Palms

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The International Palm Society

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OFFICERS:

President: Horace Hobbs, 7310 Ashburn, Houston, Texas 77061, USA, e-mail horacehobbs@pobox.com, tel. 1-713-643-4094.

Vice-Presidents: Paul Craft, PO Box 500041, Marathon, Florida 33050 USA; e-mail licuala@earthlink.net, tel. 305-289-8786.
Rolf Kyburz, K-Palms Nursery & Seeds, 39 Poinciana Drive, Browns Plains, Qld 4118, Australia, e-mail kpalms@ozemail.com.au, tel. 61-7-3800-5526.

Corresponding Secretary: Don Kurth, 10569 Apple Ln., Alta Loma, California 91737 USA, e-mail DonKurth@aol.com, tel. 1-909-945-2896.

Administrative Secretary: Libby Besse, 6729 Peacock Road, Sarasota, Florida 34242, USA, e-mail libbesse@aol.com, tel. 1-941-349-0280.

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FRONT COVER

A legacy lost. *Phoenix canariensis* displaying Class II *Fusarium oxysporum* symptomology. See the article by K. Pfalzgraf on p. 161. (Photo K. Pfalzgraf)

Palms (formerly PRINCIPES)

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Editors: John Dransfield, Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AE, United Kingdom, e-mail j.dransfield@rbgkew.org.uk, tel. 44-20-8332-5225, Fax 44-20-8332-5278.
Scott Zona, Fairchild Tropical Garden, 11935 Old Cutler Road, Coral Gables (Miami), Florida 33156, USA, e-mail szona@fairchildgarden.org, tel. 1-305-667-1651 ext. 3419, Fax 1-305-665-8032.

Associate Editor: Natalie Uhl, 467 Mann Library, Cornell University, Ithaca, New York 14853, USA, e-mail nwu1@cornell.edu, tel. 1-607-257-0885.

Supplement Editor: Jim Cain, 12418 Stafford Springs, Houston, Texas 77077, USA, e-mail palm_dude@pobox.com, tel. 1-713-689-2416.

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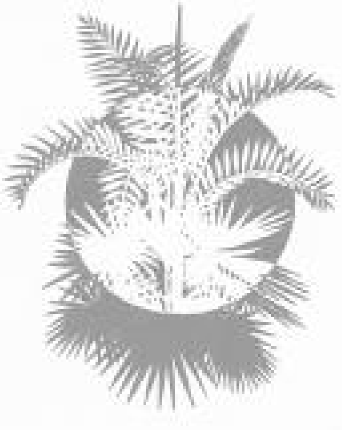
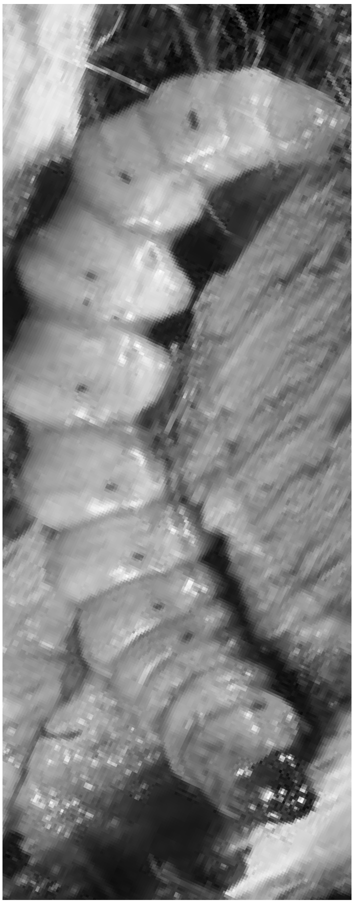
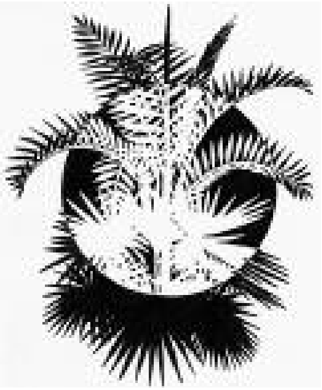


BACK COVER
Caryota sympetala, in fruit. See article on page 190 by Dransfield and Evans. (photo J. Dransfield)



A sight to strike fear in the hearts of palm lovers: the larva of the Red Palm Weevil, a destructive pest of palms. See article by Ferry and Gómez beginning on page 172.



NEWS FROM THE WORLD OF PALMS

In this issue of PALMS, we present several articles on emerging pests and diseases of palms. Some of these pests are confined to relatively small regions of the palm-growing world, but the potential for spread is so high that we all must be aware of the problems and take the necessary precautions. We have learned that *Paysandisia archon*, a South American moth which is moving into Spain and France, has also been intercepted in West Sussex, UK. We have also learned from Michel Ferry, recently returned to Elche from a date palm conference in Abu Dhabi, that there is no effective way to fight against infestations of the Red Palm Weevil. Pests and diseases, once they are introduced and become established, are difficult if not impossible to eradicate, so we must use extreme caution when moving palms from one part of the world to another.

On a happier note, we can report that the IPS Biennial, hosted by the Association Fous de Palmiers, was a great success. Attendees were treated to tours of beautiful gardens in and around Hyères les Palmiers and Nice, France, and in Monaco. Lectures from palm specialists from Cuba, Denmark, Spain, France and the USA provided food for thought, while lunches and banquets provided the kind of food for which the French are justly famous. The most enjoyable part of the Biennial was the chance to renew old friendships and make new ones among IPS members from over 20 countries. A report on the Biennial and the Post Tour is planned for a forthcoming issue of PALMS.

The Board of Directors of the IPS met just prior to the Biennial and convened a meeting of the Society's Research and Education Endowment Fund Committee. IPS past-president Jim Cain chairs the Committee and coordinated the receipt and evaluation of this year's grant applications. Proposals were judged for scientific or horticultural merit, feasibility and coincidence with the goals and objective of the IPS. The Board approved grants totaling $5594.

Last year, the Board approved a measure to send sets and subscriptions of Principes/PALMS to eleven libraries in Asia, Madagascar and Latin America. This year, a twelfth institution, the Universidad Autónoma de Guadalajara, Mexico, was added to the list of recipients. The Board is especially proud of this effort to disseminate palm information to palm-rich areas of the world.

Ms. Julissa Roncal, a Ph.D. student at Florida International University, Miami, Florida, was awarded $1674 for her work on *Geonoma* in Peru. Ms. Roncal is studying how species of *Geonoma* occupy subtly different, non-overlapping habitats in the rainforest. She is also undertaking a molecular study of the tribe Geonomeae.

On the Lesser Antillean island of Dominica, Mr. Arlington James, of the Forestry, Wildlife and Parks Division, is studying the demography and population dynamics of *Pseudophoenix sargentii*. The IPS awarded Mr. James $1120 to continue his studies.

Mr. Don Hodel, University of California Cooperative Extension, reported on his grant from the previous year to study the effects of leaf removal and tie-up during transplanting. He notified the IPS that he had some funds remaining and will use them for continued research on transplanting practices.

Finally, Dr. Andrew Henderson of the New York Botanical Garden is preparing a field guide to the palms of the Old World, as a companion volume to his popular *Field Guide to the Palms of the Americas*. The IPS was not able to underwrite the entire project but contributed $2300 toward equipment and travel expenses.

The IPS Research and Education Endowment Fund was established in 1985. If you would like to support palm research, horticulture, and education around the world, please contact IPS President Horace Hobbs at horacehobbs@pobox.com.

THE EDITORS

Loss of a Legacy – *Fusarium oxysporum* and Ornamental *Phoenix canariensis*

Ken Pfalzgraf
455 N. Rexford Dr., Room 100
Beverly Hills, CA 90210 USA
Palmdr@earthlink.net

1. One-sided die back of a frond of *Phoenix canariensis* infected with *Fusarium oxysporum*.

In temperate regions of the world, *Phoenix canariensis* (Canary Island Date Palm) is an important street and park tree. With increasing incidence of the vascular wilt, *Fusarium oxysporum*, comes the loss of significant numbers of historic specimens, some nearly a century old.

This article is intended to be a resource in identifying the pathogen *F. oxysporum*, understanding how the pathogen affects *P. canariensis* palms and in describing the treatment of an abnormality that makes *P. canariensis* more susceptible to this devastating pathogen.

Tomlinson's "The Structural Biology of Palms" (1990) described palms as "structurally overbuilt." While palms are anatomically resilient, they are monocotyledons, and as such, lack the ability to regenerate or isolate damaged tissue. They are particularly susceptible to vascular wilt diseases.

Fusarium oxysporum is a fungus that, in its pathogenic form, can infect the vessels and cause blockage of the water transport system. As an increasing number of xylem bundles become clogged, the plant is unable to transport a sufficient volume of moisture equal to its demands for transpiration, and it wilts. *Fusarium* comprises a broad range of saprophytes that include both pathogenic and non-pathogenic members, generally found in abundance in the soil microflora. The genus *Fusarium* consists of many species, and each species is further broken down into *forma specialis* (f.sp) based on their host specificity. However, many forms of *F. oxysporum* are non-pathogenic. *Fusarium oxysporum* f.sp. *canariensis* has been identified as the fatal vascular wilt of *P. canariensis* (Mercier & Louvet 1973).

Inoculation

How does *P. canariensis* become inoculated with this fatal vascular wilt? Early work (Feather et al. 1989) led the horticultural community to perceive that the pathogen was being spread from palm to palm during pruning using infected tools. Is the epidemic spread of *Fusarium* simply the result of using chainsaws and using unsterilized pruning tools between specimens? Most likely not. Infection may also arise in the crown, in dead inflorescences. However, there is no evidence of inflorescence infection. Excessive winter soil moisture and/or high soil soluble salt levels can result in inflorescence abortions in *Phoenix* palms (Carpenter & Elmer 1978), a condition known as 'Khamedj' in the date-growing regions of the world. The rotting inflorescences affect leaves in the crown through their vascular connections. Carpenter and Elmer (1978) suggested that these infections may persist for several years. The laboratory work from Khamedj-infected specimens often comes back listing a complex of diseases including *Fusarium*, *Ceratocystis*, *Mauginiella*, *Gliocladium*, etc.

I believe that Khamedj infections may not only cause subsequent *Fusarium* infections that are suspected to begin in the crown but also most likely initiate the catastrophic stem failure of *P. canariensis* termed "Sudden Crown Drop" by Californians.

Khamedj infections in the crown are probably not the way in which most *Fusarium* infections begin in *Phoenix canariensis*.

However, there is no evidence that Khamedj is caused by *Fusarium oxysporum* f. sp. *canariensis*. If some *Fusarium* infections occur, they may not be due to the true wilt pathogen, but to other *Fusarium* species.

I suspect that most inoculations of *Fusarium* occur at the root zone. The first two of the four root orders in *Phoenix* palms are aerenchymatous. Aerenchymatous roots can best be described as those having air channels. Jost (1887) who described their role in gaseous exchange (aeration), referred to these roots as pneumatodes. These roots are commonly referred to as "air roots" by the trade, and can be seen along the lower stem portion of *Phoenix* palms. Many growers may be unaware that these roots also exist in the upper portion of the root zone proper.

The work of Belarbi-Halli and Mangenot (1986) described the susceptibility of *Phoenix* pneumatode roots to invasion by *F. oxysporum*. Apparently, the pathogen is free to run unchecked in the aerenchymatous channels of pneumatode roots. Since the second order roots branch from first order roots, which are also aerenchymatous, the pathogen is free to enter the stem at every juncture via the infected first order roots. When inoculation occurs in the roots, the stem can become massively infected.

Failure to *Fusarium oxysporum*: decline symptomology

There are two (2) distinct decline symptomologies when a *P. canariensis* fails to *F. oxysporum*. One seems to linger, taking as long as two years or more, before killing the crown. The other seems to come on overnight, affecting the entire crown below the inflorescence, with the newest part of the crown seemingly unaffected for a period. The two different symptoms offer clues as to how the palm may have been infected, which in turn, may suggest ways in which infection can be avoided.

Decline symptomology I: The lingering death

Phoenix canariensis specimens affected in this manner generally begin their decline in showing a single symptomatic leaf at mid-crown near the inflorescence. This leaf will show the classic one-sided dieback (Fig. 1) of the leaflets, separated by the rachis. As time progresses, additional leaves show symptoms (Fig. 2). Ultimately, the palm is lost as the entire crown becomes infected, with the rate of crown loss accelerating with passing time. This pattern of decline is that of an inoculation occurring at the crown, and thus by pruning-derived infection. Belarbi-Halli and Mangenot (1987) found that if inoculation takes place near the crown of the plant, the spread is slower, suggesting a slight hampering effect of the plant crown. When inoculation at the crown occurs, the hyphae of the pathogen invade the vascular bundles of the petiole. As their development towards the stem progresses, the hyphae are confronted with the "bottleneck" at the petiole insertion to the stem (Zimmerman & Sperry 1983). In the unlikely event their progress passes the "bottleneck," they enter progressively larger vascular bundles. This is a difficult proposition, since the pathogen is working against the transpiration stream of the large stem axial bundles.

Decline symptomology II: quick and painless

Decline symptomology II seems to come on suddenly, with the grower commenting, "it looked fine two weeks ago." The entire crown below the current season's inflorescences declines, with the portion above appearing generally unaffected for some time (Front Cover). The surviving portion of the crown is ultimately lost as well, again over a relatively short period.

