenia bataua (Mart.) Burret	X	X			X	X	X
Maima-	Açaí	Euterpe precatoria Mart.	X	X		X			X

produce body paints. Yet apparently little use is made of palm oils among the Xiriana-teri. They do extract oil by boiling the fruits of *Mauritia flexuosa*, which is then mixed with water and rubbed on cakes of baked cassava bread.

In the Rio Negro region, Wallace (1853) discovered that the fruits of *Bactris gasipaes* are ground into a kind of flour which is then either roasted to make cakes or allowed to ferment in water, this latter process producing a creamy wine. According to Levi-Strauss (1950), Amazonian Indians commonly derive beverages or mushes from such species as *Euterpe precatoria*, *Oenocarpus bacaba*, *Jessenia bataua*, *Mauritia flexuosa* and *Maximiliana martiana* (*M. regia*). Yet although these species occur in the vicinity of Toototobi, such beverages or mushes are practically unknown among the Xiriana-teri.

Throughout tropical America, species of the genus *Euterpe* provide highly esteemed hearts of palm, generally referred to as "*palmito*." Among the Xiriana-teri, palm hearts (referred to as "*amoki*") from the species *Euterpe precatoria* are considered superior. Other species from related genera (subfamily Arecoidae) are likewise favored for palm hearts: *Jessenia bataua* and *Oenocarpus bacaba*. The cultivated *Bactris gasipaes* is also popular. In fact, the Xiriana-teri eat the palm hearts of most of the local species. Although extraction of the heart kills the palm, this does not appear to deter the Indians in their avid pursuit of palm hearts. Furthermore, the missionary at Toototobi informed me that, with the exception of the cultivated *B. gasipaes*, the Indians usually obtain edible fruits, as well as hearts, simply by cutting down the palms.

Among other tribes of the Yanomama, palms provide an additional, albeit less direct, source of food. Chagnon (1968: 30–31) describes the Yanomama's use of decaying palm trunks as sites for collecting edible insect larvae:

> The Yanomamö come very close to practicing "animal domestication" in their techniques of exploiting this food. They deliberately cut the palm down in order to provide fodder for the insect. When they cut the tree, they also eat the heart of the palm, a very delicious, crunchy vegetable that slightly resembles the taste of celery hearts. One palm we cut yielded an edible heart of about 50 pounds. After the pith has been allowed to decay for several months, it contains numerous large, fat, white grubs. The pith is dug out of the tree with sticks, broken open by hand, and the grubs extracted. Each grub is bitten behind his squirming head, and the head and intestines removed simply by pulling the body away with the teeth. If a grub gets damaged in the process of extracting it, the parts are eaten raw on the spot. A fair-sized palm tree will yield three or four pounds of grubs, some of them as large as a mouse. The grubs are wrapped in small packages of leaves and placed in the hot coals to roast. . . . I could never bring myself to eat one, but an experienced missionary told me they tasted very much like bacon . . . . The discarded seeds of palm fruits also get infected with much smaller grubs. The Yanomamö break the hard seeds open with a rock, extract the grub, and prepare it in the above manner.

Chagnon based his observations on tribes of Yanomama to the North, primarily in Venezuela. When we asked the Indians at Toototobi if they practiced this form of "animal domestica-

tion," we continually received negative responses. According to the missionary, it is basically contrary to the Xiriana-teri way of thinking to domesticate anything except an occasional pet.

Construction.

