Palms

Journal of the International Palm Society Vol. 53(4) Dec. 2009

THE INTERNATIONAL PALM SOCIETY, INC.

The International Palm Society

Founder: Dent Smith

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FRONT COVER

Stiff leaves, glossy green adaxially and silvery gray abaxially, and infructescences greatly exceeding the leaves characterize *Pritchardia bakeri* (*Hodel 2019*). See article by Hodel, p. 173.

Palms (formerly PRINCIPES)

Journal of The International Palm Society

An illustrated, peer-reviewed quarterly devoted to information about palms and published in March, June, September and December by The International Palm Society, 810 East 10th St., P.O. Box 1897, Lawrence, Kansas 66044-8897, USA.

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Annual membership dues are US$45.00 for Individuals (or US$120 for three years) and include a subscription to the Journal. Donor memberships are US$500 per year. Individual Lifetime memberships are available for a one-time fee of US$1000. Benefactor memberships require a one-time payment of US$2500. Subscription price is US$45.00 per year for libraries and institutions. Dues include mailing of the Journal by airlift service to addresses outside the USA. Dues may be paid on-line at www.palms.org.

Change of Address: Send change of address, phone number or e-mail to The International Palm Society Inc., 6913 Poncha Pass, Austin, TX 78749-4371 USA, or by e-mail to info@palms.org.

Claims for Missing Issues: Claims for issues not received in the USA should be made within three months of the mailing date; claims for issues outside the USA should be made within six months of the mailing date.

Periodical postage paid at Lawrence, KS, USA.
Postmaster: Send address changes to The International Palm Society Inc., 6913 Poncha Pass, Austin, TX 78749-4371 USA.

PALMS (ISSN 1523-4495)

Mailed at Lawrence, Kansas Dec. 15, 2009

The full text of PALMS is available on EBSCO Publishing's database.

This publication is printed on acid-free paper.

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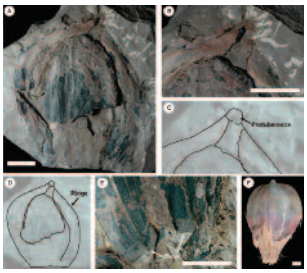
Fruits of *Dypsis plumosa* are amber to brownish purple and round to slightly elongated (garden of Lou Hooper, La Habra, California). See article by Hodel et al., page 161. Photo by Don Hodel.

BACK COVER

Desmoncus orthacanthos, growing in the Atlantic Coastal Forest of Brazil, near Linhares in Espírito Santo. The rachis has long, straight spines on the lower surface, and the peduncular bract is without spines. See article p. 180. Photo by Andrew Henderson.

PALM NEWS



A recent publication by Carolina Gomez-Navarro et al. (Amer. J. Bot. 96: 1300–1312.) on **palm fossils from northern Colombia sheds light on the distribution of *Nypa*** and the evolution of Cocosoid palms in South America. A fossil fruit of *Nypa* is one of two oldest fruit records from the Western Hemisphere. The fossil impression of a coconut-like fruit demonstrates that this lineage was already well developed 60 million years ago in the New World.

To the uses of betel nut palm, we can now add disposable bowls, plates and trays. The Swiss company Naturesse, a division of Pacovis AG (www.pacovis.ch), is offering a line of **dinnerware manufactured in India from the fallen leaves of *Areca catechu***. The products are manufactured in India from what is called the *Adaka* palm. The articles are made from leafbases, which are cleaned and moistened, formed under heat and high pressure into the desired shape and then trimmed of excess. The resulting plates and bowls are attractively mottled shades of brown and tan, light weight, water-proof and compostable. According to the manufacturer, it is dinnerware that "turns every meal into a special occasion and adds an exotic touch."

GROWING PALMS

Readers will note the **absence of the Growing Palms section** of this issue of PALMS. We shall continue to publish articles of the kind that appeared in Growing Palms, although they will be integrated with the other articles in the journal, not separated into their own section.

German scientists working in Costa Rica have observed the **Mexican mouse opossum (*Marmosa mexicana*) visiting the flowers of *Calyptrogyne ghiesbreghtiana*.** This palm produces sweet, garlic-scented, fleshy stamen tubes in the male flower and similar fleshy staminodial tubes in the female flower, and it seems that this is what attracts floral visitors. It has long been known that bats visit the flowers and can be responsible for pollination, but this is the first time that a terrestrial mammal has been rcorded visiting the flowers. In their paper in Mammalian Biology (74: 76–80. 2009) E.B. Sperr, E.A Fronhofer and M. Tschapka illustrate a mouse opossum clinging to a spike of *Calyptrogyne ghiesbreghtiana* and go on to speculate that the opossum could be a potential pollinator, though of less significance than the frugivorous bats that visit the flowers.

A Greek organization, www.redweevil.org, has formed as a call to arms in **the fight against the red palm weevil** (*Rhychophorus ferrugineus*), which has already destroyed large numbers of palms in Greece. The march of the red palm weevil in the Mediterranean seems inexorable.

Dypsis plumosa, the Madagascar Queen Palm

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1. *Dypsis plumosa* grows to over 6 m tall and bears a resemblance to the queen palm (type plant, garden of Jeff Marcus, near Hilo, Hawaii, *Hodel 2020*). Marcus planted two plants next to each other although the species is of solitary habit.

A new single-stemmed species of *Dypsis* bearing a resemblance to the queen palm (*Syagrus romanzoffiana*) has flowered and fruited in Hawaii. Because it has been widely distributed, it is named and described here as a new species.

Since publication in 1995 of John Dransfield and Henk Beentje's comprehensive work, *The Palms of Madagascar*, several new species of *Dypsis* have been discovered, described, and named. Jeff Marcus, an ardent collector and commercial palm grower, discovered three of these new *Dypsis* cultivated in Hawaii, two in his own nursery near Hilo. Marcus and others widely distributed seeds and seedlings of these new *Dypsis*, and they were subsequently described and named as *D. carlsmithii*, *D. albofarinosa*, and *D. robusta* (Dransfield & Marcus 2002, Hodel & Marcus 2004, Hodel et al. 2005). Now Marcus has brought to the attention of the horticultural world a fourth new *Dypsis* in his nursery and, because he has been distributing seedlings, it is appropriate to describe and name this new species.

Dypsis plumosa Hodel, J. Marcus & J. Dransf., **sp. nov.**, *D. ambositrae* affinis sed habitu solitario, trunco maiore (24 vs. 12 cm diam.), vaginis foliorum sine ligulis, petiolis longioribus (60 vs. 30 cm), pinnis pluribus (120 vs. 84 in quoque latere rhachidis) minoribus (65 × 2.5 vs. 89–114 × 3.5 cm) plumosis, inflorescentiis 3 ordines ramificantibus differt. Typus: Hawaii, in horto Jeff Marcus, *Hodel 2020* (ex J. Marcus) (Holotypus K). Figs. 1–7.

Solitary, to 6 m tall but undoubtedly eventually taller (Fig. 1). Trunk to 25 cm diam., greenish aging to brown, ringed, internodes 2–8 cm. Leaves 7–10, pinnate, erect to spreading; bases to 65 cm long, tubular, forming a crownshaft, densely covered with whitish to grayish red to brown tomentum; petiole to 60 cm long, at base 8 cm wide, 1.5 cm thick, concave and greenish adaxially, sharply rounded and covered with grayish ± deciduous tomentum abaxially, margins sharp; rachis to 2.3 m long, at base 3 cm wide, 2 or 3 cm thick and convex adaxially, concave abaxially, margins sharp, tapering to 1 mm diam. and rounded at apex, distal 1.9 m with ± sharp central ridge to 1 cm high; 120 pinnae per side, ± irregularly arranged, attached to rachis at different angles to give plumose effect (Figs. 1 & 2), distal 15 cm of each pinna pendulous, pinnae 4 cm apart proximally, 2 cm apart mid-blade, 1 or 2 cm apart distally, proximal mid-blade pinnae to 65 × 2.5 cm, most proximal pinnae to 90 × 1 cm, most distal pinnae to 15 × 0.4 cm, glossy green adaxially with prominent yellow-green midrib, pale abaxially with light green midrib and 1–3 medifixed dark brown, lacerate ramenta in proximal 4 cm. Inflorescences 3, ± infrafoliar, branched to 3 orders, drooping in flower and fruit (Figs. 3 & 4); peduncle 80 cm long, curved, densely covered with whitish to grayish red to brown tomentum, elliptical in cross-section, at base 8 cm wide, 1.5–2.0 cm thick, at apex 5 cm wide, 2.5 cm thick; prophyll to 75 cm long, 2-edged, attached 4–6 cm distally of peduncle base with lateral margins extending to within 1 or 2 cm of peduncle base, covered with brownish tomentum, peduncular bracts 4, attached 27, 54, 61, and 68 cm respectively distally of peduncle base, first peduncular bract fallen away and not seen, leaving short collar-like base to 1 cm high, other peduncular bracts rudimentary, 1–3 cm long, triangular; rachis to 90 cm long, curved downward especially distally, at base 5 cm wide, 2.5 cm thick, angled from depressions left by branch bases, tapering to 5 mm diam. at apex, covered with whitish to grayish red to brown tomentum, 26 branches, diverging at 45° angle, distal 10 simple rachillae, proximal 16 branched again, most proximal branch largest, to 1 m long with up to 18 branches of which the most proximal have 2–4 rachillae, all others unbranched; rachillae to 40 cm long, to 4 or 5 mm diam., drooping, sparsely covered with stellate, grayish to brownish hairs only near base (proximally), glabrous distally. Flowers in triads 4 mm apart proximally becoming more congested distally, in clefts 1.5 mm long, 3 mm wide, 0.5–0.8 mm deep, proximal bracteole subtending triad 1 mm high, crescent shaped. Staminate flowers 4 × 3.5 mm, whitish green; calyx 1.3 mm high, 2.5 mm wide, sepals imbricate nearly to apex, cupped, 2 × 2 mm, broadly rounded apically, thin, nearly transparent, very faintly nerved; petals 4 × 2.5 mm, boat-shaped, valvate, free to base, acute, thick; stamens 6, filaments 3 × 0.5 mm, erect, anthers 1.8 × 0.3 mm, opening adaxially; pistillode 2.3 × 0.8 mm, columnar, fluted. Pistillate flowers greenish white, just past anthesis 4 × 3.8–4.0 mm; calyx 1.5–2.0 mm high, 3.0–3.5 mm wide, sepals imbricate in basal ¾, cupped, broadly rounded apically, a slight medial ridge abaxially, margins thin, faintly nerved; petals 2.0–2.5 × 2.5–2.8 mm, cupped, imbricate in basal 4/5, faintly nerved, slightly mucronate; staminodes 6, 0.8–1.0 mm high, triangular; pistil 4 × 3.5 mm, style lacking, stigmatic lobes 0.8 mm high, distinct, recurved. Fruits 15–22 × 15–17 mm, amber to brownish purple (Fig. 4); seeds 12–19 × 12–13 mm, endosperm ruminate (Fig. 5), embryo lateral.

2 (top). Pinnae of *Dypsis plumosa* are more or less irregularly arranged and attached to the rachis at different angles to give a plumose effect (garden of Lou Hooper, La Habra, California).

3 (middle). Inflorescences of *Dypsis plumosa* are branched to three 3 orders and drooping in flower (type plant, garden of Jeff Marcus, near Hilo, Hawaii, *Hodel 2020*).

4 (bottom). Infructescences of *Dypsis plumosa* are drooping and attractive when heavily laden with fruit (garden of Lou Hooper, La Habra, California).

5. Seeds of *Dypsis plumosa* are prominently ruminate (garden of Lou Hooper, La Habra, California).

Measurements for the description were taken from non-dried, fresh material Marcus had collected and sent to Hodel. Fruit and seed measurements were supplemented from a plant in the garden of Lou Hooper in La Habra, California. Dried rachillae are more slender, floral pits more prominent, and proximal lip of floral pit sharper, thinner, and more knife-like than in fresh rachillae.

