PRINCIPES

Journal of the Palm Society

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THE PALM SOCIETY

A non-profit corporation primarily engaged in the study of the palm family in all its aspects throughout the world. The Society relies on voluntary contribution for support, and membership is open to all persons interested in the family. Requests for information about membership or for general information about the Society should be addressed to the Executive Secretary.

PRINCIPES

JOURNAL OF THE PALM SOCIETY

An illustrated quarterly devoted to information about palms published in January, April, July, and October, and sent free to members of The Palm Society

EDITOR: Harold E. Moore, Jr.

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Contents for April

Cover Picture

The dwarf Malay coconut which resists lethal yellowing and is useful in replanting areas ravaged by the disease. Photograph by Frank Gatteri.

THE EDITOR'S CORNER

Publication of the series of papers presented at the Palm Conference a year ago this month is completed in this issue except for the continuing series on coconut diseases. Dr. Lorne McFadden, whose summary of diseases affecting palms appears herein, is a native of Nova Scotia, Canada. He received his training at the Nova Scotia Agricultural College and Macdonald College of McGill University in Canada and at Cornell University in the United States. He received the degree of Ph.D. from the latter institution in 1956 and since has been on the staff of the Sub-Tropical Experiment Station at Homestead, Florida.

* * *

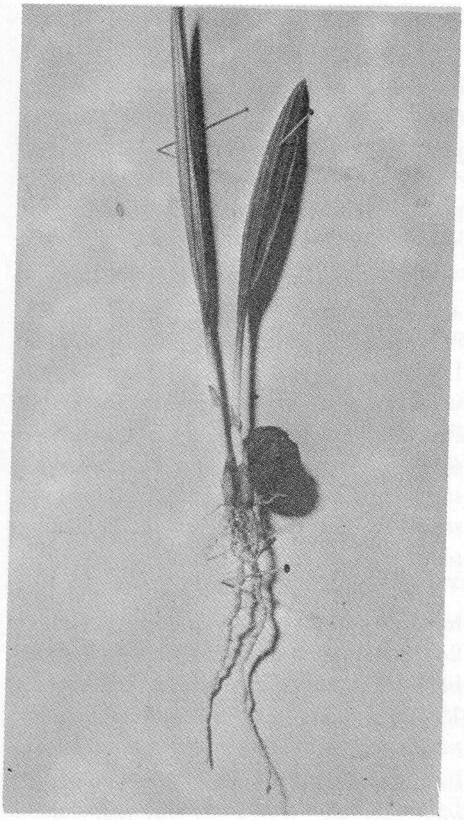
Which of two spellings to use for the specific epithet of the betel palm has been a recurrent question in recent years. The answer arrived at on page 47 has been checked with Dr. F. A. Stafleu of the International Bureau for Plant Taxonomy and Nomenclature in Utrecht, Netherlands, and with Mr. William T. Stearn of the British Museum (Natural History) in London. Thanks are due these two scholars for their assistance. Mr. Emile Kostal has provided an answer to questions about imports of living palms on page 68.

* * *

Other correspondents have written the Executive Secretary and the Editor with notes from California, Arkansas and England. Their comments are shared below.

* * *

"I thought you would be interested in the enclosed photograph of two seedlings on one seed of *Arecastrum Romanzoffianum*. I came across this existence of twins while transplanting seedlings last Sunday [October 5, 1958]. Not knowing how rare an instance of twins in the plant kingdom might be, I thought I would call it to your attention for possible notation in the Palm Society magazine."



21. *Arecastrum Romanzoffianum* twin seedlings at Palm Springs, California.

Robert O. Schnabel,
1155 Sunny Dunes Rd.,
Palm Springs, California

[Ed. Note—The twin seedlings have probably arisen from two separate seeds formed in the same fruit. Normally only one of the three ovules would mature into a seed but occasionally two or even more (in *Attalea, Orbignya*) mature.]

* * *

Mr. Dillwyn W. Paxson, Route 2, Box 156, Fort Smith, Arkansas, travels for Ferry-Morse Seed Company. He writes as follows of his palms (see Fig. 22):

"In December 1949, I put out the following three species of palms: *Trachycarpus Fortunei* (windmill palm), 3 plants; *Butia capitata,* 1 plant; *Rhapidophyllum hystrix* (needle palm), 5 plants—all along the south side of my home.

"Then I planted one windmill palm and one clump of needle palms in another location. This one windmill palm I lost to a *dry summer* (I am away all year except for most of December) . . . the needle palm withstands much dryness but seems to be host to a scale insect especially on the fruit. It does not seem to affect the plant or the other palms.

"All of the other palms are doing fine in spite of *nine below zero* on February 2, 1951. (We had a 6° above in December, 1950 and a 5° above in January, 1954.) I also have a number of *Sabal minor* which do not do well because I am not here to weed and water them. The below zero temperatures browned (killed) all the leaves on my *Butia* and two windmills, including all the center which I pulled out; I believe all that saved them was the fact that I took a razor-sharp knife and trimmed all the "dead" off the top of each of them, so that water would not be cupped in the center to sour and kill the heart.

"There are at least nine other palms I would like to try here sometime when I can be home to care for them. I have just put out another windmill, with 5½ feet of trunk. The leaves on the needle palms remained green and unaffected."

* * *

The Sandhurst Nurseries,
Sandhurst, Camberley,
Surrey, England
26th November, 1958

"I was delighted to receive the four parts of vol. 2 of PRINCIPES. This is the first interesting literature on palms I have seen, and it has quickened my interest considerably.

22. A group of three species of palms grown by D. W. Paxson photographed December 15, 1958, when the official temperature was 4° F. and the depth of snow four inches. *Butia* is to the left, *Trachycarpus* to the right, *Rhapidophyllum* between and on ends.

"This is my first season with palms, and having no contact at all in the palm seed business, I was wondering whether I might ask you if you could be so kind as to pass this note on to any firm or person you might know who is likely to supply seed of such things as *Butia capitata, Erythea armata, Sabal minor, Jubaea spectabilis* [*Jubaea chilensis*], *Livistona chinensis* and *Syagrus Weddelliana.*

"I hope that all except the last are going to prove hardy enough for the West of England, where I have seen *Phoenix canariensis, P. reclinata* (looking rather unhappy) and one *Livistona chinensis,* also looking unhappy. Apart from these in one or two gardens and botanic gardens, no palms except *Trachycarpus* are grown outside, anywhere over here, and there is obviously much experimenting to be done. Almost none has been done in the past.

"I think it would be best to start experimenting with fairly ordinary things such as the above — I say "ordinary" after reading PRINCIPES; in this country they just do not exist!, but would welcome any suggestions. The trouble is that our milder counties, having a milder winter, also have a cooler wetter summer, so that new growth is still being made when the winter frost (if any) comes.

"If you could pass this on to anyone likely to be interested, I should be extremely grateful. I am not after large quantities—about 1 pound of each species, or less, to purchase.

"The only trouble with PRINCIPES is that it makes me want to start another nursery in a better climate!

C. R. W. WADDINTON

"P.S. Probably other sabals would be worth experimenting with. A friend has suggested pritchardias, but I am rather doubtful of these."

* * *

Ed Moore of San Diego keeps an eye on the local paper for news of palms. The following is reprinted from the *San Diego Evening Tribune* for November 21, 1958 with permission of the publishers, Union-Tribune Publishing Co.

Mortero Palms Add Desert Beauty

Canyon Grove Linked to Stone Age Society

By JOE STONE
Evening Tribune Staff Writer

BORREGO SPRINGS—South from Doz Cabezas Station in the south part of the Anza-Borrego Desert State Park, the visitor who keeps eyes right will see one of those tiny flickers of beauty which makes the desert appeal to so many.

It occurs about one and four tenths miles from the station. It is a flash of green, low in a cup in a canyon.

It looks as if the Jacumba Mountains have stretched forth a canyon holding a perfect emerald jewel for your inspection and admiration.

These are the unspoiled Mortero Palms.

At about the same time, on the left, the viewer can see a large, isolated pile of rocks. In their midst is a line shack, built of ocotillo sticks as shelter for cowboys.

Ad Executive Uses Shack, Paints Trees

Last winter, park rangers say, that line shack was home for Bill Herrington, a fifty-ish New York advertising executive. He named himself mayor of Doz Cabezas and had a fine time painting water colors of the Mortero Palms.

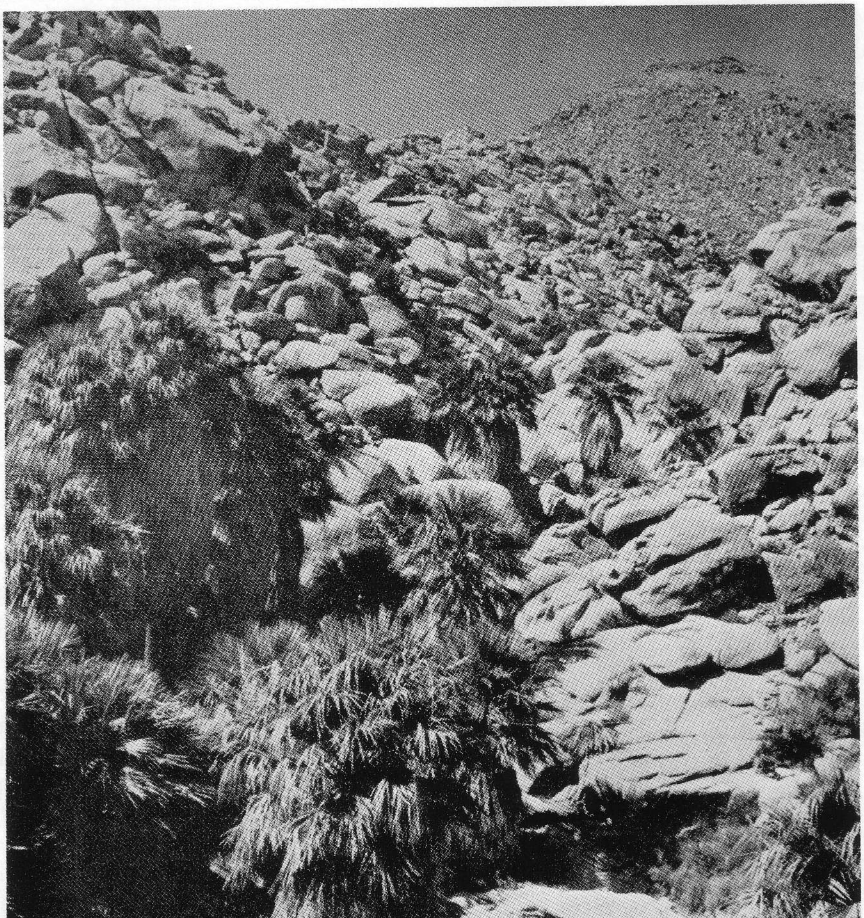
A little further along, the road that turns to the Mortero Palms Area of the park turns right.