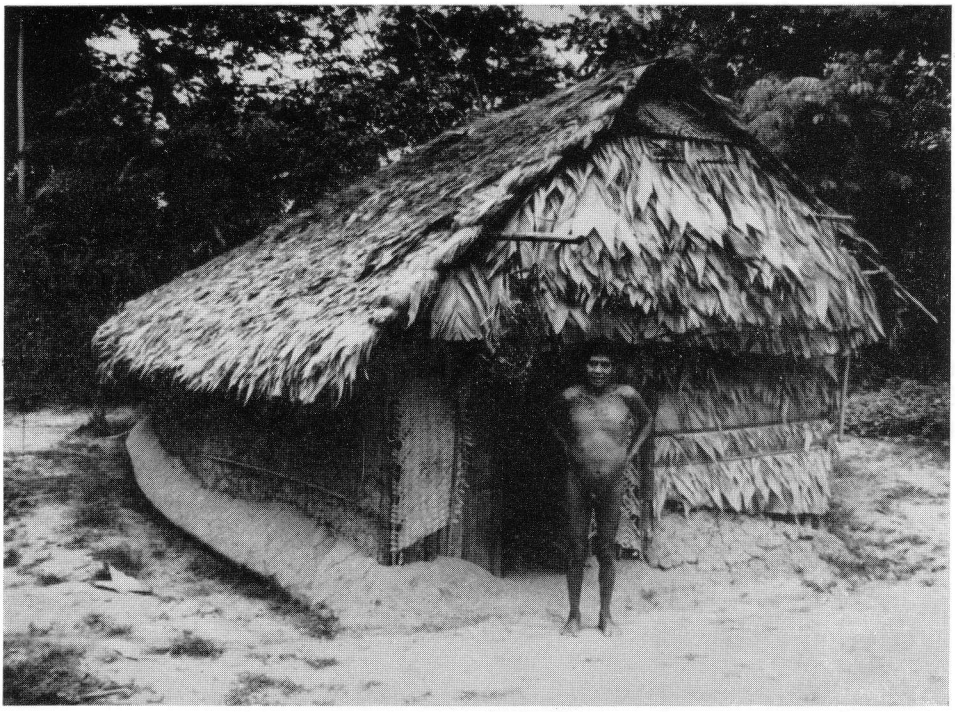
Among the Xiriana-teri, the palm that supplies the most valuable lumber is *Euterpe precatoria*. The wood of this species is durable yet soft and easy to work: it is used primarily to make wall slats, table tops, and shelves. *Socratea exorrhiza* is favored for making roof slats, although *Orbignya spectabilis* and two species of *Bactris* (*yarino-siki* and *yoroa-siki*) are occasionally used for this purpose as well. Compared with other tribes, however, the Xiriana-teri do not rely heavily on palms for construction purposes. Among other Amazonian Indians, for example, *Socratea exorrhiza* is widely employed for the construction of posts, fences, palisades, floors of canoes, shelves, and seats (Wallace, 1853; Levi-Strauss, 1950). Perhaps this species is not so widely used among the Xiriana-teri due to its scarcity in the forest adjacent to the village.

By far the best source of roof thatching is provided by *Geonoma baculifera*, a fairly common understory palm in the vicinity of Tootototobi (Fig. 3). The Xiriana-teri also utilize the leaves of *G. deversa* for roof thatching, although this species is considerably less desirable. The leaves of most *Geonoma* species are not very durable, but, according to Braun (1968), they are used by most of the Indian tribes in Venezuela because they are present in abundance, and this appears to be the case among tribes in Brazil as well. Wallace (1853) referred to a species of *Geonoma*, most likely *G. baculifera*, which occurs abundantly in flooded areas adjacent to the Rio Negro; this species was and probably still is much used for thatching by Indians in this region.

Miscellaneous uses.

The Xiriana-teri use a variety of palms to make bows and arrow points. Four species are used to make bows, which I list here in order of decreasing preference: *Socratea exorrhiza*, *Bactris gasipaes*, *Oenocarpus bacaba*, and *Jessenia bataua*. The first two species, however, are not often used to make bows. *S. exorrhiza* is relatively rare in surrounding forest adjacent to Tootototobi, and its wood is considered even more valuable for construction purposes. *B. gasipaes*, which Wallace (1853) considered to have the most durable wood of all the palms, is cultivated and regarded as extremely valuable for its fruit. Only *O. bacaba* and *J. bataua* occur commonly in the adjacent forest, and probably as a result the Indians usually make their bows from the wood of these species (Fig. 4). The fashioning of a bow is a painstaking process requiring a couple of days. Among the Xiriana-teri, metal knives serve as cutting tools, probably having replaced the lower mandible of a peccary (*Tayassu* spp.) which other tribes of Yanomama use to fashion bows (Chagnon, 1968). The final product is strong, durable, and very difficult to draw.

