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More new rattans from New Guinea and the Solomon Islands (*Calamus*, Arecaceae)

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Abstract

As part of current research on the taxonomy of the palms (Arecaceae or Palmae) of New Guinea, ten new species of the rattan genus *Calamus* are described and illustrated here: *Calamus baiyerensis*, *Calamus capillosus*, *Calamus erythrocarpus*, *Calamus heatubunii*, *Calamus jacobsii*, *Calamus katikii*, *Calamus kostermansii*, *Calamus papyraceus*, *Calamus pintaudii* and *Calamus superciliatus*. An eleventh species, *Calamus novae-georgii*, from the neighbouring Solomon Islands is also included here. The palm flora of New Guinea now includes 62 species of *Calamus*, 34 of which have been described since 2002, demonstrating the remarkable scale of botanical discovery on the island.

Key words: Calamoideae, Indonesia, lianas, Palmae, palms, Papua New Guinea, Papuasia, South-East Asia

Introduction

The island of New Guinea remains a major frontier for discovery of new taxa in the palm family. Under the auspices of the Palms of New Guinea project (Baker 2002a), three new genera (Baker *et al.* 2006, Heatubun *et al.* 2014) and numerous new species have been discovered and described in recent years (e.g. Barfod & Heatubun 2009, Heatubun *et al.* 2009, 2016, Gardiner *et al.* 2012, Keim & Dransfield 2012), especially in the rattan genus *Calamus* Linnaeus (1753: 325). *Calamus* is the largest genus of palms with ca. 520 species ranging across the Asia-Pacific region with one outlier in Africa (Dransfield *et al.* 2008, Baker 2015, Baker & Dransfield 2016). New Guinea is a significant hotspot for *Calamus* diversity (Baker & Couvreur 2012), but until recently the taxonomy of the island's species has been unclear. In preparation for a revision of New Guinea *Calamus*, we have described a large number of new species and a further 10 new species are described and illustrated here, along with one additional species from the Solomon Islands. With the new species reported here, we now recognise 62 accepted species of *Calamus* in New Guinea, 34 of which have been described since 2002 (Baker 2002b, Baker & Dransfield 2002a, 2002b, 2014, Baker *et al.* 2003, Dransfield & Baker 2003, Fernando 2014, Maturbongs *et al.* 2014, 2015).

Taxonomic treatment

1. ***Calamus baiyerensis*** W.J.Baker & J.Dransf., *sp. nov.* Type:—PAPUA NEW GUINEA. Western Highlands Province: Baiyer River Subdistrict, Rouna River (Baiyer River valley) near Kambukom village, 1160 m, 5°35'S, 144°10'E, 23 July 1971, *Zieck NGF 36252* (holotype CANB!, isotypes BH, LAE).

Diagnosis:—Distinguished by the very robust, clustering habit, the sparsely armed sheath with patchy dark indumentum, the ocrea encircling the stem that disintegrates into fibres and the very robust inflorescence with robust rachillae with funnel-shaped bracts.

Very robust, clustering rattan climbing to ca. 20 m. **Stem** with sheaths 45–55 mm diam., without sheaths to 15–18 mm diam.; internodes at least 18 cm, complete material not seen. **Leaf** ecirrate to 1.7 m long including petiole; sheath green, with patchy indumentum of densely matted, minute, brown-black hairs, sparsely armed with solitary, planar, triangular spines to 10 × 2 mm, sheath unarmed in parts; knee ca. 80 mm long, ca. 28 mm wide, colour

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FIGURE 1. *Calamus baiyerensis*. A. Leaf sheath with ocrea. B. Leaf apex. C. Mid-leaf portion. D. Primary branch of staminate inflorescence. Scale bar: A = 3 cm; B, C = 6 cm; D = 4 cm. All from *Zieck NGF 36252*. Drawn by Lucy T. Smith.

and indumentum as sheath, unarmed; ocrea to ca. 18 cm long, encircling stem, tattering and disintegrating into dry, brown fibres, unarmed; flagellum present, 5–8 m long, very robust; petiole at least 15 mm wide and 10 mm thick at base, flat to convex adaxially, rounded abaxially, glabrous, armed laterally with stout spines; rachis armed with pale, black-tipped, robust grapnel spines; leaflets 32–35 each side of rachis, regularly to subregularly arranged, linear-lanceolate, longest leaflets near base 60 × 3.5 cm, mid-leaf leaflets 55 × 3.5 cm, apical leaflets 26 × 1.4 cm, apical leaflet pair united to one quarter of their length, unarmed abaxially, with scattered black bristles on adaxial surface of two major lateral veins, with scattered bristles to 2 mm on margins, especially near tip, transverse veinlets moderately inconspicuous. **Staminate inflorescence** very robust, only incomplete material seen, branched to 3 orders; prophyll and peduncular bracts not seen, rachis bracts up to at least 32 × 13 cm, tubular and tattering at mouth, armed with grapnels as flagellum; primary branches at least 58 cm long, recurving sinuously, with numerous rachillae, bracts tubular, tattering, unarmed; rachillae 15–43 mm × 5–6 mm, robust, bilaterally compressed; rachilla bracts ca. 2.5 × 5 mm, distichous, funnel-shaped, apiculate; floral bracteole cup-shaped with two distinct keels. **Staminate flowers** ca. 3 × 2 mm, dry remains only present. **Pistillate inflorescence** not seen. **Pistillate flowers** not seen. **Sterile staminate flowers** not seen. **Fruit** not seen.

Etymology:—The species epithet reflects the type locality in the Baiyer River valley.

Distribution:—Known only from the type locality in the Baiyer River valley, Western Highlands Province, Papua New Guinea.

Habitat:—Disturbed mid-montane forest, 1200 m.

Uses:—None recorded.

Vernacular names:—*Kela* or *Sintsch* (Baiyer River valley).

Specimens examined:—PAPUA NEW GUINEA. Western Highlands: Baiyer River Subdistrict, Rouna River (Baiyer River valley) near Kambukom village, 1160 m, 5°35’S, 144°10’E, 23 July 1971, *Zieck NGF 36252* (holotype CANB!, isotypes BH, LAE).

Notes:—Here we describe two closely related species of robust, montane rattans, *Calamus baiyerensis* and *C. pintaudii*. They both occur at relatively high elevations and share features such as well-developed, disintegrating ocreas and robust inflorescences with robust rachillae bearing prominent, funnel-shaped rachilla bracts. The two can be distinguished by their spines, which are very few and triangular in *C. baiyerensis*, compared to very numerous and needle-like in *C. pintaudii*, and by the ocrea, which is encircling, straw-coloured and tattering to fibres in *C. baiyerensis*, rather than membranously papery, fragile, dark brown and cleft opposite the petiole in *C. pintaudii*. The leaflets of *C. baiyerensis* are similar in length to those of *C. pintaudii*, but are around twice the width and are less densely bristly on their margins (especially at the leaflet tip). Although the inflorescences are similar, the primary branches of *C. baiyerensis* appear to be longer, but with shorter rachillae than *C. pintaudii*. *Calamus baiyerensis* is known from a location just beyond the western limit of *C. pintaudii*. It is possible that the two represent different dimensions of a broader complex, but the available material supports the recognition of two species at this point.

The presence of a well-developed ocrea and funnel-shaped bracts potentially links these taxa to *Calamus nanduensis* Baker & Dransfield (2014: 198), *C. pseudozebrinus* Burret (1935: 319) and *C. womersleyi* Baker & Dransfield (2014: 211), all of which are recorded from moderate to relatively high elevation (700–1500 m). There is also some similarity in inflorescence morphology with *C. sashae* J.Dransf. & W.J.Baker in Baker & Dransfield (2014: 205), but this is not an ocreate species.

2. ***Calamus capillosus*** W.J.Baker & J.Dransf., *sp. nov.* Type:—INDONESIA. West Papua Province: surroundings of Ayawasi, ca. 450 m, 1°09’S, 132°29’E, 28 July 1995, *Ave 4048* (holotype L!, isotype BO).

Diagnosis:—Distinguished by the sheaths densely armed with very fine, hair-like spines, the regularly pinnate leaves with numerous bristles on veins and margins, the very long flagelliform inflorescences, the long, unbranched peduncle, the lax primary branches, and the staminate inflorescence branched to only two orders.

Slender, solitary rattan climbing to ca. 10 m. **Stem** with sheaths 12–15 mm diam., without sheaths 5–6 mm diam., exuding white sap when cut; internodes 14–17 cm. **Leaf** ecirrate to 65–90 cm long including petiole; sheath pale green, with thin, scattered indumentum of colourless and brown fibrous scales, densely armed with fine, hair-like, reddish-brown spines, spines to ca. 35 mm long, some indumentum scattered at base of spines, spines caducous later; knee 20–30 mm long, inconspicuous and obscured by spines; ocrea absent; flagellum to at least 1.9 m long; petiole 8–11 cm long, 5–5.5 mm wide and 4.5–5.5 mm thick at base, shallowly channelled adaxially, rounded abaxially, with indumentum as sheath, with caducous spines similar to sheath and grapnel spines abaxially; rachis 46–64 cm long, arching, with grapnel spines abaxially and laterally, and additional scattered, black-tipped spines; leaflets 48–53 each

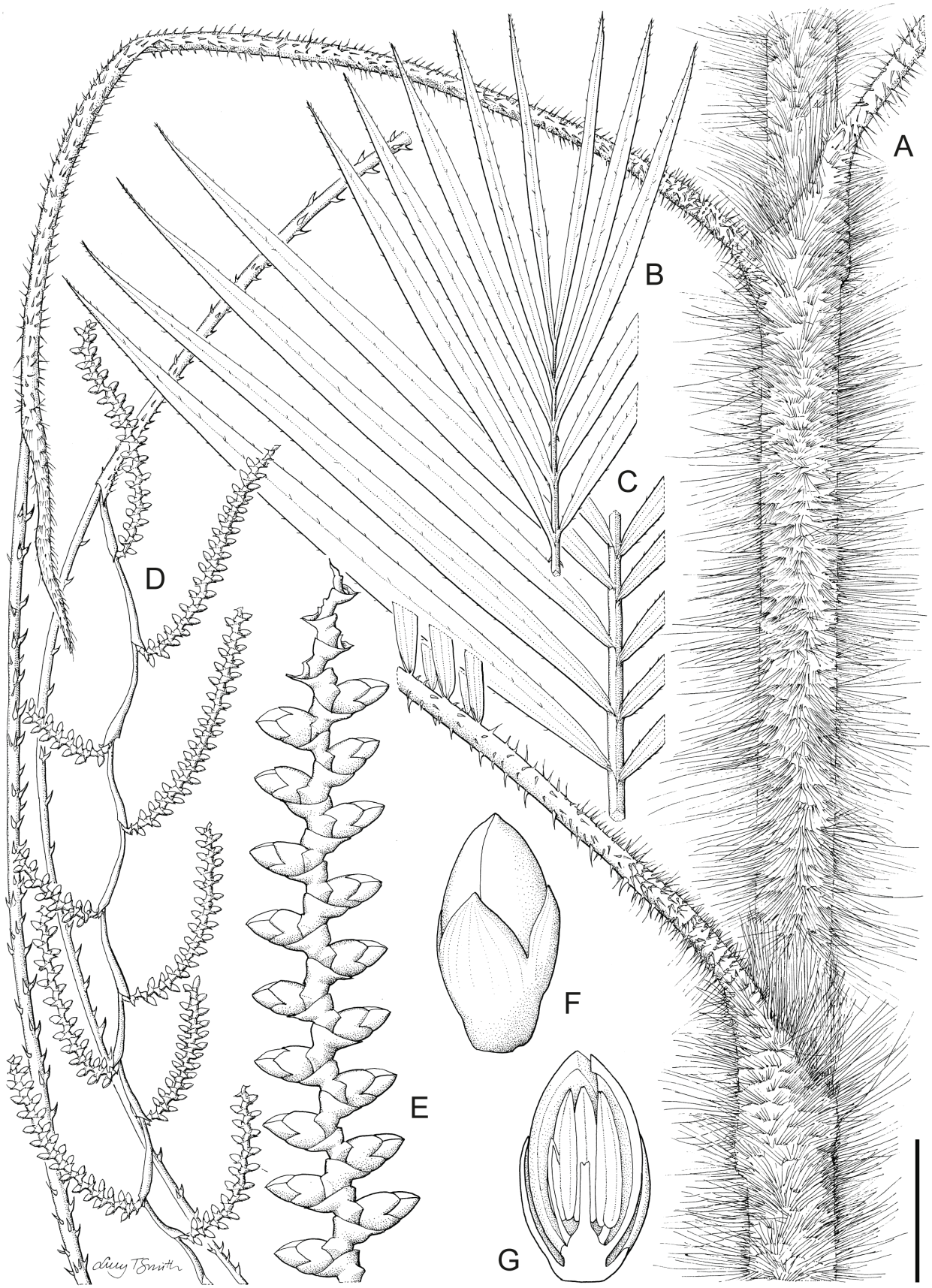

FIGURE 2. *Calamus capillosus.* A. Leaf sheath with base of inflorescence. B. Leaf apex. C. Mid-leaf portion. D. Primary branch of staminate inflorescence. E. Staminate rachilla. F. Staminate flower bud. G. Staminate flower bud in longitudinal section. Scale bar: A, D. = 2.5 cm; B, C = 3 cm; E= 7 mm, F, G = 1.6 cm. All from *Ave 4048*. Drawn by Lucy T. Smith.

side of rachis, linear, longest leaflets at mid-leaf position, mid-leaf leaflets 16.5–18 × 0.9–1.1 cm, apical leaflets ca. 10 × 0.4–0.6 cm, apical leaflets not united, leaflets armed with numerous brown-black 1–3 mm bristles on margins and major veins of both surfaces, otherwise largely glabrous, transverse veinlets moderately conspicuous. **Staminate inflorescence** flagelliform, ca. 3.2 m long, flagelliform tip only weakly formed, branched to 2 orders; prophyll 27 × 0.4 cm, strictly tubular, splitting slightly at apex, indumentum and armature as petiole; peduncular bracts 3, peduncular and rachis bracts similar to prophyll; primary branches 7, to 42 cm long, 15–30 cm apart, lax, pendulous, flexuous, with up to 27 rachillae, bracts narrowly tubular, to ca. 15 × 1 mm; rachillae 30–55mm × 0.8–1 mm, recurving; rachilla bracts ca. 2 × 3 mm, distichous, shallowly cup-shaped, with scattered brown scales; floral bracteole ca. 2.3 × 3 mm, cup-shape. **Staminate flowers** 2–2.3 × ca. 1.3 mm in bud; calyx ca. 1.5 mm diam., tubular in basal 0.5 mm, with 3 lobes ca. 0.6 × 1.2 mm, with scattered brown scales; corolla 2.3–2.5 × 1.2–1.3 mm in bud, tubular in basal ca. 0.5 mm, with scattered brown scales; stamens 6, filaments 1.1–1.2 × 0.1–0.2 mm, anthers 1.4–1.6 × 0.4–0.5 mm; pistillode 0.7–0.8 × 0.2–0.3 mm, trifid. **Pistillate inflorescence** not seen. **Pistillate flowers** not seen. **Sterile staminate flowers** not seen. **Fruit** not seen. **Seed** not seen.

