addition, it has a nice, long-lasting odour. It is in high demand for high-grade furniture, turnery and fancy articles. The often small size and poor shape of the bole with commonly rotten or hollow heart makes that the timber is often only available in small sizes and limited quantities. Very little research has been done on propagation and possibilities of domestication for this valuable species, which could be worthwhile in spite of its low growth rates.

Major references Bolza & Keating, 1972; Chikamai et al., undated; Coates Palgrave, 2002; Grace et al., 2002a; Neuwinger, 1996; Neuwinger, 2000; Palmer & Pitman, 1972–1974; Radcliffe-Smith, 1996; Tietema, Merkesdal & Schroten, 1992; van Wyk, van Heerden & van Oudtshoorn, 2002.

Other references Beentje, 1994; Bryce, 1967; Dale & Greenway, 1961; Duri, Hughes & Munkombwe, 1992; Gaugris et al., 2007; Gelfand et al., 1985; Gilbert, Holmes & Thulin, 1993; Govaerts, Frodin & Radcliffe-Smith, 2000; Luoga, Witkowski & Balkwill, 2004; Mathabe et al., 2006; Mathabe et al., 2008; Maundu & Tengnäs (Editors), 2005; Ngobeni & Mashela, 2005; Njiro, Nyaga & Kofi Tsekpo, 1994; Nube, 2003; Radcliffe-Smith, 1987a; Radcliffe-Smith, 2001; Takahashi, 1978; van Wyk & Gericke, 2000; Wimbush, 1957.

Sources of illustration Coates Palgrave, 2002; Palmer & Pitman, 1972–1974; Radcliffe-Smith, 1996.

Authors I. Kopong & W. Mojeremane

STADMANNIA OPPOSITIFOLIA Lam.

Protologue Tab. encycl. 2(2): 443 (1793).

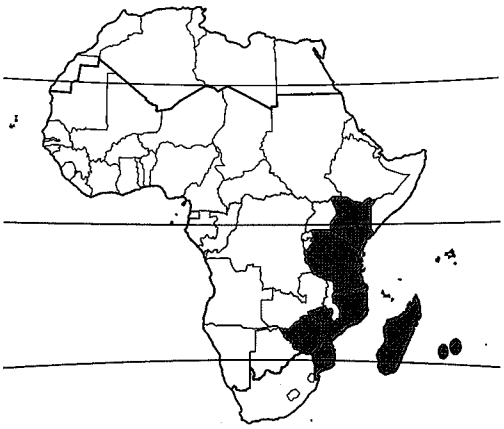
Family Sapindaceae

Vernacular names Ironwood, Bourbon ironwood, silky plum (En). Bois de fer, bois de fer de Maurice, bois de fer de Bourbon (Fr). Mfundu (Sw).

Origin and geographic distribution *Stadmannia oppositifolia* is native to Kenya, Tanzania, Zimbabwe, Mozambique, northern South Africa, Madagascar, Réunion and Mauritius.

Uses In Madagascar the wood, traded as 'elatrangidina', is used for house construction, boats, furniture and carving. It is valued for punt poles. It is suitable for heavy flooring, carpentry, planks and bridge covering. The wood yields a good charcoal. In Mauritius bark decoctions are used to alleviate fever, and as an astringent and depurative.

Properties The wood of *Stadmannia oppositifolia* is pinkish to pale red, hard and tough. It is heavy, with a density of 890–1020 kg/m^3 at 12% moisture content. It dries fairly well. The rates of shrinkage are quite high, from green to 12% moisture content 5.6–7.1% radial and 7.9–10.3% tangential.



Stadmannia oppositifolia – wild

At 12% moisture content, the modulus of rupture is 174–237 N/mm^2, modulus of elasticity 9300–14,600 N/mm^2, compression parallel to grain 72–88 N/mm^2 and Chalais-Meudon side hardness 7.5–11.4. The wood is fairly easy to work. It is moderately durable to very durable. The bark is rich in saponin. Stems and leaves contain phenols, flavonoids, flavans, saponosides and tannins.