Four-tenths of a mile west of this intersection is the park sign which designates the area.

You can drive to the right of the sign and into the wash that leads to the canyon where the palms grow.

You can't see the palms now, but they are there. It is an easy hike up to them —say, 20 minutes of leisurely stop and go.

Keep generally left at first. If you are on the right trail, you'll soon see a rusty pipe running down the canyon to your right. It formerly carried water to a concrete tank used by cattle when they grazed there.



23. Remote sight—the lonely Mortero palms nestle in a canyon in southern Anza-Borrego Desert State Park, California. They are one of the desert's unspoiled sights. Staff photo by Ed Neil, San Diego Evening Tribune.

They Grow Amid Giant Boulders

Now keep to the right of the canyon, to the ridge of rock above you, then cross it to the left, go up and over it, and soon you'll see the first of the Mortero Palms.

A few yards more and you are in the midst of the grove. The trees grow amid giant boulders, forming an almost impenetrable jungle in the canyon which curves right.

They stand against a background of almost totally barren desert mountains.

This is one of more than 1,500 kinds of palm trees, *Washingtonia filifera.* They are native to this desert.

Dalton E. (Mike) Merkel, park naturalist, says the theory is that these palms descended from millions which grew there when the area was a lush and humid jungle, back in the age of the dinosaurs.

Palm trees, since prehistoric times, have provided mankind with food, clothing, shelter, and inspiration. The palm leaf is the symbol of victory.

No Doubt Grove Once Served Indians

No doubt this grove once served the desert Indians, whose Stone Age society peopled these rugged slopes before the white man came.

En route down, watch closely for a large, flat-topped rock with man-made holes in its surface. Indian women once sat in the sun on this rock and ground those holes while making a meal of acorns, a big part of their diet.

These are morteros. They give this grove of palms its name.

WHAT'S IN A NAME?

Areca Catechu—The Correct Name for the Betel Palm

The name of the betel palm is sometimes written *Areca Catechu,* sometimes *Areca Cathecu.* The latter spelling appeared in the three editions of *Species Plantarum* edited by Linnaeus himself and was revived by L. H. Bailey in *Hortus* 59, 1930, after a lapse of many years during which the former spelling was generally used. Both spellings appear in articles today. In order to decide which is proper, it is necessary to evaluate sources and authorities for the specific epithet.

References to the betel palm appear early in the written record of medicine and botany. Serapion or Serapioni (Yuhanna Ibn Serapion), a physician of Alexandria in the third century, mentioned it as *Faufel,* an Arabian name. The famous Avicenna (979-1037), in whom Arabian medicine reached its peak, used variants of *Faufel.* The herbalists knew it by a number of names but the epithet used by Linnaeus is not among them.

Catechu (ká tee shoo, ká tee choo, ká tee cue) is a name coined in Europe during the seventeenth century and derived, according to most dictionaries, from the Malay *kachu* which was in turn borrowed from *kacchu, kaychu, kashu* in the Tamil, Telugu, and Kanarese languages of India's Malabar coast. Gowda (*Botanical Museum Leaflets, Harvard University* 14: 185. 1951), however, says that it comes from *kachu,* a word of the Kannada language of South India meaning "astringent substance." The *International Encyclopedia* states that the word is compounded from *cate,* a tree, and *chu,* juice, without indicating the language. In any event, the exact method by which the present form was derived is not clear.

Most commonly, the word catechu is used to designate astringent substances containing tannin (40-55 per cent) and derived from the bark and wood of *Acacia Catechu* and *Uncaria Gambier*, both Asiatic trees, but to some extent it is used also to designate an extract from seeds of the betel palm (*Encyclopaedia Brittanica*). This last product is more specifically known as Bombay catechu (*Webster's New International Dictionary*, 1952). It dyes cloth a brown color similar to the catechu (also known as cutch) from *Acacia* and *Uncaria*. Burkill (*A Dictionary of the Economic Products of the Malay Peninsula* 1: 225. 1935) refers to the extract as *kossa*, stating that it is used to intensify the flavor of inferior betel nuts in betel chewing. The catechu from *Acacia* or *Uncaria* is used in combination with lime, betel nut, and betel piper leaf in India.

Catechu is accounted for in early pharmacopoeias and it is still used medicinally today. The *Oxford English Dictionary* (vol. 2: 180. 1933) attributes an early or perhaps the first use of the name catechu to Johannes Schröder of Germany in his *Pharmacopoeia Medico-Chymica sive Thesaurus Pharmacologicus* published in 1654. The only edition of this work available to me is the Editio Ultima of 1672 where, on page 518, catechu is used as an alternate word for the pharmacological term terra japonica. Schröder thought the dried substance so called to be an earth which was esteemed as an astringent for catarrh and, when held in the mouth, for strengthening the head.

Samuel Dale, an English physician, devoted two and a half pages to catechu or terra japonica in his *Pharmacologia seu Manuductio ad Materiam Medicam* . . . 386-388, 1692. He considered only the betel palm as a source, for by then it was known that the "earth" of pharmacology was in reality a vegetable product.

Thus, when Linnaeus wrote a treatise on plants of Ceylon entitled *Flora Zeylanica* in 1747, he included the pharmacological name following a list of references to earlier botanical accounts. Under 392. *Arecca frondibus pinnatis, foliolis oppositis lanceolatis plicatis* we find the following notation: Pharmac. CATECHU *Terra* (*Japonica*), *Tinctura*.

Six years later, Linnaeus published *Species Plantarum* with its binomial system for naming plants. This publication is accepted as the starting point of botanical nomenclature for most plants. On page 1189 of *Species Plantarum*, the name for the betel palm is given as *Areca Cathecu* and reference is made to the prior account in *Flora Zeylanica*. The spelling *Cathecu* appeared consistently in subsequent editions of *Species Plantarum* edited by Linnaeus, in his *Systema Naturae*, and in *Systema Vegetabilium* until 1784 when J. A. Murray, who edited the fourteenth edition of the last, corrected the spelling to *Catechu*. The latter spelling was subsequently adopted nearly universally.

Linnaeus, however, used the spelling *Catechu* himself in the index to "*Nomina Trivialia*" (specific epithets) in *Species Plantarum*. He also referred to the betel palm in a thesis entitled *Herbarium Amboinense* (1754) defended by his pupil Olaf Stickmann. This thesis was later reprinted in *Amoenitates Academicae* 4 (1759), wherein both *Cathecu* and *Catechu* appear, and in a second edition edited by Schreber in 1788, wherein only *Catechu* appears. The epithet *Catechu* was used by Linnaeus the younger when he described a source of true catechu, *Mimosa Catechu* (now

Acacia Catechu), in *Supplementum Plantarum* 439. 1781.

The International Code of Botanical Nomenclature permits the correction of errors under provisions of Article 73. E. D. Merrill interpreted the spelling *Cathecu* as an error in his *An Interpretation of Rumphius's Herbarium Amboinense* 123, 1917. The evidence supports Merrill's conclusion and the correction made by Murray. *Areca Catechu*, therefore, may be considered the correct name for the betel palm.

The generic name *Areca*, (ár ee ka, a rée ka) comes from the vernacular. Most dictionaries ascribe it to the Portuguese as *Areca* or *Arecca*, derived from the Malay, Kanarese, or Tamil names *adekka*, *adike*, and *adaikay*. Wittstein (*Etymologisch-botanisches Handwörterbuch*, 1852) derives it it from *Areec*, said to be the name in Malabar for an old tree (*Royal Horticultural Society Dictionary of Gardening*, 1951). Gowda, in the place previously mentioned, says that the name is of South Indian origin. Among the Nairs the word *Areca* means "cavalier" and in Kannada, one of the major languages of the area, the betel palm is called the *adike* tree, the nut *adike*. Whether *Areca* is derived from *adike* or vice versa he is not sure.

H.E.M.

Diseases of the Coconut Palm*

M. K. Corbett

Plant Pathology Department, University of Florida, cooperating with the State Plant Board of Florida, Gainesville, Florida.

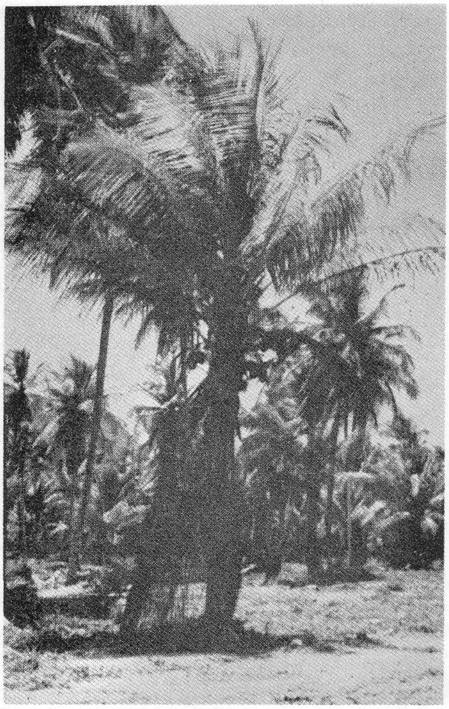
II. BRONZE LEAF WILT

The second disease to be considered in this series of articles on the diseases of the coconut palm is bronze leaf wilt which has not been reported from the United States. The symptoms attributed to this disease are very similar to those described for the lethal yellowing or unknown disease. The disease was reported from the Island of Trinidad more than thirty years ago (1, 2). It was classified under the general group of bud rots until Nowell, according to Briton-Jones (2), separated the bud rots into three distinct diseases. In one, still called bud rot, the rotting of the bud was primary and attributed to infection by the fungus *Phytophthora palmivora*. In the other two, the rotting of the bud was secondary. The second disease was termed red ring and attributed to infection by the nema *Aphelenchoides cocophilus*. The third was due to what Nowell termed "wilt" and for which he could not determine a causal organism.

