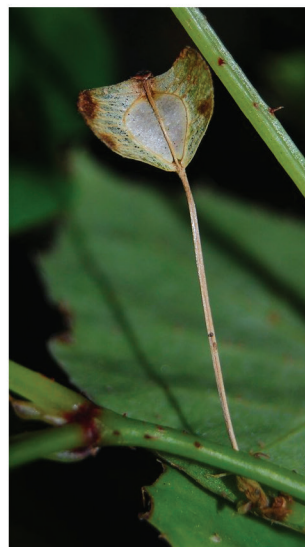
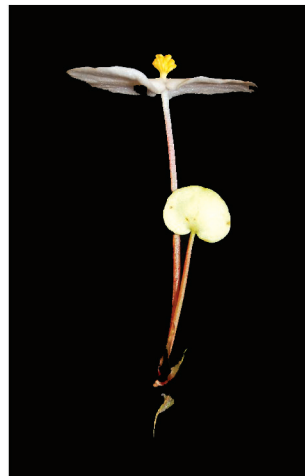




REINWARDTIA

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Correspondence on editorial matters and subscriptions for Reinwardtia should be addressed to:

HERBARIUM BOGORIENSE, BOTANY DIVISION,
RESEARCH CENTER FOR BIOLOGY–INDONESIAN INSTITUTE OF SCIENCES
CIBINONG SCIENCE CENTER, JLN. RAYA JAKARTA – BOGOR KM 46,
CIBINONG 16911, P.O. Box 25 CIBINONG
INDONESIA
PHONE (+62) 21 8765066; Fax (+62) 21 8765062
E-MAIL: reinwardtia@mail.lipi.go.id
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Cover images: *Begonia manuselaensis* Ardaka & Ardi. A. Plant habit in situ; B. Plant habit ex situ; C. Lamina abaxial surface with the small red scales on the veins; D. Stipules. E. Male inflorescence; F. Solitary female inflorescence; G. Male flower; H. Female flowers; I. Ovary cross section; J. Fruit. Source of materials: Wisnu Ardi, WI 104 (BO, KRB, SING). Photo credits: (B-J) by Wisnu Ardi; A: I.G. Tirta

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A PHENETIC STUDY OF THE *CALAMUS FLABELLATUS* COMPLEX (PALMAE) IN WEST MALESIA

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NASRIANTI SYAM

Plant Biology Graduate Program, Department of Biology, Faculty of Mathematics and Natural Sciences, Bogor Agricultural University, Darmaga Campus, Bogor 16680, Indonesia. Email: nasriantisyam@yahoo.com

TATIK CHIKMAWATI

Department of Biology, Faculty of Mathematics and Natural Sciences, Bogor Agricultural University, Darmaga Campus, Bogor 16680, Indonesia. Email: tchikmawati@yahoo.com

HIMMAH RUSTIAMI

Herbarium Bogoriense, Botany Division, Research Center for Biology, Indonesian Institute of Sciences, Jln. Raya Jakarta Bogor Km 47, Cibinong, Indonesia. Email: himmah@hotmail.com

ABSTRACT

SYAM, N., CHIKMAWATI, T. & RUSTIAMI, H. 2016. A phenetic study of the *Calamus flabellatus* complex (Palmae) in West Malesia. *Reinwardtia* 15(1): 27 – 41. — The number of species within the *Calamus flabellatus* complex is still under controversy because the taxonomic status of the species is not yet clear. Morphological observations were conducted on 119 collections of *Calamus* in the Herbarium Bogoriense (BO) and specimen images from the Singapore Herbarium (SING) and Kew Herbarium (K). The results showed that *C. flabellatus* complex (all species related to *C. flabellatus*) in West Malesia consisted of eight species and two varieties, i.e. *C. acuminatus*, *C. amplijugus*, *C. congestiflorus*, *C. corrugatus*, *C. flabellatus*, *C. hypertrichosus*, *C. javensis*, and *C. ruvidus*. They can be distinguished using several characters, i.e. leaf sheath, knee, ocrea, leaves, inflorescence, shape of fruit, number scale of fruit and seed. *Calamus flabellatus* var. *laevibus* and *C. flabellatus* var. *congestispinosus* are two new proposed varieties. Phenetic analysis of *C. flabellatus* complex in West Malesia divided all species into two major clusters with similarity coefficient of 46%.

Key words: Indonesia, new variety, palmae, rattan.

ABSTRAK

SYAM, N., CHIKMAWATI, T. & RUSTIAMI, H. 2016. Kajian fenetik *Calamus flabellatus* kompleks (Palem) di Malesia Barat. *Reinwardtia* 15(1): 27 – 41. — Hingga saat ini, tinjauan tentang jumlah jenis yang termasuk dalam *Calamus flabellatus* kompleks belum jelas, sehingga kedudukan takson masing-masing jenis yang berkerabat dekat dengan *C. flabellatus* belum diketahui dengan pasti. Pengamatan morfologi dilakukan pada 119 koleksi spesimen *Calamus* di Herbarium Bogoriense (BO), dan beberapa gambar spesimen berasal dari Herbarium Singapore (SING) dan Herbarium Kew (K). Hasil penelitian menunjukkan *C. flabellatus* kompleks (disebut *C. flabellatus* kompleks karena jenis-jenis yang dibahas lebih dekat dengan jenis *C. flabellatus*) di kawasan Malesia Barat terdiri atas delapan jenis dan dua varietas, yaitu: *C. acuminatus*, *C. amplijugus*, *C. congestiflorus*, *C. corrugatus*, *C. flabellatus*, *C. flabellatus* var. *laevibus*, *C. flabellatus* var. *congestispinosus*, *C. hypertrichosus*, *C. javensis*, dan *C. ruvidus*. Kelompok ini dapat dibedakan berdasarkan karakter pada seludang daun, lutut, okrea, daun, perbungaan, bentuk buah, jumlah sisik pada buah, dan bentuk biji. *Calamus flabellatus* var. *laevibus* dan *C. flabellatus* var. *congestispinosus* merupakan dua varietas yang diusulkan sebagai varietas baru. Analisis fenetik pada *C. flabellatus* kompleks di Malesia Barat membagi anggota kompleks tersebut menjadi dua kelompok besar dengan nilai kemiripan 46%.

Kata kunci: Indonesia, palem, rotan, varietas baru.

INTRODUCTION

Calamus is the largest genus of palms, comprising 374 species that are distributed from the humid tropics of Africa, India, Burma and South China through the Malay Archipelago to Queensland and Fiji (Dransfield *et al.*, 2008). In Indonesia this genus is widespread in Java, Sumatra, Kalimantan, Sulawesi, and Papua (Alrasjid, 1980).

Calamus was first described by Linnaeus in 1753, based on *Calamus rotang* collected by Burmman in Ceylon (Moore & Dransfield, 1979). In a monograph, Beccari (1908) classified

Calamus in the Malesian region into 16 groups based on four characters, i.e. the form of the leaflets, the presence or absence of a cirrus, the presence or absence of a flagellum in the sheath, and inflorescence structure. However, Furtado (1956) using an additional character, namely the comparative length of the inflorescence, divided *Calamus* into seven sections: *Afrocalamus*, *Coleospathus*, *Macropodus*, *Phyllantectus*, *Plathyspathus*, *Podocephalus*, and *Rhombocalamus*. Two new groups were added to Beccari's group, namely group XVII and XVIII or the *C. inops* group (Kramadibrata & Dransfield, 1992).

Calamus flabellatus is a species with wide morphological variation. The difficulty in understanding the *C. flabellatus* complex was stated by Dransfield (1979, 1984, 1992, 1997). He reported that *C. flabellatus* seemed to be related to 17 other species in Borneo and the Malay Peninsula, based on several characters such as whether apical leaflets were joined together for most of their length and if the leaves were eccirrate. This statement is consistent with Beccari's statement that *C. flabellatus* was related to 13 other species in West Malesia (Beccari, 1908), which are similar in several characters such as the lack of a cirrus and having simply furcated leaflets. On the other hand, Furtado (1956) classified *C. flabellatus* into the *Coleospathus* section in Malay Peninsula and considered that it was similar to 27 other species, mainly based on the joined apical leaflets. The differences of species number within the *C. flabellatus* complex in West Malesia indicates that the species within the group have not been satisfactorily delimited.

Most taxonomic accounts have provided reviews that contain a lot of useful information about *Calamus* in Malesia (Beccari, 1908; 1913; Furtado, 1956; Dransfield, 1979; 1984; 1992; 1997; Kramadibrata & Dransfield, 1992; Hender-

son, 2009; Rustiami, 2011). However, until recently there is no revision of the *C. flabellatus* complex in West Malesia, so the present research has aimed to resolve this taxonomic problem.

A consistent species concept in plant taxonomy is very important, especially for preparing a monograph. Palm taxonomists tend to use a morphological species concept where this may be expedient (Rustiami, 2009). This study aimed to determine the species diversity of the *C. flabellatus* complex, through analysing the phenetic similarities and clarifying the delimitation of species; provide the distribution of component taxa in the *C. flabellatus* complex; and provide an identification key to the taxa.

MATERIALS AND METHODS

Material observed in this study were 119 herbarium specimens of the *Calamus flabellatus* complex, that represented eight species *i.e.* *C. acuminatus* Becc., *C. amplijugus* J. Dransf., *C. congestiflorus* J. Dransf., *C. corrugatus* Becc., *C. flabellatus* Becc., *C. hypertrichosus* Becc., *C. javensis* Blume, and *C. ruvidus* Becc. All plant materials were collected from several areas in Sumatra, Java, Borneo and the Malay Peninsula and

Table 1. Morphological characters selected for phenetic analysis of the *Calamus flabellatus* complex in West Malesia.