Botany Monoecious small tree up to 10(–30) m tall; bark surface smooth, finely fissured, flaking, yellow to brown, often mottled, inner bark pinkish; twigs rusty or tawny hairy, becoming glabrous. Leaves alternate, paripinnately compound with (1–)2–4 pairs of leaflets; stipules absent; petiole 3–7 cm long, rachis 4–20 cm long; petiolules 1–7 mm long; leaflets opposite, elliptical, 4–15 cm × 2.5–6.5 cm, lowest pair smallest, asymmetrically cuneate at base, rounded or notched at apex, margins entire, thick leathery, glabrous apart from the midrib, pinnately veined with 10–16 pairs of indistinct lateral veins. Inflorescence an axillary, false raceme 4–12 cm long. Flowers unisexual, regular, yellow, scented; pedicel 2–3 mm long, elongating up to 5 mm in fruit; calyx cup-shaped, c. 0.5 mm long, shallowly 5-lobed; petals absent; stamens 8, free, hairy or glabrous; ovary superior, hairy, 3-lobed and 3-celled, style short, thick, 3-furrowed; male flowers with rudimentary ovary, female flowers

with reduced stamens. Fruit an ovoid capsule 1–2 cm in diameter, golden yellow when ripe, shortly soft-hairy, dehiscing, 1-seeded, 2 abortive carpels remaining attached. Seed globose or ovoid, c. 1 cm in diameter, chestnut brown, with red aril nearly completely covering the seed.

Stadmannia comprises 6 species, 5 of which are endemic to Madagascar. Two subspecies have been distinguished in *Stadmannia oppositifolia*. Subsp. *rhodesica* Exell is confined to Zimbabwe and northern South Africa, and distinguished by its smaller leaflets. All other *Stadmannia* species in Madagascar are medium-sized trees up to 30(–35) m tall and yield appreciated timber used for similar purposes as that of *Stadmannia oppositifolia*. Most important are *Stadmannia acuminata* Capuron and *Stadmannia leandrii* Capuron. Additionally, the fresh leaves of *Stadmannia glauca* Capuron are mashed and eaten or taken in infusion to improve vision, especially night vision.

Ecology In East Africa *Stadmannia oppositifolia* is restricted to dry evergreen forest and coastal bushland at about sea-level. In Madagascar it is found in evergreen forest up to 1700 m altitude, in Zimbabwe up to 1000 m altitude.

Genetic resources and breeding Although fairly widespread, *Stadmannia oppositifolia* is apparently rare in many parts of its range, and in Réunion it has become extinct. Monitoring of populations is recommended.

Prospects In Mauritius *Stadmannia oppositifolia* is considered one of the species that could well be planted for timber production. However, much research is still needed, for instance on growth rates, propagation and ecological requirements.

Major references Boiteau, Boiteau & Allorge-Boiteau, 1999; Davies & Verdcourt, 1998; Gurib-Fakim & Brendler, 2004; Parant, Chichignoud & Rakotovao, 1985.

Other references Bärner & Müller, 1942; Beentje, 1994; Exell & Sousa, 1973; Friedmann, 1997; Gurib-Fakim, Guého & Bissoondoyal, 1997; Lebigre & Petignat, 1997; Rajaonarivelo, 2000; Ruhomaun, 2003; Schatz, 2001; Stiles, 1998.

Authors C.H. Bosch

STAUDTIA KAMERUNENSIS Warb.

Protologue Nova Acta Acad. Caes. Leop.-Carol. German. Nat. Cur. 68: 241 (1897).

