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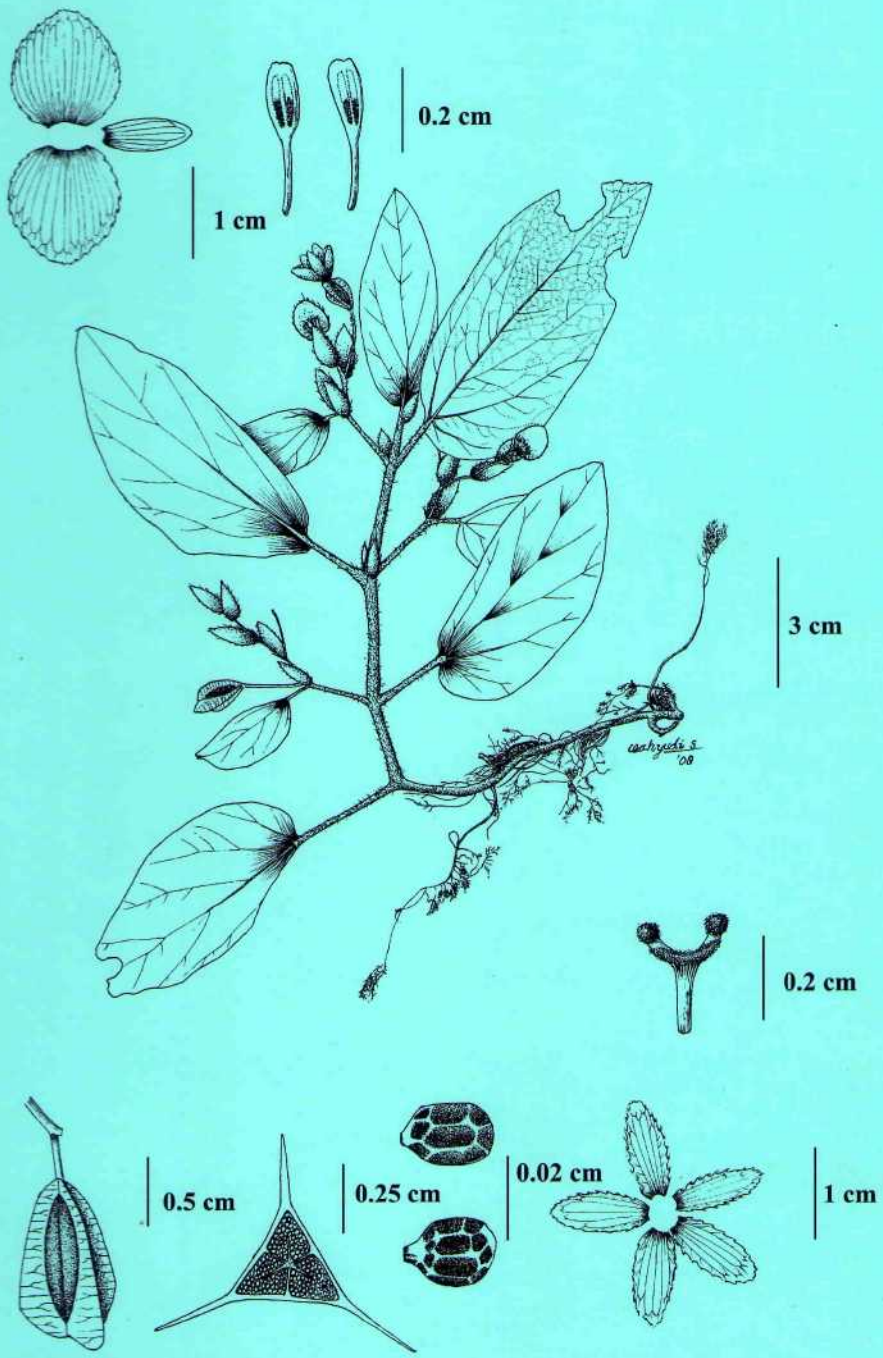

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THE PANDAN FLORA OF FOJA-MAMBERAMO GAME RESERVE AND BALIEM VALLEY, PAPUA-INDONESIA

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ABSTRACT
KEIM, A. P. 2012. The Pandan flora of Foja-Mamberamo Game Reserve and Baliem Valley, Papua–Indonesia. *Reinwardtia* 13 (3): 271–297. — Seven species of *Pandanus* and seven species of *Freycinetia* are observed in Kwerba and adjacent areas within the Foja-Mamberamo Game Reserve, Papua-Indonesia. Two species are proposed as new: *Freycinetia kwerbaensis* A.P. Keim and *Pandanus korwae* A.P. Keim. This recent study also acknowledges a new record for *F. mariannensis* and a possibly new record for *F. vidalii*. The rest are extension of distribution areas in mainland New Guinea. The discovery of a long searched almost mythical wild type of widely cultivated *P. conoideus* is also accomplished. A new species from Baliem Valley nearby Wamena in the Jayawijaya Mountains, Papua-Indonesia namely *F. wamenaensis* A.P. Keim is described

Keywords: Foja, *Freycinetia*, Jayawijaya, Mamberamo, New Guinea, Pandanaceae, *Pandanus*, Papua, Wamena.

ABSTRAK
KEIM, A. P. 2012. Flora pandan di Suaka Margasatwa Foja-Mamberamo dan Lembah Baliem, Papua-Indonesia dengan jenis dan rekaman baru serta penemuan hidupan liar dari *Pandanus conoideus* Lam. *Reinwardtia* 13 (3): 271–297. — Tujuh jenis marga *Pandanus* dan tujuh jenis *Freycinetia* teramati di kawasan Kwerba dan sekitarnya di wilayah Suaka Margasatwa Foja-Mamberamo, Papua-Indonesia. Dua jenis dipertelakan di sini sebagai jenis baru: *Freycinetia kwerbaensis* A.P. Keim dan *Pandanus korwae* A.P. Keim. Penelitian ini juga mencatat rekaman baru *Freycinetia mariannensis* dan kemungkinan rekaman baru *F. vidalii*. Selebihnya adalah perluasan persebaran di daratan New Guinea. Tumbuhan liar *P. conoideus* yang lama dicari dan hampir melegenda juga berhasil ditemukan dalam penelitian ini. Satu jenis baru dari wilayah Lembah Baliem dekat dengan Wamena di Pegunungan Jayawijaya, Papua-Indonesia, yaitu *F. wamenaensis* A.P. Keim, juga dipertelakan sebagai jenis baru.

Kata kunci: Foja, *Freycinetia*, Jayawijaya, Mamberamo, New Guinea, Pandanaceae, *Pandanus*, Papua, Wamena.

INTRODUCTION

Mamberamo Basin

The Mamberamo river basin (*i.e.* Mamberamo Basin) is a large area nurtured by the mighty river Mamberamo located in the northern-central Indonesian province of Papua. The area covers both Foja (then Gauttier, Anonymous, 1938) and van Rees Mountains, in which Foja being the largest part of the basin.

The Foja Mountains is located north of the Mamberamo river basin and covers an area of 9,712 km^2, in which more than 3,000 km^2 are composed of lavish tropical rainforests. The highest point is Mount Foja (hence the name of the mountains) with altitude of approximately 2,193 meters and located at latitude of 3°5'49"S and longitude of 138° 44'16" E.

The combination of difficult accessibility and low density of human population make the forests in the Foja Mountains are relatively untouched, and thus make them as the largest undisturbed tropical rainforest in the Asia Pacific region. Based on this exceptional nature circumstance on October 21st 1982 (Anonymous, 2004) the Indonesian government established the mountains and the neighbouring Mamberamo Basin as a protected area in the form of Game Reserve formally the Foja-Mamberamo Game Reserve.

Prior to this current study, the only information on the pandan flora of the Mamberamo Basin was by Brass based on collections made through the 3rd Archbold Expedition to New Guinea (Merrill & Perry, 1939; 1940). However, this expedition did not penetrate further north into the Foja-Mamberamo area.

This current study was carried out in the Kwerba vicinity, which is within the Foja-Mamberamo area. The main location was Bringnyawa (*ca.* 1200 m altitude) and surrounding areas from that altitude down to approximately 800 m. Bringnyawa was a village for the Kwerba people prior to the

Indonesia Administration (UNTEA Administration, *ca.* 1969). Since then the Kwerbas had moved down to the present location, Kwerba (2°38'32.2"S, 138°24'38.2"E) at much lower altitude (90 to 100 m) and Bringnyawa was deserted, but it is still regarded a sacred place though.

The result of this current study indicates that seven species of *Pandanus* and eight species of *Freycinetia* are observed in Kwerba and adjacent areas within the Foja-Mamberamo Game Reserve. Three species are proposed as new: *Freycinetia kwerbaensis* A.P. Keim, *F. wamenaensis*, and *Pandanus korwae* A.P. Keim. This recent study also acknowledges a new record for *F. mariannensis* and a possibly new record for *F. vidalii*. The rest are extension of distribution areas in mainland New Guinea. The discovery of a long searched almost mythical wild type of widely cultivated *P. conoideus* is also attained.

Baliem Valley

South of the Mamberamo river basin stand the mighty Jayawijaya Mountains with the great Baliem Valley rest within. Wamena, located at 1600 to 1700 meter altitude, is the most important city in the valley and being the centre of administration, Wamena is the capital of the mountainous District of Jayawijaya, and cultural activities it is undoubtedly the most populated area in the valley.

