

REVISION OF CALYPTROCALYX AND THE NEW GUINEA SPECIES OF LINOSPADIX (LINOSPADICINAE: ARECOIDEAE: ARECACEAE)

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SUMMARY

A revision of *Calyptrocalyx* and the New Guinea species of *Linospadix* (Linospadicinae: Arecoideae: Arecaceae) is provided. For *Calyptrocalyx*, twenty-six species are recognised, and two for *Linospadix*. Three species, *Calyptrocalyx amoenus*, *C. awa*, and *C. yamutumene* are described as new. The following new combinations are made: *Calyptrocalyx arfakianus*, *C. caudiculatus*, *C. flabel-latus*, *C. geonomiformis*, *C. hollrungii*, *C. julianetii*, *C. lepidotus*, *C. merrillianus*, *C. micholitzii*, *C. multifidus*, and *C. pusillus* which were formerly species of *Paralinospadix*. Neotypes are proposed for *C. lauterbachianus*, *C. laxiflorus*, *C. pachystachys*, *C. pauciflorus*, and *C. polyphyllus*. *Linospadix* has two species in New Guinea, *L. albertisiana* and *L. canina*.

Key words: Arecaceae, *Calyptrocalyx*, *Linospadix*, *Paralinospadix*, palms, taxonomy, New Guinea.

INTRODUCTION

The Linospadicinae, one of 15 subtribes recognised in the Arecoideae (Arecaceae), is distributed from the eastern Moluccas, throughout New Guinea and adjacent islands, eastern Australia, and Lord Howe Island (Uhl & Dransfield, 1987). Four genera are recognised for the subtribe: *Calyptrocalyx* Blume (26 spp.) is distributed in eastern Indonesia and Papua New Guinea; *Linospadix* H. Wendl. (7 spp.) is distributed throughout New Guinea (2 spp.) and in eastern Australia (5 spp.) (Dowe & Irvine, 1997); *Laccospadix* Drude & H. Wendl. (1 sp.) in northeastern Queensland; and *Howea* Becc. (2 spp.) is endemic to Lord Howe Island (Green, 1994).

The subtribe was established by Hooker (1883) to include nine species in four genera, *Bacularia* F. Muell., *Calyptrocalyx*, *Howea*, and *Linospadix*. This generic arrangement contrasts with the most recent synopsis of the subtribe that listed four contemporary genera – *Calyptrocalyx*, *Howea*, *Laccospadix*, and *Linospadix* – but with 53 species (Uhl & Dransfield, 1987). One more species of *Linospadix* was described recently (Dowe & Irvine, 1997).

TAXONOMIC HISTORY

Calyptrocalyx

Of the genera in the Linospadicinae, *Calyptrocalyx* was the first to be described (Blume, 1838) with *C. spicatus* (Lam.) Blume as the type species (Merrill, 1917).

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Rumphius (1741) originally named this species as *Pinanga silvestris globosa*. Lamarck (1783) provided the first post-Linnean name, *Areca spicata* Lam., for the species. Uhl & Dransfield (1987) indicated that there were c. 38 species for the genus, and characterised it by the adjacent attachment of the two inflorescence bracts at the base of the peduncle, numerous stamens, and anthers versatile and dorsifixed.

Laccospadix

Laccospadix, established by Drude & Wendland (1875), has often been treated as a synonym of *Calyptrocalyx*. Hooker (1883) was the first to redesignate the original species, *L. australasica* H. Wendl. & Drude, listing it as *C. australasicus* (H. Wendl. & Drude) Hook.f. *Laccospadix australasica* has since been placed in either *Laccospadix* or *Calyptrocalyx*, depending upon the interpretation by various authors. We consider *Laccospadix* to be distinct from *Calyptrocalyx*.

Burret (1928) subsequently interpreted *C. lauterbachianus* Warb. ex Becc. to belong to *Laccospadix*, but Martelli (1935) reinstated it under *Calyptrocalyx* when he edited Beccari's list of arecoid palms. *Laccospadix* is characterised by the distantly spaced attachment of the prophyll and peduncular bract on the peduncle, peduncular bract that fully encloses the rachilla, pistillate flower with numerous stamens, anthers non-versatile and basifixed, ruminant endosperm and linear-acute leaf segments.

Linospadix, *Bacularia*, and *Paralinospadix*

Appraising and interpreting *Linospadix*, and its synonym *Bacularia*, has caused considerable confusion among taxonomists. *Linospadix*, as accepted in this study and by some previous authors (Burret, 1933, 1935; Uhl & Dransfield, 1987; Dowe & Irvine, 1997), was established by Wendland (Wendland & Drude, 1875) with its only species *L. monostachya* (Mart.) H. Wendl. This species was originally named *Areca monostachya* Mart. (Von Martius, 1837) and then as *Kentia monostachya* (Mart.) F. Muell. by Mueller (1870). Hill (1874) described a second species, *L. minor* (W. Hill) Burret (as *Areca minor* W. Hill) but Wendland was obviously unaware of it. To distinguish *Kentia monostachya* from the disharmonic genus *Kentia* Blume, Mueller (1870) proposed a new genus *Bacularia*, but this name was not validly published at that time, being only a proposed name in discussion. Wendland, although aware of Mueller's proposed name, accordingly rejected the name *Bacularia* when establishing *Linospadix* (Wendland & Drude, 1875). However, Mueller (1878) in turn rejected the name *Linospadix* and proceeded to use the name *Bacularia* for the two Australian species, *Bacularia monostachya* (Mart.) F. Muell. and *B. minor* (W. Hill) F. Muell. as well as for two New Guinea species, *B. arfakiana* (Becc.) F. Muell. and *B. flabellata* (Becc.) F. Muell., previously described as species of *Linospadix* by Beccari (1877). Bentham (1878), in 'Flora Australiensis', did not recognise either *Linospadix* or *Bacularia*, but retained the two Australian species under the broadly circumscribed *Kentia*.

Up to this time, Beccari (1877) had described species collected in New Guinea under *Linospadix* only, though his generic interpretation of *Linospadix* clearly differed from that of Wendland (Wendland & Drude, 1875). Hooker (1883), perceiving the confusion between *Linospadix* and *Bacularia*, amended and expanded the descriptions of both, thus attempting to establish taxonomic stability. Accordingly, *Bacularia* was described with 6–12 stamens, basifixed anthers, with two species confined to Australia,

and *Linospadix* H. Wendl. was placed as its synonym. *Linospadix* Becc. was distinguished by 6–9 stamens, dorsifixed anthers, and with three species confined to New Guinea.

Beccari (1886, 1905, 1909) accordingly named species under both *Linospadix* and *Bacularia* in New Guinea following Hooker's generic distinctions. Hooker's scheme was subsequently followed by many other taxonomists (Ridley, 1886; Bailey, 1889; Ridley, 1895; Sander, 1898, 1903; Wright, 1906; Domin, 1915; Ridley, 1916; Burret, 1933; White, 1936) until Burret (1935) revised these genera in 1935.

Burret (1935) clearly allied Hooker's *Bacularia* with Wendland's original description of *Linospadix*, thus synonymising *Bacularia* under *Linospadix*, while placing *Linospadix* sensu Beccari [i.e. Hooker's *Linospadix* Becc.] under the new genus, *Paralinospadix* Burret, to which Burret subsequently added additional species (Burret, 1935, 1936, 1939). Burret described *Paralinospadix* with both the prophyll and peduncular bract as attached at the base of the peduncle; an inflorescence with collateral multiple spikes; flowers with versatile and dorsifixed anthers; fruit with dispersed fibres in the mesocarp and homogeneous endosperm. *Paralinospadix* was thus differentiated from *Linospadix* H. Wendl. by the latter's spicate inflorescence, the peduncular bract attached at the junction of the peduncle and the rachis, the anthers being non-versatile and basifixed to subbasifixed, and the fibres in the mesocarp forming a compact single layer adnate to the endocarp. *Paralinospadix* was eventually to include 23 species, all occurring in New Guinea, and *Linospadix* ten species, with five in Australia and five in New Guinea.

Burret (1935) in his revision also attempted to clarify the distinction between *Calyptrocalyx* and his new *Paralinospadix*, on the basis that *Calyptrocalyx* had a spicate inflorescence and a ruminant endosperm, while *Paralinospadix* had an inflorescence with multiple spikes and homogeneous endosperm. Burret (1936) was later to question his original assessment when he described an intermediate species, *Paralinospadix merrillianus* Burret, with ruminant endosperm and a multi-spiked inflorescence. He erected the section *Atopocarpus* to accommodate this single species. Although *P. merrillianus* blurred the distinction between *Paralinospadix* and *Calyptrocalyx*, many taxonomists continued to recognise both (Beccari & Pichi-Sermolli, 1955; Potztl, 1964; Corner, 1966). However, Moore (1973) was the first to list, though informally, *Paralinospadix* as a synonym of *Calyptrocalyx*. Recently, Uhl & Dransfield (1987) also listed *Paralinospadix* as a synonym of *Calyptrocalyx*, but similarly did not provide formal transfer of any species names. Some authors have 'illegally' listed former *Paralinospadix* species as *Calyptrocalyx* species (WCMC, 1993; Jones, 1995), despite the conflict of five potential homonyms created by such an action.

MATERIALS AND METHODS

Nearly 400 herbarium specimens were examined during this study. Herbaria visited were AAU, B, BM, BO, BRI, FI, K, L, LAE, QRS, and SING. Photographs of specimens were supplied by A, CANB, L, and MEL. Specimens were borrowed from AAU, K, and LAE. Field work was undertaken by MDF in Papua New Guinea in 1994–1998 and by JLD in Papua New Guinea and Indonesia in 1997–2000.

Herbarium specimens provided both morphological and distributional data. Dried herbarium materials were rehydrated, and measurements show the range of both dried and fresh materials when both were available. Type specimens of 35 taxa were examined. Nine type specimens, most of which are known to be lost, could not be located. Most of the losses occurred during the bombing of Berlin Herbarium in 1943. Neotypes are nominated for the lost types. Nomenclatural changes are proposed according to Greuter et al. (2000). Periodical abbreviations follow Lawrence et al. (1968), and herbarium acronyms follow Holmgren et al. (1990).

*A note on the gender of *Linospadix* and *Paralinospadix**

There has been considerable inconsistency in the application of the gender of specific names in *Linospadix* and *Paralinospadix*. Stearn (1992) noted that the suffix ‘*spadix*’, when used in a compound name, makes that name either masculine or feminine. In the prologue of *Linospadix*, Wendland (Wendland & Drude, 1875) used a masculine epithet, ‘monostachyos’, and thus implied that he considered the genus name to be masculine. Beccari (1877, 1905, 1909) followed Wendland’s example for his species and used masculine epithets, while Sander (1898), Schumann & Lauterbach (1900), and Ridley (1916) used feminine epithets. Martelli (1935) in posthumously editing the manuscripts of Beccari, used feminine epithets in his list of species. Whether Beccari intended the change is not known. About the same time, Burret (1935) provided the first comprehensive revision of *Linospadix*, in which he established *Paralinospadix*. Burret used masculine epithets for these genera. In recent taxonomic works (Moore, 1973; Uhl & Dransfield, 1987; Dowe & Irvine, 1997; Mabberley, 1997), there has been the consistent use of feminine epithets for *Linospadix* species. In this present revision, species names in *Linospadix* are treated as feminine in accordance with the ICBN’s ‘prevailing and established custom’ facility (Greuter et al., 2000). A proposal to conserve *Linospadix*, and other generic names with a ‘*spadix*’ suffix, as having feminine gender, has been accepted for publication in *Taxon* (Dowe & Henderson, in press).

Discussion on generic reassessment

Although *Paralinospadix* has been included as a synonym of *Calyptrocalyx* in many works (Moore, 1973; Uhl & Dransfield, 1987), no formal transfer of names has been made. This work formalises the appropriate transfer of species names.

When Burret (1935) revised *Linospadix*, invoking Wendland’s (Wendland & Drude, 1875) original circumscription in preference to that adopted by Hooker (1883), he found a group of species that could not be accommodated within *Linospadix*, and thus established *Paralinospadix*. The characters used by Burret (1935) to define *Paralinospadix* were: peduncular bract attached at the base of the peduncle; inflorescence of collateral multiple spikes; staminate flowers with elongate filaments; anthers dorsifixed and versatile; an elongate pistillode; fruit with the fibres scattered throughout the mesocarp; and endosperm homogeneous. Soon after publication of *Paralinospadix*, Burret described two new species which he noted did not sit well within his concept of *Paralinospadix*; for example *P. merrillianus* has ruminant endosperm, and thus introduced the question of disharmony within the genus. Burret did not discuss the relationship between *Paralinospadix* and *Calyptrocalyx*, but maintained them as dis-

tinct genera by the latter's more numerous stamens and solitary-stemmed habit (Burret & Potztl, 1956), among other characters. Burret did not pursue this question any further, and it was Moore (1973) who first addressed the problem of generic delimitation within the subtribe, and listed *Paralinospadix* under *Calyptrocalyx*.

Subsequently, Essig (1977) and Hay (1984) concurred with Moore's assessment, but maintained separate species lists for the two genera. Uhl & Dransfield (1987) placed *Paralinospadix* as a generic synonym of *Calyptrocalyx* and similarly did not transfer any species names. In the present work, *Calyptrocalyx* becomes a genus of 26 species. Specific variation is expressed in the following characters:

- leaf morphology – bifid, or irregularly segmented or regularly pinnate
- pinnae arrangement – in one or two planes
- habit – solitary or multi-stemmed
- inflorescence – solitary or multi-spiked
- stamen number – 6 to 140, and \pm constant for species
- filaments – free or fused
- fruit shape – globose, ellipsoid, ovoid or subfalcately ellipsoid
- fruit colour – red, orange, purple-black
- condition of the endosperm – homogeneous or ruminant

SYSTEMATIC TREATMENT

CALYPTROCALYX

Calyptrocalyx Blume, Rumphia 2 (1836) 103, t. 102d, 118, 161. — *Calyptrocalyx* subg. *Eucalyptrocalyx* Drude, in Engl. & Prantl, Nat. Pflanzenfam. 2, 3 (1889) 69. — Type: *Areca spicata* Lam. [= *Calyptrocalyx spicatus* (Lam.) Blume].

Bacularia sect. *Linospadix* (H. Wendl.) Kuntze, Lex. Gen. Phan. (1903) 57. — Type: not designated.
Paralinospadix Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 331. — *Linospadix* Becc., Malesia 1 (1877) 62, non H. Wendlan (1875); Hook.f. in Benth. & Hook., Gen. Pl. 3 (1883) 903, non H. Wendlan (1875). — *Linospadix* subg. *Eulinospadix* Drude in Engl. & Prantl, Nat. Pflanzenfam. 2, 3 (1889) 67, p.p. — Type: *Linospadix arfakianus* Becc. [= *Calyptrocalyx arfakianus* (Becc.) Dowe & M.D. Ferrero].

Paralinospadix sect. *Atopocarpus* Burret, J. Arnold Arbor. 20 (1939) 201. — Type: *Paralinospadix merrillianus* Burret [= *Calyptrocalyx merrillianus* (Burret) Dowe & M.D. Ferrero].

Solitary or clustering, acaulescent or erect, small to large, pleonanthic, monoecious palms. *Stems* slender to robust, leaf scars conspicuous; internodes congested to elongate. *Leaves* bifid, or irregularly segmented or regularly pinnate; leafbase clasping, margins smooth or densely lacerate-fibrous, not forming a cylindrical crownshaft but vertically split opposite the petiole; petiole short to long or absent, adaxially deeply or shallowly channelled or flat, abaxially rounded; pinnae single or united, apices praemorse when united, acuminate when not united. *Inflorescence* protandrous, interfoliar, solitary, spicate, or multi-spiked with the axes joined collaterally at the base sharing a common, compartmentalised peduncular bract; prophyll dorsi-ventrally compressed, bicarinate, attached at the base of the peduncle, persistent; peduncular bract tubular, attached at the base of the peduncle immediately adjacent to attachment of prophyll, persistent, apically open; peduncle long, erect to pendulous; inflorescence

becoming elongately exerted from bracts early in development, floral buds exposed prior to and at maturity; rachilla c. length of the peduncle to much less. *Flowers* spirally arranged in shallow to deep floral pits, or on the surface; floral pit margins unraised or lipped, sometimes elaborated; in triads of a single pistillate flower with two lateral staminate flowers in proximal portion of the rachilla, paired or solitary staminate flowers in distal portion. *Staminate flower* symmetric or asymmetric in bud; sepals broadly imbricate; petals c. twice as long or much longer than sepals, apically valvate; stamens 6–140, filaments shorter than, as long as, or longer than the petals, widely spread or congested, or fused for c. 3/4 their length to form a staminal tube (*C. doxanthus* only); anthers deeply or shallowly sagittate, either dorsifixed and versatile, or dorsifixed but fused to the basal 1/2 of the anther and non-versatile (*C. doxanthus* only), dehiscence latrorse; pollen circular to elliptical in polar view, monosulcate, exine tectate, finely to coarsely reticulate; pistillode columnar to apically tapered or filiform, shorter than, equal to, or longer than the stamens. *Pistillate flower* globose to conical, smaller than, c. same size or larger than the staminate flower; sepals broadly imbricate; petals with thickened valvate tips, longer than the sepals; staminodes 3–9, toothlike; stigmas recurved, small or large, 3-lobed, smooth or papillose. *Fruit* globose, ovoid, ellipsoid or cylindrical, orange, pink to red, or purple-black at maturity; stigmatic remains apical or slightly eccentric (*C. lauterbachianus* only); epicarp smooth, or finely pilose or with scattered deciduous scales (*C. elegans* only), drying finely or coarsely granular; mesocarp thin or thick, fleshy, mealy, fibrous or watery, fibres unbranched, or bifurcate, reticulate or anastomosing, distributed evenly throughout the mesocarp or densely aggregated toward the endocarp; endocarp adhering to or separating from the seed. *Seed* globose, ellipsoid, ovoid, fusiform or falcate, subbasally or laterally attached; raphe fibres anastomosing; endosperm homogeneous or ruminant; embryo basal. Germination adjacent-ligular; eophyll bifid. $n = 16$ (Read, 1966).