The Xiriana-teri make arrow points from 10 species of palms (Table 1). *Socratea exorrhiza* once again appears to be the most favored species for this purpose, although certainly not the most commonly used. The arrow point is usually fashioned from a splinter of palm wood. Lateral grooves are sometimes cut into the arrow point along its length, which cause the point to break off in the body of the target. The arrow points are coated with a poison derived from the resin of *Virola thei-*



3. Dwelling with roof thatching made from leaves of *bahanaki-siki* (*Geonoma baculifera*); weaving adjacent to door made from leaves of *okolaxi-siki* (*Maximiliana martiana* [*M. regia*]).

odora (Myristicaceae).[2] Arrow points coated with this poison are especially effective for hunting monkeys, which tend to cling to the branches when wounded; the poison acts to relax their muscles and eventually the monkeys fall to the ground.

While on the subject of weapons, I was informed that the trunk of *Jessenia bataua* is still occasionally used by the Xiriana-teri to make fighting clubs; the dense wood of this palm must make such clubs terribly effective. According to Chagnon (1968), club fights are fairly common among the Yanomama, usually resulting from arguments over women.

[2] The resin of this species is also the essential ingredient used in the preparation of a hallucinagenic snuff (Schultes and Holmstedt, 1968).

The Xiriana-teri often use palm leaves to weave makeshift baskets: *Geonoma baculifera*, *G. deversa*, and *Jessenia bataua* are favored for this purpose. The leaves of *Maximiliana martiana* (*M. regia*) (Fig. 3) and *J. bataua* (Fig. 4) are woven together and placed on the walls and doors of dwellings, apparently for decorative purposes; woven screens made from the leaves of these species serve to demarcate familial areas within the communal *maloca*. This, in addition to roof thatching, apparently represents the sum total of uses for which palm fibers are employed among the Xiriana-teri. I shall discuss this observation further in the conclusion.

In terms of bodily decor, the uses of palms are rather limited as well. The Xiriana-teri paint their bodies on ceremonial occasions, but only rarely do



4. Bow being made from trunk of *koanani-siki* (*Jessenia bataua*); weaving at left made from leaves of same species.

they use dyes obtained from palms: the fruits of *Jessenia bataua* produce a dark-blue dye, and those of *Euterpe precatoria* a black dye. The Xiriana-teri know of neighboring tribes that fashion rings from the fruits of what is apparently *Astrocaryum* aff. *aculeatum*, but they themselves do not follow the practice, although this species is common in their area.

Again one is struck by the lack of palm uses among the Xiriana-teri. Wallace (1853) reported that in several Amazonian tribes the spines of *Bactris gasipaes* were used to make tattoos; soot produced by burning pitch was then rubbed into the wounds, producing an indelible, bluish stain. Throughout the Amazon Basin, species of *Astrocaryum* are widely employed for purposes of bodily decor: the black, polished fruits are fashioned into beads, earrings, and other types of ornaments (Levi-Strauss, 1950).

Finally, during my last day among the Xiriana-teri, on the morning before a festive reunion of the tribe, the Indians were busy sweeping the ground floor of their *maloca* with the stiff inflorescences of *Euterpe precatoria*, which are ideally suited for this purpose. Apparently this practice is widespread: I have observed the inflorescences of another species of *Euterpe* employed for a similar purpose by black inhabitants of the Chocó rain forest on the Pacific coast of Colombia.