Turning again to the vascular hydraulics work of Zimmerman and Sperry (1983), we find clues that tell us this type of decline is due to a massively infected stem. In summary, this work tells us that juvenile fronds present a greater hydraulic resistance to water passing through the system than do mature fronds. This is due to the smaller physical size of their xylem bundles and the late development of the xylem bundles that join the main stem axial bundles (metaxylem). Hilgeman (1951) described vascular maturation in the crown at the first row below the developing inflorescence. Therefore, as the stem becomes massively infected, the mature fronds are lost suddenly. The line of demarcation is the inflorescence. As the xylem in these fronds develops from protoxylem to metaxylem, they mature to make their association with the infected stem axial bundles. At this point, they are lost.

Decline symptomology II can be associated with mass infection of the stem vascular bundles, which occurs due to infection of the pneumatode roots. The pathogen is free to develop in the aerenchymatous channels of the roots and enter the stem at will (Fig. 3). If one were to perform pathogen cultures on stem tissue taken from a palm that had failed via the symptoms described, one would expect that the axial bundles at the central base portion of the stem would be massively infected.

Making palms less susceptible

We know that we cannot cure palms of *F. oxysporum*, nor can we alter the genetic susceptibility or resistance of an existing palm. What we can do is look at our cultural program and make modifications as necessary to avoid conditions that favor the development and/or spread of pathogen.

Pruning: Become familiar with the logistics and issues involved in pruning palms (Pfalzgraf 2000). To summarize:

Prune fronds only after they have dried completely or if they present a hazard to passersby.

Do not use chainsaws to prune; it is impossible to sterilize a chainsaw.

Remove particles trapped in the teeth of your handsaws with a brush, sterilize your pruning saws or date hooks by immersion in a half-strength solution of bleach and water (1:1 dilution) for no less than five minutes between specimens.

Remove inflorescence after they have elongated from the prophyll.

Irrigation: Probe the soil on a regular basis to check moisture levels in the root zones of your palms. If your population is serviced by an automatic irrigation system, use tensiometers to monitor moisture levels in the root zone. There are large air spaces (macro pores) and small air spaces (micro pores) in the soil. Immediately after fully irrigating a soil, all of the air spaces are filled with water. The water that drains away freely down through the soil profile is called gravitational water. After gravitational water has drained away, the macro pores are filled with air; the micro pores are filled with water. This condition is known as field capacity. The majority of the water left in the micro pores is available for plant use. The air in the macro pores allows the root system to respire. Plants prefer this moisture level. The goal is to keep your soil moisture level at field capacity.

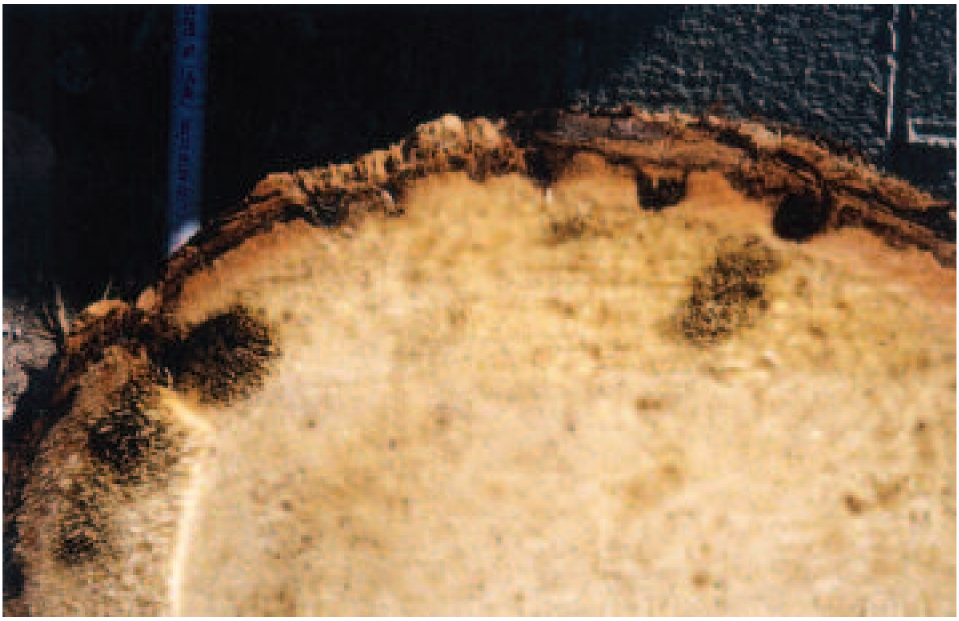
Be aware that excessive root zone moisture promotes the development of pneumatode roots and favors the development of pathogens. Pneumatode roots have a specific susceptibility to *F. oxysporum*. Excessive winter soil moisture favors the development of inflorescence rot pathogens in *Phoenix* palms. Inflorescence rots may be implicated as the cause of class I *F. oxysporum*

2. *Phoenix canariensis* displaying Class I *Fusarium oxysporum* symptomology.

infections and in the catastrophic structural failure of the stem (i.e. "Sudden Crown Drop") in *P. canariensis*. Provide stability in the manner you irrigate your palms. Avoid fluctuation and excess. Palms require consistency.

Fertilization: Take a proactive approach toward the nutrition of your palms. Submit soil and tissue samples for analysis. If this is done on a consistent basis, you can develop a trend in how efficient your palms are at taking up nutrients, by comparing changes in the soil and tissue levels against your fertilizer application history. Do not expect overnight results. Any imbalance that developed over a long period will be slow in its correction.

After your base nutritional problems are addressed, use one of the products that are formulated specifically to address the nutritional requirements



3. Section of the base of a stem of *Phoenix canariensis* infected with *Fusarium oxysporum* f. sp. *canariensis*.

of palms. Be consistent in your fertilization program.

Dense pneumatode mat: Become familiar with the pneumatode roots of your *P. canariensis* palms. As you observe the soil surface radiating from the trunk of your palms, you will notice roots that have a vertical orientation and that rise to just above the soil surface. These are pneumatode roots. How often do we see people chopping away at pneumatode roots in order to install flowers around the base of a palm? Wounding pneumatode roots is an invitation for entry by a pathogen. What if one digs in the root zone of a *P. canariensis* with pneumatode roots are infected with *F. oxysporum*? Would one not entertain the distinct possibility of infecting the next palm one works on with the infected tools? Develop an understanding of the function of pneumatode roots and their susceptibility to pathogen infection. Do not wound them. Practice the same sterilization procedures for tools used in the root zone as one uses for tools used in the crown.

Summary

Fusarium oxysporum poses a substantial threat to the stability of ornamental populations of *P. canariensis* palms worldwide. We should understand that the vast majority of *F. oxysporum* infections begin with imbalances at the root zone. The only option we have is to attempt to defeat the pathogen by removing the conditions favorable for infection. Protect your existing population with proper culture. Do not allow the use of chainsaws for pruning. Insist on a diligent pruning method that considers the importance of proper pruning tool choice and sterilization. In understanding a bit about the physiology of our palms, being sanitary in our treatments and providing our palms with stable culture, we can avoid circumstances that favor the development of this pathogen.

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Rapid Decline Syndrome of Coconut – Preliminary Report of a New Condition

C.S. RANASINGHE,
R. WIJESEKARA AND
R. WIMALASEKARA
Coconut Research Institute
Lunuwila 61150
Sri Lanka
rescri@sri.lanka.net

Coconut Rapid Decline (CRD) is a recently recognized disorder of coconut palm (*Cocos nucifera* L.) in Sri Lanka. It reduces the yield in 6–8 months and kills the palm within 2–3 years from the appearance of first leaf symptoms. About 750 palms are known to have succumbed to the disorder from 1997 to date. CRD has a unique symptom expression that differs from other reported diseases of the coconut palm. This paper details the symptoms of CRD.

The coconut palm (Fig. 1) is prone to several diseases and disorders that cause a substantial consequent loss of crop. Coconut Rapid Decline (CRD) is a recently recognized disorder of coconut in Sri Lanka. It was first observed in 1997 at Makandura Seed Garden (MSG) of the Coconut Research Institute (CRI), which was planted with improved cultivars (Tall × Tall and Ambakelle Special) of Sri Lankan tall variety. Both cultivars were equally affected by CRD. A few months later, the same symptoms were reported at Bandirippuwa Estate (BE) Lunuwila and some private estates that were planted with improved tall cultivar, in the Puttalam, Kurunegala and Gampaha districts.

The syndrome could generally be seen in palms between 15–35 years of age. Although the precise duration of the different phases of the disorder have yet to be determined, it appears that the yield is reduced in 6–8 months and the palm killed within 2–3 years from the first appearance of leaf symptoms. According to surveys conducted by the CRI, about 750 palms in the MSG and BE have succumbed to the disorder from 1997 to date.

Symptomatology

Leaf canopy

The most characteristic visual symptom of the syndrome is a drooping or hanging down of the middle and lower canopy of green fronds (Figs 2–4). In some instances, petioles of the fronds in the middle canopy break at varying lengths from the base. These drooping or broken fronds dry up rapidly leaving only a few erect fronds in the crown. With the progress of the disorder, the number of healthy fronds in the canopy reduces, leaves turn pale green and emerging fronds become shorter, resulting in a drastic reduction in the size of the crown. In the severe stage, scorching of the tips of leaflets can be observed (Fig. 4). Finally, the dried fronds drop leaving a crownless coconut trunk. However, the expression of foliar symptoms can vary from palm to palm.

1 (left). Healthy palm. 2 (right). CRD-affected palm, incipient stage.

Trunk

With the initial drooping symptoms, the trunk begins to taper and the internode length progressively reduces. With the progress of the disorder, a marked constriction of the trunk just below the crown can be observed. No abnormalities in the internal tissues of the trunk of affected palms were observed at any stage of the syndrome.

Inflorescence and nut development

The CRD syndrome also affects the reproductive system of the palm. The inflorescences that emerge during the initial stages of symptom development are shorter and thinner (Fig. 5) but the number of female flowers therein is similar to that of a healthy inflorescence. With the progress of the syndrome, the palm sets progressively fewer nuts resulting in a gradual yield decline. Further, as a result of the reduced internode length, the emerging inflorescences are arranged closer together, giving a 'rosette' like appearance to the crown. Inflorescences without any nuts (empty bunches) are also a common symptom of moderate to severely affected palms (Fig. 6, 7). In the severe stage, the developing nuts become smaller and elongated resulting in a lower kernel weight compared to healthy nuts (Figs 8). Immature nut fall is not associated with this syndrome. Germination of the mature nuts of CRD-affected palms is comparable with that of healthy palms.

Roots

No abnormalities were observed in the root system. But the formation of new roots following a rainy season was found to be less in rapid decline-affected palms as compared to healthy palms.

Occurrence and Distribution

The distribution of affected palms is mapped through observations at six monthly intervals to determine the pattern of spread at Makandura Seed Garden (MSG) and Bandirippuwa Estate (BE) of the Coconut Research Institute. Seven surveys have been conducted since 1997 and, according to the latest survey in May 2001, there has been an appreciable increase in the incidence at MSG and BE during the past 6 months (Table 1) and the


3. (left) CRD-affected palm, moderate stage. 4 (right). CRD-affected palm, severe stage.

distribution is patchy. During the years 2000 and 2001, a few more private estates were also reported to have CRD affected palms.

Etiology

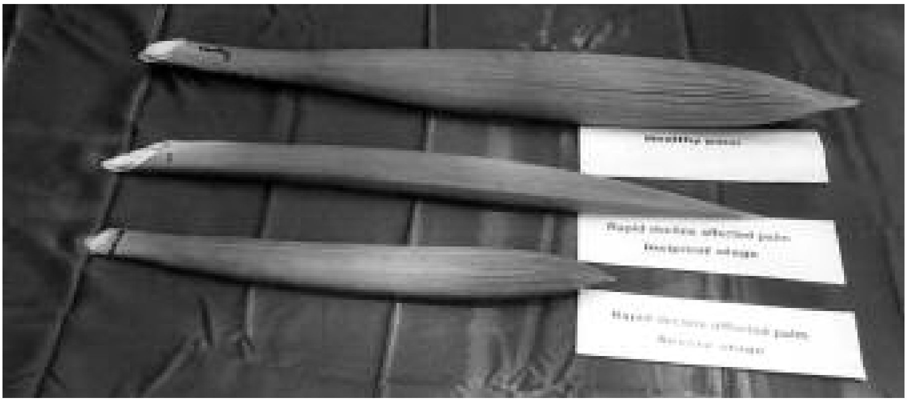
The cause of the disorder is still unknown. The first decision that needs to be made is whether the disease is abiotic or biotic. At present, experiments are in progress to determine the effects of nematicide, fungicide, tetracycline and micronutrient treatments on disease progress. Investigations were commenced in collaboration with Adelaide University, Australia and support by FAO to determine whether the CRD is associated with phytoplasmas or viroids. DNA sequencing techniques are being employed for phytoplasma detection, and detailed analytical work is in progress to detect viroidlike-sequences in the trunk, leaf and inflorescence tissues of the affected palms. If the CRD is biotic, it has the potential to create an epidemic by spreading. Therefore, it is of utmost importance to identify the cause of Coconut Rapid Decline syndrome as a priority and to establish appropriate control procedures as early as possible.

Discussion

Rapid Decline (CRD), Leaf Scorch Decline (LSD) and tapering disease (TD) of coconut in Sri Lanka: a comparison

The symptoms of CRD are distinct from previously reported 'diseases' such as LSD (Rajapakse & Fernando 1995, Mahindapala & Chandrasena

Table 1 : Incidence of CRD at MSG and BE (survey data of May 2001)

Estate	Total number under observation	Total number of affected palms	% Affected	Increase during Nov 00–May 01
BE	5377	171	3.18%	110
MSG	6350	568	8.96%	288

5. Fully matured inflorescences of healthy and CRD-affected (incipient and severe) coconut palms.

6. Appearance of nuts at different stages of development (a representative nut for each stage) – healthy palm: front row from R to L: 1st – 9th bunch, middle row from L to R: 10th – 15th bunch, back row from R to L: 16th – 21st bunch.

