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A monograph of the betel nut palms (*Areca*: Arecaceae) of East Malesia

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The palm genus *Areca* is widespread in tropical Asia and includes the economically important betel nut palm, *A. catechu*. The genus has three centres of high species diversity: the Sunda Region, the Philippines and East Malesia (to the east of Wallace's line). The taxonomy of the genus in East Malesia has been neglected. Prior to this study, 19 species were accepted for this area, all but one endemic, but their limits and differences were not understood. Here, we provide a taxonomic monograph of East Malesian *Areca* spp., based on an extensive study of the genus in herbaria and in the field. We recognize six species of *Areca* in East Malesia, including the widespread cultivated *A. catechu*. Five wild species are accepted, namely *A. macrocalyx*, *A. manducanii*, *A. novohibernica*, *A. oxycarpa* and *A. vestiaria*. We place 12 of the previously accepted species into synonymy, and provide additional new synonymy in *A. catechu*. © 2011 The Linnean Society of London, *Botanical Journal of the Linnean Society*, 2012, 168, 147–173.

ADDITIONAL KEYWORDS: conservation – *Palmae* – species – taxonomy.

INTRODUCTION

Areca, described by Linnaeus (1753), is the type genus of the palm family Arecaceae (Moore & Dransfield, 1979; Dransfield *et al.*, 2008). It is perhaps best known as the source of betel nut (primarily derived from *Areca catechu* L.), a stimulant that is regarded as the fourth most widely used addictive substance after caffeine, nicotine and alcohol (Norton, 1998). In the recent phylogenetic classification of the palm family, *Areca* was placed together with *Nenga* H.Wendl. & Drude and *Pinanga* Blume in subtribe Arecinae (Arecaceae; Arecoideae; Dransfield *et al.*, 2005,

2008). This classification is supported strongly by the results of recent phylogenetic studies (Loo *et al.*, 2006; Norup *et al.*, 2006; Baker *et al.*, 2009, 2011), which indicate that the three genera are monophyletic and that *Areca* is sister to a clade of *Pinanga* and *Nenga*.

The genera of Arecinae are found in the Asian tropics and are generally small to moderate, unarmed tree palms possessing tubular leaf sheaths that form a well-defined crownshaft, infrafoliar inflorescences, fruit with apical stigmatic remains and seed with a basal embryo. They are unusual among members of Arecaceae in bearing only one well-developed inflorescence bract (the prophyll), whereas other Arecaceae typically carry both a well-developed prophyll and peduncular bract. Like the majority of Arecoideae, genera of Arecinae bear unisexual flowers in groups of

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three (triads) comprising a central pistillate flower flanked by a pair of staminate flowers (Dransfield, 1984; Dransfield *et al.*, 2008). *Areca* is readily distinguished from the other genera because it has complete triads only at the base of each rachilla with pairs or solitary staminate flowers throughout the remainder of the rachilla, whereas *Nenga* bears numerous complete triads up to three-quarters of the length of the rachilla and *Pinanga* bears complete triads throughout each rachilla.

The last infrageneric classification of the genus *Areca* was proposed by Furtado (1933) and comprises two subgenera and five sections: subgenus *Blumeoareca* Furtado (sections *Arecella* H.Wendl. & Drude, *Oeotheanthe* (Scheff.) Furtado and *Axonianthe* Scheff.) and subgenus *Beccarioareca* Furtado (sections *Microareca* Furtado and *Mischophloeus* (Scheff.) Becc.). However, relationships within the genus were based on morphological affinities alone (Furtado, 1933; Dransfield, 1984; Harley & Dransfield, 2003), and it has been suggested that they need to be reassessed using modern methods (Dransfield, 1984). A reappraisal of the infrageneric classification of *Areca* is in progress (C. D. Heatubun *et al.*, unpubl. data).

The centre of diversity of *Areca* is in Malesia and, within this area, there are three regional hotspots for the genus that also reflect palm diversity in general in South-East Asia (Dransfield, 1987; Baker *et al.*,

1998; Baker & Couvreur, in press). In West Malesia (west of Wallace's line), the Sunda Region is the primary centre of diversity for the genus with 26 species (Govaerts & Dransfield, 2005; Heatubun, 2011). The second centre is East Malesia, the region east of Wallace's line as far as the Solomon Islands, with 18 species. The third centre is the Philippines with 11 species (Govaerts & Dransfield, 2005). The genus extends further west into mainland tropical Asia as far as China, India and Sri Lanka. Recent studies have suggested that the genus contains 48 (Dransfield *et al.*, 2008) or 50 (Henderson, 2009) species in total, although, in the light of recent taxonomic research (Heatubun, 2011; C. D. Heatubun *et al.*, unpubl. data), the current total is closer to 42 species. However, a thorough revision of the entire genus *Areca* is needed. As a step towards this goal, we present here an account of the genus in East Malesia, the area in which the genus is least well known and most poorly understood. The monograph presented here covers all *Areca* spp. from Sulawesi, Maluku, New Guinea and the Solomon Islands (Fig. 1).

The early taxonomic history of *Areca* is closely connected to East Malesia because the first species recognized for the genus was described from the region. Linnaeus erected the genus *Areca* and the first species, *A. catechu*, in his *Species Plantarum* in 1753 based on plate IV of Rumphius' (1741)



Figure 1. Distribution map of *Areca* spp. native to East Malesia. *Areca mandacanii* (circle), *A. macrocalyx* (— · —), *A. novohibernica* (— — —), *A. oxycarpa* (···) and *A. vestiaria* (full line).

Ambonese herbal, *Herbarium Amboinense*; this plate was subsequently selected by Moore & Dransfield (1979) as the lectotype for *A. catechu*. Similarly, the second species described from the region, *A. vestiaria* Giseke (1792), was also based on Rumphius (Dransfield, 1974). A further 17 species from East Malesia were described, primarily during the 19th and early 20th centuries and more recently: *A. macrocalyx* Zipp. ex Blume (Blume, 1838–1839); *A. oxycarpa* Miq. (Miquel, 1868); *A. jobiensis* Becc. (Beccari, 1877); *A. rechingeriana* Becc. (Beccari, 1910); *A. nigasolu* Becc., *A. guppyana* Becc., *A. torulo* Becc. (Beccari, 1914a); *A. warburgiana* Becc., *A. novohibernica* (Lauterb.) Becc. (Beccari, 1914b); *A. congesta* Becc., *A. ledermanniana* Becc. (Beccari, 1923); *A. nannospadix* Burret (Burret, 1931); *A. celebica* Burret (Burret, 1933); *A. rostrata* Burret (Burret, 1935); *A. multifida* Burret, *A. salomonensis* (Burret) Burret ex A.W. Hill & E.Salisb. (Burret, 1936; Hill & Salisbury, 1947); *A. mandacanii* Heatubun (Heatubun, 2008). *Areca* spp. from East Malesia fall into Furtado's (1933) sections *Axonianthe*, *Oetheanthe* and *Mischophloeus*.

Flynn (2004) reassessed the delimitation of species in *Areca* in New Guinea and the Solomon Islands using a morphometric approach, proposing a reduction of seven species into *A. macrocalyx* and two species into *A. guppyana*, although the taxonomic changes were never formally made.

MATERIAL AND METHODS

An extensive study of specimens (dried and spirit-preserved materials) deposited at international herbaria [A, AAU, B, BH, BO, BRI, BZF, CANB, E, FI, FTG, K, KEP, L, LAE, MAN, PNH, SAN, SAR, SING; herbarium acronyms following Holmgren, Holmgren & Barnett, 1990, except for BPKM, the newly established small herbarium in *Balai Penelitian Kehutanan* (Forestry Research Institute – BPKM) in Manokwari, West Papua, Indonesia] underpins this study. In addition, the authors have conducted extensive fieldwork across the region, notably between 1998 and 2011, concentrating on New Guinea and North Sulawesi. Specimens were made in the field using standard preparation guidelines for palms (Dransfield, 1986; Baker & Dransfield, 2006).

Measurements were taken from spirit-preserved material, dried herbarium specimens and living palms. Floral parts were measured from spirit-preserved material or dried specimens rehydrated by boiling. Morphological characters relating to habit, stem, leaves, inflorescence, staminate flower, pistillate flower, fruit, seed and their details were used to delimit and describe taxa. The conservation status of

each species of *Areca* in East Malesia was assessed based on the International Union for the Conservation of Nature (IUCN) red list categories and criteria, version 3.1 (IUCN, 2001).

TAXONOMY

In total, 258 distinct herbarium collections (not counting duplicate specimens) were studied. We accept six species in East Malesia, in contrast with the 19 species accepted prior to this study (Govaerts & Dransfield, 2005; Heatubun, 2008). The accepted species are *A. catechu*, *A. macrocalyx*, *A. mandacanii*, *A. novohibernica*, *A. oxycarpa* and *A. vestiaria* (see Taxonomic treatment for details). These species names are used in the remainder of this paper.

MORPHOLOGY

HABIT

The habit of *Areca* spp. can be variable, from acaulescent undergrowth palmlets to moderately robust tree palms, and from solitary to clustering (Dransfield, 1984; Uhl & Dransfield, 1987; Dransfield *et al.*, 2008). All species in East Malesia are solitary, except for *A. vestiaria* (although some populations of *A. vestiaria* are single-stemmed). No East Malesian species is acaulescent, unlike several species in West Malesia (Dransfield, 1980, 1984; Heatubun, 2011). Two *Areca* spp. in the region have stilt roots, namely *A. novohibernica* and *A. vestiaria*. Although the ecological significance of stilt roots has been debated, they are thought to be related to swampy habitats, light environments or stabilization in rocky habitats (see Dransfield *et al.*, 2008). These roots are essential for mechanical support and vascular function (Frangi & Ponce, 1985; Tomlinson, 1990), but not for ‘walking’, as erroneously proposed by Leopold (2000) (but see Bodley & Benson, 1980). According to Tomlinson (1990), stilt roots usually occur in solitary palms (such as *A. novohibernica*), providing support for the trunk, but some populations of *A. vestiaria* can be clustering with stilt roots.

STEMS

The stem size varies from slender (1.0–1.5 cm in diameter) in *A. oxycarpa* and *A. macrocalyx* to moderately large (15–20 cm in diameter) in *A. catechu* and *A. macrocalyx*. The leaf scars are prominent. The internode length is variable, and is likely to be related to the conditions in which an individual palm grows. The stems are shiny green (or yellowish-green) near the stem apex and become

brown to whitish near the base. Shiny black stems have been observed in populations of *A. macrocalyx* from heath forest in the central mountains of Japen Island, New Guinea.

LEAVES

All *Areca* spp. in East Malesia have pinnately divided leaves, contrasting strongly with the simple bifid leaves of several *Areca* spp. in West Malesia (Dransfield, 1980, 1984; Heatubun, 2011). The number of leaves in the crown of almost all species in this region varies from five to 11. The petiole ranges from lacking or short (up to 5 cm long) to long (to 50 cm long). The arrangement of leaflets is varied in *Areca* but, in most species in East Malesia, the leaflets are irregularly arranged (regular in some specimens) and arrayed in the same plane, except for *A. mandacanii* (Heatubun, 2008). This species has unique plumose leaves, with single-fold leaflets arranged irregularly in different planes. This plumose leaf is unknown in other *Areca* spp. and other members of Arecinae.

The number of leaflets on each side of the rachis varies from five to 75 in East Malesian *Areca*, with the smallest numbers being found in *A. novohibernica* and *A. oxycarpa*, and the highest in *A. macrocalyx*. The number of leaflets is variable in the genus in this region and shows a high degree of plasticity. Sometimes the variation is continuous within species and is inversely related to the number of folds per leaflet, as in *A. macrocalyx*, which can have a small number of broad leaflets to many single-folded leaflets. However, *A. mandacanii* always has single-folded leaflets.

The crownshaft, which is typical of Arecinae and many other arecoid palms, is variable in colour. It is dark brown to black only in *A. oxycarpa*, yellow to orange in *A. vestiaria* (sometimes reddish and rarely pale green or greenish-yellow) and green in all other species. A form of *A. macrocalyx* with a red crownshaft has been reported from the Finschhafen area of Papua New Guinea (Baker & Dransfield, 2006; specimen: *Banka et al. 2001*) and from Wosimi in West Papua (specimen: *Heatubun et al. 776*). The leaf sheath varies from thin in the smaller taxa to thick in emergent tree palms, and sometimes has disintegrating fibres at the margins just below the petiole.

INDUMENTUM

The indumentum can occur on the leaf sheaths, leaves, inflorescences and staminate flowers, although it is relatively unimportant to the taxonomy of *Areca* in this region, with the exception of *A. novohibernica*. Fine purple scales, filamentous brown scales and thick

black scales can be found on the leaf sheaths and petioles. Dense white, greyish and brown scales can occur on the leaf rachis. Inflorescences of *A. mandacanii*, especially the peduncle and rachillae, may carry minute red to brown dots and a thick light brown to chocolate brown indumentum. A velvet indumentum on the staminate flowers is one of the important characters separating *A. novohibernica* from *A. vestiaria*.

INFLORESCENCES

The inflorescences of all *Areca* spp. in East Malesia are infrafoliar, although interfoliar inflorescences are found in several *Areca* spp. in West Malesia (Beccari, 1877; Dransfield, 1984). Three species are usually branched to one order (*A. macrocalyx*, *A. novohibernica* and *A. oxycarpa*), *A. vestiaria* is always branched to two orders and *A. catechu* and *A. mandacanii* are branched to two or three orders. Occasionally, those species branched to one order will have a branched, basal-most rachilla. Most species in this region have erect inflorescences in the early stages of development that become pendulous when the fruits develop, although *A. oxycarpa* always has erect inflorescences even when bearing ripe fruits (Fig. 3C, D). Generally, the inflorescence of *A. macrocalyx* is erect in the early stages of development and becomes pendulous later. However, in some populations, inflorescences are always erect, whereas, in others, they are always pendulous; in some instances, combinations may be observed (Fig. 2A–F).

The prophyll, which encloses the inflorescence in bud, is thin, membranous and quickly splits and falls at anthesis. As in all other Arecinae, no further well-developed major bract occurs on the peduncle (Dransfield *et al.*, 2008). The prophyll is generally similar to the crownshaft or leaf sheath in colour. For example, in the red crownshaft form of *A. macrocalyx*, the prophyll is also red. The peduncle is shorter than the rachis in all species in this region. The rachillae are glabrous, bearing minute rachilla bracts.

