



New rattans from New Guinea (*Calamus*, Arecaceae)

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Abstract

The rattan genus *Calamus*, the largest genus of palms (Arecaceae or Palmae), is poorly known in New Guinea. In preparation for a monograph of *Calamus* in New Guinea, we describe and illustrate fourteen new species here: *Calamus badius*, *C. barfodii*, *C. bulubabi*, *C. cheirophyllus*, *C. croftii*, *C. johnsii*, *C. lucysmithiae*, *C. nanduensis*, *C. oresbius*, *C. retroflexus*, *C. sashae*, *C. spanostachys*, *C. spiculiferus* and *C. womersleyi*. Although many appear to be rather rare, several are widespread, common species and some are of considerable use to local people. These new discoveries highlight the need for further studies of palms in eastern Malesia, especially New Guinea.

Key words: lianas, palms, Papuaia, taxonomy, South-East Asia, rattans

Introduction

With approaching 400 species, *Calamus* Linnaeus (1753: 325) is the largest genus of palms (Arecaceae or Palmae; Dransfield *et al.* 2008). It is also the most widespread of the genera of rattans, the spiny climbing palms of the Old World and the source of commercial rattan cane, ranging from India to Fiji with a single outlier in humid tropical Africa. *Calamus* is most species rich in the Sunda region of Malesia, with as many as 150 species occurring across the Malay Peninsula, Borneo, Sumatra and Java (183 species if the Philippines are included), and 82 in Borneo alone (Baker & Couvreur 2012, Govaerts *et al.* 2013). However, while diversity declines sharply to the east of Wallace's Line, a secondary peak of species richness occurs in New Guinea, where some 52 are currently recognised. Compared to the Sunda region (e.g. Dransfield 1979, 1984, 1992, 1997), *Calamus* species diversity in New Guinea was neglected until the initiation of a collaborative research programme on the entire palm flora of New Guinea (Baker 2002a, Baker & Dransfield 2006), resulting in a number of treatments of smaller groups and new species (Baker 2002b, Baker & Dransfield 2002a, 2002b, Baker *et al.* 2003, Dransfield & Baker 2003).

During the course of research for a monograph of New Guinea *Calamus*, we have studied almost 1000 specimens in the most relevant herbaria (A, BH, BM, BO, BRI, CANB, L, LAE, K, MAN, MEL, NY, WRSL; acronyms following Thiers 2013), which we believe to be almost the entirety of material available globally. We have also studied *Calamus* in the wild in numerous sites across New Guinea during field work with our partners at the University of Papua, Herbarium Bogoriense and the Papua New Guinea Forest Research Institute. We have discovered a large number of undescribed species both during our own field exploration and among existing herbarium specimens. Predictably, many species are narrowly distributed and rare, but a remarkable number are widespread or even common (e.g. *Calamus bulubabi*, *C. johnsii*, *C. oresbius*, *C. retroflexus*) and are useful to local people, highlighting the inadequacy of previous knowledge of this group. In preparation for our forthcoming monograph, we describe 14 of the new species here.

Taxonomic Treatment

A note on geography:—The nomenclature of New Guinea geography can be confusing. New Guinea is the name for the entire island (the largest tropical island in the World). The island is divided into two political entities. The

western half is part of Indonesia. Until recently known as Irian Jaya, it is currently divided into two provinces, West Papua (Papua Barat) and Papua. The eastern half of the island is the independent country of Papua New Guinea, which also includes additional islands to the east, namely the Bismarck Archipelago, the Milne Bay islands and Bougainville Island. Papua New Guinea is divided into 20 provinces.

1. *Calamus badius* J.Dransf. & W.J.Baker, *sp. nov.* Type:—INDONESIA. Papua Province: Timika, between Ajkwa and Otomona Rivers, on road from Timika to mile 38, 30 m, 4°26'22"S, 136°54'27"E, 10 February 1998, Dransfield *et al.* JD 7661 (holotype K!, isotypes BO!, BH!, L!, MAN!).

Diagnosis:—Distinguished from other species of *Calamus* in New Guinea by the ecirrate leaves (leaves lacking cirri), the discoloured leaflets, mid to dark green on the upper surface, beige-brown on the undersurface, the broad-elliptic leaflets (6–8 on each side of the rachis), the well-developed ocrea, which is coriaceous, persistent and tends to diverge from the sheathed stem, and the flagellate inflorescence.

Medium-sized clustering rattan climbing to 25 m. **Stem** with sheaths 20–28 mm diam., without sheaths to 14–15 mm diam.; internodes 22–28 cm. **Leaf** ecirrate, to 50–100 cm long including petiole; sheath mid-green, drying pale to bluish green or pale brown, with thin pale brown indumentum, sheath spines usually abundant, usually rather uniform, 2.5–6 × 1–1.5 mm, with swollen bases, solitary or very rarely paired, black, horizontal, densely covered in indumentum when newly emerged; knee 41–47 × 7–9.5 mm, drying same colour as sheath, armed as the rest of the sheath; ocrea conspicuous, 33–80 × 1.4–2.6 cm, erect or slightly diverging from sheath, congenitally split on the far side of the sheath to the petiole, coriaceous, persistent, same colour as sheath, armed with scattered spines as the sheath, usually more densely so; flagellum present, to 3–4 m long; petiole 12–20 cm long, 7–9 mm wide and 4–6 mm thick at the base, flattened or slightly convex adaxially, abaxially rounded, with sparse indumentum, with scattered rigid persistent spines to 1 mm along the margins and adaxial and abaxial faces; rachis to 85 cm long, distally sparsely armed with recurved hooks; leaflets 6–8 on each side of rachis, regularly arranged or in distant groups of 2, broadly elliptic, longest leaflet in mid-leaf 33–41 × 7.5–9 cm 2–4 cm, apical leaflets usually in a group of 4, displayed in a fan, 21–26 × 3.5–6 cm, apical pair of leaflets united for half their length, adaxial surface glabrous, abaxial surface densely covered in pale chestnut-coloured indumentum, lacking bristles except for short bristles to 1 mm long along the margins, transverse veinlets conspicuous, numerous, sinuous. **Staminate inflorescence** branched to 3 orders, to 2.5 m long including the peduncle 37 cm long and a short flagelliform tip; prophyll to 36 × 1.2 cm, closely sheathing, splitting neatly at its tip, with a triangular lobe to 2.0 × 1.4 cm, covered in sparse pale to mid-brown indumentum, armed with scattered short triangular spines 1 mm long, with swollen bases; peduncular bracts absent, rachis bracts similar to prophyll but shorter, with similar indumentum and armature; primary branches 13, to at least 36 cm long, ca. 22 cm apart, with numerous rachillae; rachillae 10–40 × 1.5 mm; rachilla bracts 0.9 × 0.8 mm, distichously arranged, explanate, the triangular tip reflexed, glabrous, striate, unarmed; floral bracteole 1 × 1–1.5 mm, cup-shaped, glabrous striate. **Staminate flowers** close to anthesis 3.0 × 1 mm; calyx 1.5 mm diam., tubular in basal 1 mm, with 3 lobes 0.5 × 1.0 mm, glabrous, striate; corolla 2.5 × 1 mm in bud, tubular in basal 0.1 mm; stamens 6, filaments 0.5 × 0.3 mm, anthers 1.2 × 0.2 mm; pistillode pyramidal, 0.5 × 0.3 mm. **Pistillate inflorescence** similar to staminate inflorescence, to 2.5 m long including 20 × 0.9 cm peduncle and short flagelliform tip, branched to 2 orders; prophyll to 20 × 0.9 cm, tubular and closely sheathing, splitting apically to give a triangular lobe to 2 × 0.7 cm, bearing mid-brown indumentum and scattered spines to 1 × 0.5 mm with swollen bases; peduncular bract absent (always?), rachis bracts similar to prophyll but shorter; primary branches 4–7, to 33 cm long, 16–20 cm apart, with up to 29 rachillae; rachillae 2–6.5 × 1.5 mm; rachilla bracts triangular, explanate, the tips reflexed, 2 × 2 mm, distichously arranged, striate, unarmed; proximal floral bracteoles 1.5 mm high, ca. 1.5 mm diam., striate, explanate, distal floral bracteoles cup-shaped, 1 × 1.5 mm, scar from sterile staminate ca. 0.2 mm diam. **Sterile staminate flower** very immature, 1.5 × 1.0 mm; sepals 1.5 × 1 mm, joined in basal 1 mm; petals 1.5 × 1 mm; sterile stamens ca. 0.8 mm long. **Pistillate flowers** (immature buds) 2.5 × 1.5 mm; calyx tubular in basal 2 mm, with lobes 0.5 × 1 mm, striate, glabrous; petals 1.5 × 1 mm, joined in basal 0.5 mm, striate; other parts very immature. **Fruit** not seen. (Fig. 1)

Distribution:—Known only from lowland forest near Timika and Mindiptanah in southern Papua Province.

Habitat:—In lowland forest at altitudes up to 100 m above sea level.

Uses:—None recorded.

Vernacular Names:—*Bobnong* (Kati).

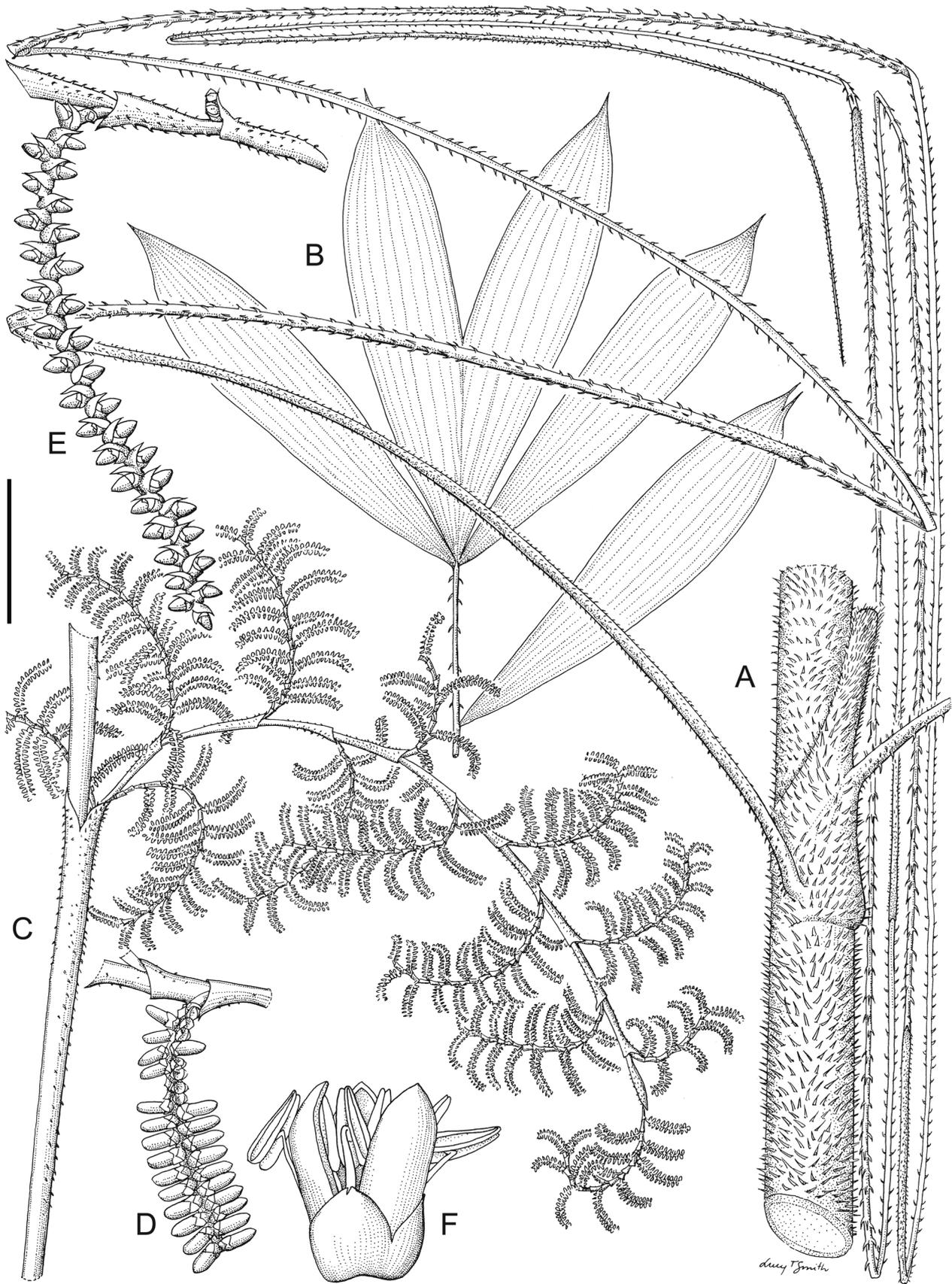


FIGURE 1. *Calamus badius*. A. Leaf sheath with flagellum. B. Leaf apex. C. Primary branch of staminate inflorescence. D. Staminate rachilla. E. Pistillate rachilla. F. Staminate flower. Scale bar: A = 4 cm; B = 8 cm; C = 6 cm; D, E = 1.5 cm; F = 2 mm. A–F from Dransfield et al. JD 7661; E from Dransfield et al. JD 7650. Drawn by Lucy T. Smith.

Specimens examined:—INDONESIA. Papua Province: Mindiptanah, 5°45'S, 140°22'E, 26 August 1957, *Dijkstra BW 6632* (L!, MAN); Timika, 100 m, 4°45'S, 136°32'E, 5 July 1995, *Maturbongs 112* (K!, MAN); Timika, road to Kali Kopi from mile 38, 80 m, 4°25'23"S, 136°56'16"E, 6 February 1998, *Dransfield et al. JD 7650* (BH, BO, K!, L, MAN); Timika, between Ajkwa and Otomona Rivers, on road from Timika to Mile 38, 30 m, 4°26'22"S, 136°54'27"E, 10 February 1998, *Dransfield et al. JD 7661* (holotype K!, isotypes BO!, BH!, L!, MAN!).

Notes:—*Calamus badius* (Fig. 1) is known from rather few collections found in two areas of Indonesian New Guinea, in lowland forest. This species is very distinctive in its few, broadly elliptic leaflets that are strongly discoloured, mid to dark green on the adaxial surface and bearing beige-brown indumentum on the abaxial surface (the specific epithet refers to the colour of the abaxial surface of the leaflets). It is one of only two species of *Calamus* in New Guinea with discoloured leaflets, the other being the unrelated *C. zieckii* Fernando (2014: in press), which otherwise differs in its cirrate leaves with grouped, linear leaflets and non-flagellate inflorescences. The leaf sheath also bears a conspicuous ocrea up to 8 cm long, which is leathery, slightly divergent from the stem and densely armed with stout spines, which are also widespread on the sheath.

One very incomplete specimen (*Morren 223*) collected in Sandaun Province, on the Hak River, Telefomin District (K) consists of a fragment of rachis and a single leaflet. The shape of the leaflet and the brown indumentum on its undersurface suggest that this could well be *Calamus badius*.

2. *Calamus barfodii* W.J.Baker & J.Dransf., *sp. nov.* Type:—PAPUA NEW GUINEA. Central Province: Kuriva Forest Logging Area, Port Moresby Subdistrict, 50 m, 9°5'S, 147°7'E, 18 July 1979, *Zieck NGF 36596* (holotype L!, isotype LAE!).

Diagnosis:—Distinguished by its moderately slender stem with well developed, inflated, persistent, clasping ocreas and the rather short, erect to arching inflorescence that bears stout, inflated bracts, which split to the base by the emergence of very compact primary branching systems.

Moderately slender, clustering rattan climbing to 30 m. **Stem** with sheaths 8–16 mm diam., without sheaths 5.5–10 mm diam. **Leaf** ecirrate, to 72–78 cm long including petiole; sheath pale green, glaucous, with very thin, white to buff-coloured woolly indumentum, armed with numerous, short, triangular, solitary spines, spines 0.5–4 × 0.5–1.2 mm, spine tips sometimes dark, with caducous indumentum as sheath; knee 17–27 mm long, 10–15 mm wide, colour and armature as sheath; ocrea 9–17 × 1–2.7 cm, persistent, inflated, boat-shaped, split longitudinally to base on side opposite petiole insertion, clasping and usually obscuring sheath, tough, brown, dark purple when young, armed as sheath, apparently inhabited by ants; flagellum present, 90–140 cm long; petiole ca. 2–4 cm, 6–8 mm wide and 3–5 mm thick at base, flat to shallowly channelled adaxially, rounded abaxially, with caducous indumentum as sheath, moderately to densely armed with spines as sheath and reflexed grapnel spines; rachis 60–65 cm, armed as petiole; leaflets 23–26 each side of rachis, regularly arranged, narrowly linear lanceolate, longest leaflet at mid-leaf position, mid-leaf leaflets 19–26 × 1.5–2 cm, apical leaflets 3.5–10 × 0.3–1.3 cm, apical leaflet pair united up to one fifth of their length or not united, leaflets glabrous, scarcely armed, with very few dark bristles towards apex on adaxial surface of midrib and on margins, transverse veinlets conspicuous, closely spaced; **Staminate inflorescence** only fragments of dead inflorescence seen, branched to three orders, similar to pistillate inflorescence. **Staminate flowers** not seen. **Pistillate inflorescence** erect to arching, 40–59 cm long including 21–40 cm peduncle, lacking flagelliform tip, branched to 2–3 orders; prophyll 21–28 × 0.6–1 cm, strictly tubular, opening slightly asymmetrically at apex and sometime splitting slightly, with caducous indumentum as sheath, sparsely to densely armed as ocrea; peduncular bracts absent, rachis bracts 3–15 × 0.8–1.7 cm, inflated, armed as ocrea, splitting to base or thereabouts by expansion of primary branches, with caducous indumentum as sheath; primary branches ca. 4, to 7 cm long, 5–8 cm apart, compact, with 10–25 rachillae; rachillae 4–13 mm × 1–1.3 mm, straight or curved, with caducous indumentum as sheath; rachilla bracts ca. 1 × 1.5 mm, subdistichous, closely adpressed to rachilla, very inconspicuous; proximal floral bracteole 1.8–2 mm diam., distal floral bracteole 1.6–2 mm, both bracteoles flat, scar from sterile staminate flower minute, elliptic. **Pistillate flowers** not seen. **Sterile staminate flowers** not seen. **Fruit** immature, ellipsoid, ca. 10 × 6 mm including beak 1.5 mm, with ca. 15 longitudinal rows of light brown to yellow scales. **Seed** not seen. (Fig. 2).

