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RESEARCH ARTICLE

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Pandanaceae of the island of Yapen, Papua (West New Guinea), Indonesia, with their nomenclature and notes on the rediscovery of *Sararanga sinuosa*, and several new species and records

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Key words

Freycinetia
New Guinea
Pandanaceae
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Papua
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Yapen

Abstract Eleven species of *Pandanaceae* are recorded for Yapen Island, Papua, Indonesia, seven of *Pandanus*, three of *Freycinetia*, including two new ones, and the rediscovery of *Sararanga sinuosa*. Except for the latter all others are new records for the island.

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INTRODUCTION

Yapen is one of the islands in the Cenderawasih (Geelvink) Bay in the Indonesian Province of Papua, West New Guinea. The island is about 2 400 km², of which approximately 3/4 is still covered with lavish lowland tropical rainforest, and an area of about 780 km² is protected as the Yapen Tengah Nature Reserve. Despite the magnificent landscape, Yapen compared to its neighbouring island Biak has remained little explored. Since a short visit by Beccari in 1875 (Solms-Laubach 1883) no further explorations on the pandan flora of the island have been made, thus the pandan flora remains largely unknown.

This paper describes the results of the most recent exploration in Yapen (Keim et al. 2006a). 11 species of *Pandanaceae* are recorded, of which 3 belong to *Freycinetia* Gaudich., 2 are new, 7 to *Pandanus* L.f., and *Sararanga sinuosa* Hemsl. Except for the latter (Solms-Laubach 1883, Guppy 1887, Hemsley 1894, Stone 1961) the rest of the species are new records.

DESCRIPTION OF SPECIES

Freycinetia

1. *Freycinetia allantoidea* A.P.Keim, *sp. nov.* — Fig. 1

Robustus scandens; infructescentia terminalis vel lateralis, plerumque lateralis, ternatus vel quaternatus; syncarpio allantoido, glaucescenti; stigmata 6. — Typus: *A.P. Keim 808* (BO), Indonesia, New Guinea, Papua, South Yapen District, Yapen Island, Sarawandori, 10 October 2006.

Robust climbing pandan, climbing up to 10 m high. *Stem* greyish green, leaf scars obvious, c. 1.2 cm diam. *Leaves* spirally arranged in 3 ranks (tristichous); each lanceolate-elongate, c. 43 cm long, 1.6 cm wide, acuminate apex, margin with spines only on 1/3 distally and basally; adaxial surface green, glabrous, venation slender; abaxial surface pale green, glaucous white, shiny, venation more obvious, main vein with spines on 1/3 distally; auricle tapered, margin integer. *Infructescences* terminal and lateral, mostly lateral (4 individuals observed, only 1 with terminal infructescence), non aromatic, ternate or quaternate, each c. 15 cm long; peduncle 3–3.5 cm long, yellowish green, scabrous; bracts 4, bright yellow, unequally, the most inner one being smaller, thick, fleshy, caducous, each 9.5–10 cm long, c. 5 cm wide, boat-shaped with acuminate apex. *Cephalium* sausage-shaped, corky-warted surface, 10–11 cm long, c. 8.5 cm circumference (2.7–3 cm diam), green, slightly glaucous white, consisting of numerous berries. *Stigmas* (stigmatic remains) 6, brown.

Etymology — The epithet name refers to the sausage-shaped appearance of the cephalia.

Distribution — Endemic.

Habitat — Lowland tropical rainforest at about 100 m altitude.

Vernacular name — Not recorded.

Uses — Not recorded.

Notes — With the robust habit, presence of both terminal and lateral infructescences, and 6 stigmas *F. allantoidea* is a member of the sect. *Lateriflorae* B.C.Stone (see Stone 1968), which contains other gigantic members, such as *F. funicularis* (Savigny) Merr., *F. lauterbachii* Warb., *F. papuana* Warb., *F. pleurantha* Merr. & L.M.Perry, and *F. rhodospatha* Ridl.

However, the possession of the sausage-shaped corky-warted cephalium of this species is unique. The corky-warted surface of the infructescence refers to the appearance of each berry that is rostrate with a rigid and succulent apex. So far no such structure has been found in any other members of the section.

Furthermore, the obvious bright yellow bracts straightforwardly distinguish *F. allantoidea* from *F. funicularis* and *F. rhodospatha*, which both have conspicuously red to reddish orange bracts (see Rumphius 1743, Ridley 1916).

Freycinetia lauterbachii is known only from male collections (Warburg 1900a, b). Warburg (1900b) mentioned that this species has many bracts, the outer ones green and the innermost ones pink. Stone (1969) regarded it as a synonym of *F. funicularis*.

Although known only from immature collections *F. pleurantha* shares many morphological characters with *F. allantoidea*,

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Fig. 1 *Freycinetia allantoidea* A.P.Keim. a. Male inflorescence showing the obvious yellow bracts; b. terminal male inflorescence; c. sausage-shaped cephalium with a corky-warted surface due to the rostrate rigid-succulent apex berries; d. lateral infructescence. Photos: Y. Purwanto & A.P. Keim.

such as the obviously glaucous abaxial surface of the leaf, both terminal and lateral (axillary) infructescences, pale glaucous unripe berries, 6–8 stigmas (see Merrill & Perry 1940). However, there is no information about the colour of the bracts and the structure of the berries, especially the pileus.

With the dimension of the cephalium (9 by 3 cm), non-succulent ovoid berries, and the 5 or 6 stigmas (Warburg 1900b), *F. papuana* is morphologically most similar to *F. allantoidea*. However, there is no information regarding the leaf or infructescence.

Warburg described the infructescence as "syncarps cylindric 9 cm long 3 cm wide, peduncled, peduncle nearly terete, margin little rugulose, 4 cm long 3 mm wide, berries not at all connate and not succulent, ovoid, c. 1.5 cm long, in the middle 1/2 cm wide, apex pyramid-shaped acuminate, below the seeds very much filled".

Martelli (1910) stated that the type of *F. papuana* (*Hollrung 218a*) consisted of half a syncarp that without doubt belonged to *F. lauterbachii*. Stone (1969), however, regarded *F. papuana* as illegitimate as the type would be a mixed collection, partly belonging to *F. funicularis*. Up to 1966 the Code ruled that names based on discordant elements (mixed collections) must be rejected, from 1972 on this Article (70) has been deleted, and the combination *F. papuana* is legitimate. *Freycinetia funicularis* is now the correct name for *F. lauterbachii* (fide Stone 1968). The reason for this statement is unclear as Warburg (1900b) did not provide any figures and the type consisting of infructescence and fruits in B were destroyed during WW II. No duplicates are known to exist.

Specimen seen. Only known from the type.

2. *Freycinetia beccarii* Solms — Fig. 2

Freycinetia beccarii Solms (1883) 100. — Type: *Beccari s.n.* (FI), Indonesia, Papua Barat, Manokwari, Andai, 1872.

Freycinetia globiceps Warb. (1900a) 159; (1900b) 30. — Syntypes: *Warburg 20996* (B†), Indonesia, Papua, Sigar; *Hollrung 857* (B†), Papua New Guinea, Constantinhafen; *Lauterbach 1522* (B†), Finschhafen, 6 January 1890; *Lauterbach 2119* (B†), Oertzen-Gebirge, August 1896.

Freycinetia streptopifolia Warb. (1905) 53. — Type: *Lauterbach s.n.* (B†), Papua New Guinea, Kaiser-Wilhelmsland, April 1902.

Freycinetia ellipsoidalis Merr. & L.M.Perry (1939) 142. — Type: *Brass 7142* (A), Papua New Guinea, Western Province, Palmer River, 2 miles below Black River Junction, June 1936.

