

PIPERACEAE

P.R. Gajurel¹ & H.K. Lua²

Giseke, Prael. Ord. Nat. Pl. (1792) 123, as ‘Piperitae’, nom. cons.; Miquel, Syst. Piperac., fasc. 1 (1843) 43; Miquel, Fl. Ned. Ind. 1(2), fasc. 3 (1859) 431; de Candolle, Prodr. 16(1) (1869) 240; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 78; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 288; Ridley, Fl. Malay Penins. 3 (1924) 25; Trelease, Contr. U. S. Natl. Herb. 26 (1927) 15; Burger, Fieldiana, Bot. 5 (1971) 5; Howard, J. Arnold Arbor. 54 (1973) 377; Lui & Wang, Fl. Taiwan 2 (1975) 556; Keng, Gard. Bull. Singapore 31 (1978) 85; Keng, Ord. Fam. Malayan Seed Pl., ed. 3 (1983) 123; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 62; Tebbs in Kubitzki et al. (ed.), Fam. Gen. Vasc. Pl. 2 (1993) 516; Cheng et al., Fl. China 4 (1999) 110; Suwanphakdee et al., Fl. Thailand 16(3) (2024) 875. **Type:** *Piper* L.

Herbs, erect or climbing shrubs, rarely trees, sometimes epiphytes, usually aromatic. **Stem** woody or succulent, glabrous or hairy, nodes distinct, mostly swollen, sometimes rooting; vascular bundles scattered as in monocotyledons. **Leaves** simple, alternate, often opposite or whorled in *Peperomia*, base of lamina often asymmetric, palmately or pinnately veined, dimorphic in some climbing species of *Piper*, petiolate; stipulate or exstipulate. **Inflorescence** a pedunculate spike, leaf opposed, terminal or axillary, rarely grouped into an umbel, erect, sub-erect or pendent, flowers densely or distantly arranged. **Flowers** small, polygamous or dioecious, rarely bisexual, always sessile; perianth absent; bracts small, usually orbicular and peltate, or cupular, sometimes raised to form a receptacle. **Stamens** 1–10, hypogynous, or basally connate with ovary; filaments short, usually free; anthers 2–4-locular, distinct or connate, longitudinally dehiscent. **Ovary** 1-celled, superior, 1-locular, ovule 1, orthotropous; stigmas 1–5, sessile or with very short styles. **Fruits:** drupes (in all Singapore species) or nutlets, indehiscent, pericarp fleshy, thin or dry, sometimes with sticky papillae (in *Peperomia*). **Seeds** with copious starchy perisperm and a minute embryo embedded in a small endosperm.

Distribution. A family of 5 genera and c. 3600 species, the large majority of which belong to the two genera *Piper* L. (with about 2000 species) and *Peperomia* Ruiz & Pav. (with about 1600 species). The family is pantropical and almost all the species are confined to tropical and subtropical regions. There are many species in Central and South America, while in the Paleotropics the highest species diversity is found in Southeast Asia, followed by the South Pacific islands. There are fewer species in Africa. Species vary from very locally endemic to being extremely widespread, with higher rates of local endemism in regions of highest diversity. The Andes and Central America in the Neotropics and China, India and Peninsular Malaysia in the Paleotropics show the highest percentages of endemic species. In Asia, the greatest diversity is found in the Indo-Malayan region with about 300 species. In Asia, all species of Piperaceae are in the genera *Piper* and *Peperomia* except for *Zippelia begoniifolia* Blume, the sole member of a monotypic genus that is found in continental Southeast Asia and

Addresses: North Eastern Regional Institute of Science & Technology, Arunachal Pradesh, India;

²National Biodiversity Centre, National Parks Board, Singapore.

Doi: 10.26492/fos4.2026-07; 4 September 2026 (online & print).

Western Malesia but not in Singapore. In Singapore, 2 genera, 1 native and 1 introduced, and 20 species, one of which has not yet been identified. Of the 19 identified species, 16 are native, 2 are naturalised and 1 is casual.

Ecology. Worldwide, the Piperaceae occupy a diverse array of habitats in tropical and subtropical forests and thrive best in warm and humid areas as part of the forest understorey. In Neotropical forests, *Piper* and *Peperomia* are two of the most species-rich genera in these habitats (Gentry, Four Neotrop. Rain Forests (1990) 141–157) and include important species for frugivorous bats. In Asia, the family is mostly confined to lowland swamps and forests below 2000 m although a few species are found up to 3000 m.

Uses. The family is well known for the species used as spices, other foodstuffs, and in medicine, particularly species from the genus *Piper*. Amongst the more economically important are *Piper nigrum* L., which is the pepper of commerce, *P. longum* Roxb., which is the pipali of Ayurvedic medicines, *P. betle* L., which is the commercial betel leaf, and *P. methysticum* G.Forst., which is the medicinal species of the Pacific islands called kava. In addition to these, many other species of *Piper* are used in traditional medicines. Several species of *Peperomia* are horticulturally important as ornamental plants.

Vernacular name. In English, known as the pepper family.

Taxonomy. The family Piperaceae belongs in the order Piperales along with Aristolochiaceae, Hydnoraceae and Saururaceae (APG IV, Bot. J. Linn. Soc. 181 (2016) 1–20). Although up to 13 genera have been recognised in Piperaceae, phylogenetic studies indicate that there are five distinct genera, namely *Piper*, *Peperomia*, *Zippelia* Blume, *Manekia* Trel. and *Verhuellia* Miq. (Wanke et al., Molec. Phylogen. Evol. 42 (2007) 477–497; Wanke et al., Ann. Bot. (Oxford) 99 (2007) 1231–1238; Samain et al., Taxon 56 (2007) 229–236). The other previously recognised genera are now included in *Piper* and *Manekia*.

Notes. The above description of the family applies to the family as it is found in Singapore and Peninsular Malaysia. Elsewhere, particularly in the Neotropics, the family is considerably more variable.

Key to genera

1. Erect herbs, annual or perennial; leaves exstipulate; flowers bisexual **1. Peperomia**
- Erect shrubs, small trees or climbers, often woody at least at base; leaves stipulate; flowers mostly unisexual **2. Piper**

1. PEPEROMIA Ruiz & Pav.

(Greek, *peperi* = pepper, *homoios* = resembling; similar to the pepper plant)

Fl. Peruv. Prodr. (1794) 8; Miquel, Syst. Piperac., fasc. 1 (1843) 63; Miquel, Fl. Ned. Ind. 1(2), fasc. 3 (1859) 432; de Candolle, Prodr. 16(1) (1869) 392; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 96; de Candolle, Rec. Bot. Surv. India 6(1) (1912) 1; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 289; Ridley, Fl. Malay Penins. 3 (1924) 26; Keng, Gard. Bull. Singapore 31 (1978) 85; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 62; Tebbs in Kubitzki et al. (ed.), Fam. Gen. Vasc. Pl. 2 (1993) 519; Suwanphakdee & Hodkinson in Suwanphakdee et al., Fl. Thailand 16(3) (2024) 876. **Type:** *Peperomia pellucida* (L.) Kunth, lectotype designated by Trelease & Yunker, Piperac. N. South Amer. (1950) 443.

Annual or perennial low herbs, terrestrial, epiphytic or saxicolous; stems prostrate, erect or decumbent, thick, often rooting at nodes. **Leaves** alternate, opposite or whorled, entire, pellucid and fleshy, exstipulate, mostly ovate cordate or rounded, glabrous or pubescent, green or variously coloured with red, yellow, brown or black glandular dots, palmately or pinnately veined, sessile or petiolate, petiole cylindrical, sulcate or alate, petiole sometimes peltate. **Inflorescence** a spike or raceme, axillary, terminal or leaf opposed, erect or pendent, rachis glabrous, pubescent or papillose; bracteate, bracts mostly orbicular, peltate, glabrous or fimbriate. **Flowers** bisexual, numerous, minute, densely or loosely arranged, sessile or sunk in the rachis, often whorled; perianth absent; stamens 2, very short, anther cells confluent; ovary obtuse, acute or beaked, 1-celled; stigma lateral or terminal, usually penicillate; ovule 1, erect. **Fruits:** drupes, small, sessile or stalked, globose, ovoid, obovoid or ellipsoid, indehiscent. **Seed** with a membranous testa.

Distribution. The genus includes about 1600 species worldwide, making it one of the largest genera of angiosperms distributed in the tropical and subtropical regions of the world (Vergara-Rodriguez et al., Trop. Conserv. Sci. 10 (2017) 1–28). Nearly 90% of *Peperomia* species are found in Neotropical regions with the rest in Southeast Asia, Africa, Australia and New Zealand (Wanke et al., Plant Biol. 8 (2006) 93–102). About 30 species are reported from Southeast Asian countries. In Singapore, 1 naturalised species.

Ecology. Across its range, mostly growing below 1500 m in moist and shady tropical and subtropical forests. Many of the species grow as epiphytes in rain forest habitats and as succulent plants in the high Andes.

Uses. Some species of *Peperomia* are grown for the ornamental value of their leaves and/or flowers. Some are also used medicinally.

Taxonomy. The infra-generic classification that has been most widely adopted is that of Dahlstedt (Kungl. Svenska Vetenskapsakad. Handl. 33(2) (1900) 1–218) which classified *Peperomia* into 9 subgenera, 7 sections and 4 subsections. This was later amended by Samain et al. (Taxon 56 (2007) 229–236) to recognise 11 subgenera.

Peperomia pellucida (L.) Kunth

(Latin, *per-* = very, *lucidus* = shining, clear, transparent; referring to the leaves when dry)

Nov. Gen. Sp. 1 (1816) 64; Miquel, Syst. Piperac., fasc. 1 (1843) 79; Miquel, London J. Bot. 4 (1845) 413; de Candolle, Prodr. 16(1) (1869) 402; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 96; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 292; Ridley, Fl. Malay Penins. 3 (1924) 27; Henderson, Malay. Wild Fls., Dicot. (1959) 436; Keng, Gard. Bull. Singapore 31 (1978) 85; Corlett, J. Biogeogr. 15 (1988) 662; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 62, fig. 58.1; Turner, Gard. Bull. Singapore 45 (1993) 188; Chew et al., Gard. Bull. Singapore 49(2) (1999 [‘1997’]) 222; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 68, 167, 267; Lok et al., Cosmos 6 (2010) 71; Hung et al., Nat. Singapore 10 (2017) 17, 23; Hung et al., Nat. Singapore 10 (2017) 47; Kaw & Neo, Wayside Fls Singapore (2018) 94; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 601; Suwanphakdee & Hodgkinson in Suwanphakdee et al., Fl. Thailand 16(3) (2024) 891. **Basionym:** *Piper pellucidum* L., Sp. Pl. 1 (1753) 30; Vahl, Enum. Pl. 1 (1804) 346. **Type:** [Published illustration] *Piper foliis cordatis, caule procumbente* in Linnaeus, Hort. Cliff. (1738 [‘1737’]) t. 4, lectotype designated by Stearn, Introd. Linnaeus’ Sp. Pl. (1957) 47. **Fig. 1.**

Piper exiguum Blume, Verh. Batav. Genootsch. Kunsten 11 (1826) 232. **Synonyms:** *Micropiper exiguum* (Blume) Miq., Comm. Phytogr., fasc. 2 (1840) 55. – *Peperomia exigua* (Blume) Miq., Syst. Piperac., fasc. 1 (1843) 77; Ridley, J. Straits Branch Roy. Asiat. Soc. 33 (1900) 128. **Type:** *Collector unknown s.n.*, [Indonesia], Java (lectotype L [L0040968], designated here).

Annual herbs, erect, 15–30 cm tall, rarely to 50 cm, quite glabrous. **Stem** succulent, weak and brittle, roots at the nodes, pellucid when dry. **Leaves** alternate; lamina membranous, ovate, 1.5–2.5 × 1–1.6 cm, base cordate, apex acute or shortly acuminate, pellucid when dry, lateral veins 3 pairs, palmate, all from base; petiole 0.8–1.5 cm long. **Spikes** leaf opposed, erect, slender or filiform, glabrous, 2–4 cm long; peduncle 1–1.5 cm long. **Flowers** densely aggregated, bisexual, minute; bracts orbicular, subsessile; stamens 2, anthers rounded, filaments very short; ovary 1, globose, stigmas 4, puberulous. **Drupes** very small, globose, mucronate at the apex, with longitudinal verruculose rib.

Distribution. Native to tropical Central and South America but now widely distributed throughout the tropical regions of the world and often naturalised as a weed. In Singapore, it is known from many semi-urban and urban habitats including Pulau Damar (*Ridley* 6722, 1894, SING [SING0042298]), Pasir Panjang (*Ridley s n.*, 1896, SING [SING0042297]), Singapore Botanic Gardens (*Purseglove* P 4007, 26 Sep 1954, SING [SING0042296]), Woodlands Road (*Tang & Sidek* 226, 28 Sep 1994, SING [SING0042294]) and Sentosa (*Lua et al.* SING2020-429, 25 Feb 2020, SING [SING0324789]).

Ecology. In shaded or open areas in moist or damp places, semi-shaded planted verges or near forest edges. Often a weed of waste ground.

Conservation assessment. Globally, not assessed. Not native in Singapore.

Uses. The entire plant is edible, both cooked and raw. Medicinally, the leaves and stems are used for the treatment of asthma, rheumatism, wounds, fever, stomach problems, kidney infections, joint pain, hypertension, diarrhoea etc. The plant is reputed to exhibit, amongst others, analgesic, anticancer, antipyretic, antidiabetic, antimicrobial, antioxidant, anti-



Figure 1. *Peperomia pellucida* (L.) Kunth. **A.** Habit. **B.** Close-up of plant. **C.** Flowering spike. **D.** Fruiting spike. **E.** Ripe drupes. (A–E from Singapore, Choa Chu Kang. Photos: H.K. Lua).

inflammatory, diuretic pharmacological properties (Burkill, Dict. Econ. Prod. Malay Penins. 2 (1935) 1722; Raghavendra & Kekuda, Inter. J. Pharm. Pharm. Sci. 10 (2018) 1–8). It is also grown for its ornamental value.

Vernacular names. *Pepper elder*, *shiny bush*, 草胡椒, 透明草 (NParks' Flora & Fauna Web, 2026).

Notes. This is a common herb that used to be frequently found in villages and gardens and still occurs in partly shaded grassy patches or around old buildings in urban areas. Its shiny leaves and succulent stem are easily bruised and feel watery when pressed or broken between the fingers.

2. PIPER L.

(Greek, *peperi* = pepper)

Sp. Pl. 1 (1753) 28; Linneaus, Gen. Pl., ed. 5 (1754) 18; Roxburgh, Hort. Bengal. (1814) 4; Roxburgh, Fl. Ind. 1 (1820) 153; Roxburgh, Fl. Ind. 1 (1832) 150; Miquel, Syst. Piperac., fasc. 2 (1844) 305; Miquel, Fl. Ned. Ind. 1(2), fasc. 3 (1859) 451; de Candolle, Prodr. 16(1) (1869) 240; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 78; de Candolle, Rec. Bot. Surv. India 6(1) (1912) 2; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 293; de Candolle, Candollea 1 (1923) 67; Ridley, Fl. Malay Penins. 3 (1924) 27; Trelease & Yuncker, Piperac. N. South Amer. (1950) 6; Chew, J. Arnold Arbor. 53 (1972) 1; Keng, Gard. Bull. Singapore 31 (1978) 85; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 62; Tebbs in Kubitzki et al. (ed.), Fam. Gen. Vasc. Pl. 2 (1993) 518; Suwanphakdee et al., Fl. Thailand 16(3) (2024) 896. **Type:** *Piper nigrum* L.

Cubeba Raf., Sylva Tellur. (1838) 84. **Type:** *Cubeba officinalis* Raf. (= *Piper cubeba* L.f.).

Muldera Miq., Comm. Phytogr., fasc. 2 (1840) 32. **Type:** *Muldera baccata* (Blume) Miq. (= *Piper baccatum* Blume), lectotype designated here.

Artanthe Miq., Comm. Phytogr., fasc. 2 (1840) 40, nom. illeg. superfl. **Type:** *Oxodium callosum* (Ruiz & Pav.) Raf. (= *Piper callosum* Ruiz & Pav.).

Steffensia Kunth, Linnaea 13(6) (1840) 609, nom. illeg. non Göpp. (1836). **Type:** Not designated.

Chavica Miq., Syst. Piperac., fasc. 1 (1843) 46, 222. **Type:** *Chavica betle* (L.) Miq. (= *Piper betle* L.), lectotype designated here.

Rhyncholepis Miq., Syst. Piperac., fasc. 1 (1843) 46, 282. **Type:** *Rhyncholepis brevicuspis* Miq. (= *Piper brevicuspis* (Miq.) Merr.), lectotype designated here.

Schizonephros Griff., Not. Pl. Asiat. 4 (1854) 383. **Type:** *Schizonephros glaucescens* Griff. (= *Piper schizonephros* C.DC.).

Erect or climbing shrubs, rarely herbs or small trees, plant parts aromatic, glabrous or hairy; branches dimorphic in climbing species. **Stem** woody or semi-woody, nodes distinct and thickened, vegetative branches rooting at nodes, nodes in fertile branches without adventitious

roots; outer vascular bundles in a ring, inner bundles scattered in one or two series. **Leaves** simple, alternate, petiolate, with prominent veins, main lateral veins all basal or partly pinnate, ascending; in climbing species leaves usually dimorphic, differing in shape on the fertile and sterile branches, leaves of sterile branches generally cordate with a long petiole, leaves of fertile branches mostly ovate-lanceolate or elliptic-lanceolate with a short petiole. **Stipules** distinct, adnate to the petiole, membranous, glabrous or hairy, deciduous. **Prophylls** present at nodes of fertile branches, often adnate to petiole, deciduous, forming a prominent ring like stipular scar at each node. **Inflorescence** a spike, solitary, leaf opposed, rarely terminal, sometimes axillary; bracts small, orbicular and peltate or cupular, sometimes adnate to rachis with raised margins. **Flowers** numerous, microscopic and achlamydeous, bracteate, mostly unisexual, dioecious, less often monoecious or bisexual, sessile, hypogynous. **Male flowers** subtended by a bract on rachis; stamens 2 to 4, rarely 5 or more, anthers sessile or subsessile, 2- (or 4-) lobed, dehiscing laterally. **Female flowers:** ovary distinct, sometimes sunk in rachis, subtended by a bract, unilocular, ovule 1; stigmas mostly 4, rarely 3 or 5, sessile. **Fruits:** drupes, sessile or stalked, black, red or yellow when ripe, globose, ovoid or obovoid with cuneate base, rarely ellipsoid, laterally compressed, usually glabrous. **Seeds** minute and endospermic.