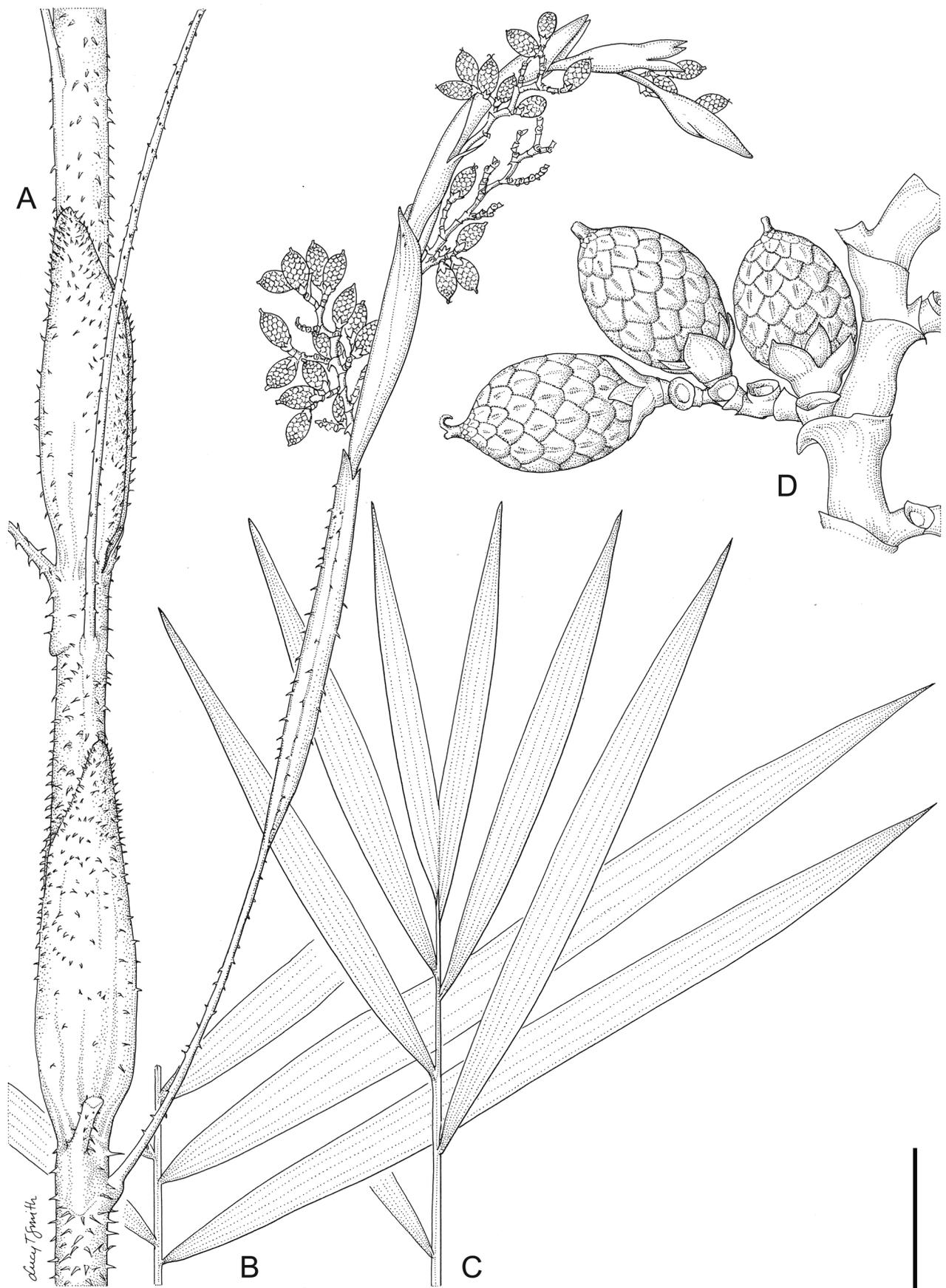


FIGURE 2. *Calamus barfodii*. A. Leaf sheath with ocreas and infructescence. B. Mid-leaf portion. C. Leaf apex. D. Fruit. Scale bar: A–C = 4 cm; D = 7 mm. A, D from Zieck NGF 36596; B, C from Barfod 464. Drawn by Lucy T. Smith.

Distribution:— Known only from three records on the south side of the Owen Stanley Range in Central Province of Papua New Guinea, 40–100 km NW of Port Moresby.

Habitat:—Lowland to lower montane rain forest from 50 to 460 m above sea level.

Uses:—None recorded.

Vernacular names:—None recorded.

Specimens examined:—PAPUA NEW GUINEA. Central Province: near Bakoiudo (above Kubuna), Kairuku Subdistrict, 460 m, 8°37'S, 146°49'E, 14 January 1972, *Zieck NGF 36320* (BRI!, L!, LAE!); Kuriva Forest Logging Area, Port Moresby Subdistrict, 50 m, 9°5'S, 147°7'E, 18 July 1979, *Zieck NGF 36596* (holotype L!, isotype LAE!); Kuriva, 300 m, 9°0'S, 147°7'E, 04 March 2000, *Barfod 464* (AAU, BRI, CANB, K!, LAE).

Notes:—*Calamus barfodii* (Fig. 2) displays a highly unusual combination of characters. It bears a well developed, inflated, persistent ocrea that clasps the stem, which resembles that displayed by *Calamus longipinna* Lauterb. & K.Schum. in Schumann & Lauterbach (1900: 203) and its relatives (Baker & Dransfield 2002a) or two species in the paired fruit group (Dransfield & Baker 2003: *C. altiscandens* Burret [1939: 196] and *C. macrochlamys* Beccari [1908: 259]). However, it bears an inflorescence unlike any found in these taxa, which is rather short, erect to arching, and bears stout, inflated bracts that split to the base by the emergence of very compact primary branching systems. In New Guinea, similar inflorescence morphology is known only in *Calamus anomalus* Burret (1935: 320), *C. essigii* Baker (2003: 720), *C. maturbongsii* Baker & Dransfield (2003: 725) and *C. nannostachys* Burret (1931: 264), none of which produce well-developed, inflated ocreas. The rachillae are also very short, bearing inconspicuous rachilla bracts and solitary rather than paired fruits. We have seen only pistillate material, but it is clear from these specimens that *C. barfodii* is one of the most distinctive of all the new species described here.

A fourth specimen (*Zieck NGF 36187* [K!, L!]) from a nearby locality close to Tapini at around 1200 m is similar to *C. barfodii*, but bears a much shorter ocrea, longer spines on the ocrea and sheath, and irregular leaflets that are bristly, rather than almost glabrous. The duplicates seen by us are sterile and cannot be identified with confidence, but the gathering may represent further morphological dimensions of this species.

This species is named for Dr. Anders S. Barfod, palm biologist at Aarhus University, Denmark, who collected one of the specimens of *C. barfodii* and has contributed greatly to our knowledge of the New Guinea palm flora.

3. *Calamus bulubabi* W.J.Baker & J.Dransf., *sp. nov.* Type:—PAPUA NEW GUINEA. Western Province: North Fly District, Tabubil-Kiunga road, 18 km SSE of Tabubil, 300 m, 5°25'7"S, 141°17'31"E, 11 December 2000, *Baker et al. 1128* (holotype K!, isotypes AAU, LAE, NY).

Diagnosis:—Distinguished by the broadly elliptic leaflets grouped in divaricate pairs, the leaf sheaths that are densely covered in fine, flexible, hair-like spines and the dense, matted, white indumentum that is often present between the spines and on other parts.

Slender to moderately robust, clustering rattan climbing to 30 m. **Stem** with sheaths 11–25 mm diam., without sheaths to 9–14 mm diam.; internodes 10–36 cm. **Leaf** ecirrate, to 78–130 cm long including petiole; sheath dark green, sometimes with thick, white, caducous, woolly indumentum of matted, fine, white and buff hairs, woolly indumentum lacking in other material, dark punctuate scales also present, densely armed with fine, flexible, brown to black, hair-like spines to 25 mm long, sometimes with indumentum as sheath; knee 26–48 mm long, 15–20 mm wide, colour and armature as sheath; ocrea not well-developed, consisting of a low crest to 5 mm high extending along adaxial surface of petiole base; flagellum present, to 2.5 m long; petiole 1–22 cm, 6–11 mm wide and 4–5 mm thick at base, shallowly channelled adaxially, rounded abaxially, indumentum as sheath, sparsely to densely armed with fine spines to 5 mm long; rachis arching, armed with reflexed grapnel spines; leaflets 10–16 each side of rachis, mainly arranged in divaricate pairs (sometimes in threes, sometimes with solitary leaflets interspersed), elliptic, cucullate, longest leaflets at base or mid-leaf position, mid-leaf leaflets 14–33 × 3.5–4.2 cm, apical leaflets 12–15 × 1–3 cm, apical leaflet pair united from half to two thirds of their length, leaflets unarmed, except for very few marginal bristles at apex and very occasional bristles on major veins of adaxial surface, leaflets sometimes glabrous, or (in forms with woolly indumentum) bearing scattered woolly indumentum and sometimes a band of woolly indumentum along adaxial surface of one leaflet margin, transverse veinlets inconspicuous, leaflets producing numerous fine fibres when cut. **Staminate inflorescence** arcuate, 1.5–2.2 m long including 15–33 cm

peduncle, lacking a flagelliform tip, branched to 3 orders (sometimes 4 orders at base); prophyll 22–28 × 1.4–2.6 cm, somewhat inflated, opening asymmetrically at apex, sometimes splitting more deeply to produce distal limb, indumentum as sheath, sparsely armed with fine spines as sheath, always subtending a primary branch; peduncular bracts absent, rachis bracts 5.5–26 × 0.3–2 cm, similar to prophyll, but usually entirely unarmed; primary branches 6–13, to 30 cm long, 8–25 cm apart, diffusely branched and sometimes recurving, with up to ca. 80 rachillae, bracts on primary branch funnel-shaped; rachillae 30–50 mm × ca. 1 mm, straight to sinuous; rachilla bracts ca. 1 × 1.2 mm, distichous, inconspicuous; floral bracteole ca. 1.5 × 1.3 mm, cup-shaped. **Staminate flowers** 3–4.2 × 2.2–2.6 mm in bud prior to anthesis; calyx 2.2–2.6 mm diam., tubular in basal 1.6–1.8 mm, with 3 lobes 1.6–2 × ca. 0.6 mm; corolla 3.8 × 4 mm in bud, tubular in basal 1.4–1.6 mm; stamens 6, filaments 1.6–2 × 0.2–0.4 mm, anthers ca. 2 × 0.6–0.7 mm; pistillode ca. 0.6 × 0.2 mm, trifid. **Pistillate inflorescence** similar to staminate inflorescence, 0.6 to at least 1.6 m long including 18–25 cm peduncle, flagelliform tip absent, branched to 2 orders (sometimes 3 orders at base); prophyll 14–26 × 0.7–1.5 cm, similar to staminate inflorescence, subtending primary branch; peduncular bracts absent, rachis bracts similar to staminate inflorescence (the inflorescence of *Dijkstra BW 6628* differs from other material in being somewhat more slender and flagellum-like inflorescence, and bearing narrower primary bracts with grapnel spines around the base, one peduncular bract and more robust rachillae; in other respects it is similar to all other material of the species); primary branches ca. 8, to 20 cm long, 6–16 cm apart, erect or recurving, with up to 17 rachillae, bracts funnel-shaped; rachillae 25–90 mm × 1.3–2 mm, more or less straight and stiff; rachilla bracts 1–2.5 × 2–2.5 mm, distichous, inconspicuous; proximal floral bracteole 2.2–2.5 diam, ca. 0.5 mm deep, distal floral bracteole 1.8–2 diam, ca. 0.5 mm deep, scar from sterile staminate flower adnate to outer surface of distal floral bracteole, rounded. **Pistillate flowers** not seen. **Sterile staminate flowers** not seen. **Fruit** spherical, ca. 13 × 13 mm including beak ca. 1 × 1 mm, with 16 longitudinal rows of brown, channeled scales. **Seed** (sarcotesta removed) 9 × 9 × 4.5 mm, discoid, concave and smoother on one side, convex and with angular sculpturing on the other side; endosperm homogeneous; embryo basal. (Fig. 3)

Distribution:—Widespread in southern New Guinea; recorded from the Timika area in Papua Province, Indonesia to Gulf Province, Papua New Guinea.

Habitat:—Occurs in a wide range of lowland primary and secondary forest habitats up to 300 m.

Uses:—Used for tying timbers in construction.

Vernacular names:—*Donggieb* (Kati), *Kurni* (Biaru), *Tipa* (Awin).

Specimens examined:—INDONESIA. Papua Province: Near Mindiptanah, 5°52'S, 140°41'E, 21 August 1957, *Dijkstra BW 6628* (AAU, CANB, L!, LAE); Timika, Campus of PT Freeport Indonesia, Kuala Kencana, walkway to clinic, 60 m, 4°24'10"S, 136°52'5"E, 9 February 1998, *Baker et al. 825* (AAU, BH, BO, K!, L, MAN); Timika, near Kuala Kencana, 50 m, 4°24'19"S, 136°50'27"E, 19 February 1998, *Dransfield et al. 7688* (BH, BO, K!, L, MAN). PAPUA NEW GUINEA. Gulf Province: Omei River, Malalaua subdistrict, 150 m, 8°3'S, 146°8'E, 16 April 1980, *Akivi & Marukumul NGF 36597* (LAE!); Malalaua, Merigem, near Kakoro/Bulldog, 75 m, 7°49'30"S, 146°29'30"E, 24 November 1972, *Zieck & Kumul NGF 36531* (K!, LAE!, L, BH); Malalaua, Omei River, near Kakoro/Bulldog, 75 m, 7°49'30"S, 146°29'30"E, 26 November 1972, *Zieck & Kumul NGF 36538* (BH, CANB, K!, L, LAE); Kerema, Murua, 18.5 km from Kerema, 10 m, 7°58'S, 145°46'E, 22 May 1989, *Poudyal et al. 82* (K!); Kikori District, bank of Kikori River near to Kopi, 13 km N of Kikori, 40 m, 7°19'16"S, 144°11'0"E, 19 November 2000, *Baker et al. 1094* (AAU, BRI, K!, LAE, NY). Western Province: North Fly District, Tabubil-Kiunga road, 18 km SSE of Tabubil, 300 m, 5°25'7"S, 141°17'31"E, 11 December 2000, *Baker et al. 1128* (holotype K!, isotypes AAU, LAE, NY).

Notes:—*Calamus bulubabi* (Fig. 3) is a widespread, though not frequently encountered rattan that is recognised by the combination of broadly elliptic leaflets grouped in divaricate pairs and “hairy” leaf sheaths that are densely covered in fine, flexible, hair-like spines. Several specimens also bear dense, matted, white indumentum between the spines and on other parts, including the leaflets, which may bear a narrow band of white indumentum along the adaxial surface of one margin. It resembles most closely *C. papuanus* Beccari (1886: 60) and *C. spiculiferus*, both of which bear somewhat similar leaves, leaflets and inflorescence morphology. However, the former is more slender and the latter more robust than *C. bulubabi*, both have a group of large leaflets at the leaf apex, whereas the leaflets of *C. bulubabi* diminish in size towards the leaf apex, both have spiny inflorescences bracts compared to the usually unarmed inflorescences of *C. bulubabi* (except for the prophyll), and neither display the typical hair-like spines. The spines are recognised in the epithet of *C. bulubabi*, which is Indonesian for pig hair.

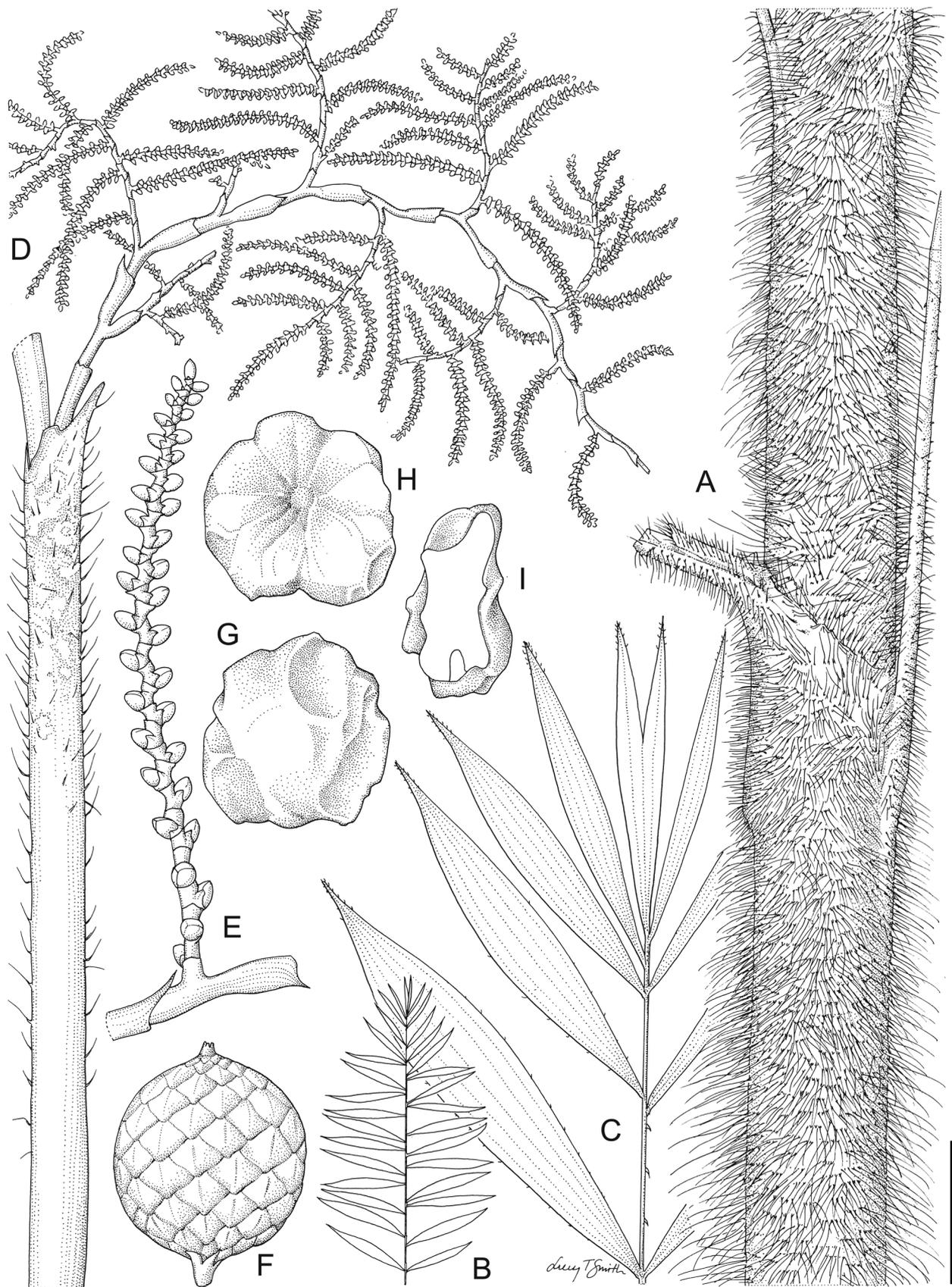


FIGURE 3. *Calamus bulubabi*. A. Leaf sheath. B. Leaf diagram. C. Leaf apex. D. Primary branch of staminate inflorescence. E. Staminate rachilla. F. Fruit. G, H. Seed in two views. I. Seed in longitudinal section. Scale bar: A = 3 cm; B = 55 cm; C = 6 cm; D = 4 cm; E, F = 1 cm; G–I = 7 mm. A–E from Baker *et al.* 1128; F–I from Baker *et al.* 1094. Drawn by Lucy T. Smith.

Some material shows close affinities to *Calamus bulubabi*, but cannot be confidently placed in the species at this time. Four specimens from 750–1300 m elevation in the Southern Highlands (*Baker et al.* 635, 655, 1121 [K!, LAE], *Zieck NGF 36258* [BH, LAE!]), all but the last sterile, resemble *C. bulubabi*, but differ in having caducous sheath spines, sometimes tough, leathery leaflets, larger apical leaflets grouped at the leaf tip and more robust rachillae. The specimens may represent a high elevation form of *C. bulubabi* or may belong to a further undescribed species. Another sterile specimen (*Rahiria & Zieck NGF 36564* [LAE!]) resembles *C. bulubabi* vegetatively, but bears low, closely spaced ridges on the stem with occasional spicules, rather than hair-like spines. This specimen was collected in northern New Guinea, whereas all other specimens come from the southern half of the island. We note that there are two gatherings labelled as *Zieck & Kumul NGF 36535* at Leiden, only one of which is *C. bulubabi*.

4. *Calamus cheirophyllus* J.Dransf. & W.J.Baker, *sp. nov.* Type:—PAPUA NEW GUINEA. Eastern Highlands Province: Kundiawa Subdistrict, Karimui, foothills of Mt. Karimui, 1280 m, 6°28'S, 144°40'E, 30 November 1972, *Zieck NGF 36515* (holotype K!, isotypes BH, L!, LAE!).

Diagnosis:—Distinguished by the slender stems, ecirrate leaves with conspicuous petiole and 7–9 leaflets crowded at the petiole tip, the leaf hence appearing almost palmate, the short, erect, eflagellate inflorescence, with few rather inflated rachis bracts and short but not condensed rachillae; resembling some forms of *C. lauterbachii*, but differing in the smaller size, the narrow leaflets with less conspicuous cross veins, the less robust, unarmed ocrea and the lax rachillae.

