

## A contribution to the systematics of *Xylopia* (Annonaceae) in Southeast Asia

D.M. Johnson & N.A. Murray

Department of Botany & Microbiology, Ohio Wesleyan University  
Delaware, OH 43015 USA  
dmjohnso@owu.edu  
namurray@owu.edu

**ABSTRACT.** Herbarium and field study of *Xylopia* L. (Annonaceae) for the *Flora of Peninsular Malaysia* and the *Flora of Thailand* projects has clarified regional diversity patterns within this ecologically significant lowland rainforest genus. Two species groups represented within Southeast Asian floras are delineated, one centred on *Xylopia ferruginea* (Hook.f. & Thomson) Baill. and the other on *Xylopia malayana* Hook.f. & Thomson. In the *Xylopia ferruginea* group, a new species, *Xylopia erythroductyla* D.M.Johnson & N.A.Murray, is distinguished from *X. ferruginea*, and a new combination, *Xylopia sumatrana* (Miq.) D.M.Johnson & N.A.Murray, is proposed, based on an earlier name for the species currently known as *Xylopia stenopetala* Oliv. In the *Xylopia malayana* group, review of the species *Xylopia elliptica* Maingay ex Hook.f. & Thomson resulted in the recognition of three additional species: *Xylopia platycarpa* D.M.Johnson & N.A.Murray, from southern Thailand and northwestern Peninsular Malaysia, *Xylopia ngii* D.M.Johnson & N.A.Murray, from Peninsular Malaysia, Sumatra and Borneo, and *Xylopia heterotricha* D.M.Johnson & N.A.Murray, from Sumatra and Borneo. The taxon *Xylopia malayana* Hook.f. & Thomson var. *obscura* Kochummen is placed in synonymy under *Xylopia elliptica* sensu stricto. *Xylopia fusca* Maingay ex Hook.f. & Thomson var. *sessiliflora* Kochummen & Whitmore is distinguished from *Xylopia fusca*, and raised to species status as *Xylopia sessiliflora* (Kochummen & Whitmore) D.M.Johnson & N.A.Murray. We recognise 23 *Xylopia* species in the Sundaic region of Southeast Asia, and provide evidence that additional collecting and taxonomic analysis in the region is needed.

**Keywords.** Annonaceae, biogeography, Borneo, Malay Peninsula, Sumatra, Sundaland, Thailand, *Xylopia*

### Introduction

The Annonaceae, a flowering plant family of 2500 species, including the economically important soursop, custard apple and ylang-ylang, is widespread across the tropics. The family is most diverse, and ecologically most significant, in tropical Asia, where it is represented by c. 40 genera and 800 species. In southeastern Asia it is one of the dominant families in lowland wet forests. Corlett & Turner (1997) determined that Annonaceae ranked fourth in species-richness among flowering plant families in Singapore; Appanah et al. (1993) found that Annonaceae ranked first in species diversity among lianas of Malaysian forests. In long-term ecological plots in Southeast

Asia Annonaceae usually rank among the top ten tree families in both number of individuals and number of species, though not in basal area (see examples in Losos & Leigh, 2004).

The genus *Xylopia* L., the only pantropical genus in the family, comprises 180–200 species of trees and shrubs worldwide. The highest concentration of species in Southeast Asia occurs in the Sundaic region extending from the Kra Isthmus in southern Thailand to Wallace's Line, a region of high diversity for many plant taxa. *Xylopias* are distinctive among the Annonaceae in their cone-shaped buds, elongate, aromatic flowers, and dehiscent fruits with seeds bearing arils or fleshy seed coats. In West Africa the peppery fruits of *Xylopia aethiopica* (Dunal) A.Rich. have long been used as a spice (Dunal, 1817; Burkill, 1985) and are sold commercially. Despite its significance, the genus has never been monographed.

In preparing keys and descriptions of the genus *Xylopia* (Annonaceae) for the *Flora of Peninsular Malaysia* and *Flora of Thailand* projects we had the opportunity to study material in herbaria with important holdings for the region as well as to observe several species in the field. At the beginning of our study 13 *Xylopia* taxa were known from Peninsular Malaysia, Singapore and Thailand combined (Sinclair, 1953, 1955; Kochummen et al., 1970; Kochummen, 1972a, 1972b; Chalermglin, 2001; Gardner et al., 2015).

Analysis of morphological and preliminary molecular data (Stull et al., 2011; Thomas et al., 2015; Stull et al., in prep.) has shown that the Southeast Asian species of *Xylopia* fall into two groups, one including *Xylopia ferruginea* (Hook.f. & Thomson) Baill. and a second including *Xylopia malayana* Hook.f. & Thomson, each with their respective allies. Our study revealed a much greater diversity of species than previously recognised in both groups. To document this diversity, and reconcile it with the previously existing taxonomy and nomenclature for the genus, the following paper is presented. A full treatment, including keys and distribution maps, is forthcoming.

Conservation assessments using IUCN (2012) criteria are not included in this account as more data are required for these than we currently have available. Although historical EOs and AOs can be calculated, we are conscious that many of the collections have been made in lowland forest areas that have suffered from rapid deforestation. In these cases the Population Reduction (A) criterion would be more appropriate, as has been used for many dipterocarp species (IUCN, 2014), but again we would require more on-the-ground knowledge than we currently have.

### ***Xylopia ferruginea* group**

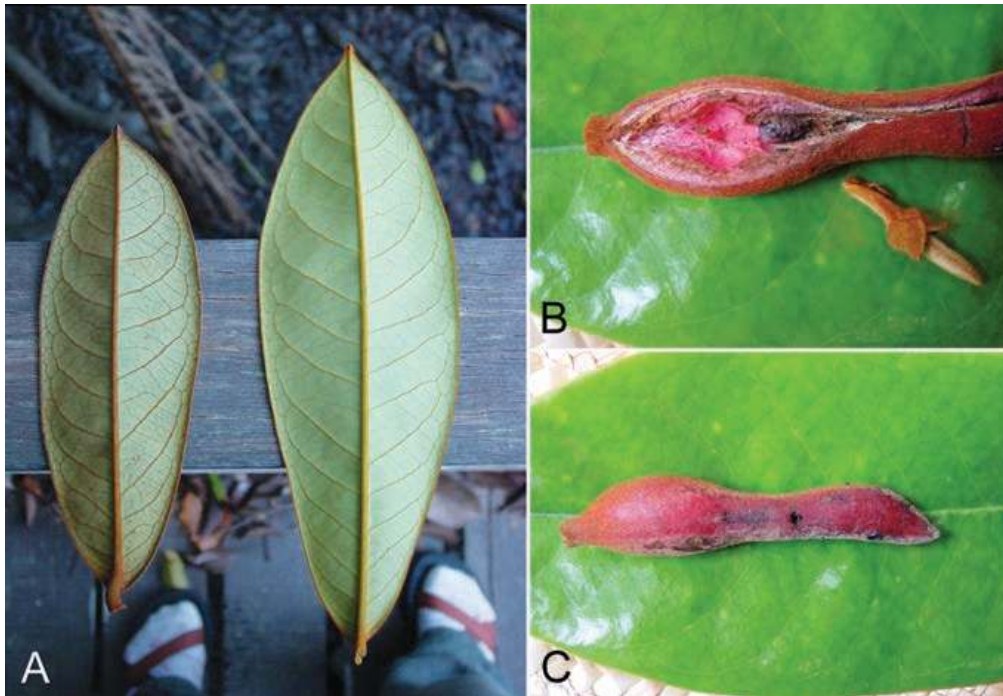
The *Xylopia ferruginea* group is characterised by stilt roots, relatively long (5–19 mm) flower pedicels, a flat receptacle lacking a staminal cone (Fig. 2K), flat narrowly oblong stamens with a tongue-shaped apex to the anther connective (Fig. 2J), stigmas studded with small papillae (Fig. 2I), and rugose seeds (Fig. 2C–D). In addition, most species of the *Xylopia ferruginea* group have relatively numerous (up to 20) linear and somewhat torulose monocarps.

Study of the group resulted in demarcation of a new species, and recognition of an earlier name for an existing species.

*Xylopia erythroductyla* D.M.Johnson & N.A.Murray, **sp. nov.**

Species resembling *Xylopia ferruginea* in the rusty pubescence of the leaves and flowers and the long narrow monocarps, but differing consistently in the more densely pubescent and thicker leaves, thicker pedicels (1.3–2.5 mm), longer sepals (4.8–7.9 mm), broader outer petals (3–3.7 mm wide at the midpoint) and narrowly oblong and weakly torulose monocarps 7.5–10.7 cm long and 0.6–1.1 cm wide. In contrast, in *Xylopia ferruginea* the pedicels are 1–1.3 mm thick, the sepals are 3–5.5 mm long, the outer petals are 2–2.2 mm wide at the midpoint, and the monocarps are linear, strongly torulose, 6.2–11.6 cm long and 0.4–0.6 cm wide. – TYPE: Malaysia, Sarawak, Teluk Bandung, Santubong, 1st Division, 18 September 1984 (fr), Awa & Ismawi S.47080 (holotype KEP; isotypes ASU, K, L, SAR). (Fig. 1, 2)

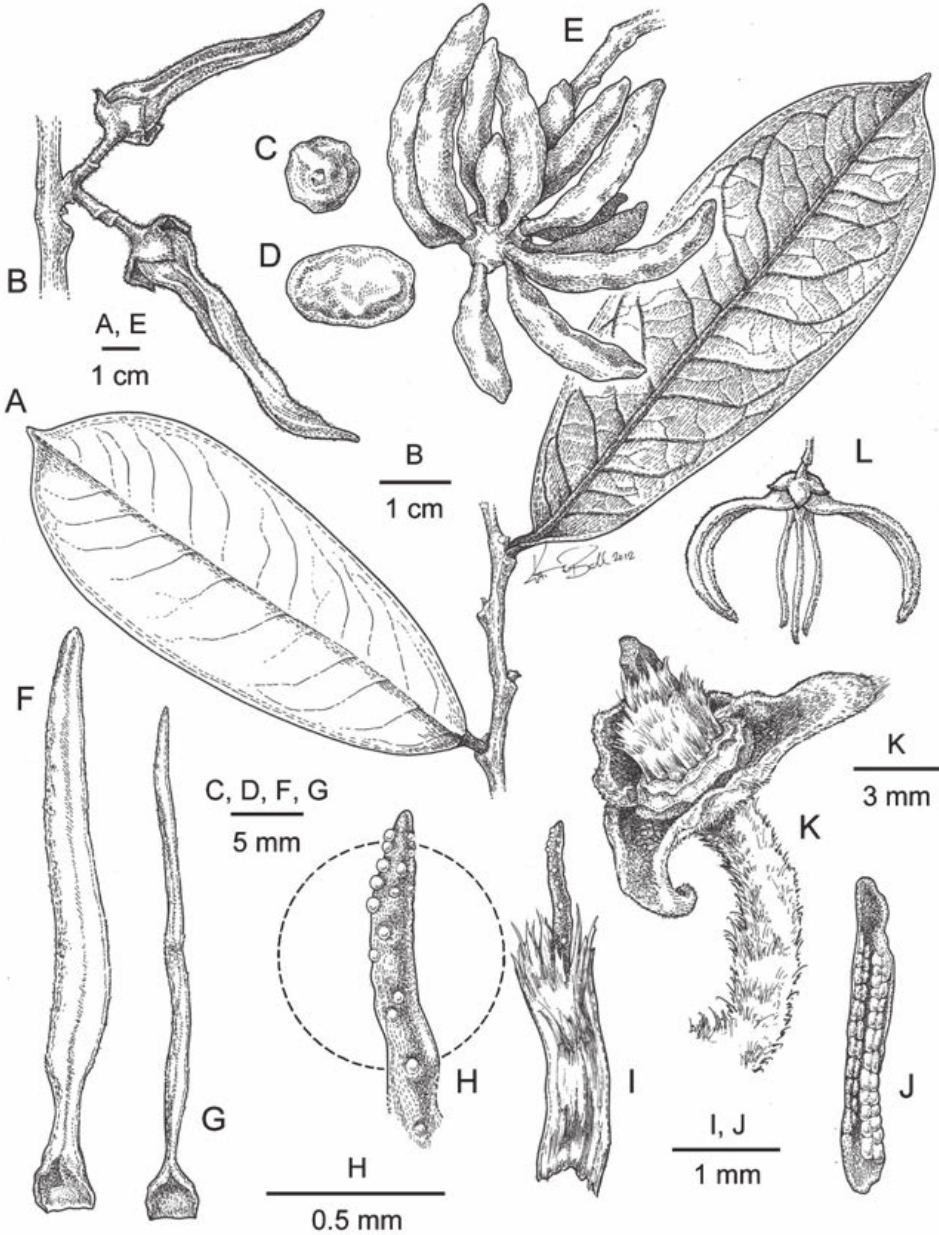
**Tree** up to 30 m tall, dbh up to 75 cm, bole smooth with stilt roots at the base; secondary branches drooping. **Bark** smooth, light brown, brown tinged with red, brick-red, or orange, very finely fissured. **Twigs** light grey to brown, eventually dark grey, densely ferruginous-pubescent/velutinous, eventually glabrate. **Leaf** with larger blades 12.4–26 cm long, 3.9–7 cm wide, subcoriaceous to coriaceous, strongly discolorous, oblanceolate, oblong-oblanceolate, or narrowly elliptic, base rounded to cuneate and short-decurrent, apex short-acuminate, the acumen 2–7 mm long, glabrous adaxially, densely ferruginous-pubescent, the pubescence especially pronounced along the midrib, secondary veins, and larger higher-order veins abaxially; midrib impressed adaxially, raised abaxially; secondary veins 11–14 per side, diverging at 50–60° from the midrib, brochidodromous, these and higher-order veins indistinct adaxially, strongly raised abaxially; petiole 5–12 mm long, deeply canaliculate (margins nearly meeting), pubescent. **Inflorescences** axillary or from axils of fallen leaves, 1–3-flowered, densely ferruginous-pubescent; peduncles 1–2 per axil, 2 mm long; pedicels 2 per peduncle, 7–14 mm long, 1.6–2.5 mm thick; bract 1, attached  $\frac{1}{3}$ – $\frac{1}{2}$  distance from base of pedicel, 2.9–3 mm long, ovate, apex acute to obtuse; buds linear-lanceolate, sometimes somewhat falciform and slightly twisted, apex obtuse. **Sepals**  $\frac{1}{8}$ – $\frac{1}{4}$ -connate, 4–7.9 mm long, 4–5.3 mm wide, coriaceous, broadly ovate to triangular, apex acute to acuminate, occasionally obtuse, pubescent along margins and at apex adaxially, ferruginous-pubescent abaxially. **Petals** pale yellow to white *in vivo*; outer petals curving outward at anthesis, 38–45 mm long, 4–5.3 mm wide at base, 3–3.7 mm wide at midpoint, linear-lanceolate, obtuse, densely grey-puberulent adaxially, densely ferruginous-pubescent abaxially; inner petals erect at anthesis, 32–40 mm long, c. 3.5 mm wide at base, c. 1.3 mm wide at midpoint, linear, densely grey-puberulent on both surfaces except for glabrous concave base. **Stamens** up to 77, 2.7–3.5 mm long, narrowly oblong, often setose along edges of anther locules, apex of connective 0.4–0.6 mm long, oblong, densely long-papillate, filament 0.3–0.5 mm long, glabrous; staminal cone absent; outer staminodes c. 18, c. 2.7 mm long,



