Palms

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The International Palm Society

Founder: Dent Smith

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

Treasurer: Howard Waddell, 6120 SW 132 St., Miami, Florida 33156 USA, e-mail hwaddell@prodigy.net, tel. 1-305-666-0476.

Bookstore: Geoff Stein, 1196 Calle Jazmin, Thousand Oaks, California 91360, USA, e-mail IPSBooks@aol.com

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FRONT COVER

Cyrtostachys renda 'Theodora Buhler' as illustrated by botanical artist Wes Jurgens. See article by H. Waddell, p. 70.

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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. 44-181-332-5225, Fax 44-181-332-5278.
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.

Garden Editor: Lynn McKamey, Rhapis Gardens, P.O. Box 287, Gregory, Texas 78359, USA.

Horticultural Editors: Martin Gibbons, The Palm Centre, Ham Nursery, Ham Street, Ham, Richmond, Surrey TW10 7HA, United Kingdom.
Katherine Maidman, Fairchild Tropical Garden,10901 Old Cutler Road, Coral Gables (Miami), Florida 33156, USA, e-mail kmaidman@fairchildgarden.org.

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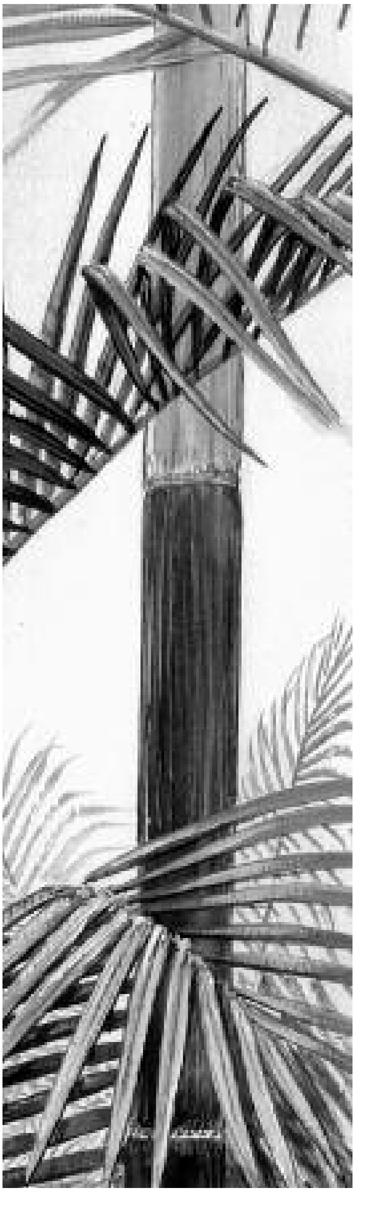
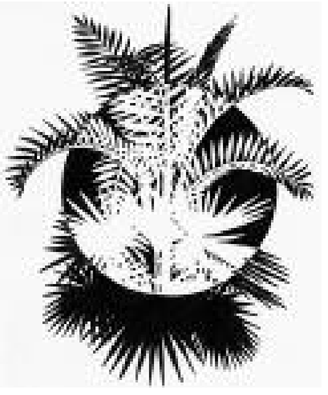


BACK COVER

Gastrococos crispa, in cultivation at Fairchild Tropical Garden, Florida. See article p. 73. Photo by C. Migliaccio.



NEWS FROM THE WORLD OF PALMS

We note with great sadness the passing of Phyllis Sneed, long-time IPS member known for the many articles she and her late husband, Melvin, contributed to Principes. Together, they travelled to many of the most interesting palm habitats in the world and wrote about their travels in a series of charming and informative articles.

It is with sadness that we also report the death of Dr. Tim Whitmore. Tim was known to many IPS members as the author of the highly successful book *Palms of Malaya*. He collected palms extensively in the Solomon Islands and then in Peninsular Malaysia. He had an unrivalled knowledge of tropical rain forest ecology.

Dr. Jerome Keuper, former president of the Palm Society (the precursor to the IPS), also passed away recently. John D. Kennedy provides an obituary on page 103 of this issue of PALMS.

The *Chamaedorea* palm research collection, developed by Donald R. Hodel, author of *Chamaedorea Palms*, was recently moved from Los Angeles County Department of Parks and Recreation's Virginia Robinson Botanical Garden in Beverly Hills to a new home at Lotusland, near Santa Barbara. The collection includes over 450 plants representing 52 species and was created as a result of Don's field work in Central America. The collection is the largest and most thoroughly documented assemblage of *Chamaedorea* palms in the world.

In a recent cancer research journal (Oncology Reports 8:1355–1357. 2001) workers have shown that an extract of the seeds of *Livistona chinensis* has potent anti-angiogenic and anti-tumor activity. It appears that the extract suppresses the growth of mouse fibrosarcoma cells and human breast and colon cancer cells. Their results suggest that an extract of *Livistona chinensis* seeds may have a potential as a supplemental source for cancer treatment. In a recent issue of Fitoterapia (72: 887–893. 2001) researchers record the presence of an anti-inflammatory and immunomodulatory polysaccharide from the babassu palm (*Attalea phalerata*). Finally, researchers publishing in the Journal of Agricultural and Food Chemistry (50: 610–617. 2002) have shown that the antioxidant and antimutagenic activity in date fruit (*Phoenix dactylifera*) is quite potent and implies the presence of compounds with potent free-radical-scavenging activity – in other words, eating dates is good for you!

THE EDITORS

Additional Species Proving Hardy in the Pacific Northwest

NICK PARKER
11692 89A Ave.
Delta, BC V4C 7J6
Canada

1. Ten-year-old *Chamaerops humilis* in Vancouver receives no winter protection. Suckers are trimmed to encourage vertical growth. (Photo N. Parker, April, 2001)

Radio garden shows are popular in Vancouver, Canada. Listeners phone with their problems and the host, usually a well-known garden expert, offers his advice. On one such show recently the well-known garden expert advised his caller that the only palm she could grow outdoors here was *Trachycarpus fortunei*. Last week another well-known garden expert advised my wife the same thing at his garden nursery. They are both wrong.

In 1994, I described the growth in popularity of *Trachycarpus fortunei* in British Columbia and the Pacific Northwest (Principes 38(2): 105–108. 1994). I noted at that time that this species alone had become established in cultivation in zone 8 areas, mature, established specimens resisting the ravages of wind, heavy snow, and sub-freezing temperatures. Experiments with *T. fortunei* have proven wildly successful, both in terms of their resistance to cold and their popularity with the public. There are now hundreds, perhaps thousands of Chusan palms growing in public and private gardens and on public streets all over western Oregon north through Puget Sound and coastal areas of southwest British Columbia as far north as central Vancouver Island. While not yet commonplace, their presence is no longer an object of curiosity, except perhaps in winter, covered in snow.

In the seven years since that report, tests of hardy species by Pacific Northwest Palm & Exotic Plant Society chapter members have continued at an accelerated rate. This expanded experimentation has been due in part to the increasing popularity of palms and subtropical gardening in this part of the world, and to the greater variety of species available in garden nurseries as a result of this popularity. Climate warming may be more perceived than real, but throw in an El Niño or two and it seems winters are definitely warmer here than ten or twenty years ago. In Vancouver, the cause is aided further with a Park Board sympathetic to testing untried palm species in high profile public areas of the city. As a result I can report that there are at least two more species that have survived at least three winters without protection, gaining a tentative foothold in British Columbia and the Pacific Northwest.

The second species to become established is *Chamaerops humilis*, the European Fan Palm. In the warmer parts of Seattle, Victoria and Vancouver mature specimens can be found growing without protection from winter's chill. Included here are photographs of specimens growing outdoors and thriving with no winter protection. The palm in Fig. 1 was planted in 1991 at the front of an apartment block in Vancouver's West End, and has never received any protection beyond its proximity to the building. More are now being planted in this favored area of the city. Other plants can be found on southern Vancouver Island in and around Victoria. Figure 2 illustrates a beautiful, lush palm growing in the garden of Bob McGinn on Salt Spring Island between Vancouver Island and the British Columbia mainland. *Chamaerops humilis* has been planted with a high success rate in British Columbia's Gulf Islands and the San Juan Islands in Puget Sound. Low winter temperatures in these zone 8b areas have for the most part stayed above 20°F (-7°C) throughout the 1990s. Like its cousin *T. fortunei*, *C. humilis* has adapted to the twin dangers of damp winters and inconsistent summers – a combination that has proven lethal for more heat-loving genera, notably *Washingtonia* and *Phoenix*. Specimens have yet to attain the huge size evident in Devon and Cornwall in England and other temperate areas of Europe, but this seems to be just a matter of time. There are now dozens of known specimens throughout the chapter, enough to declare that this species has a reasonable chance of survival if planted in favored locations near the ocean.

The third species to have successfully wintered is *Trachycarpus wagnerianus*, notably in Vancouver's West End where the Park Board has cooperated for years with the Palm Society in promoting a subtropical flavor for the area. Tests with this species were rare five years ago, due mainly to a scarcity of nursery specimens, but in recent years availability has increased a hundred-fold as hardier plants have been grown from local seed. Some nurseries have also introduced California-grown 10- and 15-gallon size plants into their mix to meet the increased demand for a greater variety of outdoor species. In 1998 the Palm Society donated three 15-year-old specimens to the city to be planted in public sidewalk planters in selected locations near the ocean. Spring 2001 marked their third winter at this location with no protection provided at all, not even a mulch around the base. As is evident from the photos taken in April of 2001 (Fig. 3), all three plants show no evidence of frost burn. This species has been in big demand by local palm enthusiasts in recent years with its smaller, rigid fronds and more disciplined appearance. Although more slow growing when young, it's just different enough from *T. fortunei* to be a novelty, a fresh face.

And how much credit for this expanded cultivation can be attributed to changes in climate? An analysis of historical winter temperatures suggests a direct link. The monthly minimum average winter temperatures show only a slight warming trend over the past forty years, not enough to produce such apparent increases in plant viability. What *have* changed however, are the episodes of extreme cold. These have all but disappeared. The lowest temperature on record in Vancouver (the official temperatures are recorded by Environment Canada at Vancouver Airport, a zone 8a area south of the city) and Seattle was recorded during the final days of December, 1950.

2. Bob McGinn photographed beside his beautiful *C. humilis* in August, 1999. It was planted in his garden on Salt Spring Island, BC in 1993. (Photo N. Parker)

3. Three 15-year-old *Trachycarpus wagnerianus*, planted on Vancouver's Beach Avenue in 1998, face their fourth year outdoors unprotected. (Photo N. Parker, April 2001)

In both cities the mercury dropped to -17.8°C (0°F). In Vancouver temperatures almost as cold were recorded in 1964 and again in December, 1968 and into January, 1969 when -16°C (3°F) was recorded during an extended coldspell. Arctic outbreaks this severe would kill most unprotected palms including all but the strongest *Trachycarpus fortunei*. But that was the last time such regimes visited the west coast. In the years since, the coldsnaps have been steadily decreasing in severity and duration. Temperatures below 10°F (-12°C) were recorded in 1978, 1980, 1983, 1985, 1993, and 1996, but in all cases the mercury stayed above 5°F (-15°C). Since January 1993 the temperature has not dropped below -12.5°C (10°F). Reports of gradual global warming have been making headlines in recent years. The data from our part of the world over the past 30 years confirms these suspicions. While coastal areas are still hit with -8° to -10°C (14–18°F) winter nights periodically, I believe it is the absence of extreme temperatures that has allowed the growth of these two hardy species, both of which do not require sustained summer heat.

Of course, as these new species prove themselves and become established, they also become less 'exotic.' Expectations rise and palm enthusiasts start looking around to see what else might prove hardy. A hardy pinnate species, long sought after, now seems to be a viable goal. A few Society members are showing some impressive results with large specimens of *Butia capitata* and *Jubaea*

4. Michael Ferguson planted this *Butia capitata* in his North Vancouver garden in 1995. The emerging spear is occasionally covered in winter. (Photo N. Parker, May 2001)

chilensis. The former has pulled through several winters although many have perished. *Butia* does not like our damp, frosty winters and would prefer hotter summers more typical of conditions in their native habitat. Nevertheless, with some protection, impressive specimens do exist (Fig. 4). Experiments with *Jubaea chilensis* have also been encouraging, although, as with *Butia capitata*, most test specimens are protected here during cold spells. Unlike *B. capitata*, however, *Jubaea* can thrive without hot summers. At least a half a dozen specimens are reporting healthy growth with minimal or no winter protection (Fig. 5).

All over the Pacific Northwest chapter from Oregon to Vancouver Island, Society members now claim to be successfully wintering individual specimens of *Washingtonia robusta, Sabal minor, S. palmetto*, *Livistona chinensis*, *Brahea edulis* and *Rhapidophyllum hystrix*, and even more tender species such as *Arenga engleri, Chamaedorea microspadix* and *C. radicalis* are producing claims of winter survival.

In Victoria on Vancouver Island, Society members have been experimenting for the past five years with some of the new *Trachycarpus* species recently introduced by Martin Gibbons and Tobias Spanner. Grown from seed in unheated greenhouses are test seedlings of *Trachycarpus takil, T. nanus, T. latisectus, T. oreophilus, T. martianus* and *Plectocomia himalayana*. Fred Feige, heading the Island experiments, recently provided a progress report on some of these new species. *Trachycarpus takil* is proving to be the fastest growing of the test species, with minimal pest problems and hardy to -9°C (14°F). *Trachycarpus latisectus,* on the other hand, is proving very difficult to grow. It is slow growing and very susceptible to spider mites but promises to be the most beautiful of the genus. *Trachycarpus oreophilus* is probably not as hardy (Tests on this species are being carried out on Salt Spring Island). In Seattle, Walter Rockfellow has small specimens of *T. nanus* overwintering in his garden with some protection. *Plectocomia himalayana* needs shade and protection. Two-leaf seedlings survived -6°C (21°F) but not -9°C (14°F). Fred has planted small specimens of each outdoors in his Victoria garden. (The Palm Society visited Fred's garden in the summer of 2000 as part of a five-garden tour.)