Prior to this current study the pandan flora of the Baliem Valley was studied by Brass (Merrill & Perry 1940), but the area understudy was restricted to around Lake Habema. Keim (Keim *et al.* 2006) incorporated wider areas covering Wamena up to Trans Kurulu-Pass Valley, excluding Lake Habema. Interestingly there has been no report of any species of *Freycinetia* in the two publications. The result of this current study reveals both the first record of *Freycinetia* in the valley and the existence of a species new to science from the Wamena Biological Garden namely *F. wamenaensis*.

Wamena Biological Garden is a 150 hectares garden located in the Gunung Susu area about 8 km Northwest of Wamena. The garden was established by the Indonesian Institute of Sciences (LIPI) on 12 June 1995. It aim is to serve as an ex-situ conservation area for the indigenous biota of the central highlands of Papua and adjacent areas including the Lorentz National Park.

There are two creeks of importance flow in the garden, the Gur and Dupuk. These creeks serve as the source of running water and are of biologically most diverse areas in the garden. *Freycinetia wamenaensis* was firstly found along the banks of Dupuk Creek in 2009. It has never been so far spotted in Gur.

DESCRIPTIONS OF SPECIES

1. **Freycinetia kwerbaensis** A.P. Keim, *sp. nov.* — Figs. 1 & 2.

Gracilis fruticosa, non scandens; infructescentiae ternate vel quaternatae; cephalium ellipsoideus; stigmata 2 vel 3, plerumque 3. — Type: *A.P. Keim* 1165 (BO!), Indonesia, Papua, Mamberamo Raya, Kwerba, Tacewaram, Kuikarawar, 21 Nov. 2008.

Slender non climbing pandan, up to 1 m high. *Stem* 0.5–0.6 cm diameter; internodes 0.8 cm. *Leaf* oblanceolate (spathoideous), 20–28 cm long, 3.5–5 cm wide, acuminate apex, spines on terminal and basal parts only; adaxial surface green, glabrous; abaxial surface light green, glabrous; auricle tapered, glabrous, brown. *Infructescence* terminal, consists of 3 or 4 cephalia (ternate or quaternate – in quaternate infructescence one cephalia undeveloped), each 4–6 cm long; peduncle 1–1.5 cm long; pedicel 1.5– 1.8 cm long, bright yellowish green, glabrous. *Cephalium* ellipsoidal, 2.5–3.5 cm long, 1–1.5 cm circumference, green when young turns to orange when mature. *Berry* 0.2 cm long, 0.1 cm wide; number of stigmatic remains 2–3, mostly 3, deep brown.

Etymology. After the village Kwerba, where the type was collected.

Distribution. Known only from type locality.

Habitat. Lowland, hill slope, commonly found close to a path at about 75 m altitude.

Vernacular name. Not recorded.

Uses. Cephalium said to be consumed by birds.

Notes. Despite sharing the possession of oblanceolate or spathoideous leaves, *F. kwerbaensis* differs from *F. oblanceolata* in 3 morphological characters (Table 1). Although the minute advantageous (*i.e.* climbing) roots are observed in *F. kwerbaensis*, this species has never been observed to undertake the climbing habit. Prior to this current study *F. arborea* is the only species in the genus known to posses a non climbing (*i.e.* arboreous) habit. The number of stigmatic remains in *F. kwerbaensis* is almost always 3. Berries with the number of stigmatic remains 2 are rarely seen and they are only observed in the undeveloped cephalium in the quaternate infructescence.

Specimen collected. Only known from the type.

Table 1. Morphological comparison on habit, number of stigmatic remains, and the length of berries between *Freycinetia kwerbaensis* and *F. oblanceolata*.

Species	Habit	Number of stigmatic remains	Length of a berry
Freycinetia kwerbaensis	Non climber, small fairly erect bush but never climber	2 to 3, mostly 3 and never less than 2	2 mm
F. oblanceolata	Climber	1 to 2, never more than 2	7 mm (according to Beccari, 1910)

Fig. 1. *Freycinetia kwerbaensis* A.P. Keim (from the type, *A.P. Keim* 1165) showing the slender habit, the oblanceolate (spathoideous) leaves that exceedingly similar to *F. oblanceolata* and the infructescence consist of 4 unequal cephalia (quaternate). Photo: A.P. Keim.

2. FREYCINETIA LAETA Merr. & L.M. Perry. — Type: *L. J. Brass* 7031 (A; iso. BO!), Papua New Guinea, Palmer River, 2 miles below Black River section, June 1936.

Distribution. Mainland New Guinea
Habitat. Lowland tropical rainforest at about 100 m altitude. In Kwerba it is found at about 85 m altitude. Although abundantly found, mostly were not in flowering or fruiting.

Vernacular name. Not recorded.
Uses. Not recorded.

Notes. Prior to this study *F. laeta* was only known from Papua New Guinea, thus the result of this study extends the species distribution into the Mamberamo Basin. *Freycinetia laeta* can be easily recognised in the field by its robust habit, the obvious reddish orange colouration on bracts and basal part of leaf, the tapered auricle, the non needle -like berries with 3 to 4 stigmas. In the field *F. laeta* looks exceedingly similar to *F. marginata*; however, the two species differ mainly in three morphological characters (Table 2). Even if the individuals are sterile, *F. laeta* can still be distinguished from *F. marginata* through the colour of the terminal leaves. The terminal leaves in *F. laeta* are green with bright orange tints. In *F. marginata* the terminal leaves are green with reddish orange to red tints on terminal parts.

Table 2. Morphological comparison on the colours of bracts and anthers, and the shapes of berries between *Freycinetia laeta* and *F. marginata*.

Species	Colour of bracts	Colour of anthers	Shape of berries
Freycinetia laeta	Orange	Orange to deep red	Prismatic
F. marginata	White or white with reddish orange to bright red tints on apical parts	Pink to deep pink	Needle-like (filiform)

Specimen collected. Indonesia, Papua, Mamberamo Raya, Mamberamo Tengah, Kwerba, Tacewaram, Kwerep, 02 Nov. 2008, *A.P. Keim* 1078 (BO!).

3. FREYCINETIA MARGINATA Blume. — Type: *Zippelius* 219-a (L), Indonesia, Papua, Triton Bay, Kaimana, Dobo, June-July 1828. — Fig. 3.

Freycinetia reineckei Warb. (1898) 578. — Syntypes: *Reinecke* 255 (B†), *Reinecke* 255a (B†), *Reinecke* 255b (B†), *Reinecke* 353a (B†), *Reinecke* 362 (B†; isosyntype BO!), Samoa, Savaii, NW of Savaii, Le Pacga, November 1894, *syn. nov.*

Freycinetia minahassae Koord. (1898) 267. — Type: *S.H. Koorders* 18465β (BO!), Indonesia, North Sulawesi, Minahassa, Upper Tondano Lake, 12 March 1895, *syn. nov.*

Freycinetia australiensis Warb. (1900) 32. — Type: *Peutzke* s.n. (B†), Australia,Queensland, Daintrie River.

Freycinetia latispina Warb. (1900) 33. — Type: *Sarasin* 669 (B†), Indonesia, North Sulawesi, Minahassa, 1893-1894, *syn. nov.*

Freycinetia maxima Merr. (1908) 310. — Syntypes: *Curran* FB 10754 (PNH†), Philippines, Luzon, Tayabas, 22 July 1908; *Curran* FB 12381 (PNH†), Albay, Sorsogon, Adumoy Hills, June 1908, *syn. nov.*

Freycinetia mariannensis Merr. (1914) 48. — Type: *Costenoble* s.n. (US), USA, Marianas Islands, Guam Island, 1914, *syn. nov.*

Freycinetia ponapensis Martelli in Kaneh. (1934) 129. — Type: *Lederman* 13245 (B†), Micronesia, Ponape, Patapat, November 1913, *syn. nov.*

Freycinetia carolinensis Kanehira (1935) 185, f. 17. — Type: *R. Kanehira* 2359 (TI), Micronesia, Palau, Aimiriik, 01 Aug. 1933, *syn. nov.*

Freycinetia mariannensis var. *microsyncarpia* Hosok. (1937) 191. — Type: *Koidzumi* s.n. (TI), Micronesia, Ponape, July 1915, *syn. nov.*

Freycinetia tesselata Merr. & Perry (1939) 149. — Type: *Brass* 3384 (A), Solomon, Ysabel, Maruto, 25 December 1932, *syn. nov.*

Freycinetia parviaculeata B.C. Stone (1970) 220. — Type: *Dan bin Haji Bakar SAR*4502 (SAR), Malaysia, Sarawak, Miri District, Sungei Dalam, June 1961, *syn. nov.*

Freycinetia carolana F. v. Muell. (1887) 126, nom. nud.

Freycinetia insignis Bailey non Blume (1902) 1691, nom. nud.

Distribution. Borneo (Sarawak), Sulawesi (including Wowoni Island), the Philippines (Luzon Island), the Moluccas (Morotai Island), Micronesia (the islands of Palau and Ponape), the Marianas (the islands of Guam, Rota, and Saipan), New Guinea (including the islands of Batanta, Waigeo, and Yapen), Solomon Islands, the island of Savaii in Samoa, and northern part of mainland Australia

Fig. 2. *Freycinetia kwerbaensis* A.P. Keim (from the type, *A.P. Keim* 1165) showing the infructescence consists of 3 ellipsoidal cephalia (ternate) and glabrous pedicel. Photo: A.P. Keim.

(Queensland).

Habitat. Lowland tropical rainforest. In Kwerba it is found from 75 to 125 m altitude, but it is abundantly seen occupying hill slope at about 85 m altitude.