**Fig. 1.** *Xylopia erythroductyla* D.M.Johnson & N.A.Murray. **A.** Two leaves, abaxial view. **B.** Flower bud and abaxial view of monocarp, the latter showing beginning dehiscence with single seed visible. **C.** Single monocarp in lateral view, resting on adaxial surface of a leaf. (Photos: N.A. Murray)

oblanceolate, flat, apex obtuse. **Carpels** 16–20; ovaries 1.5–2.5 mm long, narrowly oblong, densely ferruginous-pubescent with hairs obscuring lower portion of stigmas; stigmas loosely connivent, c. 2.2 mm long, dark, with a few scattered hairs and studded with amber-coloured papillae. **Torus** flat, c. 3.4 mm in diameter. **Pedicel of fruit** 11–20 mm long, 4–7 mm thick, pubescent; torus of fruit c. 8 mm high, 9–14 mm in diam., depressed-globose, sparsely pubescent to glabrate. **Monocarps** red with brown tomentum *in vivo*, up to 20 per fruit, 5.5–10.7 cm long, 0.6–1.1 cm wide and thick, linear to narrowly oblong, weakly torulose, terete in cross-section, apex rostrate, the beak 2.5–9 mm long, base contracted into a stipe 8–10 mm long, 3.5–4 mm thick, longitudinally wrinkled, ferruginous-pubescent to glabrate; pericarp 1.7 mm thick. **Seeds** in a single row, parallel to long axis of monocarp, 6–12 per monocarp, 7.2–8.8 mm long, 5.5–5.6 mm wide, 4.7–5.1 mm thick, ellipsoid, elliptic in cross section, dark brown, rugose, flattened or a little concave at micropylar end, rounded at chalazal end, raphe and antiraphe distinctly raised; aril and aril plate absent.

**Distribution.** Occurs in Terengganu in northeastern Peninsular Malaysia, and on the northern coast of the island of Borneo in Sarawak (East Malaysia) and in Brunei. Considering its restricted habitat and the pace of development in Sarawak, this species



**Fig. 2.** *Xylopi erythroductyla* D.M.Johnson & N.A.Murray. **A.** Habit. **B.** Inflorescence with flower buds, side view. **C.** Seed, view of micropylar end. **D.** Seed, side view. **E.** Fruit. **F.** Outer petal, adaxial view. **G.** Inner petal, adaxial view. **H.** Stigma apex. **I.** Carpel. **J.** Stamen. **K.** Close-up of flower with petals and stamens removed, to show sepals, carpels and torus. **L.** Schematic side view of flower at anthesis, one outer petal removed. Drawn by Kate Ball from (A) Awa & Ismawi S.47080, ASU; (B) Sibat ak Luang S.24502, L; (C–E) Chew & Kiah SFN.40982, A; (F, G, K) Zehnder S.16803, A; (H–J) Rogstad 704, A; and (L) field sketch.

may be more vulnerable than it appears from the collecting data.

*Ecology.* The bulk of the Sarawak and Brunei collections have come from either lowland peat swamp forest or heath (*kerangas*) forest (terminology following Saw, 2010). The collection localities in Terengganu are all from lowland dipterocarp forest, as are several in Sarawak. In general, however, the ecological range of this species is much narrower than that of *Xylopia ferruginea*. Elevational range is sea level to 250 m, with one collection from Terengganu from c. 800 m.

*Phenology.* The species shows two distinct flowering and fruiting periods throughout its distribution: flowers have been collected in late March and May–July, and then again in November–December, while fruits have been collected from February to July and also from September to December.

*Local name.* *Ako* (Sarawak: *Bojeng bin Sitam 9319*, *Zainuddin bin Bolhassan S.11941*).

*Etymology.* The species is named for the red and finger-like monocarps (Fig. 1B–C), which are thicker and less torulose than those of its congener *Xylopia ferruginea*.

*Additional specimens examined.* MALAYSIA: **Peninsular: Terengganu:** 18th mile, Jalan Kelantan, 31 Mar 1957 (fr), *Chiew & Kiah SFN 40982* (A, K, L [4 sheets], M, SING [2 sheets]); Pulau Redang, Pasir Mah Kapit, 300 m, 5 Mar 1989 (fr), *Saw FRI 36487* (A, K, KEP, L, SAR, SING); near Kampong Gong Nangka, Marang, 6 Jul 1953 (st), *Sinclair & Kiah bin Salleh SFN 39837* (L, SING [3 sheets]); 19th mile Kuala Trengganu Besut road, 15 Nov 1954 (st), *Sinclair & Kiah bin Salleh 40473* (L, SING); 18th mile Kuala Trengganu-Besut Road (west side), 7 Sep 1955 (young fr), *Sinclair & Kiah bin Salleh SFN 40748* (A, K, L, SING [2 sheets]); Ulu S. Loh below E face G. Mandi Angin, 2300 ft., 13 Jul 1968 (fr), *Whitmore FRI 12144* (K, KEP, L); **Borneo: Sarawak:** Telok Asam, Bako N. P., 4 Jun 1963 (fl), *Ashton S.17913* (A, ASU, K, KEP, L, SAR, SING); Ulu Kenyana, Mukah, 20 Oct 1963 (young fr), *Ashton S.19488* (A, K, KEP, L, SAR, SING); Kuching, Setapok F.R., 24 Jul 1957 (fl), *Bojeng bin Sitam 9319* (BO, K, L, SAR, SING); G. Pueh F.R., June 1956 (st), *Brunig S.6369* (SING); Selang F.R., Feb 1956 (st), *Brunig S.7225* (SING); long path from Tg. Po to Telok Krui, Bako National Park, Kuching, 1st div., 15 m, 16 May 1980 (fr), *Ching S.42286* (K, KEP, L, SAR); Ulu Sungai Pasir Biawak, Lundu, Kuching, 8 Apr 1997 (fr), *Jamree et al. S.76728* (K, KEP, L, SAR); Kem Permai, Santubong, 29 Jun 1992 (fr), *Othman et al. S.65133* (KEP, L); Sampadi F.R. (near road), 25th mile, Bau/Lundu Road, 1st Division, 750 ft, 28 Jun 1968 (fl), *Paie S.26915* (K [2 sheets], L, SAR, SING); Bako National Park, just above mangrove swamp at open area on slope at start of Jalan Lintang, 6 Dec 1981, *Rogstad 703* (A fr), *704* (A fl); Nyabau Catchment area, Bintulu, 4th Division, 300 ft, 11 Jun 1966 (fl), *Sibat ak Luang S.24502* (BO, KEP, L, SAR, SING); Kuching, 100' alt., Setapok F.R., 15 Nov 1957 (fr), *Yacup 8939* (K, L, SAR, SING); Bintulu, Similajau F.R., 17 Nov 1959 (fl), *Zainuddin bin Bolhassan S.11941* (K, L, SAR, SING); Kuching, Sg. Teruntum, Sarawak Mangrove Reserve, 27 May 1962 (fl), *Zehnder S.16803* (A, K, L, SAR, SING). BRUNEI: Andulau F.R., 18 Sep 1957 (st), *Ashton BRUN 560* (L, SING); Belait District, Ulu Sungai Badas, 28 Mar 1989 (fl), *Nangkat NN105* (A, AAU, K, L, SAR, SING); Belait District, Lumut Hills, 30 Mar 1968 (st), *van Niel 4454* (L); Ulu Badas, Andulau Stateland, Sg. Liang, Belait (Labi Rd. 10 km), 25 Jun 1996 (fl), *Ogata et al. Og-B203* (L).

*Notes.* Trees of this species were observed in Bako National Park in June of 2003, where the plants were frequent along the edge of dipterocarp forest on a slope bordering mangroves. At this site there were many seedlings and saplings present; flowers or fruits were only found on individuals exceeding 15 m in height. The petals of fallen flowers were sweetly scented, the scent reminiscent of *Gardenia* (Rubiaceae). At anthesis the outer petals were widely spread while the inner petals were more or less erect (Fig. 2L). Dehiscing monocarps, gathered from the ground at this locality, were photographed (Fig. 1B).

The dried seeds, when soaked, become tan in colour, revealing a sarcotesta c. 0.2 mm thick, which may be somewhat incomplete at the chalazal end. The sarcotesta breaks away in chunks from the woody layer of the seed coat underneath, often with patches of the woody coat adhering to it.

The type description of *Xylopiopsis altissima* Boerl., based on a specimen collected by Teysmann on the island of Lingga (Boerlage, 1899), suggests the new species in its emphasis on the dense tomentum of the abaxial leaf surface, but Boerlage (p. 203) also emphasised the strongly reticulate leaves (“venis tenuibus in nervos transversis et reticulatis pertensa”) with acuminate apices. These features are frequent in Sumatran specimens of *Xylopiopsis ferruginea* s.s., which in general have larger and broader leaves than those of Peninsular Malaysian and Bornean plants, as well as a tendency toward a subcordate rather than truncate leaf base. These leaf features do not occur in *Xylopiopsis erythrodactyla*.

Two sterile specimens found in the herbarium at M bear leaves resembling those of *Xylopiopsis erythrodactyla*. The specimens were collected from a plant grown in the Bogor Botanic Garden. The provenance of the plants is not certain, but “Borneo” is written in pencil on one of the sheets. The actual labels give the following information: Hort. Bogor. IV B 18, 2 May 1895, *Spelta* [?] s.n. (M [2 sheets], as “Sapotacea Sambas v. d. Horst” on one sheet, “Columnifera?” on the other). Duplicates of these specimens were not seen at L or BO; the catalogue by Dakkus (1957) did not show any listings under either the names or the number.

