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Research article

Revision of the rattan *Calamus javensis* Blume complex (Arecaceae, Calamoideae) in Malesia with notes on all recognisable taxa and forms

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The problem of polymorphism in the *Calamus javensis* complex has been examined by various techniques in several publications. A wide range of morphological variation was identified during these studies. Characters showing high variation were leaf sheath and ocrea morphology, number and arrangement of leaflets, length and arrangement of the rachillas. All names used in the complex are here regarded as synonyms of *C. javensis* except *C. tenompokensis*, which is retained as a distinct species. One variety is recognized, *C. javensis* var. *polyphyllus* (including *C. acuminatus*). Using morphological characters, we recognized 11 informal (often not monophyletic) forms within *C. javensis* var. *javensis*. Here we present identification keys, descriptions and notes of all recognisable forms, varieties and species included in the *Calamus javensis* complex.

Keywords: Arecaceae, *Calamus javensis*, *Calamus javensis* var. *polyphyllus*, *Calamus tenompokensis*, Malesia, polymorphism, rattan, recognisable forms, species complex

Introduction

As a large genus, *Calamus* has long been of interest in the world of palm taxonomy. Recently, [Henderson \(2020\)](#) revised the entire genus, which resulted in 411 phylogenetic species; of these, 38 were recognized as new and eight species as ochlopecies. *Calamus javensis* was identified as an ochlopecies with 11 species names subsumed in it, namely *C. acuminatus* Becc., *C. amplectens* Becc., *C. amplijugus* J.Dransf., *C. congestiflorus* J.Dransf., *C. corrugatus* Becc., *C. elopurensis* J.Dransf., *C. filiformis* Becc., *C. hypertrichosus* Becc., *C. impar* Becc., *C. javensis* Blume and *C. kemamanensis* Furtado. [Henderson \(2020\)](#) treated morphotypes as recognized but not named.

Calamus javensis Blume is a polymorphic species that forms one of the most difficult species complexes in Southeast Asian palms ([Dransfield 1999](#), [Henderson 2020](#)). The species has a wide distribution, ranging from southern Myanmar, southern Thailand and Peninsular Malaysia, throughout Sumatra, Java and Borneo to Palawan



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and Luzon in the Philippines. *Calamus javensis* occurs in all major forest types except mangrove, from sea level to about 2000 m a.s.l. and is found on a wide range of soils in tropical rainforest (Dransfield and Manokaran 1993, Dransfield 1999, Watanabe and Suzuki 2007). Rattans prefer soils rich in organic carbon that are not subjected to severely dry conditions and water logging (Pantanella 2005). However, we observed that some forms of *C. javensis* grew abundantly outside the dense forest in a soil mixed with very fine gravels in Bukit Hampuan and Telupid, Sabah.

All forms in the *C. javensis* complex are defined by the presence of a flagellum, papyraceous leaves, the terminal leaflet pair conspicuously connate, distant partial inflorescences, with rachillae generally diverging at 90 degrees with rather distinctive, closely set rachilla bracts, the whole inflorescence cherry-red at anthesis, and fruits with rather flat, white scales (Dransfield 1992). Because of a high variation in width of stem, leaf sheath profile and spines, ocrea, leaflet number, shapes, and arrangement, inflorescence structure, and fruit shape and scales, the description of the species is long and with few non-variable characters.

The high variation has resulted in the description of various forms as species or infraspecific taxa. A chronological history of names and taxa involved in the *Calamus javensis* complex was presented in Atria et al. (2017). The status of these names is variable and inconsistent as some forms are more obvious and without transitional forms than others. However, no taxonomic revision of the *C. javensis* complex has been completed. Interpretations of species boundaries based on morphological characters alone frequently generated misleading results when only a limited number of samples are used, because an apparent discontinuity in a character can disappear once the sampling intensity is increased (Dransfield 1999).

A series of studies revealed the problem of polymorphism in the *C. javensis* species complex. The two most distinctive taxa in Sabah related to *C. javensis* have been separated at the specific level, viz *C. tenompokensis* Furtado and *C. amplijugus* J. Dransf, while the other taxa in this complex appear to intergrade (Dransfield 1997). However, based on recent work with multivariate (Atria et al. 2017) and molecular analysis (Atria et al. 2020), *C. amplijugus* was found to be part of the *C. javensis* group/clade and not distinctive. Both studies showed that in the complex only two groups of specimens can be distinguished, one is the robust short-stemmed rattan *C. tenompokensis* and the other is the large group formed by *C. javensis*, which consists of all the other forms and taxa formerly described in the complex. The markers used (*matK* and 5SnrDNA) gave little resolution in the phylogeny reconstruction (Atria et al. 2020), but a few groups in the *C. javensis* complex are phylogenetically and morphologically supported to some degree. More sequences of other markers or complete genomes should be added before a clear picture of the complex can be given.

The multivariate analysis (Atria et al. 2017) also showed *C. acuminatus* Becc. as more or less distinct. Phylogenetically (Atria et al. 2020), this form is less apparent, but the

narrow distribution and ecological preferences support the idea to recognise *C. acuminatus* as a distinct entity at the varietal level. Morphologically it cannot be separated from *C. javensis* Blume var. *polyphyllus* (Becc.) Becc. with which it is synonymized here. Notes about *C. acuminatus* will be presented under the description of the latter variety.

Calamus javensis seemingly adapts morphologically very well to local circumstances. This probably also means that local, recognizable forms may arise independently in parallel as several forms have disjunct distributions and/or are present in different clades (Atria et al. 2020). Recognition of the forms as informal groups, as we will do here, likely indicates that the specimens in these groups live under comparable conditions.

The polymorphism may also occur as a result of hybridization. In the Areaceae, hybridization is common in date palm species, *Phoenix* spp. (Coryphoideae) (Pintaud et al. 2013, Gros-Balthazard 2013, Flowers et al. 2019), but there is no report on hybridization in rattan species so far. Still, there is a possibility of hybridization also in *Calamus javensis*, but in our series of studies we did not focus on this nor did the material or results made us to suspect it.

The aim of this paper is to describe the various taxa and the informal groups that are morphologically recognisable.

Material and methods

In this study we use the groups described by Atria et al. (2017, 2021) and the recent revision of *Calamus* by Henderson (2020) and the revision of the Areaceae for Thailand by Barfod and Dransfield (2013). Morphological examinations were conducted on fresh material collected during fieldwork in Brunei, Java and Sabah, and on herbarium specimens made available by several herbaria: Herbarium Bogoriense (BO), Herbarium Firenze (FI), Royal Botanic Gardens Kew (K), Naturalis Biodiversity Center (L, U), the Sandakan Herbarium (SAN) and the Sarawak Herbarium (SAR).

Results

Key to the species and varieties in the *Calamus javensis* complex

- 1a. Leaf sheath abundantly covered with horizontal, hairy, black-tipped spines, 1–5 cm long; flagellum absent or short (rarely longer than 1 m); petiole and rachis somewhat angular; leaflets 8 or 9 pairs, opposite, narrowly to broadly elliptic; inflorescences to ca 1 m long, but some only ca 25 cm long; Staminate calyx tubular, with swollen lobes; pistillate rachillae bracts with a broadly cupuliform limb..... 2. *C. tenompokensis*
- b. Leaf sheath (smooth to) mostly sparsely (to densely) armed with various spines; spines mostly glabrous (some with hairs along the margin), straight and patent, reflexed upward or downward or mixed in orientation, stout, clawed to

- solid pointed, mostly with a black tip, 2–7(–15) cm long; flagellum to ca 150 cm long; petiole and rachis rounded; leaflets 2–12 pairs, usually opposite to subopposite (to alternate), mostly lanceolate to ovate, very rarely broad-ovate; inflorescences up to 1.5 m long; staminate calyx basally tubular, its lobes not swollen; pistillate rachilla with tightly sheathing bracts 2 (1. *C. javensis*)
- 2a. Leaflets in 1–6 pairs (rarely 12), grouped or more rarely subregular, usually opposite to subopposite, some alternate, mostly lanceolate to ovate, very rarely broadly ovate; inflorescences up to 1.5 m long, staminate and pistillate ones almost similar; fruits oblong to some ellipsoid to globose, up to 10 by 8 mm; pericarp covered with 15–19 vertical rows of scales, yellow to light brown scales with reddish-brown lines and mucronate apex 1a. *C. javensis* var. *javensis*
- b. Leaflets in 9–12 pairs, regularly arranged or sub-equidistant, subopposite to alternate, lanceolate to narrowly elliptic, some elliptic; staminate inflorescences ca 50 cm long; pistillate ones to ca 140 cm long; fruits broadly ovoid to globose, 4–6 by 3–4 mm; pericarp covered with 8 vertical rows of scales, yellowish with red-tinged acuminate apex 1b. *C. javensis* var. *polyphyllus*

1. *Calamus javensis* Blume

Calamus javensis Blume (1847, p. 62)

Based on the same type: *Palmijuncus javensis* (Blume) Kuntze (1891, p. 733).

Type: Indonesia, Java, C.L. Blume s.n. (lectotype: L-0699971, selected by Henderson (2020, p. 217); isolectotype: P-02147162 [photo image]).

Taxonomic synonyms: *Calamus javensis* var. *firmus* Blume (1847, p. 62). Type: not indicated by Henderson (2020, p. 217).

- *Calamus javensis* var. *tetrastichus* Blume (1847, p. 62), basionym of *Calamus tetrastichus* (Blume) Blume (1847, p. 62, tab. 153), based on the same type as *Palmijuncus tetrastichus* (Blume) Kuntze (1891, p. 733). Type: Blume, 1847, t. 153 (lectotype, designated by Henderson (2020, 217)).
- *Calamus borneensis* Miq. (1850, p. 4), based on the same type as *Palmijuncus borneensis* (Miq.) Kuntze (1891, p. 733). Type: not indicated.
- *Calamus amplexens* Becc. (1884, p. 78), based on the same type as *Palmijuncus amplexens* (Becc.) Kuntze (1891, p. 733). Type: Malaysia, Sarawak, O. Beccari s.n. (lectotype: FI-013529 selected by Henderson (2020, p. 217)).
- *Calamus javensis* var. *peninsularis* Becc. (Beccari 1892, p. 442). Type: Malaysia, Perak, King's collector 1996 (female) (lectotype: K-000207740, designated here). Henderson (2020) indicated Scortechini 236b (FI) as lectotype, but this collection is not mentioned by Beccari (1892) and cannot serve as lectotype.