Distribution. A pantropical genus estimated to include approximately 2000 species worldwide, with the greatest diversity in the American tropics (Quijano-Abril et al., J. Biogeogr. 33 (2006) 1266–1278). In Paleotropical regions, about 600 species are reported from Asia while about 100 species are in the South Pacific (Quijano-Abril et al., J. Biogeogr. 33 (2006) 1266–1278; Asmarayani, Taxon 67 (2018) 693–724). Only a few species occur in Africa and on the island of Réunion. About 450 species are reported from the Malesian region, the centre of diversity of Paleotropical *Piper* (Yuncker, Brittonia 10 (1958) 1–7). In Singapore, 19 species, one of which has not yet been identified.

Ecology. The genus is mostly found in tropical and subtropical evergreen and semi-evergreen forests as well as in moist deciduous forests, with most species preferring moist and shady habitats. Although several species are exclusively found in primary forest in the understorey of lowland tropical rain forests, many are present in secondary forests or in clearings. In primary forests they grow mainly where more light can penetrate, such as along forest margins, forest tracks, and on the banks of streams and rivulets, although some are found in the deep shade of the forest understorey. Mostly they prefer thinly shaded habitats with loose soil rich in humus. Across their distribution, they are generally found at an elevational range of 0 to 2500 m, with a few above 3000 m (Quijano-Abril et al., J. Biogeogr. 33 (2006) 1266–1278), but with the highest number of species occurring at 200–800 m. Species not native to Singapore, such as *Piper nigrum*, *P. retrofractum* Vahl and *P. betle*, were formerly cultivated in plantations and village gardens in Singapore. Only *Piper betle* is still commonly found today, in home gardens and as remnants of past cultivation. The Neotropical *Piper* species have well known associations with specific frugivores, ants and herbivore specialists. In contrast, the dispersal ecology of Paleotropical *Piper* is barely known.

Uses. *Piper* species are rich in essential oils, hence are aromatic and have for centuries been well known for their value as spices and in medicines. The secondary metabolites of the species tested have shown strong antimicrobial and antioxidant activities and reputedly possess therapeutic and preventive potential against many chronic disorders (Salehi et al.,

Molecules 24-1364 (2019) 2–118). *Piper nigrum*, the king of spices and the source of the black and white pepper of commerce, is used internationally while *P. longum*, the pipali of Ayurveda, is used in hundreds of Ayurvedic preparations. Several species form the ingredients in the formulation of the Ayurvedic-Chinese-Unani-Compo systems of medicine. Chewing of the leaves of *Piper betle* with various adjuncts is an ancient practice in India and East Asian countries. The emerging herbal medicine kava is obtained from *Piper methysticum*. Many of the wild *Piper* species occurring in Southeast Asia are used traditionally in folk medicines and rituals, and as spices and vegetables etc. (Burkill, Dict. Econ. Prod. Malay Penins. 2 (1935) 1766; Chaveerach, et al., Ethnobot. Res. Applic. 4 (2006) 223–231; Gajurel et al., *Piper* spp. NE India-Arunachal Pradesh (2008)). Some of the species found in Singapore that have been reported as having traditional uses are *Piper baccatum*, *P. lanatum* Roxb., *P. porphyrophyllum* (Lindl. ex Blandy) N.E.Br., *P. ribesioides* Wall., *P. rostratum* Roxb. and *P. sarmentosum* Roxb.

Taxonomy. *Piper* has a very long list of generic synonyms but we have only included the above genera which have been used for species found in Singapore.

The taxonomy of *Piper* has long been found to be challenging and there is no single classification system that has been accepted and followed worldwide. Early classifications of *Piper* (Kunth, Linnaea 13(6) (1840) 562–726; Miquel, Syst. Piperac. (1843–1844); de Candolle, Prodr. 16(1) (1869) 235–471; de Candolle, Candollea 1 (1923) 65–415) resulted in more than 15 infrageneric groups. In the more recent phylogenetic studies, three distinct monophyletic clades have been recognised, corresponding to the Neotropical, South Pacific and Asian distributions. In the Neotropics there are eight distinct subclades (Jaramillo et al., Syst. Bot. 33 (2008) 647–660) and in the Paleotropics there are 17 distinct subclades (Asmarayani, Taxon 67 (2018) 693–724). Although classically recognised sections such as *Piper* sect. *Cubeba* (Raf.) Hook.f., *P.* sect. *Muldera* (Miq.) Benth. & Hook.f., *P.* sect. *Piper*, *P.* sect. *Pseudochavica* Hook.f. and *P.* sect. *Sarcostemon* C.DC. are recognisable among the 17 subclades in phylogenetic studies, it has also been established that no currently recognised infrageneric groups in Asian *Piper* are monophyletic. Classification of the species, including those found in Singapore, into distinct subgenera and sections will require further study and a wider sampling of species from throughout the range of the genus. Consequently, no subgeneric or sectional classification is adopted in this account.

Key to *Piper* species

1. Climber with distinct shingling leaf habit; leaves roundish and adpressed on climbing surface; flowering spikes unknown **10. *P. obtusissimum***
Tree, climber, creeper or erect shrub without shingling leaf habit; leaves mostly ovate and not adpressed; flowering spikes varied 2
2. Tree with woody main stem; spikes curved with bisexual flowers **1. *P. aduncum***
Erect, creeping or climbing shrub; spikes straight with unisexual flowers, monoecious or dioecious 3
3. Erect shrub, < 150 cm tall; monoecious or dioecious 4
Low creeping or climbing shrub; dioecious 7

4. Plant < 40 cm tall; leaves oblong; young parts finely pubescent; fruit densely aggregated, sessile; style persistent **16. P. rostratum**
 Plant > 40 cm tall; leaves oblong or elliptic; young parts hirsute; fruit loosely aggregated, stipitate; style absent 5
5. Plant < 70 cm tall; leaves elliptic; spikes monoecious; fruiting spikes < 5 cm long; fruit ovoid **12. P. protractum**
 Plant > 70 cm tall; leaves oblong; spikes monoecious or dioecious; fruiting spikes > 5 cm long; fruit globose 6
6. Leaves glabrous or sparsely hairy above, hairs usually < 2 mm long; monoecious **9. P. muricatum**
 Leaves hairy on both surfaces, hairs usually > 2 mm long; dioecious **15. P. ridleyi**
7. Low creeper or climber up to 10 m high; stamens 2 to 4, attached to the rachis; fruit sessile or stipitate in non-cupular bracts 8
 Stout woody tall climber more than 10 m high; stamens 5 or more in raised cleft receptacle; fruit sessile in cupular bracts 16
8. Fruiting spikes erect or sub-erect 9
 Fruiting spikes pendent 13
9. Fruit densely aggregated, sessile and basally connate; low creeping shrub with erect fertile shoots **17. P. sarmentosum**
 Fruit loosely aggregated, stipitate and basally free; climbing shrub 10
10. Leaves membranous, ovate-lanceolate; fruiting spikes thin, fruit small and indistinct, pedicel < 10 mm long 11
 Leaves coriaceous, ovate-elliptic; fruiting spikes thick, fruit larger and distinct, pedicel > 10 mm long 12
11. Plant parts glabrous, climbing up to 6 m high **5. P. curtisii**
 Plant parts densely or finely hairy, climbing up to 3 m high **6. P. lanatum**
12. Leaf lamina < 15 cm long; fruiting spikes 2.5–3 cm diameter, pedicel longer than fruit **4. P. crassipes**
 Leaf lamina > 15 cm long; fruiting spikes 1–2 cm diameter, pedicel as long as fruit **14. P. ribesioides**
13. Fruit loosely aggregated; leaves pigmented in understorey vegetative shoots **11. P. porphyrophyllum**
 Fruit densely aggregated; leaves without pigmentation 14
14. Fruiting spikes $\geq$ 15 cm long (15–20 cm), fruit turning bright red when ripe; all veins emerging from leaf base **7. P. macropiper**

- Fruiting spikes < 15 cm (6–12 cm) long, fruit turning orange or black when ripe; secondary veins emerging from leaf base and higher along midrib 15
15. Plant parts mostly glabrous; fruit completely sunken in rachis, turning black when ripe ...
..... **3. *P. betle***
Plant parts hairy, the stem, petiole and peduncle clothed with ramulose hairs; fruit basally connate and free above, turning orange when ripe **13. *P. ramipilum***
16. Leaves thickly coriaceous; plant parts glabrous; female spikes 3–4 cm long; ovary always 1 in each receptacle **2. *P. baccatum***
Leaves thinly coriaceous; plant parts tomentose or pubescent; female spikes 5–10 cm long; ovaries 1–4 in each receptacle 17
17. Male spikes 5–6 cm long; stamens 5–8; ovaries 1–2 in each receptacle ... **8. *P. maingayi***
Male spikes 12–16 cm long; stamens 8–10; ovaries 2–4 in each receptacle
..... **18. *P. schizonephros***

1. *Piper aduncum* L.

(Latin, *aduncus* = hooked, bent, curved; referring to the spikes)

Sp. Pl. 1 (1753) 29; Turner, Gard. Bull. Singapore 47 (1997 [‘1995’]) 399; Tan et al., Nat. Singapore 1 (2008) 55; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 267; Lok et al., Cosmos 6 (2010) 71; Yee et al., Fl. Singapore 1 (2019) 58; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 601. **Synonyms:** *Artanthe adunca* (L.) Miq., Comm. Phytogr., fasc. 2 (1840) 49. – *Steffensia adunca* (L.) Kunth, Linnaea 13(6) (1840) 633. **Type:** [Published illustration] *Saururus arborescens, fructu a dunco* in Plumier, Descr. Pl. Amer. (1693 [‘1713’]) t. 77, lectotype designated by Saralegui Boza in Greuter & Rankin (ed.), Fl. Republ. Cuba, ser. A, 9 (2004) 81). **Fig. 2.**

Small trees, to 6–8 m tall, with short prop-roots, branching near the base, branches drooping, boles c. 8 cm diam. **Leaves** alternate; lamina ovate to oblong or oblong-lanceolate, 15–20 × 6–8 cm, apex acuminate, base asymmetric, lateral veins prominent ventrally, 10–15 pairs; petiole very short, 2–5 mm long. **Spikes** leaf opposed, with flowers of both sexes, 10–15 cm long, curved or bent downward above from the base of the spike, whitish or pale yellow, turning green with maturity; peduncle thick and cylindric, 1.4–3 cm long, glabrous; not much changed in fruit. **Flowers** bisexual, minute, densely crowded, stamens usually 4; ovary globose, stigmas 3. **Drupes** ovoid or oblongoid, c. 1 mm diam., flattened longitudinally, truncate towards base and apex, reticulate, beak minute.

Distribution. A native of the West Indies and mainland tropical America. In Singapore, it is naturalised and has been collected in the vicinity of Zhenghua Park (*Lua et al. SING2011-200*, 11 May 2011, SING [SING0160292]), Pulau Ubin (*Ali Ibrahim SING2007-438*, Dec 2007, SING [SING0108813]), Kranji (*Samsuri et al. KJ 15*, 20 May 2003, SING [SING0044625]; *Lua et al. SING2020-681*, 21 Aug 2020, SING [SING0340895]), Sungei Punggol (*Tan 884*, 2003, SINU [SING0370810]) and several other places.



Figure 2. *Piper aduncum* L. **A.** Habit. Inset: Lower surface of leaves. **B.** Close-up of bisexual spike. **C.** Fruiting spikes. **D.** Ripe spikes with seeds. (A–D including inset from Singapore, A & A inset, Kranji; B–D, Tengah. Photos: H.K. Lua).

Ecology. Grows in open woodland and forest margins. *Piper aduncum* is fast-growing and is able to produce fruiting spikes throughout its lifespan upon reaching reproductive maturity. It favours the margins of open vegetation along vehicular tracks and trails where its characteristic curved fruiting spikes are held above the leafy twigs and easily visible. It is, however, only rarely found inside forest or in the shady understorey.

Conservation assessment. Globally, Least Concern (LC) (IUCN Red List, 2026). Not native in Singapore.

Uses. The leaves, stems, roots and fruit of this species are traditionally used for the treatment of a large number of diseases in various parts of the world. Some of the reported uses are for the treatment of intestinal and stomach ailments, various skin conditions, including burns, bites, cuts and grazes, gynaecological conditions, kidney infections, fevers, general aches and pains, and other infections (Salehi et al., *Molecules* 24-1364 (2019) 54).

Notes. This species is a relatively recent introduction to Singapore and has been spreading through open woodland and forest margins over the past two decades. It has a weak stem due to its rapid growth and can form monospecific stands quickly when conditions are suitable. It re-sprouts easily from broken stems or intact roots. The fruit on each spike contains many seeds. Many heterotypic synonyms, not relevant for Singapore and the Malesian region, have been reported from the New World.

2. *Piper baccatum* Blume

(Latin, *baccatus* = berry-like; referring to the fruit)

Verh. Batav. Genootsch. Kunsten 11 (1826) 172; de Candolle, *Philipp. J. Sci.*, C 5(5) (1910) 462; Merrill, *Enum. Philipp. Fl. Pl.* 2 (1923) 4; Suwanphakdee et al., *Nordic J. Bot.* 34 (2016) 607; Suwanphakdee et al., *Thai Forest Bull., Bot.* 48 (2020) 150; Lindsay et al., *Gard. Bull. Singapore* 74(Suppl. 1) (2022) 601; Suwanphakdee et al., *Fl. Thailand* 16(3) (2024) 903, fig. 13, pl. 106: C. **Synonym:** *Muldera baccata* (Blume) Miq., *Syst. Piperac.*, fasc. 2 (1844) 341; Miquel, *Fl. Ned. Ind.* 1(2), fasc. 3 (1859) 456; Miquel, *Ann. Mus. Bot. Lugduno-Batavi* 1, fasc. 5 (1863) 137. **Type:** *Blume* 624, [Indonesia], Java (lectotype L [L1535860], designated by Suwanphakdee et al., *Nordic J. Bot.* 34 (2016) 607; isoelectotype K [K000794885]). **Fig. 3.**

Piper recurvum Blume, *Verh. Batav. Genootsch. Kunsten* 11 (1826) 176. **Synonym:** *Muldera recurva* (Blume) Miq., *Syst. Piperac.*, fasc. 2 (1844) 342; Miquel, *Fl. Ned. Ind.* 1(2), fasc. 3 (1859) 456. **Type:** *Blume s.n.*, [Indonesia], Java (lectotype L [L1547132], designated by Suwanphakdee et al., *Nordic J. Bot.* 34 (2016) 607).

Muldera firma Miq., *Ann. Mus. Bot. Lugduno-Batavi* 1, fasc. 5 (1863) 140. **Synonym:** *Piper firmum* (Miq.) C.DC. in de Candolle, *Prodr.* 16(1) (1869) 242. **Type:** *Korthals s.n.*, [Indonesia], Sumatra, 1863 (lectotype L [L1545934], designated by Suwanphakdee et al., *Nordic J. Bot.* 34 (2016) 607).

Piper ceylanicum C.DC. in de Candolle, *Prodr.* 16(1) (1869) 242. **Type:** *Thwaites* 2175, Ceylon [Sri Lanka] (lectotype G [G00203250], designated by Suwanphakdee et al., *Nord. J. Bot.* 34 (2016) 607).

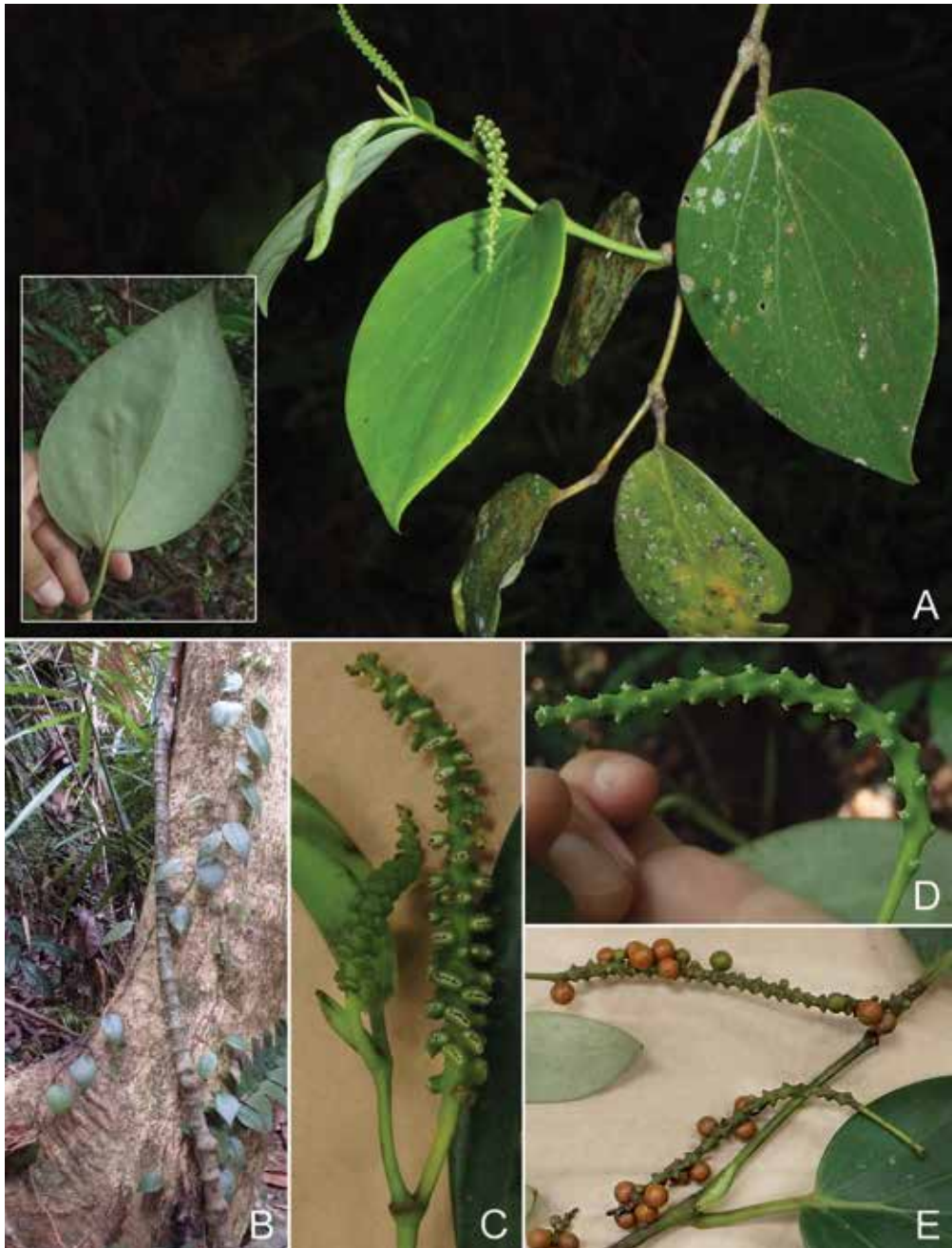


Figure 3. *Piper baccatum* Blume. **A.** Fertile branch. Inset: Lower surface of a leaf. **B.** Climbing habit. **C.** Male flower spike. **D.** Female flower spike. **E.** Fruiting spikes. (A–E including inset from Singapore, A, Nee Soon, *Asmarayani & Lua Rani661*; A inset & D, Central Catchment, *Asmarayani & Lua Rani673*; B, Bukit Timah, *Lua & Ho SING2016-114*; C, Upper Seletar, *Lee & Lua SING2015-104*; E, Upper Seletar, *Lee & Lua SING2015-105*. Photos: H.K. Lua).