*Xylopiopsis sumatrana* (Miq.) D.M.Johnson & N.A.Murray, **comb. nov.** – *Unona sumatrana* Miq., Fl. Ned. Ind., Eerste bijv. 3: 377 (1861). – *Xylopiopsis malayana* Hook.f. & Thomson var. *macrocarpa* Boerl., Icon. Bogor. 1(2): 123 (1899). – TYPE: Indonesia, Sumatra occid. in prov. Priaman, *Diepenhorst* s.n. (holotype U).

*Xylopiopsis stenopetala* Oliv., Hook. Icon. Pl. 21: t. 1563 (1887). – TYPE: Malaysia, Penang, Government Hill, 600 ft, June 1886, *Curtis* 857 (lectotype K, designated by Turner (2011); isolectotype SING).

*Distribution.* Peninsular Malaysia, Sumatra, Borneo, Philippines (Mindanao).

*Additional specimens examined (representative specimens).* MALAYSIA: **Peninsular: Pahang:** Frasers Hill at the lower gate, 3000' alt, 29 May 1968 (fl, fr), *Ng FRI 6172* (A, K, SING); G.

Benom Game Reserve, Ulu Krau, 1800' alt, 22 Apr 1967 (fl), *Yusoff KEP 99124* (A, K, SING); **Penang:** Tunnel road, Penang Hill, 2200 ft, 28 May 1938 (fr), *Henderson SFN 21425* (SING [2 sheets]); **Selangor:** Kepong, F.R. Inst., 50th mile, Gap Road, 15 April 1990 (fl), *Kochummen FRI 29090* (A, K, SAR); Ulu Gombak F.R., 1800 ft alt, 18 Jan 1966 (fr), *Kochummen FRI 80497* (A, K, SING); **Borneo: Sabah:** Lamag District, close to exit stream of Gunong Lotung, lake Inarat, 1200 ft, 21 May 1976 (fl), *Cockburn SAN 83321* (K, L, SAR, SING); Tawau Dist., Mile 26, Apas Rd, 120 ft, 25 Jun 1959 (fr), *Meijer SAN 19321* (K, L, SING); **Sarawak:** Pk in Kuching, Dec 1892 (fl), *Haviland =10[?]* (BM, L, MO, SING); Perkulen Ampat, b.p.m.d. (fl, fr), *Haviland 142/10 [A.13.9]* (SAR, SING); Bkt. Lobang, Punung Lusong, Sg. Linau, Belaga, 7th division, 470 m, 14 Jun 1979 (fr), *Lee S.39802* (ASU, K, L, SAR); path from Kpg. Seropak to Bungoh Range, Bau, secondary forest on hillside, c. 1000 ft, 29 Nov 1969 (fl), *Paie & Mamit S.29584* (A, K, L, SAR, SING).

INDONESIA: **Borneo: East Kalimantan:** Meratus, 5230 area PT. ITCI, Kenangan Balikpapan, 70 m, 27 Sep 1992 (fr), *Ambriansyah A. A:611* (A, K, L); PT. ITCI, road Kenangan to G. Meratus, than to Basecamp Birawa, km 52, 500 m, 28 Mar 1995 (fl), *Kessler et al. P.K.949* (A, K); E Kutei, Sangkulirang subdivision, Sg. Susuk region, 10 m, 26 Jun 1951 (fl), *Kostermans 5456* (A, BM, K, L [2 sheets], SING); **West Kalimantan:** G. Bentuang area, 5–10 km N of Masa village, 150 km NE of Pontianak, steep ridge above Semawang River, 00°52'N, 110°26'E, 50 m, 23 Jun 1989 (fl, fr), *Burley et al. 2823* (A [2 sheets], F, K, L, MO, NY [2 sheets], SING); **Sumatra: Aceh:** Gunung Leuser Nature Reserve, Gunung Bandahara c. 6 km NE of Kampung Seldok (Alas Valley), c. 25 km N of Kutatjane, c. 800–1000 m alt, 20 Mar 1975 (fl, fr), *de Wilde & de Wilde-Duyffes 15599* (K [2 sheets], MO, US); **North Sumatra:** East Coast, vicinity of Loemban Ria, Asahan, 5 Feb–12 Apr 1934 (st), *Rahmat si Boeea 8096* (A, MICH, US); East Coast, Asahan NE of Tamuan Delok and W of Salabat, 500 m, 15 Jun–9 Jul 1936 (fl), *Rahmat si Boeea 9269* (A [2 sheets], K, L, MICH, NY, US, W).

PHILIPPINES: **Mindanao: Surigao Sur:** Manobo District, PICOP Bislig, Apr 1976 (fl), *Rojo 325* (MO).

*Notes.* The type specimen of *Unona sumatrana* Miq. from the Utrecht herbarium (now housed at L) includes two separate branches, one with a fruit attached, and the other with two small leaves. The two leaves are slightly obovate-oblong, one 6.5 cm long and 3 cm wide and the other 3.9 cm long and 2.3 cm wide. The leaves are retuse at the apex and broadly cuneate and decurrent at the base. The fruit shows the distinctive characteristics of *Xylopia stenopetala*: there are two monocarps and a portion of a third on the specimen, none of them fully mature. The intact monocarps are narrowly oblong, one 6.8 cm long and 0.8 cm wide and slightly torulose, sparsely pubescent, with about 7 seeds arranged in a single row. The monocarps are acute at the apex and taper to a stipe c. 8 mm long. The monocarps are borne on a pedicel 10 mm long and 4.3 mm thick, and a torus 11 mm in diameter, 8 mm high, and depressed-globose in shape.

Although the name *Unona sumatrana* was reduced to a variety of *Xylopia malayana* by Boerlage (1899), and placed in synonymy under *X. malayana* by Turner (2011), the fruit on the type specimen of *Unona sumatrana* clearly distinguishes it from *X. malayana*: the narrow monocarps have up to 7 seeds (seeds usually 3 or fewer per monocarp in *X. malayana*), and, at 6.8 cm in length, are already longer than those found in *X. malayana* (which never exceed 4 cm in length).



The type of the name *Unona sumatrana* from 1861 was thus found to represent the same species as *Xylopia stenopetala* from 1887 and the earlier name must take precedence. This name is not to be confused with *Xylopicrum sumatranum* (Miq.) Kuntze, Revis. Gen. Pl. 8, 1891, which is based on *Parartabotrys sumatranus* Miq., now considered a taxonomic synonym of *Xylopia malayana* (Sinclair, 1955; Turner, 2011).

*Xylopia sumatrana* has been collected in Peninsular Malaysia in the states of Pahang, Penang and Selangor, and on the islands of Sumatra, Borneo, and Mindanao (Philippines), where it is found at elevations of 50–1000 m, the widest elevational range of any Asian species of *Xylopia*.

### *Xylopia malayana* group

Members of the *Xylopia malayana* group lack stilt roots (with the exception of *Xylopia sessiliflora* treated below), the flower pedicels are 5 mm long or less, the receptacle bears a distinct but low and irregularly laciniate staminal cone formed from the connate bases of the filaments, the stamens are clavate with a transversely flattened apex to the anther connective, the stigmas lack papillae, and the seeds are smooth. Within this group the monocarps tend to be relatively few in number (ten or fewer, but see *Xylopia heterotricha* below) and relatively broad and oblong.

Species of the *Xylopia malayana* group are distinctive and well circumscribed with the exception of *X. elliptica* and *X. malayana*. We found that the primary source of taxonomic difficulty with these two species stemmed from the inclusion of multiple distinct taxa under the name *Xylopia elliptica*. The simplest route to clarification is to retrace the taxonomic history of that species.

Hooker & Thomson (1872: 86) originally based *Xylopia elliptica* on a single Maingay collection from Malacca. The protologue, reproduced verbatim below, shows that the diagnosis emphasised the glabrous branches, the small elliptic, obtuse, membranous, glabrous leaves and the solitary flowers:

14. **X. elliptica**, *Maingay mss.*; branches glabrous, leaves small elliptic obtuse membranous glabrous, tip rounded, nerves faint reticulate, flowers small solitary erect pubescent, sepals subacute united to the middle, ovaries 1–3.

Malacca, *Maingay*.

A lofty tree; trunk thick; branches glabrous, almost black; branchlets pubescent. *Leaves* 1 ½–2 by 1 ¼–1 ½ in., base obtuse or acute, pale on both surfaces, browner beneath; petiole ¼ in., puberulous. *Flowers* ½–¾ in., slender; peduncle half as long or shorter, and calyx rusty-pubescent; bracts [sic] median, minute. *Petals* pale brown-tomentose; outer linear-subulate, from a rather broad base, concave; inner trigonous, base excavated. *Stamens* minute. *Ovaries* sunk in the deeply urceolate torus, hidden amongst long white hairs; ovules 4–6.

The circumscription of the species was enlarged by King (1892), who identified two additional specimens, *Wray 3194* from Perak and *Curtis 2482* from Penang, as belonging to this species. The latter specimen in particular departed from Hooker and

Thomson's protologue, however, in having distinctly pubescent leaves and multiple flowers per inflorescence borne on longer pedicels. Ridley (1922) subsequently maintained King's concept of the species intact. Sinclair (1955) identified four additional specimens as *Xylophia elliptica*: *Awang 42444* from Kedah, *Wray 3562* from Perak, *20309*, without collector's name, from Pahang, and *Yeob 5037* from Selangor. Sinclair stressed the significance of the pubescence of twigs and leaves as a characteristic important in distinguishing this species from the otherwise similar *Xylophia malayana*, and apparently on this basis identified a number of specimens of *Xylophia* from Sarawak and Sabah in various herbarium collections as belonging to *X. elliptica*.

It has become clear from re-examination of these specimens, plus study of a wider range of material than was available to these authors, that *Xylophia elliptica* in the sense of Sinclair is a mixture of four very distinctive species. The concept adopted here is one of *Xylophia elliptica* in a restricted sense, and the recognition of three previously undescribed species to accommodate the variants.

*Xylophia elliptica* Maingay ex Hook.f. & Thomson, Fl. Brit. India 1: 86 (1872). – *Xylopicrum ellipticum* (Maingay ex Hook.f. & Thomson) Kuntze, Revis. Gen. Pl. 1: 8 (1891). – TYPE: Malaysia, Malacca, 9 May 1867, *Maingay 2376* [Kew Distribution no. 82] (lectotype K [2 sheets, barcode nos. K000574709, K000574712], designated by Turner (2011); second-step lectotype, designated here: K000574709; isotype CAL).

*Xylophia malayana* var. *obscura* Kochummen, Gard. Bull. Singapore 26(1): 49 (1972). – TYPE: Malaysia, Terengganu, Gunong Padang Expedition, Ulu Brang, camp 1 nr. K. Lallang, 1000' alt, 15 September 1969 (fl, fr), *Whitmore 12594* (holotype KEP; isotypes A, K, L, SING).

*Distribution.* Peninsular Malaysia. Although it has been collected from four states in Peninsular Malaysia, *Xylophia elliptica* is known from only eight collections, all from forests below 300 m in elevation.

*Additional specimens examined.* MALAYSIA: **Peninsular:** **Johor:** Compt 10, Rengam F.R., 14 Nov 1966 (fl), *Kochummen FRI 2188* (A, K, KEP, L, SING); Compt 34, Gunong Arang F.R., 13 Sep 1969 (fr), *Kochummen FRI 2761* (K, KEP, L); Keluang, 20 Nov 1990 (fl, fr), *Teo & Remy KL 3968* (KLU); Hutan Simpan Endau, 23 Oct 1997 (fl), *Teo & Tetu KL 4951* (KEP); **Pahang:** Chini Forest Reserve, 11 Dec 2008 (fl), *Khairil bin Mahmoud et al.* s.n. (UKMB); without definite locality [Raub, according to Sinclair (1955)], collector unknown, *KEP 20309* (KEP).

*Notes.* *Xylophia elliptica* in the sense of its type applies to relatively small-leaved plants with glabrous to sparsely pubescent leaves, inflorescences of a single flower, and relatively short petals. This same circumscription also includes the taxon *Xylophia malayana* var. *obscura*. *Xylophia elliptica* in this restricted sense is endemic to Peninsular Malaysia, where it is infrequent in lowland forests up to an elevation of 300 meters in Johor, Melaka, Pahang, and Terengganu. The report of *Xylophia elliptica* for southern

Thailand in Gardner et al. (2015) is based upon a misidentified specimen of *Xylopiaceae pierrei* Hance; the southern Thailand population of *X. pierrei* is disjunct from the main distribution of the species in eastern Thailand, Cambodia, and Vietnam.