No	Characters	Character set (code)
1	Habit	clustering (0), solitary (1)
2	Diameter of stem with sheath (cm)	≤ 1.5 cm (0), > 2 cm (1)
3	Diameter of stem without sheath (mm)	≤ 8 mm (0), > 10 mm (1)
4	Leaf sheath surface	Glabrous and smooth (0), spiny (1), corrugated (2)
5	Leaf sheath indumentum	absent (0), present (1)
6	Scales on leaf sheath surface	absent (0), present (1)
7	Solitary spines on leaf sheath	absent (0), present (1)
8	Grouped spines on leaf sheath	absent (0), present (1)
9	Triangular spines on leaf sheath	absent (0), present (1)
10	Stout claw-like spines on leaf sheath	absent (0), present (1)
11	Length of ocrea (cm)	≤ 1 cm (0), > 1 cm (1)
12	Ocrea with bristles	absent (0), present (1)
13	Knee	flat (0), inflated (1), folded (2)
14	Length of flagellum (m)	≤ 1 m (0), > 1 m (1)
15	Rachis indumentum of leaf	absent (0), present (1)
16	Number of leaflets	≤ 10 on each side of the rachis (0), > 10 on each side of the rachis (1)
17	Fusion of terminal leaflets	joined < 1/2 of their length (0), ≥ joined 1/2 of their length (1)
18	Surface of abaxial leaflets	glabrous (0), spiny (1)
19	Surface of adaxial leaflets	glabrous (0), spiny (1)
20	Spine on leaflet margin	absent (0), present (1)
21	Arrangement of leaflets	subdistant (0), distant (1)
22	Ocrea splitting position	opposite to petiole (0), opposite to flagellum (1)

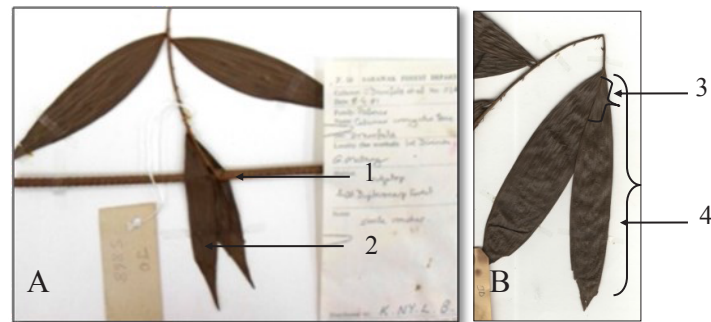


Fig. 1. Leaflet characters of *C. flabellatus* complex: A. Lowermost pair of leaflets swept back across the stem, petiole very short or absent, leaf pinnate at base, with opposite leaflets, shown for *Calamus corrugatus* (BO-0100415); B. Ratio of 3 and 4 = 1:4 in *C. flabellatus* var. *laevibus* (BO-0097347). 1. Stem, 2. Lowermost leaflet. 3. Length of fusion of apical leaflets, 4. Length of apical leaflets.

deposited in the Herbarium Bogoriense (BO). Some specimen images from Singapore Herbarium (SING) and Kew Herbarium (K) were examined.

Morphological Observations

A data matrix of characters was arranged according to standard species descriptions. The characters were coded as binary and multi state data. The observed morphological features included several characters of the stem, knee, ocrea, leaves, flowers, fruits and seed (Beccari, 1908; Furtado, 1956; Dransfield, 1979; 1986; 1992; 1997; Rustiarni *et al.*, 2011) (Table 1).

In this study, 22 characters consisting of qualitative and quantitative characters were selected for the phenetic study using cluster analysis (Table 1).

RESULTS AND DISCUSSION

Species diversity of *C. flabellatus* complex

The *Calamus flabellatus* complex was morphologically characterized by specific characters, *i.e.* leaves ecirrate, petiole very short or absent, leaf pinnate at base with leaflets of different sizes, lowermost pair of opposite leaflets swept back across the stem (Fig. 1A), apical leaflets joined for 1/4 to 2/3 of their length (Fig. 1B).

Based on this study, the *C. flabellatus* complex consists of eight species, *i.e.* *C. acuminatus*, *C. amplijugus*, *C. congestiflorus*, *C. corrugatus*, *C. flabellatus*, *C. hypertrichosus*, *C. javensis* and *C. ruvidus*. *Calamus flabellatus* shows much variation in morphological characters, such as leaf sheath indumentum, knee characters and the fusion of apical leaflets. Two varieties of *C. flabellatus*, are proposed namely, *C. flabellatus* var. *laevibus* and *C. flabellatus* var. *congestispinosus*.

When considered together, Beccari, Furtado and Dransfield have stated that in West Malesia *C. flabellatus* was closely related to 36 species (Beccari, 1908; 1913; Furtado, 1956; Dransfield,

1979; 1984; 1992; 1997). However, in this phenetic study, only eight distinct species were found to be included in the *C. flabellatus* complex. A reduced number of species is recognised for the *C. flabellatus* complex because of the broader delimitation recognised. Only stable characters were used to delimitate each species.

Distribution of *C. flabellatus* complex

The *C. flabellatus* complex is distributed in West Malesia. It can be found in lowland Dipterocarp forest, alluvial forest river, valley bottoms, hill slopes, disturbed primary forest and limestone forest. Its vertical distribution ranges over an elevation of 80–2000 m asl.

Two species of the *C. flabellatus* complex are more widely distributed, but most species are quite narrowly restricted. *Calamus javensis* is one of the widespread species. In Sumatra, *C. javensis* occurs in Aceh, North Sumatra, as well as South Sumatra and West Sumatra. In Java this species was found in Ungu Kulon (Banten) and West Java. In Borneo this species occurs throughout including South Kalimantan, East Kalimantan, West Kalimantan, Central Kalimantan, Brunei, Sabah and Sarawak (Malaysia). In Borneo, Java, Singapore, Sumatra and Peninsular Malaysia, it is found in both lowland and mountain rain forest, *ca.* 1200 m elevation (Henderson, 2009). It also occurs in South Thailand, and in the Philippines it has been recorded in Palawan and Bataan, and on Mt. Arayat in Pampanga at Chromite mine site (Baja-Lapis, 2010). *Calamus javensis* can grow in all forest types except mangrove (Dransfield, 1992).

Calamus flabellatus has the widest distribution after *C. javensis*. Its occurrence is scattered throughout West Malesia except in Java. In contrast, *Calamus acuminatus*, *C. amplijugus*, *C. corrugatus*, *C. congestiflorus*, *C. hypertrichosus* and *C. ruvidus* are much more restricted in distribution in Borneo.

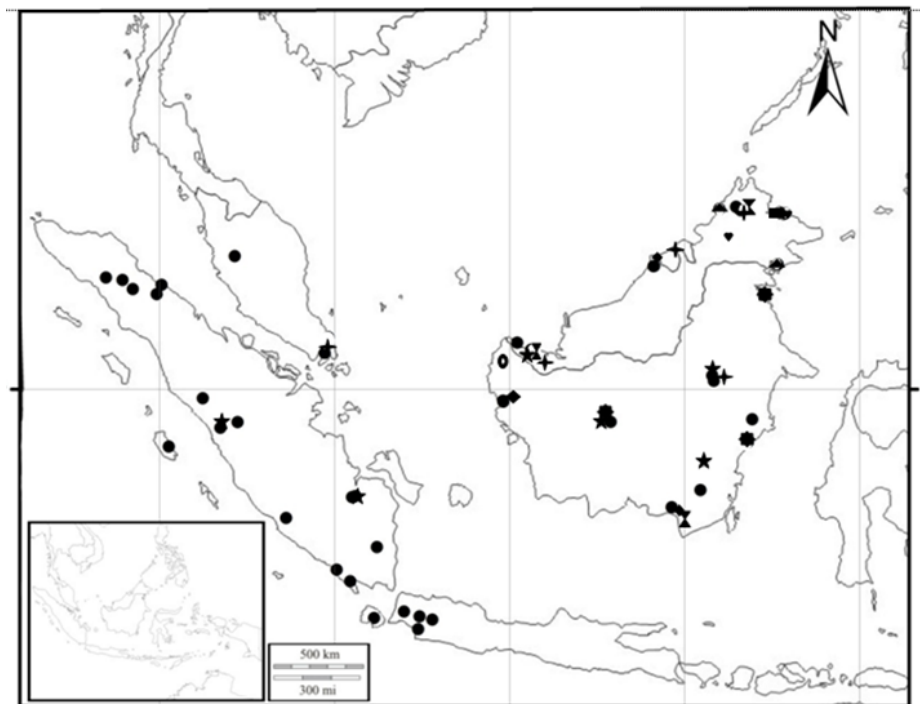


Fig. 2. Distribution of *C. flabellatus* complex in West Malesia ▲ *C. acuminatus*, ■ *C. amplijugus*, ♥ *C. congestiflorus*, ✕ *C. corrugatus*, ★ *C. flabellatus*, + *C. flabellatus* var. *laevibus*, * *C. flabellatus* var. *congestispinosus*, ○ *C. hypertrichosus*, ● *C. javensis*, ◆ *C. ruvidus*.