FLOWERS

As explained previously, in *Areca*, complete floral triads are confined to the proximal part of the rachillae, these reducing to paired or solitary staminate flowers distally. The distribution of triads in the rachilla is important taxonomically in *Areca*, especially in East Malesia. Complete triads occur up to halfway along the rachillae of *A. novohibernica* and *A. vestiaria*, whereas triads occur on the lower third of the rachilla of *A. oxycarpa*. Only one triad is found at the base of each rachilla in *A. catechu* and *A. mandacanii*. In the remarkable inflorescence of *A. macro-*

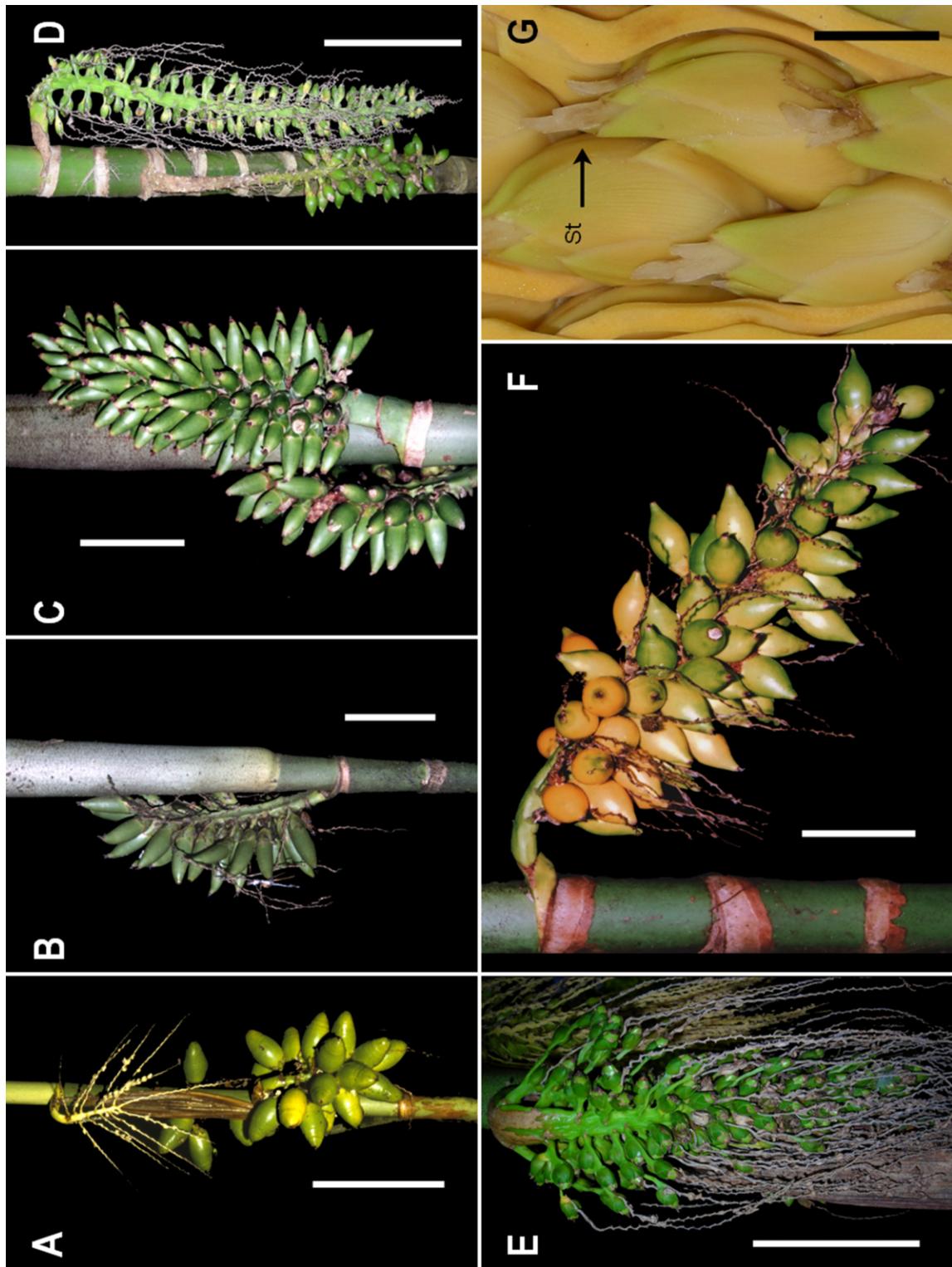


Figure 2. The inflorescence (inflorescence) and pistillate flower morphology of *Areca macrocalyx*: A, lax, pendulous inflorescence; B, C, crowded, erect inflorescence; D, long pendulous, lax inflorescence with paired fruits; E, pendulous inflorescence with more than one triad on basal-most rachilla; F, turning from erect to pendulous; G, pistillate flowers at anthesis, stigmas congenitally exposed (St). Scale bars: A, 10 cm; B, C, F, 5 cm; D, 20 cm; E, 25 cm; G, 1 cm. Photographs: A, William J. Baker; B, John Dransfield; C–G, Charlie D. Heatubun.

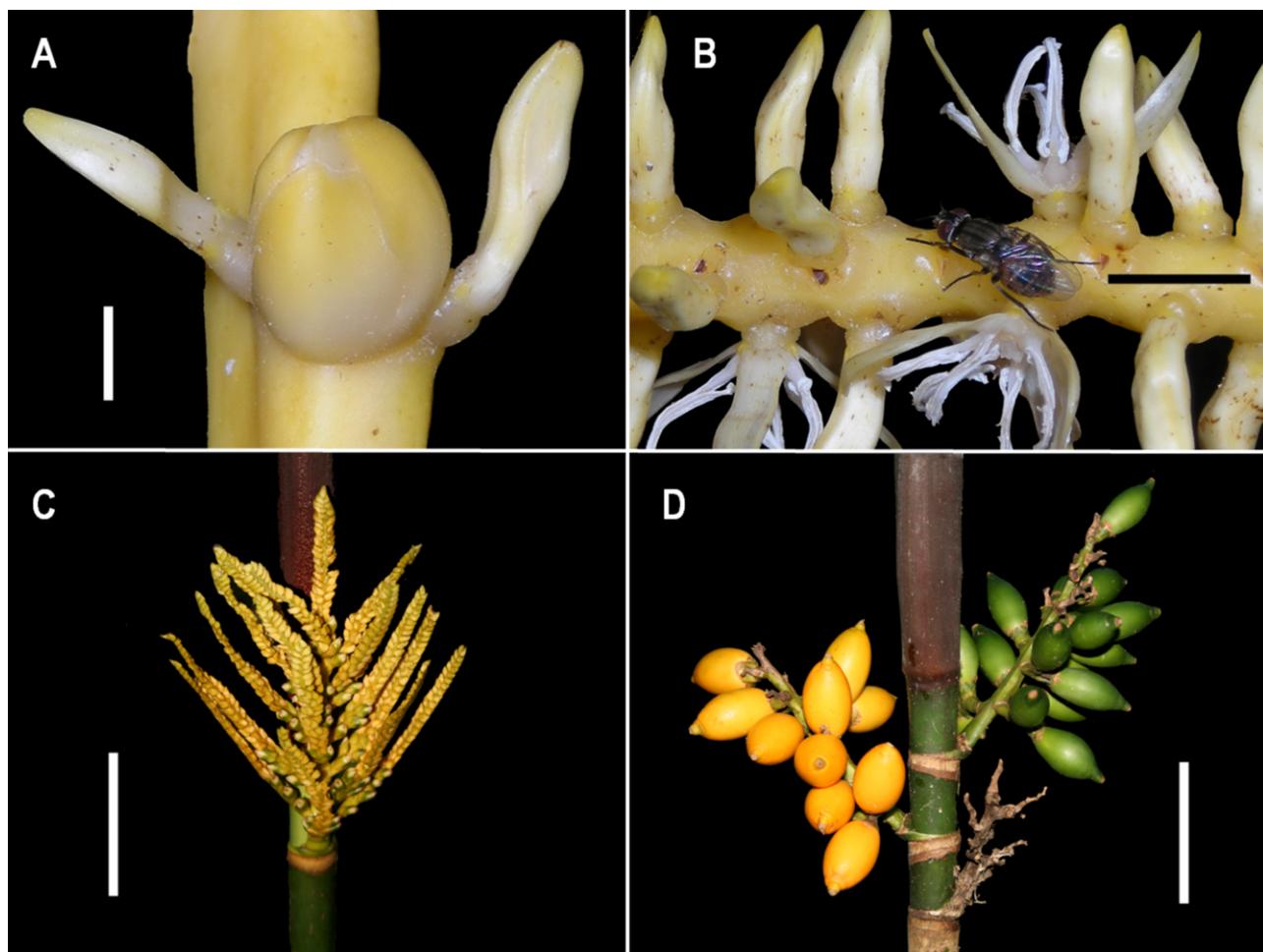


Figure 3. Reproductive organs of *Areca vestiaria* and *A. oxycarpa*: A, triad in *A. vestiaria*, comprising two lateral staminate flowers and a central pistillate flower; B, different stage at anthesis of the staminate flowers of *A. vestiaria*, with flesh fly (Sarcophagidae) visiting the flowers; C, inflorescence of *A. oxycarpa*, slightly congested and protogynous; D, ripe and young fruits of *A. oxycarpa*. A, B, from Heatubun et al. 885; C, from Heatubun et al. 883; D, from Heatubun et al. 877. Scale bars: A, 2 mm; B, 10 mm; C, D, 7 cm. Photographs by Charlie D. Heatubun.

calyx, one to five complete triads including pistillate flowers occur at the very base of each rachilla. The remaining purely staminate portion of the rachilla is slender and dries and falls after anthesis, the remaining part of the inflorescence then resembling a spike and becoming congested and maize-like in fruit (Fig. 2A–F).

As in many palms, the flowers in *Areca* are sexually dimorphic. The staminate flowers are smaller than the pistillate flowers. In East Malesian species, the staminate flowers are cream coloured in bud and white to yellowish-white at anthesis. The pistillate flowers are cream coloured to white or greenish-white with green at the tip in bud, and cream coloured to greenish-cream coloured near the tip at anthesis.

The staminate flowers have three distinct, slightly imbricate, triangular sepals or a cupular calyx with or

without three triangular lobes. The corolla comprises three triangular to elongate triangular or slightly spatulate, valvate petals much longer than the sepals. All species in East Malesia have six free stamens, except *A. novohibernica* with epipetalous stamens. The filaments are short to elongate with linear to sinuous anthers, sometimes irregular. A pistillode may be present, sometimes minute and inconspicuous, other times in the form of a conspicuous, trifid column as long as the stamens.

Two distinct groups can be separated easily based on the nature of the staminate flowers among *Areca* spp. in East Malesia. The first has staminate flowers with a cupular calyx and three elongate triangular to slightly spatulate petals [*A. novohibernica* and *A. vestiaria* (Fig. 3A, B); i.e. section *Mischopleous* (Furtado, 1933)], and the second has the calyx with three, slightly imbricate, triangular sepals and three

triangular petals (including *A. catechu*, *A. macrocalyx*, *A. mandacanii* and *A. oxycarpa*).

The pistillate flowers are sessile, globular to triangular and much larger than the staminate flowers. The three sepals are distinct and imbricate (and/or united near the base in *A. novohibernica* and *A. vestiaria*). Petals are similar to the sepals, sometimes valvate at the very tip, otherwise imbricate. Four to six staminodes may be present. They can be triangular or ovate, or form a membranous to fleshy ring with four to six teeth. The gynoecium is unilocular, uniovulate, globose to ovoid, with three stigmas that are reflexed at anthesis.

FRUITS AND SEEDS

The fruits of East Malesian *Areca* are small to rather large for the genus (to 70 mm × 45 mm), and vary widely in shape. The epicarp is thin and smooth with a mesocarp that can be thin to moderately thick and fibrous or fleshy and juicy. A fibrous endocarp surrounds the solitary seed. The seeds are relatively large (up to 35 mm × 30 mm × 30 mm) with a basal hilum and anastomosing raphe branches. The size and shape of the fruits and seeds vary greatly within individuals and populations, especially in the widespread native or cultivated species *A. catechu*, *A. macrocalyx* and *A. vestiaria*. Although fruit dimensions were used by Beccari (1919) as the main character to distinguish Philippine *Areca* spp. and their varieties, and by Furtado (1933) in his infrageneric classification, we observed a high degree of plasticity in this character in this region.

TAXONOMIC TREATMENT

ARECA L. SP. PL. 1189 (1753)

Type species: *Areca catechu* L., Sp. Pl. 1189 (1753).

Mischophloeus Scheff., Ann. Jard. Bot. Buitenzorg 1: 115, 134 (1876). Type: *Mischophloeus paniculatus* (Scheff.) Scheff. (*Areca paniculata* Scheff.) = (*Areca vestiaria* Giseke).

Gigliolia Becc., Malesia 1: 171 (1877) (non Barb. Rodr.). Lectotype: *Gigliolia insignis* Becc. (= *Areca insignis* (Becc.) J.Dransf.).

Pichisermollia H.C. Monteiro-Neto, Rodriguesia 28: 195 (1976). Type: *Pichisermollia insignis* (Becc.) H.C. Monteiro-Neto (*Gigliolia insignis* Becc.) (= *Areca insignis* [Becc.] J.Dransf.).

Distribution: India and south China, through Malesia to New Guinea and the Solomon Islands.

Number of species: 42 species in total, including six species in East Malesia.

1. *ARECA CATECHU* L. (FIG. 4A–I)

Sp. Pl. 1189 (1753). *Areca faufel* Gaertn., Fruct. Sem. Pl. 1: 19 (1788), nom. superfl. *Areca hortensis* Lour., Fl. Cochinch. 568 (1790), nom. superfl. Type: *Pinanga Rumphius*, Herb. Amboin. 1: t. IV (1741) (Lectotype, designated by Moore & Dransfield, 1979).

Areca cathechu Burm.f., Fl. Indica: 241 (1768) (orthographic variant).

Areca catechu var. *nigra* Giseke, Prael. Ord. Nat. Pl. 73 (1792). Type: *Pinanga nigra* Rumphius, Herb. Amboin. 1: 29 (1741). (Lectotype, designated here). **Syn. nov.**

Areca catechu var. *alba* Blume, Rumphia 2: 68 (1839). Type: *Pinanga alba* Rumphius, Herb. Amboin. 1: 29 (1741). (Lectotype, designated here). **Syn. nov.**

Areca catechu var. *batanensis* Becc., Philipp. J. Sci. 3: 304 (1908). Type: Philippines, Batanes Island, 6.vi.1907, Fenix 3834 (holotype: FI!). **Syn. nov.**

Areca macrocarpa Becc., Philipp. J. Sci. C4: 601 (1909). Type: Philippines, Mindanao, Zamboanga District, Port Banga, i.1908, Whitford & Hutchinson 9103 (holotype: FI!). **Syn. nov.**

Areca catechu var. *longicarpa* Becc., Philipp. J. Sci. 6: 229 (1911). Type: Philippines, Polillo Island, 10.xi.1909, McGregor 10470 (holotype: FI!). **Syn. nov.**

Areca catechu f. *communis* Becc., Philipp. J. Sci. 14: 304 (1919). Type: Philippine, Mindanao, Misamis Province, Katajan, Mt. Malindang, Mearns & Hutchinson 4717 (holotype: FI!). **Syn. nov.**

Areca catechu var. *silvatica* Becc., Becc., Philipp. J. Sci. 14: 304 (1919). Type: Philippine, Palawan, Lake Manguao, iv.1913, Merrill 9447 (holotype: FI!; isotypes: K!, L!). **Syn. nov.**

Invalid names: *Areca himalayana* Griff. ex H.Wendl. in O.C.E.de Kerchove de Denterghem, Palmiers: 231 (1878). Nom. nud.

Areca nigra Giseke ex H.Wendl. in O.C.E.de Kerchove de Denterghem, Palmiers: 231 (1878). Nom. nud.

Sublimia areca Comm. ex Mart., Hist. Nat. Palm. 3: 169 (1838). Nom. inval.

Description: Moderate to large, solitary tree palm, 15–25(–30) m. STEM 15–25(–40) cm in diameter; internodes close to elongate (to 20 cm long). LEAVES 8–12 in crown, crown shuttle-cock shaped to arching, 150–270 cm long (including petiole); sheath tubular, 50–130 cm long; crownshaft 100–175 cm long, 15–20 cm in diameter, light green to green; petiole almost lacking or short to 15 cm long, channelled adaxially, rounded abaxially; leaflets 20–35 on each side of the rachis, each comprising more than one fold, appearing more or less regular, distributed evenly along the rachis in one plane, basal leaflets c. 109 × 9 cm, middle leaflets c. 100 × 11 cm, apical leaflets c. 68 × 9.5 cm, briefly pointed and sometimes

KEY TO SPECIES OF ARECA IN EAST MALESIA

1. Palm with stilt roots; floral clusters spirally arranged on the rachillae; complete triads including pistillate flowers occurring from the base to half the length of each rachilla; sepals of the staminate flower united (calyx cupular), petals elongate and spathulate; fruits with fleshy and juicy mesocarp **2**
1. Palm without stilt roots; floral clusters uniseriate or distichously (or subdistichously) arranged on the rachillae; complete triads including pistillate flowers occurring only at the base and/or along the lower third of each rachilla; sepals of the staminate flower triangular, fused basally or free, petals triangular; fruits with fibrous mesocarp... **3**
2. Small palm with stem to 4(–5) m tall and to 5 cm in diameter; always solitary; crownshaft green; inflorescence branched to one order (rarely two orders); staminate flowers covered with velvet-like indumentum, stamens epipetalous, anthers irregular and sometimes twisted; Manus Island, the Bismarck Archipelago and the Solomon Islands..... **4. *A. novohibernica***
2. Moderate to large palm with stem to 10(–15) m tall and 7–15 cm in diameter; solitary or clustering; crownshaft brilliant orange, reddish to bright red (rarely pale green); inflorescence always branched to two orders; staminate flowers glabrous, stamens not epipetalous, anthers sagittate and elongate; Sulawesi to Maluku... **6. *A. vestiaria***
3. Small, undergrowth to robust, emergent tree palm; inflorescence somewhat compact and rachillae slightly congested along main axis, branched to one order (rarely two orders); protogynous..... **4**
3. Moderate to robust, emergent tree palm; inflorescence divaricate, branched from two or three orders; protandrous. **5**
4. Small, undergrowth to robust, emergent tree palm (to 25 m high); stem 3–20 cm in diameter; leaf sheath and crownshaft mostly green in colour (sometimes reddish to bright red); inflorescence club-like; rachillae numerous (up to 600), slender and sinuous to zigzag in appearance; complete triads including one to five pistillate flowers occurring at the very base of each rachilla, the remaining purely staminate portion slender, drying and falling after anthesis, giving the appearance of a spicate inflorescence, becoming congested and maize-like in fruit; Maluku through New Guinea to Solomon Islands..... **2. *A. macrocalyx***
4. Small undergrowth palm (to 3 m high); stem 1–3 cm in diameter; leaf sheath and crownshaft always dark brown to black in colour; the inflorescence erect and divergent; rachillae few (up to 16), straight and rather stiff; the complete triads including pistillate flowers occurring along the lower third of all rachillae; endemic to North Sulawesi..... **5. *A. oxycarpa***
5. Leaflets multi-fold, all in the same plane; inflorescence divaricate, broad and crowded, mostly branched to three orders (rarely two); fruits with beaked or rounded with pointed apex; cultivated across the Old World tropics, commonly so in East Malesia..... **1. *A. catechu***
5. Leaflets single-fold, held in different planes (plumose); inflorescence somewhat elongate and slender, mostly branched to two orders (rarely three); fruits with conspicuous woody discoid depression at the apex; native to Bird's Head Peninsula in western New Guinea..... **3. *A. mandacanii***

notched at apices, green, concolorous when dried. INFLORESCENCE infrafoliar, divaricate, 29–80 cm long, branched two or three orders; rachillae numerous; prophyll caducous, 65–78 × 15–17 cm, leathery; peduncle short, c. 6 cm long and c. 8 cm wide at the base; rachillae c. 10–40 cm long, rachilla bracts inconspicuous, calyces sometimes persistent on rachillae after fruits fallen. FLORAL CLUSTER distichous on rachilla with one to three complete triads including pistillate flowers occurring at the base of each rachilla. STAMINATE FLOWERS small, 4.0–7.5 × 2–5 mm, asymmetrical; sepals three, low, slightly connate near the base; petals three, 6–7 × 2.5–4.0 mm, triangular, cream coloured; stamens 12; filaments 1 mm long; anthers 1–2 × 0.5–0.7 mm; pistillode to 3 mm long, trifid. PISTILLATE FLOWERS larger than the staminate, 12–15 × 7–10 mm, triangular; sepals three, to 10 × 10 mm, imbricate, strongly keeled, cream to green at anthesis; petals three,

10–15 × 7–10 mm, cream; gynoecium c. 10 × 5 mm (including stigma 5 mm), stigma trifid; staminodes forming a membranous ring. FRUITS 5–7 × 2–4 cm, variously ovoid to ellipsoid, green and yellow to orange or reddish-orange when ripe; epicarp smooth and thin; mesocarp fibrous and thick; endocarp fibrous and thin. SEEDS 3.0–3.5 × 2.5–3.0 cm, variously subglobose to ovoid, more or less flat at the base.