The detached fruit on the sheet of *KEP 20309* does not look like a fruit of Annonaceae, Sinclair's determination of the specimen notwithstanding, but the leaves of the collection possibly represent this species.

Turner (2011) designated the specimens K000574709 and K000574712 at K as lectotypes of the name *Xylopiaceae elliptica*. Both sheets include leafy twigs and flowers. Hand-written descriptive notes that are incorporated into the protologue are present on K000574709, and it is therefore designated as a second-step lectotype as permitted by Article 9.17 of the ICN (McNeill et al., 2012). The sheet K000574712 does not bear these notes.

***Xylopiaceae platycarpa* D.M.Johnson & N.A.Murray, sp. nov.**

Resembling *Xylopiaceae vielana* by its pubescent leaves with a broadly cuneate to rounded base, but differing in the longer and narrower petals often curled at the apices and the flat monocarps that are white and marked with fine red veins. – TYPE: Thailand, Trang Province, Yanta Khao District, Peninsular Botanic Garden (Thung Khai), near office, 07°28'N 99°38'E, 25 m, 7 July 2005 (fl, fr), *Gardner et al. ST1882* (holotype L; isotypes BKF, L) (Fig. 3A–D, Fig. 4A–G)

**Tree** up to 22 m tall, dbh up to 48 cm. **Bark** orange to pale brown, flaking. **Twigs** brown or grey to blackish brown, eventually lenticellate, pubescent; double-branching occasional. **Leaf** with larger blades 6.5–9.4 cm long, 2.4–4.1 cm wide, chartaceous to subcoriaceous, lanceolate to oblong-lanceolate, elliptic-lanceolate, or ovate, base broadly cuneate to rounded-truncate, apex acute to obtuse, pubescent but becoming glabrate adaxially, pubescent abaxially; midrib slightly impressed adaxially, raised abaxially; secondary veins 7–12 per side, diverging at 45–50° from the midrib, brochidodromous, these and higher-order veins indistinct to slightly raised adaxially, indistinct or slightly raised abaxially; petiole 6–8 mm long, shallowly canaliculate, pubescent. **Inflorescences** axillary, 1–3-flowered, dusty yellow-pubescent; peduncles 1 or sometimes 2 per axil, 1.5–4 mm long; pedicels 1 or 2 per peduncle, 1–4.2 mm long, bracts 2, the uppermost just below the calyx, 1.7–2.3 mm long; buds linear and sometimes falcate, apex acute. **Sepals**  $\frac{1}{3}$ – $\frac{2}{3}$  connate, 2–3 mm long, c. 3.1 mm wide, coriaceous, ovate to broadly triangular, apex acute, pubescent. **Petals** pale yellow *in vivo*; outer petals 20.6–28 mm long, 2–3.1 mm wide at base, 0.8–1.5 mm wide at midpoint, linear, apex acute, sometimes curling at the tips, densely puberulent except for glabrous base; inner petals 16.5–22.3 mm long, 1.5–2 mm wide at base, 0.7–0.8 mm wide at midpoint, linear, apex acute, flat at base except for two slightly thickened areas along the margin, densely puberulent except for glabrous base. **Stamens** c. 70, 1.2–1.4 mm long, narrowly oblong to clavate, apex of anther connectives 0.2–0.3 mm long, bluntly conical to subglobose, puberulent; staminal cone c. 0.6 mm high, 1.4–2 mm in diameter, low, jagged; outer staminodes 1.2–1.5 mm long, oblong, flat, apex

obtuse to acute; inner staminodes c. 0.8 mm long, narrowly oblong. **Carpels** 3–5; ovaries 0.6–0.8 mm long, lanceolate to narrowly oblong, pubescent; stigmas connivent, 1.5–1.8 mm long, black, shiny, with a few hairs at apex but otherwise glabrous. **Torus** flat, 2.2–2.5 mm in diameter. **Pedicel of fruit** 3–5.5 mm long, 1–2 mm thick; torus of fruit 1–1.5 mm high, 3 mm in diameter. **Monocarps** cream-coloured with fine dull red veining outside, bright red inside *in vivo*, up to 4 per fruit, up to 5.2 cm long, c. 0.8 cm wide, c. 0.5 cm thick, oblong and slightly falcate, flattened-ellipsoid in cross section, apex forming a beak c. 5 mm long, base contracted into a narrow stipe 8–14 mm long, 1–1.5 mm wide, strongly rugose, sparsely pubescent to glabrate; pericarp c. 0.5 mm thick. **Seeds** arranged in a single row, oblique to long axis of monocarp, up to 3 per monocarp, grey *in vivo*, 7.9–8.3 mm long, 6.2–6.7 mm wide, 4.7–4.8 mm thick, broadly ellipsoid, elliptic to semicircular in cross section, smooth, flat on micropylar end, rounded on chalazal end, sarcotesta translucent, black layers of seed coat visible underneath; aril forming a fleshy crown-like ring around the micropyle, c. 2.8 mm high, c. 4 mm in diameter.

**Distribution.** Restricted to a small area of southern Thailand and northwestern Peninsular Malaysia.

**Ecology.** All localities are in lowland evergreen forest.

**Phenology.** Flowers in July and August, fruit collected in July.

**Local name.** *Kerangi lotong* (Kedah: *Awang 42444*).

**Etymology.** The species is named for its unusually flattened and beanlike monocarps.

**Additional specimens examined.** MALAYSIA: **Peninsular: Kedah:** Perangin Forest Reserve, 30 Jul 1938 (fl), *Awang 42444* ([Sinclair cites specimen at K, but this was not found in July 2014], KEP); **Penang:** Sungei Penang, Aug 1890 (fl), *Curtis 2482* (BM, CAL (Sinclair, 1955), K, SING [2 sheets], US).

**Notes.** *Xylopi platycarpa* stands apart from other Asian species of the genus by its uniquely flattened cream-coloured monocarps with red veining. It occupies a very narrow distribution in northwestern Peninsular Malaysia and southern Thailand. At present this species is only known from three localities and has not been collected from Peninsular Malaysia since 1938. Its biogeography is unusual, in that the distribution of the species crosses the Kangar-Pattani Line, which has been widely recognised as a prominent botanical transition line on the Malay Peninsula (Woodruff, 2003).

The new species most closely resembles *Xylopi vielana* of northeastern Thailand, Laos, Cambodia, Vietnam and southern China by virtue of its persistently pubescent twigs and chartaceous, pubescent, acute to obtuse leaves. It has been identified as that species in a recent floristic work (Gardner et al., 2015), but *Xylopi platycarpa* has, in addition to the uniquely flattened pallid monocarps, longer completely pale yellow petals (16.5–26 mm long) that tend to curl at the apices. The petals of *Xylopi vielana*,

in contrast, are only 11–14 mm long, do not curl at the apex, and are flushed with red or purple at the base.

The Curtis specimen, cited here as belonging to *Xylopiia platycarpa*, was identified by King (1892), Ridley (1922), and Sinclair (1955) as *Xylopiia elliptica*, but we found that it differs from the type of that name by its distinctly pubescent twigs and leaves, the leaves lanceolate rather than elliptic in shape, and the tendency to have multiple flowers per leaf axil, these often borne on a relatively long common peduncle (Fig. 4B). The Awang specimen, also cited under *Xylopiia elliptica* by Sinclair (1955), shares these same features, and in fact Sinclair used relative lengths of peduncle and pedicel as a way to distinguish *X. malayana* and *X. elliptica*: pedicel longer than peduncle in *X. malayana*, and peduncle longer than pedicel in *X. elliptica*. This pattern of long peduncles and relatively short pedicels however, was never seen in specimens of *Xylopiia elliptica* s.s. in our study.

***Xylopiia ngii* D.M.Johnson & N.A.Murray, sp. nov.**

Species differing from *Xylopiia malayana* in the narrowly acuminate to caudate apex of the leaf, the sepals only 2–2.9 mm long and sparsely pale brown pubescent with acute to apiculate apices, the outer petals longer and narrower (up to 34 mm long and 0.7–1.6 mm wide at the midpoint), the larger monocarps 3.1–6.4 cm long with pericarp 2–4 mm thick and sessile or broadly short-stipitate, and 8–12 seeds per monocarp, the seeds 14–18 mm long. – TYPE: Malaysia, Sabah, Tawau, Cpt. A., sub-cpt. 13, Bombay Burmah T. C. Licence Area, Kalabakan, 30 mi WNW of Tawau, 350 ft, 30 April 1954 (fr, A & L sheets also have flowers), *Wood A 3454* (holotype A; isotypes K, L, SING). (Fig. 3E–F, Fig. 4O–V)

**Tree** up to 40 m tall, dbh up to 60 cm, with a clear bole up to 30 m and steep buttresses up to 5 m high and 1 m wide. **Bark** brown to reddish brown, somewhat scaly, sapwood yellow to cream-yellow. **Twigs** dark brown to brownish grey, eventually lenticellate, glabrous or finely but sparsely pubescent and soon glabrate; double-branching occasional. **Leaf** with larger blades 6.5–10.9 cm long, 2.4–4.8 cm wide, chartaceous or occasionally subcoriaceous, slightly discolourous, elliptic, ovate, oblong-elliptic, or elliptic-oblongate, base cuneate, sometimes obliquely or broadly so, apex narrowly acuminate to caudate, the acumen 3.5–14 mm long, often deflexed to one side when pressed, glabrous adaxially, glabrous or sparsely pubescent abaxially; midrib impressed adaxially, raised abaxially, secondary veins 7–12 per side, diverging at 60–75° from the midrib, weakly brochidodromous; secondary and higher-order veins slightly raised adaxially, slightly raised to raised abaxially; petiole 4–9 mm long, shallowly canaliculate, transversely wrinkled, glabrous or sparsely pubescent. **Inflorescences** axillary or from the axils of fallen leaves, occasionally axillary on expanding axillary shoots, 1–5-flowered, pale brown pubescent; peduncles 1–2 per axil, 1–2 mm long or lacking; pedicels 1–3 per peduncle, 1.7–7 mm long, bracts 2, the lower at about the midpoint of the pedicel and the upper subtending the sepals, upper bract larger than lower bract, 1.6–2.4 mm long, 2.1–2.8 mm wide, clasping, semicircular; buds linear,

apex obtuse or acute. **Sepals**  $\frac{1}{3}$ – $\frac{1}{2}$ -connate, 2–2.9 mm long, 2–2.8 mm wide, coriaceous, ovate-triangular, acute to apiculate, pale brown appressed-pubescent abaxially. **Petals** yellow-green to greenish white *in vivo*; outer petals 13.5–34.2 mm long, 1.9–2.5 mm wide at base, 1–1.6 mm wide at midpoint, linear, flat adaxially, longitudinally ridged abaxially, densely puberulent on both surfaces except for glabrous base; inner petals 17.2–29 mm long, 1.8–1.9 mm wide at base, 0.7–0.8 mm wide at midpoint, linear to filiform, shallowly concave at base, acute at the apex, longitudinally ridged and densely puberulent on both surfaces. **Stamens** 26–29 (including staminodes), 1.5–1.7 mm long, clavate to narrowly oblong, apex of anther connectives c. 0.4 mm long, oblong to conical, obtuse, densely papillate, filament 0.3 mm long; staminal cone c. 0.3 mm high, c. 1.1 mm in diam., a low ring surrounding the bases of the ovaries; outer staminodes 7–8, narrowly oblong to clavate, flat, apex acute, glabrous. **Carpels** 3–4; ovaries 1–1.2 mm long, narrowly oblong, pubescent; stigmas somewhat connivent, 1.3 mm long, barely exceeding tops of stamens, clavate, glabrous. **Torus** c. 1.3 mm in diameter. **Pedicel of fruit** 3–20 mm long, 4.5–10 mm thick at midpoint; torus of fruit 6–17 mm in diameter, 4–9 mm high. **Monocarps** greenish brown to brown, dehiscing when mature to reveal a bright pink endocarp *in vivo*, up to 4 per fruit, 3.1–6.4 cm long, 2.5–3.5 cm wide, 2–2.7 cm thick, oblong, ellipsoid, ovoid, or nearly globose, apex rounded, base sessile or contracted into a stipe 3–5 mm long and c. 7 mm thick, dark brown to black, blotched with lighter-coloured corky spots, glabrate or with a few scattered hairs; pericarp 2–4 mm thick. **Seeds** lying in two short partially overlapping rows, transverse to long axis of monocarp, 8–12 per monocarp, light green *in vivo*, 14–18 mm long, 10.3 mm wide, 8–8.1 mm thick, more or less ellipsoid, narrowly oblong to cuneiform in cross section, smooth, dark grey with white crusty patches, flat across micropylar end, chalazal end rounded; micropyle encircled by a rough irregular aril plate.