Piper pachyphyllum Hook.f., Fl. Brit. India 5, fasc. 13 (1886) 80, nom. illeg. non Baker (1885); de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 337; Ridley, Fl. Malay Penins. 3 (1924) 31; Keng, Gard. Bull. Singapore 31 (1978) 86; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 62; Turner, Gard. Bull. Singapore 45 (1993) 189; Turner, Gard. Bull. Singapore 47 (1997 ['1995']) 401; Chew et al., Gard. Bull. Singapore 49(2) (1999 ['1997']) 207; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 196. **Type:** *Griffith s.n.* [HEIC 4427], [Malaysia], Malacca [Melaka] (lectotype K [K000575309], designated by Middleton et al., Gard. Bull. Singapore 76 (2024) 244).

Piper flavimarginatum C.DC., Rec. Bot. Surv. India 6(1) (1912) 26; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 335; Ridley, Fl. Malay Penins. 3 (1924) 31; Corner, Gard. Bull. Singapore, Suppl. 1 (1978) 80; Keng, Gard. Bull. Singapore 31 (1978) 86; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 62; Turner, Gard. Bull. Singapore 45 (1993) 188; Turner, Gard. Bull. Singapore 47 (1997 ['1995']) 400; Turner et al., Gard. Bull. Singapore 48 (1998 ['1996']) 154; Chew et al., Gard. Bull. Singapore 49(2) (1999 ['1997']) 207; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 210; Turner & Chua, Checkl. Vasc. Pl. Sp. Bukit Timah Nat. Res. (2011) 63; Wong et al., Checkl. Pl. Sp. Nee Soon Swamp Forest (2013) 200, 467; Neo et al., Nat. Singapore 6 (2013) 71; Neo et al., Nat. Singapore 7 (2014) 106; Ho et al., Gard. Bull. Singapore 71(Suppl. 1) (2019) 105. **Type:** *Ridley 3772*, Singapore, Bukit Timah, 1892 (lectotype CAL [CAL0000020925], designated by Middleton et al., Gard. Bull. Singapore 76 (2024) 244).

Piper protrusum Chaveer. & Tanee, J. Syst. Evol. 49 (2011) 473. **Type:** *Chaveerach 615*, Thailand, Phangnga, Sriphangnga National Park (holotype BK).

Woody lianas, dioecious, stout, climbing to 20 m high, quite glabrous, rooting at the nodes, stems thick, terete. **Leaves:** lamina thickly coriaceous, glabrous; in vegetative branches lamina almost orbicular, 15–20 × 12–16 cm, apex acuminate, base rounded, subcordate or cordate, shiny above, dull pale-green beneath, ascending lateral veins 3–4 pairs, petiole to 6 cm long, sheathing at the base, stipule ovate-lanceolate, 2–3 cm long, adnate to the petiole; in fertile branches lamina broadly ovate, 12–22 × 7–10 cm, apex acuminate, base rounded to cuneate, sometimes oblique, ascending lateral veins 3 pairs, the upper pair arising 2–3 cm above the base, tertiary veins numerous, conspicuous, petiole 2–3 cm long; prophyll stout, thick, ovate, 10–15 mm long, glabrous. **Spikes** laterally erect, stout, glabrous, flowers distantly arranged; bracts in male spike raised to form a receptacle, receptacle cleft; in female spike cupular, glabrous outside and hairy inside. **Male spike** 6–8 cm long, glabrous, green when mature, senescing pale yellow; peduncle 1–2 cm long; stamens 8, placed in a cup-like receptacle. **Female spike** 2–3 cm long, flowers rather distant; peduncle 1–2 cm long; ovary 1, globose, stigmas 4, ovate. **Fruiting spikes** lengthening up to 10 cm long, 1 cm diam., green; peduncle c. 2 cm long. **Drupes** distinct, globose, c. 4 mm diam., sessile, turning yellow and red when mature.

Distribution. South India, Sri Lanka, Myanmar, Thailand, Malaysia, Indonesia and the Philippines. In Singapore, known from Nee Soon (*Asmarayani & Lua Rani661*, 17 Jul 2012, SING [SING0179360]), the Central Catchment (*Asmarayani & Lua Rani673*, 30 May 2014, SING [SING0211908]), Bukit Timah (*Ridley s.n.*, 1899, SING [SING0014992]; *Lua & Ho SING2016-114*, 1 Mar 2016, SING [SING0236462]) and Jurong (*Corner s.n.*, 17 Apr 1933, SING [SING0014991]).

Ecology. Grows in shaded moist areas in primary and mature secondary forest with extensive vegetative growth. It creeps along the forest floor before climbing up tall tree trunks to a height below the tree canopy where it can be observed flowering high up on the tree trunk.

Conservation assessment. Globally, not assessed. In Singapore, assessed as Critically Endangered (CR/D) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 502).

Uses. The fruit is reported to be used to treat colds and coughs while the leaves are reported to be used in poultices for sprains in Java and Borneo. A decoction of the roots has been reported to be used for the treatment of venereal disease in Malaysia (Burkill, Dict. Econ. Prod. Malay Penins. 2 (1935) 1767).

Notes. This is one of three distinct species from Singapore placed in *Piper* sect. *Muldera* (although see earlier comments on infrageneric classification in *Piper*). All three *Piper* sect. *Muldera* species in Singapore have a robust habit with distinct orthotropic and plagiotropic shoots. The other two species that are close to *Piper baccatum* but distinct from it are *P. maingayi* and *P. schizonephros*. The glabrous, thickly coriaceous leaves and the short female spike with only one ovary distinguishes *Piper baccatum* from the other two species. In Singapore and Malaysia, this species has mostly been identified on specimens and in the literature as either *Piper pachyphyllum* or *P. flavimarginatum*, which are both treated here as synonyms of *P. baccatum* along with a number of other synonyms. However, more extensive taxonomic studies in the Indo-Malayan region involving habitat analyses, along with a critical comparative morphological investigation and molecular studies, may be required to resolve remaining issues in the complicated *Muldera* group.

3. *Piper betle* L.

(from a vernacular name)

Sp. Pl. 1 (1753) 28; Willdenow, Sp. Pl., ed. 4, 1(1) (1797) 159; Roxburgh, Fl. Ind. 1 (1820) 160 ; Roxburgh, Fl. Ind. 1 (1832) 158; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 85; Ridley, J. Straits Branch Roy. Asiat. Soc. 33 (1900) 127, as '*betel*'; Keng, Gard. Bull. Singapore 31 (1978) 85; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 62, fig. 58.2; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 263; Lok et al., Cosmos 6 (2010) 76; Neo et al., Nat. Singapore 5 (2012) 282; Neo et al., Nat. Singapore 6 (2013) 15; Neo et al., Nat. Singapore 6 (2013) 82; Neo et al., Nat. Singapore 6 (2013) 122; Neo et al., Nat. Singapore 6 (2013) 283; Neo et al., Nat. Singapore 7 (2014) 66; Neo et al., Nat. Singapore 7 (2014) 106; Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 150; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 602; Suwanphakdee et al., Fl. Thailand 16(3) (2024) 905, pl. 106: D. **Synonym:** *Chavica betle* (L.) Miq., Syst. Piperac., fasc. 1 (1843) 228; Miquel, Fl. Ned. Ind. 1(2), fasc. 3 (1859) 439. **Type:** Herb. Hermann 3: 32, no. 27, [Sri Lanka] (lectotype BM [BM000621919], designated by Huber in Dassanayake, Fl. Ceylon 6 (1987) 287). **Fig. 4.**

Piper siriboa L., Sp. Pl. 1 (1753) 29. **Type:** Herb. Hermann 3: 17, no. 29, [Sri Lanka] (lectotype BM [BM000621853], designated by Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 151).

Semi woody lianas, dioecious, climbing to 8 m high, stems to 4 cm diam., all parts glabrous except occasionally with sparse hairs along internodes of young shoots; nodes in vegetative branches with distinct adventitious roots, internodes long reddish or with pinkish stripes; nodes in fertile branches swollen, internodes short compact and green. **Leaves:** lamina subcoriaceous; in vegetative branches lamina ovate-elliptic, $9\text{--}11 \times 5\text{--}7$ cm, apex acuminate, base cordate, glabrous, ascending lateral veins mostly 3 pairs, opposite, arising within 3 cm of the base, petiole 4–6 cm long, stipule membranous, c. 1.5 cm long; in fertile branches lamina ovate to ovate-lanceolate, $10\text{--}15 \times 6\text{--}8$ cm, apex acuminate, slightly bent, base asymmetric, glabrous, ascending lateral veins 3–4 pairs, opposite, the upper pair arising almost near the middle of the lamina, petiole short, 1–2 cm long; prophyll ovate-lanceolate, glabrous. **Spikes** leaf opposed, mostly in upper or terminal nodes, pendulous, cylindric, yellowish or pale green, rachis glabrous, densely flowered; bracts orbicular and peltate, c. 1 mm diam. **Male spikes** pendulous, pale green, 5–10 cm long, 5–8 mm diam.; peduncle 3–4 cm long, glabrous; stamens 2, minute, in rows alternating with bracts. **Female spikes** 6–8 cm long; peduncle long, 2.5–3.5 cm long, almost equal to the flowering part of the spike, glabrous; ovary globose, 1–2 mm diam., completely embedded in the rachis, stigmas 5–8. **Fruiting spikes** 8–12 cm long, 6–8 mm diam. and turning black when mature, pendulous, cylindric; peduncle 4–5 cm long. **Drupe**s densely aggregated and sunken on rachis.

Distribution. India, Myanmar, Thailand, Cambodia, Laos, Vietnam, Malaysia, Indonesia and the Philippines. In Singapore, the species is treated as casual and was previously recorded as being in cultivation or possibly having escaped at Chan Chu Kang [Nee Soon] (*Ridley s.n.*, 1892, SING [SING0014970]), Pulau Ubin (*Ridley 4684*, 1892, SING [SING0042317]), Bukit Mandai (*Ridley 5851*, 1894, SING [SING0014969]), Pulau Damar (*Ridley 9099*, 1897, SING [SING0042318]) and Pasir Panjang (*Burkill s.n.*, 30 Sep 1915, SING [SING0042316]). The species is currently known to occur as a remnant of past cultivation in secondary forests across the island including at Bukit Brown (*Asmarayani & Lua Rani645*, 29 Jun 2012, SING [SING0185189]) and in MacRitchie (*Hassan Ibrahim et al. SING2013-006*, 3 Jan 2013, SING [SING0192221]), as well as being cultivated in home gardens.

Ecology. This species grows in moist shaded areas in secondary forests and at forest margins as a remnant of past village garden cultivation. It climbs up tree poles and larger trunks, it has pale brown and rough stems with vertically-arranged protrusions when mature, sometimes with adventitious roots on old stems near the ground, and produces fertile lateral aerial branches between 3 and 8 m high, usually where there is exposure to light. This species is easily propagated by stem cuttings and persists as long-lived plants requiring minimal care.

Conservation assessment. Globally, Least Concern (LC), assessed here. Not native in Singapore.

Uses. In Southeast Asian countries the mature leaves are mostly chewed with betel nut (*Areca catechu* L.) along with a little lime. It is also used medicinally and culturally in celebrations and religious ceremonies. In Singapore, where the practice of betel chewing has all but disappeared, leaves of this species are more commonly used in traditional culinary practices and customary ceremonies and are grown as ornamental plants.



Figure 4. *Piper betle* L. **A.** Climbing habit. Inset: Mature stem. **B.** Reddish young stem. **C.** Lower surface of leaves and ripening female spike. **D.** Close-up of female flowers with thrips. **E.** Female flower spike. (A–E including inset from Singapore, A, B & D, Bukit Brown, *Asmarayani & Lua Rani645*; A inset, C & E, MacRitchie, *Hassan Ibrahim et al. SING2013-006*. Photos: H.K. Lua).

Vernacular names. *Betel, betel pepper, betel vine, betle pepper, pan, sireh* (NParks' Flora & Fauna Web, 2026).

Notes. The male plants are very rare. Extant plants encountered by the authors in Singapore have thus far been exclusively female.

4. *Piper crassipes* Korth. ex Miq.

(Latin, *crassus* = thick, *pes* = foot; probably referring to the thick fruiting spike)

Comm. Phytogr., fasc. 1 (1839) 22; de Candolle, Prodr. 16(1) (1869) 344; Suwanphakdee et al., Kew Bull. 73-33 (2018) 5; Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 156; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 602; Suwanphakdee et al., Fl. Thailand 16(3) (2024) 911, fig. 16, pl. 108: A. **Synonym:** *Cubeba crassipes* (Korth. ex Miq.) Miq., Comm. Phytogr., fasc. 2 (1840) 45; Miquel, Syst. Piperac., fasc. 1 (1843) 292; Miquel, Fl. Ned. Ind. 1(2), fasc. 3 (1859) 448. **Type:** *Korthals s.n.*, [Indonesia], Sumatra (lectotype K [K000575314], designated by Middleton et al., Gard. Bull. Singapore 76 (2024) 244). **Fig. 5, 6.**

Cubeba neesii Miq., Syst. Piperac., fasc. 1 (1843) 292; Miquel, Fl. Ned. Ind. 1(2), fasc. 3 (1859) 449. **Synonyms:** *Piper pedicellosum* Wall. [Numer. List no. 6646 (1832), nom. nud.] ex C.DC. in de Candolle, Prodr. 16(1) (1869) 343, nom. illeg. superfl.; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 81; Ridley, J. Straits Branch Roy. Asiat. Soc. 33 (1900) 127; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 321; Ridley, Fl. Malay Penins. 3 (1924) 34; Keng, Gard. Bull. Singapore 31 (1978) 86; Maxwell, Gard. Bull. Singapore 35(2) (1983 ['1982']) 197; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot (1990) 62; Turner, Gard. Bull. Singapore 45 (1993) 189; Turner et al., Gard. Bull. Singapore 46(2) (1995 ['1994']) 29; Turner, Gard. Bull. Singapore 47 (1997 ['1995']) 402; Chew et al., Gard. Bull. Singapore 49(2) (1999 ['1997']) 208; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 210; Wong et al., Checkl. Pl. Sp. Nee Soon Swamp Forest (2013) 201, 467. – *Piper neesii* (Miq.) P.K.Mukh., Phytotaxa 289 (2016) 190; Ho et al., Gard. Bull. Singapore 71(Suppl. 1) (2019) 105, 132. **Type:** *Wallich s.n.* [EIC 6646A], Singapore, 1822 (lectotype K-W [K001124404], designated by Middleton et al., Gard. Bull. Singapore 76 (2024) 245).

Lianas, dioecious, climbing to 10 m or more high, the lower vegetative branches often creeping, young shoots puberulent. **Leaves:** lamina coriaceous, drying yellow-brown below; in vegetative branches lamina ovate, 4–6 × 2–3 cm, apex acute or shortly acuminate, base deeply cordate with rounded lobes, ascending lateral veins 2–3 pairs, all arising from the base, prominent beneath, petiole 2–3 cm long, petioles and undersurface of leaves finely pubescent; in fertile branches lamina ovate-elliptic, 3–6 × 2–3 cm, apex shortly acuminate, base oblique and slightly cordate, quite glabrous above, finely pubescent beneath, major lateral veins 2 pairs, emerging within 1 cm of the base, petiole 5–8 mm long; prophyll small, caducous. **Spikes** leaf opposed, erect, densely flowered; bracts ovate, adnate to rachis with raised margin. **Male spikes** green, cylindric, 3–5 cm long; peduncle 0.5–0.9 cm long or equal to the petiole, hairy; rachis hairy; stamens 2 or 3, c. 1 mm long. **Female spikes** 2–2.5 cm long and c. 2 mm diam.; peduncle 0.6–0.8 cm long; rachis hairy, pale green; ovary globose, c. 1 mm diam., stigmas 4. **Fruiting spikes** lengthening up to 4 cm long, 2.5–3 cm diam.; peduncle c. 1 cm long, puberulous, deep green when mature. **Drupes** oblong, distinct, with a long pedicel,

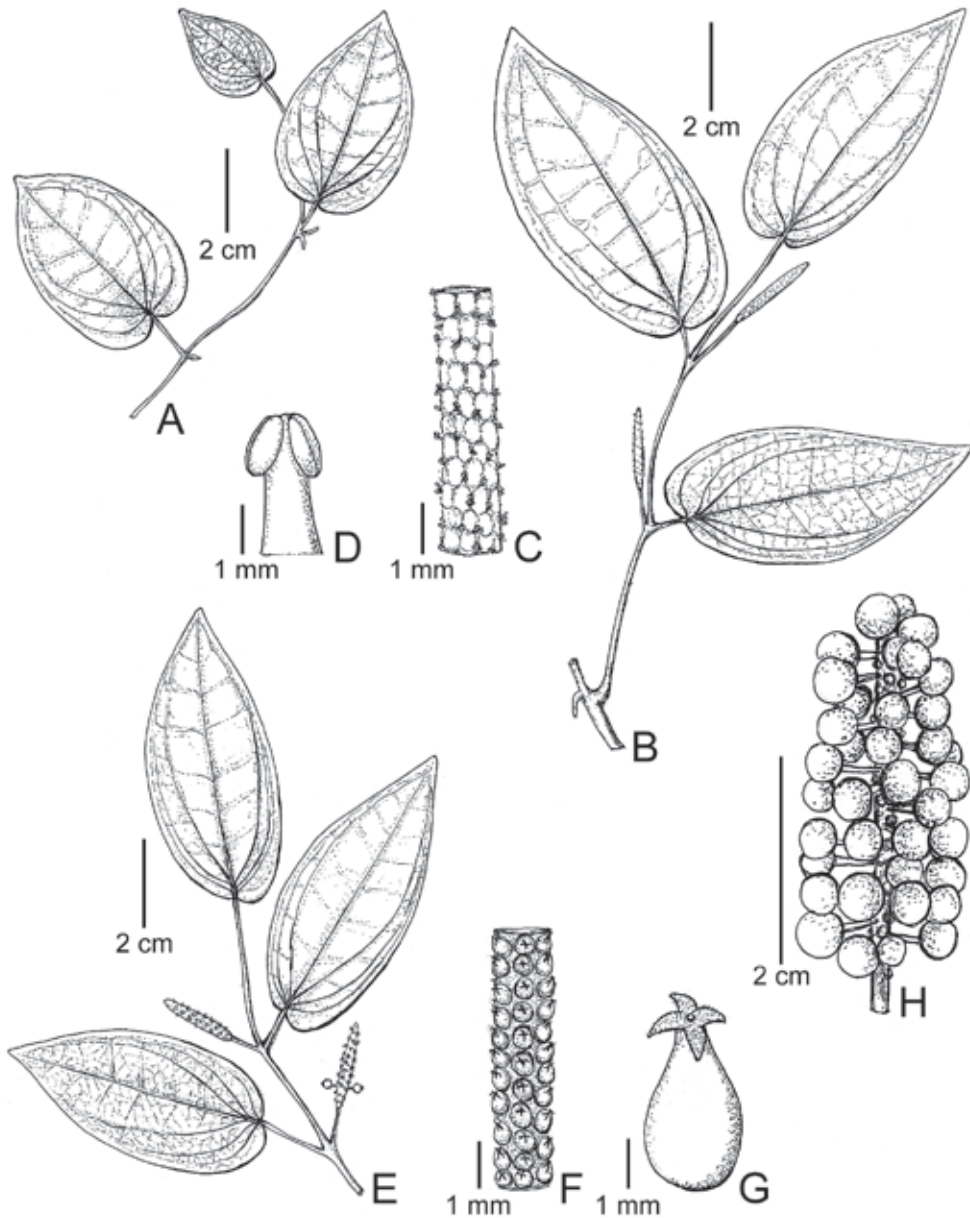


Figure 5. *Piper crassipes* Korth. ex Miq. **A.** Climbing young shoot with roots. **B.** Fertile branch with male spikes. **C.** Close-up of male spike with stamen arrangement. **D.** Close-up of stamen. **E.** Fertile branch with female spikes. **F.** Female inflorescence. **G.** Female flower bud. **H.** Fruiting spike (A–H from Singapore, A, E–G, Admiralty Park, Lua *et al.* Rani644; B–D, Admiralty Forest, Asmarayani & Lua Rani672; H, MacRitchie, Asmarayani & Lua Rani675. Drawn by V. Chye).