Calamus acuminatus, an endemic species in Sabah, can be found in Dipterocarp forest. *Calamus amplijugus* can grow in lowland dipterocarp forest in valley bottoms and hill slope in Brunei and Sabah, possibly also in Sumatra (Dransfield, 1997). *Calamus congestiflorus*, an endemic species at Nabawan, grows in the fringe of a swamp in transitional forest between lowland dipterocarp forest and kerangas; and at Sapa Payau, a non reproductive plant was found in similar habitat (Dransfield, 1984). *Calamus corrugatus* is found in mixed dipterocarp forest and forest transitional to kerangas, from sea level to 900 m asl, and endemic to the area including Mt. Pueh, Mt. Matang, Bako, Sabal Tapang, Semengoh, and the Hose Mountains in Sarawak. So far, this species has not been found in other locations (Dransfield, 1992). *Calamus hypertrichosus* is endemic at Semengoh, Sarawak, collected on a hill slope in lowland mixed dipterocarp forest (Dransfield, 1992). *Calamus ruvidus* is found in the Lambir hills, north Sarawak, growing in alluvial forest 500 feet altitude, also endemic to Borneo.

Based on our observations, the species with wider distribution have greater morphological variation in a number of features; on the other hand, species with limited distribution have a more constant morphological expression. The morphological variations were particularly noted in the

spine arrangement on the leaf sheath, leaflets and fruit shape.

Morphological variation of *C. flabellatus* Complex

Calamus flabellatus complex has high variation in morphological characters. They can be distinguished using several characters, *i.e.* leaf sheath indumentums, form of knee, length of ocrea, shape, surface, margin and total number of leaflets, flower, shape and size of fruit, and total scale of fruit (Table 1).

Habit and Stem

The habits of all species are generally clustered, with less than 1 cm in diameter, but *C. ruvidus* has solitary and clustered stems, with diameter up to 3 cm. The internode length of *C. flabellatus* complex varies from 9 to 25 cm long. Most species of *C. flabellatus* complex climbs up to 20 m, but *C. hypertrichosus* climbs up to 3 m, and *C. javensis* generally climbs up to 7 m.

Indumentum

The stems of some taxa in the *C. flabellatus* complex are covered by indumentum, such as scales or hairs on the leaf sheath, leaf rachis and inflorescence peduncle. Whereas *C. flabellatus* has no indumentum, *C. javensis* has much variation in its indumentum density.

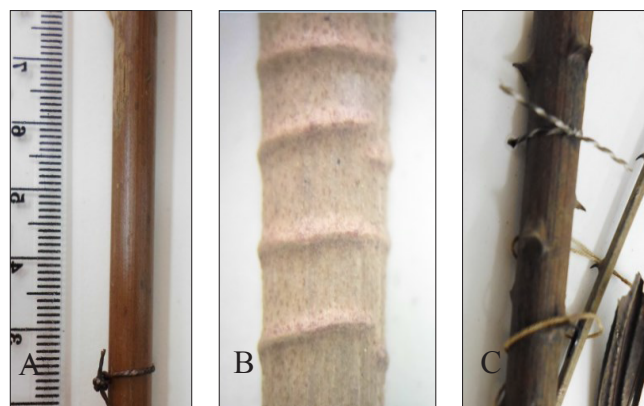


Fig. 3. Leaf sheath variations of *C. flabellatus* complex. A. Smooth on *C. flabellatus* var. *laevibus* (BO-0097347); B. Corrugated on *C. corrugatus* (BO-0100415); C. Spiny on *C. flabellatus* (BO-0063380).

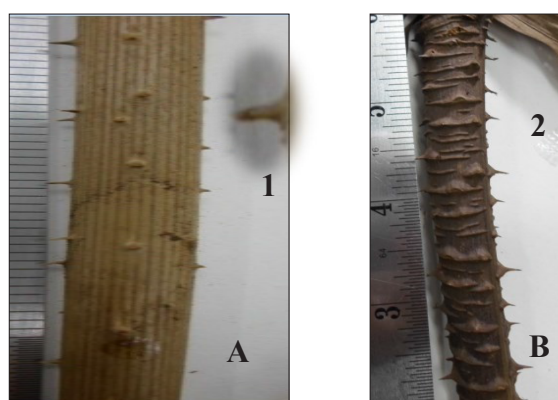


Fig. 4. Spine type on leaf sheath of *C. flabellatus* complex. A. Solitary spine on *C. javensis* (BO-0102145); B. Groups of spines on *C. flabellatus* var. *congestispinosus* (BO-0100195). 1. Solitary spine; 2. Groups spines.

Spines

Most species of *C. flabellatus* complex have spines on their leaf sheaths, but *C. flabellatus* var. *laevibus*, *C. hypertrichosus* and *C. corrugatus* have no spines. *C. flabellatus* var. *laevibus* has glabrous leaf sheaths, while *C. corrugatus* has corrugated leaf sheaths (Fig. 3).

Spine are solitary or in groups (Fig. 4). Solitary spines on leaf sheaths were found in *C. acuminatus*, *C. amplijugus*, *C. congestiflorus*, *C. flabellatus*, and *C. javensis*. Groups of spine occurs only in *C. ruvidus* and *C. flabellatus* var. *laevibus*.

The shape of spine on the leaf sheath can be triangular or stout and claw-like. Triangular spine occurs in *C. ruvidus*, but sometimes can be found in *C. javensis*. Stout claw-like spines are found in *C. congestiflorus*. The orientation of spines on leaf sheaths is also varied, horizontal to descending (oriented towards the top of the sheath), and ascending (oriented towards the sheath base) (*C. ruvidus*) as well as irregular spine direction (*C. acuminatus*, *C. flabellatus* and *C. javensis*) (Fig. 5). Spine size is also varied. It is relatively small and homogenous in size such as in *C. acuminatus*, *C. congestiflorus*, and *C. flabellatus*. *Calamus amplijugus*, *C. javensis* and *C. ruvi-*

dus has various sizes of spines, including small to large spines.

Ocrea

All species of the *C. flabellatus* complex are generally ocreate. The ocrea of *C. flabellatus* complex are varied in their form and size. The ocrea form is long (*C. acuminatus*), long with bristles (*C. javensis*), tiny with hairs or bristles (*C. amplijugus*, *C. congestiflorus*, *C. corrugatus* and *C. hypertrichosus*) and short ocrea type (*C. flabellatus*, *C. flabellatus* var. *congestispinosus*, *C. flabellatus* var. *laevibus*, *C. hypertrichosus* and *C. ruvidus*). The ocrea size is up to 5 mm long in all species, except *C. acuminatus* which has an ocrea up to 2.8 cm long and *C. javensis*, in which the ocrea is up to 1 cm long.

Knee

The leaf-sheath knee is varied in its form. An inflated type was found in *C. acuminatus*, *C. amplijugus*, *C. flabellatus*, *C. flabellatus* var. *laevibus*, *C. javensis*, *C. hypertrichosus* and *C. ruvidus*. A flat type was found in *C. congestiflorus* and a folded knee occurs in *C. corrugatus*.



Fig. 5. Spine direction on leaf sheath of *C. flabellatus* complex. A. horizontal to descending, and ascending on *C. ruvidus* (BO-0104187); B. irregular spine direction on *C. javensis* (BO-0123022).

Flagella

The flagellum is born on the opposite or lateral side of the petiole. Flagella vary in length, 1–2.5 m, but the flagella of *C. corrugatus*, *C. hypertichosus* and *C. javensis* are shorter, reaching only ca. 60 cm long.

Leaves

Leaves in the *C. flabellatus* complex are ecirrate, 20–60 cm long, but leaves of *C. ruvidus* are longer, up to 80 cm long or more. The leaflet shape of most species is broadly lanceolate, but *C. acuminatus* and *C. ruvidus* leaflets are narrowly lanceolate. Generally the number of leaflets is 3–7 on each side of the rachis, but *C. acuminatus* and *C. ruvidus* have up to 12–20 leaflets on each side. The leaflet surfaces are generally glabrous, except *C. hypertrichosus* which has leaflet surfaces densely covered with soft pale hairs.

Inflorescences

The inflorescences of *C. flabellatus* complex are born opposite to the petiole, 20–200 cm long, with 6 or more partial inflorescences. The inflorescence is adnate to the internodes and leaf sheath of the following leaf. Staminate and pistillate inflorescences are superficially similar, but the staminate inflorescence usually branches to 3 orders and the pistillate inflorescence branches to 2 orders only (Dransfield, *et al.*, 2008). The staminate inflorescence has male flowers only, whereas pistillate inflorescence bears dyads (pairs of flowers), consisting of a female flower and a sterile male flower (Fig. 6).

Peduncles

Peduncles also vary in shape and size. The peduncle shapes are cylindrical to tubular shape, 9–80 cm long, but *C. javensis* has shorter peduncles than other species, ca. 9 cm long. *C. ruvidus* has peduncles up to 80 cm long, but in the other species (*C. acuminatus*, *C. amplijugus*, *C. congestiflorus*, *C. flabellatus*, *C. flabellatus* var. *laevibus*, *C.*

flabellatus var. *congestispinosus* and *C. javensis*) the peduncle is only 18–46 cm long.

Prophylls

The prophyll encloses the base of the partial inflorescence. The prophyll shapes of *C. flabellatus* complex are varied, tubular and cylindrical. The prophyll is up to 90 cm long. *Calamus acuminatus*, *C. congestiflorus*, *C. javensis* and *C. ruvidus* have prophyll longer than peduncles. The mouth of the prophyll is generally sloping, except *C. ruvidus*, which has an oblique prophyll mouth. The spines on prophyll are varied in structure and shape. The spines are solitary or in groups. The spine shapes are triangular or stout claw-like.

Rachis bracts

Most species have tubular to infundibuliform rachis bracts. Rachis bracts enclose part of the inflorescence rachis to various lengths (the inflorescence rachis is unenclosed in *C. amplijugus*, *C. flabellatus*, *C. javensis*, *C. ruvidus*, enclosed < 1/6 part in *C. acuminatus*, enclosed about 1/3 part in *C. congestiflorus*). The spines of rachis bracts are generally scattered on the abaxial surface, except in *C. ruvidus*, which has a smooth rachis bract surface.