Slender rattan climbing to 4.5 m only, densely clustering (up to 50 stems per clump). **Stem** with sheaths 6.5–13 mm diam., without sheaths to 6 mm diam.; internodes to 11 cm. **Leaf** ecirrate, 30–50 cm long; sheath drying pale green, with abundant mid-brown indumentum, sheath spines abundant, slender, persistent, very varied in length, 1–12 × 0.5–2 mm, scattered or sometimes in horizontal groups, straw-coloured, horizontal or slightly reflexed, narrow triangular, laminar, spines around the leaf sheath mouth crowded, very slender, sometimes much larger than on the rest of the sheath and erect, to 15 mm; knee present but scarcely conspicuous, to 18 × 5 mm, drying same colour as sheath, armed as the rest of the sheath; ocrea well developed, conspicuous, 7–13 × 0.5–1 cm, papery, splitting into 2 lobes and disintegrating into a fibrous network, bearing abundant brown scales, unarmed, but sheath spines often penetrating through network; flagellum present, to 1.8 m long; petiole 9–12 cm long, 2–4 mm wide, densely armed with short straw-coloured spines on all surfaces and bearing abundant brown indumentum; rachis very short, 2–3 cm long, armed abaxially with a few recurved spines, adaxially unarmed, both surfaces densely covered with brown indumentum; leaflets 7–9 in total, arranged in a fan at the tip of the petiole, narrowly elliptic, 24–35 × 1–3 cm, unarmed apart from black bristles to 1 mm long along margins and adaxial surface of mid-vein, leaflets lacking indumentum, transverse veinlets close, sinuous, moderately conspicuous. **Staminate inflorescence** not seen. **Staminate flowers** not seen. **Pistillate inflorescence** 14–34 cm long, including peduncle 7–23 cm, branched to 2 orders; prophyll borne 5–7 cm above the base, to 7 × 0.5 cm, tubular and loosely sheathing, papery, with a truncate tip, becoming lacerate, bearing abundant brown indumentum and rarely with a few scattered straw-coloured spines, to ca. 1 mm; peduncular bracts absent; rachis bracts similar to prophyll but shorter and more inflated; primary branches 4, crowded together, 2–6 cm long, with up to 12 rachillae; rachillae crowded, ± straight, the basal the longest, to 20 × 1 mm, decreasing towards the tip of the first order branch; rachilla bracts triangular, acuminate, membranous, striate, 1.5 × 1 mm, distichous, unarmed, partially obscured by caducous pale brown indument; proximal floral bracteoles cup-shaped, ca. 1.5 mm diam., distal floral bracteoles cup-shaped, 1 × 1 mm, scar from sterile staminate ca. 0.3 mm diam. **Sterile staminate flower** only known as very young buds ca. 1.5 mm diam. **Pistillate flower** buds with calyx ca. 2 mm long, with low triangular lobes; petals ca. 2 × 1 mm; other parts very immature. **Fruit** globose, 10 × 10 mm, with a beak to 1 × 1 mm and covered with 18 vertical rows of matt pale straw-coloured scales with pale margins. Seed globose, 7.5 × 7.5 × 6.5 mm, with a longitudinal groove on one side, seed surface very shallowly grooved and dimpled, endosperm homogeneous, embryo basal. (Fig. 4)

Distribution:—Known from montane forest at Karimui, Kundiawa Subdistrict, Eastern Highlands Province and a possible record from Erave in Southern Highlands Province in Papua New Guinea.

Habitat:—Montane forest at approximately 1100–1400 m above sea level.

Uses:—None recorded.

Vernacular names:—*Tiwi* (Kojari).

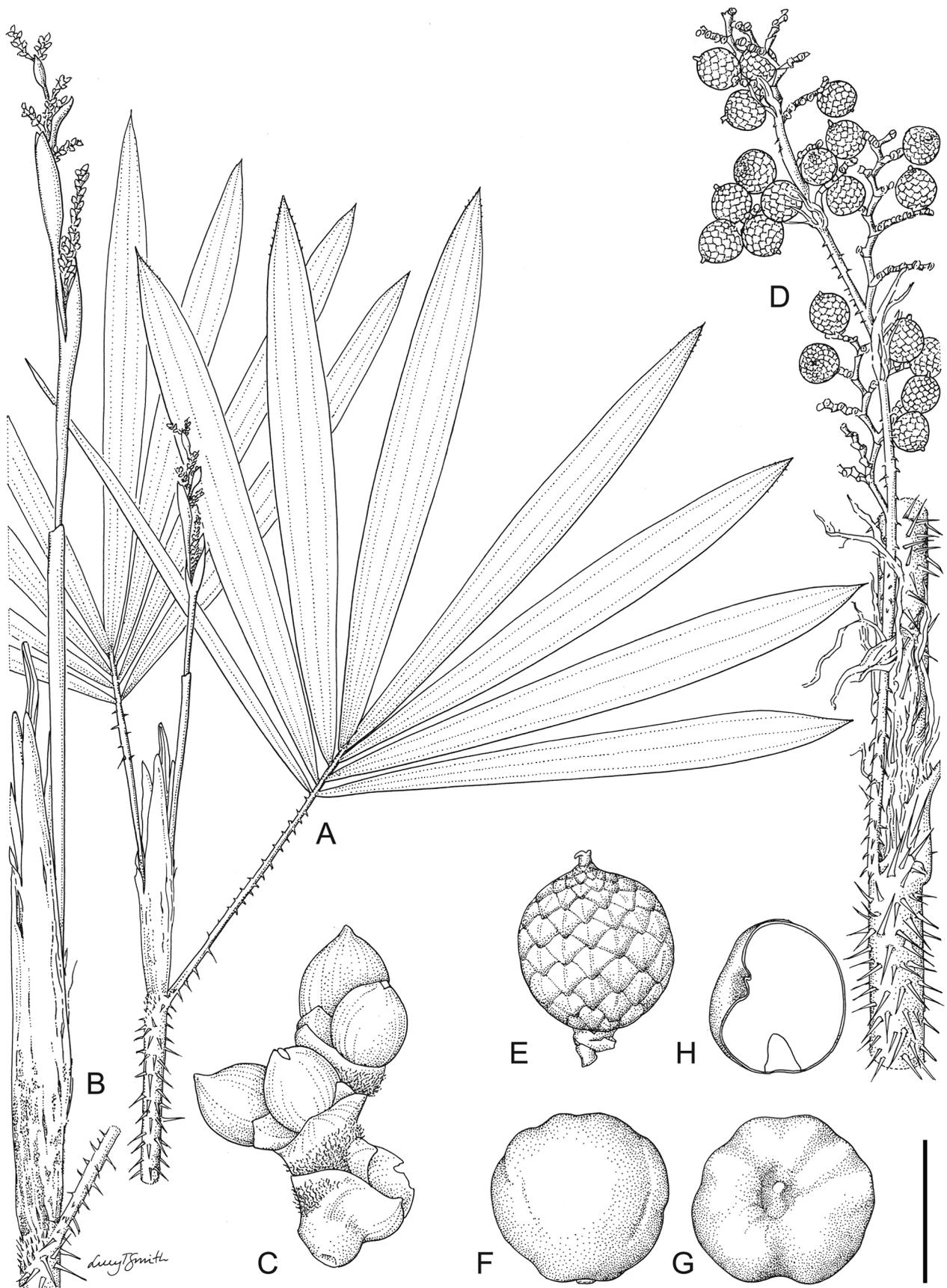


FIGURE 4. *Calamus cheirophyllus*. A. Habit, including leaf sheath, ocrea, leaf and inflorescence. B. Leaf sheath, ocrea and inflorescence. C. Portion of pistillate rachilla. D. Inflorescence attached to leaf sheath, showing tattering ocrea. E. Fruit. F, G. Seed in two views. H. Seed in longitudinal section. Scale bar: A = 6 cm; B = 2.5 cm; C = 2.5 mm; D = 3 cm; E = 1 cm; F–I = 7 mm. All from Zieck NGF 36515. Drawn by Lucy T. Smith.

Specimens examined:—PAPUA NEW GUINEA. Eastern Highlands Province: Kundiawa Subdistrict, Karimui, foothills of Mt. Karimui, 1280 m, 6°28'S, 144°40'E, 30 November 1972, *Zieck NGF 36515* (holotype K!, isotypes BH, L!, LAE!); Kundiawa Subdistrict, Karimui, lower slopes of Mt. Karimui, 1340 m, 6°28'S, 144°40'E, 30 November 1972, *Zieck NGF 36516* (BH, K!, L!); Kundiawa Subdistrict, Karimui, 1340 m, 6°28'S, 144°40'E, 30 November 1972, *Zieck NGF 36517* (BH!), *Zieck NGF 36518* (LAE!). Southern Highlands: Erave Subdistrict, Erave, 1067 m, 6°35'S, 143°55'E, 27 July 1971, *Zieck NGF 36257* (A, BH, BRI, CANB, K!, L, LAE!).

Notes:—This slender mountain rattan (Fig. 4) is most immediately recognised by the superficially palmate appearance of its leaves, in which the 7–9 pinnately arranged leaflets are crowded at the apex of a relatively long petiole. Though it bears a well-formed flagellum, the inflorescences are eflagellate and erect, measuring up to only 34 cm in length in material seen by us. The primary bracts of the inflorescence are slightly inflated and papery, tending to tatter and disintegrate. A conspicuous, unarmed, inflated ocrea to 13 cm in length that encircles the stem is also present, though, like the primary bracts, it is papery and tends to disintegrate. The species resembles *C. lauterbachii* Beccari (1908: 491; *synon. C. humboldtianus* Becc. in Gibbs [1917: 93]), but differs in its smaller stature, the narrow leaflets, with less conspicuous cross veins, the less robust, unarmed ocrea, and the laxly arranged (rather than densely congested) rachillae.

One collection (*Zieck 36257*) probably belongs to this species. It is even more slender than the other cited collections, and is said to grow into the forest canopy. It has very few spines on the sheaths and there are generally fewer leaflets. The specific epithet (Greek – hand leaf) refers to the unusual, almost palmate appearance of the leaf.

5. *Calamus croftii* J.Dransf. & W.J.Baker, *sp. nov.* Type:—PAPUA NEW GUINEA. Oro Province: Popondetta Subdistrict, Ehu, (New Kikinota), Kumusi Timber Permit Area, 50 m, 8°27'S, 148°14'E, 31 January 1973, *Zieck NGF 36542* (holotype L!, isotypes BH, CANB, K!, LAE).

Diagnosis:—Distinguished by the slender stems, sheaths lacking a well-developed ocrea and rather densely covered with horizontal spines, the leaves with irregularly arranged lanceolate leaflets and the large pointed fruit borne on short, rather lax, zigzag rachillae.

Slender rattan, climbing to 30 m or more, whether solitary or clustering not recorded. **Stem** with sheaths 10–15 mm diam., without sheaths to 6–8 mm diam.; internodes 15–31 cm. **Leaf** ecirrate, 60–75 cm long; sheath drying dull greenish brown, with abundant, caducous, woolly, pale grey indumentum, sheath spines abundant, persistent, uniformly distributed, of varying length, 3–27 × 1–2 mm, horizontal, shiny straw-coloured with black tips, often edged with woolly indumentum, spines around the leaf sheath mouth crowded, similar in form to those on the sheath; knee conspicuous, to 40 × 4 mm, drying same colour as sheath, armed as the sheath; ocrea to 10 mm long, armed as the sheath; flagellum present, 1.25 m long; petiole 10–15 cm long, 5–7 mm wide at the base, adaxially flattened, unarmed, abaxially rounded, bearing caducous white indumentum and armed as the sheath; rachis to 65 cm long, adaxially unarmed, abaxially armed with recurved hooks; leaflets 4–8 on each side of rachis, irregularly arranged, usually in 2–4 groups, but sometimes groups scarcely evident, broadly lanceolate with acute tips, longest leaflet in mid-leaf, basalmost leaflets 17–28 × 3–4.5 cm, mid-leaf leaflets 23–30 × 4.5–5.5 cm, apical leaflets 9–14 × 2–2.5 cm, apical leaflets joined for one third of their length, leaflets armed with sinuous black bristles to 3 mm long along margins near the tip, otherwise unarmed, leaflets lacking indumentum, transverse veinlets conspicuous. **Staminate inflorescence** to at least 70 cm, apparently lacking a terminal flagellum, branched to 3 orders; prophyll to 25 cm long, coriaceous, basally closely tubular, distally with an expanded triangular limb to 2.5 cm long, very sparsely armed; peduncular bracts absent; rachis bracts similar to prophyll, very sparsely armed, somewhat inflated; primary branches at least 3, to 12 cm long, with numerous rachillae; rachillae to 10–30 × 0.8 mm diam.; rachilla bracts rather distant, 2 × 1 mm, distichously arranged, not overlapping, striate, with apiculate recurved tips and scattered brown indumentum, unarmed; floral bracteole explanate, 1.2 mm wide, unarmed. **Staminate flowers** 4.5 × 2.5 mm; calyx 3 × 2.5 mm, with short triangular lobes to 1 mm high; petals 4 × 1.5 mm; stamens 3 mm long, anthers 2 × 0.3 mm. **Pistillate inflorescence** to 1 m long, including peduncle 27 cm, branched to 2 orders, apparently lacking a terminal flagellum; prophyll to 27 × 1.2 cm, sparsely armed with spines to 4 mm; peduncular bracts absent; rachis bracts similar to prophyll, to at least 21 × 0.6 cm, sparsely armed; primary branches 4, to at least 15 cm long, with up to 10 rather distant rachillae; rachillae more or less zigzag and recurved, the basal ones the longest, to 30 × 1.5 mm, rather lax, bearing up to 5 female flowers; rachilla bracts triangular, 1.5 × 2 mm,

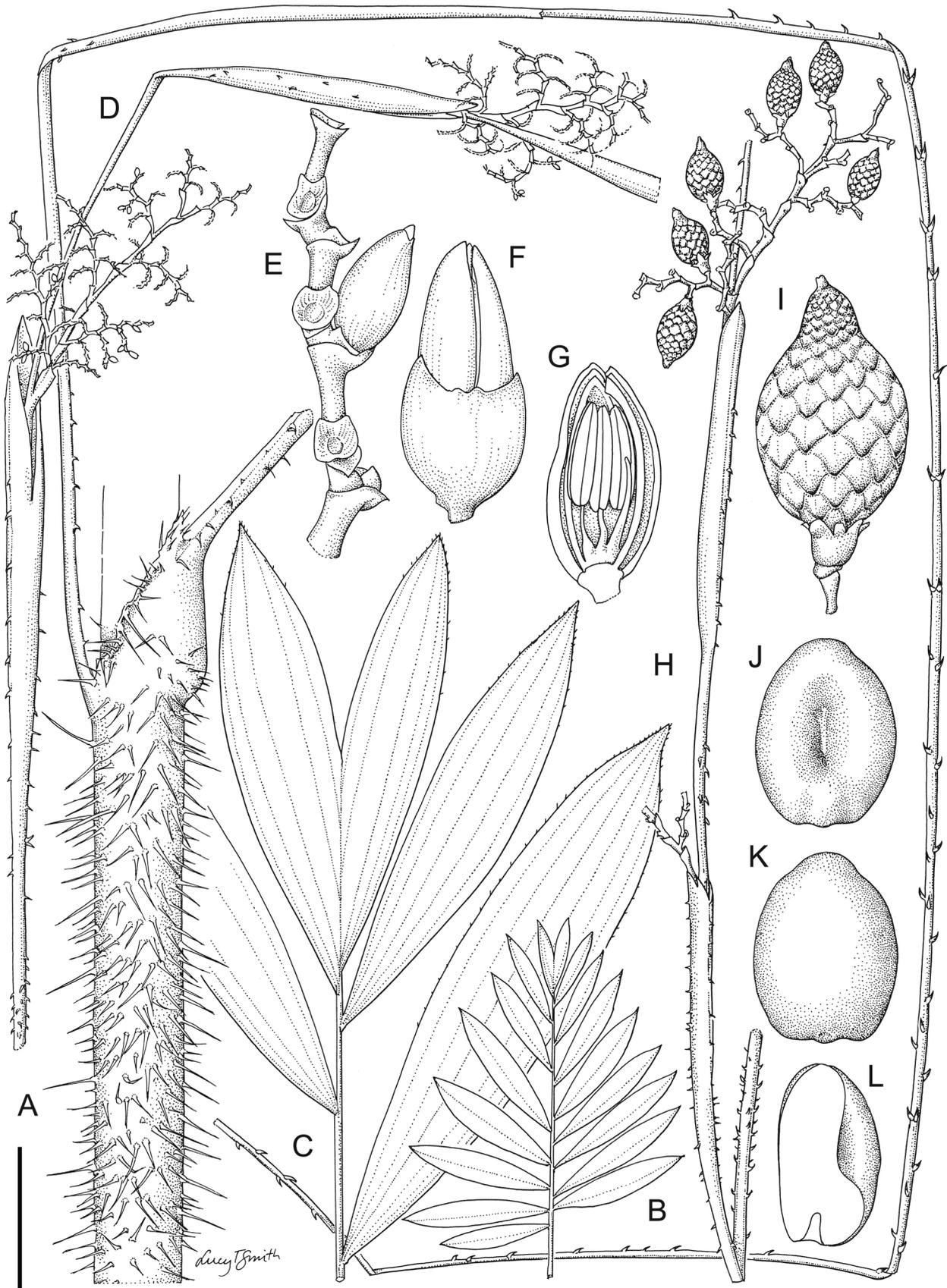


FIGURE 5. *Calamus croftii*. A. Leaf sheath with flagellum. B. Leaf diagram. C. Leaf apex. D. Portion of staminate inflorescence. F, G. Staminate flower bud whole and in longitudinal section. H. Portion of infructescence. I. Fruit. J, K. Seed in two views. L. Seed in longitudinal section. Scale bar: A = 2.5 cm; B = 25 cm; C = 4 cm; D, H = 6 cm; E = 3.3 mm, F = 2.2 cm; G = 2 mm; I = 1.5 cm; J–L = 1 cm. All from Croft & Lelean LAE 68504. Drawn by Lucy T. Smith.

distichous, not overlapping, with short triangular tips, unarmed, bearing scattered brown indument; proximal floral bracteoles explanate, ca. 2 mm diam, distal floral bracteoles explanate, ca. 1.5 mm high, scar from sterile staminate minute, 0.1 mm diam. **Sterile staminate flower** not known. **Pistillate flowers** not known. **Fruit** pyriform, pointed, 23 × 13 mm, with a beak to 1.5 × 1.5 mm, and with ca. 16 vertical rows of mid-brown scales with darker margins. **Seed** 13 × 8 × 7 mm, with a very deep groove on one side, seed surface smooth, endosperm homogeneous, embryo basal. (Fig. 5)

Distribution:—Known from lowland forest in Morobe and Oro Provinces, Papua New Guinea.

Habitat:—Lowland forest up to about 150 m above sea level.

Uses:—None recorded.

Vernacular Names:—None recorded.

Specimens examined:—PAPUA NEW GUINEA. Morobe Province: Natter Bay logging area, 93 miles SE of Lae, 150 m, 7°31'S, 147°21'E, 26 July 1976, *Croft & Lelean LAE 68504* (LAE!). Oro Province: Popondetta Subdistrict, Ehu, (New Kikinota), Kumusi Timber Permit Area, 50 m, 8°27'S, 148°14'E, 31 January 1973, *Zieck NGF 36542* (holotype L!, isotypes BH, CANB, K!, LAE).

Notes:—This poorly known rattan (Fig. 5), recorded from only two localities, is recognised by its slender stems, leaf sheaths that are rather densely covered with horizontal, triangular spines, ecirrate leaves with irregularly arranged lanceolate leaflets and, most conspicuously, by the large pointed fruit widely spaced on short, zigzag rachillae. It most closely resembles *C. lucysmithiae*, but this species bears a well-developed, divergent ocrea and much smaller fruit that are densely crowded on strongly recurving rachillae.

This rattan is named for Jim Croft, currently of the Australian National Herbarium and prolific collector of many plants during his 15 years stationed at the Papua New Guinea National Herbarium.

6. *Calamus johnsii* W.J.Baker & J.Dransf., *sp. nov.* Type:—Type: PAPUA NEW GUINEA. Milne Bay Province: Normanby Island, East Sewa Bay, 10°0'10"S, 150°59'25"E, 07 April 2008, *Johns 11279* (holotype K!, isotypes BRIT!, L, LAE, SING, UPNG).

