



A monograph of *Heterospathe* (Areceae, Arecaceae) in New Guinea

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Abstract

A revision of the genus *Heterospathe* Scheff. in New Guinea and immediately adjacent islands is presented. We recognise 14 species for this area. Taxonomic and nomenclatural changes are outlined, and each species is thoroughly described, mapped and illustrated. A key to the species in the area is included as well as preliminary IUCN Red List Assessments.

Keywords: Arecoideae, Indonesia, Papua New Guinea, Palmae, Taxonomy

Introduction

Heterospathe Scheffer (1876: 141) is a genus of arecoid palms that is widely distributed from the Philippines in the west through Micronesia and the Moluccas to Papuasia, Vanuatu and Fiji in the east (Dransfield *et al.* 2008). The genus is highly varied in habit, ranging from small understorey species with subterranean stems to canopy tree palms with robust trunks. It is well-supported as monophyletic and is firmly placed within the major Indo-Pacific tribe Areceae, but current molecular evidence is inadequate to assign it to subtribe (Norup *et al.* 2006, Dransfield *et al.* 2008, Baker *et al.* 2009, Baker *et al.* 2011, Baker & Dransfield 2016).

As is the case with several other genera within Areceae, *Heterospathe* is not distinguished by any unique morphological synapomorphies, but instead by a combination of widespread character traits (Norup *et al.* 2006). For almost all species of *Heterospathe* these characters are: “leaf sheath splitting to the base [i.e. crownshaft lacking], interfoliar inflorescences (at least at anthesis), peduncle longer than the rachis, peduncular bract longer than the prophyll, prophyll persistent, and peduncular bract persistent” (Norup *et al.* 2006). There are exceptions to this character set. The recently discovered *Heterospathe barfodii* L.M.Gardiner & W.J.Baker in Gardiner *et al.* (2012: 96) has infrafoliar inflorescences and leaf sheaths that are split only about halfway to their bases and form a distinct crownshaft. This species could be confused with a few other genera, most notably the monotypic genus *Dransfieldia* W.J.Baker & Zona in Baker *et al.* (2006: 61), but molecular evidence supported its placement in *Heterospathe* (Gardiner *et al.* 2012). The poorly known Moluccan *H. glauca* Scheffer (1876: 162) also appears to have a well-defined crownshaft and infrafoliar inflorescences (M. Abdo, pers. comm.); this species has not yet been included in molecular phylogenetic analyses of Areceae and requires further scrutiny.

Prior to this revision, 42 species of *Heterospathe* were accepted (Govaerts *et al.* 2019) including 20 from New Guinea. The genus has so far not been treated in detail as a whole. A regional account exists from the Philippines (Fernando 1990), which accepted 11 species with two additional species (Fernando & Sotalbo 2001, Adorador 2019) being described from the region, and a subset of the New Guinea species was monographed more recently (Trudgen & Baker 2008). Here we present a revision of *Heterospathe* from New Guinea and adjacent islands, from the Raja Ampat Islands in the west to the Bismarck and Louisiade Archipelagos in the east. We accept 14 species from this area. Four species are synonymised, and three names are considered to be of uncertain application. In addition, one variety from Palau is placed in synonymy. Although three new species have been described in recent years (Trudgen & Baker 2008, Gardiner *et al.* 2012, Baker & Heatubun 2012) from New Guinea, no further new species were discovered in this study.

Taxonomic history and phylogeny

Heterospathe was erected as a monotypic genus by Scheffer (1876) in the first volume of *Annales du Jardin de Buitenzorg*. In the same issue he also described the genus *Ptychandra* Scheffer (1876: 140). Several species were subsequently described in both genera (Beccari 1888, Beccari 1905, Beccari 1909, Beccari 1914a, Beccari 1914b, Beccari 1923, Burret 1933, Martelli 1934, Burret 1935, Burret 1937) until *Ptychandra* was eventually placed in synonymy within *Heterospathe* by Moore (1969), who noted that species such as *Heterospathe annectens* Moore (1969: 100) and *H. pulchra* Moore (1969: 104) combined key characters that had been attributed to *Ptychandra* and *Heterospathe*.

Two other genera, *Barkerwebbia* Beccari (1905: 281) and *Alsmithia* H.E. Moore in Moore *et al.* (1982: 122) have also become synonymous with *Heterospathe*. It was Beccari (1909) who first synonymised *Barkerwebbia*, but the genus was later resurrected by Martelli (1935) only to be placed in synonymy a second time by Beccari & Pichi-Sermolli (1955), a sequence of taxonomic changes described in more detail by Trudgen & Baker (2008). The monotypic Fijian genus *Alsmithia* was described by Moore (Moore *et al.* 1982) and placed in the *Clinostigma* alliance, an informal higher group established by Moore (1973), which also contained *Heterospathe*. Moore *et al.* (1982) conjectured that *Alsmithia* was quite distinct from all other genera in this group due to its striking endocarp sculpturing and seed shape, but a molecular phylogenetic study demonstrated that *Alsmithia* was clearly nested within *Heterospathe* (Norup *et al.* 2006) prompting Norup (2005) to subsume the former in the latter.

Norup *et al.* (2006) explored the relationships among species of *Heterospathe* based on a partial sampling of species (ca. 30%). They found that two well-supported clades emerged within the genus, one containing species from the Philippines, Fiji and New Guinea, and the other solely including species endemic to New Guinea. This topology supported the taxonomic changes made by Beccari (1911) and Moore (1969) in reducing *Barkerwebbia* and *Ptychandra* into synonymy with *Heterospathe*.

This account does not provide a formal infrageneric classification due to the lack of sufficient phylogenetic evidence. However, with usability in mind, the taxonomic treatment is split into two informal groups, the 6 Stamen Group and the 6–20 Stamen Group. Notwithstanding some overlap, they serve as a practical tool for subdividing the group for taxonomic and identification purposes. It is acknowledged that these two groupings are potentially artificial.

Taxonomic treatment

Heterospathe Scheffer (1876: 141). Type: *H. elata* Scheff.

Ptychandra Scheffer (1876: 140). Type: *P. glauca* Scheff. (= *Heterospathe glauca* (Scheff.) H.E. Moore).

Barkerwebbia Beccari (1905: 281). Type: *B. elegans* Becc. (= *Heterospathe elegans* (Becc.) Becc.).

Alsmithia H.E. Moore in Moore *et al.* (1982: 122). Type: *A. longipes* H.E. Moore (= *Heterospathe longipes* (H.E. Moore) Norup).

Dwarf to robust, solitary or clustering, unarmed, pleoanthic, monoecious palms. **Stem** creeping or erect, sometimes acaulescent, sometimes basally expanded, grey-green to brown, leaf scars usually prominent. **Leaf** pinnate, rarely entire bifid, erect, becoming spreading, often reddish when young; sheath splitting abaxially and not forming a well-defined crownshaft or rarely with a distinct crownshaft (*H. barfodii* and *H. glauca*), margins fibrous, acute, glaucous or not; petiole short to elongate, usually deeply channelled adaxially, rounded abaxially, variously indumentose; rachis straight or curved, basally channelled adaxially, distally ridged, rounded abaxially, variously indumentose; leaflets, when present, single- or multi-fold, acute to acuminate, prominent, midrib elevated, marginal ribs often thickened, veins adaxially ± waxy or glabrous, abaxially tomentose or brown-dotted, with or without basifixed rammenta on midrib. **Inflorescence** interfoliar or infrafoliar, branched to 1–4 orders, often with ferruginous (reddish-brown), caducous tomentum; peduncle prominent, usually elongate, elliptic in cross-section; prophyll persistent or rarely falling off late, attached near the base and completely encircling the peduncle, tubular, 2-keeled laterally, ± dorsiventrally flattened, splitting apically to abaxially; peduncular bract 1 or rarely 2 (*Heterospathe trispatha*), attached below or sometimes above the middle of the peduncle, terete, beaked, enclosing the inflorescence in bud, usually greatly exceeding the prophyll, splitting abaxially and caducous or marcescent as the inflorescence matures; rachis short to elongate, bearing spirally arranged, short and inconspicuous (or rarely long and acuminate) bracts subtending a few simple rachillae, or

multiple branches with basal bare portions; rachillae slender, bearing sessile or slightly depressed, spirally arranged triads subtended by spreading lip-like bracts throughout the rachillae, or with paired or solitary staminate flowers toward the apex of the rachillae; bracteoles of the staminate flowers small, bracteoles surrounding the pistillate flower 2, spreading to cupular and imbricate. **Staminate flower** symmetrical or slightly to markedly asymmetrical; sepals 3, distinct, broadly imbricate and rounded, \pm keeled dorsally and gibbous basally; petals 3, distinct, valvate, usually about twice as long as the sepals, prominently lined when dry, \pm acute, one usually somewhat larger than the others; stamens 6–36 or more, distinct, the filaments awl-shaped and strongly inflexed at the apex, anthers oblong in outline, dorsifixed and versatile at anthesis, dehiscence latrorse; pistillode usually either small and conical or columnar, prominent and nearly as long as the stamens, sometimes with an expanded apex. **Pollen** grains ellipsoidal, asymmetric, occasionally oblate triangular; aperture a distal sulcus, infrequently a trichotomosulcus; ectexine tectate, perforate, perforate and micro-channelled or finely perforate-rugulate, aperture margin similar or slightly finer; infratectum columellate; longest axis ranging from 26–54 μm . **Pistillate flower** symmetrical, \pm same size as the staminate; sepals 3, distinct, broadly imbricate, rounded; petals 3, distinct, broadly imbricate with briefly valvate apices; staminodes 3–10, tooth-like; gynoecium unilocular, uniovulate, short, soft, expanded upward into a thick stylar region below 3 recurved, short stigmas, the ovule lateral at top of locule, pendulous, hemianatropous. **Fruit** globose to ellipsoidal, small to large, orange to red when mature, stigmatic remains apical, eccentrically apical or subapical to lateral; epicarp smooth but drying granular or with irregular lines over short sclerosomes in the thinly to thickly fleshy mesocarp, with flattened anastomosing fibres, endocarp thin, operculate, smooth, shining within, or with thickened adnate fibres, irregularly sculptured, ridged and grooved, beaked at the apex, with a mass of slender fibres within a framework of thickened fibres at the base. **Seed** not adherent to endocarp, globose to ellipsoidal, attached apically and laterally by the elongate hilum extending nearly the length of the seed, raphe branches simple to anastomosing, endosperm ruminant or rarely homogeneous (*H. longipes* and *H. uniformis*); embryo basal. **Germination** adjacent-ligular; eophyll bifid where known. **Cytology**: $2n = 32$ (Generic description modified from Dransfield *et al.* [2008]).

Key to *Heterospathe* in New Guinea

1. Acaulescent palm.....2
- Palm with well-defined aerial stem.....3
2. Peduncle 50–140 cm long, peduncular bract attached in distal quarter of peduncle; staminate flowers green, with 6 stamens and columnar pistillode about the length of the filaments (Papua New Guinea and the Cyclops Mts.)...*H. elegans* subsp. *humilis* (2b)
- Peduncle 45–75 cm long, peduncular bract attached in proximal half of peduncle; staminate flowers purple, with 7–10 stamens (rarely 6 stamens) and conical pistillode about half the length of the filaments (SE Papua New Guinea) ... *H. sphaerocarpa* (14)
3. Palm rheophytic and clustering; inflorescence 50–65 cm long including 17–22 cm peduncle; at low elevation (SW Papua New Guinea) *H. macgregorii* (3)
- Palm not rheophytic and usually solitary; inflorescence 50–160 cm long including 22–140 cm peduncle; often, but not always at high elevation4
4. Stem 1–5 cm in diam. (rarely as wide as 7.5 cm in diam.); peduncular bract inserted in proximal or distal half of peduncle5
- Stem 6–23 cm in diam.; peduncular bract inserted in proximal half of peduncle.....8
5. Inflorescence with 2 or 3 orders of branching; peduncular bract inserted in proximal half of peduncle; fruit ca. 20 mm long, with 6 or 7 highly distinctive longitudinal ridges (when dry; Supiori Island)*H. porcata* (6)
- Inflorescence with 1 or 2 orders of branching; peduncular bract inserted in distal half of peduncle; fruit 10–18 mm long (when dry), not prominently ridged 6
6. Peduncular bract inserted in distal quarter of peduncle; fruit 10–15 mm long (Papua New Guinea or Papua Province, Indonesia)..
.....*H. elegans* subsp. *elegans* (2a)
- Peduncular bract inserted in distal third quarter of peduncle; fruit 15–18 mm long.....7
7. Leaflets 10–15 each side of rachis, the basal-most pair multi-fold; flowers green with glabrous sepals (Central Province, Papua New Guinea).....*H. pullenii* (7)
- Leaflets 21–35 each side of rachis, the basal-most pair single-fold; flowers yellowish with \pm lepidote sepals (Oro Province, Papua New Guinea).....*H. lepidota* (4)
8. Robust palm; leaf usually 3–5 m long (rarely as short as 1.7 m); leaflets 61–89 each side of rachis; inflorescence branched to 3 or 4 orders (Moluccas, Philippines, Micronesia, and Gag Island in western New Guinea)*H. elata* (1)
- Moderately slender to robust palm; leaf 1.15–4.1 m long; leaflets 22–56 each side of rachis; inflorescence branched to 1–3 orders (Papua New Guinea or Papua Province, Indonesia).....9
9. First-order branches of inflorescence to 70 cm long; pistillode about the length of the filaments, columnar; fruit globose with apical to eccentrically apical stigmatic remains (New Britain)*H. parviflora* (5)
- First-order branches of inflorescence to 45 cm long; pistillode shorter than the filaments, conical or more rarely \pm columnar; fruit globose to broadly ellipsoid, with subapical stigmatic remains (Papua Province, Indonesia or Papua New Guinea).....10
10. Crownshaft well-defined (SE Papua New Guinea) *H. barfodii* (9)
- Crownshaft lacking.....11

11. Leaflets 22–30 each side of rachis; inflorescence branched to 1 order (Rossel Island)..... *H. annectens* (8)
 - Leaflets 40–56 each side of rachis; inflorescence branched to 2 or 3 orders 12
 12. Leaflets narrowly acuminate at their tips; rachillae to 19 cm long; staminate flower with 6 stamens; fruit 8–8.5 mm long (when dry; Islands of Milne Bay Province, Papua New Guinea)..... *H. pulchra* (13)
 - Leaflets acute to acuminate at their tips; rachillae to 30 cm long; staminate flower with 6–20 stamens; fruit at least 9 mm long (when dry; mostly mainland New Guinea) 13
 13. Staminate flower pink, with 6 stamens (Papua New Guinea)..... *H. ledermanniana* (10)
 - Staminate flower green, yellow, cream or purple, with 12–20 stamens 14
 14. Staminate flower with 12–15 stamens; fruit 10–15 mm long (Papua New Guinea or Papua Province, Indonesia).....
 *H. muelleriana* (11)
 - Staminate flower with 19–20 stamens; fruit 29–35 mm long (SE Papua New Guinea) *H. obriensis* (12)

Species accounts

6 Stamen Group

Additional characters: pistillode columnar, prominent, about the same length as the filaments.

1. *Heterospathe elata* Scheffer (1876: 162). Neotype (designated here):—INDONESIA. West Java Province: Cultivated at Buitenzorg [Bogor Botanical Garden], origin: Ambon, *Scheffer s.n.* [FI053592] (FI!).

Heterospathe palauensis Beccari (1914a: 4). *Heterospathe elata* var. *palauensis* (Becc.) Becc. in Martelli (1934: 140). Type:—PALAU. West Carolines, 1910, *Kraemer s.n.* (holotype FI!), *synon. nov.*

Heterospathe elata var. *guamensis* Becc. in Martelli (1934: 140). Lectotype (designated here):—GUAM. 1911, *Guam Experiment Station 129* (FI!).

Figure 1 (line drawing). Figure 2 (photo plate). Figure 3 (map).

Robust, solitary palm to 12(–20) m tall, bearing 14–21 leaves in crown. **Stem** (8–)10–23 cm in diam.; internodes 3–7 cm long near the top where nodal scars prominent. **Leaf** (1.7–)3–5 m long including petiole; sheath 50–85 cm long, with fibrous margins, ferruginous-lepidote and glaucous or ± glabrous, crownshaft absent; petiole (20–)50–100 cm long, ferruginous-lepidote or ± glabrous; rachis 1.5–4 m long, slightly arching, indumentum as petiole; leaflets (50–)61–74(–89) each side of rachis, arranged regularly, ± drooping, borne 2–5 cm apart, single-fold, linear, acuminate at their tips, adaxially green, abaxially paler green and with ramenta scattered on basal portion of midrib and major veins; middle leaflet 50–82 × 2–4.5 cm. **Inflorescence** 90–150 cm long including peduncle, interfoliar at least at emergence, branched to 3 or 4 orders; prophyll 30–53 × 5–6 cm, persistent, splitting apically, ferruginous-lepidote; peduncular bract(s) 1(–2); first peduncular bract 55–146 × 6 cm, attached in proximal half of peduncle, caducous, splitting longitudinally, indumentum as prophyll; second peduncular bract (if present) as long as 25 cm; peduncle 30–55 × 1–3.5 cm, ferruginous-lepidote; first-order branches 18–25, to 60 cm long, inserted 2–10 cm apart, with up to 83 rachillae, indumentum as peduncle, rachis bracts usually inconspicuous, but sometimes up to 10 cm long; rachillae to ca. 24 cm long, 1–2 mm in diam.; triads inserted 1.5–4 mm apart. **Staminate flower** ca. 1.5–2.5 × 2 mm pre-anthesis (when dry), cream to pinkish-lavender; sepals 3, 1.1–1.3 × 1.5–2.2 mm, glabrous; petals 3, 2–2.5 × 1.5–2 mm; stamens 6; filaments 1–1.2 mm long, linear; anthers 1–1.3 × 0.2–0.6 mm, medifixed; pistillode 1.3–1.8 × 0.2–0.3, columnar. **Pistillate flower** 2.5–2.9 × 2–2.2 mm near anthesis, cream to pinkish-lavender; sepals 3, 1–1.3 × 2.5–3 mm, glabrous; petals 3, ca. 2–2.5 × 3–3.5 mm; staminodes ca. 4, minute; ovary ca. 2 × 1.4 mm, ovoid, stigma minute. **Fruit** 6.4–10 × 6.4–10 mm, (6–8 × 6–8 when dry) globose, red when ripe; stigmatic remains subapical. **Seed** ca. 6 × 6 mm, globose; endosperm ruminant.

Distribution:—Gag Island in western New Guinea, the Moluccas, the Philippines, Palau and Guam. The species is believed to have been introduced to Guam (Merrill 1914; Moore and Fosberg 1956). It is conceivable that the distribution of *H. elata* has been influenced by humans elsewhere in its range, given its small, easily transported seed and potential usefulness.

Habitat:—The species occurs in limestone forest on Gag Island, 0–50 m.

Uses:—The stem is sometimes used for traditional house construction on Gag Island (Heatubun *et al.* 2012). The species is well-established in cultivation (Riffle *et al.* 2012).

Vernacular names:—The species is known as *Gul ways* (Gebe) on Gag Island.



FIGURE 1. *Heterospathe elata*. A. Habit. B. Leaf apex. C. Mid-leaf portion. D. Leaf base. E. Inflorescence. F. Portion of rachilla with flowers. G. Staminate flower whole and in longitudinal section. H. Pistillate flower whole and in longitudinal section. I. Fruit whole and in longitudinal section. Scale bar: A = 230 cm; B–D = 8 cm; E = 6 cm; F, I = 5 mm; G–H = 2 mm. A–D from *Heatubun* 740; E–H from *Rodin* 737; I from *Chapin* 55. Drawn by Lucy T. Smith.



FIGURE 2. *Heterospathe elata*. A. Crown. B. Inflorescence. C. Portion of infructescence. D. Portion of inflorescence. All from Gag Island, Indonesia. All photos: Charlie D. Heatubun.