Dypsis plumosa keys best to the upper couplet of E15, Key 5 in *The Palms of Madagascar* but its mostly infrafoliar inflorescence distinguishes it from all other species on this string at or below this junction in the key. Its leaf rachis much shorter than 3 m and peduncle much longer than 40 cm distinguish it from all species in the lower couplet of E15, Key 5 or the string below it. *Dypsis ambositrae*, with which *D. plumosa* had been confused, differs in its cespitose habit, smaller stem (12 vs. 25 cm diam.), ligules at the apex of the leaf sheath, shorter petiole (30 vs. 60 cm), fewer (84 vs. 120 on each side of rachis) and larger (89–114 × 3.5 cm vs. 65 × 2.5 cm) pinnae in one plane, and inflorescences branched mostly to two orders.

Marcus originally obtained several small plants and or seeds of *Dypsis plumosa* from Curt Butterfield of Australia in the middle to late 1990s. Butterfield and others, including the late Maria Boggs, probably obtained the seeds from Alfred Razafindratsira, a long-time collector of Madagascar palms. Butterfield, Boggs and others distributed seeds and plants throughout Australia and elsewhere, and referred to the palm as *D. ambositrae* because it bore a resemblance to that species. In Australia *D. plumosa* is sometimes also grown under the name *Dypsis* "Fine Leaf" (Ian Edwards, per. comm.). Inge Hoffmann distributed seeds of *D. plumosa* in the 1990s from plants cultivated in Australia but called it *D. ambositrae* "(from Australia)" (Ian Edwards, per. comm.). Marcus's plant began fruiting in 2001 and he also widely distributed it as *D. ambositrae*. However, doubt was cast on the true identity of this palm when palm enthusiasts who had seen the true *D. ambositrae* in Madagascar reported that it differed substantially from the plant that Butterfield, Marcus, and now others were growing.

Dypsis plumosa would make a suitable ornamental for parks, public areas, and gardens in the tropics and warm subtropics, and flowers and fruits at a relatively small size. It has some cool tolerance, and flowers and fruits in more temperate areas also, such as regions with a Mediterranean climate, but is less vigorous and grows to smaller dimensions. A flowering and fruiting plant in the garden of Lou Hooper in La Habra, California near Los Angeles has tolerated freezing and near-freezing temperatures on several occasions and has grown steadily but slowly, increasing from about 2 m to 4 m in overall height and increasing the trunk from about 30 cm to 130

6 (left). A flowering and fruiting plant of *Dypsis plumosa* in the garden of Lou Hooper in La Habra, California near Los Angeles has tolerated freezing and near-freezing temperatures on several occasions and has grown steadily but slowly. In 2001 it was about two m tall overall and had a trunk about 30 cm tall. Compare with the same plant in Fig. 7 (right), nearly eight years later, by which time it increased to four m in overall height and had a trunk about 130 cm tall. Lou Hooper provides scale.

cm in eight years (Figs. 6 & 7). Ian Edwards (per. comm.) reports that it grows well in Sydney, Australia. *Dypsis plumosa* is most graceful and ornamental when grown with a little shade, the whitish crownshaft being an appealing complement to the greenish, ringed trunk. A faster grower in tropical areas, the type plant in the Marcus nursery in Hilo, Hawaii increased its trunk height from 10 cm to nearly 200 cm in six years and overall height from about 2 m to 6 m during the same time.

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Hodel, D. R. and J. Marcus. 2004. The white powder *Dypsis*: a new species from cultivation. Palms 48: 90–93.

Hodel, D. R., J. Marcus, and J. Dransfield. 2005. *Dypsis robusta*, a large new palm from cultivation. Palms 49: 128–130.

PALM LITERATURE

L'ÉPOPÉE DES PALMIERS. Frédéric Tournay. Opera Editions, Haute-Goulaine, France [www.editions-opera.fr]. 2009. ISBN 978-2-35370-054-7. Price 25€. Softcover. Pp. 189. (In French)

The history of palm horticulture too often goes undocumented. In rare instances, the discovery of a palm and its introduction into cultivation are well documented, but more often than not, details of the introduction – the who, the when and the where – are obscured by the passage of time. Enter Tournay's *L'Épopée des Palmiers* [The Saga of Palms], which tells the many stories of how exotic palms first arrived in France. The book is in French, but even readers with a minimum of French vocabulary can appreciate the scope of this book. It is a fascinating book for lovers of both garden history and palms.

The subtitle of this work is "*Histoire de leur acclimatation en France*" [History of their Acclimatization in France]. Acclimatization was a scientific paradigm firmly rooted in the colonial ambitions of Europe (Osborne 2000). Acclimatization of plants outside their native habitat was a movement that reached its peak in the mid- to late-nineteenth century, when Europeans, especially the French and British "acclimatization societies," engaged in heroic efforts to "enrich" plant communities both home and abroad. European plants (and animals) were shipped to overseas colonies (sometimes with catastrophic results for the native flora and fauna), and plants, especially tropical plants, were introduced in gardens in the warmest parts of Europe, such as the Canary Islands and the French Riviera. There was some hope that tropical plants might gradually adapt (acclimate) to these northern way stations, permitting their introduction to wider areas of Europe. The enthusiasm with which the French embraced acclimatization resulted in the introduction of many species of palms into southern France, and these new palms were documented by the horticultural and scientific press. Tournay was fortunate in having a rich vein of magazine articles to mine for information of the first introduction, the first flowering and the first fruiting of exotic palms in French gardens. Were it not for the enthusiasm of 19th century acclimatization societies, Tournay's source material would have been much diminished.

This work is unlike most of the palm-related books reviewed in this journal, in that it is at its core a history of horticulture. The format of the book is an account of 36 species, from *Brahea armata* to *Washingtonia robusta*. For nearly every species, Tournay meticulously recounts synonyms, natural distribution, discovery by botanists and introduction to horticulture. A brief description of each species and cultural notes are given, along with "testimonials," brief synopses of the culture of palms in France as noted in period horticultural press. It is worth mentioning that not all of the palms profiled in the book are 18th or 19th century introductions; modern introductions, such as those of *Trachycarpus princeps* and *Guihaia argyrata*, are also documented. Species accounts are illustrated with reproductions of vintage postcards and photographs, 19th century engravings and deft drawings by the author. A section of color photos of palms in French gardens appears in the middle of the book. The book is chock-full of interesting historical firsts, often vividly recounted in the writings of the pioneering horticulturists of the day. It is a book ideally suited to dipping in and sampling chapters at random.

The author is the curator of collections at the botanical garden of the University of Strasbourg, and his love of history and palms is everywhere evident in this remarkable book. There is no other book like it. After reading it, I could only wonder, Who will write the history of palm horticulture in other countries?

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SCOTT ZONA
Miami, Florida, USA

A New Species of *Salacca* from Sarawak

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1. *Salacca bakeriana*, in cultivation at Semengoh Arboretum, Kuching, Sarawak.

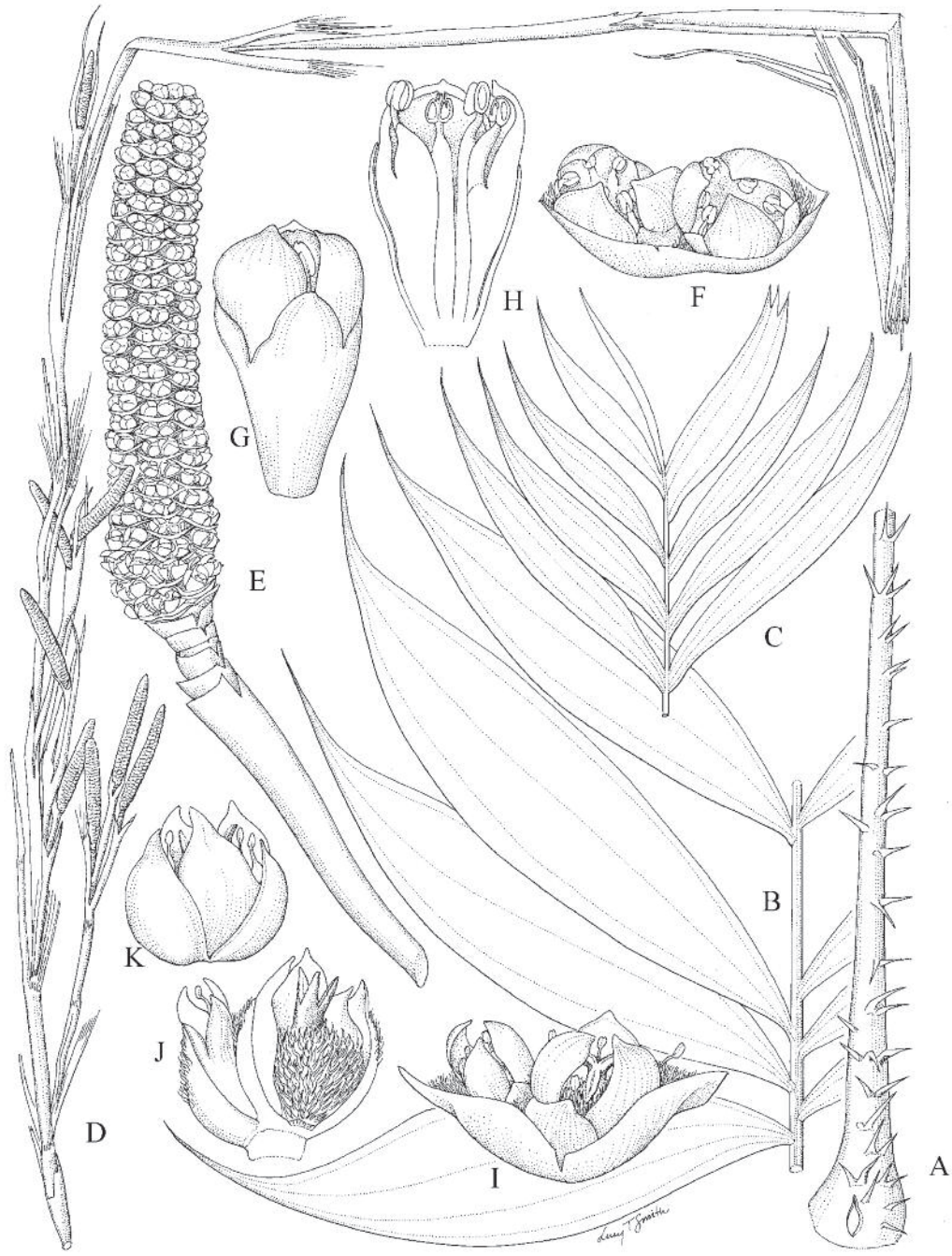
The new species of *Salacca* (Fig. 1) described below is known from a very restricted area of western Sarawak. It has been introduced into the Forestry Department Arboretum at Semengoh where it flowers abundantly.

Salacca, a genus of approximately 20 species (Dransfield et al. 2008), shows a high degree of local endemism. Although there are widespread species such as *S. affinis* and *S. zalacca*, many of the species are restricted to very small areas. New species continue to be discovered and described and the subject of the present paper is known from a small area of Borneo, south of Kuching in Sarawak, East Malaysia.

Salacca bakeriana J.Dransf., **sp. nov.**, inter species borneenses inflorescentiis longis flagelliformibus non radicantibus, foliolis nitentibus distincta. Typus: BORNEO. Sarawak: Kuching Division, Baker & J. Dransfield WJB724 (Holotypus K; isotypi KEP, SAN, SAR, SING).

Acaulescent, clustering, spiny, dioecious palm of the forest undergrowth. Stems ca. 6 cm diam., with leaf sheaths ca. 12 cm diam. Leaves erect, to ca. 3.5 m long including the petiole to 2 m long; sheath expanded at the base, armed with scattered or grouped spines and bearing scattered, caducous, red-brown indumentum; petiole covered with dense, caducous, chocolate-brown scales and scattered and grouped, horizontal or reflexed, narrow, triangular spines to 20 × 4 mm; rachis to 1.5 m long, gradually tapering, unarmed; leaflets leathery, somewhat sigmoid, long acuminate, discolorous, 17–25 on each side of the rachis, arranged in groups of 2 or 3 near the base, ± regularly arranged near the tip, the apical pair composed of 2 or 3 folds, all other leaflets single-fold, the longest to 35 × 5–7.5 cm, upper surface glossy dark green, under surface with thin gray to buff-gray indumentum, transverse veinlets very conspicuous, distant adaxially, invisible abaxially. Staminate and pistillate inflorescences similar, up to 1.2 m long, emerging from a vertical cleft in the abaxial surface of the subtending leaf sheath, then lying along the surface of the ground and partly obscured by leaf litter (Fig. 2). Peduncle of staminate inflorescence to 2 cm long, ca. 0.7 cm diam.; prophyll not exceeding ca. 10 mm, soon tattering; peduncular bracts absent; rachis to at least 90 cm long, bearing ca. 5 evenly spaced rachis bracts; rachis bracts tubular, to ca. 35 cm long, ca. 0.8 cm diam., densely brown scaly and hairy, tattering longitudinally, each subtending a first order branch; first order branches to 20 cm long, each with (1)2 or 3 rachillae; rachillae cream-colored at first, to 4 × 0.6 cm; rachilla bracts 2.5 × 1.5 mm, each subtending a pair of staminate flowers. Staminate flower (pre-anthesis) ca. 2.5 × 1 mm; sepals thin, membranous, striate, ca. 2.3 × 0.9

2. *Salacca bakeriana*, young rachillae held along the surface of the ground, Semengoh Arboretum, Kuching, Sarawak.