7. Appearance of nuts at different stages of development (a representative nut for each stage) – severely affected palm: front row from L to R: 1st – 7th bunch (note the empty bunches 3rd, 4th, 5th and 6th) back row from R to L: 8th – 12th bunch.

1975, Gunasekara et al. 1973, Perera 1971, Humphries 1970, Ekanayake 1968, Peries 1968, Maramorosch 1964, Davies 1962) and TD (Cooke 1950, Cooke et al. 1950) of coconut. The cause of all three disorders is still unknown.

The most striking visible symptom of LSD-affected palm is the scorching of leaflets starting from the tip and advancing towards the mid rib of the frond, accompanied by a slight curling, and progressing from the lower to the middle whorl fronds (Rajapakse & Fernando 1995). In TD-affected palms, the characteristic symptom is the pale green color and asymmetrical canopy subsequently diminishing the size due to shortening of the newly formed fronds (Cooke 1950). The drooping of middle and lower canopy of green fronds, as observed in CRD, is not a characteristic of the above two syndromes. This is an important distinction between CRD and other two disorders. Tapering of the trunk just below the crown occurs fairly rapidly in TD-affected palms whereas in the LSD and CRD-affected palms it is observed only in the advanced stage (Rajapakse & Fernando 1995, Cooke 1950). In the aspect of root characteristics CRD is completely different from LSD and TD, where root decaying is very high in the affected palms (Davis 1962, Cooke 1950).

8. Split nuts of healthy and CRD affected coconut palms. Front row: mature nuts of a healthy palm; back row: mature nuts of a severely affected palm.

All three disorders have a very striking similarity with regard to the size of the inflorescence, nut set, nut yield and shape of nuts in the advanced stage. Similarly, all three disorders are seen in the coconut palms above 15 years of age.

There is a remarkable difference in the pattern of distribution between CRD and the other two disorders. LSD- and TD-affected palms show a scattered distribution and slow spreading pattern whilst CRD shows a patchy distribution and appreciably rapid spreading pattern. This appears to indicate that the CRD is transmissible but that LSD and TD are not such 'diseases' (Humphries 1970, Davis 1962, Cooke 1950). Nevertheless, in LSD and TD, death of the palm is much delayed (6–10 years or more) but in CRD killing occurs within 2–3 years.

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The Red Palm Weevil in the Mediterranean Area

M. FERRY

AND

S. GÓMEZ
Estación Phoenix,
Apartado 996,
03201 Elche, Spain

1. Adult red palm weevil.

The red palm weevil, *Rhynchophorus ferrugineus* Olivier, has become the most important pest of the date palm in the world (Gomez & Ferry 1998).

2 (left). Larva in a date palm trunk. 3 (right). Adult red palm weevil emerging from its cocoon.

Originating in southern Asia and Melanesia, where it is a serious pest of coconuts, this weevil has been advancing westwards very rapidly since the mid 1980s. It had reached the eastern region of the Kingdom of Saudi Arabia in 1985 (pers. obs.) and afterwards spread to many other areas in the Kingdom (Abozuhairah et al. 1996). The pest was first recorded in the northern United Arab Emirates in 1985, and since then it has spread to almost the entire U.A.E. (El-Ezaby 1998) and to Oman. In Iran, it was recorded in Savaran region in 1990 (Faghih 1996). Then it was discovered in Egypt at the end of November 1992 in El-Hussinia, Sharquiya region (Cox 1993). In 1994, it had been captured in the south of Spain (Barranco et al. 1996) and in 1999 had been found in Israel, Jordan and the Palestinian Authority Territories (Kehat 1999).

The cause of the high rate of spread of this pest is human intervention, by transporting infested young or adult date palm trees and offshoots from contaminated to uninfected areas.

In this article we present the current situation of the red palm weevil in Spain, Egypt and the Near East, to demonstrate the seriousness of this pest and the high risk of its arrival in other Mediterranean countries. In these countries, the two main palm species concerned are *Phoenix dactylifera* and *P. canariensis*, the main crop and ornamental species in the Mediterranean area, but it could attack some others ornamental palms (Barranco et al. 2000). Our purpose is to emphasise the need for urgent and strong prophylactic

4. Damage to a leaf base.

measures to avoid new catastrophes and for the reinforcement of co-operative international research against this pest.

The red palm weevil is a member of Coleoptera: Curculionidae. The male and female adults are large reddish brown beetles about 3 cm long and with a characteristic long curved rostrum; with strong wings, they are capable of undertaking long flights.

Damage to palms is produced mainly by the larvae. Adult females lay about 200 eggs at the base of young leaves or in wounds to the leaves and trunks; the grubs feed on the soft fibers and terminal bud tissues. They reach a size of more than 5 cm before pupation. Except just before pupating, they move towards the interior of the palm making tunnels and large cavities. They can be found in any place within the palm, even in the very base of the trunk where the roots emerge.

Pupation occurs generally outside the trunk, at the base of the palms. The larva pupates in a cocoon made of brown dried palm fibres.

Overlapping generations with all life stages can be present within the same palm tree. Generally the adult weevils present in a palm will not move to another one while they can feed on it.

Usually the damage caused by the larvae is visible only long after infection, and by the time the first symptoms of the attack appear, they are so serious that they generally result in the death of the tree. This late detection of the presence of the weevil constitutes a serious problem in the fight against the pest and in any attempt to guarantee pest-free status in adult trees. Despite research carried out so far, no safe techniques for early detection of the pest have been devised.

In Spain, very soon after the red palm weevil killed the first *Phoenix canariensis* in some gardens of Almuñecar, the relevant authorities initiated various actions to combat the pest.

Intensive chemical treatments have been used to protect the *Phoenix* palms and to try to cure affected trees. Despite the difficulty in operating in the public gardens environment, foliage spraying has been conducte with various insecticides: Fenitrotion, Clorpirifos, Diazinon or Metidation. Preventive treatment of all the palms, even healthy ones, has been repeated once a month outside the tourist season.

Insecticides such as carbaril and imidacloprid have been injected several times and in various places all around the stems of palms. Simultaneously, a programme of mass trapping using aggregation pheromone and semi-synthetic kairomone has been initiated (Esteban-Durán et al. 1998). But despite all these efforts, more than one thousand *Phoenix* have been killed. In an area that extends from Motril to Nerja, in the Mediterranean coast of Granada and Málaga, the weevil is still present and has spread to villages close to the initial points of infection.

There is every evidence to suggest that the first weevils were introduced into Spain from adult palms imported from Egypt. Before the arrival of the weevil in the south of Spain, Egypt was the westernmost place where the red palm weevil has been recorded. Furthermore, as the importation of palms from Egypt was not prohibited, Egypt has been the main source of supply of ornamental adult *Phoenix* palms to satisfy the very substantial demand that exists in all the coastal cities of Spain and, more generally, of southern Europe.

In Egypt itself, the introduction of the red palm weevil was caused by an importation of offshoots from the United Arab Emirates. At the beginning, the extension of this pest into Egypt was restricted to a limited number of locations in two north-eastern provinces. In 1995, three years after its first discovery in Egypt, an Egyptian agriculture official considered that the red palm weevil had been eradicated (Ferry 1996). Unfortunately, this announcement was erroneous. In the two provinces where the pest was first recorded, the red palm weevil continues to infect and kill new date palms year after year, despite all the efforts developed to combat it.

Various techniques have been used to try to control the red palm weevil (pheromone traps) and to save infested date palms (chemical control by pouring pesticides into the trunk and injection of entomopathogenic nematodes (Shamseldean 1994)). Despite good results of these techniques in the laboratory, they are not efficient enough in the field to succeed in eliminating red palm weevil. The reason for this is probably the great difficulty in reaching all life stages of the weevil inside an adult palm tree, even with intensive and repeated stem injections or perfusions. Furthermore, such intensive activity is impossible for economic and practical reasons in places with a large number of date palms.

In Egypt, as well as in the south of Spain, the elimination of infested trees has not been applied systematically as soon as the pest were detected. The possibility of saving these trees and avoiding serious economic consequences as a result of their elimination, and the practical difficulties of carrying out this operation have unfortunately limited or delayed the destruction of infested trees. The affected trees have then constituted an

important focus for further spread of the red palm weevil.

At present the situation in Egypt is very worrying. Although a small number of date palms are affected, red palm weevils have been recorded in each of the Delta administrative districts, as well as in some orchards along the road between Cairo and Alexandria and even in the capital itself. This extension is certainly partly due to the difficulty of implementing a ban on the exchange or transplanting of offshoots or ornamental adult palms as a rigorous prophylactic measure. Although the red palm weevil does not usually fly very much in the orchards where it is present, it probably flies to new orchards when, after killing all the existing date palms, it does not find enough food.

In Israel, early detection of the pest, when the number of affected trees was still very limited, resulted very quickly in the establishment of a program of integrated pest management. Substantial financial and human resources have been dedicated to avoiding the spread of the pest. Each new affected tree is immediately eliminated. More that 4000 pheromone traps have been located at a high density in 450 ha date plantations along the Jordan Valley. The incorporation of the systemic pesticide Confidor

5 (left). Date palm crown destroyed by red palm weevil.
6 (below). Leaf damage caused by red palm weevil.

7 (left). Injection of insecticide. 8 (right). Pheremone traps.

in the irrigation water has also been used. Despite all these efforts, newly infested trees are still being recorded, three years after the first detection of the pest, and red palm weevils are still being caught in traps.

Conclusions

Even when important and costly means are dedicated to combat the red palm weevil, an efficient solution to fight against it when it first arrives is still missing

However, the main ornamental tall palms planted in the gardens and in the streets of the Mediterranean coast cities are date palms. Thousands of them are imported from Egypt each year directly or indirectly into Spain and other European countries. These palms must have a phytosanitary passport but in specimens such as adult date palms, a large quantity of hidden insects and diseases, can evidently remain undetected, even after very careful phytosanitary scrutiny, and this is, of course, the case red palm weevil eggs and larvae.

In response to the appearance of the red palm weevil in the south of Spain, the Spanish government promulgated a decree in 1996 forbidding the importation of palms from countries where pests of the group of *Rhynchophorus* have been recorded. Four years later this decree was modified, and one of the consequences has been that importation of date palms from Egypt is no longer illegal. This modification to the decree was probably made partly because adult date palms were still arriving in Spain from neighboring countries, with the disappearance of the border controls between European Union member countries

The market for adult date palms from Egypt is very lucrative. It also seems difficult to convince decision-makers and individuals to wait until specimens grown locally became tall enough for landscaping, instead of asking for palms from Egypt. For these two reasons, we think that there is a need for phytosanitary regulations at a European and North African country level to forbid totally the importation of date palms. Otherwise disasters such as the one that has occurred in Almuñecar or, worse still, the one that continues to develop in Egypt, are probable in other places around the Mediterranean. Such disasters could occur in the coastal cities where *Phoenix* palms constitute one of the characteristic landscape elements; from there, it could extend to the important inland date palm groves of North Africa. It could be also a catastrophe in Elche where the date grove has been nominated as a World Heritage Site. We consider also that European research centers should contribute to help all countries affected by red palm weevil to find a solution to combat this pest.

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10 (above). Perfusion of entomopathogenic nematodes. 11 (below). Extraction of a large number of larvae and cocoons from an infected but not eliminated palm.

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Importation of Mature Palms: A Threat to Native and Exotic Palms in Mediterranean Countries?

JEAN DRESCHER
AND
ANNE DUFAY
I.N.R.A.,
37 bd du Cap,
06600 Antibes, France
drescher@antibes.inra.fr

1. *Paysandisia archon*: adult moth.

A large moth, *Paysandisia archon* (Fig. 1), has been discovered recently on the French Riviera as a new pest and appears to be very noxious to palms. It is native to Argentina and Uruguay and was probably introduced into France through the importation of mature plants of *Trithrinax campestris*.

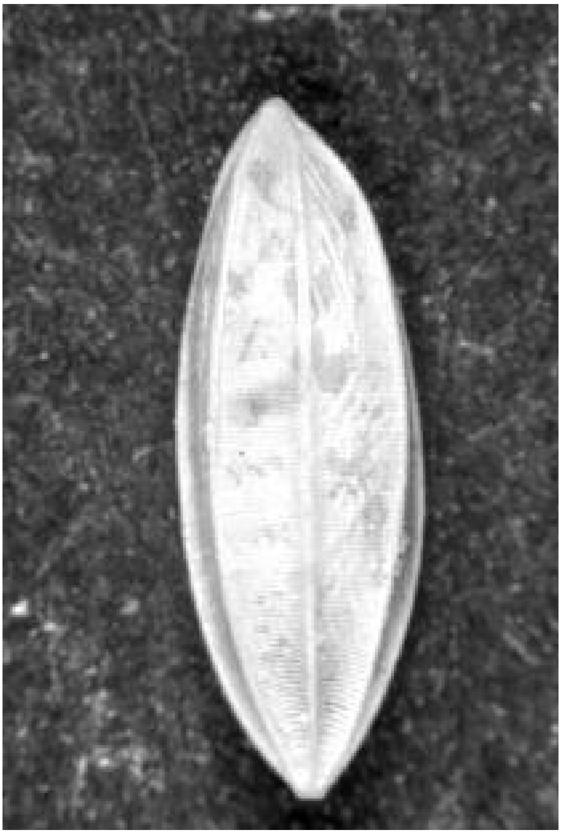
At the beginning of summer 2001, INRA (Institut National de la Recherche Agronomique) in Antibes (France) was alerted by people from the Department of Var that they had a lot of palm trees severely damaged by a "white grub," and some palms had even died. It was the starting point for an official report of a new exotic moth introduced accidentally into France. This beautiful insect – the largest introduced accidentally into Europe – is indeed a serious pest for a great number of palm species.