Diagnosis:—Distinguished by its slender stem, the sheaths with fine, scattered black spines with somewhat swollen bases, the ecirrate leaves with petiole very short or absent and few, irregularly arranged, broadly elliptic leaflets with very conspicuous cross veins, by the inflorescences with few, small first order branches and relatively robust primary bracts and by the relatively large fruit.

Slender, clustering rattan climbing to 20 m. **Stem** with sheaths 4.5–20 mm diam., without sheaths 3.5–7 mm diam.; internodes to 23 cm. **Leaf** ecirrate, to ca. 75 cm long; sheath drying pale green, with thin sparse pale grey indumentum, sheath spines sparse to abundant (rarely absent), slender, persistent, rather uniform, 2–25 × 1–2 mm, scattered or sometimes in horizontal groups of 2–3, shiny black with conspicuously swollen pale green bases, horizontal or slightly reflexed, very narrow triangular, laminar, spines sometimes crowded around the leaf sheath mouth, very slender, some bristle-like; knee conspicuous, to 36 × 13 mm, drying same colour as sheath, ± unarmed or sparsely armed as the rest of the sheath; ocrea scarcely developed; flagellum present, up to at least 1.1 m long; petiole very short or absent (rarely up to 4.2 cm long), 2–3.5 mm wide and 2.5–5 mm thick at base, flat adaxially, rounded abaxially; rachis to 50 cm long, variously armed with spines similar to leaf sheath, abaxially armed with recurved hooks; leaflets 5–7 on each side of rachis, irregularly arranged, but scarcely in well defined groups, or rarely arranged in two widely spaced groups (in Sudest Island form), the basalmost pair swept back across the stem, broadly elliptic (or more narrowly so in Sudest Island form), longest leaflet in mid-leaf, basalmost leaflets 10–34 × 0.7–7 cm, mid-leaf leaflets 15–41 × 1.5–8 cm, apical leaflets 11–38 × 1–6.5 cm, apical leaflets joined for one fifth to half their length, leaflets unarmed apart from very short sparse black bristles to 2 mm long along margins near the leaflet tips, leaflets lacking indumentum, longitudinal veins 5–7, very conspicuous, transverse veinlets close, sinuous, very conspicuous. **Staminate inflorescence** branched to 3 orders, up to ca. 1.6 m, including peduncle to ca. 16 cm, with a terminal flagellum to 45 cm; prophyll 14–16 × 0.4–0.6 cm; peduncular bracts absent; rachis bracts to 39 × 0.8 cm with entire triangular tip and bearing scattered reflexed spines to 3 mm with swollen bases; primary branches up to 5, rather distant, to 21 cm long, the branching system ± triangular in outline, with numerous rachillae; rachillae straight to somewhat recurving, longest towards base, to 20 × 1 mm, distalmost to 3 × 1 mm; rachilla bracts 0.5 × 0.6 mm, distichously arranged, striate, with apiculate tips and scattered brown

indumentum, unarmed; floral bracteole cuplike, 0.6×1 mm, unarmed. **Staminate flowers** 3×1 mm; calyx 2.5×1 mm, with triangular lobes to 0.5×0.5 mm; petals 2×0.7 mm, narrow pointed; stamens to 1.5 mm, anthers ca. 0.8×0.2 mm. **Pistillate inflorescence** to 1.7 m long, including peduncle to 88 cm, similar to staminate inflorescence, branched to 2 orders; prophyll to 44×0.7 cm, tubular and closely sheathing, similar to staminate inflorescence, with a triangular lobe, sometimes bearing sparse pale brown indumentum and rather densely armed with short black spines, mostly to ca. 1 mm, but occasionally to 8 mm, with conspicuous swollen bases; peduncular bracts absent; rachis bracts similar to staminate inflorescence; primary branches 2–3, 10–18 cm long, with up to 22 rachillae; rachillae arcuate, the basal the longest, to 5×0.2 cm, decreasing towards the tip of the first order branch; rachilla bracts triangular, 2×2 mm, distichous, unarmed, bearing scattered brown indumentum; proximal floral bracteoles explanate, ca. 1.5 mm diam., distal floral bracteoles cup-shaped, 0.5×1 mm, scar from sterile staminate ca. 0.3×0.1 mm diam. **Sterile staminate flower** not seen. **Pistillate flowers** not seen. **Fruit** broadly ellipsoid, $12\text{--}20 \times 10\text{--}14$ mm, with a beak to 1×1.5 mm and covered with ca. 17 vertical rows of matt pale brown scales with darker margins. Seed $10\text{--}12 \times 7.5\text{--}9.5 \times 6\text{--}7$ mm, with a longitudinal groove on one side, seed surface mostly smooth, endosperm homogeneous, embryo basal. (Fig. 6)

Distribution:—Known from scattered coastal locations in Morobe Province from Lae southwards and in Milne Bay province from Sudest and Normanby Islands, and adjacent areas of mainland.

Habitat:—Lowland primary and secondary forest from sea level to 350 m.

Uses:—None recorded.

Vernacular names:—*Jeje* (Dzjedrje).

Specimens examined:—PAPUA NEW GUINEA. Milne Bay Province: Alotau Subdistrict, near Yane Yanene Village, 30 m, $10^{\circ}17'S$, $150^{\circ}19'E$, 14 August 1974, *Zieck NGF 36567* (BH, BRI!, CANB, L!, LAE, L!); Alotau Subdistrict, 2 km NE of Kaporika village, 200 m, $10^{\circ}20'S$, $150^{\circ}25'E$, 11 May 1978, *Essig & Young LAE 74089* (BH!, LAE!); Tagula Subdistrict, Lysalys Village, 6 m, $11^{\circ}30'S$, $153^{\circ}30'E$, 08 April 1978, *Zieck NGF 36590* (BH, BRI!, L!, LAE!); Normanby Island, Waikaiuna, 20 m, $10^{\circ}4'S$, $150^{\circ}58'E$, 13 April 1956, *Brass 25397* (K!, L!, LAE!); Normanby Island, Waikaiuna, Inland half mile from coast, $10^{\circ}4'S$, $150^{\circ}58'E$, 18 April 1956, *Womersley & Brass NGF 8604* (LAE!, BRI!); Normanby Island, Sewa Bay, 3 m, $10^{\circ}0'S$, $151^{\circ}0'E$, 21 October 1971, *Essig LAE 55061* (BH, CANB, K!, L!, LAE!); Normanby Island, E Sewa Bay, $10^{\circ}0'10"S$, $150^{\circ}59'25"E$, 07 April 2008, *Johns 11279* (holotype K!, isotypes BRIT!, L, LAE, SING, UPNG). Sudest Island, Mt. Riu, west slopes, 350 m, $11^{\circ}31'S$, $153^{\circ}25'E$, 25 August 1956, *Brass 27857* (K!, L!, LAE!); Sudest Island, Yawata River, Rambuso, 5 m, $11^{\circ}29'S$, $153^{\circ}33'E$, 31 January 2009, *Johns & Maru 12839* (BRIT, K!, L, LAE, UPNG). Morobe Province: Buso River, Lae Subdistrict, 2 m, $7^{\circ}25'S$, $147^{\circ}10'E$, 28 April 1972, *Streimann NGF 24479* (BH, LAE!); SE of Lae, opposite Lasanga Island, 0 m, $7^{\circ}25'S$, $147^{\circ}10'E$, 24 November 1973, *Jacobs 9698* (L!, LAE); Morobe, $7^{\circ}45'S$, $147^{\circ}37'E$, 21 January 1948, *Womersley NGF 3153* (BRI!, K!, CANB!); Lae, Speedway, $6^{\circ}42'52"S$, $147^{\circ}01'40"E$, 24 April 2008, *Simaga 9743* (BRIT, K!, L, LAE, UPNG).

Notes:—This relatively widespread rattan (Fig. 6) is distinguished by its slender stem, sheaths with fine, scattered black spines with somewhat swollen bases, by its ecirrate leaves with the petiole very short or absent and few, irregularly arranged, broadly elliptic leaflets with very conspicuous cross veins, and by the inflorescences with few, small first order branches and relatively robust primary bracts. The fruits are also distinctive in being among the largest in New Guinea *Calamus* species and being covered in scales that are usually pale with darker margins. Although the species is morphologically coherent, we note some regional differentiation. The specimens from Morobe are more robust, especially in leaf and inflorescence size, whereas the Sudest Island form is the most slender and bears narrower leaflets in two widely spaced groups. Nevertheless, intermediates exist among the specimens seen by us and taxonomic recognition of these variants cannot be supported.

Calamus johnsii displays superficial vegetative similarities to *C. anomalus*, *C. lucysmithiae*, *C. nannostachys* and *C. oresbius*. *Calamus anomalus* and *C. nannostachys* differ in their unique inflorescence morphology in which the primary bracts are split at or to the base by the emerging primary branches. *Calamus lucysmithiae* is distinct in several ways, including its well developed, divergent ocrea and its pistillate flowers and fruit being sometimes borne on pedicelliform stalks. *Calamus oresbius* is a palm of much higher elevations (700–2200 m) and is easily distinguished by its very fine flagelliform inflorescence.

This species is named for our friend and colleague Prof. Robert (Bob) Johns, collector of the type specimen, in recognition of his many contributions to botanical knowledge of New Guinea during his long career in Papua New Guinea and at the Royal Botanic Gardens, Kew.

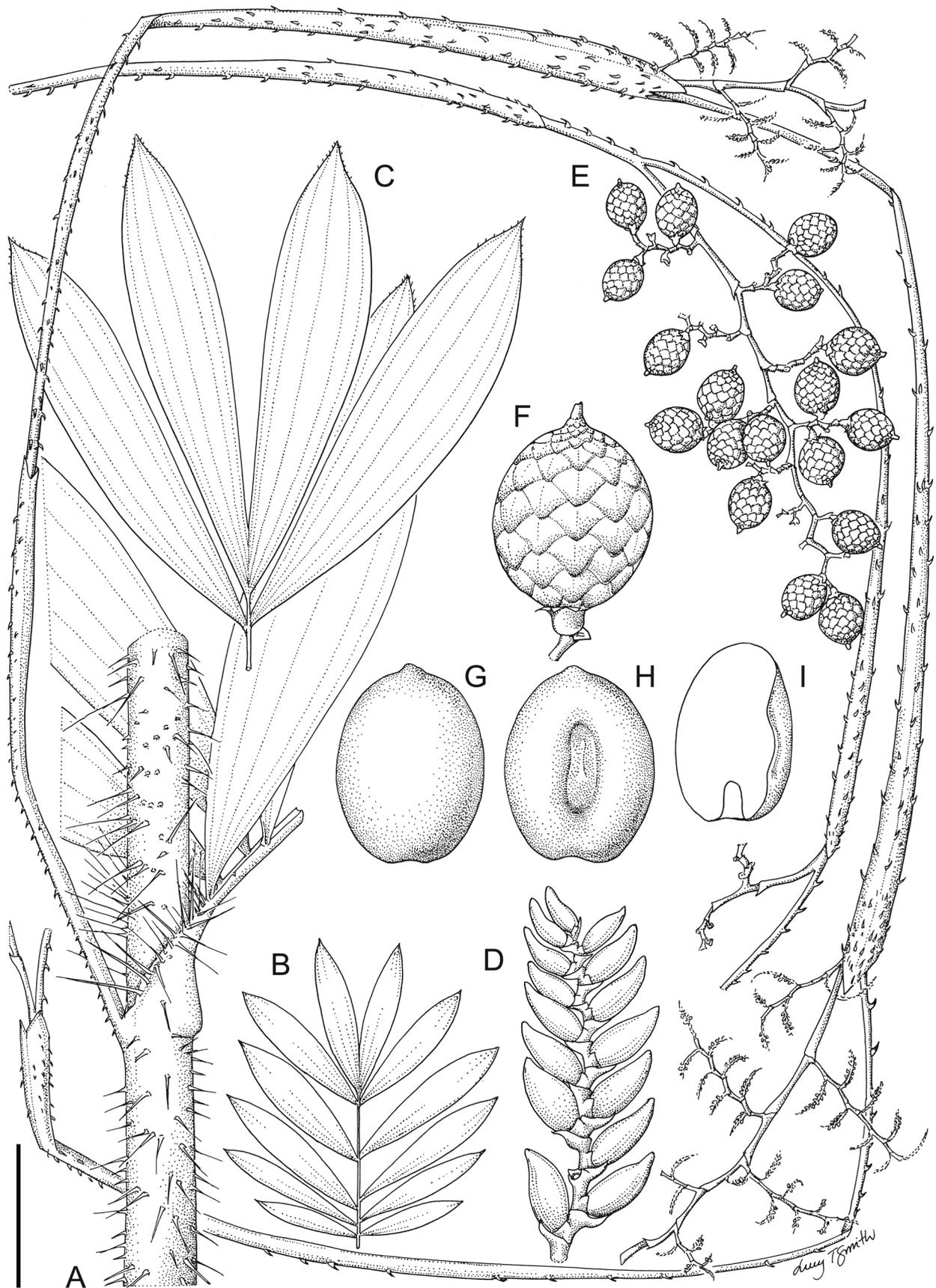


FIGURE 6. *Calamus johnsii*. A. Leaf sheath with basal leaflets and staminate inflorescence. B. Leaf diagram. C. Leaf apex. D. Staminate rachilla. E. Portion of infructescence. F. Fruit. G, H. Seed in two views. I. Seed in longitudinal section. Scale bar: A = 3 cm; B = 25 cm; C = 6 cm; D = 3.3 cm; E = 4 cm; F = 1 cm; G–I = 7 mm. A–D from *Essig LAE 55061*; E–I from *Brass 25397*. Drawn by Lucy T. Smith.

7. *Calamus lucysmithiae* W.J.Baker & J.Dransf., *sp. nov.* Type:—PAPUA NEW GUINEA. Central Province: Port Moresby sub-district, Hegore village near Kanosia plantation, 0 m, 8°59'S, 146°58'E, 12 July 1973, Zieck NGF 36555 (holotype L!, isotypes A, BH, BRI, CANB, LAE!).

Diagnosis:—Distinguished by its short, but well-developed, divergent ocrea, the widely spaced, broadly elliptic leaflets and the long, trailing inflorescence with strongly recurving rachillae and pistillate flowers sometimes borne on pedicel-like stalks.

Slender rattan climbing to 30 m. Stem with sheaths 6–11 mm diam., without sheaths to 4–8 mm diam. **Leaf** ecirrate, to 45–80 m long including petiole; sheath glaucous green to reddish brown, with scattered to dense, thin indumentum of fine brown and translucent scales, moderately armed with scattered, stiff, dark, needle-like spines, spines 1–13 mm long, scattered indumentum as sheath; knee 15–24 mm long, 4–10 mm wide, colour as sheath, unarmed or lightly armed as sheath; ocrea 20–48 × 4–10 mm, divergent, triangular with edges inrolled, stiff, brown, unarmed or densely armed as sheath, especially at apex, persistent; flagellum 120–200 cm; petiole 3–50 mm, 2–3 mm wide and 3–5 thick at base, flattened adaxially, rounded abaxially, scattered indumentum as sheath, with scattered grapnel spines; rachis 33–61 cm, armed as petiole; leaflets 6–8 each side of rachis, regularly to subregularly arranged, rather widely spaced especially at tip, broadly elliptic, longest leaflets at mid-leaf position, mid-leaf leaflets 14–24 × 3.5–4.5 cm, apical leaflets 7–13 × 0.6–2 cm, apical leaflet pair not united or united up to half their length, leaflets unarmed except for minute, scattered marginal bristles, glabrous except for occasional scattered indumentum along veins, transverse veinlets relatively inconspicuous. **Staminate inflorescence** not seen. **Staminate flowers** not seen. **Pistillate inflorescence** trailing, 170–230 cm long including 24–36 cm peduncle and 35–120 cm flagelliform tip, branched to 2–3 orders; prophyll 25–34 × 0.4–1 cm, strictly tubular, opening symmetrically or asymmetrically at apex, sometimes with further secondary splitting, with dense to scattered indumentum as sheath, unarmed or with scattered grapnel spines; peduncular bracts absent, rachis bracts similar to prophyll; primary branches 3–7, to 27 cm long, 20–40 cm apart, erect to strongly recurving, somewhat congested in some specimens, unarmed, with up to 30 rachillae, bracts on primary branch narrow and strictly tubular, with abundant, detachable marginal hairs, widely spaced to 18–30 mm; rachillae 5–70 mm × 0.5–1.2 mm, strongly recurving; rachilla bracts 1–2.5 × 1.4–1.6 mm, subdistichous, with scattered to dense indumentum as sheath, detachable hairs present on margin; proximal floral bracteole 0.5–2 × 1–2 mm, pedicelliform, narrowly funnel-shaped, distal floral bracteole 0.5 × 1.5–2 mm, saucer-shaped, scar from sterile staminate adnate to abaxial surface of distal floral bracteole. **Pistillate flowers** not seen. **Sterile staminate flowers** not seen. **Fruit** ellipsoid, ca. 14.5 × 10 mm including beak to 2 mm, with 14 longitudinal rows of pale scales with brown margins. **Seed** (sarcotesta removed) ca. 8 × 6.5 × 5.5 mm, ellipsoid with with a shallow pit on one side, seed surface smooth; endosperm homogeneous; embryo basal. (Fig. 7)

Distribution:—Known from three localities along the southern coast of SE Papua New Guinea in Central Province and its border with Gulf Province.

Habitat:—Rain forest from sea level to 90 m, on hills, valleys and at the edge of mangroves.

Uses:—None recorded

Vernacular names:—*Eraharo* (Toaripi)

Specimens examined:—PAPUA NEW GUINEA. Central Province: ca. 12 km N of Amazon Bay, 90 m, 10°11'S, 149°23'E, 13 June 1969, Pullen 7573 (CANB!); Port Moresby sub-district, Hegore village near Kanosia plantation, 0 m, 8°59'S, 146°58'E, 12 July 1973, Zieck NGF 36554 (A, BH, BISH, BRI!, CANB, ED, K!, L!, LAE, MUN, QRS, SYD, US), Zieck NGF 36555 (holotype L!, isotypes A, BH, BRI, CANB, LAE!). Gulf Province: Malalaua sub-district, Iokea, 50 m, 8°35'S, 146°18'E, 20 November 1974, Rahiria & Zieck NGF 36576 (LAE!), Rahiria & Zieck 36577 (A, CANB!, BH, LAE!).

Notes:—*Calamus lucysmithiae* (Fig. 7) is a lowland rattan of south-eastern New Guinea. It is easily distinguished by its short, but well-developed, divergent ocrea, its leaf with widely spaced, broadly elliptic leaflets and its long, trailing inflorescence with strongly recurving rachillae with pistillate flowers sometimes borne on pedicel-like stalks (comprising bracteole and floral axis). It is superficially similar to *C. croftii* and *C. johnsii* in leaf and sheath morphology, but neither of these bears a conspicuous ocrea or stalked pistillate flowers.

This species is named for Lucy T. Smith, botanical artist resident at the Royal Botanic Gardens, Kew, who has executed outstanding line illustrations of the majority of species of New Guinea palm, including the plates used in this article.