Figure 6. *Piper crassipes* Korth. ex Miq. **A.** Leafy twiner with male spike on fallen tree. Inset: Climbing young leaves. **B.** Climbing stem. **C.** Female flower spike. Inset: Close-up of male flowers on a male spike. **D.** Unripe drupes. (A–D including insets from Singapore, A, Admiralty Forest, *Asmarayani & Lua Rani672*; A inset, Upper Seletar; B, MacRitchie; C, Admiralty Park, *Asmarayani & Lua Rani665*; C inset, Mandai; D, Admiralty Road West, *Lua SING2014-107*. Photos: H.K. Lua).

pedicel c. 1 cm long when fruit ripe, much longer than the fruit, fruit to 6 mm diam., turning orange and red at maturity.

Distribution. India, Sri Lanka, Myanmar, Thailand, Malaysia and Indonesia. In Singapore, known from Singapore Botanic Gardens Rain Forest (*Furtado s.n.*, 15 Apr 1931, SING [SING0014994]), MacRitchie (*Lua & Ali Ibrahim SING2012-355*, 10 Aug 2012, SING [SING0183491]; *Asmarayani & Lua Rani675*, 3 Jun 2014, SING [SING0212068]) and Admiralty Forest (*Asmarayani et al. Rani644*, 29 Jun 2012, SING [SING0185188]; *Lua SING2014-299*, 29 May 2014, SING [SING0212063]).

Ecology. Growing in a variety of habitats from forest margins and secondary forests to primary forests in shady areas, often climbing on trunks of tall trees to 10 m high before producing fertile branches.

Conservation assessment. Globally, Least Concern (LC), assessed here. In Singapore, assessed as Least Concern (LC) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 502).

Vernacular name. *Sireh murai* (NParks' Flora & Fauna Web, 2026).

Notes. This species very closely resembles *Piper ribesioides*, particularly in the leaves on the vegetative branches and in the fruiting spikes. However, the leaves and all plant parts are smaller in *Piper crassipes*. Also, in *Piper ribesioides*, the leaves are much thicker, the fertile shoots are quite glabrous and the drupes are larger. *Piper crassipes* also resembles *P. lanatum*, particularly in its vegetative leaves. However, in *Piper lanatum* the leaves are membranous and more hairy with a rounded or slightly cordate base, does not dry yellow-brown below and it is a slender low-climbing vine compared to the more robust lianescent *P. crassipes*. Female plants are more frequently encountered than the male plants. Mature *Piper crassipes* lianas may have stems up to 2 cm diam.

5. *Piper curtisii* C.DC.

(Charles Curtis, 1853–1928, English botanist and first Superintendent of Penang Botanic Gardens)

Rec. Bot. Surv. India 6(1) (1912) 14; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 318; Ridley, Fl. Malay Penins. 3 (1924) 37; Burkill, Dict. Econ. Prod. Malay Penins. 2 (1935) 1774; Turner, Gard. Bull. Singapore 47 (1997 ['1995']) 400; Gajurel & Lua, Gard. Bull. Singapore 72 (2020) 136; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 602. **Type:** *Alvins* 2337, [Malaysia], Malacca [Melaka], 1 October 1885 (lectotype SING [SING0206243], designated by Gajurel & Lua, Gard. Bull. Singapore 72 (2020) 136). **Fig. 7.**

Piper burkillii Ridl., J. Straits Branch Roy. Asiat. Soc. 82 (1920) 189; Ridley, Fl. Malay Penins. 3 (1924) 37; Turner, Gard. Bull. Singapore 47 (1997 ['1995']) 399; Turner, Gard. Bull. Singapore 64 (2012) 252. **Type:** *Burkill* 1177, [Malaysia], Negeri Sembilan, Gunong Tampin Hill, 10 July 1916 (lectotype K [K000794927], designated by Middleton et al., Gard. Bull. Singapore 76 (2024) 245; isoelectotype SING [SING0068757]).

Slender climbers, dioecious, climbing to 6 m high; stems thin, 2–3 mm diam., terete, branchlets quite glabrous. **Leaves:** lamina membranous, almost the same in fertile and vegetative shoots, ovate or ovate-lanceolate, 6–10 × 2–3 cm, apex long acuminate, base equal, rounded in vegetative shoot and cuneate in fertile shoots, glabrous, shiny above, silvery beneath, ascending lateral veins 2 pairs, one arising near the base, the other higher up, about 2–3 cm above the base, secondary lateral veins many, distinct, petiole 2–3 cm long in vegetative shoot and 1–1.5 cm long in fertile shoot; prophyll short and glabrous. **Spikes** leaf opposed, erect, glabrous, densely flowered; bracts orbicular, peltate, glabrous. **Male spikes** slender, 2–3 cm long; peduncle 1–1.5 cm long, glabrous; stamens 2, very minute, c. 1 mm long. **Female spikes** 2–3 cm long; ovary globose, glabrous, stigmas 3–4, ovate-acuminate. **Fruiting spikes** erect, lengthening up to 4 cm long; peduncle c. 1.5 cm long. **Drupes** loosely aggregated, globose, c. 4 mm. diam., turning yellowish red when mature, pedicellate, pedicel almost equal in length or shorter than fruit, thick.

Distribution. Peninsular Malaysia. In Singapore, known from Bukit Timah (*Asmarayani & Lua Rani*651, 9 Jul 2012, SING [SING0179351]; *Gajurel et al.* SING2019-166, 13 Mar 2019, SING [SING0272419]).

Ecology. Grows in a shaded moist area by a stream at the bottom of a forested valley in primary forest. Climbing on trees in the forest understorey within the vicinity of the stream. Known only from one locality with a few individuals.

Conservation assessment. Globally, not assessed. In Singapore, assessed as Critically Endangered (CR/D) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 502).

Notes. This species was collected for the first time from Bukit Timah in 2012. It can be mistaken for *Piper lanatum*, which is found in the same valley, but is quite glabrous with more slender branchlets, the leaves are somewhat smaller with secondary veins emerging from along the midrib, and it climbs much higher than *P. lanatum*. It is a distinctive species in its leaf venation. The flowering and mature fruiting spikes have not been seen in Singapore.

6. *Piper lanatum* Roxb.

(Latin, *lanatus* = woolly; referring to the indumentum)

Fl. Ind. 1 (1820) 161; Roxburgh, Fl. Ind. 1 (1832) 159; de Candolle, Prodr. 16(1) (1869) 364; Ridley, Fl. Malay Penins. 3 (1924) 38; Keng, Gard. Bull. Singapore 31 (1978) 86; Keng, Concise Fl. Singapore vol. 1, Gymn. Dicot (1990) 62; Turner, Gard. Bull. Singapore 45 (1993) 188; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 196; Turner & Chua, Checkl. Vasc. Pl. Sp. Bukit Timah Nat. Res. (2011) 63; Wong et al., Checkl. Pl. Sp. Nee Soon Swamp Forest (2013) 200, 466; Neo et al., Nat. Singapore 6 (2013) 71; Neo et al., Nat. Singapore 7 (2014) 66; Neo et al., Nat. Singapore 7 (2014) 106; Ho et al., Gard. Bull. Singapore 71(Suppl. 1) (2019) 105; Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 159; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 602; Suwanphakdee et al., Fl. Thailand 16(3) (2024) 923, pl. 109: D. **Synonym:** *Piper caninum* Blume var. *lanatum* (Roxb.) Hook.f., Fl. Brit. India 5, fasc. 13 (1886) 82, as '*lanata*', nom. illeg. superfl.; Ridley, J. Straits Branch Roy.



Figure 7. *Piper curtisii* C.DC. **A.** Habit. **B.** Lower surface of leaves. **C.** Flowering spike on herbarium sheet. **D.** Young spike. **E.** Fruiting spike on herbarium sheet. (A & B from Singapore, Bukit Timah, *Asmarayani & Lua Rani651*; C & E from Peninsular Malaysia, *Kiah SFN 32136*; D from Singapore, Bukit Timah, *Lua et al. SING2019-166*. Photos: H.K. Lua).

Asiat. Soc. 33 (1900) 127, as '*lanata*'. **Type:** *Roxburgh s.n.*, India (lectotype BR [BR0000006597801], designated by Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 159). **Fig. 8.**

Piper lowong Blume, Verh. Batav. Genootsch. Kunsten 11 (1826) 161; Ridley, Fl. Malay Penins. 5 (1925) 328. **Type:** *Blume s.n.*, [Indonesia], Java (lectotype AMD [AMD82238], designated by Suwanphakdee et al., Kew Bull. 73-33 (2018) 5; isolectotype G-DC [G00206348]).

Piper caninum Blume, Verh. Batav. Genootsch. Kunsten 11 (1826) 214; de Candolle, Prodr. 16(1) (1869) 341; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 82; Ridley, J. Straits Branch Roy. Asiat. Soc. 33 (1900) 127; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 317; Ridley, Fl. Malay Penins. 3 (1924) 38; Henderson, Malay. Wild Fls., Dicot. (1959) 422; Keng, Gard. Bull. Singapore 31 (1978) 85; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 62; Turner, Gard. Bull. Singapore 45 (1993) 188; Turner et al., Gard. Bull. Singapore 46(2) (1995 ['1994']) 29; Turner, Gard. Bull. Singapore 47 (1997 ['1995']) 399; Chew et al., Gard. Bull. Singapore 49(2) (1999 ['1997']) 207; Suwanphakdee et al., Thai Forest Bull., Bot. 34 (2006) 206; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 230; Suwanphakdee et al., Kew Bull. 73-33 (2018) 5. **Synonym:** *Cubeba canina* (Blume) Miq., Comm. Phytogr., fasc. 2 (1840) 33; Miquel, Syst. Piperac., fasc. 1 (1843) 293. **Type:** *Blume s.n.*, [Indonesia], Java (lectotype L [L1545499], designated by Suwanphakdee et al., Kew Bull. 73-33 (2018) 5).

Piper javanicum C.DC. in de Candolle, Prodr. 16(1) (1869) 343. **Type:** *Wallich s.n.* [EIC 6645B], Singapore, 1822 (lectotype K-W [K001124403], designated by Suwanphakdee et al., Kew Bull. 73-33 (2018) 5).

Piper thwaitesii C.DC. in de Candolle, Prodr. 16(1) (1869) 357. **Synonym:** *Piper caninum* Blume var. *thwaitesii* (C.DC.) Hook.f., Fl. Brit. India 5, fasc. 13 (1886) 82. **Type:** *Thwaites 2178*, Ceylon [Sri Lanka] (lectotype G-DC [G00206602], designated by Suwanphakdee et al., Kew Bull. 73-33 (2018) 5).

Piper caninum Blume var. *angustifolium* Miq. ex Hook.f., Fl. Brit. India 5, fasc. 13 (1886) 82; Ridley, J. Straits Branch Roy. Asiat. Soc. 33 (1900) 127; Ridley, Fl. Malay Penins. 3 (1924) 38. **Type:** *Maingay 3097* [Kew Distribution 1333], [Malaysia], Malacca, 12 November 1867 (lectotype K [K000842287], designated here).

Piper pilobracteatum Chaveer. & Sudmoon, Acta Phytotax. Sin. 44 (2006) 449. **Type:** *Chaveerach 63495*, Thailand, Phangnga, Sri Phangnga National Park (holotype BK).

Slender climbers, dioecious, climbing to 3 m high, preferring to stay low; stems thin, terete, branchlets hairy, female plants more hairy than male. **Leaves:** lamina membranous; in vegetative shoots lamina ovate, 3–5 × 2.5–3 cm, apex short acuminate, base cordate or subcordate, densely hairy beneath, hairs c. 2 mm long, sharp pointed, ascending lateral veins 2 pairs, all arising from the base, petiole 2–5 cm long; in fertile shoots lamina ovate or ovate-lanceolate, 6–10 × 3–4 cm (sometimes long-lanceolate, 7–12 × 2–3 cm), apex acuminate, base rounded or cuneate, slightly unequal, sparsely or densely pubescent beneath and on petiole, petiole c. 1.5 cm long; prophyll stout and pointed, 7–10 mm long, finely pubescent. **Spikes** leaf opposed, erect; bracts orbicular, peltate, densely hairy beneath. **Male spikes** slender, 2–4 cm long, white; peduncle c. 2 cm long, hairy; stamens 2, minute. **Female spikes** thicker, short cylindric, 2–3 cm long; ovary globose, stigmas 3–4. **Fruiting spikes** erect, 2.5–3.5 cm long; peduncle 1–2 cm long, hairy; rachis hairy. **Drupes** loosely aggregated, ovoid-globose, 2–3 mm long, turning yellow and bright red when mature, pedicellate, pedicel shorter than fruit, 1–2 mm long.



Figure 8. *Piper lanatum* Roxb. **A.** Habit. Inset: Climbing habit. **B.** Lower surface of leaves. **C.** Male spike. **D.** Close-up of male spike. **E.** Unripe fruiting spike. Inset: Ripening fruiting spike. (A–E including insets from Singapore, A, B & E, Bukit Timah, *Asmarayani & Lua Rani646*; A inset, D & E inset, Bukit Timah; C, MacRitchie. Photos: A, A inset & B–E, H.K. Lua; E inset, X.Y. Ng).

Distribution. India, Sri Lanka, Myanmar, Thailand, Malaysia, Indonesia, Philippines and the Solomon Islands. In Singapore, previously known from Changi (*Ridley 4686*, 1890, SING [SING0014979]), Pulau Tekong (*Ridley 4687*, 1892, SING [SING0014971]), Siglap (*Hullett s.n.*, 1893, SING [SING0014982]) and Bukit Mandai. More recently, it has been collected from Bukit Timah (*Maxwell 82-136*, 16 Apr 1982, SING [SING0014985]), MacRitchie (*Aung Thame & Liew SING2016-163*, 30 Sep 2016, SING [SING0252083, SING0252084]) and Singapore Botanic Gardens' Rain Forest.

Ecology. In primary and mature secondary forest, in full shade in the forest understorey and also in partially shaded areas at the forest margin along trails. Usually climbing around the stems of small understorey trees.

Conservation assessment. Globally, not assessed. In Singapore, assessed as Vulnerable (VU/D) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 502).

Uses. Medicinally, due to reputed antiseptic properties, the leaves have been reported to be used to treat hoarseness and sore throats and as a cleanser after childbirth. The drupes are used as adulterants for cubeb pepper (*Piper cubeba* L.f.) and as a good flavouring agent. The leaves are sometimes chewed as a substitute for betel leaves (Burkill, Dict. Econ. Prod. Malay Penins. 2 (1935) 1774); Salehi et al., Molecules 24-1364 (2019) 68).

Vernacular name. *Sireh utan* (NParks' Flora & Fauna Web, 2026).

Notes. The species shows a wide range of variation in its leaf shape and size. Female plants usually have larger leaves than male plants. In general, the species as it is found in Singapore, particularly the male plants growing in the Singapore Botanic Gardens' Rain Forest and old specimens from Siglap, Bukit Mandai and Changi, have much narrower lanceolate leaves than is mostly found elsewhere. The typical plant from Java has much larger leaves. *Piper lanatum* may be mistaken for the much rarer *P. curtisii* but can be distinguished by its usually larger leaves, secondary veins emerging mainly from the lower third of the laminae, and climbing usually no higher than 3 m high.