Etymology:—The species epithet refers to the very hairy appearance of the leaf sheaths, due to the abundance of fine, hair-like spines, and the numerous hair-like bristles on the leaflets.

Distribution:—Known only from the type locality near Ayawasi in the Bird's Head Peninsula.

Habitat:—Disturbed forest at ca. 450 m.

Uses:—None recorded.

Vernacular names:—None recorded.

Specimens examined:—INDONESIA. West Papua Province: surroundings of Ayawasi, ca. 450 m, 1°09'S, 132°29'E, 28 July 1995, *Ave 4048* (holotype L!, isotype BO).

Notes:—Among the non-ocreate, flagellate *Calamus* species in New Guinea, *Calamus capillosus* is likely to be confused only with *C. schlechterianus* Beccari (1913: 119), on account of its sheaths densely armed with very fine, hair-like spines and regularly pinnate leaves with linear leaflets. The species is much more slender than *C. schlechterianus* and is entirely different in reproductive form, producing very long flagelliform inflorescences with a long peduncle, and primary branches that are elongate, lax and branched only to two orders in the staminate material seen by us. *Calamus schlechterianus*, in contrast, has much more robust, non-flagelliform inflorescences, with relatively compact and highly branched primary branching systems. There is also a superficial similarity to the Australian *C. australis* Martius (1838: 213), which also has sheaths densely armed with fine spines and regularly pinnate leaves. Nevertheless, while only a single staminate specimen was available to us, we are in no doubt that it represents a species that is new to science.

3. ***Calamus erythrocarpus*** W.J.Baker & J.Dransf., *sp. nov.* Type:—PAPUA NEW GUINEA. Central Province: Sogeri Subdistict, near Jawarere (Subitana), 450 m, 9°25'S, 147°25'E, 3 September 1968, *Zieck NGF 36176* (holotype LAE!, isotype BH, L!)

Diagnosis:—Distinguished by the moderately robust, clustering habit, the subcirrate leaf with few broadly lanceolate, cucullate leaflets, the longest leaflets at the base of the leaf, the leaf apex bearing a vestigial leaflet pair remnant or a short cirrus, the leaf sheaths armed only with few, minute spines, the short inflorescences lacking peduncular bracts, the rachis bracts significantly exceeding the primary branches and splitting to the base (not tattering), and the rounded red fruit covered with unchannelled, erose-margined scales.

Moderately robust, clustering rattan climbing to ca. 40 m. **Stem** with sheaths 12–23 mm diam., without sheaths to 9–13 mm diam.; internodes 24–40 cm. **Leaf** subcirrate, to 70–97 cm long including subcirrus and petiole; sheath mid-green when dry, with thin, pale grey caducous indumentum of matted hairs and irregular scales, almost unarmed with the exception of very few, scattered, minute, upward-pointing, brown-tipped spines to ca. 0.5 mm long; knee 24–28 mm long, 10–20 mm wide, colour and indumentum as sheath, unarmed; ocrea a low, tightly sheathing, unarmed, leathery crest encircling leaf sheath, 7–13 mm high, darker than sheath, unarmed, leathery, persistent; flagellum to 220 cm long; petiole 2–7 cm long, 5–8 mm wide and 3–4.5 mm thick at base, rounded adaxially, flattened abaxially, indumentum as sheath, unarmed or armed with solitary grapnel spines; rachis ca. 60–90 cm, moderately armed with grapnels; leaflets 8–11 each side of rachis, subregularly arranged, rather widely spaced 3.5–11 cm apart, broadly lanceolate, usually cucullate, longest at base 23–37 × 2–5 cm, mid-leaf leaflets 22–34 × 3–5 cm, apical leaflets highly reduced to a vestigial remnant 2.2–3.7 × 1–2 cm, or even reduced to a fibre-like structure ca. 1.2 × 0.1 cm, the leaf apex then resembling a short cirrus, leaflets unarmed and glabrous, with the exception of a very few, fine, marginal bristles near apex of some leaflets, transverse veinlets moderately conspicuous. **Staminate inflorescence** compact, erect, possibly arching when mature, 40–55 cm long including ca. 20 cm peduncle, lacking flagelliform tip, branched to 3 orders; prophyll 24–31

FIGURE 3. *Calamus erythrocarpus.* A. Leaf sheath with basal leaflets. B. Leaf sheath with flagellum. C. Leaf diagram. D. Leaf apex. E, F. Staminate inflorescence. G. Apex of pistillate inflorescence. H. Fruit. I. Seed in two views. J. Seed in longitudinal section. Scale bar: A, B, D, E, F, G = 4 cm; C = 24 cm; H, I, J = 7.5 cm. A, B, D from *Zieck NGF 36176*; C, E–G from *Zieck NGF 36181*. Drawn by Lucy T. Smith.

× 12–17 cm, tubular, with asymmetrically acute tip, keeled, apparently splitting on maturity, indumentum as sheath, unarmed; peduncular bracts lacking, rachis bracts 2.5–18 × 0.8–1.7 cm, similar to prophyll, but splitting to base to expose primary branches, overlapping, at least two times longer than primary branches, unarmed; primary branches ca. 6, to 3–6 cm long, ca. 5 cm apart, compact, finely branched, exceeded by and enclosed within rachis bracts, with numerous rachillae, moderately well-developed bracts on main axis; rachillae 3–10 mm × ca. 0.5 mm, straight; rachilla bracts 1.5 mm long, triangular, subdistichous, inconspicuous; floral bracteole 0.2 × 0.5 mm, shallow cup-shaped. **Staminate flowers** 1.2–2 × 1–1.2 mm in early bud (only immature material available); stamens 6. **Pistillate inflorescence** similar to staminate inflorescence, erect, ca. 37 cm long including ca. 9 cm peduncle, lacking flagelliform tip, branched to 2 orders; prophyll ca. 22 × 1.7 cm, tubular, but split deeply to base by emerging subtended primary branch, exceeding the primary branch by more than twice its length, indumentum as sheath, unarmed; peduncular bracts lacking, rachis bracts similar to staminate inflorescence rachis bracts in dimensions, overlapping, splitting deeply to base by emergence of primary branches and the remainder of the inflorescence, but typically remaining tubular at the tip, unarmed; primary branches ca. 4, 2–6 cm long, ca. 4 cm apart, erect, sparsely branched, exceeded by and enclosed within prophyll and rachis bracts, with up to 9 rachillae, bracts as in staminate inflorescence; rachillae 3–27 mm × 1–2 mm, straight; rachilla bracts 0.5 × 1.5 mm, distichous, tubular; proximal floral bracteole 1 × 1.5 mm, distal floral bracteole 1 × 1 mm, scar from sterile staminate peg-like and protruding to side of pistillate scar. **Pistillate flowers** not seen. **Sterile staminate flowers** not seen. **Fruit** ellipsoid, ca. 16 × 11 mm including beak 1.5 × 1 mm, with ca. 13 longitudinal rows of red, smooth, unchannelled scales with erose margins. **Seed** (sarcotesta removed) 9 × 8 × 5.5 mm, ellipsoid with deep lateral pit; endosperm homogeneous; embryo basal.

Etymology:—The specific epithet refers to the red colour of the fruit.

Distribution:—Known from many gatherings at a single locality in hills 35 km east of Port Moresby, Central Province.

Habitat:—Rain forest on lower slopes and bottom of a creek valley, ca. 460 m.

Uses:—None recorded.

Vernacular names:—*Ohana* (Goari).

Specimens examined:—PAPUA NEW GUINEA. Central Province: Sogeri Subdistict, near Jawarere (Subitana), 460 m, 9°25’S, 147°25’E, 3 September 1968, *Zieck NGF 36176* (holotype LAE!, isotype BH!, L!), 1 October 1968, *Zieck NGF 36181* (BH!, LAE!); Sogeri Subdistict, Subitana, 460 m, 9°25’S, 147°32’E, 4 February 1970, *Zieck NGF 36233* (BH!, LAE!).

Notes:—*Calamus erythrocarpus* is a member of the *Calamus anomalus* complex. All species of this group produce relatively short inflorescences that are unarmed (except for the prophyll in some instances), lack a flagelliform tip, and bear overlapping, papery bracts that exceed the internode above and that are punctured or split by the relatively short, emerging inflorescence branches. Most species of this group (*C. anomalus* Burret [1935: 320], *C. erythrocarpus*, *C. essigii* Baker [2002: 720], *C. nannostachys* [1931: 264]) have a rather narrow distribution restricted to the Owen Stanley Range in Central Province and adjacent Northern Province in south-eastern Papua New Guinea, where they are separated along an elevational gradient, whereas *C. maturbongsii* Baker & Dransfield (2002: 725) occurs in the vicinity of Sorong in far western Indonesian New Guinea. This striking disjunction constitutes a 1700 km gap in distribution records. Even more remarkably, *C. erythrocarpus* grows in close proximity with *C. anomalus* and *C. essigii*, with the closest site records separated by just ca. 3–5 km, but its morphology indicates that it is very closely related to the disjunct *C. maturbongsii*. In fact, initially we regarded *C. erythrocarpus* and *C. maturbongsii* as the same species, but closer study has revealed important differences.

Similarities that are shared by *C. erythrocarpus* and *C. maturbongsii*, include the moderately robust, clustering habit, overall leaf structure (few broadly lanceolate, cucullate leaflets, longest leaflets at the base of the leaf), almost glabrous leaf sheaths armed only with few, minute spines, and the robust inflorescence relative to other members of the group. Their fruit are strikingly similar in their shape, colour (red in *C. erythrocarpus*, orange in *C. maturbongsii*), in the structure of their rather flat scales with erose margins, and in the smooth seed within. The most obvious difference is the subcirrate leaf of *C. erythrocarpus* in which the apical leaflets are highly reduced to a vestigial remnant no more than 4 cm long that in one specimen is reduced to a fibre-like structure, the leaf apex then resembling a short cirrus. The apical leaflets of *C. maturbongsii* are a more typical leaflet pair that are not united or partly united by one quarter of their length. Only pistillate inflorescences are known for *C. maturbongsii*, but these are much longer than pistillate inflorescences of *C. erythrocarpus* (62–81 cm long as opposed to ca. 37 cm), primarily due to the much longer peduncle that bears peduncular bracts, which are not observed in either pistillate or staminate material of *C. erythrocarpus*. The rachis bracts of *C. maturbongsii* split deeply and also tatter, while *C. erythrocarpus* bracts split deeply, but do not tatter. The primary branches of *C. erythrocarpus* pistillate inflorescences bear fewer rachillae (up to nine in available material, compared to up to 17 in *C. maturbongsii*).

4. ***Calamus heatubunii*** W.J.Baker & J.Dransf., *sp. nov.* Type:—INDONESIA. West Papua Province: Kota Sorong, Klasaman km 14, Klasagan, 50 m, 0°54'50"S, 131°21'32"E, 2 February 2013, *Baker et al. 1392* (holotype K!, isotypes AAU!, BO!, BRI!, L!, MAN!).

Diagnosis:—Distinguished by the few, broad, leathery leaflets, typically arranged in a single, divaricate group, the well-developed, purple-brown ocrea armed with numerous, solitary triangular spines, and the short, erect inflorescences lacking a flagelliform tip with compact, but not congested branching.