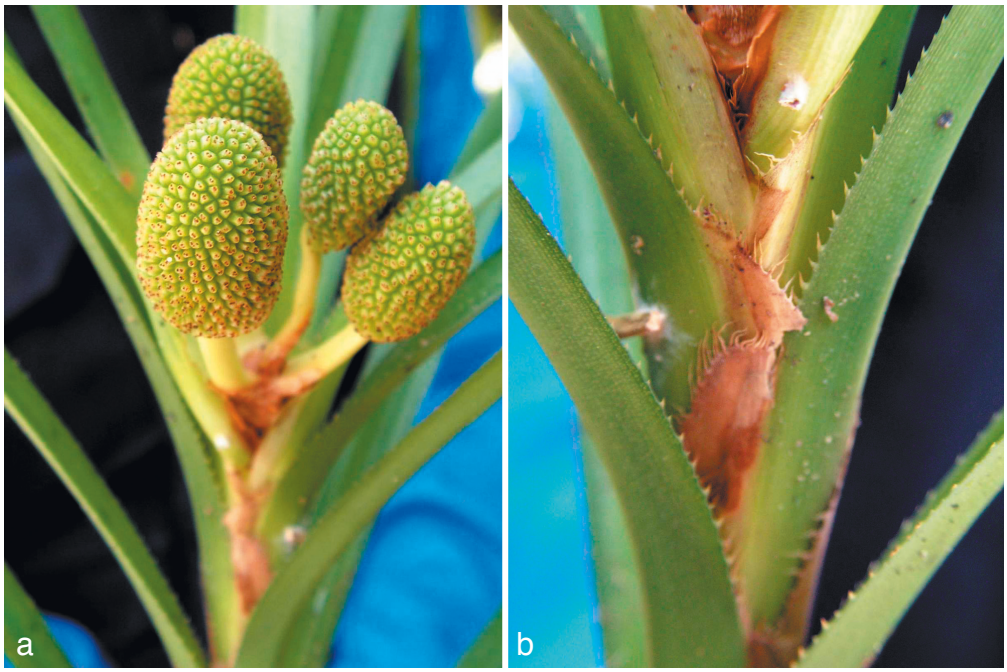

Fig. 2 *Freycinetia spinifera* A.P.Keim. a. Infructescence with 4 spirally arranged cephalia (quaternate); b. obvious spiny auricles. Photos: Y. Purwanto & A.P. Keim.

Freycinetia nervosa Merr. & L.M.Perry (1939) 142. — Type: *Brass 6926* (A), Papua New Guinea, Western Province, Palmer River, 2 miles below Black River Junction, June 1936.
Freycinetia elliptica Merr. & L.M.Perry (1939) 143. — Type: *Clemens 3810* (A), Papua New Guinea, Morobe Province, Yunzaing, 4 August 1936.

Slender climbing pandan, climbing up to 10 m high. *Stem* greyish green, 0.5–0.7 cm diam, leaf scars obvious. *Leaves* arranged in 3 ranks; each leaf elliptical to oblong, 15 cm long, 4 cm wide; adaxial surface green, glabrous, venation glabrous, acuminate apex, integer margin except in the most basal part; abaxial surface pale green, venation more obvious, main vein with spines up to 1/3 apically; auricle tapered, apical part with spines. *Infructescence* terminal, ternate; bracts yellowish green. *Cephalium* oblong, pale green, c. 2 cm long, c. 1 cm diam, consisting of numerous compactly arranged berries; pedicel c. 2 cm long, glabrous, pale green. *Stigmas* (stigmatic remains) 2–3, mostly 2.

Distribution — Moluccas, northern part of mainland New Guinea, Yapen Island.

Habitat — Lowland tropical rainforest to montane forest at 100–2650 m altitude. In Yapen Island *F. beccarii* is commonly found at 100 m altitude.

Vernacular name — Not recorded.

Uses — Not recorded.

Note — This is a new record for Yapen. The result of this study recognises *F. ellipsoidalis*, *F. elliptica*, *F. globiceps*, and *F. nervosa* as synonyms of *F. beccarii* (Table 1). The important morphological features used as distinctive characters for the three species are slight and have proven to be continuous (i.e. not discrete). It is also in accordance with Martelli (1910) and Merrill & Perry (1939) in recognising *F. streptopifolia* as a synonym of *F. beccarii*.

Specimen seen. Indonesia, Papua, Yapen Island, South Yapen District, Sarawandori, 10 Oct. 2006, *A.P. Keim 806* (BO!).

3. *Freycinetia spinifera* A.P.Keim, *sp. nov.*

Gracilis scandens; auricula spinosa; infructescentiae plerumque quaternatae raro ternatae; stigmata plerumque 2, raro 3. — Typus: *A.P. Keim 807* (BO!), Indonesia, New Guinea, Papua, Yapen Island, South Yapen District, Sarawandori, 10 October 2006.

Slender climbing pandan, climbing up to 10 m high. *Stem* greyish green, 0.5–0.8 cm diam. *Leaves* spirally arranged in 3 ranks (tristichous); each lanceolate-elongate, 36–37 cm long, 1 cm wide, acuminate apex, integer margin – except in the lower most part (c. 1/3 basally) with minute spines; adaxial surface green, glabrous, venation slender; abaxial surface pale green, glabrous, main nerve obvious, with minute spines on uppermost part; auricle with obvious spines, pectinate, brown; leafsheath pale green. *Infructescence* terminal, ternate or quaternate, mostly quaternate; peduncle pale yellow, scabrous, 1.7–1.8 cm long; bracts caducous. *Cephalium* globose or slightly elongate, c. 2 cm long, 1 cm diam, green, consisting of many berries. *Stigmas* usually 2, rarely 3.

Etymology — The epithet means spine-bearing, which refers to the spines on the auricle.

Distribution — Endemic.

Habitat — Lowland tropical rainforest at about 100 m altitude.

Table 1 Morphological comparisons on leaf dimension, number of stigmas, and the number of cephalia per infructescence in *F. beccarii*, individuals of *F. beccarii* found in Yapen Island, *F. elliptica*, and *F. globiceps*.

Species	Leaf dimension	Number of stigmas	Number of cephalia per infructescence
Freycinetia beccarii	8 by 1.8 cm	2	2–3
F. beccarii (Yapen individuals)	15 by 4 cm	2–3, mostly 2	3
F. ellipsoidalis	4.5–5.5 by 1.5 cm	1–2	3
F. elliptica	8–10 by 4–4.5 cm	1–3	3
F. globiceps	16–18 by 2–2.5 cm	2–3, mostly 2	2–3
F. nervosa	9–11(–14) by 3–3.5(–5) cm	1–3	3

Table 2 Morphological comparisons on leaf dimension, cephalium shape, number of cephalia per infructescence and stigma between *Freycinetia pectinata*, *F. rigidifolia*, and *F. spinifera*.

Species	Leaf dimension	Cephalium shape	Number of cephalia per infructescence	Number of stigmas
Freycinetia pectinata	15–20 by 0.9 cm	cylindrical	4	4–6(–12)
F. rigidifolia	30 by 0.8–1 cm	oblong-cylindrical	3	2
F. spinifera	36–37 by 1 cm	slightly elongated globose, (2 by 1 cm)	3–4, mostly 4	2–3, mostly 2

Vernacular name — Not recorded.

Uses — Not recorded.

Notes — In appearance *F. spinifera* is extremely similar to the West Malesian *F. rigidifolia* Hemsl., especially regarding the habit, leaf dimension and the cephalium shape. The two species differ only on 2 morphological characters, the numbers of cephalia and stigmas (Table 2).

By the possession of spiny auricles *F. spinifera* seems to be a member of sect. *Hemsleyella* B.C.Stone, to which *F. rigidifolia* and *F. pectinata* Merr. & L.M.Perry also belong (see Stone 1968).

Until recently the only member of this section known from New Guinea and adjacent areas was *F. pectinata* of the Solomon Islands. Despite the same slender habit, spiny auricles and quaternate infructescences *F. spinifera* instantly differs from *F. pectinata* in the number of stigmas (Table 2). The number of stigmas in *F. spinifera* varies from 2–3 (mostly 2); while in *F. pectinata* there are 4–6(–12) (see Merrill & Perry 1939). A study of the isotype of *F. pectinata* (*Brass 3247*, BO) showed that *F. spinifera* is indeed distinct from *F. pectinata*.

Specimen seen. Only known from the type.

Pandanus

1. *Pandanus conoideus* Lam.

Pandanus conoideus Lam. (1785) 372. — *Pandanus ceramicus* Rumph. (1743) 149, t. 79, nom. inval. — *Pandanus ceramicus* Kunth (1841) 98, nom. superfl. — Holotype: *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†), nom. prov., inval. ("beschreibe ich vorläufig"), Papua New Guinea, D'Entrecasteaux Islands, Fergusson Island.

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

Pandanus hollrungii Warb. (1900a) 161, nom. nud.; (1900b) 71. — Type: *Hollrung s.n.* (B†), Papua New Guinea, presumably from mainland Papua New Guinea (then Kaiser-Wilhelmsland).