The symptoms of the disease to which the name bronze leaf wilt was applied by Briton-Jones (2, 3) are similar to those of the lethal yellowing disease, which makes it difficult to differentiate the two diseases.

The lowest three leaves of an apparently healthy palm may start to turn

*For the previous article in this series, see Principes, 3:5, 1959. Florida Agricultural Experiment Station Journal Series, No. 845.



24. Coconut palm in Trinidad exhibiting symptoms attributed to the bronze leaf wilt disease. Note presence of some fruit still on the tree.

yellowish-bronze from the tip backwards. The tips of the succeeding younger leaves start to turn yellow and the extent of the yellowing increases with the age of the leaf. Figure 24 illustrates a diseased palm in Trinidad in advanced stages of yellowing. The lower fronds on this palm are almost completely yellowish-bronze. The heart leaves have not started to change color, but the heart of the palm has started to decay. According to Bain (1) the rot extends into the cabbage and may develop to a considerable degree before the heart leaves change color. At a later stage the heart leaves tend to wilt. The fronds become greyish-brown and may collapse at the base. The diseased palm in Figure 24 has not shed all its older fruits. This is one point of difference between lethal yellowing and the bronze leaf wilt disease (6). In lethal yellowing usually all the fruits are shed except in cases where the symptoms are unilateral (i.e., on one side only) (5).

Figure 25 illustrates several palms in Trinidad in advanced stages of bronze leaf wilt. The heart fronds of the palm to the right have collapsed and the remaining fronds are yellowish-bronze. The lower fronds on the palm in the center are yellowish-bronze, but the heart fronds have not yet completely changed color. The heart fronds are greyish-green and tend to hang or wilt at the tips. This symptom is also a distinguishing character between bronze leaf wilt and lethal yellowing. In the case of lethal yellowing, the fronds usually remain turgid until the heart is dead (6). The bronze leaf wilt disease usually seems to affect only older palms, while lethal yellowing has been reported to affect trees of all ages. Palms of the tall variety replanted in areas affected by lethal yellowing usually succumb again within two to three years (6). At present no information is available on the effect of bronze leaf wilt disease on palms of the Malayan dwarf variety.

The etiology or cause of the bronze leaf wilt disease has not been conclusively proved, although several hypotheses have been proposed. Many attempts have failed to show nemas or fungal or bacterial organisms associated with the disease (2, 3, 4). To quote from Briton-Jones (2), the following is his conclusion with regard to the etiology of bronze leaf wilt disease: "The only alternative explanation of the pathological condition of the plant is that it develops in response to external physiological factors. Whether or not an organism is associated with the disease is

25. Coconut palms in advanced stages of the bronze leaf wilt disease. Note fronds hanging over or wilting at the tips.

not known but the writer's observations in Trinidad and St. Lucia suggest very strongly that the *prima causa* is a soil factor. The very definite correlation between the lack of drainage and the incidence of the disease indicates that the organism, if there is one, is secondary. The trouble might be described as 'physiological drought' since it occurs on badly drained land and on land subject to desiccation during the dry season. Excessive soil moisture and too little moisture have the same physiological effect on the coconut palm as on a good many other plants."

Bain (1) reported, after an extensive investigation of the problem, that the particular factor to be stressed with this disease is a water deficiency in the plant. He concluded that the differences in nutrient status should be considered as contributory factors. Bain (1) considers the bronze leaf wilt disease as a physiological die-back resulting from a water deficiency in the plant. He explains the pattern of disease spread as a result of the exposure of the palm to the wind, which produces high transpiration in the leaves. This, he concludes, causes a physiological die-back that results in the death of the palm. The palm, being a monocotyledonous plant, has only one bud, and death of this growing point results in death of the palm (1).

Recovery from bronze leaf wilt may occur if affected palms are watered in the early stages of the disease (1, 4). Recovery is not necessarily permanent and the condition of palms may fluctuate with weather conditions (4). A satisfactory explanation has not been proposed to account for the fact that some palms start to show symptoms during the rainy season (4). This recovery is another difference between the bronze leaf wilt disease and lethal yellowing, where recovery has never been observed (7).

Bronze leaf wilt was first described from the Caribbean area. Diseases very similar in symptom expression, and thought to be identical with bronze leaf wilt, have since been reported from Africa. In Nigeria and Ghana the disease has been termed awka wilt and Cape St. Paul wilt, respectively (6). If the bronze leaf wilt disease is caused by the physical condition of the soil, then to have the same disease occur in such varied locations, on many different soil types, and under different environmental conditions induced by the same soil conditions seems highly speculative (6). It thus seems that factors other than physiological drought are needed to explain the cause of bronze leaf wilt.

Adequate control measures are not available. Briton-Jones (4) recommended the use of effective drainage and wider intervals of planting. Unfortunately, information regarding the practicality of such measures is not available.

Acknowledgments

Grateful acknowledgments are made to the State Plant Board of Florida for making this study possible; to Miss Jean Smith for assistance with illustrations; and to John Spence, Agricultural Department, Trinidad, whose assistance was greatly appreciated.

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Seed Bank News

The Society's Seed Bank is interested in obtaining seeds of *Rhapidophyllum hystrix* for future distribution. Will anyone who can supply such seeds please write the Executive Secretary? Another listing of seeds available through the Seed Bank will appear in the July issue.

Further Notes Concerning The Central Australian Cabbage Palm – Livistona Mariae

T. R. N. Lothian,
Director, Botanic Garden, Adelaide, South Australia.

In this journal (*Principes* 2:92-94, 1958) some general comments were given earlier concerning the habits and habitat of *Livistona Mariae*. Since these were written, a visit has been made to Palm Valley as part of an overall botanical reconnaissance of the northwest of South Australia and southern central portions of Central Australia. Whilst in Palm Valley, the opportunity was taken to make further observations and to collect a small quantity of seed. This seed was obtained with a view to carrying out a few germination tests; not only to discover the type of seed which was viable, but to enquire into the stages of germination.

General Observations

The natural soil of Palm Valley is, as one would expect, river-washed sand and gravel. About 6-9 inches below the surface, heavier material is found, and stones often 4-5 inches in diameter occur. The surface of the soil is covered with decaying organic matter. In the palm thickets (Fig. 30) this debris has built up to a considerable thickness. It is often several feet above the general level of the river bed, and unless the river is in very high flood, very little of this matter is lost by water.

The bed of the Finke River, which forms the gorge and habitat where *Livistona* grows, is approximately two miles long, and up to 200 yds. wide. There are, however, one or two outliers still within the general gorge area, but quite separate, and forming "islands."

In the field a large number of seedlings of this palm were seen. These occurred in various places: in dense colonies under palms, as rows of seedlings which have grown from seed washed into rock crevices; or as individual seedlings in isolated small pockets of soil in the rock mass.

The age to which palms grow before dying is not known. A careful investigation was made in Palm Valley, but very few fallen trunks were noted. Most certainly none had fallen in recent years. It is likely, however, that trees live to a considerable age, because palms of 50 or 60 feet high had only commenced to develop the root mound which most palms produce as they reach maturity. In half a dozen cases only were these root mounds of any consequence (Fig. 28). In these instances they were 4-6 feet through at the base and about 5 feet high. Other than this, the trunks appeared to develop straight from the soil level.

The old fronds initially remain on the trunks, bend downwards, and become appressed around the trunk like an apron, where they die. As in *Washingtonia,* these old fronds stay in position until blown off by strong winds, but in the centre of the thickets where wind velocity is greatly reduced, the fronds remain adhering to the trunk. However, as the palm grows and the crown and trunk are taken above the protective stand, the dead leaves either fall or are blown off, leaving the trunk bare (Fig. 26).

One feature rarely noted amongst

stands of palms was the number of curving, twisted, and crooked trunks. From observations it was not possible to decide what had caused the trunks to grow in this position (Fig. 30, right), although interference by other plants cannot be overlooked. Reference to the plate (Fig. 52) in my previous article will show that the tall palm is greatly arched; but as the photo shows (Fig.

26. Palms show the retained apron of old fronds in the centre of a thicket, but bare trunks above and to right.

29) the trunks are in the form of an "S." The height of these palms is approximately 60 feet.

Seedlings in the Field

The initial seedling leaf is single, and except for some broadening towards the apex, the next three to six leaves are undivided. This broadening of the lamina proceeds, then the leaf divides at the tip, and in the 10th or 12th leaf a palmate frond develops. The young leaves have weak spines along their edges but these quickly disappear. As the subsequent leaves occur, the spines become more rigid and stronger along their petioles, until those along the stalks of the initial palmate fronds are quite strong and sharp and are small replicas of those to be seen along the mature leaf stalks.

The leaves of the seedlings growing amongst the mature palms are green and never assume a reddish hue. It was noted, however, that in those seedlings growing away from the main colony of palms the leaves were a deeper colour, and in one or two instances they had already commenced to turn reddish. It would appear that the young plants assume the reddish tinge to dull red and almost cinnamon red only when growing in fully exposed sites, and more especially when growing as individual seedlings well separated from the main palm colony (such as in rock crevices or pockets). On the other hand, without exception, the seedlings growing in exposed sites had red leaves, and it was not until these plants commenced to produce a trunk that the colour of the leaves changed from red to a glaucous colour.

It would appear, therefore, that to produce red juvenile or young foliage under cultivation it is essential to grow seedlings in a hot fully exposed site, and probably in a soil deficient in organic matter.

The rate of growth following the production of the initial leaf is not known, but it undoubtedly depends on the water supply. Rain in this region is by no means regular, although there is probably a certain amount of underground water which the roots of these plants can draw on freely. When the seedling has developed a trunk approximately the diameter of the mature palm, the trunk commences to elongate. This may take at least 10 to 12 years in the field. At this stage the petioles may still be coloured, but the lamina commences to change from red to glaucous colour, and when the trunk is about 6 feet high normal green leaves are produced.