Distribution — About 26 species distributed in Indonesia in the eastern Moluccas and throughout Papua, and in Papua New Guinea to as far east as New Ireland.

Etymology — From *calyptra* – veil or cover, and *calyx* – collective term for the sepals of one flower; in reference to the hooded appearance of the bracts that subtend the flowers in the type species, *C. spicatus*.

KEY TO THE SPECIES OF CALYPTROCALYX

- 1a. Rachilla not fusiform, \pm the same diameter as the peduncle, or only slightly greater by 1–10% 2
- b. Rachilla fusiform, in the widest part a greater diameter than the peduncle by 11–100% 9
- 2a. Leaves simply bifid or with minor basal divisions, never irregularly segmented or regularly pinnate 3
- b. Leaves irregularly segmented or regularly pinnate 4
- 3a. Petiole absent 18. *C. micholitzii*
- b. Petiole 13–20 cm long 24. *C. sessiliflorus*
- 4a. Leaves irregularly segmented with pinnae united, never with single pinnae 16. *C. leptostachys*
- b. Leaves always regularly pinnate, pinnae with a single midrib 5

- 5a. Petiole, rachis, inflorescence axis, and peduncular bract densely lepidote **15. C. lepidotus**
- b. Petiole, rachis, inflorescence axis, and peduncular bract not densely lepidote 6
- 6a. Peduncle 3 mm or less in diameter 7
- b. Peduncle more than 3 mm in diameter 8
- 7a. Floral pits congested, 1–5 mm apart. Fruit 9–13 mm long **2. C. amoenus**
- b. Floral pits well spaced, 10–15 mm apart. Fruit 19–21 mm long **14. C. laxiflorus**
- 8a. Stamens shorter than or same length as the petals. Fruit with apical stigmatic remains **1. C. albertisianus**
- b. Stamens longer than the petals. Fruit with eccentric stigmatic remains **13. C. lauterbachianus**
- 9a. Rachilla 41–100% thicker than the peduncle 10
- b. Rachilla 11–40% thicker than the peduncle 14
- 10a. Staminate flower with filaments fused, apically inflexed with anthers fused **6. C. doxanthus**
- b. Staminate flower with filaments not fused, anthers not fused 11
- 11a. Lamina with ribs strongly curved toward the apex **10. C. geomiformis**
- b. Lamina with ribs more or less parallel with each other, not strongly curved toward the apex 12
- 12a. Endosperm ruminant **7. C. elegans**
- b. Endosperm homogeneous 13
- 13a. Floral pits shallow. Pistillode the same length as the petals. Fruit 10–12 mm long, purple-black **5. C. caudiculatus**
- b. Floral pits deep. Pistillode much shorter than the petals. Fruit 16–18 mm long, pinkish orange to red **20. C. pachystachys**
- 14a. Endosperm ruminant 15
- b. Endosperm homogeneous 19
- 15a. Leaves always regularly pinnate 16
- b. Leaves bifid or irregularly segmented with pinnae united, never regularly pinnate 18
- 16a. Solitary stemmed palms to 14 m tall **25. C. spicatus**
- b. Clustering palms to 4 m tall 17
- 17a. Stamens 8. Fruit 18–20 mm long **17. C. merrillianus**
- b. Stamens 10–16. Fruit 9–11 mm long **22. C. polyphyllus**
- 18a. Fruit globose or subglobose, black **3. C. arfakianus**
- b. Fruit ovoid or ellipsoid, red **21. C. pauciflorus**
- 19a. Staminate flowers in bud appressed in a pair resembling rodent incisor teeth **11. C. hollrungii**
- b. Staminate flowers in bud not appressed 20
- 20a. Fruit globose **4. C. awa**
- b. Fruit ellipsoid 21
- 21a. Leaves never bifid, but irregularly segmented or regularly pinnate 22
- b. Leaves bifid, or irregularly segmented or regularly pinnate 24
- 22a. Stems to 5 m tall **9. C. forbesii**
- b. Stems to 2 m tall 23

- 23a. Floral pit margins raised. Fruit with fleshy mesocarp **12. C. julianettii**
 b. Floral pit margins not raised. Fruit with fibrous mesocarp . . . **19. C. multifidus**
 24a. Diminutive 'elfin' palms to 1 m tall **23. C. pusillus**
 b. Moderate palms 2.5–3 m tall 25
 25a. Solitary stemmed palms **8. C. flabellatus**
 b. Clustering palms **26. C. yamutumene**

1. *Calyptrocalyx albertisianus* Becc.

Calyptrocalyx albertisianus Becc., Webbia 1 (1905) 305. — Type: *d'Albertis s.n.* (holo FI), Papua New Guinea, Western Province, Fly River, 1885–1887.

Calyptrocalyx albertisianus Becc. var. *minor* Burret, Notizbl. Bot. Gart. Berlin-Dahlem 13 (1936) 73, syn. nov. — Type: *Brass 5790* (holo BRI; iso A n.v., NY n.v.), Papua New Guinea, Western Province, Wuroi, Oriomo River, Jan. 1934.

Calyptrocalyx clemensiae Burret, Notizbl. Bot. Gart. Berlin-Dahlem 15 (1940) 9, syn. nov. — Type: *Clemens 8629* (holo B), Papua New Guinea, Morobe Province, above Boana, 1200–1500 m, 15 Aug. 1938.

[*Ptychosperma normanbyi* auct. non F. Muell.: Becc. in L.M. d'Albertis, New Guinea 2 (1881) 399.]

Solitary or infrequently clustering, moderate to large palms. *Stems* 1–4, 2–15 m tall, erect, 4–15 cm diam., internodes 2–10 cm long, green, grey with age; crown with 6–18 leaves. *Leaves* regularly pinnate, 150–450 cm long, new leaf emerges red; leaf-base green to purplish, 40–110 cm long, longitudinally striately-nerved, with dark lepidote scales, spotted with minute tubercles, the apex finely lacerate-fibrous, fibres thin and interwoven; petiole 20–75 cm long, deeply channelled adaxially, margins acute, glabrous, sparingly dark lepidote; pinnae 14–37 per side, narrowly attached to the rachis, dark green adaxially, lighter green abaxially, 60–90 by 3–8 cm, linear, attenuate, frequently caudate, midrib prominent adaxially, abaxially ramentaceous, 6–8 secondary veins prominent abaxially. *Inflorescence* 1–6 spiked, 60–260 cm long, pendulous; prophyll 30–40 cm long, with flat deciduous, dark scales; peduncular bract 35–65 cm long, papyraceous, dorsi-ventrally compressed, deciduous, with dark scaly tomentum; peduncle 65–130 cm by 7–13 mm, terete to broadly elliptical in cross section; rameal bracts 1 or 2, triangular, to 12 mm long; rachilla 32–110 cm long, slightly thicker than the peduncle, 10–14 mm wide, elongately fusiform; margins of floral pits broadly rounded to cupular, 3–4 mm long, margin sharp. *Flowers* congested, cream to green. *Staminate flower* broadly ovoid in bud, widely to not widely opening at maturity; sepals carinate, 4–5 by 1.5–2 mm, margins ciliate to hyaline; petals 6–13 by 4–10 mm, broadly ovate, densely striate, deciduous scales dispersed evenly on abaxial surface; stamens 22–60, 6–13 mm long; filaments c. 3 mm long; anthers cream, 2–3 mm long, versatile; pistillode columnar, c. 1 mm high, broad, trilobed; pollen mostly circular, monosulcate, exine finely reticulate. *Pistillate flower* c. 10 mm long; staminodes 8 or 9, triangular, c. 1 mm long. *Fruit* globose to ellipsoid, 15–42 mm long, 10–26 mm diam., attenuated toward the apex, red; epicarp smooth, to 0.5 mm thick, minutely granular when dry; mesocarp to 5 mm thick, densely fibrous, fibres distributed evenly throughout the mesocarp, anastomose at the base, becoming unbranched at the apex; endocarp membranous. *Seed* globose to ellipsoid, basally rounded, apically subapiculate, 10–30 mm long, 8–18 mm diam.; endosperm deeply ruminate.

Distribution — Indonesia: Papua: Sorong, Paniai, and Japen Waropen Divisions where it has been observed but without collections. Papua New Guinea: W Sepik, E Sepik, Western, Eastern Highlands, Gulf, Morobe, Central, Milne Bay, New Britain, and New Ireland Provinces.

Habitat & Ecology — In rain forest at 0–2000 m.

Etymology — The species was named for Count Luigi Maria d'Albertis (1841–1901), Italian zoologist, ethnologist, and explorer, collector of the type specimen.

Vernacular names — Panjaway (Ndu language – E Sepik Province), kerekere (Milne Bay Province), korakh (Daga language – Milne Bay Province), wokoton hokiliba (Was-sisi language – W Sepik Province), kuwei-sinii (Baiamo Sani language – E Sepik Province).

Notes — 1. *Calyptrocalyx albertisianus* is distinguished by a solitary or occasionally clustering habit, moderate to tall, robust stem(s), regularly pinnate leaves, numerous stamens and ruminant endosperm. It is most closely related to *C. spicatus* of the Moluccas, but differs by its smaller stature, smaller lip of the floral pit, smaller fruit, and fewer stamens.

2. There is considerable variation in fruit size throughout the distributional range. Accordingly, Essig (1977; 1995) noted a possible new *Calyptrocalyx* sp. from the Milne Bay and New Britain Provinces, listed as *Calyptrocalyx* sp. nov. ined. H.E. Moore, but this and other collections examined from these areas fit within the overall variation for *C. albertisianus*. The name *Calyptrocalyx* 'brassii' was subsequently applied by H.E. Moore to a specimen collected from Maneau Range, conserved at Arnold Arboretum (A) and labelled as a 'type' in anticipation of publication which never eventuated. *Calyptrocalyx clemensiae* was described for a collection from Boana, Morobe Province, and *C. albertisianus* var. *minor*, a variety described with a short stem and smaller fruit, was named from Oriomo River, Western Province, but these are attributable to *C. albertisianus*.

3. This species is used as a betel nut substitute.

2. *Calyptrocalyx amoenus* Dowe & M.D. Ferrero, *spec. nov.* — Fig. 1

Palma caespitosa, statura moderata, segmentis foliorum regulariter dispositis, pinnis a apice brevibus sed basi longioribus et intervallio inter pinnas descrescente distalis. Inflorescentia multi-spicata, spicis filiformibus, fructibus ellipsoideis, mesocarpio tenui, endospermio homoganeo. — Typus: *Ferrero 980037* (holo LAE; iso BRI), Papua New Guinea, W Sepik Province, Freida River, Spiau area of Omasai Creek, up from Wabia village, 120–140 m alt., Mar. 1998.

Solitary or clustering small to moderate palms. *Stems* 2.6–5 m tall, 2–5 cm diam.; internodes 3–6 cm long, dark green; crown with 8–12 leaves. *Leaves* regularly pinnate, 140–190 cm long, new leaf emerges crimson-red; leafbase 30–40 cm long, light green, glabrous, margin moderately lacerate-fibrous; petiole 8–10 cm by 3–5 mm, shallowly channelled adaxially, glabrous; pinnae 9–24 per side, alternate to subopposite, 2–22 cm apart, sometimes with extended gaps between pinnae, becoming increasingly closer together and smaller toward the apex, basal pinnae long and very widely separated, broadly lanceolate, acuminate, basally constricted, cupped, abruptly caudate with a 4–10 cm long, 2 mm wide filamentous drip tip; pinnae glossy dark green adaxially, dull lighter green abaxially, 13–44 by 1.2–12 cm, midrib prominent, secondary veins

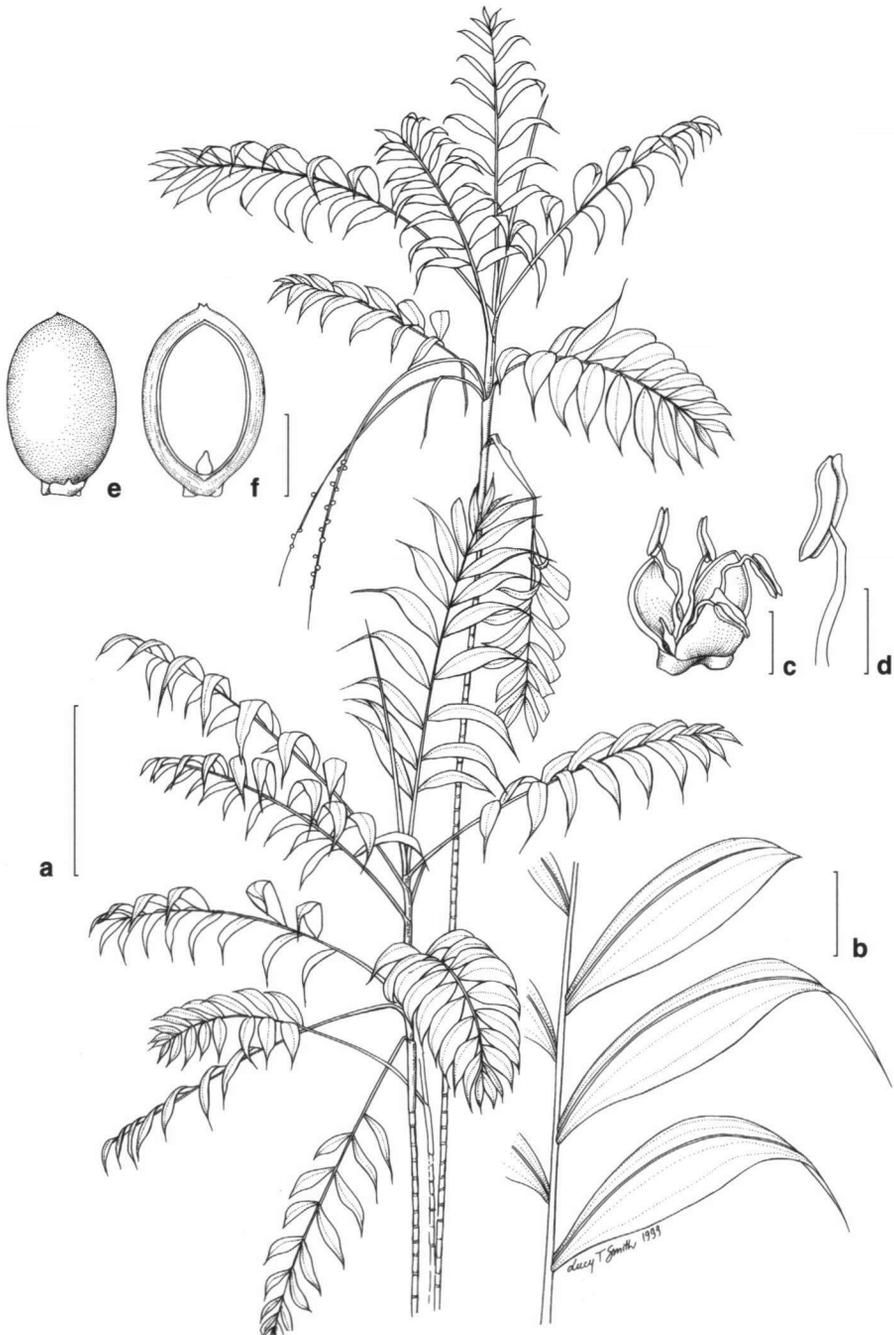


Fig. 1. *Calyptrocalyx amoenus* Dowe & M.D. Ferrero. a. Habit; b. leaf detail with pinnae; c. staminate flower; d. stamen; e. fruit; f. fruit in longitudinal section. — Scale bars: a = 30 cm; b = 5 cm; c & d = 1 mm; e & f = 5 mm (Ferrero 980037). Drawing by Lucy T. Smith.

almost as strong, all veins raised adaxially, only minor veins dominant abaxially; marginal veins thicker than secondary veins; two terminal pinnae basally united. *Inflorescence* 70–115 cm long, 2-spiked, filiform, rigid, moderately arched; peduncle 40–75 cm by c. 3 mm, dorsi-ventrally compressed; rachilla 30–35 cm by c. 3 mm; floral pits congested. *Flowers* c. 1.5 mm apart, cream. *Staminate flower* broadly ovoid in bud, c. 2 mm high, widely opening at maturity; sepals c. 0.5 mm long, triangular, obtuse, apex acute, strongly carinate, margins hyaline; petals c. 2 mm long, triangular, broadly ovate, apex moderately acute, inward curving, longitudinally striate; stamens 6, 2.5–3 mm long; filaments c. 0.1 mm diam., not noticeably tapered, c. 2.5 mm long, extended outward between the petals; anthers ovoid, c. 1.2 mm long, with \pm parallel sides, versatile; pistillode elongate, c. 2.5 mm long, slightly tapered toward the apex, apex flat; pollen mostly circular, monosulcate, exine finely reticulate. *Pistillate flower* not seen. *Fruit* ellipsoid, 9–13 mm long, 6–10 mm diam., crimson; epicarp smooth, minutely granular when dry; mesocarp sparsely fibrous; endocarp crustaceous. *Seed* ellipsoid, 7–10 mm long, 4–6 mm diam.; endosperm homogeneous.

Distribution — Papua New Guinea: W Sepik Province; Freida River area.

Habitat & Ecology — In rain forest at 120–140 m.

Etymology — From *amoena* – delightful, in reference to the general appearance of the palm.

Vernacular name — Yurrimak.

