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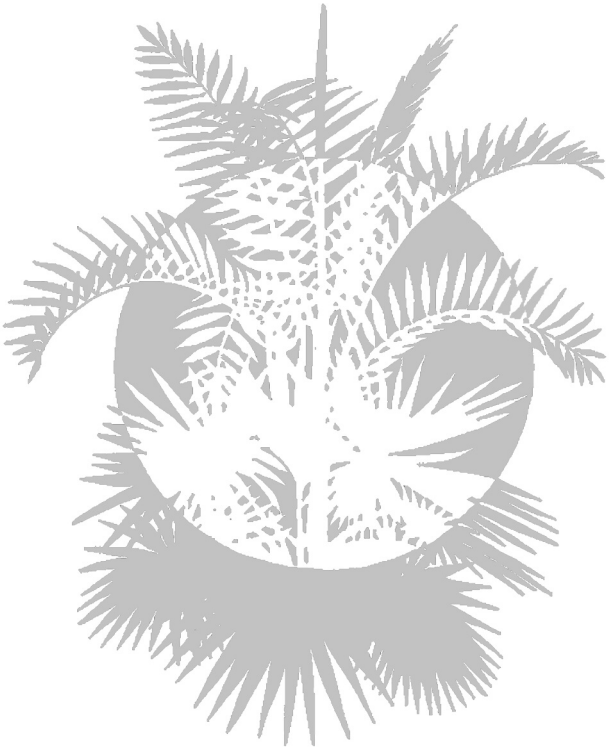

FRONT COVER

The fruits of *Astrocaryum paramaca*, which open and resemble flowers. See article by Noblick, p. 116. Photo by L. Noblick.

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Hydriastele brassii, Biak. See article by W.J. Baker and C.D. Heatubun, p.131. Photo by W.J. Baker.

Hydriastele biakensis, fruits. Note sinuous rachillae. See article by W.J. Baker and C.D. Heatubun, p.131. Photo by W.J. Baker.

Use of Glyphosate to Suppress Basal Suckers on Mediterranean Fan Palm (*Chamaerops humilis* L.)

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Pruning and/or removal of small, short suckers or offshoots (basal, vegetative lateral shoots) from the base of trunks of multi-trunked palms to manipulate clump density and eventual height is a time-consuming and costly procedure. In a study in San Diego, California we applied glyphosate, the active ingredient in Roundup® and other herbicides, to recently pruned suckers of the Mediterranean fan palm (*Chamaerops humilis* L.) to inhibit or retard their regrowth, thus eliminating or at least much reducing the need to reprune them in the future.

Palms are important constituents of landscape plant palettes in subtropical and tropical regions. They are exceedingly popular and lend to the atmosphere a dramatic, exotic, tropical ambience or motif that few other plants can duplicate. Some of the most picturesque and versatile landscape palms are those that form graceful, multi-trunked clumps naturally through the production of suckers or offshoots that arise from the base of an existing trunk. Unfortunately, suckers must be pruned or removed periodically to manipulate clump density and eventual height to maintain the clump's functional landscape use. Pruning and

removal of suckers is a difficult, tedious, time-consuming, costly, and, because of some palms' spiny nature, dangerous procedure.

Several landscape maintenance professionals and palm collectors have asked about chemical control for retarding or prohibiting growth of suckers on clumping palms. However, research-based information is lacking on the effectiveness of herbicides or growth regulators in retarding growth of palms. In a phytotoxicity study of several herbicides for weed control of container-grown palms, though, Donselman and Broschat (1986) found that some species appeared rather resistant to foliar applications of glyphosate and, while distorted growth occurred in most species, the plants recovered and resumed normal growth after several months. The apparent relatively high resistance of palms to glyphosate, Michael's anecdotal observations of the effect of glyphosate on palms in the landscape and the availability of glyphosate, encouraged us to consider it for controlling suckers of clumping palms. Thus, we conducted a two-year study to determine the effectiveness of glyphosate in inhibiting or retarding growth of suckers of the Mediterranean fan palm.

Materials and Methods

In September, 2008 we selected 10 clumps of the Mediterranean fan palm of more or less equal size, vigor and quality at Golden Hill Park in San Diego, California. All clumps were two to three meters high and wide and had four to five tall, main trunks (Fig. 1) and numerous small, short, basal suckers with little or no visible trunk and composed primarily of small leaf blades, petioles and leaf bases. We pruned off all small, short suckers of each of the 10 clumps (Figs. 2 & 3), pruning sufficiently low to remove all green tissue (leaf blades and petioles) but not damaging the apical meristem. Pruned suckers appeared as a low, tight bundle of white, truncated, short petiole stubs (Fig. 4). We randomly selected five of the 10 clumps and applied a three percent solution of glyphosate to their just-pruned suckers (Fig. 5). We made the three percent solution by diluting Ranger Pro® (Monsanto, Inc, St. Louis, MO) according to product label directions. We sprayed the solution to the cut surface of each sucker to run off. We made no applications to the remaining five clumps. We randomly selected five pruned suckers from each of the 10 clumps to track their growth for two years. Every six months (February and September, 2009 and 2010) we

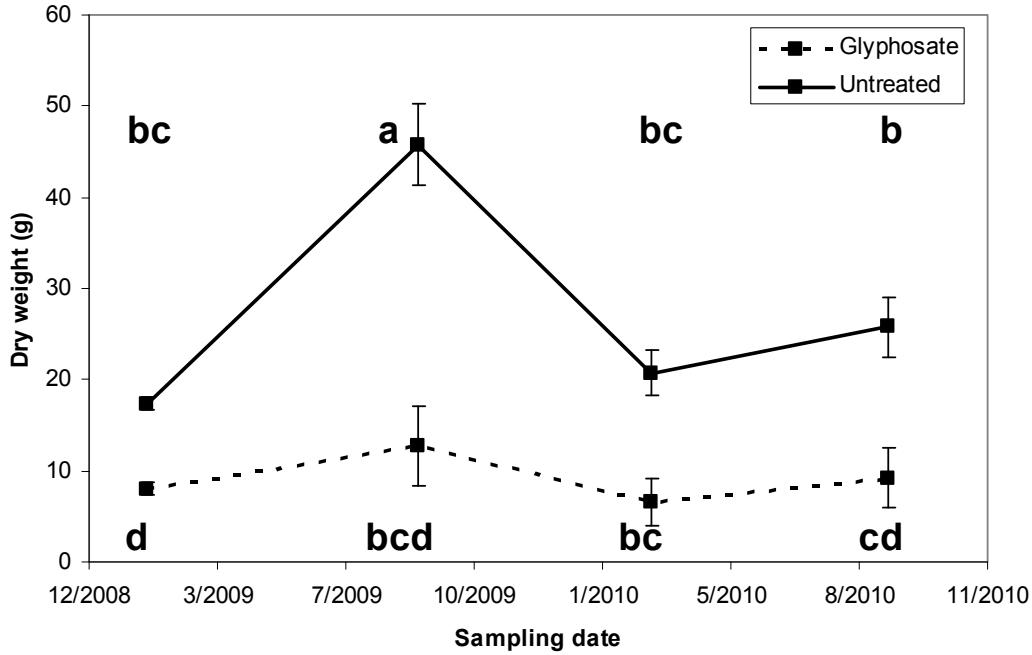
1. All clumps of the Mediterranean fan palm used in the study were two to three meters high and wide and had four to five main trunks and numerous small, short basal suckers (D.R. Hodel).

2 (top). Work crews pruned the suckers of all 10 clumps of Mediterranean fan palms used in the study (D.R. Hodel). 3 (bottom). One of the workers poses with a clump of the Mediterranean fan palm with the pruned suckers (D.R. Hodel).

repruned all suckers of each of the 10 clumps back to their original pruning point (initial pruning of September, 2008) and collected, dried and weighed the clippings (regrowth) of the five selected suckers from each of the 10 clumps. We dried the clippings at 65ºC for five days and then averaged the weights within each clump of the two treatment classes. After

4 (top). Suckers were pruned back sufficiently low to removed all green tissue without damaging the apical meristem; pruned suckers appeared as a tight bundle of white, truncated, short petiole stubs (D.R. Hodel). 5 (bottom). Co-author Michael Marika sprays the three percent solution of glyphosate to the just-pruned suckers (D.R. Hodel).

six months, in February, 2009, we made a second application of glyphosate to the same five clumps to which it was originally applied. We assessed overall quality of each clump in 2010 (canopy fullness, leaf color) and leaf production of one large trunk from each of the 10 clumps from February, 2009 to September, 2010.



6. Mean dry weight of clippings from glyphosate-treated and untreated suckers of *Chamaerops humilis*, Golden Hill Park, San Diego, CA.

The experimental design was completely randomized with five replications. Because we collected clippings from the same suckers and plants in multiple sampling dates, we used the Mixed Procedure (v. 9.2, SAS Systems, Cary, NC) to perform repeated measures analysis of variance to account for potential auto-correlation. We selected the Heterogeneous Compound Symmetry (CSH) covariance model based on measures of relative fit of competing covariance models.

Results and Discussion

Glyphosate-treated suckers produced significantly less growth than untreated suckers during the two years of the study (Table

Table 1. Mean dry weight of clippings, number of new leaves, and overall quality from glyphosate-treated and untreated suckers of *Chamaerops humilis*, Golden Hill Park, San Diego, CA.

Treatment	Dry weight of clippings, g				New leaves, no.[y]	Quality, 1=dead, 5=perfect	
	Feb. 2009	Sept. 2009	Feb. 2010	Sept. 2010		Feb. 2010	Sept. 2010
Glyphosate	8 c[z]	13 bc	7 c	9 cd	7 b	4.2 a	4.4 a
Untreated	17 b	46 a	21 b	26 b	9 a	4.2 a	4.2 a
P value	0.0029	0.02	0.75				

[z]Means followed by the same letter are not significantly different at $P<0.05$.

[y]Total new leaves from Feb 2009 to Sept. 2010.

The same letters denote non-significant comparisons ($P<0.05$) of the same treatment over time. The effect of time and interactions between treatment and time were significant ($P=0.0029$).

7 (top). Glyphosate-treated suckers produced significantly less growth than untreated suckers, shown in Fig. 8 (bottom). (both by D.R. Hodel).

1, Figs. 6–10). Clumps with glyphosate-treated suckers tended to produce slightly fewer leaves overall (7 treated vs. 9 untreated) on the large trunks but quality of the clump was unaffected (Table 1). From a commercial landscape management strategy, suppression of growth without loss of quality is desirable because it reduces the amount of green waste entering the urban waste stream and helps to promote sustainability in the landscape.

9 (left). Glyphosate-treated sucker. Compare with untreated sucker in Fig. 10 (right). (both by D.R. Hodel).

In a few cases the glyphosate applications terminated regrowth of suckers completely and they died. Less frequently even a few of the suckers not treated with glyphosate died. Death of suckers may be undesirable in some instances. For example, retarding regrowth rather than killing the sucker enables landscape managers to use that sucker in the future to maintain or enhance clump density, height and functional use if the need arises.

In some instances dead suckers or those with retarded growth were somewhat less esthetically pleasing than suckers not treated with glyphosate, appearing slightly frayed, tattered or "ratty" from stunted partial regrowth or death, particularly when viewed within five meters. However, from more than five meters, their less-than-optimal esthetic quality was not distracting to the entire clump. Nonetheless, landscape managers should be aware of this aspect of glyphosate when considering its use.

In summary, glyphosate or similar materials may hold promise for retarding or eliminating small, short, unwanted basal suckers of clumping palms. Further work is needed, though, to determine more accurately frequency and rates of application and long-term (five years or more) effect on clumps.