Taxonomy

The scientific name for this moth is *Paysandisia archon* Burmeister; it belongs to the family Castniidae (Lepidoptera), most members of which live in South America.

Description

The adult is a beautiful moth, with a large wingspan of 9–11 cm. The fore-wings are olive brown-coloured and the hind-wings are brightly coloured with red, black and white (Fig. 1). The antennae are clubbed. Females are a little larger and are easily recognizable by their chitinous ovipositor at the end of the abdomen. The eggs are laid separately; they are oblong (5 mm long), cream-coloured and with longitudinal ribs (Fig. 2). Just after hatching, the larva is pink-coloured and less than 1 cm long, but turns white as it grows. It reaches 6–7 cm at the end of its



2 (above). *Paysandisia archon*: egg. 3 (below). A larva of *Paysandisia archon* in its gallery.

development, looking a bit like a grub, and with four pairs of pseudopods (Fig. 3).

Geographical distribution

The moth is native to the central region of Argentina and neigboring Uruguay where it lives on palms, *Trithrinax campestris* among other species. *Trithrinax campestris* grows in the wild on the plateau of the central northern part of Argentina (east of Cordoba) where up until the present is very common. However, as shown in Gibbons' paper (2001), this palm (*el Caranday*) seems now to be threatened in its native country. There is a huge need for agricultural land in Argentina, and so *T. campestris* has to be eliminated as land is cleared for fields. For this reason, a great number of them are burned or at best uprooted for commercial purposes. They are exported to other countries, such as in Europe, where they are first put together in the same site before they are sold and spread to other north Mediterranean places.

In France, *Paysandisia archon* is presently localized in the Department of Var, between Toulon and Hyères (Fig. 4) where it has been introduced most probably with imported *Trithrinax* from Argentina. It is also recorded in Spain, in the area of Girona (Catalonia) with the same probable origin (Aguilar 2001). Until now, no record has been officially reported in other Mediterranean countries, although it is likely to be present in Italy as well. It arrived in France a few years ago (probably about 1995) but its presence was not notified at that time and the official record with accurate scientific identification was only made in July 2001 (Drescher & Dufay 2001). With the increasing interest in palms in all the towns of the south of France, it is likely that the dispersal range of this pest will enlarge to other areas of the region in the near future.

Biology

Very few data are available on *P. archon* in the literature. The main reason is that it is not considered as a pest in its native country, probably due to the presence of natural enemies (parasites and predators), which limit its populations, but also to the fact that it lives originally on palm trees growing naturally and not on crops. Its life cycle has not been studied in Argentina. Only one author, F. Bourquin, has written a small paper with some biological information on this moth, in an Argentinian journal (Bourquin 1933).

The few observations made in France suggest that the moth has a long cycle of development. The adults are observed from June to September. They are active during the day. All stages of development, from egg to chrysalis have been recorded at the same time, in July. The egg is laid at the basis of the leaf on the stem or in the terminal bud. The larva bores a gallery (Fig. 3) through the stem or through the young leaves, not yet expanded at the stem apex (in the terminal bud), causing characteristic damage (Fig. 5). When several larvae bore simultaneously in the stem, the palm becomes weak (Fig. 6) and can even die. Except for the period when the adults are flying, it is difficult to detect the presence of the pest; at the larval stage the only sign may be the presence of plugs of debris, like sawdust, visible at the outermost extremity of the gallery (Fig. 7). The larva turns into a chrysalis, protected by a cocoon made with palm fibres (Fig. 8), inside the gallery. At the very end of its development, the chrysalis frees itself from the cocoon at the outermost extremity of the gallery, and a new adult moth is born after tearing this envelope. The remains of the chrysalis are often attached to the exit hole of the gallery for a while.

Damage

In Argentina, *P. archon* was reported to attack native palms such as *Trithrinax campestris* and *Butia yatay*, as well as occasional exotic species such as *Latania*, *Chamaerops* or *Phoenix canariensis* (Bourquin 1993). In France, the moth appears to have a large range of hosts and can damage many different palms besides *T. campestris*, for example *Chamaerops humilis, Livistona chinensis, L. decipiens, L. saribus, Sabal* spp., *Phoenix canariensis, P. dactylifera, P. reclinata, Trachycarpus fortunei* and *Washingtonia filifera*. This list is probably not exhaustive and will have to be added to following other future observations. In Spain, it has been observed on *Trachycarpus fortunei*, *Phoenix canariensis*, *Washingtonia* spp. and *Chamaerops humilis* (Aguilar 2001).

The damage is observed at different levels of the tree: leaves, rachis and top of the stem. Once hatched, the larva bores towards the heart of the palm and if several larvae are present on the same tree, this can lead to the death of the palm. Big palms can survive if they are not too severely attacked, but small ones or plants in the nursery or in containers are very exposed to attack. It is this ability to feed on a large variety of palm species that makes this pest a real threat to the future of palms in regions of Europe where it has been accidentally introduced.

Control methods

Unfortunately since this moth is not a pest in its native country, no control method has been developed. Some chemicals must be tested before

4. Map showing the two main areas of distribution of *Paysandisia archon* in France and Spain.

being allowed to be uses in parks and gardens, but it is not certain how effective they can be in reaching the larva hidden inside the trunk. Biological control (i.e. the use of natural enemies) could be another possibility, safer for the environment, but it needs several years for development.

Conclusion

As far as we know to date, this pest has been observed in only two limited areas (in France and in Spain), but *Paysandisia* could spread to a much larger region if no severe measures are taken. In France, this pest has been recently included in the

5. Typical damage caused by the larva of *Paysandisia archon* on a leaf of *Washingtonia filifera*.

6 (left). Serious damage to *Trachycarpus fortunei* caused by *Paysandisia archon*. 7 (right). "Sawdust plugs" ejected at the outside of the gallery by the larva of *Paysandisia archon* (damage on *Phoenix canariensis*).

list of noxious organisms submitted for compulsory control measures (Official Journal, February 2002). With the large number of palm species susceptible to its attacks, the moth could seriously threaten the palms that represent a large part of the tourist image of the south of France. The international trade in mature palm trees must be severely limited and controlled to prevent pests from being introduced (other exotic pests have been recently discovered on imported palms in

8. Chrysalis of *Paysandisia archon* extracted from its cocoon.

France and in the soil around their roots), because this practice can lead to severe damage to already established palms. It is the role of palm lovers to be aware of this serious problem and to act in order that the object of their passion can live safely for many years; any observation of new or suspected damage on trees must be notified to experts.

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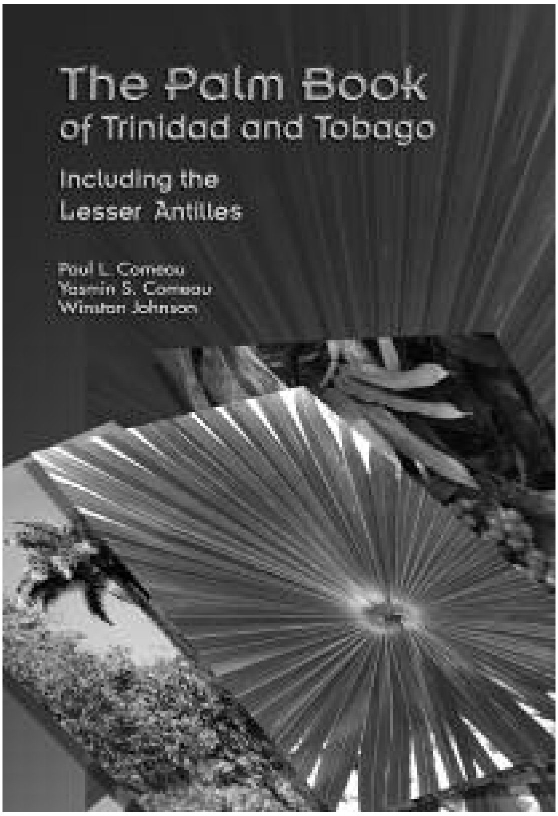

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Losses to Lethal Yellowing Cast Doubt on Coconut Cultivar Resistance

T.K. Broschat,
N.A. Harrison
and
H. Donselman
University of Florida,
Fort Lauderdale
Research and
Education Center,
3205 College Avenue,
Fort Lauderdale, FL
33314 USA

After nineteen years' exposure in an area of active lethal yellowing disease (LY) at Fort Lauderdale, Florida, a coconut cultivar trial recorded losses of 74 of the 106 Malayan Dwarf (70%) and 10 of the 12 hybrid Maypan (83%) coconuts to the disease. The loss of 0 of 4 true-to-type Fiji Dwarf coconuts suggests that this cultivar deserves further testing.

Lethal yellowing is a widespread and fatal disease of coconut (*Cocos nucifera* L.) and at least 37 other species of palms in Florida and the Caribbean region (Harrison et al. 1995). The disease is believed to be caused by phytoplasmas (formerly known as mycoplasma-like organisms or MLOs) (Beakbane et al.1972, Heinze et al.1972, Plavsic-Banjac et al. 1972). These unculturable, cell wall-less organisms belong to a class of bacteria known as mollicutes (Seemüler et al. 1998). The phytoplasma is transmitted to palms during feeding activities by *Myndus crudus*, a phloem-feeding planthopper (Homoptera: Cixiidae) (Howard et al. 1983). Similar phytoplasma diseases of coconut include Cape St. Paul wilt in Ghana, Awka wilt in Nigeria, Kaincopé disease in Togo, Kribi disease in Cameroon, lethal disease in Tanzania, Kenya, and Mozambique, Kalimantan wilt and Natuna wilt in Indonesia, and several other lesser known diseases of coconuts in other parts of the world (Eden-Green 1997a, 1997b).

Although tetracycline injection (McCoy 1972) has been highly effective in preventing LY infections in coconuts, this control measure has usually been considered a temporary solution to the problem. Long-term management recommendations have always included the planting of LY-resistant palm species and coconut cultivars (Been 1995; McCoy 1983).

Lethal yellowing resistance field trials in Jamaica suggested that some coconut cultivars had excellent resistance to this disease. Been (1981), Harries (1973), and Whitehead (1968) reported that Malayan Dwarf and hybrid Maypan (Malayan Dwarf × Panama Tall) coconuts were highly resistant to LY, thus these varieties became the primary focus of coconut replanting efforts in Florida and the Caribbean (Harries et al. 1970–71, Harries & Romney 1974). In the early 1980's a field trial was begun at the University of Florida Fort Lauderdale Research and Education Center (FLREC) to test the performance of these and other promising coconut cultivars. This report is a summary of the data generated from that study.

Materials and Methods

During the summer of 1980, about 200 certified seed nuts of Malayan Dwarf (included green and gold (red) color forms) and smaller numbers of Maypan, Ceylon Dwarf, King, Panama Tall, Red

Spicata, and Fiji Dwarf (Niu Leka) were imported to Florida from the Jamaican Coconut Industry Board (CIB). Although a high percentage of seeds germinated, all of the King and Ceylon Dwarf seedlings died during the severe freezes of 1980–1981. In the spring of 1982 we planted a 5-acre (2-ha) palm grove at the FLREC with the surviving seedling coconuts, along with a wide range of other palm species to test their relative susceptibility to LY. The border on one side of this triangular plot consisted of a row of 33 Jamaica Tall (highly susceptible) coconuts to insure that LY would be active at this site. Within this plot, blocks consisting of 48 green Malayan Dwarf, 28 golden (red) Malayan Dwarf, and 12 Fiji Dwarf coconuts were established. Of the 10 surviving Fiji Dwarf coconuts, we noted that only 4 developed into true-to-type dwarf palms, the remaining 6 being "tall" off-types. In the area remaining in the trial plot 4 Red Spicata, 6 golden Malayan Dwarf, 10 Panama Tall, and 12 Maypan coconuts were interplanted among about 60 other species of palms. In addition, 24 green Malayan Dwarf coconuts were planted in front of the main building at the FLREC.

Of the palms that were diagnosed as having LY, at least 75% were analyzed by N. A. Harrison, who confirmed that the LY pathogen was present, initially by using electron microscopy (mid 1980's), and later by DNA probes or PCR methodology (Thomas et al. 1980, Harrison et al. 1992, 1994).

Results and Discussion

Lethal yellowing became active at this site and remained so from the mid 1980's until about 1999. During that time, 91% (30 of 33) of the Jamaica Tall, 70% (74 of 106) of the Malayan Dwarf, 83% (10 of 12) of the Maypan hybrids, and 50% (5 of 10) of the Panama Tall coconuts died from LY (Table 1). Losses of about 50% for the Panama Tall coconuts in this study are similar to those reported by Been (1981) for Jamaica. However, our losses for Malayan Dwarf and Maypan coconuts are much higher than reported by Been (1981) for Jamaica, where losses for Malayan Dwarfs were less than 4% and those for Maypan were about 12%.

In 1987, Howard et al. reported "unusually high" losses for Malayan Dwarf and Maypan coconuts at several sites in south Florida and Jamaica. The percentage of coconuts that died at these sites varied from about 11 to 40%. Since LY does not kill all susceptible palms in any one year, losses usually continue to occur over time for as long as the disease remains active at a particular site. If the sites in Florida mentioned by Howard et al. (1987) had been monitored continually over a longer time frame as in this 19-year study, perhaps the percentage of Malayan and Maypan coconuts dying from LY would have been higher. Furthermore, the high incidence of LY-related deaths in Malayan Dwarf and Maypan coconuts in Florida is not restricted to this study at the FLREC or those sites mentioned by Howard et al. (1987). The authors are aware of several additional large municipal plantings (e.g., Pembroke Pines and Pompano Beach, Florida) of these coconut varieties in south Florida where losses are estimated to be well over 50%.