For palm lovers in the Pacific northwest these are interesting times. With exciting new species to experiment with, a warming climate, and the increasing popularity of exotic gardening, the possibilities grow with each passing season.

Acknowledgments

My thanks to Fred Feige for his report on ongoing hardiness tests with the new species by his fellow gardeners Keith Greenhalgh and Jeff St Gelais in Victoria.

5. Walt Rockfellow planted this *Jubaea chilensis* in his Seattle garden as a 15-gallon palm in 1992. At 9–10 ft tall (3m), it will soon be too large for its nominal winter covering of lightweight fleece sheet. (Photo N. Parker, April 2001)

Livistona chinensis var. *subglobosa* on Aoshima, Japan

HIROSHI EHARA
Faculty of Bioresources
Mie University
Kamihama-cho, Tsu 514-8507, Japan
ehara@bio.mie-u.ac.jp

JOHN LESLIE DOWE
Tropical Plant Sciences
James Cook University
Townsville, Queensland 4811, Australia

RYUJI NAGATOMO AND AKIRA KAWASAKI
The Aoshima Shinto Shrine
Aoshima, Miyazaki 889-2162, Japan

1. *Livistona chinensis* palms in the central zone.

***Livistona chinensis* var. *subglobosa* occurs on the islet of Aoshima, Japan, the northern limit of the range of natural regeneration. Here it is the dominant species of the flora on Aoshima and forms mono-specific stands in many areas.**

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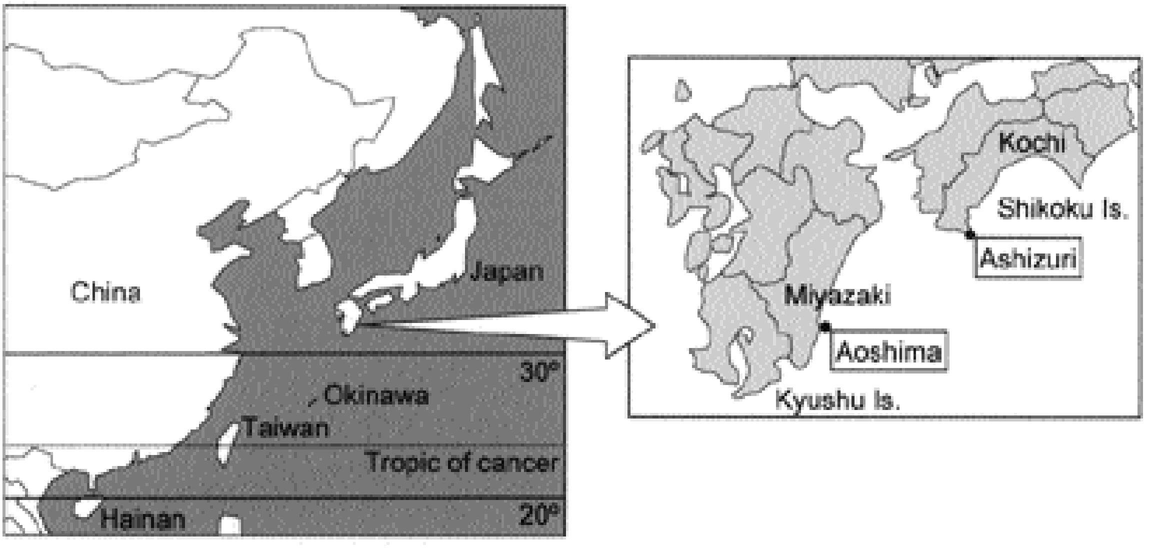
Livistona R. Br., with ca. 34 species, is distributed in the Horn of Africa and Yemen, throughout east and south-east Asia, Malesia to the Solomon Islands and Australia where there is a great diversity of species (Uhl and Dransfield 1987). The ecology of *Livistona* species is varied. *Livistona chinensis* var. *subglobosa* Becc. is distributed in south-eastern China, northern Taiwan, through the Ryukyu Islands to as far north as Kyushu and Shikoku islands (Dransfield 1997), where it occurs in subtropical woodland and littoral forest. According to Horikawa (1972), south-western Shikoku Island is the eastern and northern limit of growth of *L. chinensis*. Here, *L. chinensis* var. *subglobosa* is found in a small area of Ashizuri Promontory, in Kochi Prefecture (Suzuki 1982). This population is remnant, and apparently not capable of sustained self-regeneration. Therefore, the islet of Aoshima, in Miyazaki Prefecture in south-eastern Kyushu, is the northern limit of the range of natural regeneration, with the population being demographically stable with abundant self-regeneration. *Livistona chinensis* is indeed the dominant species of the flora on Aoshima (Fig. 1). Despite its dominance, an understanding of the ecology of *L. chinensis* is limited as the entire population of *L. chinensis* on Aoshima is protected within the boundary of the Aoshima Shinto Shrine, and therefore cannot be disturbed or interfered with in any way.

The Shinto Shrine on Aoshima was established in the ninth century, and since that time the islet has become known colloquially as the 'Islet of the Gods.' The English translation of the islet's name is 'ao,' meaning green or blue, and 'shima,' meaning island. The natural environment has been protected under the stewardship of the Shinto Shrine, that owns all land on the islet. Since 1925, the Japanese Government has recognized the importance of the natural environment on Aoshima, and has therefore forbidden any disturbance or maintenance.

General descriptions of *Livistona chinensis* on Aoshima

Aoshima, an islet of 4400 m^2, is located on the south-eastern coast of Kyushu in Miyazaki Prefecture (31°48'N, 131°28'E), facing the Sea of Hyuga (Fig. 2), and is situated on a basement of so-called 'washboard rocks' (Fig. 3). Elevation is near sea level and topography is mildly undulating. The Kuroshio Current flows northwards from Taiwan through the Ryukyu Islands, thus creating a warm climate on Aoshima that is similar to that on oceanic subtropical islands. Air temperature does not fall below 0°C, the difference between daily maxima and minima is relatively small, and humidity is high, even in winter, compared to the main island of Kyushu (Araki and Kanemaru 1984). This mild climate allows various subtropical and even some tropical plants to grow on Aoshima.

About 27 species of plants are native to Aoshima, with *L. chinensis* var. *subglobosa* the dominant species forming mono-specific stands in many areas. Soils consist primarily of a sub-layer of sand and sea shells on a bedrock basement, and a shallow humus upper layer. Araki and Kanemuru (1984) suggested that the shallow soil on Aoshima was most suitable for shallow-rooted plants such



2. Location of Aoshima in Kyushu Island, Japan, the northern limit of natural regeneration of *Livistona chinensis*.

3. Aoshima islet covered with *Livistona chinensis* palms.

4. Inflorescence of *Livistona chinensis* palm in the eastern zone

as *L. chinensis*, and which may be the primary controlling factor for the palm's abundance. *Livistona chinensis* dominates the northern zone of the islet. Elsewhere other plants also occur. In the central zone, vegetation consists of *Clerodendrum japonicum* Sweet as well as *L. chinensis*; in the south-western zone *Alocasia macrorrhiza* Schott, *Ipomoea indica* (Brum.) Merrill, *Litsea japonica* (Thunb.) Juss., *Arundo donax* L., *Ardisia sieboldii* Miq., *Chimonobambusa marmorea* Makino and *Clerodendrum japonicum* also occur, while in the eastern zone *L. japonica* and *A. donax* also occur.

The number of *L. chinensis* palms with an elongated (i.e., above ground) stem was estimated to be about 5000. A count of 4335 was provided in 1948, but that count has recently been revised upward. The density of palms is very high (Fig. 6). Light conditions on the forest floor are relatively dark, accompanied by high humidity especially in the central zone of the islet. There are many young palms and seedlings growing within the forest over most of the islet.

The tallest palms, to 8 m high, were growing in the central zone where the surface soil was rich in humus (Fig. 1). In the eastern and northern zones, palms reached 6 m tall, and in the south-western zone they grow only to 5 m tall. In this last zone there was considerable competition from *Arundo donax*, particularly at the forest margins.

As for reproductive effort, only old and dead inflorescences were occasionally located (Fig. 4). It has been observed that flowering and fruiting has not occurred for several years on any part of the islet. Regeneration was observed on most parts of the islet, although young plants and seedlings were completely absent from a small area of the eastern zone where the soil surface was covered with dead palm leaves.

There are two hypotheses as to the origin of *L. chinensis* on Aoshima. One involves the dissemination of seeds or vegetative propagules from a southern origin via the Kuroshio Current (Honda 1918), and that the palm is a relatively newly established species on Aoshima. The other hypothesis involves a once widespread palm population that was forced to contract during the Tertiary period due to a cooling climate (Nakano 1925). Accordingly, the Aoshima population is therefore considered a relict of a formerly wider distribution. Confirmation of the past distribution of fan palms beyond their present geographical limits in Japan and nearby regions is held in the fossil record (Ôyama and Matsuo 1964; Chaloner and Creber 1990), but it is not known if these are attributable to *Livistona* or to another genus. Yoshida et al. (2000) conducted RAPD (random amplified polymorphic DNA) analysis of *L. chinensis* in locations in south-west Japan. Their results suggested that seeds or living trunks (or shoots) were disseminated by tidal currents from the south.

Staff of the Aoshima Shinto Shrine conducted a preliminary experiment on seed germination in *L. chinensis*, and found that seeds germinated even after having been soaked in seawater for 60 days. Although detailed data of the germination experiment are not available, their preliminary results support Honda's hypothesis of a southern origin assisted by northward tidal currents. Some of the palms that germinated during that experiment are now growing near the entrance to the Aoshima Shrine in the south-western zone of the islet (Fig. 5). It would be interesting to investigate the genetic distances between *L. chinensis* populations from Aoshima, Taiwan and China to clarify the evolutionary and dispersal background of *L. chinensis* on Aoshima.

Aerial branching of *Livistona chinensis* on Aoshima

During our survey of *L. chinensis* on Aoshima, we found one palm, in the central zone, that had produced aerial branching (Fig. 7). This palm was c. 7 m tall, and it was difficult to distinguish the crowns of the stems from those of the surrounding palms within the canopy. However, both stems of the branching palm carried some green leaves, thus implying continuing growth for the stems. A nearby dead palm had coincidentally come to lean on the fork produced by the aerial branching, following a typhoon during the mid 1990s, and is therefore not the cause of branching, which was initiated much earlier.

There are no former reports of other individuals of the palm where branching has occurred (Nakajima 1984); however, there is anecdotal evidence suggesting that it has occurred previously on at least one occasion. We conclude that the aerial branching in the single individual on Aoshima was caused by some kind of extraneous factor.

Acknowledgments

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facing page:

5 (top). *Livistona chinensis* palms in the south-western zone. Seeds from palms in the south-western population germinated after treatment with seawater.

6 (bottom). *Livistona chinensis* palms in the forest of eastern zone.

7. *Livistona chinensis* palm with an aerially branched stem (central zone).

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PALM LITERATURE

CRC WORLD DICTIONARY OF PLANT NAMES: COMMON NAMES, SCIENTIFIC NAMES, EPONYMS, SYNONYMS, AND ETYMOLOGY. By Umberto Quattrocchi. CRC Press, Boca Raton, Florida. 2000. ISBN: 0-8493-2673-7. US$600, hard bound. 4 vols. pp. 2896

In this set of four volumes, IPS member Umberto Quattrocchi has compiled an extensive list of generic and species names, of which palm names are only a small part. At 8 kg (17.5 lbs) and $600 (or $34.28/pound), this reference set is not aimed at the average palm enthusiast, but rather at the professional taxonomist, research institution or university library.

These volumes do the work of several other books on the library shelf, such as Willis' *A Dictionary of Flowering Plants and Ferns*, Mabberly's *The Plant Book*, Coombes' *A Dictionary of Plant Names*, and Principes' long-running column, "What's in a Name?" The format of the book is alphabetical by genus name, which in each case is followed by author and family. Quattrocchi provides etymology and, for generic names derived from the names of men and women (eponyms), biographical information. He includes generic names without regard to current usage. In other words, generic names long relegated to synonymy are found alongside names in current use. Both *Martinezia* and *Euterpe* are included, although the former has long been regarded as a synonym of the latter. Sometimes classical or recent literature (monographs, revisions, or articles in Principes/ PALMS) is referenced. For some entries, species are listed, and sometimes the etymological derivations of the species epithets are included. Common names in various languages are included too. Missing is some sort of introduction that explains how the author selected names for inclusion in this work.

I very much enjoyed perusing these books, looking up obscure names and brushing up on Latin and Greek. They are the sort of books that one can open to any page and learn something new. In preparing for this review, I sat down with the list of genera given in the inside covers of Uhl and Dransfield's *Genera Palmarum* and started looking up names. I was pleased to see so many palm names included, although Quattrocchi's books are far from complete. Many genera are absent, such as *Aristeyera*, *Beethovenia*, *Kajewskia*, *Rooseveltia* and *Wissmania*. The reader may not miss these names, as they are no longer in use (they are synonyms of *Asterogyne*, *Ceroxylon*, *Veitchia*, *Euterpe* and *Livistona*, respectively). Unfortunately, several genera that are still recognized are missing, viz. *Barcella*, *Basselinia*, *Chambeyronia*, *Lavoixia*, *Medemia*, *Moratia*, *Reinhardtia*, *Veillonia*, and *Welfia*.