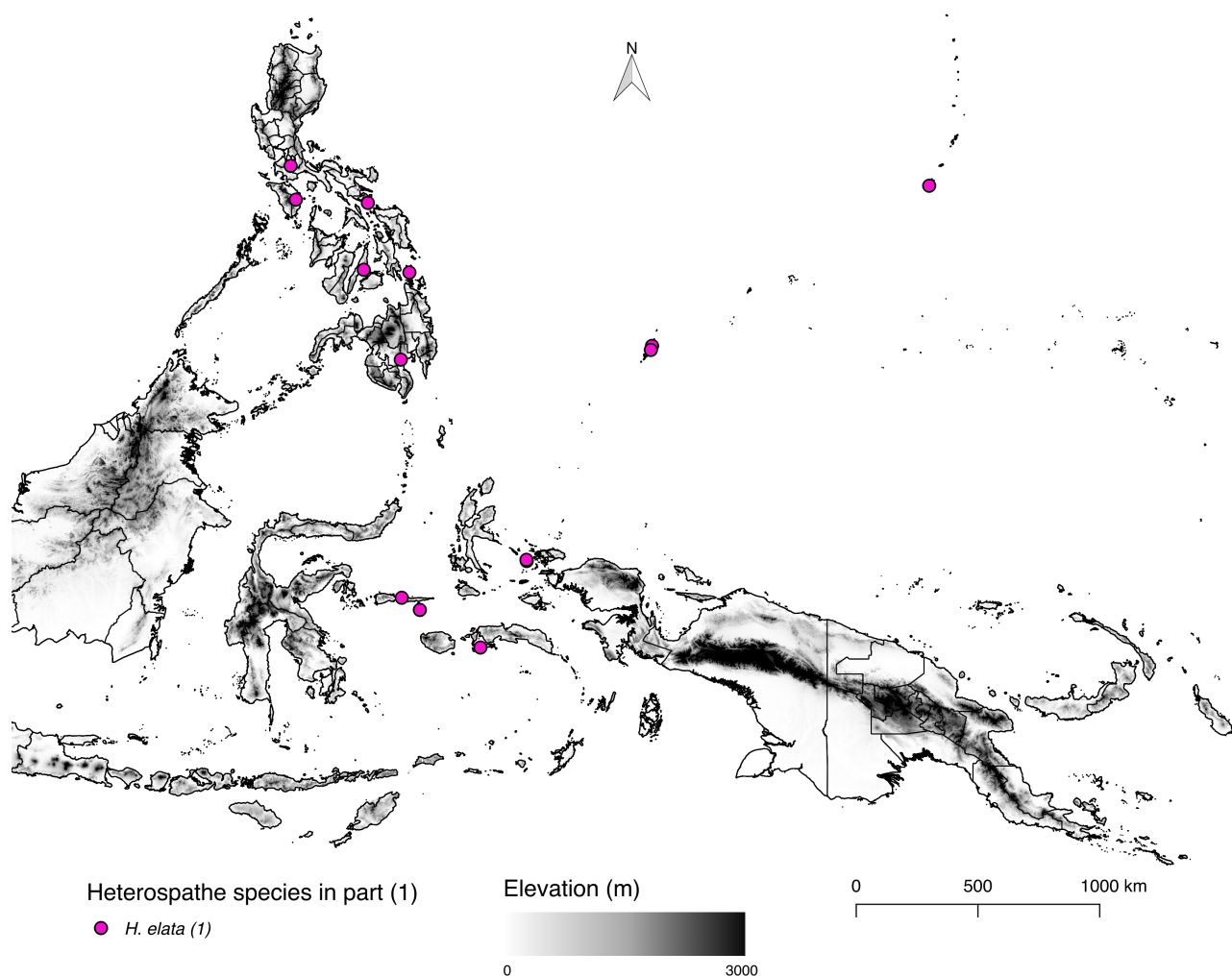


FIGURE 3. Distribution map of *Heterospathe elata*.

Conservation status:—Least Concern (LC). This species is very widely distributed (extent of occurrence [EOO] is ca. 2,761,000 km²; Bachman *et al.* [2011]) based on 12 localities or locations (area of occupancy [AOO] is 48 km²).

Specimens examined:—GUAM. 1911, *Guam Experiment Station 129* (FI!); Background from Yona toward Ylig River, 13°24'N, 144°46'E, 28 September 1945, *Rodin 737* (K!); Lower Fonte River, W of Agana, 24 January 1950, *Fosberg 31215* (BH!); Macajna Mt. just S of Agana, 16 December 1953, *Fosberg 35240* (BH!); Pago River between the gaging station and its confluence with the Sigua River, 16 May 1983, *Herbst 7173* (BH!). INDONESIA. **North Maluku Province:** Soela Eil. [Sula Islands], Soela Sanana [Sanana Island], t'N.O. van Fowata, in de bergen, 150 m, 12 August 1939, *Bloembergen 4532* (BO, K!); Soela Eil. [Sula Islands], Soela Taliaboe [Taliabu Island], Samoeja, ten W. van de baai, langs weg Samoeja-Parigi, 100 m, 23 October 1939, *Bloembergen 4784* (A!, K!); **West Papua Province:** Raja Ampat Regency, Gag Island, Forest in airstrip side, 10 m, 0°24'S, 129°54'E, 26 July 2006, *Heatubun 739* (AAU, BO, K!, MAN); Same locality as preceding, 10 m, 0°24'S, 129°54'E, 26 July 2006, *Heatubun 740* (BO, K!, MAN); Raja Ampat Regency, Gag Island, Kapatpapo, 30 m, 0°26'S, 129°54'E, 24 July 2006, *Heatubun 735* (AAU, BO, K!, MAN, NY). PALAU. 1910, *Kraemer s.n.* (FI!); Babeldaob Island, west coast, Itau, first estuary S of Me'ebe'ubul broad valley, with series of terraces, March 1950, *Fosberg 32419* (BH!); Ins. Korror [Koror Island], in collis calcareis, 7°20'N, 134°29'E, 26 August 1939, *Tuyama 9328* (K!). PHILIPPINES. **Dinagat Islands Province:** Dinagat Island, 10°12'N, 125°35'E, May 1919, *Ramos 35243* (K!); **Province of Laguna:** Los Baños, Mt. Maquiling, 14°8'N, 121°12'E, June 1917, *Elmer 18222* (K!, L!); **Province of Sorsogon:** Irosin (Mt. Bulusan), 12°46'N, 124°3'E, September 1918, *Elmer 17297* (K!); **Province of Masbate:** Palanoc, March 1886, *Vidal 3962* (K!); **Davao del Sur:** Mt. Apo, Todaya, 6°58'N, 125°21'E, May 1909, *Elmer 11968* (K!, L!); **Oriental Mindoro:** Bongabon and Pinamalayan, 1941, *Maliwanag s.n.* (BH!); Bongabon and Pinamalayan, 1941, *Maliwanag 218* (BH!). CULTIVATED. CUBA. **Cienfuegos Province:**

Atkins Garden, Soledad, 26 February 1952, *Moore 6100* (BH!). INDONESIA. **West Java Province:** Buitenzorg [Bogor Botanical Garden], origin: Guam, 1936, *Furtado 31135* (A!, BH!, BRI!, K!, L!); Same locality as preceding, origin: Philippines, 1936, *Furtado 30932* (A!, BH!, L!). PHILIPPINES. **Province of Laguna:** College of Agriculture Campus, 27 August 1958, *Pancho 2039* (BH!). SINGAPORE. Singapore Botanic Garden, unknown origin, 18 June 1929, *Furtado s.n.* (BH!, K!); Same locality as preceding, unknown origin, 24 June 1929, *Furtado s.n.* (K!). SRI LANKA. Royal Botanic Gardens Peradeniya, Q-302, 22 July 1986, *Rutherford 122* (K!). UNITED STATES. **Florida:** Fairchild Tropical Garden, Coral Gables, Dade County, unknown origin, 10 June 1965, *Read 1294* (BH!); **Hawaiian Islands:** Kauai, Koloa District, Lawai Valley, NTBG living collections, Big Valley Section, near Stillwater Dam, 30 m, 18 October 1999, *Chapin 55* (K!, PTBG).

Notes:—*Heterospathe elata* is the most widely distributed species of *Heterospathe* although it occurs only on Gag Island in western New Guinea within our area. It is usually a robust palm with long, slightly arcuate leaves bearing numerous leaflets (61–74 per side), and large inflorescences with three orders of branching. All other species of *Heterospathe* that occur in New Guinea and adjacent islands differ in their leaves with fewer than 57 leaflets on each side of the rachis and inflorescences with one to three orders of branching.

The population of *H. elata* from Gag Island appears somewhat distinct from other populations with individuals there being moderately robust and displaying leaves with 74–89 leaflets on each side of the rachis and inflorescences often branched to four orders. Heatubun *et al.* (2012) demonstrated that the proportion of fruit with multiple lobes is higher on Gag island than elsewhere. These differences are insufficient to recognise the Gag Island form as taxonomically distinct.

The type of *H. elata* was erroneously referred to by Fernando (1990) as “Fig. 134 in Scheff. *l.c.*”, misinterpreting the text of Moore & Fosberg (1956) in which a Figure 134 depicting *H. elata* was presented. Scheffer’s (1876) protologue did not include any illustrations that can be interpreted as a type, nor was any original material cited. We conclude that *H. elata* requires typification. Here, we select a specimen as neotype that was sent by Scheffer from Buitenzorg (Bogor) to Beccari. It is likely that this collection is derived from the same material that Scheffer used to describe the species. The new type sheet is located in the Herbarium Palmarum in Florence (FI) under the barcode FI053592. Although it only has flowers and fruit, we believe the authenticity of the material speaks in favour of it being selected.

A lectotype of *Heterospathe elata* var. *guamensis* Becc. is formally designated here. Although Beccari (Martelli 1934) does not cite the material selected here directly, the protologue has a clear reference to Merrill (1914), who noted that *G.E.S. 129* had been seen by Beccari making lectotypification appropriate. Having examined ample material of *Heterospathe elata* we conclude that the characters previously used to delimit *H. elata* var. *palauensis*, including fruit size and shape, rachilla thickness and leaflet rugoseness (Beccari 1914a; Moore & Fosberg 1956), are variable throughout the species’ range and consequently the variety is placed in synonymy here.

The name *Euterpe pisifera* Gaertner (1788: 25) (= *Heterospatha pisifera* (Gaertn.) Burret [1929: 76]) has been linked to *Heterospathe elata* in the past (Beccari 1912, Burret 1929, Beccari & Pichi-Sermolli 1955). This link is based on crude drawings for fruits and seeds published in Gaertner (1788; Tab. 9, Fig. 3). However, Moore & Fosberg (1956) reject this link, highlighting significant differences, for example in position of stigmatic remains and embryo. We concur with Moore & Fosberg (1956) and treat *Heterospathe pisifera* and its synonyms as names of uncertain application (see below).

2. *Heterospathe elegans* (Becc.) Beccari (1909: 205). *Barkerwebbia elegans* Beccari (1905: 283). *Heterospathe elongata* Beccari (1914b: 36), orth. var. *Barkerwebbia elongata* (Becc.) Becc. ex Martelli (1935: 31), orth. var. Type:—PAPUA NEW GUINEA. Bismarck Range, *Schlechter 14071* (holotype B†, isotype FI!). Epitype (designated by Trudgen & Baker [2008]):—PAPUA NEW GUINEA. Madang Province: southern foothills of Finisterre Range, *Pullen 5958* (CANB!).

Figure 4 (line drawing). Figure 5 (photo plate). Figure 6 (map).

Slender, solitary or clustering understorey palm, acaulescent or with aerial stem, bearing 7–12(–18) leaves per crown. **Stem** to 2.5 m high, 1–5 cm in diam.; internodes 1.5–3.5 cm long. **Leaves** 1–3.3 m long including petiole; sheath indistinct or up to 42 cm long with fibrous margins, ± densely ferruginous-lepidote, crownshaft absent; petiole 42–130 cm long, indumentum as sheath; rachis 20–140 cm long, indumentum as sheath; lamina pinnate or occasionally entire-bifid; leaflets (when present) 6–43 each side of rachis, arranged regularly or rarely in pairs, borne 1–10 cm apart, single- or multi-fold, linear to lanceolate and ± sigmoid, acuminate to acute at their tips, dark green adaxially, abaxially green and often with rammenta scattered on basal portion of midrib; middle leaflet 21–58 × 1–3 cm, comprising



FIGURE 4. *Heterospathe elegans* subsp. *elegans*. A. Leaf apex. B. Leaf bases. C. Inflorescence upper portion. D. Infructescence. E. Portion of rachilla with pistillate flowers. F. Staminate flower whole and in longitudinal section. G. Fruit whole. Scale bar: A, C–D = 4.5 cm; B = 4 cm; E = 5 mm; F = 2.5 mm; G = 1 cm. A–C, F from Baker & Kage 656; D, G from Baker & Kage 652; E from Baker et al. 634. Drawn by Lucy T. Smith.



FIGURE 5. *Heterospathe elegans* subsp. *elegans* (A–B) and *H. elegans* subsp. *humilis* (C–D). A. Habit. B. Inflorescence. C. Habit. D. Inflorescence. A–B from Baker *et al.* 1130; C from the Huon Peninsula, Papua New Guinea; D from Banka 2011. All photos: W.J. Baker

1–8 folds; apical leaflets comprising 1–10 folds. **Inflorescence** 65–150 cm long including peduncle, interfoliar, branched to 1 or 2 orders; prophyll ca. 12.5–46 × 0.5–2 cm, persistent, splitting apically; peduncular bract(s) 1(–2); first peduncular bract 12.5–60 cm long × 0.25–1.5 cm, attached in the distal quarter of the peduncle, usually persistent and splitting longitudinally or rarely caducous; second peduncular bract (if present) 0.1–1.5 cm long; peduncle 50–140 × 0.15–0.65 cm, ± tomentose-lepidote especially distally; first-order branches 4–16, to 26 cm long, inserted 0.5–5.5 cm apart, with up to 7 rachillae, rachis bracts subtending first-order branches usually inconspicuous, more rarely triangular and as long as 10 cm; rachillae to 17 cm long, 1–2 mm in diam.; triads inserted up to 2 mm apart. **Staminate flower** 1.8–3.8 × 1.5–2.6 mm at anthesis, green; sepals 3, 1–2 × 1.5–2.5 mm, imbricate, glabrous; petals 3, 1.4–3 × 1.2–3 mm, valvate; stamens 6; filaments 0.8–1.9 mm long, free; anthers 1–2 × 0.2–1.5 mm, medifixed; pistillode 0.8–1.8 × 0.2–0.5 mm, columnar to slightly tapering. **Pistillate flower** 1.5–2.9 × 1.7–2.9 mm; sepals 3, 1.5–2.4 × 1.3–2.5 mm, imbricate, glabrous; petals 3, 1–2.3 × 0.7–1.7 mm, imbricate; staminodes present, small; ovary 1–2 × 0.8–1.8 mm, ± globose, stigma minute. **Fruit** 10–15 × 8–10 mm, ellipsoid to globose, red when ripe; stigmatic remains eccentrically apical. **Seed** 5–8 × 5–8 mm, globose; endosperm ruminant (Species description modified from Trudgen & Baker [2008]).

Notes:—*Heterospathe elegans* is one of the commonest and most widely distributed species of *Heterospathe* in New Guinea. The species is distinguished by its long, slender inflorescence, which is often exserted from the crown and has a persistent peduncular bract inserted in the distal quarter of the elongated peduncle.

Two subspecies are accepted with one being acaulescent (*H. elegans* subsp. *humilis*) and usually clustering, and the other having an aerial, solitary stem as long as 2.5 metres (*H. elegans* subsp. *elegans*). *Heterospathe elegans* subsp. *elegans* can be confused with *H. pullenii* and *H. lepidota*, but those species have a caducous peduncular bract inserted in the distal third quarter of the peduncle and usually larger fruit. *Heterospathe elegans* subsp. *humilis* can be confused only with *H. sphaerocarpa* on account of the acaulescent habit, but *H. sphaerocarpa* has purple inflorescences with the peduncular bract inserted in the proximal half of the less elongate peduncle.

Having studied the type material and protologue of *Heterospathe pilosa* we conclude that it falls within the range of variation of *H. elegans* subsp. *humilis* and thus synonymise it accordingly.

Trudgen & Baker (2008) gave a detailed account of the *Heterospathe elegans* complex.

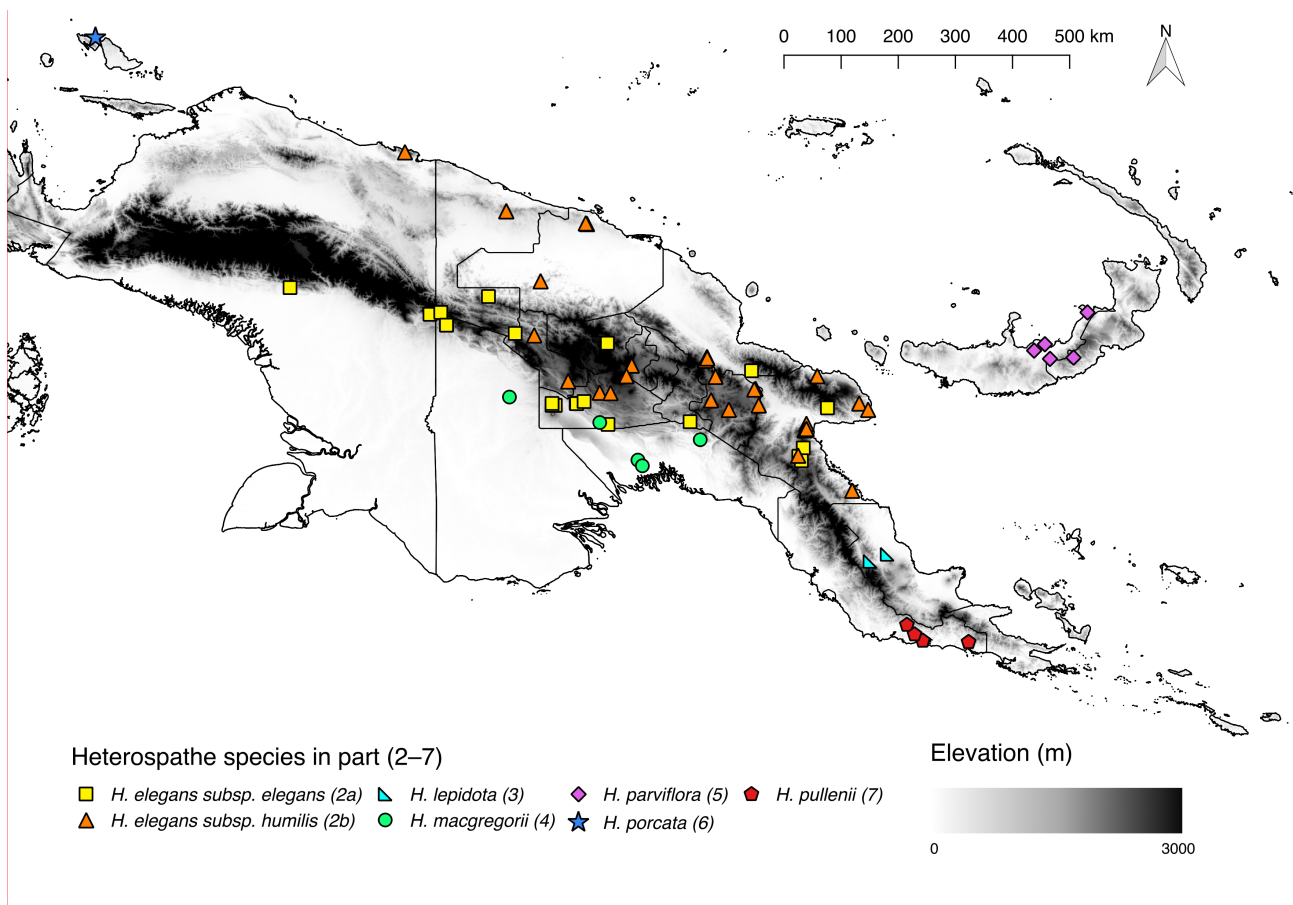


FIGURE 6. Distribution map of the species of *Heterospathe* in part.

2a. *Heterospathe elegans* (Becc.) Becc. subsp. *elegans*

Heterospathe versteegiana Beccari (1909: 203). Type:—INDONESIA. Papua Province: Mt. Resi, *Versteeg 1669* (holotype FI!, isotypes BO, K!, L). Epitype (designated by Trudgen & Baker [2008]):—PAPUA NEW GUINEA. Sandaun Province: Telefomin Distr., *Croft LAE 65734* (BRI!, isoeotypes BH!, L!, LAE).

Solitary, stem well-defined, to 2.5 m tall. Leaves usually divided into single-fold leaflets apart from the 2-fold apical pair, or occasionally divided into fewer, multi-fold leaflets. Inflorescence often branched to 2 orders, with 9–15 first-order branches (Subspecific description modified from Trudgen & Baker [2008]).

Distribution:—Widespread in the Papua New Guinean portion of the central New Guinea highlands and the Huon Peninsula, but also known from two localities in the highlands of Papua Province, western New Guinea.