Undoubtedly the rate of growth also determines not only the age but the height at which this palm reaches maturity (flowers). Numerous specimens were examined, but none had produced flowers if the trunk was under 15 feet. However, palms of 25-30 feet showed old flower heads present and it is likely that somewhere about this height they commence to flower.

It was previously stated that flowering is "probably annual." In the main this statement remains substantially true, because at this height the palms are likely to be drawing freely on underground water supplies and are therefore no longer dependent on seasonal rains. Prolonged droughts only would curtail regular growth and flowering.

A large number of seedlings was excavated in an endeavour to trace their root growth and root development during the young years. Following germination, roots descend rapidly. The crown was at least 4-6 inches below the soil level and the roots of seedlings having three or four leaves extended to at least 18 inches deep. By this stage there was also considerable lateral root spread. As can be seen from the accompanying photograph (Fig. 32), the development of the seedlings following the production of the shoot and fourth leaf is fairly regular, but the trunk development is extremely slow.

Germination of Seed

From the seed collected in the field, a quantity was sown under controlled conditions at the Adelaide Botanic Garden. Before sowing the seed was sorted into five groups. (See Fig. 27.)

Group A: The thin but fleshy exocarp of brownish-plum colour was entire. This was present season's seed.

Group B: Exocarp covering was slightly chipped, brownish-black in colour, but at least 75 per cent of the individual seed was covered. Probably present season's seed.

Group C: The covering had started to rot away, was comparatively thin, grey coloured, and in some instances covered less than approximately 50 per cent of the seed. This could be seed of previous years (seasons).

Group D: The covering was entirely removed, and represented fresh seed.

Group E: This comprised obviously old seed. The fruit was in some instances deeply pitted or indented, black in colour, and when cut in half before sowing, it appeared either dead or almost so.

The five lots of seed were sown on 1st August in our usual seed soil mixture (based on John Innes Standard) in 4-inch pots which were plunged into bottom heat of 80° F. Ten seeds of each type were sown to a pot.

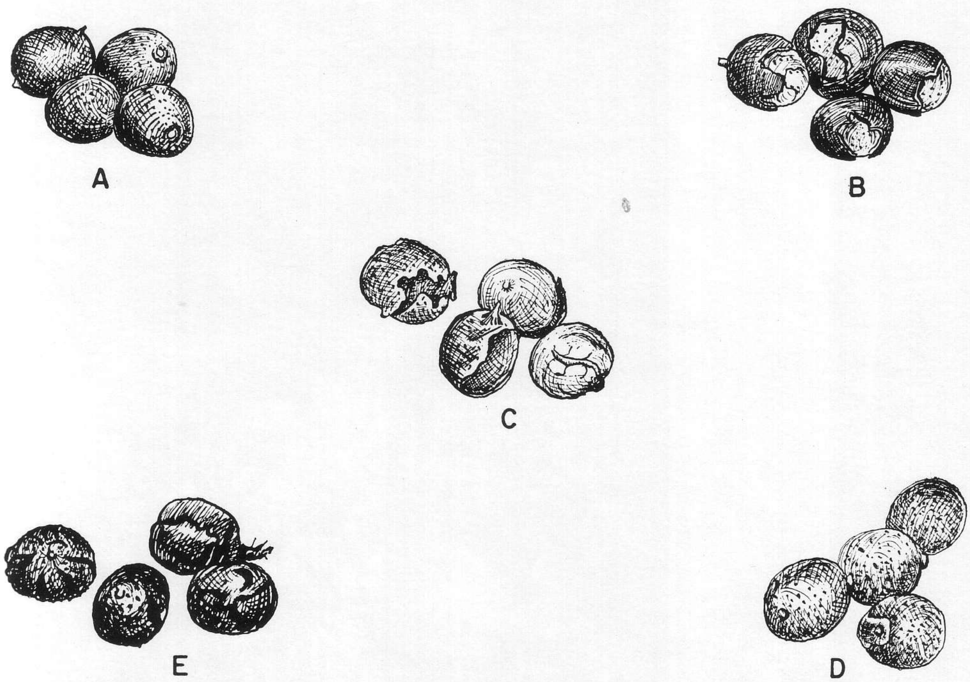
Five weeks later (5th September) no seedlings had occurred in groups A and E. In group B there were two seedlings, and in groups C and D one seedling in each had appeared above the ground.

By 27th September, the following germinations had taken place: Group A—one seedling commencing to show above the soil; Group B — two seedlings; Group C — one seedling; Group D — eight seedlings, five several inches high and three just breaking the soil level; Group E—no germination.

On 27th October, the following was the progress of the five batches of seed: Group A—two seedlings were growing, one freely with an upright leaf, the other slowly with an abnormal leaf (curled and prostrate); Group B—two seedlings produced, one growing strongly, the other very weak; Group C — two seedlings which subsequently died; Group D—nine seedlings well above the soil level, all growing very strongly; Group E—no germination.

On 19th November, approximately 15 weeks after sowing the seed, the pots were removed from the propagating pit, each was emptied, and a check was made on the number of seeds which had germinated, the condition of the seedlings and of the remaining seeds. The results were as follows:

Group A—Four seedlings produced, of which two seeds had germinated recently and were just pushing through the surface of the soil. The other two were well established. The seedling with the curled and prostrate leaf had continued to grow but at a rate slower than the other. The length of leaf in the vigorous seedling was 12 inches. Within the seed soil, five further seeds had recently germinated. One seed failed to germinate, but was still viable on dissection.



27. The various groups of seeds which were used in germination tests. Note the cracked appearance of Group E.

Group B—Of the ten seeds, four had germinated. Two of the seedlings had died, the two remaining were growing strongly. Within the seed soil two further seeds had germinated into strongly developing seedlings. The primary root was well developed and the shoot (plumule) was commencing to grow. Four viable seeds remained.

Group C—A total of six seeds germinated and one of these had produced a sturdy primary leaf well above the level of the seed soil. Of the remaining five seedlings, four had commenced to produce shoot growth above the ground, but subsequently died, and one had just broken the soil level. The four remaining seeds were rotten and infertile, and were quite likely dead before sowing.

Group D—All ten seeds germinated. Nine seedlings had each produced a vigorous primary leaf up to 14 inches long, including three seedlings which had commenced to produce a second leaf. One seedling had subsequently died. The primary leaves were green, somewhat channelled, and along their edges were fine but distinct bristles.

Group E—No germination. After carefully washing the seed soil, five rotten seeds only were recovered, the remainder had disintegrated. All were probably dead before sowing.

The above results are rather interesting (although the number of seeds used was limited). It would appear that the fleshy fruit covering may contain an inhibiting agent such as is known to exist in the fleshy covering of many fruits (e.g. Rosaceae) which prevents the seed from germinating until this has rotted. It will be noted that as this cover rotted, so germination occur-

28. These palms rarely produce "root mounds," and it would appear that external causes contribute to their development.

29. A view looking "straight" up the trunk of the palms shown in Figure 30.

30. Grove of *Livistona Mariae* showing seedlings (centre) and various stages of growth. Note twisted trunks on right. Tall palm in centre is approximately 55-60 feet high.

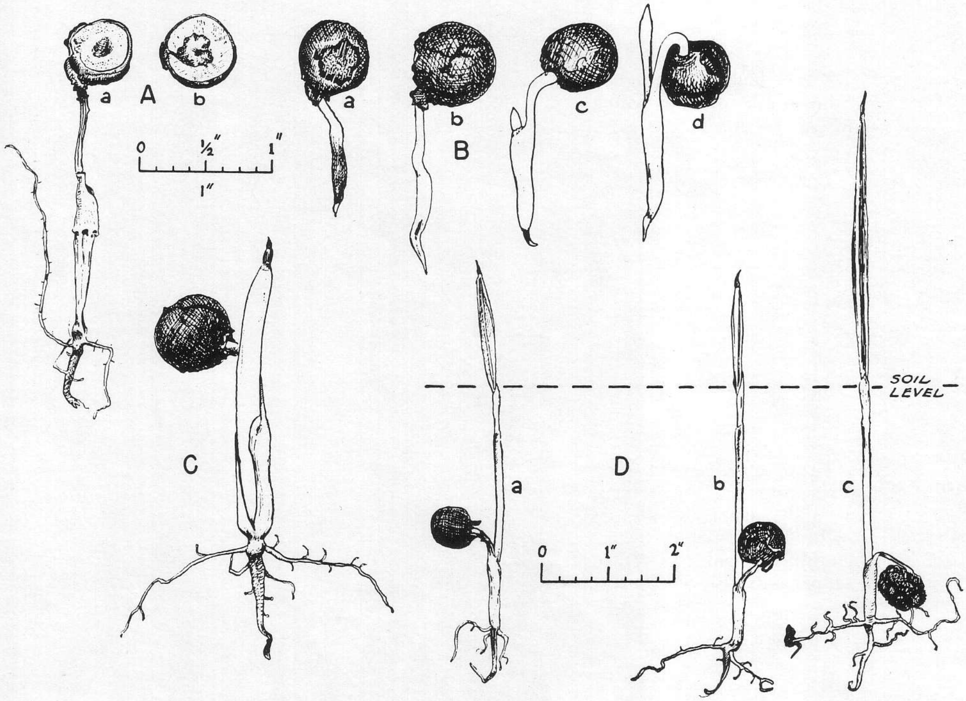
red. The five seeds of Group A which had germinated by the middle of November but had not yet produced shoot growth above ground level, showed strong deterioration of the seed cover.

It would appear essential before sowing seeds of *Livistona* (and possibly of other palms as well) that this soft succulent covering should be removed, and further, that fresh seeds only should be sown. This appears to be the explanation for the rather contrary results obtained in Group C, of which the four seeds which were rotten (and probably dead) were in actual fact old seed, while the fresh seed germinated.