Quattrocchi documents no fewer than nine common names used in Italy for *Chamaerops humilis*. He gives 19 names used in Gabon for *Elaeis guineensis* and an astonishing 26 names used in India for *Caryota urens*! In other cases, the selection of species and their common names appears somewhat arbitrary and puzzling. Why is a Brazilian name for *Balaka seemannii*, a palm of Fiji, included but a Fijian name is not? Japanese and Brazilian names are given for *Sabal minor*, an American palm widely cultivated in Europe, but French, Spanish, and Italian names are not provided. The reader is left wondering why so many names are included but so many more are not. I had the suspicion, while using these books, that names were included only when the Quattrocchi happened upon them, that he did not actively seek out sources of common names. As there is no explanation of his methods, I was left with my suspicions. Regrettably, I did not feel that these books are in any way exhaustive and authoritative.

It is in the mini-biographies provided for each eponym that Quattrocchi really shines. The people honored by *Barkerwebbia*, *Jessenia*, *Liberbaileya*, *Maxburretia*, *Neonicholsonia*, *Pichisermollia*, *Sommieria* and others are given extensive treatments, with references to their published works on botany and other topics, along with other biographical sources. I learned that *Alfonsia* (a synonym of *Elaeis*) honors Alfonso II (1533–1597), an Italian aristocrat, the fifth and last Duke of Ferrara and patron of the greatest Italian poet of the late Renaissance, Torquato Tasso, who is celebrated for his epic poem "Gerusalemme Liberata." I was also fascinated by the number of palm genera named after astronomers: *Brahea*, *Copernicia* and *Gaussia* (*Keppleria* might also be added to this list, but I found no entry for this genus). What is the connection, I wonder, between palms and planets?

Quattrocchi follows standard etymologies for the palm names with which I am familiar. Readers of the books have the opportunity to learn the difference in meanings of *Cyphokentia* and *Siphokentia*, although Quattrocchi is not always able to get into the minds of the botanists who contrived the names. The etymology is unambiguous, but the reasoning behind *Hyospathe* ("pig spathe") is a mystery. For a few entries, no etymological information was provided. For example, *Sagus* and *Solfia* are included but without explanation. A quick check in my ten-year index to Principes revealed that *Solfia* honors Wilhelm Solf, governor of German Samoa in 1900 (Moore. What's in a name? Principes 14: 116. 1970) and that *Sagus* is derived from an Indonesian/Malay vernacular name (Dransfield. What's in a name? Principes 38: 145. 1994).

The business of naming and classifying plants continues on a thousand different fronts. One hopes that Quattrocchi will keep pace with the changes and make significant additions and corrections to future editions of his opus. One also hopes that CRC Press will consider issuing an inexpensive version of the *Dictionary* on CD-Rom, which will allow more readers to have access to this useful work.

INSECTS ON PALMS. By F.W. Howard, D. Moore, R.M. Giblin-Davis and R.G. Abad. CABI Publishing, New York. 2001. ISBN: 0-85199-326-5. US$120, hard bound. pp. 400.

This book invites comparisons with what is perhaps the only other book of its kind – Lepesme's *Les Insectes de les Palmiers*, published in 1946 and long out-of-print and out-of-date – but in this modern work, Howard and co-authors have bested Lepesme and set a new standard. What sort of book is *Insects on Palms*? It is not merely a pest control guide, although pest control operators will certainly find it very useful. It is not a taxonomic or faunistic account of all the insects associated with palms, although the work covers a wide range of taxa and regions. In fact, the book is a broad survey of the many kinds of insects associated with palms, both beneficial and detrimental and gives life history data, control and integrated pest management strategies and fascinating insights into the world of economic entomology. Large-scale palm growers in the tropics, tropical ecologists and entomologists will want to have this book in their reference collection. In the authors' own words, "To understand the natural history of palms, to protect them in cultivation and to conserve them in the wild, it is important to try to understand their relationships with insects."

The book begins with introductions to both the class Insecta and the palm family, thus ensuring that, whether the reader's background is entomology, botany or horticulture, he or she will have the necessary foundation to understand successive chapters. The introduction is followed by "Defoliators of Palms," "Sap-feeders on Palms," "Insects of Palm Flowers and Fruits" and "Borers of Palms." By organizing the chapters according to how and where the insects feed on palms, the authors have made their subjects accessible and comprehensible. Within each chapter, insects are discussed by order, and I happily note that, despite the book and chapter titles, mites are also included. These chapters discuss the major pests of the three most important crop palms, coconut, date and African oil palm, but the lesser-known pests of ornamental palms and the crop pests of limited distribution are also given appropriate attention. Given that the insect faunas for 85% of palm genera are completely unknown, the authors are to be congratulated on amassing and synthesizing so much useful data. Also included are line drawings, half-tones and color illustrations of damage caused by insects and the culprits themselves.

Interspersed among the text are a number of delightful text boxes describing such things as the history of biological control of certain coconut pests, the uses of palms throughout the world and the nomenclature of palm diseases. I especially enjoyed the story of how "good entomology, teamwork, monumental determination and no small amount of luck" led to the successful biological control of a moth larva pest of coconuts on Fiji. The epic story, involving the detection, capture, transport and release of a parasitic fly from Malaysia into the coconut fields of Fiji, is as gripping a yarn as has ever been told in biology.

The book continues with chapters on pest control and integrated pest management. The authors provide information on chemical control, but more importantly, they stress many forms of biological control that are more eco-friendly and less costly for farmers in developing countries. The final chapter, "Field Techniques for Studies of Palm Insects," is as unexpected as it is welcome. Throughout the book, the authors point out areas in which questions still remain, questions of natural history, ecology, host-parasite relations and distribution. The final chapter will help students and researchers design experiments and collect data that will, in the future, answer some of the many questions that remain. I can think of no higher praise for this book than to say it will doubtlessly inspire an entire generation of entomologists working with palms. The impact of this book will reverberate through universities, agricultural research stations and museums for many years to come.

SCOTT ZONA
FAIRCHILD TROPICAL GARDEN

A New Palm Cultivar: *Cyrtostachys renda* 'Theodora Buhler'

HOWARD WADDELL
6120 SW 132 Street
Pinecrest, FL 33156
USA

1. *Cyrtostachys renda* 'Theodora Buhler' in the Conservatory at Fairchild Tropical Garden.

In this article, a rare and unusually colored cultivar of *Cyrtostachys renda* of somewhat mysterious origin is described. This cultivar has been named after one of the original members of The Palm Society, Theodora Buhler. Surviving transplanting, freezes, and hurricanes, Teddie's palm has grown outdoors for nearly 30 years.

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2. Note the multi-colored vertical striping on the internodes and the distinct leaf scars on the stems.

3. The crownshafts of this unusual palm exhibit orange and yellow-green vertical stripes.

Recently, Theodora Buhler, one of the original members of The Palm Society, as it was known before it became The International Palm Society, celebrated a landmark birthday with friends and family in Miami, Florida where she has lived since 1935. Over the years, Teddie has played an important role in the growth and development of IPS.

In 1972, when she joined the board of directors as executive secretary, a position she held until 1980, Teddie took responsibility for mailing dues notices, collecting dues, answering all correspondence, labeling and mailing Principes (now PALMS), and storing all back issues of the journal. During that time, IPS membership grew from 600 to 1500. Teddie also served on the board of directors of The South Florida Chapter of IPS (now The South Florida Palm Society) and still regularly attends general meetings.

Teddie also has been a frequent contributor to Principes and PALMS for as long as they have been published. Her most recent article, "*Livistona carinensis* in Miami, Florida USA," appeared in the March 2001 issue of PALMS.

Shortly after moving to the retirement community where she now lives, Teddie commandeered a small parcel of vacant land on the property and created a palmetum that is home to approximately 100 species of palms, many of which are now mature specimens. Teddie also has a small collection of palms growing in her backyard. One of these palms is a uniquely colored and somewhat mysterious cultivar of *Cyrtostachys renda*.

In the autumn of 1969, Fairchild Tropical Garden received 80 *Cyrtostachys renda* seedlings from U.A. Young, a physician who would become president of The International Palm Society in 1974. Fairchild's records show that the original seed for Young's plants came from the Bogor Botanic Garden on the island of Java in Indonesia.

Today, the whereabouts of only three of those original plants is known. Two are in the conservatory at Fairchild. The other is in Teddie Buhler's private garden.

An inquiry with Bogor Botanic Garden revealed that no donations of *Cyrtostachys* seed were recorded in the late 1960s. It also revealed that no *Cyrtostachys* looking like the three plants in Miami is currently in the Bogor collection. Consequently, there is no information about the parent plant or its origin. And the plant is certainly no longer available for seed production or vegetative propagation. Unfortunately, the existing plants in Miami are not known ever to have flowered, let alone fruited. *Cyrtostachys* in Miami rarely do.

What is unique about these palms is not the brilliance of their coloring but the coloring itself (Front Cover). A description of the plants follows:

The palm is heavily clustered with unarmed, erect, bare stems to about 5 meters. Stem diameter ranges from 90 mm at the base to 50 mm at the lower edge of the crownshafts. The stems show distinct, white leaf scars with 80–300 mm separation. At the bases of the main stems are masses of adventitious roots.

The freshly exposed internodes, directly below the crownshafts, have thin but conspicuous vertical stripes of purple and green (Fig. 1). These colors match the various shades of Greyed Purple 187 and Yellow-Green 152 in the Royal Horticultural Society's Colour Chart. The upper, more mature internodes also show the same vertical striping but include two additional colors, Green 137, which predominates, and Red-Purple 59 (Fig 2).

The leaves are pinnate with each main stem having 6–8 upright leaves of approximately 265 cm in length. Leaflets are green on both upper and lower sides. There are 40–45 regularly arranged leaflets on each side of the leaf. The acuminate leaflets, themselves, are up to 40 mm wide and 60 cm long.

The well-defined crownshafts are approximately 75 cm in length. Like the internodes, the crownshafts are colored by thin vertical stripes but, in this case, different shades of orange and some green. Matching RHS colors are Grayed Orange 172 on the darker crownshafts and Grayed Orange 167 and Yellow-Green 152 on the lighter crownshafts (Fig. 3).

Despite their size and coloring, the plants at Fairchild often go unnoticed by visitors to the conservatory because they are located just a few feet from an attention-grabbing *Cyrtostachys renda* whose spectacularly bright crownshafts (RHS Orange-Red 34) are at eye level.

Teddie Buhler's plant was originally planted at her home on an island in Biscayne Bay, between Miami and Miami Beach. In 1980, when she moved to her current home on the mainland, Teddie took her *Cyrtostachys* with her. Planted in the ground, this palm survived Miami's Christmas Eve freeze of 1989 and a direct hit by Hurricane Andrew in 1992 although the storm did break the plant's main stem. Today, this plant is less than half the size of the plants at Fairchild but is very healthy.

To recognize Teddie Buhler for her many years of service to The International Palm Society, the unique striped *Cyrtostachys* cultivar discussed in this article has been named *Cyrtostachys renda* 'Theodora Buhler.' A botanical illustration of this cultivar was commissioned by The South Florida Palm Society (Front Cover) and resides for posterity in the Fairchild herbarium with specimens from the plant.

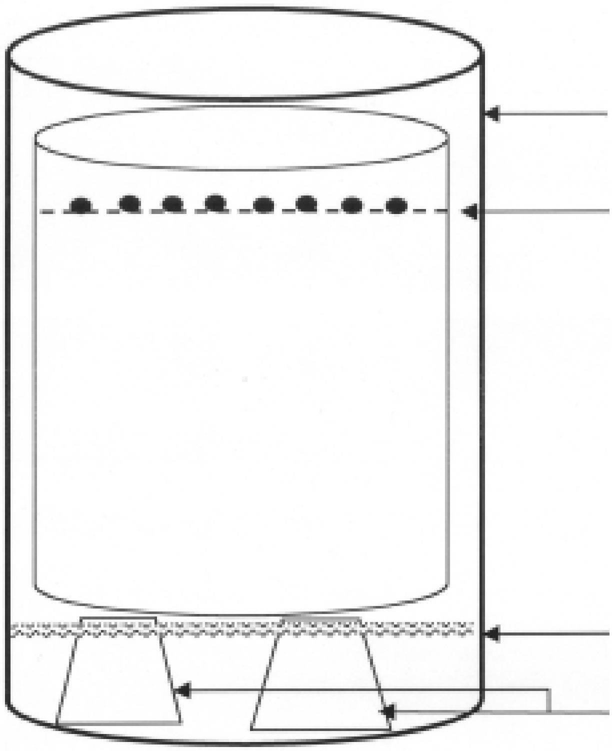
As an ironic postscript, it was learned when preparing this article that Teddie herself had been giving serious thought to writing her own article for PALMS about this same *Cyrtostachys* cultivar. We are hopeful that she will be forgiving of our having contacted the editors before she did.

Acknowledgements

I thank the following people who assisted me with the research for and preparation of this article: Jocko Witono at the Bogor Botanical Garden, Mary Collins and Dr. Scott Zona at Fairchild Tropical Garden, Chris Migliaccio and Libby Besse.

Germinating *Gastrococos* – Quickly and Easily

CHRIS MIGLIACCIO
Dept. of Natural Sciences, Health & Wellness,
Miami-Dade Community College
300 NE 2nd Avenue
Miami, Florida 33157, USA
cmigliac@mdcc.edu



1. Drawing of pot used to germinate *Gastrococos.*

Gastrococos crispa **is considered a difficult palm to germinate because of the thick seed coat. A quick and reliable germination technique is presented here.**

Gastrococos crispa is a solitary, swollen-trunked palm native to the alkaline savannas of Cuba. It is cultivated worldwide in the humid tropics and warm subtropics because of its unique beauty (Back Cover). However, while mature specimens in South Florida regularly fruit, this palm has a reputation as being difficult to germinate.