Notes — 1. *Calyptrocalyx amoenus* is distinguished by caudate pinnae that decrease in size towards the leaf tip, a 2-spiked inflorescence, staminate flower with 6 elongate stamens, ellipsoid fruit 9–13 mm long, 6–10 mm diam. that are crimson at maturity, and homogeneous endosperm.

2. The stem of this palm is used to make spears, spear heads, or practice bows. Stems are also used for cross-beams in houses. Staminate flowers have a soapy smell.

3. *Calyptrocalyx arfakianus* (Becc.) Dowe & M.D. Ferrero, *comb. nov.*

Linospadix arfakianus Becc., Malesia 1 (1877) 62. — *Bacularia arfakiana* (Becc.) F. Muell., Fragm. 11 (1878) 58. — *Paralinospadix arfakianus* (Becc.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 333, syn. nov. — Type: *Beccari s.n.* (holo FI; iso FI, K), Indonesia, Papua, Mt Arfak, Hatam, 1500–2000 m, July 1875.

Linospadix pachystachys Burret, Notizbl. Bot. Gart. Berlin-Dahlem 11 (1933) 711. — *Paralinospadix pachystachys* (Burret) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 335, syn. nov. — Type: *Stein 128* (holo B \dagger), Indonesia, Papua, Waigeo, 250 m, 20 May 1931.

Solitary, small palms. *Stem* erect, 1–2 m tall, 10–14 mm diam.; internodes to 3 cm long, dark green; crown with 6–10 leaves. *Leaves* irregularly segmented, 75–100 cm long; leafbase 15–18 cm long, green, minutely nerved, margin moderately lacerate-fibrous; petiole 15–25 cm by 2–3 mm, adaxially channelled; lamina to 50 cm long, to 16 cm wide, dark glossy green adaxially, much lighter abaxially; segments unequal on either side, irregularly arranged, 2 per side or 1–4 on one side and up to 10–12 on the other, with some major divisions; basal segments narrow c. 12 mm wide; terminal segments united to form a deeply bifid apex, margins truncate, toothed; primary ribs adaxially prominent, 15 mm apart, not raised abaxially; secondary veins raised slightly on both surfaces. *Inflorescence* to 75 cm long, 2–4-spiked, pendulous; prophyll to 12 cm long; peduncular bract to 20 cm long; peduncle 45–55 cm long, to 2 mm wide,

glabrous; rachilla 18–20 cm long, to 3 mm diam., fusiform. *Flowers* bright yellow. *Staminate flower* pointed in bud, widely opening at maturity; sepals c. 1 mm long, scarcely carinate, moderately striate; petals to 5 mm long, broadly ovate, triangular, pointed, rigid, longitudinally striately-nerved; stamens 8 or 9, c. 6 mm long, unequal in length; anthers 1–1.5 mm long, versatile, yellow; pistillode elongate. *Pistillate flower* c. 3 mm high, obtusely pyramidal; sepals c. 1.5 mm long, obtuse, with ciliate margins, gibbose-carinate; petals c. 3 mm long, striately-nerved; stigma papillose. *Fruit* globose to subglobose, 11–12 mm long, 7–8 mm diam., black; epicarp smooth, crustaceous when dry; mesocarp mealy, fibrous, bright yellow, with fibres tightly fused, reticulate to anastomose; endocarp adherent to the seed. *Seed* globose to ovoid, c. 8 mm long, c. 6 mm diam.; raphe longitudinal; endosperm ruminant.

Distribution — Indonesia: Papua: Sorong, Manokwari, and Fakfak Divisions.

Habitat & Ecology — In rain forest at 250–2000 m.

Etymology — The species was named for the type locality, Arfak Mts.

Vernacular name — Mbep (Anggi language – Arfak Mts).

Note — *Calyptrocalyx arfakianus* is distinguished by the combination of a solitary habit, small stature, multi-spiked inflorescence, globose to subglobose black fruit, and ruminant endosperm. The original description of *Paralinospadix pachystachys* from Waigeo Island matches *C. arfakianus* very closely, and despite the loss of the type specimen, *Stein 128* (B[†]), the name is placed as a synonym of *C. arfakianus*.

4. *Calyptrocalyx awa* Dowe & M.D. Ferrero, *spec. nov.* — Fig. 2

Palma caespitosa, statura parva, foliis segmentis foliorum irregulariter dispositis, vaginis foliorum marginibus laevibus, inflorescentia bi-spicata, spicis filiformibus flexuosis, petalis apicaliter rubro-vittatis, filamentis elongatis, staminibus 6–7, pistillodio columnari, fructu globoso, mesocarpio fibroso, fibris aggregatis prope endocarpium, endospermio homogeneo. — Typus: *Dowe & Ferrero 507* (holo BRI; iso K, LAE), Papua New Guinea, W Sepik Province, Vanimo District, Pual River area, Wasimei, 10 Feb. 1998.

Clustering, small palms. *Stems* 2–5, 2–3 m tall, 20–30 mm diam.; internodes to 5 cm long, green; crown with 8–11 leaves. *Leaves* bifid, or irregularly segmented or regularly pinnate, 90–129 by 30–58 cm, new leaf emerges peach-bronze; leafbase 16–30 cm long, margin ± smooth; petiole 5–18 cm long, shallowly channelled adaxially; rachis 50–69 cm long, ridged adaxially, rounded abaxially; segments 2–6, with 1–8 ribs per side, irregularly arranged; ribs adaxially prominent; lamina semi-glossy green adaxially, lighter dull green abaxially; ribs and veins not raised abaxially. *Inflorescence* 40–70 cm long, 2-spiked; prophyll 17 cm long; peduncular bract to 26 cm long; peduncle 10–20 cm by 3–4 mm; rachilla 30–50 cm long, 3.5–4.5 mm diam. *Flowers* cream to green. *Staminate flower* c. 2 mm high; sepals c. 0.5 mm long; petals c. 2 mm long, triangular, rigid, red-tinged, densest toward the apex; stamens 6 or 7, c. 1 mm long; filaments c. 1 mm long; anthers linear, 0.5 mm long, shallowly sagittate, versatile; pollen mostly circular in polar view, long axis 21.7–25.3 μm , short axis 16.3–21.7 μm , monosulcate, exine finely reticulate; pistillode columnar, c. 1.5 mm long. *Pistillate flower* not seen. *Fruit* globose, 10–12 mm diam., orange; epicarp smooth, thin; mesocarp moderately fibrous; fibres thick, aggregated toward the endocarp. *Seed* globose, 7–10 mm diam.; endosperm homogeneous.

Distribution — Papua New Guinea: W Sepik Province, Vanimo District.

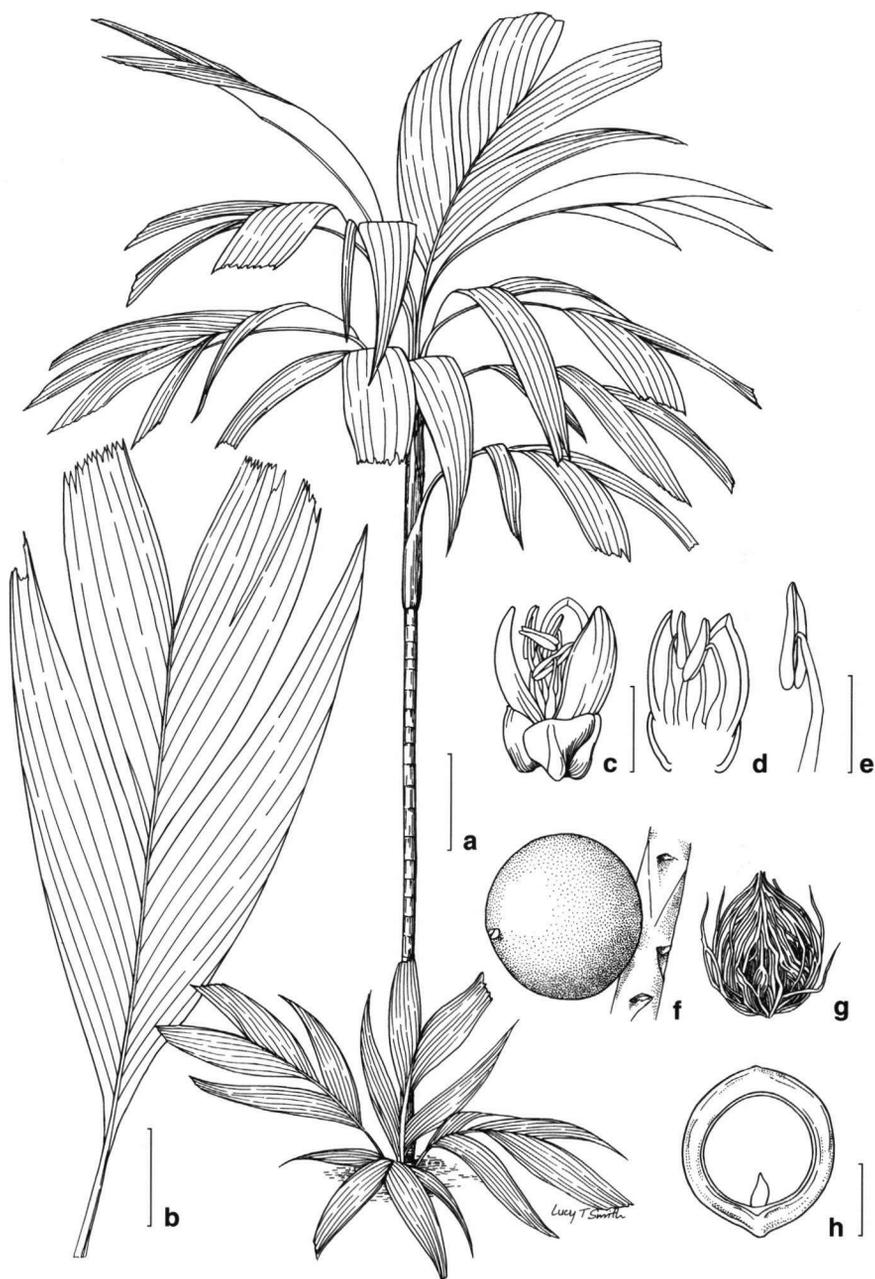


Fig. 2. *Calyptrocalyx awa* Dowe & M.D. Ferrero. a. Habit, with dominant stem and basal sucker; b. leaf; c. staminate flower; d. staminate flower in longitudinal section; e. stamen; f. fruit attached to rachilla; g. fruit with epicarp removed to reveal mesocarp fibres; h. fruit in longitudinal section. —Scale bars: a = 20 cm; b = 10 cm; c & d = 1 mm; e = 0.5 mm; f–h = 5 mm (Dowe & Ferrero 507). Drawing by Lucy T. Smith.

Habitat & Ecology — In rain forest at 10–60 m.

Etymology — The species name is taken from the vernacular name, *awa*, used by the Osima people from Pual River and Oiru areas, inland from Vanimo. The name *awa* is also used for *C. pachystachys*, an unrelated species.

Notes — 1. *Calyptrocalyx awa* is distinguished by a clustering habit, staminate flowers with small, rigid, red-tinged petals, 2-spiked inflorescence, globose orange fruit and homogeneous endosperm. Fruit is widely spaced on the rachilla.

2. Seedling leaves have a metallic lustre that gradually fades as plants assume a size to about 30 cm tall. New leaves emerge peach-bronze in juvenile and adult plants.

3. Stems are occasionally used to make practise bows by children.

5. *Calyptrocalyx caudiculatus* (Becc.) Dowe & M.D. Ferrero, *comb. nov.*

Linospadix caudiculata Becc., Nova Guinea 8 (1909) 213. — *Paralinospadix caudiculatus* (Becc.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 335, *syn. nov.* — Type: *Koch s.n.* (holo L; iso FI), Indonesia, Papua, Etna Bay, 1904–1905.

Clustering, small palms. *Stems* 2–10, erect, to 3 m tall, 10–20 mm diam.; internodes to 4 cm long, dark green; crown with 9–11 leaves. *Leaves* regularly pinnate, 55–70 cm long, to 30 cm wide, new leaf emerges red; leafbase to 17 cm long, 2 cm wide, with fine longitudinal striations, scattered brown scales, ligule marcescent; petiole 13–35 cm by 7 mm, adaxially channelled, with scattered brown scales; rachis with scattered brown scales; pinnae 8 or 9 per side, alternate, placed c. 12 cm apart, sigmoid to lanceolate, irregularly blotched, narrowing toward the base, apically caudate to a filamentous drip tip 7–8 cm by 1 mm; midleaf pinnae 27–28 by 4.5–5 cm, chartaceous, dark green adaxially, lighter green abaxially; midrib prominent. *Inflorescence* 90–120 cm long, 2–8-spiked; peduncle 50–70 cm long, 2 mm diam., terete, with fine longitudinal striations, sparse reddish scales; rachilla 40–50 cm long, 4 mm diam.; floral pits shallow. *Flowers* cream. *Staminate flower* c. 2 mm long; petals c. 2 mm long, triangular, cupped; stamens 6–8, unequal in length, c. 4 mm long; anthers linear-sagittate, versatile, cream; pistillode c. 2 mm long, filiform. *Pistillate flower* c. 2 mm long, subglobose to conic, pointed. *Fruit* broadly ellipsoid to subglobose, 10–12 mm long, 5–6 mm diam., purple-black; epicarp smooth, coarsely granular when dry. *Seed* ovoid, 8–10 mm long, 6–8 mm diam.; endosperm homogeneous.

Distribution — Indonesia: Papua: Fakfak Division.

Habitat & Ecology — In rain forest.

Etymology — The specific epithet is from *caudiculus* – a small tail, referring to the extended ‘drip-tip’ of the pinnae.

Notes — 1. *Calyptrocalyx caudiculatus* is distinguished by a clustering habit, sigmoid, caudate pinnae, multi-spiked inflorescence, broadly ellipsoid to subglobose purple-black fruit and homogeneous endosperm.

2. Seedling leaves are strongly blotched.

6. *Calyptrocalyx doxanthus* Dowe & M.D. Ferrero — Fig. 3

Calyptrocalyx doxanthus Dowe & M.D. Ferrero, Wodyetia 4 (1999) 9. — Type: *Dowe 530* (holo BO; iso BRI, K), ex cult., Indonesia, Java, Bogor, Baranangsiang Indah, Salacca Breeding Laboratory Garden, 12 Dec. 1998, cultivated from material collected by G. Hambali from Jayapura Division, Cyclops Mts, Ifar, 250–800 m alt., Dec. 1992.



Fig. 3. *Calyptrocalyx doxanthus* Dowe & M.D. Ferrero. a. Habit, with dominant stem and basal sucker; b. leaf, with blotching partially shown on only two pinnae; c. staminate flower; d. staminate flower in longitudinal section; e. stamen, extended, with vasculature indicated by a broken line; f. pistillate flower; g. fruit; h. fruit with epicarp removed to show mesocarp fibres; i. fruit in longitudinal section. — Scale bars: a = 30 cm; b = 8 cm; c & f = 4 mm; d = 3 mm; e = 1 mm; g–i = 5 mm (*Hambali s.n.*). Drawing by Lucy T. Smith.

Solitary or clustering, small palms. *Stems* 1–4, 1.5–2 m tall, to 2 cm diam.; internodes 2.5–3 cm long, green; crown with c. 7 leaves. *Leaves* 77–120 cm long, regularly pinnate, new leaf emerges crimson; leafbase 16–17 cm long, enclosing almost entire stem, pale light green, glabrous, margins moderately lacerate-fibrous; petiole 28–30 by 1 cm, terete in cross section, light green, glabrous, 2 carina running parallel on adaxial side; rachis 56–60 cm long, to 7 mm wide, glabrous, adaxially ridged; pinnae 14–17 per leaf, alternate to sub-opposite, sigmoid or broadly lanceolate and briefly caudate, 11–25 cm long with a filamentous drip-tip 5–10 cm long, lower pinnae much reduced, apical pair basally united, adaxial surface matt light green to yellow green, strongly blotched with dark veins, abaxial surface whitish grey to pale green; midrib prominent on adaxial surface, not raised on abaxial surface, 8 or 9 secondary veins prominent on abaxial surface. *Inflorescence* 54–55 cm long, 1-spiked; prophyll 14–17 by 2.5 cm, margins acute, light tan with reddish scales; peduncular bract 32–37 by 1.2–1.3 cm, light tan with dense reddish scales; peduncle 40–42 cm by 2–3 mm, sub-terete in cross section, dense brown persistent tomentum; rachilla 13–15 cm long, 4–10 mm diam., fusiform, with red to brown tomentum. *Staminate flower* bullet-shaped in bud, symmetrical, 4–8 mm long; sepals c. 1.5 by c. 2.5 mm, strongly carinate, white; petals 4–8 mm long, white to cream, apically acute, longitudinally striate; stamens 8–10, equal in length, bright lavender; filaments fused for their entire length forming a staminal tube, at the apex they are deflexed inward and fused with the anthers; anthers 2.5–3 mm long, dorsifixed, connate in its basal 1/2 with the filament, non-versatile, purple; pollen mostly circular in polar view, long axis 21.3–24.8 μm , short axis 20–23.6 μm , monosulcate, exine finely reticulate; pistillode squat, to 1 mm high, trilobed. *Pistillate flower* to 4 mm high; sepals c. 2 mm long, not carinate; petals c. 3 by c. 1 mm, not carinate, margins ciliate; stigma large, strongly recurved; ovary 0.6 mm long. *Fruit* ellipsoid, 11–15 mm long, 9–12 mm diam., red; epicarp smooth, thin; mesocarp fleshy, clear, fibres scattered throughout. *Seed* ovoid, 10–11 mm long, 7–10 mm diam.; endosperm homogeneous.

Distribution — Indonesia: Papua: Jayapura Division, seaward slopes of Cyclops Mts, Wambena area, and Mt Ifar.