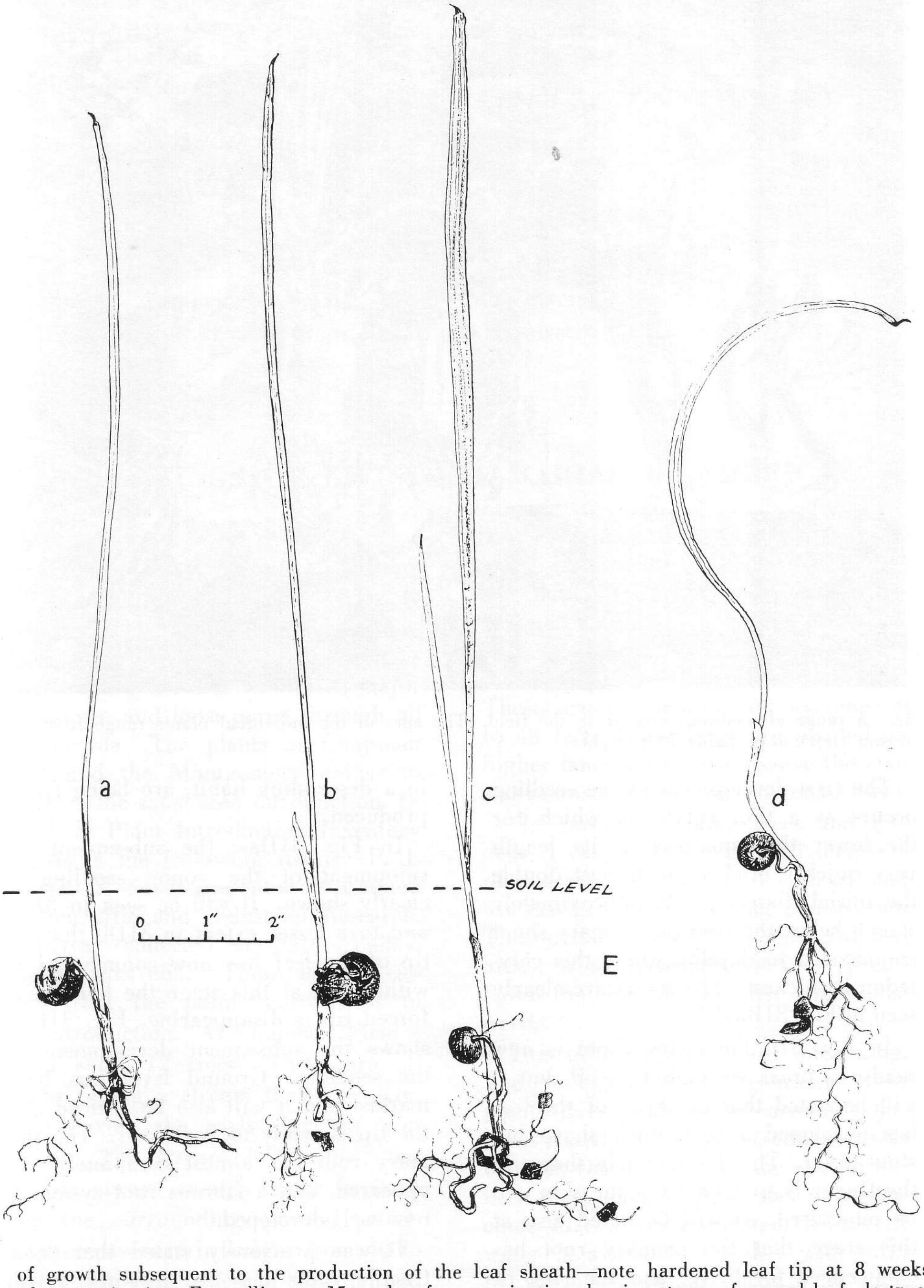
Development of Seedlings

In the above results, reference is made to some of the seedlings dying subsequent to germination. Two reasons can be advanced for this happening. The first is that the bottom heat was well maintained at 80° and on some days varied between 85° and 90°F. As this temperature is too high for the well-being of the seedlings, the pots should be removed to slightly cooler temperatures following germination.

The second reason, either coupled with the above or independent, is that for a very short period the bottom layers of the seed soil dried out. The effect of this can be clearly seen in Fig. 31Aa. (Fig. 31Ab is a cross section of a fertile seed, showing the flesh still firm and shiny whereas the remains of the germinated seed were mealy.)



31. Germination of *Livistona Mariae*. A, cross section of seeds; Aa, seed germinated but subsequently died—note mealy appearance of endosperm; Ab, viable but ungerminated seed: B, stages of germination—note that the plumule commences growth below the level of the seed: C, greatly enlarged and somewhat later stage of Bd, showing development of leaf sheath: D, various stages



of growth subsequent to the production of the leaf sheath—note hardened leaf tip at 8 weeks after germination: E, seedlings at 15 weeks after germination showing stages of second leaf, destruction of endocarp and (d) an abnormal leaf.

32. A range of seedlings dug up in the field. The ages of the individual plants range from one season (left) to probably 7-10 (right).

The first development of the seedling occurs as a thin cotyledon which for the lower three-quarters of its length very quickly thickens to almost double the initial diameter. At approximately 1 inch below the seed the primary shoot commenced to develop where this cotyledon is thickest. The stages are clearly seen in Fig. 31Ba-d.

In Fig. 31C the young shoot is now ready to break through the soil, but it will be noted that the apex of the leaf has developed a very thick sharp but stout point. This is extremely sharp. If the finger is pressed on it the skin can be punctured. It will be noted also at this stage that the primary root has commenced to shrivel and the first of the true roots, developing laterally but in a descending habit, are being freely produced.

In Fig. 31Da-c the subsequent development of the young seedling is clearly shown. It will be seen in 31Dc and to a lesser extent in 31Db that the tip of the leaf has now commenced to wither and at this stage the hard reinforced tip is disappearing. Fig. 31Ea-c shows the subsequent development of the seedling. Ground level has been marked and it will also be noticed that the tip is ready to break off. The primary root has almost completely disappeared, and a fibrous root system is now well developed.

It was previously stated that "contractile roots may be responsible for drawing the crown of the plant below ground level." From the current investigations it is obvious that the crown is already below ground level, but it is not clear whether in actual fact contractile roots do pull the seedlings down further into the soil. Subsequent investigation is now being carried out by sowing seeds at different levels in an endeavour to discover this particular and other aspects. For example, under natural conditions most seeds germinate where they fall, namely *on the surface of the soil.* However other seeds which are washed into crevices or holes could be deeply buried and, while the seeds germinate, the depth of material above may be too great to allow the seedling to reach the soil surface before the endosperm is expended.

Acknowledgements

I wish to record my thanks to the Plant Propagator (Mr. R. M. Hardie) for caring for the seedlings during this investigation, and to Mr. L. Dutkiewicz for the drawings. The photos were taken by myself.

PLANTINGS OF LIVISTONA MARIAE IN AMERICA

The following is an extract from a letter from Mr. Nat J. De Leon, Miami, Florida, who writes:

"Further information concerning plantings of *Livistona Mariae:*—I have since combed the area, the three major collections, and have pored through all the records. The plants at Chapman Field and the Montgomery collection are from the same seed introduction. In the U. S. Plant Introduction Inventory records is the following listing: P. I. No. 95077, 'Seeds presented by Council for Scientific and Industrial Research, Canberra; collected at Palm Valley, Central Australia.' There can be no doubt that the palms correspond to this introduction. At Chapman Field I found some 12 trees. These are all planted along a stream that was man-made during the early days of that station. The stream is shallow, but there is always enough water in it to keep the surrounding ground moist. The trees average in height from 40 to 60 feet. Only the tallest of these fruited this year, and bore quite a heavy crop. I was also able to compare seed samples which check out. Incidentally, the original date in the inventory records is December 11, 1931. The trees at the Montgomery collection from the same seed lot are represented by about five trees. These are all smaller and average 30 to 40 feet. These trees are planted on higher land and do not receive the constant moisture found at Chapman Field.

"In further checking trees and records, I can conclude that all members of this genus do very well with us, and are fast growers when once planted out. This includes those from more tropical areas, as we have at least four species from the Philippines that grow like weeds."

This information is most interesting. The very rapid growth which these plants have made rather astounds me. If, as stated, the initial introduction was made in December 1931, the growth has been most remarkable. I can only conclude that where a constant supply of water is available, together with mild to warm conditions, growth is continuous rather than seasonal.

The Status of Palm Taxonomy*

Harold E. Moore, Jr.

It may be well, at the outset of a consideration of palm taxonomy, to define the term taxonomy. Briefly, it concerns the identification, naming, and classification of plants (or animals). Identification is the determination of a plant as being identical with or similar to another and already known plant or, if all known possibilities are eliminated, its determination as new to science. Naming involves the determination of the correct name of a known plant according to the nomenclatural system accepted internationally, so we may have a means of referring to the plant. Classification is the placing of a plant or group of plants in categories within the framework of a master system which tries to show relationships among the various components of the plant kingdom. Ideally, all the techniques of the science of botany should be used in the identification, naming, and classification of plants—morphology and anatomy (the study of the external and internal structure of a plant), cytology and genetics (the study of cell and reproductive mechanisms and of inheritance), physiology (the study of plant functions), paleobotany (the study of plants now mostly extinct but preserved in the fossil record).

Having very generally defined taxonomy, we may be better able to appreciate the present status of the taxonomy of palms by tracing in outline the history of the study of palms. Modern taxonomy goes back to 1753 when Linnaeus gave us a system of naming plants that was easy to understand and to use. Before that time, travelers and early botanists or herbalists had written about many plants, some accounts dating back to Greek civilization. Few palms were known to the ancients, however, and even in 1753 Linnaeus wrote about only nine—*Areca Catechu* (the betel palm), *Borassus flabellifer* (the toddy palm of India), *Calamus Rotang* (a rattan palm), *Caryota urens* (an Indian fishtail palm), *Chamaerops humilis* (the only palm native in Europe), *Cocos nucifera* (the coconut), *Corypha umbraculifera* (the talipot palm of India), and two date palms, *Phoenix dactylifera,* or the cultivated date, and the wild date which he called *Elate sylvestris,* but which we know today as *Phoenix sylvestris.* Linnaeus depended largely on earlier accounts for his study—those of Rheede who wrote of the Malabar coast in India, of Rumphius, whose *Het Amboinsche Kruid-Boek* or *Herbarium Amboinense* published in 1741-1755 described palms and many other plants of the Moluccas and adjacent areas, and of other writers who recorded botanical information noted in their travels.