Rachilla bracts

The number of rachilla bracts in most species varies from 3–9, but *C. ruvidus* has up to 27 rachillas and bracts. The surface of rachilla bracts is covered by solitary spines, but *C. flabellatus* var. *laevibus* has glabrous rachilla bracts and *C. ruvidus* has hairy rachilla bracts.

Flowers

The staminate flower is 2–2.5 mm long, and 1–1.5 mm wide. The calyx of staminate flower is shorter than its corolla (Fig. 6A). There are two types of staminate calyx found *i.e.* campanulate or rounded at the base. The calyx apex has 3 lobes, up to 2 mm long, with entire margin. The corolla consists of 3 lanceolate small petals. The size of

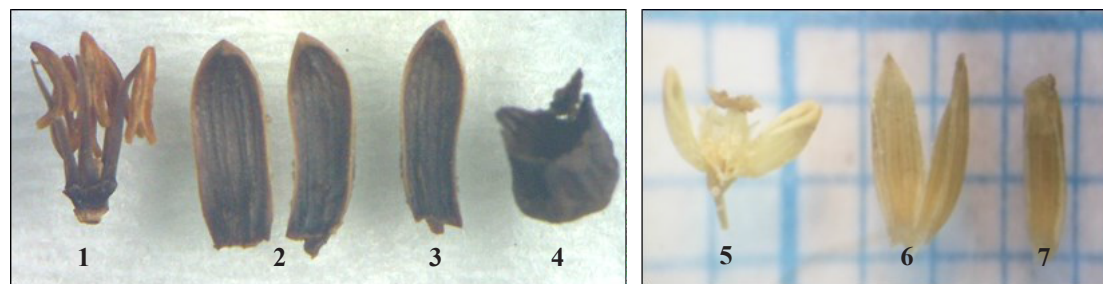


Fig. 6. Staminate and Pistillate flowers of *C. flabellatus* complex. A. Staminate flower of *C. javensis* (BO-0123022); B. Pistillate flower of *C. flabellatus* var. *congestispinosus* (BO-0100199). 1. Stamen; 2. Pistil; 3. Corolla; 4. Calyx; 5. Filament; 6. Anther; 7. Stigma.



Fig. 7. Shape of fruits and seeds of *C. flabellatus* complex. A. Ovoid in *C. acuminatus* (BO-0009150) and B. Spherical in *C. flabellatus* (BO-010200) 1. Fruit; 2. Seed.

each petal is 2 mm long, and 1 mm wide. All species have 6 stamens with basifixed anthers. The stamen with anther is 1.7 mm long, and the filament is up to 7 mm long, but pistillode is up to 2 mm long.

The pistillate flower is 2–3.2 mm long, and 1–2 mm wide (Fig. 6B). The calyx of a pistillate flower is campanulate or rounded at the base, 3 lobed at the apex. Its tube is up to 2.5 cm long, and 1.5 mm in diameter, with triangular lobes, with an acute point to 2 mm long. The corolla consists of 3 lanceolate petals, each 1.8 – 3 mm long. The pistil is 1.2 mm long, including a stigma *ca.* 1 mm long, and style is 1.1 mm long. *C. javensis* pistillate flower has shorter size than that staminate flower.

Fruit and seeds

The fruit typically has 1 seed, and is covered in vertical rows of reflexed scales, and there is often a beak at the top of the fruit, tipped by the remains of the stigmas, while the remains of sepals and petals are found at the base of the fruit (Dransfield, 1992). Fruits are broadly ovoid in *C. acuminatus*, spherical in *C. flabellatus* (immature) and *C. congestiflorus*, rounded in *C. amplijugus*, ovoid to spherical in *C. javensis*. Fruit of other five species are unknown because of incomplete material. The fruit scales they are arranged in 10–15 vertical rows, but in *C. flabellatus* is arranged in 10–12 vertical rows. The endosperm is homogeneous (Fig. 7).

TAXONOMIC TREATMENT

Calamus

Calamus Linnaeus, Sp. Pl. (1753) 325; Gagnep. & Conrard, Indo-Chine 6 (1973)1014; Hodel & Vatch., Palms and Cycads of Thailand (1998) 20; Evans *et al.*, Kew Bull. 57 (2012) 1; J. Dransf. *et al.*, Thai Forest Bull., Bot. 32 (2004) 36; J. Dransf. *et al.*, Genera Palmarum ed. 2 (2008) 191; A.J.Hend., Palms of Southern Asia (2009) 38. – *Palmijuncus* Rumph. Ex Kuntze, Revis. Gen. Pl. 2: 731. 1891, *nom. illeg.* – *Rotanga* Boehm., Defin. Gen. Pl. 395. 1760, – *Rotang* Adans., Fam. Pl. 2: 24. 1763. – *Zalaccella* Becc., Ann. Roy. Bot. Gard. (Calcutta) 12 (1908) 496; – *Calospatha* Becc., Ann. Roy. Bot. Gard. (Calcutta) 12 (1911) 232; – *Cornera* Furtado, Gard. Bull. Singapore 14 (1995) 525.

Solitary or clustering, stemless to high climbing or erect pleonanthic dioecious rattans; sheaths usually heavily armed with spines, the spines frequently highly organised. Flagellum (sterile inflorescence) often present, born on the leaf sheath, sometimes absent and replaced by a cirrus at the end of the leaf, very rarely both present or both absent; knee often present; ocrea sometimes well developed, usually inconspicuous. Male and female inflorescence superficially similar, often ending in a long flagellum, sometimes with gradual succession of branches, often with discrete distant branches (partial inflorescences); bracts

Key to species of the *C. flabellatus* complex in West Malesia

- | | | | |
|---|----|--|--------------------------|
| 1 | a. | Leaf sheath with spines | 2 |
| | b. | Leaf sheath without spines | 7 |
| 2 | a. | Length of ocrea < 1 cm | 3 |
| | b. | Length of ocrea ≥ 1.2 cm | 4 |
| 3 | a. | Knee elongate folded | <i>C. acuminatus</i> |
| | b. | Knee elongate inflated but not folded | <i>C. javensis</i> |
| 4 | a. | Leaf sheath covered by groups of spines..... | <i>C. ruvidus</i> |
| | b. | Leaf sheath covered by solitary spines | 5 |
| 5 | a. | Ocrea splitting opposite to the petiole | <i>C. amplijugus</i> |
| | b. | Ocrea splitting opposite to the flagellum | 6 |
| 6 | a. | Internodes up to 11 cm, knee flat, fruit scales in up to 21 vertical rows..... | <i>C. congestiflorus</i> |
| | b. | Internodes up to 20 cm, knee inflated, fruit scales in up 10–12 vertical rows... | <i>C. flabellatus</i> |
| 7 | a. | Leaf sheath corrugated, surface and margin of leaflets glabrous | <i>C. corrugatus</i> |
| | b. | Leaf sheath smooth (not corrugated), surface and margin of leaflets hairy | <i>C. hypertrichosus</i> |

always tubular at the base, rarely with broad limbs splitting down one side, but if so, the base always tubular and unsplit, bracts variously armed; partial inflorescences usually much longer than the subtending bract, very rarely shorter, involucre and involucrophore inconspicuous. Male flower with cup-shaped calyx, usually with 3 well defined lobes; corolla split almost to the base into 3 petals; stamens 6, very shortly epipetalous; pistilode minute. Female flower born together with a sterile male flower as a pair. Sterile male flower like the fertile male, but with empty anthers. Female flower usually larger than the male, with calyx shallowly 3-lobed; corolla with 3 petals; staminodes 6, joined basally to form a ring; ovary tipped with 3 stigmas and covered with reflexed scales. Seed usually one only, very variable in shape, covered in a thin to thick sarcotesta; endosperm homogenous or ruminant; embryo basal or lateral. Seedling leaf bifid or pinnate (Dransfield *et al.*, 2008).

Distribution. With about 374 species, *Calamus* is the largest palm genus. It has very wide distribution, found in equatorial Africa, India, the Himalayan foothills to south China, throughout Southeast Asia to the western Pacific Islands and Australia (Dransfield *et al.*, 2008).

Habitat. This genus can be found from sea level to over 3000 m asl. Most of the species are adapted to primary and secondary tropical rain forest.

Uses. Cane of several *Calamus* are collected commercially for tying and basket.

Synopsis of *C. flabellatus* complex in West Malesia

1. *Calamus acuminatus* Becc.

Calamus acuminatus Becc. Ann. Roy. Bot. Gard. Calcutta 11 (Suppl.) (1913) 16; *C. acuminatissimus* Becc. ex Gibbs. J. Linn. Soc. Bot. 242 (1914) 170; Dransfield Ratt. Sabah (1984) 138. –Type: Borneo, British North Borneo, January 1910, *L. S. Gibbs* 4349 (Suppl. Plate 9, Ann. Roy. Bot. Gard. Calcutta 11).

Ecology and habitat. This species can be found in hill dipterocarp forest, altitude 700 m asl.

Distribution. Only known from Sabah.

Vernacular name. *Rotan peladas* (Tenom Murut language), *rotan padas* (Keningau Murut language) (Dransfield, 1984).

Uses. Not recorded.

Specimens examined. Borneo: Sabah Ranau District, Bambang, 20 November 1987, *Amin and Jarius*, 121188 fruiting (BO, SAN). Tawao, Elphinstone Province, October 1922 to March 1923, *A.D.E. Elmer* 21331, fruiting (BO).