Conclusion

The material and spiritual importance of palms in the lives of South American Indians has been documented by numerous authors, including Wallace (1853), Levi-Strauss (1950), Civrieux (1957), Braun (1968), Schultes (1974) and Wilbert (1976). While palms are obviously of great importance among the Xiriana-teri, particularly in their diet, these Indians exploit palms to a far lesser degree than do many other South American tribes. To a large extent this is because the material aspect of their culture is rudimentary by comparison with other forest tribes. But the lack of palm utilization by the Xiriana-teri may also be due to a scarcity of palms in the vicinity of Toototobi.

For example, two species that are particularly valuable among tribes throughout Amazônia—*Mauritia flexuosa* and *Socratea exorrhiza*—are not common in the vicinty of Toototobi, and the missionary there informed me that both species have become depleted in recent years. It is likely that these and perhaps other palm species have been overexploited during the relatively long period (at least 15 years) that the Xiriana-teri have resided at Toototobi. As noted above, the Indians usually cut down wild palms in order to collect fruits or palm hearts; according to the missionary, this practice has definitely contributed to the scarcity of certain palm species in the vicinity of Toototobi. Cocco (1972) suggests that palms are scarce among other Yanomama tribes for precisely the same reason. The pressures that an Indian tribe exerts on its local palm resources can be appreciated by considering that an estimated minimum of 39,000 palm leaves are needed for roof thatching in a typical Waika Indian village in Venezuela (Braun, 1968); furthermore, these leaves are by no means very durable and must be replaced every few years.

Such pressures on local resources can be an important factor in explaining why many tribes of the Amazonian terra firme are or have been traditionally nomadic, settling at a given site for a few years and then moving on (Meggers, 1971). Among the Xiriana-teri, however, the advantages of maintaining contact with the missionary (who supplies

medicine, machetes, cooking utensils etc.) appear to outweigh whatever disadvantages are incurred by overexploitation of local resources. Furthermore, the price of overexploitation may not be particularly high among the Xiriana-teri.

Consider the relative lack of utilization of palm fibers by the Xiriana-teri. Among the majority of tribes throughout Northern South America, the principal provider of fibers is the ubiquitous *Mauritia flexuosa*. The Warao Indians of the Lower Orinoco, for example, utilize the fibers from this species to manufacture clothes, ornaments, hammocks, fishing tackle, baskets, fans, trays and a host of other items (Levi-Strauss, 1950; Wilbert, 1976). The Warao's extensive exploitation of *M. flexuosa* is no doubt the result of the abundance of this species in the Lower Orinoco, where virtually pure stands occur over immense areas. In contrast, while pure stands of *M. flexuosa* do occur in the vicinty of Toototobi, these are relatively small and scattered. Probably as a result, the Xiriana-teri utilize other plants to provide vegetal fibers. In addition to the cultivation of cotton, the Indians obtain fibers from a species of Araceae, *Cecropia* sp. (Moraceae), a species of Cyclanthaceae, a species of Annonaceae, *Couratari* sp. (Lecythidaceae) etc. The fibers from these plants are used to produce clothing, baskets, bags, twine and other articles, which Indians elsewhere produce from the fibers of palms. The ability of the Xiriana-teri to discover and exploit alternative sources of technology reveals a flexibility which they share with native peoples throughout tropical South America, a point made by Levi-Strauss (1950: 466–467):

> In tropical South America, the general cultural levels are determined historically rather than by the local plant resources, for no fundamental culture traits appear to depend directly on the botanical environment. . . . The striking fact is that, far from depending on the natural environment, South American Indians throughout the tropical area show exceptional ability to discover substitutes wherever a vegetal species is lacking.

Acknowledgments

Field work for this paper was carried out while the author held a fellowship from the Thomas J. Watson Foundation in Providence, Rhode Island, U.S.A. The trip to Toototobi was arranged by the National Film Board of Canada in Montreal. The missionary at Toototobi, Mr. Bruce Hartman, provided considerable information that proved invaluable in writing this paper. Two INPA researchers, Dr. Robert Pinger and Mr. Inocencio de Souza Gorayeb, obtained further information during subsequent trips to the tribe. Dr. Harold E. Moore, Jr., helped with the identification of palm specimens at Bailey Hortorium. Finally, the manuscript was reviewed by Dr. Ghillean Prance, New York Botanical Garden, and Dr. Nigel Smith, INPA.