As more and more parts of the world were explored by persons who collected and catalogued its plant resources, the list of palms increased. In the early nineteenth century a Dutch botanist, C. L. Blume, collected and wrote about palms of the East Indies; Baron von Humboldt gave accounts of American palms; William Griffith, an Englishman in the employ of the East India Company, published fine studies of the Indian palms; Liebmann, a Dane, collected them in Mexico. Thus, using the experience of these men, Von Martius, who had spent two years in Brazil himself, was able to produce between 1829 and 1850 a monumental three volume

* Presented at the Palm Conference, Fairchild Tropical Garden, April 18, 1958.

work on the natural history of palms, the *Historia Naturalis Palmarum*, in which he accounted for those species then known, a number small when compared with the total today.

In the latter part of the nineteenth century, much important work was done with palms, principally by R. H. C. C. Scheffer from the botanic garden at Buitenzorg, Java (now Bogor, Indonesia), Hermann Wendland from Hanover, Germany, J. Barbosa Rodrigues, J. W. H. Trail, and O. Drude on palms of Brazil, and Odoardo Beccari of Italy on palms from the islands of the Pacific and continental Asia. From these accounts and from the study of dried specimens of palms stored at the Royal Botanic Garden, Kew, England, Sir Joseph Hooker was able to write another study of palms (in Bentham and Hooker f., *Genera Plantarum*) in 1883, this time dealing comprehensively with the genera as they were then understood. Following him, Otto Drude wrote a similar but less detailed study for Engler and Prantl, *Die natürlichen Pflanzenfamilien* (1889).

From the beginning of the twentieth century to the present, such men as Beccari in Italy, Max Burret in Berlin, C. X. Furtado in Singapore, A. Dugand in Colombia, Brother Léon in Cuba, O. F. Cook, L. H. Bailey, Miriam Bomhard, and B. E. Dahlgren in the United States were able to study an increasing number of palms in the herbarium and in the field. Burret, in the thirty years of his active study, described about 550 species of palms from all warmer parts of the world. Thus, in 1954, when I attempted to sift out the duplication among palms described before then, it appeared that there were in the vicinity of 236 genera of palms known to science and somewhere in the vicinity of 2,650 species (as distinguished from names, many of which duplicate one another in one or more ways).

But despite two centuries of work, our knowledge of palms is painfully incomplete. Most palms have been described from herbarium specimens brought from far parts of the world to botanical laboratories and museums here and abroad. These specimens could give but part of the whole story, for few botanists were so fortunate as to study palms in the field as well as in the laboratory and thus to provide us with more complete accounts.

This brings us to the present status of palm taxonomy. Today, as a result of the exploration of the world's tropics, we have a permanent record in the form of dried specimens, incomplete as they may be, representing some 2,600 or more different species of palms as opposed to only 300 that can be studied more intensively from plants now known in cultivation. These specimens have been studied by various botanists, we have names for the species they represent, and we have been able to fit these species into genera, the genera into tribes, the tribes into subfamilies, giving us the outline, though still a very imperfect one, of a system or hierarchy of palm classification. We have, in effect, a sort of "bureau of standards" for the identification, naming, and classification of palms with herbarium specimens as the vouchers or standards. We compare new material with these to determine whether an unidentified palm agrees with one already described or is new to science.

The standards are woefully inadequate. A grass, for example, can be preserved in its entirety and comparisons of whole made against whole. Most palms are so unwieldy that only parts can ordinarily be preserved. It may be that material which is sent for identification consists of parts different from those represented by the "standard" or type-specimen so that direct comparison is impossible. Then identification can at best be only tentative. We have only a skeleton system which must be fleshed out before palms are understood by botanist, horticulturist, or others in the way that smaller plants are now understood.

Perhaps an example will help to make clear the inadequacy of present palm taxonomy. The Fairchild Tropical Garden has distributed among its members plants of a palm known to some as *Chrysalidocarpus* sp. "Soledad" or to others as the Cabada palm. Its story is representative of the taxonomist's problems.

When I first started visiting the Atkins Garden of Harvard University at Soledad, Cuba, Mr. Walsingham, then Superintendent, asked me to identify a handsome cluster palm with red fruit which grew beside the laboratory. Seed had come originally from a plant established in the garden of Dr. Cabada in nearby Cienfuegos. Dr. Cabada had been a ship's doctor, if I understand correctly, and had apparently brought the palm from some other part of the world—but which part no one knew.

In 1952, I photographed the palm, made notes on its habit, colors, size, and collected leaves and fruit, for there were then no flowers. The habit, fruit, shape and certain other characteristics of the inflorescence led me to suspect that it might be a species of *Chrysalidocarpus*, a genus which occurs naturally in Madagascar and the nearby Comores group of islands. I therefore went to the most recent publication on palms of Madagascar and the Comores and tried to identify it with the keys and descriptions therein. If it were a species of *Chrysalidocarpus*, it failed to fit the descriptions of those then known with one possible exception, *C. lanceolatus* from Grand Comore. The latter, unfortunately, is known only from some fragments of a leaf and parts of an inflorescence with flowers deposited in the herbarium at Paris. Furthermore, *Chrysalidocarpus* was not supposed to have red fruit. Therefore no comparison could be made then.

The next step was to obtain flowers of the Cabada palm. When these were examined, I felt more strongly than ever that the palm was indeed a species of *Chrysalidocarpus*. Although I now had a complete picture of the cultivated palm and although, in general, there was considerable agreement between it and the fragments of the palm from the Comores, no definite identification could be made. Had we known that the Cabada palm came from Grand Comore, there would have been basis for a reasonable assumption that it was *Chrysalidocarpus lanceolatus* despite the lack of information on fruit of the latter. But we do not know from where it came.

Now we must somehow obtain a complete picture of the Comores palm, a not too easy task. In time a letter to government authorities in Madagascar asking for assistance in obtaining fruiting material of *C. lanceolatus* produced some results. I received parts of two palms from the Comores. One had fruit but was immediately identifiable as a species of *Ravenea*, thus was removed from consideration. The other was truly a *Chrysalidocarpus* but in flower. Another letter has gone out explaining that we need fruit of the second.

In the meantime, I had come across the description of a palm growing on the island of Pemba off the east coast of Africa which answered the description of the Cabada palm in some respects, and I had been fortunate enough to study specimens of it in the herbarium at the Royal Botanic Garden in Kew, England. There was no question but that this was a *Chrysalidocarpus,* and furthermore it had red fruit. The fruit, however, was considerably larger than that of the Cabada palm.

Now we are faced with a dual problem. What is the palm from Pemba which appears to represent a species as yet unknown to science? And still—what is the Cabada palm? To further complicate this problem, we must now re-examine the relationship between *Chrysalidocarpus* and another genus from Madagascar, *Neophloga. Chrysalidocarpus* is not supposed to have red fruit; *Neophloga,* though it does have red fruit, is supposed to be a genus of dwarf palms. When considering the delimitation of genera, size cannot be considered of much importance since the basis for all our classification is based on the more constant characteristics of flowers, fruits, and leaves. Perhaps the two genera *Neophloga* and *Chrysalidocarpus* are but one (with variation similar to *Bactris* in the New World) which contains within its limits both yellow- and red-fruited species, both tall and dwarf palms, but which is distinguished from all other palms by more constant and important differences.

Thus the problem has grown and no answer is yet in sight for the identity of the Cabada palm. I hope that fortune will permit someone to visit Madagascar and the Comores, and if so that he may find *Chrysalidocarpus lanceolatus* in fruit on Grand Comore. Then it should be relatively easy to say whether the Cabada palm is identical with it or different. If the former, we must suppose that Dr. Cabada (or someone else, for the same palm has since been found cultivated in other parts of the Caribbean area) brought seed from Grand Comore. If not, then we must search further to discover its native home but, having already eliminated all possibilities, can still with some certainty consider it a new species, proceed to describe and name it, and assign it to a place in our scheme of classification. It is likely that a period of as much as ten years will be required to give an answer to Mr. Walsingham's simple question "What is it?"

33. Mr. Walsingham serves as a scale beside one of several clumps of *Chrysalidocarpus* sp. at the Atkins Garden, Soledad, Cuba.

What has been said before deals with what has been done, and with what is being done at present. There are fewer persons actively working with the taxonomy of palms today than there were a century ago despite the great increase in material for study. Hence the slow pace at which we progress. Obviously the taxonomist is not working under either ideal conditions nor in an ideal manner. The riches of the tropics are still overwhelming and we are still faced with the problem of finding out what palms grow there utilizing what little information we can obtain from specimens and notes. Large collections of specimens from the Pacific Islands and from the American tropics still await study in the herbarium at the L. H. Bailey Hortorium and in other herbaria. I know that there are undescribed species in those collections and surely further exploration of remote regions will disclose more, though how many one would be hard-pressed to estimate. For years yet, palm students must continue at least in part in the standard "old-fashioned" taxonomy.

Old - fashioned, because time has brought change to our study of plants. In temperate regions of the world, the describing and cataloguing of plants has largely been done. Today the taxonomist can truly fill his role in bringing together information from all techniques of botany. He can study the species of plants as a whole using experimental methods and arriving at more objective conclusions. Ideally, the taxonomy of palms should someday—and hopefully soon—follow in this more complete fashion so we may understand palms as biological units rather than as museum fragments.

NOTES ON CULTURE

Regulations for the Introduction of Palms

Palms are principally introduced into cultivation through the medium of seeds. Some which do not produce seeds and special clones of others, however, may also be introduced as live plants. Mr. Emile Kostal, Acting Station Head, Agricultural Research Service, Plant Quarantine Division, 209 River Street, Hoboken, New Jersey, has kindly provided pertinent governmental information for the guidance of Palm Society members. This, in the form of Circular Q.37-13 (6-55), is reproduced below. It should be remembered that an import permit from the Import and Permit Unit of the Division is required before material is introduced.