Vernacular name. Érorit (Kwerba).

Uses. Local people mentioned that cephalium is eaten by birds.

Notes. *Freycinetia marginata* can be easily recognised in the field by the possession of robust habit, conspicuous white inner bracts, white with reddish orange to red tints on apical parts on the much larger and more persistent outer bracts, pink to deep pink numerous anthers (thus giving the colour to the whole male inflorescence), ternate to quaternate infructescence, elongate-ellipsoidal cephalium, and the distinctive needle-like (filiform) berries. Even when sterile, the habit and colouration of bracts and terminal leaves are sufficient for identification.

Blume (1835) did not mention the exact location of the type; however, Zippelius was known to visit and collect botanical specimens at Dobo in Triton Bay, Kaimana on June to July 1828 (van Steenis, 1950). Thus it is assumed here that the type was collected in that area and around that time. The presence of *F. marginata* in Mamberamo Basin extends the species distribution in mainland New Guinea.

The result of this current study regards the species listed above as synonyms of *F. marginata*. Apart from the slight differences in the surface of pedicels and sizes of cephalia (Table 3), there is no distinctive morphological character that can be used to distinguish any of those species from *F. marginata*. In fact all the species share one obvious morphological character that is considered unique in the genus, the needle-like (*i.e.* filiform) berries. Stone (1968) based on the common possession of this character grouped twelve species into a section of their own, *Filiformicarpae*, but with a note that the section is noticeably homogenous and the species included were rather poorly defined.

Among the species listed above possess glabrous pedicels except three species, *F. parviaculeata*, *F. ponapensis*, and *F. tesselata* (Table 3). This raises a question concerning the inclusion of the three species into the synonyms of *F. marginata*. Yet, despite having scabrous pedicels in this present study the three species are treated as a synonym of *F. marginata* based on the fact that scabrous and glabrous pedicels can be found in the same individual as can be seen in the then *F. minahassae*, where the fairly scabrous and glabrous pedicels can be found in different infructescences but of the same individual (Keim & Wahjuningsih, *in prep.*). Thus, the result of this current study indicates that at least in the section *Filiformicarpae* the scabrous or glabrous pedicels are considered less important in defining a species. Consequently, *F. parviaculeata*, *F. ponapensis*, and *F. tesselata* perish into synonymy.

This result is not in accordance with Stone (1967a) that regarded the pedicel covering (scabrous versus glabrous) as an important character and was employed as the most distinctive character to differ *F. mariannensis* from *F. ponapensis* despite thought that *F. ponapensis* was morphologically very similar to *F. mariannensis*. As in this study the pedicel surface has been regarded as less important in determining a species the boundary between *F. mariannensis* and *F. ponapensis* subsequently disappears. The two species thus are placed here as synonyms of *F. marginata*.

Indeed, apart from the differences in the surface of the pedicels, there is no distinctive morphological character that can be used to set any of the two species apart from *F. marginata*. Apparently Stone failed to spot the presence of both scabrous and glabrous pedicels in the same species as in the case of *F. minahassae*. Nevertheless, it is assumed here that by the time Stone studied the section *Filiformicarpae* there was not enough material of *F. minahassae* in his disposal. Indeed then *F. minahassae* was known only from the type kept at BO; thus there was insufficient variations within the species could be observed. The situation was worsened by the fact that Stone was never known to conduct any collecting activities in Sulawesi. It is not surprise to know that *F. minahassae* was neither mention nor included in the first publication of the section *Filiformicarpae* (Stone, 1968).

Nonetheless the result of this current study is in accordance with Stone (1967a) that placed *F. mariannensis* var. *microsyncarpia* as the synonym of *F. ponapensis* based on the possession of scabrous pedicels. However, as the pedicel coverings has been regarded as less important character for species determination, both *F. ponapensis* and *F. mariannensis* var. *microsyncarpia* have been reduced here into synonymies.

Merrill & Perry (1939) mentioned that *F. tesselata* was very closely related to *F. ponapensis*; thus suggesting morphological similarities. *Freycinetia tesselata* was separated from *F. ponapensis* based on the broader and somewhat abruptly acuminate leaf-tips and scabrous

Table 3. Morphological comparison between *F. carolinensis, F. marginata, F. marianensis*, *F. mariannensis* var. *microsyncarpia*, *F. minahassae*, *F. ponapensis*, *F. reineckei*, and *F. tesselata*.

Species name	Colour of outer bracts	Colour of inner bracts	Surface of pedicel	Size of cephalium	Colour of cephal-ium	Length of a berry	Number of stig-matic remains
Freycinetia caro-linensis	No data	White	Glabrous	9.5 by 5 cm	Orange to red	15 mm	2–3, rarely 3
F. marginata	Reddish or-ange or white with reddish orange tints on apical parts	White	Glabrous	8–13 by 1.5–3 cm (Stone 1982)	Red	5–8 mm	2–3, mostly 2
F. marianennsis	Salmon to orange	Creamy white (Stone 1967b)	Glabrous	8–9 by 5 cm	Orange to red	10–15 mm	2–3, mostly 2
F. marianennsis var. *microsyncar-pia*	Yellow with scarlet tints on apical part (Stone 1967a)	Creamy white	Sparsely scabrous	6 by 1 cm (Stone 1967a)	Orange to red	10–15 mm	2–3, mostly 2
F. minahassae	Orange or reddish or-ange	White to milky white (Koorders in the field note attached onto the type)	Glabrous or sparsely scabrous	8–20 by 1.8–5 cm	Orange to red	5–18 mm	2–3, mostly 2
F. parviaculeata	No data	No data	Scabrous	7 by 3 cm	Bright red	13–15 mm	2–3, rarely 3
F. ponapensis	Orange (yellow with orange tints on apical part; Stone 1967a)	No data	Sparsely scabrous	5–5.5 (6–7 ; Stone 1967) by 1 –1.2 cm	Orange to red	No data	2–3
F. reineckei	Yellow with orange tints on apical part to orange	Creamy white (Stone 1967b)	Glabrous	6–7 by 2.5 –3 cm (7–9 by 2.5–3 cm ; Mar-telli 1934)	Orange to red-dish or-ange	10 mm (13 mm; Mar-telli 1934)	2–3, mostly 2
F. tesselata	Orange	White	Scabrous (at least on apical part; Merrill & Perry 1939)	10 by 3–3.5 cm	Red	7–8 mm	2–4, mostly 2

Fig. 3. *Freycinetia marginata* Blume. a. Conspicuous white outer bracts enclosing young male inflorescence; b. Young terminal staminate inflorescence consists of 3 flowering parts (ternate) enclosed by layers of bright white thick-fleshy inner bracts, in which each flowering part consists of numerous pink to deep pink anthers. Photos: A.P. Keim.

pedicels (peduncles of syncarps, according to Merrill & Perry, 1939). In this current study the differences are regarded less significant. In *Freycinetia* the leaves can be greatly varies including shapes and the forms of apical parts as can be seen in *F. marginata* (particularly the then *F. minahassae*) or *F. scandens*. The same is also for the pedicel covering as can be seen in *F. minahassae*. Therefore, *F. tesselata* follows *F. ponapensis* into the world of synonymies.

Despite mentioned *F. carolinensis* that was published previously by Kanehira (1935), Merrill & Perry (1939) regarded *F. carolinensis* as a synonym of *F. ponapensis*; thus disregarding Kanehira that mentioned *F. carolinensis* as morphologically near to *F. mariannensis* and distinguished by the possession of prominently tessellate leaves (Kanehira, 1935; Merrill & Perry cited the publication year of Kanehira's protologue of *F. carolinensis* as 1937). In this current study it is assumed that Merrill & Perry (1939) failed to spot the tessellate leaves and glabrous pedicels possessed by *F. carolinensis*. As the consequence they placed the glabrous pedicels possessing *F. carolinensis* as the synonym of the scabrous *F. ponapensis*. Furthermore, the tessellate leaves, which is the prominent distinctive character of *F. carolinensis* (Kanehira, 1935) was used as the important character to distinct their proposed new species *F. tesselata* from *F. ponapensis* (Merrill & Perry, 1939). The reason for this sloppy work was unknown.

Although there is a difference in the sizes of berries (Table 3), it is continuous; thus cannot be used as a strong distinctive character to define *F. minahassae*. In other word, in this current study *F. minahassae* is regarded as the synonym of *F. marginata*. The placement of the eastern Malesian widespread species of *F. minahassae* and *F. parviaculeata*, the only member of the section *Filiformicarpae* occurs in western Malesia have a consequence that *F. marginata* is now recognised as the most widely distributed species in the genus, extending from Borneo in the west to Samoa in the east (encompassing both western and eastern Malesia and beyond), and surpassing the previously known *F. scandens*.

Freycinetia reineckei has smaller cephalia but fairly larger berries than *F. marginata* (Table 3). However, these differences are regarded in this current study as less important compared to more obvious similarities between the two species, such as the colour of both bracts and the shape of berries. Thus, *F. reineckei* is lowered to the rank of synonym.