**Distribution.** Occurs in Peninsular Malaysia, East Malaysia (Sarawak and Sabah), and Indonesia (Riau Province of Sumatra and Central Kalimantan, East Kalimantan, and West Kalimantan Provinces of Borneo).

**Ecology.** Mixed lowland dipterocarp forest and sometimes secondary forest, from sea level up to 300 m.

**Phenology.** This species has been collected in flower in January, March–May, and November; fruits have been collected February–April, June–September, and November–December.

**Local names.** *Djangkang*, *djerendjang* (East Kalimantan), *medang* (name also commonly used for various Lauraceae), *ngkurari* (West Kalimantan: *de Jong* 439), *podjeng* (East Kalimantan: *Kostermans* 10205).

**Etymology.** With pleasure we name this distinctive species in honour of Dr Francis Ng, former Deputy Director General of the Forest Research Institute of Malaysia

and recipient of the 2009 David Fairchild Medal for Plant Exploration. Dr Ng has contributed to knowledge of the flora of the region through a large body of work, including the *Tree Flora of Malaya* and his study of the family Ebenaceae. Through his studies of the seeds and seedlings of Southeast Asian forest trees (Ng, 1991; Ng & Mat Asri Ngah Sanah, 1991) Dr Ng obtained valuable seedling data for the new species.

*Additional specimens examined.* MALAYSIA. **Peninsular: Negeri Sembilan.** Pasoh F.R., Plot 2 at the slope near the Percolation Pits and Lateral Flow, Pasoh, Kuala Pilah, 1 Mar 1977 [presumably had a fruit, as there is a seedling specimen attached], *Mat Asri FRI 25722* (KEP); Pasoh Forest Research Station, Ecology Plot No. 1, tree no. 1325, 6 Oct 1983 (st), *Mat Salleh & Normalawati KMS 40* (SING); Pasoh Forest Reserve, 50 ha Long-term Ecological Research Plot, 2°58'N 102°18'E, 20 Feb 1988 (fr), *LaFrankie 2758* (KEP); **Pahang:** Ulu Sg. Kepong, Gua Peningat, 15 Jul 1970 (fl buds), *Burgess FRI 19047* (KEP, L); **Perak:** "Upper Perak," May 1889 (fl), *Wray 3562* (K, SING); **Selangor:** Bernam River State Land, 28 Jul 1920 (fr), *Yeob 5037* ([Sinclair cites duplicate at K, but not found July 2014], KEP); **Terengganu:** Mandi Angin Exped., S. Loh nr. Kuala Datok, 5 Jul 1968 (fl), *Whitmore FRI 8965* (K, KEP, L); **Borneo: Sabah:** Tawau District, Jalan Kuala Apas, 31 May 1961 (fr), *Bakar SAN 17302* (L); Sandakan District, Leila F.R., 18 Apr 1962 (fl), *D.B. & J.S. SAN 34713* (K, SING); Sipitang District, Mesapol, 1 Jul 1962 (young fr), *Mikil SAN 27180* (L [2 sheets]); Tawau District, ch. 5 Jalan from MI.15 1/2 Quain Hill Road, c. 100 ft, 15 Jun 1964 (fr), *Pereira SAN 44208* (K, SING); Keningau District, Sook-Tulid road mile 7¼, 3000 ft, 27 May 1965 (fl), *Sadau SAN 49574* (L [2 sheets], SING); Tawau, mi 10 1/2 on road through Apas Forest Reserve (10 mi E of Tawau), 300 ft, 7 Nov 1955, *Wood SAN 17182* (A + sep. carpol., L, SING); **Sarawak:** Without definite locality, without date, *Beccari 1578* (FI-W, K), *Beccari 1579* (FI-W, K).

INDONESIA. **Borneo: Central Kalimantan.** Sintang HPH km 70 W of camp of main (new) logging road, 0°51'54"S [given as 00°51'33.6" S on one sheet] 112°13'30"E [given as 112°13'29.9"E on one sheet], 120 m, 17 Apr 1994 (fl, fr), *Mahyar et al. 990* (A, K, L, SAR, SING); **East Kalimantan:** Wanariset research area, Rd Samboja-Semai, km 2 Rintis B. Baru, 01°S, 117°E, 50 m, 3 Aug 1991 (fr), *Ambri & Arifin W801* (A, BO, K, L); Bukit Soeharto area off km 65 Balikpapan-Samarinda, 50 m, 20 Nov 1993 (fl), *Ambri & Arifin A.A.891* (A, BO, K, L); Wanariset, Rintis Baru, Plot Matthijs, 01°S, 117°E, 50 m, 29 Jan 1992 (fl), *Ambri & Arifin W1007* (A, K, L [2 sheets], MO); Sg. Wain region N of Balikpapan (fl), *Kostermans 4488* (L, SING); Mentawir region, N of Balikpapan, 20 m, Sep 1950 (st, fr on L & SING sheets), *Kostermans 4512* (BO, K, L, SING); Loa Djanan, W of Samarinda, 30 m, 15 Apr 1952 (fl), *Kostermans 6451* (A, K); island Nunukan (northern part), 100 m, 2 Dec 1953 (fr), *Kostermans 8895* (A, BO, K, L, SING); Balikpapan distr., nr village Mentawirflow, 3 Mar 1955 (st), *Kostermans 10154* (L, NY, SING); East Kutei, Loa Djanan region along road Balikpapan-Samarinda, km 25, 15 Mar 1955 (fl), *Kostermans 10205* (L); E Kutei, Sg Tiram, 40 m, 15 Apr 1952 (fl), *Kostermans bb.35023* (A, K); East Kutai Reserve, vicinity of Sengata and Mentoko Rivers, altitude below 300 m, 0°30'N, 117°20'E, 15 Apr 1978, *Leighton 154* (L); Z.O. Afd. V. Borneo, Boeloengan, Noekoekan (Boschtuin), 18 May 1939 (st), *Neth. Ind. For. Service bb.29395* (A, L); **West Kalimantan:** Kabupaten Sanggau, 10 Aug 1993 (fr), *de Jong 439* (L, NY); Melawi, Tjatit, B. Gontuk, c. 180 m, 3 Mar 1939 (fl), *Netherlands Indies Forest Service bb.27013* (A, BISH, K, L, NY, SING); Melawi, B. Ulu, Borusepan, 275 m, 23 Jul 1939 (young fr), *Neth. Indies For. Service bb.29037* (L, SING). **Sumatra: Riau:** Indragiri, the uplands, Danau Mengkuang, 21 Apr 1939 (young fr), *Buwalda 6633* (A, K, L, SING); Riouw en Ond. Indrag. Bovenlanden, Danau Mengkuang, 21 Apr 1939 (young fr), *Netherlands Indies Forest Service bb.27571* (A, K, L, NY).

*Notes.* Material of this species is usually identified in herbarium collections as *Xylophia malayana*, but *X. ngii* differs consistently from that species in its smaller (2–2.9 mm long) sepals sparsely covered with pale brown pubescence and the longer (13.5–34.2 mm) and narrower (1–1.6 mm wide at the midpoint) outer petals. In *Xylophia malayana* the sepals are 2.7–4 mm long and densely covered with rusty pubescence, and the outer petals are 13.5–20 mm long and 1.5–2 mm wide at the midpoint. The leaves of *Xylophia ngii* have a characteristic narrow acumen, which is often bent to the side in pressed specimens, rather than the gradually acuminate tip seen in the leaves of *X. malayana*, which tends to press flat; the bending of the leaf apex in *X. ngii* is the result of the fact that its leaf midrib is usually curved downward towards the apex. The most striking difference between the two species, however, is in the fruits and seeds: the monocarps of *Xylophia ngii* are 3.1–6.4 cm long, 2.5–3.5 cm wide, sessile or broadly short-stipitate with a stipe 3–5 mm long and c. 7 mm thick and a pericarp 2–4 mm thick, each monocarp containing 8–12 seeds 14–18 mm long. In *Xylophia malayana* the monocarps are 1.9–3.9 cm long, 0.9–1.7 cm wide, distinctly stipitate with a narrow stipe 2.5–7 mm long, and with a pericarp 0.3–0.5 mm thick, each monocarp containing up to 3 seeds 7.5–8 mm long. In fruit *Xylophia ngii* can only be confused with *X. dehiscens* (Blanco) Merr., a species of the Philippines and northern Borneo, which has a blunt leaf apex and a fruit drying black and without the corky blotches of *X. ngii*.

Part of the difficulty in separating *Xylophia ngii* from *X. malayana* and other congeners has been the fact that the flowers and fruits of the species are rarely collected together. Thus the type collection and the specimen *Mahyar et al.* 990 have played a critical role in our delimitation of the species. While the taxonomic confusion has been principally with *Xylophia malayana*, specimens of this species have also been confused with *X. elliptica* and even with *X. fusca* Maingay ex Hook.f. & Thomson: the specimens *Wray* 3562 and *Yeob* 5037 were identified as *X. elliptica* by Sinclair (1955), the specimens *Ambriansyah & Arifin AA* 891, *Ambriansyah & Arifin W* 801, and *Ambriansyah & Arifin W* 1007 were identified as *X. malayana* in Sidiyasa et al. (1999). Turner (2014) determined the collections *Mikil SAN* 27180 and *Pereira SAN* 44208 as *Xylophia malayana*, and *Sadaw SAN* 49574 as *X. fusca*. *Xylophia ngii* was illustrated in LaFrankie (2010: 100, reproduced in Fig. 3F here), where it was called *Xylophia fusca*.

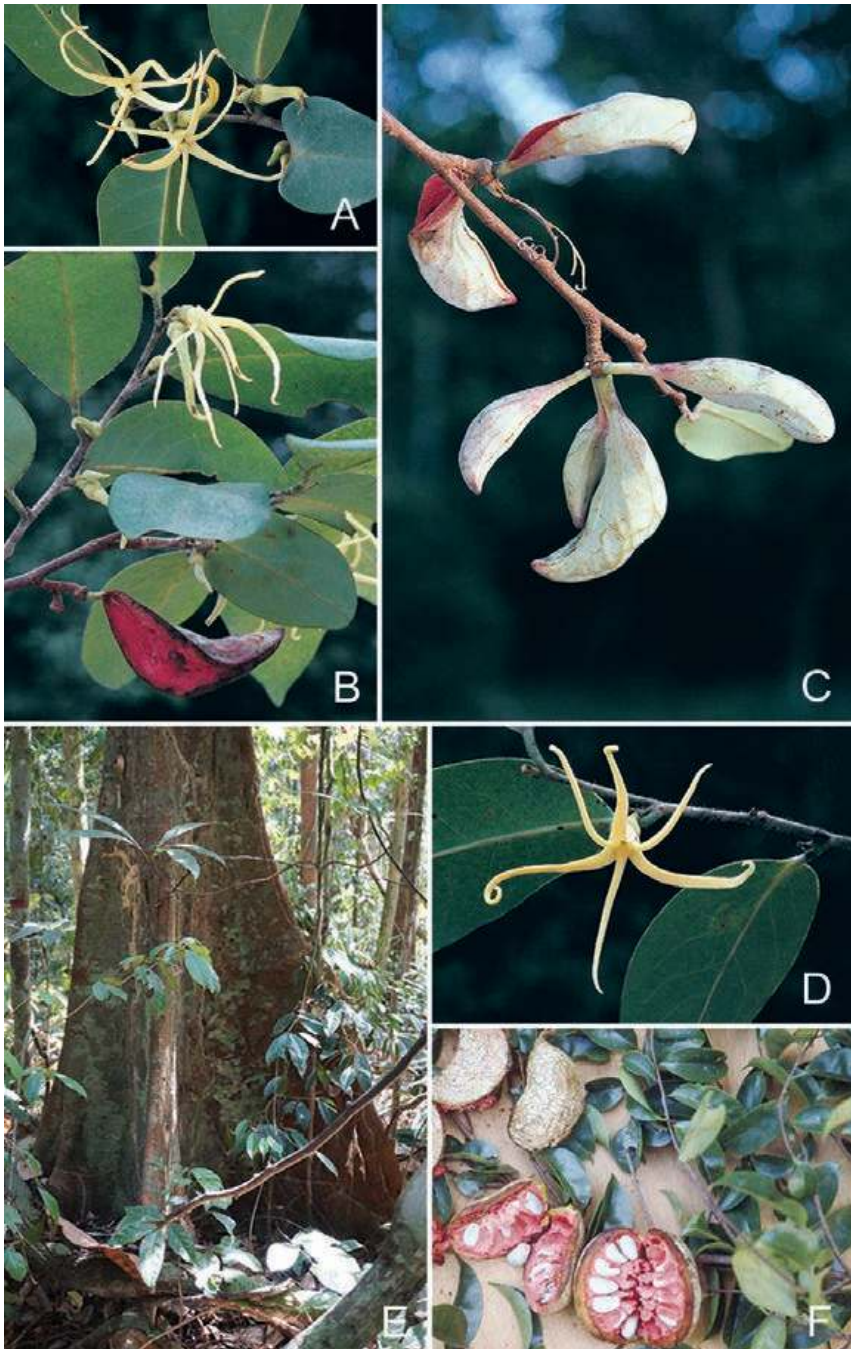
The descriptions of seedlings of “*Xylophia malayana*” in Ng (1991) and Ng & Mat Asri Ngah Sanah (1991) are based on this species. A seedling specimen is attached to the KEP sheet of the collection *Mat Asri FRI* 25722, the apparent original seed source for the seedling studies.