Habitat:—Understorey in premontane to montane rainforest, 500–2150 m.

Uses:—Used for making spear heads.

Vernacular names:—*Dalung* (Weng, Busilmin), *Fitigit* (language unknown), *Tiritiri* (language unknown).

Conservation status:—Least Concern (LC; Trudgen & Baker 2008).

Specimens examined:—INDONESIA. **Papua Province:** Mt. Resi, 900 m, 4°37'S, 138°43'E, 27 August 1907, *Versteeg 1669* (BO, FI!, K!, L); Okwalimkam, 1200 m, 5°2'S, 140°55'E, 26 June 1967, *Ridsdale NGF 33316* (LAE!). PAPUA NEW GUINEA. Bismarck Range, 1000 m, January 1902, *Schlechter 14071* (B†, FI!); **Chimbu Province:** Crater Mt. Wildlife Management Area E of Haia Village, 800 m, 6°43'S, 145°00'E, 17 March 1997, *Takeuchi 11835* (A!); **Madang Province:** Near Damanti Village, S foothills of the Finisterre Range, eastern Madang District., 1050 m, 5°55'S, 145°58'E, 6 October 1964, *Pullen 5958* (CANB!); **Morobe Province:** Lae, Mt. Jacob, near Musom, Sankwep River, 950 m, 6°30'S, 147°10'E, 28 November 1979, *Katik LAE 74748* (L!, LAE); Kulolo River, 9 km SE of Bulolo, 1200 m, 7°16'S, 146°43'E, 22 February 1980, *Kairo 746* (LAE!); Same locality as preceding, 1200 m, 7°16'S, 146°43'E, 22 February 1980, *Kairo 747* (LAE!); Wau Subdistr., road half way to Yamap, 1500 m, 7°8'S, 146°47'E, August 1969, *Kairo NGF 44074* (BH!, L!, LAE); Road to Yamap, 1200 m, 7°20'S, 146°45'E, 19 January 1963, *Millar NGF 23091* (LAE!); **Sandaun Province:** Telefomin Subdistr., N foothills of Star Mts., 1500 m, 5°0'S, 141°5'E, 28 March 1975, *Croft LAE 65734* (BH!, BRI!, L!, LAE); Telefomin Subdistr., Carpentaria Exploration, Antap Mt., 1250 m, 4°45'S, 141°50'E, 29 April 1978, *Essig LAE 74063* (LAE!); Telefomin Subdistr., Oksamin, 1600 m, 5°20'S, 142°15'E, 25 October 1968, *Henty NGF 41759* (BH, L!, LAE); Star Mts., Busilmin, 1600 m, 5°0'S, 141°5'E, 20 May 1975, *Veldkamp 6896* (L!); **Southern Highlands Province:** Erave District, Ridge near road to Gobe oil rigs, 93 km NW of Kikori, 1250 m, 6°45'S, 143°43'E, 27 November 2000, *Baker et al. 1117* (AAU, K!, LAE, NY); Moro, Iagifuago, path along water pipeline from well site down to road, WWF Integrated Conservation and Development Project Area, 1350 m, 6°26'S, 143°13'E, 12 February 1996, *Baker & Kage 656* (FTG, K!, LAE!); Moro, Iagifuago, path along water pipeline from well site down to road, WWF Integrated Conservation and Development Project Area, 1350 m, 6°26'S, 143°13'E, 12 February 1996, *Baker & Kage 661* (K!); Moro, Ulisili, near to Sisibiu 1 oil well, WWF Integrated Conservation and Development Project Area, 850 m, 6°26'S, 143°13'E, 12 February 1996, *Baker & Kage 652* (FTG, K!, LAE!); Mt. Bosavi, near Bosavi Mission (also known as Dudessa or Ludessa Village), WWF Integrated Conservation and Development Project Area, 750 m, 6°28'S, 142°53'E, 5 February 1996, *Baker et al. 633* (FTG, K!, LAE!); Same locality as preceding, 750 m, 6°28'S, 142°53'E, 5 February 1996, *Baker et al. 634* (K!, LAE!); Tari Subprov., Mt. Bosavi, Head of Kuri Creek, 1300 m, 6°28'S, 142°50'E, 24 August 1986, *Gideon LAE 57403* (L!, LAE); Kutubu patrol area, limestone karst ridge next to Waro, 500 m, 6°24'S, 143°20'E, 3 August 1991, *Takeuchi 7296* (A!); Koroba Subdistr., Mandi near Hedemari mision, 5 July 1972, *Gebo UPNG 1797* (CANB!, L, LAE, UPNG); Mt. Bosavi, N side, 1000 m, 6°26'S, 142°50'E, 23 October 1973, *Jacobs 9395* (CANB!, LAE, L!); **Western Province:** North Fly Distr., road from Tabubil to Ok Tedi copper mine, 8.5 km N of Tabubil, ca. 2 km NW of Finalbin, 1000 m, 5°12'S, 141°10'E, 12 December 2000, *Baker et al. 1130* (K!, LAE); Same locality as preceding, 1000 m, 5°12'S, 141°10'E, 12 December 2000, *Baker et al. 1134* (AAU, K!, LAE); Papua New Guinea. **Western Highlands Province:** W Highlands District, Ecological site No. 19, near the old Lutheran sawmill at Yaibos, near Wabag, 2150 m, 5°29'S, 143°42'E, 28 December 1964, *Flenley ANU 2277* (CANB!).

2b. *Heterospathe elegans* (Becc.) Becc. subsp. *humilis* (Becc.) Trudgen & Baker (2008: 644).

Heterospathe humilis Beccari (1914b: 35). *Barkerwebbia humilis* (Becc.) Becc. ex Martelli (1935: 31). Type:—PAPUA NEW GUINEA. Ibo-Gebirge [Ibo Mts.], *Schlechter 17099* (holotype B†, isotypes FI!). Epitype (designated by Trudgen & Baker [2008]):—PAPUA NEW GUINEA. Morobe Province: Wagau, *Sayers 21607* (BRI!, isoeotypes L!, LAE).

Rhynchoscarpa pilosa Burret (1933: 712). *Heterospathe pilosa* (Burret) Burret (1935: 328). Type:—INDONESIA. Papua Province: Cyclops Mts., 25 August 1928, *Mayr 509* (holotype B†, isotype BO!), *synon. nov.*

Solitary or clustering, acaulescent or with a short, prostrate stem, rooting from the base. Leaves entire or divided into single- or multi-fold leaflets, or a combination of both, usually with apical and basal leaflets 2–10-folded. Inflorescence branched to 1 or 2 orders, with 4–16 first-order branches (Subspecific description modified from Trudgen & Baker [2008]).

Distribution:—Widely distributed in the Papua New Guinean portion of the central New Guinea highlands, the Huon Peninsula and northwestern Papua New Guinea. In western New Guinea known only from the Cyclops Mountains.

Habitat:—Understorey in premontane to montane (rarely lowland) rainforest, (50–)600–2200 m.

Uses:—None recorded.

Vernacular names:—*Sowangu* (Waskuk), *Bossowa* (Wagu), *Yawi* (Enga), *Kakanda* (language unknown).

Conservation status:—Least Concern (LC; Trudgen & Baker 2008).

Specimens examined:—INDONESIA. **Papua Province:** Cyclops Mts., 900 m, 25 August 1928, *Mayr 509* (B†, BO!); Cyclops Mts., Jayapura, 1200 m, 11 August 1998, *Heatubun 274* (BO, FTG, K!, MAN). PAPUA NEW GUINEA. Ibo-Gebirge [Ibo Mts.], 1200 m, 30 December 1907, *Schlechter 17099* (B†, FI!); *Hamilton 75* (LAE!); **East Sepik Province:** Prince Alexander Range, E slope Mt. Turu, 1050 m, 3°37'S, 143°23'E, 17 August 1959, *Pullen 1460* (BH, CANB!, L, LAE); Yangoru Subdistr., S slope of Mt. Turu, 1000 m, 3°36'S, 143°22'E, 11 January 1999, *Marai 445* (AAU!); Ambunti Subdistrict., Eastern ridge of Sumset (Mt. Hunstein), 1300 m, 4°31'S, 142°39'E, 11 August 1966, *Hoogland 10924* (BRI!, CANB, K!, L); **Eastern Highlands Province:** Kainantu Subdistr., Andandara, 1600 m, 6°28'S, 146°5'E, 19 January 1972, *Essig LAE 55145* (LAE!); Same locality as preceding, 1600 m, 6°28'S, 146°5'E, 19 January 1972, *Essig LAE 55146* (LAE!); Kainantu Subdistr., Kassam, 1200 m, 6°12'S, 146°2'E, 12 March 1968, *Henty NGF 29360* (BH!, BRI!, L!, LAE); Kassam, 1350 m, 6°13'S, 146°1'E, 2 November 1959, *Brass 32351* (A, K!, L, LAE); Mt. Michael, northeast slopes, 2000 m, 6°23'S, 145°20'E, 4 September 1959, *Brass 31343* (K!, L, LAE!); Nagamiza, 5 km N of Goroka, 1700 m, 6°1'S, 145°24'E, 10 April 1982, *Streimann 8316* (LAE!); Near Okapa, 1850 m, 6°32'S, 145°37'E, 1 January 1966, *Hornibrook 83* (LAE!); **Madang Province:** Usino Bundi, Bana Numbu (Bundi Station), above camp 1700 on trail to plots, 1700 m, 5°45'S, 145°14'E, 2 November 2012, *Pintaud 678* (K!, LAE, P); Usino Bundi, G.B., plot 1200a, 1200 m, 5°43'S, 145°16'E, 4 November 2012, *Pintaud 680* (K!, LAE, P); Same locality as preceding, 1200 m, 5°43'S, 145°16'E, 4 November 2012, *Pintaud 681* (K!, LAE, P); **Morobe Province:** Wagau, 1150 m, 6°50'S, 146°50'E, 14 January 1965, *Sayers NGF 21607* (BRI!, L!, LAE); Finschhafen Distr., Banario Mountain, near Nanduo village, 28 km NW of Finschhafen, 1000 m, 6°25'S, 147°40'E, 6 December 2000, *Banka 2011* (AAU, K!, LAE); Finschhafen Subdistr., 600 m, 6°32'S, 147°48'E, 25 October 1999, *Barfod 438* (AAU!, BRI, CANB, K, LAE); Wau Subprovince., foothills of Mt. Missim, 1100 m, 7°15'S, 146°42'E, 5 January 1984, *Kini LAE 72549* (LAE!); Hills NE of airstrip at Wagau, 1050 m, 13 March 1964, *Moore 9289* (LAE, BH!); Lae Subdistr., hillside NW of Ana Village, 50 m, 7°48'S, 147°33'E, 27 January 1972, *Essig LAE 55157* (LAE); Buang region, near Wagau, 1200 m, 6°45'S, 146°50'E, 3 November 1963, *Womersley NGF 17904* (BH!, L!, LAE); ridge NE of Wagau, 1200 m, 6°51'S, 146°48'E, 13 January 1965, *Jermy 4780* (K!); SW of Bupu Village, above Wampit River, 850 m 4 March 1964, *Moore 9262* (BH!, LAE); Wagau (Buang), 1150 m, 6°51'S, 146°48'E, 14 November 2004, *Kuria LAE 87030* (LAE!, NSW, UPNG); Mumeng Subdistr., Wagau, 1050 m, 6°50'S, 146°50'E, 22 November 1967, *Millar NGF 12080* (BRI, L, LAE!, K!); **Sandaun Province:** Miwaute, 950 m, 3°25'S, 142°7'E, 20 November 1996, *Barfod 392* (AAU!); Same locality as preceding, 950 m [1], 3°25'S, 142°7'E, 20 11 1996, *Barfod, A. 394* (AAU!); **Southern Highlands Province:** 15 km SSW of Mendi, 1600 m, 6°16'S, 143°35'E, 18 December 1982, *Vinas 149* (LAE!); Mondia Range between Pawarri and Paua on the Kutubu-Tari track, 1500 m, 6°5'S, 143°5'E, 15 August 1961, *Pullen 2821* (CANB!); **Western Highlands Province:** Hagen Subdistr., Togoba sawmill, Nbelyer divide, 2000 m, 5°50'S, 144°5'E, 18 July 1957, *Robbins 481* (CANB!); Same locality as preceding, 2000 m, 5°50'S, 144°5'E, 18 July 1957, *Robbins 483* (CANB!); Kapiogo Subdistr., near Kapiogo, 1450 m, 5°22'S, 142°33'E, 3 November 1968, *Womersley NGF 37323* (LAE!).

3. *Heterospathe macgregorii* (Becc.) Moore (1970: 91). *Rhopaloblaste macgregorii* Becc. in Martelli (1934: 134). Type:—PAPUA NEW GUINEA. Western Province: Fly River, *MacGregor s.n.* (holotype FI!, isotype (fragment) BH!).

Figure 7 (line drawing). Figure 8 (photo plate).

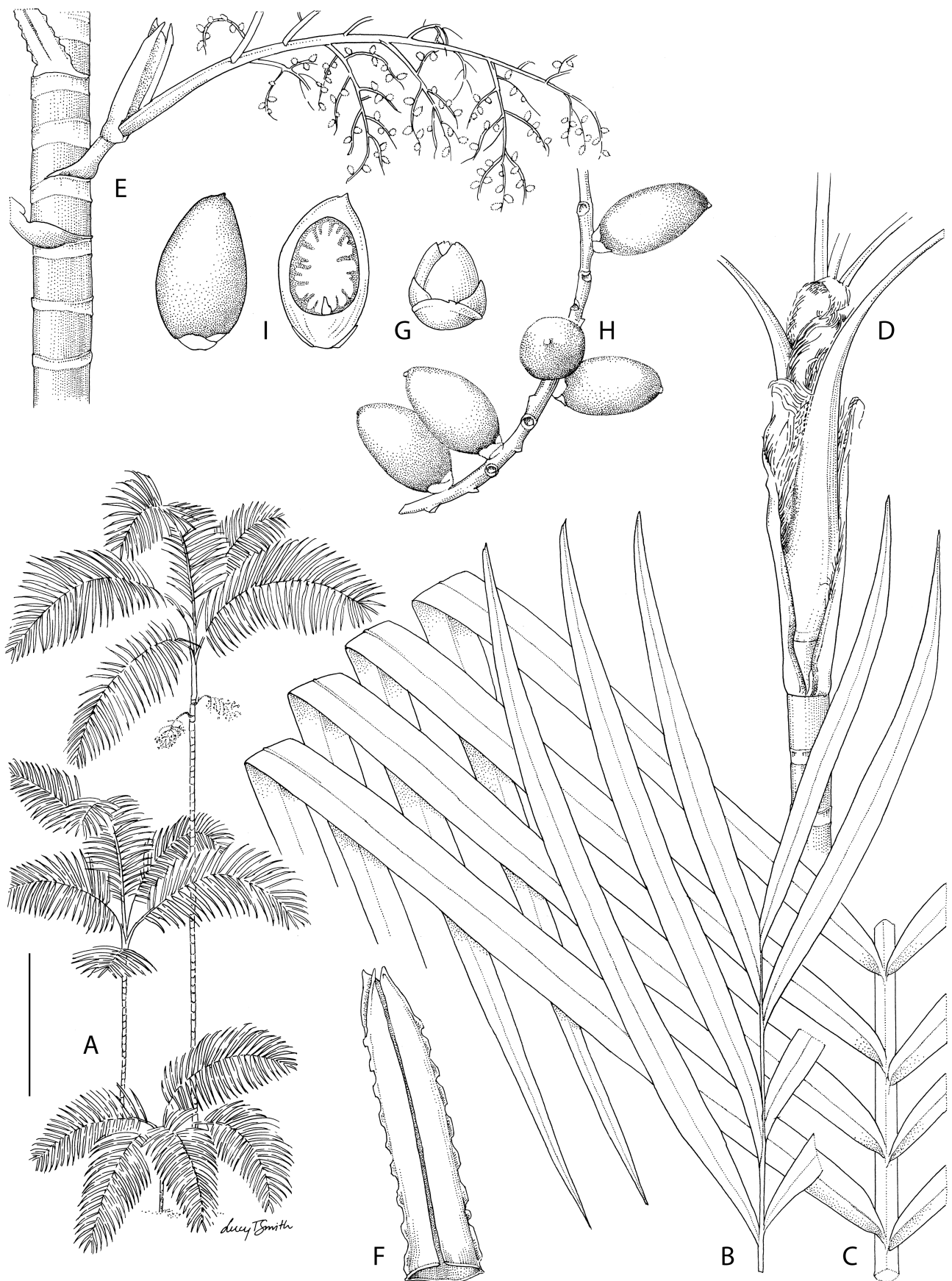


FIGURE 7. *Heterospathe macgregorii*. A. Habit. B. Leaf apex. C. Mid-leaf portion. D. Crown basal portion. E. Stem upper portion with attached infructescence. F. Prophyll. G. Pistillate flower whole. H. Portion of rachilla with fruit. I. Fruit whole and in longitudinal section. Scale bar: A, D–E = unknown; B–C, F = 6 cm; G = 7 mm; H = 2.5 cm; I = 2 cm. A, D–E from WJB’s photos from the Kikori River, Papua New Guinea; B–C, F–I from *Baker et al. 651*. Drawn by Lucy T. Smith.



FIGURE 8. *Heterospathe macgregorii*. A–B. Habit. C. Inflorescence. D. Portion of inflorescence with fruit. A–C from Kikori River, Papua New Guinea; D from *Baker et al. 1090*. All photos: W.J. Baker.

Slender, clustering rheophytic palm to 7 m tall, sometimes with adventitious roots forming cone at stem bases, bearing ca. 9 leaves per crown. **Stem** 4–7.5 cm in diam.; internodes 3–12 cm long. **Leaf** 1–2.5 m long including petiole, slightly arcuate; sheath 26–40 cm long, light green with brown fibrous margins, ferruginous-lepidote, crownshaft absent; petiole 19–80 cm long, indumentum as sheath; rachis 1.1–1.5 m long, indumentum as sheath; leaflets 32–44 each side of rachis, arranged regularly, borne 2–3 cm apart, single-fold, linear, acuminate at their tips, light to dark green, abaxially with ramenta scattered on basal portion of midrib and major veins; middle leaflet 38–52 × 1.5–2.3 cm. **Inflorescence** 50–65 cm long including peduncle, interfoliar at least at emergence, branched to 2 or 3 orders; prophyll ca. 20 × 2.5 cm, falling off late, splitting apically to one side, ferruginous-lepidote; peduncular bract ca. 25 × 1.5 cm, inserted in proximal half of peduncle, caducous, ferruginous-lepidote; peduncle 17–22 × 0.6–2 cm, indumentum as peduncular bract or glabrous; first-order branches 10–18, to 45 cm long, inserted 1–4 cm apart, with up to 16 rachillae, subtended by inconspicuous rachis bracts, indumentum as peduncular bract; rachillae to 20–27 cm long, 1–2 mm in diam.; triads inserted 1–4 mm apart. **Staminate flower** 1.3–3 × 1.2–2 mm pre-anthesis, green; sepals 3, 1–1.7 × 1–1.8 mm, imbricate, glabrous; petals 3, 0.8–3 × 0.6–2 mm, valvate; stamens 6; filaments 0.3–1.5 mm long, linear; anthers 0.3–2 × 0.1–0.7 mm, medifixed; pistillode 0.3–2 × 0.1–0.4 mm, columnar. **Pistillate flower** ca. 3 × 3 mm near anthesis, green; sepals 3, ca. 2 × 2.5 mm, imbricate, glabrous; petals 3, ca. 2.5 × 2 mm, imbricate; staminodes ca. 3, minute; ovary ca. 2.5 × 1.5 mm, ellipsoid, stigma low, inconspicuous. **Fruit** ca. 20–22 × 12 mm (ca. 19–20 × 9–11 mm when dry), broadly ellipsoid, red when ripe; stigmatic remains eccentrically apical. **Seed** 12–12.5 × 8.5–9.5 mm, ellipsoid; endosperm deeply ruminant.

Distribution:—Fly, Wisaa, Kikori, Mubi, Rentoul and Strickland Rivers in south-western Papua New Guinea.

Habitat:—River banks on karst limestone or alluvium on limestone, 50–450 m.

Uses:—None recorded.

Vernacular names:—None recorded.

Conservation status:—Least Concern (LC). The calculated range of this species is relatively narrow (EOO is ca. 11,287 km²; Bachman *et al.* [2011]) and based on only five localities or locations (AOO is 20 km²). However, with these figures expected to increase, threatened status is not assigned. The species was reported as common in at least on locality.

