

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

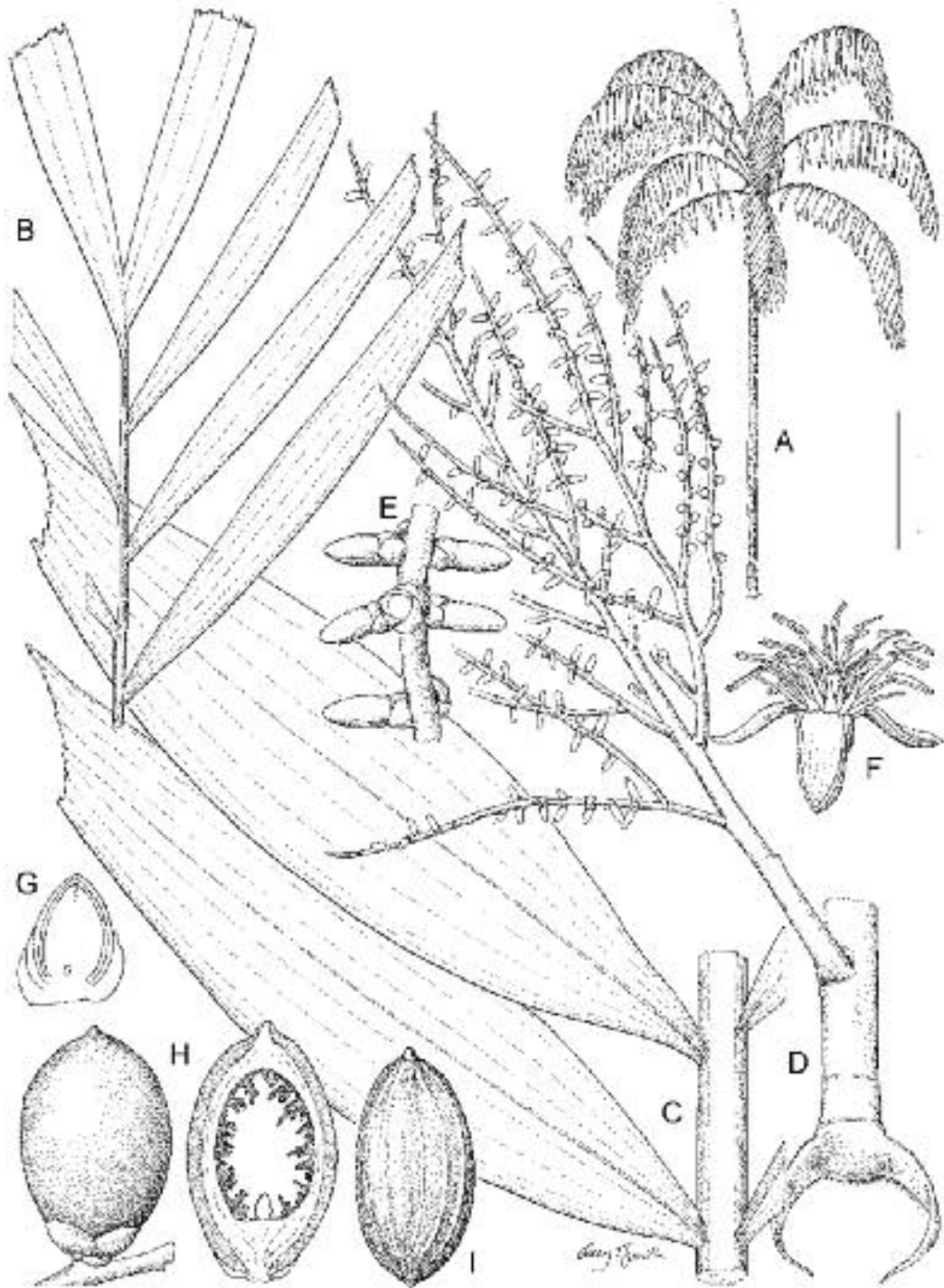




3. *Pinanga rumphiana*, Biak. (Photo: W.J. Baker)

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 discoloured, 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 rammenta 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, exerted 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 maturbongsi*. 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 matabongii*, 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; gynoeceum 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 ruminant; 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 ruminant 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 rameta 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 ruminant; 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.