3. *Salacca bakeriana*. **A**. leaf base and petiole × ¼; **B**. mid-section of leaf × ¼; **C**. leaf tip × 1/3; **D**. staminate inflorescence × 1/3; **E**. staminate rachilla × 1½; **F**. dyad of staminate flowers within rachilla bract × 6; **G**. staminate flower × 8; **H**. staminate flower in vertical section × 8; **I**. dyad of sterile staminate flower and pistillate flower × 5; **J**. sterile staminate flower and pistillate flower with sepal and petal removed × 4; **K**. pistillate flower × 4. A, C–H from *Baker & Dransfield 724*; B, I–K from *Baker & Jegong 711*. Drawn by Lucy T. Smith.

mm, connate in basal half; petals 2.5 × 0.9 mm, coriaceous, connate in basal half; anthers ca. 0.5 × 0.3 mm. Pistillate inflorescence (at least in cultivation) longer and more robust than the staminate, bearing several distant first order branches, each with a single rachilla; pistillate rachillae to 5 × 1.3 cm; rachillae bracts ca. 10 × 6 mm, splitting irregularly, each

subtending a dyad of a sterile staminate and a fertile pistillate flower. Sterile staminate flower at anthesis 6 × 2 mm; sepals 4 × 1 mm, connate in basal 2–3 mm; corolla tube 4 mm long, lobes 2 × 1.5 mm; filaments ca. 1 mm, anthers rounded ca. 0.2 × 0.2 mm. Pistillate flower 7 × 5 mm, obpyriform; sepals membranous, striate, 5 × 4 mm, broad triangular with rounded tips; corolla coriaceous, with basal tube ca. 4.5 mm long, lobes 2.5 × 2.5 mm; filaments ca. 1 mm; ovary 3.5 × 3 mm, epicarp scales very numerous, erect, spine-like; stigmas sinuous, 1.2 mm long. Mature fruit not known (Fig. 3).

BORNEO. Sarawak: Kuching Division, Padawan, near road to Borneo Highlands Resort, Mt. Penrissen, steep bank above stream, very disturbed forest, 100 m alt., 23 April 1996, *Baker & Dransfield WJB724* (Holotype K; isotypes KEP, SAN, SAR, SING); cultivated, Semengoh Arboretum, Kuching, originally from Padawan area, *Baker & Jegong WJB711* (K, KEP, SAR).

So far, *Salacca bakeriana* seems to be restricted to the Kuching (First) Division of Sarawak, Borneo. In Borneo, it is unlikely to be confused with any other species; the extraordinary long inflorescences held along the surface of the ground (Fig. 2) are unusual, though known in several species in Peninsular Malaysia and Thailand, such as *S. flabellata* Furtado and *S. stolonifera* Hodel. However, the tips of the inflorescences of *S. bakeriana* do not develop into new shoots as happens in these two species. Like many species of *Salacca*, *S. bakeriana* tends to form rather untidy clumps when seen in disturbed forest, but the plant cultivated in Semengoh Arboretum is certainly handsome, with its neat glossy leathery leaflets, dark red-brown petioles and the surprising skirt of inflorescences lying along the ground. It is named for the collector, Bill Baker of Kew, who has contributed so much to our understanding of palm phylogeny.

Acknowledgments

I thank the staff of the Forest Herbarium, Forestry Departmet, Kuching, Bill Baker and Professor John Beaman for help in the field. Lucy Smith prepared the analytical drawing.

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Caryota kiriwongensis Revisited

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In 1998 I named, described and illustrated *Caryota kiriwongensis*, a rare, splendid, giant, fishtail palm from unusually palm-rich, wet forest in southern peninsular Thailand (Hodel 1998, p. 53). In the Latin diagnosis, a requirement for naming a new species, I simply used one word, *grandissima*, which means the largest, because *C. kiriwongensis* is the largest and most imposing species in the genus.

At the time of publication, some nomenclatural authorities did not regard the publication as valid, as they felt the one-word Latin diagnosis I employed when I named *Caryota kiriwongensis* was insufficient. They were concerned that the diagnosis did not clearly distinguish this species from other large species in the genus, and thus, the species was not validly published in 1998. Here I offer an expanded, more descriptive Latin diagnosis and also provide a brief description, discussion and illustration of this splendid and remarkable palm. For a complete and detailed description see Hodel (1998).

Caryota kiriwongensis Hodel, **sp. nov.**, *C. obtusae* affinis sed trunco cano non ventricoso, inflorescentiis multo brevioribus (2.5 m vs. 6 m), floribus pilis abundantibus longis ferrugineis non appressis, perianthiis fructificantibus lobis profundis, seminibus vix sulcatis, endospermio homogeneo, eophyllis pinnatis differt. Typus. Thailand. Nakhon Si Thammarat: Kiriwong, *Hodel et al. 1809* (Holotypus BK, Isotypus BH.). Fig.1.

Caryota kiriwongensis is a massive, solitary, emergent, monoecious, monocarpic tree palm to 35 m tall. The gray trunk is about 85 cm in diameter and uniform throughout its length or only slightly ventricose. The immense leaves are clustered tightly in a spreading crown at the top of the trunk and the blade alone is over 8 m long. Each leaf has up to 25 twice divided pinnae to 3.5 m long with only slightly drooping tips on each side of the rachis. The pendulous inflorescence is only about 2.5 m long, making it much shorter than that of the similar *C. obtusa*. Abundant, long, reddish brown, non-appressed hairs cover the flowers. The purplish red fruits, 2.6 × 3.3 cm, typically contain two, scarcely grooved seeds with homogeneous endosperm. The homogeneous endosperm is unusual for the genus and occurs elsewhere only in *C. ophiopellis* and *C. zebrina*, two species amply distinct in their conspicuously and colorfully marked petioles. The pinnate eophyll is unique for the genus (Hodel 1999).

Not a gregarious species, only about 50 large plants of *Caryota kiriwongensis* are scattered across the bottoms of steep, rocky slopes in an area about five kilometers wide in wet mountain forest at about 1200 m elevation. In 1998 only a few plants were reproductive and there were few seedlings and saplings. The species may now be in cultivation and, by its sheer size alone, would obviously make an outstanding ornamental in an appropriate landscape or garden setting.

1. *Caryota kiriwongensis* is a massive, solitary, emergent, tree palm to 35 m tall. Note the standing man in a green shirt barely visible at the right side of the base of the trunk (*Hodel 1809*).

Acknowledgments

I thank seed dealer Tobias Spanner for bringing to my attention the homogeneous endosperm of *Caryota kiriwongensis* and James Reveal and Sherry Vance of the Bailey Hortorium for arranging the loan of the isotype for study.

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A New Species of *Pritchardia* and the Rediscovery of *P. lowreyana* on Oahu, Hawaii

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For many years the Koolau Mountains, which rise to about 1000 m elevation and stretch like a spine along the eastern side of the island of Oahu in Hawaii, were considered home to only one species of *Pritchardia*, the highly variable *P. martii*. However, in my recent treatment of *Pritchardia* (Hodel 2007) I showed that at least one more species, *P. kahukuensis*, occurs there and that another taxon, a variant of *P. martii* with exceptionally long infructescences greatly exceeding the leaves, perhaps could be segregated out and recognized as a distinct species. Indeed, a reassessment of this variant of *P. martii*, during preparation of a book on the Hawaiian species of the genus, has shown that it is distinct, and I take great pleasure in naming and describing it here. Nearly simultaneously, the unexpected, recent rediscovery in the Koolau Mountains of *P. lowreyana*, long thought to be extinct or simply reported erroneously, raises an intriguing nomenclatural question and shows that amazing discoveries await intrepid explorers of Hawaiian forests.

Pritchardia bakeri, A New Species

Pritchardia bakeri Hodel, **sp. nov.** *P. martii* affinis sed infructescentibus foliis longioribus differt; *P. hardyi*, *P. kaalae*, et *P. thurstonii* affinis sed fructibus maioribus (35 mm vs. 7–25 mm)differt. Typus: USA. Hawaii. Oahu: Koolau Mountains, Koolauloa District, Lands of Kahuku, *Hodel 2019* (Holotypus BISH). Figs. 1–6.

Solitary, moderate tree palm to 7(–10) m tall (Figs. 1 & 2). Trunk 20–25 cm diam., mostly grayish, sometimes brownish when protected and unexposed, longitudinally grooved, obscurely ringed, internodes 2–5 cm, distal

portion just below crown of leaves frequently retaining a "skirt" of dead leaves and/or leaf bases. Leaves 35–40, stiffly spreading; leaf bases ca. 20 cm long, 20–25 cm wide proximally, tapering to 10–12 cm wide distally; petioles 30–45 cm long, 4–6 cm wide and 1.5 cm thick at blade, convex adaxially, rounded abaxially, margins sharp, blade-like, and proximally with few, coarse, tan fibers, densely covered abaxially and especially proximally with whitish to brownish pink, mealy indumentum, hastula semicircular, 8 mm high; blade ca. 75 × 75 cm, slightly undulate, costapalmate for 15–20 cm, divided to ca. two-fifths into 55–60 segments, middle-lateral ones the largest, these to 60 cm long, 4 cm wide at point of disjunction, free apical portion 15–30 cm long and bifid for two-thirds to nearly same length, tips stiff, long-acuminate, glossy green adaxially, grayish and thickly and completely covered with minute hair-like scales (lepidia) abaxially, indumentum on petiole extending onto segment folds abaxially, most proximal segments 30–35 × 0.5 cm. Inflorescences 5–8, interfoliar, ascending to nearly spreading and ca. equaling subtending leaf and to 1.3 m in long in flower, arching to pendulous and greatly exceeding the subtending leaf and to 2.8 m long in fruit (Figs. 1–3), composed of 1 long peduncle or several long peduncle-like axes terminating in a relatively short panicle, peduncle or axes to 1 m long in flower and to 2.6 m long in fruit, base 5.5 cm wide, 0.8–1 cm thick, apex 1.0 × 0.8 cm diam., glabrous, ± tightly sheathed in imbricate bracts for nearly its entire length, prophyll to 40 cm long, inserted 3 cm above base, 2-keeled, up to 8 peduncular bracts, these green in flower, tan to brownish in fruit, papery, lightly to moderately covered with grayish tomentum, proximal bracts lanceolate, acute, ± tightly sheathing, distal bracts broadly lanceolate, inflated distally and more loosely sheathing, 2 most distal bracts the smallest and partially covering the proximal branches of panicle; panicles compact in flower (Fig. 3), expanded in fruit, branched to 2 orders, rachis to 18 cm long, proximal branches with sub-peduncle to 2.5 cm long, sub-rachis to 2.5 cm long and with up to 4 rachillae each, distal branches simple rachillae; rachillae to 10 cm long, 4 mm diam., terete, strongly flexuose, glabrous (Fig. 3) or moderately covered with short, velvety hairs, bracts subtending rachillae and panicle branches 5 × 0.8 mm. Flowers 3.5–8.0 mm apart; at anthesis 13 × 16 mm, greenish yellow to nearly orange (Fig. 4); calyx 6.5 × 6.0 mm, tubular, shallowly 3-lobed and yellow distally, greenish proximally, coriaceous, sepals imbricate to apex, mucronate; corolla tubular

1 *Pritchardia bakeri* grows 7– 10 m tall and forms rather tight colonies at the type locality in Kahuku at the northern end of the Koolau range on Oahu, Hawaii (*Hodel 2019*).

at base, base 8 × 7 mm, only slightly exceeding calyx, yellow, distally divided into 3 valvate lobes that fall away at anthesis, these not seen; stamens 6, filament bases connate in a ring exserted 2 mm above corolla base, stamens spreading, borne on short tips 2 mm long of staminal ring, anthers 5–6 mm long, oblong, dorsifixed near base; pistil 7 mm tall, spindle-shaped, exserted 3 mm above staminal ring, columnar, tapered apically. Fruits (green and not fully mature) 40 × 35 mm (Fig. 5), ovoid-oblong, eventually likely turning dark brown to black.