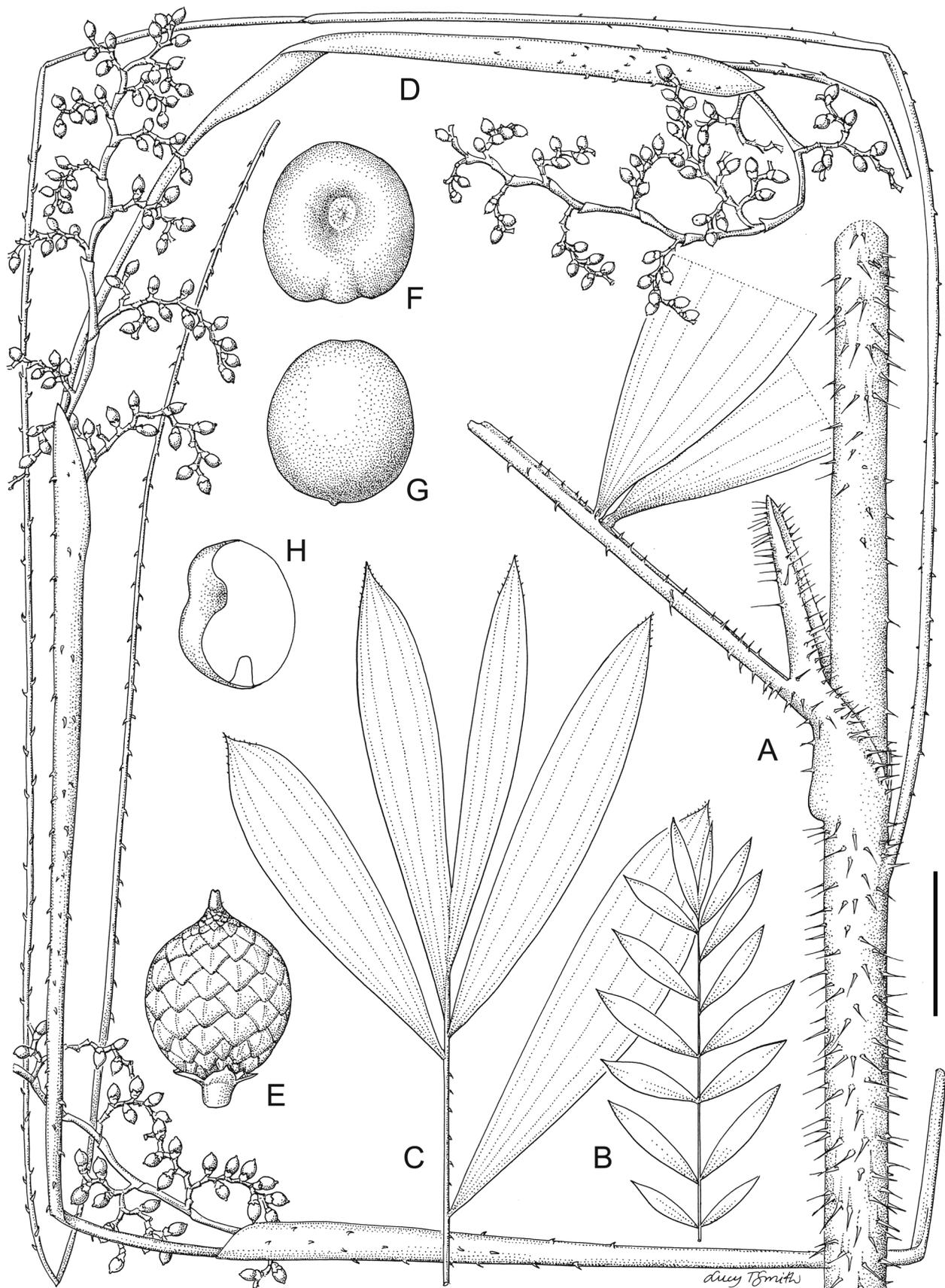


FIGURE 7. *Calamus lucysmithiae*. A. Leaf sheath with ocrea and flagellum. B. Leaf diagram. C. Leaf apex. D. Portion of infructescence. E. Fruit. F, G. Seed in two views. H. Seed in longitudinal section. Scale bar: A = 3 cm; B = 20 cm; C = 6 cm; D = 3 cm; E = 1 cm; F–I = 7 mm. A, E–I from *Rahiria & Zieck NGF 36577*; B, C from *Rahiria & Zieck NGF 36576*; D from *Zieck NGF 36555*. Drawn by Lucy T. Smith.

8. *Calamus nanduensis* W.J.Baker & J.Dransf., *sp. nov.* Type:—PAPUA NEW GUINEA. Morobe Province: Finschhafen District, Banario Mountain, near Nanduo village, 28 km NW of Finschhafen, 1200 m, 6°25'56"S, 147°40'3"E, 06 December 2000, *Banka et al. 2010* (holotype K!, isotypes AAU!, LAE!, NY!).

Diagnosis:—Distinguished by its robust, clustering habit, the sheath with fine, easily dislodged spines and dense, grey or brown indumentum, a well-developed, fragile ocrea, and the long inflorescence with conspicuous funnel-shaped bracts on primary branches and pistillate rachillae (staminate material not seen).

Robust, clustering rattan climbing to 20 m. **Stem** with sheaths 14–35 mm diam., without sheaths to 9–20 mm diam., cut stems exuding white sap, internodes 6–17 cm. **Leaf** ecirrate, to 72–118 m long including petiole; sheaths dull to dark green, with dense, grey to brown indumentum (rusty orange on young sheaths) composed of matted, minute, dark brown and white, fibrous scales, indumentum completely covering surfaces of young sheaths, becoming patchy on older sheaths, armed with numerous, very fine, needle-like, sinuous, grey-brown, solitary, dry spines to 4 mm long, spines readily detached, leaving residual spine base, some spines erect and adpressed to sheath, spines bearing some indumentum as sheath, cut sheath exuding pink to purple sap; knee 30–65 mm long, 16–25 mm wide, colour and indumentum as sheath, more or less unarmed; ocrea 10–20 cm, ligule-like or splitting into auricles, well developed adjacent to petiole, not developed opposite the petiole, papery, brown, unarmed, fragile, soon disintegrating; flagellum 1.8–3 m; petiole 12–16 cm, 0.8–1.1 × 0.4–0.5 cm at base, flat or shallowly channelled adaxially, rounded abaxially, patchy indumentum as sheath, moderately armed with short, straight spines adaxially and on margins, armed with robust grapnels abaxially, cut petiole exuding pink to purple sap; rachis 50–90 cm, somewhat arching, largely unarmed adaxially, armed with robust grapnels abaxially, scattered indumentum as sheath; leaflets 21–29 each side of rachis, regularly arranged, narrowly elliptic or linear-lanceolate, glossy, longest leaflet near to base 31–54 × 2–2.5 cm, mid-leaf leaflets 29–45 × 2–2.8 cm, apical leaflets 8.5–12 × 0.5–0.7 cm, apical leaflet pair united to one fifth of their length or not united, leaflet armed with few marginal spines, widely spaced brown or black bristles to 5 mm on adaxial surface of major veins, unarmed abaxially, with scattered indumentum as rachis and petiole at base and on veins, transverse veinlets moderately conspicuous. **Staminate inflorescence** not seen. **Staminate flowers** not seen. **Pistillate inflorescence** pendulous, ca. 5.2 m long including ca. 0.6 m peduncle and ca. 2.3 m flagelliform tip, branched to 2 orders; prophyll not seen; peduncular bracts not seen, rachis bracts to ca. 34 × 1.2 cm, tubular, opening asymmetrically at apex to form acute triangular limb, splitting secondarily at apex by ca. 2 cm, with patchy indumentum as sheath, armed with scattered, robust grapnel spines; primary branches 7, to ca. 40 cm long, to ca. 45 cm apart, stiff, arching, with up to ca. 31 rachillae, bearing conspicuous, inflated, funnel-shaped bracts to ca. 17 × 8 mm; rachillae 60–120 mm × 4 mm, stiff, recurving; rachilla bracts ca. 4 × 5 mm, distichous, funnel-shaped; proximal floral bracteole ca. 4 × 2.5 mm, distal floral bracteole ca. 2 × 2.7 mm, scar from sterile staminate flower elliptic. **Pistillate flowers** ca. 5 × 2.2–2.3 mm at anthesis; calyx 2.2–2.3 mm diam., tubular in basal 3.5–3.8 mm, with 3 lobes to 0.8–1 × 1.3–1.4 mm; corolla 4 × 1.6–1.7 mm, tubular in basal 2.5–3 mm, with 3 lobes to ca. 0.8 × 0.8 mm; staminodes 6, 1.1–1.3 mm long, staminodal ring 1.3–1.5 mm high; ovary ca. 1.5 × 1.3 mm, globose, style 0.6–1 mm long, stigmas 0.8–1.2 mm long, erect, recurving at tips. **Sterile staminate flowers** not seen. **Fruit** not seen. **Seed** not seen. (Fig. 8)

Distribution:—Known from two adjacent localities along the road to Pindiu in the foothills of the Saruwaged Range, NW of Finschhafen.

Habitat:—Primary and secondary montane fores, 1100–1200 m.

Uses:—None recorded.

Vernacular Names:—*Kobing* (Kotte).

Specimens examined:—PAPUA NEW GUINEA. Morobe Province: Pindiu, Finschhafen-Pindiu road, 1100 m, 6°36'S, 147°51'E, 19 February 1996, *Baker et al. 678* (K!, LAE!); Finschhafen District, Banario Mountain, near Nanduo village, 28 km NW of Finschhafen, 1200 m, 6°25'56"S, 147°40'3"E, 06 December 2000, *Banka et al. 2010* (holotype K!, isotypes AAU!, LAE!, NY!)

Notes:—*Calamus nanduensis* (Fig. 8) is distinguished by its robust, clustering habit, sheaths with numerous, very fine, easily dislodged spines and dense, grey or brown indumentum (also present on other organs), a well-developed, but fragile ocrea, and its long inflorescence with conspicuous funnel-shaped bracts on primary branches and pistillate rachillae (staminate material has not been seen). In its inflorescence morphology and the presence of an ocrea, it bears some resemblance to some members of the paired fruit group (Dransfield & Baker 2003), especially *C. pholidostachys* Dransfield & Baker (2003: 381), though *C. nanduensis* does not bear paired fruit. The



FIGURE 8. *Calamus nanduensis*. A. Leaf sheath with ocrea. B. Leaf apex. C. Portion of pistillate inflorescence. D. Pistillate rachilla with immature fruit. Scale bar: A = 3 cm; B, C = 4 cm; D = 7 mm. From *Banka et al. 2010*. Drawn by Lucy T. Smith.

presence of funnel-shaped bracts is also shared with *C. sashae* though the inflorescence of this species is more robust. The sheath armature *C. sashae* and *C. pholidostachys* is entirely different to that of *C. nanduensis*, being very robust and borne in partial collars rather than needle-like and solitary.

The presence of a well-developed ocrea and funnel-shaped rachilla bracts is also shared with *C. pseudozebrinus* Burret (1935: 319) and *C. womersleyi*. Like *C. nanduensis*, *C. pseudozebrinus* bears fine, needle-like and readily detached spines, although they are arranged in collars, rather than solitary. The inflorescence of *C. pseudozebrinus* is robust, but the primary branching systems are relatively short, the largest being around half the length of *C. nanduensis* with much smaller rachilla bracts. *Calamus womersleyi* is a smaller rattan overall, distinct in this group on account of its smaller leaf with irregularly arranged leaflets, short, truncate, strictly sheathing ocrea, and its more slender inflorescence and primary branching systems.

The epithet refers to Nanduo village near the type locality in recognition of the warm welcome and support that the villagers provided the first author and his colleagues during the field trip on which the type material was collected.

9. *Calamus oresbius* W.J.Baker & J.Dransf., *sp. nov.* Type:—PAPUA NEW GUINEA. Southern Highlands Province: Erave District, side of road to Gobe oil rigs, 91 km NW of Kikori, 1000 m, 6°46'46"S, 143°43'59"E, 27 November 2000, *Baker et al.* 1122 (holotype K!, isotypes AAU!, BRI!, L!, LAE!, NY!).

Diagnosis:—Distinguished by its slender, flagellate stems, the short leaves with 3–6 pairs of broad, elliptic or oblanceolate, leathery leaflets, which are usually arranged in two widely spaced groups, and by the narrow, flagelliform inflorescence with fine rachillae.

Slender, clustering rattan climbing to 25 m, though more frequently to ca. 10 m. **Stem** with sheaths 4–18 mm diam., without sheaths to 3–8 mm diam.; internodes 8–22 cm. **Leaf** ecirrate, 16–54 cm long including petiole; sheath dull green to yellow-green, with sparse to moderately abundant, thin, grey-brown indumentum comprising brown linear scales and, in some specimens, translucent, amorphous scales, sparsely to densely armed with fine, needle-like, grey to brown spines 0.5–15 mm long (spines minute and erect in Southern Highlands and Western Province forms), sometimes with concentration of longer spines near sheath mouth to 48 mm; knee ca. 7–20 mm long, ca. 4–9 mm wide, unarmed or armed as sheath; ocrea 2–5 mm high, forming a persistent, closely sheathing, dry crest, brown, unarmed or armed as sheath; flagellum 0.3–2 m long (vestigial flagellum ca. 10 cm in very slender forms), armed with recurved grapnel spines; petiole 0.5–12 cm long, 1.5–3.5 × 1.5–3.5 mm at base, flat or shallowly channelled adaxially, rounded abaxially, indumentum and armature as sheath; rachis 5–22 cm, straight, indumentum and armature as sheath; 3–5 (rarely 6) leaflets each side of rachis, typically clustered at leaf apex with 1–2 pairs at base, sometimes with additional leaflets at mid-leaf position or more rarely clustered in a single group at the leaf apex, elliptic to oblanceolate, sometimes cucullate, leathery, basal leaflets 9–32 × 1–4.5 cm, spreading or somewhat recurved across stem, longest leaflets at leaf apex 11–36 × 2.5–4.5 cm, apical leaflet pair united from one fifth to half their length, leaflet with scattered bristles on margin, especially near tip, otherwise glabrous except for indumentum as rachis at base, transverse veinlets conspicuous and closely spaced. **Staminate inflorescence** flagelliform, pendulous or trailing, 1–2 m long including ca. 20–100 cm peduncle and ca. 5–20 cm flagelliform tip (much smaller in *Hartley 13102*, an atypical diminutive form), inflorescence to 40 cm with 7.5 cm peduncle), branched to 2 or sometimes 3 orders, third order of branching occurring only in the lowermost branches of the basal primary branching system; prophyll 19–26 × 0.2–0.4 cm, strictly tubular and tightly sheathing, indumentum as sheath, armed as flagellum; peduncular bracts 0–3, peduncular and rachis bracts similar to prophyll; primary branches 2–8, to 54 cm long, 9–38 cm apart, pendulous, with up to ca. 40 rachillae; rachillae 5.5–45 mm × 1 mm, slender, straight to sinuous; rachilla bracts 1.5 × 1.8–2 mm, distichous, funnel-shaped, glabrous; floral bracteole 0.5 × 0.5 mm, cup-shaped, glabrous. **Staminate flowers** 2.5–4 × 1.2–1.5 mm in bud prior to anthesis; calyx 1.2–1.5 mm diam., tubular in basal 0.7–1.3 mm, with 3 lobes 0.7–1 × ca. 1 mm, glabrous or with scattered, brown, linear scales; corolla 2.2–3.5 × 1.2–1.3 mm in bud, tubular in basal 0.6–0.7 mm, indumentum as calyx; stamens 6, filaments 1–1.3 × 0.2–0.3 mm, anthers 1.2–1.5 × 0.3–0.4 mm; pistillode 0.3 × 0.3 mm, trifid. **Pistillate inflorescence** similar to staminate inflorescence, but branched to 2 orders; primary branches 1–3, to 6–40 cm long, 14–21 cm apart, pendulous, with up to 12 rachillae; rachillae 10–48 mm × 1–1.5 mm, straight to sinuous; rachilla bracts 0.8–1 × 2–2.5 mm, subdistichous, funnel-shaped, glabrous or with scattered, brown scales; proximal floral bracteole 1.4–1.5 × ca. 2.2 mm, distal floral bracteole ca. 1 × 1.3–1.7 mm, scar from sterile staminate round,

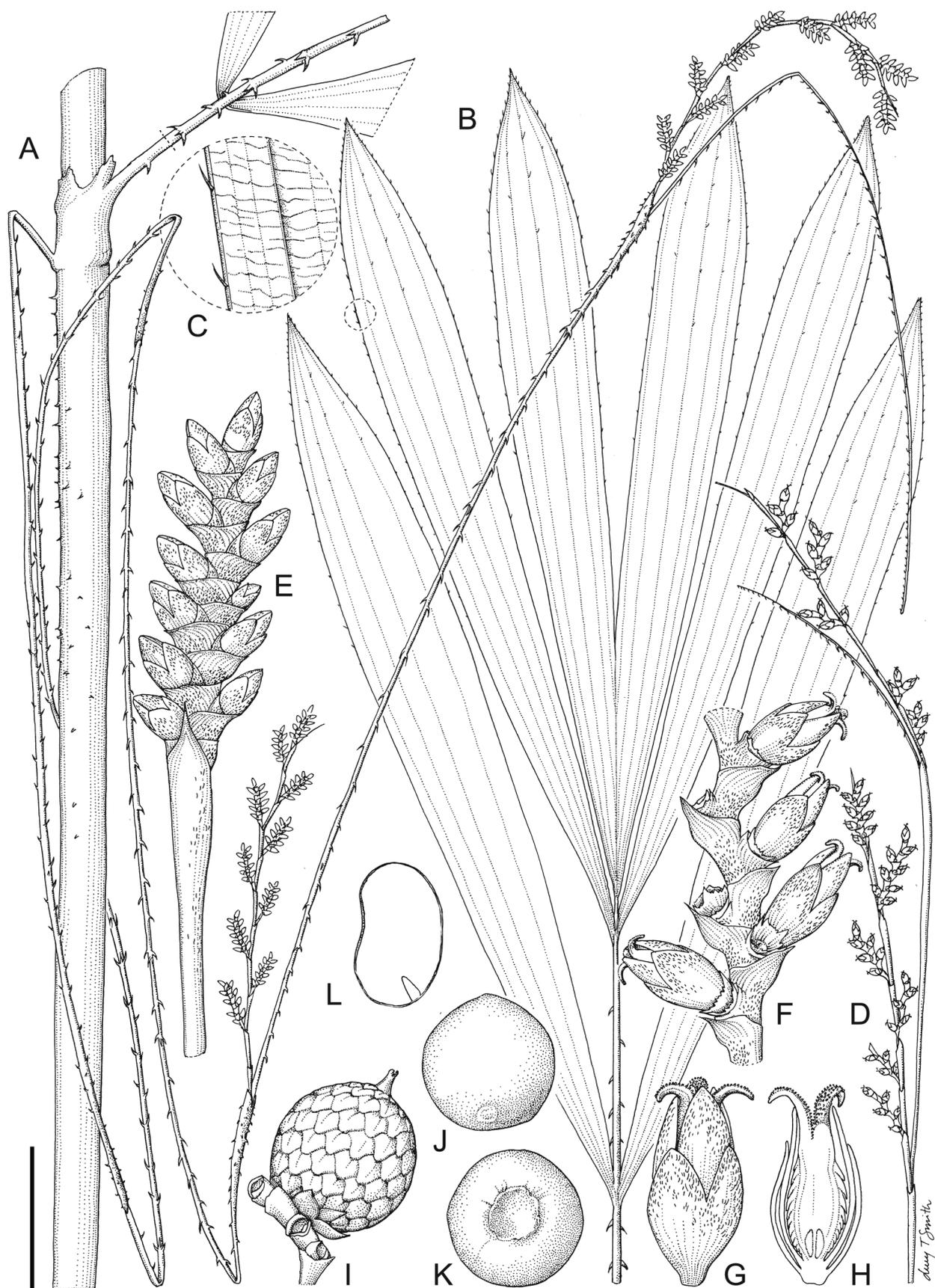


FIGURE 9. *Calamus oresbius*. A. Leaf sheath with staminate inflorescence. B. Whole leaf. C. Leaflet detail showing transverse veinlets. D. Portion of pistillate inflorescence. E. Staminate rachilla. F. Portion of pistillate rachilla. G, H. Pistillate flower whole and in longitudinal section. I. Fruit. J, K. Seed in two views. L. Seed in longitudinal section. Scale bar: A, D = 3 cm; B = 6 cm; C = 1 cm; E, F = 5 mm; G, H = 3 mm, I = 1 cm; J–L = 7 mm. A–C, E from Baker *et al.* 627; D, F–H from Baker *et al.* 609; I–L from Baker *et al.* 624. Drawn by Lucy T. Smith.

minute, with scattered, brown scales. **Pistillate flowers** ca. 4 × 2.5 mm at anthesis; calyx ca. 2.5 mm diam., tubular in basal ca. 1.8 mm, with 3 lobes to ca. 1.3 × 1.6 mm, with scattered, brown, linear scales; corolla ca. 3.5 × 2 mm, tubular in basal ca. 2.5 mm, with 3 lobes to 2 × 1.6 mm, indumentum as calyx; staminodes 6, ca. 0.5 mm long, staminodal ring ca. 1.7 mm high; ovary ca. 1.5 × 1.5 mm, globose, style ca. 1 mm long, stigmas 1.5 mm long, strongly recurved. **Sterile staminate flowers** 2.3 × 1.5 mm in bud, similar to staminate flower, but with empty anthers. **Fruit** globose, ca. 10–18 × 8–14 mm including beak ca. 2 × 1 mm, with 17–21 longitudinal rows of yellow to orange scales with brown margins. **Seed** (sarcotesta removed) 6–12 × 6–11 × 4.5–8 mm, globose, seed surface smooth, with a deep, lateral depression; endosperm homogeneous; embryo sub-basal. (Fig. 9)

Distribution:—Widespread in the central highlands of Papua New Guinea, though not yet recorded from the easternmost mountains of Oro or Central Province.