The premise that Malayan Dwarf and Maypan coconuts are highly resistant to LY is based on cultivar trials in Jamaica (Whitehead 1968, Harries 1973). Since then the high resistance of these varieties has become almost universally accepted and reports of higher LY losses in these varieties have generally been viewed as anomalous. However, recent observations from Jamaica describe severe outbreaks of LY in some large Malayan and Maypan coconut plantations (Myrie & Been 2001, Schuiling 2001). Myrie and Been (2001) report the loss of 747 of 874 (85%) Malayans at one site and 782 of 792 (99%) Maypans at another. Schuiling (2001) describes "massive" losses of Malayan and Maypan coconuts due to LY at eight additional sites. If all the reports of Malayan Dwarf and Maypan losses to LY in Florida and Jamaica (Howard et al. 1987, Myrie & Been 2001, Schuiling 2001, and this study) are considered, then it would appear that those earlier results from Jamaica (Been 1981) are anomalous, as subsequent observations in Florida and Jamaica have failed to support those claims of LY resistance for Malayan and Maypan coconuts.

Although our 70% loss rate over 19 years for Malayan Dwarf coconuts and 83% for Maypans are lower than the 91% loss rate for Jamaica Talls, from a practical standpoint Malayan and Maypan coconuts cannot be considered "resistant" to this disease. The fact that only about 5% of the Malayans in the first Jamaican trials died from LY (Been 1981) does not prove that they are resistant – only that for reasons yet unknown they did not contract this disease during the time period that their trials were conducted. However, documentation of high loss rates among Malayan Dwarf and Maypan coconuts to LY at this and other sites in Florida and Jamaica is evidence that these varieties are not inherently (i.e., genetically) resistant to this disease and that when duly exposed, they may die at rates nearly as high as those of the "highly susceptible" Jamaica Tall variety.

Table 1. Losses of coconut cultivars due to lethal yellowing (LY) at the University of Florida Fort Lauderdale Research and Education Center, 1982-2001.

Cultivar	No. planted	Losses to LY	Percent loss
Jamaica Tall	33	30	91
Malayan Dwarf	106	74	70
Maypan	12	10	83
Panama Tall	10	5	50
Red Spicata	4	3	75
Fiji Dwarf (Niu Leka)	4	0	0
Fiji Dwarf (off-types)	6	3	50

A number of reasons have been suggested to account for the high loss rate among Malayan and Maypan coconuts in Florida and Jamaica, including fertility, weather, insect vector populations, ground cover, etc., but none of these factors seems to be consistently correlated with LY losses (Howard et al.1987). The possibility that the LY phytoplasma has mutated and is now able to kill Malayan Dwarf and Maypan, as well as Jamaican Tall coconuts, has been raised. This may be a plausible explanation in Jamaica, where current high loss rates contrast sharply with the early reports of minimal losses of Malayan and Maypan coconuts to the disease. However, even in the mid 1980's there were several sites in Jamaica that experienced unexpectedly high losses of those varieties (Howard et al. 1987). It is hoped that molecular studies of the LY agent currently in progress will clarify this issue.

Similarly, it had been suggested that the Malayan Dwarfs dying from LY may be genetically different from the original population described by Harries et al. (1970). Certainly, many of the coconuts offered for sale as Malayan Dwarfs in Florida since the mid 1980's are phenotypically distinct from the true Malayan Dwarf type. However, all but 1 of the 106 Malayans we received from the CIB were phenotypically true-to-type. Whether these, as well as those planted throughout Jamaica that subsequently died from LY, are as LY-resistant as those original Malayan Dwarfs remains to be determined by DNA analysis.

In addition to the susceptibility of Malayan Dwarf and Maypan coconuts, our study also suggests a high degree of LY resistance in the Fiji Dwarf (Niu Leka) cultivar. None of the four true-to-type Fiji Dwarfs at this site died from LY, nor did any of the 12 additional true-to-type Fiji Dwarfs planted at the US Department of Agriculture Chapman Field Station in Miami, FL (A.W. Meerow, pers. comm.). Very high LY disease pressure during the 1980s and 1990s killed a high number of Malayan and Maypan coconuts at both sites. Sample sizes at both sites were small, however, and additional testing at other sites is needed to determine if this cultivar is indeed highly resistant.

Data for Fiji Dwarf plantings in Jamaica showed about 50% loss due to LY (Been 1981). However, due to the high degree of heterozygosity in this Jamaican Fiji Dwarf population even the controlled pollination methods used in the propagation of Fiji Dwarfs by the CIB resulted in a number of tall "off-type" recombinants being produced from true-to-type dwarf parents (Whitehead 1968, Harries, pers. comm.). The resistance data for Fiji Dwarf coconuts published by Been (1981) do not distinguish between true-to-type and off-type Fiji Dwarf coconuts due to the relatively young age at which these palms were exposed to LY (D. Romney, pers. comm.). It is possible that if the LY losses for true-to-type Fiji Dwarfs had been separated from the off-types, the Jamaican results for true-to-type Fijis might have been lower than reported. Fiji Dwarf also showed some degree of resistance compared to other varieties of similar age in trials in Tanzania where the related lethal disease was rampant (Kullaya et al. 1995). Malayan Dwarf coconuts at these same sites experienced loss rates as high as 95% from this disease.

Hugh Harries (pers. comm.) has stated that the original Fiji Dwarf coconuts imported by the CIB from St. Lucia and Fiji segregated phenotypically for dwarf and tall habit, as well as for LY resistance when selfed or sib pollinated. He has speculated that the Fiji Dwarf coconut may be no more than a dwarf (and LY-resistant) mutant selected from the Fiji Tall population on Fiji. If this is so, then the tall off-type Fiji Dwarfs obtained from the CIB may in fact be genotypically and phenotypically Fiji Talls, a highly susceptible variety. It is hoped that future DNA studies will clarify this issue. However, the high degree of heterozygosity among Fiji Dwarf coconuts means that only cloning or seed propagation by controlled pollination of known homozygous individuals can be used predictably to reproduce this apparently resistant phenotype.

In conclusion, this study supports a growing body of evidence that Malayan Dwarf and Maypan coconuts are not highly resistant to LY as previously claimed. Although the Fiji Dwarf appears to be a promising LY-resistant cultivar for ornamental use in south Florida, additional field trials in Florida and elsewhere may or may not support this hypothesis.

Acknowledgments

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Caryota sympetala

JOHN DRANSFIELD
Herbarium,
Royal Botanic Gardens, Kew,
Richmond, Surrey, TW9 3AE, UK
AND
TOM EVANS
Oxford Forestry Institute,
University of Oxford,
Oxford OX1 3RB, UK

1. A valley in the Annamite Mountains, with rich primary tropical rain forest.

Caryota sympetala **is a poorly known species. The authors have recently found it in the Annamite Mountains on the border between Laos and Vietnam and describe the differences between it and *C. mitis*.**

Identifying different species of *Caryota*, especially those in cultivation, often presents problems; this is because our understanding of the limits of the different species remains incomplete. These often huge palms with their complex bipinnate leaves effectively defeat the herbarium method of pressing and drying bits of leaves, flowers and fruits and attaching the bits to a sheet of paper. Differences that may be easily appreciated in the field or in a garden are almost impossible to represent in the fragments of a herbarium specimen. Nevertheless, nomenclatural practice demands that the name of a plant should be validated by a unique herbarium specimen, the type. In the case of *Caryota*, the interpretation of the often old and fragmentary type specimens is particularly difficult and this means that there may be real problems in working out how the many published names should be applied to living plants. It is, thus, always a matter for celebration when a previously rather obscure name can be applied with some confidence to a distinctive living plant.

During our recent fieldwork for rattans in the Annamite chain of mountains in the Lao People's Democratic Republic we came across a very distinctive *Caryota* that we illustrate here. It turns out to be *Caryota sympetala* Gagnep., first described from Vietnam in 1937; we have confirmed this by comparison with the type in Paris herbarium and with more recently collected material from Vietnam in Kew herbarium. This species may be well known to Vietnamese botanists, but as far as we are aware it remains a poorly known species elsewhere and is probably not in cultivation.

Young plants without inflorescences would almost certainly be passed over as juveniles of *Caryota mitis* Lour. When we first saw it as we travelled by longboat up a branch of the Nam Theun River, we did, indeed, consider that it was *C. mitis*. Occurring abundantly along the riverbank, the plants formed clumps of typical doubly pinnate fishtail leaves; we saw no inflorescences. Eventually we were to see it close to, as we walked up a small stream into the mountains. It was then that we realized that we were not dealing with *C. mitis* but with a different species altogether – when fertile there is no mistaking the two. The plant forms clumps of several shoots without visible aerial stems. At flowering stage, the slender stem elongates and eventually reaches 1–2 m tall, but scarcely exceeding 10 cm in diameter. It thus looks rather different from *C. mitis* that can produce a trunk to at least 5 m tall, often much more, and with a diameter of at least 15 cm. In *C. sympetala*, up to four or five inflorescences are produced on each stem and like most members of the genus, they are branched to one order only and contain both male and female flowers. In comparison with *C. mitis* the overall shape of the inflorescence is shorter and wider and the rachillae are certainly significantly shorter and fatter. The male flowers are larger and wider than in *C. mitis* and have dark purplish petals 18 × 8 mm and about 2.5 mm thick, with over 90 stamens (109 in one count) with anthers measuring 9–12 × 1–1.2 mm. This compares with *C. mitis*, where the male flowers have greenish petals up to 12×4 mm and approximately 0.7 mm thick, and have 11–20 stamens with anthers about 7.5 × 0.5 mm.

Hahn and Sytsma (1999) discussed the possible role of hybridization in the origin of some taxa in *Caryota*. They mentioned that *C. sympetala* is in several ways intermediate between *C. monostachya* and *C. mitis* that are said to be sympatric in Vietnam, citing the small clustering stems, semi-erect inflorescence with flowers and fruit of intermediate size, and implying that *C. sympetala* may be of hybrid origin. For the record, we saw no individuals of either *C. monostachya* or *C. mitis* along the Nam Theun River, and *C. sympetala* itself seemed to present a rather uniform appearance throughout the area of Laos that we visited.

As to whether this species has horticultural merit, it has to be said that it appears perhaps even more scruffy than does *C. mitis*, and while avid collectors will want to obtain plants to add to their lists of *Caryota* species, it is unlikely that this species will have any ornamental merit that is not already displayed by *C. mitis*.

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2 (top). The Annamite Mountains that form the boundary between Vietnam and Central Lao PDR. 3 (bottom, left). *Caryota sympetala*, showing few dead inflorescences borne on a short and slender stem. 4 (bottom, right). *Caryota sympetala*: detail of infructescence.

Pinanga in Java and Bali

JOKO R. WITONO
Center for Plant Conservation
Bogor Botanical Gardens–LIPI
Jalan Ir. H. Juanda 13
Bogor 16003, Indonesia

JOHANIS P. MOGEA
Herbarium Bogoriense–LIPI
Jalan Ir. H. Juanda 22
Bogor 16002, Indonesia

AND

S. SOMADIKARTA
Biology Department
Program Pascasarjana FMIPA
Universitas Indonesia
Gedung E FMIPA
Depok 16424, Indonesia

1. *Pinanga javana*. (Photo J. Dransfield)

In this taxonomic account of *Pinanga* in Java and Bali three species are recognized. Two, *P. javana* and *P. arinasae,* are single-stemmed. The latter is described as new. A third species, *P. coronata,* is clustered. The well known *P. kuhlii* is shown to be a synonym of *P. coronata*.

Pinanga consists of about 120 species, occurring from the Himalayas and south China to New Guinea, with the greatest diversity in the wet areas of the Sunda Shelf and very poorly represented in Papuasia (Uhl & Dransfield 1987). In Indonesia, the genus is represented by about 40 species, at least 14 of which are endemic.

Pinanga is found throughout Java, from sea level to montane forests, but the taxonomy of Javanese *Pinanga* has been interpreted variously in the botanical literature. Scheffer (1876) recorded three species on the island, i.e. *P. javana* (Fig. 1), *P. kuhlii* and *P. coronata*. Beccari (1886) added *P. noxa* of Blume to the Javanese list. In contrast, Koorders (1911) mentioned that Java has only two species, i.e. *P. javana* and *P. kuhlii*, while he considered *P. coronata* to be synonymous with *P. kuhlii*. According to Backer & Bakhuizen van den Brink, Jr. (1968), *Pinanga* is represented by only one taxon in Java, namely *P. coronata* (Blume ex Mart.) Blume. *Pinanga globulifera* (non Blume) Merr., *P. kuhlii* Blume and *P. noxa* Blume were all cited as synonyms. In their note, they mentioned that the poorly known *P. javana* Blume may be conspecific with *P. coronata*. However, there was no detailed taxonomic justification for the reduction in the number of species.

On the island of Bali, Dransfield and Mogea collected an unidentified species of *Pinanga* in 1973; this was recently referred to by Whitten (1994) and Whitten et al. (1996) but was not studied in detail. The Balinese taxon is described herein as new.

Pinanga Blume

Blume, Bull. Sci. Phys. Nat. Néerl. 1: 65. 1838. Lectotype: *Pinanga coronata* (Blume ex Mart.) Blume.

Cladosperma Griff., Not. Plant. Asiaticas 3: 165. 1851. Type: *C. paradoxa* (Griff.) Griff. (*Areca paradoxa* Griff.) (= *Pinanga paradoxa* (Griff.) Scheff.).