7. *Piper macropiper* Pennant

(Greek, *macros* = large; the genus *Piper*; referring to the long spikes)

Outlin. Globe 4 [View Malay. Isl.] (1800) 242; Merrill, J. Arnold Arbor. 29 (1948) 191; Chew, J. Arnold Arbor. 53 (1972) 10; Turner, Gard. Bull. Singapore 47 (1997 ['1995']) 401; Ali Ibrahim et al., Gard. Bull. Singapore 49(1) (1998 ['1997']) 53; Chew et al., Gard. Bull. Singapore 49(2) (1999 ['1997']) 207; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 210; Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 166; Turner & Chua, Checkl. Vasc. Pl. Sp. Bukit Timah Nat. Res. (2011) 63; Wong et al., Checkl. Pl. Sp. Nee Soon Swamp Forest (2013) 200, 467; Ho et al., Gard. Bull. Singapore 71(Suppl. 1) (2019) 105; Gajurel & Lua, Gard. Bull. Singapore 72 (2020) 137; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 603; Suwanphakdee et al., Fl. Thailand 16(3) (2024) 928, fig. 23, pl. 111: A. **Type:**

[Published illustration] Rumphius, Herb. Amboin. 5 (1747) t. 28: fig. 1, lectotype designated by Chew, J. Arnold Arbor. 53 (1972) 11. **Fig. 9.**

Piper arborescens Roxb., Hort. Bengal. (1814) 80; Roxburgh, Fl. Ind. 1 (1820) 161; Blume, Verh. Batav. Genootsch. Kunsten 11 (1826) 182; Roxburgh, Fl. Ind. 1 (1832) 159; Miquel, Syst. Piperac., fasc. 2 (1844) 320; Miquel, Fl. Ned. Ind. 1(2), fasc. 3 (1859) 452; de Candolle, Prodr. 16(1) (1869) 358; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 85; Merrill, Interpret. Herb. Amb. (1917) 180; Merrill, J. Arnold Arbor. 29 (1948) 191. **Type:** [Published illustration] Rumphius, Herb. Amboin. 5 (1747) t. 28: fig. 1, lectotype designated by Merrill, Interpret. Herb. Amboin. (1917) 180.

Piper lanceolatum Roxb., Fl. Ind. 1 (1820) 162, nom. illeg. non Ruiz & Pav. (1798); Roxburgh, Fl. Ind. 1 (1832) 159. **Synonyms:** *Piper lonchites* Schult., Mant. 1 (1822) 241. – *Piper moluccanum* Spreng., Syst. Veg. (ed. 16) 1 (1824 [‘1825’]) 112, nom. illeg. superfl. – *Chavica lanceolata* Miq., Syst. Piperac., fasc. 1 (1843) 264, nom. illeg. superfl.; Miquel, Fl. Ned. Ind. 1(2), fasc. 3 (1859) 445. **Type:** *Roxburgh s.n.* [EIC 6644A], [Indonesia, Moluccas] (lectotype K-W [K001124398], designated by Middleton et al., Gard. Bull. Singapore 76 (2024) 246).

Piper miniatum Blume, Verh. Batav. Genootsch. Kunsten 11 (1826) 166; Blume, Enum. Pl. Javae 1 (1827) 65; de Candolle, Prodr. 16(1) (1869) 354; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 85; Ridley, J. Straits Branch Roy. Asiat. Soc. 33 (1900) 127; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 303; Ridley, Fl. Malay Penins. 3 (1924) 39; Henderson, Malay. Wild Fls., Dicot. (1959) 440; Corner, Gard. Bull. Singapore, Suppl. 1 (1978) 80; Keng, Gard. Bull. Singapore 31 (1978) 86; Keng, Concise Fl. Singapore vol. 1, Gymn. Dicot (1990) 62; Turner, Gard. Bull. Singapore 45 (1993) 188; Turner et al., Gard. Bull. Singapore 48 (1998 [‘1996’]) 154. **Synonym:** *Chavica miniata* (Blume) Miq., Syst. Piperac., fasc. 1 (1843) 234; Miquel, Fl. Ned. Ind. 1(2), fasc. 3 (1859) 440; Miquel, Ann. Mus. Bot. Lugduno-Batavi 1, fasc. 5 (1863) 136. **Type:** *Collector unknown s.n.*, [Indonesia], Java, Tjiradjas (lectotype L [L1546296], designated by Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 166).

Piper auriculatum Blume, Verh. Batav. Genootsch. Kunsten 11 (1826) 171, fig. 8; Blume, Enum. Pl. Javae 1 (1827) 66. **Type:** [Published illustration] Blume, Verh. Batav. Genootsch. Kunsten 11 (1826), fig. 8, lectotype designated here.

Piper glandulosum Opiz in Presl, Reliq. Haenk. 1, fasc. 3 (1828) 158. **Synonym:** *Chavica glandulosa* (Opiz) C.Presl, Abh. Königl. Böhm. Ges. Wiss., ser. 5, 6 (1851) 583; Presl, Epimel. Bot. (1851 [‘1849’]) 223. **Type:** *Haenke s.n.*, Philippines, Luzon, [1792] (lectotype PRC [PRC450581], designated by Gajurel & Lua, Gard. Bull. Singapore 72 (2020) 138; isolectotypes HAL [HAL0101617], PRC [PRC450108]).

Lianas, dioecious, climbing to 10 m high; glabrous, finely pubescent or puberulent on petioles and young stems, young stems purple or reddish. **Leaves:** lamina membranous or thinly coriaceous; in vegetative branches lamina broadly ovate, 6–9 × 4–6.5 cm, apex shortly acuminate, base rounded or slightly cordate, ascending lateral veins mostly 2 pairs, arising from the base, petiole 3–5 cm long; in fertile branches lamina ovate or ovate-lanceolate, 9–18 × 3–7 cm, apex acuminate, base sometimes oblique, rounded or cuneate, shiny above, glabrous on both surfaces, ascending lateral veins 2 to 3 pairs, arising from the base, petiole short, 0.5–0.8 cm long, often hairy; prophyll 4–6 mm long, whitish, densely hairy, early caducous. **Spikes** leaf opposed, pendent, slender and long, densely flowered; peduncle 2–3 cm long, glabrous; bracts orbicular and peltate, less than 1 mm diam. **Male spikes** 10–18 cm long, slender; rachis hairy; stamens 3, filaments very short, c. 1 mm long. **Female spikes** to 16 cm long, slender; ovary free, oblong or ovate, glabrous, stigmas 3. **Fruiting spikes** to 20 cm long; peduncle 3–4

cm long, glabrous. **Drupe**s densely aggregated, mostly oblong or obovate, tip pointed, c. 2 mm long, sessile, turning bright red when ripe.

Distribution. India, Peninsular Malaysia, Sumatra, Java, Sulawesi, Philippines, Moluccas, New Guinea and the Solomon Islands. In Singapore, known from Tuas (*Goodenough JSG 4684*, 29 May 1890, SING [SING0042325]), MacRitchie (*Ridley 4826*, 1893, SING [SING0042307]; *Gwee SING2009-709*, 12 Dec 2009, SING [SING0144142]), Bukit Timah (*Chew CWL 1442*, 30 May 1967, SING [SING0042322]) and Nee Soon (*Asmarayani & Lua Rani660*, 17 Jul 2012, SING [SING0179457]).

Ecology. Mostly found in moist shaded areas in primary forest, particularly near rivulets, and in freshwater swamp forest.

Conservation assessment. Globally, Least Concern (LC), assessed here. In Singapore, assessed as Endangered (EN/D) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 502).

Uses. Different parts of the plant are reported to be used in traditional medicine in Indonesia and Papua New Guinea. It is used as a spice, a tonic and as a natural food preservative due to its reputed antibacterial activity (Salehi et al., *Molecules* 24-1364 (2019) 69).

Notes. This species is easily distinguished from other *Piper* species in Singapore by the almost parallel veins in climbing and mature leaves, unlike the venation of most *Piper* species in Singapore. The leaves are dimorphic, with basal young leaves smaller and ovate with a slightly cordate leaf base. These leaves resemble those of *Peperomia pellucida* with which it may be confused. It can be locally common where it is found, but is rarely observed to be in a fertile state.

8. *Piper maingayi* Hook.f.

(Alexander Carroll Maingay, 1836–1869, English physician,
colonial administrator and botanist)

Fl. Brit. India 5, fasc. 13 (1886) 80; Ridley, J. Straits Branch Roy. Asiat. Soc. 33 (1900) 127; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 336; Ridley, Fl. Malay Penins. 3 (1924) 31; Keng, Gard. Bull. Singapore 31 (1978) 86; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 62; Turner, Gard. Bull. Singapore 45 (1993) 188; Turner, Gard. Bull. Singapore 47 (1997 [‘1995’]) 401; Chew et al., Gard. Bull. Singapore 49(2) (1999 [‘1997’]) 207; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 196; Gajurel & Lua, Gard. Bull. Singapore 72 (2020) 138; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 603. **Type:** *Maingay 1336*, [Malaysia], Malacca [Melaka], April 1867 (lectotype K [K000575318], designated by Gajurel & Lua, Gard. Bull. Singapore 72 (2020) 138; isolectotype G-DC [G00320526]). **Fig. 10.**

Lianas, dioecious, stout, climbing to 25 m high, quite glabrous except rachis and bracts of the flowering spike. **Leaves:** lamina coriaceous, shining green; in vegetative branches lamina elliptic, 8–12 × 6–10 cm, apex shortly acuminate, base rounded or slightly cuneate, ascending

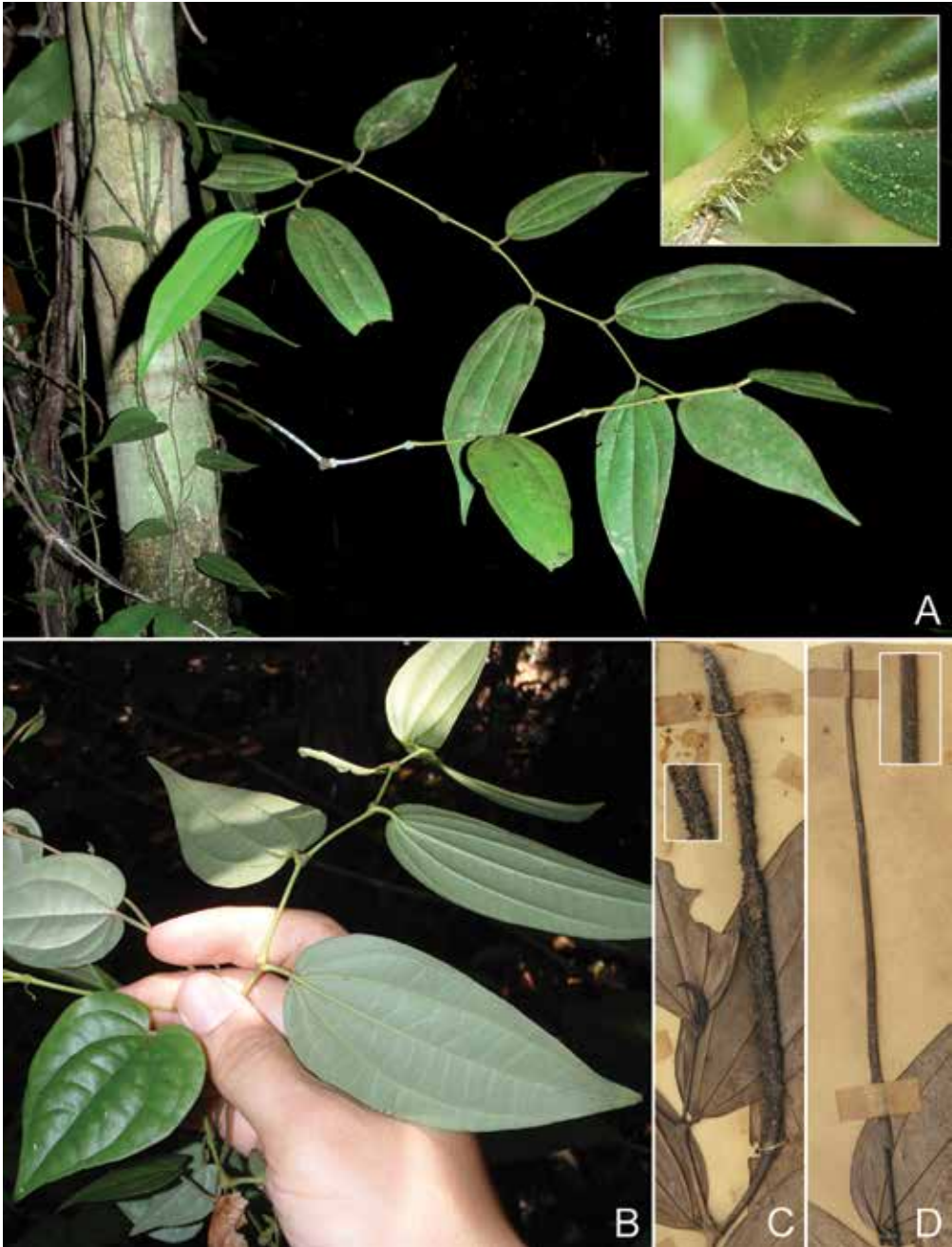


Figure 9. *Piper macropiper* Pennant. **A.** Habit. Inset: Unequal leaf base. **B.** Young leaves (upper surface) and mature leaves (lower surface). **C.** Female spike on herbarium sheet. Inset: Close-up of the same spike. **D.** Male spike on herbarium sheet. Inset: Close-up of the same spike. (A–D including insets from Singapore, A & B, Nee Soon; A inset, Nee Soon, *Asmarayani & Lua Rani660*; C & C inset, Tuas, *Goodenough 4684*; D and D inset, Chan Chu Kang, *Ridley 6153*. Photos: A, A inset & B, H.K. Lua; C, C inset, D & D inset, W.H. Lim).

lateral veins 3–4 pairs, petiole 3–5 cm long; in fertile branches elliptic-lanceolate, 8–10 × 3–6 cm, apex acuminate, base oblique, ascending lateral veins 2 pairs, the upper pair arising at 2–3 cm above the base, petiole 1–1.5 cm long; prophyll stout, glabrous. **Spikes** leaf opposed, pendent, rachis woody, covered with velvety hair, flowers distantly arranged; bracts in male spike raised to form receptacles, receptacles cleft, velvety outside and inside, stalked; in female spike cupular, raised from the rachis. **Male spikes** 8–10 cm long; peduncle 1.5–2.5 cm long; rachis tomentose; stamens 5–8, placed linearly at the top of the cup-like receptacles. **Female spikes** 4–6 cm long; peduncle c. 2 cm long; ovary 1–2 in each bract, only one developing into a fruit, ovate, stigmas 4. **Fruiting spikes** lengthening up to 10 cm long; peduncle 2–2.5 cm long. **Drupe**s loosely aggregated, distinct, globose, c. 5 mm diam., basally inserted in the cupular bract, sessile.

Distribution. Peninsular Malaysia. In Singapore, known only from the Central Catchment (Asmarayani & Lua Rani664, 26 May 2014, SING [SING0211905]; Asmarayani & Lua Rani674, 3 Jun 2014, SING [SING0215136]).

Ecology. Primarily in partially shaded areas on the margins of mature secondary and primary forest.

Conservation assessment. Globally, not assessed. In Singapore, assessed as Critically Endangered (CR/D) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 502).

Notes. Very close to *Piper schizonephros*, particularly in its habit, leaves and fruiting spike. However, in *Piper maingayi* only a single ovary in a female flower develops into a fruit and in the male flower there are only 5–6 stamens, in contrast to *P. schizonephros* in which 3–4 ovaries develop into fruit and the male flower has 8–10 stamens. Although the recent study by Asmarayani (Bot. J. Linn. Soc. 201 (2023) 175–197) on *Piper* sect. *Muldera* of the Malay Peninsula suggests that *P. maingayi* could be treated as a synonym of *P. schizonephros*, due to the aforesaid distinct differences we are retaining it as a distinct species. As noted under *Piper baccatum*, more extensive studies on the *Piper* species of the *Muldera* group are required to understand the inter and intraspecific variabilities and thereby better delineate the species.

9. *Piper muricatum* Blume

(Latin, *muricatus* = rough with short hard points or tubercles like the shell of the sea snail *Murex*; probably referring to the long-pointed hairs)

Cat. Gew. Buitenzorg (1823) 33; Blume, Verh. Batav. Genootsch. Kunsten 11 (1826) 219; Miquel, Syst. Piperac., fasc. 2 (1844) 326; Miquel, Fl. Ned. Ind. 1(2), fasc. 3 (1859) 454; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 82; Ridley, J. Straits Branch Roy. Asiat. Soc. 33 (1900) 127; Ridley, Fl. Malay Penins. 3 (1924) 32; Henderson, Malay. Wild Fls., Dicot. (1959) 441; Backer & Bakhuizen van den Brink, Fl. Java (Spermatoph.) 1 (1963) 169; Keng, Gard. Bull. Singapore 31 (1978) 86; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 62; Turner, Gard. Bull. Singapore 45 (1993) 189; Turner et al., Gard. Bull. Singapore 46(2) (1995 [‘1994’]) 29; Turner, Gard. Bull. Singapore 47 (1997 [‘1995’]) 399; Turner et al., Gard. Bull. Singapore 48 (1998 [‘1996’]) 154; Chew et al., Gard. Bull. Singapore 49(2) (1999 [‘1997’])



Figure 10. *Piper maingayi* Hook.f. **A.** Climbing habit. Inset: Leaf lower surface. **B.** Mature liana stem. **C.** Hairs on young stem. **D.** Male flowering branch. **E.** Close-up of male spike. **F.** Old dropped fruiting spikes. (A–F including inset from Singapore, A, A inset, B, C & F, MacRitchie, *Asmarayani & Lua Rani664*; D & E, MacRitchie, *Asmarayani & Lua Rani674*. Photos: H.K. Lua).

207; Suwanphakdee et al., Thai Forest Bull., Bot. 34 (2006) 210; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 210; Turner & Chua, Checkl. Vasc. Pl. Sp. Bukit Timah Nat. Res. (2011) 64; Wong et al., Checkl. Pl. Sp. Nee Soon Swamp Forest (2013) 201, 467; Suwanphakdee et al., Kew Bull. 73-33 (2018) 7; Ho et al., Gard. Bull. Singapore 71(Suppl. 1) (2019) 105; Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 167; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 603; Suwanphakdee et al., Fl. Thailand 16(3) (2024) 932, fig. 26, pl. 111: C. **Type:** *Blume s.n.*, [Indonesia], Java (lectotype L [L1547468], designated by Suwanphakdee et al., Kew Bull. 73-33 (2018) 7). **Fig. 11.**

Piper birmanicum C.DC. var. *macrostachyon* C.DC. in de Candolle, Prodr. 16(1) (1869) 338. **Type:** *Griffith 4408*, [Malaysia], Malacca [Melaka] (holotype K [K000794931]).

Piper malaccense C.DC., Rec. Bot. Surv. India 6(1) (1912) 12; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 318; Ridley, Fl. Malay Penins. 3 (1924) 33; Maxwell, Gard. Bull. Singapore 35(2) (1983 [‘1982’]) 197; Turner, Gard. Bull. Singapore 45 (1993) 188; Wong et al., Checkl. Pl. Sp. Nee Soon Swamp Forest (2013) 201, 467. **Type:** *Goodenough [& Ridley?] 617*, [Malaysia], Malacca [Melaka], Merlimau, 1893 (lectotype K [K000794929], designated by Suwanphakdee et al., Kew Bull. 73-33 (2018) 14).