Habitat:—Montane rain forest from 700 to 2200 m, including secondary forest. Also cultivated in some areas.

Vernacular names:—*Ep* (Mendi), *Karrikaribu* (Koijari), *Kral* (Bolin), *Kurnin* (Biaru), *Waiang* (Bolin, Ganja, Narak, Nondugl, Noltubi), *Waiangl* (Kuman), *Waiink* (Bolin), *Wajam* (Yoowi; *Wajamumum* for fruits), *Wi-kiral* (Sinasina).

Uses:—Weaving baskets, armbands, waistbands and finer rattan work. Used as a long-lasting binding in fence- and house-building.

Specimens examined:—PAPUA NEW GUINEA. Simbu Province: Gandigl, Simbu Valley, 2200 m, 5°53'S, 145°4'E, 16 May 1975, *Sterly 75-122* (L!); Kundiawa, Bolin Village (Simasina), 1675 m, 6°1'S, 144°58'E, 04 December 1972, *Zieck NGF 36520* (BH, K!, LAE!); Near Kerowagi, Kundiawa Sub-district, 1525 m, 5°50'S, 144°50'E, 4 December 1972, *Zieck NGF 36522* (LAE, L!, BH). Eastern Highlands Province: About five miles NE of Okapa, 1524 m, 6°28'S, 145°40'E, 24 September 1964, *Hartley 13102* (A, L!, CANB!); Keglsugl, Kundiawa Sub-district, 2135 m, 5°50'S, 145°6'E, 3 December 1972, *Zieck NGF 36521* (BH, LAE!); Sinasina, Kundiawa subdist., 1840 m, 6°7'S, 145°0'E, 06 June 1972, *Hide. 108* (LAE!). Morobe Province: 10 km NE of Wau, 1550 m, 7°18'S, 146°47'E, 2 November 1977, *Pratt 77-1003* (LAE!); Kaigan, West of Biaru Valley, Wau subdist., 2195 m, 7°39'S, 146°45'E, 23 June 1969, *Zieck NGF 36223* (L!, LAE!); Mt. Missim, Wau area, 1800 m, 7°13'S, 146°49'E, 25 February 1986, *van Valkenburg 459* (L!); Road halfway to Yamap, Wau Sub-district, 1500 m, 7°8'S, 146°47'E, August 1969, *Kairo NGF 44077* (BH, BRI, CANB, L, LAE!); Wau, Mt. Missim, Kuper Range, 1250 m, 7°13'0"S, 146°49'0"E, 12 August 1985, *Wada et al. 60* (BRI, KYO, LAE!, U); Wau-Salamau Track 13 km NE of Wau, 1700 m, 7°19'S, 146°48'E, 31 October 1982, *Streimann 8670* (LAE!). Southern Highlands Province: Between the Kagua and Wiru roads, ca. 2 miles S of Ialibu patrol post, 2042 m, 6°17'S, 143°59'E, 15 July 1961, *Pullen 2745* (CANB!); Ca. 6 miles W of Kagua patrol post near Wasuma, 1524 m, 6°26'S, 143°48'E, 26 July 1961, *Pullen 2804* (CANB!, LAE!); Mt Bosavi, Wasaso, near Bona village, WWF Integrated Conservation and Development Project Area, 700 m, 6°26'S, 142°47'E, 2 February 1996, *Baker et al. 609* (K!, LAE!); Mt Bosavi, near Bona Village, WWF Integrated Conservation and Development Project Area, 750 m, 6°26'S, 142°47'E, 3 February 1996, *Baker et al. 624* (K!, L, LAE!), *Baker 627* (K!, L, LAE!); Mt Bosavi, northern side, 1250 m, 6°26'S, 142°50'E, 25 September 1973, *Jacobs 8782* (L!); Mt Bosavi, northern side, near the mission station, 700 m, 6°26'S, 142°50'E, 04 October 1973, *Jacobs 8982* (L!); Erave District, side of road to Gobe oil rigs, 91 km NW of Kikori, 1000 m, 6°46'46"S, 143°43'59"E, 27 November 2000, *Baker et al. 1120* (AAU!, BRI!, LAE!, K!, NY!), *Baker et al. 1122* (holotype K!, isotypes AAU!, BRI!, L!, LAE!, NY!); Erave, 1067 m, 6°35'S, 143°55'E, 27 July 1971, *Zieck NGF 36259* (BH, CANB!, BRI!, L, LAE). Near Ebenda, Anga Village, 1920 m, 6°13'S, 143°42'E, 25 July 1961, *Schodde 1600* (A, CANB! L, LAE). Western Highlands Province: 2 miles E of Tabibuga Airstrip, Mt Hagen Sub-district, 1219 m, 5°36'S, 144°42'E, 25 January 1969, *Hainsworth 90* (LAE!); Kubor Range, Nona-Minj Divide, Uinba, 1950 m, 5°54'S, 144°41'E, 7 September 1963, *Vink 16507* (A, K!, L!); Mt slope named Andem, Nondugl, Banz Sub-district, 1829 m, 5°50'S, 144°45'E, 30 July 1971, *Zieck NGF 36254* (BH, L!, LAE!); Noltubi, NE of Melip Village, Minj District, 1900 m, 5°54'S, 144°41'E, 23 February 1981, *Vinas 3946* (L, LAE!, UPNG); Nondugl, Kaming Village, Banz Sub-District, 1829 m, 5°50'S, 144°45'E, 30 July 1971, *Zieck NGF 36253* (BH, BRI!, CANB, L!, LAE!); Nondugl, Minj subdist, 1981 m, 5°50'S, 144°45'E, 16 February 1965, *Millar NGF 23852* (BH, L!, LAE). Western Province: North Fly District, road from Tabubil to Ok Tedi copper mine, 8.5 km N of Tabubil, ca. 2 km NW of Finalbin, 1000 m, 5°12'31"S, 141°10'42"E, 12 December 2000, *Baker et al. 1131* (AAU!, K!, LAE!, NY!).

Notes:—It is remarkable that this widespread and apparently rather useful rattan has not been described previously. *Calamus oresbius* (Fig. 9) is a variable, yet distinctive, slender, flagellate species that is characterised by its short leaves (up to ca. 54 cm long) with 3-6 pairs of leaflets, which, in most forms, are arranged in two

widely spaced groups, one clustered at the apex and one or two pairs grouped at the base. The leaflets are broadly elliptic to oblanceolate and leathery, the apical pair being fused for one fifth to half their length. Its inflorescence is narrow and flagelliform, with fine rachillae, and is branched to two orders (or scarcely to three orders in some staminate material). There is some variation in leaflet arrangement, leaf sheath armature and overall stature, with some apparent differentiation into regional forms, though these are not recognised taxonomically here.

Calamus oresbius might be confused with *Calamus johnsii*, which occurs at much lower elevation and is easily distinguished by its relatively robust inflorescence, or *Calamus anomalus*, which is similar in stature and leaflet arrangement, but has unique inflorescence morphology. “*Oresbius*” is an infrequently used epithet meaning “mountain-dwelling” (Stearn 1992).

10. *Calamus retroflexus* J.Dransf. & W.J.Baker, *sp. nov.* Type:—INDONESIA. Papua Province: Timika, upstream from end of road to Kali Kopi river from mile 38, 95 m, 4°25'43"S, 136°57'7"E, 24 February 1998, *Dransfield et al.* JD 7723 (holotype K!, isotypes BH!, BO!, L!, MAN!).

Diagnosis:—Distinguished from all other species in New Guinea by the ecirrate leaves with strongly grouped narrow lanceolate to linear leaflets, the leaflets of the most proximal group on each side of the rachis swept back across the sheathed stem, forming a chamber in which ants frequently make their nests; inflorescences long, flagellate, with distant primary branches and lax rachillae.

Medium-sized clustering rattan climbing to 30 m. **Stem** with sheaths 18–21 mm diam., without sheaths to 6–15 mm diam.; internodes 23–40 cm. **Leaf** ecirrate, to 60–150 cm long; sheath mid-green, drying pale green or pale brown, with thin sparse pale brown indumentum, sheath spines slender, persistent, usually abundant, usually rather uniform, 4–40 × 1–2 mm, with only slightly swollen bases, solitary, pale green, drying yellowish, horizontal, very narrow triangular, laminar, often larger spines interspersed with smaller spines; knee inconspicuous, scarcely swollen, to 27 × 16 mm, drying same colour as sheath, armed as the rest of the sheath; ocrea scarcely developed; flagellum present, 1.5–2 m long; petiole absent; rachis to 60–110 cm long, basally armed abaxially with slender spines as on the leaf sheath, adaxially armed with abundant erect spines, distally armed with recurved hooks; leaflets 23–30 on each side of rachis, arranged in 4–8 distant groups, crowded within the groups, those of the basalmost pair swept back across the stem, forming a chamber occupied by ants (?always), linear or very narrow lanceolate, longest leaflet in mid-leaf, basalmost leaflets to 5.5 × 0.6 cm, distalmost leaflets of basal group 20–28 × 1.8–3.5 cm, mid-leaf leaflets 21–31 × 1.5–3 cm, apical leaflets 9–10 × 1–1.2 cm, apical leaflets not joined, leaflets armed with short, dark, pale based spinules to 1 mm long, along 3 veins adaxially, margins, and midrib abaxially usually conspicuously so, but sometimes very inconspicuous, leaflets lacking indumentum, transverse veinlets conspicuous. **Staminate inflorescence** branched to 3 orders, to 80–250 cm long including the peduncle 63 cm long; prophyll to 21 × 1 cm, closely sheathing, splitting neatly at its tip, with a triangular lobe, covered with thin brown indumentum, unarmed; peduncular bracts absent; rachis bracts to 36 cm long with entire or lacerate tip and bearing scattered reflexed spines to 1.5 mm with swollen bases and scattered dark brown scales; primary branches up to 12, to at least 60 cm long, ca. 35–40 cm apart, with numerous rachillae; rachillae 4–24 × 2 mm; rachilla bracts 1 × 1.5 mm, distichously arranged, cup-shaped, with scattered dark brown scales, unarmed; floral bracteole 1.3 × 1.3 mm, triangular, unarmed. **Staminate flowers** not seen. **Pistillate inflorescence** to 4 m long, including peduncle to 2.5 m, branched to 2 orders; prophyll to 70 × 0.9 cm, tubular and closely sheathing, with a triangular lobe, bearing sparse brown indumentum and very sparsely armed with pale marginal spines to 8 mm; peduncular bracts 3, similar to prophyll, but more densely armed; rachis bracts similar to peduncular bracts; primary branches 3, to 90 cm long, with up to 22 rachillae; rachillae 5.5–10 × 0.25 cm; rachilla bracts triangular, 2 × 2 mm, distichous, very sparsely armed, and bearing scattered dark brown scales; proximal floral bracteoles 2 × 1 mm, distal floral bracteoles cup-shaped, 1 × 1 mm, scar from sterile staminate ca. 0.2 mm diam., borne on a cushion 1 mm diam. **Sterile staminate flower** not seen. **Pistillate flowers** not seen. **Fruit** (reconstructed from empty pericarp) globose, ca. 10 × 10 mm with ca. 22 vertical rows of pale brown scales with darker margins. Seed not seen. (Fig. 10)

Distribution:—Scattered across New Guinea from Raja Ampat Islands to Gulf Province, Papua New Guinea, with a concentration of records in the Bird’s Head Peninsula.

Habitat:—Lowland forest at altitudes up to 640 m above sea level.

Uses:—Used for cordage and thatching.

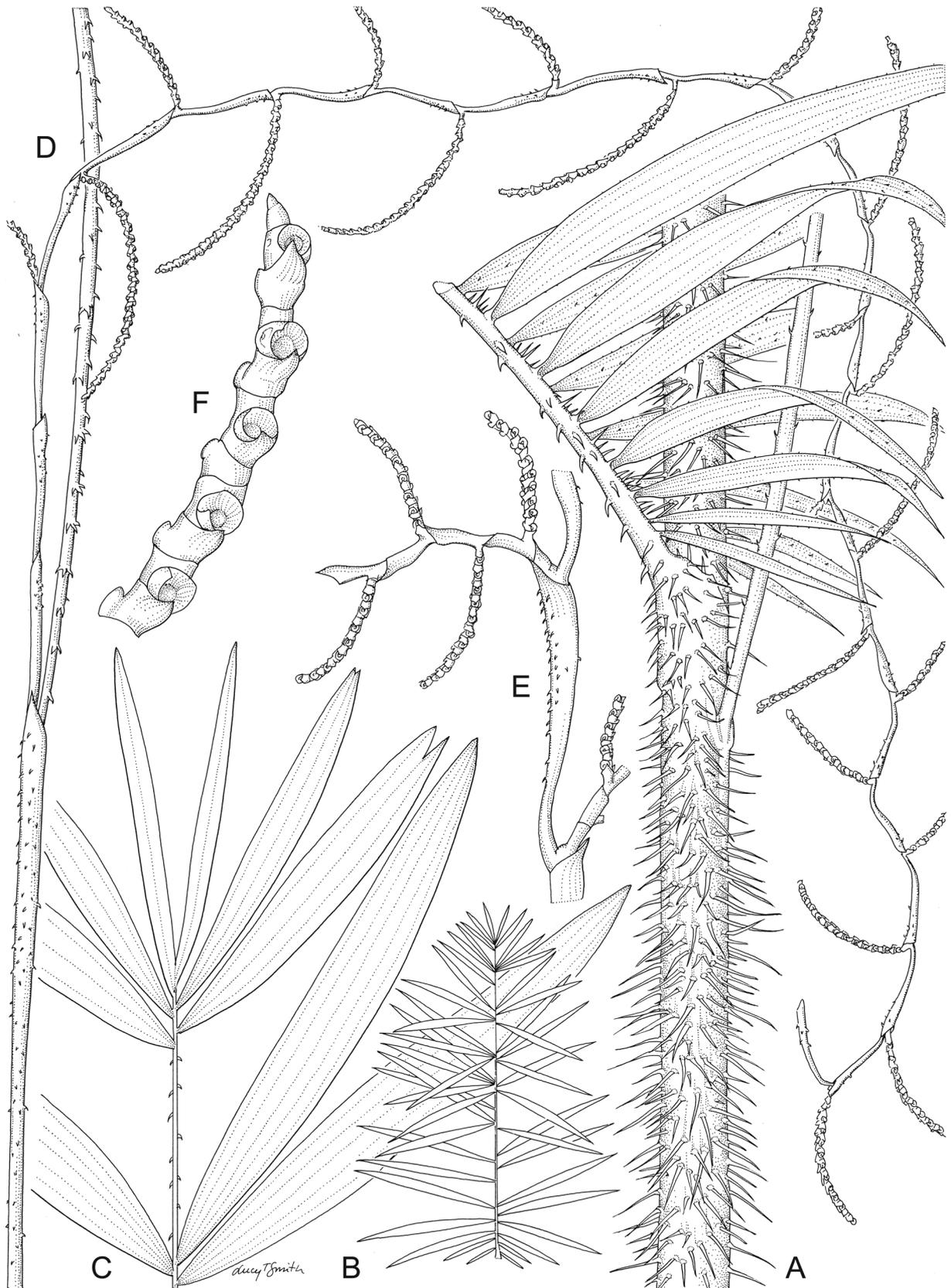


FIGURE 10. *Calamus retroflexus*. A. Leaf sheath with basal leaflets. B. Leaf diagram. C. Leaf apex. D. Primary branch of pistillate inflorescence. E. Portion of staminate inflorescence primary branch with rachillae. F. Pistillate rachilla. Scale bar: A, C = 4 cm; B = 30 cm; D = 6 cm; E = 1.5 cm; F = 7 mm. A, D, F from *Dransfield et al. JD 7723*; B, C, E from *Maturbongs et al. 651*. Drawn by Lucy T. Smith.

Vernacular Names:—*Are* (Sayal), *Sinsin* (Merigem).

Specimens examined:—INDONESIA. Papua Province: Timika, 95 m, 4°45'S, 136°32'E, 11 July 1995, *Maturbongs 191* (K!, MAN); Timika, between Ajkwa and Otomona Rivers, on road Timika to Mile 38, 30 m, 4°26'22"S, 136°54'27"E, 10 February 1998, *Dransfield et al. JD 7662* (BH!, BO!, K!, L!, MAN!); Timika, upstream from end of road to Kali Kopi river from mile 38, 95 m, 4°25'43"S, 136°57'7"E, 24 February 1998, *Dransfield et al. JD 7721* (BH!, BO!, K!, L!, MAN!), *Dransfield et al. JD 7723* (holotype K!, isotypes BH!, BO!, L!, MAN!). West Papua Province: Sorong, Klasaman, km 14, 60 m, 0°55'S, 131°22'E, 15 September 1995, *Maturbongs 276* (K!, MAN), 16 September 1995, *Maturbongs 279* (K!, MAN); Sorong, Makbalim Village, Aimas, 25 m, 1°4'S, 131°24'E, 01 July 1997, *Maturbongs 543* (K!, MAN), *Maturbongs 545* (K!, MAN); Kota Sorong, Klasaman, 20 m, 0°55'37", 131°20'7.3E, 2 February 2013, *Baker et al. 1396* (BO!, K!, MAN!); Sorong Selatan, Sayal, Maampow, 10 m, 21 February 2003, *Heatubun et al. 417* (BO, K!, MAN); Wasior, Senderawoi Village, 26 February 2000, *Maturbongs et al. 651* (AAU, BRI, K!, L, MAN); Kecamatan Ayfat, Ayawasi, 450 m, 1°9'S, 132°29'E, 14 February 1995, *Yumte 198* (L!); Merdey Subdistrict, 640 m, 1°35'S, 133°20'E, 01 August 1998, *Wally 834* (BO, K!, MAN); Fak-Fak District, Yumur Village, Buama river, km 45 of logging road of PT. Kaltim Hutuma, 50 m, 01 February 2001, *Maturbongs et al. 668* (BO, K!, LAE, MAN). PAPUA NEW GUINEA. Sandaun Province: Bewani, lowland, 0 m, 3°1'S, 141°8'E, 19 March 2000, *Barfod 489* (AAU, BRI, CANB, K!, LAE). Gulf: Malalaua Subdistrict, Merigem, near Kakoro-Bulldog, 60 m, 7°49'30"S, 146°29'30"E, 24 November 1972, *Zieck & Kumul NGF 36532* (BH, CANB, K!, L, LAE!).

Notes:—This rattan (Fig. 10) is easily distinguished by its ecirrate leaves with strongly grouped narrow leaflets, the basalmost of which are swept back across the stem (hence the specific epithet), forming a chamber in which ants make nests. The leaf bears a striking resemblance to *C. laevigatus* Mart. ex Walpers (1852: 489), a widespread species in western Malesia. However, this latter species is cirrate and eflagellate (rather than ecirrate and flagellate) and belongs to an entirely different group of *Calamus* (section *Phyllanthectus* Furtado [1956: 81] rather than section *Calamus* [synon. section *Coleospathus* Furtado 1956: 157]).