Indeed, so far *F. reineckei* is the only member of the section *Filiformicarpae* known to possess the tendency of bisexuality or towards monoecy (Cox, 1981, 1982, 1990; Cox *et al.,* 1984; Poppendieck, 1987); however, this tendency is also possessed by other species from various morphologically different sections such as *F. cumingiana* (§ *Polystachyae*), *F. funicularis* (§ *Blumeella*), *F. imbricata* (§ *Sarawakenses*), *F. negrosensis* (§ *Pristophyllae*), and *F. scandens* (§ *Oligostigma*; see Poppendieck, 1987; Cox, 1990). In other word, the tendency is wide spread within the genus. On the contrary, the needle-like (filiform) berries are exclusively possessed by the members of the section Filiformicarpae, in which *F. reineckei* and *F. marginata* are grouped (Stone, 1968). Therefore, if we put too much emphasis on the tendency of bisexuality we might disregard a more important morphological character for phylogeny of the section understudy, the possession of filifom

berries.

Specimens collected. Indonesia, Papua, Mamberamo Raya, Mamberamo Tengah, Kwerba, Tacewaram, Kwerep, 03 Nov. 2008, *A.P. Keim* 1100 (BO!); Itanem, Karenepu Hill, 19 Nov. 2008, *A.P. Keim 1159* (BO!); Kuikarawar, 21 Nov. 2008, *A.P. Keim* 1166 (BO!).

4. FREYCINETIA OBLANCEOLATA Martelli. — Syntypes: *Beccari* 545 (FI), Indonesia, Papua Barat, Manokwari, Andai, 19 July 1872; *Beccari* s.n. (FI); *De Albertis* s.n. (FI); Dorei, *J.E. Teijsmann* 6762 (BO!).

Distribution. Sulawesi (Keim & Rustiami, 2007) and mainland New Guinea (including the Raja Ampat Islands, Keim *et al.,* 2007).

Habitat. Lowland tropical rainforest. In Kwerba it is commonly found from 85 to 250 m altitude. Although it was found abundant during exploration most were found without flowers or fruits. Apparently both the flowering and fruiting times were over by the time the research proceeded.

Vernacular names. Daidoté (Papasena), kakacir (Kwerba).

Uses. Not recorded.

Notes. The presence of *F. oblanceolata* in the Mamberamo Basin extends the species distribution area in the mainland New Guinea. In the field *F. oblanceolata* looks exceedingly similar with *F. kwerbaensis*; however the two species differ in three morphological characters described in Table 1 (see above).

Specimens collected. Indonesia, Papua, Mamberamo Raya, Kwerba, Tacewaram, 02 Nov. 2008, *A.P. Keim* 1084 (BO!); Hehetem, Pumpunom Hill, close to Lake Hehetem, 12 Nov. 2008, *A.P. Keim* 1127 (BO!).

Table 4. Morphological comparison on leaf and cephalium dimensions, shape of auricle, number of cephalia per infructescence, and number of stigma between *F. angustissima*, *F. forbesii*, *F. oblanceolata*, *F. scandens*, *F. sumbawaensis*, and *F. wamenaensis*.

Species	Leaf dimension	Shape of auricle	Number of cephalia per infructescence	Cephalium dimension	Number of stigma
Freycinetia angustissima	5–6 by 0.6 cm	Tapered	1 to 2	1.26–1.3 by 1.26–1.3 cm	2 or 3 (current study), but 1 or 2 (Stone, 1967)
F. forbesii	10–15 by 1.9 –2 cm	Tapered	3 to 4	1.9–2 by 1.9–2 cm	1 or 2, rarely 2
F. oblanceolata	15–21 by 3–4 cm	Tapered	3 to 4	2.5 by 2 cm	1 or 2
F. scandens	8–10 by 1– 2.7 cm	Tapered	1 to 4	3–6 by 2.5–3 cm	2 to 4, usually 2 & rarely 4S
F. sumbawaensis	10 by 1.5 cm	Tapered	2 to 3	2.5 by 1.5 cm	1
F. wamenaensis	11–12 by 2.5 –3.5 cm	Lobed	3, rarely 4	4.5–5 by 2–2.5 cm	1, rarely 2

Fig. 4. Habit of *Freycinetia wamenaensis* A.P. Keim with mature infructescence as can be seen in the bank of Dupuk Creek in Wamena Biological Garden. In appearance *F. wamenaensis* is exceedingly similar to *F. scandens*. Photo: A.P. Keim.

Fig. 5. *Freycinetia wamenaensis* A.P. Keim (× 2.5) showing the evidence of the distinctive lobed auricle (arrow). Photo: A.P. Keim.

Fig. 6. The ternate infructescence of *Freycinetia wamenaensis* A.P. Keim showing the elongate-ellipsoidal cephalia (× 1.5) with number of stigma almost always one, very rarely two. Photo: A.P. Keim.

Fig. 7. a. Lanceolate-elongate immature cephalium of *F. wamenaensis* A.P. Keim (× 2) clearly showing the number of stigma almost always one. b. The number persists through maturity (× 1.5). Photo: A.P. Keim.

Fig. 8. The fairly scabrous pedicels (× 6) in the mature infructescence. Although regarded in this present study as a less distinctive morphological character compared to the lobed auricle, nevertheless it differs *F. wamenaensis* from *F. forbesii* and *F. sumbawaensis*, two species that *F. wamenaensis* shares most of its noticeable morphological characters (Table 4). Photo: A.P. Keim.

5. FREYCINETIA SCANDENS Gaudich. — Type: *Gaudichaud* s.n. "crescit in Insula Timor" (P), Indonesia, Nusa Tenggara Timur (Eastern Lesser Sunda Islands), Timor (presumably from West Timor).

Freycinetia gaudichaudii R. Br. & Benn. in Horsfield (1838) 31, t. 9. – Type: *Horsfield* s.n. (BM), Indonesia, Java, West Java.

Freycinetia muelleri Martelli (1910) 311, 313. – Type: *Mueller* s.n. (possibly at BM or K), Australia, Queensland.

Freycinetia propinqua Domin (1915) 150. – Type: *Domin* s.n. (possibly at PR).

Freycinetia gonocarpa Moore in Gibbs (1917) 309 – Type: *Gibbs* 6348 (BM), Australia, Queensland.

Distribution. Sumatra, Java, Borneo, Sulawesi (including the Sangir and Talaud Islands), Timor, New Guinea (including the islands of Waigeo and Yapen), and northern part of mainland Australia (Queensland).

Habitat. Lowland tropical rainforest to lower montane forests from coastal to about 1000 m altitude. In Kwerba it is found growing close to a creek from 75 to 250 m altitude.

Vernacular names. Not recorded.

Uses. Not recorded.

Notes. *Freycinetia scandens* has previously never been reported from Mamberamo Basin, thus the species distribution extends further into the interior of New Guinea. Following the placement of several species into the synonyms of *F. marginata* (see above) that increases the distribution area of *F. marginata*, in this current study *F. scandens* is regarded as the second most widely distributed species in the genus. As in *F. marginata*, such a wide distribution reflects also in the vast morphological variations. Several other species found in New Guinea, such as *F. beccarii* Solms, *F. ellipsoidalis* Merr. & L.M. Perry, *F. elliptica* Merr. & L.M. Perry, *F. globiceps* Warb., *F. nervosa* Merr. & L.M. Perry, and *F. streptopifolia* Warb. are suggested in this study would eventually fall into synonymies. Further study is being proceeded.

Specimen collected. Indonesia, Papua,

Mamberamo Raya, Kwerba, Tacewaram, 04 Nov. 2008, *A.P. Keim* 1110 (BO!); Hehetem, 09 Nov. 2008, *A.P. Keim* 1117 (BO!); 12 Nov. 2008, *A.P. Keim* 1139 (BO!); Kwerba, close to airstrip, 17 Nov. 2008, *A.P. Keim* 1148 (BO!); Maner, 18 Nov. 2008, *A.P. Keim* 1153 (BO!).

6. **Freycinetia wamenaensis** A.P. Keim, *sp. nov.* — Figs. 4–8.

Mediocris scandens, auricula lobatus. Infructescencia terminalis, ternate. Cephalium elongatus-ellipsoideus, stigmata plerumque una, rariore duo. — Typus: *A.P. Keim* 1280 (BO!), Indonesia, Papua, Jayawijaya, Wamena, Gunung Susu, Wamena Biological Garden, 8 Km NW of Wamena, 03 Aug. 2010.

Medium size climbing pandan, climbing up to 15 m high. *Stem* green, glabrous, 0.5–0.7 cm diameter, internodes 1–1.5 cm. *Leaf* elongate-oblong to spathoideous, 11–12 cm long, 2.5–3.5 cm wide, acute to acuminate apex, minute spines on apical part, rest of leaf margin glabrous; adaxial surface green, glabrous; abaxial surface light green, slightly glaucous; auricle lobed, persistent already disintegrated into fibres, light brown. *Male inflorescence* ternate, persistent, already dried, *ca.* 5 cm long; pedicel *ca.* 2 cm long, scabrous, flowering part 2 cm long. *Female inflorescence* not observed but it seems in a different branch with male inflorescence. *Infructescence* terminal, ternate or rarely quaternate, 6.5–8 cm long; peduncle short, 1–1.5 cm long; pedicel 1–1.5 cm long, light green, fairly scabrous; bracts persistent, *ca*. 9 cm long, *ca*. 15 cm wide, already disintegrated. *Cephalium* elongate-ellipsoidal, 4.5–5 cm long, *ca*. 2–3cm wide, green when young turns to reddish orange to deep red when mature; number of stigmatic remains almost always one, very rarely two, deep blackish brown.

Etymology. After Wamena, the city where the type was collected.

Distribution. Known only from type locality.

Habitat. Montane forest at about 1700 to 1750 m altitude. *Freycinetia wamenaensis* is also reported to inhabit the banks of the neighbouring Holima Creek about 1 km west of the Dupuk. However, there is no collection has been made so far to confirm this report.