Piper muricatum Blume f. *peninsulare* C.DC., Rec. Bot. Surv. India 6(1) (1912) 17; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 325. **Type:** *Ridley 8531*, [Malaysia], Selangor, Pahang Track, 1981 (lectotype SING [SING0194875], designated by Suwanphakdee et al., Kew Bull. 73-33 (2018) 7).

Piper ridleyi C.DC. f. *β* C.DC., Rec. Bot. Surv. India 6(1) (1912) 20; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 327. **Based on:** *King’s Collector 8810*, [Malaysia], Perak Ulu Kerling (G-DC [G00322824]).

Erect shrubs, monoecious, 60–150 cm tall, often straggling at lower nodes, sparsely hairy with very short pilose hairs. **Leaves:** lamina membranous, elliptic or oblong, 20–30 × 10–14 cm, apex shortly acuminate, base oblique, rounded or subcordate, scabrous, densely hairy on margin, on midrib beneath and lateral veins beneath, lateral veins 3 pairs, the first two pairs near the base, the upper pair slightly higher at 3–4 cm from base; petiole very short, c. 3 mm long, densely hairy; prophyll thick, ovate-lanceolate, 10–15 mm long, apex pointed, densely hairy. **Spikes** leaf opposed and mostly terminal, erect, cylindric, 3–5 cm long when flowering, densely flowered, male flowers towards the apex and female flowers more basal; peduncle 0.2–0.3 cm long; rachis densely hairy; bracts orbicular and peltate, 2 mm diam.; male flowers with 2 stamens; female flowers with a globose ovary, ovary c. 2 mm diam., stigmas 4–5. **Fruiting spikes** lengthening up to 8 cm long; peduncle 0.4–0.5 cm long, yellow when mature. **Drupe**s sparse, oblong or globose, 3–4 mm diam., pedicel 2–3 mm, fruit turning orange and red when ripe.

Distribution. India, Myanmar, Thailand, Malaysia and Indonesia. In Singapore, known only from Bukit Timah (*Ridley s.n.*, May 1898, SING [SING0042338]; *Nur 25987*, 24 Aug 1932, SING [SING0042339]; *Asmarayani & Lua Rani653*, 9 Jul 2012, SING [SING0179353]; *Lua et al. SING2016-149*, 19 Jul 2016, SING [SING0230838, SING0230839]; *Lua et al. SING2019-169*, 13 Mar 2019, SING [SING0272429]).

Ecology. In Singapore, in primary forest, along the banks of rivulets at the bottom of a steep valley.



Figure 11. *Piper muricatum* Blume. **A.** Habit. **B.** Young plant. **C.** Lower surface of leaves. Inset: Hairy petioles and stipules. **D.** Close-up of bisexual spike. **E.** Ripening drupes. (A–E including inset from Singapore, A & E, Bukit Timah, *Lua et al. SING2019-169*; C & C inset, Bukit Timah, *Asmarayani & Lua Rani653*; B & D, Bukit Timah. Photos: H.K. Lua).

Conservation assessment. Globally, not assessed. In Singapore, assessed as Critically Endangered (CR/D) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 502).

Notes. A larger and more robust shrub than *Piper protractum* C.DC. Very close to *Piper ridleyi* C.DC. but in that species the drupes are always globose and the plants are more hirsute with hairs on both leaf surfaces and with long hairs on the twigs. The twigs of *Piper muricatum* are glabrous or sparsely hairy with very short pilose hairs.

Piper malaccense is treated as a synonym of *P. ridleyi* by Suwanphakdee et al. (Kew Bull. 73-33 (2018) 14) and of *P. protractum* by Chew (Blumea 20(1) (1972) 147). However, after close examination of the original material of *Piper malaccense* we found it closely matches *P. muricatum* rather than *P. ridleyi* or *P. protractum* and hence it is treated here as a new synonym of *P. muricatum*. There has been some confusion over the details of the specimen designated as lectotype of *Piper malaccense*. In the protologue, de Candolle cited it as *Merliman 1617* but ‘Merliman’ is actually the locality Merlimau in Melaka and not the collector. Also, the number would appear to be 617 rather than 1617, the ‘1’ possibly being a ‘J’ instead. Chew (Blumea 20(1) (1972) 148) cited this specimen as *Goodenough 1617* and Suwanphakdee et al. (Kew Bull. 73-33 (2018) 14) as *Ridley 1617*. Although the label was written in Ridley’s handwriting, he gives his own name once, his initials once and Goodenough’s initials twice. It is likely a Goodenough specimen, possibly collected together with Ridley. Despite these variations, there is no doubt as to which specimen each author intended.

Two specimens at SING collected from Bukit Timah (*Ridley s.n.*, May 1898, SING [SING0042338]; *Nur 25987*, 24 Aug 1932, SING [SING0042339]), previously identified as *Piper ridleyi*, rather belong here. They are, however, slightly smaller plants than is typical for *Piper muricatum*.

10. *Piper obtusissimum* Miq.

(Latin, superlative of *obtusus*= blunt, obtuse;
referring to leaves with a blunt apex)

Syst. Piperac., fasc. 2 (1844) 337; Gajurel & Lua, Gard. Bull. Singapore 72 (2020) 138; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 603; Suwanphakdee et al., Fl. Thailand 16(3) (2024) 936, fig. 27, pl. 112: A. **Synonym:** *Piper clypeatum* Wall. [Numer. List no. 6655 (1832), nom. nud.] ex C.DC. in de Candolle, Prodr. 16(1) (1869) 378, nom. illeg. superfl.; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 96; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 333; Merrill, Enum Philipp. Fl. Pl. 2 (1923) 18. **Type:** *Wallich s.n.* [EIC 6655B], Singapore, 1822 (lectotype GZU [GZU000256190], designated by Gajurel & Lua, Gard. Bull. Singapore 72 (2020) 138). **Fig. 12.**

Ficus peltata Blume, Bijdr. Fl. Ned. Ind., pt 9 (1825) 438. **Type:** *Collector unknown s.n.*, [Indonesia], Java (lectotype L [L0064265], designated here; possible isoelectotypes K [K000820069], L [L0484149], P [P06827586]).

Piper manillanum Miq., Syst. Piperac., fasc. 2 (1844) 339. **Type:** *Wallich s.n.* [EIC 6655B], Singapore, 1822 (lectotype GZU [GZU000256191], designated by Gajurel & Lua, Gard. Bull. Singapore 72 (2020) 138).

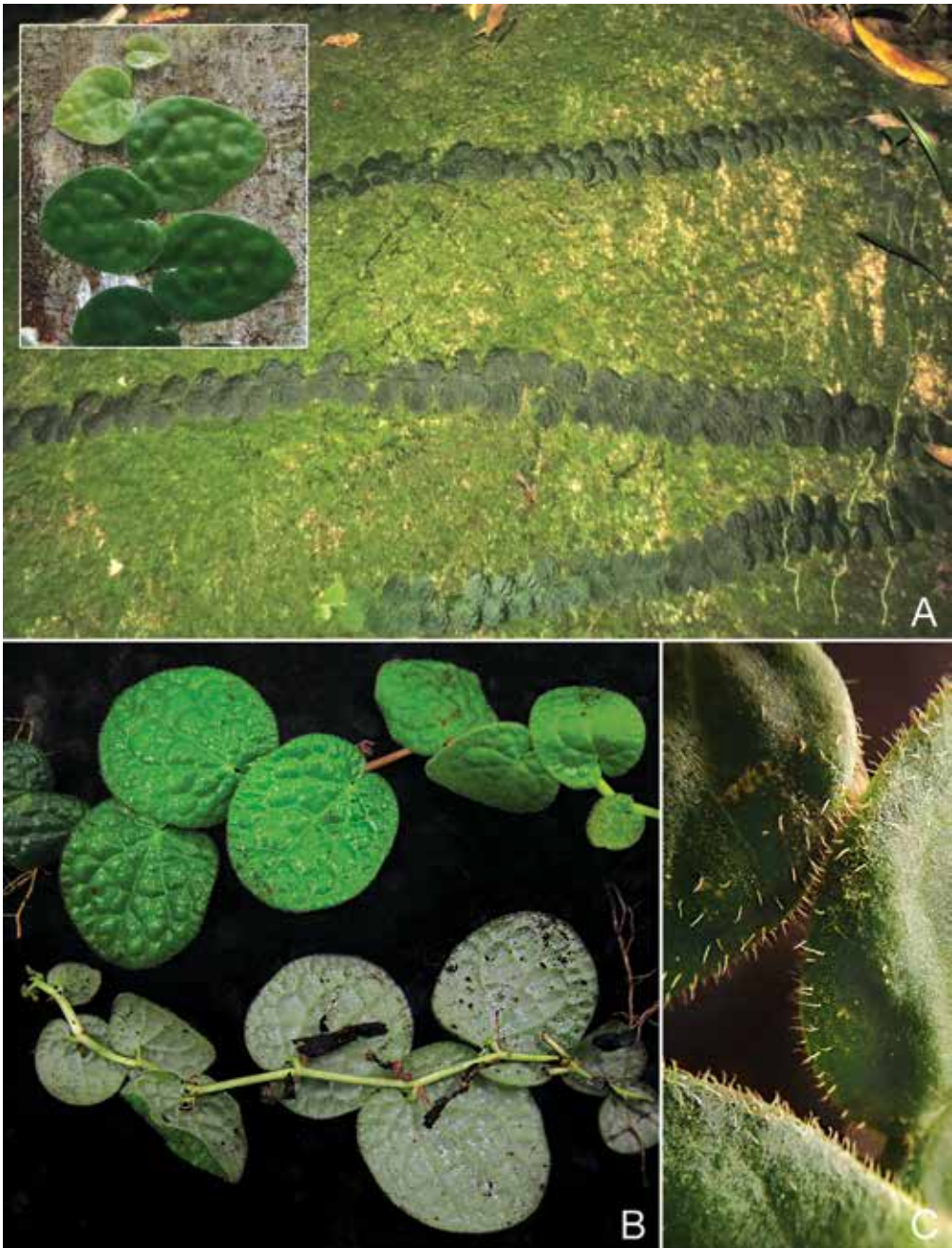


Figure 12. *Piper obtusissimum* Miq. **A.** Habit, clambering horizontally over boulder. Inset: Habit, on tree trunk. **B.** Upper surface of leaves (top); lower surface of leaves (bottom). **C.** Hairy leaf margins. (A–C including inset from Singapore, A & C, Bukit Timah, *Lim et al. SING2019-023*; A inset, Nee Soon; B, Pasir Panjang Nursery (cultivated from native stock), *Yeoh SING2019-1383*. Photos: A, R.C.J. Lim; A inset & C, H.K. Lua; B, W.H. Lim).

Climbing shrubs on tree trunks and rocks, quite hirsute; stems with short internodes, rooting at the nodes, glabrous or sparsely hairy. **Leaves:** lamina ovate to orbicular, adpressed on climbing surface with recurved margins, highly variable in size, 6–12 × 5–12 cm, apex short acute, base cordate or rounded, hairy above, hairy along veins beneath, ascending lateral veins 3–6 pairs mostly from the base, subsessile or with very short petiole, 2–5 mm long. **Spikes** not known.

Distribution. India, Myanmar, Malaysia and Indonesia. In Singapore, the earliest collection is the type collection from an unspecified locality (*Wallich s.n.* [EIC 6655B], 1822, GZU [GZU000256190]). It was later collected from Bukit Timah (*Hullett 908*, 5 April 1885, K [K000842487]) and, more recently, it was relocated in the same area (*Lim et al. SING2019-023*, 16 Jan 2019, SING [SING0285687]). It has been observed but not collected in Nee Soon Freshwater Swamp Forest.

Ecology. Found in moist shady places in primary forest and in freshwater swamp forest.

Conservation assessment. Globally, not assessed. In Singapore, assessed as Critically Endangered (CR/D) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 502).

Notes. *Piper obtusissimum*, which has mostly been reported under the name *P. clypeatum*, is one of the most distinctive species of *Piper* but has, until recently, not been recorded in its fertile state. Suwanphakdee et al. (Nord. J. Bot. 2023: e04099), however, reported fertile branches with flowers and fruit in Thailand. We have not included these features here as we have not seen and verified any fertile specimens. This species is easily recognised by the shingling climbing habit with its roundish leaves having recurved margins adpressed onto the surface of tree bark or the rock on which it is climbing. It does not possess the obvious swollen nodes typical of Piperaceae. It does, however, have a faint and unmistakable peppery scent when bruised. It looks similar to some *Pothos* L. species in the Araceae.

Blume (Bijdr. Fl. Ned. Ind., pt 9 (1825) 438) described *Ficus peltata* Blume based on a collection from Java. The original material had already been identified as more likely belonging to *Piper* and we place it here in synonymy of *P. obtusissimum* as the epithet is not available in *Piper* for a new combination.

Although Gajurel & Lua (Gard. Bull. Singapore 72 (2020) 138) included the Philippines as a locality for this species, it likely does not occur there. The inclusion of the Philippines in the distribution of the species was based only on one of the syntypes of *Piper manillanum* but Merrill (Enum. Philipp. Fl. Pl. 2 (1923) 18) and Quisumbing (Philipp. J. Sci. 43 (1930) 1–246) have both contended that the locality of this specimen as being from Manila is a mistake and the material is probably from Singapore or Penang.

11. *Piper porphyrophyllum* (Lindl. ex Blandy) N.E.Br.

(Greek, *porphyreos* = purple, *phyllon* = leaf; referring to the young leaves which are purple beneath)

Gard. Chron., n.s. 22 (1884) 438; Ridley, J. Straits Branch Roy. Asiat. Soc. 33 (1900) 128; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 313; Ridley, Fl. Malay Penins. 3 (1924) 45; Keng, Gard. Bull. Singapore 31 (1978) 86; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 62; Turner, Gard. Bull. Singapore 45 (1993) 189; Turner, Gard. Bull. Singapore 47 (1997 ['1995']) 402; Chew et al., Gard. Bull. Singapore 49(2) (1999 ['1997']) 208; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 217; Wong et al., Checkl. Pl. Sp. Nee Soon Swamp Forest (2013) 201, 467; Neo et al., Nat. Singapore 6 (2013) 71; Neo et al., Nat. Singapore 6 (2013) 283; Neo et al., Nat. Singapore 7 (2014) 106; Suwanphakdee et al., Kew Bull. 73-33 (2018) 7; Lim et al., Fl. Singapore 1 (2019) 89; Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 171; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 604; Suwanphakdee et al., Fl. Thailand 16(3) (2024) 942, fig. 30. **Basionym:** *Cissus porphyrophylla* Lindl. ex Blandy, Proc. Roy. Hort. Soc. London 1 (1860) 225, as '*porphyrophyllus*'. **Type:** Wallich s.n. [EIC 6643E], [Malaysia], Penang, August 1822 (neotype K [K000794902], designated by Suwanphakdee et al., Kew Bull. 73-33 (2018) 14; isoneotypes K [K000794900], K-W [K001124395]). **Fig. 13.**

Slender climbers or low creeping shrubs, dioecious, climbing to 10 m high, young stems in creeping vegetative branches purple and succulent, plant parts finely pubescent. **Leaves:** lamina in vegetative branches membranous, ovate or orbicular, 5–9 × 4–8 cm, apex acute or acuminate, base deeply cordate, dark green or blackish with rose or white pigmented speckles above, purple beneath, pubescent on both the sides but dense beneath, ascending lateral veins 4 pairs, all from base, the lower pair often inconspicuous, petiole 3–5 cm long, finely pubescent purple; lamina in fertile branches coriaceous, ovate-lanceolate or obovate, 8–15 × 4–7 cm, apex acuminate, base cuneate, dark green above, pale green beneath, hairy beneath mostly on veins, ascending lateral veins mostly 3 pairs, within 2 cm of the base, petiole 1–2 cm long, grooved, finely pubescent; prophyll thick, ovate, 1–1.5 cm long, densely hairy. **Spikes** leaf opposed, long and pendent, slender, flowers loosely aggregated; peduncle 1.5–2 cm long, glabrous or finely pubescent; rachis hairy; flowering rare; bracts oblong and adnate to rachis with free margins, c. 2 mm long, glabrous. **Male spikes** 10–15 cm long; stamens 3, c. 2 mm long. **Female spikes** 6–9 cm long; ovary globose, c. 1.5 mm diam., stigmas 3 or 4, linear. **Fruiting spikes** lengthening up to 12 cm long; peduncle 2–4 cm long, glabrous. **Drupe**s loosely aggregated, distinct, ovate-attenuate, sessile.

Distribution. India, Thailand and Malaysia. In Singapore, first collected by Hullett at an unspecified locality (*Hullett 397*, 1886, SING [SING0041343]). More recently collected from MacRitchie (*Asmarayani & Lua Rani658*, 12 Jul 2012, SING [SING0179358]) and Mandai (*Lua SING2016-139*, 5 Aug 2016, SING [SING0236469, SING0236471]). Ridley (Fl. Malay Penins. 3 (1924) 45) mentioned the occurrence of this species at Bukit Timah and in the 'Garden Jungle' [Singapore Botanic Gardens' Rain Forest], but no specimens have been traced.

Ecology. In the understorey of primary and mature secondary forests, near streams and on forest slopes. Rather slow growing and rarely observed with fertile spikes.

Conservation assessment. Globally, not assessed. In Singapore, assessed as Critically Endangered (CR/D) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 56, 502).

Uses. The leaves have been reported as having medicinal properties for the treatment of weakness and pain of the bones and chest, for leprosy, stomach ache in children, after childbirth by women and in skin diseases. The plant is also cultivated as an ornamental for its pigmented young leaves (Burkill, Dict. Econ. Prod. Malay Penins. 2 (1935) 1781).

Vernacular names. *Tiger's betel*, 紫背胡椒 (NParks' Flora & Fauna Web, 2026).

Notes. A distinctive species, particularly in its young vegetative condition due to the purple stems and the leaves with their coloured spots on the upper surface and being purple beneath. The leaves on more mature stems higher in the canopy are green, having lost the unique colouration.

12. *Piper protractum* C.DC.