In explanation of quarantines, Mr. Kostal writes: "The concern of the Department [of Agriculture] relative to palm importations dates back many years to the time a very destructive date scale insect was introduced on date palm offshoots. This insect was a very serious handicap to our developing date palm industry in the southwest. After many years of effort and great expenditure of public money this scale was eradicated. Palms, such as date palm offshoots and large old palm plants, are very difficult to examine for plant pests because of the many overlapping leaf sheaths."

STATUS OF PALMS UNDER QUARANTINE NO. 37

Under the provisions of Regulation 18d of Quarantine No. 37 the importation of palms and woody species which can be grown from and which come true from seed may be imported only as seeds. The Regulation provides that plants within size and age limits may be imported when it is impossible to procure viable seed. Exceptions are also made for clonal material. There should be no difficulty in getting seeds of common palms such as *Acrocomia, Attalea, Cocos, Kentia (Howea), Livistona, Rhapidophyllum, Sabal, Scheelea, Washingtonia*, and others. Viable seeds of genera which may be more difficult to get are those of the so-called under growth palms and others which are likely to be of botanical interest to scientific institutions including arboretums. They would include but not be limited to certain species of such genera as *Chamaedorea*,

Continued on page 75

Palm Diseases*

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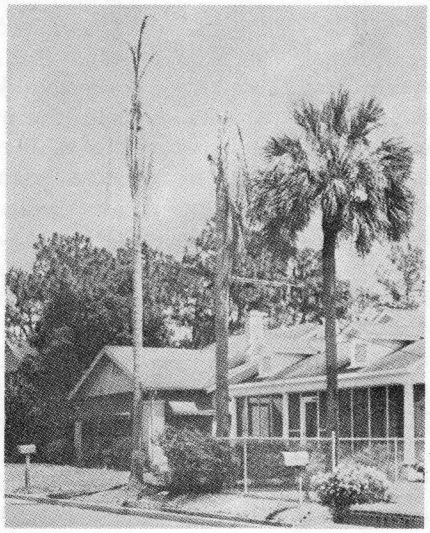
Once established, the palm tree is usually considered easy to grow and maintain and not especially subject to diseases. However, a wide variety of either parasitic or saprophytic organisms, including fungi, bacteria, nematodes and possibly viruses, occur on palms.

Diseases Affecting The Roots and Trunks

Butt rot of palms—The butt rot disease, believed caused by the fungus *Ganoderma lucidum* (Leys.) Karst. (*G. sulcatum* Murr.) has been reported in Florida, Mysore, Burma, Malaya and the West Indies. The list of palms attacked by this fungus includes *Arecastrum Romanzoffianum* (Cham.) Becc., *Cocos nucifera L.*, *Phoenix sylvestris* (L.) Roxb, *Serenoa repens* (Bartr.) Small, *Phoenix canariensis* Chab., *Sabal Palmetto* (Walt.) Lodd., *Arikuryroba schizophylla* (Mart.) L. H. Bailey, *Areca Catechu L.*, and probably many others. In neglected palm plantings the disease spreads rapidly particularly when prompt attention is not given to removal of infected trees. Affected trees are often growing in areas surrounded by dense shrubbery or in wet, poorly drained locations. This disease is especially important since the pathogen usually attacks palms 10 years and upward in age. These trees are of great value in ornamental plantings (Fig. 34). Once the fungus invades the roots and trunk of a tree it becomes difficult or impossible to eradicate the disease.

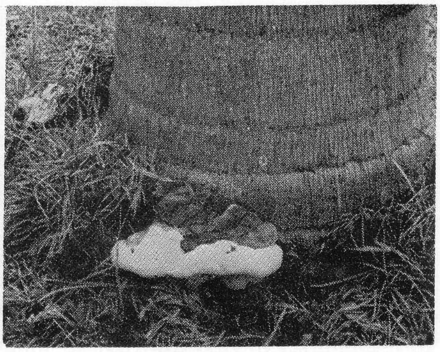
First evidence of the butt rot disease in affected palms is poor growth and vigor. The lower leaves turn yellow and die, hang down giving a general drooping effect. The newly formed leaves become progressively smaller until only a few dead leaves remain (Fig. 34). Progress of the disease may be slow, requiring months or possibly years before the tree is finally killed. In the coconut palm the yield of nuts is reduced and an exudation or bleeding of a sticky, reddish-brown juice occurs near the base of affected trees. When cut open, the interior of the trunk is brown for several feet from the ground; the advanced margin of decay is yellowish in color and the rotted tissues emit a musty odor.



34. *Arecastrum Romanzoffianum*. Palms on left infected with butt rot fungus. Photograph by J. F. L. Childs.

The fungus spreads through the soil from diseased to healthy roots and also by means of air-borne spores. The

*Presented at the Palm Conference, Fairchild Tropical Garden, April 18, 1958. Florida Agricultural Experiment Station Journal Series, No. 881.



35. Trunk of a palm showing fruiting structures (sporophores) of *Ganoderma lucidum*. Photograph by J. F. L. Childs.

spores are borne in mushroom-like structures (sporophores) which grow out from the trunk and roots of diseased trees (Fig. 35). At first greyish and spongy, the sporophores later become hard with a brownish, lacquered upper surface. Mature spores of the fungus fall from the under surface and are disseminated by wind.

Control of the butt rot disease is difficult since the fungus is well established within the roots and trunk of the palm before visible symptoms appear. Root and trunk injury to palms should be avoided, as the fungus probably enters through such wounds. Susceptible palms should not be planted in damp locations or where shrubbery causes excessive shading. Infected trees including sporophores should be removed and burned. The application of fine sulfur to the soil around the trees was found helpful in Mysore (20). In addition, good drainage and sanitation are stressed.

Phytophthora trunk rot.—This disease was reported occurring in California (6) on several plantings of the native fan palm, *Washingtonia filifera* (Lind. ex André) H. Wendl. Leaves of affected trees rapidly die due to the rot that develops at or near the base of the trunk. Within two to three months after infection the rot becomes soft and spongy. Young seedlings, when inoculated, were noted to die within 10 days. The roots of diseased palms are apparently not rotted. The causative organism is considered to be a water mold, *Phytophthora parasitica* Dastur, and infections are believed to occur through wounds under wet conditions.

Trunk canker.—A trunk canker of *Arecastrum Romanzoffianum* (Cham.) Becc. caused by *Penicillium vermoeseni* Biourge occurs in California. A leaf base rot of *Phoenix canariensis* Chab. and a bud rot of *Washingtonia filifera* (Lind. ex André) H. Wendl. are caused by the same fungus (2).

Root rot.—In Arizona, a root rot of *Washingtonia filifera* (Lind. ex André) H. Wendl. was observed in the Salt River Valley in 1935 (4). The leaves of affected palms die from below upward to the crown and finally the terminal bud dies. Diseased roots turn brown and become water-soaked. The cause of this disease is not known, although laboratory isolations suggested that a *Fusarium* fungus may be involved.

Red ring.—A disease of *Cocos nucifera* L. occurring in Brazil, Venezuela, Colombia, Panama, British Honduras and elsewhere is caused by a nematode, *Aphelenchoides cocophilus* Cobb. The nematodes feed in the periphery of the cortex of young palms, releasing a toxic substance which kills affected trees. The region in which large numbers of nematodes are actively feeding turns red-brown in color. Mature palms are not attacked by the nematodes. Infected trees should be removed and burned (11).

Wilt and trunk rot.—A disease occurring on *Cocos nucifera* L. and *Roystonea regia* (H.B.K.) O. F. Cook, at Ft.

Lauderdale and Key West, Florida, was briefly described in 1957 (19). Symptoms of the disease include wilting and greying of lower leaves, accompanied with a gumlike exudate along the trunk. When the trunk of an infected palm is split open the vascular tissues adjacent to the point of leaf attachment may be orange-red in color and brown longitudinal streaks are often evident on diseased fronds. The lower leaves wilt and die prematurely. Disease development is rapid, resulting in a complete breakdown of the interior trunk prior to death of the bud. Cause of the disease is not known. Although a *Xanthomonas*-like bacterium was isolated, its pathogenicity was not established.

Diseases Attacking The Buds of Palms

Phytophthora bud rot.—Coconut bud rot caused by *Phytophthora palmivora* Butler is one of the most destructive palm diseases. Its occurrence has been noted wherever palms are grown. Trees of any age may be attacked by this fungus.

During seasons of normal rainfall, bud rot is usually not serious. However, during wet seasons or after hurricanes this disease is frequently troublesome. This is probably due to mechanical damage which makes conditions favorable for the fungus to enter the bud; the fungus also is highly dependent upon water and wind for its dissemination. Small coconut seedlings under crowded, wet conditions in the nursery are at times killed by this fungus (17).

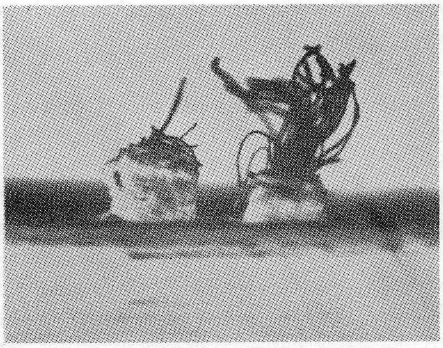
Symptoms of the bud rot disease include wilting, yellowing of the leaves and finally death of the terminal bud. Once the bud is killed the life of the palm is terminated. Infected bud tissues are quickly reduced to an odoriferous, gelatinous mass from which many saprophytic organisms may be isolated.

Phytophthora bud rot is also said to occur on *Borassus flabellifer* L. and *Areca Catechu* L.

Bacterial bud rot.—A disease first observed in the West Indies and Mauritius in 1913 on the royal palm and the areca nut palm is caused by a bacterial parasite, *Xanthomonas vasculorum* (Cobb.) Dowson. A bud rot of *Dictyosperma album* (Bory) H. Wendl. & Drude ex Scheff. has also been traced to the same cause. On royal palms the disease is characterized by wilting, yellowing and browning of the leaves which later become dry and brittle. Upon cutting open the cabbage leaves, the core area is found to be reduced to a vile-smelling soft rot. A yellow gum-like substance exudes from the vascular vessels when the fronds are cut. As the rot progresses, infected trees become top heavy and the crown falls over. On *Areca Catechu* L. the organism is less destructive. Diseased sections show a dappled pattern, as evidenced by the small brown areas in the affected tissues (15).