Family Myristicaceae

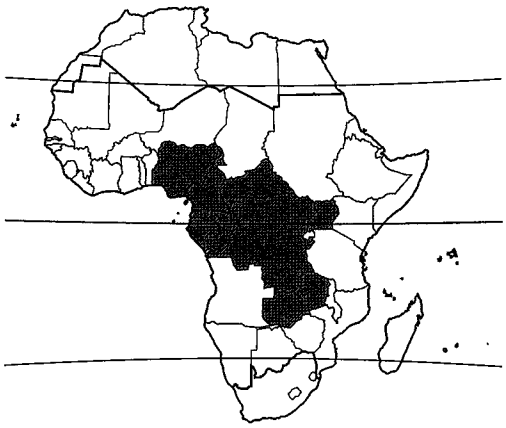
Synonyms *Staudtia gabonensis* Warb. (1903), *Staudtia stipitata* Warb. (1903).

Vernacular names Niové, arbre à pagaies (Fr). Pau vermelho, vlêmê (Po).

Origin and geographic distribution *Staudtia kamerunensis* occurs from Nigeria eastward to Uganda, and southward to DR Congo, Zambia and Cabinda (Angola). It is most common in Cameroon, Gabon and Congo.

Uses In Gabon the wood is traditionally used to make rafters and peddles, and for the construction of bridges. It is used in house construction and for flooring, carpentry, stairs, ship building, vehicle parts, furniture, cabinet work, railway sleepers, vats, walking sticks, tool handles, turnery, pencils and decorative sliced veneer. It is suitable for interior trim, mine props, sporting goods, precision instruments, musical instruments, toys, novelties, draining boards and pattern making. The wood is also used as firewood.

In traditional medicine in Central Africa, bark decoctions are drunk against menstrual problems, dysentery, lung complaints and cough. In DR Congo they are given to children to drink or applied as enema against cough, and applied as a rub to treat skin diseases, oedema and wounds. They are used as a gargle against mouth diseases. Bark sap is applied against snakebite. In DR Congo bark sap diluted with water is taken against diarrhoea. It is also used in wound healing, to stop bleeding and to treat painful eyes. In Gabon the sap is rubbed



Staudtia kamerunensis – wild

onto the gums of babies to ease teething. Pulverized bark mixed with wood powder of padouk (*Pterocarpus soyauxii* Taub.) is applied on ulcers including yaws. Wood chips are boiled to make a medicine against gonorrhoea and rheumatism. In Congo fresh twigs are ground and salted, and chewed as an aphrodisiac. In DR Congo the root is chewed and the sap is swallowed by children against cough. Heated leaves are rubbed on the breasts as a galactagogue. Seed pulp mixed in palm oil is rubbed on the skin against sand flies.

The seeds yield a yellow, aromatic fat used as an ointment or medicine against scabies; seeds are also used as bait for porcupines and palm rats. The seed aril is edible. In western Cameroon the bark is used in making soup.

Production and international trade Already in the 1960s Equatorial Guinea and Congo exported on average 600 m^3 and 750 m^3, respectively, of logs per year. Cameroon reported total production of niové logs of 1000 m^3 in 2000 and 1200 m^3 in 2001. Congo reported total exports of 5000 m^3 in 2004 (at an average export price of US$ 333/m^3), 3000 m^3 in 2005 and 5500 m^3 in 2006. Gabon reported total exports of 4650 m^3 in 2000, 1700 m^3 in 2001, 4200 m^3 in 2002, 3100 m^3 in 2003, 2450 m^3 in 2004 and 5850 m^3 in 2005. In Cameroon niové is classified as a group 1 timber (principal timbers of great value of which the exportation of logs requires permission). Cameroon exported 2500 m^3 of logs and 1100 m^3 of sawn wood in 2009 and Congo 1350 m^3 of logs.

Properties The heartwood is yellowish brown, turning dark red-brown upon exposure, with slightly darker streaks, distinctly demarcated from the up to 10 cm wide, pale yellowish white to pinkish sapwood, but separated by a zone of orange-brown transition wood. The grain is straight, occasionally wavy, texture fine and even. The surface is slightly lustrous and occasionally oily. A reddish substance is sometimes present. Sawn boards have a pepper-like smell. The wood is heavy, with a density of 750–1000 kg/m^3 at 12% moisture content. Logs should be quarter-sawn before drying. The wood dries slowly and there is a risk of end splitting, surface checking and case hardening. Initial air drying is recommended before kiln drying. The rates of shrinkage are moderate, from green to oven dry 3.6–6.2% radial and 5.2–7.6% tangential. Once dry, the wood is moderately stable in service.