Ophiria Becc., Ann. Jard. Bot. Buit. 2: 128. 1885. Type species: *O. paradoxa* (Griff.) Becc. (*Areca paradoxa* Griff.) (= *Pinanga paradoxa* (Griff.) Scheff.)

Pseudopinanga Burret, Notizb. Bot. Gart. Berlin-Dahlem 13: 188. 1936. Type: *P. insignis* (Becc.) Burret (= *Pinanga insignis* Becc.)

Description of the genus based on Javanese and Balinese material

Small to robust, solitary or clustered, erect, unarmed, pleonanthic, monoecious palms. Stem slender to moderate, with elongate internodes and conspicuous leaf scars. Leaves pinnate; sheaths tubular, forming a well defined crownshaft; petiole present, adaxially rounded or channelled, abaxially rounded, glabrous or variously indumentose; leaflets with one to several folds, regularly to irregularly arranged, acute, acuminate, or lobed, the lobes corresponding to the folds, the apical leaflets almost always lobed, blade occasionally mottled, sometimes paler beneath, often with a wide variety of scales and hairs, transverse veinlets usually obscure. Inflorescence infrafoliar, usually rapidly becoming pendulous, occasionally erect, protogynous, branching to 1 order only; peduncle short, dorsiventrally flattened, glabrous or tomentose in bud, quickly splitting to expose the flowers; peduncular bracts absent; rachis bracts triangular, inconspicuous; rachillae bearing spirally or distichously arranged triads throughout their length; floral bracteoles minute. Staminate flower asymmetrical, sessile; calyx cupular with 3 triangular lobes; petals 3, triangular, joined briefly basally, valvate in bud, much exceeding the calyx lobes; stamens 12–68; filaments short, anthers linear; pistillode absent. Pistillate flower usually globose, symmetrical, much smaller than the staminate; sepals 3, membranous, striate, imbricate, distinct; petals 3, distinct, imbricate, membranous; staminodes absent; gynoecium unilocular, uniovulate, globose, stigma often brightly colored (reddish to orange). Fruit globose or ellipsoidal, orange to black, stigmatic remains apical; epicarp smooth, shiny, mesocarp thin, fleshy, endocarp of longitudinal fibers, usually adhering to the seed, becoming free at the basal only, fruit without a solid beak. Seed conforming to the fruit shape, basally attached; endosperm deeply ruminate; embryo basal or lateral near the base.

Key to *Pinanga* in Java and Bali

1. a. Small clustering palm . . . . *P. coronata*

   b. Robust solitary palm 2

2. a. Crownshaft purplish-green, covered with silvery indumentum; leaflets 35–45; inflorescence silvery indumentose at the base and verruculose; rachillae 20–30, spirally arranged on the rachis; fruit obovoid . *P. arinasae*

   b. Crownshaft brownish-green, covered with scaly brown indumentum; leaflets 10–15, inflorescence glabrous; rachillae 8–14, arranged distichously and alternate on the rachis; fruit ovoid to ellipsoid . . . . *P. javana*

Pinanga arinasae J. R. Witono, sp. nov.

P. javanae affinis sed caudice solitario, vaginis foliorum sublepidotis, frondibus pinnatisectis, segmentis utroque latere 35–45 linearo-lanceolatis acuminatis, inflorescentiis lepidotis et verruculosis, ramis (20–30) spiralibus, fructibus obovoideis.

Typus: INDONESIA. Bali, Bedugul, Bukit Tapak, 1973, *Dransfield et al. JD3512* (holotypus BO; isotypi BH, K, L).

Robust, solitary palm. Stem erect, 12–15 cm diam., 10–12 m tall, medium brown to gray brownish; internodes 10–25 cm, scars to 3 cm. Crownshaft slightly swollen, 130–180 cm long, 14.0–17.5 cm diam., yellow when young and purplish green when adult, covered with silvery indumentum. Leaves 7–10 in the crown, pinnate, whole leaf 250–330 × 240 cm; leaf-sheath to 110 cm, inside white and smooth, petiole 16–40 cm, deeply oblique, convex abaxially, silvery indumentose below; rachis to 215 cm, silvery indumentose below, concave then flattened adaxially, convex abaxially, terete near the apex; leaflets 35–45 on each side of rachis, entire, regularly arranged, linear to lanceolate, basal leaflets 50–58 × 1.0–1.8 cm, ribs 2, middle leaflets 90–120 × 4–5 cm, ribs 2, apical leaflets 30–48 × 0.6–3 cm, ribs 2–4, indumentose on lower ribs, the surfaces discolorous, upper dark green, lower pale green when fresh, on drying becoming pale brown on lower surface and dark brown on upper surface. Inflorescence infrafoliar, arcuate, eventually pendulous, branched to one order only, silvery indumentose at the base and verruculose, 50–55 cm long, base very stiff; prophyll pale yellow distally and greenish yellow near base when fresh, brownish yellow when dry, papery, smooth, 37 × 8 cm; peduncle erect, flattened, 11–18 × 1.6–2.5 cm, rachis 18–27 × 1 cm, rachillae 20–30, spirally arranged on the rachis; rachillae bearing 16–28 triads on each side, basal rachillae longer than apical rachillae. Staminate flowers sessile, calyx with 3 subulate sepals, 7 × 3.5 mm; corolla with 3 petals, longer than sepals, ovate, 10 × 6 mm; stamens 45–68, pale yellow, 2–4 × 0.3–0.5 mm. Pistillate flowers sessile; calyx cup-shaped, pale yellow, 4 mm diam. with 3 triangular imbricate orbicular sepals, lobes 5.5–6 × 4 mm, ciliate at margins, striate, apex mucronate; corolla with 3 cucullate free rounded, orbicular, ciliate pale yellow petals, similar to sepals in size, striate, apex mucronate-obtuse; ovary rounded, 3 × 2 mm. Fruit obovoid, 12–17 × 8–12 mm. Young fruit green, mature fruit red blackish. Seed obovoid, deeply ruminate. (Figs. 2, 3, 7, 8)

DISTRIBUTION: Endemic to Bali at Bukit Tapak near Eka Karya Botanic Garden. We did not find this species in nearby Bukit Lesung and Bukit Pohen. A long time ago, *P. arinasae* was probably present there, but the habitat is now highly degraded.

SPECIMENS EXAMINED: BALI. Bukit Tapak, Apr 1973, *Dransfield JD3512* (Holotype BO); sterile, Mar 1992 *Afriastini 163* (BO); seedling, May 1998 *Witono 74* (BO); flower, May 1998 *Witono 75* (BO).

ECOLOGY: Occurring on a very steep hill slope on rocky outcrops in *Casuarina* and *Engelhardtia* forest at altitudes of 1100–1400 m above sea level.

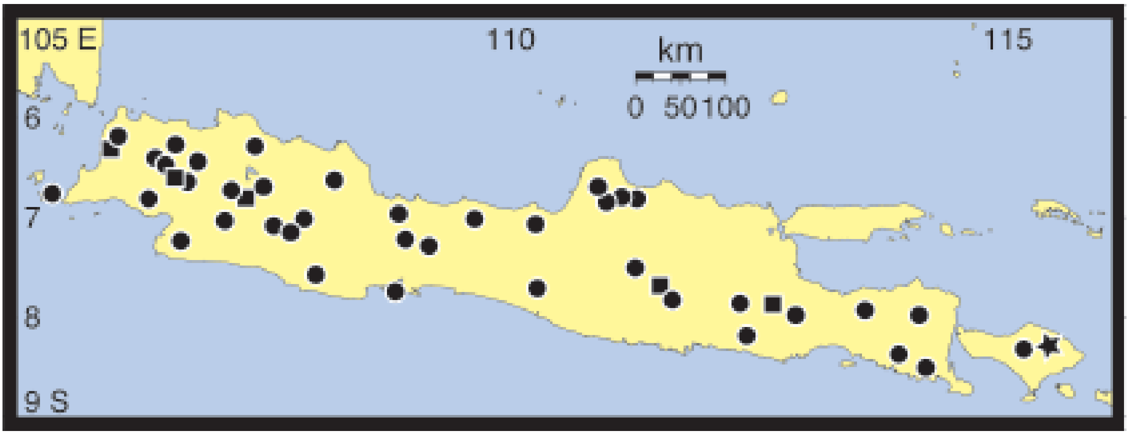
LOCAL NAMES: *Nyabah*, *jabah* or *pinang jawa*.

USES: A highly ornamental palm, popular with local people near the botanic garden. Young fruits are used as a substitute for betel nut (*Areca catechu*), young leaves (cabbage or *umbut*) can be eaten. Stems are used for traditional cremation ceremonies ("*ngaben*"), and leaf-sheaths are used for making a "*cukup*" (a Balinese umbrella).

This handsome "pinang" is named for Mr. I.B.K. Arinasa who assisted us in the field. *Pinanga arinasae* is closely related to the single-stemmed *P. javana* from Java, *P. insignis* from the Philippines and to *P. punicea* from Papua and Maluku. The major differences between *P. arinasae* and the above mentioned species are presented in Table 1.

2. Pinanga javana Blume, Bull. Sci. Phys. Nat. Néerl. 1: 65. 1838 and Rumphia 2: 81. 1839. Type: Java, *Blume s.n.* (holotype L!).

Robust, solitary palm. Stem erect, 4–10 m tall, 10–15 cm diam., internodes to 10–30 cm, stem surface green brownish, smooth, slightly fissured longitudinally. Crownshaft elongate, 150–200 cm long, 25 cm diam., swollen, purplish brown, with brown scales. Leaves 10 in crown, pinnate; whole leaf (including leaf-sheath, petiole, and rachis) 250–300 cm with silvery indumentum on petiole and rachis, very massive; leaf-sheath to 100 cm; petiole to 30 cm, concave adaxially, convex abaxially; rachis 3 cm diam.; leaflets 10–15 on each side of rachis, regularly arranged, slightly arcuate, elongate linear-lanceolate, falcate-sigmoid, equidistant, basal leaflets 65–95 × 1–6 cm, ribs 1–3, middle leaflets 70–115 × 2.7 cm, ribs 1–3, apical leaflets 19–55 × 1.5–7.5 cm, ribs 2–7. Inflorescence infrafoliar, hand-like, spreading pendulous, 40–50 cm long, peduncle erect at base, flattened, 9–16 cm long, 0.8–1.5 cm thick; prophyll not known; rachillae 8–13, arranged distichously alternate, at the base 23–35 cm with 19–21 triads, at the apex 18–27 cm with 15–17 triads, peduncle, rachis, and rachillae green when young, pinkish red with age. Triads distichous, alternate. Pistillate flower (calyx and corolla) cream, ovary green; calyx cup-shaped, sepals 3, imbricate, broadly orbicular, 6–8 × 4–4.5 mm, smooth, thick at the middle, thin at side, with ciliate margins, apex mucronate; corolla with 3 cucullate rounded ciliate petals, 4–6 × 3–4 mm, apex mucronate-obtuse. Fruit ovoid to ellipsoid, 20–26 × 11–14 mm, pale pinkish yellow when



2. Distribution of *Pinanga* in Java and Bali. Circles = *P. coronata*. Squares = *P. javana*. Star = *P. arinasae*.

young, when ripe turning dark red then black, pericarp densely fibrous, endocarp thin, membranous. Seed ovoid to ellipsoid, 18–21 × 10–13 mm, deeply ruminate. (Figs. 1, 2, 5, 6)

DISTRIBUTION: Endemic to Java, now confined to the mountains of West Java. This species was recorded on Mt. Slamet (Central Java) (Whitten et al. 1994) but was not found when we searched for it in 1999. Specimens collected by Backer in 1914 from Mt. Wilis and by Kobus from Mt. Tengger indicate that it once grew in East Java; however, during field observation in 1998, no *P. javana* was found in either locality. It is possible that this species is extinct (extirpated) at these locations.

3 (left). *Pinanga arinasae*, Bukit Tapak, Bali, habit. 4 (right). *Pinanga coronata*, detail of infructescence. (Photos: Joko Witono)

SPECIMENS EXAMINED: JAVA. West Java. Mandalawangi, Mt. Pulasari, Apr 1974, *Dransfield JD4185* (BO); Bogor, Mt. Salak, Apr 1971, *Dransfield JD1358* (BO); Mt. Salak, Jul 1971 *Dransfield JD1758* (BO); Cibodas, Oct 1970, *Dransfield JD951* (BO); East Java. Kediri, Mt. Wilis, Feb 1914, *Backer 11491* (BO); Mt. Tengger, *Kobus 204* (BO).

ECOLOGY: Occurring on very steep hillsides in moist lower montane forest and damp montane forest in deep soil at altitudes of 800–1,700 m above sea level, but not on ridgetops. Dransfield collected *P. javana* in 1973 on Mt. Pulasari, Mandalawangi, West Java, where this species is abundant in summit mossy forest at altitude 800 m asl. In its morphology, *P. javana* is quite different from *P. coronata*. It is a robust palm, always solitary, and the arrangement of the rachillae is always alternate and distichous. On the other hand, *P. coronata* is a small and clustered palm, and the arrangement of its rachillae is always spiral. The distribution of these species is also different. *Pinanga javana* is very restricted, found only in lower montane forest (800–1,700 m asl) in West and East Java, while *P. coronata* is more widespread, and is found from Sumatra, Java, to Lesser Sunda Islands, from sea level to montane forest.