Habitat & Ecology — On slopes above creeks and creek banks in seasonally dry forest at c. 300 m.

Etymology — The specific epithet, *doxanthus*, is in reference to the unique staminate flower, from *doxa* – glorious, *anthus* – flowers (see Notes).

Vernacular name — Demah kupei (I'ou'wanupeio language), literally means leaf (demah) and tail (kupei), in reference to the caudate pinnae.

Notes — 1. The staminate flower of *C. doxanthus* is unique within the subtribe. The filaments are fused for their entire length to form a broad tube that sits in the centre of the flower, somewhat resembling flowers in some genera of the Meliaceae. The filaments are deflexed inward at the apex and the anthers are connate for half their length to the filament. The anthers remain tightly compact at anthesis. The staminal tube holds a sweetly scented sugary nectar that is attractive to ants. The nectar appears to exude from the pistillode.

2. The species is furthermore characterised by pinnae that have a strongly blotched appearance due to the contrast between the veins and associated tissue, which are dark coloured, and the adjoining laminal tissue, which is lighter coloured.

7. *Calypstrocalyx elegans* Becc.

Calypstrocalyx elegans Becc. in K. Schum. & Hollrung, Fl. Kais. Wilhelmsl. (1889) 16. — Type: *Hollrung 646* (holo B†; iso FI), Papua New Guinea, E Sepik Province, Mouth of the Sepik River, 1886–1887.

Calypstrocalyx schultzeanus Becc., Bot. Jahrb. Syst. 52 (1914) 32, syn. nov. — Type: *Schultze 137* (holo B†; photo SING), Papua New Guinea, E Sepik Province, Lower Sepik River, 10 Sept. 1910.

Calypstrocalyx moszkowskianus Becc., Bot. Jahrb. Syst. 52 (1914) 33, syn. nov. — Type: *Moszkowski 241* (holo B†; photo SING), Indonesia, Papua, Mamberamo River, 1910.

Calypstrocalyx bifurcatus Becc., Bot. Jahrb. Syst. 58 (1923) 450, syn. nov. — Type: *Ledermann 10041* (holo B†), Papua New Guinea, E Sepik Province, Lordberg, 1000 m, 1912.

Solitary or clustering, small to moderate palms. *Stems* 1–15, erect to leaning, 1–5 m tall, 2.5–6 cm diam.; internodes to 6 cm long, dark green; crown with 6–15 leaves. *Leaves* bifid, or irregularly segmented or regularly pinnate, 32–120 cm long; leafbase green, margins densely lacerate-fibrous; petiole 12–30 cm by 3–6 mm, adaxially channelled; pinnae few to numerous if leaf pinnate, regularly arranged or grouped, closely spaced to distant, narrowly linear acuminate, elongate lanceolate to sigmoid, 40–60 cm by 20–50 mm, rigid, chartaceous, distal pinnae becoming smaller, two terminal pinnae basally united; bifid leaf with lamina to 30 cm long, broadly cuneate, rigid, chartaceous, subconcolourous, c. 10 ribs on both sides, lobes basally broad, acuminate subfalcate and attenuated toward the apex, margin two-pronged dentate-incised. *Inflorescence* 50–90 cm long, 1-spiked, pale yellow with dark scaly tomentum; prophyll to 12 cm long; peduncular bract to 30 cm long; peduncle 15–60 cm by 2–5 mm; rachilla 9–30 cm by 5–10 mm, apex attenuate-subulate; floral pits congested, to 5 mm wide, lips erect, margins smooth to crenulate. *Flowers* cream to green to yellow orange. *Staminate flower* lanceolate to acuminate in bud, occasionally curved, 7–10 mm long, to 3 mm diam., widely opening at maturity; sepals 2–3 mm long, basally carinate, margins hyaline, dorsal ridge sharp, subcristate and papillose to chaffy; petals 7–10 mm long, ovate to lanceolate to triangular, pointed, rigid, cartilaginous, surface striate and with sparse orbicular clear scales; stamens 7–30, of equal length; filaments 5–6 mm long; anthers narrow, 2.5 mm long, linear, versatile; pollen circular or elliptical in polar view, long axis 27.6–41.6 μm , short axis 25.3–27.6 μm , monosulcate, exine finely reticulate; pistillode columnar, c. 1 mm tall. *Fruit* ellipsoid, 12–14 mm long, 10–12 mm diam., red; epicarp with scattered deciduous brown scales; mesocarp watery, slightly sticky, moderately fibrous, fibres aggregated toward the endocarp. *Seed* ellipsoid, c. 12 mm long, c. 7 mm diam.; endosperm ruminant.

Distribution — Indonesia: Papua: Jayapura and Jayawijaya Divisions. Papua New Guinea: W Sepik, E Sepik, and Madang Provinces.

Habitat & Ecology — In rain forest at 0–1000 m.

Etymology — The specific epithet is from *elegans* – elegant.

Vernacular names — Mara (Ndu language – E Sepik Province), boalak (Kaka language – lower Sepik, E Sepik Province), sanumb (Bewani language – W Sepik Province), siterarum (Olo language – Torricelli Mts, W Sepik Province), kel keyik (Mai language – Wassisi, W Sepik Province), malu (Bifrau language – Green River District, W Sepik Province), kohili (Madang Province).

Notes — 1. *Calyptrocalyx elegans* is distinguished by a solitary or clustering habit, leaves that are bifid, irregularly segmented with united pinnae or regularly pinnate, solitary-spiked inflorescence, ellipsoid fruit, and ruminant endosperm.

2. *Calyptrocalyx schultzeanus*, *C. moszkowskianus*, and *C. bifurcatus* are placed as synonyms of *C. elegans* following examination of photos of the types of the former two and an assessment of the description of the latter.

3. Stems are used to make spear heads and shafts, and the leaves to wrap food. As a bush food, the spear leaf is pulled out of the palm and the heart is eaten. In Bewani, stems are broken off to encourage borers to lay their eggs so that edible larvae may eventually be harvested.

8. *Calyptrocalyx flabellatus* (Becc.) Dowe & M.D. Ferrero, *comb. nov.*

Linospadix flabellatus Becc., Malesia 1 (1877) 64. — *Bacularia flabellata* (Becc.) F. Muell., Fragm. 11 (1878) 58. — *Paralinospadix flabellatus* (Becc.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 334, syn. nov. — Type: *Beccari s.n.* (holo FI; iso FI, K), Indonesia, Papua, Mt Arfak, Hatam, 1500–2000 m, July 1875.

Solitary, small palms. *Stem* erect or leaning, to 3 m tall, 6–7 cm diam.; internodes 2–3 cm long, dark green; crown with 6–9 leaves. *Leaves* bifid, irregularly segmented or regularly pinnate, 35–150 cm long; leafbase 7–8 cm long, margin moderately lacerate-fibrous; petiole 8–12 cm long, shallowly channelled adaxially; lamina basally cuneate, when bifid, segments lanceolate to elliptic, acuminate, apically dentate, dark green adaxially, light green abaxially; major ribs 6 or 7, converging at the apex. *Inflorescence* 35–70 cm long, 2–4-spiked; prophyll 7–12 cm long; peduncular bract 14–20 cm long; peduncle 18–50 cm by 1.5–2 mm, glabrescent; rachilla 17–20 cm by 2–3 mm, slightly fusiform. *Flowers* cream, well spaced. *Staminate flower* twisted and asymmetric in bud, 2.5 mm long, widely opening at maturity, sepals c. 1 mm long, broadly acute, gibbose-carinate; petals c. 2 mm long, c. 7-nerved; stamens 9; filaments c. 3 mm long; anthers deeply sagittate, versatile. *Pistillate flower* 3 mm long. *Fruit* ellipsoid, 11–12 mm long, 7–8 mm diam., orange to scarlet. *Seed* ellipsoid, 8–10 mm long, 5–6 mm diam.; endosperm homogeneous.

Distribution — Indonesia: Papua: Sorong, Manokwari, and Fakfak Divisions.

Habitat & Ecology — In rain forest at 65–2000 m.

Etymology — The specific epithet, from *flabellum* – fanned, refers to the morphology of the leaf.

Vernacular names — Owe (Maibrat language – Sorong Division), kiligata (Amoi language – Sorong Division).

Note — *Calyptrocalyx flabellatus* is distinguished by a solitary habit, bifid or irregularly segmented or regularly pinnate leaves, ellipsoid fruit and homogeneous endosperm.

9. *Calyptrocalyx forbesii* (Ridl.) Dowe & M.D. Ferrero

Calyptrocalyx forbesii (Ridl.) Dowe & M.D. Ferrero, Wodyetia 4 (1999) 10. — *Linospadix forbesii* Ridl., J. Bot. 24 (1886) 358. — *Paralinospadix forbesii* (Ridl.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 334. — Type: *Forbes 163* (holo BM), Papua New Guinea, Central Province, Sogeri, 800 m, 22 Oct. 1885.

Linospadix petrickiana Sander, Gard. Chron. 24, 617 (1898) 298. — *Paralinospadix petrickianus* (Sander) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 334; 13 (1937) 471. — Type: not designated.

Paralinospadix stenochistus Burret, Notizbl. Bot. Gart. Berlin-Dahlem 13 (1936) 323. — Type: Carr 12130 (holo A; iso BM, K), Papua New Guinea, Central Province, Koitaki, 1500 ft, 3 May 1935.

Solitary or clustering, small to moderate palms. *Stems* 1–10, erect or leaning, to 5 m tall, 1.3–9 cm diam., internodes 1–12 cm long, dark green; crown with 8–10 leaves. *Leaves* regularly pinnate, 50–200 cm long, new leaf emerges purple-brown; leafbase 14–18 cm long, slightly swollen, green, margin densely lacerate-fibrous; petiole 2–10 cm by 4–10 mm, shallowly channelled adaxially, with scattered dark scaly tomentum; rachis sharply angled; pinnae 10–30 per side, opposite to subopposite, dark glossy green adaxially, much lighter abaxially, narrow linear, acuminate, subfalcate, apical segments congested and basally joined, 15–40 cm by 8–15 mm, midrib prominent adaxially, ramenta on abaxial midrib. *Inflorescence* 30–130 cm long, 1–4-spiked; prophyll 10–23 cm long; peduncular bract 20–42 cm long, 4–6 mm diam., narrowly cylindrical, papyraceous, with dark scaly tomentum; peduncle 10–65 cm long, 3–4 mm diam.; rachilla 20–54 cm long, 4.5 mm diam., rigid, longitudinally angled, with brown velutinous tomentum; floral pits not closely spaced, margins truncate. *Flowers* cream. *Staminate flower* 4–4.2 mm long in bud, symmetrical, widely opening at maturity; sepals c. 1 mm high, ovate, carinate, margin ciliate; petals c. 3.5 by c. 1.5 mm, lanceolate, dorsally striately-nerved; stamens 6–12; filaments c. 6 mm long; anthers linear to c. 2 mm long, shallowly sagittate, versatile; pollen circular or elliptical in polar view, long axis 23.5–29 μm , short axis 14.5–21.7 μm , monosulcate, exine very finely reticulate; pistillode small, conic to cylindrical. *Pistillate flower* to 3 mm high; stigma small. *Fruit* ellipsoid, 7–20 mm long, 4–12 mm diam., orange to red; epicarp smooth, thin, coarsely granular when dry; mesocarp with dense fibres; endocarp crustaceous. *Seed* ellipsoid, c. 15 mm long, c. 8 mm diam.; endosperm homogeneous; $n = 16$ (Read, 1966).

Distribution — Papua New Guinea: Central and Milne Bay Provinces.

Habitat & Ecology — In rain forest at 0–1000 m.

Etymology — The species was named for British botanist Henry Ogg Forbes (1851–1932), collector of the type specimen.

Notes — 1. *Calyptrocalyx forbesii* is distinguished by a solitary or clustering habit, leaves that are regularly pinnate with narrow pinnae, a rigid, filamentous 1–4-spiked inflorescence, staminate flower with long petals, ellipsoid fruit and homogeneous endosperm.

2. *Paralinospadix stenochistus* was described from a plant collected at Boridi, Carr 12130 (A), in Central Province. This specimen is indistinguishable from *C. forbesii*, and also matches plants collected in Milne Bay Province.

3. The name *Paralinospadix petrickianus* was published with the following brief description "... elegant, pinnately-leaved palm ..." and was accompanied by an illustration of a juvenile plant (Sander, 1898). Subsequently, the name was applied to plants in cultivation in Bogor and Berlin Botanic Gardens (Burret, 1935). These living collections are no longer extant, but herbarium specimens labelled *Paralinospadix petrickiana* taken from the plants in Kebun Raya Bogor match *C. forbesii*.

10. *Calypstrocalyx geonomiformis* (Becc.) Dowe & M.D. Ferrero, *comb. nov.*

Linospadix geonomaeformis Becc., Nova Guinea 8 (1909) 211, t. 51, 1. — *Paralinospadix geonomiformis* (Becc.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 335, syn. nov. — Type: *Versteeg 1627* (holo FI), Indonesia, Papua, Paniai Division, Mt Resi, 250 m, 1907.

Solitary or clustering, small palms. *Stems* to 1 m tall, 12–14 mm diam.; internodes 2–2.5 cm long. *Leaves* bifid or irregularly segmented, 45–55 by 28–30 cm; leafbase to 27 cm long, slightly swollen, with scattered orange-brown appressed scales, margins lacerate-fibrous; petiole 4–11 cm long, shallowly channelled adaxially; rachis rounded on both sides, with scattered orange-brown appressed scales; lamina when bifid, cuneate, broadly attached to the rachis, 16–18 ribs per side raised on adaxial surface, with brown scales abaxially; when segmented with 2 or 3 segments per side, basal and apical segments broad, 31–40 by 5–8 cm, falcate-acuminate, terminally acute, apex dentate, segments and ribs strongly curved toward the leaf apex, mid-leaf segments much narrower, 31–35 cm by 10–12 mm with a single rib; lamina chartaceous, rigid, dark green adaxially, lighter green abaxially. *Inflorescence* 40–60 cm long, 1- or 2-spiked; prophyll 8 cm long; peduncular bract 21–26 cm long, membranous, disintegrating into marcescent fibres; peduncle 36–48 cm long, 2–3 mm diam., dorsiventrally compressed with acute margins, surface with reddish scaly tomentum; rachilla 18–20 cm long, broadly-fusiform, 5–6 mm wide in the middle; floral pits congested, deep, with reddish scaly tomentum. *Staminate flower* ovoid in bud, 4–5 mm long, slightly asymmetrical; stamens 6, equal, erect; filaments linear; anthers narrowly sagittate, apex obtuse or obscurely bidentate, versatile; pistillode elongate, about as long as the stamens, trigonal, apex trifid. *Pistillate flower* ovoid, c. 3.5 mm long, sepals c. 1.5 mm long, rounded; petals c. 3 mm long, apex briefly apiculate; stigma broadly triangular; staminodes 6, equal. *Fruit* not seen.

Distribution — Indonesia: Papua: Paniai Division. Mt Resi and Mt Carstensz.

Habitat & Ecology — In rain forest at 250–1000 m.

Etymology — The specific epithet is from *geonoma*, and possibly relates to the resemblance of the leaf to some species in the genus *Geonoma* Willd.

Note — *Calypstrocalyx geonomiformis* has a distinct leaf morphology with the ribs in all segments strongly curved toward the leaf apex. This feature is known to occur in only one other species, *C. julianettii*, from Central Province, Papua New Guinea, although differences in inflorescence structure indicate that these are two readily differentiated species. The inflorescence of *C. geonomiformis* is 1- or 2-spiked, with the rachilla considerably thicker than the peduncle, and that in *C. julianettii* is consistently 4-spiked with the rachilla scarcely thicker than the peduncle. In addition, the petiole of *C. geonomiformis* is moderate to elongate, while it is absent to very short in *C. julianettii*.

11. *Calypstrocalyx hollrungii* (Becc.) Dowe & M.D. Ferrero, *comb. nov.*

Linospadix hollrungii Becc. in K. Schum. & Hollrung, Fl. Kais. Wilhelmsl. (1889) 16. — *Paralinospadix hollrungii* (Becc.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 334, syn. nov. — Type: *Hollrung 226* (holo B†; iso and illustrations FI), Papua New Guinea, Morobe Province, Sattelberg, 1886.

Linospadix hellwigiana Warb. in K. Schum. & Lauterb. (nomen tantum, 'in Mons. ined.'). Fl. Deutsch. Schutzgeb. Südsee (1900) 206 [as *Linospadix helwingianus* Warb. (nomen) in Becc.,

Webbia 1 (1905) 293]. — Type: *Lauterbach 602* (holo B†; iso FI), Papua New Guinea, Morobe Province, Sattelberg, summit forest, 970 m, 24 July 1890.

Linospadix schlechterii Becc., *Webbia* 1 (1905) 296. — *Paralinospadix schlechterii* (Becc.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 335, syn. nov. — Type: *Schlechter 13955* (holo B†; photos and illustrations FI), Papua New Guinea, Madang Province, Bismarck Mts, 1000 m, Jan. 1902.

Paralinospadix clemensiae Burret, Notizbl. Bot. Gart. Berlin-Dahlem 13 (1936) 322, syn. nov. — Type: *Clemens 1828* (holo B†), Papua New Guinea, Morobe Province, Wareo, hill forest, 800 m, 1 Feb. 1936.