At 12% moisture content, the modulus of rupture is 136–236 N/mm^2, modulus of elasticity 13,000–21,600 N/mm^2, compression parallel to grain 74–109 N/mm^2, shear 10.5–16.5 N/mm^2, cleavage 12.5–26 N/mm, Janka side hardness 7070–9110 N, Chalais-Meudon side hardness 4.7–12.2 and Janka end hardness 9870 N.

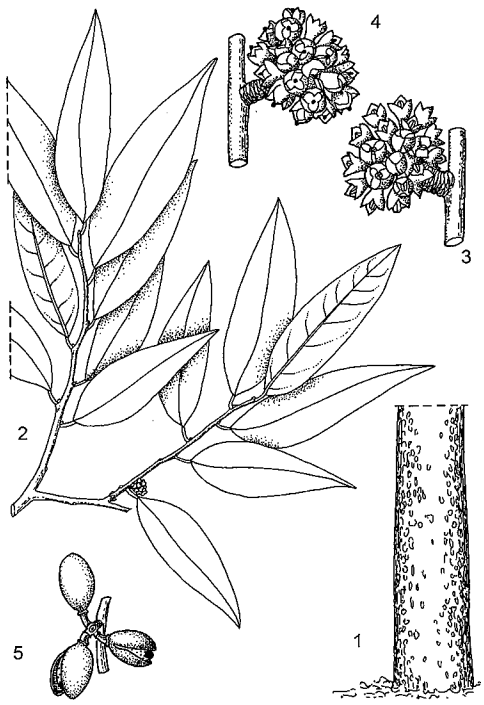
The wood saws slowly because of its high density, but without problem because the silica content is very low. The blunting effect is fairly high; stellite-tipped or high-pitched saw blades and tungsten-carbide tool edges are recommended. The wood planes easily and well, giving a nice finish. Boards have a tendency to split upon nailing, and pre-boring is needed; the nail-holding properties are moderate to good. Surfaces take paint, wax and varnish well. Gluing properties are good. The wood can be sliced after softening by steaming.

The heartwood is durable, being resistant to fungi and termites, but liable to attack by marine borers. The sapwood is susceptible to pinhole borers. The heartwood is resistant to impregnation with preservatives, the sapwood is permeable.

The wood contains 40–41% cellulose, 24–26.5% lignin, 16–17% pentosan, 0.4–0.8% ash and little silica. The solubility is 7.4–13.5% in alcohol-benzene, 2.5–7.6% in hot water and 13.6–18.3% in a 1% NaOH solution.

The seed oil is mainly composed of myristic acid. Analysis of the essential oils hydrodistilled from seed and bark of *Staudtia kamerunensis* showed as main components the sesquiterpenes germacrene D (35%) and β-caryophyllene (12%) in the seed oil, and trans-α-bergamotene (39.5%) and β-caryophyllene (13%) in the bark oil. The extracts did not have important antioxidant activities. Several lignans have been isolated from seeds and bark. The diterpene staudtenic acid has been isolated from bark extracts.

Description Evergreen, dioecious or monoecious, medium-sized to fairly large tree up to 35(–40) m tall; bole branchless for up to 25 m, straight or slightly wavy, cylindrical, up to 90(–110) cm in diameter, sometimes fluted at base or with narrow buttresses up to 2 m high; bark surface rough, reddish grey or cinnamon-coloured, flaking off in round, orange patches, inner bark crimson-coloured, exuding copious, watery, dark red sap; crown with spreading, often sinuous branches; twigs slightly angular and ridged, glabrous. Leaves alternate, simple and entire; stipules absent; petiole 0.5–1.5 cm long; blade narrowly oblong to oblong-lanceolate or narrowly elliptical, 5.5–16 cm × 1.5–6.5 cm, base cuneate to rounded, apex