Specimens examined:—PAPUA NEW GUINEA. **Gulf Province:** Kikori District, small island near to Kopi, 13 km N of Kikori, 50 m, 7°19'S, 144°11'E, 19 November 2000, *Baker 1090* (AAU, BRI!, E, K!, LAE, NY); Kikori Subdistr., Wisaa River, 100 m, 7°0'S, 145°10'E, 19 August 1975, *Conn 66324* (BH!, BRI, L!, LAE); Kikori River, 7°25'S, 144°15'E, 12 February 1959, *White NGF 10714* (BRI!, K!, LAE); **Southern Highlands Province:** Kantobo, Wadbera Island near Mabogo Island, Mubi River, near Globo Village, WWF Integrated Conservation and Development Project Area, 450 m, 6°44'S, 143°35'E, 11 February 1996, *Baker 651* (BH, K!, LAE); **Western Province:** Fly River, 25 January 1890, *MacGregor s.n.* (FI!); Nomad Subprov., junction of Rentoul and Strickland rivers, 80 m, 6°20'S, 142°10'E, 11 November 1979, *Croft LAE 71583* (AAU, CANB!, CBG, LAE, US, USF).

Notes:—*Heterospathe macgregorii* is an unmistakable species. No other species of *Heterospathe* in New Guinea is rheophytic or has clustering aerial stems. *Heterospathe elegans* subsp. *humilis* is a clustering palm, but it is acaulescent so lacks aerial stems. The relatively large, ellipsoid, red fruit are also distinctive.

4. *Heterospathe lepidota* Moore (1969: 103). Type:—PAPUA NEW GUINEA. Oro Province, *Hoogland & Womersley 3241* (holotype A, isotypes BH, BRI!, CANB, K!, L).

Figure 9 (line drawing).

Slender, solitary palm to 5.5 m tall. **Stem** 2–7.5 cm in diam., internodes not seen. **Leaf** 1–2.5 m long including petiole; sheath 15–30 cm long, with fibrous margins, ferruginous-lepidote, crownshaft absent; petiole ca. 15–40 cm long, indumentum as sheath; rachis 85–210 cm long, indumentum as sheath or glabrous; leaflets 21–35 each side of rachis, arranged regularly, borne 2–5 cm apart, single-fold apart for the multi-fold apical leaflets, linear, acuminate at their tips, dark green adaxially, abaxially light green and with ramenta scattered on basal portion of midrib and major veins; middle leaflet 45–57 × 1.5–2 cm; apical leaflet pair comprising 3–4 folds. **Inflorescence** 85–100 cm long including peduncle, interfoliar, branched to 2 orders; prophyll ca. 27–33 × 2–2.5 cm, persistent, splitting apically, ferruginous-lepidote; entire peduncular bract not seen, attached in the distal third quarter of the peduncle, caducous, indumentum as prophyll; peduncle 57–70 × 0.5–1.2 cm, indumentum as prophyll or more densely lepidote; first-order branches 10–15, to 45 cm long, inserted 1–5 cm apart, with up to 6 rachillae, subtended by inconspicuous rachis bracts, indumentum as peduncle; rachillae to 30–35 cm long, 1.5–2.5 mm in diam.; triads inserted 1–4 mm apart. **Staminate flower**

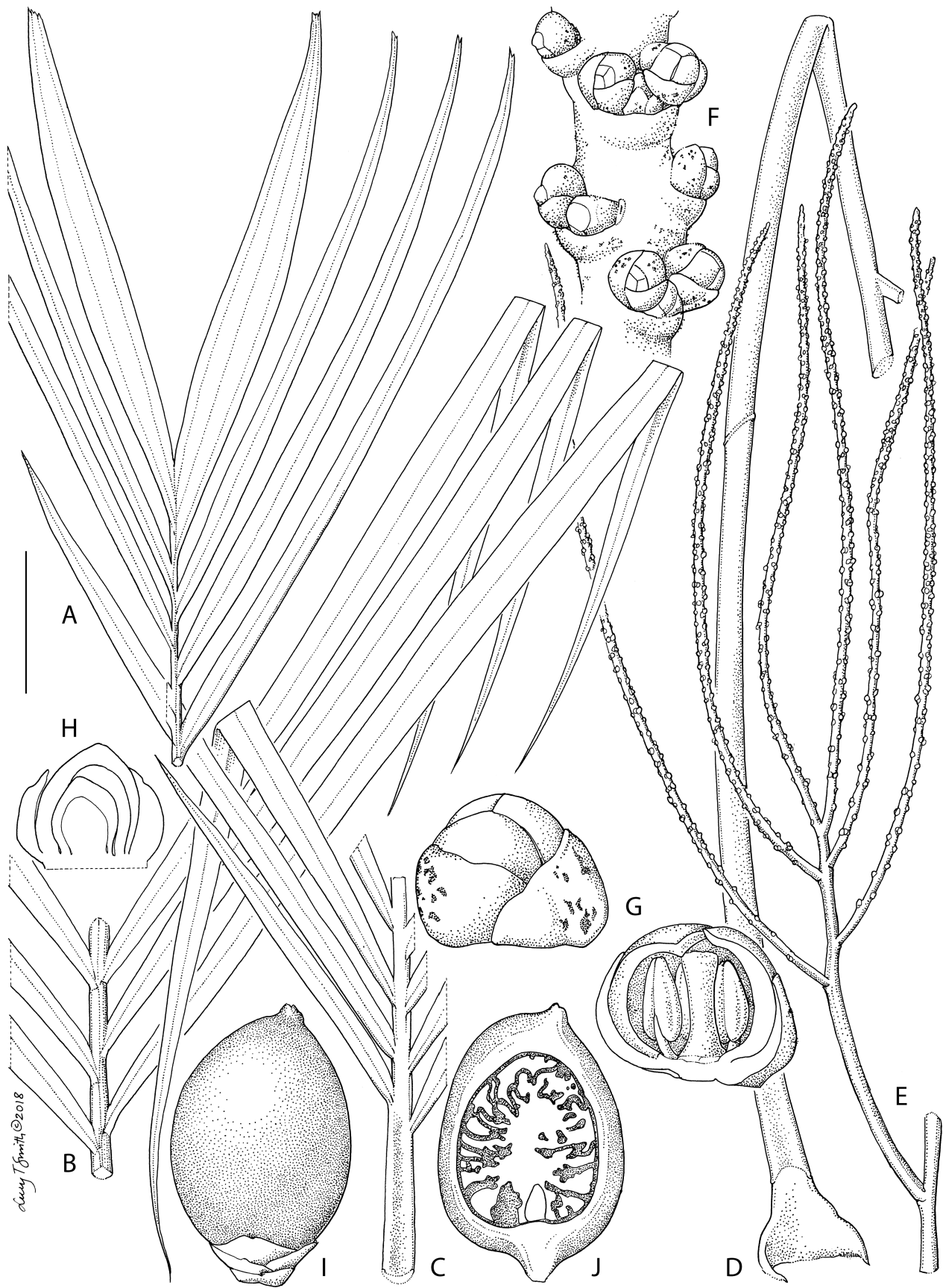


FIGURE 9. *Heterospathe lepidota*. A. Leaf apex. B. Mid-leaf portion. C. Leaf base. D. Inflorescence peduncle. E. Inflorescence side-branch. F. Portion of rachilla with triads. G. Staminate flower whole and in longitudinal section. H. Pistillate flower in longitudinal section. I–J. Fruit whole and in longitudinal section. Scale bar: A–E = 6 cm; F = 4 mm; G = 1.25 mm; H = 0.8 mm; I–J = 7.5 mm. All from Hoogland & Womersley 3241. Drawn by Lucy T. Smith.

ca. 2.5×2 mm pre-anthesis (when dry), yellowish; sepals 3, ca. 1.3×2 mm, imbricate, \pm ferruginous-lepidote; petals 3, ca. 2×1.5 mm, valvate; stamens 6; filaments ca. 1.5 mm long, linear; anthers ca. $1.3 \times 0.2\text{--}0.4$ mm, medifixed; pistillode ca. $2 \times 0.3\text{--}0.4$ mm, columnar. **Pistillate flower** ca. 1.3×1.2 mm near anthesis (when dry), yellowish; sepals 3, ca. 1×2 mm, imbricate, indumentum as staminate sepals; petals 3, $0.5\text{--}1 \times 0.5\text{--}1$ mm, imbricate; staminodes ca. 4, small; ovary minute (aborted?), ca. 0.1×0.1 mm, conical, stigma inconspicuous. **Fruit** ca. 15×10 mm (when dry), broadly ellipsoid, red when ripe; stigmatic remains eccentrically apical. **Seed** ca. 9×7.5 mm (when dry), ovoid; endosperm deeply ruminant.

Distribution:—Oro Province, Papua New Guinea.

Habitat:—Lowland rainforest on slopes, ca. 180–200 m.

Uses:—None recorded.

Vernacular names:—*Soriki* (Orokaiva)

Conservation status:—Data deficient (DD). More data are needed about the range and abundance of this species.

Specimens examined:—PAPUA NEW GUINEA. **Oro Province:** ca. 2 km NE of Sangara homestead, ca. 10 km W of Popondetta, 200 m, $8^{\circ}48'S$, $148^{\circ}6'E$, 8 July 1953, *Hoogland 3241* (A, BH, BRI!, CANB, K!, L); Kokoda Subdistr., 3 km W of Sisireta Village, 180 m, $8^{\circ}55'S$, $147^{\circ}50'E$, 29 September 1975, *Wiakabu LAE 70266* (LAE!).

Notes:—*Hydriastele lepidota* is a slender palm distinguished by having leaves with 21–35 leaflets on each side of the rachis, all single-fold apart from the multi-fold apical leaflet pair, a peduncular bract inserted in the distal third quarter of the peduncle, yellowish flowers with more-or-less lepidote sepals, and fruit measuring at least 15 mm in length. This species most closely resembles *H. pullenii* but that species differs in having 10–15 leaflets on each side of the rachis with the basal leaflet pair being multi-fold, and green flowers with glabrous petals. *Hydriastele lepidota* can also be confused with *H. elegans* subsp. *elegans* but *H. elegans* has the peduncular bract inserted in the most distal quarter of the peduncle, and usually smaller fruit.

5. *Heterospathe parviflora* Essig (1992: 4). Type:—PAUPA NEW GUINEA. West New Britain Province: Mts. S of Hoskins, *Essig & Katik LAE 64060* (holotype USF, isotypes BH, K!, LAE, NY!).

Figure 10 (line drawing). Figure 11 (photo).

Slender to moderately robust, solitary palm to 8 m tall. **Stem** 7.5–10(–15) cm in diam., internodes not seen. **Leaf** (0.75–)2–3.2 m long including petiole; sheath 25–40 cm long, with fibrous margins, ferruginous-lepidote, crownshaft absent; petiole 20–25 cm long, ferruginous-lepidote to nearly glabrous; rachis ca. 1.8–3 m long, indumentum as petiole; leaflets 26–33 each side of rachis, arranged regularly, borne 4–10 cm apart, single-fold but the apical leaflets may be 2-fold, linear, acuminate to acute at their tips, dark green adaxially, abaxially mid green and with few ramenta scattered on basal portion of midrib and major veins; middle leaflet (33–)57–67 \times (2–)4–6.5 cm. **Inflorescence** ca. 150 cm long including peduncle, interfoliar, branched to 2 or 3 orders; prophyll ca. 45×4 cm, persistent, splitting apically, lepidote to glabrous; peduncular bract ca. 140 cm long, attached in proximal half of peduncle, ferruginous-lepidote; peduncle ca. 80–90 cm long, ferruginous-lepidote; first-order branches ca. 15, to 60–70 cm long, inserted 1–6 cm apart, \pm swollen at their bases, with up to 14 rachillae, subtended by inconspicuous rachis bracts, indumentum as peduncle; rachillae to 32–37 cm long, 1.5–2.5 mm in diam.; triads inserted 1–10 mm apart. **Staminate flower** ca. 2.5×2.5 mm pre-anthesis (when dry), reddish-brown; sepals 3, ca. 2×3 mm, imbricate, glabrous; petals 3, ca. 2.5×2 mm, valvate; stamens 6; filaments ca. 1 mm long, linear; anthers ca. $1.4 \times 0.4\text{--}0.8$ mm, medifixed; pistillode ca. 1.3×0.5 , columnar. **Pistillate flower** ca. 2×2.5 mm near anthesis (when dry), reddish-brown; sepals 3, $1.5\text{--}2 \times 2\text{--}4$ mm, imbricate, glabrous; petals 3, ca. 1×1.5 mm, imbricate; staminodes not seen; ovary ca. 1×0.5 mm, ovoid, stigma inconspicuous. **Fruit** ca. $12\text{--}13.5 \times 10.5$ mm (when dry), subglobose (globose when fresh), red when ripe; stigmatic remains apical to eccentrically apical. **Seed** 9–10 \times 8–9 mm (when dry), subglobose; endosperm deeply ruminant.

Distribution:—The central portion of New Britain in the Bismarck Archipelago, Papua New Guinea.

Habitat:—Lowland or montane, pristine or disturbed rainforest on volcanic soil, 0–1500 m.

Uses:—None recorded.

Vernacular names:—None recorded.

Conservation status:—Vulnerable (VU). This species has a relatively narrow distribution (EOO is 3,190 km²; Bachman *et al.* [2011]) based on five localities or locations (AOO is 20 km²). Although these figures may increase in the future due to present under-collecting, the intensity of forest change, including clearing of forest for oil palm plantations, has been high in West New Britain (Shearman *et al.* 2008), presenting a threat to this species. *Heterospathe parviflora* has been reported as common in at least one locality.

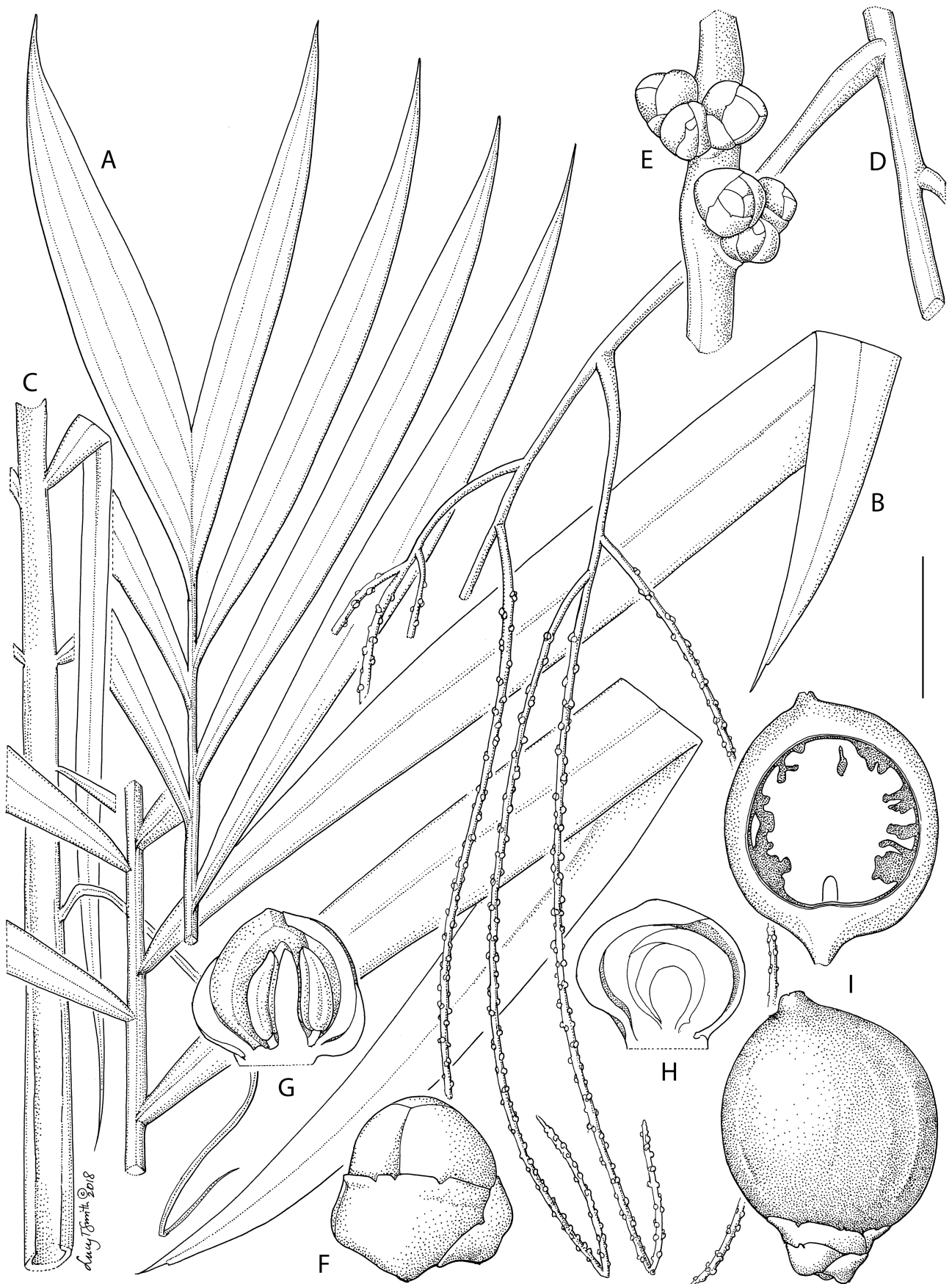


FIGURE 10. *Heterospathe parviflora*. A. Leaf apex. B. Mid-leaf portion. C. Leaf base. D. Inflorescence side-branch. E. Portion of rachilla with triads. F–G. Staminate flower whole and in longitudinal section. H. Pistillate flower in longitudinal section. I. Fruit whole and in longitudinal section. Scale bar: A–D = 6 cm; E = 5 mm; F–H = 2 mm; I = 7 mm. All from *Essig & Katik LAE 64060*. Drawn by Lucy T. Smith.



FIGURE 11. *Heterospathe parviflora*. A. Leaf, inflorescence and infructescence. B. Portion of infructescence. C. Portion of inflorescence. All from central New Britain, Papua New Guinea. All photos: Frederick B. Essig.

Specimens examined:—PAPUA NEW GUINEA. **West New Britain Province:** Mts. S of Hoskins, Kapiura Timber area, near village of Sampantabil, 650 m, 5°44'S, 150°40'E, 20 February 1989, *Essig & Katik LAE 64060* (BH, K!, LAE, NY!, USF); Base of Mt. Ulamona, logging area, 5°30'S, 150°35'E, 23 February 1989, *Essig LAE 64064* (K!, LAE, NY, USF); Subdistr. Hoskins, Ulamona W of Nantambu, 150 m, 5°0'S, 151°15'E, 4 June 1973, *Isles NGF 32300* (BH!, BRI!, L!, LAE); Pomio Subdistr., lower slopes of Mt. Lululua, 1500 m, 5°43'S, 151°2'E, 6 May 1973, *Stevens LAE 58272* (BH!, BRI!, L!, LAE); Talasea Subdistr., 0 m, 5°36'S, 150°25'E, 9 April 1959, *White NGF 10813* (LAE!).

Notes:—*Heterospathe parviflora* is the only species of *Heterospathe* known from the Bismarck Archipelago and it is distinguished from all species in New Guinea by its large, brush-like inflorescence with long, straight branches (first-order branches reaching 70 cm in length). The species is further distinguished by the small and reddish-brown flowers and the globose fruit with apical to eccentrically apical stigmatic remains.

H. parviflora is possibly most closely related to the poorly known *H. woodfordiana* Beccari (1914c: 281) from Santa Isabel and San Jorge Islands in the Solomon Islands archipelago (Essig 1992).

6. *Heterospathe porcata* Baker & Heatubun (2012: 142). Type:—INDONESIA. Papua Province: Supiori Island, *Maturbongs RAM 680* (holotype K!, isotypes AAU!, BO, CANB, LAE, MAN).

Figure 12 (line drawing).