- *Calamus javensis* var. *peninsularis* subvar. *intermedius* Becc. (1892, p. 443), basionym for *Calamus javensis* var. *intermedius* (Becc.) Beccari (1902, p. 201). Type: Malaysia, Perak, B. Scortechini 236b (lectotype: FI-018943*), indirectly selected by Henderson (2020, p. 217). Henderson (2020) regarded the specimen in FI as holotype, but Beccari (1892) did not indicate a holotype, which makes all duplicates syntypes, therefore we consider Henderson's choice as a lectotypification.
- *Calamus javensis* var. *peninsularis* subvar. *penangiana* Becc. (Beccari 1892, p. 443). *Calamus penicillatus* var. *penangiana* (Becc.) Ridl. (Ridley 1907, p. 192). Based on the same type of *Calamus javensis* var. *penangiana* (Becc.) Ridl. (Ridley 1925, p. 51). Type: Malaysia, Pulau Penang: Mount Elvira, C. Curtis s.n. (lectotype: SING-0186878 (photo image), selected by Henderson (2020, p. 217)).
- *Calamus javensis* var. *peninsularis* subvar. *purpurascens* Becc. (1892, p. 443). Type: Malaysia, Perak, King's collector 7932 (lectotype CAL, n.v.; isolectotypes: BM, n.v., FI-018947*(photo image), K-000207739, selected by Henderson (2020, p. 217)).
- *Calamus javensis* var. *peninsularis* subvar. *tenuissimus* Becc. (1892, p. 443). Basionym of *Calamus javensis* var. *tenuissimus* (Becc.) Becc. (Beccari 1902, p. 201). Type: Malaysia, Perak: summit of Gunong Tambang Batok, Scortechini 648b (lectotype FI-018949*(photo image), indirectly selected by Henderson (2020, p. 217)). Henderson (2020) regarded the specimen in FI as holotype, but Beccari (1892) did not indicate a holotype, which makes all duplicates syntypes, therefore we consider Henderson's choice as a lectotypification.
- *Calamus filiformis* Becc. (Beccari 1902, p. 609). Type: Malaysia, Sarawak: Mount Mattang, prop. Kutcing [Kuching], O. Beccari PB 1909 (holotype: FI-008448).
- *Calamus corrugatus* Beccari (1902, p. 201). Type: Malaysia, Sarawak, O. Beccari PB 1910 (holotype: FI-008446).
- *Calamus penicillatus* var. *purpurascens* Ridl. (Ridley 1907, p. 192). Basionym of *Calamus javensis* var. *purpurascens* (Ridl.) Ridl. (Ridley 1925, p. 49). Type: Malaysia, Perak: Gunong Batu Putih, L. Wray 981 (lectotype: CAL, n.v., selected by Henderson 2020, p. 217).
- *Calamus penicillatus* var. *inermis* Ridl. (Ridley 1907, p. 192). Basionym of *Calamus javensis* var. *inermis* (Ridl.) Ridl. (Ridley 1925, p. 51). Type: Malaysia, Negeri Sembilan: Gunong Angsi, H.N. Ridley s.n. (lectotype: SING-0056674, selected by Furtado (1956, p. 176)).
- *Calamus javensis* var. *javensis* subvar. *exilis* Becc. (Beccari 1908, p. 178). Type: Indonesia, Java, C.G.C. Reinwardt s.n., (holotype: M-0199069*[photo image]).
- *Calamus javensis* var. *sublaevis* Becc. (Beccari 1908, p. 184). Type: Malaysia, Sarawak: Kutcing [Kuching], Mt Mattang, O. Beccari PB 1694 (holotype: FI-013528).
- *Calamus javensis* var. *acicularis* Becc. (Beccari 1908, p. 185). Type: Malaysia, Sarawak: Mt Mattang [Matang], R.W. Hullett 3471 (lectotype: FI-018945* (photo image), indirectly selected by Henderson (2020, p. 217); isolectotype: SING-0192571). Henderson (2020) regarded

the specimen in FI as holotype, but [Beccari \(1908\)](#) did not indicate a holotype, which makes all duplicates syntypes, therefore we consider Henderson's choice as a lectotypification.

- *Calamus javensis* var. *tetrastichus* subvar. *mollispinus* [Becc.](#) ([Beccari 1913](#), p. 15). Type: Indonesia, Borneo: Sungei Mandai, J.G.(H.) Hallier 2569 (holotype: BO-0036501; isotype: FI-018948* (photo image)).
- *Calamus hypertrichosus* [Becc.](#) ([Beccari 1913](#), p. 17). Type: Indonesia, Borneo: J.E. Teijsmann HB 16330 (holotype: BO-0039113; isotype: iso FI-018946* (photo image)).
- *Calamus impar* [Becc.](#) ([Beccari 1913](#), p. 19). Type: Indonesia, Borneo: Sungei Kenepai, J.G. (H.) Hallier 2033 (holotype: BO-0063384; isotype: FI, n.v.).
- *Calamus fissijugatus* [Burret \(1943\)](#), p. 804). Type: Indonesia, north Sumatra: Sabang, B. Krug 145 (holotype: B, destroyed).
- *Calamus kemamanensis* [Furtado \(1956\)](#), p. 170). Type: Malaysia, Terengganu: Kemaman, Sungai Nipa, E.J.H. Corner SFN 30535 (holotype: SING-0056675; isotypes: BH, n.v., K-000207734).
- *Calamus javensis* var. *laevis* [Furtado \(1956\)](#), p. 177). Type: Malaysia, Johore: Sedinak 8, H.N. Ridley 13518 (holotype: SING-0056830; isotype: BM, n.v.).
- *Calamus congestiflorus* J.Dransf. ([Dransfield 1982](#), p. 785). Type: Malaysia, Sabah: Nabawan District, mile 46, Nabawan, J. Dransfield et al. 5635 (holotype: K-000113076; isotypes: KEP, n.v., L, SAN, n.v., SAR, n.v.).
- *Calamus amplijugus* J.Dransf. ([Dransfield 1982](#), p. 787). Type: Malaysia, Sabah: Sandakan District, Lungamis Experimental Plots, J. Dransfield 5775 (holotype: K-K000112913!; isotypes: L, n.v., SAN, n.v., SAR, n.v.).
- *Calamus elopurensis* J.Dransf. ([Dransfield 1982](#), p. 787). Type: Malaysia, Sabah: Sandakan, Elopura, Sepilok Forest Reserved, B. Kadir A 2651 (holotype: K-000113249; isotypes: KEP, n.v., SAN, n.v., SING, n.v.).
- *Calamus equestris* auct. non Willd.: [Blume \(1830\)](#), p. 1330).

(Shrub to) liana, small, clustering, dioecious; stem with leaf sheaths 5–20(–35) mm in diameter, without sheaths to about 8(–10) mm in diameter; internodes to 30 cm long. Sheaths light green to dark brown when dry; smooth to distinctly striate; (smooth to) mostly sparsely (to densely) armed with various spines, spines straight and patent, pointing upward or downward or mixed in orientation, flattened triangular, stout, clawed to solid pointed, mostly with a black tip, 2–7(–15) cm long, almost always swollen at base, usually with a black tip; knee present, sometimes conspicuous; ocrea reddish, quite conspicuous, quickly tattering, rarely persistent. Flagellum up to 150 cm long, with groups of 2- or 3-clawed spines. Leaves alternate, ecirrate, 35–40(–60) cm long; petiole usually very short, only 2–5 cm long, but occasionally longer, with abundant dark hairs in young plants; rachis sparsely armed with small, curved or clawed spines, sometimes in groups of 2 or 3, rarely smooth,

sometimes with some indumentum. Leaflets 2–6(–12) on each side of the rachis, grouped or more rarely subregular, usually opposite to subopposite (to alternate), mostly lanceolate to ovate, very rarely broad-ovate, the largest ones up to 29 by 4 cm, with 3 conspicuous parallel main veins; apex acuminate, mostly with spinules, latter sometimes also along the margin; lowermost pair always swept back across the stem, in some forms clasping the stem; median leaflet pairs usually smaller than the other two above, but sometimes the longest pair; adult leaves always with a terminal flabellum formed by 2 apical leaflets joined for $\frac{1}{4}$ – $\frac{3}{4}$ of their length, the latter not always forming the largest leaflets; the pair of leaflets below the flabellum (penultimate) usually very close (0–1 cm distant) to the flabellum, rarely far apart (more than 3 cm), opposite to subopposite, rarely regularly arranged, mostly not grouped. Inflorescences up to 1.5 m long, pendulous, staminate and pistillate ones almost similar, staminate ones finer/more slender than pistillate ones, each with 4–8 partial inflorescences, rachillae 4–8 cm long in staminate inflorescences and up to 12 cm long in pistillate inflorescences. Prophyll tubular at base, tightly enclosing the rachis, some loosely enclosing with a long distal opening, smooth to more spin, y with sparse, small, black-tipped spines, curved or tending to be so in the end; peduncular bracts with tubular base, enclosing the rachis but free at the end, with sparse, small, curved spines; rachis bracts tightly enclosing the rachis, some loose and keeled, mostly smooth or prickly with sparse, small, curved spines, rarely densely so. Staminate rachillae with bracts, explanate, 1.5–2.0 mm by ca 1 mm; 1 striated tubular prophyllar bracteole subtending one staminate flower within the axil of the rachilla bract. Pistillate rachillae bigger than staminate one, with tightly sheathing rachilla bracts; prophyllar bracteoles tubular with two opposite acute tips, striate, subtending a dyad of a pistillate and a sterile staminate flower, each flower with only ca 1 mm interval on each side and thus appearing crowded. Staminate flowers: calyx basally tubular, deeply divided into 3 lobes (lobes not swollen), valvate, free on the top with acute tip; lobes elliptic, ca 1.5 by 1 mm; corolla usually quite far exceeding the calyx; petals oblong, 3.0–3.5 × 8.0–10.0 mm; stamens six, filaments narrow, tapering to the top, 1.5–2.0 mm long, with hooked tip; anthers ca 1.5 mm long, dorsifixed, hanging freely, versatile, opening latrorse with longitudinal slit. *Pistillate flowers*: calyx tubular, basally connate, shallowly divided into 3 valvate lobes, the latter broadly elliptic, 1.0–1.8(–2.0) by 1.3–1.5(–1.8) mm; corolla rarely or slightly exceeding the calyx; petals ovate to elliptic, 2.0–2.5 × 0.8–1.5 mm, acute to acuminate at apex; staminodes 6, epipetalous, filaments united into a membranous, toothed ring with empty anthers attached on top; pistil ca 2.0–2.5 mm long, style short, together with stigma only 1.0–1.5 mm long, with 3 reflexed fleshy stigmas. *Fruits* one-seeded, oblong to somewhat ellipsoid to globose, up to 12–15 × ca 8 mm, mucronate; pericarp covered with 8–15(–19) scales, ca 3.0 × 1.0–1.5 mm, yellow to brown, with reddish brown margins. Seeds rounded, somewhat angular, 8–11 × 7–10 mm, endosperm homogenous.

Distribution

Southern Myanmar, Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, western Java, Borneo and the Philippines (Palawan and central Luzon).

Habitat and ecology

Calamus javensis ranges from the lowlands to up to 2000(–2600) m a.s.l. and occurs on a wide variety of soils. Flowering: whole year through, but mainly April to August; fruiting: June to November.

Vernacular names

Thailand: Rote batu, Wai ukan, Wai tek (S part). Malay Peninsula: rotan lilin (throughout the peninsula); coonk stook (Perak). Sumatra: Rotan opot (Bengkulu). Java: Howe cacing (western Java). Borneo: Sabah: Lempinit ular-ular; Kalimantan: Rotan lilin. Philippines: Arorog, Arurug (Palawan).