Distribution and ecology: This is the most widely cultivated species in the genus and has been distributed by humans throughout the tropics. As a result of domestication, the country of origin is not known with certainty. However, several locations have been suggested based on the distributions of close wild relative species, including the Philippines, Malaysia, Celebes (Sulawesi) and New Guinea (Beccari, 1919; Furtado, 1933; Corner, 1966; Jones, 1995; Heatubun, 2008).

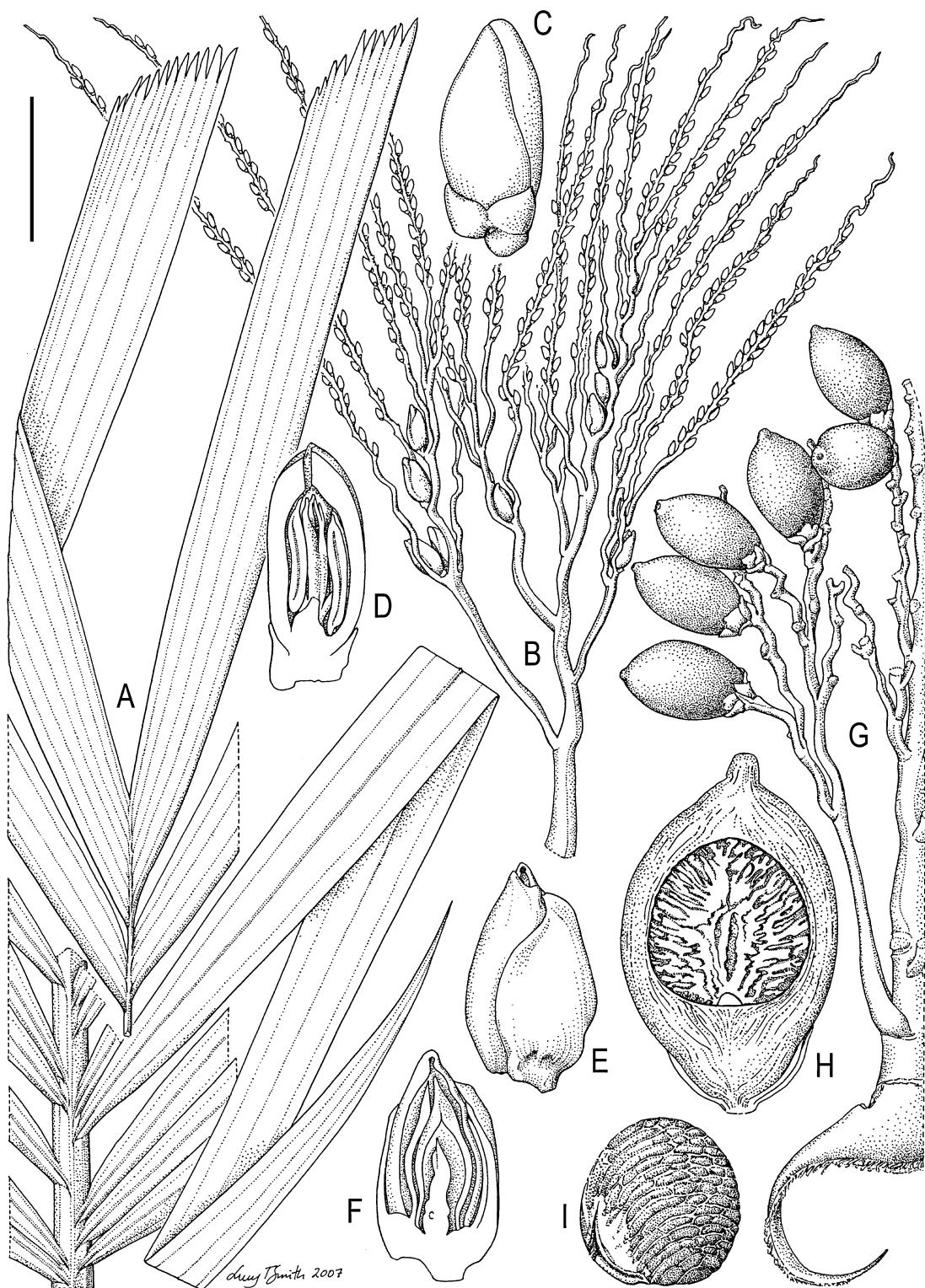


Figure 4. *Areca catechu* L.: A, apical and mid-portion of leaf; B, portion of inflorescence; C, staminate flower; D, staminate flower in section; E, pistillate flower; F, pistillate flower in section; G, portion of infructescence; H, fruit in section; I, seed. Scale bar: A, 8 cm; B, G, 6 cm; C, D, 3 mm; E, F, 1 cm; H, I, 2 cm. A–F, H, I, from Noblick 5180; G, from de Vogel 3266. Drawn by Lucy T. Smith.

Local names and uses: Many names have been recorded for this widely cultivated species of *Areca*; *angiro* (Solomon Islands: Kwar'ae), *adakka*, *gua*, *supari* (India), areca or areca-nut palm, betel nut (English), *arec cachou*, *arequier* (French), *betelnusspalme* (German), *bu* (Yap), *bua* (Palau), *buai* (Papua New Guinea Pidgin English), *buei* (New Ireland: Pala), *boa* (Bali), *boá*, *boñga*, *buá*, *buñga*, *lúyos*, *takotob* (Philippines), *cau* (Vietnam), *cun pan*, *kunti* (Myanmar), *doma* (Bhutan), *inan'* (Biak), *jambe* (Javanese), *mark* (Thailand), *palma catechou* (Spanish), *pinang* (Indonesian), *pin lang* (China), *poc* (Pohnpei), *pu* (Chuuk), *puak* (Sri Lanka), *pugua* (Guam), *sawu* (Wandamen), *vua* (New Ireland: Lamekot).

The scale of betel nut palm use is enormous (Norton, 1998; Lee & Choi, 1999; Sullivan *et al.*, 2000; Byun *et al.*, 2001; Ray & Reddy, 2001; Staples & Bevacqua, 2006), and it has become one of the most important stimulant products in the world, used by around 200–400 million people (Norton, 1998; Gupta & Warnakulasuriya, 2002; Zumbroich, 2008). The origin and dispersal of the betel nut palm and the chewing habit have been discussed for many years, and the most comprehensive review was provided by Zumbroich (2008). Betel nut palm plantations have been shown to play an important role in maintaining biodiversity in the Western Ghats, India (*The Economist*, 8th November 2008: 100).

Conservation status: Least Concern – LC (IUCN, 2001). The widespread cultivation of this species means that it is not threatened. Nevertheless, the lack of evidence for the species in the wild suggests that its progenitors are unknown or may even be extinct.

Specimens cited: **UNITED KINGDOM.** Cultivated at Royal Botanic Gardens, no. x.1.776, *s.n.* (K!). **TANZANIA. Dar Es Salaam,** University Agriculture and Forestry campus, Morogoro, T6, 535 m, 11.xi.1976, *Wingfield* 3708 (K!). **INDIA. Bengal**, Cari Bangar, Baharchara, 11.x.1943, *Sinclair* 3272 (E!). **East Bengal**, 1863–1864, *Griffith* *s.n.* (K!). **Assam**, *Masters* *s.n.* (BO!). **Calcutta**, Botanic Garden, cultivated at Botanic Garden, *s.n.* (E!, L!). **SRI LANKA**. 1.iv.1860, *Dubuc* 1869 (E!). **Peradinya**, Botanic Garden, lawn Q–306, 27.iii.1986, *Rutherford* & *Bandara* 124 (K!); 23.ii.1909, *Baker* 136 (BO!, K!). **Sinharaja**, *Barfod* *s.n.* (AAU photo!). **CHINA. Yunnan**, Yunnan Institute of Tropical Botany, 600 m, 2.vii.1978, *Chen* 18806 (K!). **TAIWAN. Kagi Province**, Kagi, 24.ii.1918, *Wilson* 9891 (K!); Orchid Island, Ten-tzu, 31.viii.1969, *Huang* & *Kao* 5234 (L!). **Hainan**, 16.vii.1933, *Liang* 62129 (K!); xi.1889, *Henry* 8406 (K!); central eastern Hainan, between Kacheck and Ling Mon, 5.vi.1922, *Canton Christian*

College 9808 (E!, K!); Taam Chau District, Na Lin Sham, 30.v.1928, *Tsang* 146 (K!); Ngai District, Naam Shan Leng, 16.vi.1932, *Lau* 266 (E!, K!). **THAILAND. Bangkok**, 4.vi.1920, *Graff* 134 (K!). **Phangnga Province**, Laemson National Park, Kampuan Substation, Ton Lan, hill dipterocarp forest, 50–100 m, 22.ii.1994, *Barfod et al.* 45235 (AAU!, BKF, PSU). **SINGAPORE.** Botanic garden, iv.1920, *s.n.* (K!); lawn X, 19.vi.1929, *s.n.* (K!); lawn J, 26.vii.1929, *s.n.* (K!); National University Hospital, Kent Ridge wing, 13.vii.2001, *Ching* & *Tan* TC 01 (K!). **THE PHILIPPINES. Luzon**, Manila, Isaac Peral Street, 1935, Bartlett 16226 (K!). **Rizal Province**, Antipolo, xi.1914, *Merrill Species Blancoanae* 213 (BO!, K!, L!, PNH). **Laguna Province**, Los Banos, Mt. Makiling, vi–vii.1917, *Elmer* 17468 (BO!). **Tayabas Province**, Lucban, v.1907, *Elmer* 7795 (BO!, E!). **Isabela Province**, Jones, St. Domingo, 120 m, 22.iv.1987, *Fernando* 665 (K!). **Bataan Province**, Mt. Mariveles, Lamao River, 3.xii.1903, *Williams* 330 (K!); vii.1904, *Borden* 20192 (*Forestry Bureau* 1272) (K!). **Batanes Province**, Batan Island, Mt. Iraya, viii.1930, *Ramos* (*Bureau of Science*) 80360 (K!). **Camarines Norte Province**, Labo, Bo Fondado, coconut grove, 14.vii.1985, *Fernando* 546 (K!). **Visayas – Western Samar Province**, Mt. Malingon, Brgy Lokilokon, Paranas, 13.x.1992, *Reynoso et al.* 7363 (K!). **Mindanao**, Zamboanga Peninsula, La Paz, Camp Susana, 500 m, 4.vii.1986, *Fernando* 600 (K!). **Mindoro**, Mt. Yagaw, SE slope, 5.viii.1953, *Conklin* 18651 (L!); 300 m, 6.ii.1958, *Conklin* 1055 (PNH 37593) (L!). **MALAYSIA. Sarawak**, 1865–1868, *Beccari PB* 3112 (FI!, K!); Triboh scheme, Serian, 14.iii.1988, *Othman* & *Munting S* 61606 (K!, SAR!); Batu Bedanan, Ngarai Talong, Sungai Engkari, Batang Ai, Lubok Antu, 270 m, 31.vii.1994, *Lai S* 68676 (K!, L!, SAR!, KEP); Kampung Melayu, Ulu Layar, Betong, 4.vii.1988, *Lee S* 55696 (K!, L!, KEP, SAN, SAR!); Kapit, Upper Rejang River, 1929, *Clemens* 21501 (K!). **Sabah**, Ranau District, Bundu Tuhan village, Siba, Himbaan village, 13.v.1994, *Soibeh* 778 (K!); Poring village, at hill slopes, 31.x.1993, *Sambuling* 8 (K!); 6.ii.1994, *Sambuling* 76 (K!); Sandakan, mile 12, 10.iii.1949, *Acuadian* 202 (K!); Lahad Datu, Masuri, Ulu Segama, 20.xi.1949, *Acuadian* 254 (K!); Sorinsim village, Hutan muda, 13.iii.1993, *Sibil* 153 (K!); Melangkap Tomis village, 10 m from village hall, 29.v.1995, *Lugas* 442 (K!); Tongod District, 22 km logging road to upstream Milian River, 31.x.1984, *Mansus* & *Aban* SAN 69388 (K!, L!); Kiaunuluh village, Nuluhon, 4.ii.1993, *Duaneh* 255 (K!); Kota Marudu District, Serinsim village, 9.iii.1995, *Bakia* 416 (K!). **INDONESIA. Riau Islands Province**, Bengkalis, Singoro, 4 m, 17.ix.1919, *Beguin* 330 (BO!). **West Sumatera Province**, Siberut, 9.ix.1924, *Boden-Kloss* 11440 (BO!); Mentawai Islands, Sipora