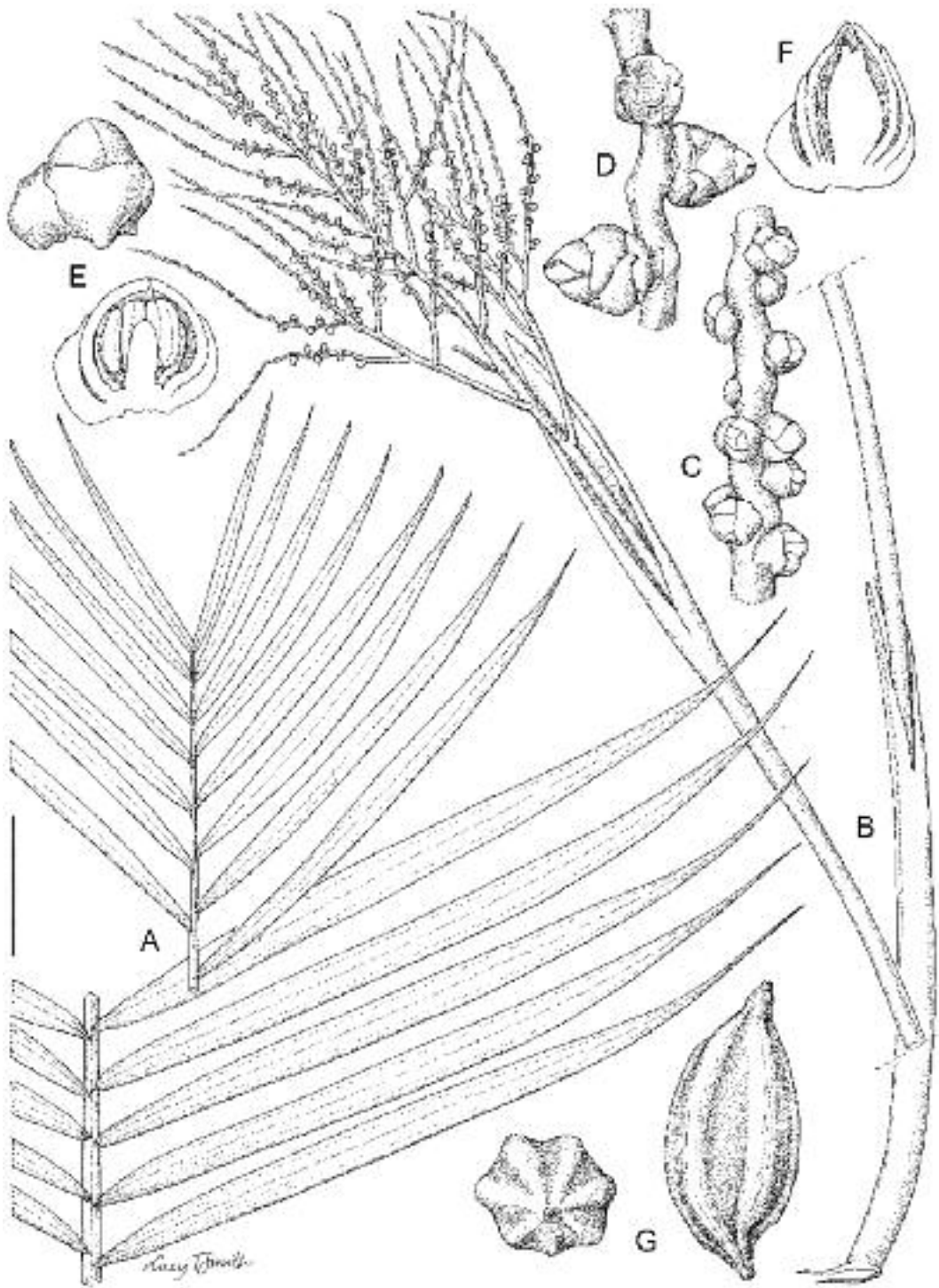
**Conservation status:** Data deficient (IUCN 2001). Current knowledge of populations of this palm and the condition of the forests on Supiori is insufficient for a conservation assessment to be completed at this time.