Calamus retroflexus is unlikely to be confused with other species in New Guinea. However, there are several specimens in the herbarium that are less typical of the species that we have illustrated here and we are not entirely sure of their identity. A series of collections made by Wanda Avé from limestone at Ayawasih on the western end of the Bird's Head Peninsula share features with *Calamus retroflexus*. Most of the collections, however, are sterile and are very much more slender than typical *C. retroflexus* (Avé 4166, 4168, 4169, 4170, 4171, 4172, 4176, 4341). Two of the collections are fertile (Avé 4221 – dead staminate flowers, and Avé 4341 – fruiting). In size these two collections approach typical *C. retroflexus*, but they differ in having highly condensed leaves and crowded leaflets, the whole specimens having the appearance of being from a montane habitat, yet these were collected on limestone at relatively low elevation (450 m). We are sure that the slender sterile collections are conspecific with these two fertile collections, but this suggests that juvenile stems are much more slender than adults, a situation not unknown in rattans, but certainly unusual. We have observed similar possible dimorphism at Klasaman, near Sorong in lowland *C. retroflexus*. More field work is required to substantiate our inferences. Currently, we include Wanda Avé's collections tentatively in *C. retroflexus*.

A further collection, *Heatubun 137*, from Waigeo Island in the Raja Ampat group is reminiscent of *C. retroflexus*, but the stems are very slender, the sheath armature is sparse and composed of short black-tipped spines unlike typical *Calamus retroflexus*. Without fertile material we are unable to identify this with certainty.

11. *Calamus sashae* J.Dransf. & W.J.Baker, *sp. nov.* Type:—INDONESIA. West Papua Province: Manokwari Regency, Warmare, valley of River Prafi, new road to Manyambo, 400 m, 0°47'S, 133°58'E, 25 August 1995, *Dransfield et al. JD 7601* (holotype K!, isotypes BO!, FTG!, MAN!)

Diagnosis:—Distinguished by its robust habit, ecirrate leaves with regularly arranged rather narrow leaflets, the sheaths armed with large, scattered or grouped spines, the knee unarmed, and the very robust pistillate inflorescence with few, very distant partial inflorescences, rachillae with widely funnel-shaped, almost overlapping dark bracts and solitary fruit.

Robust solitary or clustering rattan climbing to 20 m. **Stem** with sheaths 27–35 mm diam., without sheaths to 15–19 mm diam.; internodes up to 37 cm. **Leaf** ecirrate, to 2.5 m long; sheath mid-green, drying pale brown, with dense mid-brown indumentum, sheath spines robust, persistent, abundant, usually rather uniform, 20–40 × 3–5 mm,

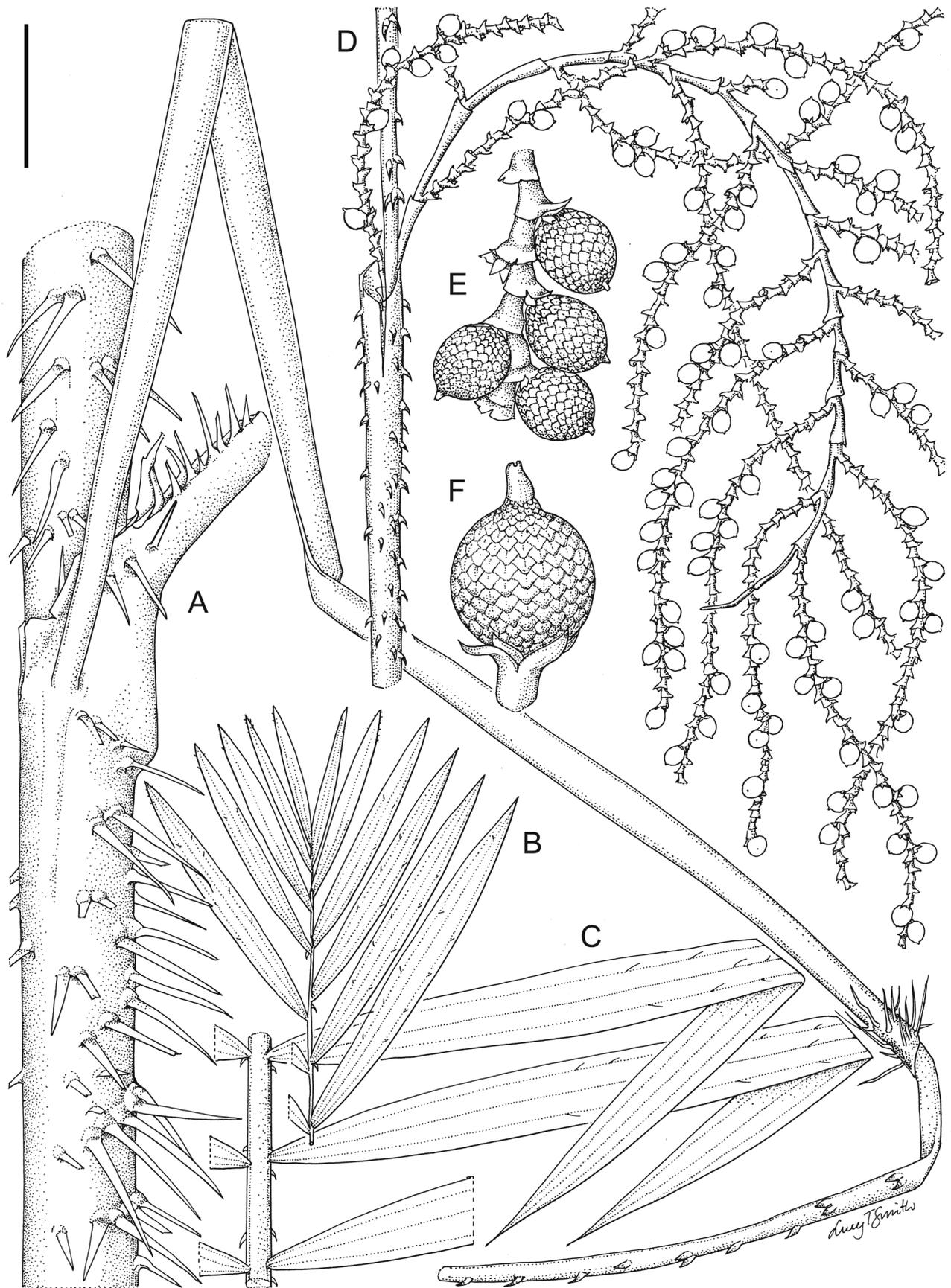


FIGURE 11. *Calamus sashae*. A. Leaf sheath with portion of flagellum. B. Leaf apex. C. Mid-leaf portion. D. Primary branch of infructescence. E. Pistillate rachilla with fruit. F. Rachilla. Scale bar: A = 4 cm; B–D = 6 cm; E = 2 cm; F = 1 cm. All from Dransfield *et al.* JD 7601. Drawn by Lucy T. Smith.

with swollen bases, solitary or grouped in partial whorls, pale brown with reddish bases when fresh, drying brown, horizontal or reflexed, narrow triangular, laminar, those around the leaf sheath mouth smaller and more crowded; knee conspicuous, to 60 × 13 mm, drying same colour as sheath, unarmed; ocrea poorly developed, membranous; flagellum very robust, to 4 m long; petiole 10–40 cm long, 20 mm wide and 9 mm thick at base, armed along margins with sparse slightly reflexed spines to 15 mm long, with swollen bases and black tips and sparse spines on abaxial surface, brown indumentum abundant; rachis to 2 m long, basally armed abaxially with scattered robust reflexed spines to 10 × 3 mm with swollen bases, distally armed with grapnel groups of spines; leaflets to 62 on each side of rachis, regularly arranged, narrow lanceolate, longest leaflet in mid-leaf, basalmost leaflets to 22–24 × 1.1–1.2 cm, mid-leaf leaflets 38–40 × 2.3–2.7 cm, apical leaflets 7–9 × 0.7–0.9 cm, apical leaflets joined in basal 2 cm, leaflets armed adaxially with slender, dark, sometimes pale tipped bristles to 9 mm long, along 2 main lateral veins and, rarely, also the midrib and along margins only at leaflet tip, leaflets lacking indumentum, transverse veinlets conspicuous, margins conspicuously thickened, leaflet drying dull adaxially, somewhat shiny abaxially. **Staminate inflorescence** not seen. **Staminate flowers** not seen. **Pistillate inflorescence** to 6.1 m long, including peduncle to 3.65 m, branched to 2 orders; prophyll and peduncular bracts not seen; rachis bracts strictly tubular, coriaceous, to at least 24 cm long with triangular tip, and bearing abundant reflexed spines to 6 mm long; primary branches 3, very distant, to 65 cm long, with up to 18 rachillae; rachillae 20–25 × 0.4 cm; rachilla bracts triangular, explanate, funnel-shaped, dark brown, 5 × 7 mm, distichous, tips reflexed, unarmed, and bearing dense dark brown indument; proximal floral bracteoles cup-shaped, 4 × 5.5 mm, distal floral bracteoles cup-shaped, 3 × 4 mm, scar from sterile staminate ca. 0.1 mm diam. **Sterile staminate flower** not seen. **Pistillate flowers** not seen. **Fruit** (reconstructed from empty pericarp) ovoid, ca. 15 × 12 mm with 24 vertical rows of pale brown highly convex scales with darker margins. Seed not seen (all mummified and severely damaged by insects). (Fig. 11)

Distribution:—Known only from lowland forest in the foothills of the Arfak Mountains near Warmare and from the Wandammen Peninsula, both in West Papua Province, Indonesia.

Habitat:—Lowland forest at altitudes up to 400 m above sea level.

Uses:—None recorded.

Vernacular Names:—None recorded.

Specimens examined:—INDONESIA. West Papua Province: Manokwari Regency, Warmare, valley of River Prafi, new road to Manyambo, 400 m, 0°47'S, 133°58'E, 25 August 1995, *Dransfield et al.* JD 7601 (holotype K!, isotypes BO!, FTG!, MAN!); Manokwari Regency, Wasior District, Wandammen Peninsula, Kowi, near Wondiwoi village (formerly known as Kobiari village), ca. 9 km south of Wasior, 350 m, 2°37'50"S, 134°29'55"E, 23 February 2000, *Barrow et al.* 127 (BO, K!, L, MAN).

Notes:—This robust rattan (Fig. 11) is easily distinguished by its ecirrate leaves with regularly arranged rather narrow leaflets, the sheaths armed with large, scattered or grouped spines, the unarmed knee, and the very robust female inflorescence with only few very distant partial inflorescences, the rachillae with explanate, funnel-shaped, almost overlapping dark bracts. Its general inflorescence morphology is similar to that of the paired fruit group (Dransfield & Baker 2003), especially *C. pholidostachys* with which it also shares similar robust leaf sheath armature, but *C. sashae* does not bear paired fruit, nor does it possess a well-developed ocrea, as is typical for this group. The widely, funnel-shaped rachilla bracts are more pronounced than in any other New Guinea *Calamus* species, although they also occur, if less prominently, in other species such as *C. nanduensis*, *C. pseudozebrinus* and *C. womersleyi*. Of these, *C. sashae* is most similar to *C. nanduensis*, but this species differs in its much smaller rachilla bracts, the fine, needle-like leaf sheath spines and well-developed ocrea.

The species is named in honour of our former colleague and palm expert, Dr. Sasha Barrow, who collected one of the two known specimens of this species while accompanying the first author on joint fieldwork with the University of Papua and Herbarium Bogoriense.

12. *Calamus spanostachys* W.J.Baker & J.Dransf., *sp. nov.* Type:—INDONESIA. Papua Province: Nassau Mountains [Sudirman Mountains], 700 m, October 1926, *Docters van Leeuwen 10473* (holotype L!, isotypes BO, K!)

Diagnosis:—Distinguished by its extremely slender, short stems, which apparently lack flagella, the ecirrate leaves with only two or three pairs of leaflets, the apical pair being substantially larger than the lower one, and by the short, erect inflorescence branched to only one (pistillate) or two (staminate) orders.



FIGURE 12. *Calamus spanostachys*. A. Habit, including leaf sheath, leaf and pistillate inflorescences. B. Leaf sheath with staminate inflorescence. C. Staminate rachilla. D. Pistillate rachilla with young fruit. E, F. Staminate flower bud whole and in longitudinal section. G. Fruit. Scale bar: A = 4 cm; B = 3 cm; C = 2.5 mm; D = 4 mm; E, F = 1.1 mm; G = 7 mm. All from *van Leeuwen 10473*. Drawn by Lucy T. Smith.

Very slender rattan to 1.5 m. **Stem** with sheaths 3–5 mm diam., without sheaths 2–3 mm diam.; internodes 7–11 cm. **Leaf** ecirrate, to 37 m long including petiole; sheath mid-green, with scattered, caducous indumentum on young sheaths, sparsely armed in distal portion of sheath, spines to 12 mm long, 0.5 mm long at the base, narrowly triangular; knee scarcely developed, unarmed or sparsely spiny; ocrea scarcely developed; flagellum absent in available material; petiole 7–13 mm long, 2–3 mm wide at base; rachis 7–18 cm, unarmed or sparsely armed with short, reflexed spines; leaflets 2–3 on each side of rachis, subregular, lanceolate, basal and mid-leaf leaflets 12–19 × 1–2.2 cm, apical leaflets 22–29 × 2.5–4 cm, apical leaflet pair united up to one quarter of their length, leaflets sparsely armed with minute spines on margins and abaxial surface, lacking indumentum, transverse veinlets conspicuous. **Staminate inflorescence** erect, ca. 36 cm long including 8 cm peduncle and 5 cm flagelliform tip, branched to 2 orders; prophyll 8 × 0.3 cm, closely sheathing, opening eccentrically at the apex, with sparse indumentum, sparsely armed as rachis; peduncular bracts absent, rachis bracts similar to prophyll, to 6 × 0.3 cm; primary branches 4, to ca. 6 cm long, ca. 8 cm apart, with up to 10 rachillae; rachillae 8–21 mm × ca. 1 mm, straight to slightly recurved; rachilla bracts minute, triangular, distichous; floral bracteole 1.5 × 1 mm, deeply cup-shaped. **Staminate flowers** ca. 2.5 × 1.4 mm in bud; calyx 1.3–1.4 mm diam., tubular in basal 0.7–1 mm, with 3 lobes 0.5–0.6 × 1 mm; corolla ca. 1 × 1 mm in bud, tubular in basal ca. 0.6 mm; stamens 6, filaments 1–1.2 × 0.1 mm, anthers 0.7–1 × 0.2 mm; pistillode absent. **Pistillate inflorescence** similar to staminate inflorescence, to 16 cm long including 3–4 cm peduncle and 1–6 cm flagelliform tip, branched to 1 order; prophyll 3 × 4 cm, closely sheathing, minutely armed; peduncular bracts absent, rachis bracts similar to prophyll; primary branches (= rachillae) 2–4; rachillae 3.3–4 mm × ca. 2 mm, erect, relatively robust; rachilla bracts 2 × 2 mm, distichous; floral bracteoles cup-shaped, scar from sterile staminate conspicuous. **Pistillate flowers** ca. 2.5 × 1.7 mm in bud; calyx ca. 1.7 mm diam., tubular in basal ca. 1.9 mm, with 3 lobes to ca. 0.6 × 0.7 mm; corolla ca. 2.2 × 1.3 mm, tubular in basal ca. 1.6 mm, with 3 lobes to 0.6 × 0.7 mm; staminodes forming membranous cup around gynoecium, ca. 1 mm high, bearing 6 vestigial anthers; ovary immature, 1.2 × 0.6 mm, globose, style scarcely developed. **Sterile staminate flowers** ca. 1.5 × 0.8 mm in bud, similar to staminate flower, but with empty anthers. **Fruit** immature, globose, 11 × 8 mm including beak to ca. 1 mm long, with 15 longitudinal rows of scales, pale brown when dried. **Seed** not seen. (Fig. 12)

Distribution:—Known from a single gathering near the Upper Rouffaer River in the Sudirman Mountains.

Habitat:—Primary forest around 700 m.

Uses:—None recorded.

Vernacular Names:—None recorded.

Specimens examined:—INDONESIA. Papua Province: Nassau Mountains [Sudirman Mountains], 700 m, October 1926, *Docters van Leeuwen 10473* (holotype L!, isotypes BO, K!).

Notes:—This rattan (Fig. 12) has been collected only once during the 1926 Dutch-American expedition to New Guinea, which explored the upper reaches of the Rouffaer River from the Mamberamo basin. It is an extremely slender, short-stemmed species, lacking flagella (or indeed cirri) in the material seen by us, with only two or three pairs of leaflets, the apical pair being substantially larger than the lower ones. Its inflorescences are erect and short, with a poorly developed flagelliform tip, and are branched to only one (pistillate) or two (staminate) orders (hence the species epithet). Of the New Guinea rattans, *Calamus spanostachys* is most similar to *C. kebariensis* Maturbongs *et al.* (2014: 235) from the Bird's Head Peninsula, which differs in being largely unarmed and bearing leaves with numerous, fine, regularly arranged leaflets.

13. *Calamus spiculiferus* J.Dransf. & W.J.Baker, *sp. nov.* Type:—INDONESIA. Papua Province: Idenburg River, 4 km SW of Bernhard Camp, 850 m, 3°29'S, 139°6'E, March 1939, *Brass 13341* (holotype L!, isotypes A, BM!, BRI).

Diagnosis:—Distinguished by its moderately robust stem, the minute, easily detached spicules on the leaf sheath and the ecirrate leaves with very broad cucullate leaflets borne in pairs in the upper leaf.