Unknown diseases.—In recent years considerable attention has been directed toward certain disorders of *Cocos nucifera* L. Throughout tropical and subtropical regions this palm is valued for the coconut crop and for its ornamental attractiveness in landscape plantings.

The cause of unknown disease of the northern Caribbean and bronze leaf wilt of the southern Caribbean and West Africa have not been directly associated with any recognized parasites. Likewise, the cause of *cadang-cadang* in the Philippines and a root disease of coconut palms in Southern India is not known. Both viruses and mineral deficiencies or excess have been under careful investigation in order to explain the above disorders but the true causes remain a mystery (12).



36. Enlarged profile view of *Graphiola phoenicis* on leaf of *Phoenix canariensis*. Photograph by A. P. Martinez.

Palms infected with unknown disease and bronze leaf wilt usually die within four to six months after the first symptoms appear. Yellowing of the outer fronds accompanied with nut fall occurs prior to death of the bud. Bronze leaf wilt causes an earlier leaf wilt and often the older nuts are not shed, whereas in the unknown disease the yellowing foliage remains turgid until the bud dies and all the nuts are shed. Bronze leaf wilt usually attacks older trees. When healthy palms are replanted in areas where the unknown disease occurred, they also become infected within two or three years.

Symptoms of *cadang-cadang* disease of the Philippines include yellowing of the crown and a gradual reduction in size of leaves and a tapering of the stem. Decline of infected palms is gradual prior to actual death.

An unknown disease of the coconut palm occurring at Key West, Florida, resembles in many respects the so-called lethal yellowing disease of coconut in Jamaica. Symptoms include dropping of fruit and a progressive yellowing and withering of the leaves. Affected trees should be removed and burned, since no other known treatment will arrest the disease. The disease has not been observed on the Florida mainland, although danger of spread from the Keys area still exists.

The dwarf Malay coconut has been observed to show considerable resistance or immunity to the disease and widespread planting of this variety has been suggested.

Diseases Attacking The Leaves of Palms

Many fungi are associated with the various leaf spots on palms.

Anthracnose.—Several palm leaf and twig spots have been reportedly caused by the anthracnose fungi (*Colletotrichum, Gleosporium, Glomerella*) (7). Leaves and stem of fishtail palms (*Caryota* spp.) and others frequently become scorched or blighted due to numerous spots which coalesce causing entire leaflets and fronds to die. Elongated greyish spots with brown borders characterize the anthracnose diseases. Upon close observation, tiny black spore-producing structures are visible in the center of the spots. Under moist conditions rose-colored spores ooze out in mass and are splashed by rain to adjacent leaves. Nurserymen have experienced good control using frequent applications of either maneb or ferbam fungicides and by avoiding overhead watering when possible.

False smut.—Many species of palms, particularly *Phoenix dactylifera* L. and *P. canariensis* Chab., are susceptible to attack by the false smut fungus, *Graphiola phoenicis* (Moug.) Poit. Infected leaves contain numerous dark, scablike spots or warts with powdery brown or yellow centers. Under magnification, long flexuous sterile hyphae or threads may be seen (Fig. 36). Control of this disease is largely a matter of destroying infected leaves and spraying plants with a protective fungicide. Avoiding overhead watering and syringing helps prevent spread of the fungus spores (7).

Leaf blight.—The fungus *Pestalotia*

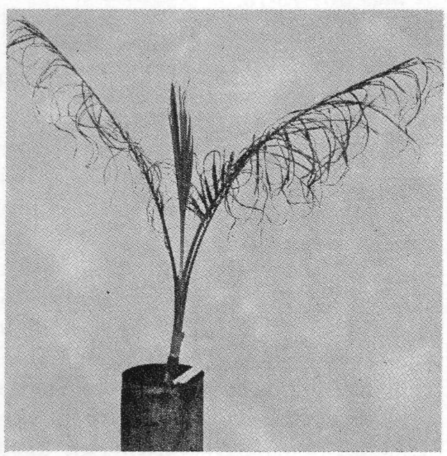
37. Container-grown palms in nursery. Plants on left dying from *Helminthosporium* leaf spot. Close spacing of plants and overhead irrigation provide excellent environment for the fungus. Photograph by A. P. Martinez.

palmarum Cke. is reported to occur on leaves of *Cocos nucifera* L., *Arecastrum Romanzoffianum* (Cham.) Becc., *Howeia Forsteriana* (C. Moore & F. Muell.) Becc., *H. Belmoreana* (C. Moore & F. Muell.) Becc. and *Phoenix dactylifera* L. This fungus is not an aggressive parasite but usually causes leaf spots on old or weakened palms or palms growing under unfavorable conditions; young palms exposed to long periods of cold weather frequently develop leaf spots in large numbers (1), (8).

Helminthosporium leaf spot. — Leaf spots characterized by oval to irregular sunken spots having tan centers with a definite margin are caused by the fungus *Helminthosporium* (9). Seedlings of *Roystonea regia* (H.B.K.) O. F. Cook, *Arecastrum Romanzoffianum* (Cham.) Becc, *Howeia, Cocos nucifera* L., *Phoenix, Sabal* and *Thrinax* may be attacked. Under moist humid conditions and high temperatures the spots coalesce, forming large necrotic areas which may involve the entire leaf, killing the young palms (Figs. 37, 38, 39). Regular spray applications of either maneb or ferbam have given satisfactory control. Overhead irrigation should be prevented in so far as possible and removal of dead leaves and debris is suggested. Proper spacing of young palms in the nursery also helps reduce disease incidence.

Cylindrocladium leaf spot.—A leaf spot fungus, *Cylindrocladium macrosporum* Sherb., was first described in Florida occurring on seedlings of *Washingtonia robusta* H. Wendl. The spots are numerous, round to oblong, small, dark in color with translucent borders. The surface of the spots is smooth except in moist or damp weather when they become covered with a thin whitish growth of the fungus. Spread and development of the disease occurs when moisture is present and where poor air ventilation exists, such as under greenhouse conditions. Control of the disease is largely a matter of providing the palms with good ventilation and keeping the leaves dry. (18).

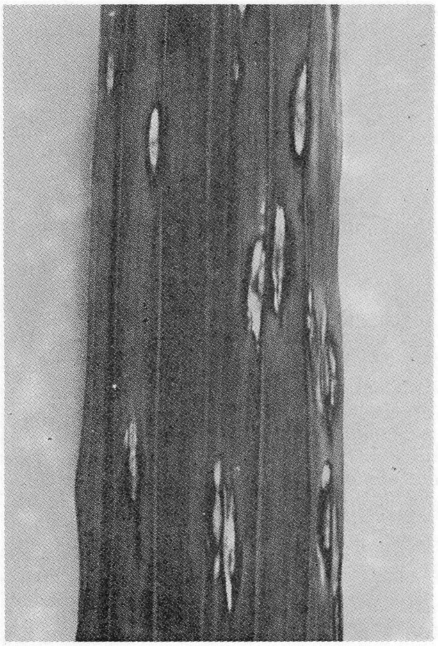
Exosporium leaf spot.—A leaf spot common on many palms is caused by the fungus *Exosporium palmivorum* Sacc. The disease is usually found on plants grown under greenhouse or lath where insufficient light is provided. The



38. Royal palm showing outer leaves infected with *Helminthosporium* leaf spot while new leaf unfolding appears normal. Reproduced from *Principes* 2: Fig. 56.

spots are small, round, yellowish and transparent. These areas coalesce to form large irregular grey-brown blotches which may result in death of entire leaves. Severity of the disease may be reduced by removing infected leaves and spraying the foliage at regular intervals with a fungicide. Overhead watering of the foliage should be avoided whenever possible (7).

Diamond leaf spot.—Diamond leaf spot or diamond scale has been reported to occur in California. The causal fungus, *Sphaerodothis neowashingtoniae* Shear. produces elongated diamond-shaped black shiny pustules on the surface of leaves and leafstalks of *Washingtonia*. Affected leaves may live for several years but heavily infected trees eventually die. Diseased leaves should be removed and the plants sprayed with a good fungicide (7).



39. Typical leaf spots on leaves of *Roystonea regia* caused by a species of *Helminthosporium*. Photograph by A. P. Martinez.

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NOTES ON CULTURE

Continued from page 68

Coccothrinax, Euterpe, Geonoma, Reinhardtia, and *Roystonea.*

Some species of palms are not known to produce seeds such as *Cyrtostachys Renda* var. *Duvivierianum;* certain species of *Areca, Coleospadix,* and *Pinanga; Rhapis* palms; and perhaps a few others. These may be imported as plants. Horticultural varieties of palms which do not come true from seed may likewise be imported as plants. In this category would be our varieties of date palm which, incidentally, are subject to growing in postentry quarantine. Palm plants if permitted entry must conform to size and age limitations discussed elsewhere in this circular.

A large and varied assortment of palms is now established in the United States which should make it possible to get all material likely to be desired from a domestic source. Other desired species would be those which have not been introduced and are to be imported for study or trial by institutions staffed with competent specialists in the group. Wherever possible, botanical material of this category should be imported in the form of seeds either sprouted or unsprouted.

In the importation of palm material, institutions should arrange this with a minimum of pest risk. Seeds or sprouted seeds would offer the least risk of pest introduction. Sprouted seeds would probably give the best results. To import seeds in the most viable condition they should be taken from fresh fruit. From these, the flesh and fiber should be rubbed off. It is our observation that the seeds will ship best if packed in about half their volume of slightly moistened sphagnum and wrapped in pliofilm or similar plastic moistureproof cloth. It would be desirable to import by air, air parcel post if possible. Collectors should be instructed to carefully examine seeds to see that embryos are alive. Many palm embryos range from 1/16 to ¼ inch in diameter and are embedded in hard seeds covered over with thin fibrous integument.

Importation of palm plants, when this has been authorized either because viable seed cannot be procured or because the plants consist of clonal material, must be limited to the smallest plants capable of being imported and successfully reestablished. As a rule these would be plants with not more than 2 mature permanent leaves. Where rare material is involved and a plant is not available within size and age limits the institution concerned should put up a case for a specimen plant, giving reasons why a smaller plant is not obtainable.