Island, 18.x.1924, *Iboet* 440 (BO!). **Banten Province**, Panaitan Island, Ciharahas, upstream, 5.ix.1951, *Borssum-Waalkes* 350 (BO!, K!); Peucang Island, Ujung Kulon, 4 m, 13.iv.1971, *Dransfield* 1403 (BO!); track to Cibunar, 5 m, 17.iv.1971, *Dransfield* 1467 (BO!); *Dransfield* 1471 (BO!); Ujung Kulon National Park, c. 1 km NW of Cibunar security post, along the bank of Cibunar River, 40 m, 2.x.1998, *Noblick et al.* 5180 (BO!, K!, MBC). **Jakarta Province**, Bidara Cina, xi.1863, *Edeling s.n.* (BO!). **West Java Province**, Bogor, Botanic Garden, ex cultivated, lawn II.F.9, *s.n.* (BO!); lawn VII.B.78, *s.n.* (BO!); lawn VII.B.79, *s.n.* (BO!, L!); lawn VII.B.80, *s.n.* (BO!); lawn VII.B.81, *s.n.* (BO!); lawn VII.B.84, *s.n.* (BO!, L!, G); lawn VII.B.85, *s.n.* (BO!, L!); lawn VII.B.87, *s.n.* (B, BO!, K!, L!); lawn VII.B.88, *s.n.* (BO!, L!); lawn VII.B.89, *s.n.* (BO!, L!); lawn VII.B.91, *s.n.* (BO!); lawn XI.B(XX)6, *s.n.* (BO!); lawn XIII.A.6, *s.n.* (BO!); Ciherang, 700 m, 8.i.1928, *van Steenis* 212 (BO!); W of Bogor, Leuwiliang, Pasir Honje, 300 m, 5.vi.1927, *Bakhuisen van den Brink* 6724 (BO!); *Bakhuisen van den Brink* 6782 (BO!); *Bakhuisen van den Brink* 6788 (BO!); *Bakhuisen van den Brink* 6789 (BO!); 7.vi.1927, *Bakhuisen van den Brink* 6807 (BO!, L!); 14.viii.1927, *Bakhuisen van den Brink* 6866 (BO!); Tasikmalaya, Nusa Gede, Penjalu, 720 m, 30.vii.1917, *Koorders* 396 (BO!). **Central Java Province**, Banyumas, Jagadanda River, 3 m, 10.v.1921, *Backer* 31478 (BO!). **Gorontalo Province**, 250 km W of Gorontalo, 75 km inland from Papayuto, on tributary of Papayuto River, 150 m, 30.iii.1990, *Burley et al.* 4215 (A, BO!, K!). **South Sulawesi Province**, c. halfway South road Soroaku–Wasupoda, 700 m, 1.vi.1979, *de Vogel et al.* 6048 (BO!, L!). **North Sulawesi Province**, Bolaang Mongondow, Pindool District, Lolak, 50 m, 19.x.1973, *Dransfield & Mogea* 3808 (BO!, L!). **Southeast Sulawesi Province**, Kolaka area, Mt. Watuwila foothills, above Sangguna, Mokwu camp, 200 m, 30.x.1989, *Coode* 6074 (BO!, K!). **East Nusa Tenggara Province**, Alor Island, Atimelang, 750 m, 24.i.1939, *Du Bois* 24 (BO!); Timor Island, Baumata village, 50 m, 21.iii.1939, *Bloembergen* 3555 (BO!); *Bloembergen* 3556 (BO!). **North Maluku Province**, Halmahera Island, Ekor, near the village, 20 m, 1.x.1974, *de Vogel* 3266 (BO!, K!, L!); Tidore, 17.v.1921, *Beguin* 1613 (BO!, B); Bacan Island, NE Bacan, 2.ix.1985, *Sidiyasa et al.* TCW 3580 (K!). **Maluku Province**, Seram Island, Masohi, Waipia, Jerili village, 10 m, 18.xi.1981, *Mogea* 3140 (BO!). **West Papua Province**, Raja Ampat Islands District, Gag Island, 10 m, 29.vii.2006, *Heatubun et al.* 751 (BO!, K!, MAN!, BPKM!); *Heatubun et al.* 752 (BPKM!); *Heatubun et al.* 753 (BO!, K!, MAN!, BPKM!). **Papua Province**, Japen Island, Konti Nuai village, 100 m, 25.ii.2008, *Heatubun et al.* 870 (BO!, K!, MAN!, BPKM!).

Notes: *Areca catechu* is the most widespread cultivated species in the genus and has long been the subject of selection by humans. It is planted throughout tropical regions and, although it is most often encountered in village gardens, it has also been developed in large-scale plantations in some areas, notably India. This palm is planted mainly for betel nut production, and thus fruits and seeds are the main target for selection, although cultivation for ornamental purposes has increased in recent years. Anthropogenic selection pressure makes this species variable in cultivation, especially the habit, fruits and seed size, shape, colour and even taste (Zumbroich, 2008).

In this treatment, we apply a broad species concept to *A. catechu* and do not recognize any infraspecific taxa as proposed by earlier authors (Giseke, 1792; Blume, 1838–1839; Beccari, 1908, 1911, 1919). In our view, the morphological features highlighted in these entities are simply part of the spectrum of variation in this variable species. Moreover, distinct individuals, populations or groups found within the morphological range of *A. catechu* are better treated as cultivars, being the product of human selection. Merrill collected a specimen (*Merrill* 9447) in primeval forest in Palawan, Philippines, but he noted in a letter to Beccari (Beccari, 1919) that the trees he collected originated from seeds accidentally left there by native people. The two varieties, var. *nigra* (Giseke, 1792) and var. *alba* (Blume, 1838–1839), are based on interpretation of Rumphius' 'Pinanga nigra or pinang itam' and 'Pinanga alba or pinang poëtilh' in *Herbarium Amboinense* (Rumphius, 1741: 29), varieties erected on the basis of different colours in the plant and reproductive organs, including fruits. Beccari (1919) keyed out three varieties and one form of *A. catechu* in the Philippines, var. *batanensis* (Beccari, 1908), var. *longicarpa* (Beccari, 1911), var. *silvatica* (Beccari, 1919) and forma *communis*, based on stem, inflorescence, fruit and seed characters. Finally, we follow Merrill (1923: 26) in treating *A. macrocarpa* Becc. as a synonym of *A. catechu*.

2. ARECA MACROCALYX ZIPP. EX BLUME (FIGS 2A–G, 5A–K)

Rumphia 2: 75 (1839). *Areca macrocalyx* var. *zippelliana* Becc., Malesia 1: 19 (1877). **Type:** New Guinea, SW coast, Zippel *s.n.* (holotype: L!).

Areca jobiensis Becc., Malesia 1: 21 (1877). **Type:** New Guinea, Geelvink Bay, Japen Island, Ansus, iv.1875, Beccari *s.n.* (holotype: FI!; isotype: K!). **Syn. nov.**

Areca macrocalyx var. *aruensis* Becc., Malesia 1: 20 (1877). **Type:** Aru Islands, Vokan (Wokam), iii.1875, Beccari *s.n.* (holotype: FI!; isotype: K!). **Syn. nov.**

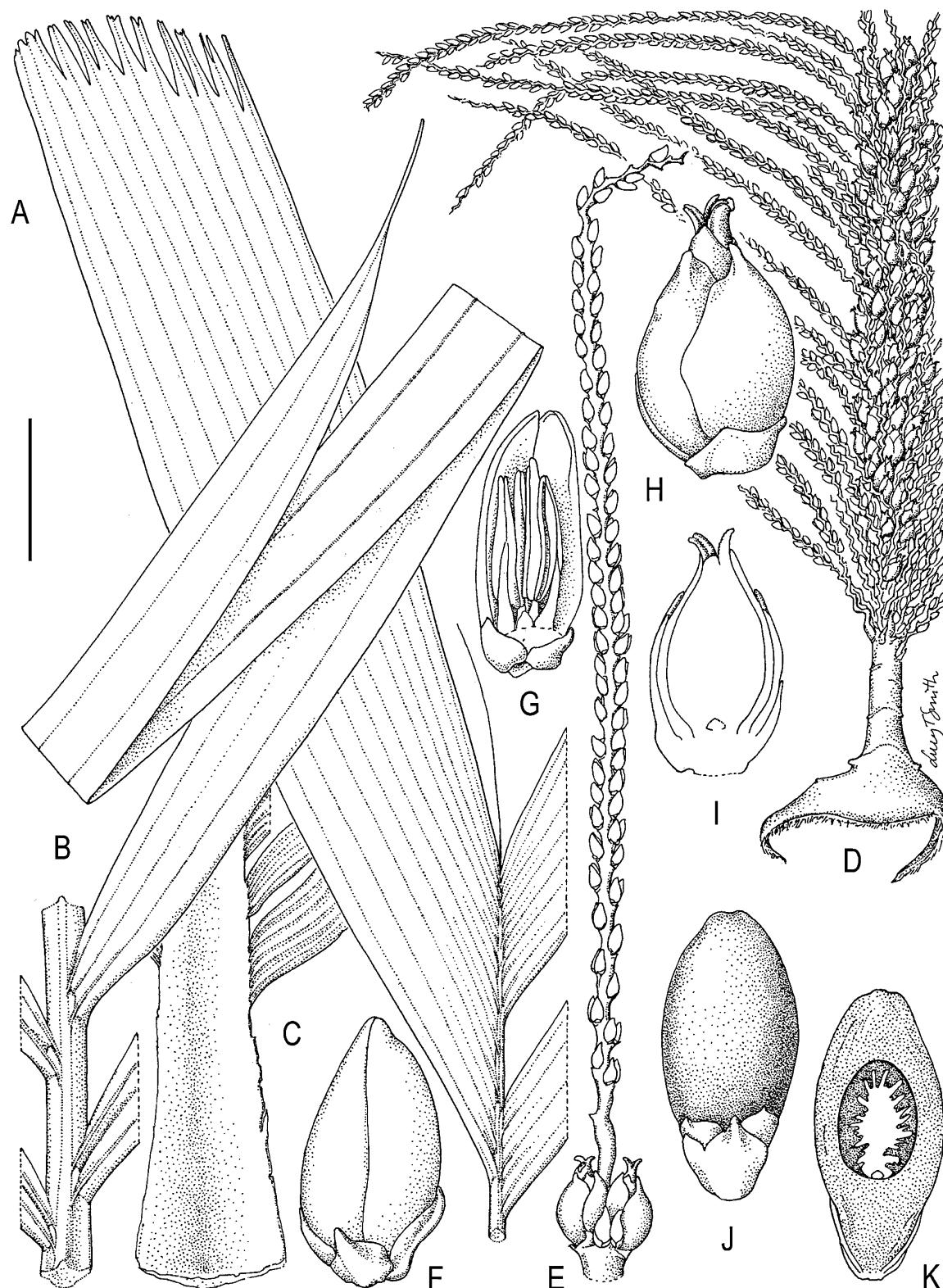


Figure 5. *Areca macrocalyx* Zipp. ex Blume: A, apical portion of leaf; B, middle portion of leaf; C, petiole; D, inflorescence; E, portion of rachilla with staminate and pistillate flowers; F, G, staminate flower whole and in section; H, I, pistillate flower whole and in section; J, K, fruit whole and in section. Scale bar: A–C, 8 cm; D, E, 6 cm; F–I, 7 mm; J, K, 1.5 cm. All from Baker 1100. Drawn by Lucy T. Smith.

Areca macrocalyx var. *conophyla* Becc., Malesia 1: 20 (1877). *Type*: New Guinea, NW coast, Ramoi and Amberbaken, 1872, Beccari s.n. (holotype: FI!; isotype: K!). **Syn. nov.**

Areca macrocalyx var. *waigheuensis* Becc., Malesia 1: 20 (1877). *Type*: New Guinea, Waigeo Island, Wakker (Wakre), iii.1875, Beccari s.n. (holotype: FI!; isotype: K!). **Syn. nov.**

Areca rechingeriana Becc., Webbia 3: 163 (1910). *Type*: Papua New Guinea, Bougainville Island, Kieta, Rechinger 3992 (holotype: B†; isotype: FI!). **Syn. nov.**
Areca macrocalyx var. *intermedia* Becc., in R. Rechinger, V. Teil. Denkschr. Kaiserl. Akad. Wiss. Wien Math.-Naturwiss. Kl. 89: 506 (1913). *Type*: Papua New Guinea, Bougainville Island, Kieta, Rechinger 4182 (holotype: B†, isotype: FI!). **Syn. nov.**

Areca nigasolu Becc., Webbia 4: 256 (1914). *Type*: Solomon Islands, Treasury Island, Guppy 95 (holotype: K!, photograph FI!). **Syn. nov.**

Areca torulo Becc., Webbia 4: 253 (1914). *Type*: Solomon Islands, Treasury Island, Guppy 94 (holotype: K!). **Syn. nov.**

Areca warburgiana Becc., Bot. Jarhrb. Syst. 52: 24 (1914). *Type*: New Guinea, Sigar, Warburg 20 (holotype: B†, photograph FI!; isotype: FI!). **Syn. nov.**

Areca nannospadix Burret, J. Arnold Arbor. 12: 265 (1931). *Type*: Papua New Guinea, Ihu, Vailala River, rain forest, 9.ii.1926, Brass 921 (holotype: A!). **Syn. nov.**

Areca rostrata Burret, Notizbl. Bot. Gart. Berlin-Dahlem 12: 322 (1935). *Type*: Papua New Guinea, Diemi, Onange road, Central Division, 6.v.1933, Brass 3971 (holotype: A!). **Syn. nov.**

Areca multifida Burret, Notizbl. Bot. Gart. Berlin-Dahlem 13: 331 (1936). *Type*: New Guinea, Papua New Guinea, Veiya, 11.iii.1935, Carr 11661 (holotype: B†, isotypes: A!, K!). **Syn. nov.**

Invalid names: *Areca glandiformis* Lam., Encycl. 1: 241 (1783). Nom. nud.

Areca macrocalyx var. *keyensis* Becc. in Martelli, Nov. Giornale Bot. Italiano 42: 24 (1935). Nom. nud.

Description: Solitary, slender to robust palm, height to 1.5–25.0 m. STEM 2.5–25.0 cm in diameter; internodes close to elongate, 2–20 cm long, light brown to whitish with conspicuous leaf scars, and shiny green near the crown. LEAVES 6–10 in crown, lamina glabrous, to 250 cm long (including petiole); sheath tubular, to 92 cm long; crownshaft to 150 cm long, green to dark green (reddish-green to bright red in some populations) with numerous black dot-like scales; petiole almost lacking or to 10 cm long, channelled adaxially, rounded abaxially; 6–75 leaflets on each side of rachis, regularly to irregularly arranged, papery, including broad leaflets with several main folds to

single folded leaflet, basal-most leaflets slightly sigmoid with oblique-acuminate tips, terminal leaflets slightly flabellate to linear with notched tips, green, discolored when dried. INFLORESCENCE infrafoliar, protogynous, erect to pendulous, elongate and compact, 10–65 cm long and to 16 cm wide, branched to one order (sometimes basal-most rachillae branched again), the branches spirally arranged and more congested distally; prophyll to 60 × 16 cm, cream to reddish; peduncle to 10 cm long and to 7 cm at the base, elongate; rachis much more robust than rachillae, up to 30 times wider than rachillae, solid; rachillae numerous (12–600), to 41 cm long, to 3 mm wide, cream to green, slender, elongate, sinuous to zigzag in appearance, somewhat congested along main axis of inflorescence, sometimes perianth persistent on rachillae after fruits fall; rachilla bracts triangular, up to 5 cm long and 1 cm wide at the base, caducous. FLORAL CLUSTER distichously arranged on the rachillae, one to five complete triads including pistillate flowers at the very base of each rachilla, sometimes two triads seated opposite or distichously almost at the same level on the rachilla and appearing paired, the remaining purely staminate portion very slender, and drying and falling after anthesis, giving the appearance of spike-like inflorescence, becoming congested and club- or maize-like in fruit. STAMINATE FLOWERS numerous, triangular, c. 14 × 7 mm, asymmetrical, cream; sepals three, united at the base, low, three-lobed, c. 7 × 4 mm; petals three, thick and fleshy, c. 12 × 4 mm, triangular, striate; stamens six, 7–9 mm long; filaments c. 3–4 mm long; anthers 6–7 mm long; pistillode minute. PISTILLATE FLOWERS larger than staminate flowers, triangular, to 20 × 15 mm; sepals three, imbricate, 10–17.5 × 5–10 mm; petals three, imbricate, 10–20 × 7.5–10.0 mm; gynoecium 10.0 × 17.5 mm (including stigma 5 mm); staminodes circular, membranous. FRUITS typically obovoid, but somewhat variable from conical to spindle shaped to almost globose, to 5 × 3 cm, with beak 1.0–14.5 mm long, green to bright yellow or orange or even red when ripe. SEEDS to 3 × 2 cm, ovoid, rounded apically and flattened basally.

Distribution and ecology: This is the most widespread species of *Areca* in East Malesia, distributed from the Maluku through New Guinea to the Solomon Islands in the east (Fig. 1). It occupies a wide ecological spectrum, growing from sea level to the highlands up to 1500 m.

Local names and uses: Several local names have been recorded for this species within its area of distribution; *are* (Sayal), *ariki* (Onate), *aupmo* (Keroom), *kasmai* (Waigeo), *monbat* (Matbat), *muncu sirbi*

(Arfak), *owee* (Yamur), *rigi* (Kotte), *sias* (Karon), *sunggeri piawan* (Wandamen), *pinang hutan* (Indonesia) and *wauneb* (Amungkal).

Areca macrocalyx is often used as a substitute for betel chewing when *A. catechu* is unavailable. There is some limited use of *A. macrocalyx* in New Guinea, e.g. stems and leaves are used for building materials (flooring and thatching for huts or temporary houses) and fruits are used for medicine.

Conservation status: Least Concern – LC (IUCN, 2001). This is a widespread species in East Malesia that is locally common. Nevertheless, anthropogenic forest degradation is likely to reduce the extent and abundance of this species.