Uses

People make baskets and musical instruments from the cane, and they use it as binding material, for traps and carrying baskets. The length and strength of the cane itself is excellent and in quality only second to *C. caesioides* Blume. The raw cabbage is eaten to cure coughs (Dransfield and Manokaran 1993, Watanabe et al. 2006, Barfod and Dransfield 2013).

Notes

The type of *Calamus javensis* Blume (1847) was collected on the Halimun-Salak mountain in West Java. However, already at this location, individuals showed variation in leaf blades and leaf sheaths, linked by intermediates. The populations found in northern Borneo show most variation, perhaps connected to different ecological niches, not only in the leaf sheath spines, leaflets number and arrangement, but also the ocrea, inflorescence rachillae, and some exhibit an erect habit; but individuals with intermediate characters can also be found. Previous studies on morphometry and phylogeny of *C. javensis* (Madulid 1981, Atria et al. 2017, 2020, Henderson 2020) have shown that almost all variation (*C. tenompokenensis* excepted) is part of one big cluster. The complexity of *C. javensis* has also been discussed in a work of Syam et al. (2016). Their treatment of *C. javensis* differed from our (Atria 2017), as they regarded all names as part of the *C. flabellatus* Furtado complex (including not only *C. javensis*, but also *C. acuminatus*, *C. amplijugus*, *C. congestiflorus*, *C. corrugatus*, *C. hypertrichosus* and *C. ruvidus*). However, the name is incorrect as *C. javensis* is the oldest name. *Calamus javensis* is a polymorphic taxon and consists of several small groups of specimens that show recognizable characters next to the more amorphous mass formed by most specimens. These recognizable groups are here described as informal taxa (group). As most specimens group under Form *Javensis*, this group will not be keyed out, due to too much overlap; therefore, all specimens that cannot be assigned to any of the Forms are part of Form *Javensis*. Specimens examined for Form *Javensis* are listed in the Supporting information.

1b. *Calamus javensis* Blume var. *polyphyllus* (Becc.) Becc.

Calamus javensis Blume var. *polyphyllus* (Becc.) Becc. (Beccari 1902, 201)

Calamus javensis Blume var. *polyphyllus* (Becc.) Becc. (Beccari 1902, 201; 1908, 184). Basionym for *Calamus javensis* Blume var. *peninsularis* Becc. subvar. *polyphyllus* Becc. (Beccari 1892, 443). Type: Malaysia, Perak, summit of Gunong Tambang Batak, B. Scortechini 657b (lectotype: FI-1018944* [photo image], indirectly indicated by Henderson 2020). Henderson (2020) indicates that Scortechini 657b (FI) is the holotype, but Beccari (1892) mentions two collections that are syntypes, therefore we consider Henderson's choice as a lectotypification.

Calamus acuminatus (1913, 16). Type: Malaysia, British north Borneo (= Sabah), Tenom, 700 ft, L.S. Gibbs 4349 (lecto FI-1014285* [photo image] (indirectly selected by Henderson 2020), iso BM n.v.). Beccari (1913) did not indicate a holotype, therefore all duplicates are syntypes and Henderson's (2020) selection of the FI specimen as holotype is regarded here as a lectotypification.

Clustering rattan. Stem to 10 m long, ca 8 mm in diameter with leaf sheath, ca 5 mm in diameter without leaf sheath. Leaf sheath striate, mostly smooth or almost smooth or with few small, clawed spines or pointed swollen-based spines, 3–5 mm long. Ocrea tubular, persistent, 20–30(–40) mm long. Knee conspicuous. Flagellum ca 1 m long. Leaves ecirrate, 35–40(–58) cm long; petiole very short, less than 2 (sometimes to 16) cm long; rachis with small, clawed, some black-tipped, swollen-based spines. Leaflets 9–12 pairs, regularly arranged or subequidistant, subopposite to alternate, lanceolate to narrowly elliptic, some elliptic, 9–15(–24) × 1.5–4.0 cm, conspicuously 3-nerved, with several black-tipped spines along the nerves, with conspicuous transverse veinlets, along margin with small, soft spines, acuminate (to cuspidate) at apex, abaxial surface with red soft spines along main vein; uppermost pair joined for 1/3–1/2, forming a flabellum, ca 8.0(–13.0–19.0) × 1.0–3.5 cm; penultimate pair very close; basal pair smallest, spreading or swept back, 8.0–10.0 × 1.0–1.5 cm. Staminate inflorescences ca 50 cm long; prophyll tubular, closely sheathing, up to 27 cm long, prickly or with small, clawed spines; peduncular bracts tubular, sparsely armed with small black, clawed spines; rachis bracts tubular, smooth, 11–16 cm long, closely sheathing, with short longitudinal opening and asymmetrically extended into narrowly elliptic limb, ca 3 mm long, with several small, brown, swollen-based, downward pointing, ca 1 mm long spines, subtending 2 partial inflorescences each with up to 10 rachillae; rachillae 4–8 cm long; rachilla bracts strongly striate, tubular, later slightly cupuliform, with small extended limb; rachilla bracts strongly striate, shortly tubular, later cupuliform or explanate with broadly ovate limb asymmetrically extended into acuminate tip; floral bracteole explanate, shortly tubular with 2 acute tips. Staminate flowers ca 2 mm long; inserted at

an angle of 45° with the axis; calyx valvate, deeply divided into 3 lobes; lobes broadly elliptic, ca 1.5 × 1.0 mm, acuminate at apex; petals 3, oblong, 1.0–2.5 × ca 0.5 mm; stamens 6, filaments triangular, flat, tapering, ca 1.5 mm long; anthers hastate, 1.0–1.5 mm long, versatile to the filament; pistillode with 3 reddish, linear stigmas, ca 1 mm long. Pistillate inflorescences to 140 cm long, with main inflorescence axis inserted in a conspicuous, swollen-based prophyll; prophyll tubular, ca 19 cm long, closely sheathed, with few small, clawed spines; peduncular bract tubular, closely sheathed, ca 21 cm long, with short, broad limb, sparsely armed with small, clawed spines; rachis bract tubular, ca 17 cm long, with limb expanded to 4 cm long, armed with clawed spines, subtending 3 partial inflorescences; subsequent bracts first tubular, closely sheathing, 12–20 cm, moderately armed with small, brown, downward-pointing spines, later with expanded limb to 6 cm long; rachillae 4–8, 4.0–8.5 cm long; rachilla bracts striate, tubular, smooth or almost smooth, reddish, closely sheathing, later cupuliform, with a one-sided extension into an acuminate tip, 10–20 mm long; rachilla bracts strongly striate, tubular, later cupuliform with extension on one side ending into an acuminate tip, subtending 2 floral bracteoles; bracteoles cupuliform, subtending a fertile pistillate flower. Pistillate flowers seen young, ca 2 mm long; calyx valvate, with 3 ovate lobes, acuminate at apex, ca 1.5 × 1.0 mm; petals three, small, ovate, ca 2 by 1.8 mm; staminodes thin, connected at base, their filaments short, less than 0.5 mm long, and anther empty, sagittate, dorsifixed, yellow, short, ca 0.5 mm long; stigmas 3, reddish, ovate, short, ca 0.5 mm long. Fruits broadly ovoid to globose, 4–6 × 3–4 mm, with beak ca 1 mm long; scales narrowly elliptic to elliptic, in 8 vertical rows, yellowish with red-tinged acuminate tip. *Seed* oblong, ca 30 × 22 mm, to globose, ca 50 × 48 mm; endosperm ruminant.

Distribution

Peninsular Malaysia, Sumatra, Borneo (Brunei, Sarawak and Sabah).

Habitat and ecology

Lowland mixed dipterocarp primary forest to rocky hill slopes and ridges, in Sabah often in secondary forests and roadside 'belukar' (weedy vegetation of small woody plants) (Dransfield 1984), up to 1350 m altitude. Flowering: February, May to August, November, December; fruiting: January, February, April, September, November. Seemingly, this taxon can withstand areas affected by pollution as it was abundant in an open area in Mamut Copper Mine (Sabah) (Jopony and Tongkul 2009, van der Ent and Edraki 2016).

Specimens examined

Brunei: Kuala Belalong, Atria MAT 103A (L); Temburong, Gunong Retak, Johns 6509 (L). Indonesia: Sumatra, Aceh, Gunung Leuser Nature Reserve, de Wilde & de Wilde-Duyfjes 12847 (L). Malaysia: Kedah, Bukit Seblak-Weng, Furtado SFN 33068 (L); Sabah: Kabili-Sepilok, Atria MAT 025 (L); Kabili-Sepilok, Atria MAT 026 (L); Kabili-Sepilok, Atria MAT 027 (L); Kabili-Sepilok, Atria MAT 028 (L);

Kabili-Sepilok, Atria MAT 029 (L); Kabili-Sepilok, Atria MAT 030 (L); Kabili-Sepilok, Atria MAT 031 (L); Kabili-Sepilok, Atria MAT 033 (L); Kabili-Sepilok, Atria MAT 034 (L); Kabili-Sepilok, Atria MAT 036 (L); Kabili-Sepilok, Atria MAT 037 (L); Kabili-Sepilok, Atria MAT 038 (L); Kabili-Sepilok, Atria MAT 039 (L); Kabili-Sepilok, Atria MAT 056 (L); Kabili-Sepilok, Atria MAT 057 (L); Kabili-Sepilok, Atria MAT 058 (L); Kabili-Sepilok, Atria MAT 059 (L); Kabili-Sepilok, Atria MAT 060 (L); Kabili-Sepilok, Atria MAT 061 (L); Kabili-Sepilok, Atria MAT 062 (L); Ranau, Asin & Jarius SAN 121188 (L); Ranau, Amin & Jarius SAN 116575 (L); Keningau, Krispinus SAN 121886 (K, L); Keningau, Ag. Abas SAN 85869 (L); Ulu Tungud FR, Saw et al. SAN 146090 (K); Bukit Tenom, Moore & Meijer 9208 (L); Tambunan, Maikin & Joseph SAN 125852 (K). Keningau, along road Keningau-Kimanis, Vermeulen & Duistermaat 679 (L); Keningau, Kg. Bandukan, Clemens 5982 (K); Mt Kinabalu, J. & M.S. Clemens 27320 (L); Pensiangan, SAN (Jimpin) 139385 (K); Pinangah Tongod, Dewol & Mansur SAN107646 (K, L); Sandakan: Dransfield JD 5584 (L); Kinabatangan, Sundaling SAN 97700 (L); Sarawak: Sematan, Gn. Pueh, Dransfield et al. JD 5992 (L).