In the Pasoh Forest Reserve an individual of *Xylophia ngii*, tree #414079, was c. 40 m tall with a dbh of 43.9 cm, with steep buttresses at its base (Fig. 3E). The tree was growing on some of the highest ground in the plot (Manokaran et al., 1992).

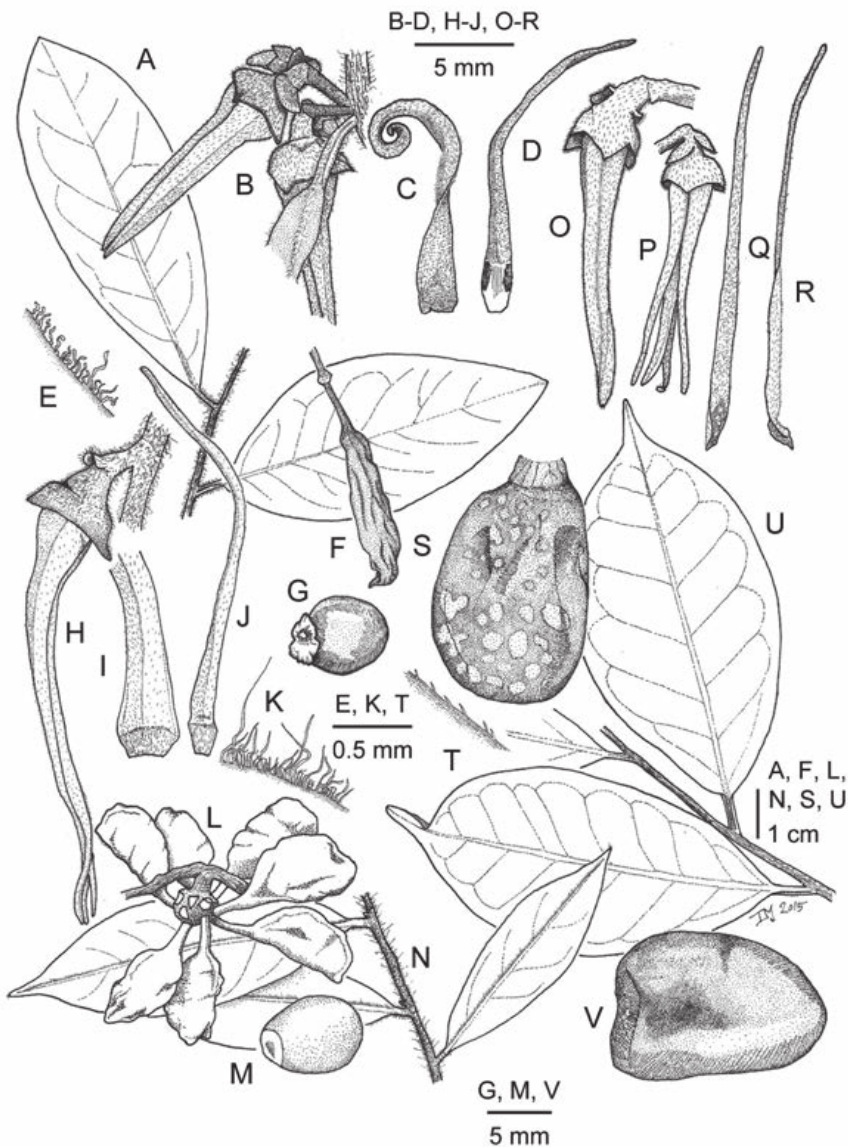
***Xylophia heterotricha* D.M.Johnson & N.A.Murray, sp. nov.**

Species differing from its congeners by the twig pubescence consisting of a mixture of acicular hyaline spreading hairs 0.5–0.7 mm long and curling appressed yellow-brown





**Fig. 3.** A–D: *Xylopi platycarpa* D.M.Johnson & N.A.Murray. **A.** Two open flowers and a single bud. **B.** Open flowers and a single dehiscent monocarp. **C.** Monocarps of two fruits, the uppermost ones in the photograph just beginning to dehisce. **D.** Single open flower, showing curled ends of petals. E–F: *Xylopi ngii* D.M.Johnson & N.A.Murray. **E.** Base of tree #414079, Pasoh Forest Reserve, showing the prominent buttresses and absence of stilt roots. **F.** Dehiscent monocarps and leafy branches. (Photos: A–D: S. Gardner; E: N.A. Murray; F: J. LaFrankie)



**Fig. 4.** A–G. *Xylopiya platycarpa* D.M.Johnson & N.A.Murray. A. Habit. B. Inflorescence. C. Outer petal, adaxial view. D. Inner petal, adaxial view. E. Profile view of twig indument. F. Monocarp, lateral view. G. Seed, lateral view. H–N. *Xylopiya heterotricha* D.M.Johnson & N.A.Murray. H. Flower bud, lateral view. I. Base of outer petal, adaxial view. J. Inner petal, adaxial view. K. Profile view of twig indument. L. Fruit. M. Seed, lateral view. N. Habit. O–V. *Xylopiya ngii* D.M.Johnson & N.A.Murray. O, P. Flower buds, lateral view. Q. Outer petal, oblique adaxial view. R. Inner petal, adaxial view (twisted toward apex). S. Monocarp, lateral view. T. Profile view of twig indument. U. Habit. V. Seed, lateral view. Drawn by D.M. Johnson from (A, C, D, F, G) *Gardner ST1882*, L; (B, E) *Curtis 2482*, K; (H) *Puasa 4550*, KEP; (I, J, N) *Puasa 4550*, A; (K) *McDonald & Ismael 3526*, A; (L, M) *Ambri & Arifin W602*, A; (O, S, T) *Wood SAN A 3454*, A; (P) *Ambri & Arifin W1007*, MO; (Q, R) *Ambri & Arifin AA891*, A; (U) *Mahyar et al. 990*, SING; (V) spirit collection gathered beneath tree #414079 in Pasoh Forest Reserve.

hairs 0.1–0.2 mm long, the latter often persisting on leafless twigs. It differs from *Xylopia elliptica* in addition in having the leaf blades persistently pubescent abaxially, the petals 28–47 mm long (versus 5.5–10 mm long) and the monocarps up to 17, stipitate (stipes 7–10 mm long) and distinctly pubescent at maturity (versus monocarps 1–2, short-stipitate (stipes 1.5–3.5 mm long) and glabrate). – TYPE: Malaysia, Sabah, Sandakan, Bettotan, 27 March 1935 (fl), *Puasa 4550* (holotype KEP; isotypes A, K, L, SING, US). (Fig. 4H–N)

**Tree** up to 36 m tall, dbh up to 48 cm, with a clear bole up to 26 m, occasionally with buttresses up to 1.5 m high. **Bark** light grey, rarely white, yellowish green, or dark brown, smooth. **Twigs** dark brown, densely pubescent, the pubescence consisting of a mixture of acicular hyaline spreading hairs 0.5–0.7 mm long and curling appressed yellow-brown hairs 0.1–0.2 mm long, the latter often persisting on leafless twigs; double-branching occasional. **Leaf** with larger blades 7.9–10.2 cm long, 2.4–3.7 cm wide, chartaceous, often mottled adaxially when dried, narrowly elliptic to oblong, base cuneate, apex acuminate, the acumen 8.5–18 mm long, punctate and glabrous adaxially except for the densely hispid-pubescent midrib, pubescent with loosely appressed hairs abaxially; midrib plane adaxially, raised abaxially; secondary veins 9–13 per side, diverging at 45–60° from the midrib, weakly brochidodromous, secondary and higher-order veins slightly raised adaxially, slightly raised to raised abaxially; petiole 2.5–3 mm long, deeply canaliculate, pubescent. **Inflorescences** axillary or from the axils of fallen leaves, 1-flowered, brownish to yellowish pubescent; peduncles absent; pedicels 4.5–5.5 mm long, bracts 2, the lower bract attached at or below the midpoint and the upper bract attached to distal half of pedicel, upper bract 3 mm long, ovate, acute; buds linear, apex acute. **Sepals** ½-connate, 3–4 mm long, coriaceous, broadly ovate, apex acute, acuminate, or caudate, brown-pubescent abaxially. **Petals** white to yellow *in vivo*; outer petals 28–47 mm long, c. 2.5 mm wide at base, 1–1.2 mm wide at midpoint, linear, flat adaxially, longitudinally ridged abaxially, apex acute, densely puberulent on both surfaces except for glabrous base; inner petals 30–36 mm long, 1.6–1.7 mm wide at base, c. 0.8 mm wide at midpoint, filiform, apex acute, longitudinally ridged and densely puberulent on both surfaces. **Stamens** 65–74, 1.8–1.9 mm long, clavate to narrowly oblong, apex of anther connectives 0.4–0.5 mm long, bluntly conical, densely papillate, filament 0.3–0.4 mm long; staminal cone barely visible, a low ring surrounding the bases of the ovaries; staminodes 16–19, c. 2 mm long, narrowly elliptic, narrowly oblong or oblanceolate, glabrous. **Carpels** 17–18, ovaries c. 0.8 mm long, oblong, densely pubescent; stigmas more or less connivent, c. 1.2 mm long, linear, dark, glabrous or occasionally with a tuft of hairs at the apex. **Torus** flat or a little concave beneath the carpels, c. 3.2 mm in diameter. **Pedicel of fruit** 3–14 mm long, 4.5–10 mm thick at midpoint; torus of fruit 4–9 mm high, 6–17 mm in diameter. **Monocarps** light green to glaucous green, dehiscent when mature to reveal a bright red endocarp *in vivo*, up to 17 per fruit, 2.8–3.6 cm long, 1.1–1.4 cm wide, 1.2–1.3 cm thick, oblong to ellipsoid, roughly circular in cross section, apex rounded, base contracted into a stipe 7–10 mm long and 2.8–3.5 mm thick, irregularly sunken but raised into a longitudinal ridge along the abaxial

midline, pubescent; pericarp 0.3–0.5 mm thick. *Seeds* arranged in two irregular rows, perpendicular to long axis of monocarp, 5–6 per monocarp, grey-white to purple *in vivo*, 7.1–7.6 mm long, 5.3–5.9 mm wide, 4.6–4.9 mm thick, broadly ellipsoid, elliptic in cross section, smooth, obliquely flattened at micropylar end, rounded at chalazal end, sarcotesta evident after soaking as a thin pale yellow layer over dark brown seed coat layers; aril plate surrounding micropyle 3.2–3.3 mm long, 2.7–3 mm wide, a flat ring, white.

*Distribution.* Occurs in East Malaysia (Sarawak and Sabah), and Indonesia (Bangka Belitung, Bengkulu and South Sumatra Provinces of Sumatra and neighbouring islands, and Central Kalimantan and East Kalimantan Provinces on Borneo).