Notes. This species has ocreas up to 2.8 cm long with scattered solitary spines.

2. *Calamus amplijugus* J. Dransf.

Calamus amplijugus J. Dransf., Kew Bull. 36 (1982) 787; Ratt. Sabah (1984) 140; Ratt. Sarawak (1992) 156;

Ratt. Brunei Darussalam (1997) 139. –Type: Malaysia, Borneo, Sabah, Sandakan, Lungumis Experimental Plots, 18 October 1979, *J. Dransfield*, 5775 (Holotype K, image seen).

Ecology and habitat. Lowland dipterocarp forest in valley bottoms and hill slopes from 50 until 700 m asl.

Distribution. 1st Division, Elsewhere in Brunei and Sarawak, possibly also in Sumatra (Dransfield, 1997).

Vernacular name. Not recorded.

Uses. Provides a thin Cane for basketry (Dransfield, 1997).

Specimen examined. Pictures in Kew Herbarium (K000112913).

Notes. This species has dull green leaf sheaths with scattered deciduous brown scale.

3. *Calamus congestiflorus* J. Dransf.

Calamus congestiflorus J. Dransf. Kew Bull. 36 (1982) 785; Ratt. Sabah (1984) 140. –Type: Malaysia, Borneo, Mile 46, Nabawan, 11 September 1979, *J. Dransfield*, 5635 (Holotype K, image seen).

Ecology and habitat. At the side of a swamp in forest transitional between lowland Dipterocarp forest and *kerangas*; at Sapa Payau, the sterile specimen was found in a similar habitat, altitude 400 m asl.

Distribution. Endemic at Nabawan; a sterile specimen from Sapa Payau F.R. is probably this species.

Vernacular name. *Lempit puluput* (Murut language).

Uses. Produces an excellent cane for twine, frequently collected (Dransfield, 1984).

Specimen examined. Images in Kew Herbarium (K000113076).

Notes. This species has green leaf sheaths, tinged crimson, with thin brown indumentum and armed with numerous scattered spines. The knee is developed but not very conspicuous.

4. *Calamus corrugatus* Becc.

Calamus corrugatus Becc. Beccari Rec. Bot. Surv. India 2 (1902) 201; Ann. Roy. Bot. Gard. Calcutta 11 (1908) 187; Dransfield, Ratt. Sarawak (1992) 161.

–Type: Malaysia, Borneo, Sarawak Mount Mattang, near Kuching, 1853, *Beccari*, *P. B.* 1910 (Holotype K!).

Ecology and habitat. Ridgetop, hill dipterocarp forest and *Kerangas*, altitude 400–900 m asl.

Distribution. Borneo and Sumatra (Dransfield, 1992).

Vernacular name. Not recorded.

Uses. The cane appears to be of excellent quality (Dransfield, 1992).

Specimen examined. Borneo: Sarawak, 1st Division Kuching, G. Matang, 8 April 1981, *J. Dransfield et al.* *JD* 5860, sterile (BO). 1st Division Serian, Sabah Tapang, F. R. mile 70, 19 May 1981, *J. Dransfield et al.*, *JD* 6080, sterile (BO). South Kalimantan, Bandjarmasin, *lg. ign.* 23, sterile (BO).

Notes. *Calamus corrugatus* is easily distinguished from allied species by its corrugated leaf sheath.

5. *Calamus flabellatus* Becc.

Calamus flabellatus Becc. Malesia 3 (1886) 62; Ann. Roy. Bot. Gard. Calcutta 11 (1908) 176; Dransfield Kew Bull. 45 (1990) 87; Ratt. Sarawak (1992) 150; Ratt. Brunei Darussalam (1997) 135. –Type: Malaysia, Borneo, on Mount Mattang, near Kuching in Sarawak, *Beccari PB* 1911 (Holotype Herb. Beccari, plate 37). *Calamus flabelloides* Furtado Gard. Bull. Singapore 15 (1956) 173; Dransfield Ratt. Mal. Pen. (1979) 195; Ratt. Sabah (1984) 145. –Type: Malaya, Johor, Sungai Kayu, *Corner*, 29284 (Isotype BO! K!).

Slender clustering climbing rattan up to 20 m; stem without sheaths about 6 mm in diam., with sheaths about 12 mm in diameter, internodes up to 15 cm long, all drying parts brown coloured. Sheath dark green with scattered reflexed broad base spines to 5 mm long; knee present, elongate inflated, glabrous or spines surface; ocrea inconspicuous, very short to 3–5 mm long. Flagellum up to 2 m or more. Leaf ecirrate, up to 60 cm long; petiole absent or very short 1–2 mm; leaflets 3–5 on each side of the rachis or leaf bearing a single pair of leaflets, when more than 1 pair, to 4–11 × 0.8–2 cm, basal or only pair of leaflets swept back across the stem; middle leaflets to 14–17 × 2.8–4 cm; apical pair joined for 1/3 to 2/3 of their length; leaflets bristly only at the tips, bluish–grey surface, transverse veinlets conspicuous. Inflorescences male up to 1.2 m long with 6 partial inflorescences, tending to be longer in the female; peduncle to 45 cm long, with scattered stout claw–like spines, hooked, blackish tip; prophyll tubular sheathing 19–21 cm long, shorter than peduncle, mouth of prophyll sloping, with scattered stout claw–like spines, hooked, blackish tip at all sur-

Key to varieties of *C. flabellatus* in West Malesia

- 1 A Spines on the leaf sheath present, leaf sheath surface very rough, the apical leaflets joined $>1/3$ of their length, and inflorescence rachis bracts and rachilla bracts armed with scattered stout claw-like, hooked, blackish-tipped spines 2
- B Spines on the leaf sheath absent, leaf sheath surface smooth, the apical leaflets joined $1/4$ of their length, and only the proximal inflorescence rachis bracts armed with spines, and rachilla bracts glabrous *C. flabellatus* var. *laevis*
- 2 A Leaf sheath with solitary spines, knee inflated and the apical leaflets joined $2/3$ of their length *C. flabellatus* var. *flabellatus*
- B Leaf sheath with in group spines, knee flat and the apical leaflets joined $1/2$ of their length *C. flabellatus* var. *congestispinosus*

face, curved; rachis bract similar to the prophyll, to 2 cm long, enclosed the base of partial inflorescence, spine scattered over the surface. Partial inflorescence, bearing tubular rachilla bracts to 1.7 cm long, armed mouth of rachilla bracts sloping. Staminate flower 22.5 mm long, 11.5 mm wide; calyx 3 lobed, campanulate or rounded at the base, lobes triangular, to 1.6 mm long, margin entire, acute; corolla with 3 petals, each 2×1 mm; stamens 1.7 mm long, anther basifixed 1 mm long, filament 7 mm long and yellow. Inflorescence male borne opposite to petiole, erect, up to 3 m long, bearing up to 6 partial inflorescences, up to 27 cm a part. Peduncle up to 76 cm long, 3 mm in diam., cylindrical. Prophyll tubular sheathing 67 cm long, longer than peduncle, mouth of prophyll sloping, bristle, enclosing the base of branch. Partial inflorescence, with scattered stout claw-like spines, hooked, blackish tip; rachis bracts similar to prophylls, 6.7–10.5 cm long, 2 mm diameter, abaxial surface armed, with scattered stout claw-like spines, solitary, enclosing the base of partial inflorescence; partial inflorescence bearing up to 9 rachilla bracts, tubular infundibuliform, up to 2.4 cm long, 1 mm in diameter, with spines, truncate, the mouth sloping, bearing up to 20 rachillae. Pistillate flower $2\text{--}3.2 \times 12$ mm; calyx campanulate rounded at the base, 3 lobed; calyx tube to 2.5 cm long, 1.5 mm in diameter, lobes triangular, with acute point to 2 mm long; corolla of 3 petals, each 2.8–3 mm long, lanceolate. Ripe fruit spherical to ovoid, 11×7 mm, with beak to 2 mm, covered 12 vertical rows of greenish scales. Seed ovoid, shallowly pitted; endosperm homogeneous.

Ecology & habitat. This species can be found at 100–700 m asl in disturbed primary forest and lowland primary mixed dipterocarp forest.

Distribution. Borneo, Sumatra.

Vernacular name. *Paikat lilin* (Dayak Lawang language), *Rotan tjatjet* (Borneo language), *Rotang ranting udang* (Kutei language), *Kehes* (Samarinda language) *Rotan klikoeng Daoen* (Palembang language).

Uses. This species is useful as ropes and materials for making baskets by local communities in Sarawak (Dransfield, 1979; 1984).

Specimens examined. Borneo: East Kalimantan. Kenangan Balikpapan, P.T. ITCI Concession, 10 August 1974, *J. Dransfield*, 4360, sterile (BO). Kenangan Balikpapan, P.T. ITCI Concession, 13 August 1974, *J. Dransfield* 4421, sterile (BO). Central Kalimantan. Bukit Raya, Katingan, 23 November 1982, *J.P. Moge* and *W.J.J.O. de Wilde* 4115, fruiting (BO). Bukit Raya and upper Katingan (Mendawai), 23 November 1982, *J.P. Moge* and *W.J.J.O. de Wilde* 3609, sterile (BO). Nunukan, Northern Port, KM 7, Rintus 6, 23 November 1953, *W. Meijer* 2324, sterile (BO). S. Mentoko S. Sengata, Kutei, 19 June 1971, *J. Dransfield*, 1628 sterile (BO). West of Samarinda, Loa Djanan, 11 April 1952, *Kostermans* 6401, flowering (BO). South Kalimantan. District Tabalong, Upper Tabalong Area, PT Aya Yayang Indonesia Concession, Misim, 06 August 2000, *JP Moge* 7407, sterile (BO). 1st division, Serian, Sabal Tapang, F.R. Block 14, *J. Dransfield, et al., J. D.* 6070, sterile (BO). **Sumatra:** South Sumatra. Palembang, Rawas, 22 May 1916, *W. Grashoff* 1024, sterile (BO). West Sumatra. Jambi, district Kerinci, Kg. Penetai road to Sg. Penuh, 21 July 1972, *J. Dransfield, JD* 2610 sterile (BO).