Vernacular name. Wuluhélé (Wamena).

Uses. Local people mentioned that cephalium is consumed by Cuscus (*Spilocuscus maculatus*). Stem is used for strings.

Notes. The result of this present study indicates that now there are five species of the genus *Freycinetia* known to possess a berry with single stigmatic remain: *F. angustissima*, *F. forbesii*, *F. oblanceolata*, *F. sumbawaensis*, and *F. wamenaensis* (Table 4). Nevertheless, *F. wamenaensis* can be easily distinguished by its distinctive lobed auricle. In fact *F. wamenaensis* is the only species bearing lobed auricles and berries with single stigmatic remain, thus it is proposed here as a new species. Prior to this present study Ridley (1886) suggested *F. forbesii* and *F. scandens* as closely ally. Keim & Rahayu (2010) expanded the alliance with the inclusion of *F. sumbawaensis*. The result of this current study increases the number of species in the alliance with the addition of *F. wamenaensis*.

Specimens collected. Indonesia, Papua, Jayawijaya, Wamena, Gunung Susu, Wamena Biological Garden, 8 Km NW of Wamena, 13 July 2009, *A.P. Keim* 1231 (BO! DNA material only); 25 July 2009, *A.P. Keim* 1233 (BO!); 03 Aug. 2010, *A.P. Keim* 1280 (holotype BO!); 30 June 2011, *A.P. Keim* 1342 (BO!), *A.P. Keim* 1343 (BO!), *A.P. Keim* 1344 (BO! sterile collection).

7. FREYCINETIA CF. ANGUSTISSIMA Ridl.

Distribution. New Guinea.

Habitat. Lowland tropical rainforests.

Vernacular name. Not recorded.

Uses. Not recorded.

Notes. The specimen *A.P. Keim 1149* is sterile, thus identification is based on the vegetative character, especially lanceolate-elongate leaf (9 × 1.2 cm). Thus, this taxon is regarded here a possibly belonging to *F. angustissima*.

Specimen collected. Indonesia, Papua, Mamberamo Raya, Mamberamo Tengah, Kwerba, 17 Nov. 2008, *A.P. Keim* 1149 (BO!).

8. FREYCINETIA AFF. VIDALII Hemsl.

Distribution. Prior to this publication *F. vidalii* was known only from the Philippines. It is strongly suggested here that the distribution area may expands to New Guinea.

Habitat. Lowland tropical rainforest.

Vernacular names. Araripaja (Papasena), kamaha-kurau (Kwerba).

Uses. Not recorded.

Notes. This taxon is also identified based on sterile collection. Nevertheless the possession of lobed auricle indicates that this taxon belongs to the section *Auriculifoliae* (Stone, 1968). Except *F. vidalii* (a species previously known as endemic to the Philippines), all members of this section are robust climbers; thus the result of this current study suggests that this taxon (*A.P. Keim* 1128) possibly belonging to *F. vidalii*. The strong floristic link between the Philippines and Eastern Malesia is not something new as it has been suggested previously by Lam (1945a; 1945b). It seems that the result of this study supports the existence of such link.

Specimen collected. Indonesia, Papua, Mamberamo Raya, Mamberamo Tengah, Kwerba, Hehetem, 12 Nov. 2008, *A.P. Keim* 1128 (BO!).

9. PANDANUS ATROPURPUREUS Merr. & L.M. — Type: *Brass* 13648 (A; iso. BO!), Indonesia, Papua, 4 km SW of Bernhard Camp, Idenburg (now Taritatu) River, March 1939.

Pandanus columbiformis B.C. Stone (1974) 8. – Type: *B.C. Stone* 10131 (LAE), Papua New Guinea, Central, Vailala.

Distribution. Mainland New Guinea.

Habitat. Lowland and swampy forests at 200 to 800 m altitude. In Kwerba it is found in the lowland or hill slope rather open area at altitude 80 to 90 m. Not a common species, very rarely seen.

Vernacular name. Tatacir (Kwerba).

Uses. Local people report that the cephalium and drupes are eaten by birds.

Notes. Prior to this recent study *P. atropurpureus* was known only from the type locality (Merrill & Perry, 1940; Stone, 1982; Jebb, 1992). Thus, the result of this study extends the species distribution further north in the Mamberamo Basin. The result of this study also suggests that *P. columbiformis* fall

Fig. 9. *Pandanus conoideus* Lam. a. Cephalium from the cultivated form at Kwerba, b. The yellow variety, c. The cephalium being prepared showing the much longer size, d. Cephalium of the wild form showing the shorter and smaller size compare to the cultivated one, e & f. Cephalia collected from wild individuals showing colour variation from orange to red. Photos: Hari Sutrisno & Suparno (MZB, used here with permission).

Fig. 10. *Pandanus conoideus* Lam. Lateral section (l-s) of a cephalium showing the massive insect invasion (arrows) into pedicel through the pericarps, where the vegetable fat is produced and usually extracted. The invasion is mainly at the basal parts. The invasive insect is still not yet identified. The correct identification of this invasive insect is essential to protect the highly valued cultivated forms (cultivars) from possibly imminent danger. Photo: Suparno (MZB, used here with permission).

into synonymy with *P. atropurpureus*. Apart from the small difference in the shape of drupe, there is no significant morphological difference between the two species. *Pandanus columbiformis* is characterised by the shape of its drupes that are like "*small pigeons"* (hence the name, see Stone, 1974), but some other drupes have approximately the same shape, size and colours than *P. atropurpureus*. Furthermore, some drupes of *P. atropurpureus* collected in this current study also bear small pigeons shape. A molecular phylogeny will hopefully solve this question. Until the data from molecular study became available *P. columbiformis* is considered here as a synonym of *P. atropurpureus.*

Specimen collected. INDONESIA, Papua, Mamberamo Raya, Kwerba, Tacewaram, Karenepu Hill, Itanem, 19 Nov. 2008, *A.P. Keim 1158* (BO!).

10. PANDANUS CONOIDEUS Lam. — Figs. 9–10.

Pandanus ceramicus Rumph. (1743) 149, t. 79, nom. inval. – *Pandanus ceramicus* Kunth (1841) 98, nom. superfl. – Type: *Rumph., Herb. Amboin. 4: t. 79. 1743*.

Bryantia butyrophora Webb ex Gaudich. (1843) t. 20, f. 1–15. – *Pandanus butyrophorus* (Webb) Kurz (1869) 150. – Lectotype: the plate, designated here.

Pandanus subumbellatus Becc. ex Solms (1883) 96. – Type: *Beccari* s.n. (FI), Indonesia, Moluccas, Aru Archipelago, Wokam Island, Giabu-Lenga (Jabulenga).

Pandanus macgregorii F. Muell. ex Solms (1889) 511. – Type: *Mac Gregor* s.n. (B†), Papua New Guinea, D' Entrecasteaux Islands, Fergusson Island, nom. prov., inval.("beschreibe ich vorläufig").

Pandanus cominsii Hemsl. in Hook. (1900) t. 2654. – Type: *Comins* 363 (K), Papua New Guinea, Solomon Islands, Florida Group, Siota Island, Rev.

Pandanus hollrungii Warb. (1900-a) 161, nom. nud.; (1900-b) 71. – Type: *Hollrung* s.n. (B†), Papua New Guinea, northern part of mainland Papua New Guinea (then Kaiserwilhelmsland).

Pandanus hollrungii Warb. forma *caroliniana* Martelli (1912) 66. – Type: *Kraemer* s.n. (B†), Micronesia, Caroline Islands, Truck Island, Tol Uman.

Pandanus englerianus Martelli (1912) 65. – Syntypes: Penloup 5 (FI), Papua New Guinea, New Ireland (then Neu Mecklenburg), 1908; *Peekel* 91 (B†); *Naumann* s.n. (B†).

Pandanus magnificus Martelli (1912) 65. – Type: *Kraemer* s.n. (B†), Papua New Guinea, Admiralty Islands, Manus Island.

Pandanus ruber St. John (1961) 579. – Type: *Brass* 5463 (BRI, iso. NY), Papua New Guinea,

Table 5. Morphological and ecological comparison on habitat preferences, stem height, dimensions of leaf and drupe between *Pandanus carrii* and *P. korwae*.

Species name	Habitat preferences	Stem height	Leaf dimension	Drupe dimension
Pandanus carrii	Savanna grass-land	5 m	120 by 3 cm	60 by 15 mm
P. korwae	Lowland tropical rainforest	1.5 m	300–450 by 10 cm	55–60 by 8 mm

Fig. 11. *Pandanus korwae* A.P. Keim showing the shape and size of cephalium with long peduncle. Photo: H. Sutrisno (MZB, used here with permission).