Specimens Examined: USA, Hawaii, Oahu, Koolau Mountains. Koolauloa District: Kahuku Forest Reserve, Lands of Kahuku, upper reaches of Ohia Ai Gulch, to east of trail off Drum Road from Pupukea to Summit Trail, north- and east-facing slopes, ca. 525 m elev., N 21.63617, W 157.98871, *Hodel & Leinau 2019* (BISH). Honolulu District: Honolulu Watershed Forest Reserve, Kuliouou-Niu Ridge, *Obata 87-452* (BISH), *Wood 2613* (PTBG), *Zschokke 1282* (BISH).

The epithet honors Ray Baker of Lyon Arboretum of the University of Hawaii in Honolulu, who has selflessly toiled for over 30 years in amassing and curating one of the finest collections of tropical ornamental plants in the world.

Distribution and Ecology: *Pritchardia bakeri* occurs in wet, low, disturbed, windswept, mostly exposed shrubby and/or grassy areas, sometimes on steep slopes, at the northern and southern ends of the Koolau Mountains, Oahu, Hawaii, 475–650 m elevation (Fig. 6).

Conservation Status: Although exact numbers are uncertain, it is estimated that fewer than 250 plants of *Pritchardia bakeri* occur in the Koolau Mountains. It should probably be considered endangered. Threats include severe habitat degradation, rats, pigs and weeds. Its narrow, restricted range increases susceptibility to single, disruptive event, like a hurricane, and to potential damage from weeds, animals and disease. Highly fragmented populations, low seedling recruitment and relatively small overall numbers suppress regeneration. Its occurrence in forest reserves provides the potential for protective management.

Notes: *Pritchardia martii* has long been considered to be one of the most variable

2 (left). Joby Rohrer holds infructescences of *Pritchardia bakeri*, which can be twice the length of the leaves. Kuliouou Ridge, southern Koolau range. 3 (right). Like all species of the genus, *Pritchardia bakeri* typically has yellow, compact panicles in flower (*Hodel 2019*).

4 (top). Rachillae may be glabrous, as shown here, or have short, velvety hairs, while the flowers of *Pritchardia bakeri* are yellow (*Hodel 2019*). 5 (bottom). Fruits of *Pritchardia bakeri* are large and green when immature (*Hodel 2019*).

species in the genus. Indeed, a remarkable range of variability, including size of plants, shape and size of leaves, amount and type of indumentum on inflorescences, shape and size of fruit and length of inflorescences, is readily apparent over the ca. 40 kilometers that *P. martii* occupies along the crest of the Koolau Mountains. The last character, the length of the inflorescence (and infructescence) relative to the subtending leaf, can be a critical, diagnostic feature for distinguishing many species of *Pritchardia* (Hodel 2007). Nonetheless I felt that this character was relatively unimportant in circumscribing *P. martii* and settled on a species encompassing individuals with a range of infructescence lengths, from not exceeding the petiole to greatly exceeding the leaf blade.

However, I alluded (Hodel 2007) that, with further study, the variant of *Pritchardia martii* with exceptionally long infructescences perhaps could be segregated out and recognized as a distinct species, and that has now been borne out. Additional study and a reassessment of *P. martii* has shown that infructescence length is less variable than once thought, and two, distinct taxa can be neatly separated within *P. martii*. One, with infructescences generally not exceeding the petioles, is *P. martii*, while the other, with infructescences greatly exceeding the leaf blades, is *P. bakeri*.

Pritchardia bakeri has a disjunct distribution, and is known only from the far northern and southern ends of the Koolau range, like bookends, with *P. martii* sandwiched in between. At both ends of the Koolau range it occurs close to *P. martii*, and at the northern end it occurs with *P. kahukuensis*, which, with infructescences about equaling the leaf blades, may have contributed to the perception that *P. martii* had infructescences ranging from shorter than the petioles to greatly exceeding the leaf blades.

Pritchardia kaalae from the Waianae Mountains on Oahu, *P. hardyi* from Kauai and *P. thurstonii* from the Lau Group in Fiji and Eua in Tonga share the exceptionally long infructescences with *P. bakeri*, but they all differ in their much smaller fruit (not exceeding 25 mm in diameter). *Pritchardia bakeri* would key out to couplet 6b in the key to the species of *Pritchardia* (Hodel 2007, p. S-9) and is illustrated in the same publication (Fig. 25, p. S-26) as *P. martii*.

Rediscovery of *Pritchardia lowreyana* on Oahu, Hawaii

Beccari, in his monograph of *Pritchardia* (Beccari & Rock 1921), concluded that the Koolau Mountains behind downtown Honolulu was the home of the little known *P. macrocarpa*, despite the fact that Rock, who had searched the Koolau range for many years, had never encountered it there. Beccari surmised that encroaching urbanization and collection for landscape use in Honolulu had likely exterminated it in the wild. He noted that Rock had identified several cultivated specimens of *P. macrocarpa* in Honolulu, the most famous of which is a now fenced, historical specimen in Foster Garden of the Honolulu Botanical Gardens. Rock made a collection from this cultivated specimen, which sketchy records show was collected from

6. Near the southern end of the Koolau range *Pritchardia bakeri* is a small plant and occurs on exposed, steep, windswept slopes along Kuliouou Ridge.

7 (left). Just a few, mostly tall and probably very old specimens of *Pritchardia lowreyana* occur on an unusually steep slope below the summit of Puu Ohulehule in the Koolau range. 8 (right). Infructescences of *Pritchardia lowreyana* are pendulous when heavily laden with large fruits and about equal the leaf in length.

the not-too-distant Nuuanu Valley behind Honolulu. From this collection, Beccari was able finally to provide a detailed description and purported origin of *P. macrocarpa*.

I showed, however, that *Pritchardia macrocarpa* was a name of uncertain application and best dropped from use, and the appropriate name for these cultivated plants in Honolulu was *P. lowreyana*, heretofore known with certainty only from Molokai, about 45 km east-southeast of Oahu (Hodel 2007). That *P. lowreyana* has leaves with green abaxial blade surfaces lightly and incompletely covered with lepidia, in rather striking contrast to the silvery grayish white abaxial blade surfaces thickly and completely covered with lepidia of all previously known *Pritchardia* in the Koolau range (*P. kahukuensis*, *P. bakeri* and *P. martii*), appeared to bolster the claim by many Hawaiian plant aficionados that these cultivated *P. lowreyana* probably originated not on Oahu but more likely on Molokai. Indeed, for years, they scoffed at the idea that these cultivated plants, including the famous specimen in Foster Garden, could have come from Oahu because nothing even remotely like them had been found in modern times on the island.

However, intrepid hikers and naturalists Joel Lau and Kenji Suzuki discovered a small colony of *Pritchardia lowreyana* on Oahu in April, 2008, clinging tenaciously at 515 m elevation to a very steep, north-facing slope about 175 m below the summit of Puu Ohulehule, the pyramid-shaped peak on the ridge running to the east from the main Koolau range and separating Waikane and Kahana Valleys (Figs. 7 & 8). Their find is especially significant because it confirms that this species does, in fact, occur there and that Beccari and Rock were correct in referring to it when they wrote of a *Pritchardia* (erroneously referred to as *P. macrocarpa*) with green abaxial blade surfaces that once grew in the Koolau Mountains behind Honolulu and survived only as a few cultivated plants in the city.

Lau and Suzuki's rediscovery of *Pritchardia lowreyana* in the Koolau Mountains on Oahu was also significant because it could affect its nomenclatural standing and that of *P.*

gaudichaudii. In my recent review of the genus (Hodel 2007), I contended that the name *P. gaudichaudii* was best applied to material from the Koolau range on Oahu and, thus, is a synonym of *P. martii* because only one species occurred there near downtown or the historic section of Honolulu and it had abaxial blade surfaces completely covered with lepidia. My position, partially based on an examination by Fred Stauffer of the type of *P. gaudichaudii* at Geneva (G) that showed the abaxial blade surface to be completely covered with lepidia (or at least once was), was in contrast to that of Beccari and Rock (1921) who described *P. gaudichaudii* as having green abaxial blade surfaces incompletely covered with lepidia, and occurring on Molokai.

Lau and Suzuki's discovery of a *Pritchardia* with green abaxial blade surfaces in the Koolau Mountains prompted me to wonder if I had misinterpreted what Fred Stauffer had told me about the abaxial blade surface of the type of *P. gaudichaudii* at G. If the type at G actually had abaxial blade surfaces incompletely covered with lepidia, *P. gaudichaudii* would likely be resurrected from synonymy with *P. martii*, and *P. lowreyana* would become a synonym of *P. gaudichaudii*. Fred graciously agreed to reexamine the type of *P. gaudichaudii* at G, which confirmed his earlier finding that the abaxial blade surface was completely covered with lepidia. Thus, *P. gaudichaudii* remains a synonym of *P. martii*, and *P. lowreyana* is now verified as occurring on Oahu, extending its range from Molokai and making it one of the few Hawaiian *Pritchardia* to occur on more than one island. It also confirms Beccari and Rock's earlier contention that a *Pritchardia* with green abaxial blade surfaces inhabited the Koolau Mountains.

Acknowledgments

I extend my sincere thanks to Bob Leinau, who assisted in collectiong the type of *Pritchardia bakeri*, and Fred Stauffer who, at my request, graciously and enthusiastically reexamined the type of *P. gaudichaudii* at G. I also profusely thank Joel Lau and Kenji Suzuki who happily took me on the arduous climb up Puu Ohulehule in May, 2008 to see their discovery, and Leland Miyano, who told me of their discovery and helped to arrange the 2008 trek.

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Field Guide to the Palms of Rio de Janeiro State, Brazil

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This Guide is designed specifically for the participants in the IPS Rio Biennial, but will allow anyone to identify naturally occurring palms within Rio de Janeiro State and in adjacent areas of São Paulo, Minas Gerais, and Espírito Santo.

Note that cultivated palms (of which there are many in Rio) are not included. I have indicated, for each species, sites in Rio de Janeiro State where they may be found, mostly National Parks or other protected areas. So, enjoy the Biennial, and don't forget to bring this guide!

Key to the Genera

1a. Spiny palms . . . . . 2.

1b. Non-spiny palms . . . . . 5.

2a. Climbing or scrambling palms; leaf tips with hooks instead of leaflets . . . ***Desmoncus***

2b. Non-climbing palms; leaf tips without hooks . . . . . 3.

3a. Stems to 50 cm diameter; leaflets irregularly arranged and spreading in different planes . . . . . ***Acrocomia***

3b. Stems to 15 cm diameter; leaflets usually regularly arranged and spreading in the same plane . . . . . 4.

4a. Leaflets silvery-gray on the lower surfaces; fruits spiny. . . . . ***Astrocaryum***

4b. Leaflets green, rarely silvery-gray on the lower surfaces; fruits not spiny . . . . . ***Bactris***

5a. Leaf sheaths forming a distinct crownshaft; inflorescences borne below the crown-shaft . . . . . ***Euterpe***

5b. Leaf sheaths not forming a crownshaft; inflorescences borne amongst the leaves . . 6.

6a. Stems slender, brown, ringed, 1–4.5 cm tall and 1–4 cm diameter; fruits small, black, to 1.5 cm long . . . . . ***Geonoma***

6b. Stems short and subterranean or stout, not ringed, 5–25 m tall, 10–35 cm diameter; fruits larger, brown or greenish, to 9 cm long . . . 7.

7a. Inflorescences unbranched, with the fruits densely crowded . . . . . ***Allagoptera***

7b. Inflorescences branched, the fruits usually not densely crowded . . . . . 8.

8a. Leaflets silvery-gray on the lower surfaces. . . . . ***Lytocaryum***

8b. Leaflets green on the lower surfaces . . . 9.