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Exploring for Palms in French Guiana

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In this article, I describe a recent palm-hunting trip to French Guiana.

Except for the coastal region, most of French Guiana is largely uninhabited and in its natural state (Fig. 1), in spite of the fact that it was colonized by the French and other Europeans as early as 1624. Most of its estimated 400,000 residents live in the major coastal cities, like Cayenne with a population of about 250,000. According to botanical studies done over the years, there are about 73 species of palms. French Guiana is about the size of Maine with numerous low mountains, inselbergs (isolated, island-like, granitic outcrops) and an abundance of rivers and creeks. Much of the land has still not been explored botanically due to its inaccessibility. Because of the potential for new discoveries and the ease of obtaining permits to collect, this would seem the perfect place for botanists to flock to, except that it is part of the European Union and its currency is the Euro making everything expensive when compared with neighboring South American countries. Nevertheless the opportunity to explore a new part of South America and to collect new species attracted me in April and May 2012. For three weeks during the height of the rainy and fruiting season, I explored French Guiana.

Recommendations from Dr. Scott Mori, a New York Botanical Garden botanist, who has worked there since the 1980s, led me to stay at a small place outside Cayenne called the Emerald Jungle Village run by Dutch-born Johannes (Joep) Moonen and his wife, Myrajka, from Suriname, and it proved to be a great place to start my trip. Just behind their lodging is a very nice nearly primary forest, with a well marked forest trail and several species of palms including *Astrocaryum paramaca, A. sciophilum, A. vulgare, Attalea maripa, Bactris campestris, B. rhaphidacantha, Euterpe oleracea, Mauritia flexuosa, Oenocarpus bacaba* and *Syagrus inajai*.

Armed with information from Jean-Jacques de Granville, who has worked in Guiana since the 1970s, Joep's organizational skills and excellent knowledge of trails and the help of Pierre-Olivier Albano and members of the local palm society, I was able to locate and see many different species. Joep helped me to explore the Kaw mountains, especially the Tresor Trail and Preserve (which years ago he helped design and build) and the botanically well-explored Piste de St. Elie area. With the help of the palm society, I was able to explore near Petit Saut, Bagne de Annamites, Savane Roche de la Virginie (an inselberg) and many other areas close to these. Joep and I also took a short flight into central French Guiana to explore the primary forests surrounding the isolated village of Saül, once a thriving gold mining community.

French Guiana palms

A major portion of the French Guiana palm flora is well armed. Great care must be taken to collect the spiny genera of *Astrocaryum, Bactris* and *Desmoncus*. Even *Mauritiella* and *Socratea* (Fig. 2) have their own armature.

1. The vast, undisturbed rain forests of central French Guiana near Saül.

Since on this trip most of my collecting was done near the coast, I encountered only a few of the several *Geonoma* species found in French Guiana, such as *G. stricta, G. baculifera* and *G. oldemanii*. Many smaller *Bactris* species commonly fill the *Geonoma* niche in the forest understory, such as *Bactris aubletiana, B. gastoniana* and *B. simplicifrons*.

French Guiana has only two species in the genus *Syagrus*. The most common is a single, thin-trunked palm of rather unimpressive stature called *Syagrus inajai*. The other species, *S. stratincola*, is a rarely seen clustering palm of isolated inselbergs in the interior. It is difficult to mistake it for anything else because of its unusual, globose fruits with their grooved exterior (Fig. 3).

Of particular interest to me on this trip were the species of *Attalea*. One of the most commonly seen is the *Attalea maripa*, which formerly belonged in its own genus *Maximiliana* with male flowers possessing stamens that far exceed its petals. Glassman described four new acaulescent *Attalea* (*Scheelea*) species, but he may have been a bit too eager based on so few specimens. By contrast, Andrew Henderson may have been a bit too quick to synonomize everything into one species. The truth is probably somewhere in the middle. I arrived too late for fresh flowers and too early for mature fruit. It is not surprising why there is so little known about the acaulescent *Attalea* species. Although individuals can be found in abundance in the forest understory and have the potential of producing both male and female inflorescences, very few produce flowers or have any indications that they ever have flowered. There just is not enough sunshine available in the forest understory to induce flowering. When flowers do occur, more than 90% are males (great for identification, but bad for seed collecting). Female inflorescences are a rare item indeed, because of their high energy cost and they probably need an opening in the forest canopy to be successful. Encountering mature fruit is rarer still, but when they do have fruits, they usually produce a lot.

Some of these acaulescent *Attalea* belonged originally to the genus *Orbignya* and all of the others belong to the former *Scheelea* genus. The *Orbignya* group is characterized by having all of the male flowers attached to one side of the inflorescence branches (rachillae) and the flowers have spoon-shaped (spatulate) petals. Not enough material has been collected yet to determine if there is just one species (*Attalea microcarpa*) as proposed by Henderson

(personal comm.) or if there are two, one with thin rachillae and smaller flowers which was misnamed *Attalea polysticha* because someone mistakenly thought that the flowers were attached all the way around the rachillae (which they are not) and *A. sargotii*, which grows on well drained soils and has much thicker rachillae with much larger, unilaterally attached flowers. The *Scheelea* group of *Attalea* have more cylindrical petals that are slightly tapered at both ends and the stamens are smaller or equal to the petals and is the most problematic group to understand. Although Henderson has placed them all in *Attalea guianensis* (Henderson, personal comm.), there are some differences I observed in the field in terms of their preference of habitat. Some grow on well-drained mountain forest slopes and never extend their populations into the adjacent wetter depressions close to the creeks and streams. Others grow only in poorly drained swamp forests or on the flood plains of creeks and streams and never grow up onto the adjacent well-drained forest slopes. That would seem to indicate that there probably is more than one species, but perhaps fewer than the four that Glassman proposed based on his meticulously collected measurements of the length of the male rachillae and size of the male flowers in the few specimens that he had available to him.

The Tresor Preserve

The Tresor Preserve is located in the Kaw mountains just east of Cayenne. The trail is well marked and maintained, but it does not contain a great diversity of palm species. Along this trail we saw the trunkless *Astrocaryum paramaca* and thin trunked *A. gynacanthum*. Both have fruits that split open at the tip and peel back displaying a yellow-coated ball (seed) center, begging for some creature to carry it off (Front Cover). There is also the menacing *Astrocaryum sciophilum*, whose slow steady growth makes it a common palm in many well-drained forested sites along with occasional *Bactris gastoniana*. Along the trail we also encountered an acaulescent *Attalea* with old fruit but which could not be identified for lack of male flowers. Close by, at the trail of the Piste de Caiman, there were more sterile acaulescent *Attalea* on a well-drained site.

Piste de St. Elie

Piste means track or road and there are many roads that say that they go to places that they do not, and the Piste de St. Elie does not go to

2. The spines on the stilt roots of *Socratea exorrhiza*.

3. The longitudinally grooved exterior of *Syagrus statincola* fruits.

St. Elie. However, it is the site of a well-established trail and camp that have been used by the botanists from the Herbier de Guyane for many years. Sterile, acaulescent *Attalea* on well-drained soils were seen here. The trail also had a number of other interesting palms, like single stemmed species of *Oenocarpus, O. bataua* and *O. bacaba* (Fig. 4) and a *Geonoma* with strap shaped leaves, *G. oldemanii*. There was also *Bactris rhaphidacantha, B. aubletiana, B. simplicifrons* and *Astrocaryum sciophilum*. Although no palm collections could be made at the Piste de St. Elie, we found mature orange fruiting *Astrocaryum vulgare* (Fig. 5) at the edge of a wet savanna on our return, and I was able to collect seed from several mother plants and make a spiny voucher.

Asterogyne guianensis

My first day out with Pierre Olivier Albano and the Ti-Palm society's palm enthusiasts was educational. Although *Asterogyne guianensis* (Fig. 6) has been thought to be a very rare palm and has fallen under the legal protection of the French Government, it has been found to be not so rare by the local palm society. I was led down a well-drained slope onto a large flood plain where there was a very large and healthy

4. The horse-tail-like inflorescence of *Oenocarpus bacaba* near the Piste de St. Elie.

population of the species, which the members have been carefully monitoring for several months. The palm appears to grow on a soggy flood plain. On the adjacent or surrounding slopes, we passed *Geonoma maxima, Bactris aubletiana, B. rhapidacantha, B. gastoniana, Oenocarpus bataua* and several acaulescent *Attalea* (*Scheelea*) on well drained soils with

several producing immature fruit at this time. We then continued farther west to Route de Petit Saut (little rapids road) and there on another flood plain near Crique de Eau we saw *Bactris elegans* (Fig. 7), the rare *B. nancibaensis* (Fig. 8), *B. acanthocarpoides, B. acanthocarpa* var. *exscapa* (= *B. humilis*), *B. gastoniana, B. oligocarpa, B. aubletiana, Oenocarpus bataua* and more acaulescent *Attalea* (*Scheelea*).

The white sands of Sinnamary

The soils close to Sinnamary are a coarse-grained white to gray sand probably from decomposing granite, and here we found *Attalea* (*Orbignya sagotii*-type) and some very healthy *Bactris gastoniana, B. oligocarpa, B. aubletiana* and my personal favorite, *Bactris constanciae*, with its red, spiky fruits that

5. The attractive, orange-fruited but dangerously spiny *Astrocaryum vulgare*.

6 (top). *Asterogyne guianensis* growing in habitat in a swampy depression. 7 (bottom). The elegant leaves and fruits of *Bactris elegans*.

8. The rare, endemic *Bactris nancibaensis* with its entire bifid leaves.

resemble "koosh balls" or rambutans (Fig. 9). It is a very attractive but rather odd palm fruit.

Trail to le Bagne des Annamites

The trail to Bagne de Annamites (Fig. 10) initially crosses a swamp forest with an abundance of acaulescent *Attalea* (*Scheelea*) (Fig. 11). It rained for most of the day producing flooded trails and streams. This was the last day I hiked with dry feet in French Guiana. Palms seen along this trail were *Desmoncus polyacanthos*, *Syagrus inajai*, *Oenocarpus bataua, Bactris rhaphidacantha, B. acanthocarpa* var. *exscapa, B. nancibaensis, B. aubletiana, Astrocaryum paramaca, A. sciophilum* and *Geonoma deversa*. Pierre Olivier claims that he has recorded as many as 18 palm species along this trail.

9. The red, spiky fruits of *Bactris constanciae*.

Crique de Margarite

Near the Crique de Margarite, I visited the palm collection of Andres Billot. It was a fine collection; however, the palm that most interested me was a native acaulescent *Attalea* (*Scheelea*) that he had cleared around and that was now producing female infructescences. In the adjacent well-drained forest, I found the same species of *Attalea* with old male inflorescences. Initially, I thought that the unusually small male flowers (<3 mm) seen in the female inflorescence (Fig. 12) were unique to the female inflorescence, but after seeing and measuring those in the old male inflorescences, I discovered that the measurements were the same. Interestingly, this palm does not match up with anything that Glassman described.

Savane Roche de la Virginie (the inselberg)

The next day we drove along Route Nacional 2 (RN2) east towards a granitic rock outcrop called Savane Roche de la Virginie, also known as an inselberg. Along the RN2, Pierre Olivier and his palm enthusiast friends pointed out a fast growing *Astrocaryum rodriguesii* (Fig. 13). It displays its fruit in the same attractive fashion as *A. paramaca* (Front Cover) and *A. gynacanthum*. We also stopped at a forest near kilometer marker 52, where we saw *Geonoma baculifera, G. oldemanii* and *G. stricta*.