Notes

This taxon always has many (9–12) narrow leaflets, regularly arranged, subopposite and with a smooth or almost smooth leaf sheath. The appearance of the leaf sheath and leaflet arrangement is variable, but the most frequent form bears 10 or 11 subequidistant linear leaflets. The inflorescences resemble those of form *javensis* in the var. *javensis*, but those are mostly smaller or finer. The size of the fruit varies. Beccari (1908) stated that *C. acuminatus* is indistinguishable from some *C. javensis* varieties. The first author observed that *C. acuminatus* is similar to Beccari's *C. javensis* var. *polyphyllus* (Beccari 1908: pl. 40), but *C. acuminatus* has an almost smooth leaf sheath, smaller flowers and fruits and the bracts of the peduncle are more cupuliform. Beccari (1913) considered to treat this entity as a subspecies. However, several specimens with characters partly intermediate can still be recognized. Mega MAT 027 (Sabah) was identified as *C. javensis* var. *polyphyllus* as it exhibits the characters of var. *polyphyllus*, but the leaf sheath is almost smooth, like the leaf sheath of *C. acuminatus*. One sample, identified as *C. acuminatus* (Dransfield JD 5584), agrees with *C. acuminatus* in the almost smooth leaf sheath, numerous (9) leaflets and prickly peduncular bracts (in *C. javensis* var. *javensis* a robustly spiny leaf sheath, eight leaflets and spiny peduncular bracts), but the fruits are more ovoid, like *C. javensis* var. *javensis*, and not spherical as typical *C. acuminatus* (Dransfield 1984). In the phylogenetic analysis (Atria et al. 2020) it groups in group B, not even closely related to the rest of the *C. acuminatus* specimens. Other intermediate specimens have leaflets varying between lanceolate and narrowly elliptic and leaf sheaths ranging from smooth to moderately spiny; the inflorescence can range from fine to the size of typical *C. javensis* var. *javensis*. J & M.S. Clemens 27320 resembles typical *C. acuminatus*, but with a petiole to 17 cm long (absent in *C. acuminatus*).

Moore & Meijer 9208 has characters like *C. acuminatus*: a smooth leaf sheath, 11 subopposite leaflets, lowest pair swept back, no petiole, but the pistillate inflorescences resemble those of *C. javensis* var. *javensis*. In his description, [Beccari \(1908\)](#) mentioned that the female prophyll of *C. acuminatus* has a very conspicuous axillary callus at the insertion with the stem. However, this character is not typical for *C. acuminatus* as a unique *C. javensis* var. *javensis* specimen from Java (Kostermans 136) shows the callus too. As there are no constant differences between the two taxa, *Calamus acuminatus* is synonymized with *C. javensis* var. *polyphyllus* and recognized at the variety level. This variety is polyphyletic in the phylogeny ([Atria et al. 2020](#)).

Key to groups

(non-fitting specimens are form *Javensis*)

1. Stem slender, ca 5–6 mm in diameter with leaf sheath, 2–3 mm in diameter without leaf sheath; leaf sheath smooth, without spines..... 2
 - Stem slender to robust, 5–25 mm in diameter with leaf sheath, 2.5–10.0 mm in diameter without leaf sheath; leaf sheath with spines 5
2. Leaflets only 1 pair (flabellate) or 2 pairs (upper most pair biggest and flabellate) 3
 - Leaflets in 3–9 pairs; uppermost pair flabellate, not the biggest 4
3. Leaflets only 1 pair (2 pairs when juvenile), flabellate, joined for 1/2 of their length; abaxial midrib with few clawed spines group *Kemamanensis*
 - Leaflets in 2 pairs, the uppermost pair largest, forming a flabellum, joined for 3/4 of their length, penultimate pair always sub opposite to alternate; abaxial midrib smooth group *Impar*
4. Leaf sheath with corrugated horizontal lines, mostly connecting and forming a circle; flagellum thick, 20–30 cm long; leaf 25–37 cm long; petiole 2–10 cm long, with dark indumentum present on long petioles; rachis pilose, with abundant red hairs; leaflets in 3–5(–9) pairs, opposite (some subopposite), glabrous; terminal pair of leaflets joined for 1/4–3/4 of their length, not the biggest pair group *Corrugatus*
 - Leaf sheath smooth; flagellum very slender, ca 50 cm long; leaf up to 40 cm long; petiole very short, less than 2 cm long, floccose; rachis floccose; leaflets in 7 pairs, the middle pair alternate; both leaf margin and surface tomentose, with hairs whitish yellow, swollen-based; terminal pair of leaflets joined for 3/4 of their length, biggest of all pairs group *Hypertrichosus*
5. Leaflets in 2 or 3 pairs, terminal pair (flabellum) usually very big and the biggest pair 6
 - Leaflets in 4–13 pairs, terminal pair (flabellum) not always the biggest pair 8
6. Stem very short, to 1.5 m tall; flagellum absent; leaflets in 3 pairs, their surfaces floccose with yellow hairs; terminal pair of leaflets much bigger than the other pairs; abaxial main vein floccose, and with small spines on half part of the vein; pistillate inflorescence ca 20 cm long; all bracts abundantly floccose group *Acaulis*
 - Stem 2–10 m tall; flagellum to 1 m long; leaflets in 2 or 3 pairs, glabrous; terminal pair of leaflets not always the biggest; abaxial main vein glabrous; pistillate inflorescences ca 40 cm long; all bracts glabrous (unknown for form *Elopurensis*) 7
7. Stem to 10 m tall; flagellum up to 1 m long; ocrea with triangular limb, up to 6 cm long; leaves 27–50 cm long; petiole 9–15 cm long; leaflets in 2 or 3 pairs, if 2 pairs then all leaflets in rosette, if in 3 pairs, then the penultimate usually opposite; leaflets narrowly elliptic to broadly elliptic; staminate inflorescences more than 1 m long; prophyll ca 28 cm long, closely sheathing, smooth group *Elopurensis*
 - Stem 2–3 m tall; flagellum ca 60 cm long; ocrea apically truncate, short; leaves ca 32 cm long, petiole 4–5 cm long; leaflets in 2 pairs, the penultimate always subopposite to alternate, narrowly elliptic; staminate inflorescences very fine or slender, ca 56 cm long; prophyll ca 8 cm long, closely sheathing, but later with extended limb, sparsely armed with small, clawed spines group *Impar*
8. Petiole very short or absent; leaflets in 6 pairs, narrowly obovate to elliptic; pistillate rachillae short, congested, to only 2.5–5.0 cm long group *Congestiflorus*
 - Petiole usually longer, to 28 cm long, if absent or very short then leaflets in 8–13 pairs; leaflets in 4–13 pairs, narrowly elliptic to broadly elliptic; pistillate rachillae long (more than 5 cm) or not congested (unknown for form *Rubro-ochreatus* and form *Setosus*) 9
9. Leaflets abaxially with several setae along the veins, one long black seta on the main vein, ca 9 mm long group *Setosus*
 - Leaflets abaxially smooth 10
10. Flagellum and cirrus absent group *Rubro-ochreatus*
 - Flagellum present and cirrus absent or present 11
11. Ochrea absent or poorly developed, glabrous; pistillate inflorescence long, up to 1.8 m; prophyll to 25 cm long, later extended into an ovate limb, ca 4 cm long group *Amplijugus*
 - Ochrea conspicuous, hirsute with stiff hairs or spines, partly torn apart; pistillate inflorescence short, only 16–18 cm long; prophyll to ca 17 cm long, truncate, without limb group *Brevipaniculatus*

Informal groups in var. *javensis*

The synonyms pertaining to a group are only mentioned, the full nomenclature is provided under the species.

Group *Acaulis*

Representative specimen: Malaysia, north Borneo: Sarawak, Gunung Murud National Park, 15 September 1982, Yii Puan Ching S 44664 (K).

Non-climbing rattan. Stem very short, to 1.5 m tall; with leaf sheath ca 15 mm in diameter, without leaf sheath ca 10 mm in diameter. Leaf sheath abundantly floccose, moderately armed with flat, pointing, horizontal or upward pointing spines, to 15 mm long. Ocrea absent. Knee absent. Flagellum absent. Leaves ecirrate, ca 80 cm long; petiole long, ca 35 cm long, abundantly floccose, proximally armed with several flat, pointing spines up to 5 cm long, then with several small spines; rachis floccose, glabrous or with few horizontal, pointing black-tipped spines 5–9 mm long. Leaflets in 3 pairs, elliptic to broadly elliptic, acuminate at tip, hairy, with surfaces and margin tomentose with bulbous-based yellow hairs, conspicuously 3-nerved with transverse veins obvious; terminal pair very big, forming a flabellum, bifid, joined for 2/3, ca 33 by 4 cm, their main vein floccose on abaxial part, and with small horizontal, swollen-based spines only halfway to the vein, ca 1 mm long; penultimate pair close to flabellum, ca 29.0 × 5.5 cm; basal pair spreading, ca 25 × 5 cm, ca 15 cm below penultimate pair. Staminate inflorescences and flowers unknown. Pistillate inflorescences short, ca 20 cm long; all bracts abundantly floccose; prophyll tubular, glabrous, closely sheathing, extended into an elliptic limb ca 1.5 cm long; peduncular bracts tubular, glabrous or with few short spines, closely sheathing, later with an extended, split limb, ca 2 cm long; rachis bracts tubular, smooth, closely sheathing, later with an auriculiform limb to 6 mm long; rachillae 4–6 cm long; rachilla bracts very shortly tubular, later infundibuliform, with an ovate extension at one side, with tip acuminate, ca 2 × 1 mm.; prophyllar bracteoles striate, short tubular, explanate, subtending 2 flowers. Pistillate flowers ca 4.5 mm long; calyx valvate, deeply divided into 3 elliptic lobes; lobes ca 2.0 × 1.5 mm, acuminate at apex; petals 3, ovate, ca 4.5 × 1.0 mm; staminodes 6, thin; filaments triangular, 3 filaments attached to the petals, ca 3.5 mm long, the other 3 alternate to the petals, ca 2.5 mm long, connected at the base or at the middle, reddish; anther empty, sagittate, dorsifixed, yellow, ca 1.5 mm long; stigmas 3, curled. Fruits seen in young stage only, elliptic, ca 7 × 4 mm; beak to 1.8 mm long; scales ca 1.5 × 1.0 mm, in 10 vertical rows, light brown, with red margin and tip. Seed unknown.

Distribution

Borneo (Sabah & Sarawak).

Habitat and ecology

Mixed dipterocarp hill forest and lower montane forest; up to 1300 m a.s.l.

Other specimen examined

Malaysia: Sabah, Sipitang, Diwol & John et al. SAN 144483 (K, L).

Notes

'Group Acaulis' was called 'Form 3' in [Atria et al. \(2017\)](#). Unfortunately, the specimens did not yield usable DNA sequences and are absent in the phylogeny ([Atria et al. 2020](#)).

This entity differs from other specimens in the *C. javensis* complex, because it is stemless, has a peculiar arrangement of the floccose leaflets, and stigmas with a curled tip. Tomentose leaflets are also present in 'group Hypertrichosus', but the latter is climbing, has 7 leaflet pairs (3 pairs in this group) with a leaflet arrangement as in typical *C. javensis*.

The two specimens are both pistillate. SAN 144483 has leaflets without hairs, but there are remnants of hairs.

Group Amplijugus

Based on *Calamus amplijugus* J. Dransf., see nomenclature under species.