Specimens cited: **INDONESIA. Maluku Province**, Seram Island, Masohi, Waipia, Jerili village, 10 m, 19.xi.1981, *Mogea* 3139 (BO!, K!); Aru Islands, Kobroor Island, 10 m, 6.xi.1994, *van Balgooy* 6864 (L!, BO!). **West Papua Province**, Kepulauan Raja Ampat District, Misool Island, Motlol, 10 m, 22.i.2002, *Heatubun et al.* 360 (K!, MAN!); c. 10 km SW of Limalas village, around Wavari camp, 5 m, 20.i.2002, *Wanggai et al.* 03 (AAU!, BO!, K!, LAE!); Gag Island, Kaplebet River, 10 m, 28.vii.2006, *Heatubun et al.* 747 (BO!, K!, MAN!, BPKM!); Waigeo Island, Omrab, 21.viii.1956, *Manuputty BW* 958 (BO!, CANB!, L!, MAN!); Sorong District, road between Bayangkate village to Makbon, 72 m, 9.iii.2008, *Heatubun et al.* 876 (BO!, K!, MAN!, BPKM!); Manokwari District, Manokwari subdistrict, Amban, Pantai Anggori, 5 m, 9.viii.1995, *Dransfield et al.* JD 7533 (BO!, K!, MAN!); Mupi, c. 40 km S of Manokwari, along coast of Arfak Nature Reserve, 50 m, 11.iv.1994, *Mogea* 6204 (BO!, K!, MAN!); Ransiki subdistrict, Siwi village, 28.i.1999, *Heatubun* 292 (AAU!, BO!, FTG!, MAN!); Mountains S of the Arfak Plains, step ridge between the Arfak Plains and Mt. Itswei, 900 m, 27.iv.1994, *Sands et al.* 6365 (BO!, K!); Teluk Bintuni District (before as Bintuni subdistrict of Manokwari District), near Saengga village, 10 m, *Maturbongs et al.* 728 (BO!, K!); Kaimana District (before as Kaimana subdistrict of Fakfak District), Arguny Bay, subdistrict Arguni Bawah, Manggera village, Wasesu Forest, 22 m, 6.x.2010, *Heatubun et al.* 1095 (K!, MAN!); Etna bay, Urie Base camp, km-36 road of PT. Kaltim Hutama, 70 m, 1.ii.2001, *Heatubun et al.* 331 (AAU!, K!, MAN!). **Papua Province**, Japen Island, Ambaidiru village, 800 m, 23.xi.1998, *Maturbongs et al.* 605 (BO!, K!, MAN!); Mamberamo Raya District, Idenburg River, 4 km SW of Bernhard Camp, 850 m, iii.1939, *Brass* 13437 (A!, L!); *Brass* 13437A (A!, L!); *Versteeg* 1592 (BO!, L!); Bivak Eiland, 6.x.1907, *Versteeg* 1782 (L!); Jayapura District, North Cyclops Mts., 100–200 m, 30.i.2001,

Desianto 04 (AAU!, K!, MAN!); Keerom District, Tami River, 91 m, 16.ii.2008, *Heatubun et al.* 796 (BO!, K!, MAN!, BPKM!); *Heatubun et al.* 798 (BO!, K!, MAN!, BPKM!); *Heatubun et al.* 799 (BO!, K!, MAN!, BPKM!); Arso, Tami River, Yawu, 80–110 m, 16.iii.2002, *Gusbager et al.* 20 (K!, MAN!). **PAPUA NEW GUINEA. Sandaun Province**, Bewani District, N of Bewani Patrol Post, 150 m, 28.viii.1985, *Karenga LAE* 55423 (L!, LAE!); Bewani, 0 m, 19–20.iii.2000, *Barfod et al.* 488 (AAU!, BRI!, CANB!, K!, LAE!); Round house village, 200–250 m, 27.xi.1996, *Barfod* 416 (AAU!, K!); Vanimo, Warastron Forestry Station, 1–2 m, 9.ix.1982, *Karenga LAE* 56441 (L!, LAE!); Sepik District, Aitape subdistrict, near Sumo village, Rhainbrum River, 15 m, 7.vii.1961, *Darbyshire & Hoogland* 8089 (CANB!, L!, LAE!); Telefomin District, Mt. Entaldam, immediately S of Busilmin airstrip, 1500 m, 28.iii.1975, *Vinas LAE* 67031 (L!, LAE!); Hak valley, head of Bal Creek, tributary of Sek River, Donner Mts., S of airstrip, 1050 m, 15.x.1993, *Morren* 3049 (K!). **Western Province**, Palmer River, 2 miles below junction, Black River, 100 m, vi.1936, *Brass* 7001 (A!, L!); vii.1936, *Brass* 7170 (A!); *Brass* 7188 (A!); *Brass* 7386 (A!); lower Fly River, Sturt Island, x.1936, *Brass* 8189 (A!, A photo!); near Ingembit village, 144 m, 16.vi.1967, *Henty et al.* NGF 33055 (LAE!); *Henty et al.* NGF 33057 (L!, LAE); Oriomo River, 2–7.vii.1968, *Reeve* 899 (CANB!); upper Fly River, near N'glei village, c. 10 miles N of Kiunga, 60 m, 10.vii.1967, *Pullen* 7299 (CANB!); Kiunga, 25 m, 12.ix.1972, *Streimann & Lelean* NGF 18311 (LAE!); *Streimann & Lelean* NGF 34118 (BRI, L!, LAE); Lake Daviumbu, middle Fly River, ix.1936, *Brass* 7901 (A!, L!). **East Sepik Province**, Wewak-Anggoram area, c. 5 miles N of Timbunke on Kwoiwut track, right hand side of Minjim River, 30 m, 12.ix.1959, *Pullen* 1712 (CANB!, L!, LAE!); Sepik District, Ambunti, eastern ridge of Sunset (Mt. Hunstein), 1140 m, 18.viii.1966, *Hoogland & Craven* 11081 (CANB!, K!, L!, LAE); Sepik River, vicinity of Langu village, 40 m, 18.viii.1994, *Takeuchi* 10075 (A!, LAE). **Southern Highlands Province**, Mt. Bosavi, northern side, 1250–1350 m, 25.ix.1973, *Jacobs* 8761 (L!); 700–800 m, 4.x.1973, *Jacobs* 9002 (L!); 900–1000 m, 26.x.1973, *Jacobs* s.n. (L!); near Bosavi mission, Dudessa or Ludessa village, 750 m, 5.ii.1996, *Baker et al.* 631 (K!, LAE); Tari, Mt. Bosavi, head of Kuru Creek, 1300 m, 24.viii.1986, *Gideon LAE* 57404 (L!, LAE!); E of Mendi, upper Agimo River, Mt. Gilure, southern slopes, 2017.5 (?) m, 27.vi.1961, *Pullen* 2638 (CANB!). **Madang Province**, Bogia, mouth of Ramu River, Bogia–Bosmun road, near to Bosmun 2 village, 50 m, 20.i.1996, *Baker & Utteridge* 591 (K!, LAE); Josephstaal FMA area, near Kumamdeber, along stream flowing to SW of Expedition camp 1, 160 m,

31.vii.1999, Takeuchi *et al.* 13638 (A!, LAE). **Eastern Highlands Province**, Kainantu District, between Ayura and Akuna, 1800 m, 12.x.1957, Pullen 725 (CANB!, L!, LAE). **Gulf Province**, Kikori District, Victory junction (confluence of Sirebi River and Kuru River), 34 km N of Kikori, 50 m, 20.xi.2000, Baker *et al.* 1098 (AAU!, K!, LAE, NY); Kopi–Kikori road, 10 km NW of Kikori, 40 m, 21.xi.2000, Baker *et al.* 1100 (AAU!, BRI, K!, LAE, NY); Panini Creek, 13.xi.1959, White NGF 10716 (LAE!); Baimuru, Purari River, 240 m, 27.iii.1974, Croft *et al.* LAE 61183 (BRI, L!, LAE). **Morobe Province**, Finschhafen District, Jivewaneng village, 14 km NW of Finschhafen, 500 m, 5.xii.2000, Banka *et al.* 2001 (AAU!, K!, LAE, NY); Wantot (Wantoat), c. 1170 m, 11.iv.1940, Clemens 11351 (K!); Lae, Eriku, cultivated in Bulae International Primary School, 20.iii.1996, Gideon s.n. (K!); Houn Peninsula, Masba Creek, 3 miles S of Pindiu, 600 m, 22.v.1964, Hoogland 9026 (CANB!, LAE, NY); NW of Waria River, along the streambed Wara Eya, near Yai village, 150–200 m, 15.vi.1999, Takeuchi *et al.* 13374 (A!, LAE). **Central Province**, Gulf District, Kikori River, 13.ii.1959, White NGF 10715 (K!, LAE); Karuku District, 2 miles N of Maipa village, 97.5 m, 10.ix.1962, Derbyshire 921 (CANB!); Abau District, Cape Rodney, Mori River, 60 m, 19.vi.1968, Henty NGF 38541 (L!, LAE); Dieni, Ononge road, 500 m, iv–v.1933, Brass 3971 (A!, NY); Nunumai, c. 12 km N of Amazon bay, 30 m, 19.vi.1969, Pullen 7641 (CANB!, LAE). **Milne Bay Province**, Alotau District, 2 km NE of Kapurika village, 200 m, 11.v.1978, Essig & Young LAE 74091 (LAE!); SE of Kaporika village, road to Baraga and Cumuni villages, 70 m, 24.xi.1975, Larivita & Katik LAE 70501 (LAE!); Sagarai, Pini Range, southern slopes, 200 m, 2.iii.1984, Gideon LAE 76950 (CANB, K!, L!, LAE, USF); Gideon LAE 76951 (L!, LAE); Raba-Raba District, junction Ugat and Mayu River, near Mayu I, 350 m, 29.vi.1972, Streimann & Katik NGF 28593 (LAE!); 1100 m, 19.vii.1972, Streimann & Katik NGF 28994 (L!, LAE); Gwari River, Biniguni camp, 200 m, iii–iv.1938, Brass 23977 (A!). **West New Britain Province**, West Wakanau, near cape Hoskins, Glilo village, 3.viii.1954, Floyd 6422 (A!, LAE); Gasmata, 40–50 m, 29.v.1987, Karenga & Obedi LAE 62315 (L!, LAE, USF). **East New Britain Province**, Pomio District, Aiwit River, E of Fulleborn harbour, 50 m, 11.v.1973, Croft & Katik NGF 14984 (L!, LAE); Gaselle Peninsula, Warangoi valley, 60 m, ix.1955, Kazakoff NGF 7057 (A!, LAE). **New Ireland Province**, Feni group, Ambitle Island, E side of Nanum Caldera, 50 m, 13.xi.2003, Takeuchi 16771 (A!, LAE). **North Solomon Province**, Bougainville Island, 1932–1933, Waterhouse s.n. (K!); vicinity of Aku village, c. 10 miles W of Buin Station, 30 m, 14.ix.1964, Schodde & Craven 4029 (A!, BRI, CANB!,

K!, LAE). **SOLOMON ISLANDS. Eastern District**, Santa Cruz Island, Towuto Noi Island, Ngambwani area, 4.iv.1972, Powell BSIP 19467 (CANB!, BSIP); St. Ysabel Island, Bogutu Peninsula, Longuhutu River, SE corner of Tanegoba harbour, 0–30 m, 21.iii.1964, Moore & Whitmore 9303 (BSIP 4051) (BSIP, K!); Guadacanal, Honiara, behind Lengakiki ridge, 2.xii.1963, Whitmore BSIP 1268 (K!, BSIP); New Georgia, 15.vii.1929, Waterhouse 185 (K!); San Cristobal, Wairaha River, 5 miles from North Coast, 300 m, 11.v.1964, Whitmore BSIP 4273 (K!). **CULTIVATED. Sri Lanka**, Paradineya Botanic Garden, Q-451, 23.vii.1986, Rutherford & Bandara 154 (K!). **Thailand**, Bangkok, Sumawong s.n. (K!). **Singapore**, Botanic Gardens Singapore, Lawn X, 9.x.1929, Furtado s.n. (K!, SING).

Notes: *Areca macrocalyx* is easy to distinguish from other *Areca* spp. in East Malesia by the congested, club-like infructescence. The staminate-only portions of the rachillae are thin compared with the basal parts bearing complete triads including pistillate flowers. The staminate portion dries after anthesis and falls off as the fruits mature leaving a spike-like infructescence.

We have observed this species extensively in the wild. Flynn (2004) analysed *Areca* in New Guinea and the Solomon Islands using a morphometric approach, and, despite problems with missing data, concluded that seven species (*A. congesta*, *A. jobiensis*, *A. ledermanniana*, *A. multifida*, *A. nannospadix*, *A. rostrata* and *A. warburgiana*) should be included within *A. macrocalyx*. Based on our experience in the field and herbarium, we concur with this decision.

The morphology of *A. macrocalyx* is quite complex, perhaps as a response to different types of habitat and distribution. This species occupies a wide range of ecological conditions from littoral and swampy areas in lowlands to heath forest in lower montane vegetation, from evergreen rain forest to drier areas in savannah lands, and from the main island of New Guinea to small offshore islands, Maluku and the Solomon Islands. Adaptation to various habitats is reflected in the variable appearance. If two specimens from different localities are compared in isolation, the impression is readily gained that more than one taxon exists. However, with careful examination of the type specimens and protologues of the species listed in the synonymy above and a large number of other herbarium specimens, we found that morphological variation is continuous and overlapping, as Flynn discovered. No disjunctions in variation occur that would allow the consistent separation of species in this complex as proposed by previous authors. The narrow species concept used in the past reflects limited information obtained from single collections.

Although our treatment is aligned with that of Flynn (2004), we have included three species (*A. rechingeriana*, *A. nigasolu* and *A. torulo*) and five varieties of *A. macrocalyx* that were not covered by him, and consider two other species (*A. ledermanniana* and *A. congesta*) as doubtful taxa rather than as synonyms of *A. macrocalyx*. *Areca nigasolu* and *A. torulo* were described by Beccari (1914a) from Guppy collections in the Solomon Islands. The material is inadequate and consists of a fragment of leaf and a few fruits, but the fruits are typical of *A. macrocalyx*. *Areca macrocalyx* vars. *zippeliana*, *aruensis*, *conophylla*, *waigheuensis* and *intermedia* were described by Beccari (1877, 1913) based on different fruit characters and collection localities.

The types of *A. rechingeriana* and *A. warburgiana* and several specimens from recent collections (e.g. Heatubun et al. 796, 798, 799, Tami River, Keerom, Indonesian Province of Papua) possess inflorescences that are elongate and slender with a thin rachis and laxly arranged pistillate flowers. The arrangement of two pistillate flowers in triads seated close to each other at the base of the rachilla and the 'stalk' formed by the rachilla give the distinct impression as the fruits develop of fruit borne in pairs. However, the typical inflorescences of *A. macrocalyx* with crowded pistillate flowers and/or fruits have also been observed in this population.

Two specimens in the Florence Herbarium (*Jaheri n. 245 ex Bogor* and *n. 279 culta in Bogor Botanic Garden, lawn V. K15. 1915*) are annotated by Beccari with his handwriting as *A. macrocalyx* var. *keyensis*, but this name was never published. In the synonym list of tribe Areceae provided by Martelli (1935), this variety was cited as having been published in Malesia (1: 20). This is not the case and the name is in fact a *nomen nudum*. Similarly, *A. glandiformis* (Lamarck, 1783) was published without a proper description.

Several different collections of *A. macrocalyx* from the main island of New Guinea have distinctive appearances, e.g. with thick-brown indumentum on the leaf sheaths, or the bright red crownshaft form from the Finschhafen area, Papua New Guinea and Wosimi, Indonesian Province of West Papua. Nevertheless, these striking forms fall within the general variation of *A. macrocalyx*, although they may represent unusual ecotypes.

We treat *A. congesta* and *A. ledermanniana* as doubtful taxa in this monograph because the type specimens of *A. congesta* (Ledermann 12331 & 7250) and *A. ledermanniana* (Ledermann 9766) were destroyed during the Second World War in Berlin, and we have been unable to locate other duplicates. Beccari's descriptions (Beccari, 1923) indicate that these taxa could fit within the range of variation of *A. macrocalyx*, but, in the absence of authentic material, it is

not possible to synonymize these two species names formally.

The morphological plasticity in the size of the whole plant, leaf plication, inflorescence size and shape, and fruit size, shape and colour that occurs in *A. macrocalyx* displays gradual and often overlapping variation, and this has influenced the broad species concept used in this revision.

3. ARECA MANDACANII HEATUBUN (FIG. 6A–I)

Palms 52: 199 (2008). *Type*: Indonesia, West Papua Province, Sorong Selatan, Teminabuan, Sayal, Maampou Forest, 21.ii.2003, Heatubun et al. 423 (holotype: BO!; isotypes: K!, MAN!).