Slender, ?solitary understory palm to 6 m tall, bearing ca. 16 leaves in crown. **Stem** ca. 3 cm in diam.; internodes 1–2 cm long. **Leaf** ca. 1.5 m long including petiole; entire sheath not seen, with fibrous margins, ferruginous-lepidote, crownshaft absent; petiole ca. 50 cm long, indumentum as sheath but denser; rachis ca. 1 m long, indumentum as petiole but denser; leaflets ca. 40 each side of rachis, arranged regularly, borne 1–4 cm apart, single-fold, linear and slightly sigmoid, acuminate at their tips, abaxially with ramenta scattered on basal portion of midrib and major veins; middle leaflet ca. 45 × 2 cm. **Inflorescence** 124–138 cm long including peduncle, interfoliar, branched to 2 or 3 orders; prophyll ca. 39 × 1.7–2 cm, persistent, splitting apically, lepidote; peduncular bract ca. 68 × 0.8–1.8 cm, inserted one third to halfway along the peduncle from its base, persistent, splitting apically to one side, lepidote; peduncle 102–110 × 2.5–4 cm, ferruginous-lepidote; first-order branches 9–13, to 28 cm long, inserted 1–4 cm apart, with up to 14 rachillae, subtended by inconspicuous rachis bracts, indumentum as peduncle; rachillae to 17 cm long, 1–2 mm in diam.; triads inserted 2–6 mm apart. **Staminate flower** 1.1–1.5 × 1.5–2 mm pre-anthesis (when dry); sepals 3, ca. 1 × 1.3–1.5 mm, imbricate, glabrous; petals 3, 1.1–1.5 × 1.1–1.3 mm, valvate; stamens 6; filaments 0.5–0.6 mm long, linear; anthers 0.5–0.8 × 0.1–0.3 mm, medifixed; pistillode ca. 0.5–0.6 × 0.3 mm, columnar. **Pistillate flower** 1.5 × 2.2 mm near anthesis (when dry); sepals 3, 1.3 × 2, imbricate, glabrous; petals 3, ca. 1.5 × 1.5 mm, imbricate; staminodes 2–6, minute; ovary ca. 1 × 0.3 mm, columnar, stigma inconspicuous. **Fruit** ca. 20 × 9 mm (when dry), ellipsoid, with 6 or 7 highly distinct longitudinal ridges running from the apex to the base (may be less conspicuous when fresh), red when ripe; stigmatic remains eccentrically apical. **Seed** ca. 13.5 × 7 mm (when dry), elongate, conforming to contours of endocarp; endosperm ruminant.

Distribution:—Known only from the type locality on Supiori Island in the Biak Islands archipelago.

Habitat:—Secondary lowland rainforest on limestone, ca. 30 m.

Uses:—The stem is used for making bows and the fruit is used as a betel nut substitute.

Vernacular names:—None recorded.

Conservation status:—Data Deficient (DD; Baker & Heatubun 2012).

Specimens examined:—INDONESIA. **Papua Province:** Biak Islands, Supiori Island, North Supiori Nature Reserve, Fanjur Village, 30 m, 0°41'S, 135°39'E, 12 June 2001, *Maturbongs RAM 680* (AAU!, BO, CANB, K!, LAE, MAN).

Notes:—Occurring well beyond the ranges of other members of *Heterospathe* in New Guinea, *H. porcata* is the only species of the genus known from the Biak Islands archipelago. This slender palm has inflorescences branched to 2 or 3 orders, a peduncular bract inserted in the proximal half of the peduncle and, most strikingly, fruit with six or seven parallel, fibrous ridges spanning its full length. These ridges are highly distinctive and conspicuous when dry and arise as the outer pericarp shrinks around the fibrous ribs of the bony endocarp. Such fruit is most similar to that found in *H. longipes* from Fiji although that species has a much more ornate endocarp (Baker & Heatubun 2012).



FIGURE 12. *Heterospathe porcata*. A. Leaf apex. B. Mid-leaf portion. C. Inflorescence in two halves. D. Portion of rachilla with flowers. E. Portion of rachilla with pistillate flowers in late development. F. Staminate flower whole and in longitudinal section. G. Pistillate flower in longitudinal section. H. Fruit in two views. Scale bar: A–C = 8 cm; D–E = 7 mm; F = 2 mm; G = 3 mm; H = 1 cm. All from *Maturbongs RAM 680*. Drawn by Lucy T. Smith.

7. *Heterospathe pullenii* Trudgen & Baker (2008: 645). Type:—PAPUA NEW GUINEA. Central Province: Nunumai, *Pullen 7640* (holotype K!, isotypes BH, CANB, L, LAE).

Figure 13 (line drawing).

Slender, solitary palm to 6 m tall. **Stem** ca. 2–4 cm in diam., internodes not seen. **Leaf** ca. 1.2–1.5 m long including petiole; sheath 15–20 cm long, with fibrous margins, ferruginous-lepidote, crownshaft absent; petiole 30–45 cm long, indumentum as sheath; rachis ca. 80–105 cm long, indumentum as sheath; leaflets 10–15 each side of rachis, arranged regularly, borne 2–3.5 cm apart, single-fold apart for the multi-fold basal and apical leaflets, linear, light to dark green, abaxially with ramenta scattered on basal portion of midrib and major veins; basal leaflet pair comprising 5–8 folds, acuminate at the tip; middle leaflet 36–50 × 1–1.5 cm, acuminate at the tip; apical leaflet pair comprising 5–7 folds, acute at the tip. **Inflorescence** 50–120 cm long including peduncle, interfoliar, branched to 1 or 2 orders; prophyll ca. 16–33 × 1–2 cm, persistent, splitting apically, dark purple-lepidote; entire peduncular bract not seen, attached in the distal third quarter of the peduncle, caducous, indumentum as prophyll; peduncle 30–77 × 0.3–0.8 cm, dark purple-lepidote; first-order branches 7–9, to 18–30 cm long, inserted 1–3.5 cm apart, with up to 5 rachillae, subtended by inconspicuous rachis bracts, indumentum as peduncle; rachillae to 25 cm long, 1–2.5 mm in diam.; triads inserted 2–8 mm apart. **Staminate flower** ca. 2.5 × 2.3 mm pre-anthesis (when dry), green; sepals 3, ca. 1.5 × 2 mm, imbricate, glabrous; petals 3, ca. 2.5 × 1.5 mm, valvate; stamens 6; filaments ca. 1.5 mm long, linear; anthers ca. 1.5 × 0.2–0.6 mm, medifixed; pistillode ca. 1.5 × 0.4, columnar. **Pistillate flower** ca. 2.2 × 2.2 mm near anthesis (when dry), green; sepals 3, ca. 1 × 2.5 mm, imbricate, glabrous; petals 3, ca. 2 × 2 mm, imbricate; staminodes 3–5, minute; ovary ca. 1.5 × 0.5 mm, obovoid, stigma inconspicuous. **Fruit** ca. 18 × 10 mm (when dry), broadly ellipsoid, red when ripe; stigmatic remains eccentrically apical. **Seed** ca. 9 × 5.5 mm (when dry), elongate; endosperm condition unknown.

Distribution:—South-eastern portion of Central Province, Papua New Guinea.

Habitat:—Lowland rainforest, 10–130 m.

Uses:—None recorded.

Vernacular names:—*Saz* (Amele), but this name may apply to a different palm (Trudgen & Baker 2008).

Conservation status:—Endangered (EN; Trudgen & Baker 2008).

Specimens examined:—PAPUA NEW GUINEA. **Central Province:** Nunumai, ca. 12 km N of Amazon Bay, 30 m, 10°11'S, 149°23'E, 19 June 1969, *Pullen 7640* (BH, CANB, K!, L, LAE); Nunumai, 12 km N of Amazon Bay, 90 m, 10°11'S, 149°23'E, 13 June 1969, *Pullen 7568* (CANB!, LAE); Abau Subdistr., Minari logging area, 10 m, 10°10'S, 148°40'E, 9 July 1974, *Katik LAE 62145* (LAE!); Same locality as preceding, 10 m, 10°10'S, 148°40'E, 9 July 1974, *Katik LAE 62147* (BH!, L!, LAE); Abau Subdistr., Yano Logging area, Mori River Block, 130 m, 9°55'S, 148°25'E, 2 June 1977, *Wiakabu LAE 70460* (BH!, LAE!); Mori River, ca. 15 km NE of Cape Rodney, 20 m, 10°4'S, 148°32'E, 27 August 1969, *Pullen 8116* (CANB!, LAE).

Notes:—*Hydriastele pullenii* is a slender understory palm distinguished by its leaves with 10–15 leaflets on each side of the rachis, all single-fold apart from the multi-fold basal and apical leaflet pairs, and green, glabrous flowers. This species most closely resembles *H. lepidota* in aspects of the leaf, flowers and the peduncular bract, which is inserted in the distal third quarter of the peduncle in both species, but *H. lepidota* differs in having 21–35 leaflets per side with the basal-most pair being single-fold, and yellowish flowers with more-or-less lepidote petals. *Heterospathe pullenii* can also be confused with *H. elegans* subsp. *elegans* but *H. elegans* has the peduncular bract inserted in the distal quarter of the peduncle, occurs at higher elevation, and has smaller fruit than *H. pullenii*.

6–20 Stamen Group

Additional characters: pistillode usually conical and shorter than the filaments.

8. *Heterospathe annectens* Moore (1969: 100). Type:—PAPUA NEW GUINEA. Milne Bay Province: Rossel Island, *Brass 28409* (holotype A, isotypes K!, L, LAE).

Figure 14 (line drawing). Figure 15 (map).

Slender, solitary palm to 12 m tall. **Stem** ca. 8 cm in diam., internodes not seen. **Leaf** ca. 1.15 m long including petiole; sheath ca. 35 cm long, ferruginous-lepidote, crownshaft absent; petiole ca. 54 cm long, not seen; rachis ca. 60 cm long, ferruginous- to greyish-lepidote; leaflets ca. 22–30 each side of rachis, arranged regularly, borne 3–6 cm apart, single-fold, linear, acuminate at their tips, ± dark green, abaxially with ramenta scattered on basal portion of midrib

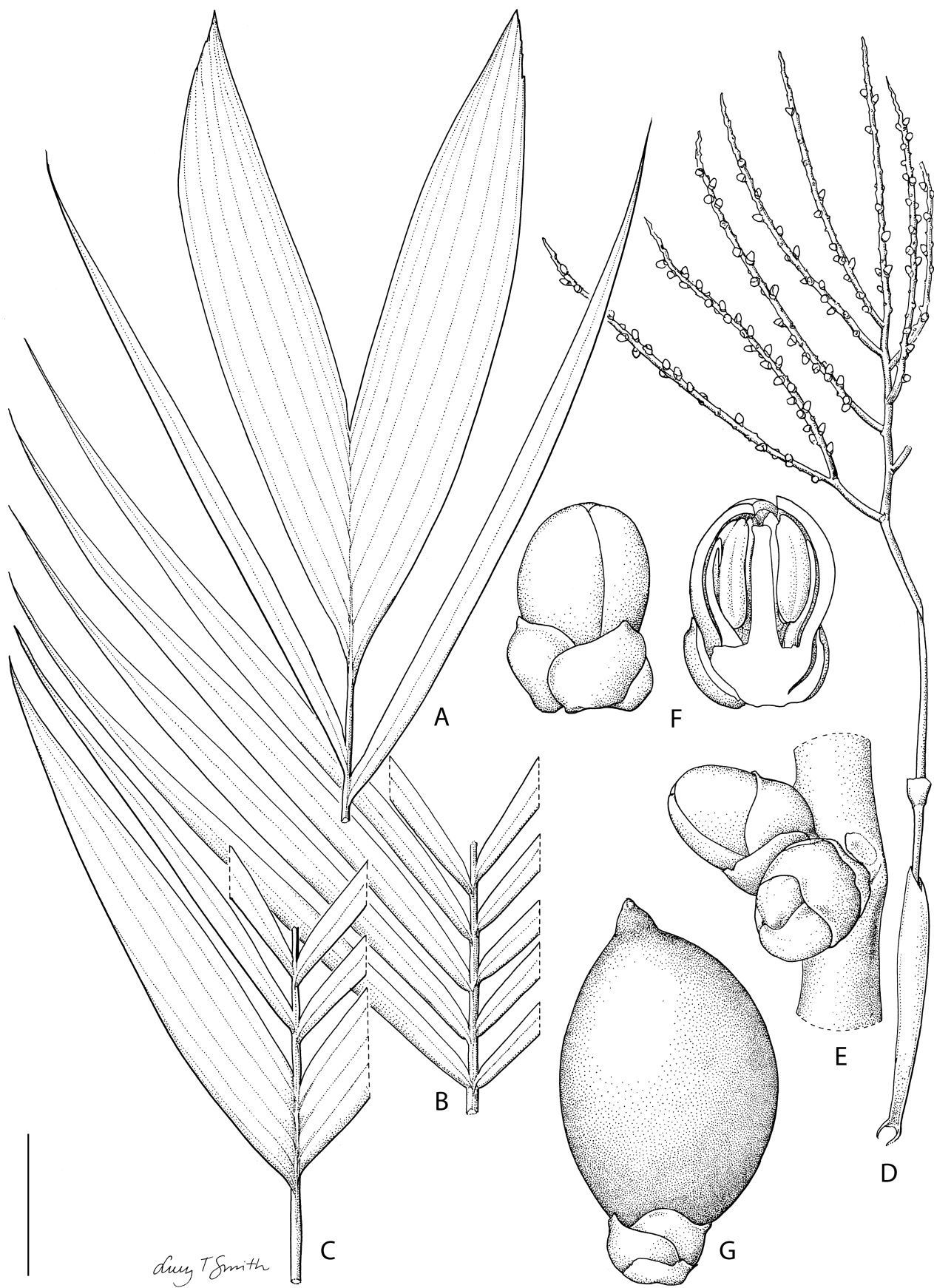


FIGURE 13. *Heterospathe pullenii*. A. Leaf apex. B. Mid-leaf portion. C. Leaf base. D. Inflorescence. E. Portion of inflorescence with triad (one staminate flower removed). F. Staminate flower whole and in longitudinal section. G. Fruit. Scale bar: A–C = 8 cm; D = 6 cm; E = 2.5 mm; F = 2 mm; G = 7 mm. A, D from Pullen 7640; B, C, G from Pullen 8116; E, F from Wiakabu LAE 70460. Drawn by Lucy T. Smith.



FIGURE 14. *Heterospathe annectens*. A. Leaf apex. B. Mid-leaf portion. C. Inflorescence. D. Infructescence. E. Staminate flower whole and in longitudinal section. F. Pistillate flower whole, two views, and in longitudinal section. G. Fruit whole and in longitudinal section. Scale bar: A–D = 6 cm; E = 5 mm; F = 4 mm; G = 1 cm. All from *Brass 28409*. Drawn by Lucy T. Smith.

and major veins; middle leaflet ca. 63×3.5 cm. **Inflorescence** 60–70 cm long including peduncle, interfoliar at least at emergence, branched to 1 order; prophyll $25\text{--}35 \times 2.5\text{--}3$ cm, becoming fibrous with age, ferruginous-lepidote; peduncular bract ca. $30\text{--}57 \times 2.5\text{--}3.5$ cm, attached in proximal half of peduncle, splitting longitudinally, becoming fibrous with age, indumentum \pm as prophyll; peduncle ca. $32\text{--}37 \times 0.35\text{--}1$ cm, indumentum \pm as prophyll; first-order branches 2–3, undivided, to ca. 34 cm long, inserted ca. 2 cm apart, subtended by inconspicuous rachis bracts, \pm glabrous; rachillae to 28 cm long, 3–4 mm in diam.; triads inserted 3–12 mm apart. **Staminate flower** ca. 6×4.5 mm pre-anthesis (when dry), cream; sepals 3, ca. $3 \times 4\text{--}5$ mm, imbricate, glabrous; petals 3, ca. 6×4 mm, valvate; stamens ca. 16; filaments 4 mm long, linear; anthers ca. $3 \times 0.5\text{--}1$ mm, medifixed; pistillode ca. 2×1.5 mm, conical. **Pistillate flower** ca. 4×4 mm near anthesis (when dry), cream; sepals 3, ca. 3×5 mm, imbricate, glabrous; petals 3, $3\text{--}3.5 \times 4\text{--}5$ mm, imbricate; staminodes ca. 4, minute; ovary ca. 3×1.2 mm, ovoid, stigma inconspicuous. **Fruit** ca. 18.5×12.5 (when dry and not completely mature), broadly ellipsoid, red when ripe; stigmatic remains subapical. **Seed** ca. 10×10 mm (when dry), globose; endosperm ruminant.

Distribution:—Known only from Rossel Island in Milne Bay Province, Papua New Guinea.

Habitat:—Hill forest, 700 m.

Uses:—None recorded.

Vernacular names:—None recorded.

Conservation status:—Data deficient (DD). More data are needed about the range and abundance of this species.

Specimens examined:—PAPUA NEW GUINEA. **Milne Bay Province:** Rossel Island, Mt Rossel, 700 m, $11^{\circ}22'S$, $154^{\circ}14'E$, 14 October 1956, *Brass 28409* (A, K!, L, LAE); Rossel Island, Mt. Rossel, 700 m, $11^{\circ}20'S$, $154^{\circ}10'E$, 16 March 1979, *Katik LAE 70921* (BRI, CANB!, L, LAE, USF).

Notes:—*Heterospathe annectens* is a moderately slender tree palm immediately recognisable on account of its short inflorescences with one order of branching. Other species in New Guinea and adjacent islands with the same order of inflorescence branching are either acaulescent or more slender. *Heterospathe annectens* is also distinguished by its relatively large flowers, an androecium consisting of many stamens and relatively large fruit.

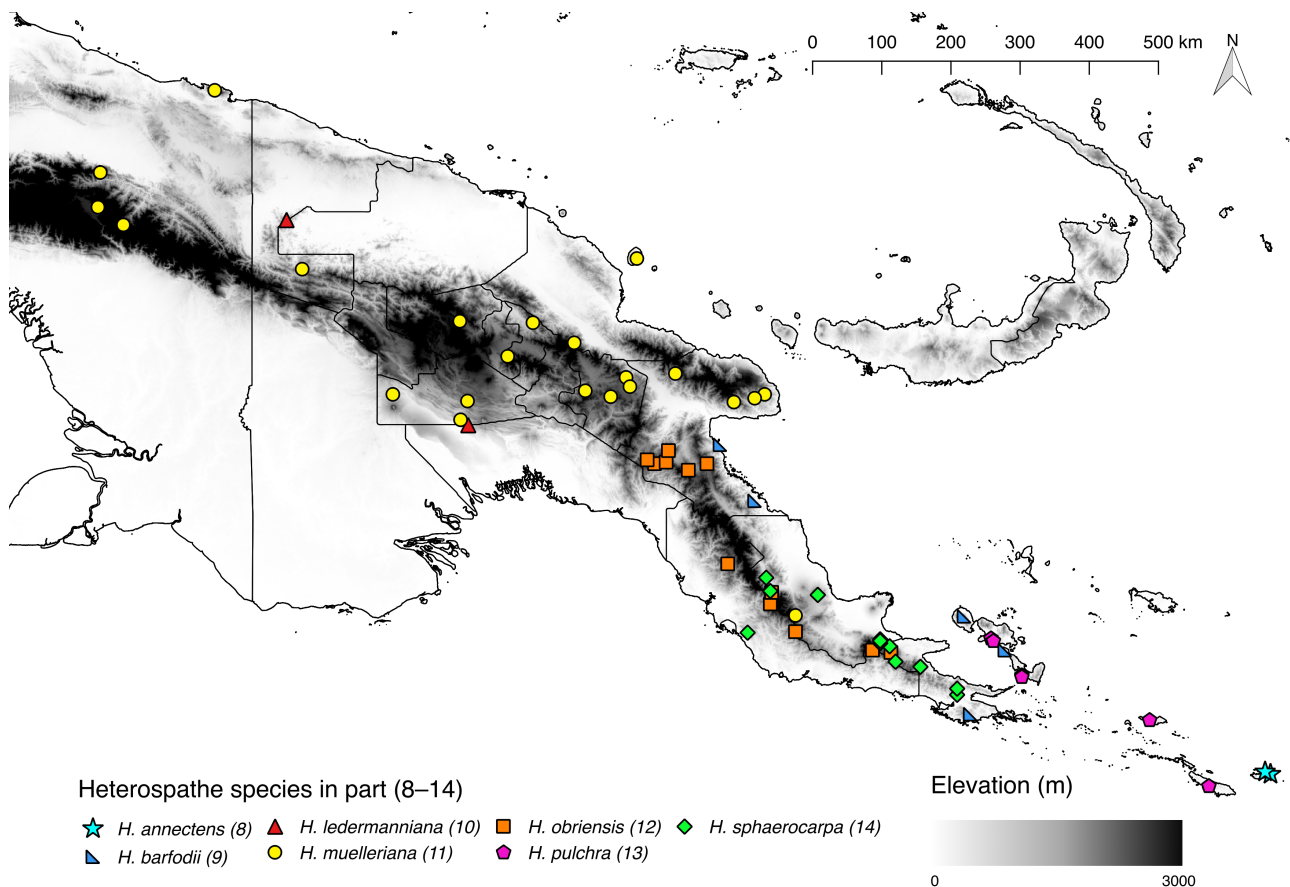


FIGURE 15. Distribution map of the species of *Heterospathe* in part.