Clustering rattan. Stem robust, up to 15 m tall, 1.5–2.5 cm in diameter with leaf sheath, to 1 cm in diameter without leaf sheath. Leaf sheath moderate to densely armed with flat horizontal spines, up to 2.5 cm long. Ocrea absent or poorly developed, glabrous. Knee conspicuous. Flagellum ca 1.5 m long, armed with small, downward-pointing, black spines, solitary (not in groups). Leaves ecirrate, up to 65 cm long; petiole absent or very short; rachis moderately armed with small but stout, swollen-based spines, ca 3 mm long. Leaflets in 8–13 pairs, elliptic to broadly elliptic, conspicuously 3-nerved, with transverse veins not so obvious, acuminate at tip, regularly arranged, opposite to subopposite, abaxially smooth; the terminal pair forming a flabellum, joined for 2/3, 16.0–25.0 × 4.5–6.0 cm; median leaflets usually bigger than other pairs, 17–26 × 5–8 cm; the last 2 pairs amplexicaul, smaller, ca 8.0 × 2.5 cm. Staminate inflorescences and staminate flowers unknown. Pistillate inflorescences robust, up to 1.8 m long; prophyll tubular to 25 cm long, closely sheathing, later extended into an ovate limb of ca 4 cm, lower part with small clawed spines, upper part glabrous; peduncular bract tubular, closely sheathing, ca 60 cm long, sparsely armed with small clawed spines, upper part with longitudinal opening 2.5–10.0 cm long; rachis bracts tubular, armed with small, clawed, black-tipped spines, upper part asymmetrically extended into an acute tip, ca 4 cm long; rachilla very long, up to 25 cm; rachilla bracts first tubular, then cupuliform, extended on one side into an acuminate tip, striate, ca 2–3 mm long; floral bracteoles short-cupuliform, extended into 2 acute tips, striate. Pistillate flowers: pedicel short, 3–4 mm long; calyx valvate, shallowly divided into 3 broadly ovate lobes of ca 2.0 × 1.5 mm; petals 3, ovate, ca 2.5 × 1.0 mm; staminodes thin, 6, filaments valvate, connected at the base, with narrowly elliptic lobes; anthers empty; stigmas 3, curled. Fruit globose, 5–6 × 5–6 mm, or oblong, ca 5.0 × 3.5 mm, with beak to 1.5 mm long; scales narrow, ca 3 × 1 mm, acute to acuminate at tip, yellow with red or dark red lines along the margin and on the tip. Seeds broadly elliptic to globose, ca 4–5 × 3 mm; endosperm ruminate.

Distribution

Borneo (Brunei and Sabah, in latter especially abundant in Tawai Forest Reserve in Telupid district).

Habitat and ecology

In disturbed and primary mixed dipterocarp forest, areas with high relief, on ultrabasic soil and sediments; up to 300 m a.s.l. Flowering: January and May; fruiting: June to July.

Specimens examined

Brunei: Belait, Teraja FR, Atria MAT 109 (L); Teraja FR, Atria MAT 109C (L); Labi Mendaram, Dransfield JD 6548 (K). Malaysia: Sabah, Telupid, Tawai FR, Atria MAT 043 (L); Tawai FR, Atria MAT 044 (L); Tawai FR, Atria MAT 045 (L); Tawai FR, Atria MAT 046 (L); Tawai FR, Atria MAT 048 (L); Tawai FR, Atria MAT 049 (L); Tawai FR, Atria MAT 050 (L); Dengiranuk, Lugas 1600 (K); Sandakan, Bukit Silam, Perumal & Diwol S. SAN 134344 (K); Kabili-Sepilok, Puasa 6712 (K); Kampung Takutan, Tadong 320 (K).

Notes

This group can easily be recognized by its many pairs (8–13) of shiny, broadly elliptic leaflets, a long pistillate rachilla and narrow fruit scales.

Group *Brevipaniculatus*

Representative specimen: north Borneo, Sabah, Mt Kinabalu, Mesilau Cave, Chew & Corner RSNB 4835 (L).

Clustering rattan. Stem to 10 m tall, ca 8 mm in diameter with leaf sheath, up to 6 mm in diameter without leaf sheath. Leaf sheath robust with a triangular, flat, hairy margin, covered with spines, the latter swollen-based, mostly pointing but several bent upward, the longest up to 3 cm long. Ocrea conspicuous, partly torn apart, hirsute (covered with long stiff hairs) or spines. Knee conspicuous. Flagellum 35–60(–100) cm long. Leaves ecirrate, ca 56 cm long; petiole ca 5 cm long, armed with a few triangular ca 11 mm long spines; rachis floccose, sparsely armed with horizontal, flattened, 8–10 mm long, or clawed spines. Leaflets in 4–6 pairs, narrowly elliptic, conspicuously 3-nerved, with transverse veins conspicuous, along margin with soft spines, acuminate with ciliate tip, abaxially smooth; upper most pair forming a flabellum, joined for 1/2, ca 21 by 2.5 cm; penultimate pair largest, ca 25.0 × 3.5 cm, very close to the flabellum; the lowest pair when 4 pairs of leaflets not swept back across stem or spreading, ca 19.0 × 3.5 cm, when 6 pairs of leaflets then lowest pair swept back. Staminate inflorescences quite long, ca 25 cm long, when young with all bracts reddish; prophyll tubular, first with few small, clawed spines, later smooth, ca 12.5 cm long, with a narrowly elliptic limb to 4.5 cm long; peduncular bract tubular, closely sheathing, ca 35 cm long, armed with several clawed, swollen-based spines, later with extended elliptic limb to 5 mm long, subtending 5–7 partial inflorescences; rachis bracts tubular, closely sheathing, ca 6 cm long, later with ca 5 cm long limb, armed with dull brownish yellow, downward pointing, swollen-based spines which are up to 2 mm long; rachilla to 8 cm long; prophyll bracts smooth, tubular, up to 3 cm long, first closely sheathing, then loose, opening longitudinally with acuminate tip;

rachilla bracts strongly striate, cupuliform, with one side extended into acuminate tip; prophyllar bracteole strongly striate, cupuliform with 2 acute tips, subtending staminate flower. Staminate flowers young, inserted at ca 45°, ca 4 mm in diameter; calyx valvate, shallowly divided into 2 elliptic lobes of ca 3.0 × 1.5 mm; petals three, narrowly elliptic, ca 3 × 1 mm; stamens 6; filaments ensiform, brown, ca 2 mm long; anther sagittate, dorsi-versatile, yellow, ca 2 mm long; pistillode with 3 linear, reddish stigmas, ca 1.3 mm long. Pistillate inflorescences short, 16–18 cm long; prophyll tubular, ca 17 cm long, closely sheathing, truncate, armed with several small, clawed spines, gradually glabrous distally; peduncular bract ca 22 cm long; rachis bract ca 21 cm long, with an extended 2–3 cm long limb, narrowly elliptic, acute at apex, subtending 2 partial inflorescences, each with 4 or 5 rachillae, all bracts sparsely armed with small, clawed spines; subsequent rachis bracts tubular, closely sheathing, 10–18 cm long, later with ca 2.5 cm long narrowly elliptic limb, armed with small, brown, stout, clawed, swollen-based spines; rachillae up to 9 cm long, in one specimen twisted (Chew et al. 168); prophyll bracts smooth, tubular, closely sheathing, with several small, stout, black-tipped, swollen-based spines; rachilla bracts tubular, later with one side extending into an acuminate ca 2 mm long tip; floral bracteoles 2, strongly striate. Pistillate flowers ca 3 mm long, rather distantly arranged, ca 8 mm apart; calyx shallowly divided into 3 lobes; lobes broad-elliptic, ca 2.0 × 1.5 mm, obtuse-acuminate at apex; petals 3, slightly longer than calyx, elliptic, ca 2.5 mm long, acute at apex; staminodes 6, united into a ring at the base of the ovary, each with a free, empty anther; stigmas 3, reddish, fleshy; some pistillate flowers longer, up to 8 mm long; calyx like in other flowers but with swollen base; petals oblong, ca 6.0 × 1.5 mm, acuminate at apex; staminodes like in smaller flowers; anther hastate, ca 0.5 mm long; stigmas 3, ca 1 mm long, dark spotted, fleshy. Fruit ellipsoid, ca 15 × 10 mm, yellowish brown; beak to 2 mm long; scales ca 2 × 1 mm, in 10 vertical rows.

Distribution

Sumatra and Borneo (Sabah).

Habitat and ecology

In mossy montane heath forest, 1300–1800 m a.s.l. Fruiting specimens collected in February, April and July.

Specimens examined

Indonesia: west Sumatra, Payakumbuh, Gunung Sago, Mejia 2019 (K); central Sumatra, Kerinci, Aumeeruddy YA 308 (K). Malaysia, Sabah: Mt Kinabalu, Mesilau Cave, Chew & Corner RSNB 4835 (L); Mt Kinabalu, Mesilau river, Chew & Corner RSNB 7025 (K); Mt Kinabalu (eastern shoulder), Chew et al. 168 (K); Ulu Meligan, Diwol et al. SAN 144475 (K).

Notes

This group was called 'Form 4' in [Atria et al. \(2017, 2020\)](#). This group is easily recognized by its peculiar rough ocrea

texture, which is typically covered either with white setae or hirsute hairs or spines. Typical *C. javensis* almost always has a tubular, smooth, reddish and glabrous ocrea. Other characters that distinguish this form from typical *C. javensis* are the length of the pistillate inflorescences, which are shorter, up to only 18 cm and which have a twisted rachilla (especially specimen Chew et al. 168) and the flowers are rather far apart, while typical *C. javensis* usually has a longer pistillate inflorescences, up to 1.5 m long, with a straight rachilla and closely arranged flowers. Chew & Corner RSNB 4835, selected as representative specimen, has only 4 pairs of leaflets, but other specimens resemble the arrangement of *C. javensis* with 5 or 6 pairs of leaflets. The label of Chew & Corner RSNB 4835 states that the flowers are purple instead of the typical red of *C. javensis*.

This group differs from group *Elopurensis*, which also has 4 pairs of leaflets, in the staminate inflorescence: the rachilla is longer in group *elopurensis* (up to 14 cm versus ca 9 cm), the bracts are much longer in group *Elopurensis* (up to 16 cm versus ca 3 cm).

A short rachilla in the *C. javensis* complex is also shown by group *Congestiflorus*, but the latter has a short rachilla bearing very congested flowers. The leaflets in group *Congestiflorus* are obovate to elliptic and not narrowly elliptic as in group *Brevipaniculatus*. Beccari (1908, plate 41) described *C. javensis* var. *acicularis* (belonging to typical *C. javensis*) based on a slender specimen (SING 0192571*, collected by R. H. Hullet in 1890) which also has a short pistillate inflorescence with short rachillae, but the features of the leaf sheath, ocrea and leaflets are different from group *Brevipaniculatus*. In the *acicularis* group of *C. javensis* the leaf sheath is armed with scattered short horizontal spines, ocrea tubular and glabrous, leaflets in two pairs and there is a pair of acicular spines (3.0–3.5 cm long) inserted between petiole and leaf sheath.