Moderately robust, clustering rattan climbing to 20 m. **Stem** with sheaths 11–18 mm diam., without sheaths 7–11 mm diam.; internodes 13–28 cm. **Leaf** ecirrate 70–90 cm long including petiole; sheath dark green, with caducous indumentum of matted grey hairs, soon falling, densely and evenly armed with solitary spines 2–4 × 0.5–1.5 mm, triangular, orange-brown tipped; knee 20–33 mm long, 9–12 mm wide, colour and indumentum as sheath, partially armed as sheath; ocrea 18–ca. 50 × 2–2.5 cm, boat-shaped, somewhat inflated and clasping, split to base on side opposite the petiole insertion, erect, papery, dark purple-green, drying brown, armed with numerous, scattered solitary spines similar to sheath spines, persistent, but eventually disintegrating; flagellum to 2.5 m long; petiole 20–26 cm, 5.5–9 mm wide and 3–4.5 mm thick at base, flattened adaxially, rounded abaxially, with indument and armature as sheath, with some solitary grapnel spines abaxially; leaflets 2–5 each side of rachis, broadly lanceolate, cucullate, glossy green, leathery, clustered in a single, divaricate group (typically of four leaflets) at the petiole apex (appearing digitate), less commonly an additional divaricate group of leaflets also present, apical leaflets 33–52 × 6–10 cm, apical leaflet pair united from one half to two thirds of their length, rachis extending conspicuously through the united portion of the terminal leaflet pair, remaining leaflets 32–50 × 5–9 cm, leaflet surfaces almost entirely unarmed, leaflet margins evenly armed with fine, stiff spines 1–2 mm long, leaflets lacking indumentum, transverse veinlets conspicuous. **Staminate inflorescence** erect, compact, held close to stem, ca. 35 cm long including ca. 9.5 cm peduncle, lacking flagelliform tip, branched to 3 orders; prophyll ca. 11 × 0.8 cm, narrowly tubular, indumentum not seen, armed as sheath; peduncular bracts lacking (prophyll subtending primary branch), rachis bracts 37–53 × 0.5–0.8 cm, narrowly tubular, with asymmetric, acute, distal limb, indumentum not seen, with very few spines as sheath; primary branches ca. 8, to ca. 14 cm long, ca. 4 cm apart, erect and appressed to main inflorescence, with up to ca. 30 rachillae, erect, held at acute angle with primary branch axis; rachillae 20–40 mm × 2–3 mm, straight or somewhat curved; rachilla bracts ca. 1 × 2–2.5 mm, distichous, openly funnel-shaped; floral bracteole ca. 1 × 2 mm, cup-shaped. **Staminate flowers** not seen. **Pistillate inflorescence** similar to staminate inflorescence, erect, compact, held close to stem, 22–33 cm long including 6–17 m peduncle, lacking flagelliform tip, branched to 2 orders; prophyll 10–20 × 0.7–0.8 cm, similar to staminate inflorescence; peduncular bracts lacking, rachis bracts similar to staminate inflorescence; primary branches 8, to 6 cm long, 13–25 mm apart, erect, appressed to main axis, with up to 9 rachillae; rachillae 21–37 mm × 3–5 mm, twisted; rachilla bracts 1.2–1.5 × 2 mm, distichous, funnel-shaped, mostly subtending floral dyads, but in some instances floral triads present at base of rachillae, apparently comprising one sterile staminate flower, and two pistillate flowers subtended by the proximal floral bracteole; proximal floral bracteole ca. 3 × 2 mm, distal floral bracteole ca. 2 × 2 mm, scar from sterile staminate inconspicuous. **Pistillate flowers** ca. 5 × 2.2 mm at anthesis; calyx ca. 2.2 mm diam., tubular in basal 3 mm, with 3 lobes to ca. 1 × 1.5 mm; corolla ca. 3.5 × 2.2 mm, tubular in basal ca. 2 mm, with 3 lobes to 1.5 × 1.5 mm; staminodes 6, 0.5–0.8 mm long, staminodial ring ca. 1 mm high; ovary ca. 1.5 × 1.7 mm, spheroidal, style 1 mm long, stigmas 1.5 mm long, strongly recurving. **Sterile staminate flowers** not seen. **Fruit** spherical, 13 × 10–11 mm including beak 1 × 1 mm, with 16–17 longitudinal rows of brown, dark margined, shallowly channelled scales. **Seed** (sarcotesta removed) ca. 8.5 × 7.5 × 4 mm, rounded, but bilaterally compressed and concave on one side, with irregular channels and ridges; endosperm homogeneous; embryo basal.

Etymology:—*Calamus heatubunii* is named for our friend and long-time collaborator in New Guinea palm research, Prof. Charlie D. Heatubun of Universitas Papua, Manokwari, Indonesia.

Distribution:—Recorded from several localities near to Sorong and from Waigeo in the Raja Ampat Islands in far western New Guinea.

Habitat:—Lowland forest, including secondary, hill and swamp forest, 45–180 m.

Uses:—None recorded.

Vernacular names:—None recorded.

Specimens examined:—INDONESIA. West Papua Province: Sorong, Desa Klasaman, Lereng Bukit, 110 m, 0°55'S, 131°22'E, 12 November 1994, *Maturbongs 33* (K!, MAN); Sorong, Klasaman, km 24, Intimpura Camp, 180 m, 0°57'S, 131°27'E, 18 September 1995, *Maturbongs 285* (K!, MAN); Kota Sorong, Klasaman km 14, Klasagan, 50 m, 0°54'50"S, 131°21'32"E, 2 February 2013, *Baker et al. 1392* (holotype K!, isotypes AAU!, BO!, BRI!, L!, MAN!), *Baker at al. 1394* (BO!, K!, L!, MAN!); Sorong, Makbalim Village, Aimas, 45 m, 1°4'S, 131°24'E, 1 July 1997,

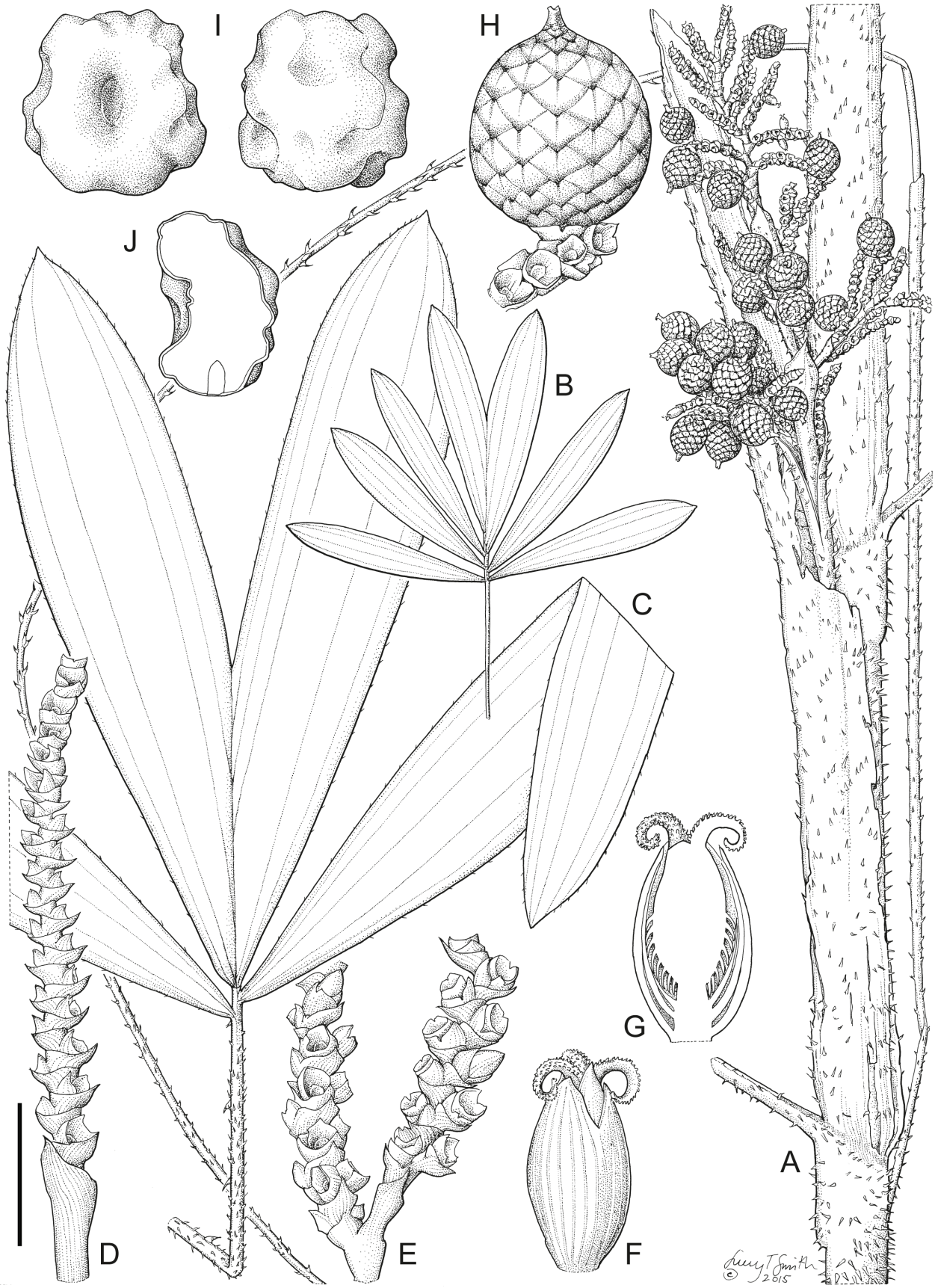

FIGURE 4. *Calamus heatubunii.* A. Leaf sheath with ocreas and infructescence. B. Leaf diagram. C. Whole leaf. D. Staminate rachilla. Pistillate rachillae. F. Pistillate flower at anthesis. G. Pistillate flower in longitudinal section. H. Fruit. I. Seed in two views. J. Seed in longitudinal section. Scale bar: A = 4 cm; B = 24 cm; C = 8 cm; D, E = 1 cm; F, G = 3 mm, H–J = 8 mm. A, B, H–J from *Baker et al. 1392*; C–G from *Baker et al. 1394.* Drawn by Lucy T. Smith.

Maturbongs et al. 542 (K!, MAN); Raja Ampat Islands, Waigeo Island, Waifoi Village, 50 m, 0°14'S, 130°50'E, 26 June 1997, *Maturbongs et al. 516* (MAN, K!)

Notes:—This species belongs to the *Calamus lauterbachii* group (also containing *C. cheirophyllus* J.Dransf. & W.J.Baker in Baker & Dransfield [2014: 189] and *C. lauterbachii* Beccari [1908: 491]), which is characterised by strongly grouped, rather broad, leathery leaflets, conspicuous ocreas and rather compact inflorescences, sometimes with congested primary branching systems. *Calamus heatubunii* is a moderately robust species with very few leaflets, which are most often arranged in a single, divaricate group at the leaf apex. Its well-developed, purple-brown ocrea can reach ca. 50 cm in length and is armed with numerous, solitary triangular spines, similar to those found on the leaf sheath. The inflorescences are short, lacking a flagelliform tip, and erect, with compact, though not congested branching. It appears to be most closely related to the widespread species *C. lauterbachii*, which differs in the leaflets being more numerous, ocrea spines being organised in neat rows like eyelashes, the inflorescence bearing a flagelliform tip and congested primary branching systems, and the seed with shallower and less angular sculpturing. *Calamus heatubunii* also resembles *C. cheirophyllus* in the typically digitate arrangement of the leaflets and the erect, non-congested inflorescence, but this species is a montane taxon, that is much more slender in all its parts, with a fragile, unarmed papery ocrea that readily disintegrates.

Based on currently available records, the range of *C. heatubunii* does not overlap with that of the other two species. *Calamus lauterbachii* is widespread in New Guinea, but the most westerly record comes from the Arfak Mountains. *Calamus cheirophyllus* is known only from a few records in the Eastern and Southern Highlands of Papua New Guinea.

5. ***Calamus jacobsii*** W.J.Baker & J.Dransf., *sp. nov.* Type:—PAPUA NEW GUINEA. Morobe: south-east of Lae on the coast, opposite Lasanga Island, 500–600 m, 7°25'S, 147°10'E, 11 November 1973, *Jacobs 9561* (holotype L!, isotypes LAE).

Diagnosis:—Distinguished by the leaves and leaf sheaths drying brown, the unarmed leaf sheath, the very short petiole, the few, subregularly arranged, elliptic leaflets, and the non-flagelliform staminate inflorescence that is branched to 4 orders.

Moderately robust rattan climbing to 15 m. **Stem** with sheaths 18–24 mm diam., stem without sheaths not seen; internodes ca. 35 cm. **Leaf** ecirrate to 76 cm long including petiole; sheath brown when dried, with thin, dense, caducous indumentum consisting of minute, cup-shaped, translucent, colourless scales and brown or colourless fibrous scales, spines lacking; knee 25 mm long, colour and indumentum as sheath; ocrea 4–6 mm high, forming an inconspicuous bony crest that extends into the lower part of the petiole, unarmed, colour and indumentum as sheath, persistent; flagellum to ca. 220 cm; petiole ca. 5 mm long, ca. 7.5 mm wide and ca. 5 mm thick at base, shallowly grooved adaxially, rounded abaxially, indumentum as sheath, armed with one or two solitary grapnel spines abaxially; rachis ca. 40 cm, armed with scattered solitary or grouped grapnel spines abaxially; leaflets ca. 4–5 each side of rachis, subregularly arranged, broadly elliptic, longest leaflet at mid-leaf position, mid-leaf leaflets ca. 37 × 8 cm, apical leaflets 35 × 5 cm, apical leaflet pair united to approximately two thirds of their length, leaflets unarmed except for very rare minute marginal bristles at apex, with scattered patches of indumentum as leaf sheath, transverse veinlets conspicuous; **Staminate inflorescence** arching, moderately robust, at least 87 cm long (complete inflorescence not seen), apparently lacking flagelliform tip, branched to 4 orders; prophyll not seen; peduncular bracts at least 1, peduncular and rachis bracts 7–26 × 0.7–1.2 cm, strictly tubular with asymmetrically pointed tip, not splitting, with indumentum as sheath, unarmed; primary branches at least 3, to ca. 21 cm long, 16–26 cm apart, erect, diffusely and finely branched, with numerous rachillae, bracts to 18 × 4 mm, funnel-shaped, relatively conspicuous, with indumentum as sheath; rachillae 5–16 mm × 0.5–1 mm, straight to slightly recurving; rachilla bracts ca. 1.5 × 0.5–1 mm, distichous, explanate, apiculate, with scattered indumentum as sheath; floral bracteole 1.3–1.5 × 0.8–1 mm, flattened, glabrous. **Staminate flowers** ca. 2 × 1.3–1.8 mm in early bud, immature. **Pistillate inflorescence** not seen. **Pistillate flowers** not seen. **Sterile staminate flowers** not seen. **Fruit** not seen. **Seed** not seen.