9. *Heterospathe barfodii* L.M.Gardiner & W.J.Baker in Gardiner *et al.* (2012: 96). Type:—PAPUA NEW GUINEA. Milne Bay Province, *Barfod et al.* 4539 (holotype K!, isotypes AAU!, BRI, CANB, LAE).

Figure 16 (line drawing). Figure 17 (photo plate).

Slender to moderately robust, solitary palm to 15 m tall, bearing 7–8 leaves in crown. **Stem** 6–15 cm in diam.; internodes 3–4 cm long near the top where nodal scars prominent. **Leaf** 2.5–4 m long including petiole; sheath 50–67 cm long, green, ferrugineous-lepidote, glaucous, crownshaft distinct, 50–100 cm long; petiole 20–100 cm long, sparsely ferrugineous-lepidote or glabrous; rachis 2.4–2.8 m long, indumentum as petiole; leaflets (38–)48–56 each side of rachis, arranged regularly, borne 2–5 cm apart, single-fold, \pm linear, acuminate to acute at their tips, without prominent venation, mid green to dark green, abaxially with ramenta scattered on basal portion of midrib and major veins; middle leaflet 50–75 \times 3.5–5 cm. **Inflorescence** 75–150 cm long including peduncle, infrafoliar, branched to (2–)3 orders, with purple axes in bud; prophyll 28–34 \times 5–7 cm, persistent, splitting apically, ferrugineous-lepidote, glaucous; peduncular bract ca. 55 cm long, inserted in proximal half of peduncle, caducous, indumentum not seen; peduncle 27–50 cm long, ferrugineous-lepidote becoming \pm glabrous with age; first-order branches 18, to 43 cm long, inserted 2–4 cm apart, with up to 18 rachillae, subtended by inconspicuous rachis bracts, indumentum as peduncle; rachillae to 24–30 cm long, 2–3.5 mm in diam.; triads inserted 2–3 mm apart. **Staminate flower** ca. 4 \times 3 mm pre-anthesis, purple; sepals 3, ca. 1.5 \times 1.5 mm, imbricate, glabrous; petals 3, ca. 4 \times 2 mm, valvate; stamens 6–9; filaments ca. 2 mm long, linear; anthers ca. 1.5 \times 0.3–0.8 mm, medifixed; pistillode ca. 1 \times 0.5 mm, conical to \pm columnar. **Pistillate flower** ca. 2.5 \times 3 mm near anthesis, purple; sepals 3, ca. 1.5 \times 3 mm, imbricate, glabrous; petals 3, ca. 2 \times 3 mm, imbricate; staminodes 3–4, minute; ovary ca. 2 \times 1 mm, ellipsoid, stigma inconspicuous. **Fruit** 7–10 \times 7–9 mm, subglobose to globose, red when ripe; stigmatic remains subapical. **Seed** ca. 8 \times 7 mm, broadly ellipsoid; endosperm ruminant.

Distribution:—South-eastern Papua New Guinea including the D'Entrecasteaux Islands.

Habitat:—Lowland to premontane forest, 0–950 m.

Uses:—None recorded.

Vernacular names:—*Vekiniya* (Labania), *Zagi* (language unknown, SE Morobe Province, PNG).

Conservation status:—Least Concern (LC). This species appears to be relatively widely distributed (EOO is ca. 32,300 km²; Bachman *et al.* [2011]) based on 5 known localities or locations (AOO is 20 km²). With these figures likely to increase as a result of future botanical surveys, this species is not currently assessed as threatened.

Specimens examined:—PAPUA NEW GUINEA. **Milne Bay Province:** Along the Kabawawa highway, 0 m, 10°35'S, 150°20'E, 1 March 2000, *Barfod* 453 (AAU!, BRI, CANB, K!, LAE); Esa'ala District, Goodenough Island, track from Kalimatatubutu to Summit, 950 m, 9°19'S, 150°15'E, 19 December 1977, *Croft LAE 71227* (BH!, BRI, L!, LAE, UPNG); Esa'ala District, Normanby Island, W of Esa'ala, Mt. Solomonai, 700 m, 9°45'S, 150°47'E, 26 November 1976, *Croft LAE 68949* (BH!, BRI!, L, LAE!); **Morobe Province:** Lae Subdistr., Mountain slope, S side of Mo River in valley a few miles SE of Ana Village, 150 m, 7°49'S, 147°32'E, 28 January 1972, *Essig LAE 55162* (LAE!); Bulili Ridge, near Lababia Guesthouse, 50 m, 7°5'S, 147°5'E, 6 April 2000, *Kjaer 513* (AAU!, BRI!, CANB, K!). CULTIVATED. UNITED STATES. **Hawaiian Islands:** Hawai'i, Floribunda Palms, 5 June 2009, *Marcus 1* (K!).

Notes:—*Heterospathe barfodii* is immediately recognisable on account of its well-defined, usually glaucous, crownshaft.

Our study has revealed that *H. barfodii* is more widely distributed than previously thought. We have identified further localities in Morobe Province and the D'Entrecasteaux Islands of Milne Bay Province.

10. *Heterospathe ledermanniana* Beccari (1923: 451). Type:—PAPUA NEW GUINEA. East Sepik Province: Felsspitze [Rocky Peak], *Ledermann 12606a* (holotype B⁺). Neotype (designated here):—PAPUA NEW GUINEA. Southern Highlands Province: Erave District, *Baker et al.* 1115 (K!, isoneotypes AAU!, BRI, LAE, NY).

Figure 18 (line drawing). Figure 19 (photo plate).

Slender, solitary palm to 10 m tall, bearing 7–9 leaves in crown. **Stem** 6.5–7 cm in diam.; internodes ca. 3–4 cm long. **Leaf** 1.7–2.5 m long including petiole; sheath ca. 30 cm long, with fibrous margins and \pm powdery ferrugineous-whitish indumentum, crownshaft absent; petiole 29–37 cm long, ferrugineous- to greyish-lepidote; rachis 1.4–2.1 m long, indumentum as petiole; leaflets 41–44 each side of rachis, slightly drooping, arranged regularly,

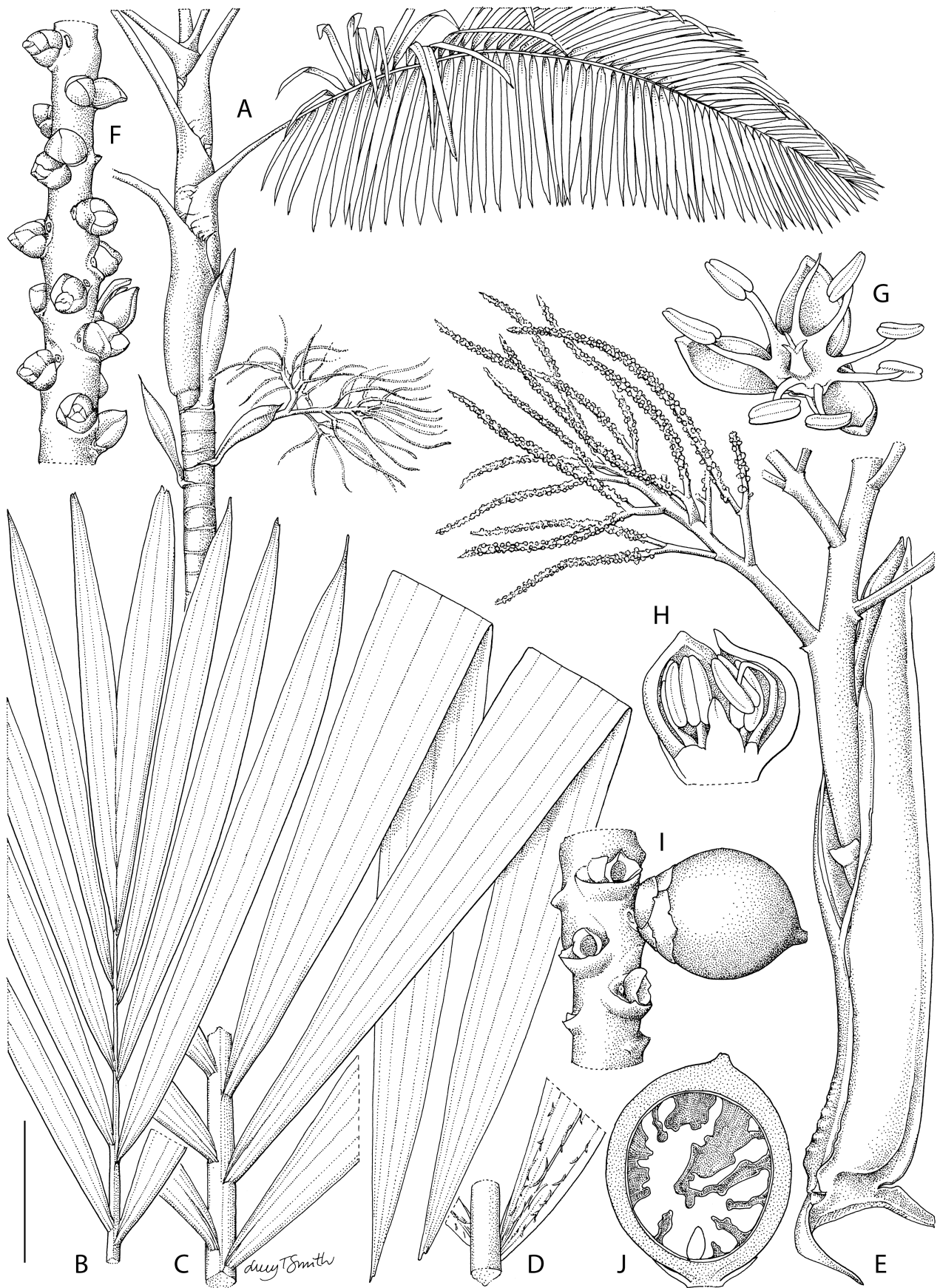


FIGURE 16. *Heterospathe barfordii*. A. Crownshaft with leaf and inflorescences. B. Leaf apex. C. Mid-leaf portion. D. Leaflet abaxial side with ramenta. E. Inflorescence basal half with prophyll. F. Portion of rachilla with flowers. G. Staminate flower open. H. Staminate flower in longitudinal section. I. Portion of rachilla with fruit. J. Fruit in longitudinal section. Scale bar: A = 50 cm; B–E = 8 cm; F, I = 1 cm; G = 5 mm; H = 3 mm; J = 7 mm. All from *Marcus 1*. Drawn by Lucy T. Smith.



FIGURE 17. *Heterospathe barfodii*. A–C. Crown with inflorescences at various stages of development. D. Portion of inflorescence with staminate flower at anthesis. All from Floribunda Palms & Exotics, Hawaii. Photo A: W.J. Baker; Photos B, D: John Dransfield; Photo C: Jeff Marcus.



FIGURE 18. *Heterospathe ledermanniana*. A. Habit. B. Leaf apex. C. Mid-leaf portion. D. Inflorescence with prophyll and peduncular bract. E. Infructescence basal side-branch. F. Portion of rachilla with flowers. G–H. Staminate flower whole and in longitudinal section. I. Pistillate flower whole and in longitudinal section. J. Fruit whole and in longitudinal section. Scale bar: A = 110 cm; B–C = 6 cm; D–E = 8 cm; F = 7 mm; G–I = 3.3 mm; J = 1 cm. All from Baker *et al.* 1115. Drawn by Lucy T. Smith.



FIGURE 19. *Heterospathe ledermanniana*. A. Habit. B. Crown. C–D. Inflorescence at two stages of development. All from *Baker et al. 1115*. All photos: W.J. Baker.

borne 2–3 cm apart, single-fold but the apical leaflets may be 2-fold, linear, acuminate at their tips, abaxially with ramenta scattered on basal portion of midrib and major veins; middle leaflet 45–60 × 2–4 cm. **Inflorescence** ca. 100 cm long including peduncle, interfoliar at least at emergence, branched to 2 or 3 orders, with pink axes; prophyll ca. 35 × 4–5 cm, becoming fibrous with age, splitting apically, lepidote becoming glabrous; peduncular bract ca. 65–75 × 5 cm, attached in proximal half of peduncle, becoming fibrous with age, splitting longitudinally, indumentum as prophyll or with powdery greyish- to ferruginous-lepidote indumentum; peduncle 40–50 cm long, ± greyish- to ferruginous-lepidote; first-order branches 18–23, to 45 cm long, inserted 1–4 cm apart, with up to 33 rachillae, subtended by 2–6 cm long rachis bracts or rachis bracts inconspicuous, indumentum as peduncle; rachillae to ca. 20 cm long, 1–3 mm in diam., ± sinuous at their tips; triads inserted 2–5 mm apart. **Staminate flower** 3.5–4 × 2–3 mm pre-anthesis, pink; sepals 3, 1–1.5 × 1.2–1.5 mm, imbricate, glabrous; petals 3, 3–4 × 2–2.5 mm, valvate; stamens 6; filaments 1.2–1.5 mm long, linear; anthers ca. 2 × 0.5–1 mm, medifixed; pistillode ca. 1 × 0.2–0.3 mm, ± columnar. **Pistillate flower** ca. 3 × 2.5–3 mm near anthesis, pink; sepals 3, ca. 1.5–2 × 3–3.5 mm, imbricate, glabrous; petals 3, ca. 2–2.5 × 3 mm, imbricate; staminodes ca. 4, minute; ovary ca. 2 × 1.5 mm, broadly ellipsoid, stigma inconspicuous. **Fruit** ca. 15 × 11 mm, subglobose, red when ripe; stigmatic remains subapical. **Seed** ca. 10 × 9 mm, subglobose; endosperm ruminant.

Distribution:—Sandaun and Southern Highlands Provinces, Papua New Guinea.

Habitat:—Montane forest on limestone karst, 1000–1400 m.

Uses:—None recorded.

Vernacular names:—None recorded.

Conservation status:—Data deficient (DD). More data are needed about the range and abundance of this species.

Specimens examined:—PAPUA NEW GUINEA. **Sandaun Province:** Felsspitze [Rocky Peak], 1400 m, 4°10'S, 141°27'E, 1913, *Ledermann 12606a* (B†); **Southern Highlands Province:** Erave District, Road to SE Gobe oil rig, 80 km NW of Kikori, 1000 m, 6°50'S, 143°48'E, 26 November 2000, *Baker et al. 1115* (AAU!, BRI, K!, LAE, NY).

Notes:—*Heterospathe ledermanniana* is distinguished by its slender tree habit in combination with pink flowers, an androecium composed of six stamens and a more-or-less columnar pistillode shorter than the filaments. The species most closely resembles *H. muelleriana*, but that species is often more robust, has green to yellow (or rarely purple) flowers and an androecium consisting of 12–15 stamens.

Having examined the protologue of *H. ledermanniana* we are satisfied that the collection *Baker et al. 1115* belongs to that species and we therefore consequently designate it as a neotype to replace the holotype, which was destroyed in Berlin during the Second World War. Another collection, *Baker et al. 1142* resembles *H. ledermanniana* in most aspects, but is not included within that species here as its pistillate flowers were reported as “yellow-white”. This difference could be trivial in light of the broad floral colour variation observed in related species, e.g. *H. muelleriana*, but more data are needed in order to ascertain whether that is the case. In the phylogenetic tree constructed by Norup *et al.* (2006), *Baker et al. 1115* and *Baker et al. 1142* were resolved as sister taxa, but low bootstrap-support and restricted sampling limit the conclusions that can be drawn from this finding.

Based on staminate floral morphology *H. ledermanniana* might reasonably be placed in the 6 Stamen Group with its six stamens and somewhat columnar pistillode. However, here we place it in the 6–20 Stamen Group because it resembles members of that group in other characters, which are more useful for identification, such as leaf, inflorescence and fruit morphology. In addition, the pistillode of *H. ledermanniana* is pointed at the tip, which is common in the conical pistillodes of the 6–20 Stamen Group but more rarely seen in the 6 Stamen Group where the pistillode is often strictly columnar.

11. *Heterospathe muelleriana* (Becc.) Becc. in Martelli (1934: 139). *Ptychandra muelleriana* Beccari (1888: 177). Type:—PAPUA NEW GUINEA. Oro Province: Mt. Obree, *Sayer s.n.* (holotype FI!, isotype BH! (fragments), MEL!).

Ptychandra glabra Burret (1933: 713). *Heterospathe glabra* (Burret) Moore (1969: 102). Type:—INDONESIA. Papua Province: Cyclops Mts., *Mayr 611* (holotype B†, isotype BO!), *synon. nov.*

Ptychandra clemensiae Burret (1937: 468). *Heterospathe clemensiae* (Burret) Moore (1969: 101). Type:—PAPUA NEW GUINEA. Morobe Province: Yunzaing, *Clemens 3473* (Holotype B†), *synon. nov.*

Figure 20 (line drawing). Figure 21 (photo plate).

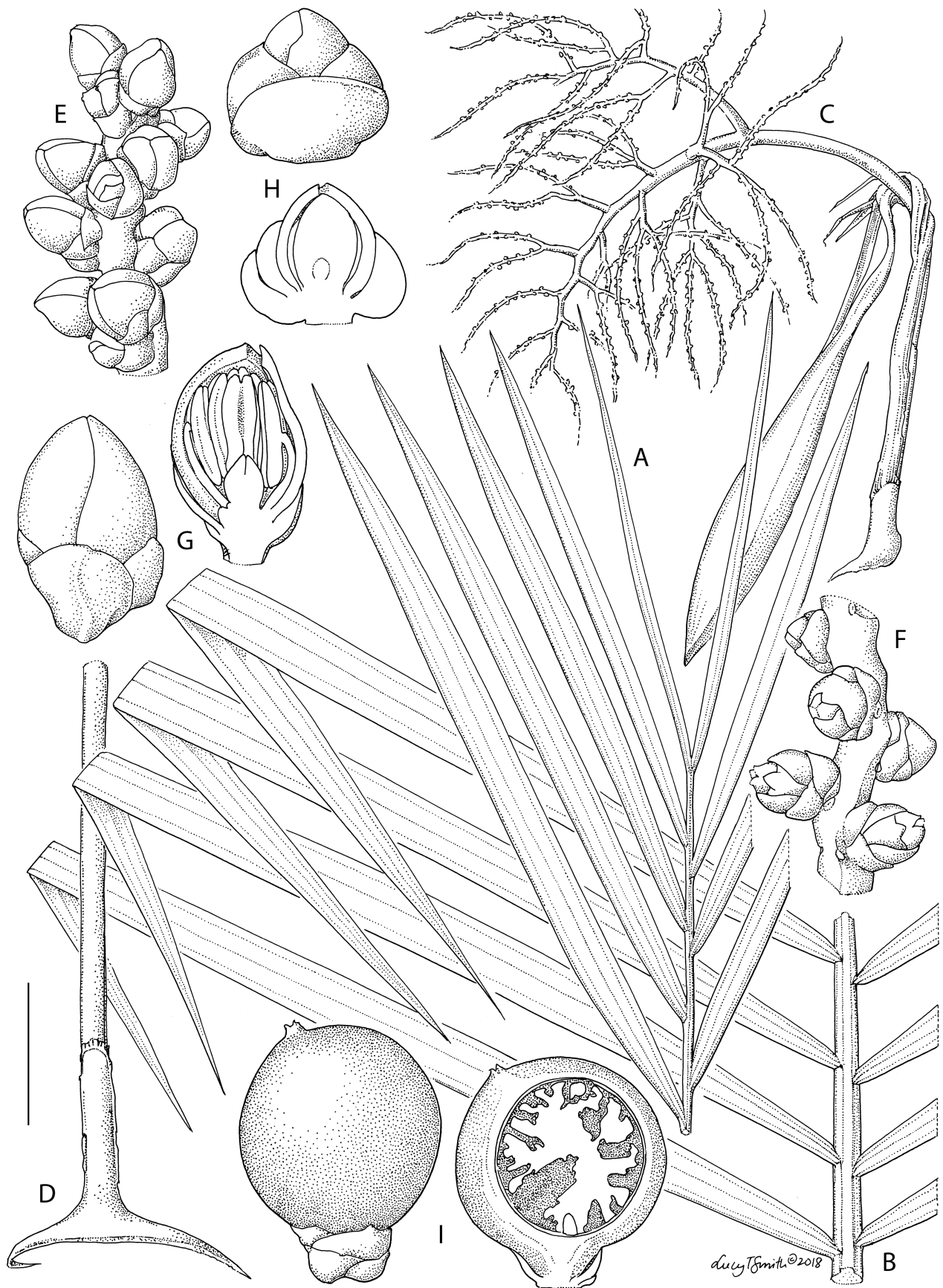


FIGURE 20. *Heterospathe muelleriana*. A. Leaf apex. B. Mid-leaf portion. C. Inflorescence. D. Inflorescence peduncle. E. Portion of rachilla with triads. F. Portion of rachilla with pistillate flowers in late development. G. Staminate flower whole and in longitudinal section. H. Pistillate flower whole and in longitudinal section. I. Fruit whole and in longitudinal section. Scale bar: A–B, D = 8 cm; C = 15 cm; E–F, I = 1 cm; G–H = 4 mm. All from *Banka* 2008. Drawn by Lucy T. Smith.