Group *Brevipaniculatus* is apparently confined to higher altitudes, between 1300 and 1800 m a.s.l., while *acicularis* of form *javensis* was found in lowlands at ca 240 m a.s.l.

Group *Congestiflorus*

Based on *Calamus congestiflorus* J. Dransf., see nomenclature under the species.

Clustering rattan. Stem to 33 m high, ca 6 mm diameter with sheath, ca 4 mm diameter without sheath. Leaf sheath slightly striate, with scattered, small, flat, bulbous spines facing downward. Ocrea obvious, first tubular, later torn apart, up to 8 mm long. Knee conspicuous. Flagellum 28–60 cm long. Leaves ecirrate, 24–46 cm long; petiole very short or absent; rachis floccose, with several small, black-tipped, clawed spines. Leaflets in 6 pairs, narrowly obovate to elliptic, acuminate, tip with soft spines, with 3 main nerves and transverse veinlets conspicuous, margin glabrous; uppermost pair joined for ca 1/3, 12.0–17.0 × 2.0–3.5 cm; penultimate pair opposite, ca 1 cm below the terminal one, ca 15.0 × 3.5 cm; median pair subopposite to alternate, ca 7 cm below the penultimate one, ca 15 × 3 cm; lowest pair swept back across stem, 7.0–10.0 × 1.5–2.5 cm. Staminate inflorescence and flowers not known.

Pistillate inflorescences short, 27–40 cm long; prophyll tubular, mainly on the proximal part of 10–28 cm long, closely sheathing, with several small, clawed, black-tipped spines, limb ca 5 cm long; peduncular bract tubular, closely sheathing, ca 14 cm long, armed with scattered small black-tipped spines, subtending 2 partial inflorescences; bracts much longer or the same length as the partial inflorescence; rachis bracts tubular, closely sheathing, 10–15 cm long, distally armed with a few very small, black, clawed spines, either with a prickly lanceolate limb, up to 13.0 × 0.5 cm, or an oblong limb of ca 3.5 × 1.5 cm; prophyll bracts tubular, closely sheathing, floccose, ca 1.5 mm long or less, some with several short black spines, with ca 4 mm extension limb enclosing the rachilla; rachillae short, congested, 2.5–5.0 cm long; rachilla bracts very short, only ca 1 mm long, with conspicuous acuminate tip; floral bracteoles strongly striate, explanate. Pistillate flowers very close together (crowded); calyx valvate, deeply divided into 3 broad elliptic lobes, acuminate at tip; sepals ca 2 by 1 mm; petals 3, elliptic, ca 3.0 × 1.5 mm; staminodes thin, valvate, with 6 small elliptic lobes, ca 0.5 mm long; stigmas 3, curled. Fruit in young stage small, ca 4 mm long, with ca 8 diamond-shaped scales, of ca 2 × 2 mm, yellow, and white margin; beak ca 1.5 mm. Seed broadly ellipsoid, ca 7 × 5 mm to globose and up to 10 × 8 mm; endosperm ruminant.

Distribution

West Java, Borneo (Sabah and east Kalimantan).

Habitat and ecology

Flowering: February; fruiting: February, March and November.

Specimens examined

Indonesia: east Kalimantan, Maruwai, Kessler et al. PK 2688 (L); west Java: Ujung Kulon Reserves, Mt Pajung, Kostermans et al. 136 (L). Malaysia, Sabah: Telupid, Sapi Nangoh FR, Atria MAT 042 (SAN, L); Keningau, Crocker Range Nature Center, Atria MAT 079 (SAN, L); Crocker Range Nature Center, Atria MAT 080 (SAN, L); Nabawan, Dransfield JD 5635 (K); Pandewan, Mesopo river, SAN (Krispinus) 114061 (L); Sandakan, Tawau, SAN (Sundaling) 105576 (K).

Notes

This group, only represented by a single entry in the phylogeny of Atria et al. (2020), has a disjunct distribution and probably comprises parallel, locally evolved forms.

The group is easily recognized by its crowded and congested flowers due to the very short rachillae. A few specimens consigned to this group are somewhat intermediate with more typical *javensis*. SAN 105576 from Tawau (Sabah) has the closest resemblance with the type of *C. congestiflorus*, but it slightly differs in the smaller rachis limb that is oblong instead of lanceolate as in more typical group *Congestiflorus*. SAN 114061 (Pandewan, Sabah) has a similar rachis limb as in typical group *Congestiflorus*, but the prophyll is longer (ca 40 cm long) versus ca 15 cm in group *Congestiflorus*; and the

shape of the leaflets and their arrangement is closer to typical *Calamus javensis* than to group *Congestiflorus*.

Included is a specimen from west Java (Kostermans et al. 1936), because it also has a subtending oblong bract, a short pistillate inflorescence and a congested rachilla ca 4.5 cm long (versus up to 11 cm in typical *C. javensis*), but that is still longer than the rachilla in the Borneo specimens (only ca 2.0–2.5 cm).

Group *Corrugatus*

Based on *Calamus corrugatus* Becc., see nomenclature under the species.

Stem slender, ca 6 mm in diameter with leaf sheath, ca 2 mm in diameter without leaf sheath. Leaf sheath striate, glabrous (without spines), with corrugated horizontal lines, mostly connecting and forming a circle. Ocrea conspicuous, tubular, ca 2 cm long, floccose. Knee prominent. Flagellum 20–30 cm long. Leaves ecirrate, about 25–37 cm long; petiole 2–10 cm long, with few, small, clawed spines, with dark indumentum on the long petioles; rachis pilose, with abundant reddish hairs, sparsely armed with small, swollen-based, black-tipped, clawed spines, some in groups of 3. Flagellum thick, 20–30 cm long. Leaflets in 3–5(–9) pairs, opposite, some subopposite, narrowly elliptic, acuminate to caudate at apex, glabrous; terminal pair forming a flabellum, joined for 1/4–3/4, not the biggest pair, 9–13 × 2–3 cm; penultimate pair 2–4 cm below flabellum, 11.0–15.0 × 2.0–3.5 cm; 2 lower pairs swept back across stem, 7.0–11.0 × 2.0–2.5 cm and the lowest pair 5.0–7.5 × 0.5–2.0 cm. Pistillate flowers small, ca 3 mm high; calyx valvate, shallowly divided into 3 elliptic lobes, ca 1.5 × 0.8 mm; petals 3, narrowly elliptic, ca 3 × 1 mm; staminodes thin, 6, ca 2.5 mm long; filaments valvate, triangular; anther empty, sagittate, ca 1 mm long; pistil ca 3 mm long, with 3 stigmas, not curved.

Distribution

Borneo (Sarawak, central Kalimantan).

Habitat and ecology

In primary mixed, dipterocarp forest, secondary forest and heath forest, on (steep) slopes, soil with clay or sandstone, at low altitudes up to 900 m a.s.l. Flowering: March.

Specimens examined

Indonesia: central Kalimantan, Bukit Raya, 24 Nov. 1982, Mogeia 3615 (L). Malaysia, Sarawak: Mt Mattang, 8 Apr. 1981, Dransfield JD 5868 (L); Sabal Tapang, 19 May 1981, Dransfield JD 6080 (L); Semongoh FR, 9 July 1976, Dransfield JD 4930 (L). Lubuk Antu, 5 June 1993, Dransfield JD 1428 (K); Ulu Temalad, Hose mountain, 27 Mar. 1964, S (Ashton) 19775 (K).

Notes

This group has two unique characters, the corrugated ring-like lines on the sheaths and the complete absence of spines. However, the arrangement of the leaflets is similar to that

of typical *C. javensis*. The corrugate lines are not completely circular in all specimens. A specimen from central Kalimantan (Mogeia 3615) has the typical *Calamus javensis* feature of an incomplete corrugate leaf sheath. In the phylogeny (Atria et al. 2020) the three included specimens are para/polyphyletic in unsupported clades.

Group *Elopurensis*

Based on *C. elopurensis* J. Dransf., see nomenclature under the species.

Clustering rattan. Stem to 10 m tall, ca 5–8(–10) mm in diameter with leaf sheath, up to 2.5–5.0 mm in diameter without leaf sheath. Leaf sheath smooth or striated, moderately armed with small, clawed spines, or with spines short triangular-bulbous, or tubular and pointing horizontally, spines to 5 mm long. Ocrea conspicuous, tubular with triangular limb, reddish, up to 6 cm long. Knee conspicuous. Flagellum to 1 m long. Leaves ecirrate, about 27–50 cm long; petiole floccose, sometimes abundantly hairy, ca 9–15 cm long, with short, clawed, swollen-based, ca 3 cm long spines, some in groups or with triangular flat spines; rachis abundantly floccose, very short in specimens with only two pairs of leaflets and ca 13 cm long in specimens with three pairs, armed with a few small, stout, clawed, bulbous-based spines. Leaflets in 2 or 3 pairs, narrowly elliptic to broadly elliptic, glabrous (also abaxial main veins), conspicuously 3-nerved, with conspicuous transverse veins and smooth margin, acuminate with ciliate tip; when in 2 pairs, then penultimate pair forming a rosette with the terminal one and upper-most pair forming a big flabellum, joined for 3/4, ca 20–35 × 3–6 cm; penultimate pair ca 13–33 × 3–8 cm, very close to the flabellum; if in 3 pairs, then the flabellum 25–36 × 3–6 cm; penultimate pair usually opposite, narrowly elliptic to broadly elliptic, ca 33.0 × 6.5 cm; basal pair 8.0–24.0 × 2.5–6.0 cm. Staminate inflorescences long, more than 1 m; prophyll tubular, closely sheathing, smooth, ca 28 cm long; peduncular bract tubular, closely sheathing, ca 30 cm long, armed with several clawed, black, bulbous-based spines; rachis bract tubular, ca 20 cm long, with an extended ca 9 cm long limb, armed with small black, clawed, bulbous-based spines, subtending six partial inflorescences; subsequent rachis bracts floccose, tubular, closely sheathing, 13–15 cm long, older ones with a 3–5 cm long limb, armed with dark, downward-pointing and swollen based spines, up to 2 mm long; rachilla 8–12 cm long; rachilla bracts strongly striate, infundibuliform, with a 1-sided extension into an acuminate tip; floral bracteole strongly striate, cupuliform with 2 acute tips, subtending staminate flower. Staminate flowers, Pistillate inflorescences and flowers and fruits unknown.

Distribution

North Borneo (Sabah).

Habitat and ecology

Disturbed mixed, lowland dipterocarp forest, recorded from swampy hollows, 50–200 m a.s.l. Flowering: October.

Specimens examined

Malaysia, Sabah: Kinabatangan, Andersen & Rasit bin Abdullah 224 (K); Sandakan, Segaliud Lokan mile 42, Virgin Jungle Reserves, Dransfield JD 5774 (K); Danum valley, Dransfield 6265 (L); Ranau, Sani Sambuling 130 (K).