Etymology:—The species is named for Marius Jacobs (1929–1983), a senior botanist of the Rijksherbarium, Leiden and collector of the type specimen. Jacobs died at the age of 53, unexpectedly cutting short his career in plant taxonomy and conservation in Malesia (Kalkman 1983).

Distribution:—Known from two localities in mountains south of Lae, Papua New Guinea.

Habitat:—Primary forest at an elevation of 500–600 m.

Uses:—None recorded.

Vernacular names:—None recorded.

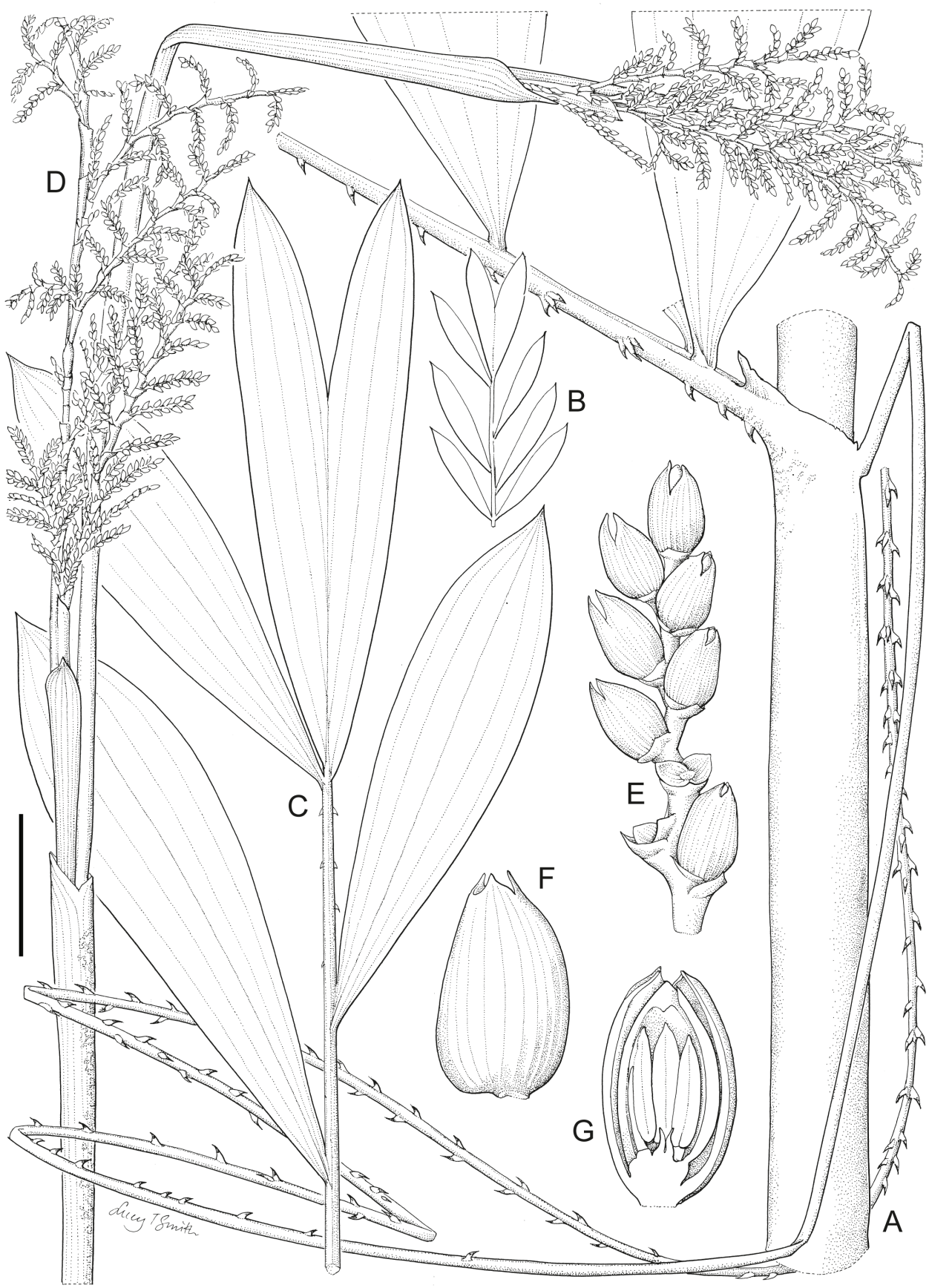

FIGURE 5. *Calamus jacobsii.* A. Leaf sheath with basal leaflets and flagellum. B. Leaf diagram. C. Leaf apex. D. Portion of staminate inflorescence. E. Staminate rachilla. F. Staminate flower bud. G. Staminate flower bud in longitudinal section. Scale bar: A, D = 3 cm; B = 35 cm; C = 8 cm; E = 1.6 mm; F, G = 1.5 mm. All from *Jacobs 9561*. Drawn by Lucy T. Smith.

Specimens examined:—PAPUA NEW GUINEA. Morobe Province: south-east of Lae on the coast, opposite Lasanga Island, 500–600 m, 7°25'S, 147°10'E, 11 November 1973, *Jacobs 9561* (holotype L!, isotypes LAE); ridge crest in mountains north-west of Ana village, 7°48'S, 147°33'E, 500 m, *Essig LAE 55159* (LAE!, BH).

Notes:—*Calamus jacobsii* is known from relatively incomplete material from two collections, one including a staminate inflorescence in bud (the type, *Jacobs 9561*), the other (*Essig LAE 55159*) an apparently juvenile sterile specimen. Nevertheless, it is sufficiently distinct to be described as new here. The species dries a distinctive brown colour. The leaf sheath is unarmed and covered with thin, but dense, caducous indumentum, which also occurs on other organs. The petiole is very short (ca. 5 mm) and the leaf bears very few (4–5), large, elliptic leaflets, which are themselves almost entirely unarmed. The staminate inflorescence seen by us is not flagelliform and is branched to four orders. It is perhaps most easily confused with *C. johnsii*, a robust form of which also occurs in the vicinity of the type locality of *C. jacobsii* (*Jacobs 9698*, L!). The two species are similar in leaflet size, shape and number and the lack of a petiole. *Calamus johnsii*, however, is more slender, dries pale green, is armed on its leaf sheath with planar, black spines, and bears slender, whip-like inflorescences that have a flagelliform tip and that are branched to three orders in the staminate. *Calamus johnsii* is also not known from above 350 m elevation.

6. ***Calamus katikii*** W.J.Baker & J.Dransf., *sp. nov.* Type:—PAPUA NEW GUINEA. Morobe Province: Wau Subprovince, Kodama Range, Mount Walker, Korpera River, 1829 m, 7°20'S, 146°40'E, 16 November 1981, *Katik LAE 74954* (holotype LAE!, isotypes NSW, USF).

Diagnosis:—Distinguished by the slender habit, ecirrate leaves with very few (ca. 4 pairs) grouped leaflets, the sparsely armed, flagellate leaf sheaths, the short inflorescence with flagelliform tip and large fruit relative to the size of the plant.

Very slender rattan climbing to 5 m. **Stem** with sheaths 3.5–5 mm diam., without sheaths ca. 3 mm diam.; internodes 9.5–12 cm. **Leaf** ecirrate, to 24 cm long including petiole; sheath orange-green, with indumentum of sparse, minute, dark hair-like scales, interspersed with translucent, crustaceous scales, sparsely armed with narrow, brown-black, needle-like spines 2–4 mm long; knee ca. 8 mm long, ca. 4 mm wide, with spines and indumentum as sheath, though scales denser; ocrea ca. 1.5 mm high, insignificant, tightly sheathing, armature as sheath; flagellum present, at least 35 cm long, only incomplete material seen; petiole 16–18 mm long, 1.5–2 mm wide and ca. 1.5 mm thick at base, shallowly channelled adaxially, rounded abaxially, indumentum as sheath, armed with few, recurved, hook-like spines; rachis 9–10 cm, armed with few, recurved grapnel spines; leaflets 4 each side of rachis, arranged in two widely spaced groups, narrowly elliptic, longest leaflets in lower group, ca. 13 × 1.2–1.5 cm, apical leaflets 11.5–13 × 1.2–1.4 cm, apical leaflet pair united to one fifth of their length, leaflets almost unarmed except for minute dark bristles on margins at apex, with scattered indumentum as sheath, transverse veinlets moderately conspicuous. **Staminate inflorescence** not seen. **Staminate flowers** not seen. **Pistillate inflorescence** arching, ca. 40 cm long including 11 cm peduncle and 19 cm flagelliform tip, branched to 2 orders; prophyll ca. 7 × 0.3 cm, strictly tubular, armature and indumentum as sheath; peduncular bracts absent, rachis bracts ca. 5 × 0.3 cm, similar to prophyll; primary branches 2, to 3.7 cm long, 10 cm apart, with up to ca. 6 rachillae; rachillae 5–12 mm × ca. 2 mm, sinuous; rachilla bracts 1–2 × 1.5 mm, widely spaced, funnel-shaped, indumentum as sheath; proximal floral bracteole ca 2.5 × 2.5 mm, distal floral bracteole ca. 2 × 2 mm, scar from sterile staminate 0.6–1 mm diam., round to elliptic, raised. **Pistillate flowers** not seen. **Sterile staminate flowers** not seen. **Fruit** globose, ca. 20 × 15 mm including beak 2 × 0.5 mm, with 16 longitudinal rows of cream-orange scales, channelled with minutely fimbriate margins. **Seed** (sarcotesta removed) ca. 12 × 6 × 9 mm, ellipsoid with broad, shallow pit; endosperm homogeneous; embryo basal.

Etymology:—This species is named for Paul Katik, renowned botanist, formerly of the Papua New Guinea Forest Research Institute, and collector of the type specimen.

Distribution:—Known only from a single collection from the Kodama Range, Morobe Province, Papua New Guinea.

Habitat:—Montane, mossy forest at ca. 1800 m.

Uses:—None recorded.

Vernacular names:—None recorded.

Specimens examined:—PAPUA NEW GUINEA. Morobe Province: Wau Subprovince, Kodama Range, Mount Walker, Korpera River, 1829 m, 7°20'S, 146°40'E, 16 November 1981, *Katik LAE 74954* (holotype LAE!, isotypes NSW, USF).

Notes:—This new species most closely resembles *C. cuthbertsonii* Beccari (1888: 179) in its very slender habit, short inflorescences and narrow leaflets. The two species appear also to overlap in range. *Calamus katikii* is however readily distinguished by its small number of leaflets (4 pairs, rather than 5–13 pairs), which are arranged in two distant

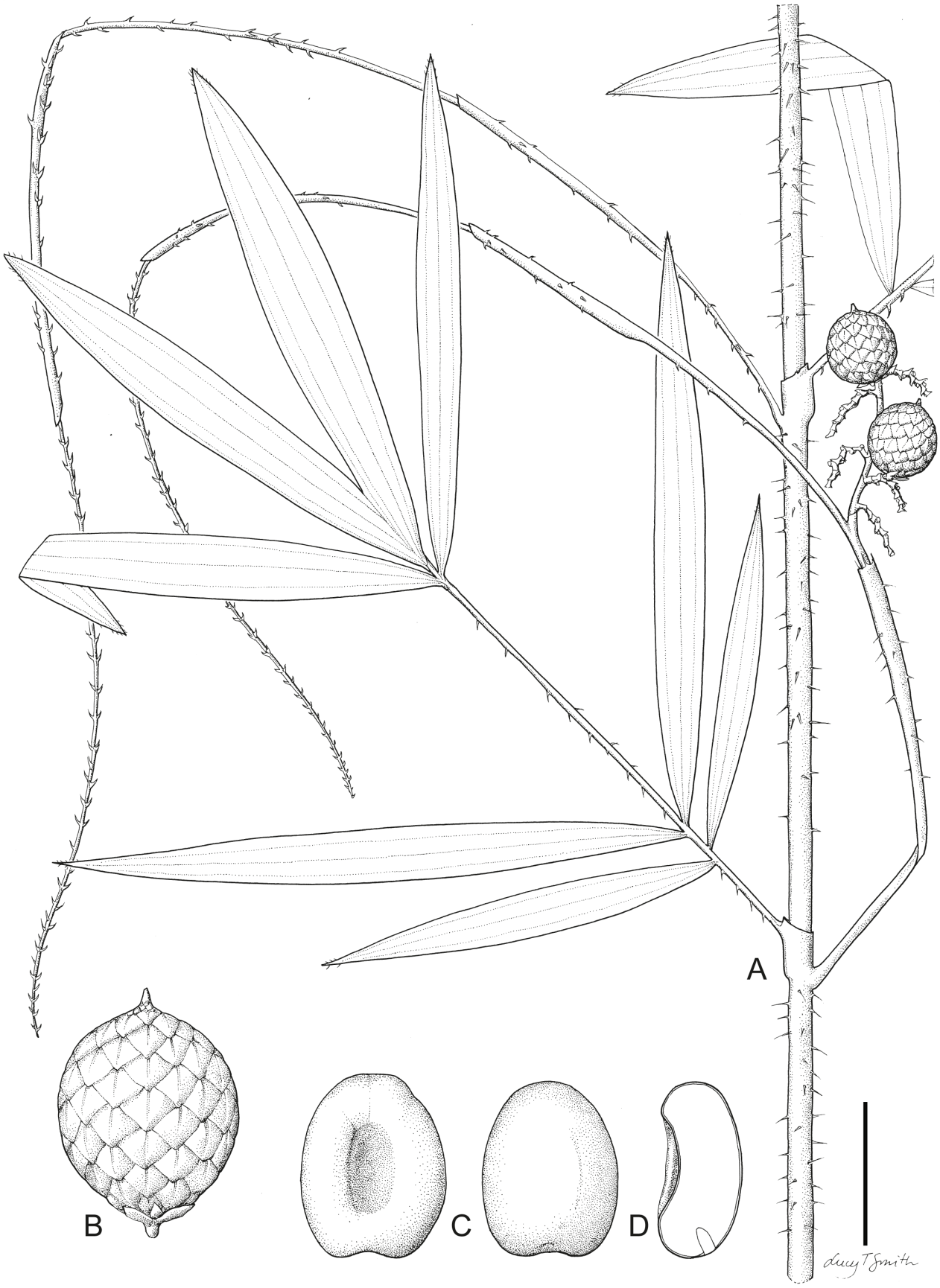

FIGURE 6. *Calamus katikii.* A. Leaf sheath with whole leaf and infructescence B. Fruit. C. Seed in two views. D. Seed in longitudinal section. Scale bar: A = 3 cm; B–D = 1 cm. All from *Katik LAE 74954*. Drawn by Lucy T. Smith.

groups as opposed to being regularly to subregularly arranged, and its sparser armature. Its inflorescence is also distinct in having a short flagelliform tip, which is entirely lacking in *C. cuthbertsonii*. *Calamus katikii* also produces a disproportionately robust fruit, up to 20 mm long, which is not known in *C. cuthbertsonii*.