Moderately robust rattan, climbing to 35 m or more, whether solitary or clustered not recorded. **Stem** with sheaths 21–28 mm diam., without sheaths to 15 mm diam.; internodes to at least 23 cm. **Leaf** ecirrate, 80–90 cm long; sheath drying pale greenish brown, with caducous dark brown scales and thin grey indumentum, sheath spines minute, easily detached, uniformly distributed, 1.5 × 0.1 mm, black with minute swollen pale bases, pointing

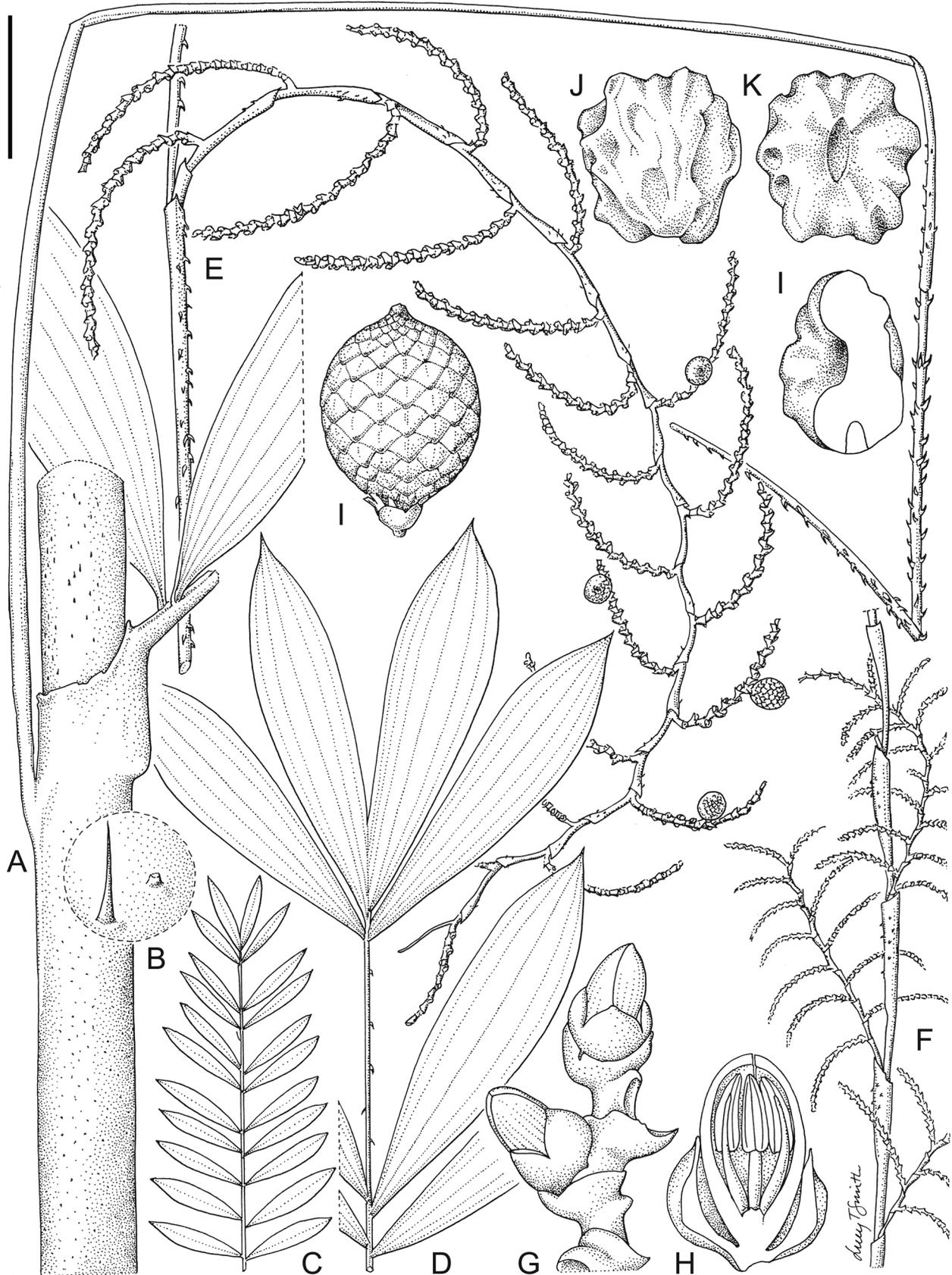


FIGURE 13. *Calamus spiculiferus*. A. Leaf sheath with portion of flagellum. B. Detail of leaf sheath spicule. C. Leaf diagram. D. Leaf apex. E. Primary branch of infructescence. F. Portion of primary branch of staminate inflorescence. G. Portion of staminate rachilla with flower buds. H. Staminate flower bud in longitudinal section. I. Fruit. J, K. Seed in two views. L. Seed in longitudinal section. Scale bar: A = 4 cm; B = 1.8 mm; C = 30 cm; D–F = 6 cm; G = 3.3 mm; H = 2.2 mm; I = 1 cm; J–L = 7 mm. A, B, F–H from Zieck NGF 36558; C–E, I–L from Brass 13341. Drawn by Lucy T. Smith.

upward, spines around the leaf sheath mouth absent; knee conspicuous, to ca. $40 \times 10\text{--}15$ mm, drying same colour as sheath, unarmed; ocrea scarcely developed; flagellum present, 2.7 m long; petiole absent or very short, to 2 cm long, 1 cm wide, adaxially flattened, abaxially rounded, bearing caducous dark brown scales, adaxially armed with a few very short spines to 1 mm; rachis to 2.6 m long, adaxially armed with scattered short black spines to 2 mm long, abaxially armed with recurved hooks; leaflets 9–11 on each side of rachis, irregularly arranged in 4–5 pairs, the basal 1–3 leaflets on each side not grouped, diverging within the pair, very broad spatulate, cucullate, longest leaflet in mid-leaf, basalmost leaflets $22 \times 5\text{--}6$ cm, mid-leaf leaflets $19\text{--}28 \times 5\text{--}6$ cm, apical leaflets $18\text{--}19 \times 3\text{--}4$ cm, apical leaflets joined for half their length, leaflets armed with black bristles to 2 mm long along margins near the tip and sometimes abaxially along main veins and midrib, adaxially unarmed, leaflets lacking indumentum, transverse veinlets very conspicuous. **Staminate inflorescence** not known in complete state, said to be 2.5 m long with a terminal flagellum, branched to 3 orders, total length unknown; prophyll not seen; peduncular bracts not seen; rachis bracts not seen; primary branches 5, to at least 75 cm long, with numerous rachillae; rachillae to $25\text{--}50 \times 1.2$ mm diam.; rachilla bracts 1.5×1 mm, distichously arranged, not overlapping, striate, sometimes splitting, with apiculate recurved tips and scattered brown indumentum, unarmed; floral bracteole cup-shaped, 1.2 mm high, unarmed. **Staminate flowers** 2×1.5 mm; calyx much thickened, 1.2×1.5 mm, with very short triangular lobes to 0.2 mm high; petals 2×0.7 mm; stamens 1.2 mm long, anthers 1×0.2 mm. **Pistillate inflorescence** to 2.7 m long, including peduncle 35 cm, branched to 2 orders; prophyll not seen; peduncular bracts not seen; rachis bracts to at least 21×0.7 cm, bearing reflexed hooks; primary branches 7, to at least 60 cm long, with up to 20 rather distant rachillae; rachillae \pm arcuate, the basal ones the longest, to 12×0.3 cm; rachilla bracts triangular, 2×3 mm, distichous, not overlapping, with triangular tips, unarmed, bearing scattered brown indumentum; proximal floral bracteoles explanate, ca. 1 mm high, distal floral bracteoles cup-shaped, ca. 0.5 mm high, scar from sterile staminate minute, 0.2 mm diam. **Sterile staminate flower** not known. **Pistillate flowers** not known. **Fruit** globose, 13×10 mm, with a beak to 1.5×1.5 mm, and with ca. 18 vertical rows of mid-brown scales with darker margins. **Seed** $8 \times 7 \times 6$ mm, with a very deep groove on one side, seed surface deeply scalloped and pitted, endosperm homogeneous, embryo basal. (Fig. 13)

Distribution:—Known from submontane forest in Sandaun Province, Papua New Guinea and the Idenburg River, Papua Province, Indonesia.

Habitat:—Montane forest at ca. 1300 m above sea level.

Uses:—None recorded.

Vernacular Names:—*Nelmo* (Kabori).

Specimens examined:—INDONESIA. Papua Province: Idenburg River, 4 km SW of Bernhard Camp, 850 m, $3^{\circ}29'S$, $139^{\circ}6'E$, March 1939, *Brass 13341* (holotype L!, isotypes A, BM!, BRI). PAPUA NEW GUINEA. Sandaun Province: Lumi Subdistrict, Kabori, 700 m, $3^{\circ}20'S$, $141^{\circ}52'E$, 02 April 1974, *Zieck NGF 36558* (BH, LAE!).

Notes:—This rattan (Fig. 13) is distinguished by its moderately robust stem, the minute, easily detached spicules on the leaf sheath (hence the epithet) and the ecirrate leaves with very broad cucullate leaflets borne in pairs in the upper part of the leaf. In leaf and inflorescence morphology, it resembles *C. bulubabi* and *C. papuanus*. *Calamus bulubabi* is immediately distinguished by the abundant, hair-like spines and by the apical leaflets diminishing in size (compared to the large leaflets grouped at the leaf apex of *C. spiculiferus*). *C. papuanus* is a more slender palm, variously armed and with a short, but well-defined, truncate, tightly sheathing ocrea.

Three sterile specimens (*Heatubun et al. 1075*, *Maturbongs 604* and *Dransfield et al. JD7652*) are tentatively included here.

14. *Calamus womersleyi* J.Dransf. & W.J.Baker, *sp. nov.* Type:—PAPUA NEW GUINEA. Morobe Province: McAdam Memorial Park, 5 miles S of Wau, 1200 m, $7^{\circ}24'S$, $146^{\circ}43'E$, 12 March 1964, *Moore & Womersley 9285* (holotype LAE!, isotype BH!).

Diagnosis:—Distinguished by its slender stem, rather sparse pale spines, the short, truncate membranous ocrea, the ecirrate leaves with irregularly arranged in groups, usually regularly arranged within groups, narrow lanceolate leaflets and the thin, dark indumentum scattered on leaf sheath and rachis, and inflorescence bracts.

Slender clustering rattan, total length not recorded. **Stem** with sheaths 13–15 mm diam., without sheaths to 6.5 mm diam.; internodes to 16–19 cm. **Leaf** ecirrate, 45–69 cm long; sheath drying pale brown, with thick caducous dark

brown scales and thin grey indumentum, sheath spines almost absent to abundant, slender, easily detached, rather uniform, $5\text{--}19 \times 1\text{--}1.5$ mm, scattered, pale straw coloured with conspicuously swollen bases, horizontal, very narrow triangular, laminar, spines around the leaf sheath mouth absent; knee conspicuous, to 15×4.5 mm, drying same colour as sheath, \pm unarmed or with a few short spines to 2 mm along the mid-line; ocrea conspicuous, strictly tubular, to 14 mm, truncate, unarmed, membranous, drying dark brown; flagellum present, 1.3 m long; petiole 2–7 cm long, 0.6 cm wide, adaxially flattened, abaxially rounded, bearing caducous dark brown scales and pale indumentum, unarmed or with a few short spines to 3 mm abaxially; rachis to 35–71 cm long, basally armed abaxially with scattered short spines as on the leaf sheath and abundant dark brown caducous indumentum, distally armed with recurved hooks, adaxially densely covered with caducous dark brown indumentum; leaflets 16–24 on each side of rachis, irregularly arranged in 2–4 groups, regularly arranged within the groups, narrowly lanceolate, abruptly constricted at the base, longest leaflet near the base, basalmost leaflets $20\text{--}21 \times 1.4\text{--}2$ cm, mid-leaf leaflets $16.5\text{--}29 \times 1.6\text{--}2.2$ cm, apical leaflets $10\text{--}11 \times 1.5$ cm, apical leaflets joined for ca. 2 cm, leaflets armed with black bristles to 4 mm long along margins near the tip and adaxially along 2 or 4 lateral veins and sometimes also along midrib, abaxially unarmed, leaflets lacking indumentum, transverse veinlets moderately conspicuous. **Staminate inflorescence** branched to 3 orders, total length unknown; prophyll 32 cm long, closely tubular with a triangular membranous tip, and armed along margins with very sparse short spines, caducous brown indumentum abundant; peduncular bracts absent; rachis bracts not seen; primary branches, total number not known, to at least 22 cm long, the branching system \pm triangular in outline, with numerous rachillae; rachillae to 50×2.5 mm; rachilla bracts 3×2 mm, distichously arranged, overlapping, striate, with apiculate tips and scattered brown indumentum, unarmed; floral bracteole 2×0.5 mm, unarmed. **Staminate flowers** 3×2 mm; calyx 2.5×1 mm, with triangular lobes to 0.5×0.5 mm; petals 2×0.7 mm, narrow pointed; stamens not preserved. **Pistillate inflorescence** to 1 m long, including peduncle 18–43 cm, branched to 2 orders; prophyll $13\text{--}23 \times 0.7$ cm, tubular and closely sheathing, with a triangular lobe, bearing dense caducous brown indumentum and sparse short black spines, mostly to ca. 1 mm; peduncular bracts absent; rachis bracts similar to prophyll, bearing reflexed hooks; primary branches 3–6, 6–28 cm long, with up to 19 rachillae; rachillae \pm arcuate, the middle ones the longest, to 5×0.3 cm; rachilla bracts triangular, 4×2 mm, distichous, overlapping, unarmed, bearing scattered brown indumentum and fringed with hairs; proximal floral bracteoles to 3×1.5 mm, distal floral bracteoles strongly bilobed, 1×0.5 mm, scar from sterile staminate minute, 0.1 mm diam. **Sterile staminate flower** 4×1.5 mm; calyx 3.5×1.5 ; petals 3×1 mm, other parts not preserved. **Pistillate flowers** 4.5×2.5 mm; calyx 4×2.5 mm with lobes 1.5×1.5 mm; petals 4×1 mm, with gradually narrowing triangular tips; staminodes triangular 0.5×0.5 mm; ovary 2×1.5 mm with recurved stigmas to 1.5×0.4 mm. **Fruit** globose, 6 mm diam., with ca. 20 vertical rows of pale brown scales with darker margins. Seed $7 \times 6.5 \times 5.5$ mm, with a deep pit on one side, seed surface smooth, endosperm homogeneous, embryo basal. (Fig. 14)

Distribution:—Known only from montane forest near Wau and Bulolo, Morobe Province in Papua New Guinea.

Habitat:—Montane forest at ca. 1100–1500 m above sea level.

Uses:—None recorded.

Vernacular Names:—*Ren* (Biaru).

Specimens examined:—PAPUA NEW GUINEA. Morobe Province: Bulolo, Manki divide range, 1200 m, $7^{\circ}10'S$, $146^{\circ}40'E$, 1 January 1960, *Womersley & Thorne NGF 12753* (LAE!), *Womersley & Thorne NGF 12758* (LAE!); McAdam Memorial Park, 5 miles S of Wau, 1200 m, $7^{\circ}24'S$, $146^{\circ}43'E$, 12 March 1964, *Moore & Womersley 9285* (holotype LAE!, isotype BH!); Wau Subdistrict, Bulolo, Nauwata Banda, Compound 10, 1463 m, $7^{\circ}13'S$, $146^{\circ}40'E$, 12 June 1969, *Zieck NGF 36222* (L!, LAE!); Wau Subdistrict, Potmor, Bairu, 1524 m, $7^{\circ}43'S$, $146^{\circ}46'E$, 28 June 1969, *Zieck NGF 36224* (LAE!); Wau Subdistrict, Wau, along forestry road no 6, 1370 m, $7^{\circ}20'S$, $146^{\circ}43'E$, 4 July 1969, *Zieck NGF 36227* (LAE!); Wau Subdistrict, foothills of Mt. Missim, 1100 m, $7^{\circ}15'S$, $146^{\circ}42'E$, 5 January 1984, *Henty & Kini LAE 72548* (L!, LAE)

Notes:—This rattan (Fig. 14), which has been collected several times, but only from montane areas near Wau and Bulolo, is distinguished by its relatively slender stem armed with rather sparse, pale spines, by the short, tightly sheathing, truncate, membranous ocrea, and by the ecirrate leaves with narrow lanceolate leaflets that are arranged in irregular groups, but usually regularly arranged within the groups. Dark caducous indumentum is present in patches on leaf sheath, rachis and inflorescence bracts in the material available to us, lending the specimens a dirty appearance.

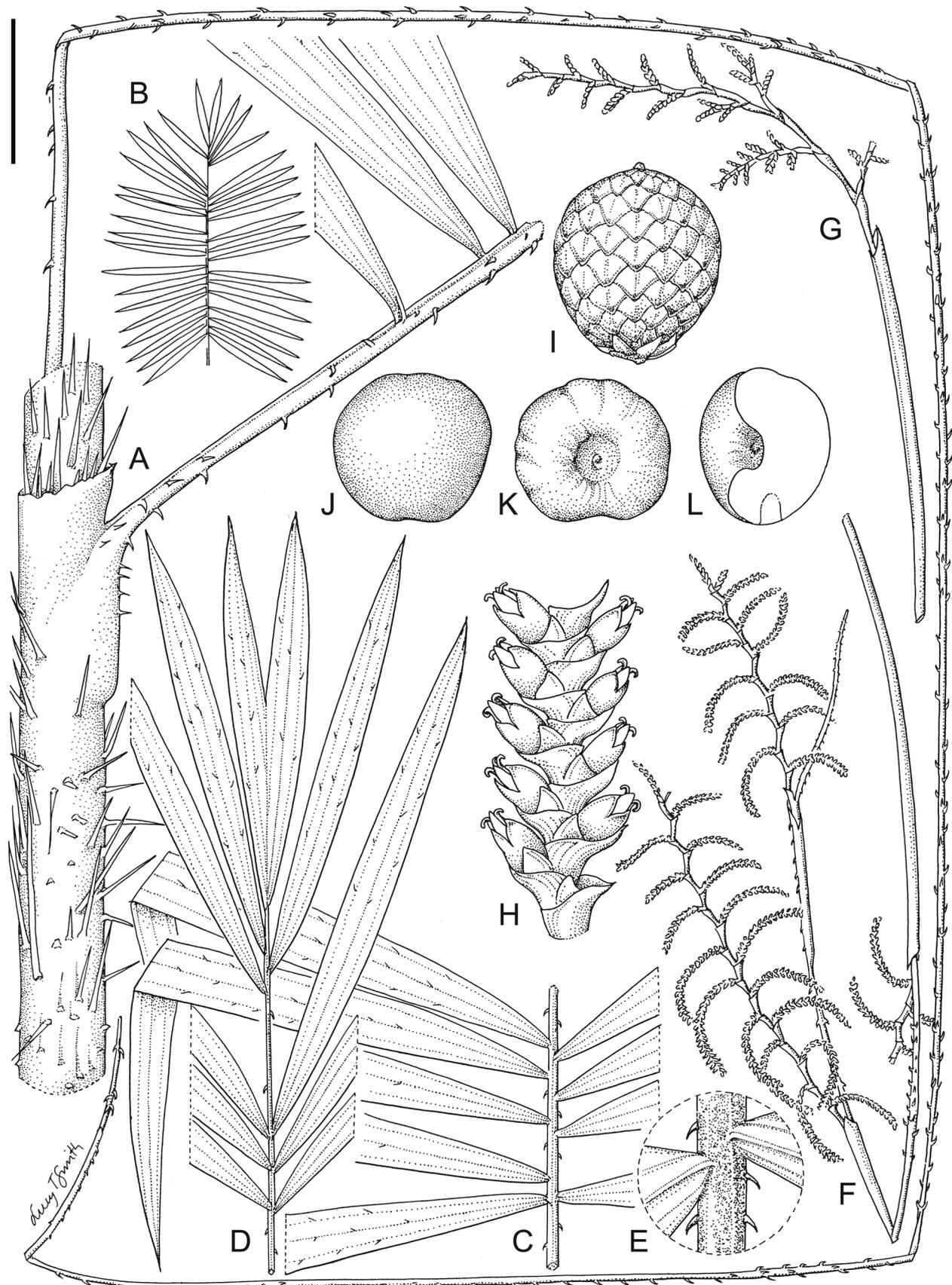


FIGURE 14. *Calamus womersleyi*. A. Leaf sheath with ocrea and flagellum. B. Leaf diagram. C. Mid-leaf portion. D. Leaf apex. E. Details of leaf rachis with indumentum. F. Portion of pistillate inflorescence. G. Portion of staminate inflorescence. H. Portion of pistillate rachilla. I. Fruit. J, K. Seed in two views. L. Seed in longitudinal section. Scale bar: A = 2.5 cm; B = 24 cm; C, D = 6 cm; E = 1.5 cm; F, G = 8 cm; H, J–L = 7 mm; I = 7 mm. A, C–E, G from Moore & Womersley 9285; B, F, H from Womersley & Thorne NGF 12753; I–L from Womersley & Thorne NGF 12758. Drawn by Lucy T. Smith.

Calamus womersleyi appears to be most closely related to *C. nanduensis* and *C. pseudozebrinus* (see notes under *C. nanduensis*).

This species is named for John Womersley, former Assistant Director of the Division of Botany, Department of Forests, Papua New Guinea, who made several specimens of this species and collected the type specimen with American palm authority, Harold E. Moore, Jr.

Acknowledgements

We thank the directors and staff of the herbaria at A, BH, BM, BO, BRI, CANB, L, LAE, K, MAN, MEL, NY and WRSL for access to specimens. We are particularly grateful to our friends and collaborators in Indonesia (Universitas Papua, Herbarium Bogoriense) and Papua New Guinea (Papua New Guinea Forest Research Institute), and our many local counterparts and field assistants who have worked with us in the field, especially Deby Arifiani, Roy Banka, Charlie Heatubun, Rudi Maturbongs, Himmah Rustiami and Jack Wanggai. We also thank our colleagues at Kew for support and collaboration in the field, in particular Sasha Barrow, Marie Briggs, Mark Coode, Soejatmi Dransfield, Rogier de Kok, Lauren Gardiner, Kathleen King, Bob Johns and Tim Utteridge, and Scott Zona of Florida International University. Lucy T. Smith executed the beautiful illustrations that accompany this paper. Thomas Couvreur and Martin Callmander provided helpful comments on an earlier draft of this manuscript. We gratefully acknowledge financial and logistical support from the Royal Botanic Gardens, Kew, the Pacific Biological Foundation, the UK Darwin Initiative, the BAT Biodiversity Partnership, Rio Tinto, PT Freeport Indonesia, Ok Tedi Mining Ltd and the WWF Integrated Conservation and Development Project.

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