Description: Solitary, moderate tree palm. STEM up to 15 m tall, 8–10 cm in diameter; internodes 13–30 cm long, dark green, shiny, nodal scars conspicuous, white. LEAVES eight in crown, pinnate, appearing plumose, 200–250 cm long (including petiole); sheath tubular, c. 92 cm long, smooth, light green; crown-shaft well defined, up to 152 cm long and up to 15 cm in diameter; petiole short to 6 cm long, channelled adaxially, rounded abaxially; rachis somewhat arching, with adaxial longitudinal ridge, rounded abaxially; blade with irregularly arranged leaflets, divided into 13–15 groups, in several planes, c. 60 leaflets on each side of the rachis, smaller near petiole and gradually becoming larger distally, terminal leaflets regularly arranged (c. 13–14 leaflets); leaflets somewhat arching, single-fold, linear, 4 cm long and 4 mm wide at the very base near petiole, tips pointed, 55–60 cm long and 2 cm wide in the middle leaflets, tip acuminate, notched, split to 3 cm depth, papery, green adaxially and lighter green abaxially. INFLORESCENCE infrrafoliar, c. 60 cm long at anthesis, protandrous, mostly branching to two (rarely three) orders; peduncle 5 cm long, green with numerous minute red-brown dots; prophyll 64 × 6 cm, borne about one-third way up the peduncle, lanceolate, two-keeled, papery, cream to light brown, entirely enclosing the inflorescence, then splitting longitudinally and falling before staminate anthesis; first order branch elongate, slender, laxly branched; rachis green to whitish-green; rachillae numerous, 37 cm long, covered by thick light brown to chocolate-brown indument, highly contrasting with the rachis, first branching rachillae c. 50 cm long, elongate. FLORAL CLUSTER distichously arranged on the rachillae, only one complete triad including a pistillate flower occurring at very base of each rachilla. STAMINATE FLOWERS triangular, 4.5 × 2.5 mm, asymmetric; sepals three, low, about 2 × 1 mm; petals three, strongly keeled, valvate, 4.5 mm long, c. 1.25 mm wide at base; pistilode 2.5 × 0.5 mm, trifid, dark brown; stamens six,

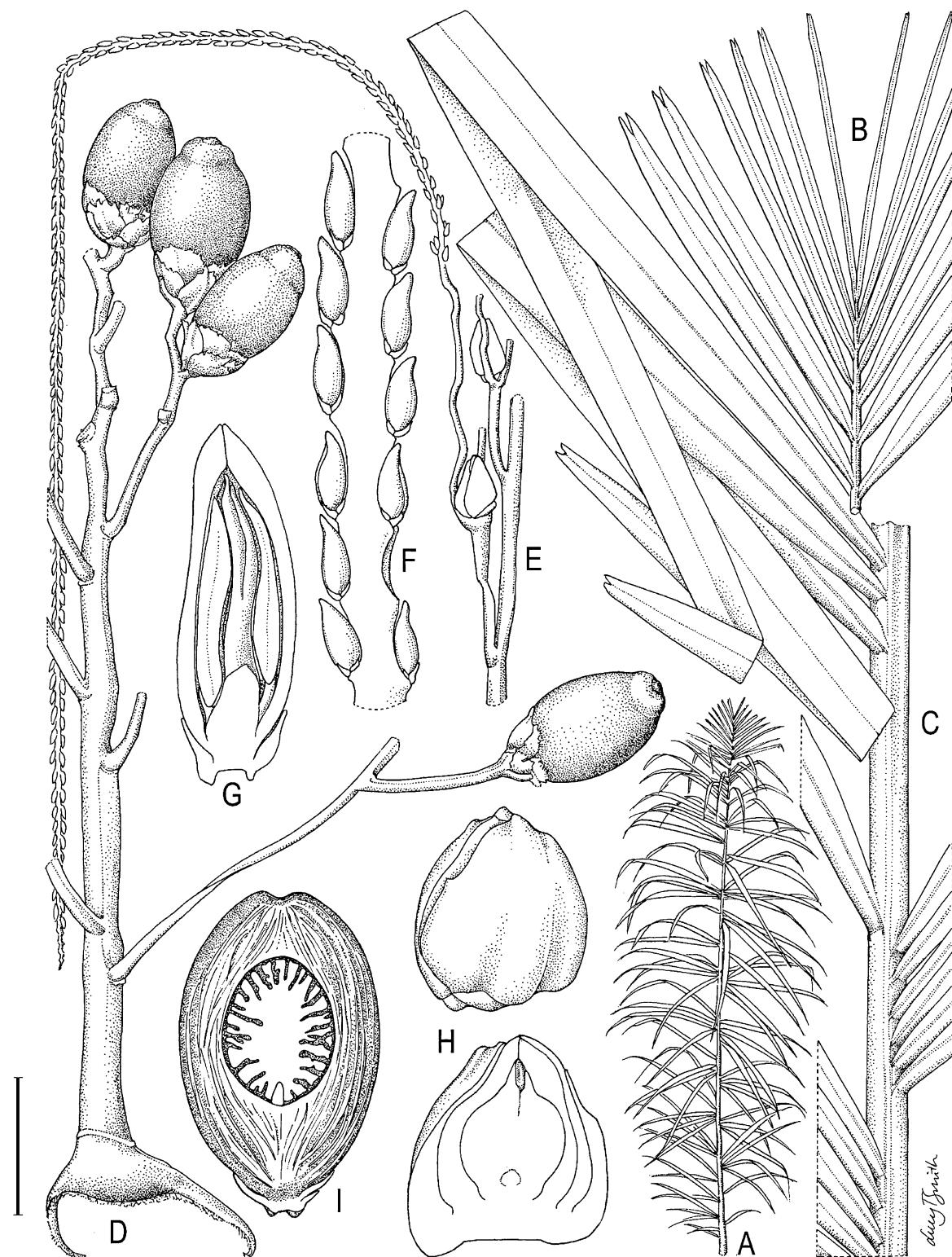


Figure 6. *Areca mandacanii* Heatubun: A, leaf; B, apical portion of leaf; C, mid-portion of leaf; D, infructescence with immature fruits; E, portion of rachilla showing position of staminate and pistillate flowers; F, staminate flowers on rachilla; G, staminate flower in section; H, pistillate flower whole and in section; I, fruit in section. Scale bar: A, 62.5 cm; B–D, 4 cm; E, I, 3 cm; F, 7 cm; G, 1.6 mm; H, 1 cm. A, from photograph taken by Charlie D. Heatubun; B–E, H, from Heatubun 423; F, G, I, from Heatubun 413. Drawn by Lucy T. Smith.

1.5 mm long; anthers 1.5 mm long, sagittate, cream, longer than the filaments, twisted basally; filaments 0.5 mm long, dark brown. PISTILLATE FLOWERS larger than the staminate, triangular, 10–13 mm in diameter; sepals three, imbricate, triangular, 10–13 mm long, 10–12 mm wide, 1–3 mm thick, asymmetrical, thicker at base, cream to light green; petals three, imbricate, triangular, 13 × 10 mm, 0.5 mm thick, cream; staminodes ovate, 10 mm high, 9 mm wide, pointed, brown at the tip, fleshy. FRUITS ellipsoid, 65–70 × 42–45 mm, with conspicuous woody shallow disc-shaped depression at apex, 10–12 cm in diameter, stigmatic remains persistent in centre of depression, perianth persistent; epicarp smooth, shiny, c. 0.5 mm thick, dark green when young, turning to golden yellow or light orange when mature; mesocarp fibrous, c. 10 mm thick, but much thicker at the base of fruit (below the seed), where c. 20 mm thick; endocarp thin, adhering closely to seed. SEEDS c. 28 × 25 mm, subglobose; embryo basal.

Distribution and ecology: Endemic to Maampou Forest, Sayal, in Sorong Selatan District in Bird's Head Peninsula of Western New Guinea (Fig. 1). This palm grows in the transition between swamp forest and lowland rain forest, where the soils are temporarily inundated by water.

Local name and uses: Ngafa (Sayal). The fruits are chewed as a betel nut substitute and the stem is used for flooring.

Conservation status: Critically Endangered (CR B1ab, B2ab). *Areca mandacanii* is estimated to have an extent of occurrence of < 100 km² and an area of occupancy of < 10 km², being known from only a single location. Previously, the conservation status of *A. mandacanii* was given as Data Deficient (Heatubun, 2008), but the IUCN category of this endemic palm is updated here because no additional localities have been found in subsequent fieldwork, and we now recognize more potential threats to its area of distribution. Oil palm plantations and coal mining are planned in the vicinity of its occurrence. Moreover, the local people usually chop down the tree when they want to harvest the fruits or nuts for use as a betel nut substitute.

Specimens cited: INDONESIA. West Papua Province, Sorong Selatan District, Teminabuan subdistrict, Sayal village, Maampow forest, 10 m, 21.ii.2003, Heatubun et al. 413 (K!, MAN!); Heatubun et al. 424 (MAN!). CULTIVATED. Indonesia, West Papua Province, Manokwari District, Reremi, 75 m, 10.iv.2008, Heatubun & Iwanggin 902 (MAN!).

Notes: The differences between *A. mandacanii* and the New Guinean *Areca*, including *A. catechu*, are discussed in detail by Heatubun (2008). The plumose leaves are unique in both *Areca* and Arecinae. It is most similar to *A. catechu*, but the inflorescence of *A. mandacanii* is more slender and laxly branched to two (rarely three) orders, as opposed to congested or crowded and branched mostly to three orders in *A. catechu*. Although fruits are varied in *A. catechu*, they have never been reported to have a conspicuous woody discoid depression at the apex, as in *A. mandacanii*.

Despite similarities to *A. catechu*, the known populations are certainly wild (as opposed to cultivated). Nevertheless, the discovery of *A. mandacanii*, apparently a close relative of *A. catechu*, in the wild in western New Guinea is important because it indicates that New Guinea should be considered alongside the Philippines (Beccari, 1919; Furtado, 1933), Malaysia (Corner, 1966; Jones, 1995) and Sulawesi (Corner, 1966) as a potential area of origin for *A. catechu*.

A specimen identified by Heatubun (2008) as *A. mandacanii* (*Maturbongs s.n.*, K) was cited in error. In fact, this is a duplicate of Heatubun et al. 413 that was labelled incorrectly.

4. ARECA NOVOHIBERNICA (LAUTERB.) BECC. (FIG. 7A–J)

Bot. Jahrb. Syst. 52: 24 (1914). *Nenga novohibernica* Lauterb., Bot. Jarhb. Syst. 45: 357 (1911). Type: Papua New Guinea, Bismarck Archipelago, New Ireland, Nabumai, Urwald, *Peekel* 110 (holotype: B!, photograph FI!; isotypes: FI!, K!).

Areca guppyana Becc., Webbia 4: 258 (1914). Type: Solomon Islands, Shorland Islands, Alu Island, 1 to 2 miles from coast, *Guppy* 107 (holotype: K!). **Syn. nov.**

Areca novohibernica var. *salomonensis* Burret, Notizbl. Bot. Gart. Berlin-Dahlem 13: 69 (1936). *Areca salomonensis* (Burret) Burret ex A.W.Hill & E.Salisb., Index Kew. Suppl. 10: 19 (1947). Type: Papua New Guinea, Bougainville Island, Kugumaru, Buin District, 2.vii.1930, *Kajewski* 1908 (holotype: B†; isotype: A!). **Syn. nov.**

Description: Solitary, small and slender, undergrowth palm, height 2–4(–5) m, with stilt roots. STEM 5–10 cm in diameter; internodes 3–4 cm long, light brown to whitish with conspicuous leaf scars (± 1 cm wide), and shiny green near the crown. LEAVES five to eight in crown, 120–150 cm long (including petiole); sheath tubular, 30–70 × 6.5–10.0 cm; crownshaft 60–90 cm long, light green to green; petiole 30–50 cm long, c. 1 cm wide at the base, channelled adaxially, rounded abaxially, covered by thick brown indumentum that continues on to the leaf rachis; leaflets more

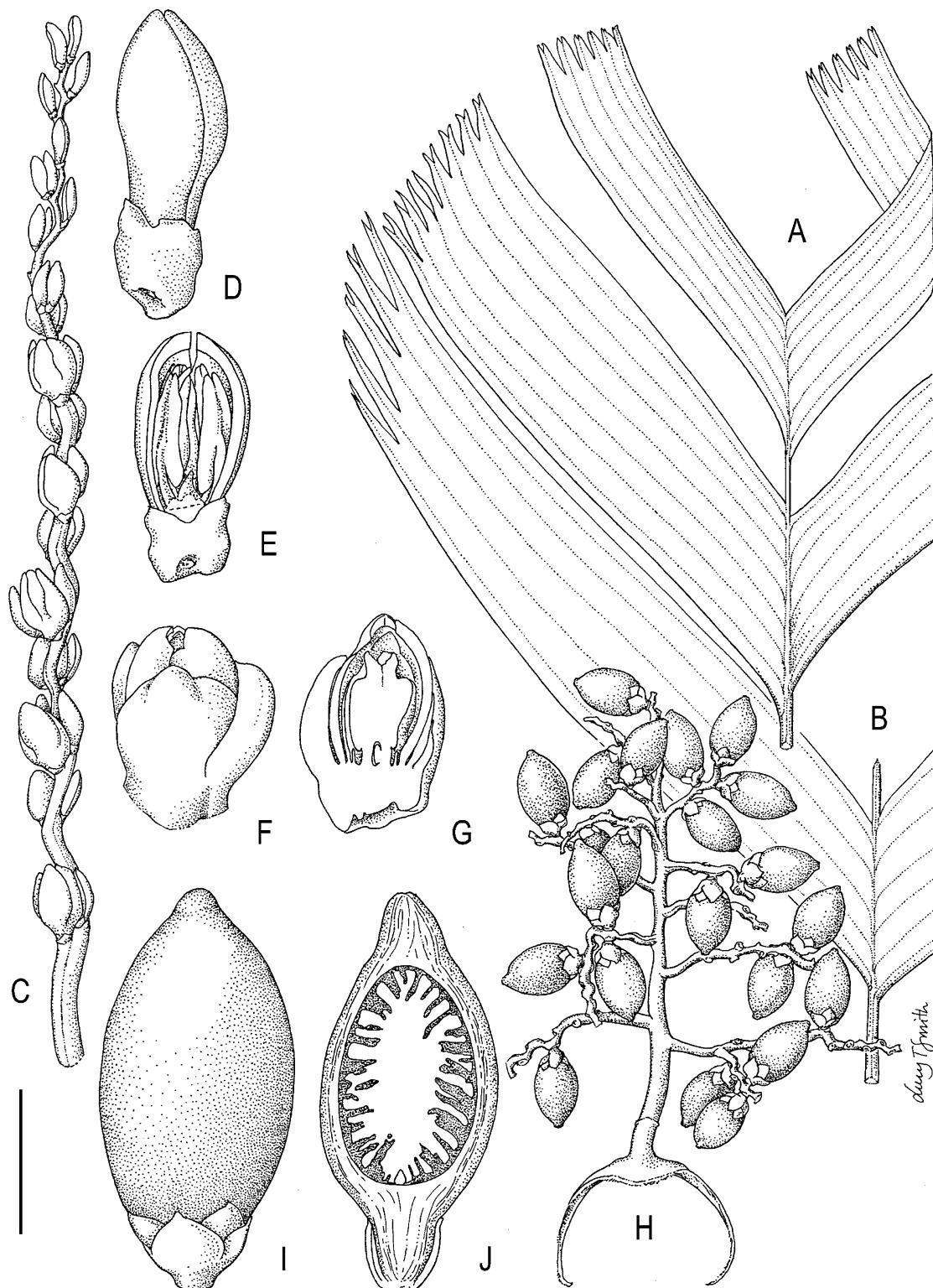


Figure 7. *Areca novohibernica* (Lauterb.) Becc.: A, apical portion of leaf; B, middle portion of leaf; C, portion of rachilla with staminate and pistillate flowers; D, E, staminate flower whole and in section; F, G, pistillate flower whole and in section; H, inflorescence; I, J, fruit whole and in section. Scale bar: A, B, 8 cm; C, I, J, 1.5 cm; D, E, 3 mm; F, G, 7 mm; H, 6 cm. A, B, from Sands 726; C-G, I-J, from Sands 2124; H, from Takeuchi 16802. Drawn by Lucy T. Smith.

or less regularly arranged, papery, c. five leaflets on each side of rachis, the basal-most leaflets 56.0–65.5 × 2.5–11.0 cm, three- to six-fold and slightly sigmoid with oblique-acuminate tip, the middle leaflets 54.0–73.5 × 9.5–12.5 cm, five- to seven-fold, slightly sigmoid with oblique, notched tip, splits between folds to 3–5 cm depth, terminal leaflets broader, 31–39 × 15–22 cm, with 9–15 folds, flabellate with truncate tips, green, slightly discolored when dried, dark coloured adaxially, and paler abaxially. INFLORESCENCE infrrafoliar, 15–36 × 14–30 cm, branched to one order (sometimes basal branched to two orders basally), erect at anthesis, pendulous in fruit; prophyll papery, 30–37 × 5–7 cm; peduncle 3–6 cm long and 1–2 cm wide at the base; rachilla 10–21, divaricate, 7–16 cm long and 2–4 mm wide, greenish-cream to green, sometimes perianth persistent on rachillae after fruits fall. FLORAL CLUSTER spirally arranged on the rachilla, complete triads including pistillate flowers occurring from the base up to half the length of the rachilla, and continuing with only pairs of staminate flowers to the tip. STAMINATE FLOWERS small, elongate, triangular, 5.25–6.50 × 2.50–2.75 mm, asymmetrical, white to greenish-cream, glaucous, covered with velvet-like indumentum; calyx copular, low, cup-shaped with marginal lobes, 2.0–2.5 × 1.75–1.80 mm; petals three, thick and fleshy, valvate, striate, 4.0–5.5 × 2.0 mm; stamens six, epipetalous, 3.50–3.75 mm long, fused with petals up half the height of the petal; filaments shorter than anthers, 0.50–0.75 mm long; anthers 2.8–3.0 mm long, sometimes twisted; pistillode low, about 0.5 mm high, variously shaped. PISTILLATE FLOWERS larger than staminate flowers, 8–9 × 7.0–7.5 mm; sepals three, imbricate, united 2–4 mm from the base, 7–9 × 6–7 mm, obovate, thick; petals three, imbricate, 6–8 × 5.5–6.2 mm; gynoecium 6–7 × 5 mm (including stigma 0.5–1.0 mm), stigma trifid; staminodes forming a membranous ring with four to six irregular teeth. FRUITS small, 3.2–4.0 × 1.6–2.0 × 1.5–2.0 cm, ellipsoid to slightly ovoid, ripening through yellow, orange to red; epicarp thin and smooth; mesocarp fleshy and juicy; endocarp fibrous. SEEDS 1.2–1.5 × 1.0–1.5 × 1.0–1.2 cm, slightly globose to ellipsoid, rounded apical and flattened basally, embryo basal.