Notes. This species has much variation in the leaf sheath surface, leaflets and inflorescence. The leaf sheath surface is glabrous or spiny. In this study, two new varieties are proposed based on the indumentum on the leaf sheath surface. The first new variety, *C. flabellatus* var. *congestispinosus*, has two distinctive characters, *i.e.* leaf sheath with group of triangular spines and inconspicuous knee. The second new variety, *C. flabellatus* var. *laevibus* from the Malay Peninsula and Borneo, has smooth or glabrous leaf sheath surfaces and rachilla bracts.

6. *C. flabellatus* var. *congestispinosus* N. Syam & H. Rustiami, var. *nov.*

var. *congestispinosus* N. Syam & H. Rustiami, var. *nov.*
– Type: Indonesia, Borneo, East Kalimantan, Nunutan, N. of Tarakan, 5 December 1953, *W. Meijer* 2414, fruiting (Holotype BO!).

Leaf sheath with groups of triangular spines, knee elongate flat, leaflets up to 8 on each side of the rachis or leaf bearing a single pair of leaflets, apical pair joined up to 1/2 of their length, and inflorescence bracts with scattered stout hooked, claw-like spines, with blackish tips.

Ecology and habitat. This species can be found at about 80–700 m asl in disturbed primary forest, and lowland primary mixed dipterocarp forest.

Distribution. Borneo (only known from type locality)

Vernacular name. *Rotang ranting udang* (East Kalimantan language).

Uses. Not recorded.

Specimens examined. Borneo: South Kalimantan, District Tabalong, Upper Tabalong Area, PT Aya Yayang Indonesia Concession, Missim, 05 August 2000, *JP Moge* 7397, sterile (BO). S. Mentoko S. Sengata, Kutei, 19 June 1971, *J. Dransfield* 1628, sterile (BO). West of Samarinda, Loa Djanan, 11 April 1952, *Kostermans* 6401, flowering and fruiting (BO).

Notes. The varietal epithet refers to the leaf sheath covered with groups of spines.

7. *C. flabellatus* var. *laevibus* N. Syam & H. Rustiami, var. *nov.*

var. *laevibus* N. Syam & H. Rustiami, var. *nov.* –Type: Borneo, Malaysia, Sabah, Telupid district, Sapa Payau F.H. mile 75, Sandakan, 26 October 1979 fertile, *J. Dransfield*, *JD* 5810 (Holotype BO!).

Leaf sheath surface very smooth, knee elongate inflated and unarmed, leaflets 3–4 on each side of

rachis, apical pair joined together for ¼ of their length, first inflorescence rachis bract with scattered stout claw-like spines, blackish-tipped spines and rachilla bracts glabrous.

Ecology and habitat. This species can be found at about 100 m asl in the disturbed ridgetop, *kapur* forest on old river terrace, hill slope and lowland Dipterocarp forest.

Distribution. Only known from type locality in Malay Peninsula, Borneo.

Vernacular name. *Wi takong* (Iban language), *Rotang ranting udang* (Kutei language), *Wi tautuk* (Bidayuh Selakan language).

Uses. Not recorded.

Specimens examined. Malay Peninsula: Johor Malaya, Sungai Kayu, 11 October 1936, *Kiah Bin Haji Salleh SFN* 32457, sterile (BO). **Borneo:** East Kalimantan. S. Mentoko S. Sengata, Kutei, 19 June 1971, *J. Dransfield* 1627, sterile (BO). Sarawak, 4th Division, Bt. Lambir National Park, mile 21, 21 April 1981, *J. Dransfield et al.* 5936, sterile (BO). Sabah, Telupid district, Sapa Payau F.H. mile 75, Sandakan, 26 October 1979, *J. Dransfield* 5810, fertile (BO). Sabah, Beaufort district, Beaufort hill, 2 October 1979, *J. Dransfield* 5717, sterile (BO). 1st Division, Sematan, G. Pueh Forest Reserve, Kg. Pueh, *J. Dransfield et al.* 5996, sterile (BO).

Notes. The varietal epithet *laevibus* refers to the unarmed or smooth leaf sheath. The first inflorescence bract is armed with very short triangular, blackish-tipped spines.

8. *Calamus hypertrichosus* Becc.

Calamus hypertrichosus Becc. Beccari Ann. Roy. Bot. Gard. Calcutta 11 (Suppl.) (1913) 17; Dransfield Ratt. Sarawak (1992) 158. –Type: Indonesia, Borneo, Kalimantan, *Teysmann* 16330 (Holotype BO!).

Ecology and habitat. Hill slope in lowland mixed dipterocarp forest.

Distribution. Endemic to Borneo.

Vernacular name. *Rotan lolas* (Borneo Language).

Uses. Not recorded.

Specimen examined. Borneo, Kalimantan, *Teysmann* 16330, sterile (BO).

Notes. A specific character in this species is the hairy leaflets and rachis. There is not enough

information on this species because of incomplete material.

9. *Calamus javensis* Blume

Calamus javensis Blume, Rumphia 3 (1847) 62. –Type: Indonesia, Java (Holotype image seen at plate 137D).

Ecology and habitat. This species is found up to ca. 2000 m asl in disturbed dipterocarp forest, lowland mixed dipterocarp forest, and lower montane forest. Also recorded on soil with limestone at hill bases.

Distribution. Sumatra, Peninsular Malaysia, Java and Borneo.

Vernacular name. *Pulut* (Dyak Tunjung language), *Rotan peladis* (Pontianak language), *Howi lilin* (West Borneo language), *Uwe lilin* (Borneo language), *Rotan pendas* (East Borneo language), *Paikat lilin* (Dayak Lawang language), *Pelege* (Siberut language).

Uses. Provides a thin cane for tying and basketry (Sanusi Djamal, 2012).

Specimens examined. **Borneo:** 1893-1894, *Hallier* 3309, sterile (BO). *Teysmann* 16333, sterile (BO). Bukit Raya Expedition, Tumbang Tupi, 24 January 1983, *Wiriadinata* 3403, fruiting (BO). Near Power station, Kinabalu, District Ranau, 24 September 1979, *J. Dransfield* 5672, sterile (BO). Central Borneo, Bukit Raya and Upper Katingan (Mendawai) River Area, 6 December 1982, *JP Moge*a 3988, flowering (BO). Bukit Raya and Upper Katingan (Mendawai) River area ca. 59-100 Km, WNW of Tumbang Samba, 20 November 1982, *JP Moge*a 3463, sterile (BO). East Borneo, PT. KGM concession, Kelian Upper Mahakam River, 9 November 1991, *MCS* 95, fruiting (BO). RKT 9293. INHUTANI I Concession Berau, 8 December 1991, *MCS* 140 sterile (BO). Kutei, Sg. Susuk Region, 30 June 1951, *A. Kostermans* 5565, fruiting (BO). Kab. Pasir, Kec. Batu Kajang, Kelamping, 30 November 1979, *Moge*a 1861, sterile (BO). Tabang, a Ratu way to G. Batu Kenyek, 9 November 1979, *Moge*a 1590, sterile (BO). Tabang, a road way to G. Batu Kenyek, 9 November 1979, *Moge*a 1591, sterile (BO). About 1020 Km North of Sebelu, 29 December 1978, *Moge*a 1940, sterile (BO). Gunung Mendam, North of Tabang, 15 January 1979, *Moge*a 2612, sterile (BO). South Borneo, Pegunungan Meratus, foot hills of G. Besar, Berabai, 14 October 1972, *J. Dransfield* 2791, flowering (BO). G. Halaunlalu, Pegunungan Meratus, Berabai, 23 October 1972, *J. Dransfield* 2860, flowering (BO). Banjarmasin, *Heyne* 7, flowering (BO). Banjarmasin, *Heyne* 14, sterile (BO). Banjarmasin, *Heyne* 43,