Solitary or clustering, small palms. *Stems* 1–20, erect or leaning, to 3 m tall, 12–20 mm diam.; internodes 1.5–8 cm long, pale brown; crown with 6–11 leaves. *Leaves* bifid or irregularly segmented or regularly pinnate, 45–180 by 16–29 cm, new leaf emerges dark red, crimson or purple; leafbase 11–22 cm long, green, margins moderately lacerate-fibrous; petiole 4–30 cm by 4–7 mm, adaxially flat or deeply channelled, with dark scaly tomentum, abaxially rounded; lamina dark green adaxially, lighter green abaxially, rigid, coriaceous. Leaves, when bifid, are deeply lobed, cuneate-attenuate at the base, with apex minutely dentate, 12 or 13 ribs raised on adaxial surface, secondary veins much thinner than the ribs; in irregularly segmented leaves, segments 3–14, variously arranged with some segments narrow linear to acuminate, 1- or 2-ribbed, others broader with 5–7 ribs and the apex attenuate to caudate, spacing between segments broad to narrow, secondary veins abaxially scaly; in regularly segmented leaves, pinnae 13–16 per side, flatly falcate, basally narrowing, midrib prominent, apical pinnae basally joined and with 3 veins; apical pinnae to 13 cm long, to 1 cm wide, mid-leaf pinnae to 22 cm long, to 6 mm wide. *Inflorescence* 68–120 cm long, 1–3-spiked, spikes often curling; prophyll 18–24 cm long, narrowly cylindrical, 5 mm diam., brown, with dark scaly tomentum; peduncular bract 30–48 cm by c. 8 mm, light brown; peduncle 40–59 cm by 2–3 mm, subterete, with dark scaly tomentum; 1 or 2 rameal bracts c. half-way along peduncle, narrow linear, 1–4 mm long; rachilla 20–30 cm long, 3–4 mm diam., slightly thicker than the peduncle, with scaly tomentum. *Flowers* cream to straw coloured, closely or distantly placed; floral pits glabrous, margin truncate. *Staminate flower* to 4 mm high, linear to lanceolate, in bud appressed in pairs resembling rodent incisor teeth; sepals 1–1.5 mm high, roundly ovate, carinate, apex obtuse, margin ciliate; petals 3–4 mm long, linear, striate on the outer surface; stamens 6–12; anthers linear, 3 mm long, deeply sagittate, versatile; pollen circular to elliptical in polar view, long axis 21.7–32.6 μm , short axis 14.5–23.5 μm , monosulcate, exine finely reticulate; pistillode small with a pointed trifid apex. *Pistillate flower* globose, 2–2.5 mm high; sepals c. 1 mm long; petals c. 2 mm long; staminodes narrow; stigma obtuse, 0.6 mm long. *Fruit* ovoid to ellipsoid, 12–16 mm long, 6–9 mm diam., orange to red; epicarp smooth, granular-scabrous when dry; mesocarp fibrous, fibres scattered throughout. *Seed* globose to pyriform, 9–10 mm long, 6–7 mm diam.; endosperm homogeneous.

Distribution — Papua New Guinea: Madang, Morobe, and Northern Provinces.

Habitat & Ecology — In rain forest at 90–1000 m.

Etymology — The species was named for Max Udo Hollrung (1858–1937), collector of the type specimen.

Vernacular name — Hulameng (Khotte language – Sattelburg).

Notes — 1. *Calyptrocalyx hollrungii* is distinguished by a clustering or solitary habit, leaves bifid or irregularly segmented or regularly pinnate, paired staminate flowers that are appressed in bud and resemble a pair of rodent teeth, straw-coloured elongate petals; straight or often curling filamentous inflorescence spikes, and orange to red ovoid to ellipsoid fruit with homogeneous endosperm.

2. *Linospadix hellwigiana* is attributable to this species, and represents an irregularly segmented leaf form. Similarly *Paralinospadix clemensiae*, collected from Wareo, an area close to Sattelburg, and *P. schlechterii*, collected from Bismarck Mts, Madang Province, are both attributable to *C. hollrungii*. The former collection displays a regularly pinnate leaf, while the latter has a bifid leaf.

12. *Calyptrocalyx julianettii* (Becc.) Dowe & M.D. Ferrero, *comb. nov.*

Linospadix julianetti Becc., Webbia 1 (1905) 295. — *Paralinospadix julianettii* (Becc.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 334, syn. nov. — Type: *Loria & Giulianetti s.n.* (holo FI), Papua New Guinea, Central Province, Mekeo Dist., upper St Joseph River, 'Camp 14', Nov. 1892.

Paralinospadix amischus Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 335, syn. nov. — Type: *Brass 3826* (holo BRI; iso A n.v., NY n.v.), Papua New Guinea, Central Province, Ononge Road, Dieni, 500 m, 21 Apr. 1933.

Solitary or clustering, small palms. *Stems* erect, 1–2 m tall, 12–24 mm diam.; crown with c. 10 leaves. *Leaves* irregularly segmented, 60–90 by 25–30 cm, with outer margin curved toward the leaf apex; leafbase 14–18 cm long, cylindrical, with scaly tomentum, margin finely lacerate-fibrous; petiole absent, or 1–3 cm by 3–4 mm, shallowly channelled adaxially; lamina 36–70 cm long, outline elongate to elliptical, 5–12 segments per side, segments falcate to sigmoid, rigid, dark green adaxially, lighter abaxially; narrow segments with a single midrib, broad segments with 2–12 ribs, lowest segments shortest, with 1–3 ribs, apical segments broad with 7–9 ribs, midleaf segments narrower than either basal or apical segments, 10–15 mm wide; midribs raised only on adaxial surface. *Inflorescence* 40–90 cm long, 1–4-spiked; prophyll 16–17 cm long; peduncular bract 24–38 cm long, with dark scaly tomentum; peduncle 20–40 cm long, subterete, 1.5–3 mm wide; rameal bracts in distal portion to 2 mm long; rachilla 15–30 cm long, 3–3.5 mm diam., fusiform, with dark scaly tomentum; floral pits distantly to closely spaced, margin raised. *Staminate flowers* 2.5–5 mm long in bud, ovoid; sepals c. 1 mm long, broadly ovate, basally ridged, margins ciliate; petals 2–5 mm long, longitudinally striate, cream; stamens 9; anthers linear, shallowly sagittate, versatile; pistillode narrow, columnar. *Pistillate flowers* with sepals broadly rounded; petal apex briefly triangular. *Fruit* ellipsoid, tapered acutely to the apex, 11–13 mm long, 6–9 mm diam., red; epicarp smooth, minutely linear granular when dry; mesocarp fleshy. *Seed* globose, 5–8 mm diam.; endosperm homogeneous.

Distribution — Indonesia: Papua: Fakfak Division. Papua New Guinea: Morobe, Northern, and Central Provinces.

Habitat & Ecology — In rain forest at 100–1200 m.

Etymology — It was named for the collector of the type specimen, Amedeo Giulianetti, expedition assistant to Dr Lamberto Loria.

Notes — 1. *Calyptrocalyx julianettii* is distinguished by a solitary or clustering habit, irregularly segmented leaves, multi-spiked inflorescence, ellipsoid fruit, and homogeneous endosperm.

2. *Calyptrocalyx amischus*, described from a collection from Dieni, Central Province, Brass 3826 (BRI), is attributable to *C. julianettii*.

13. *Calyptrocalyx lauterbachianus* Warb. ex Becc.

Calyptrocalyx lauterbachianus Warb. ex Becc., Webbia 4 (1913) 158. — *Grisebachia lauterbachiana* Warb. in K. Schum. & Lauterb. (nomen, 'in Mons. ined.'). Fl. Deutsch. Schutzgeb. Südsee (1900) 206. — *Linospadix lauterbachianus* Warb. ex Becc., Webbia 4 (1913) 158, in obs. — *Laccospadix lauterbachianus* (Becc.) Burret, Repert. Spec. Nov. Regni Veg. 24 (1928) 290. — Type: *Warburg s.n.* (holo B†), Papua New Guinea, Morobe Province, Sattelberg, Apr. 1889. Neotype: *Moore & Millar 9261* (neoholo LAE, here designated; neoiso BH), Papua New Guinea, Morobe Province, ridge trail SW of Bapu village on track to Engabu above Wampit River, 900–1000 m, 4 Mar. 1964.

Calyptrocalyx stenophyllus Becc., Bot. Jahrb. Syst. 52 (1914) 32, syn. nov. — Type: *Schlechter 19829* (holo B†; iso FI; photo SING), Papua New Guinea, Morobe Province, Dschischugari, 900 m, May 1909.

Calyptrocalyx archboldianus Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 323, syn. nov. — Type: *Brass 5290* (holo BRI; iso A n.v., BO, NY n.v.), Papua New Guinea, Central Province, Mafulu, 1350 m, Sept. 1933.

Solitary or clustering, small to moderate palms. *Stem* erect, 2–9 m tall, 3.5–8 cm diam.; crown with 7–9 leaves. *Leaves* regularly pinnate, semi-plumose, arching, 160–300 cm long, new leaf emerges red; leafbase 40–60 cm long, split almost to the base, green, with dark scaly tomentum, apex with two narrow lanceolate lobes, margins and apex moderately lacerate-fibrous; petiole 20–50 cm by 9–11 mm, adaxially channelled, with scaly tomentum; pinnae 20–60 each side of leaf, opposite to subopposite, in groups of 2–4, set in 1 or 2 planes, 3–9 cm apart, chartaceous, rigid, ensiform, acuminate, dark green adaxially, lighter green abaxially, midrib prominent adaxially, midrib and secondary veins moderately raised abaxially; ramenta on midrib abaxially; midleaf pinnae 45–60 by 3.5–5 cm; lowest pinnae narrow linear to lanceolate, 30–33 cm long, 2–3 cm diam.; apical pinnae 20–30 cm long, 3–3.4 mm wide, flatly falcate, becoming smaller and closer spaced toward the apex. *Inflorescence* 80–200 cm long, 1–6-spiked, axes bright green; prophyll 30–50 cm long, narrow, with dark scaly tomentum; peduncular bract 60–70 cm long; peduncle 68–130 cm long, terete, 4–9 mm diam., with dark scaly tomentum; rameal bracts in the distal portion, spirally arranged; rachilla 19–60 cm long, 3.5–9.5 mm diam., at first with scaly tomentum, then becoming glabrous; floral pits deep, closely spaced or distant, floral pit with a sharp margin, glabrous. *Staminate flower* to 4 mm long in bud, cream to green with purplish bases; sepals c. 2 mm long, broadly ovate to cymbiform, dorsally rounded; petals 3–4 mm long, broadly rounded, apex triangular, outside densely striately-nerved, margin minutely ciliate; stamens 12–24, 5–6 mm long; filaments c. 5 mm long; anthers linear, shallowly sagittate, versatile, pale cream, connective reddish; pollen mostly elliptical in polar view, long axis 19.9–38 μm , short axis 14.5–27.2 μm , monosulcate, exine finely reticulate. *Pistillate flower* cream tinged pink; sepals cymbiform, dorsally round-

ed, margin minutely ciliate; petals ovate, triangular; staminodes 6. *Fruit* globose to subfalcately ellipsoid, slightly irregular, 12–40 mm long, 9–25 mm diam., red to bright crimson, stigmatic remains slightly eccentric; epicarp smooth, minutely granular when dry; mesocarp with soft, dry, white or pinkish pulp, evenly fibrous throughout. *Seed* globose, 7–11 mm diam.; endosperm ruminant.

Distribution — Papua New Guinea: Madang, Morobe, Eastern Highlands, Northern and Central Provinces.

Habitat & Ecology — In rain forest at 600–2000 m.

Etymology — The species was named for German botanist and explorer, Carl Adolf Georg Lauterbach (1864–1937).

Vernacular names — Tofe (Okapa language – Eastern Highlands Province), koiya (Anga language – Aseki, Morobe Province).

Notes — 1. *Calyptrocalyx lauterbachianus* is distinguished by leaves with grouped pinnae inserted in different planes, a moderate solitary or infrequently clustering habit, a long multi-spiked inflorescence with bright green axes, irregular ellipsoid fruit with slightly eccentric stigmatic remains, and ruminant endosperm.

2. The type of *C. lauterbachianus*, *Warburg s.n.*, was destroyed in the burning of Berlin Herbarium during the Second World War. The collection *Moore & Millar 9261* is chosen as the neotype as it matches what is an easily characterised species. *Calyptrocalyx archboldianus* and *C. stenophyllus* are attributable to *C. lauterbachianus* as the collections, *Brass 5290* and *Schlechter 19829*, are indistinguishable.

3. Mature fruits are used as a betel nut substitute by the Aseki and Menyamyama people of the Morobe Highlands.

14. *Calyptrocalyx laxiflorus* Becc.

Calyptrocalyx laxiflorus Becc., *Webbia* 1 (1905) 311. — Type: *Schlechter 14312* (holo B⁺), Papua New Guinea, W Sepik Province, Torricelli Mts, 600 m, Apr. 1902. Neotype: *Barfod 396*, with *Ferrero & Damborg* (neoholo AAU, here designated; neoiso BRI, LAE), Papua New Guinea, W Sepik Province, Torricelli Mts, 3 km from Fatima, across creek from Miwaute village, 950–1000 m alt., 21 Nov. 1996.

Acaulescent or very shortly stemmed, solitary or clustering palms. *Stems* 1.5–2 cm diam.; internodes 0.5–2 cm long; crown with 4–9 leaves. *Leaves* regularly pinnate, 64–90 cm long, erect to arching, new leaf emerges pink to bronze; leafbase 12–24 cm long, glabrous, yellow to green, margin moderately lacerate-fibrous; petiole 9–70 cm long, adaxially flat, glabrous; pinnae 2–11 per side, alternate, 15–20 by 3–4 cm, placed c. 4 cm apart, broadly lanceolate to sigmoid, apex acuminate, prolonged into a filamentous drip-tip, base narrow and briefly decurrent; midrib prominent, 2 or 3 secondary veins; two terminal segments briefly united at the base; lamina with metallic sheen, mid-green adaxially, lighter green abaxially, papyraceous, rigid. *Inflorescence* 60–70 cm long, 1–8-spiked, filiform; bracts not seen; peduncle 30–40 cm long, to 2 mm wide, dorsi-ventrally compressed, longitudinally striate with scaly tomentum; small rameal bracts in distal portion; rachilla 25–30 cm long, 2.2 mm diam.; floral pits spaced 10–15 mm apart, subdistichous. *Staminate flower* not seen. *Pistillate flower* ovoid, 5.5 by 2.5 mm; sepals c. 2 mm long; petals c. 5 mm long, concave, striate, apex obtuse, convolute and imbricate at the base; stigma large; staminodes inconspicuous. *Fruit* ellipsoid, to 19–21 mm long, c. 9 mm diam., red; epicarp finely pilose; mesocarp

watery, fibres aggregated and compacted toward the endocarp. *Seed* fusiform to falcate, c. 15 mm long, c. 7 mm diam.; endosperm homogeneous.

Distribution — Papua New Guinea: W Sepik Province, Torricelli Mts.

Habitat & Ecology — In rain forest at c. 600 m.

Etymology — The specific epithet is from *lax* – loose or well spaced, and *florus* – flowers, and refers to the wide spacing of the flowers.

Vernacular name — Timenum (Olo language – Torricelli Mts).

Notes — 1. *Calyptrocalyx laxiflorus* is the only species in which mature plants may be acaulescent. The species is usually solitary, but infrequently clustering, with regularly pinnate leaves, caudate pinnae, multi-spicate inflorescence, ellipsoid fruit, and homogeneous endosperm. Seedling leaves have a metallic silver lustre that fades with maturity of the plant.

2. The type of *C. laxiflorus*, *Schlechter 14312*, was destroyed in the burning of the Berlin Herbarium during the Second World War. The collection *Barfod 396 with Ferrero & Damborg*, from the same locality and closely resembling the original description, is chosen as the neotype.

15. *Calyptrocalyx lepidotus* (Burret) Dowe & M.D. Ferrero, *comb. nov.*

Paralinospadix lepidotus Burret, J. Arnold Arbor. 20 (1939) 199, syn. nov. — Type: *Brass 7316* (holo A; iso BRI), Papua New Guinea, Western Province, Palmer River, 2 miles below junction with Black River, 100 m, July 1936.

Solitary, moderate palms. *Stem* erect, 4–10 m tall, 2.5–4 cm diam.; internodes elongate, purplish green to brown; crown with 10–12 leaves. *Leaves* regularly pinnate, 80–160 cm long, new leaf emerges brown; leafbase to 24 cm long, with patches of dark scaly tomentum, margin finely lacerate-fibrous; petiole 44–64 cm by 6–7 mm, channelled adaxially, with dense dark scaly tomentum; rachis densely lepidote; pinnae 6–12 per side, opposite to subopposite, 17–40 cm long, 3 or 4 basal and 2–4 apical pinnae laterally joined, midleaf pinnae to 5 cm wide, oblanceolate, very slightly falcate, caudate, midrib prominent adaxially, numerous secondary veins prominent abaxially, lamina rigid, dark green adaxially, brown lepidote abaxially. *Inflorescence* 125–140 cm long, 1–7-spiked, pendulous; prophyll 30 cm long; peduncular bract papyraceous, very densely lepidote; peduncle c. 70 cm by 2–3 mm, densely lepidote; rachilla 26–70 cm long, 3–3.2 mm diam., very densely lepidote with scales long and twisted; floral pits congested. *Staminate flower* ovoid in bud, 2.5 mm high, sepals c. 1 mm long, basally carinate, apex broadly rounded, briefly cupular; petals c. 2 mm long, elliptical to triangular, apex obtuse; stamens 6; filaments c. 2 mm long; anthers linear, deeply sagittate, versatile; pistillode c. 2 mm long, columnar. *Pistillate flower* globose, 2–3 mm high; sepals c. 1 mm long; petals 2–3 mm long, broadly rounded, pouched, ovate, apex briefly triangular, outside densely nerved. *Fruit* ellipsoid, 8–9 mm long, 4–4.5 mm diam., red; epicarp smooth, coarsely granular when dry; mesocarp densely fibrous, fibres evenly distributed. *Seed* subglobose, c. 4 mm diam.; endosperm homogeneous.