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

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

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

Pandanus ruber H.St.John (1961) 579. — Type: *Brass 5463* (BRI; iso NY), Papua New Guinea, 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 January 1965.

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

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

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

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

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

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

Solitary tree pandan, 3–10 m high. *Prop roots* present, obvious. *Stem* branched. *Leaves* in a rosette, spirally arranged in 3 ranks (tristichous); each lanceolate-elongate, c. 180 cm long, 3–5 cm wide, margin with spines; adaxial surface dark green, glabrous, adaxial ventral pleats present; abaxial surface pale green, main vein apparent, with minute spines, recurved spines obvious. *Infructescence* terminal, solitary; peduncle 38–44 cm long, c. 5.4 cm diam (c. 17 cm circumference). *Cephalium* cylindrical (elongated ellipsoidal) trigonal, bright yellow to red and crimson, 42–70(100–110) cm long, 9.6–11 cm diam (30–34.5 cm circumference), slightly covered with persistent bracts; pedicel white; composed of numerous drupes. *Drupe* obviously trigonal (triangular), pericarp fatty, yellow or red.

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

Habitat — Cultivated from sea level up to 2 000 m altitude. Never found in the wild. In Yapen Island, the red and yellow varieties are cultivated almost in every part of the South and East districts except in the Menawi area, where only the red variety is planted.

Vernacular names — Pandan Buah Merah (Indonesia), Pandan Séran (Malay-Moluccan dialect), Saun (Moluccas-Seran), Kleba (Moluccas-Buru), Siho (Moluccas, North Halmahera-Galela), Goroko ina Ngauku (Moluccas, North Halmahera-Tobias), Kobokana (Yapen-Kerenui), Awone Mangkaki (Yapen-Menawi, for individuals with yellow cephalia), Awom Mangkaki (Yapen-Mantembu, for individuals with yellow cephalia), Awone Waransir (Yapen-Mantembu, for individuals with red cephalia), Abo (Yapen-Menawi, for individuals with red cephalia), Saj (Papua-Wamena), Marita (Pidgin of Papua New Guinea), Bunam (New Ireland-Pala), Bunumia (New Ireland-Kuanua), Vurume (New Ireland-Lamekot), Deg (New Ireland-Pala), Si-tararak (New Ireland-Lamekot), Besbes (New Ireland-Ugana).

Uses — Leaves are used for mats. Vegetable fat extracted from the pericarp is used as sauce, medicine, and tonic. The cephalia are economically important and sold in the local market. Peekel (1984) and French (1986) under *P. englerianus* described a usage and method of preparation of the pulp extracted from the pericarp that is similar to the way *P. conoideus* is treated.

Notes — The presence of *P. conoideus* in Yapen Island is a new record. It is a good example of a species with a widespread distribution and an outstanding spectrum of morphological variation. The differences between *P. conoideus* and the numerous species listed above are slight and are merely in the dimensions of the leaves and drupes (Table 3) underrating the obvious similarities in the shape of the cephalia and stigmas. Despite the differences in the size all taxa listed above each have an obvious long cylindrical trigonally (triangular)-shaped yellow to

Table 3 Morphological comparisons on the sizes of leaf, cephalium, drupe and shape of cephalium between *Pandanus conoideus* and some species listed above as synonyms.

Species	Size of leaf (cm)	Size of cephalium (cm)	Size of drupe (mm)	Shape of cephalium
Pandanus cominsii	60–120 by 5–6	30 by 5–6	12–16 by 3	cylindrical-trigonal
P. conoideus	180–200 by 3–12	42–110 by 9.6–11	25 by 3	cylindrical-trigonal
P. englerianus	250 by 10	60 by 12	18 by 5–6	slightly trigonal
P. hollrungii	no data (leaf not collected)	35 by 4–7	11–13 by 2.5–3	cylindrical-subtrigonal
P. hollrungii forma *caroliniana*	no data (leaf not collected)	35 by 4–7	15–18 by 2.5–3	cylindrical-subtrigonal
P. latericus	205 by 4	35 by 9	12 by 3	cylindrical-trigonal
P. macgregori	136 by 4.5	23–25 by 5	15 by 6	cylindrical-subtrigonal
P. magnificus	no data (leaf not collected)	65 by 11	15–16 by 3–5	cylindrical-trigonal
P. minusculus	150–265 by 5	23 by 5	12 by 4	cylindrical-trigonal
P. plicatus	100–200 by 4–5	20 by 6.3	22 by 4	cylindrical-trigonal
P. ruber	172 by 10.2	42 by 10.5	13–15 by 3–4.5	cylindrical-trigonal
P. subumbellatus	200–300 by 6	20 by 8–10	12–15 by 3	cylindrical-subtrigonal

red cephalium, a characteristic of *P. conoideus*, which has been recorded as early as Rumphius (1743). Keim et al. (2006a) have suggested that the size of the cephalia from individuals found in the island tends to be smaller than those, which are found in the mainland. The length of cephalium collected from individuals in Yapen rarely exceeds 50 cm, while those found in the Wamena highlands of Indonesian New Guinea can reach 100–110 cm (Keim et al. 2006b). This current study is also in accordance with Stone (1982) and Jebb (1992) in placing *P. erythros* and *P. plicatus* as synonyms of *P. conoideus* and recognising *P. rubrispicatus* as a nomen nudum. Nevertheless these species share three important morphological characters with *P. conoideus*, the long cylindrical-trigonal and red cephalium with small vertical flat stigmas (St John 1968). The placement of species listed above as synonyms has the consequence that *P. conoideus* is now also known to occur in the Caroline Islands (Micronesia), and so is a new record for *P. conoideus*. As *P. conoideus* has never been found in the wild, the widespread distribution of *P. conoideus* is undoubtedly due to human activities rather than to natural causes (Stone 1982, Hyndman 1984, Walter & Sam 2002).

Specimens seen. Indonesia, Papua, Yapen Island, East Yapen District, Kerenui, 19 Sept. 2006, *A.P. Keim 781* (BO!); South Yapen District, Mantembu, 23 Sept. 2006, *A.P. Keim 782* (BO!); Menawi, 25 Sept. 2006, *A.P. Keim 783* (BO!), *A.P. Keim 784* (BO!); Mantembu, 26 Sept. 2006, *A.P. Keim 786* (BO!).

2. *Pandanus dubius* Spreng.

Pandanus dubius Spreng. (1826) 897. — *Folium baggea maritimum* Rumph. (1743) 151, t. 80, nom. inval. — *Pandanus bagea* Miq. (1855) 159, nom. superfl. — Type: *Rumph.*, *Herb. Amboin. 4: t. 80. 1743*. — Epitype: *Robinson Pl. Rumph. Amboin. 55* (US; iso A, BM, BO, F, K, L (Carpol. 10415), MO, NSW, NY), designated here, Indonesia, Moluccas, Amboina, Latuhalat, along the seashore, 22 September 1913.

Folium baggea verum sive Pandanus magnus Rumph. (1743) 150, nom. inval. — Included here by Warburg (1900b), but Merrill (1917: 82) thought that this possibly is *P. tectorius* Parkinson ex J.P. du Roi.

Pandanus latissimus Blume (1835) 175, 202, t. 53, nom. nud.; ex Miq. (1851) 29. — Type: Indonesia, Moluccas, Banda. Not found in L.

Barrotia tetrodon Gaudich. (1843) t. 13, f. 1–8. — *Pandanus tetrodon* (Gaudich.) Balf.f. (1878) 63. — Type: *Gaudichaud s.n.* (P), Mariana Islands.

Hombronia edulis Gaudich. (1843) t. 22, f. 17. — *Pandanus edulis* (Gaudich.) de Vriese in Hook. (1854) 264, non Thouars, 1808. — Type: *Gaudichaud s.n.* (P), Mariana Islands.

Pandanus bidoer Jungh. (1853) 268. — Type: *Junghuhn s.n.* (L. sh. 903.257-697), Indonesia, Java, Bantam, Ujong Kulon, G. Payong, 14 May 1846.

Pandanus macrocarpus Vieill. (1861) 51. — *Barrotia macrocarpa* (Vieill.) Brongn. (1875) 279, t. 14, f. 1. — Type: *Pancher 761* (P), New Caledonia, in the mountains near Diaoé. See note.