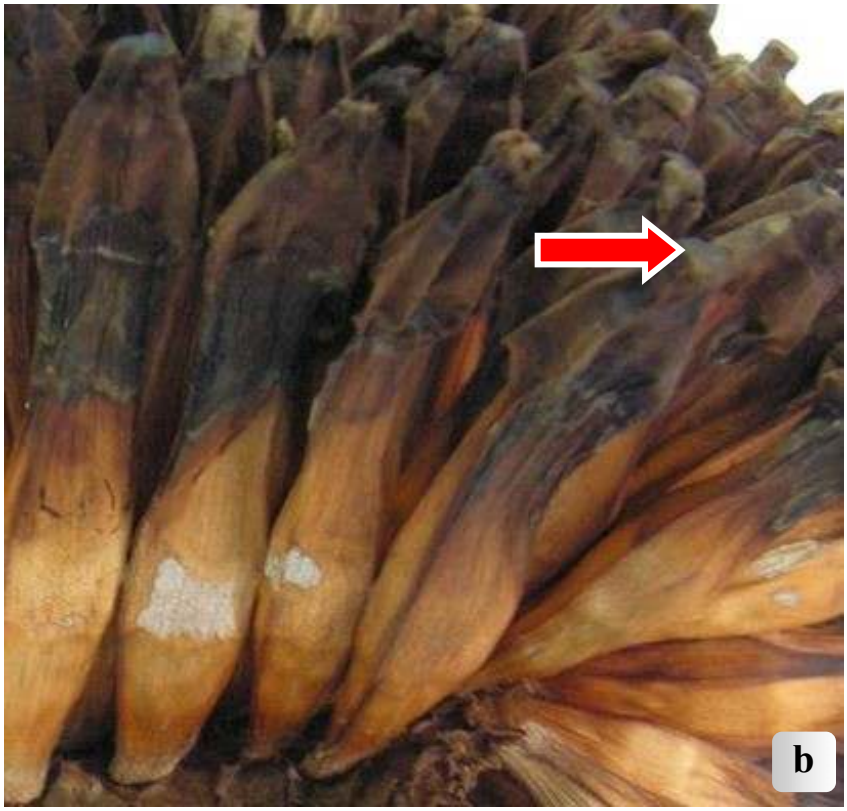

Fig. 12. *Pandanus korwae* A.P. Keim. a. Ellipsoidal drupe, long-elongated conical pileus. b. Blunt-flattened stigmatic remain (arrow) indicates that this species is a member of the subgenus *Lophostigma* and section *Karuka*. Photos: A.P. Keim.

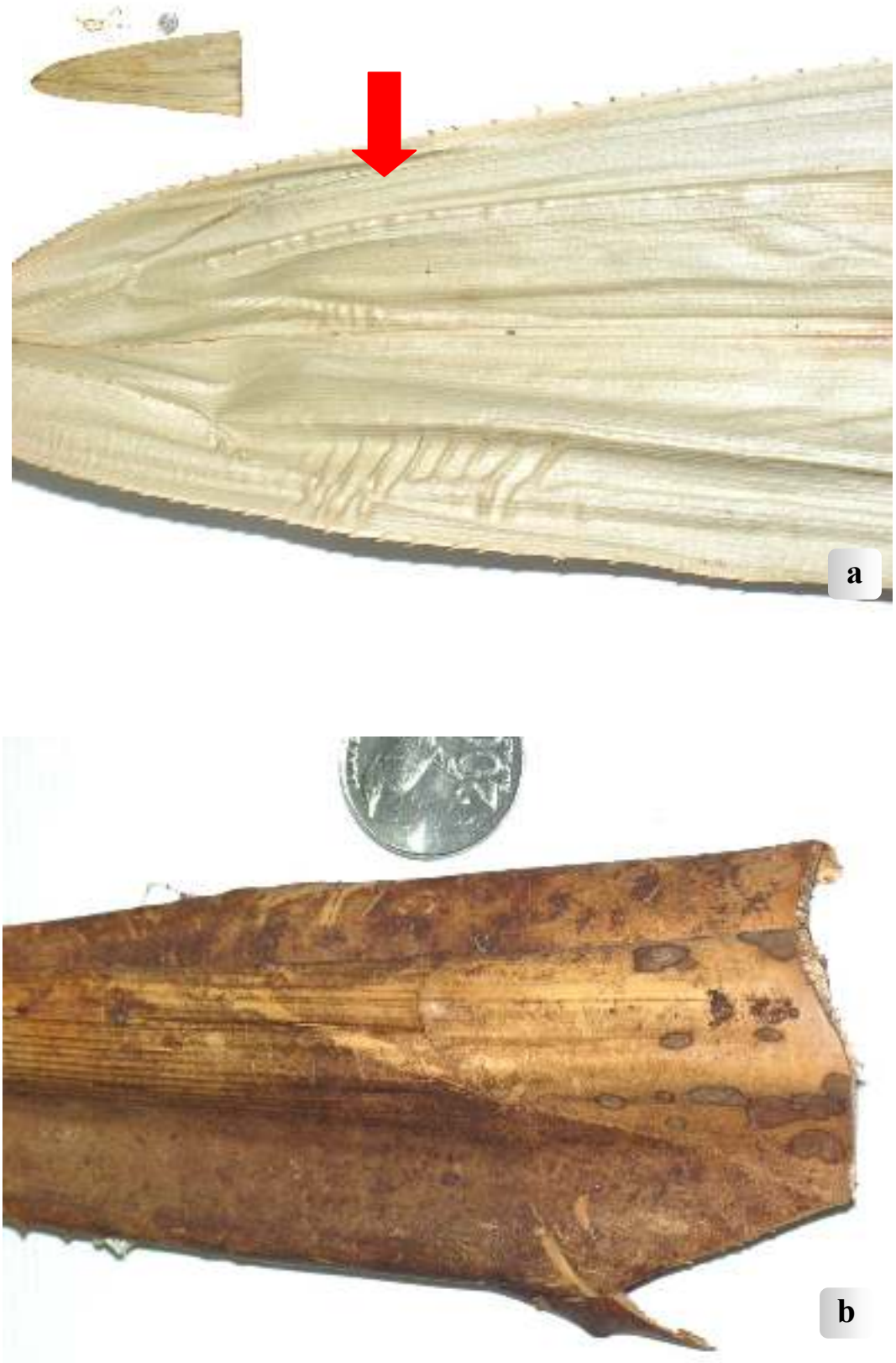

Fig. 13. *Pandanus korwae* A.P. Keim. a. The presence of minute adaxial ventral pleats (arrow). b. The absence of recurved spines. Photos: A.P. Keim.

Central, Bella Vista.

Pandanus cominsii Hemsl. var. *micronesicus* B.C. Stone (1965) 5. – Type: *B.C. Stone* 5340 (PH), Micronesia, Caroline Islands, Truk Islands, Tol, 7° 25' N 151° 47' E, cultivation, 30 Jan. 1965.

Pandanus latericius B.C. Stone (1965) 2. – Type: *B.C. Stone* 2637 (BISH), Papua New Guinea, New Ireland, Kavieng.

Pandanus minusculus B.C. Stone (1965) 3. – Type: *B.C. Stone* 2627 (BISH), Papua New Guinea, New Ireland, Kavieng.

Pandanus erythros St. John (1968) 515. – Type: *Carr* 15922 (BM, L), Papua New Guinea, Central, Isuarava.

Pandanus plicatus St. John (1968) 517. – Type: *Carr* 12590 (BM), Papua New Guinea, Central, Koitaki.

Pandanus rubrispicatus St. John (1968) 519. – Type: Not designated. nom. nud, anglice, "Northeast New Guinea".

Pandanus cominsii Hemsl. var. *augustus* B.C. Stone (1972) 109. – Type: *B.C. Stone* 2570 (fem.) (BISH), Solomon Islands, Santa Isabel Isl., Vulavu to Thathaje trail, along south-west coast, 17 October 1957.

Distribution. Moluccas, New Guinea and adjacent islands, Bismarck Archipelago, Solomon Islands and the islands of Micronesia (*i.e.* Caroline Islands).

Habitat. Mostly cultivated from sea level up to 2000 m altitude. In Kwerba village three cultivars are observed; the individuals with red, yellow, and brown long-trigonal (triangular) shaped cephalium with the red cultivar being the most widely planted. In Hehetem-Kwerba the wild individuals are mostly found growing close to a creek at about 200 m altitude.

Vernacular names. Kutéri péri, péri (Papasena), éhéna (Kwerba, for the yellow cultivar), Piri (Kwerba, for the red and brown cultivars).

Uses. Leaves are used for mats and cigarette papers. Vegetable fat extracted from the pericarp is used as sauce, medicine, and tonic. The use of vegetable fat is only recorded from the cultivated individuals.

Notes. Both the people of Kwerba and Papasena recognised the wild individuals as belonging to the same taxon with the red cultivar indicated by the use of the same vernacular name, "piri" or "péri". The addition of the word "kutéri" in the "kutéri péri" is to identify that it is a wild kind ("kutéri" means wild, bush or a kind of forest in Papasena language).

The taxonomical study of this species has been done by Keim (2009; see also 2006a). Prior to this current study, *P. conoideus* was known only as cultivated plants (Stone 1982; French 1986; Jebb 1992; Walter & Sam 2002). Although large efforts had been done to find the wild form of this species –including by the author of this paper in the neighbouring Wamena area (*i.e.* Baliem valley, see Keim, 2006b), the wild form had never been successfully found. Therefore, the result of this study is significant for the study of this highly praised (both culturally and economically) and widely cultivated species of *Pandanus* in New Guinea.

Cephalium of the wild form is observed greenish orange then turns to orange and finally deep red and it is noticeably smaller than the cultivated ones (Figure 9). The difference in the size as seen in the cultivated forms is apparently related with the domestication effect. The morphological features observed in the wild form of *P. conoideus*, most particularly the size and colour of cephalia, support the placement of several closely related species mentioned above into synonymies proposed by Keim (2009).

Unlike the cultivated form (*i.e.* cultivar), the cephalia of the wild form of *P. conoideus* are almost always found being invested by insect (Figure 10). This is presumably due to high concentration of vegetable fat as source of nutrition for the insect pupa. Interestingly, the case of insect invasion to the cephalium of the cultivated form (cultivar) has never been reported. Study is being done by entomologists from the Museum Zoologicum Bogoriense (MZB) at Cibinong, West Java.