Local growers have reported that the key to germinating *Gastrococos* is heat and humidity, and have described such strategies as placing seeds in plastic ziplock bags and placing them in trays on rooftops or in attics, burying the seeds in compost piles and then digging out the seedlings, or planting seeds in community pots of decom-

2. *Gastrococos* endocarps, whole and sectioned.

posing oak leaves and pine needles. Time to germination has always been measured in months to a year. So, after many years of unsuccessful attempts to germinate *Gastrococos* myself with the traditional methods (community pots or zipock bags of damp sphagnum moss kept in warm locations), I decided to try to increase the heat and humidity as much as possible.

Fig. 1 shows a simple and inexpensive method I developed that results in a germination rate of over 90% in as short a time as two weeks during our summer season.

An important key to success is to use fresh seeds. Ripe fruits are orange-yellow and contain an irregularly globose, pitted, black endocarp 2–4 mm thick that contains the seed (Fig. 2). Throughout this paper, I refer to the endocarp and seed together as the "seed."

The key to this method is finding the largest plastic pot that easily fits inside a bucket with a tight-fitting lid. This enables the maximum number of seeds to "steam." A 25-cm (10-inch) pot in a 20-liter (5-gallon) bucket holds about 35 seeds in a single surface layer. This technique is upwardly scalable for larger seed quantities as long as temperature and humidity are maintained at a high level.

During the time of this trial (May–September 2001), daily air temperatures ranged from 26–33ºC (78–92ºF) while water temperatures in the bottom of the bucket ranged from 26ºC (78ºF) after four days of cloudy weather to 33ºC (92ºF), the typical daytime water temperature. Soil temperature around the seeds ranged from 27ºC (80ºF) at night to 43ºC (110ºF) (daytime under sunny conditions). Humidity inside the bucket was not measured but was very high. No condensation was observed on the walls or lid of the bucket.

Using this method, I have been able to germinate *Gastrococos* in as short a time as two weeks, with

3. The saxophone stem of *Gastrococos*.

four weeks being the average time. Because *Gastrococos* has remote germination, once the cotyledonary stalk emerges from the seed, I carefully remove the seedling and place it in its own pot with a well-drained mix. The first seedling leaf is visible above the soil in about 2–3 weeks after the cotyledonary stalk emerges. All leaves have golden-brown prickles – making handling the seedling a matter for care. The stem is descending shortly and recurved "saxophone style" (Fig. 3).

In South Florida, it takes about 6–8 years before the palm begins to develop an upright stem with overlapping leaves that precedes trunk development. Even at this stage, *Gastrococos* is a showy addition to any garden and is deserving of wider cultivation (Fig. 4). Perhaps with this germination method, plants will become more readily available.

Acknowledgements

I would like to thank South Florida palm enthusiasts John Bishock, Dale Holton and Howard Waddell for sharing their *Gastrococos* growing techniques with me.

4. Photo of juvenile *Gastrococos* next to Vivian Waddell in Howard and Vivian Waddell's garden in South Florida (Photo. C. Migliaccio).

Growth Response of *Phoenix canariensis* to Inoculation with Arbuscular Mycorrhizal Fungi

ASUNCIÓN MORTE
AND
MARIO HONRUBIA
Dpto. Biología Vegetal, Facultad de Biología, Universidad de Murcia, Campus de Espinardo 30.100, Murcia, Spain. Email: amorte@um.es

Roots of palms are known to be mycorrhizal (St. John 1988a, Blal et al. 1990, Zona 1996, Fisher and Jayachandran 1999). Mycorrhizal colonization promotes palm growth in nutrient-poor native soil (Janos 1977) and is potentially significant in the ecology of wild palms and in the cultivation of ornamental palms (Fisher and Jayachandran 1999).

Artificial mycorrhizal inoculation in palm culture is particularly appropriate as nursery conditions often eliminate or exclude native symbionts through the use of sterilized soil or biocides, over-fertilization or other incompatible practices. Therefore, plants produced in the nursery may suffer slow growth during the nursery phase and consequently be at a considerable disadvantage when transplanted to the field (St. John 1988b).

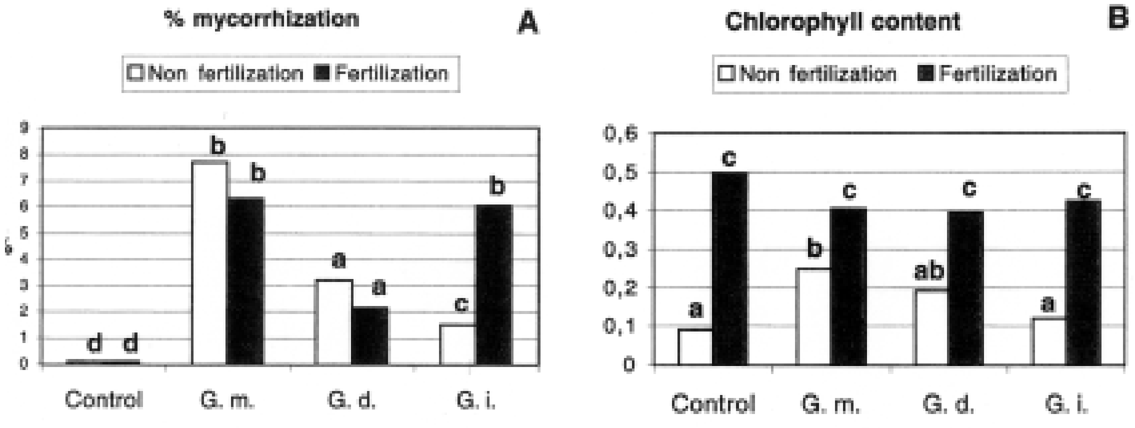
The objective of this work was to evaluate the effect of three arbuscular mycorrhizal fungi (*Glomus mosseae* Nicholson & Gerdeman, *G. deserticola* Trappe, Bloss & Menge and *G. intrarradices* Schenck & Smith) on the growth and mineral nutrition of Canary palms (*Phoenix canariensis* Hort. et Chabaud) in fertilized and unfertilized conditions, in an attempt to reduce the time to harvest and fertilization costs.

Materials and methods

One-month old seedlings of *P. canariensis* were inoculated with *G. mosseae* (I.C.I.A., La Laguna, Tenerife, Spain), *G. intraradices* (BEG 72, IRTA, Cabrils, Spain) and *G. deserticola* (Estación E. Zaidin, CSIC, Granada, Spain) at the moment of transplanting from the nursery bed to pots (3 l). The inoculum per plant consisted of 20 g of rhizosphere soil from Sudan grass (*Sorghum sudanense* (Piper.) Stapf.) stock culture, containing spores and infected root fragments. The pot substrate was peat:compacted pine bark (2:3 by volume). The substrate was sterilized by autoclaving at 100ºC for 1 hour.

For each fungal treatment, 100 plants were inoculated and 100 plants were left uninoculated as a control (the total number of plants was 400).

Half of the plants (50 plants/ treatment) were maintained unfertilized and were arranged randomly in the greenhouse where maximum/ minimum temperatures were 22–30ºC and relative humidity was maintained at around 60%. The other half (50 plants/treatment) were fertilized with an N–P–K (10–20–5) solution during the autumn and winter and with ammonium nitrate 33.5% during the spring and summer at nursery conditions with temperatures ranging from



1. Mycorrhizal colonization percentage and chlorophyll leaf content of *Phoenix canariensis* inoculated with *Glomus mosseae* (G. m.), *G. deserticola* (G. d.) and *G. intraradices* (G. i.) in both fertilized and unfertilized conditions twelve months after inoculation. Data followed by the same letter in a column are not significantly different according to Duncan's test (P< 0.05).

15–37ºC, and the relative humidity was between 50–70%. The pots were watered as needed.

At harvest (1 year after mycorrhizal inoculation) 10 plants/treatment were analysed. Fungal colonization was assessed on cleared and stained root samples (Phillips and Hayman 1970) after the inoculation process to check the presence or absence of mycorrhiza. The percentage of fungal root colonization was estimated according to the gridline intersect method (Giovannetti and Mosse 1980) under a stereomicroscope. Harvested plants were weighed and the percentage of colonization was determined before the plants were dried for 48 hours at 100ºC to determine the relative water content. To determine the chlorophyll content, plants were harvested, weighed and stored at minus 20ºC. Chlorophyll was extracted in acetone. The absorbance of the chlorophyll extract was assessed with a spectrophotometer, and chlorophyll concentration was calculated with the equations of Inskeep and Bloom (1985).

Dry shoot samples were used to determine nutrient content. Mineral concentrations (N, P, K, Na, Ca, Mg, Fe, Mn, Zn and B) were measured in both shoots and root tissues. Determinations were made by M.A.P.A. method (1981).

The effects of treatment were assessed by an analysis of variance and treatment means were compared by least significant difference (P<0.05) using Duncan´s test.

Results

The percentage colonization by mycorrhizae was very low and did not exceed 8% in any case (Fig. 1A). In spite of this, all the measured growth parameters (plant height, leaf number per plant, fresh and dry weights, stem diameter and leaf length) indicated that the plants with mycorrhizae were significantly more developed than the control plants in both fertilized and unfertilized conditions. *Glomus mosseae* stimulated these parameters to the greatest extent under both

Table 1. Growth response of *Phoenix canariensis* to inoculation with *Glomus mosseae*, *G. deserticola* and *G. intraradices* in unfertilized conditions twelve months after inoculation. Data followed by the same letter in a column are not significantly different according to Duncan's test (P< 0.05).

Treatment	Plant height (cm)	Leaf L (cm)	Base stem diam. (mm)	Leaf no.	Fresh wt. (g)	Dry wt. (g)
Control	30.4 c	19.9 b	12.9 b	5.5 b	13.5 c	4.5 c
G. mosseae	38.4 a	24.5 a	19.9 a	6.8 a	34.7 a	11.4 a
G. deserticola	33.7 abc	32.1 a	20.2 a	6.6 a	31.2 ab	9 ab
G. intraradices	32.5 bc	21.8 ab	18.5 a	6.1 ab	20 bc	6.5 bc

Table 2. Growth response of *Phoenix canariensis* to inoculation with *Glomus mosseae*, *G. deserticola* and *G. intraradices* in fertilized conditions twelve months after inoculation. Data followed by the same letter in a column are not significantly different according to Duncan's test (P< 0.05).

Treatment	Plant height (cm)	Leaf L (cm)	Base stem diam. (mm)	Leaf no.	Fresh wt. (g)	Dry wt. (g)
Control	26.9 a	16.1 b	24.1 b	7.3 b	35.7 b	13.3 a
G. mosseae	30.9 b	20.9 c	28.6 a	8.1 a	51.2 a	17.1 a
G. deserticola	27.2 a	17.2 ab	27.5 a	8 ab	44.5 ab	16.9 a
G. intraradices	28.9 ab	18.7 a	27.3 a	7.6 ab	51.5 a	13.3 a

cultivation conditions, followed by *G. deserticola*. The fertilization did not affect the percentage colonization by *G. mosseae* and *G. deserticola*. However, this parameter was lower with *G. intraradices*-colonized and unfertilized plants than fertilized palms.

The leaf chlorophyll content increased significantly over uninoculated control levels in unfertilized palms inoculated with *G. mosseae* and *G. deserticola* but not with *G. intraradices* (Fig. 1B). However, no significant differences were observed in this parameter in the case of fertilized palms, inoculated with the fungi. The fertilized palms presented a higher chlorophyll content respect to the unfertilized palms in all the cases.

With respect to the growth parameters (Tables 1 and 2), there were only significant differences between control and all mycorrhizal/fertilized and unfertilized plants in the base stem diameter for the three tested fungi (Tables 1 and 2), mycorrhizal/fertilized plants having a greater base stem diameter and in plant height with *G. mosseae* (greater for unfertilized palms). In fresh and dry weights and in leaf length and number, there were also significant differences between control and *G. mosseae* and *G. deserticola*-colonized plants but not with *G. intraradices*-colonized plants in unfertilized conditions (Table 1). However, these growth parameters were only stimulated with *G. mosseae* (except dry weight), *G. intraradices* increased leaf length and fresh weight but *G. deserticola* did not stimulate any of them in fertilized conditions (Table 2).

Colonization by mycorrhizae also improved the mineral nutrition of Canary palm. In the case of the fertilized palms, the improvement was only significant for phosphorus, the content of which increased more than twice in plants inoculated with *G. mosseae* (110%), by 60% with *G. intraradices* and by 20% with *G. deserticola* (Table 4). In non-fertilized palms, this nutritional improvement was significant for phosphorus (Table 3), which increased by 54% with *G. mosseae*, 46% with *G. deserticola* and 61% with *G. intraradices,* and potassium, the content of which increased by 60% with *G. mosseae*, 15% with *G. deserticola* and 37% with *G. intraradices*. There was a significant decrease in the manganese content in leaves of *P. canariensis* plants inoculated with all three fungi and an increase of 40% in the sodium content of palms inoculated with *G. deserticola*. However, no significant increase was observed for nitrogen content in any of the cases.

Discussion

The low colonization percentage recorded was partly due to a methodological sampling problem; many of the small mycorrhizal roots were lost during sampling because they are very brittle. Another reason for this low colonization percentage is that the palms begin their mycorrhizal association very late, the fungal colonization was observed periodically (every two months) and it started at eight months from the inoculation.