We continued on to kilometer marker 118 on the RN2 to the trailhead that would lead us towards the inselberg. I had slowly walked about the first half of this trail on an earlier trip with Joep, and we had seen *Bactris rhapidacantha, B. gastoniana, B. paramaca, Manicaria saccifera* and *Syagus inajai*. We also saw a large group of flowerless acaulescent *Attalea* on well-drained soils.

On this trip, we went a lot farther passing a population of *Geonoma stricta* and *Astrocaryum rodrigesii*, and just before we reached the inselberg, we came across a healthy population of *Syagrus inajai,* which I collected. The trail continued up a steep incline to the inselberg, and as it began to rain, we finally descended to the inselberg's open rock surface (Fig. 14) only to have to climb up a wet, steep, treacherously slippery (algae-covered) rock face to reach the spot where we would have lunch. The inselberg was interesting but was not rich with palms. There were many species of orchids, aroids, Melastomataceae, Clusiaceae,

10 (top). Ruins of the former prison at Bagne de les Annamites. 11 (bottom). The swamp-loving acaulescent *Attalea* (*Scheelea*) of Bagne de les Annamites with L. Noblick.

12. Female inflorescence of an acaulescent *Attalea* (*Scheelea*) with small (<3 mm) male flowers.

etc. After spending some time exploring the inselberg, we all returned to the cars soaked in rain and sweat.

Saül

The next day I flew with Joep to Saül and into the well preserved, seemingly endless forests of central French Guiana (Fig. 1). To and from Saül there are no roads. The muddy airstrip is its only physical connection to the outside world, other than the free public internet. At least three major trails can be explored near the village, and there are no paved roads. After all the rain, the trails, roads and airstrip were

13. The fast-growing and horribly spiny *Astrocaryum rodriguesii*.

muddy. All terrain vehicles (ATVs) are apparently the vehicle of choice, as we saw several people using them to meet family members at the airstrip. ATVs are indeed the most practical way of getting around Saül, and I thought that it would be the only vehicle we would see. However, as we waited at the airstrip, we were met by a bright red pickup truck, one of the few non-ATVs in town. This one was owned by the fire department. One fireman helped the single baggage handler at the airport to load passengers' luggage into the truck and transport it to the city hall, along with the few passengers lucky enough to find space in his truck. The truck took its time in negotiating the slippery road to Saül from the airstrip. We picked up our backpacks at the city hall and hiked a short distance to our

14. The Savane Roche de la Virginie inselberg with its dangerously slippery granite slopes.

lodging, Les Carbets du Bord. Our sleeping quarters were open to the elements, and the building where we stayed also had a small kitchen, large dining area with several picnic tables for eating and preparing meals (or pressing plants). The sleeping area was located on a higher level and included two foldout beds with mosquito netting but was mainly designed for hanging hammocks. In the evening, the electric lights were run from batteries, which were recharged daily by solar panels. We were pleasantly surprised to learn that they even had warm water (solar-heated) showers. We made an advanced reservation with a restaurant in town, which was required since we would be their only guests. It did not take us long to familiarize ourselves with the town, which included the city hall, the post office, the church, the fire station, and the National Park office.

Hike to Eau Claire (Clear Water)

The next day, we set out for Eau Claire, the weather was good for most of the day, but ended in a torrential downpour, which occurred exactly when I was collecting and measuring a spiny *Astrocaryum*. Jean-Jacque de Granville had told us of a healthy population of *Syagrus inajai* on both sides of the road that was about 7 km from Saül on the road to Eau Claire and we found the population just as he had described it, but it was well past flowering and fruiting. Only a few old seed were found from this population that we labored so hard to get to. Although about 32 species of palm have been recorded from the forests surrounding Saül (Mori, 1997), this particular track was not that species rich. Along the track we saw *Astrocaryum gynacanthum, Bactris paramaca, B. oligocarpa, B. acanthocarpa* var. *exscapa*, *Oenocarpus bacapa, O. bataua* and *Socratea exorrhiza*. The gently sloping trail was not difficult, but its wet, sticky, and often slick clay surface offered many opportunities to slip and fall. We took our time walking towards Eau Claire, but the return was a non-stop two and half hour march. Unfortunately, the bottoms of my feet blistered from sliding around inside my wet hiking shoes. We saw spectacular trees along the way, and I found an impressive *Socratea exorrhiza* (Fig. 15) from which I gathered seed. Unfortunately, I could not voucher such a magnificent specimen as the spiny root cone (Fig. 2) was over 2 meters high and positioning the stem too far from the ground to reach and climb with the

equipment that I carried. That evening, we arrived in town late. We were unable to make a reservation at the restaurant and had to subsist on crackers, bread and cookies. At any rate, I used the extra time to press the palm material that I had collected that day. The next day, we prepared to leave on the plane, rested up from our hike and had another leisurely

15. A magnificent fruiting *Socratea exorrhiza* between Saül and Eau Claire in central French Guiana.

walk around town. We saw the original bulldozer that they had flown into Saül during the early days to make the airstrip and town's roads. I learned that they airlifted the bulldozer in a few pieces at a time and then reassembled it there.

Gallion

During my last week, I left early one morning to accompany Ludovic, a botanist, and his zoologist colleague Kevin to another large population of acaulescent *Attalea*. They had discovered this large *Attalea* population in the process of working on an environmental impact study. The first part of the trip was down what looked like a flooded logging road with logs and tree debris still jammed together along the roadside. It was a balancing act to climb over all of the debris and not fall into the muddy water, but luckily that only lasted for the first kilometer, then we crossed a flooded savanna with *Bactris campestris*. We proceeded down a flooded savanna road with the soft clay mud sucking at each footstep as the water deepened well past the tops of our boots, each step becoming a laborious effort. The first population of *Attalea* was the typical sort found in flooded swamp forest that I had seen in Bagne des Annamites. We labored on past this population, down another flooded road, across another savanna and up a moderate slope to some more muddy logging roads. In the low swampy depressions between the slopes was an abundance of the same *Attalea* that I had seen before. I am now convinced that all of these swamp forest-loving acaulesent *Attalea* (*Scheel*ea-type) are all the same species.

Type locality at kilometer marker 22 on National Route 2

The type locality for a species is the very place from which the original dried specimen (holotype) for that species was collected. There is no better way to understand a species than to return to its original collecting site. Kilometer marker 22 on National Route 2 is just such a site. It is the type locality for *Attalea degranvillei* that Glassman had originally described as a *Scheelea*. Its habitat is not "mountain forest" as reported by Glassman (1999) but rather a poorly drained, swamp forest. It is the same palm and habitat as seen at Bagne des Annamites and Gallion. Therefore the mysterious swamp forest loving palm is *Attalea degranvillei*.

In the very near future, we hope to be able to determine the correct name for the acaulescent *Attalea* (*Scheelea*) of well-drained soils. It may be *Attalea guianensis*, as Henderson has proposed, or several species. I may be able to answer that question after my next trip to French Guiana in which I shall attempt to visit some of the other less accessible *Attalea* type localities.

Acknowedgments

I would like to thank all those who offered advice or help in organizing this collecting trip including: Scott Mori (NY), Jean-Jacques de Granville (CAY), and Sophie Gonzalez (CAY), Pierre Olivier Albano, President of the Ti-Palm Society, and Johannes Moonen of the Emerald Jungle Village. For funding I would like to acknowledge the support of Lillian Fessenden, the Paul Drummond Fund for Palm Conservation and of course Montgomery Botanical Center. Finally I would like to thank the Fairchild Tropical Botanic Garden herbarium (FTG) for use of their facilities to finish processing my dried plant material.

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New Palms from Biak and Supiori, Western New Guinea

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1. View from Samber across the limestone cliffs of western Biak. (Photo: W.J. Baker)

The Indonesian islands of Biak and Supiori sit at the mouth of Cenderawasih Bay, the broad arc of ocean to the north of the neck of New Guinea's Bird's Head Peninsula. Already known for their remarkable animal endemism, the islands are home to four unique palm species, three of which are described here for first time.

Of the many islands scattered around Cenderawasih Bay (also known as Geelvink Bay), Biak, Supiori, Numfor and Yapen stand out on account of their relatively large size. Yapen, a land bridge island, sits close to the New Guinea mainland to which it was once connected, while the remaining three are oceanic in origin and located in the north of the bay. Biak forms an island pair with the smaller Supiori, the two being separated only by a narrow channel, and Numfor is located some 60 km to the south-west. Together, Biak and Supiori measure some 125 km in length and 40 km at the widest point. In common with other islands in the region, they are dominated by rugged limestone (Fig. 1) perforated by sink-holes and caves, with sporadic occurrences of other geologies. Biak played an important role in World War II and was the scene of some of the bloodiest fighting in the Pacific. The Japanese made use of some of Biak's caves as bases and defensive position, but were ultimately defeated by Allied forces after a bitter stand-off. Biak's large airstrip dates back to that time and has allowed Biak to function as a hub for air travel in the region.

The relative accessibility of Biak by boat and air has no doubt contributed to the degradation of the island's rain forest, much of which has now been destroyed. The North Biak Island Reserve encompasses a portion of the northern tip of the island and much of Supiori is also protected, although the effectiveness of these reserves is not clear. Some unprotected areas of the interior of the island also appear to retain good forest, though further analysis of the condition of the remaining primary vegetation is urgently required.

The plants of Biak and Supiori are poorly known. The palms, however, have been the subject of a series of expeditions to Biak, two led by Rudi Maturbongs with colleagues from Universitas Negeri Papua in 1998 and 2001, and three involving the authors and various colleagues from Universitas Negeri Papua, Herbarium Bogoriense and the Royal Botanic Gardens, Kew in 2000, 2009 and 2010. The 2001 expedition also included a short visit to Supiori. As a result of these expeditions, we have obtained sufficient material for the description of four remarkable new endemic species, three from Biak and one from Supiori. The first of these, *Hydriastele dransfieldii* was described following the expeditions led by Maturbongs (Baker et al. 2000). This palm had already been introduced to cultivation prior to its formal description but was poorly known in the wild until these expeditions. The remaining three new species are described here for the first time.

As a whole, the palm flora of Biak is not particularly rich (Table 1). Nineteen species have been recorded, with all non-endemic species being shared with mainland New Guinea. Widespread New Guinean species are present, such as *Arenga microcarpa*, *Caryota rumphiana* and *Hydriastele costata*, as well as two that are distinctive western New Guinean species, *Pigafetta filaris* and *Pinanga rumphiana* (Figs. 2 & 3). The Biak palm flora also includes several widespread New Guinea rattan species such as *Calamus aruensis*, *C. heteracanthus*, *C. pachypus*, *C. vitiensis*, *C. zebrinus* and *Korthalsia zippelii*. Of Biak's non-endemic palms, only *Calamus dasyacanthus* and *Hydriastele brassii* (Back Cover) could be regarded as less well known. Our knowledge of the palm flora of Supiori is less complete. We expect that it is likely to be broadly similar to that of Biak, although the presence of a high peak (>1000 m) and somewhat different geology (Masria et al. 1981) may result in the occurrence of additional montane species.