Pandanus leram auct. non Jones ex Voigt: Kurz (1867) 105. — *Pandanus andamanensium* Kurz (1869) 148. — *Pandanus leram* Jones ex Voigt var. *andamanensium* (Kurz) B.C.Stone (1975a) 118. — Type: *Kurz s.n.* (CAL) India, Andaman Islands.

Pandanus compressus Martelli (1905) 363. — *Pandanus dubius* Spreng. var. *compressus* (Martelli) B.C.Stone (1975b) 50. — Type: *Guppy s.n.* (K), Solomon Islands.

Pandanus yamagutii Kaneh. (1936) 544. — Type: *R. Kanehira 3721* (FU), Micronesia, Truk Island, Truk District Office, September 1935.

Robust solitary tree pandan, 10–15 m high. *Prop roots* obvious, more than 1 m high, spiny; outer bark greyish brown; inner bark whitish crème. *Leaves* in a rosette, spirally arranged in 3 ranks (tristichous); lanceolate-elongate, c. 93 cm long, c. 11 cm wide, slightly rotundate margin with minute spines; adaxial surface green, glabrous, adaxial ventral pleats absent, venation slender green; abaxial surface pale green, venation more obvious, green, recurved spines absent. *Infructescence* solitary, terminal, 62–65 cm long; peduncle 28–30 cm long, glabrous. *Cephalium* globose, 34–35 cm long, c. 20.7 cm diam (circumference c. 65 cm), green, glaucous white, composed of phalanges. *Phalange* ellipsoidal ovate, hard, pale green, glaucous white, 5–6 cm long, c. 4 cm wide; stigmas 2–7 arranged in 1 linear row.

Distribution — Andaman Islands, Malesia, Bismarck Archipelago, Solomon Islands, Caroline Islands (i.e. islands of Micronesia), Palau Island, Mariana Islands, Fiji, Tonga, Vanuatu (New Hebrides), Niue Island.

Habitat — Coral and rocky shores, never found far inland.

Vernacular names — Bidur (Java, Sunda), Pandan wong (Sunda), Pandan pantai buah durian (Malay-Yapen), Haun lainulun (Moluccas-Ambon), Haun pantai (Moluccas-Ambon), Pung (Moluccas, South Halmahera-Weda, North Halmahera-Tobias), Boku (Moluccas, North Halmahera-Galela, Moluccas-Ternate), Bou (Moluccas-Tidore), Vaum (New Ireland-Kuanua), Lau (New Ireland-Pala), Fom, Faum (New Ireland-Lamekot), Na Vaku (Vanuatu-Nguna), Navaka (Vanuatu-Tongariki), Pohk (Caroline Islands-Truk), Poko (Palau), Meu-yok (Caroline Islands-Kusai), Pafung (Marianas Islands-Saipan).

Uses — Leaves are used for mats and roofing. In Yapen the leaves are used as wrappers for steaming fish. This usage has never been reported before. In the Moluccas the leaves are used in preparing (i.e. cooking) the Sago (Heyne 1927), in which the starch is enwrapped with the leaves and then baked, a practise which is not found in Yapen. The cephalium is not eaten in Yapen, but it is in the New Hebrides (Stone 1967) and elsewhere in the Pacific region (Walter & Sam 2002). The flavour is much like that of coconut meat.

Notes — Martelli (1904, 1913) suggests that *P. macrocarpus* Vieill. is a mixed collection which he split up in *P. macrocarpus s.s.* and *P. veillardii* Martelli. Brongniart (1875) did not comment on this, but noted that the description of the fruits did not agree with what he had seen, while in CAEN there was a fruit of *P. odoratissimus* under this name. He attributed this to a mix-up of labels.

The presence of *P. dubius* in the Andaman Islands and Yapen are new records. In Java in some phalanges in the apical part

Table 4 Morphological comparisons on the sizes of the phalanges, number of stigmas and their arrangement between *Pandanus andamanensium*, *P. bidoer*, *P. compressus*, *P. dubius*, *P. leram*, and *P. yamagutii*.

Species	Size of phalange (cm)	Number of stigma per phalange	Arrangement of stigmas in a phalange
Pandanus andamanensium	5–7 by 4	1–2 (3–5 according to Hooker 1894; 2–3 according to Backer & Bakhuizen van den Brink Jr. 1968)	1 linear row
P. bidoer	8–14 by 4–8	2–5	1 linear row
P. compressus	7–15 by 4	3–4 or up to 5–7, rarely only 1	1 linear row
P. dubius	5–6 by 4 (10–14 by 5–7 in individual found in Java according to Keim et al. 2006c)	2–3, but phalanges in the distal (apical) part can be seen with only 1 stigma	1 linear row
P. leram	12–14 by 10–12	6–12	1 linear row
P. yamagutii	3 by 1.5–1.7	2–3	1 linear row

of the cephalium there may be only a single stigma (Keim et al. 2006c). Thus the difference is insufficient to keep the two species apart and *P. andamanensium* is submerged. Despite the difference in the number of stigmas in a phalange, the stigmas in these two species are arranged in a single row (Table 4).

Actually, Kurz (1869) himself already noted that *P. andamanensium* is very similar to *P. dubius* and would differ only by the number of stigmas per phalange, 1–2, while *P. dubius* would have 2–3. Although when comparing these two species Kurz cited the protologue of *P. dubius*, the possession of 2 stigmas in a linear row in *P. dubius* was not discussed. Warburg (1900b) mentioned that *P. andamanensium* is very much the same as *P. dubius* and differs only in the size of the phalange and numbers of stigmas but still kept them as two distinct species. Backer & Bakhuizen van den Brink Jr. (1968) reported that phalanges from individuals found in Java regarded to belong to *P. andamanensium* were observed with 2–3 stigmas in a row; thus fitting *P. dubius*.

The same argument is also applied when placing *P. compressus* in the synonymy of *P. dubius*. The arrangement of 3–4 stigmas in a linear row per phalange here (Martelli 1905) is slightly different from *P. dubius*. Stone (1967) noted that *P. compressus* is very similar to *P. dubius* and differs particularly in the number of stigmas (Table 3), and seeds (usually 2–3, while usually solitary in *P. dubius*), and the position of the seed (basal, while central in *P. dubius*). In the present study these characters only vaguely distinguish *P. compressus* from *P. dubius*. Although it rarely happens *P. compressus* can also possess a phalange with 1 stigma (Stone 1968), so its range overlaps that of *P. dubius*. On the other hand, although the phalanges of *P. dubius* are usually found with a single seed, sometimes they may have more, thus agreeing with *P. compressus*.

The result of my study indicates that *P. bidoer* is also a synonym of *P. dubius*, which is in accordance with the opinions of Warburg (1900b), Koorders (1911, 1913, see also Koorders-Schumacher 1913) and Stone (1972a) but not with Backer & Bakhuizen van den Brink Jr. (1968) who treated *P. bidoer* as a distinct species.

The main differences between *P. bidoer* and *P. dubius* would be in the dimensions of the leaf (200 by 40 cm against 93–500 by 11–14 cm in *P. dubius*) and phalanges (Table 4), which are regarded here as insufficient. The length (and corresponding width) of the leaves in a single individual of *P. dubius* may vary from less than 100 up to 500 cm. The size of phalanges from an individual of *P. dubius* (identified by 2–3 stigmas in 1 linear row) found in Java can reach 10–14 by 5–7 cm (Keim et al. 2006c). Thus *P. bidoer* cannot be distinguished.

Pandanus yamagutii is also treated here as a synonym of *P. dubius*. The straightforward similarity with *P. dubius* is in the number of stigma per phalange (Table 4). The smaller size of the phalange described for *P. yamagutii* is due to the immature nature of the cephalium (Kanehira 1936). The rest of the characters match *P. dubius* and even Kanehira mentioned that the species was a member of a section that is recorded chiefly from the Asiatic continent and the Philippines (see Kanehira 1936).