Specimens collected. Indonesia, Papua, Mamberamo Raya, Mamberamo Tengah, Kwerba, Hehetem, 09 Nov. 2008, *A.P. Keim* 1116 (BO!); 14 Nov. 2008, *A.P. Keim* 1141 (BO!); Kwerba village, 17 Nov. 2008, *A.P. Keim* 1146 (BO!); *A.P. Keim* 1147 (BO!); 22 Nov. 2008, *A.P. Keim* 1167 (BO!).

11. **Pandanus korwae** A.P. Keim, *sp. nov.* — Figs. 11–13.

Fruticosus, circa 1.5 m altus; pileus elongatus, conicus; stigma obtusus, complanatus. — Typus: *A.P. Keim 1144* (BO!), Indonesia, New Guinea, Papua, Mamberamo Raya, Mamberamo Tengah, Kwerba, Tacewaram, Mancin, Kuwamuk Creek, 17 Nov. 2008.

Solitary short stemmed or shrubby pandan, 1.5 m tall. *Prop roots* short, 50 cm tall, deep brown with sharp nodules. *Stem* very short, less than 50 cm long with sharp nodules, unbranched. *Leaves* in a

rosette, tristichously arranged; each 300–450 cm long, 10 cm wide, spines throughout length; adaxial surface deep green, glabrous, adaxial ventral pleats present; abaxial surface light green, glabrous, recurved spines absent. *Infructescence* terminal, solitary, pendulous, 90 cm long, massive, heavy; peduncle 51 cm long, light green, glabrous. *Cephalium* globose-slightly elongate, 39 cm long, 62 cm circumference, deep green, consisting of numerous drupes. *Drupe* ellipsoidal, 5.5–6 cm long, 0.8 cm wide; pileus 4.2–4.5 cm long, orange to reddish orange; style elongate, conical, deep purplish green, 1.3–1.5 cm long; stigmatic remains blunt, flattened, deep brown.

Etymology. After Michael Korwa, a member of the team involved in this RAP 2 and community developer for the Conservation International stationed at Kwerba.

Distribution. Known only from type locality.

Habitat. Lowland tropical rainforest growing close to a creek.

Vernacular name. Técéni (Kwerba).

Uses. Cephalium is said to be consumed by Cassowaries.

Notes. The ellipsoidal drupe, long-elongated conical pileus, and blunt-flattened stigma (Figure 12) indicate that this taxon is a member of the subgenus *Lophostigma* and section *Karuka*. The section *Karuka* includes three edible and economically important highland species of New Guinea: *Pandanus brosimos* Merrill & Perry (1940), *P. iwen* B.C. Stone (1984), and *P. jiulianettii* Martelli (1912; 1913). Prior to this current study the members of the section *Karuka* are massive tree pandans with stems height more than 10 m. The only member of this section to have stem height less than 10 m was the imperfectly known *P. carrii* St. John (1968). However, *P. carrii* is known to have a stem of 5 m tall and grows in savanna grassland at much lower altitude that is about 450 m altitude. Furthermore, *P. korwae* differs from *P. carrii* in two other morphological characters: The dimensions of leaves and drupes (Table 5).

Specimen collected. Only known from the type.

12. PANDANUS KRAUELIANUS K. Schum. — Type: *Hollrung* 164 (B†), Papua New Guinea (then German New Guinea), Morobe (then Kaiserwilhelmsland), Kollua near Finschhafen.

Pandanus silvestris Rumph. (1743) 145, t. 77 ("Keker wassi"), nom. inval. – *Pandanus rumphii* Warb. (1900-b) 84, non Gaudich., 1846. – *Pandanus ceramicus* Kunth (var.) sylvestris Kunth (1841) 98. – Type: Rumph., Herb. Amboin. 4: t. 77. 1743. Warburg (1900-b) erroneously used "montanus" as the name for this plate. Rumphius had two "species", "silvestris" and "montanus". The plate is of "silvestris", Rumphius wrote. – Epitype: Indonesia, Moluccas, Amboina, Lateri, Sept. 9, 1913, Robinson Pl. Rumph. Amboin. 31 (US; iso:

Fig. 14. *Pandanus pseudosyncarpus* Kanehira. a. Mature cephalium. It looks like the cephalium is a compound fruit constructed of numerous single compactly arranged simple fruits (drupes), thus a syncarp. b. Lateral section of cephalium, which clearly explaining the structure of the cephalium that it is actually constructed of complex fruits (phalanges); thus the cephalium look as if it is a syncarp hence the epithet "pseudosyncarpus". Photos: Suparno (MZB, used here with permission).

A, BM, BO!, F, K, L!, MO, NSW, NY), designated here.

Pandanus montanus Rumph. (1743) 145 ("Keker ewan"), nom. inval. – *Pandanus montanus* Miq. (1855) 161, non Bory, 1804. – *Pandanus terrestris* Warb. (1900-b) 84.– Type: Not indicated. – Merrill (1917) erroneously identified the Rumphian plate with this.

Pandanus amboinensis Warb. (1900-b) 83. – Type: *De Vriese* s.n. (L), Indonesia, Moluccas, Ambon.

Pandanus flabellistigma Martelli (1905) 366. – Type: *Kurz* s.n. (CAL), Cult. in Hort. Bot.Buitenzorg.

Pandanus tabbersianus Rendle ex Gibbs (1917) 198. – Type: *Gibbs* 6213 (BM), Indonesia, Papua Barat, Manokwari track to Ambani (Amban), Jan. 1914.

Pandanus kivi Martelli (1929) 140. – Type: *Brass* 1557 (A), Territory of Papua, Eastern Div., Lower Mori River, 28 May 1926.

Pandanus microdontus Merr. & L.M. Perry (1939) 177, t. 1, f. 18. – Type: *Brass* 7695 (A; iso. L), Papua New Guinea, Western, Lake Daviumbu, Middle Fly River, Sept. 1936.

Pandanus xanthocarpus Merr. & L.M. Perry (1939) 179, t. 1, f. 17. – Type: *Brass* 8487 (A; iso. L), Papua New Guinea, Western, Wassi Kussa River, Tumbuke, December 1936.

Pandanus cernuifolius Merr. & Perry (1939) 180. t. 1, f. 20. – Type: *Brass* 3916 (A; iso. BRI, NY), Papua New Guinea, Central, Ononge Road, Dieni, 1 May 1953.

Pandanus zea St. John (1960) 239, t. 8. – Type: *Brass* 19293 (BRI; iso. L), Australia, Queensland, Cape York Peninsula, Iron Range, 22 June 1948.

Pandanus flavicarpus B.C. Stone (1965) 2. – Type: *B.C. Stone* 2478 (holotype LAE), Papua New Guinea, Solomon Islands, Santa Ysabel.

Pandanus nakanaiensis B.C. Stone (1965) 2. – Type: *NGF* 6440 (Floyd) (LAE), Papua New Guinea, New Britain.

Pandanus roseus B.C. Stone (1965) 2. – Type: *B.C. Stone* 2559 (LAE), Papua New Guinea, Solomon Islands, Rendova Island.

Pandanus rubellus B.C. Stone (1965) 2. – Type: *B.C. Stone* 2565 (LAE), Papua New Guinea, Bougainville Island.

Pandanus spodiophyllus B.C. Stone (1965) 2. – Type: *B.C. Stone* 2617 (holotype LAE), Papua New Guinea, New Britain.

Pandanus biciliatus St. John (1973) 64, t. 311. – Type: *Brass* 28746 (K, iso. L, US), Papua New Guinea, Woodlark Island, Kulumadau rain forest, 14 November 1956.

Pandanus biformatus St. John (1973) 67, t. 312. – Type: *Brass* 23765 (K; iso. A, L, LAE), Papua New Guinea, Milne Bay, Gwariu River, Biniguni Camp, 2 August 1953.

Pandanus luteus St. John (1973) 77, t. 318, 319. – Type: *Brass* 24732 (K, iso LAE), Papua New Guinea, Goodenough Island, eastern slope, mossy oak forest, 8–15 October 1953.

Pandanus croceus B.C. Stone (1974) 23, t. 9–11. – Type: *B.C. Stone* 10290 = *LAE* 53590 (Stone & Streimann) (LAE; iso. A, BISH, BRI, CANB, K, L, US), Papua New Guinea, Admiralty Islands, Manus Island, hills above Lorengau, 18 June 1971.

Pandanus auritus St. John ex Huynh (1976) 93, gallice, nom. nud. – Voucher: *Brass* 27272 (L, incl. Carpol. 13298), Papua New Guinea, Fergusson Isl., Agamoia, 22 June1956.

Pandanus bidrupaceus St. John ex Huynh (1976) 93, gallice, nom. nud. – Voucher: *Brass* 28120 (L), Papua New Guinea, Sudest Isl., Rambuto, 16 September 1956.

Pandanus cernuus St. John ex Huynh (1976) 92, gallice, nom. nud. – Voucher: *BW* 6582 (Koster) (L), Indonesia, Papua Barat, Kebar, Sanopi, 17 February 1958.

Pandanus flexibilis St. John ex Huynh (1976) 93, gallice, nom. nud. – Voucher: *Brass* 32315 (LAE), Papua New Guinea, Morobe.

Pandanus imbrialis St. John ex Huynh (1976) 93, gallice, nom. nud. – Voucher: *Brass* 5655 (FI), Papua New Guinea.