Staudtia kamerunensis – 1, base of bole; 2, twig with inflorescence; 3, male inflorescence; 4, female inflorescence; 5, fruits.
Redrawn and adapted by G.W.E. van den Berg

acute to acuminate, thin-leathery, glabrous but densely minutely glandular-punctate beneath, pinnately veined with c. 10 pairs of lateral veins. Inflorescence a globose head 0.5–1 cm in diameter, usually on 2-year-old branches in axils of fallen leaves, reddish brown short-hairy, 10–50-flowered; peduncle 2–5 mm long, stout. Flowers unisexual, regular, with short pedicel; perianth 3-lobed, c. 2 mm long, densely reddish brown short-hairy; male flowers with staminal tube bearing 3 anthers; female flowers with superior, globose, short-hairy, 1-celled ovary, with sessile stigma. Fruit an ellipsoid drupe 2–5 cm × 1.5–4.5 cm, in clusters of up to 20, somewhat fleshy when ripe, yellow or cinnamon-coloured, at first short-hairy, later glabrous and shining, eventually dehiscent with 2 valves, 1-seeded. Seeds ellipsoid or ovoid, 1–2 cm long, dark brown, with thin-fleshy, red or pink aril enveloping nearly completely the seed, lobed at the apex.

Other botanical information *Staudtia* probably comprises a single species, but a second poorly known species described as *Staudtia pterocarpa* (Warb.) Warb. may be present in São Tomé.
In *Staudtia kamerunensis* 2 varieties have been distinguished; var. *gabonensis* (Warb.) Fouilloy has smaller fruits than var. *kamerunensis*.

Anatomy Wood-anatomical description (IAWA hardwood codes):
Growth rings: 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; 13: simple perforation plates; (14: scalariform perforation plates); (15: scalariform perforation plates with ≤ 10 bars); 22: intervessel pits alternate; (23: shape of alternate pits polygonal); (26: intervessel pits medium (7–10 μm)); 27: intervessel pits large (≥ 10 μm); (30: vessel-ray pits with distinct borders; similar to intervessel pits in size and shape throughout the ray cell); 32: vessel-ray pits with much reduced borders to apparently simple: pits horizontal (scalariform, gash-like) to vertical (palisade); (33: vessel-ray pits of two distinct sizes or types in the same ray cell); 42: mean tangential diameter of vessel lumina 100–200 μm; 47: 5–20 vessels per square millimetre; 56: tyloses common. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 70: fibres very thick-walled. Axial parenchyma: 75: axial parenchyma absent or extremely rare; 78: axial parenchyma scanty paratracheal; (89: axial parenchyma in marginal or in seemingly marginal bands); 93: eight (5–8) cells per parenchyma strand; (94: over eight cells per parenchyma strand). Rays: 96: rays exclusively uniseriate; 97: ray width 1–3 cells; 100: rays with multiseriate portion(s) as wide as uniseriate portions; 106: body ray cells procumbent with one row of upright and/or square marginal cells; 107: body ray cells procumbent with mostly 2–4 rows of upright and/or square marginal cells; (108: body ray cells procumbent with over 4 rows of upright and/or square marginal cells); 115: 4–12 rays per mm. Secretory elements and cambial variants: (132: laticifers or tanniferous tubes). Mineral inclusions: (152: crystals of other shapes (mostly small)).
(R. Shanda, E. Uetimane, P.E. Gasson & E.A. Wheeler)

Growth and development *Staudtia kamerunensis* grows slowly. In Gabon seedlings planted in the open reached 5 m tall 11 years after planting, with a survival rate of only 11%. However, when planted in exploited forest, they reached 11 m tall with an average bole diameter of 7.5 cm after 11 years. In natural

forest in the Central African Republic average annual diameter increment of the bole has been estimated at 1–4 mm, in Gabon at 2.5–5 mm. In Gabon fruits ripen in August–October. Numerous animals eat the seed aril and serve as seed dispersers.