The author wishes to express his gratitude to all of the persons and institutions mentioned above.

Literature Cited

Braun, A. 1968. Cultivated palms of Venezuela. Principes 12: 39–103; 111–136.

Chagnon, N. A. 1968. Yanomamö: the fierce people. Holt, Rinehart & Winston, N.Y.

Civrieux, J. M. 1957. Nombres folklóricos de algunas palmeras Amazonico-Guayanesas con apuntes etnobotánicos. Bol. Soc. Venez. Ci. Nat. 18: 195–233.

Cocco, P. L. 1972. Iyëwei-teri: Quince años entre los Yanomamos. Caracas, Venezuela.

LEVI-STRAUSS, C. 1950. The use of wild plants in tropical South America. Handbook of South American Indians 6: 465–486. Cooper Square Publishers, N.Y.

MEGGERS, B. J. 1971. Amazonia: man and culture in a counterfeit paradise. Aldine, Chicago.

PECHNIK, E., I. V. MATTOSO, J. M. CHAVES AND P. BORGES. 1947. Possibilidade de aplicação do buritĺ e tucumã na industria alimentar. Arquiv. Brasil. Nutricão 4: 33–37.

SCHULTES, R. E. 1974. Palms and religion in the Northwest Amazon. Principes 18: 3–21.

SCHULTES, R. E. AND B. HOLMSTEDT. 1968. De plantis toxicariis e mundo novo tropicale commentationes II. The vegetal ingredients of the myristicaceous snuffs of the Northwest Amazon. Rhodora 70: 113–160.

SMOLE, W. J. 1976. The Yanoama Indians: a cultural geography. University of Texas Press. Austin.

SPIELMAN, R. S., E. C. MIGLIAZZA, AND J. V. NEEL. 1974. Regional linguistic and genetic differences among Yanomama Indians. Science 184: 637–644.

TAYLOR, K. I. 1974. Sanumá fauna: prohibitions and classifications. Monografía No. 18, Fundacion La Salle de Ciencias Naturales, Caracas.

WALLACE, A. R. 1853. Palm trees of the Amazon. John Van Vorst, London.

WILBERT, J. 1976. *Manicaria saccifera* and its cultural significance among the Warao Indians of Venezuela. Bot Mus. Leafl. 24:275–335.

NATURAL HISTORY NOTES

The freezing weather at Daytona Beach, Florida, in January, 1977, when a minimum temperature of 23°F occurred at the writer's garden, resulted in the death of many tropical palms, conspicuous among them 30 adult fishtail palms of the multiple-stem species *Caryota mitis*. Virtually all the tallest stems (trunks), numbering over 100, were freeze-killed. Of these dead stems, about a third had flowered and fruited before the freeze, some of them for several consecutive years. The roots of these cluster-forming palms were not frozen, and hence new growth sprang up after warmer weather returned; and barring hard freezes during the next several years, these new shoots will begin forming trunks within three or four years.

Some 20 of the adult trunks, all ostensibly stone dead, have produced pristine inflorescences at intervals of from three months after the freeze to as much as six months afterward. Singular indeed to see a wretched brown pole, with a collapsed crown of foliage, put forth one or more vivid green inflorescences from leaf axils below the brown dead fruits still hanging from the previous year! An obvious speculation is that the palms were shocked by the freeze into trying to perpetuate the species. What appears to be phenomenal, however, is doubtless not a phenomenon at all, but readily explicable by a plant anatomist or other botanical scientist versed in the mysteries of palm anatomy. It may not be news that freeze-shock sometimes causes plants to attempt reproduction of themselves even if futile, but it is nevertheless startling to observe a green inflorescence emerging from a palm trunk that has been hopelessly dead in all its parts, to all appearances, for half a year. A wasted effort, for no following fruits will mature to the point of seed production. Unluckily black-and-white photographs do not serve to distinguish between dead and living inflorescences of the caryotas under discussion, and so the affected palms are not illustrated in graphic support of this note. The writer does have, however, color slides and also prints that plainly reveal the striking contrasts.