**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)



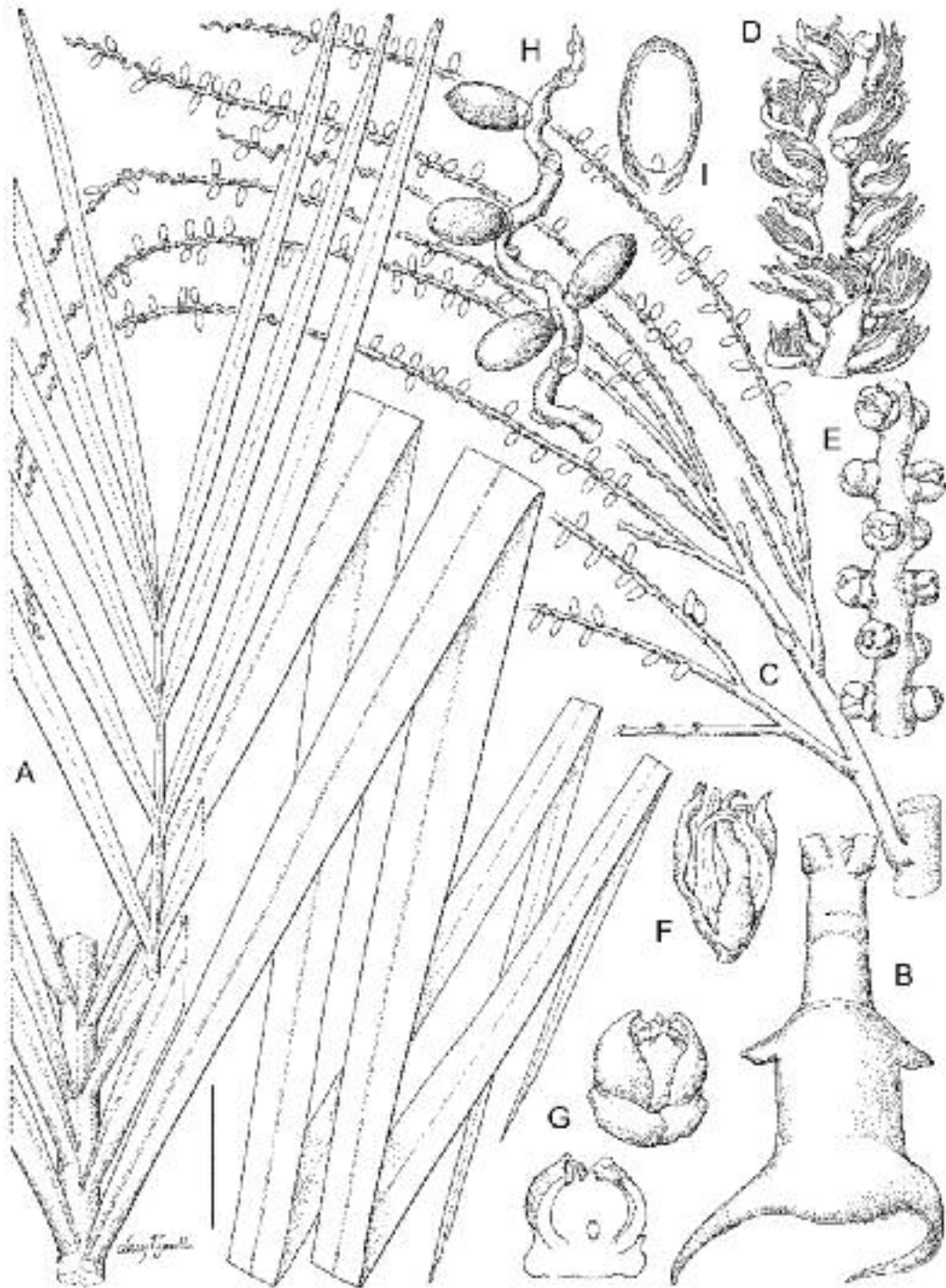




14. *Hydiastele biakensis*, cultivated at Marau, Biak. (Photo: W.J. Baker)

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 rameta attached



15. *Hydiastele 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.

*Hydiastele 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.