9a. Fruits one-seeded. . . . . ***Syagrus***

9b. Fruits multi-seeded . . . . . ***Attalea***

ACROCOMIA

One species in Rio de Janeiro.

Acrocomia aculeata (Jacq.) Lodd.*"macauba, mucuja"*

A solitary stemmed palm with tall, stout, spiny stems to 11 m tall and 50 cm diameter. The leaves are spiny, pinnate, with many, linear leaflets which are clustered and spread in different planes, giving the leaf a plumose appearance. Inflorescences are borne amongst the leaves. Fruits are large, smooth, yellowish, and rounded, and can reach 5 cm diameter.

Acrocomia aculeata (Fig. 1) is widely distributed through Central and South America. It grows in open places and disturbed areas. It is uncommon in Rio.

ALLAGOPTERA

Two species in Rio de Janeiro.

Key to the species of ***Allagoptera***

1a. Stems tall and aerial . . . . . ***A. caudescens***

1b. Stems short and subterranean . ***A. arenaria***

Allagoptera arenaria (Gomes) Kuntze *"caxandó, côco da praia"*

A clustered stemmed palm with short and subterranean stems, sometimes forming large clumps. The leaves are pinnate, and the leaflets

1. *Acrocomia aculeata.*

are irregularly arranged along the rachis and spread in different planes. The leaflets are somewhat gray-waxy. The unbranched inflorescences are borne amongst the leaves and stick up amongst them. The fruits are densely packed together, giving a club-shaped infructescence. The fruits are irregular in shape due to mutual pressure

Allagoptera arenaria (Fig. 2) occurs along the Atlantic coast of Brazil from Bahia to São Paulo. It grows on dunes and sandy soils near the sea shore. It is common in Rio although much reduced because of beach-front development. It has been recorded from Sepetiba Bay.

Allagoptera caudescens (Mart.) Kuntze *"buri"*

A solitary stemmed palm with stems to 8 m tall and 20 cm diameter (rarely, but not in Rio, the stems are short and subterranean). The leaves are pinnate, and the leaflets are irregularly arranged along the rachis and spread in different planes. The leaflets are white-wooly on the lower surfaces. The unbranched inflorescences are borne amongst the leaves but curve down below them, and appear sausage-like when in fruit. The fruits are irregular in shape due to mutual pressure, and are to 4.5 cm long.

Allagoptera caudescens (Fig. 3), formerly included in the genus *Polyandrococos*, is distributed along the Atlantic coast of Brazil from Alagoas to Rio de Janeiro. It grows in lowland forest at low elevations, and persists in disturbed areas. In Rio it has been recorded from the Reserva Biológica Poço das Antas.

ASTROCARYUM

One species in the Rio de Janeiro region.

Astrocaryum aculeatissimum (Schott)Burret *"brejauva"*

A clustered stemmed palm with stems to 8 m tall and 15 cm diam., the stems densely covered with rings of black spines. The leaves are spiny and the leaflets are regularly arranged along the rachis and spread in the same plane. The leaflets are silvery-gray on the lower surfaces. Fruits are large, up to 4.5 cm long, and are covered with easily removed spines.

2 (left). *Allagoptera arenaria*. 3 (right). *Allagoptera caudescens*.

Astrocaryum aculeatissimum (Fig. 4) is distributed along the Atlantic coast of Brazil from Bahia in the north to Santa Catarina in the south. In Rio it has been recorded from Reserva Biológica do Tinguá, Reserva Biológica Poço das Antas, and the Parque Natural Municipal de Prainha.

ATTALEA

Three species in Rio de Janeiro.

Key to the species of ***Attalea***

1a. Stems short and subterranean . ***A. humilis***

1b. Stems tall and aerial . . . . . 2.

2a. Leaflets irregularly arranged and spreading in different planes . . . . . ***A. dubia***

2b. Leaflets regularly arranged and spreading in the same plane . . . . . ***A. apoda***

Attalea apoda Burret *"catolé"*

Stems are tall and stout, and reach 10 m tall and 25 cm diam. The leaves are spreading to erect, and the numerous leaflets are regularly arranged and spread in the same plane. The inflorescences are borne amongst the leaves. The fruits, borne in large bunches, are oblong, brown, and to 7 cm long.

Attalea apoda occurs in Minas Gerais and just enters Rio de Janeiro. It occurs in disturbed places. There is one record from Rio de Janiero state, near Teresopolis.

Attalea dubia (Mart.) Burret *"babassu, bacuaçu"*

Stems are tall and stout, and reach 25 m tall and 35 cm diam. The leaves are spreading to erect, and the numerous leaflets are irregularly arranged and spread in different planes. The inflorescences are borne amongst the leaves and are pendulous. The fruits, borne in large bunches, are oblong, brown, and to 6.5 cm long.

Attalea dubia occurs along the Atlantic coast of Brazil from Espírito Santo to Santa Catarina. It occurs in lowland forest and coastal forests or disturbed places. It has been recorded from the Parque Natural Municipal de Prainha.

4 (left). *Astrocaryum aculeatissimum.* 5 (right). *Attalea humilis.*

6. *Bactris caryotifolia.*

Attalea humilis Mart. *"catolé, pindoba"*

Stems are short and subterranean. Leaves are erect and the leaflets are regularly arranged and spread in the same plane. The inflorescences are borne amongst the leaves and are erect. The fruits, borne in bunches, are oblong, brown, and to 9 cm long.

Attalea humilis (Fig. 5) occurs along the Atlantic coast of Brazil from Bahia to São Paulo. It grows in low forest near the sea or on grassy hillsides. In Rio it has been recorded from the Reserva Biológica Poço das Antas.

BACTRIS

Three species in Rio de Janeiro.

Key to the species of ***Bactris***

1a. Leaflets wedge-shaped with jagged apices. . . . . ***B. caryotifolia***

1b. Leaflets linear with pointed apices . . . . 2.

2a. Leaf sheath spines black or reddish-brown; leaflets silvery-gray on the lower surfaces. . . . . ***B. vulgaris***

2b. Leaf sheath spines yellowish; leaflets green on the lower surfaces . . . . . ***B. setosa***

Bactris caryotifolia Mart. *"tucum branco"*

A small, spiny palm with clustered stems to 1.5 m tall and 2 cm diam. The leaflets are unique in *Bactris* in being wedge-shaped and having jagged apices. They are irregularly arranged and spread in different planes, and are silvery-gray on the lower surfaces. Inflorescences are borne amongst the leaves and have 4–6 flowering branches. Fruits are rounded, purple-black, and to 1.8 cm diameter.

Bactris caryotifolia (Fig. 6) occurs along the Atlantic coast of Brazil from Bahia to Rio de Janeiro. It grows in lowland forest at low elevations. In Rio it has been recorded from Parque Nacional Tijuca and Reserva Biológica do Tinguá.

Bactris vulgaris Barb. Rodr. *"tucum, tucum preto"*

A medium-sized, spiny palm with clustered stems to 3 m tall and 3.5 cm diam. Leaf sheaths are covered with black or reddish-brown spines. The leaflets are numerous (21–46 per side of the rachis), regularly arranged and spreading in the same plane, and are gray on the lower surfaces. Inflorescences are borne amongst the leaves. Fruits are rounded, purplish, and 2.4 cm diameter.

Bactris vulgaris occurs along the Atlantic coast of Brazil from Bahia to Rio de Janeiro. It grows in lowland forest. It has been recorded from the Parque Natural Municipal de Prainha.

Bactris setosa Mart. *"jucúm, tucum"*

A medium-sized, spiny palm with clustered stems to 6 m tall and 4 cm diam. Leaf sheaths are covered with yellowish, black-tipped spines. The leaflets are numerous (30–57 per side of the rachis), linear, regularly arranged and spreading in the same plane, and are green on the lower surfaces. Inflorescences are borne amongst the leaves. Fruits are rounded, purple-black, and to 2 cm diam.

Bactris setosa occurs along the Atlantic coast of Brazil from Bahia to Rio Grande do Sul. It grows in lowland forest in wet, swampy areas. In Rio it has been recorded from Parque Nacional Tijuca and Reserva Biológica Poço das Antas.

DESMONCUS

Two species in Rio de Janeiro

Key to the species of ***Desmoncus***

1a. Leaf rachis with short, recurved spines on the lower surface; inflorescence bracts covered with short, recurved spines . . ***D. polyacanthos***

7. *Desmoncus polyacanthos.*

1b. Leaf rachis with long, straight spines on the lower surface; inflorescence bracts usually without spines, brown felty . . ***D. orthacanthos***

Desmoncus orthacanthos Mart. *"jacitara"*

A climbing or scrambling palm with stems to 4 m long and 2 cm diam. The leaf rachis has long, black spines on the lower surface. There are 6–10 leaflets per side of the rachis, and at the rachis apex the leaflets are modified into hooks. The inflorescence bract is without spines, and is felty-brown. Fruits are ovoid or ellipsoid and about 2 cm long.

Desmoncus orthacanthos is distributed along the Atlantic coast of Brazil from Pernambuco to Santa Catarina. It grows in forest or disturbed places at low elevations, especially near the sea. In Rio it has been recorded from disturbed places at low elevations near the sea.

Desmoncus polyacanthos Mart. *"jacitara"*

A climbing or scrambling palm with stems to 3 m long and 1.5 cm diam. The leaf rachis has short, recurved spines on the lower surface. There are 7–10 leaflets per side of the rachis, and at the rachis apex the leaflets are modified into hooks. The inflorescence bract is covered with short, recurved spines. Fruits are ovoid or ellipsoid and about 2 cm long.

8. *Euterpe edulis*.

Desmoncus polyacanthos (Fig. 7) is distributed along the Atlantic coast of Brazil from Pernambuco to Rio de Janeiro. It grows in disturbed places, especially at low elevations near the sea. In Rio it has been recorded from the Reserva Biológica Poço das Antas and the Parque Natural Municipal de Prainha

EUTERPE

One species in Rio de Janeiro.

Euterpe edulis Mart. *"juçara"*

A tall, solitary-stemmed palm with stems to 12 m tall and 15 cm diam. There is a prominent crownshaft at the apex of the stem. Leaflets are numerous, regularly arranged, and spread horizontally or are somewhat pendulous. Inflorescences are borne below the crownshaft and have many flowering branches. Fruits are rounded, purple-black, and about 1.5 cm diam.

9. *Geonoma elegans.*

Euterpe edulis (Fig. 8) is distributed along the Atlantic coast of Brazil, from Pernambuco to Rio Grande do Sul, and also reaches Argentina and Paraguay. It grows on forested slopes in the Atlantic Coastal Forest. In Rio it has been recorded from many places, including the Estação Ecológica do Paraíso, Ilha Grande, Parque Nacional Tijuca, Reserva Biológica Poço das Antas, Parque Nacional do Itatiaia, Parque Natural Municipal de Prainha, and Reserva Biológica do Tinguá. *Euterpe edulis* is one source of palm heart, palmito, and was formerly much exploited.

GEONOMA

Nine species in Rio de Janeiro. The state is a center of diversity for this genus, but several species are poorly known and may eventually be included in other species.

Key to the species of ***Geonoma***

1a. Inflorescences unbranched; veins on upper surfaces of leaves not raised . . . . . 2.

1b. Inflorescences branched (rarely unbranched); veins on upper surfaces of leaves raised. . . . . 3.

2a. Leaves undivided, narrow . . . . ***G. bifurca***

2b. Leaves with 3 broad leaflets per side of the rachis, occasionally also with a few narrow leaflets . . . . . ***G. elegans***

3a. Inflorescences with 2 or 3 flowering branches. . . . . 4.

3b. Inflorescences with numerous flowering branches. . . . . 5.

4a. Leaves with 3 broad leaflets per side of the rachis . . . . . ***G. rodeiensis***

4b. Leaves with to 20 narrow leaflets per side of the rachis . . . . . ***G. trinervis***

5a. Leaves with to 34 narrow, closely spaced leaflets per side of the rachis . . ***G. schottiana***

5b. Leaves with 3–7 or more, widely spaced leaflets per side of the rachis . . . . . 6.

6a. Flowering branches noticeably hairy . . . . . ***G. fiscellaria***

6b. Flowering branches not hairy . . . . . 7.

7a. Flowering branches unusually narrow with widely spaced pits . . . . . ***G. gastoniana***

7b. Flowering branches not narrow . . . . . 8.