Calamus katikii also resembles closely some unusual specimens of *C. johnsii* Baker & Dransfield (2014: 193) from Sudest Island (*Johns 12839 & Maru* [BRIT, K!, L, LAE, UPNG], *Brass 27857* [K!, L!, LAE!]) in slender habit, leaf structure and the rather large fruit. However, *C. johnsii* is known from 13 records, none of which occurs above 350 m, whereas *C. katikii* is known only from ca. 1800 m. The type locality of *C. katikii* is ca. 900 km from the locations of these two unusual specimens, and other records of *C. johnsii* that occur nearest to *C. katikii* are consistent with the robust typical form of the species. *Calamus katikii* can be distinguished from the two unusual *C. johnsii* specimens by being less heavily armed, somewhat smaller in stature with shorter primary branching that does not split the strictly tubular rachis bracts, unlike the rachis bracts of *C. johnsii*, which are often somewhat split at the apex by the emerging primary bracts.

Vegetatively, *C. katikii* could also be confused with *C. anomalus* or *C. essigii* from the nearby Owen Stanley Range, but these species are immediately distinguished by their characteristic inflorescence morphology.

7. ***Calamus kostermansii*** W.J.Baker & J.Dransf., *sp. nov.* Type:—INDONESIA. Papua Province: Fak-Fak, Timika, sago swamp, between Timika and port, km 23, 10 m, 4°38’0”S, 136°54’21”E, 16 February 1998, *Baker et al. 848* (holotype K!, isotypes BO!, MAN!, BH!, L!).

Diagnosis:—Similar to *Calamus longipinna*, but differs in the dense chocolate brown caducous indumentum on sheaths, short triangular spines on sheaths, tough ocrea that disintegrates into fibres at the margin and the more elongate and short-spiny rachis bracts.

Moderately robust, clustering rattan climbing to ca. 10 m. **Stem** with sheaths 18–27 mm diam., without sheaths to 15–18 mm diam., without exudate; internodes 16–31 cm. **Leaf** ecirrate to ca. 1 m long; sheath yellowish green, covered with dense caducous chocolate-brown indument, bearing scattered short spines with slightly swollen bases, spines 2–7 mm, triangular, pale green with brown tips, abaxially with brown indumentum, the spines scattered or rarely in groups of 1–3; knee ca. 35 mm long, pale green unarmed or with scattered spines along margins, with scattered scales near base and sides, otherwise glabrous; ocrea ca. 16 × 2.5 cm, elongate, enclosing the stem, thick papery in texture next to the petiole and leaf rachis, disintegrating into long fibres on the opposite side, straw-coloured, unarmed or with a few scattered spines near the base, and with scattered thin caducous pale brown indumentum; flagellum 2–3 m long; petiole very short or absent; rachis ca. 100 cm long, armed distally with scattered or grouped short reflexed spines to 3 mm; leaflets ca. 50 on each side of rachis, regularly arranged, narrow lanceolate, longest leaflet in mid leaf, basal leaflets ca. 14 × 0.3 cm, mid-leaf leaflets ca. 30 × 1.4 cm, apical leaflets ca. 18 × 0.7 cm, apical leaflet pair free, leaflets armed with conspicuous black bristles to 2 mm long along 3 veins adaxially, and along margins and 3 veins abaxially with shorter bristles to 1 mm, transverse veinlets conspicuous, rather dense. **Staminate inflorescence** not seen. **Staminate flowers** not seen. **Pistillate inflorescence** flagelliform, ca. 4 m long including 1 m peduncle and 2 m flagelliform tip, branched to 2 orders; prophyll ca. 35 × 1.2 cm, tightly sheathing, splitting and eroding into fibres distally, glabrous, bearing 2 rows of short spines to 2 mm long along the keels; peduncular bracts absent, rachis bracts, tightly sheathing, similar to the prophyll, 15–25 × 0.7–1 cm, splitting distally into irregular fibrous lobes, glabrous, with scattered short spines; primary branches 4, to ca. 105 cm long, ca. 25 cm apart, pendulous, with up to 12 rachillae; rachillae 120–350 mm × 2–2.5 mm, terete; rachilla bracts ca. 12 × 20 mm, distichous, strictly tubular, with triangular tips, and bearing scattered very short spines and caducous dark brown indument; proximal floral bracteole acute, ca. 3 × 2 mm, distal floral bracteole acute with scattered indument, 2 × 2 mm, scar from sterile staminate flower ca. 1 mm diam.. **Pistillate flowers** ca. 3.5 × 1.5 mm in very early bud. **Sterile staminate flowers** 3 × 1 mm in very early bud. **Fruit** ellipsoid, ca. 15 × 7 mm including beak ca. 1 × 1 mm, with 14 longitudinal rows of pale brown, shallowly channelled, scales with dark margins, sarcotesta. **Seed** (sarcotesta removed) ca. 8 × 3 × 2 mm, ellipsoid; endosperm immature, probably homogeneous; embryo basal.

Etymology:—This species is named for A.J.G.H. Kostermans (1906–1994), the celebrated Dutch-Indonesian botanist whose specimen drew our attention to the existence of this species.

Distribution:—Known from only two localities in central and western Indonesian New Guinea.

Habitat:—Riverine and swamp habitats, ca. 10 m elevation.

Uses:—None recorded.

Vernacular names:—None recorded.

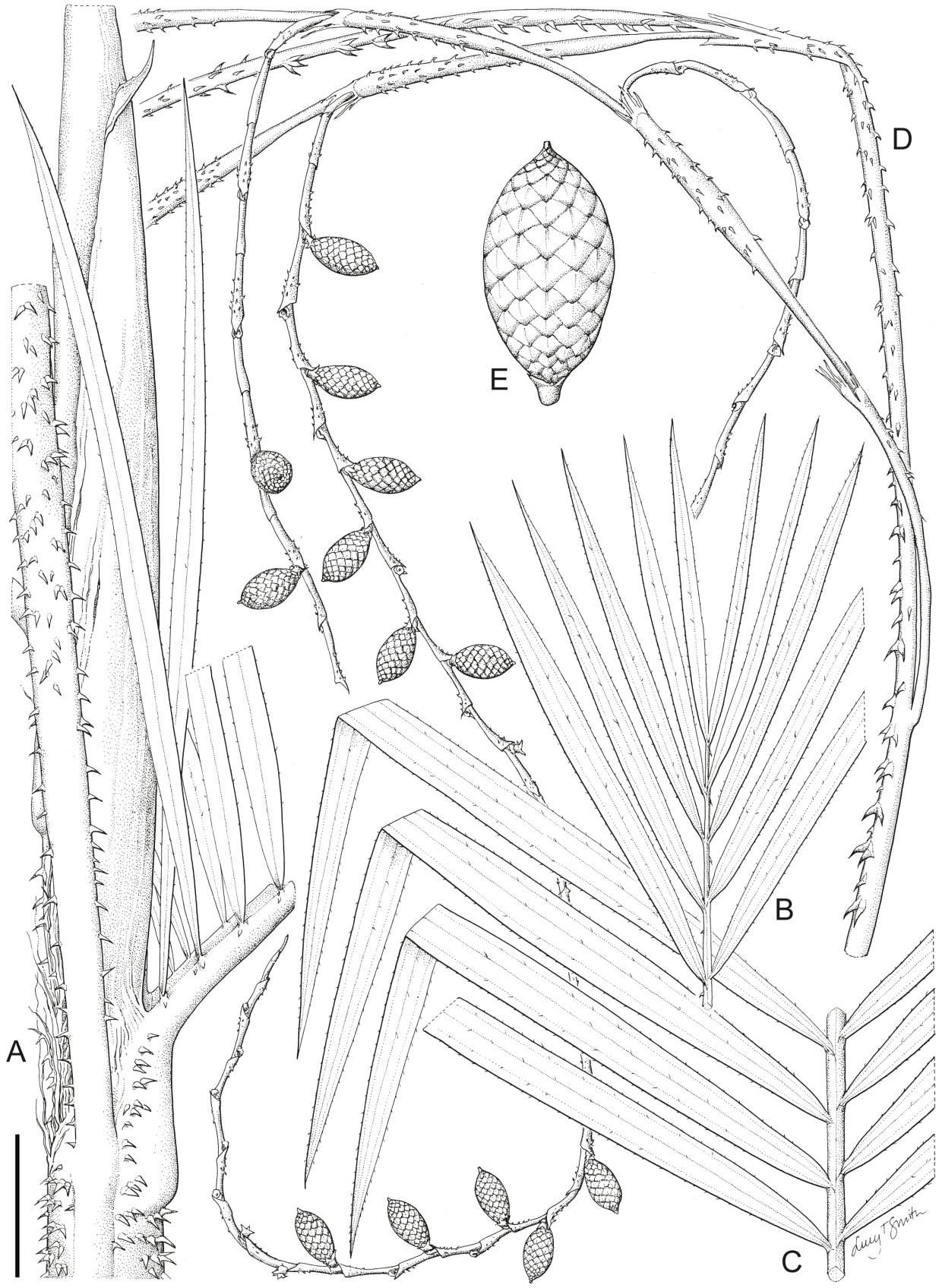

FIGURE 7. *Calamus kostermansii.* A. Leaf sheath with ocrea and infructescence base. B. Leaf apex. C. Mid-leaf portion. D. Portion of infructescence. E. Fruit. Scale bar: A = 3 cm; B–D = 4 cm; E = 1 cm. All from *Kostermans K10*. Drawn by Lucy T. Smith.

Specimens examined:—INDONESIA. Papua Province: Fak-Fak, Timika, sago swamp, between Timika and port, km 23, 10 m, 4°38'0"S, 136°54'21"E, 16 February 1998, *Baker et al. 848* (holotype K!, isotypes BO!, MAN!, BH!, L!). West Papua Province: Manokwari, Warami, along river, 4 October 1982, *Kostermans K10* (L!).

Notes:—In our paper discussing *Calamus longipinna* Lauterb. & K.Schum. in Schumann & Lauterbach (1900: 203) and its relatives in New Guinea (Baker & Dransfield 2002a), we mentioned several specimens under *Calamus longipinna* that differed somewhat from typical *C. longipinna* and were geographically isolated. One of these (*Baker et al. 848*) from the Timika area of southern Papua is greatly disjunct from the main area of distribution of *Calamus longipinna* in north-eastern New Guinea; it is also distinctive in having an ocrea that partially disintegrates into fibres, abundant indumentum on the sheath and rather elongate rachilla bracts.

Since we published this paper we have found a second collection, *Kostermans K10* from Warami south of Manokwari that seems to be conspecific. With these two collections, the distinction from *C. longipinna* seems best reflected in its description as a separate taxon.

8. ***Calamus novae-georgii*** W.J.Baker & J.Dransf., *sp. nov.* Type:—SOLOMON ISLANDS. New Georgia: Munda-Noro Road, 8°15'S 157°19'E, 12 September 1991, *Qusa 124* (*BSIP 22101*) (holotype K!).

Diagnosis:—Distinguished by the sheaths with dense chocolate-brown indumentum and abundant straw-coloured spines, the long, slender, flagelliform inflorescence, the fine, zig-zag rachillae and the stalk-like first bracteole in the dyad of the pistillate inflorescence.