Ecology *Staudtia kamerunensis* is characteristic for dense evergreen forest, up to 1350 m altitude. It is fairly common in fringing forest and secondary forest. In DR Congo it is often found in forest dominated by *Gilbertiodendron dewevrei* (De Wild.) J.Léonard, *Brachystegia laurentii* (De Wild.) Louis ex Hoyle and *Julbernardia seretii* (De Wild.) Troupin.

Propagation and planting There are about 140 seeds per kg. In tests in Congo, seeds started to germinate 60–80 days after sowing, with a germination rate of 48–64%.

Management In forest in south-western Cameroon, the average density of *Staudtia kamerunensis* trees with a bole diameter of more than 60 cm is 0.4 per ha, with a mean wood volume of 1.9 m³/ha. In Gabon *Staudtia kamerunensis* is fairly abundant, with mean wood volumes of 3.5 m³/ha. Very little experiments have been done on the management of *Staudtia kamerunensis* both in natural stands and as a potential plantation species. In the Central African Republic thinning in natural forest increased the diameter growth of seedlings and trees from 1 mm/year to 4 mm/year during a period of 4 years, after which it decreased again to 2.5 mm/year for the subsequent 4 years. In cocoa farms in Cameroon, it is sometimes retained as a source of construction wood or firewood.

Harvesting In Cameroon and the Central African Republic the minimum bole diameter allowed for harvesting is 50 cm, in Gabon 60 cm.

Yield A log of 13.5 m long and with a diameter of 80 cm felled in DR Congo yielded 4.5 m³ of wood.

Handling after harvest Freshly harvested logs sink in water and cannot be transported by river. Logs can stay for some time in the forest after harvesting without treatment with a preservative.

Genetic resources *Staudtia kamerunensis* is widespread and occurs in fair densities in various forest types. There are no indications that it is in danger of genetic erosion, although in several regions it is exploited in considerable amounts.

Prospects *Staudtia kamerunensis* produces a good, nicely figured general-purpose timber. In spite of its hardness the wood is relatively easy to work. Its main draw-back is its slow growth, requiring long cutting cycles for sustainable harvesting. More information on its management in natural stands and plantation forest is needed. Pharmacological research to evaluate its uses in traditional medicine is also warranted.

Major references Burkill, 1997; CTFT, 1988; Fouarge & Gérard, 1964; Gilbert & Troupin, 1951; Neuwinger, 2000; Normand & Paquis, 1976; Pope, 1997; Raponda-Walker & Sillans, 1961; Vivien & Faure, 1985; White & Abernethy, 1997.

Other references Agnaniet et al., 2004; Apema et al., 2010; de Freitas, 1987; de Saint-Aubin, 1963; Durrieu de Madron & Daumerie, 2004; Durrieu de Madron et al., 1998b; Fouilloy, 1965; Fouilloy, 1974; Keay, 1954d; Koumba Zaou et al., 1998; Laird, Leke Awung & Lysinge, 2007; Mezée et al., 2010; Noumbissie et al., 1992; Service permanent d'inventaire et d'aménagement forestiers, 2007; Tailfer, 1989; Verdcourt, 1997; Vernay, 2000; Wilks & Issembé, 2000; World Conservation Monitoring Centre, 2011; Yankep et al., 1999.

Sources of illustration Verdcourt, 1997; Wilks & Issembé, 2000.

Authors L.P.A. Oyen & D. Louppe

STEMONOCOLEUS MICRANTHUS Harms

Protologue Bot. Jahrb. Syst. 38: 77, fig. 2 (1905).

Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

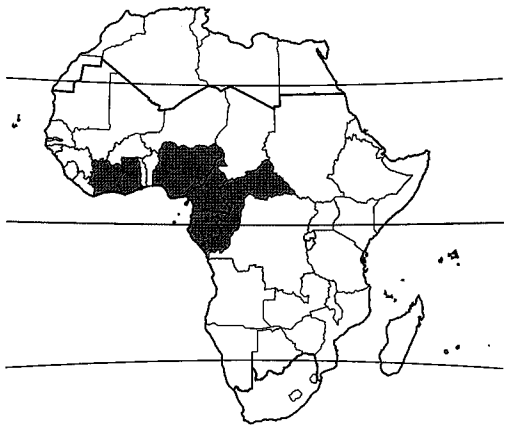
Chromosome number $2n = 24$

Origin and geographic distribution *Stemonocoleus micranthus* occurs from Côte d'Ivoire east to the Central African Republic and south to Gabon and Congo.