The study began with one-month old seedlings and the experiment lasted 12 months. A low colonization percentage was also observed in *Phoenix roebelenii* (Jaizme-Vega and Díaz-Pérez 1999).

The positive effect of mycorrhizal colonization on Canary palm growth has been also observed in other palms like *Bactris gasipaes* (Janos 1977), *Oenocarpus* (as *Jessenia*) *bataua* (St. John 1988b) and *Phoenix dactylifera* (Oihabi et al. 1993). This confirms data already reported in other plant species (Hayman and Tavares 1985, Aziz and Habte 1990, Díaz and Honrubia 1993, Morte et al. 1996), which show that even with low percentages of colonization, arbuscular mycorrhizal fungi could significantly improve plant growth.

No significant differences were observed in leaf chlorophyll content in the case of fertilized palms

Table 3. Average mineral concentrations measured in shoot tissues of *Phoenix canariensis* after 12 months from inoculation with three mycorrhizal fungi and non-inoculated control palms in fertilized conditions. Average based on 10 replicates. Data followed by the same letter in a column are not significantly different according to Duncan test (P< 0.05).

Treatment	N %	P %	K %	Ca %	Mg %	Na %	Fe mg/kg	Mn mg/kg	Zn mg/kg	B mg/kg
Control	2.08 a	0.10 a	1.49 a	0.56 a	0.15 a	0.22 a	125.3 a	63.2 a	23.8 a	10.3 a
G. mosseae	2.29 a	0.21 b	1.65 a	0.62 a	0.19 a	0.20 a	111.1 a	58.2 a	22.1 a	11.7 a
G. deserticola	2.10 a	0.12 c	1.59 a	0.55 a	0.16 a	0.23 a	119.7 a	63.1 a	26.7 a	23.2 a
G. intraradices	2.25 a	0.16 d	1.52 a	0.41 a	0.17 a	0.24 a	111.2 a	56 a	27.6 a	15.6 a

Table 4. Average mineral concentrations measured in shoot tissues of *Phoenix canariensis* after 12 months from inoculation with three mycorrhizal fungi and non-inoculated control palms in unfertilized conditions. Average based on 10 replicates. Data followed by the same letter in a column are not significantly different according to Duncan test (P< 0.05).

Treatment	N %	P %	K %	Ca %	Mg %	Na %	Fe mg/kg	Mn mg/kg	Zn mg/kg	B mg/kg
Control	0.535 a	0.13 a	1.29 a	0.58 a	0.12 a	0.42 a	66.3 a	68.7 a	45.3 a	20.2 a
G. mosseae	0.735 a	0.20 b	2.07 b	0.48 a	0.13 a	0.37 a	70.1 a	35.7 b	36.5 a	19.2 a
G. deserticola	0.725 a	0.19 b	1.49 ac	0.51 a	0.16 b	0.59 b	64.1 a	50 ab	63.6 a	28.9 a
G. intraradices	0.615 a	0.21 b	1.77 bc	0.55 a	0.14 ab	0.42 a	61.7 a	49.9 ab	38.8 a	19.2 a

inoculated with the fungi, probably because there was no limitation in nutrient availability.

In this study, mycorrhizal plants had higher internal phosphorus concentrations than non-mycorrhizal ones in both fertilization and non-fertilization conditions. These concentrations were correlated with increased plant growth especially in plants inoculated with *G. mosseae*. In studies involving *P. roebelenii*, the sodium and potassium contents increased but phosphorus did not (Jaizme-Vega and Díaz-Pérez 1999) while in *P. dactylifera,* the phosphorus content was four times higher in mycorrhizal plants than in control plants (Oihabi et al. 1993). The different results obtained on mineral nutrition of diverse palm species could be influenced by the use of artificial medium and not natrual soil, but not only because of the physical-chemical characteristics, but also because a different microbial (fungi-bacteria) populations could affect growth of the introduced arbuscular fungi.

These results indicate that fertilization could be reduced in mycorrhizal plants, especially with *G. mosseae*, without affecting growth during the first year of nursery growth. However, futher studies are necessary to test the right level of fertilization reduction and the possible effect on plant growth of this reduction during following years in nursery.

Conclusions

The colonization of individuals of *P. canariensis* by mycorrhizae during their first year of growth in the nursery increased growth and mineral nutrition, demonstrating the clear dependence of this palm on arbuscular symbiosis. Under the conditions of the present trial, mycorrhizae shortened the length of time needed for the palms to mature, although mid- and long-term overall effects still need to be evaluated.

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CLASSIFIED

Non-Native Ornamental Palms Invade a Secondary Tropical Forest in Panama

JENS-CHRISTIAN SVENNING
Smithsonian Tropical Research Institute
Unit 0948
APO AA 34002-0948
USA

current address:

Dept. of Systematic Botany
Biological Institute
University of Aarhus
Nordlandsvej 68
DK-8240 Risskov
Denmark
svenning@biology.au.dk

Palms are often introduced outside their natural range as beautiful and spectacular ornamentals. Some species may however invade natural vegetation and could become a threat to local native species.

Invasive alien organisms are a serious threat to native species and even ecosystems in many parts of the world. While invasive plants cause serious conservation problems in tropical forests on many oceanic islands, continental tropical forests seem to have been much less affected. However, with increasing fragmentation and disturbance of tropical forests this situation may well change (cf. Phillips 1997; Laurance 2000). A few published accounts of such invasions of continental forests already exist (e.g., Laurance 2000). Notably, in an isolated 4-ha forest fragment in the Singapore Botanic Gardens some alien plant species have become common and as many as five non-native palms species now occurs there (Turner et al. 1996). In North America the far majority of invasive woody plants are escaped ornamental species (Reichard & White 2001). As palms are among the most preferred ornamental plants in tropical areas, problems with invasive palms species are to be expected. In fact, palms have invaded forests from botanical gardens and urban areas in many parts of the tropics (e.g., Lorence & Sussman 1986; Jones 1995; Turner et al. 1996; Horvitz et al. 1998; Maunder et al. 2001). While little is known about the effects of invasive non-native palm species on the natural tropical plant communities, some appear to be crowding out native plants (even other palms); e.g., *Heterospathe elata* on Guam (Jones 1995) and *Livistona chinensis* on Mauritius (Maunder et al. 2001). Here I will describe an example where non-native ornamental palms massively invade a tropical secondary forest in Panama and seem likely to become an abundant, if not dominant, long-term part of the vegetation.

Study site

Gamboa (09° 07’ N, 79° 41’ W) is a town of c. 150 houses located at the Panama Canal and surrounded by the 22,104 ha Parque Nacional Soberania. The climate in the area is tropical monsoon climate and the natural vegetation is semi-deciduous tropical forest. The study site is a

1. Numerous *Roystonea* cf. *regia* seedlings, the Gamboa forest.

2. *Ptychosperma macarthurii*, the Gamboa forest.

c. 16 ha secondary (probably 40-60 years old) forest that divides Gamboa in two parts. The forest canopy is generally 15-20 m in height, but with taller emergent trees, and is mainly composed of tree species such as *Anacardium excelsum*, *Apeiba tibourbou*, *Bursera simarouba*, *Cecropia* spp., *Cordia alliodora*, *Ficus* sp., *Guazuma ulmifolia*, *Gustavia superba*, *Luehea semannii*, *Miconia argentea*, *Ochroma pyramidale*, *Schefflera morotoni*, *Spondias mombin*, *Triplaris americana*, *Virola sebifera*, and *Xylopia* spp. Lianas such as *Gouania lupuloides* are abundant, and the understory is often dense. Some typical understory plants are the coarse herbs *Aechmea magdalenae*, *Carludovica palmata*, *Costus* spp., *Cyclanthus bipartitus*, *Heliconia* spp, and *Renealmia cernua*, the slender bamboos *Chusquea simpliciflora*

3. *Areca triandra*-dominated understory, the Gamboa forest.

4. Well-established juvenile of *Livistona saribus*, the Gamboa forest.

and *Rhipidocladum racemiflorum*, the grasses *Pharus latifolius* and *Olyra latifolia*, the ferns *Adiantum* spp., *Cyclopodium semicordatum*, and *Tectaria incisa*, and various shrubs and treelets, e.g. *Cupania* spp., *Lacistema aggregatum*, *Piper* spp., *Psychotria pubescens*, and *P. poeppigiana*. Palms are among the most abundant plants throughout the forest, in particular in the understory and midstory.

The local palm flora

The palms comprise 14 species, only six of which are native to Panama. Of these, three are relatively common: the spiny, clonal understory palm *Bactris major* Jacq., the clonal midstory/canopy palm *Oenocarpus mapora* H. Karst. and the climbing *Desmoncus orthacanthos* Mart. The spiny midstory palm *Astrocaryum standleyanum* L. H. Bailey, the massive canopy palm *Attalea butyracea* (Mutis ex L. f.) Wess. Boer, and the massive understory palm *Elaeis oleifera* (Kunth) Cortés have more scattered occurrences. Outnumbering the native palms, eight species of exotic palms have invaded the forest:

Aiphanes aculeata Willd. – Trinidad to Colombia, SW Brazil to Peru and Bolivia.

Areca triandra Roxb. ex Buch.-Ham.– India and Southeast Asia.

Bentinckia nicobarica (Kurz) Becc. – Nicobar Islands.

Dypsis madagascariensis (Becc.) H. Beentje & J. Dransf. – Madagascar.

Livistona saribus (Lour.) Merr. ex A. Chev. – South-East Asia

Ptychosperma macarthurii (H. Wendl. ex H.J. Veitch) H. Wendl. ex Hook. f. – Australia and New Guinea.

Roystonea oleracea (Jacq.) O. F. Cook – Lesser Antilles to Colombia

Roystonea regia (Kunth) O. F. Cook – Northern Caribbean.

Status of the non-native species

Of these eight species, at least four appear completely naturalized, all having many reproductive adults in the forest and lots of regeneration: *Roystonea regia* occurs in high abundance as both seedlings (Fig. 1) and juveniles throughout and appears to be more or less taking over a wet, central part of the forest. It is also quite frequent as large subadults and adults all over the forest, and is by far the most abundant palm reaching the upper canopy. *Ptychosperma macarthurii* (Fig. 2) and *Areca triandra* (Fig. 3) are abundant as seedlings, juveniles, and adults in the western half of the forest and sometimes completely dominate the understory. While *Aiphanes aculeata* is less abundant, it is nevertheless common both as immature and adult individuals in most of the forest.

Roystonea oleracea has a much more restricted occurrence in the forest, being concentrated in one creek, but here appears well naturalized with many adults and much regeneration (as I was unable to distinguish seedlings and juveniles of the two *Roystonea* spp., I am assuming that they belong to the species whose adults occur most close by). *Dypsis madagascariensis* occurs only in a small, peripheral area of the forest, but here has both juveniles and adults. The related *Dypsis lutescens* (H. Wendl.) Beentje & J. Dransf. is very frequently planted in gardens in Gamboa and produces lots of seedlings there, but apparently is unable to invade the forest. While *Livistona saribus* has no adults in the forest, it is abundant as well-established, small to massive (leaves reaching 3–5 m in height) juveniles in much of the forest (despite only a limited number of adults in Gamboa) (Fig. 4). It seems likely that at least some of these juveniles will be able to reach maturity and thus it may simply be a question of time before *Livistona saribus* becomes naturalized, too. *Bentinckia nicobarica* likewise has no adults in the forest, but has several well-established large juveniles in one sector of the forest (Fig. 5). As this species exhibits profuse spontaneous regeneration in unkempt parts of the Summit Botanical Garden, some 8 km away, I suspect its scarcity at the study site simply reflects is rarity in the gardens of Gamboa.

Invasions outside Gamboa?

The distribution of most of the exotic palms suggests that they are currently dispersal limited within the Gamboa forest: With exception of *Roystonea regia* and *Aiphanes aculeata*, the other species are all highly concentrated in parts closest to the main garden source areas. Thus, given time at least the well-naturalized *Areca triandra* and *Ptychosperma macarthurii* must be expected to spread and become abundant in all of the forest. This raises the concern that with time the exotics may also spread to the neighbouring national park. Indeed, this has already occurred. I have observed both adults and juveniles of *Areca triandra* and *Roystonea regia* as well as a number of more or less massive, well-established juveniles of *Livistona saribus* in the edge of the forest of the national park bordering Gamboa. While I have not surveyed other Canal Area forests systematically, at least *Roystonea regia* occurs frequently in forest and scrub close to houses in the whole Canal Area. It seems particularly well naturalized in swamp or lakeside forests, i.e. in habitats similar to its natural habitats in the northern Caribbean (Henderson et al. 1995). A number of other non-native palm species, notably *Euterpe oleracea* Mart., *Livistona saribus*, *Ptychosperma macarthurii*, *Bentinckia nicobarica*, and *Areca triandra*, also exhibit vigorous spontaneous regeneration in or just outside Summit Botanical Garden (also see Hubbuch & Craft 1995). *Euterpe oleracea* and *Ptychosperma macarthurii* are also well naturalized in the adjacent forest, the first dominating large tracts of swamp forest.