Moderately robust, solitary rattan climbing to 8–10 m tall. **Stem** with sheaths 13–25 mm diam., without sheaths to 12–16 mm diam.; internodes ca. 18 cm (only one complete sample available). **Leaf** ecirrate or slightly subcirrate, to 95 cm long including petiole; sheath dull brown, densely covered with chocolate-brown indument, spines dense, varying in size and orientation, 1–30 × 1 mm, slender, needle-like or flattened, with slightly swollen bases, straw-coloured, more or less glabrous, scattered or partially grouped horizontally; knee 30–60 mm long, 5–7 mm wide, similar in colour to rest of sheath, armed as the sheath or very sparsely armed, spines around the leaf sheath mouth generally larger and upward pointing; ocrea to 0.5 cm, on either side of petiole, membranous, dark brown, unarmed or with a few sparse, short spines, disintegrating; flagellum ca. 2 m long; petiole 13–24 cm long, 8 mm wide, 5 mm thick at base, adaxially slightly channelled or flattened, rounded abaxially, glabrous or with scattered, caducous, chocolate-brown scales, armed with a few long spines to 30 mm long on margins near base, scattered or dense short triangular spines distally; rachis to 70 cm long, armed with scattered bulbous-based reflexed spines abaxially, with short scattered or grouped spines adaxially; leaflets 35 on each side of rachis, regularly arranged, linear to narrowly lanceolate, longest leaflet at mid-leaf position 26 1.7 cm, apical leaflets 10 × 0.4 cm, apical leaflet pair free, leaflets bearing abundant bristles 2–3 mm long on margins and 3 veins adaxially and abaxially, glabrous, transverse veinlets conspicuous, close; cirrus absent. **Staminate inflorescence** flagelliform, to at least 1.9 m long, peduncle not seen, flagelliform tip to at least 90 cm long, branched to 3 orders; prophyll (only base seen), ca. 10 mm wide, armed with long golden spines to 22 mm long along the margins, and abundant mid brown caducous indument; peduncular bracts not seen; rachis bracts to 32 0.7 cm, strictly tubular and not splitting, distally armed with very sparse spines and sparse caducous brown indument; primary branches at least 3, to 25 cm long, ca. 40 cm apart, with up to 80 rachillae, bracts on first order branches inconspicuous; rachillae 5–30 mm × 1 mm, zigzag; rachilla bracts 0.7 mm, distichous, explanate with an attenuate triangular tip, with quite dense brown scaly indument; floral bracteole minute. **Staminate flowers** 3 1 mm prior to anthesis; calyx 1.5 mm diam., tubular in basal 1.2 mm, with 3 triangular lobes 0.3 0.3 mm, glabrous; corolla 2.5 × 1.5 mm in bud, tubular in basal 0.1 mm, glabrous; stamens 6, filaments 1.5 0.2 mm, anthers 1.5 × 0.5 mm; pistillode 0.7 0.1 mm, trifid. **Pistillate inflorescence** similar to staminate inflorescence, flagelliform, ca. 2 m long including at least 0.8 m peduncle and 0.9 m flagelliform tip, branched to 2 orders; prophyll 30 × 0.7 cm, strictly tubular, not splitting, indument brown, sparse, caducous, armed along margins with scattered short triangular spines; peduncular bracts 1 (?always), peduncular and rachis bracts 20–25 × 0.2–0.5 cm, strictly tubular, not splitting, with sparse brown indument, sparse short black-tipped reflexed spines to 1 mm; primary branches to at least 3, to 21 cm long, to 28 cm apart, rather distant, tending to be more or less triangular in outline, with up to 25 rachillae; rachillae 5–70 mm × 1 mm, somewhat reflexed and somewhat zigzag; rachilla bracts 1.1 mm, triangular, reflexed, striate with abundant chocolate-coloured scales; proximal floral bracteole pedicelliform, 1.0 0.7 mm, distal floral bracteole very inconspicuous, ca. 0.1 mm, scar from sterile staminate flower 0.5 0.3 mm, oval. **Pistillate flowers** not seen. **Sterile staminate flowers** not seen. **Fruit** at maturity rounded, 7 7 mm including beak 0.5 × 0.5 mm, with 15 longitudinal rows of straw-coloured, slightly channelled scales with dark margins and tips. **Seed** (sarcotesta removed) 5 × 4.5 × 4 mm, slightly flattened on one side; endosperm homogeneous with a rounded lateral intrusion; embryo sub-basal.

Etymology:—The species epithet reflects the type locality on New Georgia Island.

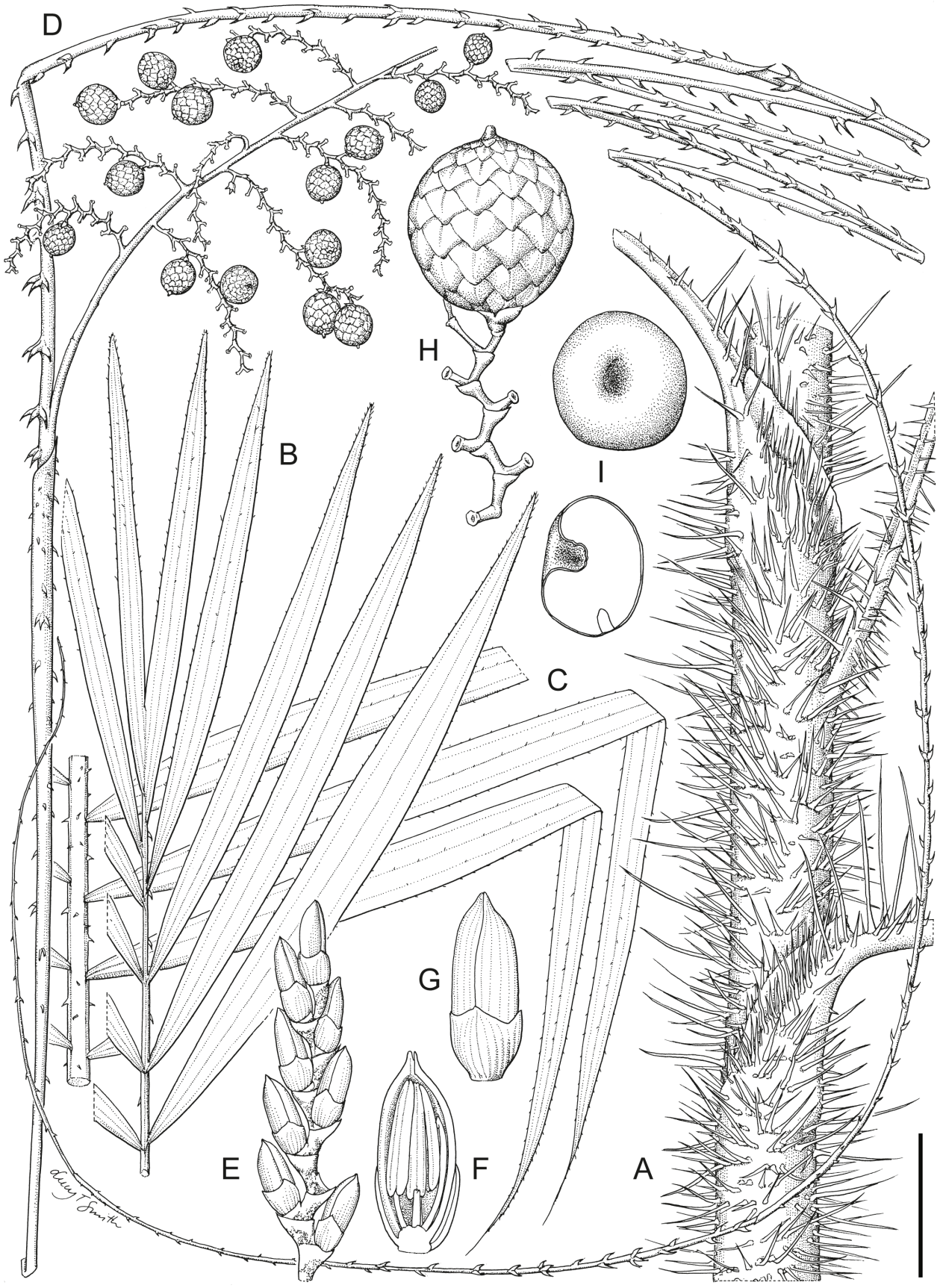

FIGURE 8. *Calamus novae-georgii.* A. Leaf sheath. B. Leaf apex. C. Mid-leaf portion. D. Infructescence apex with primary branch. E. Staminate rachilla. F. Staminate flower bud in longitudinal section. G. Staminate flower bud. H. Fruit attached to pisillate rachilla, showing stalk-like first bracteole. I. Seed whole and in longitudinal section. Scale bar: A, D = 3 cm; B, C = 4 cm; E = 5 mm; F, G = 2.2 mm; H, I = 7 mm. A–D, H, I from *Qusa 124*; E–G from *Qusa 123*. Drawn by Lucy T. Smith.

Distribution:—Known only from New Georgia Island in the Solomon Islands.

Habitat:—Primary, lowland forest on hills, ridges and flat plains.

Uses:—None recorded.

Vernacular names:—*Hezi* (New Georgia)

Specimens examined:—SOLOMON ISLANDS. New Georgia: 17 May 1929, *Waterhouse 22* (K!); Munda-Noro Road, 8°15'S 157°19'E, 12 September 1991, *Qusa 123* (*BSIP 22100*) (K!), *Qusa 124* (*BSIP 22101*) (holotype K!), 13 September 1991, *Qusa 127* (*BSIP 22104*) (K!), *Qusa 128* (*BSIP 22105*) (K!).

Notes:—*Calamus novae-georgii* is unusual among Papuasian and West Pacific *Calamus* species in the stalk-like first bract in the dyad of the pistillate inflorescence. The rachillae appear zigzag and with peg-like protrusions on which are borne the flowers and fruit. Such 'pedicelliform involucrophores' are a feature of *C. heteracanthus* Zippelius ex Blume (1847: 56) and the species previously included in *Daemonorops* Blume in Schultes & Schultes (1830: 1333). However, this new species with its flagelliform inflorescence is quite unrelated to *Daemonorops* and furthermore in vegetative details *C. novae-georgii* is completely different from *C. heteracanthus*, in having much more slender stems, armed very differently, with narrow ciliate-hairy leaflets. Based on the available morphological evidence, the relatives of this very distinctive species are not at all obvious.

9. ***Calamus papyraceus*** W.J.Baker & J.Dransf., *sp. nov.* Type:—PAPUA NEW GUINEA. East Sepik Province: Wewak-Angoram area, Maprik Subdistrict, Prince Alexander Range, SE side of Mt. Turu above Ambakanja village, 600 m, 19 August 1959, *Pullen 1506* (holotype CANB!, isotype LAE).

Diagnosis:—Distinguished by the slender habit, the regularly pinnate leaves, the leaf sheaths with collars of fine, caducous spines, the long, disintegrating papery ocrea armed with fine spines, the erect, congested inflorescence lacking a flagelliform tip with dry, papery bracts, erect primary branches and short pistillate rachillae, and typically conventional calamoid sympodial floral clusters producing a single fruit per cluster in the pistillate plant.

Slender rattan climbing to 6.5 m. **Stem** with sheaths 10–12.5 mm diam., without sheaths to 6–7 mm diam. **Leaf** ecirrate 0.7–2.5 m long including petiole; sheath pale brown when dry, with indumentum of scattered pale brown fibrous scales, densely armed with fine, brown, hair-like spines to 30 mm long, spines grouped in short whorls and fused into a ridge at the base; knee ca. 30 mm long, ca. 10 mm wide, rather weakly developed, same colour as, but less densely armed than the sheath; ocrea ca. 27 × 1.2 cm, erect, splitting longitudinally opposite the petiole insertion, papery, brown, armature similar to sheath, but less dense, with indumentum of pale brown and colourless fibrous scales, disintegrating into fibres; flagellum present, ca. 1 m long; petiole 14–26 cm, 4.5–6 mm wide and 4–5.5 mm thick at base, channelled adaxially, rounded abaxially, with thin, silvery indumentum of easily detached, colourless or brown, fibrous scales, margins armed with stout spines; rachis 0.5–2.3 m, armed with scattered grapnel spines abaxially; leaflets 15–22 on each side of rachis, arranged regularly, linear-lanceolate, longest leaflet at mid-leaf position, mid-leaf leaflets 20.5–46 × 1.5–2.2 cm, apical leaflets 10–26 × 0.6–1.5 cm, apical leaflet pair united to one third of their length, leaflets armed with conspicuous black bristles 1.5–5.5 mm on margins and major veins of both surfaces, leaflets largely glabrous or with some scattered indumentum as petiole, transverse veinlets conspicuous. **Staminate inflorescence** not seen. **Staminate flowers** not seen. **Pistillate inflorescence** erect, 49–65 cm long including 13–30 cm peduncle and 8–10 cm sterile tip, branched to 2 orders; prophyll 20–21 × 0.6–0.7 cm, tubular, but becoming paper and tattering deeply distally, indumentum as petiole, armed with whorls of fine brown spines similar to those on ocrea; peduncular bracts lacking, rachis bracts 8–18 × 0.5–0.7 cm, similar to prophyll, papery and tattering; primary branches 3–4, to 12 cm long, 6–12 cm apart, inserted at very acute angle, held erect and parallel to rachis, rather congested, with up to 7 rachillae, bracts funnel-shaped and armed with numerous short spines, papery (especially near apex); rachillae 17–35 × 2.5–3.5 mm, straight; rachilla bracts 4–5 × 2.5–3.5 mm, distichous, imbricate, funnel-shaped, acutely apiculate, papery and tattering at apex, indumentum as petiole, very dense around margins of young bracts, armed with numerous short spines, subtending a typical calamoid floral dyad (one triad observed in *Pullen 1506* [CANB] containing scars of two pistillate flowers and a single staminate flower); proximal floral bracteole 4 × 3 mm, distal floral bracteole 2.5 × 2.5 mm, scattered brown scales on outer surface of bracteoles, scar from sterile staminate flower round. **Pistillate flowers** ca. 4 × 2.5 mm, material at or near anthesis not seen. **Sterile staminate flowers** not. **Fruit** spherical, ca. 13 × 9.5 mm including beak 2.5 × 1.5 mm, with ca. 21 longitudinal rows of yellow scales with brown margins. **Seed** (sarcotesta removed) 7 × 6 × 6 mm, globose with shallow lateral pit; endosperm homogeneous; embryo basal.

Etymology:—The species epithet refers to the papery texture of the ocrea and of the inflorescence bracts.

Distribution:—Known from a single locality near Mt. Turu in the Prince Alexander Range in East Sepik Province, Papua New Guinea.