In contrast to the relatively ordinary non-endemic palm flora, the endemic palms are remarkable in various ways. *Hydriastele dransfieldii* was originally described in *Siphokentia* (Baker et al. 2000), a genus that was later reduced into synonymy with *Hydriastele*, following in depth molecular phylogenetic studies (Baker & Loo 2004, Loo et al. 2006). While this taxonomic change is corroborated by morphology, the two species formerly accepted in *Siphokentia* (*H. dransfieldii* and the Moluccan *H. beguinii*) remain a distinctive pair of sister species within *Hydriastele*, characterized by the fused petals and sepals in the female flower. We found *H. dransfieldii* to be widespread on limestone in Biak and abundant in places. Occasionally, it can even be observed in disturbed roadside vegetation, although it is unlikely to be regenerating in such secondary habitats. *Hydriastele dransfieldii* has been reported (sight records only) from Numfor and Supiori, but the species is not known from Yapen or mainland New Guinea.

The three remaining endemic species, described as new to science below, are apparently far less common on Biak and face a greater threat of extinction. Like *H. dransfieldii*, they are palms of limestone, two

Table 1. Checklist of the palms of Biak and Supiori. Where available, a voucher to substantiate the record is given, though additional vouchers are available for many of these species (specimens at K, variously duplicated at MAN, BO, AAU, NY and FTG). Sight records for species lacking vouchers were made by the authors in 2009 and 2010. A dash indicates that a species has not been observed.

Species	Biak	Supiori
Actinorhytis calapparia (Blume) H.Wendl. & Drude ex Scheff.	Sight record (cultivated?)	–
Adonidia maturbongsii W.J.Baker & Heatubun	*Heatubun et al. 971*	–
Arenga microcarpa Becc.	*Maturbongs et al. 548*	–
Calamus aruensis Becc.	Sight record	*Jitmau et al. 308*
Calamus dasyacanthus W J. Baker & al.	*Maturbongs et al. 687*	–
Calamus heteracanthus Zipp. ex Blume	*Baker et al.1334*	–
Calamus pachypus W J. Baker & al.	Sight record	–
Calamus vitiensis Warb. ex Becc.	*Maturbongs et al. 568*	–
Calamus zebrinus Becc.	*Baker et al.1340*	*Maturbongs et al. 683*
Calyptrocalyx sp.	–	*Maturbongs et al. 681*
Caryota rumphiana Mart.	Sight record	–
Heterospathe porcata W.J.Baker & Heatubun	–	*Maturbongs et al. 680*
Hydriastele biakensis W.J.Baker & Heatubun	*Baker et al. 1342*	–
Hydriastele brassii (Burret) W.J.Baker & Loo	*Baker et al. 1339*	*Maturbongs et al. 679*
Hydriastele costata F.M.Bailey	*Maturbongs et al. 573*	–
Hydriastele dransfieldii (Hambali & al.) W.J.Baker & Loo	*Maturbongs et al. 555*	–
Korthalsia zippelii Blume	Sight record	*Maturbongs et al. 684*
Licuala sp.	*Heatubun et al. 972*	*Maturbongs et al. 682*
Nypa fruticans Wurmb.	Sight record	–
Pigafetta filaris (Giseke) Becc.	*Maturbongs et al. 565*	–
Pinanga rumphiana (Blume) J.Dransf. & Govaerts	*Maturbongs et al. 558*	–

2. *Pigafetta filaris*, a common palm in disturbed vegetation on Biak. (Photo: W.J. Baker)

of which (like *H. dransfieldii*) show biogeographic relationships with species on islands to the north-west, remarkable in view of the much greater species pool in nearby New Guinea to the south. All three represent significant additions to our knowledge of the palms of the New Guinea region and serve to focus attention on the importance and plight of Biak's dwindling rain forest.

Taxonomic treatment

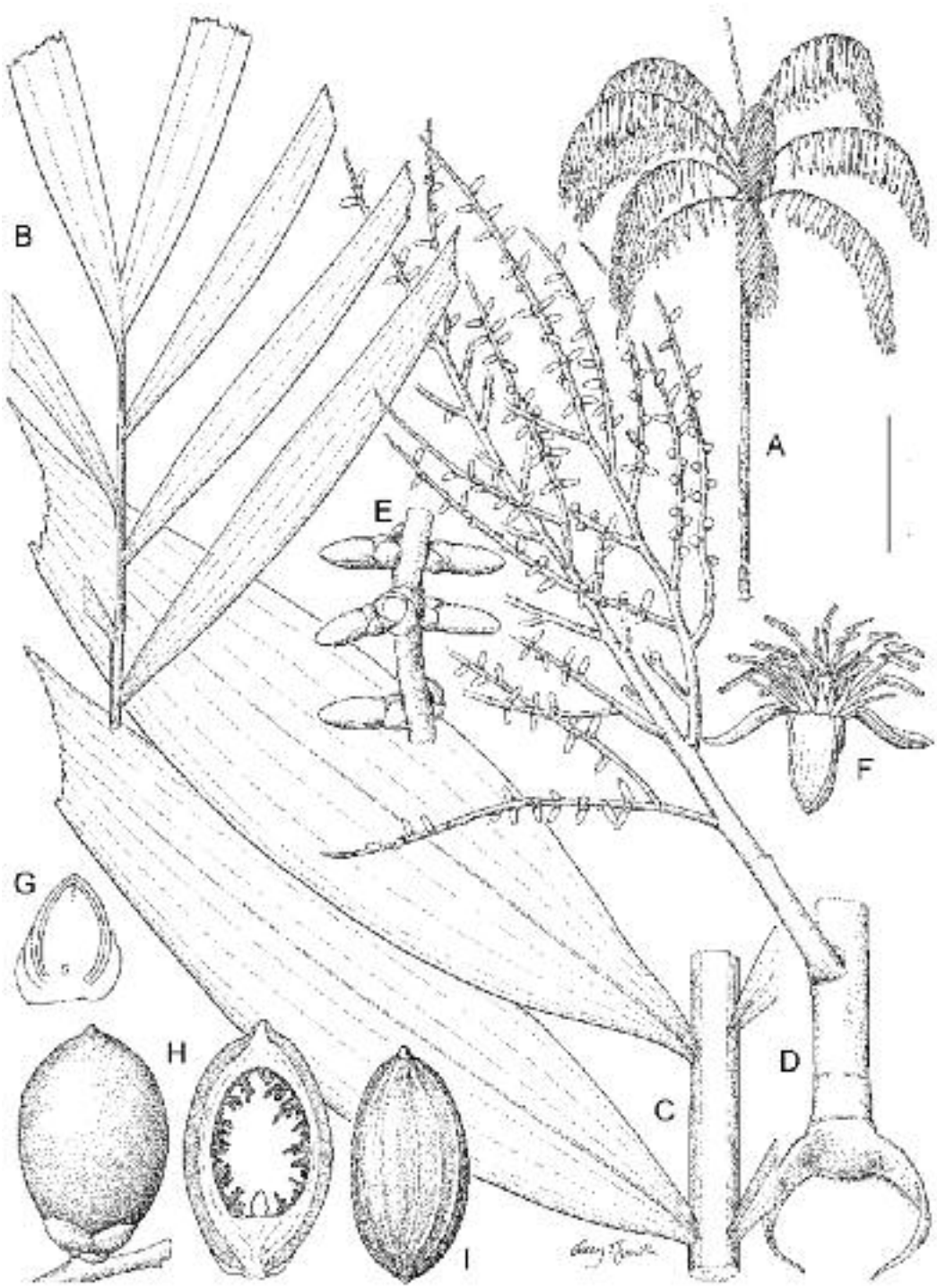
1. Adonidia maturbongsii W.J.Baker & Heatubun, **sp. nov.** Type: Indonesia, Papua, Biak Island: forest on the road side, main road from North Biak Nature Reserve to Biak town, July 2009, *Heatubun et al. 971* (holotype K, isotypes BO, FTG, MAN, NY). (Figs. 4–11)

Diagnostic characters: *Adonidia maturbongsii* is distinguished from *A. merrillii* by the arching leaf, broad, pendulous leaflets in a single plane, wide, concave leaflet tips and staminate flowers containing 30–32 stamens.

Medium, solitary, mid-story to emergent palm. **Stem** 10–15 m tall, 10–20 cm in diam., tapering towards apex, surface brown with

3. *Pinanga rumphiana*, Biak. (Photo: W.J. Baker)

white blotches, leaf scars prominent, internodes 2–4 cm apart. **Leaves** ca. 10 in crown, arching; sheath 60–70 cm long, pale, dull green, with thin grey scurfy indumentum with scattered purple-brown scales, somewhat eroded or fibrous at mouth, forming crownshaft 80–90 cm × 10–12 cm; petiole 26–45 cm long, channelled adaxially, rachis 2.5–3 m long, indumentum as on sheath; leaflets 25–30 pairs each side of the rachis, regularly arranged (or somewhat subregularly), in one plane, drooping or pendulous in emergent individuals, slightly discolorous, with persistent reins attached to lowermost



4. *Adonidia maturbongsii*. **A**. Habit. **B**. Leaf apex. **C**. Mid-leaf portion. **D**. Inflorescence. **E**. Portion of rachilla with triad. **F**. Staminate flower. **G**. Pistillate flower in section. **H**. Fruit whole and in section. **I**. Endocarp showing longitudinal fibers. Scale bar: A = 2 m; B–D = 6 cm; E = 1.5 cm; F, G = 7mm; H, I = 7 mm. From *Heatubun et al. 971*, except A from photograph and F from *Baker et al. 1338*. Drawn by Lucy T. Smith.

5. *Adonidia maturbongsii* on the outskirts of Kota Biak. (Photo: W.J. Baker)

pair of leaflets, with minute brown punctate scales and scattered medifixed ramenta abaxially; middle leaflets 40–49 cm long, 9–12 cm wide, oblanceolate, cucullate, apex obliquely praemorse, concave, transverse veinlets inconspicuous; terminal leaflets linear or narrowly elliptic, apex truncate, praemorse.