Notes

This group can easily be distinguished by the rosette of large leaflets and the peculiar rachis bracts with a long-extended limb to 9 cm. It should not be confused with group *Impar*, which also has few leaflets, but with a much narrower stem (ca 5 mm versus to 10 mm), and a different staminate rachilla (up to 12 cm in group *Elopurensis* versus ca 5 cm in group *Impar*).

Group *Hypertrichosus*

Based on *C. hypertrichosus* Becc., see nomenclature under the species.

Stem slender, ca 6 mm in diameter with leaf sheath. Leaf sheath smooth, striate, glabrous. Ocrea tubular, conspicuous, truncate. Flagellum very fine, ca 50 cm long. Leaves up to 40 cm long; petiole very short, less than 2 cm long, floccose (densely covered with dark woolly tufts of hairs); rachis floccose. Leaflets in 7 pairs, narrowly elliptic, acuminate at apex, with both margins and surfaces tomentose with swollen-based, whitish yellow hairs, conspicuously 3-nerved, with transverse veinlets not obvious; terminal pair forming a flabellum, joined for 3/4, ca 16 × 3 cm, bigger than all other pairs; penultimate pair ca 2 cm below the flabellum, subopposite to alternate; middle pairs alternate, 11.0–14.0 × 2.0–3.5 cm; 2 lowest pairs swept back across stem, 5.0–7.5 × 1.0–3.0 cm. Inflorescences, flowers and fruits unknown.

Distribution

Endemic in Borneo (Sarawak).

Habitat and ecology

Hill slope in lowland mixed dipterocarp forest; ca 25 m a.s.l.

Specimen examined

Malaysia, Sarawak, Semongoh FR, near Kuching, Dransfield JD 4637 (K, L).

Notes

Beccari (1913) described *C. hypertrichosus* based on a sterile specimen from Borneo; the type has leaflets in four pairs and a very long petiole (ca 30 cm long). Seemingly the type was a young plant, while the specimen examined is fully grown with leaves with seven pairs of leaflets in an arrangement that resembles typical *C. javensis*. The specimen studied only differs from typical *Calamus javensis* in having the leaflets covered with whitish yellow hairs.

This group was not represented in the phylogenetic analysis of Atria et al. (2020) as the DNA extraction failed.

Group

Based on *C. impar* Becc., see nomenclature under the species.

Stem 2–3 m high; ca 5 mm in diameter with leaf sheath, ca 3 mm in diameter without leaf sheath. Leaf sheath striate, some floccose, unarmed or sparsely armed with small, black-tipped, swollen-based spines. Ocrea conspicuous, closely sheathing, truncate, short. Flagellum ca 60 cm long. Leaves ca 32 cm long; petiole floccose, 4–5 cm long; smooth or with spines. Leaflets in 2 pairs, narrowly elliptic, glabrous (including abaxial vein), the upper-most pair largest, forming a flabellum, joined for ca 3/4, 23–26 × 2–3 cm; penultimate pair always subopposite to alternate, with one leaflet 0.5–4.0 cm below the flabellum, ca 17.0 × 1.5–2.5 cm. Staminate inflorescences very fine or slender, ca 56 cm long; prophyll tubular ca 8 cm long, closely sheathing, later with extended limb, sparsely armed with small, clawed spines; rachis bracts subtending inflorescences 2, 10.0–12.5 cm long, tubular, distally with an extended limb 1.0–1.5 cm long and longitudinally opening, armed with solitary, clawed, black-tipped spines; subtending 3 partial inflorescences; subsequent rachis bracts tubular, closely sheathing, up to 11 cm long, with extended limb up to 7 mm long, almost smooth or with few small clawed spines; rachillae ca 5 cm long; rachilla bracts striate, infundibuliform, ca 1 mm long, shorter in mature inflorescences, slightly extended on one side into a conspicuous acuminate tip, bent in some specimens, subtending one prophyllar bracteole, strongly striate, short-cupuliform, with two acute tips. Staminate flowers small, attached at 90° to the axis; 4–5 mm long; calyx valvate, tubular, deeply divided into 3 lobes; lobes elliptic, ca 1.0 × 0.8 mm, acute to acuminate at apex; petals slightly longer than calyx, oblong-elliptic, ca 3 × 1 mm, acute at apex; stamens 6, dorsi-versatile; filament triangular, tapering, ca 1.5 mm long; anther sagittate, yellow, ca 1.5 mm long; pistillode with 3 red, slightly falcate stigmas, ca 1.5 mm long. Pistillate inflorescences slender, ca 40 cm long; prophyll tubular, ca 17 cm long, smooth, with an ca 10 mm long extended lanceolate limb; peduncular bracts tubular, closely sheathing, ca 23 cm long, with few small clawed spines on swollen bases; rachis bracts tubular, closely sheathing, ca 20 cm long, with a small ca 8 mm long limb, subtending 2 rachillae; each rachilla 7–8 cm long; subsequent bracts tubular, more than 9 cm long, with a few brown, downward-pointing, swollen-based spines; prophyll bracts tubular, closely sheathing, 2–3 cm long, smooth or with one or two small bulbous-based spines; prophyllar bracteoles striate, first tubular then cupuliform, reddish, 2–3 mm long. Pistillate flower unknown. Fruits broadly elliptic, ca 8 × 6 mm, with yellow scales, latter in 10 rows, with reddish margin and beak; beak to 7 mm long.

Distribution

Peninsular Thailand, Malay Peninsula (Perak), Borneo (Sabah, east Kalimantan).

Habitat and ecology

In primary forest, often on steep hills or ridges, locally on ultrabasic soil with loose stones and boulders and thick layer of litter, or on bare rock in full sun; ca 900 m a.s.l. Flowering: February, April.

Specimens examined

Indonesia: east Kalimantan, Berau, Watanabe NMW 41 (K); West Java, G. Kendeng, Dransfield JD 1434 (L). Malaysia, Sabah: Ranau, Mt Kinabalu, de Vogel 8695 (L); Kinabalu, Lugas 14 (K); Ranau, Meijer SAN 21064 (K, L); Kampung Poring, Sambuling 115 (K); Kampung Poring, Sambuling 130 (K); Ranau, SAN (Amin et al.) 114102 (L); Kinabalu, Lugas 1626 (K); Perak: Kp. Tapah, Ave 136 (L). Thailand: Klóng Seang, Pangnga, Niyomdham 1253 (L).

Notes

The description of [Beccari \(1913\)](#) is here broadened by adding more variability. [Beccari \(1913\)](#) described *C. impar* as a taxon with a deeply bilobed flabellum, but also observed were specimens with the flabellate pair joined for 2/3rd. The type has the penultimate pair of leaflets alternate, with one leaflet growing directly below the flabellum and the other leaflet 4–5 cm further below. In a specimen from Sabah (SAN 21064), two forms of penultimate arrangement can be observed, one alternate with one leaflet closely attached to the flabellum and the other rather distant, but also opposite penultimate pairs in other leaves.

From typical *C. javensis* it differs in the number of leaflets and the arrangement. The penultimate pair in *C. javensis* is almost always opposite and close to the flabellum. Among other forms within the *C. javensis* complex, this taxon resembles group *Elopurensis* as both have a few pairs of leaflets (two pairs in group *Impar* and up to three pairs in group *Elopurensis*). The ocrea of group *impar* is said to be cylindrical and truncate, however, one specimen from Ranau, Sabah (*Sambuling 130*), has the typical group *Impar*'s conspicuous ocrea, closely sheathing, truncate and short, but the leaflet arrangement resembles group *Elopurensis*. Another specimen from Ranau, Sabah (SAN 114102), has two pairs of leaflets, one pair flabellate and the penultimate pair alternate but the upper leaflet not very close to the terminal pair, and it has an ocrea that resembles group *Elopurensis*. However, the size of the leaflets in group *Impar* is smaller than in group *Elopurensis* (up to 20 cm versus up to 35 cm long, respectively), moreover, in group *Elopurensis*, the staminate inflorescence has a conspicuous peduncle bract with a long limb up to 10 cm long, while in group *Impar* the peduncle bract is tubular, ca 13 cm long, closely sheathing, and with an extended limb to 2.5 cm long. These differences clearly segregate both forms.

Group *Kemamanensis*

Based on *C. kemamanensis* Furtado, see nomenclature under the species.

Slender clustering rattan. Stem ca 4 m long; ca 6 mm in diameter with leaf sheath, ca 3 mm in diameter without leaf sheath. Leaf sheath striate, glabrous. Ocrea conspicuous, tubular, to 1 cm long. Knee conspicuous. Flagellum ca 75 cm long, with small, clawed spines. Leaves ecirrate, 27–35 cm long; petiole floccose, 5–7 cm long, longer in juvenile plants, armed with clawed spines. Leaflets narrowly elliptic, in adult plants only 1 pair, flabellate, joined for 1/2, 26.0–29.0

× 4.5–5.0 cm, acute at apex, with setae, conspicuously 3-nerved, with transverse veins conspicuous and abaxial midrib with a few clawed spines. Staminate and pistillate inflorescence, flowers and fruits unknown.

Distribution

Endemic in Peninsular Malaysia (Trengganu).

Habitat and ecology

Hill dipterocarp forest; ca 350 m a.s.l.

Specimens examined

Malaysia: Kuala Trengganu, Ulu Nerus Forest Reserves, Dransfield et al. JD 6506 (K); Kemaman, Sungai Nipa, SFN (Corner) 30535 (K).

Notes

This is the only form with one pair of leaflets in adult plants; Corner's specimen is a juvenile specimen with two pairs of leaflets in a rosette. It was not included in the phylogenetic analysis of [Atria et al. \(2020\)](#) due to a DNA isolation failure.

Group *Rubro-ochreateus*

Representative specimen: north Borneo: Sarawak, Mt Mulu National Park, Dransfield JD 5301 (L).

Clustering rattan. Stem up to 3 m tall; ca 15 mm in diameter with sheath, ca 8 mm in diameter without sheath. Leaf sheath striate, robustly armed with flat spines, spines pointing horizontally or upward, some reaching up to 15 mm long. Ocrea conspicuous, persistent, to 3.5(–10.0) cm long, covered with abundant red hairs, torn apart. Knee inconspicuous. Flagellum absent. Cirrus absent. Leaves to 60 cm long; petiole up to 25 cm long, with a few, flat, horizontally pointing, 6–8 mm long spines; rachis striate, floccose, with a few pointed, black-tipped, up to 17 mm long spines with swollen base. Leaflets in 10 or 11 pairs, very regularly arranged, of more or less the same size except for the lowest pair, narrowly elliptic to elliptic, conspicuously 3-nerved, with distinct transverse veins and smooth margin, acuminate at apex; tip hairy, abaxially smooth; terminal pair joined for 1/2, ca 15.0 × 2.5 cm; lowest pair swept back across stem, ca 9.0 × 1.5 cm. Staminate inflorescences short, ca 20 cm long; bracts of inflorescence red floccose; prophyll smooth, tubular, closely sheathing, with swollen base, ca 7 cm long, with a small elliptic limb; rachis bract tubular, closely sheathing, glabrous, ca 4 cm long, later with an elliptic, ca 3 mm long limb, bearing 2 partial inflorescences; rachilla 3–4 cm long; prophyll bracts tubular, smooth, with 2 or 3 short swollen spines in the first part, then smooth, ca 2.5 cm long, with extended broadly ovate limb, ca 3 mm high, enclosing rachilla and subsequent bracts; floral bracteole warty, striate, shortly tubular, with a one-sided extension into a small acuminate tip; tip usually bent. Staminate rachilla borne on the 2nd branch of the inflorescence. Staminate flowers unknown. Pistillate inflorescences, flowers and fruits unknown.