Stone (1975a) regarded *P. andamanensium* as a variety of *P. leram*, *P. leram* var. *andamanensium*. He believed that it represents the wild form of the cultivated *P. leram*. I am not in accordance with this. *Pandanus leram* has several straightforwardly distinctive morphological characters, especially the number of stigmas in a row (Table 4). Furthermore, it is a native of the Nicobar Islands. It is only in Ceylon that this species has never been found in the wild. Until data from molecular study become available, the 'polyploidy' theory involving the 'wild' *P. andamanensium* and the 'cultivated with doubled number of stigmas' *P. leram* as was suggested by Stone (1975a) is regarded here as tentative, thus best avoided. Based on the morphological data available at present *P. andamanensium* is undoubtedly the same as *P. dubius*.

Specimen seen. Indonesia, Papua, Yapen Island, South Yapen District, Menawi, beach, 30 Sept. 2006, *A.P. Keim 788* (BO!).

3. *Pandanus kaernbachii* Warb.

Pandanus kaernbachii Warb. (1900a) 159, nom. nud.; (1900b) 49. — Syntypes: *Kaernbach s.n.* (B†), *Hollrung s.n.* (B†), German New Guinea, Kaiser-Wilhelmsland.

Pandanus scabribracteatus Martelli (1929) 139. — Holotype: *Brass 987* (A), Papua New Guinea, Central, Vailala River.

Large solitary tree pandan, c. 10 m high. *Prop roots* present, obvious, 2–5 m high, spiny. *Stem* branched, spiny, pale greenish cream to yellowish cream. *Leaves* in a rosette, spirally arranged in 3 ranks (tristichous); each lanceolate-elongate, 240–250 cm long, 9–11 cm wide, margin with spines; adaxial surface green, glabrous, main vein pale green, adaxial ventral pleats obvious; abaxial surface pale green, glaucous white, venation more obvious, recurved spines absent, basal part pale yellow to white; leafsheath pale yellow to white. *Infructescence* terminal, spike of 2 cephalia. *Cephalium* globose, 21–22 cm long, c. 16 cm diam (c. 50 cm circumference), composed of phalanges; phalanges compactly and densely arranged; each phalange composed of 8–10 drupes. *Drupe* green on distal part, yellow on basal part, hard; stigmatic remains hard, brown.

Distribution — Eastern and southern parts of mainland Papua New Guinea, Bismarck Archipelago, and Yapen Island.

Habitat — Coastal and freshwater swamp.

Vernacular name — Pandan pantai buah banyak (Malay).

Uses — Leaves are used for making mats. The cephalium is not eaten.

Note — The presence of *P. kaernbachii* in Yapen Island is a new record.

Specimen seen. Indonesia, Papua, Yapen Island, South Yapen District, Sarawandori, about 1 hour drive West of Serui, western side of the island, 10 Oct. 2006, *A.P. Keim 801* (BO!).

4. *Pandanus krauelianus* K.Schum.

Pandanus krauelianus K.Schum. (in K.Schum. & Hollrung 1889) 17. — Holotype: *Hollrung 164* (B†), German New Guinea, Kaiser-Wilhelmsland, Kollua near Finschhafen.

Pandanus silvestris Rumph. (1743) 145, t. 77 (‘*Keker wassi*’), nom. inval. — *Pandanus rumphii* Warb. (1900b) 84, non Gaudich. 1846. — *Pandanus ceramicus Kunth* (var.) *sylvestris* Kunth (1841) 98. — Type: *Rumph.*, *Herb. Amboin. 4: t. 77. 1743.* Warburg (1900b) erroneously used ‘*montanus*’ as the name for this plate. Rumphius had two ‘species’, ‘*silvestris*’ and ‘*montanus*’. The plate is of ‘*silvestris*’, Rumphius wrote. — Epitype: *Robinson Pl. Rumph. Amboin. 31* (US; iso A, BM, BO!, F, K, L!, MO, NSW, NY), designated here, Indonesia, Moluccas, Amboina, Lateri, 9 September 1913.

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

Pandanus amboinensis Warb. (1900b) 83. — Type: *De Vriese s.n.* (L sh. 898.273-5 & 6), Indonesia, Moluccas, Amboina, 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, Manokwari track to Ambani (Amban), January 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, Lake Daviumbu, Middle Fly River, September 1936.

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

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

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

Pandanus flavicarpus B.C.Stone (1965) 2. — Type: *B.C. Stone 2478* (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* (LAE), Papua New Guinea, New Britain.

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

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

Pandanus luteus H.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 H.St.John ex Huynh (1976) 93, gallice, nom. nud. — Voucher: *Brass 27272* (L, incl. *Carpol. 13298*), Papua New Guinea, Fergusson Isl., Agamoia, 22 June 1956.

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

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

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

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

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

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

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

Pandanus kosteri B.C.Stone (1987) 435, t. 5. — Type: *BW 6852* (*Koster)* (L), Indonesia, West Irian, Kebar, Sanopi, 17 February 1958.

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

Usually solitary, sometimes clustered tree pandan, 2–3 m high. *Prop roots* present, not obvious, less than 1 m high (c. 50 cm high). *Stem* slender, branched, greyish green to whitish cream, spiny. *Leaves* in a rosette, spirally arranged in 3 ranks (tristichous); lanceolate-elongate, 150–250 cm long, 7–9 cm wide, acuminate apex, margin with spines throughout the length; adaxial surface green to yellowish green, glabrous, venation slender, adaxial ventral pleats present; abaxial surface pale green, glaucous white, venation more obvious, main vein with spines, recurved spines obvious, basal part yellowish green to whitish green; leafsheath yellowish green to whitish green. *Male inflorescence* solitary, terminal, fragrant, c. 100 cm long, consisting of 10 inflorescence branches, each sausage-shaped, covered with white bracts, bracts c. 33 cm long, c. 12 cm wide, stamens numerous. *Infructescence* solitary, terminal, hanging, 43–57 cm long; peduncle glabrous, pale green, 20–40 cm long. *Cephalium* covered with layers of persistent green turns to yellowish green and finally cream orange bracts, only terminal part seen, in appearance resembling corn (*Zea mays*), oblong to elongated ellipsoidal, slightly triangular to subtruncate, pinkish orange (salmon pink) to orange, 17–23 cm long, 8–11 cm diam (25–34 cm circumference) consisting of numerous compactly arranged drupes. *Drupe* 20–21 mm long, 4–5 mm wide; stigma sunken, hard, brown, not sharp, ascending.

Distribution — Moluccas, mainland New Guinea, Yapen Island, Bismarck Archipelago, D’Entrecasteaux Islands, Solomon Islands and northern part of Australia (Queensland).

Habitat — Mangrove, lowland swampy up to submontane forests from 0 up to around 1600 m altitude. In Yapen abundantly found at around 100 m altitude.

Vernacular names — Raintui (Yapen-Menawi), Rei (Manus), I (New Ireland-Kuanua), Isis (New Ireland-Pala), Siliut (New Ireland-Lamekot).

Uses — In Yapen the cephalium is eaten. The usage and method of preparing the fatty substrate extracted from the pericarp is 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). The leaves are used for mats.

Notes — Prior to the present study *P. krauelianus* was only known from the eastern part of mainland Papua New Guinea and the Bismarck Archipelago (Stone 1992). As it has now also been found in Yapen this is a new record. Several names have turned out to be synonyms. Except for relatively slight differences in the sizes of leaf, cephalium, drupe and its colour, there appear to be no significant morphological differences with *P. krauelianus* (Table 5). Stone (1992) mentioned the semi-dwarf habit of *P. kosteri* (1.7–2 m high), the red colours of bracts and cephalium as diagnostic characters for the species. Indeed, compared to the other members of sect. *Maysops* H.St.John *P. kosteri* is the smallest one. However, the discovery of 2–3 m high individuals straightforwardly belonging to *P. krauelianus* as is indicated by the salmon pink to orange cephalia covered with layers of green, bright yellowish green to cream orange bracts in Yapen undermined the recognition of *P. kosteri* as a distinct species and it is therefore reduced here. This has a further consequence that *P. krauelianus* is now to be recognised as a widespread species occurring from the Moluccas through the mainland of New Guinea and its adjacent islands to the Solomon Islands and the northern part of Australia with a wide spectrum of morphological variation. Species with such a great variability are not uncommon in *Pandanus* as can be seen in *P. conoideus*, *P. odoratissimus* L.f., and *P. polycephalus* Lam.

Table 5 Morphological comparisons on the sizes of leaf, cephalium, drupe and colour of drupe between *Pandanus krauelianus* and several species placed in this paper as synonyms.