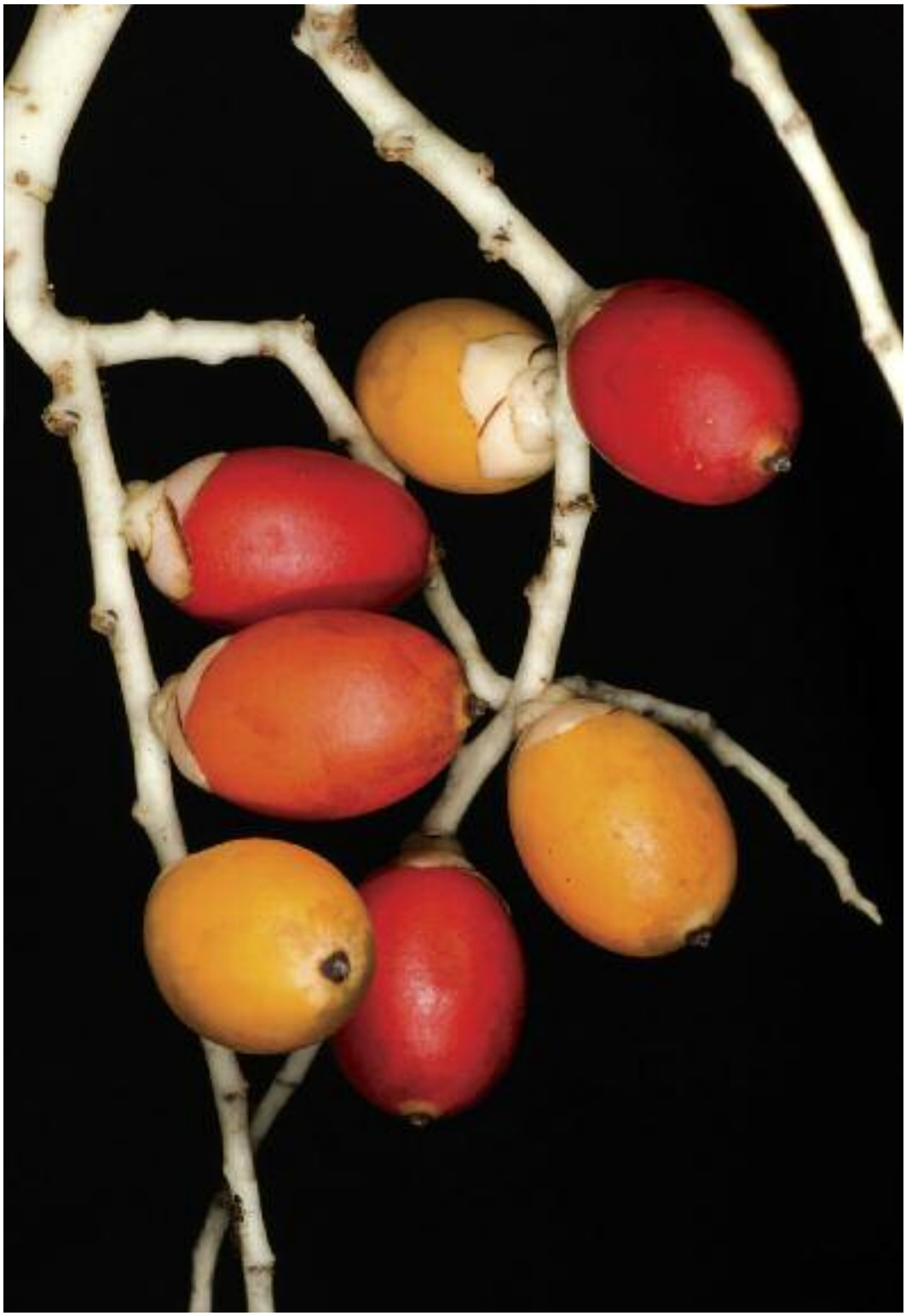
Inflorescence 60–70 cm long, infrafoliar, protandrous, divaricate, patent, deflexed in fruit, branched to 4 orders, axes white, rubbery, with caducous floccose orange-brown indumentum when young; prophyll 24–26 cm long, 6–8 cm wide, greenish white, splitting apically, caducous later; first peduncular bract

31–35 cm × 5–7 cm, attached 15–20 mm above prophyll insertion, exserted from prophyll apex and enclosing inflorescence prior to anthesis, caducous later; peduncle 8–14 cm long, 2–2.5 cm wide, scurfy indumentum of black-brown scales basally; primary branches 25–28, longest primary branch (basalmost) 40–65 cm; rachillae 8–19 cm long, 1.5–3.5 mm in diam., triads 3–9 mm apart, spirally arranged. **Staminate flower** 6.5–8 mm long,

6 (top). *Adonidia maturbongsii*, a young specimen emerging from the canopy with less pendulous leaflets than adults, Samber forest, Biak. 7 (bottom). *Adonidia maturbongsii* leaf. (Both photos: W.J. Baker)

2.5–3.2 mm in diam. in bud; sepals 2–2.4 mm long, ca. 3 mm wide, rounded, thickened; petals 7–7.5 mm long, ca. 3 mm wide, bony, narrowly elliptic; stamens 30–32, 4.5–6 mm long; filaments 1.5–4 mm long, briefly connate at base, awl-shaped; anthers 3–3.8 mm long, 0.5–0.8 mm wide, dorsifixed near the base, dehiscence latrorse, connective dark; pistillode

Adonidia maturbongsii. 8 (upper left). Inflorescence at staminate anthesis, held by Charlie Heatubun. 9 (upper right). Staminate flowers. 10 (bottom). Infructescence. (All photos: W.J. Baker)



11. *Adonidia maturbongsii*, fruits. (Photo: W.J. Baker)

ca. 5 mm long, 1.2–1.4 mm in diam., lageniform. **Pistillate flower** 4.5–5 mm long, ca. 4.5 mm in diam., borne in proximal half to two-thirds of the rachilla; sepals 3–4 mm

long, 4–4.5 mm wide, thickened, rounded; petals 4–4.5 mm long, 3–3.5 mm wide, similar to sepals; staminodes few, minute, tooth-like; gynoecium ca. 4 mm long, ca. 3 mm in diam., pyriform, stigmas at anthesis not seen. **Fruit** 24–31 mm long, 14–16 mm in diam., ellipsoid, ripening through orange to red, perianth cupule clasping; endocarp 23–30 mm long, 12–12.5 mm in diam., straw-colored with thick longitudinal fibers, closely adhering to seed. **Seed** 14–20 mm long, 9.5–12 mm in diam., ellipsoid; endosperm ruminate; embryo basal.

Distribution: Scattered throughout Biak Island.

Habitat: Lowland forest on limestone with thin soils and many sink holes, 80–170 m elevation.

Vernacular names: *Manjek* (Biak dialect)

Uses: Stem used for flooring and pillars in traditional houses.

Conservation status: Endangered (EN B1, 2 (a, b [i, ii, iii, iv, v]), C2a (i); IUCN 2001). Though widespread on Biak, many sites for this species are threatened by ongoing forest degradation. The species is protected in the North Biak Nature Reserve.

Specimens examined: Indonesia, Papua, Biak Island: forest on the road side, main road from North Biak Nature Reserve to Biak town, July 2009, *Heatubun et al. 971* (holotype K, isotypes BO, FTG, MAN, NY); North Biak Nature Reserve, Sansundi village, September 1998, *Maturbongs et al.* 559 (BO, K, MAN), *Maturbongs et al.* 560 (BO, K, MAN); Samber forest, July 2009, *Baker et al. 1336* (BO, K, FTG, MAN), *Baker et al. 1338* (BO, K, FTG, MAN); locality uncertain (given incorrectly on the label as Merauke district, but number sequence indicates the collector was active in Biak), June 2001, *Maturbongs et al.* 686 (AAU, BO, FTG, K, MAN).

Notes: It has been known for some time that an undescribed species from subtribe Ptychospermatinae occurs on Biak (Baker pers. obs. 2000, Zona 2000). The species appears to have been first recorded by Greg Hambali who introduced it to cultivation as *Drymophloeus* "veitchioides," an unpublished name under which it persists in some collections today. However, new molecular phylogenetic data provide evidence that the species is most closely related to *Adonidia merrillii*, the sole species of a hitherto monotypic genus restricted to parts of the Philippines and far northern Borneo (Zona et al. 2011). Although the study was based on only two DNA regions and the relationships only moderately supported by the data, we describe the new species as *Adonidia maturbongsii* as the best solution given the available data and because of morphological similarities discussed below.

Generic limits in subtribe Ptychospermatinae are fine and sometimes problematic (Zona 1999, Dransfield et al. 2008), as evidenced by the initial, but erroneous assignment of this new species to *Drymophloeus*, a genus that has experienced substantial changes in circumscription recently (Zona et al. 2011). Nevertheless, *A. maturbongsii* and *A. merrillii* share a combination of features that lends support to a close relationship between the two. Both species are moderately robust palms of limestone habitats that bear white inflorescences branched up to four orders. They produce red fruit with endocarps covered in pale, flattened, longitudinal fibers interspersed with finer fibers and seeds with ruminate endosperm. Nevertheless, *A. maturbongsii* is very different from its congener, most obviously in its arching leaf with broad, pendulous leaflets in a single plane with wide, concave, praemorse tips (in contrast to the ascending, narrower leaflets in slightly different planes with less conspicuously praemorse tips in *A. merrillii*). In addition, the staminate flowers of *A. maturbongsii* contain 30–32 stamens compared to 45–50 in *A. merrillii*.

Adonidia merrillii is a geographically disjunct species, occurring to the west of Wallace's Line whereas all other Ptychospermatinae occur to the east of this important biogeographic interface (Baker & Couvreur 2012). The expansion of the genus elaborates this biogeographic story. The link between New Guinea and the Philippines has been explained by westward stepping-stone dispersal along the Philippine-Halmahera arc during the Neogene (Zona et al. 2011), which may also account for similar biogeographic links in other taxa, such as the palm genera *Heterospathe* and *Orania*, and *Sararanga* in the Pandanaceae (Baker et al. 1998, Norup et al. 2006).

Adonidia maturbongsii is named for our friend and collaborator Rudi Maturbongs of Universitas Negeri Papua, the collector of the first herbarium specimens of the new species, in recognition of his contributions to palm exploration in Biak.

2. Heterospathe porcata W.J. Baker & Heatubun, **sp. nov.** Type: Indonesia, Papua, Supiori Island: North Supiori Nature Reserve, Fanjur village, June 2001, *Maturbongs et al. 680* (holotype K; isotypes AAU, BO, CANB, LAE, MAN). (Fig. 12)

Diagnostic characters: *Heterospathe porcata* is distinguished from other species in the genus by its inflorescence with elongate peduncle, the peduncular bract inserted in the proximal half of the peduncle, and the fruit with a bony endocarp with 6–7 longitudinal ridges.

Slender, ?solitary, understory palm. **Stem** to ca. 6 m tall, ca. 3 cm in diam.; leaf scars prominent; internodes 1–2 cm. **Leaves** 16 in crown; sheath open, margins eroded, not forming crownshaft; petiole ca. 50 cm long, adaxially channeled; rachis ca. 100 cm long, with sparse, floccose indumentum of orange-brown scales throughout; leaflets ca. 40 each side of rachis, regularly arranged, borne up to 3.5 cm apart, somewhat discolorous, basifixed ramenta scattered on proximal part of adaxial surface of midribs and major veins; middle leaflet ca. 45 cm long, 2–2.3 cm wide, linear, somewhat sigmoid at tip and base, tip narrowly attenuating, transverse veinlets inconspicuous. **Inflorescence** 124–138 cm long, interfoliar, elongate, brush-like, branched to 2–3 orders; prophyll ca. 39 cm long, 1.5–2 cm wide, splitting apically, with lepidote indumentum of dark scales; first peduncular bract, ca. 69 cm long, ca. 2 cm wide, similar to prophyll, splitting apically to one side, indumentum as prophyll, attached one third to halfway above the peduncle base; peduncle 102–108 cm long, 5.5–7.5 mm wide, with thin, dark brown tomentum and throughout all inflorescence branches; primary branches 9–13, to 28 cm long, 1.5–4 cm apart, with up to 14 rachillae; rachillae 10–17 mm long, 0.9–1.5 mm in diam., swept forward at an acute angle to the rachis, sinuous, with thin dark brown tomentum; rachilla bracts inconspicuous; triads 2–3.5 mm apart, spirally arranged. **Male flower** ca. 2 mm long, ca. 1.8 mm in diam. in young bud; sepals 3, ca. 1 mm long, ca. 1.5 mm wide, concave, imbricate; petals 3, ca. 1.5 mm long, ca. 1.3 mm wide, cucullate, valvate; stamens 6; filaments ca. 0.6 mm long, connate in a ring at base, linear; anthers ca. 0.8 mm long, ca. 0.3 mm wide, oblong, dorsifixed, connective dark; pistillode 0.6 mm long, 0.3 mm in diam., cylindrical. **Female flower** ca. 4 mm long, ca. 3.5 mm in diam., borne in proximal half of the rachillae only, bracteole forming conspicuous perianth-like cupule; sepals 3, ca. 2.5 mm long, ca. 3 mm wide, concave, imbricate; petals 3, ca. 3.6 mm long, ca. 2.5 mm wide, concave with short, triangular apical lobe, imbricate; staminodes ca. 2, linear, ca. 0.6 mm long; gynoecium ca. 3.5 mm long, ca. 1.5 mm in diam., ellipsoid, stigma inconspicuous. **Fruit** ca. 2 cm long, ca. 9 mm diam. (measured from dry material), ellipsoid, pericarp shrinking around endocarp ridges when dried, stigmatic remains eccentrically apical, red; perianth cupule clasping; endocarp ca. 2 cm long, ca. 8.5 mm in diam., ellipsoid, dark brown, bony, with 6–7 thickened, fibrous ribs radiating from the stigmatic remains and running the length of the fruit to the base. **Seed** immature, star-shaped in section, conforming to inner contours of endocarp; endosperm ruminate; embryo basal.