(Latin, *protractus* = extended; possibly referring to the elongated leaves)

Rec. Bot. Surv. India 6(1) (1912) 18; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 326; Ridley, Fl. Malay Penins. 3 (1924) 33; Chew, Blumea 20(1) (1972) 147; Keng, Gard. Bull. Singapore 31 (1978) 86; Keng, Concise Fl. Singapore vol. 1, Gymn. Dicot. (1990) 63; Turner, Gard. Bull. Singapore 45 (1993) 189; Turner, Gard. Bull. Singapore 47 (1997 ['1995']) 402; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 210; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 604. **Type:** *Chua et al. YK 2004-01*, Singapore, Nee Soon Freshwater Swamp Forest, 11 March 2004 (neotype SING [SING0053416], designated here). **Fig. 14.**

Erect shrubs, monoecious, to 50–60 cm tall, nodes distinct and thick, terminal internodal length 3–5 cm, plant parts densely hairy. **Leaves:** lamina membranous, elliptic-lanceolate, 15–20 × 6–8 cm, apex acuminate, slightly bent, base unequally rounded, ascending lateral veins 2–3 pairs arising near the base, the upper pair reaching almost to the apex, secondary lateral veins 5–6 pairs, densely hairy on midrib and veins beneath; petiole 0.8–1.2 cm long, hirsute; prophyll membranous, ovate, 5–6 mm long, densely pubescent. **Spikes** leaf opposed, erect, with flowers of both sexes, 2–3 cm long; peduncle 0.4–0.5 cm long; rachis hairy; bracts orbicular, adnate basally, glabrous; stamens 2 (or 3), short, c. 1 mm long, mostly in apical part of the spike, fewer than the female flowers; ovary ovate, c. 2 mm long, stigmas 4, sessile. **Fruiting spikes** erect, lengthening up to 5 cm long; peduncle 0.6–0.8 cm long, pale green when mature. **Drupe**s loosely aggregated, ovoid, 8–10 mm in length, pedicel very short, fruit becoming orange to red when ripe.

Distribution. Malaysia. In Singapore, known only from Nee Soon (*Abu Kassim 100*, 1955 SING [SING037087]; *Maxwell 82-199*, Jul 1982, SING [SING0014993]; *Chua et al. YK 2004-01*, Mar 2004, SING [SING0053416]).



Figure 13. *Piper porphyrophyllum* (Lindl. ex Blandy) N.E.Br. **A.** Climbing Habit. **B.** Young Leaves (upper surface). **C.** Shade leaf (lower surface). **D.** Mature leaf (lower surface). **E.** Climbing stem. **F.** Close-up of fruiting spike on herbarium sheet. (A–E from Singapore, A, C–E, Mandai forest *Lua SING2016-139*; B, MacRitchie, *Asmarayani & Lua Rani658*; F from Peninsular Malaysia, *Henderson SFN 21788*. Photos: H.K. Lua).

Ecology. In Singapore, it is found in damp areas on the deeply shaded floor of a freshwater swamp forest. The drupes on the erect fruiting spikes have been observed to ripening from green to red in three weeks.

Conservation assessment. Globally, not assessed. In Singapore, assessed as Critically Endangered (CR/D) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 502).

Notes. Chew (Blumea 20(1) (1972) 147) designated *Ridley* 6723, Singapore, Sungei Jurong, May 1894 (SING) as the lectotype of *Piper protractum*. However, neither this specimen nor any other original material can be found despite an extensive search and a neotype has, therefore, been designated here.

Piper protractum is a rather weak-looking and usually single-stemmed shrub. Although the species is similar to *Piper muricatum* and *P. ridleyi*, it can be distinguished easily by its shorter habit with weaker stem, papery-thin lanceolate leaves, occasionally with slightly wavy margins in living plants, and ovoid, very shortly-stalked, almost sessile drupes.

13. *Piper ramipilum* C.DC.

(Latin, *rami*- = pertaining to branches, *pilus* = hair;
referring to the indumentum)

Rec. Bot. Surv. India 6(1) (1912) 3; Ridley, Fl. Malay Penins. 3 (1924) 39; Turner, Gard. Bull. Singapore 47 (1997 [‘1995’]) 402; Suwanphakdee et al., Thai Forest Bull., Bot. 34 (2006) 209; Turner & Chua, Checkl. Vasc. Pl. Sp. Bukit Timah Nat. Res. (2011) 64; Ho et al., Gard. Bull. Singapore 71(Suppl. 1) (2019) 105; Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 172; Gajurel & Lua, Gard. Bull. Singapore 72 (2020) 136; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 604; Suwanphakdee et al., Fl. Thailand 16(3) (2024) 946, fig. 32, pl. 113: B. **Type:** *Curtis* 792, [Malaysia], Penang, Balik Palau, March 1892 (lectotype SING [SING0194877], designated by Gajurel & Lua, Gard. Bull. Singapore 72 (2020) 136; islectotype K [K000794922]). **Fig. 15.**

Woody lianas, dioecious, climbing to 10 m high, densely hairy with ramulose hairs, particularly in young branches, nodes swollen and with adventitious roots. **Leaves:** lamina subcoriaceous, ovate-elliptic, 9–11 × 5–6 cm, apex acute or shortly acuminate, base asymmetric or cordate, glabrous above and on margins, pubescent mostly on veins beneath, ascending lateral veins 2–3 pairs, opposite, the uppermost pair arising alternately 3–4 cm above the base; petiole short, 5–8 mm long, densely hairy; prophyll ovate-lanceolate, densely hairy. **Spikes** leaf opposed, mostly in upper or terminal nodes, pendulous, cylindric, white or pale green, rachis glabrous, densely flowered; bracts orbicular and peltate, c. 1 mm diam. **Male spikes** pendulous, green, 8–10 cm long, 2–3 mm diam.; peduncle 3–4 cm long, densely hairy; stamens 2, c. 2 mm long, in rows alternately with bracts. **Female spikes** 7–9 cm long; ovary more or less globose, 1–2 mm diam., connate at base, embedded in rachis, stigma 1, orbicular; peduncle 1.5–2 cm long, with ramulose hairs. **Fruiting spikes** 8–12 cm long, 6–8 mm diam. when mature, pendulous, cylindric; peduncle 3–4 cm long. **Drupes** densely aggregated on rachis, basally connate, free above, globose, 2–3 mm diam., yellow-orange when ripe, stigma persistent.



Figure 14. *Piper protractum* C.DC. **A.** Habit. **B.** Lower surface of leaves. **C.** Bisexual spike. **D.** Drupes ripening on spike. (A–D from Singapore, Nee Soon. Photos: H.K. Lua).

Distribution. Myanmar, Thailand and Malaysia. In Singapore, known from Bukit Timah (Ridley 12487, 1905, SING [SING0042337]; Asmarayani & Lua Rani648, 3 Jul 2012, SING [SING0185192]), Dairy Farm (Lua & Davison SING2012-215, May 2012, SING [SING0173603]; Lua SING2012-237, 22 May 2012, SING [SING0182105]) and Pulau Ubin (Lua et al. SING2014-314, 30 Jun 2014, SING [SING0212425, SING0213819]).

Ecology. In moist shaded areas in primary forest, secondary forest and forest margins along trails. It is found creeping on the ground and up tree trunks with climbing stems up to 3 cm diameter, producing fertile branches at 4–10 m high or when there is a break in the canopy.

Conservation assessment. Globally, not assessed. In Singapore, assessed as Endangered (EN/D) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 502).

Notes. This species is characterised by the presence of a dense indumentum of ramulose hairs on the stem, petiole, leaf undersurface and peduncle. It somewhat resembles *Piper crassipes* but can be distinguished from that species by the very hairy young parts with longer hairs.

14. *Piper ribesioides* Wall.

(the genus *Ribes*, Grossulariaceae, Latin, *-oides* = resembling; probably referring to the fruit resembling those of *Ribes* L.)

Pl. Asiat. Rar. 1, fasc. 4 (1830) 79, t. 91; Wallich, Numer. List no. 6637 (1832); de Candolle, Prodr. 16(1) (1869) 342; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 81; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 322; Ridley, Fl. Malay Penins. 3 (1924) 34; Henderson, Malay. Wild Fls., Dicot. (1959) 442; Keng, Gard. Bull. Singapore 31 (1978) 86; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 63; Turner, Gard. Bull. Singapore 45 (1993) 189; Turner, Gard. Bull. Singapore 47 (1997 [‘1995’]) 402; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 197; Suwanphakdee et al., Kew Bull. 73-33 (2018) 14; Lim et al., Fl. Singapore 1 (2019) 89; Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 173; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 604; Suwanphakdee et al., Fl. Thailand 16(3) (2024) 948, fig. 33, pl. 114: A. **Type:** Wallich s.n. [EIC 6637], [Myanmar], Chappedong (lectotype K-W [K001124357], designated by Suwanphakdee et al., Kew Bull. 73-33 (2018) 14). **Fig. 16.**

Cubeba sumatrana Miq., Comm. Phytogr., fasc. 2 (1840) 33. **Synonym:** *Piper sumatranum* (Miq.) C.DC. in de Candolle, Prodr. 16(1) (1869) 343; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 81; Ridley, J. Straits Branch Roy. Asiat. Soc. 33 (1900) 127, as ‘*sumatrana*’. **Type:** Wallich s.n. [EIC 6646B], [Malaysia], Penang (lectotype K [K001124405], designated by Suwanphakdee et al., Kew Bull. 73-33 (2018) 14).

Lianas, dioecious, stout, climbing to 10 m high, also creeping on rocks or stumps, pubescent in the vegetative branches and glabrous in the fertile shoots. **Leaves:** lamina coriaceous, drying yellow-brown below; in vegetative branches lamina ovate but base deeply cordate so often appearing sagittate, 5–10 × 3–6 cm, apex acute, major lateral veins 2–3 pairs, all arising from the base, prominent beneath, petiole 2–3 cm long, petiole and undersurface of leaves finely pubescent; in fertile branches lamina ovate-elliptic or elliptic-lanceolate, 15–20 × 6–8 cm, apex acuminate, base slightly oblique with rounded lobes, major lateral veins 3 pairs, two



Figure 15. *Piper ramipilum* C.DC. **A.** Climbing Habit. **B.** Branched hairs on lower surface of leaves. **C.** Female spikes on leafy branches. Inset: Close-up of female spike. **D.** Male spikes on leafy branches. Inset: Close-up of male spike. (A–D including inset from Singapore, A, Dairy Farm; B, D & D inset, Dairy Farm, Lua SING2012-237; C & C inset, Bukit Timah, Teo SING2017-345. Photos: H.K. Lua).

pairs arising from the base of the lamina and the third pair arising from 3–4 cm above the base, quite glabrous, petiole 2.5–4 cm long, glabrous; prophyll small, about 10 mm long. **Spikes** leaf opposed, erect or suberect; bracts minute, oblong, adnate to the rachis with free margin. **Male spikes** slender, 12–15 cm long; peduncle c. 2 cm long; stamens 2. **Female spikes** c. 2 cm long, c. 4 mm diam.; peduncle c. 1.5 cm long; rachis hairy; ovary oval or elongated, style short, stigmas 3–4. **Fruiting spikes** 6–10 cm long, c. 1.5 cm diam.; peduncle c. 2 cm long. **Drupes** distinct, globose, with a long pedicel, pedicel 4–6 mm long, stout, longer than the fruit, turning orange and red on maturity.

Distribution. India, Sri Lanka, Myanmar, Peninsular Malaysia and Sumatra. In Singapore, known only from MacRitchie (*Lua SING2012-387*, 12 Sep 2012, SING [SING0190194]; *Lua SING2012-388*, 12 Sep 2012, SING [SING0190195]; *Lua SING2012-389*, 12 Sep 2012, SING [SING0190196]).

Ecology. Primary forest in a highly shaded moist area.

Conservation assessment. Globally, not assessed. In Singapore, assessed as Critically Endangered (CR/D) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 502).

Uses. All parts of the plant are reported to be used medicinally in Indonesia and Malaysia. The leaves are reported to be used as a poultice for swellings and dropsy, and to alleviate chest congestion. The roots are reported to be used in the treatment of asthma, diarrhoea and abdominal pain. The immature, dried drupes are also reported to be used in the treatment of coughs, bronchitis, sinusitis, throat and genito-urinary infections, poor digestion and amoebic dysentery. The essential oil of the fruit reputedly possesses antiseptic, carminative, diuretic and stimulant properties. It has been suggested that the drupes are used as an adulterant for cubeb pepper (*Piper cubeba*) (Burkill, Dict. Econ. Prod. Malay Penins. 2 (1935) 1782); Salehi et al., Molecules 24-1364 (2019) 67).

Notes. A distinctive species that can be recognised easily by the coriaceous leaves and the distinct and long-stipitate fruit. The leaves are dimorphic, with young creeping leaves which are smaller, up to 10 cm long, with pale coloured streaks along the midrib on the upper side of the leaf. The leaves become small and lanceolate as it begins to climb and it then develops the typically large leaves as it climbs above about 1 m high, the pale streak disappearing as it develops the large mature leaves. No fertile specimens have been collected from Singapore.

15. *Piper ridleyi* C.DC.

(Henry Nicholas Ridley, 1855–1956, English botanist
and first Director of Singapore Botanic Gardens)

Rec. Bot. Surv. India 6(1) (1912) 19; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 327; Ridley, Fl. Malay Penins. 3 (1924) 33; Turner, Gard. Bull. Singapore 47 (1997 [‘1995’]) 402; Suwanphakdee et al., Thai Forest Bull., Bot. 34 (2006) 210; Turner & Chua, Checkl. Vasc. Pl. Sp.



Figure 16. *Piper ribesioides* Wall. **A.** Climbing habit. **B.** Lower surface of leaves. **C.** Creeping leaves. **D.** Fruiting spikes on herbarium sheet. (A–C from Singapore, A & B, MacRitchie; C, MacRitchie, Lua SING2012-388; D from Peninsular Malaysia, Yao & Norzamlı FRI 65467. Photos: H.K. Lua).

Bukit Timah Nat. Res. (2011) 64; Suwanphakdee et al., Kew Bull. 73-33 (2018) 14; Ho et al., Gard. Bull. Singapore 71(Suppl. 1) (2019) 105; Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 174; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 604; Suwanphakdee et al., Fl. Thailand 16(3) (2024) 950. **Type:** *Ridley 8519*, [Malaysia], Selangor, 15th mile Pahang Track, 1897 (lectotype CAL [CAL0000020947], designated by Middleton et al., Gard. Bull. Singapore 76 (2024) 248). **Fig. 17.**

Piper velutibracteum C.DC., Annuaire Conserv. Jard. Bot. Genève 21 (1920) 284. **Type:** *Ridley s.n.*, [Malaysia], North Borneo [Sabah], Labuk Bay, 1897 (lectotype SING [SING0194874], designated by Middleton et al., Gard. Bull. Singapore 76 (2024) 248).

Erect shrubs, dioecious, stout, 60–100 cm tall, plant parts densely hairy, hairs 3–4 mm long. **Leaves** membranous, oblong-rhomboid or elliptic or sometimes elliptic-lanceolate, 14–20 × 8–12 cm, apex shortly acuminate, base rounded or cuneate, densely hairy or pilose beneath and on margin, pubescent in upper surface, ascending lateral veins 3–4 pairs, the uppermost pair arising alternately near the middle of the leaf and reaching the apex; petiole 3–4 mm long, densely hairy; prophyll ovate, 15–20 mm long, finely ridged, shortly acuminate, pilose. **Spikes** leaf opposed, erect, cylindric; bracts orbicular, adnate basally, glabrous, c. 2 mm diam. **Male spikes** 4–6 cm long, whitish; peduncle 0.4–0.6 cm long; rachis glabrous; stamens 2, c. 2 mm long. **Female spikes** 3–4 cm long; peduncle 0.2–0.3 cm long; rachis glabrous; ovary globose, c. 2 mm diam., stigmas 4. **Fruiting spikes** erect, lengthening up to 10 cm long; peduncle 0.4–0.5 cm long. **Drupes** loosely aggregated, globose, 4–7 mm diam., pedicel as long as the length of the drupe or longer when ripe, fruit becoming bright red when ripe.

Distribution. Peninsular Malaysia. In Singapore, known only from Nee Soon (*Gan et al. 1187*, 1 Jun 1992, SINGU [SING0370835]).

Ecology. In Singapore, in a heavily shaded and drier part of a freshwater swamp forest.

Conservation assessment. Globally, not assessed. In Singapore, assessed as Critically Endangered (CR/D) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 503).

Notes. *Piper ridleyi* is very variable across its range, particularly in the size, shape and indumentum of its leaves and in the length of its fruiting spikes. The more elliptic leaves with hairs on the upper surface, the dense hairs on the leafy twigs, and the longer pedicellate drupes distinguish it from otherwise similar species. Young plants are more densely hairy on all parts than mature individuals.

16. *Piper rostratum* Roxb.

(Latin, *rostratus* = beaked; referring to the persistent style)

Fl. Ind. 1 (1820) 162; Roxburgh, Fl. Ind. 1 (1832) 160; de Candolle, Prodr. 16(1) (1869) 377; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 87; Ridley, J. Straits Branch Roy. Asiat. Soc. 33 (1900) 128; Suwanphakdee et al., Kew Bull. 73-33 (2018) 14; Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 174; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 604; Suwanphakdee et al., Fl. Thailand 16(3) (2024)



Figure 17. *Piper ridleyi* C.DC. **A.** Habit, young plants in wild. **B.** Young plant in cultivation. **C.** Ripe fruiting spike on herbarium sheet. (A & B from Singapore, A, Nee Soon; B, Singapore Botanic Gardens (cultivated from native stock); C from Peninsular Malaysia, *Nura Abdul Karim & Mhd Shah NK39*. Photos: A & C, H.K. Lua; B, J.J. Chia).

951, fig. 34, pl. 114: **B. Synonyms:** *Peperomia rostrata* (Roxb.) A.Dietr., Sp. Pl., ed. 6, 1 (1831) 153. – *Rhyncholepis roxburghii* Miq., Syst. Piperac., fasc. 1 (1843) 284, nom. illeg. superfl. **Type:** *Roxburgh* 2675, [Malaysia], Malacca [Melaka] (lectotype BM [BM000939635], designated by Middleton et al., Gard. Bull. Singapore 76 (2024) 249). **Fig. 18.**

Piper stylosum Miq., Ann. Mus. Bot. Lugduno-Batavi 1, fasc 5 (1863) 139; de Candolle, Prodr. 16(1) (1869) 344; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 302; Turner, Gard. Bull. Singapore 47 (1997 [‘1995’]) 403. **Type:** *Korthals s.n.*, [Indonesia], Sumatra (lectotype L [L1547514], designated by Suwanphakdee et al., Kew Bull. 73-33 (2018) 14).

Piper birmanicum C.DC., J. Bot. 4 (1866) 163. **Type:** *Griffith 4414*, [Malaysia], Malacca [Melaka] (lectotype K [K000794910], designated by Suwanphakdee et al., Kew Bull. 73-33 (2018) 14).