Distribution

Borneo (Sarawak: Mt Mulu).

Habitat and ecology

Lower montane forest; 1200–1500 m a.s.l.

Other specimen examined

North Borneo: Sarawak, Mt Mulu National Park, Dransfield JD 5353 (L).

Notes

This group was called 'Form 1' in [Atria et al. \(2017\)](#). Unfortunately, the two specimens did not provide useful DNA and are lacking in the phylogenetic analysis of [Atria et al. \(2020\)](#).

Typical for this taxon are the short staminate inflorescences, the tubular, warty rachilla bracts, the lack of a flagellum and a cirrus. This taxon is clearly different from typical *C. javensis* in the leaves and arrangement of leaflets, leaf sheath features and all inflorescence bracts. *Calamus tenompokensis* resembles this taxon, but group *Rubro-ochreatus* differs in the smaller leaflets (ca 15 cm long, *C. tenompokensis* up to 35 cm long), the tubular and warty rachilla bracts (*C. tenompokensis*: explanate and smooth) and the staminate inflorescence borne on the 2nd branch (3rd branch in *C. tenompokensis*). The multivariate analysis by [Atria et al. \(2017\)](#) showed that the two specimens of group *Rubro-ochreatus* are far apart, one near the typical *javensis* cluster and the other one is outside this cluster; this indicates that the resemblance that unites them is only in the key characters mentioned.

Group Setosus

Representative specimen: Philippines: Luzon, Pampanga, Mt Arayat, Madulid et al. 7172 (L).

Slender rattan. Stem ca 8 mm in diameter with leaf sheath, ca 5 mm without sheath. Leaf sheath striate, moderately armed with cylindrical, pointing and flat spines, horizontal or some slightly directed upward. Ocrea not so obvious, torn apart, the remnant attached to the petiole. Knee conspicuous. Flagellum absent. Leaves ecirrate, ca 50 cm long; petiole smooth, ca 28 cm long, with horizontal stiff pointing spines ca 8 mm long; rachis smooth, with several scattered horizontal stiff pointing, black-tipped spines, up to 20 mm long. Leaflets in 6 pairs, opposite, grouped, narrowly elliptic, conspicuously 3-nerved with transverse veins distinct, at margin with short setae up to the apex, acuminate at apex, abaxial parts with few setae along veins and one black to 9 mm long seta on the main vein; the terminal pair could not be examined thoroughly; penultimate pair very close to the terminal one, opposite; the 3rd pair ca 7 cm below the penultimate one, close to the 4th pair of 12.0–14.0 × 2.0–2.5 cm; the basal two pairs close to each other, ca 7 cm below the middle pairs; the 5th pair ca 12 × 1 cm, the basal or 6th pair, ca 12 × 2 cm. Inflorescences, flowers, fruits unknown.

Distribution

Philippines (Luzon: Pampanga).

Habitat and ecology

In primary forest; ca 500 m a.s.l.

Notes

This group was formerly called 'form 2' in [Atria et al. \(2017, 2020\)](#).

Typical for this group are the long black setae on the abaxial side of the main veins of the leaf blades, and one long seta on each leaflet, a character not present in other groups within the *C. javensis* complex. The leaflets resemble the arrangement of typical *C. javensis*, but with quite long petioles and peculiar rachis spines. The ocrea of this group is not tubular as it is in typical *javensis*. In [Atria et al. \(2017\)](#), group *Setosus* was separated from the cluster of typical *javensis*, but as it is only represented by a single specimen with incomplete flower and fruit data, it cannot be described as taxon.

2. *Calamus tenompokensis* Furtado

***Calamus tenompokensis* Furtado (1935, p. 260)**

Calamus tenompokensis Furtado (1935, 260). Type: British north Borneo (= Sabah), Mt Kinabalu, Tenompok, towards Lumu, 5500 ft, C. Furtado (M.S. Clemens 28408) (holotype: SING-0056713* [photo image] over 2 sheets; iso A n.v., BM n.v., BO n.v., G-00039991* [photo image], K-000521383, NY n.v.).

Calamus nanus Burret, (1943) 818. Type: Malaysia, Borneo, Sabah, Mt Kinabalu, Gurulau Spur, J. & M.S. Clemens 50397 (lectotype: BM-000517233* [photo image], designated by [Henderson 2020](#), the holotype at B destroyed).

Clustering and moderate stem rattan. Stem erect, 2–4 m long; ca 3 cm in diameter with leaf sheath, ca 2 cm in diameter without sheath. Internodes short, less than 10 cm long. Leaf sheath abundantly covered with triangular, flat, horizontal, marginally hairy, black-tipped spines 1–5 cm long. Ocrea conspicuous, to 6 cm long, spiny. Knee poorly developed. Flagellum absent or short (rarely longer than 1 m). Leaves ecirrate, ca 1 m long; petiole angular, 22–37 cm long, with several flat, triangular, 1–5 cm long, spines and towards the distal part with short-clawed spines; rachis angular, floccose, with a few small, floccose, clawed spines. Leaflets in 8 or 9 pairs, regularly arranged, opposite, narrowly to broadly elliptic, conspicuously 3-nerved, with transverse veins conspicuous, along margin with small, black, soft spines (setae), acuminate at apex; terminal pair forming a flabellum, joined for 1/2–3/4, 18–23 × 2–6 cm; middle pairs 16–35 × 3–8 cm; lowest pair swept back across stem, 19–28 × 3–6 cm. Staminate inflorescences robust, up to 1 m long, but some short, only ca 25 cm long; prophyll short, ca 8 cm long, with longitudinal opening ca 5 cm long, indumentum present, with one or two short spines; peduncular bracts tubular, more than 16 cm long, extended on one side into an elliptic, acute, ca 6 cm long point, with small, black-tipped spines with swollen bases; rachis bracts smooth, tubular, closely sheathing, 15–30

cm long, including the upper part with long splitting limb to ca 5 cm long, subtending 3–5 partial inflorescences; rachillae 6–9, each rachilla 5–12 cm long; rachilla bracts short, (slightly) swollen, cupuliform, some explanate, with a one-sided extension into an acuminate tip, subtending one flower bract; floral bracteole not tubular. Staminate flowers alternate, 4–6 mm long; calyx valvate, divided into 3 lobes, tubular, swollen at base, elliptic, ca 2 × 1 mm, acute at apex; petals 3, oblong, 4.0–6.0 × 0.5–1.0 mm; stamens 6, dorsifixed, ca 5 mm long; filament ensiform, yellowish brown, ca 3.5 mm long; anther sagittate, light yellow, 2–3 mm long; pistillode with 3 reddish, apically slightly falcate, ca 1.5 mm long stigmas. Pistillate inflorescences to 80 cm long, bearing 2 partial inflorescences; prophyll short, ca 7 cm long, smooth or almost smooth, with a longitudinal opening of ca 9 cm; peduncular bracts tubular, at first closely sheathing, later splitting longitudinally into 2 limbs, ca 12 cm long, armed with stout, black-tipped, downward-pointing spines on very swollen bases, the latter 3–4 mm long, some in groups of 3; secondary bracts tubular, ca 10 cm long, closely sheathing, later split longitudinally, ca 18 cm long, subtending the inflorescence, with sparse, black-tipped spines on swollen bases, with a tendency to become clawed; rachis bracts tubular, closely sheathing, floccose, 6–9 cm long, armed with downward-pointing, yellowish spines, these on swollen bases, some in groups of 3, the upper part of the bract with long-splitting limb to ca 10 cm long, subtending 2 partial inflorescences; with 5 or 6 rachillae, each rachilla 4–6 cm long; prophyll bracts smooth, 5–6 mm long, at first short-tubular, later split into 2 or 3 broadly ovate 4–8 mm long limbs; rachilla bracts smooth, short, tubular, only ca 1 mm long, cupuliform, with a broad limb enclosing the young flower, two-keeled with acuminate tip, ca 4 mm long, subtending 2 floral bracteoles. Pistillate flowers 5–11 mm long; calyx valvate, shallowly divided into 3 lobes; lobes elliptic to broadly elliptic, 2.0–4.0 × 1.5–1.8 mm, acute to acuminate at apex; petals 3, elliptic, 2.0–5.0 × 0.5–3.0 mm; staminodes 6, thin, adnate to the base of the ovary, with a free, empty anther at the top; pistil with 3 stigmas, ca 1.5 mm long, reddish. Fruit unknown.

Distribution

Endemic to Borneo (Brunei, Sabah, Sarawak).

Habitat and ecology

In swampy places and steep slopes in lower montane forest and on ridges; 1300–1700 m a.s.l. Observations in the field showed that the rattan lives in moist and open areas on hill-sides. Flowering: January, August, September.

Other specimen examined

Brunei: Temburong, north ridge of Bukit Retak, Wong WKM 792 (K). Malaysia: Sabah: Tenompok FR, Atria MAT 053 (L); Tenompok FR, Atria MAT 054 (L), Tenompok FR, Atria MAT 055 (L); Mt Kinabalu, Ulu langanani, Chew et al. RSNB 1653 (K, L); Mt Kinabalu, Chew & Corner RSNB 1892 (L); Mt Kinabalu, Mesilau river, Chew & Corner

RSNB 4056 (K); Mt Kinabalu, Dransfield et al. JD 5707 (L); Mt Kinabalu, Pinosok, Dransfield et al. JD 5554 (K). Malaysia: Sarawak: Lawas, S (Lee) 52573 (L).

Note

Calamus tenompokensis can easily be distinguished from other forms within the *C. javensis* complex by its vegetative parts: its angular petiole and rachis, a very different leaf sheath appearance because of the massive and robust sheath, and the number and arrangement of the leaflets. *Calamus tenompokensis* has eight or nine pairs of large, elliptic leaflets, which are almost always regularly arranged. The staminate inflorescence resembles that of *C. javensis*, but the base of the calyx lobes is swollen. The pistillate inflorescences have rachilla bracts that are different in the broadly cupuliform limb (Chew & Corner RSNB 1892).

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Mega Atria: Conceptualization (lead); Data curation (lead); Formal analysis (lead); Funding acquisition (lead); Methodology (lead); Resources (lead); Validation (equal); Visualization (lead); Writing – original draft (lead); Writing – review and editing (equal). **John Dransfield:** Data curation (equal); Supervision (equal); Validation (lead); Writing – review and editing (equal). **Peter C. Van Welzen:** Conceptualization (equal); Data curation (equal); Formal analysis (supporting); Methodology (equal); Supervision (lead); Validation (supporting); Writing – review and editing (equal).

Supporting information

The Supporting information associated with this article is available with the online version.

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