Uses The wood is suitable for light construction, flooring, joinery, interior trim, ship building, handles, ladders, sporting goods, toys, novelties, agricultural implements, boxes, crates, turnery, veneer, plywood, hardboard, particle board and pulpwood.

In the Central African Republic the bark is pounded in water and applied as a paste to treat rheumatism and infertility in women.

Properties The heartwood is purplish pink, changing to reddish brown upon exposure, and distinctly demarcated from the pale yellow sapwood. The grain is straight, texture moderately fine.



Stemonocoleus micranthus – wild

The wood is moderately heavy, with a density of about 660 kg/m³ at 12% moisture content. It air dries fairly rapidly, but may develop end checks and heart shakes. The rates of shrinkage are moderate, from green to oven dry 3.5% radial and 5.2% tangential. At 12% moisture content, the modulus of rupture is 134 N/mm², modulus of elasticity 11,950 N/mm², compression parallel to grain 57 N/mm², shear 9 N/mm², cleavage 20.5 N/mm and Chalais-Meudon side hardness 2.6.
The wood saws and works well but slowly because it is tough and moderately hard. It can be planed to a nice and lustrous surface. The wood is only moderately durable, being susceptible to termite, *Lyctus* and marine borer attacks.

Botany Medium-sized to large tree up to 45(–50) m tall; bole straight and cylindrical, branchless for up to 25 m, up to 150 cm in diameter, with thick buttresses up to 6 m high or fluted at base; bark surface fairly smooth in younger trees to longitudinally fissured in old trees, greyish brown, inner bark fibrous, pale brown to pinkish; twigs glabrous. Leaves alternate, imparipinnately compound with 4–10 leaflets; stipules minute or absent; petiole and rachis together 5–17 cm long; petiolules 5–7 mm long, often twisted; leaflets alternate, elliptical to ovate, 4–11 cm × 2–5 cm, cuneate to obtuse and often slightly asymmetrical at base, usually notched at apex, with thickened margin, papery, glabrous, with indistinct translucent glandular dots, pinnately veined with 6–10 pairs of lateral veins. Inflorescence an axillary or terminal panicle up to 12 cm long, consisting of racemes up to 5 cm long, with conspicuous scars of fallen flowers, glabrous. Flowers bisexual, regular, fragrant, sessile, with 1 bract and 2 bracteoles at base; calyx with 4 oblong to obovate lobes 2–3 mm long, greenish white; petals absent; stamens 4, fused at base; ovary superior, elongate, glabrous, stiped, 1-celled, style curved. Fruit an elliptical, papery pod 11–14 cm × 4–5 cm, yellow to pale brown, reticulately veined, often twisted at base and with slender, up to 2 cm long stipe, indehiscent, 1–2-seeded. Seeds elliptical, flattened, 1.5–2 cm long. Seedling with epigeal germination; hypocotyl 2–4.5 cm long, epicotyl 4–7 cm long; cotyledons slightly fleshy, broadly ovate, 1–2 cm long; first 2 leaves opposite, with 1–6 leaflets.
In West Africa trees can be found flowering from August to March. The papery fruits ripen about 3 months later and are dispersed by wind.
Stemonocoleus comprises a single species and belongs to the tribe *Detarieae*; it seems to be most closely related to *Augouardia*, which is endemic to Gabon.

Ecology *Stemonocoleus micranthus* occurs in lowland moist evergreen forest, often near rivers.