Distribution and ecology: *Areca novohibernica* grows on volcanic and limestone soils at 10–1350 m above sea level on the islands of Manus, New Britain and New Ireland in the Bismarck Archipelago and in the Solomon Islands (Fig. 1).

Local name and uses: *tuva* (Duke Island), *iburu bangara* (Roviana). The fruits are used as a betel nut substitute. The species has potential as an ornamental.

Conservation status: Endangered (EN B2b). The area of occupancy of this species is estimated to be < 500 km² on offshore islands on the north-eastern coast of New Guinea and the Solomon Islands. As an island species of palm, we infer that the populations of *A. novohibernica* are restricted and will potentially be affected by stochastic events or human activities. However, further population studies are still needed to assess more precisely the conservation status of this palm.

Specimens cited: **PAPUA NEW GUINEA.** **Manus Province**, Manus Island, Western Manus, South Coast, 1 km from Kabuli village, 25 m, 24.xi.1975, *Sands et al.* 2756 (K!; LAE). **West New Britain Province**, Kapiura River, near Lavege village, 30 m, 16.iv.1968, *Henty & Lelean NGF* 29417 (BRI, L!, LAE!); Hoskins District, near Dami, Kavui logging area, 15 m, 25.iv.1972, *Essig LAE* 55210 (L!, LAE); Nuau, 210 m, 19.ii.1971, *Lelean & Stevens LAE* 51221 (A!, BRI!, CANB!, K!, L!, LAE); Talasea, Mt. Tangis, ridge below rim of crater, 1350 m, 30.v.1966, *Frodin NGF* 26882 (BRI!, L!, LAE); Kandrian District, Pulie River, 10 miles from the mouth, west side, 30 m, 14.iii.1966, *Henty NGF* 27201 (BRI, L!, LAE). **East New Britain Province**, Rabaul District, Powell harbour, 30 m, 19.vi.1972, *Foreman LAE* 52115 (LAE!); Awung village, 600 m, 23.iii.1968, *Ridsdale & Katik NGF* 36757 (L!, LAE). **New Ireland Province**, Namatanai District, Hans Meyer Range, Danfu River valley, c. 8 km W and upstream of Danfu bridge, near Manga, upper terrace, behind base camp, to the north, 220 m, 27.i.1970, *Sands* 726 (L!, LAE); close to Mindih Lake, east coast, 6 km W of NW Toron, 650 m, 6.x.1975, *Sands et al.* 2124 (K!, LAE); Northern Hans Meyer Range, 70 km SE of Namatanai, 850 m, 31.x.1984, *Gideon LAE* 77178 (L!, LAE); ridge adjacent to Weitin River, 1175 m, 27.i.1994, *Takeuchi & Wiakabu* 9592 (A!, LAE); 31.i.1994, *Takeuchi & Wiakabu* 9733 (A!, LAE); Feni group, Ambitle Island, Nanum caldera, thermal spring area, 125 m, 16.xi.2003, *Takeuchi* 16802 (A!, LAE); New Hanover, west Lavongai, 2 km N of Matemulai village, 8.x.1974, *Croft & Lelean LAE* 65521 (L!, LAE). **North Solomon Province**, Bougainville Island, 15 miles N of Buim, Lake Loloru Crater, lower south slopes, 750 m, *Craven & Schodde* 202 (CANB!, L!). **SOLOMON ISLANDS.** Fauro Island, Kauriki village, ridge leading to peak, 24.iv.1964, *Whitmore BSIP* 4132 (BSIP, K!, L!). Malaita, Mt. Alasa, 21.x.1965, *Corner RSS* 223 (K!, BSIP). New Georgia Island, Duke Island, 15.viii.1929, *Waterhouse* 248 (K!).

Notes: *Areca novohibernica* is similar to *A. vestiaris* in its stilt roots, the staminate flowers spirally arranged on the rachilla, the sepals united or calyx tubular, the

petals elongate and spathulate, the pistillate flowers also spirally arranged and distributed to half the length of the rachilla, and the fruits with fleshy and juicy mesocarps. However, it differs from the latter by its slender solitary habit (sometimes in *A. vestiaris*), the green crownshaft and inflorescence branched to one order (rarely two orders). It differs from all other East Malesian species in the presence of the velvet-like indumentum on the staminate flowers, epipetalous stamens, anthers irregular and sometimes twisted, and in its distribution at the very eastern limit of subtribe Arecinae.

On re-examining the type specimens of *A. guppyana* (Guppy 107), *A. novohibernica* (Peekel 110) and *A. novohibernica* var. *salomonensis* (Kajewski 1908) alongside more recent collections, we see no reason to maintain these distinct taxa. All three taxa (*A. guppyana*, *A. novohibernica* and *A. novohibernica* var. *salomonensis*) were described from inadequate material or single specimens, and thus a narrow species concept was applied by earlier authors. The fruit characters used by previous authors (Beccari, 1914a, b; Burret, 1936) to separate the taxa show particularly high plasticity within populations, individuals or even inflorescences.

In his description of *A. novohibernica* var. *salomonensis*, Burret (1936) mentions that, if he received more material and the differences from *A. guppyana* were to appear greater, the taxon should be called *A. salomonensis*. The name was not validly published by Burret, but was later validated in *Index Kewensis* (Hill & Salisbury, 1947).

5. *ARECA OXYCARPA* Miq. (FIG. 3C, D)

Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk. 15: 1 (1868). *Type*: Celebes, Menado, Mt. Pisah, Riedel s.n. (holotype: L!).

Areca celebica Burret, Repert. Spec. Nov. Regni Veg. 32: 115 (1933). *Type*: Celebes, Tomohon, Sarasin s.n. (holotype: B!). **Syn. nov.**

Description: Solitary, slender undergrowth palm, height 1.5–3.0 m. STEM 1.0–2.5 cm in diameter; internodes 2.0–4.5 cm, light brown to whitish with conspicuous leaf scars, and shiny green near the crown. LEAVES 6–8 in crown, 80–150 cm long (including petiole), lamina glabrous; sheath tubular, 13–23 × 3–5 cm; crownshaft 25–40 cm long and 1.5–2.0 cm in diameter, dark brown to blackish-purple with numerous black punctiform scales; petiole 15–40 cm long, 4.0–6.5 mm wide and 4–6 mm thick at the base, channeled adaxially, rounded abaxially; leaflets irregularly arranged, four to eight leaflets on each side of rachis, basal-most leaflets 35–46 × 1.5–6.5 cm, two- to eight-folded, middle leaflets 42–49 × 5.9–9.0 cm, five-

to seven-folded, sometimes with a single fold leaflet between two broad leaflets, slightly sigmoid, tips oblique-acuminate, terminal leaflets 23.0–31.5 × 4.6–8.5 cm, flabellate, seven- to eight-folded, tips truncate, green, slightly discolored when dried. INFLORESCENCE infrafoliar, 8–15 cm long, branched to one order (sometimes branched to two orders basally), erect; prophyll caducous, not seen; peduncle 1–2 cm long and 5–7 mm wide at the base; rachillae 8–16, divergent, 5–8 cm long, greenish-cream to green, sometimes perianth persistent on rachillae after fruit fall. FLORAL CLUSTERS distichously arranged on rachillae, complete triads including pistillate flowers occurring along the lower third of all rachilla. STAMINATE FLOWERS 5–6 × 3.0–3.5 mm, triangular, asymmetrical, cream to greenish-yellow; calyx fused, low, cup-shaped with marginal lobes, c. 2.0 × 1.3 mm; petals three, thick and fleshy, c. 6 × 3 mm, triangular, striate; stamens six, 3.5–4.0 mm long; filaments c. 1.5–2.0 mm long; anthers c. 3 mm long; pistillode diminutive. PISTILLATE FLOWERS to 8 × 5 mm; calyx c. 7 × 5 mm, imbricate, greenish; petals three, c. 8 × 4 mm, imbricate, cream; gynoecium 8 × 3 mm (including stigma 1 mm), stigma trifid; staminodes forming a membranous ring. FRUITS 3.0–3.2 × 1.0–1.5 × 0.9–1.2 cm, elongate to ellipsoid, with 3–4 mm long beak, green to bright yellow or orange when ripe; epicarp smooth and thin; mesocarp fibrous; endocarp thin and fibrous. SEEDS small, 1.2–1.5 × 0.8–0.9 × 0.7–1.0 cm, ovoid, rounded apically and flattened basally, hard.

Distribution and ecology: This species is endemic to the northern part of Sulawesi in Tomohon, North Sulawesi Province and in Dumoga Nani Warta Bone National Park on the border between North Sulawesi and Gorontalo Provinces (Fig. 1). *Areca oxycarpa* grows at 200–450 m above sea level on volcanic soils in primary forest near streams on slopes.

Local name and uses: mamaan pita (Kotamobago). Fruits are used as a betel nut substitute, and the palm has ornamental potential.

Conservation status: Critically Endangered (CR B1ab, B2abc). *Areca oxycarpa* has a restricted area of distribution. The environmental pressures around its natural habitat are high and include land clearance, re-settlement, illegal gold mining and coconut, coffee, cocoa and rice farming. Moreover, based on direct observations in its natural habitat in Dumoga Nani Warta Bone National Park, the populations are sparse and there is limited regeneration in this species in the wild.

Specimens cited: **INDONESIA. North Sulawesi Province**, Bolaang Mongondow District, Dumoga Nani Warta Bone National Park, Tapak Kulintang, 280 m, 7.iii.1984, *Mogea* 5070 (BO!, K!); Dumoga Nani Warta Bone National Park, West Dumoga subdistrict, Matayangan village, Tumokang-Kasinggolan forest, 225 m, 16.iii.2008, *Heatubun et al.* 877 (BO!, K!, MAN!, BPKM!); 272 m, 16.iii.2008, *Asmarayani et al.* 461 (BO!, MAN!, BPKM!); 284 m, 17.iii.2008, *Heatubun et al.* 883 (BO!, K!, MAN!, BPKM!); Kasinggolan, 200 m, 28.ii.1994, *Mogea* 4961 (BO!, K!); Gunung Mogogonipa, 300 m, 1.iv.1985, *de Vogel & Vermeulen* 6950 (BO, L!, K!); Duloduo, 250 m, 16.ix.1984, *Whitmore & Sidiyasa* 3407 (BO!, BZF, K!); Minahasa District, Tomohon subdistrict, 450 m, iv.1974, *Kaseger* 210 (BO!, K!, L!). **CULTIVATED.** USA, Hawaii, Honolulu, the Harold L. Lyon Arboretum, accession no. L-94.0215, i.2008, *Bacon* 115 (K!).

Notes: The inflorescence of *A. oxycarpa* is somewhat similar to that of *A. macrocalyx* in being compact and protogynous. However, they can be differentiated easily. *Areca oxycarpa* is always a small, slender undergrowth palm, with inflorescences that are somewhat divergent, erect with few rather straight, stiff rachillae. The pistillate flowers (in triads) are confined to the basal one-third of the rachilla. Moreover, *A. oxycarpa* has a dark brown to black leaf sheath.

Burret (1933) published *A. celebica* from inadequate material collected by Sarasin in Tomohon, North Sulawesi. He separated *A. celebica* from *A. oxycarpa* on the basis of fruit characters alone. However, the fruit characters in *Areca* are variable, and there is no justification for maintaining these taxa on these grounds. Furtado (1933) expressed his suspicions about *A. celebica* in his monograph, but made no formal transfer to *A. oxycarpa*. Our observations in the field and herbarium support the reduction to a single species.

6. ARECA VESTIARIA GISEKE (FIG. 3A, B)

Prael. Ord. Nat. Pl. 78 (1792). *Pinanga vestiaria* (Giseke) Blume, Rumphia 2: 77 (1839). *Seaforthia vestiaria* (Giseke) Mart., Hist. Nat. Palm. 3: 313 (1849). *Ptychosperma vestiarium* (Giseke) Miq., Fl. Ned. Ind. 3: 31 (1855). *Mischophloeus vestiarus* (Giseke) Merr., Interpr. Herb. Amboin. 121 (1917). Type: *Pinanga sylvestris* e Buro Rumphius, Herb. Amboin. 1: 41 (1741). (Lectotype, designated by Dransfield, 1974).

Ptychosperma paniculatum Miq., Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk. 11(5): 3 (1868). *Areca paniculata* (Miq.) Scheff., Tijdschr. Ned.-Indië 32: 179 (1873). *Mischophloeus paniculatus* (Miq.) Scheff., Ann. Jard. Buitenzorg 2: 152 (1876). Type: North

Maluku, Bacan Island, Teysmann & De Vriese (holotype: L!).

Areca leptopetala Burret, Notizbl. Bot. Gart. Berlin-Dahlem 13: 199 (1936). Type: South Celebes, Porema, 10.ix.1929, Kjellberg 2324 (holotype: B†; isotype: BO!).

Areca langloisiana Potztal, Willdenowia 2: 628 (1960). Type: A. C. Langlois s.n. (holotype: B!).

Description: Solitary or clustering, moderate palm, to 10–15 m tall, with stilt roots. STEM 7–10 cm in diameter; internodes 10–20 cm long, greenish-yellow with conspicuous leaf scars. LEAVES about 11 in crown, 200–350 cm long (including petiole); sheath tubular, 60–70 × 20–30 cm; crownshaft 120–165 cm long and 20–30 cm in diameter, orange, reddish to bright red (rarely pale green) with numerous punctiform brown scales; petiole 4.5–45.0 cm long, 2–4 cm wide and 1–2 mm thick at the base, channelled adaxially, rounded abaxially, yellowish-green to orange (rarely pale green); leaflets somewhat irregularly arranged, papery to leathery, 11–16 leaflets on each side of the rachis, the basal-most leaflets 54–71 × 1.0–4.5 cm, two- to three-fold, lanceolate to sigmoid with oblique tips, the middle leaflets 95–117 × 7–16 cm, three- to four-fold, slightly sigmoid with oblique, notched tips, terminal leaflets 30–55 × 2–13 cm, flabellate, 4–11-fold, notched at tips with splits 5–11 cm deep between the folds, green, slightly discolored when dried, with fine sparse ramenta on mid-vein in abaxial surface. INFLORESCENCE infrabfoliar, 23–45 cm long and 16–30 cm wide, branched to two orders, erect to recurved and later pendulous in fruit; prophyll 20–55 × 6–11 cm, thin, papery, orange to reddish; peduncle 3–5 cm long and 1.5–3.0 cm wide at the base; rachillae numerous, up to 20 cm long, yellowish-cream, orange to red, sometimes perianth persistent on rachillae after fruit fall. FLORAL CLUSTERS spirally arranged on rachillae, complete triads including pistillate flowers occurring to half of the length of all rachillae. STAMINATE FLOWERS 7.00–9.75 × 3.00 mm at anthesis, triangular, asymmetrical, elongate, cream to yellowish-white; calyx cupular, low, 2 mm wide and 1.5–2.5 mm high, with shallow marginal lobes; petals three, thick and fleshy, 6.5–9.0 × 3.0 mm, elongate, ovate; stamens six, white to yellowish-cream, 6–7 × 1 mm; filaments shorter than anthers, 2–3 × 0.3–0.5 mm, white and becoming dark brown after anthesis; anthers 5.0–5.8 mm long, arrow-head shaped; pistillode low, various shapes. PISTILLATE FLOWERS 7–9 × 6.0–6.5 mm, triangular, asymmetrical; sepals three, 6–8 × 4.0–6.5 mm, triangular, strongly imbricate; petals three, similar to sepals, triangular, strongly imbricate; gynoecium 5.5 × 0.75–1.50 mm (including stigma), cylindrical; staminodes four to six, triangular (wedge-shaped),

low, membranous. FRUITS $2.0\text{--}3.0 \times 1.0\text{--}1.5 \times 1.0\text{--}1.5$ cm, obovate to ellipsoid, yellowish-orange to red when ripe, costate when dried; epicarp thin and smooth; mesocarp fleshy and juicy; endocarp thin and fibrous. SEEDS $1.3\text{--}1.5 \times 1.1\text{--}1.2 \times 1.1\text{--}1.2$ cm, ovoid, rounded apically and flattened basally.