Distribution — Papua New Guinea: Western Province, Palmer River, Fly River, and Black River

Habitat & Ecology — In rain forest at 50–80 m.

Etymology — The specific epithet is from *lepidotus* – scaled, and refers to the densely lepidote inflorescence axes and bracts.

Note — *Calyptrocalyx lepidotus* is distinguished by the densely lepidote petiole, rachis, inflorescence and peduncular bract, pinnae brown lepidote on the abaxial surface, 1–7-spiked inflorescence, a densely fibrous mesocarp and homogeneous endosperm.

16. *Calyptrocalyx leptostachys* Becc.

Calyptrocalyx leptostachys Becc., Webbia 1 (1905) 306. — Type: *Loria s.n.* (holo FI), Papua New Guinea, Central Province, 'Towards Mt Yule', 17 Dec. 1890.

Solitary, small palms. *Stem* 2 m tall, 10–20 mm diam.; internodes elongate. *Leaves* irregularly segmented with pinnae united, 50–70 cm long; leafbase to 25 cm long, margins densely lacerate-fibrous, particularly at the apex; petiole 8–10 cm by 4–10 mm, adaxially shallowly channelled; rachis 25–60 cm long, with sparse orange-brown scales; pinnae 3–10 per side, single or united, alternate, narrowly-lanceolate, gradually tapered, apex acuminate, chartaceous, green adaxially, lighter green abaxially, largest 30 by 3 cm, ribs 5–7, prominently raised adaxially, not so prominent abaxially, marginal veins thicker than secondary veins, distal pinnae narrow and short, terminal segments uneven. *Inflorescence* 60–70 cm long, 2-spiked, filiform; peduncle c. 4 mm wide; rachilla c. 4 mm diam.; floral pits shallow, lower lip rounded, crescentic. *Staminate flower* to 5 mm long; stamens c. 15. *Pistillate flower* globose in bud, c. 4 mm long; sepals c. 2 mm long, ovate, moderately concave, striate, dorsally ridged, thick at the apex; petals c. 3 mm long, semiorbicular, triangular, pointed at the apex, striately-nerved throughout; staminodes 6, well spaced, small. *Fruit* globose to obovoid, 16–17 mm long, c. 12 mm diam., attenuate at the base, colour not known; epicarp smooth, thin, minutely granular when dry; mesocarp fibrous, layered and compact. *Seed* globose, c. 9 mm diam.; endosperm ruminant.

Distribution — Papua New Guinea: Central Province, Mt Yule.

Etymology — The specific epithet is from *lepto* – slender, and *stachys* – spiked.

Note — *Calyptrocalyx leptostachys* is distinguished by a solitary habit, multi-spiked inflorescence, globose to obovoid fruit, and ruminant endosperm. It is not a well-known species, with only two collections additional to the type having been made.

17. *Calyptrocalyx merrillianus* (Burret) Dowe & M.D. Ferrero, *comb. nov.*

Paralinospaxis merrillianus Burret, J. Arnold Arbor. 20 (1939) 201, syn. nov. — Type: *Brass 6815* (holo A; iso BRI), Papua New Guinea, Western Province, Fly River, '528 mile Camp', just S of Palmer River junction, 80 m, May 1936.

Clustering, small palms. *Stems* 2 or 3, 2–4 m high, to 13 mm diam.; internodes elongate; crown with 7–9 leaves. *Leaves* regularly pinnate, 80–200 cm long; leafbase 30 cm long, glabrous, margin lacerate-fibrous; petiole 14–24 cm by 10–12 mm, channelled to flat adaxially; rachis dark lepidote; pinnae 14 or 15 per side, regularly arranged, basal 1 or 2 very narrow, all but the apical pinnae with strong midrib, prominent adaxially and abaxially, flatly lanceolate linear to sigmoid, becoming falcate toward the apex, finely acuminate, dark green adaxially, lighter green abaxially, 2 or 3 secondary

veins prominent abaxially, pinnae widest in the middle, 30–38 by 1.5–3.3 cm, apical pinnae with many veins, c. 15 each side. *Inflorescence* 80–90 cm long, 2–4-spiked, filiform; prophyll c. 21 cm long; peduncular bract 30–33 cm long, with dark scaly tomentum; peduncle to 60 cm long, 3–4 mm diam., with scaly tomentum; rachilla to 30 cm long, 3–4.5 mm diam.; floral pits well spaced in the lower part, becoming congested distally. *Staminate* flower 4–5 mm long, ovoid in bud; sepals 1.5–2 mm long, ovate, dorsally carinate; petals 3–4 mm long, ovate, dorsally densely nerved; stamens 8; filaments 3–4 mm long; anthers linear, 2 mm long, deeply sagittate, versatile; pistillode c. 4 mm long. *Pistillate* flower not seen. *Fruit* ovoid, beaked, 18–20 mm long, 8–10 mm diam., scarlet to purple-black; epicarp smooth, densely coarsely granular when dry. *Seed* globose, c. 10 mm diam.; endosperm ruminant.

Distribution — Papua New Guinea: Western, Gulf, and Southern Highlands Provinces.

Habitat & Ecology — In rain forest at 80–600 m.

Etymology — This species was named for the American botanist, Elmer Drew Merrill (1876–1956), who examined much of the material collected on the Archbold Expedition during which the type for this species was collected.

Vernacular name — Gurrinem (Drimskai language – upper Fly River, Western Province).

Notes — 1. *Calyptrocalyx merrillianus* is distinguished by a clustering habit, regularly pinnate leaves, multi-spiked filiform inflorescence, ovoid scarlet to purple-black fruit and ruminant endosperm.

2. This species occurs commonly on the banks of the upper Fly River, growing in full sun, an unusual habitat for *Calyptrocalyx* species.

3. Leaves are used to wrap fish and other food, and stems are used to make hunting and fishing spears.

18. *Calyptrocalyx micholitzii* (Ridl.) Dowe & M.D. Ferrero, *comb. nov.*

Linospadix micholitzii Ridl., Gard. Chron. 18, 454 (1895) 262. — *Paralinospadix micholitzii* (Ridl.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 334, syn. nov. — Type: *Micholitz s.n.* (holo BM), Papua, 1895.

Linospadix pauciflora Ridl., Trans. Linn. Soc. London, Bot. 9 (1916) 233. — *Paralinospadix pauciflorus* (Ridl.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 335, syn. nov. — Type: *Boden Kloss s.n.* (holo BM), Indonesia, Papua, Paniai Division, Snow Mts, Setakwa River, 'Camp III, 2500 ft' Observation Point, 800 m, Feb. 1913.

Solitary or clustering, small palms. *Stems* 1–5, 0.5–1 m tall, to 10 mm diam.; internodes 2–4 cm long; crown with 10–16 leaves. *Leaves* bifid, obcuneate to elongate, infrequently with 1 or 2 divisions each side, 16–100 by 8–18 cm, margins \pm parallel, new leaf emerges burgundy to purple; leafbase 6–8 cm long, with brown scaly tomentum; margins lacerate-fibrous; petiole absent. Leaves, when bifid, with c. 14 ribs each side, prominent on the upper surface, abaxially scarcely elevated; segmented leaves with broad bifid apical section, lower pinnae much narrower, in opposite pairs, apical pair to 5 cm wide, lowest pair to 1 cm wide, lamina coriaceous, glossy bright green adaxially, lighter green abaxially. *Inflorescence* 35–90 cm long, filiform, 1–3-spiked; prophyll 2.5–13 cm long, narrow linear-lanceolate; peduncular bract 20–25 cm long; peduncle 13–75 cm long, 3–4 mm diam., sparsely lepidote; rameal bracts 2–3 mm long in dis-

tal portion; rachilla 18–22 cm long, 3–4 mm diam., sparsely lepidote; floral pits shallow, widely spaced. *Staminate flower* 2–4 mm long in bud, ovoid; sepals 1.5–2 mm long, ovate, ciliate, minutely toothed on the keel; petals 3.5–4 mm long, triangular, acute, cream; stamens 8–15, equal in length; filaments c. 5 mm long, narrowing from a broad base; anthers linear, deeply sagittate, versatile. *Pistillate flower* 2–4 mm high, globose; sepals ovate, obtuse, margins ciliate; stigmas broad. *Fruit* ellipsoid to globose, 11–12 mm long, 6–8 mm diam., red; epicarp smooth, finely granular when dry; mesocarp fibrous, fibres aggregated into a layer close to the endocarp, fibres frayed at the apices. *Seed* globose, c. 7 mm diam.; endosperm homogeneous.

Distribution — Indonesia: Papua: Fakfak Division in the Timika area; Paniai Division, Snow Mts; Jayapura Division, Kaimana area.

Habitat & Ecology — In rain forest at 300–800 m.

Etymology — The species was named for Wilhelm Micholitz (1854–1932), German plant collector employed by Sander's Nursery, England.

Vernacular name — Sawat net (Kroi language – Kaimana, Papua).

Notes — 1. The origin of the type of *C. micholitzii* is not known with certainty. Ridley (1895) described the species from a specimen given to him by Micholitz who had visited New Guinea in 1891 and who had ascended mountains in the SW of the island. Ridley subsequently sent seeds to Sander's Nursery, England, from where a plant was eventually sent to Kew in 1896, flowered in 1905 and illustrated in Botanical Magazine (Wright, 1906). The specimen from which the plate was drawn, *Anon. s.n.*, is conserved in K. The species is distinguished by a solitary or clustering habit, bifid or once-segmented leaves, small staminate flowers, ellipsoid to globose fruit and homogeneous endosperm. Specimens of *Paralinospadix pauciflorus*, described from the Snow Mts, are attributable to *C. micholitzii*.

2. Seedling leaves have a metallic lustre, and are strongly blotched.

19. *Calyptrocalyx multifidus* (Becc.) Dowe & M.D. Ferrero, *comb. nov.*

Linospadix multifidus Becc., Malesia 1 (1877) 64. — *Paralinospadix multifidus* (Becc.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 334, syn. nov. — Type: *Beccari 906* (holo FI; iso K), Indonesia, Papua, Manokwari Division, Mt Arfak, Putatat, 400–500 m, Oct. 1872.

Clustering, small palms. *Stems* 2–5, 1–2 m tall, 8–40 mm diam.; internodes 2–4 cm long, dark green. *Leaves* irregularly segmented or regularly pinnate, 70–125 cm long, new leaf emerges bronze red; leafbase 8–35 cm long, dark green, glabrous, swollen at the base, margins densely lacerate-fibrous; petiole 0.5–19 cm by 3–10 mm, adaxially channelled, glabrous; pinnae of regularly pinnate leaf 4–18 per side, alternate, opposite or subopposite, placed up to 20 cm apart, lanceolate, widest above the middle, narrowing toward the base, apically acuminate, caudate, dark green adaxially, slightly lighter abaxially, reddish brown ramenta on ribs abaxially; lower pinnae shortest, apical pinnae longest; midleaf pinnae 20–60 by 10–25 cm, chartaceous; midrib prominent, but strong secondary veins present, marginal veins thicker than secondary veins; lower pinnae to 16 cm long, 12 mm wide; irregularly segmented leaf with pinnae united, one side of leaf all united or with irregular intervals between groups of united pinnae. *Inflorescence* 40–105 cm long, 1-spiked, erect, rigid; prophyll 15–28 cm by 14–25 mm, glabrous, apices acute; peduncular bract 30–40 cm by 13 mm, glabrous to densely tomentose; peduncle 20–85 cm by 2–6 mm, subterete, densely scaly; rameal bracts present

in proximal portion of the peduncle; rachilla 10–28 cm by 4–9 mm, fusiform, densely scaly; floral pits very deep, bracts not prominent, margins not raised. *Flowers* cream, congested, becoming more wider spaced proximally. *Staminate flower* 4–4.5 mm long; sepals c. 2 mm long, acutely ridged, margins smooth, broadly triangular, acute; petals c. 4 mm long, lanceolate to obtuse, triangular, with many nerves; stamens 8–10, unequal in length; filaments c. 4 mm long; anthers short, shallowly sagittate-cordate, versatile, cream; pistillode c. 4 mm long, filiform. *Pistillate flower* 4 mm long, ovoid; stigma large, papillose. *Fruit* ellipsoid, 10–16 mm long, 10–12 mm diam., red; epicarp smooth, finely granular when dry; stigmatic remains apical; mesocarp moderately fibrous, mealy, orange, fibres congested toward the endocarp, fibres anastomosing; endocarp membranous, separated from the seed. *Seed* globose to ellipsoid, c. 11 mm long, c. 7 mm diam.; raphe longitudinal, briefly attached; endosperm homogeneous.

Distribution — Indonesia: Papua: Sorong and Manokwari Divisions.

Habitat & Ecology — In rain forest at 0–500 m altitude.

Etymology — The specific epithet is from *multi* – many, and *fidus* – cleft, and refers to the numerous pinnæ of the leaf.

Vernacular name — Puah (Bahasa Maibrat – Sorong Division).

Notes — 1. *Calyptrocalyx multifidus* is distinguished by a clustering habit, irregularly segmented or regularly pinnate leaves, robust solitary-spiked inflorescence, ellipsoid fruit and homogeneous endosperm.

2. Staminate flowers have a citrus odour.

3. Variation in leaf segmentation is not truly reflected in the specific epithet *multifidus*. Leaves can be irregularly segmented or regularly pinnate. The ‘multifida’ form is but one extreme within the range of variation.

20. *Calyptrocalyx pachystachys* Becc.

Calyptrocalyx pachystachys Becc., Webbia 1 (1905) 308. — Type: *Schlechter 13780* (holo B†), Papua New Guinea, Madang Province, Bismarck Mts, 1500 m, Jan. 1902. Neotype: *Dowe & Ferrero 506* (neoholo BRI, here designated; neoiso K, LAE), Papua New Guinea, W Sepik Province, Vanimo Dist., Wasimei area, c. 30 km E of Vanimo, inland side of road to Pual River, 20 m, 10 Feb. 1998.

Calyptrocalyx schlechterianus Becc., Bot. Jahrb. Syst. 52 (1914) 33, syn. nov. — Type: *Schlechter 16951* (holo B†; photo SING), Papua New Guinea, Madang Province, Mt Bolobo, 1000 m, 1908.

Solitary or clustering, small to moderate palms. *Stems* 1–5, erect, 1–5 m tall, 2.2–4 cm diam.; internodes 3–4.5 cm long, dark green; crown with 8–10 leaves. *Leaves* regularly pinnate, 80–140 cm long, new leaf emerges brown-red; leafbase to 26 cm long, light green, glabrous, margin moderately lacerate-fibrous; petiole 8–25 cm by 3–5 mm, shallowly channelled adaxially, glabrous to tomentose; rachis glabrous, frequently with a filamentous apical extension to 16 cm long; pinnæ 9–17 per side, alternate, subopposite to irregularly placed, 2–11 cm apart, sometimes clustered, broadly lanceolate, basally constricted, cupped, acuminate, abruptly caudate to a 4–11 cm long filamentous drip tip; lamina glossy dark green adaxially, dull lighter green abaxially, pinnæ shortening toward the base and the apex, 13–44 by 1.2–12 cm, midrib prominent, secondary veins almost as strong, all veins raised adaxially,

only minor veins dominant abaxially; marginal veins thicker than secondary veins; ramenta sparse on abaxial midrib; two terminal pinnae basally united. *Inflorescence* 50–90 cm long, 1- or 2-spiked, rigid, moderately arched; prophyll 18–24 cm by 10–25 mm; peduncular bract 30–40 cm by 5–10 mm; peduncle 30–65 cm long, 3–5 mm wide, dorsi-ventrally compressed, with sparse reddish scaly tomentum; rachilla 16–39 cm by 5–12 mm, narrowly fusiform and subulate at the apex, with reddish scaly tomentum; floral pits deep, triangular, closely spaced. *Staminate flower* broadly ovoid in bud, symmetrical, not opening widely at anthesis; sepals c. 1 mm long, cupular to triangular; petals triangular, c. 4 mm long, yellow to cream, deciduous brown scales dispersed evenly on abaxial surface; stamens 7–19, unequal in length; filaments 6–7 mm long; anthers 1.5 mm long, subulate, shallowly sagittate, versatile, cream; pistillode c. 2 mm long, columnar; pollen mostly elliptical in polar view, long axis 21.7–34.4 μm , short axis 16.3–19.9 μm , monosulcate, exine finely reticulate. *Pistillate flower* 6–7 by c. 4 mm; sepals c. 4 mm long, apex acute; petals c. 6 mm long, striate, apex acute; stigma large; staminodes minute. *Fruit* ellipsoid to ventricose, 16–18 mm long, 7–8 mm diam., pinkish orange to red; epicarp smooth, finely granular when dry; mesocarp moderately fibrous, fibres throughout and congested toward the endocarp. *Seed* ovoid to falcate, 9–11 mm long, 4–6 mm diam.; endosperm homogeneous.

Distribution — Indonesia: Papua: Jayapura Division, Cyclops Mts where observed but without collections. Papua New Guinea: W Sepik, E Sepik, Madang, Western, Morobe, Eastern Highlands, and Milne Bay Provinces.

Habitat & Ecology — In rain forest at 0–1500 m.

Etymology — The specific epithet is from *pachy* – thick, and *stachys* – spiked.

Vernacular names — Briau (Bewani language – W Sepik Province), awa (Osima language – Vaimo, W Sepik Province), angop (Ningera language – E Sepik Province), apantsj (Waskuk language – E Sepik Province), yagiyas (Waskuk language – Wagu), giagian (Waskuk language – Ambunti, E Sepik Province), gurrinem (Nu language – Upper Fly River, Western Province).

Notes — 1. *Calyptrocalyx pachystachys* is distinguished by a solitary or clustering habit, regularly pinnate leaves with sigmoid to falcate pinnae with a prominent drip tip, solitary or infrequently 2-spiked inflorescence, ellipsoid fruit and homogeneous endosperm.