flowering (BO). Tabalong district, Upper Tabalong Area, PT Aya Yayang Indonesia Concession Misim, 5 August 2000, *Moge*a 7409, sterile (BO). Gunung Besar, Barabai, Datar Alai, 19 February 1979, *Moge*a 1692, sterile (BO). **Sumatra:** 27 November 1917 *H.A.B. Bunnemeijer* 1734, sterile (BO). Aceh Tenggara, Kuta Cane, 24 November 1980, *Moge*a 1992 (BO); Aceh Tenggara, lereng Gn. Kemiri, 21 August 1971, *J. Dransfield & Saerudin* 1851, sterile (BO); Kampong Adan di Tangan, jalan menuju Blangpidi, 23 October 1997, *Ikram Sangaji & Sasha Barrow* 15 (BO). Bengkulu. Kepahiang, KM 20 Pagar Kuning, 26 August 1973, *J. Dransfield* 3595 (BO). Kepahiang, Pagar Gunung, 27 August 1973 *J. Dransfield* 3613 sterile (BO); Kepahiang, Cagar Alam Tjurup, 12 February 1971, *J. Dransfield* 1228 (BO). Jambi. Jambi, Sungai Air Hitam, SM. Berbak, 12 July 1972 *J. Dransfield* 2553, sterile (BO); Jambi, KM 19. Sg. Penuh, Tapan 10 March 1974, *J. Dransfield* 4075, sterile (BO). Lampung. 1914, *Heyne* 309 (BO). South Sumatra. I Reserve, Karang Berak, 20 February 1971, *J. Dransfield* 1265 (BO); Palembang, 19 January 1915 *W. Grashoff* 190 (BO); Palembang, 18 February 1915 *W. Grashoff* 410, flowering (BO). Moeara Doea, 26 March 1916, *W. Grashoff* 519, flowering (BO). Palembang, 26 September 1916 *W. Grashoff* 635 (BO). Palembang 1917, *W. Grashoff* 994 (BO). Palembang, Lematang Oeloe, 14 December 1916, *P.M. Lambaeh* 1328 (BO). West Sumatra, Siberut *JJ Afriastini* 1900 (BO); Pasaman Timur, Jorong Bungo Tanjung, East of Gn. Talamau, 21 June 2011, *Himmah Rustiami* 1859, 1858, sterile (BO). Sijunjung, Muro Kulampi, G. Putih, 27 February 1974, *J. Dransfield* and *J. P. Moge*a 3967, sterile (BO). North Sumatra. Tandjungpura, Ulu Besitang, 4 August 1971, *J. Dransfield* 1830 (BO); Berastagi, Karo 20 July 1928, *J. A. Lorzing* 12497 (BO); Sibolangit, 21 Mei 1922, *J. A. Lorzing* 8744 (BO). **Java:** 27 December 1912, *C. A. Backer* 2080, sterile (BO). 17 November 1913, *C. A. Backer* 9996, sterile (BO). G. Asepun by Monas, 12 March 1913, *C. A. Backer* 7119, sterile (BO). 31 July 1914, *C. A. Backer* 15134, sterile (BO). Cibubur, G. Bésér mab, 15 June 1917, *C.A. Backer* 22660, sterile (BO). Tjiandjoer, 31 March 1918, *C. A. Backer* 23821, sterile (BO). 2 August 1918, *C. A. Backer* 25509, sterile (BO). S. W. Java. Ujung Kulon Reserve, Mt. Pajung, 15 November 1960, *Kostermans* 136, fruiting (BO). S.W. Java, Ujung Kulon Reserve, Mt. Pajung, 17 November 1960, *Kostermans* 176, fruiting (BO). Tjiandjoer, Jakarta, 8 April 1899, *Koorders* 32887, sterile (BO). 14 June 1912, *Koorders* 40940, sterile (BO). 10 February 1912, *Koorders*, 41573, sterile (BO). West Java. Salak, *Heyne* 2, flowering (BO). West Java, Salak, *Heyne* 5, fruiting (BO). West Java, Salak, 1913, *Heyne* 7, flowering (BO). West Java, Salak, *Heyne* 11, sterile (BO). West Java,

Salak, 1913, *Heyne* 15, flowering (BO). West Java, Salak, 1913, *Heyne* 44, flowering (BO). West Java, Salak, 1913, *Heyne* 47, Flowering (BO). West Java, Salak, 1913, *Heyne* 53, flowering (BO). West Java, Sukabumi, Lengkong, 13 November 1970, *J. Dransfield* 1033, fruiting (BO). West Java, Cibodas, forest fragment in garden, 15 December 1970, *J. Dransfield* 1106, sterile (BO). West Java, G. Kendang, slope, 15 April 1971, *J. Dransfield* 1434, sterile (BO). West Java, Sukabumi, Lengkong, 16 July 1971, *J. Dransfield* 1717, flowering (BO). West Java, Sukabumi, Lengkong, 16 July 1971, *J. Dransfield* 1718, fruiting (BO). West Java, Sukabumi, Lengkong, 16 July 1971, *J. Dransfield* 1721, sterile (BO). West Java, Sukabumi, Lengkong, 16 July 1971, *J. Dransfield* 1722, sterile (BO). West Java, Sukabumi, Ciayunan of Cireungas, 24 January 1973, *J. Dransfield* 3086, sterile (BO). Bogor, *Scheffer* s.n. flowering (BO). Tjibodas forest reserve, 26 August 1955, *M. Jacobs* s.n. sterile (BO). W. Java, G. Kencana, 20 December 1994, *Titi Kalima* 2, flowering (BO). West Java, Tugu, Prim, Forest along Djalan Mandalawangi slope of Pangerango, 13 March 1952, *W. Meijer* 17, flowering (BO). Jampang Kulon, Gunung Hanjung Barat, near Bojong Asih Plantation, 16 January 1977, *Harry Wiradinata*, 1053, flowering (BO). Pasir Tengah, *leg. ign. sn.* flowering (BO). West Java, in plot 2 Cikaniki Station, 1100 m altitude, Gunung Halimun, 15 July 2001, *A. Uchida*, *Uchida* 5, sterile (BO). Gunung Rasa, *Leaf Mans* s.n., fruiting (BO). Basitang, 21 June 1925, *H. J. Lam* 2260, sterile (BO), West Java, Lebak, 2/3 August 1936, *Soemauriraya* 3792, sterile (BO). Java, Batavia, 29 December 1923, *R. C. Bakhuizen v/d Brink* 6273, sterile (BO). Java, *leg.ign.* 275, sterile (BO).

Notes. This species has vary much variation, such as the density of spines on the leaf sheath, the arrangement of spines, and the extent of fusion of apical leaflets, but can be distinguished by its bristly ocreas.

10. *Calamus ruvidus* Becc.

Calamus ruvidus Becc. Beccari Rec. Bot. Surv. India 2 (1902) 202; Ann. Roy. Bot. Gard. Calcutta 11 (1908) 169; Dransfield, Ratt. Sarawak (1992) 176; Ratt. Brunei Darussalam (1997) 153. –Type: Malaysia, Borneo, Sarawak, 1857, *Lobb*, T. s.n. (Holotype K!).

Ecology and habitat. This species can be found at 350 m asl, in aluvial forest.

Distribution. Borneo.

Vernacular name. *Rotan roenggas* (Borneo language).

Uses. Not recorded.

Specimens examined. Borneo: Sabah, Tenompok, 28 March 1932, *J. & M. S. Clemens* 28408, fruiting (BO). Tenompok, 1932, *J. & M. S. Clemens* 29203, flowering (BO). Kalimantan, Pontianak, 1914, *Heyne* 2527, sterile (BO). *Teysmann* 16336, sterile (BO). Sarawak, 4th Division. Bt. Lambir National Park, 23 April 1981, *J. Dransfield et al.* JD 5958, flowering (BO).

Notes. *Calamus ruvidus* is a solitary rattan and has distinctive brown hairy indumentum on its inflorescence bracts.

Phenetic Analysis

A Cluster analysis based on morphological characters of the included species showed that there were two main clusters within the *C. flabellatus* complex in West Malesia with coefficient similarity of 0.46–1.00 (Fig. 8).

At the coefficient similarity of 0.46, there are two main clusters, named clusters I and II. Cluster I consists of *C. ruvidus* and *C. amplijugus*. They were separated from the others by three characters *i.e.* diameter of stem with sheath more than 2 mm, diameter of stem without sheath more than 10 mm and with triangular spines on the leaflet sheaths.

Cluster II was divided into two groups, A and B with an index of similarity of 56%. Group A consisted of *C. acuminatus*, *C. congestiflorus* and *C. javensis*, while Group B consisted of *C. corrugatus*, *C. flabellatus* var. *flabellatus*, *C. flabellatus* var. *laevibus*, *C. flabellatus* var. *congestispinosus* and *C. hypertrichosus*. Group A taxa shared many characters *i.e.* diameter of stem with sheath less than 2 cm, sheath with spines, leaf sheath with indumentum, leaf sheath with solitary, stout claw-like spines on leaf sheath, ocrea splitting position of petiole. *Calamus acuminatus* is very close to *C. javensis*, but it has consistently regular narrow lanceolate leaflets and very small spherical fruit (Dransfield, 1984). *Calamus javensis* from Mt. Lumut (Central Kalimantan) was similar to *C. flabellatus*, but it has fewer leaflets that are black in herbarium specimen. *Calamus javensis* from Sulawesi is similar to *C. minahassae*, but *C. minahassae* has papery leaflets (Witono, 2005). Based on the character of vegetative organs, *C. congestiflorus* from Sabah is very similar to *C. javensis*. However, *C. congestiflorus* has congested inflorescences (Dransfield, 1984).

Calamus corrugatus, *C. flabellatus* and *C. hypertrichosus* were in Group B, with a coefficient of similarity of 63%. They shared two characters, *i.e.* diameter of stem with leaf sheath less than 2 cm and ocreas without bristles. The most similar species in group B were *C. flabellatus* and *C. flabellatus* var. *laevibus* with a coefficient of similar-

ty of 80%. They are very two similar by being glabrous on both surfaces and margins of leaflets, and in having an elongate inflated knee. Whereas *C. flabellatus* and *C. flabellatus* var. *congestispinosus* have coefficient of similarity of 73%, both are found at the same localities.

The study showed that *C. corrugatus* is easy to distinguish among taxa in the *C. javensis* group by its ridged or wrinkled leaf sheath, lack of spines on the leaf sheath surface, and perfectly opposite and horizontal leaflets, which occur as distantly spaced pairs (Beccari, 1908).

Based on the cluster analysis *C. javensis* formed one group with a similarity coefficient ranging from 77 to 100% indicating this species has wide morphological variation. This result is in accordance with the previous study that identified seven varieties of *C. javensis*, namely *C. javensis* var. *inermis*, var. *tenuissimus*, var. *laevis*, var. *polyphyllus*, var. *peninsularis*, var. *purpurascens* and var. *pinangius* (Furtado, 1956). They can be distinguished among each other by three characters which are absent or present spine, the spacing or density of spines on the leaf sheath and shape of leaflets.