Erect shrubs, about 30–40 cm tall, usually dioecious, quite pubescent. **Leaves:** lamina membranous, elliptic or oblong, 8–12 × 4–6 cm, acute or shortly acuminate, base subcordate, rounded or acute, scabrous when young, glabrous when mature except finely pubescent on the midrib and lateral veins beneath, lateral veins 3 pairs, the first two pairs near the base, the upper pair slightly higher up at 1–2 cm from base; petiole very short, c. 0.5 cm long, finely pubescent; prophyll membranous, lanceolate, 4–8 mm long, pubescent. **Spikes** leaf opposed, erect, mostly in terminal position, rachis and peduncle hairy, mostly unisexual but sometimes also seen to have both male and female flowers on the same spike; **bracts** minute, c. 1 mm diam., orbicular and peltate, glabrous outside, pubescent inside. **Male spikes** cylindric, 3–5 cm long; peduncle 2–3 cm long, hairy; stamens 2. **Female spikes** short cylindric, 1–1.5 cm long; peduncle c. 1 cm long; rachis c. 5 mm diam., pubescent; flower dense; ovary globose, c. 2 mm diam., style long, slightly bent, stigmas 3. **Fruiting spikes** subglobose or short cylindric, to 2 cm long; peduncle c. 1 cm long. **Drupes** densely aggregated, oblong or globose, 2–3 mm diam., sessile, style persistent and as long as the fruit, hooked; fruit turning bright red when ripe.

Distribution. Myanmar, Thailand, Malaysia and Indonesia. In Singapore, known from one historical collection from an unspecified locality (*Maingay 1328*, 1867, K [K000794907]) and, more recently, from Bukit Timah (*Lim et al. SING2018-452*, 30 Apr 2018, SING [SING0274241]).

Ecology. In Singapore, in primary forest in deep shade.

Conservation assessment. Globally, not assessed. In Singapore, assessed as Critically Endangered (CR/D) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 503).

Uses. The roots are reported to be used as a decoction after childbirth. Traditionally, the plant was used to treat fevers and pain. The leaves are also eaten as vegetable (Burkill, Dict. Econ. Prod. Malay Penins. 2 (1935) 1783; Salehi et al., Molecules 24-1364 (2019) 63).

Notes. Probably the smallest *Piper* species in Asia. When fertile, it produces short fruiting spikes with characteristic beaked drupes. The species was previously only known in Singapore from one collection from 1867 but, after a gap of over 150 years, a second collection from a



Figure 18. *Piper rostratum* Roxb. **A.** Habit. **B.** Lower surface of leaf. **C.** Seedling beside fruiting plant. **D.** Young spike. **E.** Bisexual fruiting spike. (A–E from Singapore, Bukit Timah, *Lim et al. SING2018-452*. Photos: H.K. Lua).

small population was made in 2018 in one of the steep forest valleys in Bukit Timah Nature Reserve.

17. *Piper sarmentosum* Roxb.

(Latin, *sarmentosus* = with long runners; presumably referring to the creeping stems)

Asiat. Res. 11 (1810) 565; Roxburgh, Fl. Ind. 1 (1820) 162; Roxburgh, Fl. Ind. 1 (1832) 160; Ridley, J. Straits Branch Roy. Asiat. Soc. 33 (1900) 127; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 308; Ridley, Fl. Malay Penins. 3 (1924) 40; Keng, Gard. Bull. Singapore 31 (1978) 87; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 63; Turner, Gard. Bull. Singapore 45 (1993) 189; Turner, Gard. Bull. Singapore 47 (1997 ['1995']) 402; Chew et al., Gard. Bull. Singapore 49(2) (1999 ['1997']) 208; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 230; Neo et al., Nat. Singapore 5 (2012) 282; Neo et al., Nat. Singapore 6 (2013) 15; Neo et al., Nat. Singapore 6 (2013) 71; Neo et al., Nat. Singapore 6 (2013) 82; Neo et al., Nat. Singapore 6 (2013) 122; Neo et al., Nat. Singapore 6 (2013) 283; Neo et al., Nat. Singapore 7 (2014) 66; Neo et al., Nat. Singapore 7 (2014) 106; Hung et al., Nat. Singapore 10 (2017) 47; Kaw & Neo, Wayside Fls Singapore (2018) 140; Ho et al., Gard. Bull. Singapore 71(Suppl. 1) (2019) 106, 132; Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 175; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 604; Suwanphakdee et al., Fl. Thailand 16(3) (2024) 953. **Synonyms:** *Peperomia sarmentosa* (Roxb.) A.Dietr., Sp. Pl., ed. 6, 1 (1831) 161. – *Chavica sarmentosa* (Roxb.) Miq., Syst. Piperac., fasc. 1 (1843) 242; Miquel, Fl. Ned. Ind. 1(2), fasc. 3 (1859) 441. **Type:** *Roxburgh s.n.*, India, Calcutta, 1809 (lectotype LINN [Herb. Smith 73.49], designated by Middleton et al., Gard. Bull. Singapore 76 (2024) 249). **Fig. 19.**

Piper latifolium W.Hunter, Asiat. Res. 9 (1809) 392, nom. illeg. non L.f. (1782). **Type:** *Roxburgh s.n.*, India, Calcutta, 1809 (neotype LINN [Herb. Smith 73.49], designated by Middleton et al., Gard. Bull. Singapore 76 (2024) 249).

Piper brevicaule C.DC., Annuaire Conserv. Jard. Bot. Genève 2 (1898) 272, nom. illeg. non Poir. (1816). **Type:** *Balansa 3631*, [Vietnam], Tonkin, Mont Bavi, July 1886 (lectotype P [P02030064], designated by Gilbert & Xia, Novon 9 (1999) 194; isolectotype P [P02030063]).

Piper lolot C.DC., Annuaire Conserv. Jard. Bot. Genève 2 (1898) 272. **Type:** *Balansa 539*, [Vietnam], Tonkin, Environs de Quang-yen, September 1885 (holotype P [P04023422]).

Chavica hainana C.DC., Annuaire Conserv. Jard. Bot. Genève 2 (1898) 275. **Synonym:** *Piper hainana* (C.DC.) K.Schum., Just's Bot. Jahresber. 26(1) (1900) 363. **Type:** *Henry 8139*, China, Hainan, 1889 (holotype G [G00438865]; isotype G-DC [G00323022]).

Piper gymnostachyum C.DC., Fl. Indo-Chine 5, fasc. 1 (1910) 72. **Type:** *Thorel s.n.*, [Vietnam but given as Cambodia in publication], Cochinchine, Phuoc Than, 1862–1866 (lectotype P [P02025575], designated by Gilbert & Xia, Novon 9 (2) (1999) 194).

Piper pierrei C.DC., Fl. Indo-Chine 5, fasc. 1 (1910) 78. **Type:** *Pierre 1042*, [Vietnam], ad Baochiang, prov. Bienhoa in austro Cochinchine, September 1869 (lectotype P [P01656234], designated by Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 175; isolectotype P [P01656235]).



Figure 19. *Piper sarmentosum* Roxb. **A.** Habit. **B.** Male Flowering spike. **C.** Female Flowering spike. **D.** Fruiting spike. (A–D from Singapore, A & D, Singapore Botanic Gardens (cultivated); B, Bukit Timah Nature Reserve Visitor Centre (cultivated); C, Dairy Farm, *Lua et al. Rani642*. Photos: H.K. Lua).

Piper saigonense C.DC., Fl. Indo-Chine 5, fasc. 1 (1910) 79. **Type:** *Pierre 1142*, [Vietnam], ad urbem Saigon in austro Cochinchine, August 1872 (lectotype P [P01980655], designated by Suwanphakdee et al., Thai Forest Bull., Bot. 48 (2020) 175; isoelectotypes C [C10016632], MO [MO204016], P [P01980654, P01980647]).

Piper albispicum C.DC., Fl. Indo-Chine 5, fasc. 1 (1910) 85. **Type:** *Bon 982*, [Vietnam], Tonkin meridional, Ninh Binh, 4 November 1881 (holotype G-DC [G00317821]).

Piper retrofractum auct. non Vahl: Wong et al., Checkl. Pl. Sp. Nee Soon Swamp Forest (2013) 201, 467.

Piper chaba auct. non W.Hunter: Ridley, J. Straits Branch Roy. Asiat. Soc. 33 (1900) 127, p.p.; Ridley, Fl. Malay Penins. 3 (1924) 40, p.p.; Keng, Gard. Bull. Singapore 31 (1978) 86; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 62; Turner, Gard. Bull. Singapore 45 (1993) 188; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 70, 167, 195.

Creeping herbs with erect fertile shoots, thereby appearing as an erect plant, dioecious, finely pubescent when young. **Leaves:** lamina membranous, those of leaves toward base of stem ovate to suborbicular, those toward apex of stem smaller, ovate or ovate-lanceolate, 7–14 × 6–13 cm, apex acute, base cordate to rounded in basal leaves, cuneate on terminal fertile branches, slightly oblique, finely pubescent abaxially particularly along the veins, glabrous above, ascending lateral veins mostly 3 pairs, apical pair arising 2–3 cm above the base, reaching leaf apex, reticulate veins conspicuous; petiole 2–3 cm long (6–8 cm long on creeping stems); prophyll membranous, ovate, 5–6 mm long, finely pubescent. **Spikes** leaf opposed, erect, densely flowered; bracts suborbicular, peltate, c. 1 mm diam., subsessile, hairy inside. **Male spikes** cylindric, white, 2–3 cm long; peduncle 1–2 cm long; rachis pubescent; stamens 2, filaments c. 2 mm, as long as anthers, anthers subglobose. **Female spikes** 2–3 cm long, c. 0.4 cm diam., white; peduncle as in male spikes; rachis glabrous; ovary globose, c. 1 mm diam., stigmas 3–5, finely hairy. **Fruiting spikes** erect, 3–5 cm long, 0.6–0.9 cm diam.; peduncle long, 3–4 cm. **Drupes** densely aggregated, subglobose, 4-angled, 2–3 mm diam., basally connate to rachis, turning dark green or blackish when ripe, pungent.

Distribution. India, China, Thailand, Cambodia, Laos, Vietnam, Malaysia, Indonesia and the Philippines. In Singapore, known from historical collections from an unspecified locality (*Hullett s.n.*, Jun 1884, SING [SING0014968]), Almeida Road (*Goodenough s.n.*, 3 Jun 1890, SING [SING0042351]) and Race Course Road (*Teruya 573*, 4 Jul 1929, SING [SING0014967]). More recent collections are from Pulau Ubin (*Ali Ibrahim et al. SING2010-901*, 3 Aug 2010, SING [SING0153659]), Dairy Farm (*Asmarayani et al. Rani642*, 27 Jun 2012, SING [SING0185186]) and other places.

Ecology. In Singapore, this species grows in fully or partially shaded areas in secondary forest and along the banks of streams. It is also commonly planted in roadside verges. It prefers wet moist places. In other countries it can be found from sea level to 1000 m.

Conservation assessment. Globally, Least Concern (LC), assessed here. In Singapore, assessed as Least Concern (LC) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 503).

Uses. This species is traditionally used in the Malesian region in both medicines and as a food (Burkill, Dict. Econ. Prod. Malay Penins. 2 (1935) 1782; Salehi et al., Molecules 24-1364 (2019) 62). The leaves are reported to be used to make a poultice for headaches and for the treatment of discolouration of the skin. The roots are reported to be used to treat coughs, asthma and pleurisy. It is also said to be used to treat rheumatism, headaches, diarrhoea and toothache. It is reputed that the whole plant possesses anodyne, anti-inflammatory and expectorant effects. Its leaves are edible and are used as a vegetable or cooked in rice dishes such as nasi ulam. The leaves are also used as a deodorant for clothes. In horticulture, it is often planted as ground cover.

Vernacular names. *Akar bugu, chaa phluu, chabei, daun kaduk, kadok, kaduk, la lot, sirih duduk, sri tanah, wild betel, wild pepper*, 假蒟, 细叶青菱藤, 青蒟 (NParks' Flora & Fauna Web, 2026).

Notes. *Piper sarmentosum* is usually found forming a dense thicket in partial shade conditions, its erect leafy branches forming a closed cover obscuring its stems and ground beneath. Its spikes are usually erect along the leafy twigs and visible amongst the dense dark green foliage.

18. *Piper schizonephros* C.DC.

(Greek, *schizo*- = split, cleft, *nephros* = kidney; referring to the kidney-shaped split bracts of the male spike)

in de Candolle, Prodr. 16(1) (1869) 241, as '*schizonephros*'; Hooker, Fl. Brit. India 5, fasc. 13 (1886) 79; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 337; Ridley, Fl. Malay Penins. 3 (1924) 32; Turner, Gard. Bull. Singapore 47 (1997 ['1995']) 402; Gajurel & Lua, Gard. Bull. Singapore 72 (2020) 139; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 605. **Synonym:** *Schizonephros glaucescens* Griff., Not. Pl. Asiat. 4 (1854) 383, as '*Schizonephros*'. **Type:** Griffith s.n., [Malaysia], Malacca [Melaka], Ching, 1845 (lectotype K [K000842201], designated by Gajurel & Lua, Gard. Bull. Singapore 72 (2020) 139). **Fig. 20.**

Piper polygynum C.DC., Rec. Bot. Surv. India 6(1) (1912) 27; de Candolle, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 75(3) (1914) 337; Ridley, Fl. Malay Penins. 3 (1924) 31. **Type:** Wray 4068, [Malaysia], Selangor, Gunong Pass, 1 May 1892 (lectotype G-DC [G00322193], designated by Gajurel & Lua, Gard. Bull. Singapore 72 (2020) 139).

Lianas, dioecious, stem stout, climbing to 18 m high, quite glabrous. **Leaves:** lamina coriaceous; in vegetative shoots lamina broadly ovate to orbicular, 7–11 × 6–11 cm, apex shortly acuminate, base cordate or slightly truncate, finely pubescent beneath, glabrous above, ascending lateral veins 4 pairs, all arising within 3 cm of the base, petiole 5–6 cm long, sheathing at the base, finely pubescent; in fertile branches lamina lanceolate, 8–11 × 5–6 cm, apex acute, base oblique, rounded or cuneate, glabrous, ascending lateral veins 2–3 pairs, petiole 5–8 mm long, glabrous. **Spikes** leaf opposed, pendent, flowers distantly arranged, rachis woody, finely pubescent; bracts in male spike raised to form a thick receptacle, receptacles cleft, tomentose within; in female spike cupular, hairy inside. **Male spikes** 10–18 cm long; peduncle 2–4 cm long, stamens 8–10, placed linearly in the top of the cup-like receptacle; becoming pale



Figure 20. *Piper schizonephros* C.DC. **A.** Climbing habit. Inset: Mature liana stem (see arrow). **B.** Leaves (upper surface). Inset: Leaves (lower surface). **C.** Close-up of female spike. **D.** Close-up of dropped male spikes. **E.** Close-up of drupes at different developmental stages. (A–E including insets from Singapore, A, B & B inset, Admiralty Forest; A inset, Nee Soon, *Asmarayani & Lua Rani650*; C & E, Admiralty Forest, *Lua SING2014-300*; D, Upper Seletar. Photos: H.K. Lua).

green to yellowish green when mature. **Female spikes** 7–9 cm long; peduncle 1–1.5 cm long, glabrous; flowers distantly arranged in bracts forming a cup; ovary globose, 3–4 in the cupular bract, c. 2 mm diam., stigmas 4, thick, ovate, only one developing into fruit. **Fruiting spikes** lengthening up to 12 cm long; peduncle 2–3 cm long, green when mature. **Drupe**s distinct, loosely aggregated, c. 4 mm diam., turning orange to brick red when ripe.

Distribution. Myanmar and Malaysia. In Singapore, known from the Central Catchment (*Hassan Ibrahim SING2011-222*, 31 May 2011, SING [SING0162359]), including Nee Soon (*Asmarayani & Lua Rani650*, 7 Jul 2012, SING [SING0185194]). Also known from Admiralty Forest (*Lua SING2014-300*, 16 May 2014, SING [SING0211899]; *Asmarayani & Lua Rani670*, 28 May 2014, SING [SING0212502]) and Bukit Timah (*Niissalo et al. SING2022-802*, 1 Sep 2022, SING [SING0396459]).

Ecology. In partially shaded areas in primary and mature secondary forests, and marginal zones. Climbs high into trees as a large liana before flowering and fruiting.

Conservation assessment. Globally, not assessed. In Singapore, assessed as Critically Endangered (CR/D) by Middleton et al. (in Davison et al. (ed.), Singapore Red Data Book, ed. 3 (2024) 503).

Notes. Closely related to the other two *Muldera* group species, *Piper baccatum* and *P. maingayi*. This species is probably the largest *Piper* species occurring in Singapore, followed by *P. baccatum*. A stout stem with concentric node rings trailing up large trees is a telling sign of its presence. The coriaceous, somewhat hairy leaves of the creeping and climbing branches of *Piper schizonephros* are usually larger and thinner than those of *P. baccatum*. On the other hand, the thinner male spikes with reniform receptacles and female spikes with bracts bearing typically three ovaries, distinguishes it from *Piper maingayi*. *Piper schizonephros* and *P. polygynum* were previously known only from male and female plants respectively and were treated as two distinct species. However, critical observation of the specimens has led to the conclusion that they are the male and female plants of the same species and hence are treated as synonyms. The recent experimental studies of Asmarayani (Bot. J. Linn. Soc. 201 (2023) 175–197) also supports this conclusion.

19. *Piper* sp.

Woody climbing shrubs to 5 m high, glabrous. **Leaves:** lamina thinly coriaceous, glabrous; in creeping vegetative branches lamina ovate-elliptic, 8–12 × 6–9 cm, apex acuminate, base rounded, petiole 2–3 cm long, ascending veins 3 pairs; in aerial fertile branches lamina ovate, 10–14 × 6–8 cm, apex acute or shortly acuminate, base cuneate, glabrous, petiole 1–2 cm long, ascending lateral veins 3 pairs, the upper pair alternate, arising 2–3 cm from the base. **Fig. 21.**

Distribution. In Singapore, known only from Pulau Ubin (*Ali Ibrahim et al. SING2019-133*, 7 Mar 2019, SING [SING0272402]).



Figure 21. *Piper* sp. **A.** Climbing habit. **B.** Lateral shoot. Inset: Leaves (lower surface). (A, B & B inset from Singapore, Pulau Ubin, *Ali Ibrahim et al. SING2029-133*. Photos: P.R. Gajurel).

Ecology. In secondary forest in a partially shaded area along a road.

Conservation assessment. Very rare, only one plant is known but, as it has not been identified, a formal conservation assessment is not possible.

Notes. Most similar to *Piper angsiense* I.M.Turner in its leaf characters. However, this identification could not be confirmed because although some aerial fertile branches have been observed these have lacked flowering and fruiting spikes. Also, some differences from *Piper angsiense* were observed in its venation pattern. A verified identification will only be possible once flowering material is collected.