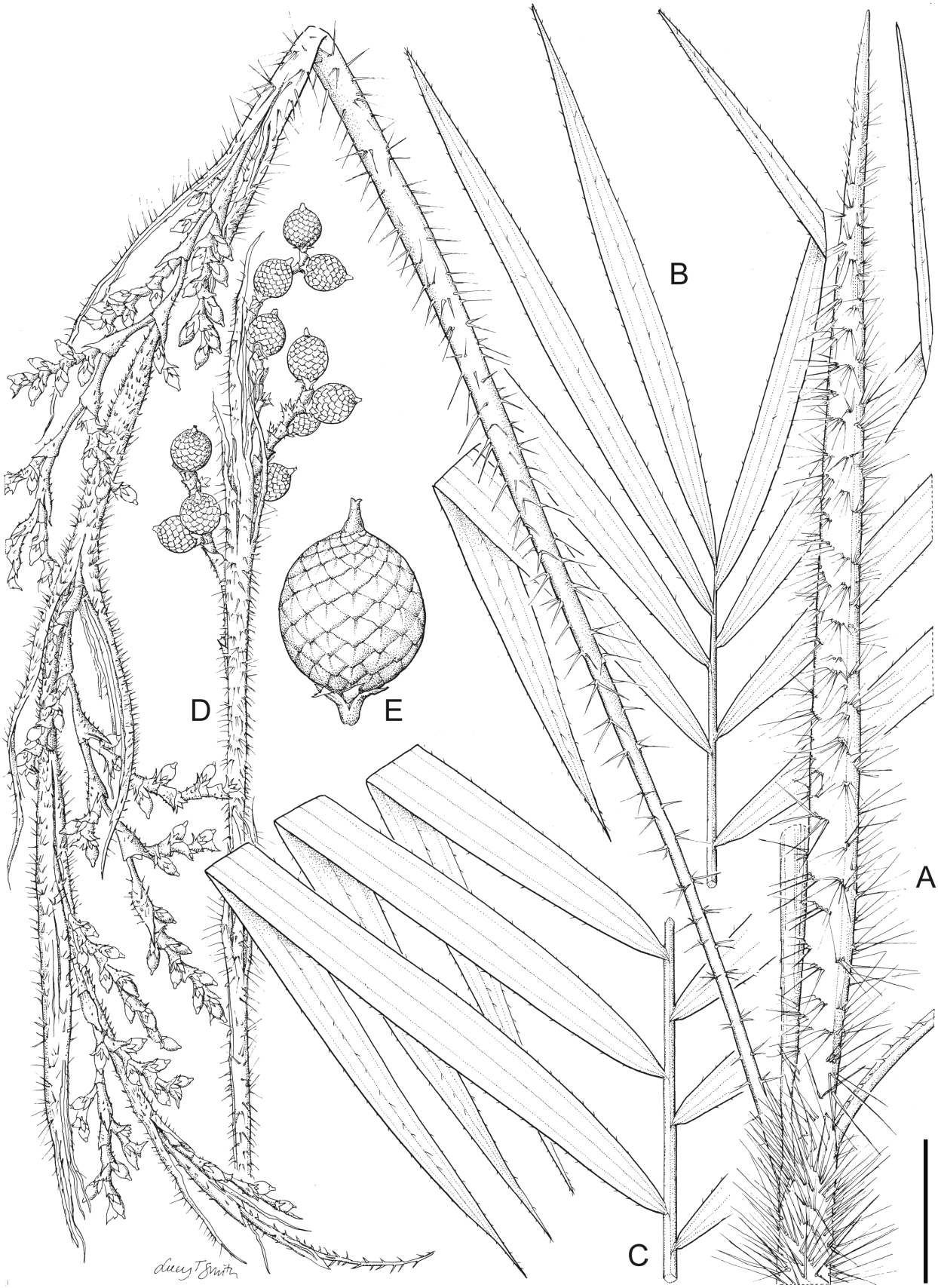

FIGURE 9. *Calamus papyraceus*. A. Leaf sheath with ocrea and whole pistillate inflorescence. B. Leaf apex. C. Mid-leaf portion. D. Apex of infructescence. E. Fruit. Scale bar: A, D = 3 cm; B, C = 6 cm; E = 1 cm. All from *Pullen 1506*. Drawn by Lucy T. Smith.

Habitat:—Rain forest on steep, stony slope, 600–1000 m.

Uses:—None recorded.

Vernacular names:—*Khaza* (Ambakanja, Maprik), *Ipis* (Jal, Madang).

Specimens examined:—PAPUA NEW GUINEA. East Sepik Province: Wewak-Angoram area, Maprik Subdistrict, Prince Alexander Range, SE side of Mt. Turu above Ambakanja village, 600 m, 19 August 1959, *Pullen 1506* (holotype CANB!, isotype LAE); Yangoru Subdistrict, southern slope of Mt. Turu, 1000 m, 3°36'S, 143°22'E, 1 November 1999, *Marai & Kjaer 443* (AAU!, LAE).

Notes:—This species resembles a slender form of *C. zebrinus* Beccari (1908: 235) in the regularly pinnate leaves, leaf sheaths with collars of fine, brittle, caducous spines, and the long, erect papery ocrea that is armed with fine spines and disintegrates early. The two species also share some reproductive similarities, such as the funnel-shaped bracts on rachillae and other branches that are densely armed with minute spines. *Calamus papyraceus* is however markedly distinct in its smaller stature, shorter ocrea (to ca. 27 cm rather than ca. 1 m), in the erect, congested inflorescence to 65 cm lacking a flagelliform tip with papery, tattering bracts throughout (rather than the elongate, flagellum-like inflorescence to 6 m of *C. zebrinus*), the erect primary branches held parallel to the inflorescence main axis (rather than the lax, open primary branches of *C. zebrinus*), and the short pistillate rachillae to 3.5 cm (4.5 to 19 cm in pistillate *C. zebrinus*). Importantly, *Calamus papyraceus* bears conventional sympodial floral clusters comprising a sterile staminate flower and a functional pistillate flower, thereby producing a single fruit per floral cluster, unlike *Calamus zebrinus* with its anomalous floral cluster with an additional pistillate flower resulting in paired fruits (Dransfield & Baker 2003). It should be noted though that a single triad was observed in *Pullen 1506* (CANB), which consisted of the scars of two pistillate flowers and a single staminate flower.

10. ***Calamus pintaudii*** W.J.Baker & J.Dransf., *sp. nov.* Type:—PAPUA NEW GUINEA. Chimbu Province: Kundiawa, Daman Nanga (Sino Pass) Village, 2200 m, 5°45'26"S, 145°11'1"E, 30 October 2012, *Pintaud et al. 671* (holotype K!, isotypes LAE, P, Binatang-RC).

Diagnosis:—Distinguished by the robust, clustering habit, the sheath drying orange-brown with dense indumentum, densely armed with needle-like spines, the papery, fragile ocrea almost encircling the sheath, but soon disintegrating, and the robust inflorescence with robust rachillae with funnel-shaped bracts.

Robust, clustering rattan climbing to 20 m. **Stem** with sheaths 20–55 mm diam., without sheaths 10–20 mm diam.; internodes 35–45 cm. **Leaf** ecirrate to ca. 2 m long including petiole; sheath orange-brown in dry material, with dense white to brown woolly indumentum comprising matted white hairs mixed with brown hairs and scales, densely armed with brown, needle-like spines up to 50 mm long and ca. 1 mm wide, varying in length, with scattered indumentum as sheath; knee 55 mm long, 15–20 mm wide, colour and indumentum as sheath, unarmed or armed as sheath; ocrea 23–30 cm long, ligule-like, almost encircling the sheath, but split on the side opposite (away from) the petiole, papery, fragile, soon tattering and disintegrating, rusty brown, unarmed; flagellum present, 3–5 m, robust; petiole 8–28 cm, 8–12.5 mm wide and 6–6.5 mm thick at base, flattened to channelled adaxially, rounded abaxially, indumentum as sheath, armed with stout, solitary spines; rachis 1–1.8 m, indumentum as sheath, armed with grapnel spines; leaflets 32–35 each side of rachis, arranged regularly, linear lanceolate, longest leaflet at mid-leaf position 36–40 × 1.8–2.2 cm, apical leaflets 6–14 × 0.2–0.6 cm, apical leaflet pair free to united by one quarter of their length, major veins with dark bristles to 7 mm long adaxially, glabrous abaxially, margins with scattered dark bristles, most dense at leaflet tip, with sparsely scattered brown scales on both surfaces, transverse veinlets moderately conspicuous. **Staminate inflorescence** robust, ca. 4.5 m long including peduncle and ca. 2 m flagelliform tip, branched to 3 orders; prophyll not seen; peduncular bracts not seen, rachis bracts ca. 35 × 0.9–1.5 cm, tubular, asymmetric at tip, indumentum as sheaths, sparsely to moderately armed with stout spines and grapnels; primary branches 4–8, to 35 cm long, erect, somewhat arching distally, with numerous rachillae, bracts tubular, 7–21 mm × 3.5–6 mm, unarmed, with scattered indumentum as sheath; rachillae 30–60 mm × ca. 8 mm, somewhat arcuate; rachilla bracts 6.5 × 3 mm, distichous, apiculate, scattered indumentum as sheath; floral bracteole 2 × 2 mm, cup-shaped. **Staminate flowers** not seen. **Pistillate inflorescence** similar to staminate inflorescence, but branched to 2 orders; prophyll not seen; peduncular bracts not seen, rachis bracts ca. 50 × 1.2 cm, tubular but with deep split to ca. 15 cm, indumentum as sheath, unarmed or lightly armed with stout spines; primary branches to ca. 35 cm long, straight to recurving, with up to ca. 22 rachillae, bracts as in staminate inflorescence; rachillae 90–160 mm × 7–8 mm, recurving; rachilla bracts 7 × 5.5 mm, distichous, deeply cup-shaped, with scattered brown scales; proximal floral bracteole 4.5 × 3 mm, distal floral bracteole 3 × 3 mm, scar from sterile staminate flower adnate to upper, outer margin of distal bracteole, discoid, concave. **Pistillate flowers** ca. 5 × 2.5 mm in early bud; calyx ca. 2.5 mm diam., tubular in basal ca. 3 mm, with 3 lobes to ca. 2 × 2 mm, with scattered brown

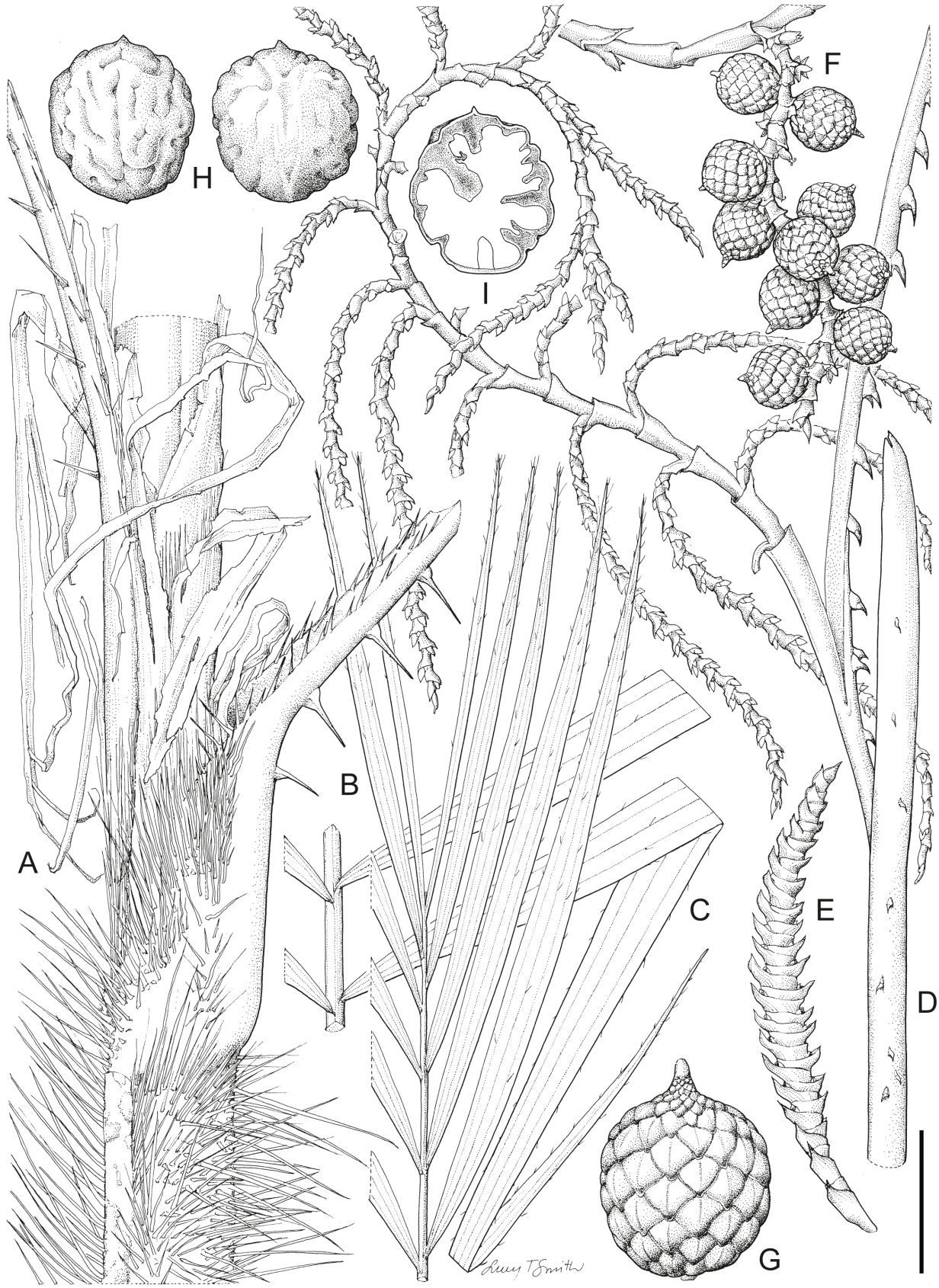

FIGURE 10. *Calamus pintaudii.* A. Leaf sheath with tattering ocrea. B. Leaf apex. C. Mid-leaf portion D. Primary branch of pistillate inflorescence. E. Staminate rachilla. F. Fruit on rachilla. G. Fruit. H. Seed in two views. I. Seed in longitudinal section. Scale bar: A, F = 3 cm; B–D = 4 cm; E = 1.5 cm; G–I = 1.5 cm. A, D from *Zieck NGF 36189*; B, C, E–I from *Pintaud et al. 671*. Drawn by Lucy T. Smith.

scales; corolla ca. 4 × 2 mm, tubular in basal 2 mm, with 3 lobes to 2 × 1.5 mm, glabrous; staminodes 6, 1.8–2 mm long; gynoecium 2.5 × 0.6 mm, cylindrical, including stigmas 0.5 mm long. **Sterile staminate flowers** 3 × 2 mm in bud, with empty anthers. **Fruit** spherical, 15.5–17.5 × 12.5–13 mm including beak 2.5–3 × 2–2.5 mm, with 17–18 longitudinal rows of brown, convex, dark-margined scales, sarcotesta testa. **Seed** (sarcotesta removed) 8.5–10 × 8–8.5 × 8–8.5 mm, spheroidal, sculptured with deep pits and grooves; endosperm homogeneous; embryo basal.