Just how does a long-dead palm trunk put forth a vivid green inflorescence? It only indicates that some parts may survive independently, if only temporarily, the death of a large palm.

Flowering, after apparent death of a stem, has occurred at my location in

caryotoid species other than *Caryota mitis*. One example of *Wallichia caryotoides*, a single-stem palm, put forth an inflorescence two months after being freeze-killed in January, 1977, and now in August as this is written, nearly eight months after the freeze, small fruits are appearing even though doomed not to develop to maturity. This *Wallichia* is now an odd spectacle consisting only of a leafless trunk about eighteen feet tall, with a pennant of small green fruits incongruously hanging from a topmost leaf axil. Another example of flowering after freeze-shock occurred in the same garden shortly after the disastrous freeze of 1962, in this case involving a wrecked *Caryota urens* which soon collapsed and fell apart.

It may not be generally known that most multiple-stem palms, that is, the suckering or cespitose kinds, will again rise from the roots after total destruction above ground level, provided of course that the ground itself has not been frozen and consequently not the roots. Conversely no single-stem palm after destruction ever erects a new stem from its roots. The cespitose kinds might well be termed "resurrection palms," for even such tender ones as pinangas after total destruction above ground commonly put forth new growth from the roots.

From past experience with hard freezes the writer knows that *Caryota mitis* will again rise from the dead, and in fifteen years of normal winter weather will attain to the same size and number of stems it had before the killing freeze.

DENT SMITH
Daytona Beach, Florida

LETTERS

The following is extracted from a letter to Mr. Sten Bergman from Ms. Anne Roebelen:

"I am delighted to know of your interest in the *Phoenix roebelenii* palm which my uncle, Carl Roebelen, found in Laos on the banks of the Mekong River, Indochina, on the 22nd parallel in the spring of 1889.

"Carl Roebelen was born January 1855 in Geislingen, Germany. After finishing his education, he served his apprenticeship at the summer castle in the King's Garden, Friedrichshafen, Germany and at the Koenigsgarten, Stuttgart, Germany. From there he went to London and was employed by Frederick Sanders, the well-known orchid king of St. Albans.

"Sanders sent him on many expeditions to the Far East in search of rare orchids. When a regular mail service was established between London and the Philippines, among other employees of Sanders, he was chosen to go to the Philippines in search of rare orchids. On one of these trips, while going through the mountains, he discovered the famous *Vanda sanderana* (1883), from which many hybrids have been made.

"After several years with Sanders, he became a freelance collector and made his home in Bangkok, Siam (now Thailand) and married a Siamese woman. They had one son, whom he educated in Switzerland.

"Carl Roebelen never traveled alone, always taking natives with him. On one occasion, they went by foot for 22 days to the northern section of Siam and crossed the Mekong River to Laos, where he discovered the palm. He dug up two plants and with a shipment of newly found orchids went to London. One of these palms he sold at the market to Sanders and the other one he gave to the Royal Botanic Gardens at Kew. Here the palm was compared with many other palms and it was verified by James O'Brien that it was a new palm. It was named *Phoenix roebelenii*.

"Carl Roebelen went for the seeds of *Phoenix roebelenii* annually, having to be there at the right time when they were ripe, otherwise the monkeys would eat the seeds and sometimes a flood would wash them away. He sent them all over the world. He sent some to the USA and my father distributed them.

"In 1914 when World War I was declared Siam entered the war against Germany. He being a German citizen, his holding were taken from him and he was interned in India as a prisoner of war for the duration. After the Armistice was signed he returned to Germany but he was not happy there. He returned to Bangkok and resumed his regular expeditions.