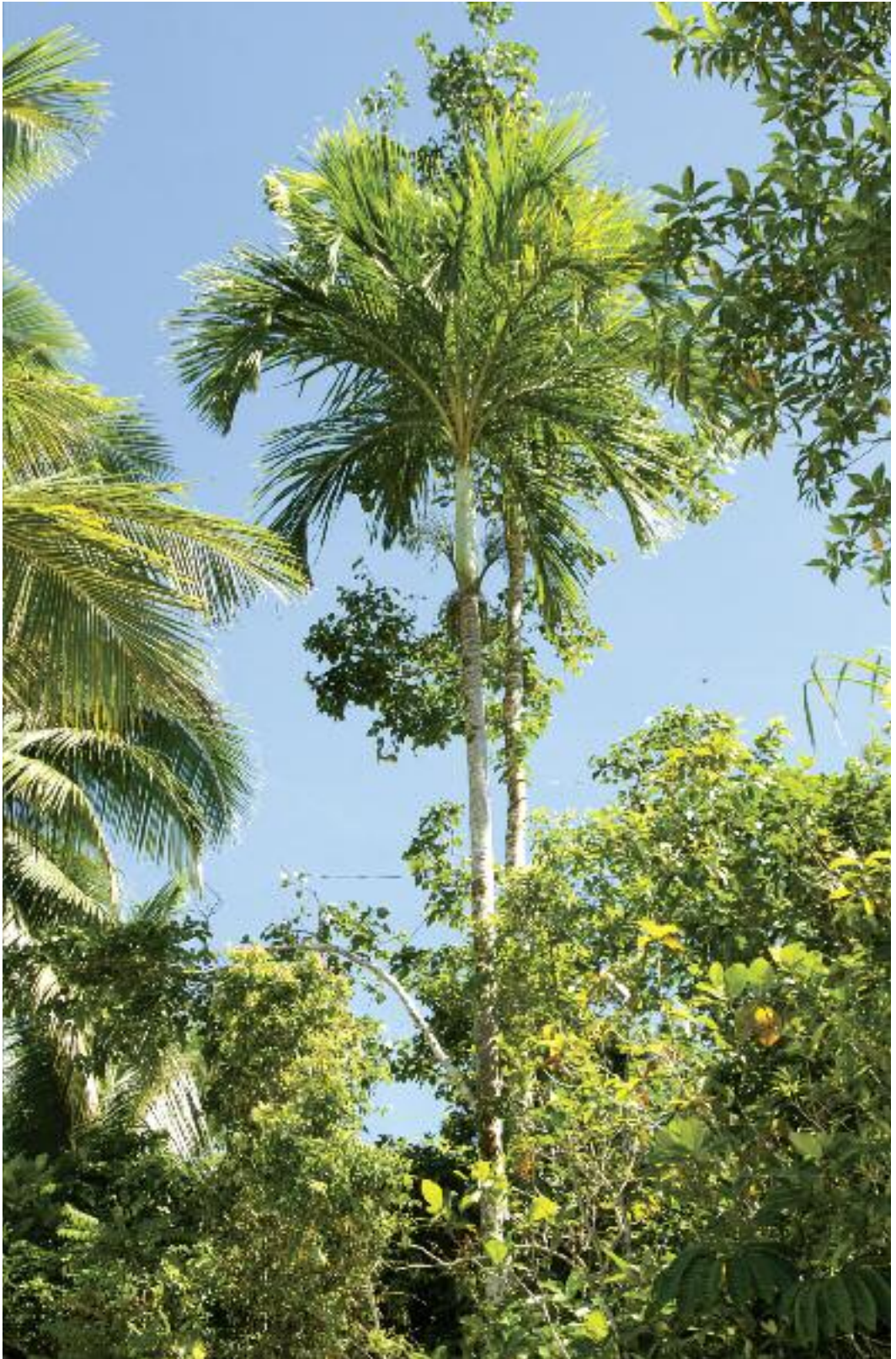
To determine the relationships of the new species, we exploited an earlier phylogenetic study of *Hydriastele* (Loo et al. 2006). Following the protocols of Loo et al., we generated new DNA sequence data for *H. biakensis* of the two low-copy nuclear genes PRK and RPB2, integrated these new data within 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. *Hydiastele 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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