Distribution: Recorded from only one locality on Supiori Island.

Habitat: Secondary limestone forest dominated by *Myristica*, *Intsia* and *Lepiniopsis* at an elevation of ca. 30 m.

Vernacular names: Not known.

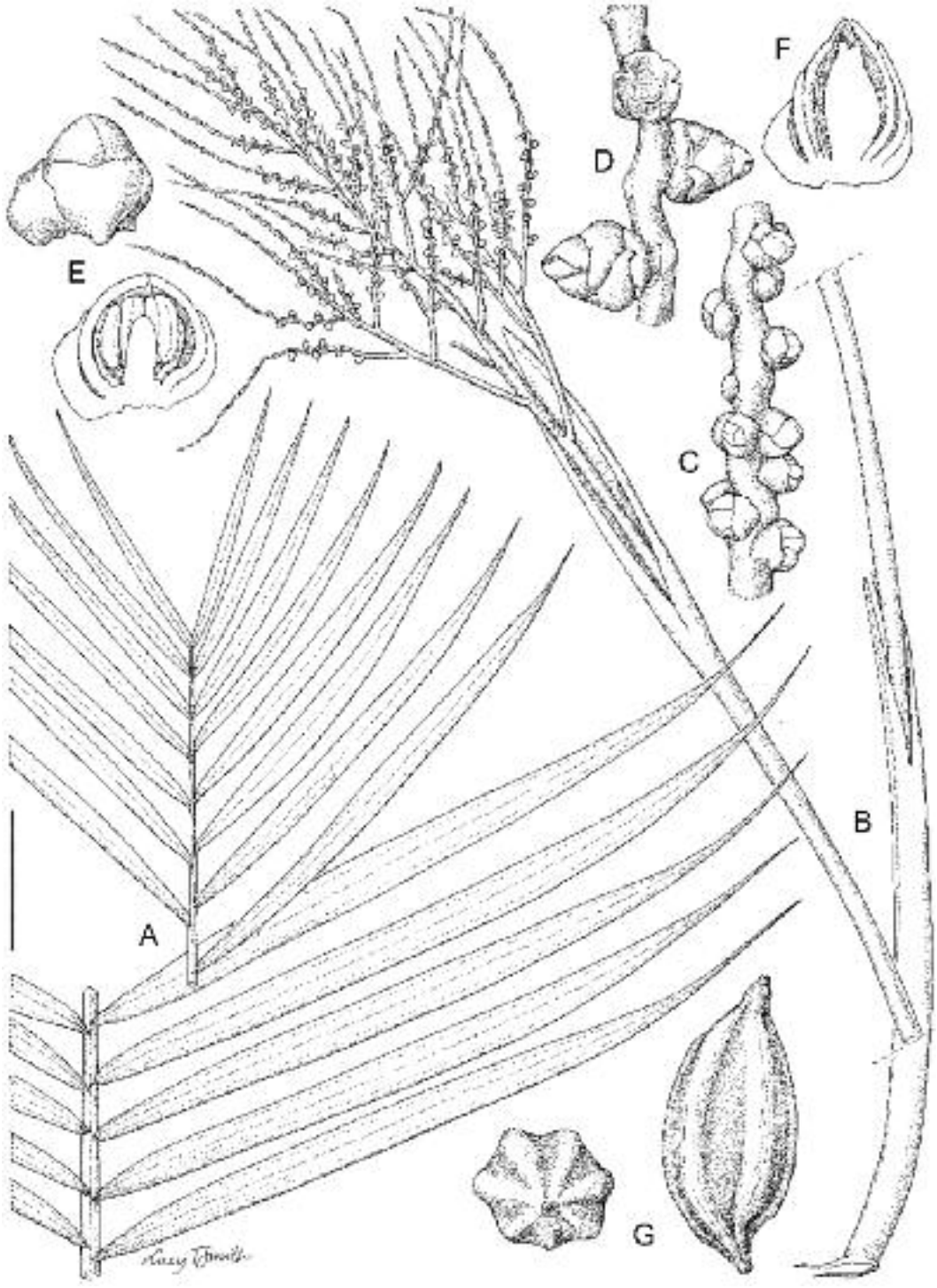
Uses: The stem is used for making bows and the fruit is used as a betel nut substitute.

Conservation status: Data deficient (IUCN 2001). Current knowledge of populations of this palm and the condition of the forests on Supiori is insufficient for a conservation assessment to be completed at this time.

Specimens examined: Indonesia, Papua, Supiori Island: North Supiori Nature Reserve, Fanjur village, June 2001, *Maturbongs et al. 680* (holotype K; isotypes AAU, BO, CANB, LAE, MAN).

Notes: *Heterospathe* has two centers of diversity, the Philippines and New Guinea. In New Guinea, species diversity is biased towards the eastern half of the island and montane elevations – around 90% of all New Guinea *Heterospathe* specimens have been collected from Papua New Guinea and more than 75% from elevations above 500 m. An undescribed species from the lowlands of an offshore island of western New Guinea is thus an unexpected discovery.

Superficially, *H. porcata* is similar to *Heterospathe elegans*, although the nearest record for this species is some 500 km away to the south-east (Trudgen & Baker 2008). The



12. *Heterospathe porcata*. **A**. Leaf apex and mid-leaf portion. **B**. Inflorescence in two halves. **C**. Detail of rachilla. **D**. Rachilla with pistillate flowers, one removed to show large floral bracteole. **E**. Staminate flower whole and in section. **F**. Pistillate flower in section. **G**. Endocarp in two views. Scale bar: A, B = 8 cm; C, D = 7 mm; E = 2 mm; F = 3mm; G = 1 cm. From *Maturbongs et al. 680*. Drawn by Lucy T. Smith.

two species share a slender habit, finely pinnate leaf and inflorescence with elongate peduncle and branches clustered near the apex. *Heterospathe porcata* appears to be a taller palm, recorded as 6 m in contrast to the reported maximum of 2.5 m for *H. elegans*. The inflorescence is also quite different, being branched to 2 or 3 orders (1 or 2 orders in *H. elegans*), the rachillae being finely sinuous (more irregularly so in *H. elegans*) and the first peduncular bract being rather long and inserted one third to halfway along the peduncle from the base (shorter in *H. elegans* and inserted in the distal quarter of the peduncle). Unusually, the fruit contains a thin, bony endocarp with 6 or 7 thickened, parallel, fibrous ridges running the full length of the fruit (hence the species epithet *porcata*, meaning ridged). These reveal themselves when the ellipsoid fruit, which are larger than the globose fruit of *H. elegans*, are dried and the mesocarp shrinks around the ridges. The space with the endocarp is somewhat star-shaped in cross section and, consequently, so is the seed, in contrast to the globose seed of *H. elegans*. Within *Heterospathe,* the only species with a comparable endocarp is *H. longipes* of Fiji, though this has much more extremely ornate structures. The combination of its geographical and elevational distribution, and almost unique reproductive morphology renders *H. porcata* a very surprising novelty indeed.

3. Hydriastele biakensis W.J.Baker & Heatubun **sp. nov.** Type: Indonesia, Papua, Biak Island: Oridek district, Wadibu village, July 2009, *Baker et al. 1342* (holotype K, isotypes AAU, BO, MAN). (Figs. 13–19)

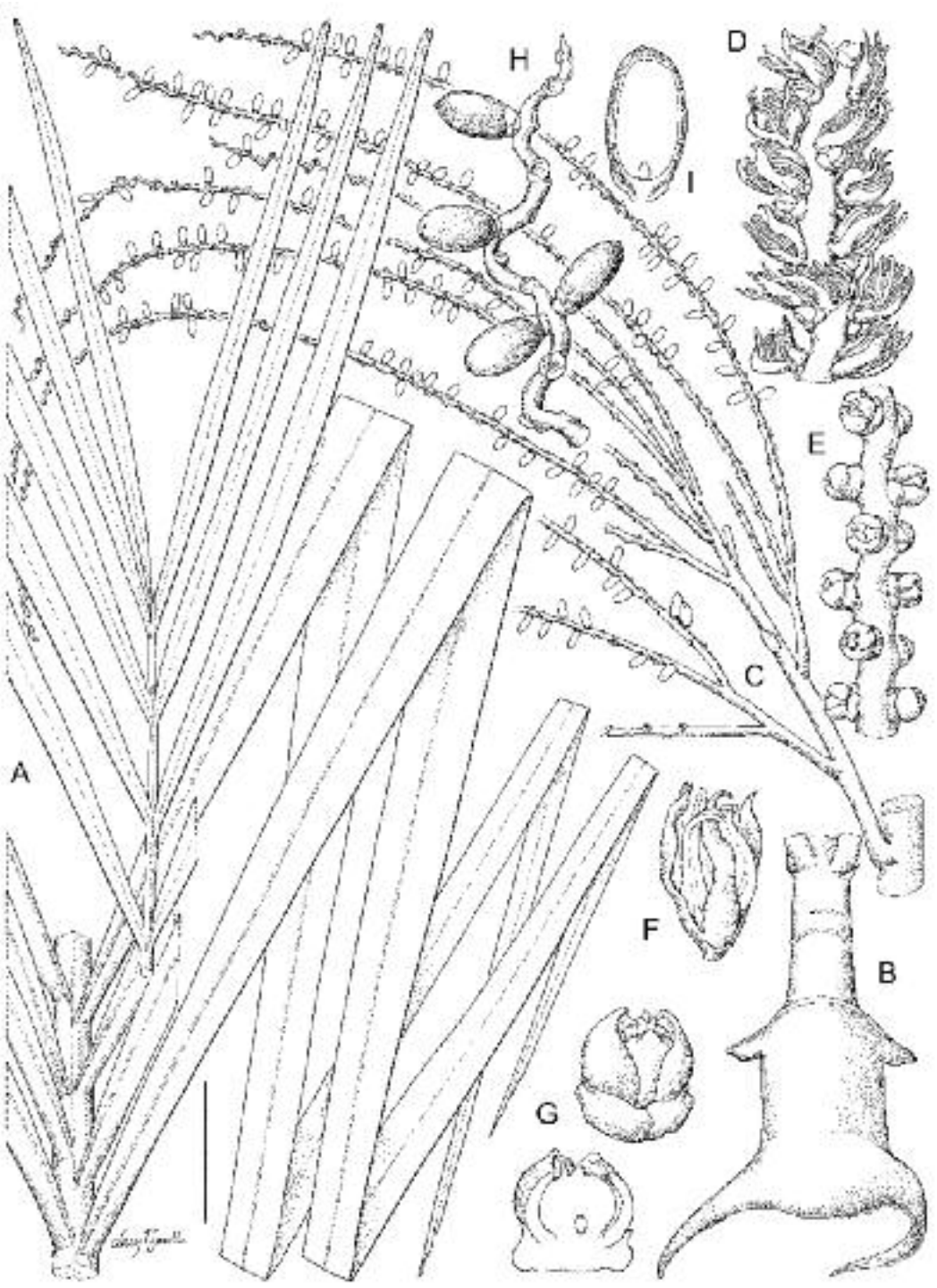
Diagnostic characters: *Hydriastele biakensis* is distinguished from other species in the genus by its large size, the recurving leaves with ascending leaflets and acute or notched leaflet apices, the often somewhat distorted prophyll bearing pronounced pithy keels, the peduncle abruptly constricting at the prophyll scar, the inflorescence branched to four orders, the highly sinuous rachillae, and the congenitally open staminate flowers.