"In December, 1927, while going to Laos in search of *Phoenix roebelenii* seeds he contracted cholera and died. He was buried in the jungle by the natives he had with him."

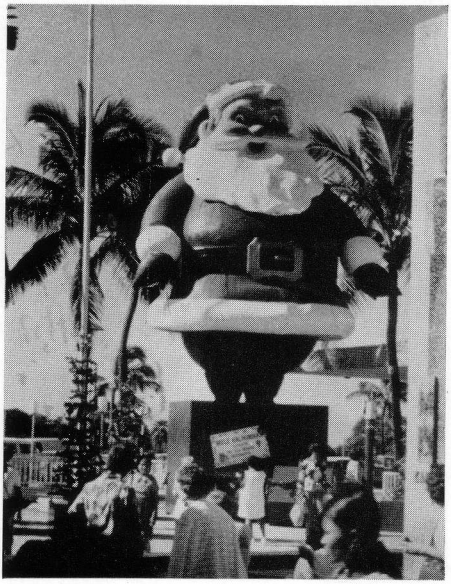
Seed Bank Notes

Seeds labelled as *Ptychosperma palauensis* were distributed by the seed bank in August 1975. It has recently been determined that these seeds are not *Ptychosperma* but *Pinanga insignis*. Members who have plants from this seed lot should note this change.

NEWS OF THE SOCIETY

A newspaper clipping from the Chillicothe, Ohio Gazette tells about one of our members there. For those who live in colder climates John Brandenburg sets an interesting example. He has been growing various tropical plants in containers for years, the oldest palm among them being a *Sabal palmetto* he brought from Florida in 1968. He says he spends about five hours daily tending his plants; most of the care consists of watering them. The plants are grown outdoors in summer, indoors in winter. "When they are inside I can be assured they are getting a normal amount of light," he is quoted as saying. The three largest plants are in 20-inch redwood tubs which he has mounted on wheels so he can move them easily. His queen palm (*Arecastrum romanzoffianum*) was bought at a local department store; it grew an 8-foot leaf this summer. Outdoors, near the house, he has planted a cabbage palm which he covers with plastic in winter and it wasn't even damaged by this winter's sub-zero cold. His house looks as if it had been transplanted from somewhere in Florida with all the lovely palms, hibiscus, and other tropical plants enhancing it.

PHOTO GALLERY



Santa Claus appeared amidst coconut palms at the Honolulu City shopping center during the 1975 Christmas season. Photo by T. A. Davis.

News from Texas

On September 8, 1977 the Houston Chapter held a meeting at the home of Dr. and Mrs. E. Heine. Bob Maurice,

who is head of the Chamber of Commerce Committee to plant palms throughout the Houston area, requested the help of Palm Society members to procure seeds of cold-hardy palms for the program. He has already given seeds of *Butia* to Gary Outenreath to germinate, and distributed seeds of *Coccothrinax argentata* received from the Lincoln Park Conservatory in Chicago.

A committee will study the possibilities of having a Palm Show at the Houston Arboretum during 1978.

A program "The Sago Palm—Palm Stem Starch" was given by Dennis Johnson who had recently completed a paper on the subject after a research trip to Malaysia where he toured the area of *Metroxylon rumphii* propagation. The starch from this palm is not to be confused with the starch produced by the cycad *Cycas revoluta*, which is not a palm at all.

Nominees for Biennial Meeting

The following are nominees proposed by the nominating committee to be presented to the membership of The Palm Society to be voted upon at the Biennial Meeting in San Diego on July 9, 1978.

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A. Total no. of copies printed	1600	1600
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1. Sales through dealers	—	—
2. Mail subscriptions	1237	1287
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1. Samples, complimentary	11	11
2. Copies distributed to news agents	None	None
E. Total distribution	1248	1298
F. Office use, left-over	352	302
G. Total (Sum of E & F)	1600	1600

I certify that the above statements made by me are correct and complete. Signed, Mrs. Theodore C. Buhler, Executive Secretary.