Etymology:—The species epithet honours our friend and colleague, the late Jean-Christophe Pintaud (1970–2015), French palm biologist and collector of the type specimen (see Anthelme *et al.* 2016).

Distribution:—Recorded from three widely separated localities in the eastern end of the central mountain chain of Papua New Guinea between Mt. Wilhelm and Mt. Suckling.

Habitat:—Primary montane forest, 600–1400 m.

Uses:—Locally used in construction of suspension bridges, binding fences and village houses.

Vernacular names:—*Kapurna* (Goilala-Tapini)

Specimens examined:—PAPUA NEW GUINEA. Central Province: Moani Mt. slope NW of Tapini, halfway along road to Matia-lavava, 1370 m, 8°19’S, 146°58’E, 4 December 1968, *Zieck NGF 36189* (BH!, L!, LAE!). Northern Province: Tufi Subdistrict, along Mt. Suckling expedition trail, ca. 1 hour above Mai-u 1 camp, 610 m, 9°39’S, 149°10’E, 13 July 1972, *Essig LAE 55228* (BH!, LAE!). Chimbu Province: Kundiawa, Daman Nanga (Sino Pass) village, 2200 m, 5°45’26”S, 145°11’1”E, 30 October 2012, *Pintaud et al. 671* (holotype K!, isotypes LAE, P, Binatang-RC).

Notes:—See notes under *Calamus baiyerensis*.

11. ***Calamus superciliatus*** W.J.Baker & J.Dransf., *sp. nov.* Type:—INDONESIA. West Papua Province: Tambrouw Regency, Fef District, forest above Fef, 730 m, 0°49’35”S, 132°27’41”E, 24 January 2013, *Baker et al. 1370* (holotype K!, isotypes BO!, MAN!, L!).

Diagnosis:—Distinguished by the leaf sheaths densely armed with fine, planar spines that form a tuft of longer spines at the sheath mouth, the relatively few leaflets (9–12 pairs) arranged in few, divaricate groups, and the lax, flagelliform inflorescence with few primary branches (1–3).

Slender, clustering rattan climbing to 8 m. **Stem** with sheaths 8–13 mm diam., without sheaths to 7–8 mm diam.; internodes 17–22 cm; juvenile stems to ca. 1.5 m with sheaths ca. 4–4.5 cm, bearing reduced leaves as short as ca. 9.5 cm in length. **Leaf** ecirrate to 74–80 cm long including petiole; sheath dark green, with scattered minute, purple-brown scales, densely and evenly armed with fine, planar, rusty-brown spines, spines to ca. 32 × 0.5–0.9 mm, sometimes with scattered colourless or brown fibrous scales, spines very dense, paler, longer (to 58 mm) and erect around sheath mouth, spines falling in older sheaths; knee 28–33 mm long, colour and armature as sheath; ocrea ca. 2–3 mm high, forming an inconspicuous, dry, papery crest extending into the petiole base, persistent, obscured by dense spines; flagellum present, to ca. 1.5 m long; petiole 11–15 cm long, 4.5–6 mm wide and 2.5–4 mm thick at base, shallowly channelled adaxially, rounded abaxially, glabrous or with sparse indumentum as sheath, armed with short spines similar to sheath and grapnel spines abaxially; rachis 46–52 cm, slightly arching, armed abaxially with grapnel spines; leaflets 9–12 each side of rachis, arranged in 3–5 widely spaced, divaricate groups, linear lanceolate, longest leaflet near base 27–29 × 2.3–2.5 cm, mid-leaf leaflets 24–27 × 2.1–3 cm, apical leaflets 18–19 × 1.7–2.8 cm, apical leaflet pair not or scarcely united at the base, leaflets very sparsely armed with few marginal bristles and very few bristles on adaxial surface of mid-rib, leaflet lacking indumentum, transverse veinlets moderately conspicuous. **Staminate inflorescence** not seen. **Staminate flowers** not seen. **Pistillate inflorescence** flagelliform, to ca. 2.2 m long including ca. 1.4 m peduncle and ca. 35 cm flagelliform tip, branched to 2 orders; prophyll 25–28 × 0.3–0.4 cm, strictly tubular, splitting slightly at apex, indumentum and armature similar to sheath, though spines shorter; peduncular bracts at least 2, peduncular and rachis bracts similar to prophyll; primary branches 1–3, to 55 cm long, ca. 30 cm apart, pendulous, lax, with up to ca. 18 rachillae, bracts 25–30 × ca. 2 mm, elongate, narrowly funnel-shaped; rachillae 20–70 mm × ca. 1.5 mm, recurved; rachilla bracts 1.5–2 × ca. 1.5 mm, distichous or somewhat subdistichous, cup-shaped, with indumentum of scattered brown scales; proximal floral bracteole ca. 1.8 × 1.5 mm, distal floral bracteole ca. 1.5 × 1.5 mm, saucer-shaped, scar from sterile staminate inconspicuous. **Pistillate flowers** 2.6–3 × ca. 1.5 mm in early bud, immature. **Sterile staminate flowers** ca. 1.8 × 1 mm in early bud, immature. **Fruit** globose, ca. 13 × 8 mm including beak 1 × 1 mm, with ca. 18 longitudinal rows of cream-white, shallowly channelled scales, sarcotesta ca. 0.6 mm thick. **Seed** (sarcotesta removed) 8.5 × 7.8 × 5.7 mm, globose with deep lateral intrusion, shallowly channeled; endosperm homogeneous; embryo basal.

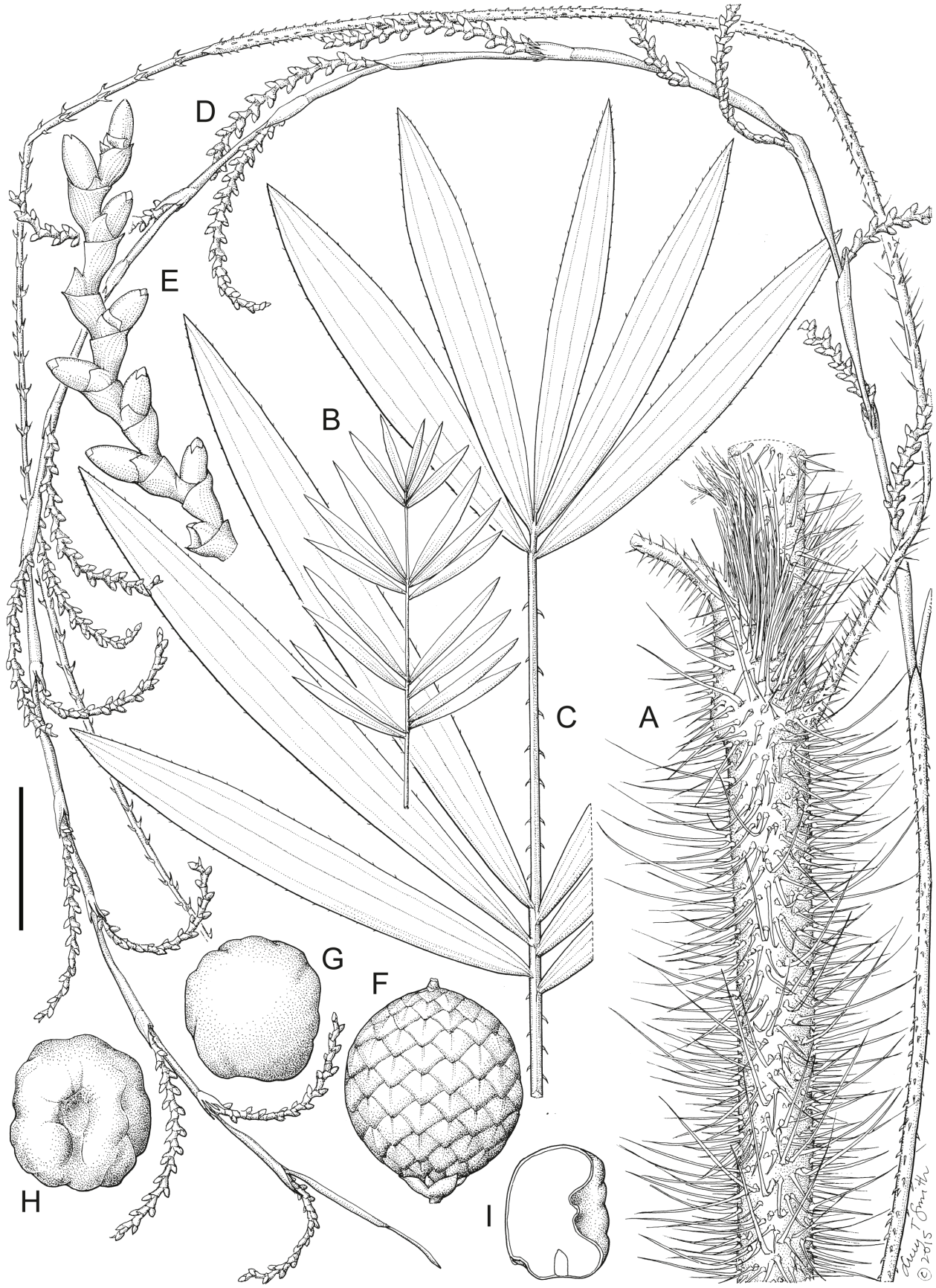

FIGURE 11. *Calamus superciliatus.* A. Leaf sheath with flagellum. B. Leaf diagram. C. Leaf apex. D. Primary branch of staminate inflorescence. E. Staminate rachilla. F. Fruit. G, H. Seed in two views. I. Seed in longitudinal section. Scale bar: A, D = 3 cm; B = 30 cm; C = 6 cm; E = 7 mm; E= 3.3 mm, F–I = 8.5 mm. A–E from *Baker et al. 1370*, F–I from *Baker et al. 1385*. Drawn by Lucy T. Smith.

Etymology:—The specific epithet refers to the fine, prolonged, erect spines that emerge around the mouth of the leaf sheath.

Distribution:—Known from two localities near Fef in the Tamrau mountains.

Habitat:—Lower montane forest at 700–900 m.

Uses:—None recorded.

Vernacular names:—None recorded.

Specimens examined:—INDONESIA. West Papua Province: Tambrouw Regency, Fef District, forest above Fef, 730 m, 0°49'35"S, 132°27'41"E, 24 January 2013, *Baker et al. 1370* (holotype K!, isotypes BO!, MAN!, L!), 700 m, 0°49'50"S, 132°27'42"E, 25 January 2013, *Baker et al. 1373* (AAU!, BO!, MAN!, K!, L!); Tambrouw Regency, Bamusbama District, forest along road to Fef east of Bamusbama, 900 m, 0°46'14"S, 132°18'49"E, 29 January 2013, *Baker et al. 1385* (BO!, MAN!, K!, L!).

Notes:—*Calamus superciliatus* is differentiated from other flagellate species lacking conspicuous ocreas in the dense, fine, planar leaf sheath spines that are particularly numerous and longer at the sheath mouth, forming a tuft. The leaves bear only 9–12 pairs of leaflets, which are clustered in few, divaricate groups, the longer leaflets being located near the base, and are very sparsely armed with bristles. The inflorescence is long, fine and flagellum-like and, in the material seen by us, bears few primary branches. Reduced, very slender juvenile stems were also observed at the type locality, which might be confused with *C. depauperatus* Ridley (1916: 234). In adult form, however, *C. superciliatus* is likely to be confused only with *C. retroflexus* J.Dransf. & W.J.Baker in Baker & Dransfield (2014: 203) on account of leaflet shape and arrangement, and spine shape, but the latter species differs in being more robust (e.g. stems with sheaths 18–21 mm diameter), in the more numerous leaflets (23–30 pairs), and in the absence of both a petiole and the conspicuous tuft of spines at the leaf sheath mouth.

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This paper is dedicated to our long-time friend and collaborator in New Guinea palm research, Roy Banka, who passed away on 21 January 2017, at only 50 years of age. Roy was a tireless advocate for building botanical capacity in Papua New Guinea and was also an avid palm biologist. His passing is a tragic loss for plant diversity research in New Guinea.

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