Pandanus maneauensis St. John ex Huynh (1976) 93, gallice, nom. nud. – Voucher: *Brass* 23461 (LAE), Papua New Guinea, Milne Bay.

Pandanus reconditus St. John ex Huynh (1976) 93, gallice, nom. nud. – Voucher: *Brass* 29252 (LAE), Papua New Guinea, Morobe.

Pandanus wauensis St. John ex Huynh (1976) 93, gallice, nom. nud. – Voucher: *NGF* 24963 (Womersley) (L), Papua New Guinea, Morobe.

Pandanus kosteri B.C. Stone (1987) 435, t. 5. – Type: *BW* 6852 (Koster) (holotype L), Indonesia, Papua Barat, Kebar, Sanopi, 17 February 1958.

Pandanus beccarii auct. non Solms: K. Schum. (1887) 192.

Distribution. Moluccas, New Guinea and adjacent islands including Yapen Island, Raja Ampat Archipelago, Bismarck Archipelago, D' Entrecasteaux Islands, Solomon Islands and northern part of Australia (Queensland).

Habitat. Mangrove, lowland swampy up to sub montane forests from 0 up to around 1600 m altitude. In Kwerba it is commonly found in lowland secondary forest at 90 to 95 m altitude.

Vernacular name. Kacir (Kwerba).

Uses. Neither leaf nor cephalium is used by the people of Kwerba and Papasena. This is a rather surprising finding as other people in New Guinea widely use the leaves and cephalia of this species, such as people from Yapen Island (Keim *et al*., 2006; Keim, 2009), where the cephalium is eaten with the usage and method of preparing the fatty substrate extracted from the pericarp similar to that of *P. conoideus* Lam. Indeed, in the other areas in New Guinea, *P. krauelianus* is used as a substitute to *P. conoideus* (Stone, 1992).

Notes. The taxonomical study has been previously done by Keim (2009). *Pandanus krauelianus* is a widespread species in mainland New Guinea. The presence of this species in Mamberamo Basin is new information on the species distribution.

Specimen collected. Indonesia, Papua, Mamberamo Raya, Kwerba, Tacewaram, 03 Nov. 2008, *A.P. Keim* 1092 (BO!).

13. PANDANUS LAUTERBACHII K. Schum. & Warb. – Type: *Lauterbach* 863 (B†), Papua New Guinea, northern part of mainland Papua New Guinea (then Kaiserwilhelmsland).

Distribution. Moluccas (Keim et al. 2008) and New Guinea including the adjacent islands.

Habitat. Swamp and lowland tropical rainforests, along riverbanks from coastal to 100 m altitude. In Kwerba found in lowland and close to a creek (riverbank) close to plantation at about 75 m altitude. Rare.

Vernacular name. Hamicah (Kwerba).

Uses. Leaves used for mats. Cephalium is said to be consumed by birds.

Notes. *Pandanus lauterbachii* is a widespread species. This species is easily recognised in the field by the presence of panicle infructescence consists of 12 to 18 cephalia and the lack of prop roots.

Specimen collected. Indonesia, Papua, Mamberamo Raya, Kwerba, Tacewaram, Aruh Creek, 19 Nov. 2008, *A.P. Keim* 1157 (BO!).

14. PANDANUS PSEUDOSYNCARPUS Kanehira. — Type: *Inokumae* 636 (FU), Indonesia, Papua, Nabire, 1940. — Fig. 14.

Distribution. New Guinea, including the island of Yapen (Keim 2009).

Habitat. Lowland tropical rainforest. In Kwerba it is found at 75 to 80 m altitude.

Vernacular name. Kawani (Kwerba).

Uses. Leaf used for mats, young leaf for cigarette paper. Cephalium is not consumed.

Notes. The taxonomical study of this species has been published by Keim (2009). Prior to this present study the presence of this species in mainland New Guinea was known only from the type locality, thus its occurrence in Mamberamo Basin extends its distribution area.

Specimen collected. Indonesia, Papua, Mamberamo Raya, Kwerba, Tacewaram, Kwerep, 01 Nov. 2008, *A.P. Keim* 1074 (BO!).

15. PANDANUS STENOCARPUS Solms. — Type: *Beccari* s.n. (FI), Indonesia, Papua Barat, Manokwari, Arfak Mountain, July 1875.

Pandanus danckelmannianus K. Schum. in K. Schum. & Hollr. (1889)18. – Type: *Hollrung* 280 (B †), Papua New Guinea, Morobe, Finschhafen.

Pandanus erinaceus B.C. Stone (1965) 1. – Type: *B.C. Stone* 2578 (BISH), Papua New Guinea, Northern Solomons, Bougainville, Buka.

Pandanus lictor B.C. Stone (1965) 2. – Type: *B.C. Stone* 2614 (BISH), Papua New Guinea, New Britain, East New Britain, Gazelle Peninsula, Warangoi.

Pandanus nigridens B.C. Stone (1966) 1. – Type: *B.C. Stone* 2304 (BISH), Solomon Islands, Malaita Island, Malaita.

Pandanus arcuatus St. John (1973) 47. – Type: *Brass* 24045 (A; iso. K)Papua New Guinea, Milne Bay, Kwagira River.

Pandanus verruculosus C. Backer ex B.C. Stone (1978) 55. – Type: *Beguin* 1816 (BO; iso. L, K, PNH †), Indonesia, Moluccas, North Moluccas, Halmahera, Poeloe Rao, Galeo, 12 Oct. 1921.

Pandanus jacobsii B.C. Stone (1983) 210. – Type: *M. Jacobs* 9281 (L), Papua New Guinea, Southern Highlands, limestone country near Waro airstrip 20 km SSW of Kutubu, 6° 31'S, 143° 10'E, 15 Oct. 1973.

Pandanus assurgens St. John, nom. nud. – Voucher: *St. John* 26132 (LAE), Indonesia, Papua, Warossor.

Pandanus batavus St. John, nom. nud. – Voucher: *Brass* 8873 (LAE), Indonesia, Papua,

Jayapura.

Pandanus eramosus St. John, nom. nud. – Voucher: *Brass* 23512 (LAE), Papua New Guinea, Mt. Dayman.

Pandanus hentyi St. John, nom. nud. – Voucher: *Henty NGF* 11581 (LAE), Papua New Guinea, Morobe, Oomsis.

Pandanus hohi St. John, nom. nud. – Voucher: *St. John* 26134 (LAE), Indonesia, Papua Barat, Manokwari, Andei (Andai).

Pandanus kalip St. John, nom. nud. – Voucher: *St. John* 26102 (LAE), Indonesia, Papua Barat, Sorong, Sele Strait.

Pandanus major St. John, nom. nud. – Voucher: *St. John* 26120 (LAE), Indonesia, Papua Barat, Manokwari, Amban.

Pandanus missimaensis St. John, nom. nud. – Voucher: *Brass* 27401 (LAE), Papua New Guinea, Milne Bay, Louisiade Islands, Missima Island.

Pandanus rugulosus St. John, *nom. nud.* – Voucher: *St. John* 26188 (LAE), Papua New Guinea, East Sepik, Angoram.

Pandanus echinatus St. John, *nom. nud.*

Pandanus noviberiensis St. John, *nom. nud.*

Pandanus rererivalis St. John, *nom. nud.*

Pandanus rudis St. John, *nom. nud.*

Distribution. Moluccas, New Guinea and adjacent islands including Raja Ampat, Bismarck, and Solomon Islands.

Habitat. This species is reported to be found from coastal up to 1300 m altitude (Stone, 1982; Jebb, 1992). In Kwerba it is found in humid lowland tropical forest below 100 m altitude (about 65 to 90 m).

Vernacular name. Kamani (Kwerba)

Uses. Leaf is used for mats, young leaf for cigarette paper. Cephalium has never been eaten.

Notes. *Pandanus stenocarpus* is a wide spread species in New Guinea. This current study places *P. danckelmannianus* K. Schum. (Schumann & Hollrung, 1889) as synonym for *P. stenocarpus*. Based on the study of the protologues, there has been no significant difference between the two species. Both species lack visible prop roots possess long and similar beaked styles. This current study also places the Moluccan (Halmahera Island precisely) species *P. verruculosus* C. Backer & B.C. Stone into synonymy. Apart from slight difference in the size of cephalia and dotted surface of the pileus, there has been no decisive character that can be used to distinguish *P. verruculosus* from *P. stenocarpus*. On the other hand, there are several important morphological features that support the placement of *P. verruculosus* into synonymy, such as the lack of visible prop roots, drupe with long and beaked style, and the distinctive colour of the mature drupe, which is bright red. The same argument can also be implemented when placing *P. jacobsii* B.C. Stone (1983) into synonymy. Further study for a proper paper regarding this matter is still being undertaken.

Specimen collected. Indonesia, Papua, Mamberamo Raya, Kwerba, Tacewaram, Kwerep, 02 Nov. 2008, *A.P. Keim* 1077 (BO!); *A.P. Keim* 1089 (BO!); Mancin, 17 Nov. 2008, *A.P. Keim* 1152 (BO!).

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ERRATUM

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1. Please change the existing word in p. 213, LINE 7 on ABSTRAK (written in Bahasa Indonesia version) with the following:

Keberadaan dua jenis terakhir melampaui distribusi yang sebelumnya hanya diketahui di **barat** garis Wallace.

2. Please change the existing epithet name in p, 214, COLUMN 1, LINE 40 on Key to the species of *Marantaceae* in Sulawesi number 5.a. after *Phrynium:*

……*longispicum*

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