Species	Size of a leaf (cm)	Size of a cephalium (mm)	Size of a drupe (mm)	Colour of a drupe
Pandanus amboinensis	180 by 5.5–7.4	170–420 by 35–105	15–19 by 4–6	greyish yellow
P. cernuifolius	125–215 by 4.4–5.3	80 by 40 (immature)	16 by 1	orange
P. croceus	200–400 by 7–12	280–410 by 85–130	13 by 4–5	yellow to pale yellowish orange
P. flavicarpus	300 by 13	500 by 150	23 by 5	orange
P. kosteri	68–100 by 2.5–3.7	65 by 35	15 by 4–5	red
P. krauelianus	150–250 by 7–9	170–230 by 80–110	20–21 by 4–5	pinkish orange (salmon pink) to orange
P. microdontus	275–300 by 6.8–8.5	250 by 80	20 by 4	pink
P. roseus	190 by 11	280 by 120	30 by 7	orange
P. rubellus	230 by 6.5	300 by 120	25 by 6	reddish orange
P. spodiophyllus	210 by 6	280 by 110	30 by 8–12	orange
P. tabbersianus	140–300 by 4.2–6.4	400–410 by 90–95	18–21 by 4–5	orange
P. xanthocarpus	150–170 by 7.5–8	220 by 110 (immature)	30–32 by 3–4	pale yellow
P. zea	150–172 by 4.1–4.2	200–220 by 70–75	14–17 by 5.5–9	ellow

The presence of *P. krauelianus* in the Moluccas, the western side of mainland New Guinea, Solomon Islands, and northern part of Australia are new records.

Specimens seen. Indonesia, Papua, Yapen Island, South Yapen District, Randu Ayaipé, hill close to the road to Pasir Putih, 5 Oct. 2006, *A.P. Keim 789* (BO!); on the way from Serui to Menawi, close to Kelapa 2 area, 7 Oct. 2006, *A.P. Keim 798*, male individual (BO!); Sarawandori, about 1 hour drive West of Serui, western side of the island, 10 Oct. 2006, *A.P. Keim 802* (BO!).

5. *Pandanus papuanus* Solms

Pandanus papuanus Solms (1883) 93. — Holotype: *Beccari s.n.* (FI), Indonesia, Maluku, Aru Archipelago, Lutor, June 1873.
Pandanus pistillaris Martelli (1912) 64, t. 40, f. 13–15. — Type: *Peekel 209* (FI), Papua New Guinea, Neu Mecklenburg (= New Ireland).
Pandanus pseudopapuanus Martelli (1913) 407, t. 33, f. 1–3. — Type: *Lauterbach s.n.* (B†; FI), Papua New Guinea, Kaiser-Wilhelmsland.
Pandanus parkinsonii Martelli (1913) 417. — Type: *Parkinson s.n.* (FI), Papua New Guinea, Bismarck Archipelago, Raoul Island.
Pandanus parkinsonii Martelli var. *kukuwae* H.St.John (1989) 12, t. 594, 595. — Type: *B.C. Stone 2616* (BISH), Papua New Guinea, Bismarck Archipelago, New Britain. Gazelle Peninsula, banks of Keravat River, 14 December 1957.
Pandanus biakensis H.St.John (1960) 231, t. 1a–g, 2–5. — Type: *H. St. John 26142* (BISH), Indonesia, Papua, Biak Island, 7 km north of Bosnek, 8 December 1957.

Large solitary tree pandan, 15–20 m high. *Prop roots* present, obvious, 3–5 m high, spiny, greyish green. *Stem* hard, spiny, branched, greyish green. *Leaves* in a rosette, arranged in 3 ranks (tristichous); each lanceolate-elongate, 280–300 cm long, 10–11 cm wide, acuminate apex, margin with spines throughout the length; adaxial surface green, glabrous, venation green, adaxial ventral pleats absent or not seen; abaxial surface pale green, glabrous, main vein obviously spiny, recurved spines absent, basal part yellowish green; leafsheath yellowish green. *Infructescence* solitary, terminal; peduncle c. 41 cm long, green to yellowish white. *Cephalium* massive, heavy, hard, c. 37 cm long, c. 21 cm diam (c. 67 cm circumference), green when young, yellowish green or yellow when old, composed of phalanges. *Phalange* consisting of 10–11 compacted arranged drupes.

Distribution — Mainland New Guinea, Biak Island, Yapen Island, D'Entrecasteaux Islands, and Bismarck Archipelago.

Habitat — Swamp to lowland tropical rainforests.

Vernacular names — Im (Moluccas, South Halmahera-Weda), Tabaluku (Moluccas, North Halmahera-Galela), Buho (Moluccas, North Halmahera-Tobias), Mandim bepos (Numfor), Waywin (Yapen-Menawi), Andim (Biak), Diem (Kurudu).

Uses — Local people in Yapen Island use the fibres extracted from the prop-roots of *P. papuanus* as source material for making strings, handicrafts (bags), and mats. The cephalium is not eaten. Heyne (1927) reported that *P. papuanus* in Halmahera can only be found in cultivation. Purwanto (2006 pers. comm.) reported that in Halmahera Island the young leaf of a taxon that closely resembles *P. papuanus* is used as a medicine.

Notes — Although in the protologue of *P. biakensis* St. John (1960) stated that the type was made from a tree planted in a forest edge and was said to have been imported from the neighbouring Yapen, prior to this study no collection had been made in Yapen; thus mine confirms this and is to be regarded as a new record.

Specimen seen. Indonesia, Papua, Yapen Island, South Yapen District, Menawi, 7 Oct. 2006, *A.P. Keim 798* (BO!).

6. *Pandanus polycephalus* Lam.

Pandanus polycephalus Lam. (1785) 372. — *Pandanus humilis* Rumph. (1743) 143, t. 76, nom. inval. — *Pandanus humilis* Rumph. ex Lour. (1790) 603, quoad synon.; Kurz (1867) 105, t. 63, nom. superfl., non Lour. 1790. — *Pandanus kurzianus* Solms (1878) 4, nom. superfl. — Type: *Pandanus humilis Rumph., Herb. Amboin. 4: t. 76. 1743.* — Epitype: *Robinson Pl. Rumph. Amboin. 54* (holo US; A, BM, BO!, F, K, L, MO, NSW, NY), designated here. Merrill (1917) mentions two collections with the same number: Indonesia, Moluccas, Amboina, Binting and Lateri, in shaded places along streams at low altitudes, or in forests at c. 250 m alt, July and August 1913.
Jeanneretia littoralis Gaudich. (1843) t. 25, f. 1–7. — *Pandanus littoralis* (Gaudich.) Kurz (1869) 150. — Type: possibly in P.
Pandanus brevispathus Martelli (1908) 69. — Type: *E.B. Copeland 442* (FI; iso NY!), Philippines, Mindanao, Davao, March 1903.
Pandanus aruensis Martelli (1912) 64, nomen; (1914) 419, descr. — Lectotype: *Beccari s.n.* (FI), designated here, Indonesia, Moluccas, Aru Islands, Wokam ('Vokan') Island, Jabulenga (Giabu-Lenga), March 1873.
Pandanus aruensis Martelli var. *contractus* Martelli (1912) 64, nom. inval.; (1913) 6, nom. nud. ('*contracta*'). — Vouchers: *Moszkowski 35* (B†), Windesi, *Van Balen s.n.* (FI), no locality, *Versteeg s.n.* (FI), Indonesia, Papua, Mamberamo, Teba, 21 May 1910.
Pandanus japensis Martelli (1912) 65. — Syntypes: *Volkens 421* (B†), Micronesia, Caroline Islands, Yap Island, 1900.
Pandanus aimiriikensis Martelli in Kaneh. (1933) 60, t. 1, photo 1, japonice; (1934) 125, t. 7, latine. — Type: *R. Kanehira 328* (FU; iso HUH, NY), Micronesia, Palau (Pelew) Island, Station, main island, Aimeireek Expedition, 10 July 1929.
Pandanus macrojeanneretia Martelli in Kaneh. (1933) 66, japonice; (1934) 121, t. 5, latine. — Type: *R. Kanehira 1976* (FU; iso NY), Micronesia, Palau (Pelew) Island, Aimiriik, August 1932.
Pandanus peliliuensis Kaneh. (1935) 113, t. 15, 16. — Type: *R. Kanehira & S. Okamato 2421* (FU; iso NY), Micronesia, Palau Islands, Peliliu Island, August 1933.
Pandanus columniformis Fagerl. (1940) 101, t. 1a–e, 5a ('*columnaeformis*'). — Type: *F. Fagerlind s.n.* (S; iso BO!), origin: Celebes, Pare-Pare, Djompi, 9 September 1912, *L. van Vuuren 268*, Indonesia, Java, Bogor Botanic Garden, Culta. Bed II A 107 patria Celebes.