2. The type of *C. pachystachys*, *Schlechter 13780*, was destroyed in the burning of the Berlin Herbarium during the Second World War. The collection *Dowe & Ferrero 506* is chosen as the neotype as it very closely matches the original description. *Calyptrocalyx schlechterianus* is attributable to *C. pachystachys* based on the resemblance of specimens and the same collection locality.

3. Stems are used to make spears.

21. *Calyptrocalyx pauciflorus* Becc.

Calyptrocalyx pauciflorus Becc., Bot. Jahrb. Syst. 58 (1923) 449. — Type: *Ledermann 9441* (holo B \dagger), Papua New Guinea, E Sepik Province, Etappenberg, 850 m, 1912. Neotype: *Hoogland & Craven 10998* (neoholo CANB, here designated; neiso BH, K, L, LAE), Papua New Guinea, E Sepik Province, eastern ridge of Samsai (Mt Hunstein), 1500 m, 15 Aug. 1966.

Calyptrocalyx angustifrons Becc., Bot. Jahrb. Syst. 58 (1923) 449, syn. nov. — Type: *Ledermann 10042* (holo B \dagger), Papua New Guinea, E Sepik Province, Lordberg c. 1000 m, 1912.

Solitary or clustering, small palms. *Stem* 1–2 m tall, 15–50 mm diam.; internodes to 2 cm long, green to dark brown; crown with 5–9 leaves. *Leaves* bifid or irregularly segmented with bifid apex and 2 basal lobes, 100–200 by 13–14 cm; leafbase 16–24 cm long, cream to green, glabrous, margins lacerate-fibrous; petiole 9–80 cm long, shallowly channelled adaxially. Leaves, when bifid, 64–65 cm long, deeply bifurcate, base gradually attenuate-cuneate, 11 or 12 ribs either side angled acutely to their point of insertion; in segmented leaves, similar but with 2 narrow basal segments with prominent midribs; lamina dark green adaxially, lighter green abaxially. *Inflorescence* 45–100 cm long, 1- or 2-spiked, filiform; prophyll to 14 cm long, to 1.5 cm wide; peduncular bract to 26 cm long; peduncle 30–60 cm long, 1.5–2.2 mm diam., with dense deciduous scales; rameal bracts 1–3, in distal portion, 2–3 mm long, triangular; rachilla 10–40 cm long, 3–3.5 mm diam.; floral pits 12–20 mm apart, margins extended and splitting. *Staminate flower* ovoid in bud, 2.5–3 mm long; sepals c. 1.5 mm long, cowl-shaped, white, with dense scales; petals c. 3 mm long; stamens 9, unequal in length; filaments c. 3 mm long, briefly basally united; anthers ovoid, versatile, white. *Pistillate flower* 5.5 mm long, petals and sepals densely scaly. *Fruit* ovoid to ellipsoid, attenuate toward the apex, c. 13 mm long, c. 10 mm diam., red; epicarp densely brown pilose. *Seed* globose, c. 9 mm diam.; endosperm ruminant.

Distribution — Papua New Guinea: W and E Sepik Provinces, Etappenberg, Lordberg, Hunstein Mts, April River, and Waskuk Hills.

Habitat & Ecology — In rain forest at 800–1500 m.

Etymology — The specific epithet is from *paucus* – few, and *florus* – flowered, and refers to the short rachilla with well-spaced flowers.

Vernacular name — Beisini (Baihinimo language – Wagu, Hunstein Mts, E Sepik Province).

Notes — 1. *Calyptrocalyx pauciflorus* is distinguished by a small solitary or clustering habit, bifid or irregularly segmented leaves, 1- or 2-spiked inflorescence, ovoid to ellipsoid fruit, and ruminant endosperm. The type of *C. pauciflorus*, *Ledermann 9441*, was destroyed in the burning of Berlin Herbarium during the Second World War. The collection *Hoogland & Craven 10998* is chosen as the neotype as it closely matches the original description and was collected in the same locality. *Calyptrocalyx angustifrons* is attributable to *C. pauciflorus* based on closely matching descriptions and the same collection locality.

2. Stems are used to make fishing spears by the Hunstein Mts and April River people.

22. *Calyptrocalyx polyphyllus* Becc.

Calyptrocalyx polyphyllus Becc., Bot. Jahrb. Syst. 58 (1923) 449. — Type: *Ledermann 8310* (holo B†), Papua New Guinea, E Sepik Province, Mt Hunstein, 600–700 m, 1912. Neotype: *Pullen 1374* (neoholo CANB, here designated; neiso L, LAE), Papua New Guinea, W Sepik Province, pass E of Mt Albanep, Lawon-Yamil track, S of But, 1000 m, 29 July 1959.

Clustering, small palms. *Stems* 2–5, 1–4 m tall, 15–20 mm diam.; internodes elongate; crown with 7–10 leaves. *Leaves* regularly pinnate, 60–100 cm long, new leaf emerges maroon to red; leafbase 16–20 cm long, margin lacerate-fibrous, apex densely fibrous; petiole 2–12 cm long, or absent, shallowly channelled adaxially, glabrous; pinnae

10–21 per side, 40–45 cm by 14–18 mm, becoming smaller toward the apex, regularly arranged, evenly spaced, subopposite to alternate, broadly sigmoid or narrowly lanceolate to falcate, cupped, apically caudate with a filamentous drip tip, dark green adaxially, lighter green abaxially, two apical pinnae briefly basally joined, midrib prominent adaxially, secondary veins prominent abaxially. *Inflorescence* 75–100 cm long, 1-spiked, rigid, arching; prophyll to 13 cm long, held within the leafbase; peduncular bract to 30 cm long; peduncle 57–75 cm long, 2–8 mm diam., terete, glabrous; rachilla 10–35 cm long, c. 12 mm diam., fusiform, glabrous, light brown; floral pits widely spaced, shallow, triangular, margins raised and medially split. *Staminate flower* to 5 mm high, white; sepals c. 2 mm long, glossy, glabrous; petals 4–5 mm long; stamens 10–16, c. 6 mm long; anthers shallowly sagittate, versatile; pollen mostly elliptical in polar view, long axis 36.2–39.8 μm , short axis 18.1–23.5 μm , monosulcate, exine finely reticulate. *Pistillate flower* to 5 mm high. *Fruit* ovoid, beaked, 9–11 mm long, c. 6 mm diam., scarlet red; epicarp smooth, minutely granular when dry; mesocarp succulent; endocarp membranous. *Seed* ovoid, c. 8 mm long, c. 5 mm diam.; endosperm ruminant.

Distribution — Papua New Guinea: W and E Sepik Provinces, Hunstein Mts, April River, Waskuk Hills, and Wasissi (Torricelli Mts).

Habitat & Ecology — In rain forest at 100–1000 m.

Etymology — The specific epithet is from *poli* – many, and *phyllus* – leaves, and refers to the numerous pinnae of the leaf.

Vernacular names — Giagiau (Baihinemo language – Wagu, Hunstein Mts, E Sepik Province), apolop (Waskuk language – Ambunti, Waskuk, E Sepik Province), pirare (Waskuk language – E Sepik Province), peliah (Brrinhimo language – Upper April River, E Sepik Province), belin eddi (Wasissi language – Wasissi, W Sepik Province).

Notes — 1. *Calyptrocalyx polyphyllus* is distinguished by a clustering habit, regularly pinnate leaves with usually caudate but infrequently lanceolate pinnae that terminate in a prominent drip tip, solitary inflorescence, ovoid fruit, and ruminant endosperm. The type of *C. polyphyllus*, *Ledermann 8310*, was destroyed in the burning of the Berlin Herbarium during the Second World War. The collection *Pullen 1374* is chosen as the neotype because the description bears very close resemblance and the specimens were collected at the same locality.

2. Stems are used to make spears by Hunstein Mts and April River people.

3. The staminate flowers have an odour like Ponds hand cream.

23. *Calyptrocalyx pusillus* (Becc.) Dowe & M.D. Ferrero, *comb. nov.*

Linospadix pusillus Becc., *Webbia* 1 (1905) 295. — *Paralinospadix pusillus* (Becc.) Burret, *Notizbl.*

Bot. Gart. Berlin-Dahlem 12 (1935) 334, *syn. nov.* — Type: *Armit s.n.* (holo FI), Papua New Guinea, Milne Bay Province, summit of Mt Dayman, 2700 m, May 1894.

Solitary or clustering, diminutive ‘elfin’ palms. *Stems* 1–4, erect, leaning or decumbent, 12–100 cm tall, 5–6 mm diam.; internodes 12–20 mm long; crown with 4–7 leaves. *Leaves* bifid or irregularly segmented, 20–50 by 7–12 cm; leafbase 5–10 cm long, glabrous, margins densely lacerate-fibrous; petiole 5–18 cm by 2–3 mm, shallowly channelled adaxially; bifid leaf deeply furcate, cuneate with 7–9 ribs per side, prominent adaxially, less so abaxially; segmented leaves with 1 or 2 segments per side, one side

with two segments, other side undivided, the division between segments 6–12 mm wide; lamina dark green adaxially, lighter green abaxially, abaxial ribs densely silver lepidote. *Inflorescence* 15–60 cm long, 1-spiked, filiform, erect, rigid; prophyll 4–13 cm by 3–7 mm, densely scaled; peduncular bract 10–28 cm long, densely scaled; peduncle 9–40 cm by 0.5–2 mm, subterete, densely scaled; 1–3 triangular rameal bracts in the distal portion; rachilla 4–21 cm long, 1–3 mm diam.; floral pits shallow, widely spaced. *Staminate flower* c. 2 mm high; sepals c. 0.5 mm long, carinate, petals c. 2 mm long, obtuse; stamens 8; filaments c. 2 mm long; anthers versatile; pollen mostly elliptical in polar view, long axis 25.3–30.8 μm , short axis 19.9–23.5 μm , monosulcate, exine finely reticulate. *Pistillate flower* c. 2 mm high, subglobose to ovoid; sepals c. 0.6 mm long; petals c. 2 mm long, obtuse, apiculate. *Fruit* ellipsoid, beaked, 8–11 mm long, 3–5 mm diam., red; epicarp smooth; mesocarp dry, fibrous, fibres congested toward the endocarp; endocarp membranous. *Seed* ellipsoid, c. 7 mm long, c. 4 mm diam.; endosperm homogeneous.

Distribution — Papua New Guinea: Milne Bay Province, Maneau Range, and Mt Dayman.

Habitat & Ecology — In cloud forest at 1000–2000 m.

Etymology — The specific epithet is from *pusillus* – very small, and refers to the diminutive habit.

Note — *Calyptrocalyx pusillus* is the smallest species in the genus and one of the smallest palm species in the family. It is distinguished by a clustering habit, bifid or irregularly segmented leaves, solitary-spiked inflorescence, small ellipsoid fruit, and homogeneous endosperm.

24. *Calyptrocalyx sessiliflorus* Dowe & M.D. Ferrero

Calyptrocalyx sessiliflorus Dowe & M.D. Ferrero, Wodyetia 4 (1999) 11.

Linospadix leptostachys Burret, Notizbl. Bot. Gart. Berlin-Dahlem 11 (1933) 711. — *Paralinospadix leptostachys* (Burret) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 335. — Type: *Mayr* 497 (holo B†; iso BO), Indonesia, Papua, Jayapura Division, Cyclops Mt, 900 m, Aug. 1928.

Solitary, small palms. *Stem* erect, 0.5–1 m tall, 5–8 cm diam; internodes 10–15 mm long, dark green; crown with 8–10 leaves. *Leaves* bifid, 30–110 by 17–26 cm; leafbase 11–15 cm long, glabrous, margins moderately lacerate-fibrous; petiole 13–20 cm by 5–7 mm, deeply channelled adaxially, glabrous; lamina oblong to lanceolate, papyraceous, rigid, glossy dark green adaxially, much lighter green abaxially, margin straight to slightly curved, 7–9 ribs prominent on adaxial surface, not raised abaxially, densely brown lepidote abaxially. *Inflorescence* 44–75 cm long, 3–7-spiked, erect to curving, rigid; bracts not seen; peduncle 18–56 cm by 0.5–1.5 mm, with patchy brown deciduous scales; rachilla 12–20 cm long, c. 1.6 mm diam.; floral pits shallow to flat on the surface, very widely spaced, lips slightly raised. *Flowers* sessile. *Staminate flower* c. 2 mm long, asymmetric in bud; sepals c. 1 mm long, carinate, longitudinally striately-nerved, dark brown; petals c. 2 mm long, white to pink, apically obtuse, outside striately-nerved; stamens 9 or 10; filaments 1.5–2 mm long; anthers linear, deeply sagittate, versatile. *Pistillate flower* globose, c. 1 mm high; sepals c. 0.2 mm long, broadly round, outside longitudinally striate; petals c. 1 mm long, basally dilated, apex triangular, outside densely longitudinally striate; staminodes many, narrow. *Fruit*

globose to slightly ovoid, c. 10 mm diam.; epicarp smooth, bright crimson; mesocarp yellowish brown, pulpy, fibrous, fibres congested toward the endocarp. *Seed* globose, c. 8 mm diam.; endosperm homogeneous.

Distribution — Indonesia: Papua: Cyclops Mts. Papua New Guinea: W Sepik Province, Torricelli Mts, and E Sepik Province in Prince Albert Mts.

Habitat & Ecology — In rain forest at 800–1400 m.

Etymology — The specific epithet is from *sessile* – seated on the surface, and *flora* – flower, in reference to the flowers being sessile or in very shallow floral pits, and not in sunken pits as is usual for most *Calyptrocalyx* species.

Vernacular name — Dami dami demah (I'ou'wanapeio language, Wambena language – Cyclops Mts, Papua), siterarum (Olo language – Torricelli Mts, W Sepik Province).

Notes — 1. *Calyptrocalyx sessiliflorus* is distinguished by a solitary habit, bifid leaves, multi-spiked filiform inflorescence, globose fruit, and homogeneous endosperm.

2. The specific epithet *leptostachys* was used for two distinct species: *Paralinospadix leptostachys* (Burret) Burret and *Calyptrocalyx leptostachys* Becc. With synonymisation of *Paralinospadix* under *Calyptrocalyx*, the name *P. leptostachys* becomes redundant and according to Articles 7.3, 33.2, and 46.4 of the International Code of Botanical Nomenclature (Tokyo Code), a new name needs to be chosen. Therefore, the specific epithet *sessiliflorus* has replaced *leptostachys* for this species. The epithet was chosen because the flowers of this species are on the surface of the rachilla and not in sunken pits as is usual for the genus.

25. *Calyptrocalyx spicatus* (Lam.) Blume

Calyptrocalyx spicatus (Lam.) Blume, Bull. Sci. Phys. Nat. Néerl. 1 (1838) 66. — *Areca spicata* Lam., Encyclopédie Méthodique, Botanique 1 (1783) 241. — Lectotype: Illustration of *Pinanga silvestris globosa*, in Rumphius, Herb. Amb. 1 (1741) t. 5, f. 1A (Merrill, 1917). [*Pinanga silvestris globosa*, in Rumphius, Herb. Amb. 1 (1741) 38.]

Solitary, moderate palms. *Stem* erect, 5–14 m tall, 15–25 cm diam.; internodes irregular, 1–8 cm long, dark green; crown with 9–12 leaves. *Leaves* regularly pinnate, horizontal to descending, 2.5–4 m long; leafbase subcylindrical, coriaceous, green to brown with minute scales, margin moderately lacerate-fibrous; petiole 15–30 by 2–4 cm, channelled adaxially; pinnae 25–40 per side, semipendulous, subopposite, linear, acuminate, apically bidentate, dark green adaxially, lighter green abaxially, 35–70 by 2–6.5 cm, lower ones narrower and shorter, upper ones becoming more congested. *Inflorescence* 1.8–2.5 m long, 1- or 2-spiked, pendulous; prophyll 30–45 cm long; peduncular bract 40–50 cm long, coriaceous, with scattered reddish scales; peduncle 45–60 cm long, subterete, c. 25 mm diam., with scattered reddish scales; rachilla 1.4–1.9 m long, 25–30 mm diam., widening slightly toward the apex; floral pits distantly spaced, lower margin elaborated into elongate lip 1–2 cm long. *Staminate flower* ovoid in bud, 10–14 mm high; sepals c. 4 mm long, carinate, margins ciliate; petals 10–14 mm long, broadly ovate; stamens 60–140, unequal; filaments c. 6 mm long, erect, subulate; anthers c. 6 mm long, linear, deeply sagittate, versatile; pollen elliptical in polar view, long axis 45.3–54.3 μm , short axis 21.7–32.6 μm , monosulcate, exine coarsely reticulate; pistillode 2.5–5 mm long, columnar, apex trifid. *Pistillate flower*

ovoid to subconical, c. 9 mm high; sepals c. 3 mm long; petals c. 9 mm long; stigma small. *Fruit* globose to ellipsoid, 40–60 mm long, 20–30 mm diam., orange to bright red; epicarp smooth; mesocarp densely fibrous, fibres aggregated toward the endocarp; endocarp fibrous to crustaceous. *Seed* globose to subglobose 20–30 mm diam.; endosperm ruminant.

Distribution — Indonesia: Moluccas: Ternate, Halmahera, Baru, Ceram, and Ambon.

Habitat & Ecology — In rain forest at 0–60 m.

Etymology — The specific epithet is from *spicate* – spike bearing, and refers to the morphology of the inflorescence.

Vernacular names — Hena hena (Moluccas, Ternate), and hoesa alang (Moluccas, Hitoe) (Miquel, 1855).

Notes — 1. *Calyptrocalyx spicatus* is distinguished by a large solitary habit, regularly pinnate leaves, solitary or 2-spiked inflorescence, large globose to ellipsoid fruit and ruminant endosperm.