Birds and ants may facilitate invasion

Birds seem to be an important seed dispersal vector for non-native palm species into the Gamboa forest and may be a key factor in the invasion of natural vegetation by these species (as they probably are elsewhere, see Horvitz et al. 1998). The fruits of all of the non-native species seem to be quite popular with many local bird species. Of particular importance might be Gray-headed Trushes (*Turdus grayi*) which are abundant both in the urban parts of Gamboa and in the forest (Fig. 6). Close to a direct observation of bird-mediated dispersal from Gamboa into the forest, I once observed a Blue-crowned Motmot (*Momotus momota*) flying out from the forest and sitting for several minutes eating (swallowing, and not regurgitating) *Ptychosperma macarthurii* fruits and then flying back into the forest. Forest birds like Keel-billed Toucans (*Ramphastos sulfuratus*) and Gray-headed Chacalacas (*Ortalis cinereiceps*) are also frequently observed eating palm fruits in Gamboa gardens. While birds may provide the colonization opportunities for the exotic palm species, it is less clear why non-native palms are able to be successful once inside the relatively diverse Gamboa forest. One factor might be the abundance of leaf cutter ants (mainly *Atta colombica*) in this and other secondary forests. At leaf cutter ant nest sites in the Gamboa forest, exotic as well as native palms seem to be among the few plants able to regenerate successfully (Fig. 5). Perhaps the high fiber content of the palm leaves causes the ants to generally avoid them.

Risk assessment needed

My observations exemplifies that popular ornamental palms are able to invade natural, albeit secondary tropical forest vegetation and further suggests that at least *Roystonea regia*, *Ptychosperma macarthurii*, *Euterpe oleracea* and *Areca triandra* could become abundant, long-term components of Panamanian forests. As species or genera that are invasive in one region often also will be invasive in other regions, these popular ornamental species may invade tropical forests in other parts of the world, too. Their congenerics *Roystonea oleracea* and *Ptychosperma elegans* certainly do so in the Guianas and Florida, respectively (Henderson et al. 1995; Horvitz et al. 1998). While many naturalized non-native plants may not really cause nature conservation problems in their new home, others seem to do so (Jones 1995; Maunder et al. 2001). In North America the majority of the invasive non-native woody plants were introduced for horticultural purposes (Reichard & White 2001), and in general the most problematic non-native plants have been intercontinental introductions (White & Schwarz 1998). As palms are very popular ornamentals, many species often being planted outside their home continents, and clearly have the potential to become problematic invasive species, it would be wise to develop risk assessment protocols for the introduction of palm species to new areas (cf. White & Schwarz 1998). A starting point would be to compile a world-wide list of invasive non-native palm species. To this end I would greatly appreciate information about invasive palm species from throughout the world (email: svenning@biology.au.dk).

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5. Large juvenile of *Bentinckia nicobarica* at a leaf cutter ant nest site, the Gamboa forest.

6. Gray-headed Trush (*Turdus grayi*) foraging on *Ptycho-sperma macarthurii* fruits in a garden just outside the Gamboa forest.

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Palm Botany in the Louisiade Archipelago, Papua New Guinea

JOHN L. DOWE
School of Tropical Biology,
James Cook University,
Townsville, Qld 4811,
Australia
John.Dowe@jcu.edu.au

AND

ROY BANKA
PNG Forest Research Institute,
PO Box 314,
Lae, Papua New Guinea
roybanka@hotmail.com

1. *Livistona woodfordii*, in coastal forest at about 50 m alt., Yeleamba, Rossel Island.

The Louisiade Archipelago is one of the remotest parts of Papua New Guinea. Although the palm flora is limited to only a few genera, there is a high degree of species endemism. On Sudest Island, the population of the tall fan palm *Livistona woodfordii* is among the most extensive for any palm in Papua New Guinea, with almost monospecific stands covering many kilometres of coastal forest.

The Louisiade Archipelago is situated in the extreme southeast part of Papua New Guinea, almost midway between the mainland and the Solomon Islands. The nearest significant landmasses are Woodlark Island, about 200 km to the north, the mainland, a similar distance to the west, and the Solomon Islands some 400 km to the east. The archipelago comprises three large islands – Misima, Sudest and Rossel – and myriad islets and coral cays. Of the main islands, Sudest (also known as Tagula) is the largest, about 60 km long by 20 km at the widest point; the smallest is Rossel, at 30 km long and 12 km wide while Misima is somewhat intermediate at about 40 km long by 10 km wide. Misima is the most populated, with about 14000 inhabitants and is also the site of one of Papua New Guinea's largest gold and silver mines, though mining operations have recently ceased. Although small aircraft regularly service Misima, the other islands can only be visited by boat.

Louisiade palms

Apart from the ubiquitous coconut (*Cocos nucifera*), betel-nut (*Areca catechu*) and sago (*Metroxylon sagu*), the palms currently recognized for the Louisiade Archipelago are not numerous (Table 1). Per land area, this makes the region one of the most palm-poor areas in Papua New Guinea. Genera, such a *Gulubia*, *Rhopaloblaste*, *Orania*, *Cyrtostachys* and *Licuala*, which are commonly encountered throughout most of lowland New Guinea, are otherwise absent. However, there appears to be a number of undescribed species, as well as some species that have been described from elsewhere but have so far not been formally recorded from the archipelago.

One possible cause of this apparent paucity, is that the islands have been visited infrequently by palm botanists or specialist palm collectors. Among the first to make palm collections was William MacGregor in 1888. MacGregor was the Administrator of the British Crown Colony of New Guinea, and apart from being an administrator and legislator, he encouraged and undertook botanical collecting in many remote parts of Papua New Guinea (Thomson 1889, van Steenis-Kruseman 1950). We are aware of no further palm collections being made until Leonard Brass collected for the 1956 Archbold Expedition. Brass (1959) visited Sudest where he ascended Mt Riu and recorded: "…a scattered emergent, pinnate palm recalled those of mountain tops in the D'Entrecasteaux Group." At Rambusa, he reported: "…as elsewhere on Sudest, palms were poorly represented." On Rossel Island he reported: "…most of the shoreline consisted of gray sand beaches, mangroves and nipa palms (*Nypa fruticans*)." Upon ascending Mt Rossel, he wrote: "…the uppermost leaf tips of two species of pinnate palms commonly came to about the level of the highest surrounding trees," and "…below the ridge crest…an abundance of a stout *Calyptrocalyx* as a substage palm." Brass's collections from the Louisiades were subsequently studied by Moore (1969) and Essig (1978), both of whom described new species using Brass's specimens as types (Table 1). One of the more interesting of Brass's collections from the archipelago was *Livistona woodfordii*, which he collected as simply *Livistonia* (sic), but this was subsequently determined as *Livistona beccariana* by H. E. Moore in 1967.

In 1972, Fred Essig and Heinar Streimann visited Misima where they collected "…*Caryota rumphiana*, a *Calyptrocalyx* sp. and an unidentified *Heterospathe*…" (Essig & Young 1981). They were unable to visit Sudest and Rossel at that time. In 1978, Essig returned to Milne Bay Province with Bradford Young. Once again an attempt was made to visit Sudest and Rossel, but the lack of transport

Table 1. Palms of the Louisiade Archipelago.

Described taxa

Calamus hollrungii Becc. – Sudest.
Calyptrocalyx albertisianus Becc. – Misima and Rossel.
Caryota rumphiana Mart. – Misima.
Heterospathe annectens H. E. Moore – Misima (?) and Rossel. Type: *Brass 28409*.
Livistona woodfordii Ridley (syn. *Livistona beccariana* Burret) – Rossel and Sudest.
Nypa fruticans Wurmb – Rossel.
Ptychosperma rosselense Essig – Rossel. Type: *Brass 28408*.
Ptychosperma tagulense Essig – Sudest. Type: *Brass 27830*.
Ptychosperma ramosissimum Essig – Rossel. Type: *Brass 28474*.

Collected taxa, either undescribed or undetermined

Calamus sp. – Rossel (*Brass 27857*).
Hydriastele sp. – Sudest and Misima (*Banka 2018, 2019 with J.L.Dowe*).
Ptychosperma sp. – Sudest (*Banka 2017 with J.L.Dowe*),

Cultivated palms observed

Areca catechu L.
Cocos nucifera L.
Metroxylon sagu Rottb.

forced them to reconsider and subsequently to undertake some trips into the interior of the mainland portion of the province (Essig & Young, 1981).

The only other collection from the Louisiades, of which we are aware, is that by A. Gillison, who collected for the PNG Forestry Department in the late 1960s. The collection, *Ptychosperma ramosissimum* (*Gillison 25399*), was deposited in the herbarium of the PNG Forest Research Institute, Lae.

The Louisiades Expedition, 2001

In May 2001, the authors visited the Louisiades as part of general palm collecting activities related to a revision of *Livistona* (by JLD) and the collaborative Palms of New Guinea (PONG) Project (JLD and RB). The PONG project involves botanists from many different institutions and facilities. After a few months of planning, the expedition began with the authors meeting in Port Moresby on 22 May 2001 where some final preparations were made with regard to forestry protocols and supplies. We flew to Misima on 24 May, where we were the guests of Misima Mining Limited who provided accommodation in the mining camp complex and local land transport. At Bwagaoia, the administrative center for the Archipelago, we met with boat owner, Luke Moimoi, with whom we planned our itinerary and made arrangements for accommodation and supplies.

Rossel and Sudest Islands do not have airline connections, so the only way to reach them is by boat. Sudest lies some 80 km to the south-east and Rossel lies some 140 km east-south-east of Misima, of which much is open ocean and the remainder a maze of reefs and lagoons. As May is within a transition period between the milder wet season conditions and the south-east trades dominated dry season, it was expected that ocean travel would be relatively comfortable (severe weather can sometimes be experienced in the area). Our vessel was what is known locally as a 'banana boat'–a five meter long fiber-glass dinghy powered by a 40 horse-power outboard motor. The boat is open to the elements, and because of its shallow draft and upturned bow is reputed to handle roughish ocean conditions better than vessels with a deeper draft.

With this in mind, we set sail for Sudest Island at first light on the morning of 25 May. Although encountering some buffeting from the strengthening southeast trades, the leg to Sudest was without incident. In the open ocean sections, dolphins leaped about the bow, flying fish glided past within arms reach and the occasional turtle surfaced nearby for air. Upon leaving Misima, the destination islands were not in view, and it was only after a few hours travelling that they appeared as specks hovering on the horizon. Gradually they enlarged until one could eventually make out the shapes of trees and other forms.

Our main destination for that day was Rossel Island. However, to take advantage of the smoother waters of lagoons and other areas protected by barrier reefs, the route takes in a swing through the complex of islands north of Sudest and also a small section of the northwest coast of Sudest. Upon passing Sudest, a small section of open ocean is crossed until the relative tranquillity of the Rossel Lagoon is reached. However, the passage into the lagoon, being very narrow, is easily missed, and our path unfortunately lay on the 'ocean' side of the reef, providing a rough trip through a two meter swell and very strong headwinds. We arrived at Rossel Island in mid afternoon, wet, salt encrusted but otherwise relieved to be on solid ground again.

Upon arrival, we arranged accommodation with the local District Officer. With formalities completed, we organized our task, and were informed that the palms that we wanted to collect were indeed within an easy walk of a kilometre or so. Accompanied by a number of 'assistants', we proceeded along a bush track until a group of Livistonas came into view. A short scramble up a steep 50 m slope and we were standing beneath a group of elegant fan palms, bearing infructescences with immature fruit (Fig. 1). The local villagers informed us that the fruit turned orange-red at maturity, usually in the months July–August. We identified the species as *Livistona woodfordii*. With collection of this palm our work in the Louisiades had begun.

The remaining daylight allowed us to prepare and press the specimens. The following morning saw an early start to visit some other parts of the island reported to have populations of the *Livistona*. Within the calm waters of Rossel Lagoon, we made our way to the northwestern side, where the *Livistona* appeared in the coastal forest (Fig. 2). Accompanying this was a small solitary stemmed palm, which we identified as *Ptychosperma ramosissimum* (Fig. 3). Collections were made at this location, and we continued on toward Sudest Island, the second destination some 30 km away in a direct line, but over twice that distance once the reefs and other obstacles are circumvented.

We arrived at Rambuso in the early afternoon, and made inquiries regarding the distribution of palms. Two possibilities were discussed – a long walk inland to see a few forest palms, most likely *Ptychosperma* or *Hydriastele* based on the

2. *Livistona woodfordii* growing within reach of salt spray at West Point, Rossel Island.

descriptions given by local villagers, or to continue by boat in a southeasterly direction where populations of *Livistona* were known to occur. At this point, the general subject of palms was discussed and a local villager demonstrated to us a fishing spear that had been made from the stem of the *Livistona* (Fig. 4). Reputedly, such spears are light-weight, strong and have a long life compared to spears made from other materials.

After a further two hours gliding through the rather calm waters of the lagoon, we turned yet another point and viewed what we considered to be one of the most magnificent palm vistas in Papua New Guinea. From about 30 km northwest of the most eastern point of Sudest, known as East Point, a stand of Livistonas stretched through the coastal forests to the southern coast of the island. The population is more or less continuous for 30–40 km.

Upon reaching East Point in the late afternoon, accommodation was arranged within the local village. The specimens collected earlier that day on Rossel were prepared and pressed. The house in which we stayed was almost completely made from palm materials. The roof was thatched with *Metroxylon*, and floors and some walls were made from the split stems of *Hydriastele* and *Ptychosperma*.

The following morning we undertook a trip into the *Livistona* forest some three kilometers north of the village. A passage was negotiated between the mangroves and a landing place near to the coast was reached. A short walk through mud and the tangle of *Rhizophora* branches and aerial roots brought us to a rocky shore. Here the Livistonas were immediately dominant, with the undergrowth a carpet of seedlings and juveniles. The climb up a steep slope brought us to a ridge about 70 m in altitude. On the adjacent slopes we

3. *Ptychosperma ramosissimum* growing in stunted coastal forest at about 50 m alt., West Point, Rossel Island.