Slender clustered tree pandan, 2–5 m high. *Prop roots* present, slender. *Stem* slender, branched, greyish green, spiny. *Leaves* in a rosette, spirally arranged in 3 ranks (tristichous); each lanceolate-elongate, 60–85 cm long, 2.5–4 cm wide, acuminate apex, margin with sharp spines throughout the length; adaxial

surface green, venation green, adaxial ventral pleats absent; abaxial surface pale green, venation green with no spines, recurved spines obvious; leafsheath yellowish white to white. *Infructescence* in a spike, 30–35 cm long, consisting of 4–7 compactly arranged and sessile cephalia; peduncle 13–18 cm long, glabrous. *Cephalium* globose, slightly depressed, 7 cm long, 4.5–4.8 cm diam (14–15 cm circumference), consisting of numerous drupes. *Drupe* elongated globose to slightly ellipsoid, green when young turning to bright yellow then to bright reddish orange or red when mature.

Distribution — Celebes, Philippines, Moluccas, New Guinea and adjacent islands including Yapen Island, Bismarck Archipelago, Solomon Islands, and Yap Island in the Caroline Islands (Micronesia).

Habitat — Coastal, beaches, mangrove, and swamps at seaside to few m altitudes.

Vernacular names — Pandan kecil (Moluccas), Berel, Keker or Kekel lainulun, Keker maän (Moluccas-Ambon), Jefe (Moluccas, South Halmahera-Weda), Oro-oro (Moluccas, North Halmahera-Weda), Liliama Dowongi (Moluccas, North Halmahera-Tobias), Pandan pantai kecil buah banyak (Malay-Yapen dialect), Benga (Sulawesi-Djompi, Pare-Pare), Denro (Sulawesi, Makassar), Panréng (Sulawesi, Bugis).

Uses — No use of this species has been recorded for Yapen. In the Moluccas the young leaf and bract are used as vegetable and eaten raw (Heyne 1927). The leaves are also used as medicine against food poisoning, especially from seafood (such as fishes and crabs). Leaves mixed with betel nut (*Areca catechu*) and pepper leaves (*Piper betle*) are chewed and act as a mild narcotic (Heyne 1927) and also believed as medicine for strengthening the teeth or masticatory (Walter & Sam 2002). Older leaves are used for mats. Beccari (see Solms-Laubach 1883) reported that the fresh cephalium is used in Sulawesi to cause abortion.

Notes — Warburg (1900b) probably because of the reference to Rumphius and the use of the same epithet treated *P. humilis* Lour. (1790) as a synonym of *P. polycephalus*, but the latter species does not occur in Indochina. Because the citation of Rumphius is too a pre-Linnaean name, Loureiro's name is not necessarily typified by it, and is the correct one for a Indo-Chinese species. Martelli (1913, 1937) regarded it as a synonym of *P. pierrei* Martelli, a species native to Cambodia and South Vietnam. It is the other way around: Loureiro's name is the correct one, and *P. pierrei* is a synonym of it. As Merrill (1917) already wrote: "The type of Loureiro's species is manifestly the Cochinchina plant described, not the Rumphian synonym".

The presence of *P. polycephalus* in Yapen Island is a new record.

Warburg (1900b) assumed that *P. polycephalus* would not be native to the Philippines and that individuals identified as such in the Philippines had actually been introduced, presumably from somewhere in Indonesia (then the Dutch East Indies, most likely from the Bogor Botanic Garden). Merrill (1904) identified two collections made by Copeland from Davao, Mindanao, as *P. polycephalus*. Martelli (1908), however, disagreed and regarded the specimens from Davao as "quite distinct" and to represent an undescribed species, *P. brevispathus*. Merrill (1922) accepted this.

It would therefore appear that *P. polycephalus* does not occur in the Philippines. However, I have reduced *P. brevispathus* to it, especially because of the similarity of the structure of the infructescences (which was already noted by Martelli himself).

Pandanus aruensis and its variety, *P. aruensis* var. *contractus* are also treated here as synonyms of *P. polycephalus* because of the structure of the infructescence. The species therefore also occurs in the southern part of the Moluccas. The variety was invalidly published as at the time the species had not yet been described. When that happened (Martelli 1914) the variety was not mentioned.

The presence of *P. polycephalus* as a native of Java has been the subject of debate for a long time. Miquel (1859, sub *P. humilis*) wrote that *P. polycephalus* is native to the Moluccas, and that according to Hasskarl (1845) it would be known in Java as 'Pandan serengseng' and 'Harrassas leutik'. Koorders (1911) mentioned the presence of *P. polycephalus* in Java with a question mark. He believed that the specimens identified by Miquel as *P. polycephalus* actually belonged to either *P. caricosus* Kurz (non Spreng.) or *P. atrocarpus* Griff. Later he (see also Koorders-Schumacher 1913) identified specimens named 'Pandan serengseng' as such. However, *P. atrocarpus* has been reported for the Malay Peninsula, Sumatra, Bangka, and Borneo, but has never been found in Java. Backer (1925; see Backer & Bakhuizen van den Brink Jr. 1968) identified Koorders' *P. atrocarpus* as *P. caricosus*. Regarding *P. polycephalus* in Java Backer (1925) noted "has been erroneously reported for the montane forest of West Java, it might, however here and there grow on the Javanese beach". This is repeated in Backer & Bakhuizen van den Brink Jr. (1968). The result of this present study indicates that specimens on which Koorders based his record of *P. atrocarpus* in Java (*Koorders 20798*, *26957*, *40265*, *40266*, and *40267*) belong to *P. kurzii* Merr., a widespread species in Java.

I therefore agree with them and Stone (1972a) that all records in BO and L for Java are based on individuals growing in the Bogor Botanic Garden with various provenances, but none from Java. The most recent exploration made in the Ujung Kulon Nature Reserve in West Java (Keim et al. 2006c) failed to prove the presence of this species.

Solms-Laubach (1883) reported a new species (but did not give it a name because of the absence of male flowers and mature fruits) based on a collection made by Beccari in July 1874 in Lepo-Lepo, Kendari Peninsula, South East Celebes. His description matches *P. polycephalus*, particularly regarding the clumping habit, moderate high stem (3–5 m), an infructescence in a spike of 8 red cephalia, each cephalium 5–6 cm long; thus it is regarded here as belonging to *P. polycephalus*, and thus marks the first record of the species for Celebes.

Fagerlind (1940) described *P. columniformis* on a collection made from a 27 year old individual in the Bogor Botanic Garden believed to be of Celebes origin according to the ledger of acquisitions of the Garden. In BO there is a voucher specimen (*Van Vuuren 268*) collected by Noerkas (one of the collectors of the Van Vuuren Expedition). Noerkas mentioned that the cephalia were red. Based on the original description, photographs, and the voucher (Table 6) this is clearly a synonym.

Pandanus japensis (Table 7) is also a synonym of *P. polycephalus* and a new record of *P. polycephalus* for Yap Island, Micronesia.

Pandanus aimiriikensis and *P. peliliuensis* are also treated here as synonyms of *P. polycephalus*. These two species have many similarities with *P. polycephalus* including the infructescences consisting of 5–8 compactly arranged sessile cephalia and the possession of both terminal and lateral infructescences.

Despite the slightly larger size of the cephalia, *P. macrojeanneretia* is very much the same as *P. polycephalus* especially because of the 5–8 compactly arranged and aggregated sessile cephalia (Kanehira 1933), thus *P. macrojeanneretia* is reduced. A lateral infructescence is a distinctive character of *P. polycephalus* as was already observed by Rumphius (1743).

Table 6 Morphological comparisons on the length and structure of the infructescences, the arrangement of the cephalia, and their colour when mature between *Pandanus columniformis* and *P. polycephalus*.