2. The seed is used as a betel nut substitute.

26. *Calyptrocalyx yamutumene* Dowe & M.D. Ferrero, *spec. nov.* — Fig. 4

Palma caespitosa, statura parva, folio simplici vel segmentato irregulariter, petiolo absenti vel brevissimo, nervis folii crassis, prominentibus in superficiebus ambabus folii, inflorescentia solitaria plus minus recta vel parum curvata, rachilla pedunculo parum crassior, flore staminato cum corolla lutea vivida, fructibus ellipsoidalibus, fibris mesocarpii crasso, praesens plus minus uniformiter omnino mesocarpium, endospermio homoganeo. — Typus: *Dowe & Ferrero 508* (holo BRI; iso K, LAE), Papua New Guinea, W Sepik Province, Bewani Mts, Niau Creek, 11 Feb. 1998.

Clustering, small palms. *Stems* 2–5, to 2.5 m tall, 10–30 mm diam.; internodes 2–3 cm long, green; crown with 11–14 leaves. *Leaves* entire, deeply bifid, 95–120 by 11.5–25 cm; leafbase 14–17 cm long, green, margin moderately lacerate-fibrous; petiole absent or to c. 1 cm long; lamina bifid, lobes elongate, ribs 7 or 8 per side, prominent, closely angled to the rachis; lamina coriaceous, dark green adaxially, lighter green abaxially. *Inflorescence* 55–96 cm long, 1-spiked; prophyll 6.5–12 cm by 10–12 mm; peduncular bract 13–27 cm by 1.5–4 mm; peduncle 40–62 cm by 1.5–2 mm, subterete, longitudinally striate with deciduous brown scales; rameal bracts 2–4, to 12 mm long, in the distal portion; rachilla 15–34 cm long, 2–3 mm diam., narrowing toward the apex, with deciduous brown scales; floral pits well spaced, shallow, lip with a sharp margin. *Staminate flower* bright yellow, c. 3.5 mm long in bud, opening widely at maturity; sepals c. 1 mm long, carinate, translucent, margins ciliate; petals obtuse, c. 3 mm long; stamens 8 or 9; filaments 3–4 mm long; anthers c. 1 mm long, shallowly sagittate, versatile, yellow; pistillode columnar, c. 1.5 mm long. *Pistillate flower* c. 3 mm high, globose, white; stigma large. *Fruit* broadly ellipsoid, 16–18 mm long, 10–12 mm diam., red; epicarp smooth, glossy; mesocarp fleshy to mealy, tan to yellow pulp; fibres thick, throughout the mesocarp but densely congested toward the endocarp. *Seed* ovoid, 9–11 mm long, 6–7 mm diam.; endosperm homogeneous.

Distribution — Indonesia: Papua: Jayapura Division, Cyclops Mts where it is known but without collections. Papua New Guinea: W Sepik Province, Bewani Mts.

Habitat & Ecology — In rain forest at 100–900 m.



Fig. 4. *Calyptrcalyx yamutumene*. Dowe & M.D. Ferrero. a. Habit, with dominant stem and basal sucker; b. leaf; c. portion of rachilla with floral bracts; d. staminate flower; e. fruit; f. fruit in longitudinal section; g. fruit with epicarp removed to reveal mesocarp fibres. — Scale bars: a = 40 cm; b = 5 cm; c = 4 mm; d = 1 mm; e–g = 8 mm (from Dowe & Ferrero 508). Drawing by Lucy T. Smith.

Etymology — The specific epithet is a name derived from the Bewani language coined by Mr Moses Meiwa of Apambo village, Bewani, to facilitate practical field recognition of this species: *yamu* – stem or stick as well as the name for *Linospadix albertisiana*, and *tumene* – large.

Notes — 1. *Calyptrocalyx yamutumene* is distinguished by a clustering habit, bifid apetiolate leaves, solitary-spiked inflorescence, broadly ellipsoid fruit, and homogeneous endosperm.

2. The crushed endosperm has a salty flavour that is used to enhance the taste of food.

LINOSPADIX

Linospadix H. Wendl. in H. Wendl. & Drude, *Linnaea* 39 (1875) 177, 198. — Type: *Areca monostachya* Mart. [= *Linospadix monostachya* (Mart.) H. Wendl. 'as *L. monostachyos*'].

Bacularia F. Muell., *Fragm.* 7 (1870) 103, nomen in obs.; 11 (1878) 58; *Hook.f., Bot. Mag.* 108 (1882) t. 6644; in Benth. & Hook., *Gen. Pl.* 3 (1883) 903. — Type: *Bacularia monostachya* (Mart.) F. Muell. [= *Linospadix monostachya* (Mart.) H. Wendl.].

Linospadix subg. *Bacularia* (F. Muell.) Drude in Engl. & Prantl, *Nat. Pflanzenfam.* 2, 3 (1887) 67. — Type: not designated.

Bacularia sect. *Linospadix* (H. Wendl.) Kuntze, *Lex. Gen. Phan.* (1903) 57. — Type: not designated.

Bacularia sect. *Bacularia* Kuntze, *Lex. Gen. Phan.* (1903) 57. — Type: not designated.

Bacularia sect. *Eubacularia* Kuntze, *Lex. Gen. Phan.* (1903) 57. — Type: not designated.

Solitary or clustering, small to moderate, pleoanthic, monoecious palms. *Stems* slender, leaf scars conspicuous; internodes elongate. *Leaves* bifid, or irregularly segmented or regularly pinnate; leafbase clasping, margins smooth or fibrous, not forming a cylindrical crownshaft but vertically split opposite the petiole; petiole elongate or absent (Australian species only), adaxially channelled, abaxially rounded; pinnae single or united, apices praemorse when united, acuminate when not united. *Inflorescence* protandrous, interfoliar, solitary, spicate; prophyll dorsi-ventrally compressed, bicarinate, attached at the base of the peduncle, enclosing inflorescence in bud, persistent; peduncular bract tubular, attached at the apex of the peduncle, apically closed, deciduous; peduncle elongate, erect; rachilla c. the same length of the peduncle to much less. *Flowers* spirally arranged in shallow floral pits, pit margins lipped and smooth; in triads of a single pistillate flower with two lateral staminate flowers in proximal portion of the rachilla, paired or solitary staminate flowers in distal portion. *Staminate flower* symmetric in bud; sepals broadly imbricate; petals 2 or 3 times longer than sepals, apically valvate; stamens 4–20, erect, filaments shorter than the petals; anthers sagittate, subbasal- to approaching basifixed, non-versatile, dehiscence laterose; pollen circular to elliptical in polar view, monosulcate, exine tectate, finely to coarsely reticulate; pistillode absent or small. *Pistillate flower* globular, smaller than, c. the same size or larger than the staminate flower; sepals broadly imbricate; petals with thickened valvate tips, longer than the sepals; staminodes 3–6, toothlike; stigmas recurved, 3-lobed, smooth. *Fruit* ellipsoid, cylindrical, globose or pyriform, yellow (Australian species only) or red at maturity; stigmatic remains apical; epicarp longitudinally striate, or smooth or rugose (Australian species only), dries smooth; mesocarp thin, fleshy, longitudinal fibres appressed to endocarp; endocarp adhering to the seed. *Seed* globose to ellipsoid, subbasally attached, raphe attached for less than 1/2 length of seed;

endosperm homogeneous; embryo basal. Germination adjacent-ligular; eophyll bifid. $n = 16$ (Röser, 1994).

Distribution — A genus of seven species, with two in New Guinea and five in northeastern and eastern Australia.

Etymology — From *linea* – thin, and *spadix* – the flower-bearing part of the inflorescence.

KEY TO THE SPECIES OF LINOSPADIX IN NEW GUINEA

- 1a. Leaf lamina coriaceous, veins prominent on both surfaces; fruit symmetrical, 13–18 mm long, 3.5–6 mm diam. 27. *L. albertisiana*
 b. Leaf lamina chartaceous, veins prominent only on adaxial surface; fruit slightly falcate, 15–28 mm long, 3.5–5 mm diam. 28. *L. canina*

27. *Linospadix albertisiana* (Becc.) Burret

Linospadix albertisiana (Becc.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 331 'as *L. albertisianus*'. — *Linospadix* sp. (no. 208), Becc., in d'Albertis, New Guinea 2 (1881) 399. — *Bacularia albertisiana* Becc., Malesia 3 (1886) 108. — Type: *d'Albertis s.n.* (holo FI), Papua New Guinea, Western Province, Fly River, 1877.

Bacularia angustisecta Becc., Webbia 1 (1905) 294. — *Linospadix angustisectus* (Becc.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 331, syn. nov. — Type: *Loria s.n.* (holo FI), Papua New Guinea, Central Province, Mekeo District, St Joseph River, Nov. 1902.

Bacularia longicuris Becc., Bot. Jahrb. Syst. 52 (1914) 35. — *Linospadix longicuris* (Becc.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 331, syn. nov. — Type: *Schlechter 20039* (holo B†; iso and photo FI), Papua New Guinea, E Sepik Province, Torricelli Mts, 600 m, 1909.

Clustering, small palms. *Stems* 2–10, erect or arching, to 2 m tall, 7–10 mm diam.; internodes to 4 cm long, dark green; crown with 4–12 leaves. *Leaves* bifid, or irregularly segmented or regularly pinnate, 30–90 cm long; leafbase 10–12 cm long, slightly swollen, glabrous, margins smooth; petiole 5–12 cm long, to 3 mm wide; pinnae in segmented leaves 2–12 per leaf, 20–30 cm by 5–10 mm, midrib prominent, acuminate, 2 terminal pinnae basally united, attenuate; in bifid leaves pinnae broadly attached to the rachis, 5–7-ribbed, apex attenuate, glossy mid to dark green adaxially, lighter green abaxially; ribs and veins prominent on both surfaces. *Inflorescence* 20–65 cm long; prophyll to 12 cm long; peduncular bract 12–25 cm long, inserted 1–4 cm below the base of the rachilla; peduncle 10–40 cm by 1.9–2 mm, dorsi-ventrally compressed, margins acute; rachilla 10–20 cm long, 2–3 mm diam. *Flowers* light green to cream. *Staminate flowers* elongate, curved, or subcylindrical, 3.5–4 mm long in bud; sepals c. 1 mm long, rounded, concavely pouched, coriaceous, dorsally ridged; petals 3–4 mm long, cymbiform, coriaceous; stamens 10–12, unequal in length, anthers subbasifixed; pollen mostly circular in polar view, long axis 18.1–28.9 μm , short axis 16.3–23.5 μm , monosulcate, exine coarsely reticulate; pistillode absent. *Pistillate flower* to 3 mm long; sepals c. 1 mm long; petals c. 2 mm long. *Fruit* ellipsoid to fusiform, symmetrical, 13–18 mm long, 3.5–6 mm diam., red; epicarp minutely longitudinally striate. *Seed* ellipsoid, c. 12 mm long, c. 3 mm diam.

Distribution — Indonesia: Manokwari and Jayapura Divisions. Papua New Guinea: W and E Sepik Province, Western, Madang, Morobe, Southern Highlands, Central and Milne Bay Provinces.

Habitat & Ecology — In rain forest at 20–2000 m.

Etymology — The species was named for Count Luigi Maria d'Albertis (1841–1901), Italian zoologist, ethnologist and explorer, and collector of the type specimen.

Vernacular names — Nana (Sentani language – Cyclops Mts, Papua), niyo (Orne language – W Sepik Province), yamu (Bewani language – W Sepik Province), yalilim (Olo language – Miwaute village, Torricelli Mts, W Sepik Province), ubo (Baihinimo language – Wagu, Hunstein Mts, E Sepik Province).

Notes — 1. *Linospadix albertisiana* is distinguished by a clustering habit, bifid or irregularly segmented or regularly pinnate leaves, fruit symmetrical and epicarp shallowly longitudinally striate.

2. *Linospadix angustisectus* and *L. longicruris* are attributable to *L. albertisiana* based on similarity of specimens and original descriptions.

3. The stems of *Linospadix* are used to 'turn' sago, in the manner of making sticky toffee. The stems are prized for this work. Two stems are strengthened over fire and are customarily handed down from mother to daughter. The stems are used to 'turn' the sago into lumps which are then placed onto serving plates.

28. *Linospadix canina* (Becc.) Burret

Linospadix canina (Becc.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 331 'as *L. caninus*'.

— *Bacularia canina* Becc., Nova Guinea 8 (1909) 209. — Type: *Versteeg 1635* (holo K; iso BO, L), Indonesia, Papua, Paniai Division, Mt Resi, 500–800 m, 23 Aug. 1907.

Linospadix elegans Ridl., Trans. Linn. Soc. London, Bot. 9 (1916) 233, syn. nov. — Type: *Boden Kloss s.n.* (holo BM; iso K), Indonesia, Papua, Paniai Division, Snow Mts, SE foothills, Utakwa River, 'Camp 1, 500 ft', c. 150 m, Dec. 1912.

Clustering, small palms. *Stems* 2–10, erect, to 2 m tall, 4–5 mm diam.; internodes 1.2–8 cm long, dark green; crown with 5–10 leaves. *Leaves* 20–30 cm long, bifid or irregularly segmented or regularly pinnate; petiole 6–7 cm long, to 3 mm wide; pinnae 2–26 per leaf, in segmented leaves 10–12 cm by 4–10 mm, acuminate, midrib prominent, 2 terminal pinnae basally united with the apex attenuate; in bifid leaves 6- or 7-ribbed, apex attenuate; pinnae semi-glossy, mid to dark green adaxially, lighter green abaxially; ribs and veins prominent on adaxial surface only. *Inflorescence* to 45 cm long; prophyll 5–6 cm long; peduncular bract linear-lanceolate, 9–15 cm long, to 2 mm wide, acuminate; peduncle 32–37 cm long, 2.5–3 mm diam.; rachilla 8–13 cm long, c. 3 mm diam. *Flowers* cream to yellow. *Staminate flowers* ovoid, apex obtuse, 3–3.5 mm long in bud; sepals c. 2 mm long, suborbicular, concavely pouched, coriaceous, dorsally ridged, margins finely ciliate; petals 3–3.5 mm long, elliptical; stamens 6–9, equal in length, anthers basifixed, narrowly sagittate, yellow to orange; pollen mostly elliptical in polar view, long axis 28.9–36.2 μm , short axis 18.1–21.7 μm , monosulcate, exine finely reticulate; pistillode rudimentary. *Pistillate flower* broadly conical, c. 3.5 by c. 2.5 mm, sepals convex, not carinate. *Fruit* ellipsoid to fusiform, slightly falcate, attenuate to both ends, 15–28 mm long, to 3.5–5 mm diam., red at maturity; epicarp minutely longitudinally striate; mesocarp succulent; endocarp membranous and opaque. *Seed* ellipsoid to falcate, c. 10 mm long, c. 2 mm diam., basally rounded, apex attenuate.

Distribution — Indonesia: Papua: Manokwari, Japen Waropen, Paniai, and Jayapura Divisions.

Habitat & Ecology — In rain forest at 150–1000 m.

Etymology — The specific epithet is from *canis* – dog; though not explained by Beccari, it probably relates to the seed resembling a dog's tooth.

Notes — 1. *Linospadix canina* is distinguished by its long, slightly falcate fruits that are about twice as long as they are in *L. albertisiana*.

2. *Linospadix elegans* is attributable to *L. canina* based on similarity of specimens, original descriptions, and collecting locality.

INSUFFICIENTLY KNOWN TAXA

Linospadix leopoldi Sander, Gard. Chron. 23, 591 (1903) t. 106. Unable to be placed due to absence of type specimen and inadequate description.

Paralinospadix microspadix (Becc.) Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 335. — *Linospadix microspadix* Becc., Bot. Jahrb. Syst. 52 (1914) 34. — Type: *Schultze 279* (holo B†; iso FI; photo SING), Papua New Guinea, E Sepik Province, Sepik River, 1910. Unable to be placed as the specimen consists of a fragment of a single inflorescence.

DOUBTFUL AND EXCLUDED NAMES

Calyptrocalyx minor Burret, Notizbl. Bot. Gart. Berlin-Dahlem 13 (1936) 73, nom. invalid. This name was mentioned in notes under Burret's description *C. albertisianus* var. *minor*.

Linospadix albertissima (Becc.) Burret, in Conservation status listing of plants: *Palmae* (1993). Cambridge, UK: World Conservation Monitoring Centre. Typographical error.

Linospadix parvulus Becc., Webbia 1 (1905) 293. Incorrect spelling for *Linospadix pusillus* Becc. [= *Calyptrocalyx pusillus* (Becc.) Dowe & M.D. Ferrero]; used as a synonym in Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12 (1935) 334.

Paralinospadix multisectus Burret, ad nota, Notizbl. Bot. Gart. Berlin-Dahlem 13 (1936) 324. Burret used this name in the discussion under *Paralinospadix stenoschistus* Burret. This is a mis-spelling for *P. multifidus*.

Paralinospadix polyschistus Burret, ad nota, Notizbl. Bot. Gart. Berlin-Dahlem 13 (1936) 324. Burret used this name in the discussion under *Paralinospadix stenoschistus* Burret. This is a mis-spelling for that species.

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| 3. <i>C. arfakianus</i> | 13. <i>C. lauterbachianus</i> | 23. <i>C. pusillus</i> |
| 4. <i>C. awa</i> | 14. <i>C. laxiflorus</i> | 24. <i>C. sessiliflorus</i> |
| 5. <i>C. caudiculatus</i> | 15. <i>C. lepidotus</i> | 25. <i>C. spicatus</i> |
| 6. <i>C. doxanthus</i> | 16. <i>C. leptostachys</i> | 26. <i>C. yamutumene</i> |
| 7. <i>C. elegans</i> | 17. <i>C. merrillianus</i> | |
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