8a. Inflorescences with 6–8 short and narrow flowering branches . . . . . ***G. wittigiana***

8b. Inflorescences with 4–32 long and stout flowering branches . . . . . ***G. pohliana***

Geonoma bifurca Drude

A small, understory palm with clustered, ringed, brown stems to 2 m tall and 1 cm diame. The leaves are undivided and narrow and the veins on upper surfaces are not raised. The inflorescence is unbranched. The fruits are unknown.

Geonoma bifurca occurs only in Rio de Janeiro. It grows in lowland forest on mountain slopes. In Rio it has been recorded from the Parque Estadual de Desengano. It is similar to *G. elegans* but differs in its narrow, undivided leaf.

Geonoma elegans Mart. *"ouricana"*

A small, understory palm with clustered, ringed, brown stems to 2 m tall and 1 cm diam. The leaves are usually divided into three broad leaflets, and occasionally there are also with a few narrow leaflets. The veins on upper surfaces are not raised. The inflorescence is unbranched and projects above the leaves. The fruits are small, black, ellipsoid, and to 1 cm long.

Geonoma elegans (Fig. 9) occurs along the Atlantic coast of Brazil from southern Bahia to Santa Catarina. It grows in lowland forest. In Rio it has been recorded from many places, including the Parque Nacional Tijuca and Reserva Biológica Poço das Antas.

Geonoma fiscellaria Mart.

A medium-sized palm with clustered, brown, ringed stems to 4 m tall and 4 cm diam. The leaves are pinnate with few to several, broad or narrow, regularly arranged leaflets. The veins on the upper surfaces are raised. Inflorescences are borne amongst the leaves and have numerous flowering branches, and these are noticeably hairy. Fruits are ovoid, black, and to 1.5 cm long.

Geonoma fiscellaria occurs only in Rio de Janeiro state. It grows in forest on mountain slopes. In Rio it has been recorded only from near Petropolis. Three species described by Barbosa Rodrigues from the same locality in Rio de Janeiro – Rodeio – are considered synonyms of *G. fiscellaria*: *G. barbigera* Barb. Rodr., *G. pilosa* Barb. Rodr. and *G. tomentosa* Barb. Rodr.

Geonoma gastoniana Glaz. ex Drude

A small-sized palm with brown, ringed stems to 1 m tall and 1 cm diam. The leaves are pinnate with few to several, broad or narrow, regularly arranged leaflets. The veins on the upper surfaces are raised. Inflorescences are borne amongst the leaves and have numerous flowering branches, and these are unusually narrow. Fruits are unknown.

Geonoma gastoniana occurs only in Rio de Janeiro state. It grows in forest on mountain slopes. It has been recorded from the Reserva Biológica do Tinguá.

Geonoma pohliana Mart. *"ouricana, ouricana preta"*

A medium-sized palm with clustered, brown, ringed stems to 4.5 m tall and 2 cm diam. The leaves are pinnate with to 3–7 broad, regularly arranged leaflets. The veins on the upper surfaces are raised. Inflorescences are borne amongst or below the leaves and have 4–32

flowering branches. Fruits are ovoid, black, and to 1.2 cm long.

Geonoma pohliana occurs along the Atlantic coast of Brazil from Espírito Santo to Rio Grande do Sul. It grows in lowland forest on mountain slopes. In Rio it has been recorded from the Parque Nacional Tijuca, Parque Nacional da Serra dos Órgãos, and the Parque Estadual da Pedra Branca.

Geonoma rodeiensis Barb. Rodr.

A medium-sized palm with stems to 4.5 m tall and 4 cm diam. Leaves are pinnate with 3 broad leaflets per side of the rachis and occasionally there are also with a few narrow leaflets. The veins on the upper surfaces are raised. Inflorescences are branched with 2 or 3 flowering branches (rarely unbranched). Fruits are rounded, black, and to 1 cm long.

Geonoma rodeiensis occurs only in Rio de Janeiro state. It grows on steep mountain slopes in forest. It is poorly known and the original locality is now destroyed, but a similar-looking palm has been recorded from Sepetiba Bay.

Geonoma schottiana Mart. *"ouricana"*

A medium-sized palm with solitary, brown, ringed stems to 3.5 m tall and 3 cm diam. The leaves are pinnate with to 34 narrow, regularly arranged, closely spaced leaflets. The veins on the upper surfaces are raised. Inflorescences are borne amongst or below the leaves and are much branched. Fruits are ovoid, black, and to 1.3 cm long.

Geonoma schottiana occurs in southeastern Brazil in Espírito Santo, Minas Gerais, Paraná, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, and São Paulo. It grows in lowland forest or gallery forest. In Rio it is common and has been recorded from the Parque Nacional da Serra dos Órgãos and Parque Nacional Tijuca.

Geonoma trinervis Drude & H. Wendl.

A small, understory palm with clustered, ringed, brown stems to 2 m tall and 1 cm diam. The leaves are pinnate with to 20 narrow, small leaflets which are regularly arranged. The veins on the upper surfaces are raised. The inflorescence has 2 or 3 stout flowering branches. The fruits are ovoid, purple-black, and to 1 cm long.

Geonoma trinervis occurs only in Rio de Janeiro state. It grows in lowland forest on mountain slopes. In Rio it has been recorded from the Parque Nacional da Serra dos Órgãos.

Geonoma wittigiana Glaz. ex Drude

A small, understory palm with clustered, ringed, brown stems to 1.5 m tall and 1 cm diam. The leaves usually have three broad leaflets per side of the rachis, but sometimes narrower leaflets are also present. The veins on the upper surfaces are raised. The inflorescence is branched with 6–8, short and narrow flowering branches. The fruits are unknown.

Geonoma wittigiana occurs only in Rio de Janeiro state. It grows in forest on steep mountain slopes. In Rio it has been recorded only from the Parque Nacional da Serra dos Orgãos. In its leaves it is very similar to *G. elegans* but differs in its branched inflorescences.

LYTOCARYUM

One species in Rio de Janeiro.

Lytocaryum weddellianum (H.Wendl.) Tol. *"agué, icá"*

A solitary stemmed palm with stems to 5 m tall and 10 cm diameter. The upper part of the stem is covered with persistent leaf bases. The sheaths, petioles and rachis are densely covered with dark hairs. The leaflets are narrow, regularly arranged, spread in the same plane, and are silvery-gray on the lower surfaces. Inflorescences are borne amongst the leaves and arch out from them. Fruits are ovoid to ellipsoid and are to 2.3 cm long and 1.7 cm wide.

Lytocaryum weddellianum (Fig. 10) occurs along the Atlantic coast of Brazil, from Espírito Santo to Rio de Janeiro. It grows in lowland rain forest in the Atlantic Coastal Forest. In Rio it has been recorded from Serra dos Orgãos.

SYAGRUS

Four species in Rio de Janeiro.

Key to the species of ***Syagrus***

1a. Fruits with a prominent 'beak'; peduncular bracts deeply grooved . . . . . ***S. pseudococos***

1b. Fruits without a prominent beak; peduncular bracts not deeply grooved . . . . 2.

2a. Fruits rounded . . . . . ***S. romanzoffianum***

2b. Fruits ovoid or ellipsoid . . . . . 3.

3a. Fruits 4.5 cm long . . . . . ***S. picrophylla***

3b. Fruits to 7cm long . . . . . ***S. macrocarpa***

10. *Lytocaryum weddellianum.*

Syagrus macrocarpa Barb. Rodr. *"Maria Rosa"*

A solitary stemmed palm with stems to 8 m tall and 20 cm diam. The upper part of the stem is often covered with persistent leaf bases. The linear leaflets are irregularly arranged in clusters and spread in different planes. Inflorescences are borne amongst the leaves, and the female flowers are exceptionally long, to 3.5 cm. The peduncular bract is shallowly grooved. Fruits are brown, ellipsoid, and to 7 cm long and 3 cm wide.

Syagrus macrocarpa occurs along the Atlantic coast of Brazil in Espírito Santo, Minas Gerais, and Rio de Janeiro. It grows in seasonal forest in rocky places It is uncommon in Rio but may occur in the western part of the state.

Syagrus pseudococos (Raddi) Glassman *"côco amargoso"*

A solitary stemmed palm with stems to 15 m tall and 25 cm diam. The upper part of the stem is often covered with persistent leaf bases. The leaflets are irregularly arranged in clusters and spread in different planes. Inflorescences are borne amongst the leaves. The peduncular bract is deeply grooved. Fruits are brown, ellipsoid with a prominent 'beak,' and to 7 cm long and 4 cm wide.

Syagrus pseudococos occurs along the Atlantic coast of Brazil in Espírito Santo, São Paulo, and Rio de Janeiro. It grows in scrub areas, sometimes on almost bare rock. It has been recorded from the Parque Natural Municipal de Prainha.

Syagrus picrophylla Barb. Rodr. *"licuri"*

A solitary stemmed palm with stems to 7 m tall and 20 cm diam. The upper part of the stem is often covered with persistent leaf bases. The leaflets are irregularly arranged in clusters and spread in different planes. Inflorescences are borne amongst the leaves. The peduncular bract is shallowly grooved. Fruits are orange, ellipsoid, and to 4.5 cm long and 3.5 cm wide.

11. *Syagrus romanzoffiana.*

Syagrus picrophylla occurs along the Atlantic coast of Brazil in Bahia, Espírito Santo, and Rio de Janeiro. It grows in scrub forest on steep slopes with granite outcrops. It is uncommon in Rio but is known from the Parque Natural Municipal de Prainha.

Syagrus romanzoffiana (Cham.) Glassman *"guariroba"*

A solitary stemmed palm with stems to 15 m tall and 50 cm diam. The upper part of the stem is often covered with persistent leaf bases. The leaflets are irregularly arranged in clusters and spread in different planes, and the tips of the leaflets are pendulous. Inflorescences are borne amongst the leaves. The peduncular bract is shallowly grooved. Fruits are brown, ovoid, and to 3 cm long and 2 cm wide.

Syagrus romanzoffiana (Fig. 11) occurs along the Atlantic coast and adjacent inland areas of Brazil, and also reaches Paraguay, Uruguay, and Argentina. It grows in a variety of habitats, and can persist in disturbed areas. It is common in Rio. This is the commonly cultivated 'queen palm.'

Acknowledgements

I thank Larry Noblick for his suggestions and Paula Leitman for her help and for providing Figure 7.

PALM LITERATURE

PALMS OF SOUTHERN ASIA. Andrew Henderson, Princeton University Press, Princeton and Oxford. 2009. ISBN978-0-691-13449-9. US$53. Hardback. 199 pp.

Henderson admits that he originally had a field guide to all Old World palms in mind. Realizing that such a task was too big for a single volume, he decided instead to cover Southern Asia defined as Afghanistan, Bangladesh, Bhutan, Cambodia, China, India, Japan, Laos, Myanmar, Nepal, Pakistan, Sri Lanka, Taiwan, Thailand and Vietnam.

Palms of Southern Asia summarizes all existing knowledge on the 352 species and 43 genera recorded in the region. The coconut is included, whereas the similarly widespread African oil palm (*Elaeis guineensis*) and sago palm (*Metroxylon sagu*) are excluded for reasons that are not evident. The language style is straightforward and will undoubtedly appeal to a wider audience than just palm specialists.

In the introduction, Henderson presents a number of "Palm Regions" within South Asia. The morphology of palms is briefly treated accompanied by a limited number of line drawings. The definition of dioecy in the calamoid palms is over simplified since *functional* female inflorescences of rattans often contain two kinds of flowers: a female flower and a sterile male flower. A dichotomous key to the palm genera is provided.

The remaining part of the book is devoted to description of palm diversity in Southern Asia. The genera are treated systematically and in alphabetical order. Each of them is introduced with what is basically a non-technical version of the descriptions in *Genera Palmarum*, followed by notes on etymology, ecology, uses and distribution. Keys to species are given for all genera with two or more species. Henderson has put great effort into basing the keys on easily recognizable characters, a task that becomes increasingly difficult as the number of species in the genus rises. Keys are partitioned by geographic regions in the case of large genera such as *Calamus*. Using both geographic distribution and morphology as characters may lead to misconceptions about variation. In the case of *Licuala peltata*, for example, one cannot help wondering whether populations in Bangladesh, Bhutan and northeastern India are solitary or not, since they key out separately.