CONCLUSION

Based on an analysis of morphological characters, the *C. flabellatus* complex in West Malesia is shown to consists of eight species and two varieties, i.e. *C. acuminatus*, *C. amplijugus*, *C. congestiflorus*, *C. corrugatus*, *C. flabellatus*, (including *C.*

flabellatus var. *laevibus* and *C. flabellatus* var. *congestispinosus*), *C. hypertrichosus*, *C. javensis*, and *C. ruvidus*. The general characters of this species complex include leaves ecirrate, petiole very short or absent, leaf pinnate with opposite, leaflets, the lowermost pair of leaflets swept back across the stem, variable size of leaflets, and the apical pair leaflets joined for 1/4 to 2/3 of their length.

The *Calamus flabellatus* complex is distributed in Malay Peninsula (*C. javensis* and *C. flabellatus* var. *laevibus*), Borneo (*C. acuminatus*, *C. amplijugus*, *C. congestiflorus*, *C. corrugatus*, *C. flabellatus*, *C. flabellatus* var. *laevibus*, *C. flabellatus* var. *congestispinosus*, *C. hypertrichosus*, *C. javensis* and *C. ruvidus*), Java (*C. javensis*) and Sumatra (*C. flabellatus* and *C. javensis*). The complex can be divided into two main groups with a similarity coefficient of 46%. Borneo is center of distribution because it is the richest in species number of *C. flabellatus* complex.

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REFERENCES

ALRASJID, H. 1980. *Pedoman Penanaman Rotan (A guide to planting rattan)*. Lembaga Penelitian Hu-

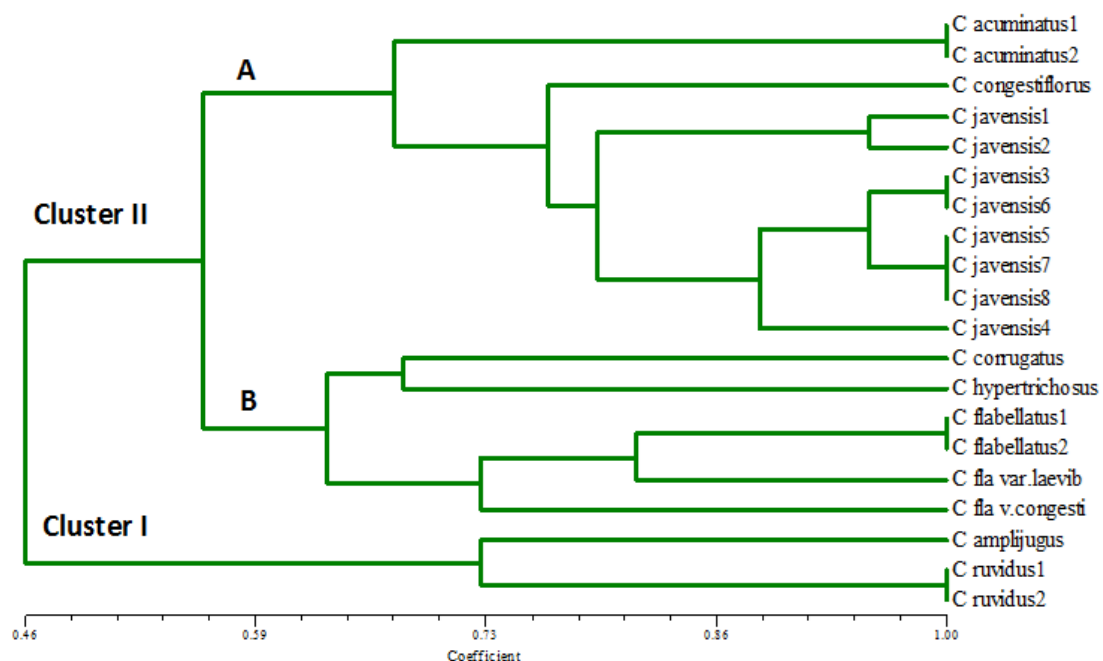


Fig. 8. Phenogram of *C. flabellatus* complex in West Malesia

- tan, Badan Penelitian dan Pengembangan Pertanian: 37.
- BECCARI, O. 1886. *Palmae. Malesia*. Genova: R. Istituto Surdo-Mun. 3: 62.
- BECCARI, O. 1908. Asiatic Palms *Lepidocaryeae*. Part 1. The Species of *Calamus*. *Ann. Roy. Bot. Gard. Calcutta* 11(1): 45–66.
- BECCARI, O. 1913. Asiatic Palms *Lepidocaryeae*. Supplement to Part 1. The Species of *Calamus*. *Ann. Roy. Bot. Gard. Calcutta* 11(1): 1–140.
- BAJA-LAPIS, A.C. 2010. *A Field Guide to Philippine Rattans*. *Asia Life Sciences Supplement* 5. Rushing Water Publishers Ltd.: Philippines.
- DJAMAL. 2012. *Rotan kekayaan belantara Indonesia*. Brilian Internasional, Surabaya.
- DRANSFIELD, J. 1979. *A Manual of Rattans of the Malay Peninsula*. Kuala Lumpur: Malaysian Forest Records No 29. Forest Department of Malaysia.
- DRANSFIELD, J. 1984. *The Rattans of Sabah*. Sabah: Sabah Forest Record No 13. Forest Department Sabah.
- DRANSFIELD, J. 1992. *The Rattans of Sarawak*. London: Royal Botanic Gardens, Kew, UK and Sarawak Forest Department, Sarawak, Malaysia.
- DRANSFIELD, J. 1997. *The Rattans of Brunei Darussalam*. Brunei Darussalam: Royal Botanic Gardens, Kew, UK and Brunei Darussalam Forest Department, Brunei.
- DRANSFIELD, J. 1990. Notes on rattans (Palmae) in Sarawak, Borneo. *Kew Bulletin* 45 (1): 87.
- DRANSFIELD, J., UHL, N. W., ASMUSSEN, C. B., BAKER, W. J., HARLEY, M. M. & LEWIS, C. E. 2008. *Genera Palmarum: The evolution and classification of palms*. Kew: Royal Botanic Garden.
- FURTADO, C. X. 1956. The genus *Calamus* in the Malayan Peninsula. *The Gardens' Bulletin Singapore* 15: 32–73.
- HENDERSON, A. 2009. *Palms of Southern Asia*. New York (US): New York Botanical Garden.
- KRAMADIBRATA, P. & DRANSFIELD, J. 1992. *Calamus inops* (Palmae: Calamoideae) and its relatives. *Kew Bulletin* 47: 581–593.
- LINNAEUS, C. 1753. *Species Plantarum*. London: Bernard Quaritch LTD 1.
- MOORE, H. E. Jr. & DRANSFIELD, J. 1979. The typification of Linnean Palm. *Taxon* 28: 59–60.
- RUSTIAMI, H. 2009. Konsep jenis palem: Sebuah pengantar. *Berita Biologi* 9 (5): 459–461.
- RUSTIAMI, H. 2011. Revision of the genus *Calamus* (Arecaceae) from Sulawesi. Institute Pertanian Bogor, Bogor. [Dissertation].
- RUSTIAMI, H., MOGEA, J. P. & TJITROSOEDIRJO, S. S. 2011. Revision of the rattan genus *Daemonorops* (Palmae: Calamoideae) in Sulawesi using a phenetic analysis approach. *The Gardens' Bulletin Singapore* 63 (1 & 2). Pp.17–30.
- WITONO, J. R. 2005. Keanekaragaman Palem (Palmae) di Gunung Lumut, Kalimantan Tengah. *Biodiversitas* 6(1): 22–30.

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- Journal : KRAENZLIN, F. 1913. *Cyrtandraceae* novae Philippinenses I. *Philipp. J. Sci.* 8: 163–179.
MAYER, V., MOLLER, M., PERRET, M. & WEBER, A. 2003. Phylogenetic position and generic differentiation of *Epithemateae* (*Gesneriaceae*) inferred from plastid DNA sequence data. *American J. Bot.* 90: 321–329.
- Proceedings : TEMU, S. T. 1995. Peranan tumbuhan dan ternak dalam upacara adat “Djoka Dju” pada suku Lio, Ende, Flores, Nusa Tenggara Timur. In: NASUTION, E. (Ed.). *Prosiding Seminar dan Lokakarya Nasional Etnobotani II*. LIPI & Perpustakaan Nasional: 263–268. (In Indonesian).
SIMBOLON, H. & MIRMANTO, E. 2000. Checklist of plant species in the peat swamp forests of Central Kalimantan, Indonesia. In: IWAKUMA, T. *et al.* (Eds.) *Proceedings of the International Symposium on: Tropical Peatlands*. Pp.179-190.
- Book : RIDLEY, H. N. 1923. *Flora of the Malay Peninsula 2*. L. Reeve & Co. Ltd, London.
- Part of Book : BENTHAM, G. 1876. *Gesneriaceae*. In: BENTHAM, G. & HOOKER, J. D. *Genera plantarum 2*. Lovell Reeve & Co., London. Pp. 990–1025.
- Thesis : BAIRD, L. 2002. *A Grammar of Kéo: An Austronesian language of East Nusantara*. Australian National University, Canberra. [PhD. Thesis].
- Website : <http://www.nationaalherbarium.nl/fmcollectors/k/KostermansAJGH.htm>. Accessed 15 February 2012.



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