*Ecology.* Lowland primary and mixed dipterocarp forest, often on hilltops or ridges, occasionally in riparian or logged over and secondary forest, in one case in forest consisting of “pole-sized dipterocarps.” It has been collected on granitic sand, sandstone, and red clay at 50–500 m. Associates at one site were species of *Aporosa* Blume, *Dipterocarpus* C.F.Gaertn., *Eugenia* L., *Hopea* Roxb. and *Shorea* Roxb. ex C.F.Gaertn.

*Phenology.* Flowers collected in March–May and July–October; fruits collected in January, April–July and September–October.

*Local names.* *Banetan koening* (Sumatra: *Endert 176 E.1[8 or P].886*), *banetan poetih* (Sumatra: *Boschproefstation nr. F or T 971*), *banitan* (Billiton: *van Rossum 46*), *banitan gadang* (Sumatra: *Dumas 1527*), *banitan laki* (Bangka: *Andong 111*), *bebanditan* (East Kalimantan: *Ambri & Arifin AA7*), *karai* (Sabah: *Maidin 3056*), *karai batu* (Sabah: *Puasa 4550*), *miwi* (East Kalimantan: *Kostermans 6634*), *pisang-pisang* (Sabah: *Ong SAN 120806*, *Wood SAN A 4819*; NOTE: this is a widely used common name for Annonaceae generally), *sebúkau* (Sarawak: *Jacobs 5409*), *usaj* (Bangka: *Kostermans & Anta 223*).

*Etymology.* Named for the twig pubescence, which consists of a mixture of two different types of trichomes: longer erect straight trichomes and shorter curled and more appressed trichomes.

*Additional specimens examined.* MALAYSIA: **Borneo: Sabah:** Kuala Penyu (Beaufort), Kepayan, 30 May 1968 (fr), *Binideh 55770* (K, KEP, L, SAR); Sabah, Nabawan District, Sg. Pingas-Maitland area, 23 May 1986 (fl), *Fidilis Krispinus SAN 115831* (K, KEP); Sandakan 87.5 Hap Seng logging, 24 Jun 1976 (fr), *Leopold & Taha SAN 83551* (K, L [2 sheets]); Beluran District, Bidu-Bidu F.R., 21 Jul 1990 (fr), *Madani SAN 128873* (K, KEP); Marotai, 8 Apr 1933 (fl), *Maidin [B.N.B. 3056]* (A, K); Lahad Datu dist., Diwats, Kennedy Bay Co. area, 60' alt, 9 Jun 1961 (fr), *Muin Chai SAN 25078* (K, L); Tawau District, Sepulut Research Plot, 13 Aug 1987 (fr), *Ong SAN 120806* (K, KEP, L); Tiulon, Nabawan, 600 ft, 16 Sep 1976 (fr), *Tarmiji & Dewol SAN 84191* (K, L, SAR, SING); mi. 61 Telupid Road, 20 m alt, 4 Jul 1980 (fr), *Termiji*

*Arshid SAN 92570* (K, KEP, L, SAR); Lahad Datu District, Cpt. 6, North Borneo Timber Co., Concession Area, Kretam, 22 May 1954 (fr), *Wood SAN A 4819* (A, L, SING); Sandakan Cpt. 16, Sepilok Forest Reserve 15 mi W of Sandakan, 30 Apr 1955 (fl), *Wood & Charington 16318* (A, KEP, L, SING); **Sarawak:** 3rd Division, Kapit District, Belaga subdistrict, left bank of Rajang River c. 10 km below Belaga, Segaham Range near Belaga airfield, 2°40'N 113°50'E, <500 m, 3 Sep 1958 (fr), *Jacobs 5409* (K, L, SAR, US), 7 Sep 1958 (fl), *Jacobs 5453* (K, L, SAR, SING, US); Ulu Sg. Semawat Belaga, 7th Division, 23 Oct 1981 (young fr), *Othman et al. S.43397* (ASU, L, SAR).

INDONESIA: **Sumatra: Bangka Belitung:** Bangka, Lobok Besar, 5 m, 14 Sep 1949 (st), *Andong 111* (L [2 sheets]); Ond. Luid. Bangka, 20 m, 16 Apr 1927 (st), *Boschproefstation bb.11299 [Mohamad Oetei 149]* (A); Lobok-besar, SE Bangka, 30 Aug 1949 (fl), *Kostermans & Anta 223* (A, K, L, NY, SING); Lobok-besar, G. Pading, 100 m, 30 Sep 1949 (fl), *Kostermans & Anta 1012* (A, K, L, SING); Billiton, s.d. (fl), *van Rossum 46* (L [2 sheets]); **Bengkulu:** Lais, Talang Benal, 250 m, 20 Mar 1925 (st), *Idris 5/bb.8858* (A); **South Sumatra:** Res. Palembang ond. Afd. Lemakang Ilir, 75 m, 8 Sep 1924 (fl), *Boschproefstation nr. F or T 971* (L); Palembang, Rawas, 27 Apr 1917 (st), *Dumas 1527* (L); Res. Palembang, ond. Afd. Banjoeasin en Koeboestrecken, 25 m, 6 Feb 1920 (fl), *Endert 176 E.1[8 or P].886* (L [2 sheets]); Banjoeasin en Koeboestrecken, 16 Nov 1915 (fr), *Grashoff 828 p.p.* (L); **Borneo: Central Kalimantan:** Samba, 1994–1995 cutting blocks of PT Handiyani, 0°43'16.7"S 112°50'34.2"E, 340 m, 24 Jan 1995 (fr), *Jarvie & Ruskandi 5229* (A, KEP, L); P. B. U. base camp and environs, Trail Jalang Nancy, 16 Jun 1990 (fl, fr), *Ridsdale PBU55* (L [2 sheets]); **East Kalimantan:** Sepaku PT ITCI, Kenangan, Balikpapan, 30 Oct 1990 (fl), *Ambri & Arifin AA7* (A, K, L); Wanariset, Wanariset Research I area, off km 35, Wanariset-semoi Road, 70 m, 16 Jan 1991 (fr), *Ambri & Arifin W602* (A, K, L); Bulungan, Nunukan, Boschtuin, 8 May 1939 (fl), *Netherlands Indies Forest Service bb.29395* (A, L, SING); Loa Djanan, W of Samarinda, 30 m, 27 Apr 1952 (fr), *Kostermans 6634* (A, BO, K, L, SING); Boeloengan, Kabiran, G. Simendoeroel, 5 Aug 1927 (st), *Zwaan bb.11722* (A); Pujungan Dist., Kayan-Mentirang Nature Reserve on Bahau River at or to 3 km above confluence with Gong Biou River towards Long Alango, 02°50'N 115°50'E, 6 Jul 1992 (fr), *McDonald & Ismail 3526* (A, F, L, SING); West Kutei, 20 Mar 1932 (st), *Netherlands Indies Forest Service bb.16521* (A, L); Kutei, 15 Jul 1957, *Schut K.22* (BO, K, L, SING); Sungai Wain Protected Forest of km 15 Balikpapan-Samarinda, 50 m, 11 Jan 1992 (fr), *Sidiyasa et al. 818* (A, K, L).

*Notes.* *Xylopiia heterotricha* is distinctive because of the unusual character of the twig pubescence, which consists of a mixture of long light-coloured acicular hairs and short brown curled hairs. The leaf blades are relatively small and oblong, often with a blotchy mottled appearance to the adaxial leaf blade surface when dried. The petals are very long, approaching in length those of *Xylopiia magna* Maingay ex Hook.f. & Thomson from Peninsular Malaysia, Singapore and Borneo. The number of carpels and monocarps is exceptional for the *Xylopiia malayana* group, reaching up to 18: the more typical number for species in this group is fewer than 7, rarely up to ten (Keng & Heaslett, 1973); The monocarps are superficially similar to those of *Xylopiia malayana* in being persistently pubescent and distinctly stipitate, but are usually wrinkled or puckered when dry and never obliquely striate as in the monocarps of *Xylopiia malayana*.

Previous reports of *Xylopiia elliptica* from Borneo (e.g., Sinclair, in litt.; Turner, 2011, 2014) all refer to *X. heterotricha*.

***Xylopi*** *sessiliflora* (Kochummen & Whitmore) D.M.Johnson & N.A.Murray, **comb. nov.** – *Xylopi* *fusca* var. *sessiliflora* Kochummen & Whitmore, Fed. Mus. J. 13: 135 (1970 [‘1968’]). – TYPE: Malaysia, Negeri Sembilan, Kuala Pilah, Pasoh F.R., Compt. No. 14, 19 February 1927, *Mohd. Yatim bin Aseh, Forester, for Serting KEP 62984* (holotype KEP).

*Distribution.* Peninsular Malaysia. Known from only five collections, each from a different state in Peninsular Malaysia. Last collected in 1972.

*Additional specimens examined.* MALAYSIA: **Peninsular: Johor:** E Johore, Sungai Kaya, 15 Mar 1937 (fl), *Kiah SFN 32403* (A, BKF, K, KEP, SING); **Melaka:** Without definite locality, without date (fl), *Herb. Cantley 5842* (SING); **Pahang:** Tasek Bera FR, 22 Jul 1972 (fl), *Chan FRI 16942* (A, K, KEP, L, SAR, SING); **Perak:** Without definite locality, without date (bud), *Wray 3194* (CAL (Sinclair, 1955), SING [2 sheets]).

*Notes.* The combination of dense appressed pubescence of the abaxial leaf surfaces and twigs and the very short flower pedicels readily distinguishes *Xylopi* *sessiliflora* from all other Peninsular Malaysian *Xylopi* species. *Xylopi* *sessiliflora* differs from *X. fusca* of the *Xylopi* *ferruginea* group in a number of significant ways. The leaf indument is silvery grey rather than golden, the leaf blades are lanceolate, ovate, or elliptic and usually acuminate at the apex, rather than oblong and obtuse, rounded, or rarely short-acuminate at the apex, the pedicel is only 2–3.4 mm long as opposed to 5–10 mm long, the calyx is only ¼-connate rather than ½–⅔-connate, the petals are up to 44 mm long rather than only up to 26 mm long, and there are 8–10 rather than 3–5 carpels. The paratype *Kiah SFN 32403* had been identified by Sinclair (1955) as *Xylopi* *malayana*. To confuse things further, this specimen was identified in turn as both *Xylopi* *elliptica* and *X. malayana* in the same publication by Corner (1978).

The fruit of this species is not yet known, and may provide additional characters for distinguishing it from other *Xylopi* species in the Pasoh Reserve and elsewhere. According to Kochummen (1997), trees of this species in the Pasoh Reserve have stilt roots, the only similarity with *Xylopi* *fusca* and other members of the *X. ferruginea* group.

Four specimens were cited in the protologue of *Xylopi* *fusca* var. *sessiliflora*. In addition to the type and *Kiah SFN 32403* already discussed, these two were cited: Johor: Labis F.R., *KEP 105267* and Kedah: Gunong Inas F.R., *KEP 104789*. The latter two specimens are sterile; the Kedah specimen definitely does not look like other material of this species, and the Johor specimen is not determinable.

## Conclusion

A clearer understanding of regional patterns of distribution of the 23 *Xylopi* species occurring in the Sundaic region of Southeast Asia is now possible. Six species are widespread across the Malay Peninsula, Sumatra and Borneo: *Xylopi* *caudata* Wall.

ex Hook.f. & Thomson, *X. ferruginea*, *X. fusca*, *X. malayana*, *X. ngii* and *X. sumatrana*. *Xylopiia* does not occur on Java. Two species are shared between the Malay Peninsula and Sumatra: *X. dicarpa* Hook.f. & Thomson and *X. oxyantha* (Wall. ex Hook.f. & Thomson) Hook.f. & Thomson. Two species are shared between the Malay Peninsula and Borneo: *Xylopiia erythroductyla* and *X. magna*. *Xylopiia magna* was previously known only from the Malay Peninsula; the following specimen represents the first record of that species for Borneo: Malaysia, Sarawak, logging area, Bukit Tubeh, Tebedu, Serian, 23 Jun 1996 (fr), *Jamree et al. S.73290* (KEP). *Xylopiia heterotricha* is shared between Sumatra and Borneo.

*Xylopiia elliptica*, *X. platycarpa*, *X. sessiliflora* and *X. subdehiscens* (King) J. Sincl. are known only from the Malay Peninsula, and *Xylopiia coriifolia* Ridl., *X. kuchingensis* I.M.Turner & D.M.Johnson, *X. mucronata* Boerl., *X. orestera* I.M.Turner & D.M.Johnson and *X. pulchella* Ridl. are unique to Borneo. There is no species currently known to be endemic to Sumatra.