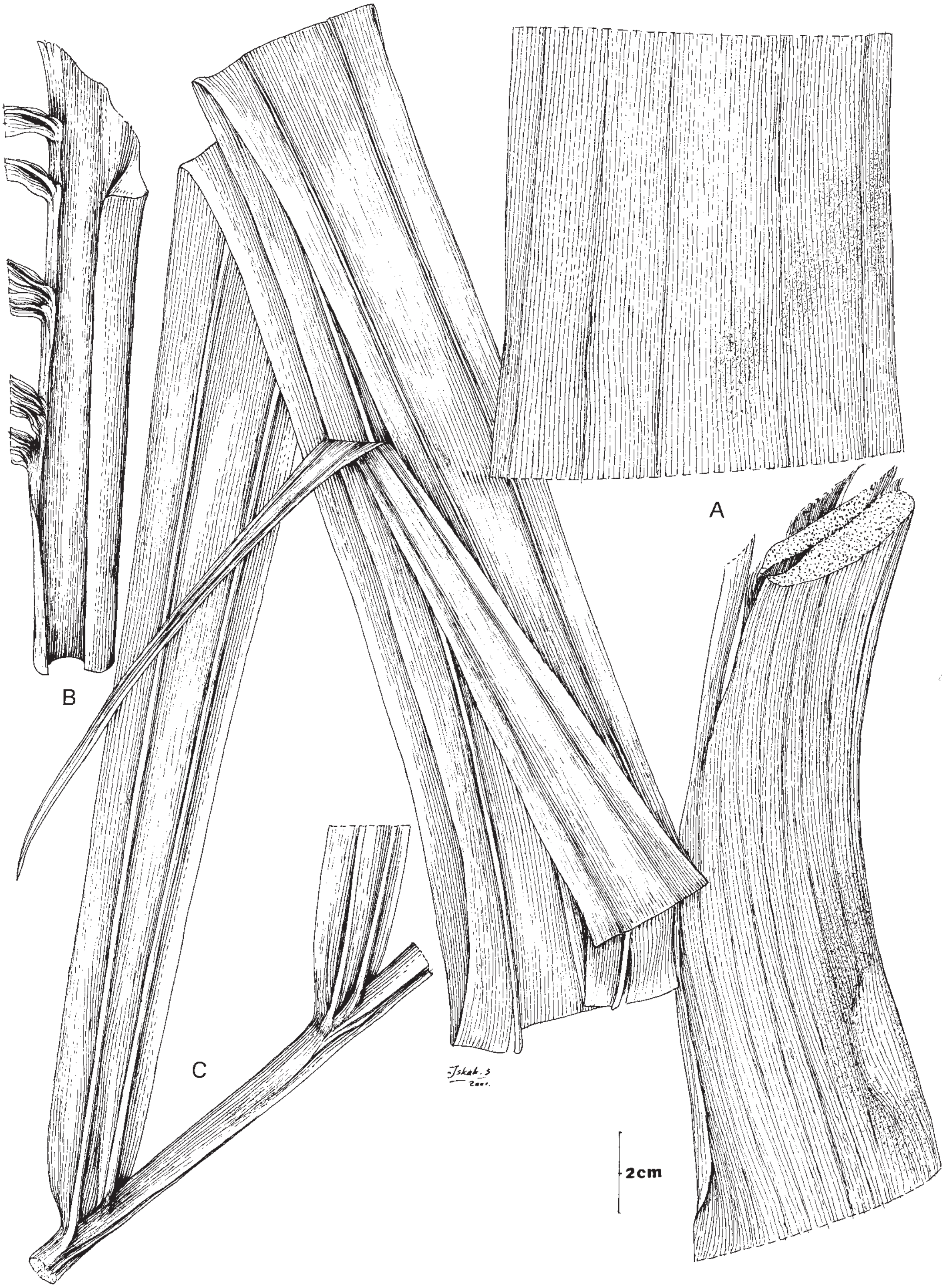
LOCAL NAMES: *Pinang hanyawar*, *pinang panyawar* (West Java), *palem barong* (East Java), *pinang jawa*.

3. Pinanga coronata (Blume ex Mart.) Blume, Bull. Sci. Phys. Nat. Néerl. 1: 65. 1838 (*nomen*); Blume, Rumphia 2: 83. 1839. *Areca coronata* Blume ex Mart., Hist. Nat. Palm. 3: 179. 1838. *Seaforthia coronata* (Blume ex Mart.) Mart., Hist. Nat. Palm. 3: 185. 1845. *Ptychosperma coronata* (Blume) Miq., Fl. Ned.-Indie 24. 1855. Type: Java, *Blume s.n.* (holotype L!).

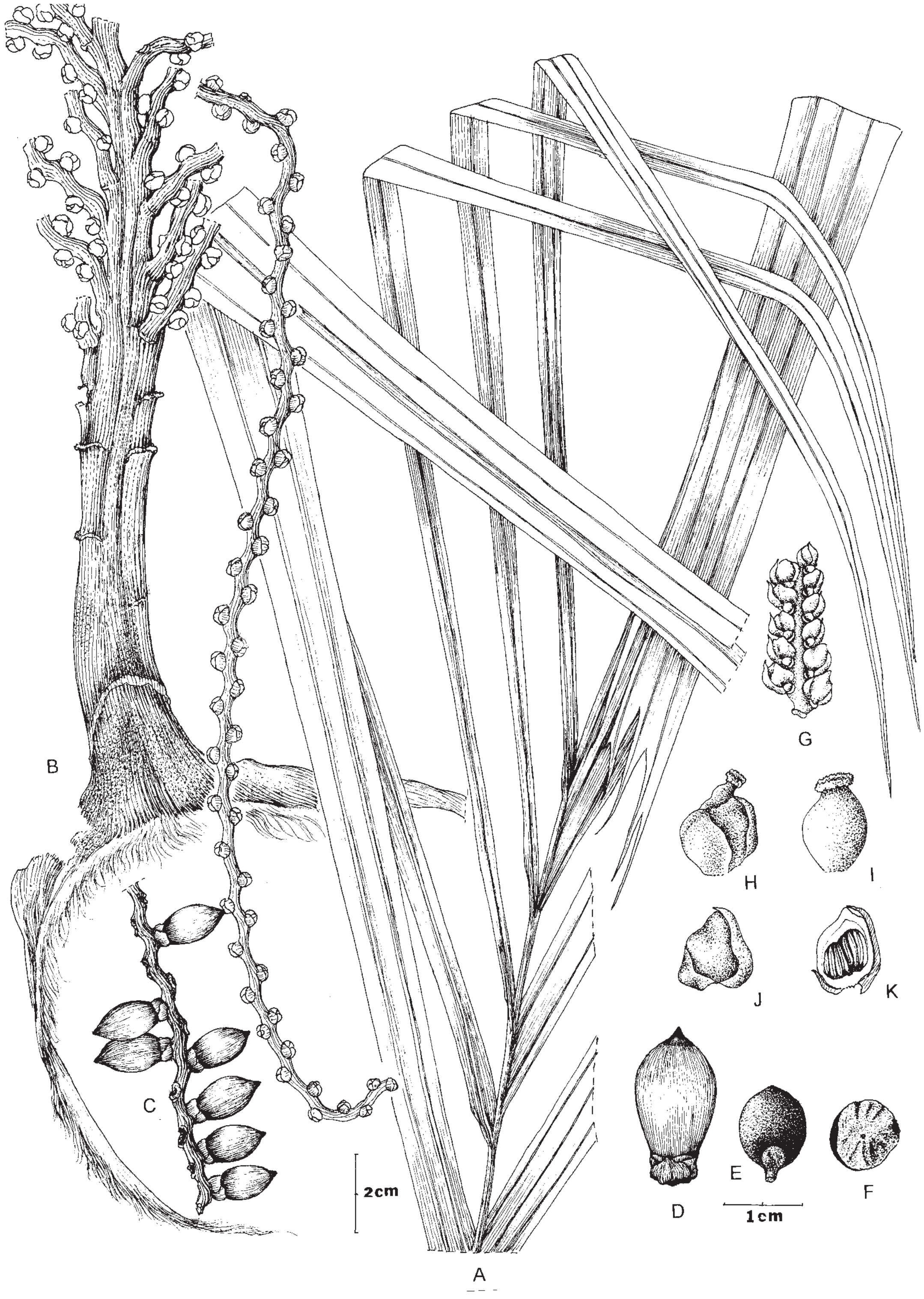
Pinanga kuhlii Blume, Bull. Sci. Phys. Nat. Néerl. 1: 65. 1838 (*nomen*); Blume, Rumphia 2: 82. 1839. *Seaforthia kuhlii* (Blume) Mart., Hist. Nat. Palm. 3: 185. 1845. *Ptychosperma kuhlii* (Blume) Miq., Fl. Ned.-Indie 21. 1855. Type: Java, *Blume s.n.* (holotype L!).

Pinanga costata Blume, Bull. Sci. Phys. Nat. Néerl. 1: 65. 1838 (*nomen*); Blume, Rumphia 2 : 80. 1839; *Ptychosperma costata* (Blume) Miq., Fl. Ned.-Indie 25. 1855. Type: Java, *Blume s.n.* (holotype L!).

5 (left). *Pinanga javana*, cultivated in Cibodas, West Java. 6 (right). *Pinanga javana*, detail of infructescences, cultivated in Cibodas, West Java. (Photos: J. Dransfield).



7. *Pinanga arinasae*: **A** leaf sheath, two views; **B** tip of petiole; **C** mid section of leaf. All from *Dransfield et al. JD3512.* Drawn by Iskak Samsudin.



8. *Pinanga arinasae*: **A** leaf tip; **B** base of inflorescence just past staminate anthesis; **C** part of rachilla in fruit; **D** fruit; **E** seed; **F** seed in cross section; **G** part of rachilla showing triads of flowers; **H** pistillate flower; **I** gynoecium; **J** petal of pistillate flower; **K** staminate bud in vertical section. All from *Dransfield et al. JD3512*. Drawn by Iskak Samsudin.

Table 1. The major differences between *Pinanga arinasae* and closely related species. Data from Scheffer (1876), Beccari (1907) and Moore and Fosberg (1956).

	P. arinasae	***P. insignis***	***P. punicea***
Outer surface of crownshaft	covered with silvery indumentum	covered in appressed radiate scales of a chestnut brown color	covered in brown scaly indumentum
Width of leaves	to 240 cm	to 150 cm	160–200 cm
Length of petiole	16–40 cm	very short or obsolete	80 cm
Apical leaflets	2–4 ribs	10 ribs	6–7 ribs
Inflorescence	50–55 cm	100 cm	50–60 cm
Length of rachillae	22–32 cm	40–50 cm	16–27 cm
Arrangement of fruit on rachillae	distichous	distichous	spiral
Fruit	obovoid (1.2–1.7 cm long by 0.8–1.2 cm diam.)	ovoid (2.4–2.5 cm long by 1.3–1.4 cm diam.)	ellipsoid (1.7 cm long by 0.9 cm diam.)

Pinanga noxa Blume, Bull. Sci. Phys. Nat. Néerl. 1: 65. 1838. (*nomen*) Blume, Rumphia 2: 81. 1839. *Ptychosperma noxa* (Blume) Miq., Fl. Ned.-Indie 23. 1885. Type: Java, *Blume s.n.* (holotype L!).

Small, clustered, undergrowth palm. Stems erect, unbranched, 2–8 (10) m tall, 1.5–7 (10) cm diam., with internodes 4.5–12 (20) cm, scars 0.5–1.2 cm; stem surface green to brownish green. Crownshaft swollen elongate, 50–100 cm long, 2.5–10 cm diam., slightly wider than the stem, green, yellowish or brownish green, or brownish to reddish yellow when adult, with brown scales, ligule poorly developed. Leaves 4–7 in the crown; whole leaf including leaf-sheath 150–300 cm; leaf-sheath 35–80 cm; petiole 20–100 cm, deeply oblique adaxially, convex abaxially; rachis 90–180 cm, petiole and rachis smooth or silvery indumentose below, flattened adaxially, convex abaxially, sharp near the apex; leaflets 6–30 on each side of rachis, entire, regularly arranged, elongate linear-lanceolate, falcate-sigmoid, basal leaflets 22–85 × 0.5–6.5 cm, with 1–5 ribs, middle leaflets 32–90 × 0.8–9 cm, with 1–7 ribs, apical leaflets 16–45 × 1.5–10 cm, with 2–13 ribs, notched to deeply cuneate to dentate, indumentose on lower ribs, the surfaces discolorous, upper pale green, lower dark green when fresh, on drying becoming pale brown to pale greenish brown on lower surface and dark brown to dark greenish brown on upper surface. Inflorescence infrafoliar, pendulous or erect then pendulous, green when young, becoming yellow pink to red, base very stiff; peduncle flattened, 1–6.5 × 0.5–2 cm; prophyll 20–28 × 4.5–8 cm, pale yellow when fresh, light brown when dry, smooth; rachis 2–9 × 0.2–1 cm, smooth; rachillae 5–22, glabrous, straight, spreading to parallel, not in same plane, basal rachillae with 19–51 triads on each side, apical rachillae with 15–36 triads. Staminate flower sessile, creamy white, stamens 12–16 (28), pale yellow, about 3–3.5 × 0.2 – 0.4 mm. Pistillate flower creamy white, sessile, calyx cup-shaped, sepals orbicular to very broad orbicular, 2.5–5 × 2–3.5 mm, membranous, striate, imbricate, acuminate-mucronate-obtuse at the apex, ciliate at margins; petals usually smaller than sepals, orbicular to very broad orbicular, 2–4.5 × 2–3.5 mm, membranous, striate, imbricate, acuminate-mucronate-obtuse at the apex; ovary rounded, about 1–2 × 1 mm. Fruit obovoid, ellipsoid to ovoid, 11–15 × 6–10 mm, green when young becoming yellow pink, red to brownish red, stigmatic remains apical; epicarp smooth, shiny; mesocarp thin, fleshy; endocarp with longitudinal fibers. Seed conforming to the fruit, 7.5–12 × 5–7.5 mm; endosperm deeply ruminate. (Figs. 2, 4)

DISTRIBUTION: Sumatra, Java, to Lesser Sunda Islands.