Slender to robust, solitary palm to 15 m tall, bearing ca. 10 leaves in crown. **Stem** 6–16(–20) cm in diam.; internodes ca. 3.5 cm long. **Leaf** (1.7–)2.3–4.1 m long including petiole; sheath 33–80 cm long, with fibrous margins, green to yellow, ferruginous-lepidote and ± glaucous, crownshaft absent; petiole (10–)25–70(–94) cm long, ferruginous- to whitish-lepidote; rachis 2–3.4 m long, indumentum as petiole; leaflets (40–)48–56 each side of rachis, slightly drooping, arranged regularly, borne 3–7.5 cm apart, single-fold but the apical leaflets may be multi-fold, linear, acuminate at their tips, without prominent venation, dark green adaxially, abaxially slightly paler green and with ramenta scattered on basal portion of midrib and major veins; middle leaflet (40–)55–95 × 2.5–5 cm; apical leaflet pair comprising 1–3 leaflets. **Inflorescence** 80–110 cm long including peduncle, interfoliar becoming infrafoliar with age, branched to 2 or 3 orders; prophyll ca. 33 × 2–2.5 cm, becoming fibrous with age, splitting apically, ferruginous-lepidote; peduncular bract 45–100 × 3–5 cm, attached in proximal half of peduncle, becoming fibrous with age, splitting longitudinally, indumentum as prophyll; peduncle 40–71 × 0.8–1.5 cm, indumentum as prophyll or ± glabrous; first-order branches 15–21, to 35 cm long, inserted 1–4 cm apart, ± swollen at their bases, with up to 14 rachillae, subtended by inconspicuous rachis bracts, indumentum as peduncle; rachillae to 25–30 cm long, 2–3 mm in diam., ± sinuous at their tips; triads inserted 3–5 mm apart. **Staminate flower** ca. 5 × 4 mm pre-anthesis, green to yellow or occasionally purple; sepals 3, ca. 2.5 × 3–5 mm, imbricate, glabrous; petals 3, ca. 5 × 3–4.5 mm, valvate; stamens 12–15; filaments ca. 2 mm long, linear; anthers ca. 3 × 1 mm, medifixed; pistillode ca. 1 × 1 mm, usually conical and half as long as filaments but occasionally as long as these. **Pistillate flower** ca. 3 × 4 mm near anthesis, green to yellow or occasionally purple; sepals 3, ca. 2 × 3.5 mm, imbricate, glabrous; petals 3, ca. 2 × 3 mm, imbricate; staminodes present, minute; ovary ca. 2 × 1.5 mm, broadly ellipsoid, stigma inconspicuous. **Fruit** (10–)11–15 × (10–)11–15 mm, globose, red when ripe; stigmatic remains subapical. **Seed** ca. 11 × 11 mm, globose; endosperm ruminant.

Distribution:—Widespread in the central New Guinea highlands, the Cyclops Mountains in western New Guinea, and the Huon Peninsula and Karkar Island in Papua New Guinea.

Habitat:—Primary or disturbed montane rainforest on slopes and ridges or in gullies, 1100–2300 m.

Uses:—Wood used for bows, arrow-heads and spears, fruit used as a betel nut substitute.

Vernacular names:—*Goomnandy* (language unknown, Chimbu Province, PNG), *Mgamba* (language unknown, Jiwaka Province, PNG), *Yawi* (Enga), *Yali* (Wirale), *Leveng* (Hube).

Conservation status:—Least Concern (LC). This species is widespread and frequently recorded (EOO is ca. 300,000 km², AOO is 84 km²; Bachman *et al.* [2011]).

Specimens examined:—INDONESIA. **Papua Province:** Cyclops Mts., 1100 m, August 1928, *Mayr 611* (B†, BO!); Jayawijaya Regency, Kurima Subdistr., Snow Mountains region, E of Baliem Valley, 1700 m, 4°14'S, 139°20'E, October 1992, *Milliken 1339* (K!); Baliem Valley, pass east of km 50 on Wamena - Passvalley road/path, 2250 m, 4°0'S, 139°0'E, 25 May 1991, *Burley 4653* (A, BO, F, K!); 15 km SW of Bernhard Camp, Idenburg river, 1800 m, 3°33'S, 139°2'E, January 1939, *Brass 12119* (A!, BRI!, L!); same locality as preceding, 1800 m, 3°33'S, 139°2'E, January 1939, *Brass 12139* (A!, L!). PAPUA NEW GUINEA. **Chimbu Province:** Kundiawa, Daman Nanga (Sino Pass), Plot 2200A, 30 October 2012, *Pintaud, J.-C. 670* (K!, LAE, P); **Eastern Highlands Province:** ca. 5 miles NE of Okapa, T.N.G., 1500 m, 6°28'S, 145°40'E, 24 September 1964, *Hartley TGH 13084* (A, CANB!, L, LAE); Gusap side of range, ca. 6 miles N of Kainantu, 1700 m, 6°13'S, 145°52'E, 5 October 1957, *Pullen 686* (A, CANB!, L, LAE); Kainantu Subdistr., a few miles S of Aiyura, Norikori swamp, Pantura, 1600 m, 6°20'S, 145°55'E, 18 January 1972, *Essig LAE 55144* (BH, LAE!); Mt. Michael, NE slopes, 2000 m, 6°23'S, 145°20'E, 9 September 1959, *Brass 31484* (A, K!, L, LAE); **Enga Province:** 1.5 miles N of Lutheran mission saw-mill at Pockenamanda, near Wabag, 2300 m, 2 February 1965, *Flenley ANU 2457* (A, CANB, K!, L, LAE); **Jiwaka Province:** Jimi Subdistr., Kompiai, 1800 m, 5°30'S, 144°39'E, 7 October 1970, *Clarke ANU 9603* (LAE!); **Madang Province:** Kar Kar Island, crater rim, 11500 m, 4°40'S, 146°0'E, 10 June 1969, *Vandenberg NGF 42197* (BH, LAE!); **Morobe Province:** Yunzaing [Yunzain], Hügelwald, 18 June 1936, *Clemens 3473* (B†); Yunzaing [Yunzain], 1350 m, 20 June 1937, *Clemens 6566* (A!); Ogeramngang, 1850 m, 24 February 1937, *Clemens 5478* (A!); Finschhafen Distr., Banario Mountain, near Nanduo village, 28 km NW of Finschhafen, 1200 m, 6°25'S, 147°40'E, 6 December 2000, *Banka 2008* (AAU!, K!, LAE, NY); Huon Peninsula, E slope of Mt. Rawlinson, ridge between Gang Creek and Bulum River, 1450 m, 6°32'S, 147°16'E, 13 June 1964, *Hoogland 9159* (CANB!, LAE, US); Pindiu Subdistr., E of Moragoc Village, Bonzuru Ridge, 2200 m, 6°29'S, 147°32'E, 7 October 1977, *Vinas LAE 59894* (BH!, BRI!, L!, LAE, UPNG, USF); Wantoat Subprov., Mt. Buruman, 1800 m, 6°10'S, 146°30'E, 28 May 1980, *Kerenga LAE 77580* (L!, LAE, USF); **Oro Province:** Mt. Obree, 2000 m, 9°31'S, 148°4'E, 1887, *Sayer s.n.* (BH!, FI!, MEL!); **Sandaun Province:** Telefomin Distr., Mt. Stolle, Mekil Research Station, 4°48.29'S, 141°39.15'E, 11 December 1997, *Salas & Stephens KP195* (A!); **Southern Highlands Province:** Erave Distr., ridge near road to Gobe oil rigs, 93 km NW of Kikori, 1250 m, 6°45'S, 143°43'E, 27 November 2000, *Baker et al. 1118* (AAU!, K!, LAE, NY); Batteri, Erave-Kagua Road, Fara range, 13 km NW of Erave, 1800 m,

9 September 1982, *Streimann 8539* (L!, LAE, USF); Mt. Bosavi, N side, 1600 m, 6°26'S, 142°50'E, 27 September 1973, *Jacobs 8840* (L!); **Western Highlands Province**: near Wankl Village on mountain slope ca. 5 km SE of Mt. Hagen station, 2000 m, 5°56'S, 144°19'E, 18 August 1956, *Hoogland 5957* (CANB!); unknown locality, 1900 m, 18 December 1967, *Manner 422* (L!).

Notes:—*Heterospathe muelleriana* is a widespread and variable species with a moderately slender to robust stem. It is distinguished by its green to yellow staminate flowers with 12 to 15 stamens, and globose fruit measuring 10 to 15 mm in diameter. The species is most similar to *H. obriensis* and *H. ledermanniana*, but the former species is often more robust, has larger staminate flowers with 19–20 stamens and fruit measuring 29–35 cm in length, while the latter is often more slender and has pink staminate flowers with only six stamens.

We interpret the collection *Baker et al. 1118* (Fig. 21B) as belonging to *H. muelleriana* even if this collection diverges somewhat in the purple flowers on green axes and rather small infructescences and fruit. Another collection, *Brass 24839* (CANB), resembles *H. muelleriana* closely in the fruit although we have chosen not to include it here because it occurs well away from other known records of *H. muelleriana* (Goodenough Island), and differs substantially in the somewhat large and elongate purple flowers on purple axes and the rather short peduncle measuring only 30 cm in length. This collection could represent a new species, but there is inadequate material to determine it as such.

Having examined the type material and the protologue of *H. glabra* and the protologue of *H. clemensiae* we are satisfied that both species fall within the range of variation of *H. muelleriana* and they are consequently placed in synonymy here.



FIGURE 21. *Heterospathe muelleriana*. A. Inflorescence. B. Infructescence. A from *Banka 2008*; B from *Baker et al. 1118*. All photos: W.J. Baker.

12. *Heterospathe obriensis* (Becc.) Moore (1969: 104). *Ptychandra obriensis* Beccari (1888: 178). Type:—PAPUA NEW GUINEA. Oro Province: Mt. Obree, *Sayer s.n.* (holotype FI!, isotype BH! (fragments), MEL!)

Ptychandra montana Burret (1935: 324). Type:—PAPUA NEW GUINEA. Central Province: Mt. Tafa, *Brass 4974* (holotype B†, isotype A!, BO, BRI!, NY!).

Figure 22 (line drawing). Figure 23 (photo plate).

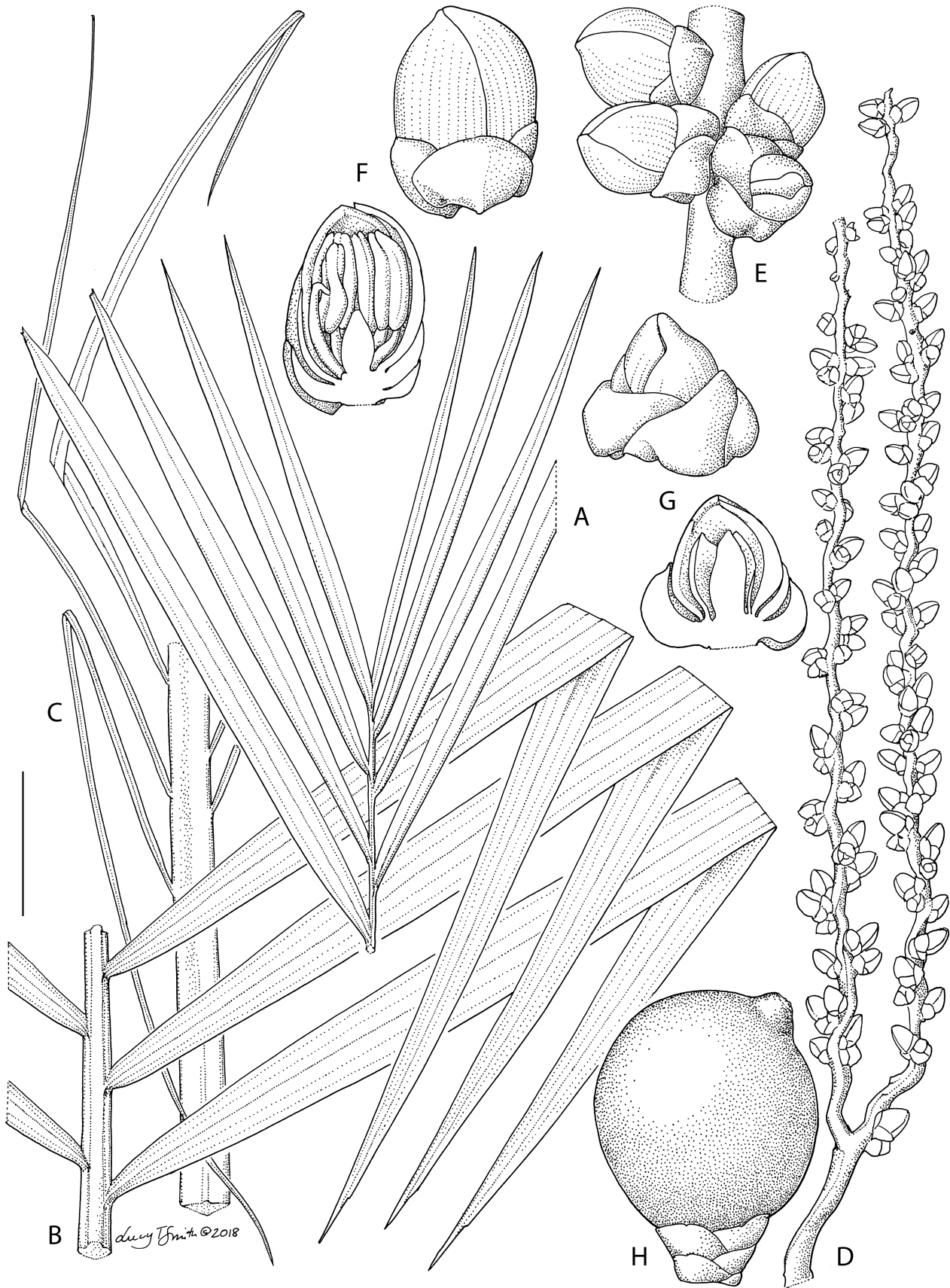


FIGURE 22. *Heterospathe obriensis*. A. Leaf apex. B. Mid-leaf portion. C. Leaf base. D. Portion of inflorescence with two rachillae. E. Portion of rachilla with flowers (one complete triad depicted). F. Staminate flower whole and in longitudinal section. G. Pistillate flower whole and in longitudinal section. H. Fruit. Scale bar: A–C = 8 cm; D = 4 cm; E = 1 cm; F–G = 7 mm; H = 1.5 cm. A–C from *Baker et al. 1310*; D–G from *Brass 22940*; H from *Carr 16004*. Drawn by Lucy T. Smith.



FIGURE 23. *Heterospathe obriensis*. A. Habit. B. Leaf sheaths. C. Inflorescence with immature fruit. All from Baker *et al.* 1310. All photos: W.J. Baker.

Robust, solitary palm to 23 m tall, bearing ca. 9 leaves in crown. **Stem** 10–20 cm in diam., internodes ca. 2 cm long. **Leaf** 1.7–3.3 m long including petiole; sheath 20–70 cm long, with ± fibrous margins, greyish- to brownish-lepidote, crownshaft absent; petiole 10–40 cm long, indumentum as sheath; rachis ca. 1.5–3 m long, indumentum as sheath; leaflets 40–54 each side of rachis, arranged regularly, borne 4–7 cm apart, single-fold but the apical leaflets occasionally multi-fold, linear, acuminate at their tips, ± dark green adaxially, abaxially somewhat paler green and with ramenta scattered on basal portion of midrib and major veins; middle leaflet 60–75 × 2.5–4 cm; apical leaflet pair comprising 1–3 folds. **Inflorescence** 70–140 cm long including peduncle, interfoliar at least at emergence, branched to 2 or 3 orders; prophyll 33–65 × 3–5 cm, splitting apically, becoming fibrous with age, greyish- to brownish-lepidote; peduncular bract ca. 60–80 × 4 cm, attached in proximal half of peduncle, splitting longitudinally, becoming fibrous with age, indumentum as prophyll; peduncle 30–70 × 0.6–1.1 cm, ferruginous- to greyish-lepidote; first-order branches 9–13, to ca. 40 cm long, inserted 2–4.5 cm apart, with up to 7 rachillae, subtended by inconspicuous rachis bracts, indumentum as peduncle; rachillae to 32–36 cm long, 2–3 mm in diam.; triads inserted 4–8 mm apart. **Staminate flower** 9–11 × 6–8 mm pre-anthesis (when dry), green or cream; sepals 3, ca. 5 × 6–9 mm, imbricate, glabrous; petals 3, 8–10 × 5–6 mm, valvate; stamens 19–20; filaments 5–6 mm long, linear; anthers 3.5–4.5 × 1–1.5 mm, medifixed; pistillode ca. 3 × 2–2.5 mm, conical. **Pistillate flower** 7–8 × 5.5–8.5 mm near anthesis (when dry), green or cream; sepals 3, 3–3.5 × 7–8 mm, imbricate, glabrous; petals 3, 6–7 × 7–8 mm, imbricate; staminodes ca. 10, small; ovary 4–5 × 2–2.5 mm, ellipsoid, stigma inconspicuous. **Fruit** 29–35 × 22–28 mm, subglobose, red when ripe; stigmatic remains subapical. **Seed** ca. 11 × 12 mm (when dry and very shrunken), subglobose; endosperm ruminant.

Distribution:—South-eastern Papua New Guinea.

Habitat:—Montane rainforest on slopes, ridges or swampy ground, 1500–2400 m.

Uses:—None recorded.

Vernacular names:—*Koge* (Montuan).

Conservation status:—Least Concern (LC). This species is relatively widespread and common (EOO is ca. 27,000 km², AOO is 48 km²; Bachman *et al.* [2011]).

Specimens examined:—PAPUA NEW GUINEA. **Central Province:** Mt. Tafa, 2400 m, 8°38'S, 147°11'E, 1933, *Brass 4974* (A!, B†, BO, BRI!, NY); Port Moresby Subdistr., E slope of Lake Myola No. 2, 1800 m, 9°9'S, 147°44'E, 14 September 1973, *Croft NGF 34609* (BH!, BRI!, L, LAE!); **Milne Bay Province:** Raba Raba Subdistr., Mt. Suckling, at Mayu II, 1750 m, 9°45'S, 149°4'E, 11 June 1972, *Stevens LAE 55774* (BH!, BRI, L); N slopes of Mt. Dayman, gorge of Upper Gwariu River, 2050 m, 9°47'S, 149°18'E, 15 June 1953, *Brass 22940* (A, CANB!, LAE!); **Morobe Province:** Menyama Subdistr., on Meyama road from Aseki near Oiwa Village, 1700 m, 7°20'S, 146°14'E, 8 January 1972, *Essig LAE 55139* (BH, LAE!); E slope of Spreader Divide, 6 miles NW of Aseki, 1850 m, 7°17'S, 146°8'E, 14 April 1966, *Schodde 4938* (A, CANB!, L, LAE!); Ekuti divide, Bulolo-Aseki road, 35 km WSW of Bulolo, 2200 m, 7°19'S, 146°23'E, 16 June 1982, *Streimann 8390* (L!, LAE!); near Bulolo, Hidden Valley, near Mt. Kaindi, close to Wau, 2200 m, 7°24'S, 146°40'E, 7 November 2006, *Baker et al. 1310* (AAU, K!, L, LAE!); Wau Subprov., road from Bulolo to Aseki, 1800 m, 7°10'S, 146°25'E, 21 May 1978, *Essig LAE 74106* (BH, LAE!, USF); Wau-Salamaua road, 1950 m, 7°20'S, 146°55'E, 8 February 1967, *Millar NGF 22788* (LAE!); **Oro Province:** Mt. Obree, 9°31'S, 148°4'E, 1887, *Sayer s.n.* (FI!, MEL!); Lala river, 1500 m, 7 March 1936, *Carr 16004* (A, B, BH, BM, BO, BRI, K!, L!, LAE!, PAR, PNH, SING); Lala river, 1500 m, 26 December 1935, *Carr 14023* (A, K!, L).