Robust, solitary, canopy palm. **Stem** ca. 15 m tall, ca. 30 cm in diam., leaf scars prominent, internodes 3–7 cm, surface brown. **Leaves** ca. 18–24 in crown, strongly recurved; sheath ca. 170 cm long, pale green with white waxy indumentum, striate near mouth, forming crownshaft 200–270 cm long, 26–27 cm wide; rachis 280–300 cm long, petiole 47–50 cm

13. *Hydriastele biakensis*, cultivated at Marau, Biak. (Photo: W.J. Baker)

14. *Hydriastele biakensis*, cultivated at Marau, Biak. (Photo: W.J. Baker)

long, 3.5–5 cm wide, channeled adaxially, petiole and lower rachis yellowish green, petiole and rachis bearing scattered to dense brown, caducous, felty indumentum and minute dark dots throughout; leaflets ca. 65 each side of rachis, regularly arranged, strongly ascending, concolorous, with minute dark dots abaxially, brown, basifixed ramenta attached



15. *Hydriastele biakensis*. **A**. Leaf apex and mid-leaf portion. **B**. Inflorescence base. **C**. Inflorescence first order branch. **D**. Rachilla showing congenitally open flowers. **E**. Rachilla with pistillate flowers at anthesis. **F**. Staminate flower. **G**. Pistillate flower whole and in section. **H**. Sinuous rachilla with fruit attached. **I**. Fruit in section. Scale bar: A,C = 6 cm; B = 8 cm; D, H = 1.5 cm; E, I = 1 cm; F = 5 mm; G = 3 mm. A–C from Baker et al. 1342, D–I from Heatubun et al. 970. Drawn by Lucy T. Smith.

to basal, abaxial portion of midrib; middle leaflets 121–126 cm long, 3–4.5 cm wide, linear, transverse veinlets conspicuous, apices narrowly acute; terminal segments linear, with apices notched, not praemorse. **Inflorescence** 95–100 cm long, infrafoliar, ?protandrous, horsetail-shaped, erect, branched to 4 orders, axes white on emergence, turning green; prophyll 70–107 cm long, 15–18 cm wide, green, often somewhat sinuous, appearing distorted, keels pithy, with thin, white indumentum; first peduncular bract, ca. 70 cm long, ca. 5.5 cm wide, similar to prophyll, attached 2.5–4.5 cm above prophyll insertion; peduncle 10–21 cm long, 8–8.5 cm wide at base, narrowing sharply above prophyll insertion to 3–3.5 cm, prophyll scar conspicuous with rounded "shoulders"; primary branches 20–22, the longest (basalmost) to 70 cm; rachillae 32–48 mm long, 2–3 mm in diam., sinuous, especially distally, triads 2–3 mm apart, decussate. **Staminate flower** 5–6.5 mm long, 2.5–4 mm in diam. in bud, variously flattened and distorted, congenitally open; sepals connate in a shallow cup with three triangular lobes ca. 0.5 mm long, white; petals 5–6 mm long, 1–1.5 mm wide, narrowly triangular, variously twisted and sinuous, briefly adnate to receptacle, white; stamens 6, 4.5–5.5 mm long, white; filaments ca. 0.5 mm long, narrowly conoid; anthers 4–5 mm long, 0.8–1.2 mm wide, oblong to sinuous, basifixed, dehiscence latrorse; pistillode minute, pyriform. **Pistillate flower** ca. 2.5 mm long, 2.5–2.8 mm in diam., borne throughout the rachillae; sepals imbricate, ca. 1 mm long, 2.5–2.8 mm wide, rounded, white; petals 2–2.5 mm long, 2.5–3 mm wide, strongly imbricate, rounded, white; staminodes 3, minute, paddle-shaped; gynoecium ca. 2 mm long, ca. 1.5 mm in diam., globose; stigma minutely trifid. **Fruit** 9.5–12 mm long, 5–6 mm in diam., oblong-ellipsoid, red, perianth cupule clasping, endocarp thin, tough, closely adhering to seed. **Seed** 7.5–8.2 mm long, 4–4.3 mm in diam., cylindrical; endosperm homogeneous; embryo basal.

Distribution: Known from few specimen localities and sight records on the south and western coast of Biak and Auki Island on the nearby Padaido Islands.

Hydriastele biakensis. 16 (left). Inflorescences. 17 (right). Infructescences. (Both photos: W.J. Baker)

Habitat: Coastal forest on limestone near to sea level, sometimes on limestone cliffs close to the beach.

Vernacular names: *Arwaf* (Biak dialect)

Uses: The stem is used for flooring and the leaf sheaths for making baskets.

Conservation status: Endangered (EN B1, 2 (a, b [i, ii, iii, iv, v]), C2a (i); IUCN 2001). This species is known only from coastal limestone forest which is severely degraded on Biak, especially on the south coast. Larger populations have been observed on the west coast and Padaido Islands.

Specimens examined: Indonesia, Papua, Biak Island: Oridek district, Wadibu village, July 2009, *Baker et al. 1342* (holotype K, isotypes AAU, BO, MAN), *Heatubun et al. 970* (BO, K, MAN, NY). A sterile specimen may also represent this species: northern Biak, Wari village, September 1998, *Maturbongs et al. 574* (BO, K, MAN).

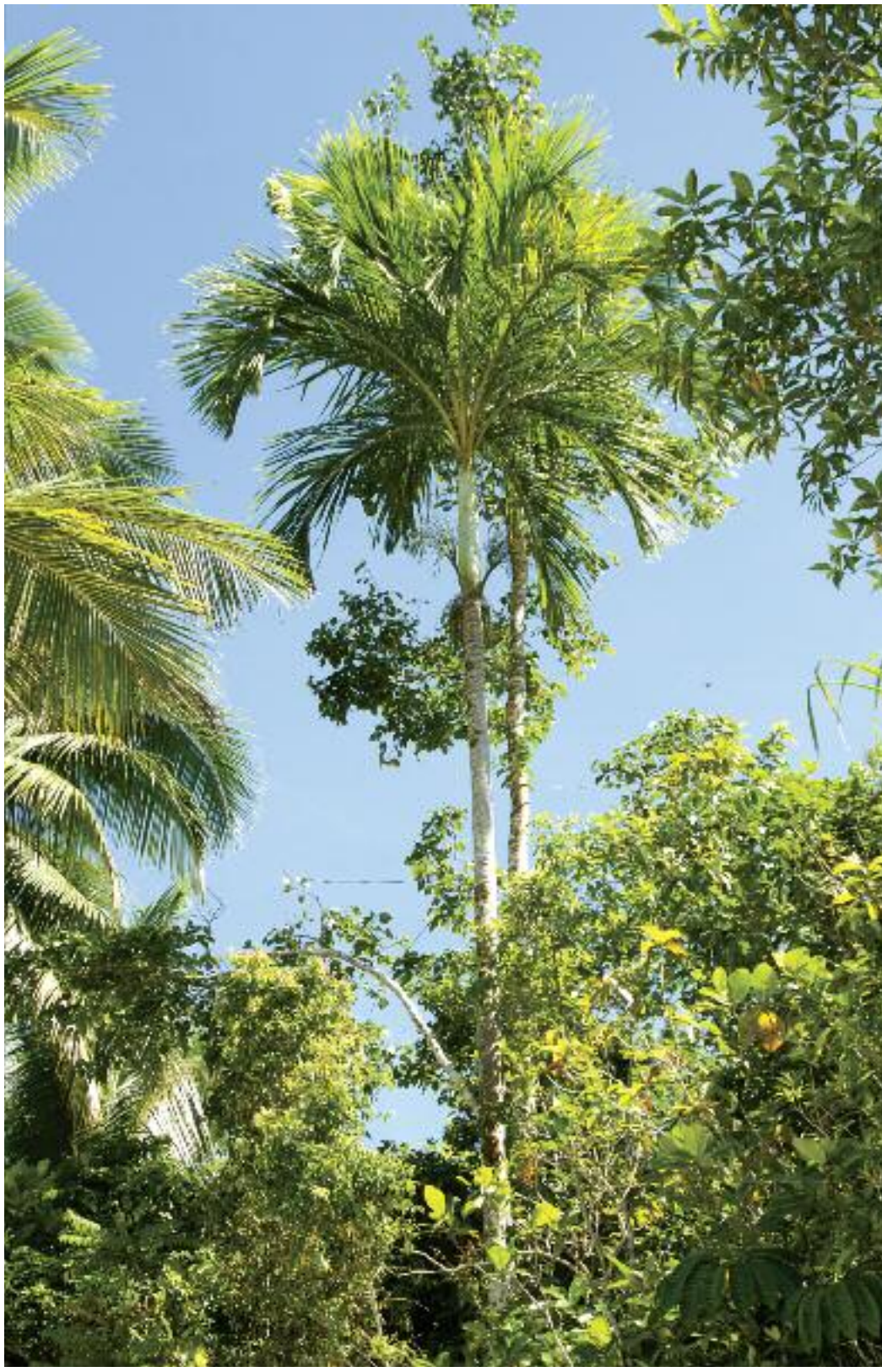
Notes: We became aware of this beautiful species during the brief visit to Biak in 2000 (Baker pers. obs.) when it was seen cultivated near the now ruined Marau Beach Hotel and persisting wild as a few scattered individuals in cleared areas near the south coast. At that time, it was regarded as a species of *Gulubia* (now a synonym of *Hydriastele*) and suspected to be undescribed when compared with the species treated in Essig's (1982) monograph of the genus. Unable to collect material at that time, we had to wait until 2009 for an opportunity to make complete specimens for herbarium and laboratory study.

To determine the relationships of the new species, we exploited an earlier phylogenetic study of *Hydriastele* (Loo et al. 2006). Following the protocols of Loo et al., we generated new DNA sequence data for *H. biakensis* of the two low-copy nuclear genes PRK and RPB2, integrated these new data within their published dataset and repeated their analyses. *Hydriastele biakensis* was strongly supported as sister species of *H. palauensis*. There are morphological similarities between the two species in general appearance, such as the strongly recurved leaves, ascending leaflets with acute or notched (but not conspicuously praemorse) apices and the glaucous crownshaft. The two also share the unusual feature of the staminate flowers being congenitally open in bud due to the large size of the stamens relative to the petals (Fig. 18).

18. *Hydriastele biakensis,* congenitally open male flowers prior to anthesis. (Photo: W.J. Baker)

This character, alongside fruit structure, was considered diagnostic for the genus *Gulubiopsis* in which *H. palauensis* was originally described (Beccari 1924, Beccari & Pichi-Sermolli 1955). Moore and Fosberg (1956) deemed these features inadequate to justify generic status, reducing *Gulubiopsis* into synonymy with *Gulubia*, which was later sunk into *Hydriastele* (Baker & Loo 2004).