Sundaic species with distributions extending outside of the region include *Xylopiia densifolia* Elmer and *X. dehiscens* (Blanco) Merr., which occur in Borneo and the Philippines. *Xylopiia pierreii*, occurring in Thailand, Cambodia, and Vietnam, just reaches the Malay Peninsula. *Xylopiia vielana* is the only species in Thailand that does not occur in the Sundaic region, its distribution extending instead from northeastern Thailand into Vietnam and southern China. With the notable exception of the Malay Peninsula endemics mentioned above, all of which belong to the *Xylopiia malayana* group, the *X. ferruginea* group and the *X. malayana* group exhibit strongly similar biogeographic patterns in the region.

Some of the rarer species of *Xylopiia* in the area may be simply under-collected. Several species are large trees more than 40 meters in height, and this, coupled with sparseness of individuals in populations, may cause them to be overlooked. Some lowland evergreen rainforest xylopiias may, however, exist only in small fragmented relict populations of the Sundaland lowland evergreen forests that contracted into refugia following the last glacial maximum (Cannon et al., 2009). This explanation accords well with the extraordinary diversity of the genus found at sites such as the Pasoh Reserve, where in 2014 we verified the occurrence of seven *Xylopiia* species in or near the Pasoh permanent 50-hectare research plot (Manokaran et al., 1992). While the Pasoh plot is known as an area of high diversity, seven *Xylopiia* species within such a small area is unequalled in our field experience with the genus.

The intensive inventories of lowland rainforest plots in southeastern Asia (see Losos & Leigh, 2004) have documented that Annonaceae are a vital component of these forests and that *Xylopiia* species are invariably a substantial component of that Annonaceae diversity (Manokaran et al., 1992; Lee et al., 2002). Data from these research plots can begin to give us a measure of population structure for many species, including those of *Xylopiia*, but only if species-level identification can be reliably established. It is hoped that this contribution toward clarification of *Xylopiia* taxonomy in the region will enable stronger cross-comparisons among these long-term plots. Our results make clear, however, that further collecting and taxonomic analysis of the Malay Peninsula flora is still critically needed.

ACKNOWLEDGEMENTS. We thank the Singapore Botanic Gardens and the Forest Research Institute Malaysia (FRIM) for their vital support of our project. The Singapore Botanic Gardens provided critical financial support in the form of SBG Research Fellowships, and we were generously supported at FRIM as FRIM Fellows, funded by the Ministry of Science, Technology and Innovation, Malaysia (MOSTI) under the “Flora of Peninsular Malaysia project” (01-04-01-000 Khas) and “Documentation & Inventory of Flora of Malaysia project,” based at Forest Research Institute Malaysia. In Singapore we received kind assistance from Edmund Chia, Bazilah Ibrahim, Nura Bte Abdul Karim, Joseph Lai, Samantha Lai, Serena Lee, Michael Leong, Paul Leong, Jana Leong-Škorničková, Low Yee Wen, Shawn Lum, David Middleton, Michele Rodda, Benito Tan, Nigel Taylor, Elango Velautham, Craig Williams, and Winnie Wong. We express our appreciation for assistance in Malaysia from Saw Leng Guan, Richard C.K. Chung, Mohamed A. Latiff, Ruth Kiew, Ummul Nazrah Abdul Rahman, Yao Tze Leong, Rafidah Abdul Rahman, Avelinah Julius, Norsham Suhaina Yaakob, Ming Yee Chew and Ong Poh Tek. Sabbatical leave support from Ohio Wesleyan University is gratefully acknowledged, as is financial support from the TEW Presidential Discretionary fund at Ohio Wesleyan, which supported our further herbarium work at L and K. Additional funding to support herbarium work at L was provided by Naturalis Biodiversity Centre in Leiden kindly arranged by Erik Smets. At Kew we were hosted by David Goyder and the Drylands Africa team and received assistance from Ian Turner. For providing key photographs of two of the new *Xylopia* species to help illustrate this paper we thank Simon Gardner and James LaFrankie. Kate Ball provided the excellent pen and ink rendering of *Xylopia erythrodactyla*. For assistance with preparation of the figures for publication we thank Sara Stuntz, Doug Thompson and Emily Gattozzi. We thank the two anonymous reviewers for suggesting improvements to the manuscript. Finally, we thank curators of the following herbaria for making specimens available to us either by loan or during our visits: A, AAU, ASU, BISH, BKF, BM, BO, K, KEP, KLU, L, M, MICH, MO, NY, SAR, SING, U, UKMB, US.

## References

- Appanah, S., Gentry, A.H. & LaFrankie, J.V. (1993). Liana diversity and species richness of Malaysian rain forests. *J. Trop. Forest Sci.* 6: 116–123.
- Boerlage, J.G. (1899). *Icones Bogorienses*. Volume 1, 3me Fascicule, plates 51–75. Leiden: E.J. Brill.
- Burkill, H.M. (1985). *The Useful Plants of West Tropical Africa*. UK: Royal Botanic Gardens, Kew.
- Cannon, C.H., Morley, R.J. & Bush, A.B.G. (2009). The current refugial rainforests of Sundaland are unrepresentative of their biogeographic past and highly vulnerable to disturbance. *Proc. Natl. Acad. U.S.A.* 106: 11188–11193.
- Chalermglin, P. (2001). Family Annonaceae. Bangkok: Ban & Suan. [in Thai]
- Corlett, R.T. & Turner, I.M. (1997). Long-term survival in tropical forest remnants in Singapore. In: Laurence, W.F. & Bierregaard, R.O., Jr. (eds) *Tropical Forest Remnants: Ecology, Management, and Conservation of Fragmented Communities*. Pp. 333–345. Chicago, Illinois: University of Chicago Press.
- Corner, E.J.H. (1978). *The Freshwater Swamp-forest of South Johore and Singapore*. *Gardens' Bulletin Supplement* No. 1. Singapore: Singapore Botanic Gardens.
- Dakkus, P.M.W. (1957). *An Alphabetical List of Plant Species Cultivated in the Hortus Botanicus Bogoriensis*. Bogor, Indonesia: Pertjetkanan Archipel.



- Dunal, M.F. (1817). *Monographie de la Famille des Anonacées*. Paris: Treuttel & Würtz.
- Gardner, S., Sidisunthorn, P. & Chayamarit, K. (2015). *Forest Trees of Southern Thailand*, vol. 1. Bangkok: The Forest Herbarium and UK: The Royal Botanic Gardens, Kew.
- Hooker, J.D. & Thomson, T. (1872). *Flora of British India*, vol. 1. London: L. Reeve & Co.
- IUCN (2012). *IUCN Red List Categories and Criteria: Version 3.1*. 2nd ed. Gland, Switzerland and Cambridge, UK: IUCN.
- IUCN (2014). IUCN Red List of Threatened Species. Version 2014.2. <https://www.iucnredlist.org>. (accessed on 9 Sep. 2014).
- Keng, H. & Heaslett, E.A. (1973). The *Xylopiinae* fruit: significance of its dehiscence. *Gard. Bull. Singapore* 26(2): 223–225.
- King, G. (1892). Materials for a flora of the Malayan Peninsula – no. 4. *J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist.* 61: 1–130.
- Kochummen, K.M. (1972a). Notes on the systematy of Malayan phanerogams XI–XVII. *Gard. Bull. Singapore* 26(1): 49–61.
- Kochummen, K.M. (1972b). Annonaceae. In: Whitmore, T.C. (ed) *Tree Flora of Malaya: A Manual for Foresters*, vol. 1. Kuala Lumpur: Longman Sdn. Bhd.
- Kochummen, K.M. (1997). *Tree Flora of Pasoh Forest. Malayan Forest Records* No. 44. Kepong, Malaysia: Forest Research Institute Malaysia.
- Kochummen, K.M., Ng, F.S.P. & Whitmore, T.C. (1970). Notes on the systematy of Malayan Phanerogams: VI–X. *Fed. Mus. J.* 13: 134–135.
- LaFrankie, J.V. (2010). *Trees of Tropical Asia: An Illustrated Guide to Diversity*. Manila, Philippines: Black Tree Publications, Inc.
- Lee, H.S., Ashton, P.S., Yamakura, T., Tan, S., Davies, S.J., Itoh, A., Chai, E.O.K., Ohkubo, T. & LaFrankie, J.V. (2002). *The 52-hectare Forest Research Plot at Lambir Hills, Sarawak, Malaysia: Tree Distribution Maps, Diameter Tables and Species Documentation*. Sarawak: Forest Department, USA: The Arnold Arboretum-CTFS Asia Program and USA: The Smithsonian Tropical Research Institute.
- Losos, E.C. & Leigh, E.G. Jr. (eds) (2004). *Tropical Forest Diversity and Dynamism: Findings from a Large-scale Plot Network*. Chicago, Illinois: University of Chicago Press.
- Manokaran, N., LaFrankie, J.V., Kochummen, K.M., Quah, E.S., Klahn, J.E., Ashton, P.S. & Hubbell, S.P. (1992). *Stand Table and Distributions of Species in the 50-ha Research Plot at Pasoh Forest Reserve*. Kepong, Malaysia: FRIM Research Data.
- McNeill, J., Barrie, F.R., Buck, W.R., Demoulin, V., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Marhold, K., Prado, J., Prud'homme van Reine, W.F., Smith, G.F., Wiersma, J.H. & Turland, N.J. (2012). *International Code of Nomenclature for algae, fungi, and plants (Melbourne Code)*. *Regnum Vegetabile* 154. Königstein: Koeltz Scientific Books.
- Ng, F.S.P. (1991). *Manual of Forest Fruits, Seeds and Seedlings*, vol. 1. *Malayan Forest Records* No. 34. Kepong, Malaysia: Forest Research Institute Malaysia.
- Ng, F.S.P. & Mat Asri Ngah Sanah. (1991). *Germination and Seedling Records*. Ibrahim, Z. (ed) Research Pamphlet No. 108. Kepong, Malaysia: Forest Research Institute Malaysia.
- Ridley, H.N. (1922). *The Flora of the Malay Peninsula*, vol. 1. London: L. Reeve & Co.
- Saw, L.G. (2010). Vegetation of Peninsular Malaysia. In: Kiew, R., Chung, R.C.K., Saw, L.G., Soepadmo, E. & Boyce, P.C. (eds) *Flora of Peninsular Malaysia, Series II: Seed Plants* 1: 21–45. Kepong, Malaysia: Forest Research Institute Malaysia.
- Sidiyasa, K., Arbainsyah & Kessler, P.J.A. (1999). *List of Collections Stored at the Wanariset Herbarium, East Kalimantan, Indonesia*. Samboja, Indonesia: The International MOFEC-Tropenbos Kalimantan Project.

- Sinclair, J. (1953). Notes on Siamese Annonaceae. *Gard. Bull. Singapore* 14(1): 40–44.
- Sinclair, J. (1955). Revision of the Malayan Annonaceae. *Gard. Bull. Singapore* 14(2): 149–516.
- Stull, G.W., Johnson, D. & Soltis, P. (2011). A preliminary molecular phylogeny of the pantropical genus *Xylopia* (Annonaceae): implications for character evolution and biogeography. Unpublished poster presentation at: Botany 2011, Healing the Planet, 9–13 July 2011, St. Louis, Missouri, USA. [<http://2011.botanyconference.org/engine/search/index.php?func=detail&aid=354>]
- Thomas, D.C., Chatrou, L.W., Stull, G.W., Johnson, D.M., Harris, D.J. & Saunders, R.M.K. (2015). The historical origin of palaeotropical intercontinental disjunctions in flowering plants: insights from the pantropical plant family Annonaceae. *Perspect. Pl. Ecol. Evol. Syst.* 17: 1–16.
- Turner, I.M. (2011). A catalogue of the Annonaceae of Borneo. *Phytotaxa* 36: 1–120.
- Turner, I.M. (2014). Annonaceae. In: Soepadmo, E., Saw, L.G., Chung, R.C.K. & Kiew, R. (eds) *Tree Flora of Sabah and Sarawak* 8: 1–200. Kepong, Malaysia: Forest Research Institute Malaysia.
- Woodruff, D.S. (2003). Neogene marine transgressions, paleogeography and biogeographic transitions on the Thai-Malay Peninsula. *J. Biogeogr.* 30: 551–567.