SPECIMENS EXAMINED. JAVA. West Java. Mandalawangi, Mt.Pulasari, Apr 1974, *Dransfield JD4182* (BO); Pandeglang, Ujung Kulon National Park, Sept 1951, *Waalkes 406* (BO); Apr 1971, *Dransfield JD1448* (BO); Apr 1971, *Dransfield JD1464* (BO); May 1992, *McDonald & Afriastini 3325* (BO); Oct 1998, *Witono 79* (BO); Depok, Dec 1894, *Hallier 1894* (BO); Nov 1896, *Hallier s.n.* (BO); *Hallier 1899* (BO); Aug 1898, *Koorders 31041* (BO); Apr 1903, *Koorders 40185* (BO); Apr 1904, *Koorders 40191* (BO), *Koorders 40192* (BO), *Koorders 40193* (BO); Oct 1898, *Backer 26279* (BO); Mar 1921, *Backer 31254* (BO); May 1939, *Van Steenis 11236* (BO), *Van Steenis 11237* (BO); Bogor, Oct

1910, *Scheffer 16317* (BO); Aug 1935, *Frank 35* (BO); Mt. Salak, Apr 1971, *Dransfield JD1352* (BO), *Dransfield JD1359* (BO); Jul 1974, *Yoshida 1576* (BO); Ciampea, Jul 1898, *Koorders 30778* (BO); Jul 1914, *Backer 15124* (BO); *Burck s.n.* (BO); Ciapus, Jun 1896, *Hallier s.n.* (BO); *Hallier s.n.* (BO); Cipancar, Jun 1896, *Scheffer s.n.* (BO); Jasinga, Oct 1970, *Dransfield JD1012* (BO); Cibodas, Jul 1895, *Hallier 412* (BO); Oct 1898, *Koorders 32072* (BO); May 1914, *Lörzing 1831* (BO); June 1941 *Bloembergen 115* (BO); May 1948, *Main 136* (BO); March 1952, *Meijer 35* (BO); Jan 1971, *Dransfield JD1135* (BO); Mar 1979, *Mogea 1715* (BO); *Boerlage s.n.*; Cianjur, Jun 1900, *Koorders 33369* (BO); Sukabumi, Lengkong, Nov 1970, *Dransfield JD1058* (BO); Apr 1980, *Mogea 865* (BO), *Mogea 866* (BO), *Mogea 867* (BO); *Ploem s.n.* (BO); Jampang Kulon, Aug 1974, *Yoshida 1888* (BO); Mt. Halimun, June 1980, *Balgooy & Wiriadinata 2902* (BO); Karawang, *De Monchy 126* (BO); Bandung, Apr 1911, *Smith 121* (BO); Oct 1918, *Backer 26236* (BO); Aug1941, *Popta 31* (BO); Feb 1971, *Dransfield JD1277* (BO); Aug 1976, *Mogea 811* (BO); Oct 1976, *Mogea 821* (BO), *Mogea 822* (BO); Garut, Jan 1897, *Koorders 26673* (BO); Bukit Himalaya Nature Reserve, Feb 1999, *Witono 89* (BO); Feb 1999, *Witono 90* (BO); Tasikmalaya, Aug 1913, *Backer 8987* (BO); Aug 1913, *Backer 9044* (BO); Jul 1917, *Koorders 44345* (BO); Jan 1971, *Dransfield JD1153* (BO); Jan 1971, *Dransfield JD1212* (BO); Cirebon, Mt. Ciremai, Oct 1912, *Backer 5059* (BO); Mt. Beser, Jun 1917, *Backer 22611* (BO); Jun 1917, *Smith 726* (BO); Mt. Cikukur, Mar 1914, *Backer 12899* (BO); Mt Hiyang, Oct 1913, *Backer 9652* (BO); Mt. Masigit, Mar 1914, *Lörzing 1241* (BO); Mt. Windu, Apr 1909, *Soegandiredja 233* (BO); West Java, Apr 1938, *Franck 121* (BO); *Mausjet 581* (BO); *Raap 484* (BO); Central Java, Cilacap, Nusa Kambangan Island, Nov 1907, *Legign* (BO); Nov 1938, *Kostermans 92* (BO); Purwokerto, Mt. Slamet, Pancuran Tujuh, Feb 1999, *Witono 85* (BO); Purbalingga, Mt. Slamet, Goa Lawa, Feb1999, *Witono 89* (BO); Tegal, Jan 1919, *Beumée 3699* (BO); Pekalongan, Mt. Prabata, Sept 1914, *Backer 15970* (BO); Kendal, Kaliwungu, *Cordes s.n.* (BO); Yogyakarta, *Teysmann s.n.* (BO); Kudus, Mt. Muria, Nov 1951, *Kostermans 6265* (BO); Jepara, Ngarengan, May 1899, *Koorders 33226* (BO); May 1899, *Koorders 33619* (BO), *Koorders 33620* (BO); May 1916, *Beumée 587* (BO); Rembang, Apr 1904, *Koorders 36522* (BO); Feb 1914, *Koorders 42260* (BO; East Java. Madiun, Mt. Wilis, Oct 1892, *Koorders 6132* (BO); May 1896, *Koorders 23153* (BO); Nov 1900, *Koorders 38635* (BO); Kediri, Jun 1896, *Koorders 22959* (BO); Mt. Wilis, Feb 1914, *Backer 11836* (BO); Dec 1998, *Witono 82* (BO); Dec 1998, *Witono 83* (BO); *Witono 84* (BO); Malang, Mar 1971, *Dransfield JD1330* (BO); Jul 1980, *Mogea 2538* (BO); Besuki, Mt. Ijen, 7 Nov 1893, *Koorders 14649* (BO); Feb 1896, *Koorders 21686* (BO); Jul 1916, *Koorders 42924* (BO); Apr 1920, *Backer 30620* (BO); Jul 1938, *Van Steenis 10717* (BO); Mar 1971, *Dransfield JD1282* (BO); *Kobus s.n.* (BO); Jember, Meru Betiri National Park, Oct 1998, *Witono 80* (BO); Situbondo, Mt. Argopuro, Apr 1914, *Backer 13258* (BO); Banyuwangi, Meru Betiri National Park, May 1973 *Dransfield JD3529* (BO); Oct 1998, *Witono 81* (BO); Madura, Bawean Isl., Mt. Tinggi, May 1928, *Karta 117* (BO). Bali. Bedugul, Bukit Tapak, May 1973, *Dransfield JD3515* (BO); Bukit Lesung, Mar 1992, *Afriastini 92* (BO); Bratan Lake, Jun 1976, *Meijer 10538* (BO); Mt. Kelatakan, Jul 1918, *Maier 64* (BO).

ECOLOGY: Occurring on very steep hillsides in montane forest and flat areas in lowland forest, from sea level to 1800 m above sea level.

LOCAL NAMES: *Bing-bin* (West Java), *piji* (Central Java, East Java, and Bali), *pinang rante* (East Java).

USES: Frequently cultivated as an ornamental and sometimes used for building material.

NOTES: Blume described *P. kuhlii* based on a specimen apparently from West Java (Java Occidentalis). Beccari (1886) mentioned that the type locality of *P. kuhlii* was Cisoka, West Java. This locality is in Lebak District, Pandeglang Regency, Banten Province. Index Kewensis says that the type locality of *P. kuhlii* is Malaya. This information is incorrect, and indeed no specimen or record has ever been documented from Malaya.

Pinanga coronata was described based on a specimen from Megamendung, on the slopes of Mt. Gede-Pangrango, to the south-east of Bogor in West Java. Again Index Kewensis incorrectly cites the type locality of *P. coronata* as Celebes; however, *P. coronata* has so far never been found in Celebes.

Blume (1839) separated *P. kuhlii* and *P. coronata* primarily based on leaves and growth of the inflorescence. The rachis of *P. kuhlii* is covered with small scales on the abaxial surface, the leaflets are broad (lanceolate to falcate), 10–13 in number and the inflorescence is pendulous. Characters of *P. coronata* are rachis smooth, leaflets narrow (linear to elongate), numerous, and inflorescence erect then pendulous. Specimens that were collected from lowlands usually have characters similar to *P. kuhlii*, but specimens from montane forest (>1000 m above sea level) usually have characters similar to *P. coronata*. In fact, between *P. kuhlii* and *P. coronata*, there are intermediate forms. Based on this evidence we conclude that the clustered *Pinanga* of Java and Bali represents a single species.

Pinanga costata and *P. noxa*, are reduced to *P. coronata* because they have similar characters and are indistinguishable in the field and in the herbarium.

Pinanga coronata was chosen by Beccari and Pichi-Sermolli (1955) as the type of the genus *Pinanga*, because *Pinanga* was first published by Blume, not in Rumphia (1838–1843), but in *Bulletin des Sciences Physiques et Naturelles en Néerlande* vol. 1 (1838). Although the genus *Pinanga* was described in the *Bulletin*, the species were merely listed and are *nomina nuda*. Before Rumphia 2 was published, Martius published *Historia Naturalis Palmarum*, vol. 3 (1838), in which he made the combination *Areca coronata*, which is the first validly published name for this species. The valid name of the clustered *Pinanga* in Java and Bali is thus *P. coronata* (Blume ex Mart.) Blume.

Other names for clustered *Pinanga* in Java are *P. nenga* which was published by Blume (1838–1843), and *P. neglecta* which was published by Burret (1940). *Pinanga nenga* is the type of the genus *Nenga*. At present, the correct name for it is *Nenga pumila*. *Pinanga neglecta* is synonymous with *Nenga pumila* (Fernando1983).

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Contact Person
Aidrich Frazier
Telephone
785-843-1221

8. Complete Mailing Address of Headquarters or General Business Office of Publisher (Not printer)
International Palm Society, P.O. Box 1897, 810 East 10th St., Lawrence, KS 66044-1897

9. Full names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor (Do not leave blank)

Publisher (Name and complete mailing address)
International Palm Society, P.O. Box 1897, 810 East 10th St., Lawrence, KS 66044-1897

Editor (Name and complete mailing address)
John Dransfield, Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AE, United Kingdom

Managing Editor *(Name and complete mailing address)*
Scott Zona, Fairchild Tropical Garden, 11935 Old Cutler Rd., Miami, FL 33156

10. Owner (Do not leave blank. If the publication is owned by a corporation, give the name and address of the corporation immediately followed by the names and addresses of all stockholders owning or holding 1 percent or more of the total amount of stock. If not owned by a corporation, give the names and addresses of the individual owners. If owned by a partnership or other unincorporated firm, give its name and address as well as those of each individual owner. If the publicaiton is published by a nonprofit organization, give its name and address.)

Full Name	Complete Mailing Address
International Palm Society	P.O. Box 1897, 810 East 10th St., Lawrence, KS 66044-1897

11. Known Bondholders, Mortgages, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities, If none, check box → ☑ None

Full Name	Complete Mailing Address

12. Tax Status (For completion by nonprofit organizations authorized to mail at special rates) (Check one)
The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes:
☑ Has Not Changed During Preceding 12 Months
☐ Has Changed During Preceding 12 Months (Publisher must submit explanation of change with this statement)

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13. Publication Title		14. Issue Date for Circulation Data Below	
Palms		August-02	
15. Extent and Nature of Circulation		Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
a. Total Number of Copies *(Net press run)*		2825	2800
b. Paid and/or Requested Circulation	(1) Paid/Requested Outside- County Mail Subscriptions stated on Form 3541. *(Include advertiser's proof and exchange copies)*	1824	1876
	(2) Paid In-County Subscriptions *(Include advertiser's proof and exchange copies)*	0	0
	(3) Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Non-USPS Paid Distribution	477	535
	(4) Other Classes Mailed Through the USPS	48	0
c. Total Paid and/or Requested Circulation *(Sum of 15b(1), (2),(3), and (4))* ▶		2349	2411
d. Free Distribution by Mail *(Samples,complimentary, and other free)*	(1) Outside-County as Stated on Form 3541	0	0
	(2) In-County as Stated on Form 3541	0	0
	(3) Other Classes Mailed Through the USPS	40	58
e. Free Distribution Outside the Mail *(Carriers or other means)*		1	1
f. Total Free Distribution *(Sum of 15d and 15e)* ▶		41	59
g. Total Distribution *(Sum of 15c and 15f)* ▶		2390	2470
h. Copies not Distributed		435	330
I. Total (Sum of 15g. and h.) ▶		2825	2800
Percent Paid and/or Requested Circulation (15c divided by 15g times 100)		98.3	97.6

16. Publication of Statement of Ownership
☑ Publication required. Will be printed in the Dec 2002 issue of this publication. ☐ Publication not required.

17. Signature and Title of Editor, Publisher, Business Manager, or Owner
Co-editor
Date
9 Sep 2002

I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).

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2. In Cases where the stockholder or security holder is a trustee, include in items 10 and 11 the name of the person or corporation for whom the trustee is acting. Also include the names and addresses of individuals who are stockholders who own or hold 1 percent or more of the total amount of bonds, mortgages, or other securities of the publishing corporation. In item 11, if none, check the box. Use blank sheets if more space is required.
3. Be sure to furnish all circulation information called for in item 15. Free circulation must be shown in items 15d, e, and f.
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5. If the publication had Periodicals authorization as a general or requester publication, this Statement of Ownership, Management, and Circulation must be published; it must be printed in any issue in October or, if the publication is not published during October, the first issue printed after October.
6. In item 16, indicate the date of the issue in which this Statement of Ownership will be published.
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