4 (above). Villager displaying a fishing spear made from the trunk of *Livistona woodfordii*, Rambuso, Sudest Island. 5 (upper right). *Ptychosperma* sp., north of East Point, Sudest Island, in rainforest at about 70 m alt. 6 (lower right). *Hydriastele* sp., north of East Point, Sudest Island, in rainforest at about 70 m alt.

encountered what appeared to be an undescribed *Ptychosperma* (Fig. 5), an undetermined but probably described *Hydriastele* (Fig. 6), and the climax of the *Livistona* forest. We chose specimens of each palm to collect, and completed the task in a few hours. By early afternoon, we were back at East Point, and in a forest inland from there collected a specimen of a solitary-stemmed cirrate *Calamus* distinguished by a spineless knee, and since determined as *C. hollrungii* (W.J. Baker, pers. comm.).

At mid afternoon we prepared the dinghy for the return trip to Misima. The breezes were rapidly freshening, and it was on the sector between Sudest and Misima that we encountered rather rough seas with a swell to three meters and a strong current. It is at such moments that the fragility of life is contemplated, and the limit of one's own mortality seriously considered. The gold mine on Misima is a dominant landmark – by day a huge scar on the side of one of the island's highest mountains and by night a blaze of lights. It was by this beacon that we reached our destination at Bwagaoia in the early evening darkness, albeit a bit dazed and bruised from the roughness of the final few hours of the trip. Once safely upon land, we organized our accommodation at the mining camp complex, and enjoyed an evening of stillness, although when our heads hit the pillows the heave of the ocean swell was relived. We estimated that we had traveled almost 600 km in our trusty dinghy over a period of three days. Whether that was some kind of record we were not sure, but it certainly felt like a marathon effort to us land-lovers.

The following day, being a Sunday, was a day or rest and recuperation. However the next day we were once again in action. This included a climb up Mt. Sisa to an altitude of about 400 meters. Palms were rather rare; we encountered only an occasional *Caryota rumphiana* and the same *Hydriastele* that we saw on Sudest. We collected the latter, as very few palm collections have been made on Misima. Our guides related that other species also occurred on the island, a putative *Ptychosperma* according to their description or perhaps Essig and Young's *Heterospathe* or *Calyptrocalyx*, but these palms were in the deep interior of the island and only accessible after a full day's walk.

Upon preparing and pressing the newly collected specimens, and packing the collections for the flight to Lae herbarium, we planned our departure from the Louisiades for the next day, 29 May. We had certainly achieved most of our objectives but further collections of those species, which we did not find, would have to wait for another time.

Acknowledgments

We would like to thank Misima Mines Limited for providing accommodation, air transport from the island and other logistical support while on Misima. Luke Moimoi is thanked for safely delivering us to our chosen destinations in his trusty dinghy, and arranging accommodation on Sudest Island. Jim Silu, of Forestry Department, Alotau, is thanked for arranging contacts with people on Misima. Funding for the expedition was provided by the Pacific Biological Foundation as part of a grant to JLD.

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The Cane Bridges of the Takamanda Region, Cameroon

TERRY C.H. SUNDERLAND,
MICHAEL P.B. BALINGA
African Rattan Research Programme
c/o Limbe Botanic Garden
P.O. Box 437
Limbe, Cameroon

AND

JACQUELINE L. GROVES
Takamanda Forest Surveys Project
c/o Limbe Botanic Garden
P.O. Box 437
Limbe, Cameroon

In common with their Asian relatives, rattan canes throughout the rain forest zone of West and Central Africa play an integral role in the livelihoods of local people. Nowhere is this more so than the Takamanda region of SW Cameroon, where rattan is used for a wide range of local products. Most impressive of these is the use of cane for the construction of "hammock" bridges.

The Takamanda area, with the Takamanda Forest Reserve at its centre, is accessed predominantly by footpath, as there are no motorable roads to within 7km of the reserve itself. Indeed, some of the enclaved villages within the reserve are up to 40km from a motorable road. The area is part of the extensive Cross River valley and is bisected by an extensive network of rivers and streams. With an annual rainfall of up to 5,000mm (or just over 16 feet!), much of which falling between the months of July to September, many of these waterways become impossible to cross either by traditional fords, or by canoes. To prevent their communities being cut-off from the outside world during the rainy season, local people have devised techniques of constructing temporary wide-span cane bridges that often provide the only means of access to the area.

Although some community members insist that the cane bridges were the idea of the colonising "white man", there is strong anecdotal evidence to contradict this, particularly among the village elders. In this regard, it is likely that the fabrication of these bridges was common prior to the exploration and colonisation of the area. Interestingly, the knowledge to construct these cane bridges is seemingly restricted to this small area of SW Province of Cameroon and the extreme SE of Nigeria, and they are not commonly found in neighbouring countries within the region. However, as with many other local traditions, the construction of cane bridges is becoming less common as development reaches the most inaccessible areas of Cameroon often accompanied by roads and concrete bridges.

In order to exhibit the natural beauty of these bridges, as well as to understand the technology and skills needed to construct one, members of the Nyang community, a village on the border of the Takamanda Forest Reserve, were invited to build

a wide-span cane bridge in the Limbe Botanic Garden. During the course of several days, detailed notes on the manufacture of the bridge were made, as was a photographic record of its construction. As it was explained to the authors, the construction of these cane bridges relies on two main construction methods: the "snake" and "spider" systems.

The first stage in the construction of the bridge relies on the choosing of a suitable site where the river is relatively narrow and, on either bank, stout trees are present from which the bridge can be hung. The next stage consists of selecting and harvesting mature stems of the small-diameter cane *Eremospatha macrocarpa* (or "echié" the local name in Denya). Although stems of this species often reach 100m in length, most often only smaller lengths are available and these are tied together end to end in order to provide 5-10 strands, each up to 200m in length, depending on the desired span.

The first strand to go across the river is carried across by the strongest swimmer in the group. This centre strand would then serve as a means of conveying the other strands and materials to be transported across the river during the rest of the bridge construction. The ends of 3-5 further strands would then be transported across to the lone weaver on the opposite bank using a running loop attached to the main strand. These would then be tied to form the handrails of the bridge to form a V-shaped frame. The tying of this framework is called the "snake system."

Once this framework is in place, the remaining members of the bridge construction team then climb up on to the main strand and begin to weave shorter vertical lengths of cane along the entire length of the bridge, forming a net-like structure. Due to its resemblance to the webs of forest spiders, often seen laden with dew at the first rays of sunlight, this weaving technique is referred to as the "spider system."

Building these bridges takes place at the beginning of the rainy season, when the rivers are not yet too full, and hence too dangerous, to swim across. Routine maintenance work is carried out about every four months. This consists of replacing any rotten or broken strands of rattan, as well as reinforcing any weakening knots and joints. One of the drawbacks of using cane as the raw material for construction is that is has a relatively short life span; usually around 2–3 years. To get around this, in some more isolated areas, such as the village of Ekong-Anaku in Cross River State, Nigeria, the cane itself has been replaced by galvanised wire strands. Although, in this case, the raw material has been replaced, the indigenous technology to construct the bridge itself remains.

The cane bridge in the Limbe Botanic Garden remains a popular exhibit for visitors to the Garden and, accompanied by interpretative information, provides a unique educational resource highlighting the importance of rattan cane to local communities in Cameroon.

Acknowledgments

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Photo Feature

One of the many fine gardens on the Italian Riviera to be visited during the Post Biennial Tour in Europe this year, the garden of Villa Ormond, San Remo, Italy, epitomizes the elegant landscape designs of the northern Mediterranean coast and includes many wonderful mature palms. (Photo: Moreschi)

The "Niu" Indies: Long Lost "Home" of the Coconut Palm

Hugh C. Harries
Centro de Investigación
Científica de Yucatán AC
Apdo. Postal 87,
Cordemex 97310,
Mérida, Yucatán, México
harries@cicy.mx

1. First landing of Christopher Columbus, Frederick Kemmelmeyer 1800/1805. National Gallery of Art, Washington DC.

The coconut palm flourishes in both the East Indies and the West Indies, but where is "home"?

Until Columbus discovered the New World the "Indies" were the islands that lay to the east of the Indian sub-continent – east of the river Indus. The famous Italian was looking for a western route to these spice islands to break the Middle East–Mediterranean overland trading monopoly. So the people he met, in what was to become America, were thought to be Indians. The mistake was quickly realized and the native Americans became "red" indians, written about and filmed in "westerns". Likewise, the sugar producing islands of the Caribbean were called the West Indies to distinguish them from the spice islands of the East Indies.

The coconut palm

The coconut palm (*Cocos nucifera*) fits into this naïve historico-geographical account because everyone should know that Columbus identified *Nux indica* as one proof of his arrival in the Indies. The "Indian nut" was a generic term that had once included nutmeg as well as coconut because they were both hard-shelled. How was a European in the Middle Ages supposed to know that the nutmeg came from a different tree and was not just a small or underdeveloped coconut? Columbus had misidentified the Cuban Royal palm and he did not see any coconut palms in the 1490s, despite fanciful but inaccurate pictures (Fig. 1) that were painted some three hundred years later, long after the coconut palm had become "ubiquitous in the dry and sandy parts of Caribbean islands such as Jamaica" (Sloane 1696).

In fact, the coconut reached Puerto Rico as early as 1549 and Bahia in Brazil in the same year (Harries 1977), yet 300 years later Wallace, the co-discoverer of the theory of evolution, could write about the coconut palm in the Amazon region "It is in a foreign land. It flourishes . . . but no part of it is applied to any useful purpose, the fruit only being consumed as an occasional luxury. In the towns and larger villages where the Portuguese have settled it has been planted, but among the Indians of the interior it is still quite unknown" (Wallace 1853). In marked contrast, when Wallace left South America he went to the East Indies where he described coconut palms at night, illuminated by bonfires of their old leaves 'The effect was most magnificent, the tall stems, the fine crowns of foliage, and the immense fruit-clusters, being brilliantly illuminated against a dark sky, and appearing like a fairy palace supported on a hundred columns, and groined over with leafy arches' (Wallace 1869).

And it was whilst in the East Indies that Wallace made his other well known discovery, that plants and particularly animals in Asia were separated from those in Australasia by a geographic divide that became know as "Wallace's Line". In an address to the Royal Geographic Society Wallace said "I would particularly call attention to the fact that the division of the Archipelago here pointed out, into two regions characterized by a striking diversity in their natural productions, does not correspond to any of the physical or climatal divisions of the surface. The great volcanic chain runs through both parts: Borneo closely resembles New Guinea, not only in its vast size but in its climate and the general aspect of its vegetation; the Moluccas are the counterpart of the Philippines in their volcanic origin, their extreme fertility, their luxuriant forests, and their frequent earthquakes; and the east end of Java has a climate almost as dry as that of Timor. Yet between these corresponding groups of islands, constructed as it were after the same pattern, there is the greatest possible contrast in the animal productions" (Wallace 1863). What Wallace had noticed was that "this sea of islands" was continental in extent (some 26 million square kilometres).

In the same address Wallace acknowledged that "It was first pointed out by Mr. George Windsor Earl, in a paper read before this Society eighteen years ago, that a shallow sea connected the great islands of Sumatra, Borneo, and Java, to the Asiatic continent, with which they generally agreed in their natural productions; while a similar shallow sea connected New Guinea and some of the adjacent islands to Australia". But Wallace went a step further than Earl: "Returning now to the Malay Archipelago, we see that the whole of the seas connecting Java, Sumatra, and Borneo with Malacca and Siam are under 50 fathoms deep, so that an elevation of only 300 feet would add this immense district to the Asiatic continent" and he drew the conclusion "that at a very recent geological epoch the continent of Asia extended far beyond its present limits in a south-easterly direction, including the islands of Java, Sumatra, and Borneo, and probably reaching as far as the present 100 fathom line of soundings" (Wallace 1863). Modern satellite imagery reveals the full extent of this area (Fig. 2).

Coconut evoultion and domestication

The current theory of coconut evolution and domestication (Harries 1995) can be considered as a logical sequence. First came the natural evolution and dissemination by floating of a variety with large, long, angular, thick-husked and slow-germinating fruit. It had a possible range between the east coast of Africa and the west coast of America, wherever currents were favourable. Domestication was predicated as happening in the region known as Malesia (Harries 1990) where characteristics such as disease resistance and windstorm tolerance, early germination, plant growth habit and bright fruit colours would have been some of the more obvious selection criteria. Slightly less obvious was the fact that domestication was for increased endosperm at the expense of husk thickness because the coconut is the only fruit that comes already filled with a drinkable liquid, the monthly flowering pattern ensuring a year-round supply. If the immature fruit is banged on a rock the husk presents no problems to a good set of teeth, and no tools are needed to enjoy the liquid and partially developed endosperm. The desirability of individual palms would become well known and they would be identified by name. This still occurs today and palms producing fruit with wild type characters are called *Niu kafa* and are used for sennet (coir fibre) whilst those with domestic type characters are called *Niu vai* and are preferred for drinking. Nuts with less husks and more endosperm are less angular, more spherical and selection by fruit shape is easy and would be applied automatically by adult or child, without conscious thought or effort, at every human and every coconut generation. Selection pressure under these circumstances would be high, despite cross-pollination (Harries 1978).

The distinction between wild (*Niu kafa*) type and domestic (*Niu vai*) type coconuts was subsequently confounded by introgression, resegregation and further selection in nautical, mercantile and agricultural ecosystems (Harries 2001) but two questions are unanswered, till now:

How and where would the non-agricultural, coastal fishing communities have grown large coconut populations isolated from recurrent introgression from wild types?

Why should selection pressure be applied just for drinking when other qualities, particularly husk fibres for coir rope production, call for diametrically opposing demands on selection?