In addition to morphological similarities, the two species occupy similar coastal limestone habitats. Moreover, Biak is among the closest of the Malesian islands to Palau, although almost 1000 km of clear ocean exists between the two. Nevertheless, the two are clearly distinct species. *Hydriastele biakensis* is much more robust than *H. palauensis,* for example with stem diameter, leaf length, leaflet number, leaflet length, sheath length and inflorescence being twice the size or more in the former than that reported for the latter (Moore & Fosberg 1956, Essig 1982). The contrast is most clear in the inflorescence which, as well as being much smaller in *H. palauensis*, lacks the striking "shoulders" formed by the abrupt



19. *Hydriastele biakensis*, on low limestone cliffs above the beach at Wadibu, Biak. (Photo: W.J. Baker)

constriction of the peduncle at the prophyll scar, and the highly sinuous rachillae (see p. 107), and in the material available to us (*Lorence et al. 8304* [PTBG]) is branched to two rather than four orders.

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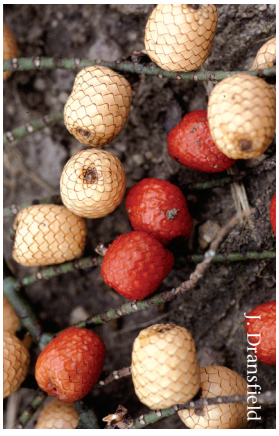
PALM NEWS

The palm borer *Paysandisia archon* continues to wreak havoc with cultivated palms in southern Europe. **The first study of its reproductive biology in France revealed some important clues to the borer's destructive capacity**. Roxane Delle-Vedove et al. (European Journal of Entomology 109: 289–292. 2012) found that nearly three-quarters of the individuals studied were sexually mature just three hours after emergence as adult moths. Mating peaked between 14:00 h and 15:00 h, and 87% of the females were fertilized and laying eggs 30 hours after mating. These findings may help researchers develop monitoring tools as well as control measures that disrupt or diminish the borer's reproductive output.

Palm squirrels (*Funambulus palmarum*) do more good than harm in coconut plantations in southern India. A recent study by A.K. Chakravarthy and N.E. Thyagaraj (Mammalia 76: 193–199. 2012) examined the impact of palm squirrels in coconut plantations, where they were believed to feed on nuts and cause economic losses. Field observations, pollination studies, gut content analyses, laboratory feeding tests and exclusion experiments established that, contrary to expectations, palm squirrels play a beneficial role in coconut plantations. Palm squirrels are important pollinators of the coconut, and fruit set was reduced by 19% when palm squirrels were excluded from the flowers. Moreover, palm squirrels also feed on insect pests. This is one of only a handful of reports of mammal pollination of a palm and the first for coconut, which was found in previous studies to be pollinated by wasps, bees and the wind.


Arun Prabhu


J. Dransfield

A new monograph of *Orania* has been published by A.P. Keim and J. Dransfield (Kew Bulletin 67: 127–190. 2012). The work documents the extraordinary diversity of the genus in New Guinea. Of the 28 species recognized in this new work, three occur in Madagascar, and 25 occur in Malesia, 11 of which are described as new to science and are beautifully illustrated with line drawings by Lucy T. Smith. Many of the newly described species are lovely palms, and we hope they will be brought into cultivation in the near future. **A taxonomic revision of the rattans of Africa (Arecaceae: Calamoideae)** by Terry C.H. Sunderland represents a milestone in our understanding of the diverse and peculiar climbing palms of the whole continent of Africa. The paper has recently appeared in the on-line journal Phytotaxa (51: 1–76. 2012). The monograph, also beautifully illustrated with plates by Kew artist Lucy T. Smith, can be downloaded for free from http://www.mapress.com/phytotaxa/content/2012/f/pt00051p076.pdf.

Alarmed by diminishing numbers of the Cuban national tree, *Roystonea regia*, the government of Cuba is supporting a massive reforestation effort on the island. Milian Rodriguez Lima, a coordinator of the Palm Department of the Cuban Botany Society, recently announced that the Agriculture Ministry, Azcuba Business Group and the National Association of Small Farmers are backing an effort to **plant three million royal palms in one year**.

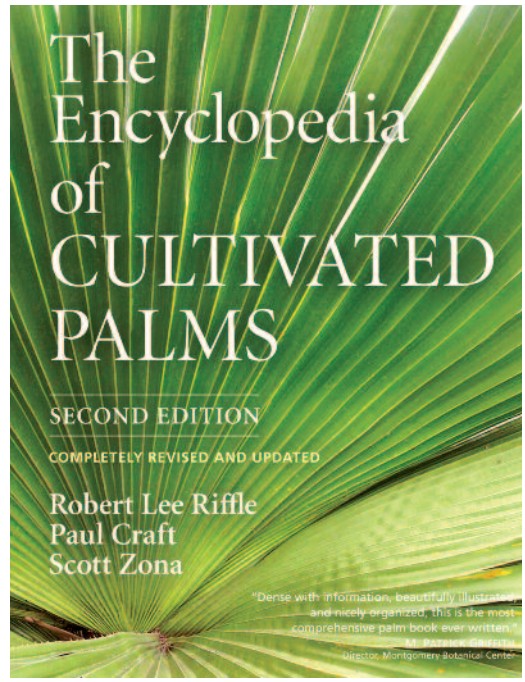
Palm Literature

THE ENCYCLOPEDIA OF CULTIVATED PALMS, 2ND EDITION – R.L. Riffle, P. Craft & S. Zona. Timber Press, Portland & London. 2012. ISBN 1604692057. Price US$59.95. Hardcover. 517 pages, 950 color plates.

Hot from Timber Press is the new edition of what is still the most comprehensive palm encyclopedia ever produced. As major illustrated references go, its price is surprisingly modest – $59.95 direct from the publisher, and I hate to say how much cheaper from a well known mail-order bookseller.

It is likely that many if not most IPS members already possess the first (2003) edition by Robert Lee Riffle and Paul Craft and so will be asking themselves whether it is worth allocating both money and bookshelf space to the new one. This review will largely be an examination of how extensively the new edition has been updated.

The text has been botanically checked and edited and new entries mainly written by professional palm taxonomist and IPS Director Scott Zona with much additional input by Paul Craft as well. Scott told me he tried to adapt to Robert Lee Riffle's enthusiastic writing style but found it hard to match. Riffle, who died in 2006, was a much loved gardening personality and wordsmith who put his soul (and much hard work) into converting dry botanical descriptions into more readable form while retaining a good measure of precision. In writing about plants grown for ornament it is difficult to find a balance between objective description and aesthetic evaluation, and Riffle could not resist the temptation to gush here and there. One example that caught my eye in the first edition was the last paragraph of the *Deckenia nobilis* entry beginning "This magnificence is one of the most beautiful palm species ..." – slightly toned down in the new edition to "This magnificent and beautiful species ..." Of course, it has been the vast palm knowledge and experience of Paul Craft as grower, collector, explorer and photographer, that has underpinned both editions.



As far as content goes, the new edition is significantly enlarged, with 119 species additional to the earlier 830, and 7 new genus entries. As to size, it is actually slightly smaller, identical in format but about 10 percent thinner. There is some cost-cutting evident, with cloth covers and dust jacket replaced by glossy board covers though still appearing quite durable and strongly bound. Internally, paper appears to be slightly thinner but still of good quality. The most significant reduction is in pages of text, shrunken from 304 to 274, achieved despite the addition of many entries by a more condensed typeface and marginally smaller point size. A random check of carried-over entries reveals only minor tightening of the wording. I did not go as far as counting words, but the small reductions must be somewhat offset by the insertion of metric measurements in parentheses, a welcome addition for readers from outside that last stronghold of the imperial system, the United States.

Pages of color plates, in contrast, have increased from 219 to 240, with the numbered plates (mostly four images per page) increasing from 929 to 950. As these numbers suggest

(and also considering the additional species entries), the average number of plates per species is lower. A quick scan revealed many have been cut from three to two or two to one. It also revealed that a great many have been replaced by different photos of the species, often with such a dubious improvement it was hard to fathom the motive for replacement. But it is good to see that many species that had no illustration in the first edition now have one. Scanning through names beginning A–D I found 86 such gaps plugged. For the 74 new species entries in A–D, I found 52 are illustrated and 19 are not (plus three in the first edition without text entries) – thus a total of 138 newly illustrated palms in the first third of the book alone!

Still on the subject of the color plates, they are of adequate quality but rather mixed aesthetic appeal. Most are square-on shots of the whole palm with only a minority showing flowers or fruit, the effect being page after page of different shades of green – a frequent accusation of those gardeners who are not turned on by palms! The new and replacement photos have hardly lessened the effect. But the feat of bringing together such a vast and comprehensive collection of palm photos is nonetheless admirable.

There are some noteworthy additions in the new book, for example the exciting new genus *Tahina* discovered in Madagascar and the newly recognized genera *Dransfieldia*, *Leucothrinax*, *Solfia* and *Saribus*. It was *Saribus* that was the big surprise for me, on learning it had very recently been split out of *Livistona* on cladistic grounds and included the popular *L. rotundifolia*. At species level the big winners, in terms of genera with the most new species entries, are *Dypsis*, more than doubled from 30 to 61, *Pinanga* from 25 to 38, and the old favorite *Chamaedorea*, from 30 to 43. Some of the newly treated palms are real rainforest gems, e.g. *Chamaedorea tenerrima*, *Dypsis beentjei* and *D. coriacea*, *Pinanga gracilis* and *Wettinia hirsuta*, or for lovers of majestic specimens to plant in open spaces, *Beccariophoenix alfredii* and *Orania ravaka*. A significant trend that emerges from the new entries, and indeed evident even in the first edition, is the flow into collections of exciting palm discoveries out of Madagascar over the last decade or two, a flow that shows little sign of slowing.

To end with the obligatory finding of minor faults, I noted the misspelling of *Bactris grayumii* (“*grayumi*”), *Coccothrinax hioramii* (“*hiorami*”) and *Rhapis laosensis* (“*loasensis*” under plate). And *Chamaerops humilis* has var. *argentata* in the text but var. *argentea* under the plate (the latter is correct). Apart from these, spelling and attention to other points of orthography appear to be of a very high standard.

If you need to be up with all the palms currently being grown (and many hardly yet in cultivation), or you are a new recruit to palm collecting, or simply that your copy of the first edition is falling apart by now, then this book is a must-buy. Yes, there is a lot of information available online, but there is so much more in the book that you would be hard put to find on the internet.

Tony Rodd
Sydney, Australia

Photo Feature

Hydriastele dransfieldii occurs on three of the islands in Cenderawasih Bay (Biak, Supiori and Numfor) adjacent to New Guinea’s Bird’s Head Peninsula. Here it is seen growing in a narrow band of primary forest that persists on a limestone ridge running parallel to the coast of southern Biak. As the photographs on the following two pages show, it grows abundantly in these conditions, rooting into the bare limestone without apparent need for well-developed soils. The species was introduced to cultivation in the 1990s, but was formally described in 2000 (Baker et al. 2000. Palms 44: 175–181) in the genus *Siphokentia*, which has since been reduced to synonymy with *Hydriastele*.

William J. Baker
Royal Botanic Gardens, Kew, UK

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	(4)	Free or Nominal Rate Distribution Outside the Mail *(Carriers or other means)*	2	2
e. Total Free or Nominal Rate Distribution *(Sum of 15d (1), (2), (3) and (4))*			3	3
f. Total Distribution *(Sum of 15c and 15e)* ▶			1401	1421
g. Copies not Distributed *(See Instructions to Publishers #4 (page #3))* ▶			99	79
h. Total *(Sum of 15f and g)* ▶			1500	1500
i. Percent Paid *(15c divided by 15f times 100)* ▶			99.8	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 56(3) Sept. 2012 issue of this publication. ☐ Publication not required.

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

Managing Editor

Date: 7 August 2012

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

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