Common names, taken from monographs, floras and herbarium specimens, are listed after the Latin name. Henderson points out that these by no means cover the multiplicity of names given to the same palm throughout its distributional range. True, but in Thailand a comprehensive dictionary of plant names already exists (Smitinand 2001) that apparently was not consulted by the author.

The species descriptions are short and based on features that are easily recognizable in the field. For some of the more speciose genera, such as *Pinanga*, they tend to be a bit repetitive when for each species we learn that the crown shaft is yellowish green. This character is actually quite variable feature in the genus, and in *P. perakensis*, for example, it is often orange to reddish-brown. Dot maps are given for all species except cultivated ones. They are based on information from more than 4400 specimens. In a few cases, sight records are included, as well as "records from reliable monographs and floras." A different symbol should have been used for these records since their identity cannot be verified. Unfortunately Henderson missed an opportunity to assign conservation status to the species. Some of the taxonomic decisions can be challenged, as is always the case. I would like to blow my own trumpet for keeping *Livistona speciosa* separate from *L. jenkinsiana,* instead of lumping the two under *L. jenkinsiana*.

A total of 256, beautifully rendered color photographs accompany the text. The list of references is by no means exhaustive but gives some of the key references for the classification. In the appendix, species checklists are given for individual countries or region, which is useful for fieldwork.

With *Palms of Southern Asia* professional and amateur palm lovers alike have a unique tool to unravel and understand the diversity of southern Asian palms. No doubt it will soon become a standard source of information on palms, and as such it can be highly recommended to all IPS members.

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Livistona chinensis, a Semi-Naturalized Palm of Swamp Forest in Subtropical South Africa

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Despite numerous exotic plant species (ca. 915 taxa) becoming naturalized in South Africa, no records suggest that any of the approximately 400 palm species cultivated locally have followed suit. This paper reports on *Livistona chinensis* as the first palm species to become semi-naturalized in South Africa after 100 years of extensive cultivation along the eastern seaboard.

The first palm to be regarded as naturalized in South Africa, was *Borassus aethiopum* (Selati Palm) from Tropical Africa (Dyer 1952). However, these days its occurrence in Limpopo is accepted by most to be indigenous, and the most southern outlier population of the species in Africa (Esterhuyse et al. 2001, Glen & Archer 2006).

Only six palm species are indigenous to South Africa (Glen & Archer 2006), probably due to prevailing temperate conditions that are unfavorable for tropical taxa. It is therefore not surprising that no non-indigenous member of the Arecaceae has previously been regarded as naturalized in South Africa (Henderson 2006).

Habitat conditions along the sub-tropical eastern seaboard of South Africa do, however, prove to be favorable for colonization by tropical palm species. An example of encroachment by a tropical palm in this region is that which resulted from the planting of *Raphia australis* (Kosi Palm) at Mtunzini in Zululand, KwaZulu-Natal, approximately 300 km south of its natural southern distribution limit at Kosi Bay in the same province. The palm was regarded as a useful stream-bank stabilizer and was subsequently planted in swamps, where large groves have successfully established in dense stands. It spreads rapidly, its seed dispersal aided by palmnut vultures and vervet monkeys, and is generally regarded

as an encroacher species that excludes typical swamp forest species due to its large size (20–15 m) (Peckham & Van Jaarsveld 1989).

This paper reports on another palm that finds the habitat conditions of swamp forest favorable, namely *Livistona chinensis*, an exotic palm species that has escaped from cultivation to become semi-naturalized in South Africa.

Species treatment

Livistona chinensis is indigenous to Japan, China and several islands in the South China Sea; its distribution is reflected in its common names, Chinese Fan Palm or Chinese Fountain Palm. In Japan, *Livistona chinensis* reaches its most northern distribution limit on Aoshima, the 'islet of the Gods', and here a rare virgin forest of this palm is regarded as sacred (Yoshida et al. 2000). The palm is well known in Chinese medicine, as the fruit and seed have a potent anti-angiogenic and anti-tumor activity (Sartippour et al. 2001).

Chinese Fan Palms are tall (4–6 m), single-stemmed and with a dense crown of divided, fan-shaped and pendulous fronds (Fig. 1). It is a hardy palm able to survive extended dry periods. Its natural habitat is open forest and it can therefore tolerate sunny conditions. Sessile flower clusters are borne during late summer on 5–7 inflorescences held within the crown. Flowers are followed by mature oval or round fruit that turn from green-blue to china-blue-gray when ripe.

Discussion

Livistona chinensis was brought to South Africa as an ornamental during the early 1900s (Esterhuyse et al. 2001). Since then it has become a common feature of coastal gardens of urban centers along the subtropical east coast of KwaZulu-Natal.

The sites where *Livistona chinensis* has now become naturalized fall within the core area of the Maputaland Centre of Endemism (Van Wyk & Smith 2001). Many aggressive alien invasive plants such as *Chromolaena odorata*, *Lantana camara* and *Melia azederach* are already problematic in this part of northern coastal KwaZulu-Natal (Henderson 2006). This palm is also recorded as naturalized in coastal areas of the USA (Oppenheimer 2003).

When the palm's non-invasive behavior for 100 years is considered, the question arises,

1. *Livistona chinensis* in situ: swamp forest along the uMhlatuze River near KwaDlangezwa. Photo: S.J. Siebert.

Table 1. Number of individuals recorded per size class for each naturalized population.

Size classes	KwaDlangezwa	Ngwelezana	Thulazihleka	total
0–1000 mm	78	18	12	108
1001–2000 mm	15	7	2	24
2001–3000 mm	4	1	2	7
3001–4000 mm	1	0	1	2
>4000 mm	1	1	0	2

how did it manage to disperse its seed to more favorable shady, moist conditions in surrounding natural forest vegetation in recent years? Despite various visits to palms in fruit, no natural dispersal vectors were noted. Corlett (2005) recorded seven indigenous bird species that took fruit from non-indigenous *Livistona chinensis* in Hong Kong. However, he concluded that seed dispersal by birds and/or fruit bats is a necessary, but not sufficient, condition for the naturalization of fleshy-fruited plants.

Further visits to collecting localities revealed evidence of garden refuse dumping at all sites. Therefore, human behavior seems to be the main dispersal agent. When masses of seeds are swept from pavements and dumped in favorable, moist conditions, there exists a chance for at least some seedlings to reach maturity. Seeds germinate readily within two to three months. Further self dispersal of seed is localiszd in proximity to the mature individuals, forming dense monocultures of seedlings on the forest floor (Table 1). An individual plant can produce on average 3000 seeds per annum (n=10). If the natural germination viability is modestly estimated at 1%, 30 seedlings will germinate from the seeds of a single palm annually.

Naturalized populations of Chinese Fan Palm occur at an altitudinal range of ca. 15–120 m above sea level. In situ it is regularly associated with an indigenous palm, *Phoenix reclinata* (Wild Date Palm), and tends to prefer forested areas along seepages characterized by large individuals of the tree species *Bridelia micrantha*, *Ficus sur*, *Trema orientalis*, *Trichilia dregeana* and *Syzygium cordatum*. Here in the

2. A dense stand of *Livistona chinensis* seedlings within a 10 m radius of the adult plant at Ngwelezana. Photo: S.J. Siebert.

subcanopy it occurs with other problematic alien or invader species such as *Canna indica*, *Nephrolepis exaltata*, *Odontonema strictum*, *Passiflora edulis*, *Pereskia aculeata* and *Psidium guajava*. A size class analysis of the palm populations suggest that the subcanopy surrounding a mature individual is dominated by palm seedlings of less than 1 m (Fig. 2). Could this be the slumbering cohort of a potential invasive alien?

There is also an urgent need to assess the invasive status and potential of other cultivated palms in South Africa. For instance, Butterfly- or Golden Cane Palm, *Dypsis lutescens*, holds a major threat to the subtropical coastal region of South Africa. This species is native to Madagascar and widely cultivated due to its artistic clumping nature, yellowish crownshafts, arching, pinnate fronds with drooping leaflets, and light-green bamboo-like stem with yellowish node scars. This palm is hardy and once established, can tolerate dry conditions. It flowers in December, is pollinated by bees and then produces masses of yellow fruit with fertile seed. Seed germinates readily and en-masse after eight weeks. In a clump, each stem can produce two to four inflorescences, which can carry approximately 1400 seeds (n=10). In gardens these palms usually have on average ten stems (n=10) resulting in a total fruit set per plant of approximately 14,000 per year. If germination viability is modestly estimated at 1%, 140 seedlings will germinate from the seeds of each palm every year. Although no birds have been noted taking seed from observation sites, the semi-sweet smelling fruit that fall to the ground are consumed whole by domestic dogs and vervet monkeys.

VOUCHER SPECIMENS

SOUTH AFRICA: KwaZulu-Natal: Empangeni, KwaDlangezwa, swamp forest along the uMhlatuze River, *Siebert 2456* (ZULU, NH, PRE); Empangeni, Ngwelezana, swamp forest along the uMhlatuze River, *Siebert 3188* (ZULU); Richards Bay, swamp forest along Thulazihleka Pan, *Siebert 3499* (ZULU).

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Flower Color Variation in *Attalea phalerata* (Arecaceae)

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Over the past few years, I have been conducting a phenology study of the arborescent palm *Attalea phalerata* Mart. ex Spreng. in southwestern Amazonia. Although botanical records have consistently reported yellow flowers on *A. phalerata* inflorescences, I observed multiple cases of non-yellow staminate flowers. Flower color varied from dark purple to violet, or a mixture of yellow-orange to magenta flowers within the same male inflorescence (Fig. 1; hereafter I refer to non-yellow flowers as purple). This article reports on field observations of flower color polymorphism in *A. phalerata* and discusses possible explanations for this anomaly.

Field observations

Phenology

I monitored flowering phenology of *Attalea phalerata* in Acre, Brazil, between January 2006 and December 2007. Using binoculars, I observed flowering from the ground at monthly intervals at six study sites (three actively grazed pastures and three areas of old-growth tropical moist forest). At each site I observed 12 reproductive palms. Between July to December 2007, observations were reduced to two sites per habitat. For each individual I recorded sex and reproductive phase of all inflorescences – closed inflorescence buds (bracts), inflorescences in anthesis (open flowers) and dried, post-anthesis inflorescence structures. I also categorized crown illumination on a scale of zero to five by counting the number of sides of the palm crown directly exposed to sunlight (four lateral sides plus top) (Bechtold 2003). Within old-growth forest, *A. phalerata* is mainly a lower canopy palm.

Attalea species alternate between pistillate, staminate, and sometimes hermaphroditic inflorescences on the same plant. During 24 months of observations of 72 *A. phalerata* palms, I registered only four instances of hermaphroditic inflorescences. The remaining inflorescences were either exclusively pistillate or exclusively staminate. The majority of *A. phalerata* staminate inflorescences initiated flowering at the beginning of the dry season between May and June, peaked in September at the end of the dry season, and dwindled during the wet season (Fig. 2). Palms growing in old-growth forest were more likely to suspend inflorescence production for a short

1. Color variation from yellow to dark purple in *Attalea phalerata* staminate inflorescences observed in eastern Acre, Brazil.

period each year between February and April, whereas pasture palms produced inflorescences continuously year-round. Still, pasture palms mimicked the overall seasonal patterns of flowering peaks and lulls in the forest.