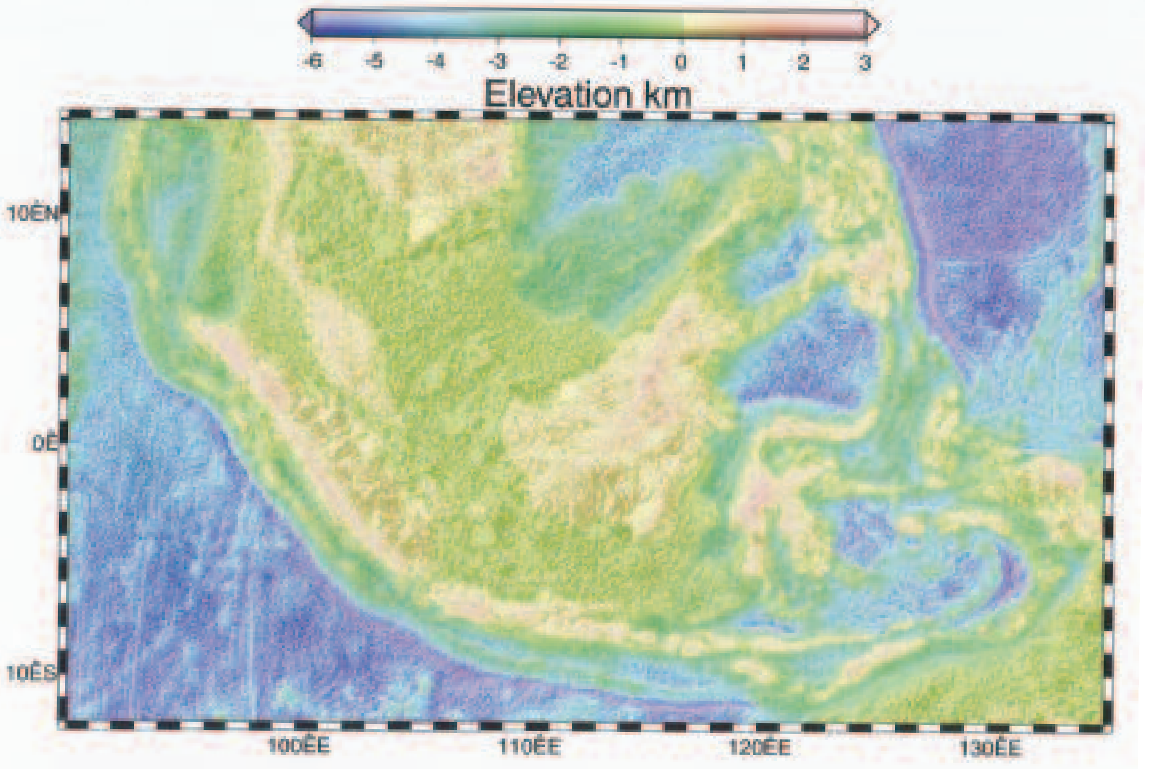
The Drowned Continent of Southeast Asia

As predicated by Wallace, it was change in sea level, flooding a huge Asiatic plain that accounted for coconut domestication in this region. This is explained in "Eden in the East" by Stephen Oppenheimer who suggested that catastrophic sea-level rises that were the result of a massive release of water following ice sheet collapse in the North American glacier lakes 8, 11 and 14 thousand years before present (Blanchon & Shaw 1995). Tidal waves and higher sea levels resulted in the submergence of a land mass, equivalent in size to the Indian sub-continent, which had been the centre for the development of paddy rice by agriculturally-based civilizations (Oppenheimer 1998).

The area of land that could have been above sea level prior to flooding is impressive but, more importantly, it is the fact that it would have been gently sloping to almost level and well watered by rivers coming from rain-fed higher ground. These represent ideal conditions for agriculture. It would also have been located in that part of the Pacific where seasonal droughts can be expected and where tropical windstorms (cyclones) are ferocious. Large agricultural communities occur there today despite those conditions.

If an agricultural civilization did populate this extensive area then coconuts would have been grown as a fruit crop (not for copra or oil which were 19th century developments). And, once the coconuts had been taken hundreds of kilometers inland (probably by boat along the major rivers) they would be beyond the introgressive effects of the wild type coastal coconuts. To this day, wild type coconuts can be found around the periphery of this area, on the Indian Ocean coast of Thailand and Indonesia or the Pacific Ocean coast of the Philippines. Yet, except during seasonal droughts, the coconut palms would have been a minor source of drinking water in a land so well served by rivers and rainfall. Nor would it have been required for coir fibre where rattans and various forms of hemp were readily available where rope and twine were needed. Coconuts would have been used in food preparation, including fattening pigs and feeding chickens. The coconut palm was a fruit tree – the haustorium inside of the germinating nut is a sweetmeat for children, varieties with edible husk (even with edible shell) when immature and with jelly-like endosperm (makapuno) would be popular (Harries et al., in press).

After the initial catastrophic rise in sea level the area of land flooded by sea water would have fluctuated as geological settling occurred but the process would have been progressive, extending over decades or even centuries (not the Biblical forty days and nights). In that period the coconut palms, which tolerate semi-saline groundwater conditions better than other plants, would have become immensely important to human populations deprived of drinking water (Harries 1979). Early germination, while the fruit was still on the palm, would also be a desirable characteristic in areas where fallen fruit might be washed away by flooding (Harries 1978, 1990). Palms surviving windstorms and epidemic diseases would account for the tolerance and resistance exhibited by the domestic type (Harries 1978).



2. West Malesia or the Sunda Shelf as visualized from satellite imagery. (Credit: NASA)

Epilogue

If the origin of *Cocos* was in Gondwanaland and the wild (*Niu kafa*) type evolved by floating between islands in the Tethys Sea, then there could have been no human intervention in either process. Therefore, the domestic (*Niu vai*) type is our earliest and most important interaction with the coconut palm. The site of that coconut continent, the "Niu Indies," is now lost but no longer forgotten.

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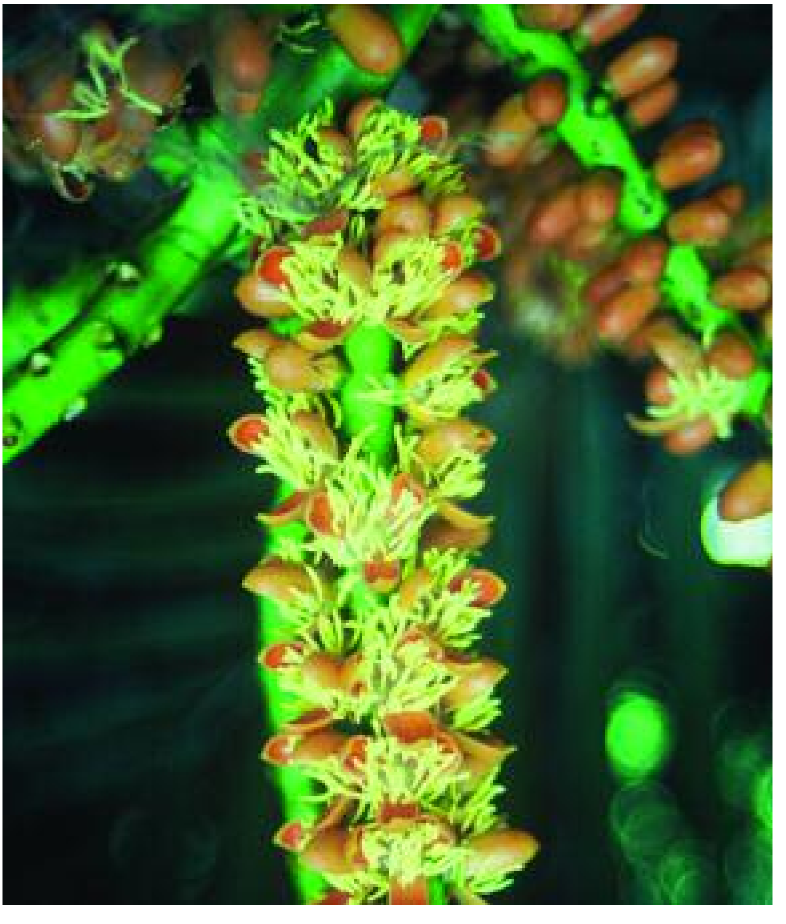
Horticulture Column

Katherine Maidman
Fairchild Tropical Garden
10901 Old Cutler Road
Coral Gables (Miami), Florida
33156 USA
kmaidman@fairchildgarden.org

Q. Are there palms you would recommend growing for the fragrance of their flowers? Stavros Bulgarides, San Juan, Puerto Rico.

A. Many palms have floral scents that attract pollinators. Some are sweet, although inflorescences which entice beetles and flies as pollinators often have a musty odor. The scent attractants come from chemicals secreted by the flower. The chemicals volatilize in warm temperatures, and in fact, some palm inflorescences actually heat up when the flowers are ready for pollination thereby volatilizing the attractant over a wider area. Fragrance potency varies during the day with changes in flower temperature and pervading breezes. Catch a flowering *Arenga pinnata* under the right conditions, and you may experience a truly heady aroma. Whether sweet-scented palms are entirely appealing to humans is a matter of debate; some people find *Arenga pinnata* and other palms to be unpleasant at their strongest.

Hyophorbe species are widely cultivated ornamentals often noted for their delicate perfume. They need to be accessible up close, near an entryway for example, for maximum enjoyment. For a more pervasive yet fresh scent there is *Arenga engleri* (Fig.1). One specimen at Fairchild Tropical Garden often gets attention from visitors



1. The flowers of *Arenga engleri* are showy and fragrant.

in the mornings, when its scent attractant hangs in the still air. Lacking a palm aromatics vocabulary, I make comparisons to well known scents to describe these attractants. For example, the floral scents of *Arenga engleri* and a number of other palms call to mind lemon oil. Quite different scents are encountered in *Copernicia*; a survey of school children at Fairchild Tropical Garden provided the handy comparison of *Copernicia* x *burretiana* to vanilla. Other *Copernicia* of moderate height may also prove interesting for fragrance.

Consider *Areca triandra* for a scent that seems to be universally appealing. This is an ornamental for cultivation in the tropics and moist situations in the subtropics. This palm has a pervasive lemon and honey fragrance and a hidden specimen in your garden will surprise people from afar.

Q. I grow palms on my property where the native soil is alkaline limestone. I would like to try growing certain tropical species, palms of acidic pH ranges, by amending or replacing the soil in one area. Can you offer any suggestions? Jackie Ege, Miami, Florida.

A. Soil amendments in the form of organic matter, such as mulch, compost, or peat, tend to cause modest changes in soil pH which are lost over time as the material breaks down. In your alkaline situation, acidifying agents, such as sulfur, provide temporary changes. At Fairchild Tropical Garden, we are experimenting with a more permanent solution for our growing needs. In 2000, Fairchild Tropical Garden created three acidic soil areas with average dimensions of 6.1 × 12.2 m (20 × 40 ft). These three areas were excavated to an average depth of 0.9 m (3 ft). The native alkaline limestone was replaced with a different acidic medium in each area: Florida red clay, coarse silica sand, or a mix consisting of 50% coarse silica sand, 35% peat moss, 15% composted pine bark. Twenty-one palm species were planted in the acidic soil areas, along with other tropical rainforest plants. A 100% controlled release fertilizer is used, and palms are given monthly foliar applications of a balanced complete micronutrient mix. Eighteen months after planting these palms overall are healthy.

Soil samples showed that 12 months after the areas were filled the silica sand and mix were both neutralized, and the soil pH values were over 7 in all soil depths. Soil pH rise in the red clay was confined to the surface and bottom layers. While our irrigation water pH is nearly neutral from acid injection, the local groundwater and runoff contains calcium carbonate which should continue to increase soil pH in all three media. The clay is expected to show the slowest increase due to its higher buffering capacity.

Do we recommend replacing native soil with areas of acidic soil? Achieving permanent acidic soil pH in most media is not possible where irrigation, groundwater, and runoff contain calcium carbonate. An acidifying agent, such as finely ground sulfur or aluminum sulphate, might be experimented with in such an area however. While these agents have very temporary effects on soil pH in the alkaline limestone, they may prove more effective here where the media are already saturated with calcium carbonate. To use these safely and effectively, however, one should apply them at rates suggested from a soil analysis.

Dr. Jerome Keuper

1921–2002

Dr. Jerome Keuper, seventh president of The Palm Society (which later became the International Palm Society), died in Melbourne, Florida, on 25 March 2002, after a long illness. He was 81 years old. Jerry Keuper could be called a 20th century Renaissance Man. He was a scientist who founded a university, a lover of palms and a scholar of Chinese linguistics. An Army intelligence officer in World War II, he returned from service in China and Burma (Myanmar) to earn degrees at Massachusetts Institute of Technology, Stanford University and a doctorate in nuclear physics from the University of Virginia. In 1958, he came to Florida to be the chief scientist for a defense contractor at what is now the Kennedy Space Center and to establish the Florida Institute of Technology (Florida Tech). Keuper served as the university's first president from 1958 until retirement in 1986. In 1997, Keuper published a dictionary of colloquial and idiomatic Mandarin Chinese, the culmination of 50 years of study.

Jerry Keuper joined The Palm Society in 1967 and served as its vice-president from 1968 to 1970 and president from 1970 to 1972. A good friend of Dent Smith, Keuper set out to make the Florida Tech campus luxuriant with palms, many of which still survive. To honor the society's founder, Keuper created the jungle-like "Dent Smith Trail" in a hardwood hammock on the campus. Described as a major palm collection by Nixon Smiley in an illustrated article in Principes (19: 39–64. 1975), the collection comprised more than 2000 palms – over 100 species – planted throughout the campus in the span of seven years. In its heyday, it was the largest collection of palms in Florida outside of the Miami area. The Biennial was held at Florida Tech in 1970 and 1976.

JOHN D. KENNEDY