Species	Infructescence structure	Length of infructescence (cm)	Arrangement of cephalia per infructescence	Colour of cephalia
Pandanus columniformis	spike of apparently 8–10 cephalia	c. 35	compact and sessile	red
P. polycephalus	spike of 4–8 cephalia	30–35	compact and sessile	bright yellow turning to red

Table 7 Morphological comparisons on the infructescence structure, length of the fruiting part of the infructescence, form, length and diam of a cephalium between *Pandanus japensis* and *P. polycephalus*.

Species	Infructescence structure	Length of the fruiting part of infructescence (cm)	Form of cephalium	Length of cephalium (cm)	Diameter of cephalium (cm)
Pandanus japensis	spike of 6 compactly arranged sessile cephalia	8–10	obscure trigonal	5	4
P. polycephalus	spike of 4–8 compactly arranged sessile cephalia	12–22	obscure trigonal	7	4.5–4.8

The placement of *P. aimiriikensis*, *P. macrojeanneretia*, and *P. peliliuensis* as synonyms has the consequence that *P. polycephalus* is now also found in the Palau Island; thus a new record.

The placement of the numerous species listed above has the biogeographical consequence that the distribution of *P. polycephalus* is recognised here as confined to East Malesia (including Celebes and the Philippines), the Pacific and beyond.

An account made by Hooker (1894) of a possible presence of *P. polycephalus* in Burma is regarded here as pertaining to *P. foetidus* Roxb. This means that *P. polycephalus* does not occur anywhere in mainland South East Asia and thus supports the phytogeographical distribution of the species.

Stone (1966) recorded the presence of *P. polycephalus* in the seashores of Malay Peninsula. However, neither detailed distributional records nor pictures were presented. It is assumed here that Stone might have misidentified *P. labyrinthicus* as *P. polycephalus*. *Pandanus labyrinthicus* shares a similar habit, some morphological features (including infructescences consisting of 3–8 cephalia), and habitat with *P. polycephalus*. Indeed, excluding the style in each drupe the two species look very similar. Prior to this study, *P. labyrinthicus* was known only from the west coast of Sumatra (see Warburg 1900b). The presence of *P. labyrinthicus* outside Sumatra is now acknowledged as I have recently re-identified a specimen collected from Tarakan Island, East Kalimantan (Indonesian Borneo, *W. Meijer 2567*) as such; thus a new record. The specimen was previously identified by St. John as *P. labyrinthicus*, but later was misidentified as *P. nitidus* by Stone (he noted: "certe non labyrinthicus") underrating the fact that it is a coastal species with an infructescence consisting of 3 cephalia, in which each drupe has an obvious forked style, a morphological feature that is not possessed by *P. polycephalus*. *Pandanus labyrinthicus*, on the other hand, does.

Specimens seen. Indonesia, Papua, Yapen Island, South Yapen District, Randu Ayapé, on the way to Pasir Putih, 5 Oct. 2006, *A.P. Keim 790* (BO!); Sarawandori, about 1 hour drive with motorbike west of Serui, 10 Oct. 2006, *A.P. Keim 803* (BO!).

7. *Pandanus pseudosyncarpus* Kaneh.

Pandanus pseudosyncarpus Kaneh. (1940) 258. — Holotype: *Inokumae 636* (FU), Dutch New Guinea, Nabire, 1940.

Solitary tree pandan, c. 5 m high. *Prop roots* present, c. 50 cm high. *Stem* unbranched, greyish green, covered with marcescent leaves. *Leaves* in a rosette, arranged in 3 ranks (tristichous); lanceolate-elongate, 360–400 cm long, 10–11 cm wide, acuminate apex, margin with obvious spines throughout the length; adaxial surface green, shiny, glabrous, venation green, adaxial ventral pleats obvious; abaxial surface pale green, glaucous white, venation more obvious, main vein with spines, recurved spines obvious, basal part yellow to whitish yellow; leafsheath yellow to whitish yellow. *Infructescence* a massive spike consisting of 16 condensed cephalia, triangle-shaped, solitary, terminal, c. 23 cm long, c. 19 cm diam (c. 60 cm circumference), bright red, cephalia not uniform in size; peduncle yellowish green, c. 40 cm long. *Cephalium* kidney-shaped (reniform), depressed-compressed, bright red, the largest being c. 5 cm long, c. 11 cm wide; style pointed, long; stigma pointed.

Distribution — Around Nabire on mainland of Papua, Indonesia (former Dutch New Guinea) and Yapen.

Habitat — Lowland tropical rainforest. In Yapen Island found at foothills at about 100 to 150 m altitude.

Vernacular name — Pandan buah rambutan (Malay).

Uses — Not recorded.

Note — Prior to the present study *P. pseudosyncarpus* was known only from a single collection, *Inokumae 636* (FU), in a forest near Nabire in 1940 (Kanehira 1940, 1941); thus this finding is a new record.

Specimen seen. Indonesia, Papua, Yapen Island, South Yapen District, on the road from Saubeba to Konti, eastern side of the island, 11 Oct. 2006, *A.P. Keim 810* (BO!).

Sararanga

1. *Sararanga sinuosa* Hemsl.

Sararanga sinuosa Hemsl. (1894) 216, t. 11. — Type: *Guppy 259* (K), British Solomon Islands, Fauro Island, 1884.

Solitary tree pandan, 9–10 m high. *Prop roots* absent, roots in general appearance resembling those of the Coconut (*Cocos nucifera*). *Stem* unbranched or branched, c. 67 cm diam. *Leaves* in a rosette, arranged in 4 ranks, persistent; lanceolate-elongate, c. 300 cm long, 9–11 cm wide, acuminate apex, margin with spines; adaxial surface glabrous, green to yellowish green, adaxial ventral pleats absent; abaxial surface glabrous, green to yellowish green, recurved spines absent, main vein obvious, with spines; leafsheath yellowish green to cream. *Infructescences* massive, branched, paniculate (each can weight up to 15 kg), terminal, bright green to brownish green; 10 infructescences can be found in 1 individual with branched stem; each branched to 3 orders, glabrous, 150–250 cm long; peduncle glabrous, c. 50 cm long, square shaped in cross sec-

tion; rachis glabrous, 100–200 cm long; rachillae numerous, glabrous, 36–38 cm long. *Fruits* syncarpous, berries c. 100 per rachillae; kidney-shaped (reniform), pale green to red when mature, exocarp soft; seeds c. 60 per berry, triangle-shaped, flat and thin, pale brown.

Distribution — Northern part of mainland New Guinea, Yapen Island, Manus Island, Solomon Islands.

Habitat — Lowland tropical rainforest from sea level up to 200 m altitude.

Vernacular names — Kayari (Yapen), Sararang (Fauro).

Uses — In Yapen Island the fruits are consumed and the leaves are used for making mats. However, the species is not considered to be an economically important plant, and it is not cultivated. The fruits are reported to be eaten by birds as well.

Notes — The presence of *S. sinuosa* in Yapen Island was first reported by Beccari when he visited the island between 4–28 April 1875 during his great travels to Celebes and the then Dutch New Guinea. He landed in Ansus, an area within reach of Sarawandori on the western side of the island. Unfortunately, the plant that he saw was not in flower or fruit, thus he could only make a sterile collection (of a leaf, which is still kept in FI). Despite this, he believed without a doubt that the taxon that he saw represented a new genus of *Pandanaceae*. To satisfy his curiosity he revisited the island from 22 to 23 November in the same year, but failed to improve on his previous collection. Apparently due to the insufficient nature of the collection he refused to publish his finding. Nevertheless, he mentioned his discovery to Solms-Laubach, who then published the information (Solms-Laubach 1883).

12 years later Guppy (1887) found in the Solomon Islands a taxon that he believed was the same as what Beccari saw in Yapen Island. In contrast to Beccari, Guppy managed to obtain a complete (i.e. fertile) collection (*Guppy 259*). Based on this Hemsley (1894) described *Sararanga* and appointed it as the type of his *S. sinuosa*. As there has been no complete collection from Yapen after the one by Beccari Hemsley's publication raised the question whether the taxon in Yapen was indeed of the same genus and species. A complete collection of *S. sinuosa* from Yapen (Keim et al. 2006a) has now supported Beccari and ended the 130 years of uncertainty.

Specimen seen. Indonesia, Papua, Yapen Island, South Yapen District, Sarawandori, about 1 hour drive West of Serui, western side of the island, 10 Oct. 2006, *A.P. Keim 800* (BO!).

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