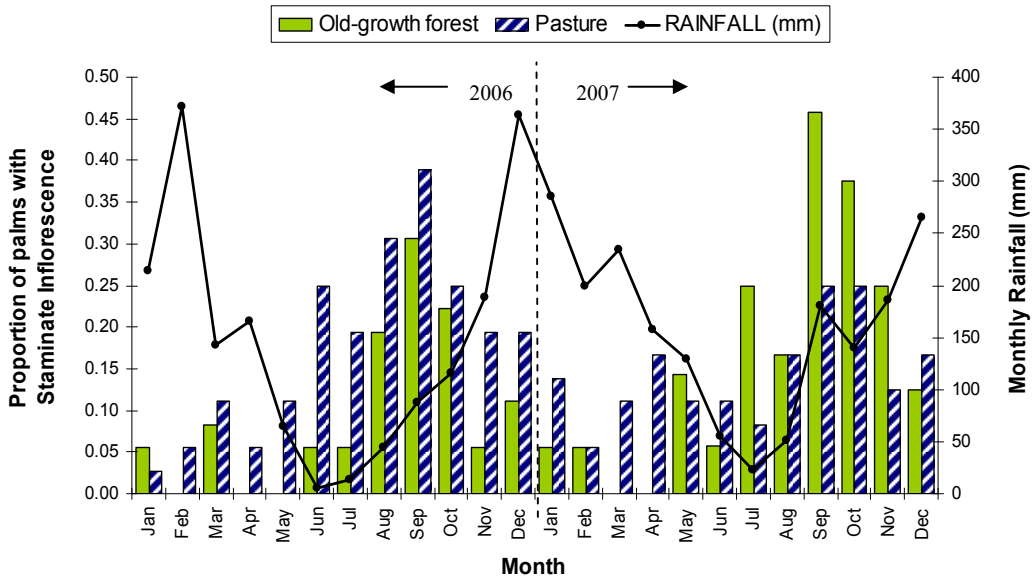
Flower color variation

To my surprise, of 55 male inflorescences observed in anthesis, the majority (55%) produced purple flowers rather than the

1. (*continued*) Color variation from yellow to dark purple in *Attalea phalerata* staminate inflorescences.

familiar yellow flowers. During two years of monthly phenological observations, I recorded 19 purple staminate inflorescences in anthesis in pastures (on 15 different palms) and 11 in forests (on nine different palms). Over the same two-year period, I observed 14 yellow staminate inflorescences in pastures (on 12 different palms) and 11 in forest (on ten different palms). Some *A. phalerata* individuals alternated between purple and yellow flowers, while a few palms (n=5) repeatedly produced purple flowers. Of the 22 *A. phalerata* individuals with purple flowers, more than half (n = 12) also produced the better known yellow flowers either before or after a purple flowering event, indicating phenotypic

2. Proportion of *Attalea phalerata* palms with staminate inflorescence and monthly rainfall from January 2006 until December 2007 in pastures and old-growth forests in Acre, Brazil.



3. Purple coloration of petal tips on flowers of an *Attalea phalerata* pistillate inflorescence in eastern Acre, Brazil.

plasticity within individual palms. In one case, a single palm exhibited one yellow and one purple inflorescence simultaneously. Both yellow and purple inflorescences were observed in anthesis, and the colors remained constant as they developed. I also observed purple coloration at the tips of creamy yellow petals of *A. phalerata* pistillate flowers (Fig. 3), but only three pistillate inflorescences were observed in anthesis during the entire study period.

Staminate flower color variation occurred not only within and among individual palm trees, but also in both the wet (November to April) and dry seasons (May to October), across different habitats (pasture and forest), and on a regional scale dispersed over 100 km^2. Purple flowers appeared at various times throughout the year, although mostly during the dry season, which corresponds to the peak flowering season of *A. phalerata* (Fig. 2, Tab. 1). Most flowering anthesis events occurred between observation visits, and for these I was unable to determine flower color.

Color polymorphism in palms

Flower color polymorphism in plants is common in nature and appears within genera, within species, and even within isolated populations. Several examples from herbaceous and other short-lived plants, both wild and cultivated, exist in the research literature (Armbruster 2002). Larry Noblick (pers. comm.) detected flower color variation between yellow and magenta in *Attalea* palms near Corumba, Mato Grosso do Sul, Brazil, in the Pantanal region, but to my knowledge no records of within-species color variation in palm inflorescences have been published.

Palms, such as the lipstick palm, *Cyrtostachys renda*, with its bright red crown shaft, *Geonoma epetiolata,* with reddish purple underside of

Table 1. Number of yellow and purple-shaded staminate inflorescences of *Attalea phalerata* observed in anthesis in pasture and old-growth forest during monthly visits in (a) 2006 when I observed 36 reproductive individuals in pastures and 36 in old-growth forests, and (b) 2007 when I observed 36 individuals in each habitat until June and 24 in each habitat from June-December.

(a) 2006		J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
PASTURE	Purple-shaded (no. palms=11)	0	0	0	0	1	3	0	3	2	0	2	2	13
	Yellow (no. palms=9)	1	0	0	0	0	1	1	1	0	2	2	1	9
OLD-GROWTH FOREST	Purple-shaded (no. palms=6)	0	0	0	0	0	1	0	2	2	0	1	1	7
	Yellow (no. palms=4)	0	0	0	0	0	1	0	1	0	1	1	1	4
	TOTAL	1	0	0	0	1	5	1	7	4	3	6	5	33

(b) 2007		J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
PASTURE	Purple-shaded (no. palms=4)	0	1	1	0	0	0	0	0	3	1	0	0	6
	Yellow (no. palms=5)	0	0	0	1	0	0	0	3	1	0	0	0	5
OLD-GROWTH FOREST	Purple-shaded (no. palms=4)	0	0	0	0	1	1	0	0	0	0	2	0	4
	Yellow (no. palms=7)	0	0	0	0	0	0	0	3	2	1	1	0	7
	TOTAL	0	1	1	1	1	1	0	6	6	2	3	0	22

young leaves (Blanco & Martén-Rodríguez 2007), and various palm genera with purple fruits (e.g., *Euterpe*, *Bactris*, *Butia*, *Coccothrinax*), testify to widespread anthocyanin production within Arecaceae. Anthocyanins (a flavonoid sub-group) are responsible for most orange, red, purple and blue flower colors and occur in almost all vascular plants (Grotewold 2006). Harborne et al. (1974) found flavonoid pigments (glycosides) specifically in the flowers of ten different palm species, and a few studies have identified other types of flavonoids in the vegetative structures of *Attalea* and other cocosoid palm species (Williams et al. 1983, Williams et al. 1985). Still, the question remains as to what drives flower color variation in *A. phalerata*.

Possible explanations for color polymorphism in *Attalea phalerata* flowers

To try and uncover the reasons for flower color variation in *A. phalerata*, I used Pearson's Chi-squared Test to examine relationships between flower color and four variables: (1) habitat (old-growth forest versus pasture) ($\chi^2 = 1.01$, d.f. = 1, p = 0.32), (2) season (wet versus dry) ($\chi^2 = 0.799$, d.f. = 1, p = 0.37), (3) year (2006 versus 2007) ($\chi^2 = 1.84$, d.f. = 1, p = 0.17), and (4) crown illumination ($\chi^2 = 10.67$, d.f. = 5, p = 0.06). Results revealed no significant associations with flower color. Crown illumination, or light availability, was marginally significant, but the absence of an association between habitat and flower color precluded any strong linkage between crown illumination and flower color, since the two habitats we compared – pasture and forest – represent two extremes in light availability.

A common explanation for color variation within and among species is pollinator selective pressures (Hannan 1981). Pollinators respond to various floral signals – color, shape, size, fragrance, temperature – and these preferences exert selective pressures on the plant to optimize reproductive success (Levin & Brack 1995, Meléndez-Ackerman et al. 1998). Studies of *A. phalerata* pollination are scarce; however, nitidulid beetles from the genus *Mystrops* are most likely the principal pollinators (Moraes et al. 1996). Beetles respond to floral signals of increased temperature and fragrance, rather than color, and *Attalea* flowers are known to mature quickly, heating up before anthesis (Henderson 2002). I observed insects, apparently pollinators, actively feeding on purple inflorescences, so purple flowers do not appear to deter pollinators. Further research may help determine if purple staminate flowers negatively affect fertilization, fruit set and reproductive success in *A. phalerata*.

Associations between anthocyanins in vegetative organs and flowers and environmental stresses may also help explain flower color variation in *A. phalerata*. In vegetative organs, plants manufacture anthocyanins to protect against environmental stresses, such as herbivory (Fineblum & Rausher 1997), photo-damage (Close & Beadle 2003) and drought (Levin & Brack 1995). Plants also synthesize pigments in response to extreme environmental conditions, such as cold temperatures (Stiles et al. 2007) and nitrogen deficiency (Bonguebartelsman & Phillips 1995). Finally, Armbruster (2002) found linkages between anthocyanins in vegetative organs and their presence in flowers. Selection pressures related to environmental heterogeneity and stress tolerance may be responsible for plant anthocyanin production in general, helping maintain flower color polymorphism within and among species (Warren & MacKenzie 2001).

Final Considerations

Until now, *A. phalerata* inflorescence color in southwestern Amazonia has been reported only as yellow or cream-colored (Evandro Ferreira, pers. comm.). Anthocyanins present in the plant to various degrees likely account for the various shades of purple observed. The question remains as to what provokes the differences in anthocyanins seen in these palms. Flower color is not genetically fixed in *A. phalerata*, since yellow inflorescences often followed the production of purple inflorescences on the same plant. If environmental stress is responsible for flower color variation in *A. phalerata*, three sources of stress come to mind: (1) Intermittent cold fronts pass through the region each year during the early dry season, dropping temperatures into the lower teens (ºC) (cf. Stiles et al. 2007); (2) A severe drought in 2005 induced soil moisture stress and could have indirectly augmented susceptibility to herbivory or pathogen attack; and (3) Extensive fires during the 2005 drought killed a large number of pollinators, and palms may have reacted with a different flower color to attract alternative pollinators. *Attalea phalerata* is a broadly distributed species, found throughout the southern and western periphery of the Amazon region, including Brazil, Bolivia and Peru, as well as the planalto

of Brazil, Bolivia and Paraguay (Henderson et al. 1995). More detailed studies of this species' flowering phenology and variation in flower color over its geographical range are warranted to understand what triggers deviations in *A. phalerata* flower color and how flower color variation affects the ecology of this species.

Acknowledgments

Research in Brazil was funded in part by the United States Environmental Protection Agency (EPA) under the Science to Achieve Results (STAR) Graduate Fellowship Program. Additional funding for field work was provided by two generous grants from the International Palm Society in 2005 and 2007. Research was carried out in collaboration with the Herbarium at the Parque Zoobotânico – Federal University of Acre in Brazil (PZ-UFAC), and their logistic support made this research possible. I wish to sincerely thank Professors Karen A. Kainer (University of Florida) and Evandro J. Linhares Ferreira (PZ-UFAC), for their valuable advice and guidance throughout this research, and I especially thank José Evandro Santos Lima, who was indispensable as my field assistant. I am also very grateful to Larry Noblick, Francis E. Putz, Wagner Vendrame and two additional anonymous reviewers for their helpful reviews and comments on this manuscript.

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1. Publication Title	2. Publication Number	3. Filing Date
Palms	7 8 2 - 7 3 0	
4. Issue Frequency	5. Number of Issues Published Annually	6. Annual Subscription Price
Quarterly	4	$ 40.00

7. Complete Mailing Address of Known Office of Publication *(Not printer) (Street, city, county, state, and ZIP+4®)*

International Palm Society, 6913 Poncha Pass, Austin, TX 78749-4371

Contact Person: Derek Gates

Telephone *(Include area code)*: 785-843-1221 x 224

8. Complete Mailing Address of Headquarters or General Business Office of Publisher *(Not printer)*

International Palm Society, 6913 Poncha Pass, Austin, TX 78749-4371

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

Publisher *(Name and complete mailing address)*

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☐ Has Changed During Preceding 12 Months *(Publisher must submit explanation of change with this statement)*

13. Publication Title: Palms

14. Issue Date for Circulation Data Below: June - 09

15. Extent and Nature of Circulation			Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Total Number of Copies *(Net press run)*			2038	1850
b. Paid Circulation *(By Mail and Outside the Mail)*	(1)	Mailed Outside County Paid Subscriptions Stated on PS Form 3541(Include paid distribution above nominal rate, advertiser's proof copies, and exchange copies)	1313	1189
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c. Total Paid Distribution *(Sum of 15b (1), (2), (3), and (4))*			1893	1767
d. Free or Nominal Rate Distribution *(By Mail and Outside the Mail)*	(1)	Free or Nominal Rate Outside-County Copies included on PS Form 3541	4	1
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f. Total Distribution *(Sum of 15c and 15e)* ▶			1900	1770
g. Copies not Distributed *(See Instructions to Publishers #4 (page #3))* ▶			138	80
h. Total *(Sum of 15f and g)* ▶			2038	1850
i. Percent Paid *(15c divided by 15f times 100)* ▶			99.6	99.8

16. Publication of Statement of Ownership

☑ If the publication is a general publication, publication of this statement is required. Will be printed in the 53(4) Dec. ____ issue of this publication. ☐ Publication not required.

17. Signature and Title of Editor, Publisher, Business Manager, or Owner: Co-Editor

Date: 11 Sept. 2009

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