Distribution and ecology: This species is relatively widely distributed in East Malesia, occurring throughout Sulawesi, north and central Maluku, except for Ambon, Kei, Aru and Tanimbar (Fig. 1). *Areca vestiaria* grows on volcanic soils from lowlands to highlands up to about 2000 m above sea level. Two collections (*Mogea* 1303, 1305) have been made on the summit of Mt. Maleno in Central Sulawesi, at an altitude of 2260 m above sea level, from a population with the tallest recorded individuals (to 30 m high), and these are quite exceptional for *A. vestiaria*.

Local names and uses: *pinang yaki* (Sulawesi and North Maluku). The fruits are used as a betel nut substitute, tonic and male contraceptive in North Sulawesi. This species is a popular ornamental.

Conservation status: Least Concern (LC). This species is widespread and also well established in ornamental horticulture as highlighted by Ellison & Ellison (2001).

Specimens cited: **INDONESIA. North Sulawesi Province**, Minahasa District, Mt. Soputan, Langoan, 900 m, 11.x.1973, *Dransfield & Mogea* JD 3755 (BO!, K!, L!, BH); Tomohon subdistrict, Mt. Lokon, 950 m, 3.x.1973, *Dransfield & Mogea* 3714 (BO!, K!, L! BH); 1000 m, 3.x.1973, *Dransfield & Mogea* 3716 (BO!, L!); Bolaang Mongondow District, Dumoga Nani Warta Bone National Park, West Dumoga subdistrict, Matayangan/Kasinggolan village, 225 m, 17.iii.2008, *Heatubun et al.* 879 (BO!, K!, MAN!, BPKM!); 257 m, 17.iii.2008, *Heatubun et al.* 885 (BO!, K!, MAN!, BPKM!); Edwards camp, 750 m, 27.iii.1985, *de Vogel & Vermeulen* 6768 (BO!, K!, L!); vicinity of Mt. Sinombayuga, 1750 m, 29.ix.1991, *Milliken & Bonde* 1115 (BO!, K!); Dumoga Nani Warta Bone National Park, 250 m, 16.ix.1984, *Whitmore & Sidiyasa* TCW 3411 (K!); Mt. Mogogonipa, 650 m, 10.iv.1985, *de Vogel & Vermeulen* 7070 (BO!, K!, L!); 220 km W of Manado, 50 km inland from Pangki, on tributary of Ilanga River, 350–750 m, 13.iii.1990, *Burley et al.* 3856 (A, BO!, K!). **Central Sulawesi Province**, Kulawi subdistrict, Moa, on the summit of Mt. Maleno, 2260 m, 17.x.1977, *Mogea* 1303 (BO!, K!, L!); *Mogea* 1305 (BO!, K!, L!); Luwuk area, inland from Batui and Saseba, on Batui River, at Totup camp 2, 2 hours upriver from Sinsing, Mt. Sohean, 170 m, 21.x.1989,

Coode 6045 (BO! K!); Palu, road Palu–Sopu valley, c. 40 km SSE of Palu, 600 m, 21.iv.1979, *de Vogel* 5006 (BO!, K!, L!); Palu, Sopu valley, c. 80 km SSE of Palu, 1000 m, 27.v.1979, *de Vogel* 5065 (BO!, K!, L!); Donggala District, Pangi-Binangga Nature Reserve, Puncak Beringin study area, 560 m, 14.x.1991, *Bynum* 8201 (A, BO!, K!); Mt. Roroka, Timbu, west slopes, 2000 m, 1979, *van Balgooy* 3267 (BO!, K!, L!); by the river S of Tongoa, 650 m, 3.iii.1981, *Johansson et al.* 151 (BO!, K!, L!); 5.iii.1981, *Johansson et al.* 179 (BO!, L!, K!); area of Mt. Nokilalaki, of lake Lindu to Sidaunta, 1000 m, 3.v.1975, *Meijer* 9993 (A, BO!, L!, MO). **West Sulawesi Province**, Mamuju District, Kaluku subdistrict, Popangatalu village, Kona-Kona River, c. 200 m, 4.ii.1993, *Afriastini* 2060 (BO!, K!). **North Maluku Province**, Bacan Island, Mt. Sibela, near Waiaua, 1050 m, 25.x.1974, *de Vogel* 3655 (BO!, K!, L!); 250 m, 28.x.1974, *de Vogel* 3725 (BO!, K!, L!); near Amasing River, 5 m, 6.xi.1974, *de Vogel* 3926 (BO!, K!, L!); *de Vogel* 3927 (BO!, K!, L!); *de Vogel* 3929 (BO!, K!, L!); Halmahera, 20 km SE of Dodinga, Darco/Modul logging camp, Tapayo, 600 m, 9.ix.1985, *Sidiyasa et al.* TCW 3611 (K!); 630 m, 13.ix.1985, *Sidiyasa et al.* TCW 3651 (K!); Mt. Sahu, near Susupu, 500 m, 5.x.1974, *de Vogel* 3272 (BO!, K!, L!); 6.x.1974, *de Vogel* 3285 (BO!, K!, L!). **Maluku Province**, Buru Island, west Buru, Wae Nibe, wood industry base camp 2, 20 km, Wae Ili, 9.xi.1984, *Mogea & Ismail* 5202 (K!, BO!). **CULTIVATED. Malaysia**, Malay Peninsula, Kepong, FRIM office, Barfod s.n. (AAU photo!). **Indonesia**, Bogor Botanic Garden, II. J. 14, iv–v.1936, *Furtado* 155 (K!).

Notes: *Areca vestiaria* is a distinctive species with a unique combination of morphological characters: moderate, clustering or solitary habit with stilt roots, the almost always brilliant orange to bright red crown-shaft, the inflorescence always branched to two orders, the staminate and pistillate flowers spirally arranged on the rachillae and the fruit with a fleshy, juicy mesocarp. For comparison with *A. novohibernica*, see notes under *A. novohibernica*.

The arrangement of staminate flowers was used by Scheffer (1876) as the basis for *Mischophloeus*, a genus distinct from *Areca*. Subsequently, Furtado (1933) synonymized with *Areca*, reducing it to a section under subgenus *Beccarioareca*. The morphological variation and wide distribution of this species have resulted in some taxonomic confusion and nomenclatural problems (Giseke, 1792; Martius, 1823–1850; Miquel, 1868; Scheffer, 1873, 1876; Merrill, 1917; Furtado, 1933; Burret, 1936; Potztal, 1960) since its first appearance in *Herbarium Amboinense* (Rumphius, 1741) until review by Dransfield (1974).

DOUBTFUL OR UNCERTAIN NAMES

- Areca congesta* Becc., Engl. Bot. Jahrb. 58: 441 (1923). Type: Papua New Guinea, Sepik, *Ledermann* 12331 (holotype: B†). See notes under *A. macrocalyx* for discussion.
- Areca ledermanniana* Becc., Engl. Bot. Jahrb. 58: 441 (1923). Type: Papua New Guinea, April River, *Ledermann* 9766 (holotype: B†). See notes under *A. macrocalyx* for discussion.

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APPENDIX

LIST OF SPECIMENS EXAMINED AND IDENTIFIED

Species numbers are given in bold in parentheses after the collection numbers. Key: (1) *A. catechu*; (2) *A. macrocalyx*; (3) *A. mandacanii*; (4) *A. novohibernica*; (5) *A. oxycarpa*; (6) *A. vestiaria*.

Afriastini: 2060 (6); Anonymous: (Cult. Kew) s.n. (1); (Cult. Calcutta) s.n. (1); (Cult. Singapore) s.n. (1); (Cult. Singapore, lawn X) s.n. (1); (Cult. Singapore, lawn J) s.n. (1); (Cult. Bogor, lawn II.F.9) s.n. (1); (Cult. Bogor, lawn VII.B.78) s.n. (1); (Cult. Bogor, lawn VII.B.79) s.n. (1); (Cult. Bogor, lawn VII.B.80) s.n. (1); (Cult. Bogor, lawn VII.B.81) s.n. (1); (Cult. Bogor, lawn VII.B.84) s.n. (1); (Cult. Bogor, lawn VII.B.85) s.n. (1); (Cult. Bogor, lawn VII.B.87) s.n. (1); (Cult. Bogor, lawn VII.B.88) s.n. (1); (Cult. Bogor, lawn VII.B.89) s.n. (1); (Cult. Bogor, lawn VII.B.91) s.n. (1); (Cult. Bogor, lawn XI.B. (XX)6) s.n. (1); (Cult. Bogor, lawn XIII.A.6) s.n. (1); Asmarayani *et al.* 461 (5).

Backer: 31478 (1); Bacon: 115 (5); Baker: 136 (1); Baker & Utteridge: 591 (2); Baker *et al.* 631 (2); 1098 (2); 1100 (2); Bakhuizen van den Brink: 6724 (1); 6782 (1); 6788 (1); 6789 (1); 6807 (1); 6866 (1); Bakia: 416 (1); Banka *et al.* 2001 (2); Barfod: s.n. (1); Barfod *et al.* 416 (2); 488 (2); 45235 (1); Bartlett: 16226 (1); Beccari: PB 3112 (1); s.n. (2); Beguin: 330 (1); 1613 (1); Bloembergen: 3555 (1); 3556 (1); Boden-Kloss: 11440 (1); Borden: 20192 (Forest Bureau 1272) (1); Borssum-Waalkes: 350 (1); Brass: 3971 (2); 7001 (2); 7170 (2); 7188 (2); 7386 (2); 7901 (2); 8189 (2); 13437

(2); 13437A (2); 23977 (2); Burley *et al.* 3856 (6); 4215 (1); Bynum: 8201 (6).

Canton Christian College: 9808 (1); Ching & Tan: TC 01 (1); Chen: 18806 (1); Clemens: 11351 (2); 21501 (1); Conklin: 1055 (1); 18651 (1); Coode: 6045 (6); 6074 (1); Corner: RSS 223 (4); Craven & Schodde: 202 (4); Croft & Katik: NGF 14984 (2); Croft & Lelean: LAE 65521 (4); Croft *et al.* LAE 61183 (2).

Darbyshire: 921 (2); Darbyshire & Hoogland 8089 (2); Desianto: 4 (2); de Vogel: 3266 (1); 3272 (6); 3285 (6); 3655 (6); 3725 (6); 3926 (6); 3927 (6); 3929 (6); 5006 (6); 5065 (6); de Vogel & Vermeulen: 6768 (6); 6950 (5); 7070 (6); de Vogel *et al.* 6048 (1); Dransfield: JD 1403 (1); JD 1467 (1); JD 1471 (1); Dransfield & Mogea: 3714 (6); 3716 (6); JD 3755 (6); JD 3808 (1); Dransfield *et al.* JD 7533 (2); Duaneh: 255 (1); Dubuc: 1869 (1); Du Bois: 24 (1).

Edeling: s.n. (1); Elmer: 7795 (1); 17468 (1); Essig: LAE 55210 (4); Essig & Young: LAE 74091 (2).

Fernando: 546 (1); 600 (1); 665 (1); Floyd: 6422 (2); Foreman: LAE 52115 (4); Frodin: NGF 26882 (4); Furtado: 155 (6); s.n. (2).

Gideon: LAE 57404 (2); LAE 76950 (2); LAE 76951 (2); LAE 77178 (4); s.n. (2); Graff: 134 (1); Griffith: s.n. (1); Guppy: 107 (4); Gusbager *et al.* 20 (2).

Heatubun & Iwanggin: 902 (3); Heatubun *et al.* 292 (2); 331 (2); 360 (2); 413 (3); 423 (3); 424 (3); 747 (2); 751 (1); 752 (1); 753 (1); 796 (2); 798 (2); 799 (2); 870 (1); 876 (2); 877 (5); 879 (6); 883 (5); 885 (6); 1095 (2); Henry: 8406 (1); Henty: NGF 27201 (4); NGF 38541 (2); Henty & Lelean: NGF 29417 (4); Henty *et al.* NGF 33055 (2); NGF 33057 (2); Hoogland: 9026 (2); Hoogland & Craven: 11081 (2); Huang & Kao: 5234 (1).

Iboet: 440 (1).

Jacobs: 8761 (2); 9002 (2); s.n. (2); Johansson *et al.* 151 (6); 179 (6).

Kajewski: 1980 (4); Karenga: LAE 55423 (2); LAE 56441 (2); Karenga & Obedi: LAE 62315 (2); Kaseger 210 (5); Kazakoff: NGF 7057 (2); Koorders: 396 (1).

Lai: S 68676 (1); Larivita & Katik: LAE 70501 (2); Lau: 226 (1); Lee: S 55696 (1); Lelean & Stevens: LAE 51221 (4); Liang: 62129 (1); Lucas: 442 (1).

Mansus & Aban: SAN 69388 (1); Manuputty: BW 958 (2); Masters: s.n. (1); Maturbongs *et al.* 605 (2); 728 (2); s.n. (3); Meijer: 9993 (6); Merrill Species Blancoanae: 213 (1); Milliken & Bonde: 1115 (6); Mogea: 1303 (6); 1305 (6); 3139 (2); 3140 (1); 4961 (5); 5070 (5); 6204 (2); Mogea & Ismail: 5202 (6); Moore & Whitmore: 9303 (BSIP 4051) (2); Morren: 3049 (2).

Noblick *et al.* 5180 (1).

Othman & Munting: S 61606 (1).

Powell: BSIP 19467 (2); Pullen: 725 (2); 1712 (2); 2638 (2); 7299 (2); 7641 (2).

Ramos: Bureau of Science 80360 (1); Reeve: 889 (2); Reynoso *et al.* 7363 (1); Ridsdale & Katik: NGF 36757 (4); Rutherford & Bandara: 124 (1); 154 (2).

Sambuling: 8 (**1**); 76 (**1**); Sands: 726 (**4**); Sands *et al.* 2124 (**4**); 2756 (**4**); 6365 (**2**); Sarasin: s.n. (**5**); Schodde & Craven: 4029 (**2**); Sibil: 153 (**1**); Sidiyasa *et al.* TCW 3580 (**1**); TCW 3611 (**6**); TCW 3651 (**6**); Sinclair: 3272 (**1**); Soibeh: 778 (**1**); Streimann & Katik: NGF 28593 (**2**); NGF 28994 (**2**); Streimann & Lelean: NGF 18311 (**2**); NGF 34118 (**2**); Sumawong: s.n. (**2**). Takeuchi: 10075 (**2**); 16771 (**2**); 16802 (**4**); Takeuchi & Wiakabu: 9592 (**4**); 9733 (**4**); Takeuchi *et al.* 13374 (**2**); 13638 (**2**); Tsang: 146 (**1**).

van Balgooy: 3267 (**6**); 6864 (**2**); van Steenis: 212 (**1**); Veersteg: 1592 (**2**); 1782 (**2**); Vinas: LAE 67031 (**2**).

Wanggai *et al.* 3 (**2**); Waterhouse: 185 (**2**); 248 (**4**); s.n. (**2**); White: NGF 10715 (**2**); NGF 10716 (**2**); Whitmore: BSIP 1268 (**2**); BSIP 4132 (**4**); BSIP 4273 (**2**); TCW 3411 (**6**); Whitmore & Sidiyasa: 3407 (**5**); Williams: 330 (**1**); Wilson: 9891 (**1**); Wingfield: 3708 (**1**). Zippel: s.n. (**2**).