Notes:—*Heterospathe obriensis* is a robust tree palm immediately recognisable on account of its large pistillate flowers, the androecium with 19–20 stamens, and the large subglobose fruit measuring 29–35 mm in length. This species is most similar to *H. muelleriana*, but that species is often less robust (if not always), has smaller flowers, an androecium consisting of 12–15 stamens, and fruit measuring 11–15 mm in length.

13. *Heterospathe pulchra* Moore (1969: 104). Type:—PAPUA NEW GUINEA. Milne Bay Province: *Brass 27116* (holotype A, isotypes BH, K!, L, LAE!).

Figure 24 (line drawing).

Moderately robust, solitary palm to 25 m tall, bearing ca. 8–10 leaves in crown. **Stem** 10–15 cm in diam., internodes not seen. **Leaf** ca. 3–4 m long including petiole; sheath ca. 35 cm long, brown, membranous-lepidote, crownshaft absent; petiole ca. 55–110 cm long, lepidote or glabrous; rachis ca. 2.5–3 m long, glabrous; leaflets (40–)53–54 each side of rachis, arranged regularly, borne 3–5 cm apart, single-fold but the apical leaflets occasionally multi-fold, linear, narrowly acuminate at their tips, prominently veined, light green to dark green, abaxially with ramenta scattered on basal portion of midrib and major veins; middle leaflet 77–99 × 2.5–3 cm; apical leaflet pair comprising 1–3 folds.

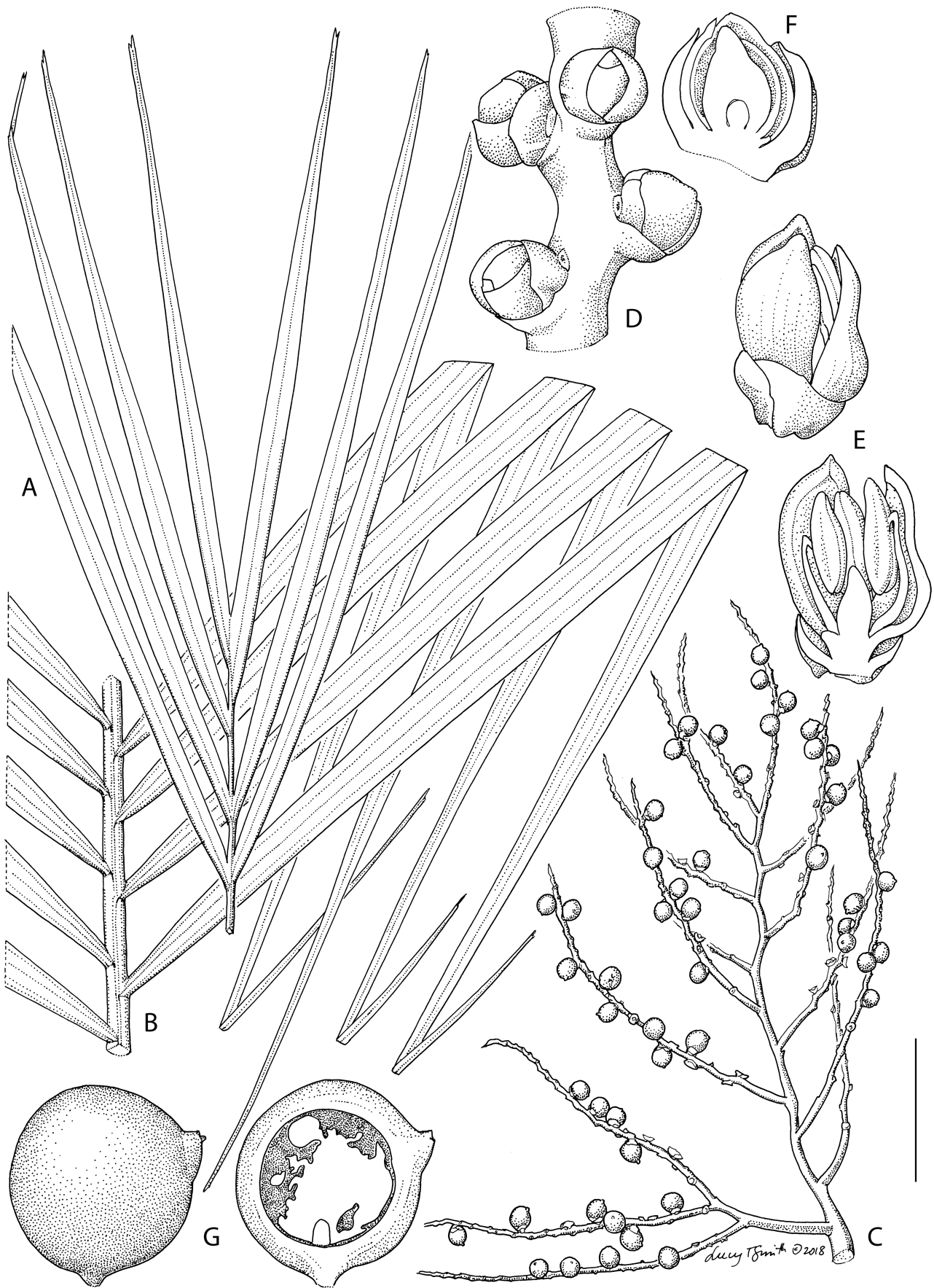


FIGURE 24. *Heterospathe pulchra*. A. Leaf apex. B. Mid-leaf portion. C. Portion of infructescence. D. Portion of rachilla with pistillate flowers. E. Staminate flower whole and in longitudinal section. F. Pistillate flower in longitudinal section. G. Fruit whole and in longitudinal section. Scale bar: A–B = 8 cm; C = 6 cm; D = 4 mm; E–F = 2 mm; G = 7 mm. All from *Brass 27116*. Drawn by Lucy T. Smith.

Inflorescence (53–)120–160 cm long including peduncle, interfoliar at least at emergence, branched to 2 or 3 orders; prophyll at least 18 cm long, persistent, splitting apically, ferruginous-lepidote; peduncular bract not seen, attached in proximal half of peduncle, caducous; peduncle (22–)40–84 cm long, lepidote or glabrous; rachis not seen; first-order branches to 37 cm long, with up to 22 rachillae, subtended by inconspicuous rachis bracts, glabrous; rachillae to 13–19 cm long, 1.5–2 mm in diam.; triads inserted 1–9 mm apart. **Staminate flower** 3.5–4 × 2–2.2 mm pre-anthesis (when dry), cream; sepals 3, 1.3–1.5 × 1.5–2 mm, imbricate, glabrous; petals 3, ca. 3–3.5 × 2 mm, valvate; stamens 6; filaments 1.3–1.5 mm long, linear; anthers ca. 2 × 0.3–0.5 mm, medifixed; pistillode ca. 1 × 0.3–0.5 mm, conical to ± columnar. **Pistillate flower** 2–2.5 × 2–2.1 mm near anthesis (when dry), cream; sepals 3, 1.2–2 × 1.5–2.8 mm, imbricate, glabrous; petals 3, 1.8–2.2 × 2–3 mm, imbricate; staminodes 4–5, minute; ovary ca. 1.3–2 × 0.2–0.5 mm, ellipsoid, stigma inconspicuous. **Fruit** 8–8.5 × 8–8.5 mm (when dry), globose, red when ripe; stigmatic remains subapical. **Seed** ca. 6 × 6 mm (when dry), globose; endosperm ruminant.

Distribution:—Islands of Milne Bay Province (Fergusson, Normanby, Misima and Sudest Islands), Papua New Guinea.

Habitat:—Lowland to premontane forest on slopes and ridge crests, 250–900 m.

Uses:—None recorded.

Vernacular names:—*Bihi Bihi* (language unknown, Fergusson Island, PNG).

Conservation status:—Vulnerable (VU). Although this species is relatively widely distributed (EOO is ca. 9,760 km²; Bachman *et al.* [2011]) this figure is calculated from only 6 island localities or locations (AOO is 24 km²). Although the species is likely to be discovered from new locations in the future due to present under-collecting, and was reported as common in two localities, Milne Bay Province suffered disproportionately high rates of forest degradation and deforestation from 1972–2002 (Shearman *et al.* 2008), which pose a threat to *H. pulchra*.

Specimens examined:—PAPUA NEW GUINEA. **Milne Bay Province:** Esa'ala Subprov., Fergusson Island, Morima Range above Ailuluai Village, 650 m, 9°38'S, 150°38'E, 26 June 1976, *Henty NGF 49870* (BH!, BRI!, L!, LAE!); Esa'ala Subdistr., Fergusson Island, Mts. between Agamoia and Ailuluai, 900 m, 9°36'S, 150°36'E, 12 March 1930, *Brass 27116* (A, BH, K!, L, LAE!); Esa'ala Distr., Normanby Island, Mt. Pabinama, 850 m, 10°5'S, 151°0'E, 5 May 1956, *Brass 25734* (A, K!, L, LAE!); Esa'ala Subprov., Normanby Island, NE of Bwasiaiai, 450 m, 10°6'S, 151°0'E, 4 December 1977, *Croft LAE 71176* (BH, BRI!, L!, LAE!); Misima Subdistr., Misima Island, mountain track from Bwagabwaga, 250 m, 10°40'S, 152°40'E, 27 October 1971, *Essig LAE 55068* (BH, LAE!); Misima Subprov., Sudest Island, SW slopes of Mt. Riu, 750 m, 11°31'S, 153°26'E, 12 March 1979, *Croft LAE 71312* (A!, BO, E, K!, L, LAE, US, USF).

Notes:—*Heterospatha pulchra* is a moderately robust tree palm distinguished by its leaves with narrowly acuminate and prominently veined leaflets, short rachillae (as long as 19 cm), cream-coloured staminate flowers with six stamens, and small fruit. The most similar species are *H. muelleriana* and *H. barfodii*, but they both have less narrowly acuminate leaflets with less prominent venation, longer rachillae and green, yellow or purple flowers. In addition, *H. muelleriana* has an androecium consisting of at least twice as many stamens, while *H. barfodii* has a well-defined crownshaft.

One collection, *Croft LAE 71312*, is included here, although it stands out somewhat among other specimens cited and accounts for the bracketed lower limits of inflorescence, peduncle and rachilla lengths as well as leaflet number in the description. It is the only known collection from Sudest Island and could represent a new species, although it is too incompletely known to be described as such. One other collection, *Croft LAE 68683* (LAE), is not included here as it appears to have a crownshaft although it resembles *H. pulchra* in other aspects.

14. *Heterospatha sphaerocarpa* Burret (1935: 326). Type:—PAPUA NEW GUINEA. Central Province: Mafulu, *Brass 5413* (holotype B†, isotypes A!, BO, BRI!, NY!).

Heterospatha delicatula Moore (1969: 101). Type:—PAPUA NEW GUINEA. Milne Bay Province: *Brass 23005* (holotype BH, isotype A!, LAE!), *synon. nov.*

Figure 25 (line drawing). Figure 26 (photo plate).

Acaulescent, solitary, understorey palm varying in size, bearing 6–12 leaves in crown. **Stem** usually below ground, rarely protruding up to ca. 10 cm above ground. **Leaf** 1–4.5 m long including petiole; sheath ± distinct, if present as long as 15 cm with fibrous margins, ferruginous-lepidote, crownshaft absent; petiole 50–270 cm long, variably lepidote; rachis 80–320 cm long, indumentum as petiole; lamina usually pinnate, rarely entire-bifid; leaflets (when present) 14–56 each side of rachis, arranged regularly, borne 2–7 cm apart, single-fold but the apical leaflet pair occasionally



FIGURE 25. *Heterospathe sphaerocarpa*. A. Habit. B. Leaf apex. C. Mid-leaf portion. D. Emerging inflorescence. E. Infructescence. F. Portion of rachilla with flowers. G. Staminate flower whole and in longitudinal section. H. Pistillate flower whole and in longitudinal section. I. Fruit whole and in longitudinal section. Scale bar: A = 100 cm; B–C = 8 cm; D = 15 cm; E = 12 cm; F, I = 7 mm; G–H = 3 mm. A from Lyon Arboretum, Oahu, Hawaii; B–C, E from Pullen 7784; D from Brisbane Botanic Gardens Mt Coot-tha; F–H from Pullen 3470; I from Brass 5413. Drawn by Lucy T. Smith.



FIGURE 26. *Heterospathe sphaerocarpa*. A. Habit. B. Inflorescence with one order of branching. C. Inflorescence with two orders of branching. D. Portion of inflorescence. A, D from private garden, Hawaii; B from Brisbane Botanic Gardens Mt Coot-tha; C from Lyon Arboretum, Oahu, Hawaii. All photos: W.J. Baker.

multi-fold, ± linear, acuminate to acute at their tips, dark green adaxially, abaxially somewhat paler green and with ramenta scattered on basal portion of midrib and major veins; middle leaflet 30–60 × 2–4.5 cm; apical leaflet pair comprising 1–5 folds. **Inflorescence** 56–120 cm long including peduncle, interfoliar, branched to 1 or 2 orders or rarely spicate, with purple axes at least in bud; prophyll 16–36 × 1.5–3 cm, persistent, splitting apically, ferruginous-lepidote; peduncular bract 26–60 × 1.5–2.5 cm, attached in proximal half of peduncle, persistent and splitting apically to one side, indumentum ± as prophyll; peduncle 45–75 × 0.3–1.5 cm, indumentum ± as prophyll; first-order branches 0–10, to 33 cm long, inserted 1–4 cm apart, with up to 6 rachillae, subtended by inconspicuous rachis bracts, indumentum ± as prophyll; rachillae to ca. 25 cm long, 2–3 mm in diam.; triads inserted 1–11 mm apart. **Staminate flower** 3–5 × 2–3.5 mm pre-anthesis (when dry), purple; sepals 3, 1–2 × 1.2–1.8 mm, imbricate, glabrous; petals 3, 3–4.5 × 1.2–3 mm, valvate; stamens (6–)7–10; filaments 1–3 mm long, linear; anthers 1.5–2 × 0.5–0.9 mm, medifixed; pistillode 0.6–1.8 × 0.3–1 mm, conical, trifid. **Pistillate flower** 1.5–3.5 × 1.5–3.5 mm near anthesis (when dry), purple; sepals 3, 0.5–2.5 × 1.2–3.5 mm, imbricate, glabrous; petals 3, 1.3–3.5 × 1.5–4.5 mm, imbricate; staminodes ca. 4, minute; ovary 1.3–2.5 × 0.3–1 mm, ellipsoid, stigma inconspicuous. **Fruit** 9–10 × 9–10 mm, globose, red (or cream?) when ripe; stigmatic remains subapical. **Seed** ca. 6.5 × 7.5 mm (when dry), subglobose; endosperm ruminant.

Distribution:—South-eastern Papua New Guinea.

Habitat:—Lowland to premontane rainforest slopes and ridges, 400–1250 m.

Uses:—None recorded.

Vernacular names:—None recorded.

Conservation status:—Least Concern (LC). The calculated range of this species is relatively narrow (EOO is ca. 16,818 km²; Bachman *et al.* [2011]), although it is based on 12 localities or locations (AOO is 48 km²).

Specimens examined:—**Central Province:** Mafulu, 1250 m, September 1933, *Brass 5413* (A, B†, BO, BRI!, NY); Astrolabe Range, Mt. Omainumu, 1000 m, 2 August 1962, *Pullen 3470* (CANB!); **Milne Bay Province:** N slopes of Mt. Dayman, Maneau Range, 1150 m, 9°42'S, 149°17'E, 22 June 1953, *Brass 23005* (A, BH, LAE!); Alotau Subprov., on slopes of Mt. Daraia, several km N of Kaporika Village, 400 m, 10°20'S, 150°10'E, 12 May 1978, *Essig LAE 74095* (BH, LAE!, USF); Alotau Subdistr., SE ridges from Mt. Dalasia, hills behind Kaporika Village, 550 m, 10°15'S, 150°10'E, 21 November 1975, *Larivita LAE 67163* (BH, LAE!); Baniara Subdistr., between Agaun and Bonenau, 1400 m, 9°54'S, 149°22'E, 4 August 1969, *Pullen 7903* (CANB!); Maiyu River, E of Mt. Suckling, ca. 12 km WNW of Biniguni airstrip, 450 m, 9°40'S, 149°10'E, 14 June 1972, *Pullen 8295* (BH, CANB!, LAE); Mt. Suckling, Mayu camp site I, 400 m, 9°37'S, 149°10'E, 9 June 1972, *Leach LAE 33289* (BH, LAE!); Mt. Moiba, ca. 10 miles W of Raba Raba., 850 m, 9°58'S, 149°41'E, 14 July 1969, *Pullen 7784* (A, CANB!, L, LAE); **Oro Province:** Tufi subdistrict, slopes around Mai-u I camp, 450 m, 9°38'S, 149°10'E, 12 July 1972, *Essig LAE 55226* (BH, CANB, K!, L, LAE); Same locality as preceding, 750 m, 9°40'S, 149°10'E, 13 July 1972, *Essig LAE 55229* (BH!, LAE!); Isuarava [Isurava], 8°59'S, 147°44'E, 4 February 1936, *Carr 15384* (A, K!, L); S side of Hydrographers Range, near Siurani village, Managalase area, 1150 m, 9°2'S, 148°21'E, 4 August 1964, *Pullen 5591* (CANB!); Same locality as preceding, 1000 m, 9°2'S, 148°21'E, 5 August 1964, *Pullen 5613* (CANB!, LAE); Yodda [Mambare] River, 1350 m, 23 December 1935, *Carr 13944* (A, K!, L).

Notes:—*Heterospatha sphaerocarpa* is distinguished by its acaulescent habit in combination with purple inflorescences and an androecium consisting of 7–10 stamens (rarely 6 stamens). The habit prompts comparison with *H. elegans* subsp. *humilis*, but *H. elegans* usually has more elongate and slender inflorescences and green staminate flowers with six stamens. The peduncular bract is also inserted in the distal quarter of the peduncle in *H. elegans* whereas it is inserted in the proximal half of the peduncle in *H. sphaerocarpa*.

H.E. Moore annotated type material of *H. delicatula* as *H. sphaerocarpa* in 1979 thus indicating that *H. delicatula* should be synonymised. We have failed to detect any distinct character breaks that might separate the two species with two collections in particular, *Essig LAE 55226* and *Essig LAE 55229*, effectively demonstrating a continuum in variation. We therefore concur with Moore's unpublished annotations and formally reduce *H. delicatula* into synonymy with *H. sphaerocarpa* here.

Incompletely known and excluded taxa

Heterospatha arfakiana (Becc.) Moore (1970: 91). *Ptychosperma arfakianum* Beccari (1877: 57). Type:—INDONESIA. West Papua Province: Arfak Mts., *Beccari s.n.* (holotype FI!, isotypes (fragments) BH!, K!).

The type of *H. arfakiana* and fruit associated with the type by Beccari (cf. Moore 1970) are congruent with *H. elegans*, although the available material of *H. arfakiana* is inadequate to be confidently synonymised at present. The type of

Heterospathe arfakiana represents the only known occurrence of *Heterospathe* from the Bird's Head Peninsula in western New Guinea.

Martelli (1935) appears to have erroneously inferred that Beccari (1885) recombined the name *Ptychosperma arfakianum* Becc. in *Rhopaloblaste* Scheffer (1876: 137). Beccari (1885) merely noted that “*Ptychosperma arfakiana* sembra una specie di *Rhopaloblaste*”. We conclude that the name *Rhopaloblaste arfakiana* Becc. (1885: 90) was never validly published and consequently we do not list it as a synonym here.

Heterospathe compsoclada (Burret) Heatubun in Heatubun *et al.* (2009: 91). *Cyrtostachys compsoclada* Burret (1936: 325). Type:—PAPUA NEW GUINEA. Central Province: *Carr 13136* (holotype B†, isotypes CANB, K!, L!).

We have been unable to treat *H. compsoclada* in this revision due to the incompleteness of the type material (cf. Heatubun *et al.* 2009).

Heterospathe micrantha (Becc.) H.E.Moore = *Dransfieldia micrantha* (Becc.) W.J.Baker & Zona in Baker *et al.* (2006: 61).

Heterospathe pisifera (Gaertn.) Burret (1929: 76). *Euterpe pisifera* Gaertner (1788: 25). *Areca pisifera* (Gaertn.) Rollisson (1875: 49). Type:—Tab. 9, Fig. 3 (*Euterpe pisifera*) in Gaertner (1788).

See notes section under *Heterospathe elata*.

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