Management In general *Stemonocoleus micranthus* is uncommon in the forest, although in some regions it has been recorded as common, e.g. in south-western Cameroon. Locally in Côte d'Ivoire, natural regeneration has been recorded as common, with many seedlings close to parent trees, often in more open sites, e.g. along roadsides. *Stemonocoleus micranthus* is characterized as a non-pioneer light demander.

Genetic resources and breeding *Stemonocoleus micranthus* is widespread and does not seem to be threatened by genetic erosion. However, it occurs scattered and is in many regions even rare, and some monitoring of populations is advisable.

Prospects *Stemonocoleus micranthus* produces an interesting multipurpose timber and the tree becomes big enough to be of commercial interest, although the bole of old trees often becomes fluted in the lower part. The species is poorly known because in most regions it occurs too scattered or is even rare. Research is needed on propagation and growth rates to determine its possibilities for sustainable exploitation in managed natural forest.

Major references Bolza & Keating, 1972; de Koning, 1983; de Saint-Aubin, 1963; Takahashi, 1978; Vivien & Faure, 1985.

Other references Aké Assi et al., 1985; Aubréville, 1959b; Aubréville, 1970; Burkill, 1995; Hawthorne, 1995; Hawthorne & Jongkind, 2006; Keay, 1989; Lewis et al., 2005; Neuwinger, 2000; Normand & Paquis, 1976.

Authors R.H.M.J. Lemmens

STROMBOSIA PUSTULATA Oliv.

Protologue Hooker's Icon. pl. 23: t. 2299 (1894).

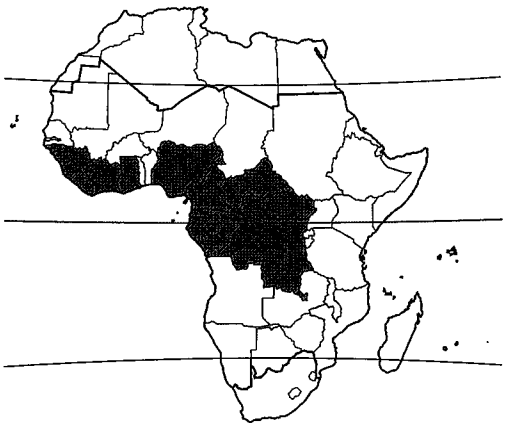
Family Olacaceae

Synonyms *Strombosia glaucescens* Engl. (1909).

Origin and geographic distribution *Strombosia pustulata* occurs from Guinea Bissau east to the Central African Republic, and southwards to DR Congo and Cabinda (Angola).

Uses The wood, known as 'afina', 'afena' or 'poé', is locally used for heavy construction including hydraulic work, poles, railway sleepers, utensils, drainage boards and tool handles. It is suitable for flooring, joinery, mine props, ship building, vehicle bodies, toys, novelties, agricultural implements, carvings, turnery and sliced veneer. It is also used as firewood and for charcoal production. The wood pulp has been tried in paper making, but it was found unsuitable because the pulp yield was low.

The plant has various medicinal uses throughout its distribution area. In West Africa the pulped bark is rubbed on the skin to treat skin complaints, wounds and sores. In Côte d'Ivoire the leaf sap is taken to treat hiccups. Different parts of the plant are used in treating cough, abscesses and furuncles. In Nigeria the seed oil is used as laxative and as lubricant for massaging. In Cameroon powdered bark, together with seeds of *Aframomum melegueta* K.Schum., is externally applied to aching muscles and kidneys. In Gabon bark decoctions are taken to treat dysentery, stomach-ache, backache and pain in the side. In Ghana the seed oil is used as ointment and in soap making.



Strombosia pustulata – wild

Production and international trade The wood of *Strombosia pustulata* is mainly used locally and rarely traded on the international market and then often sold in mixed consignments with other *Strombosia* spp.

Properties The heartwood is pale brown with purplish streaks, and more or less distinctly demarcated from the yellowish to pale brown, wide sapwood. The grain is fairly straight, sometimes wavy, texture fine. The wood is lustrous, slightly gummy and rather oily to the touch, with an unpleasant odour when freshly cut.

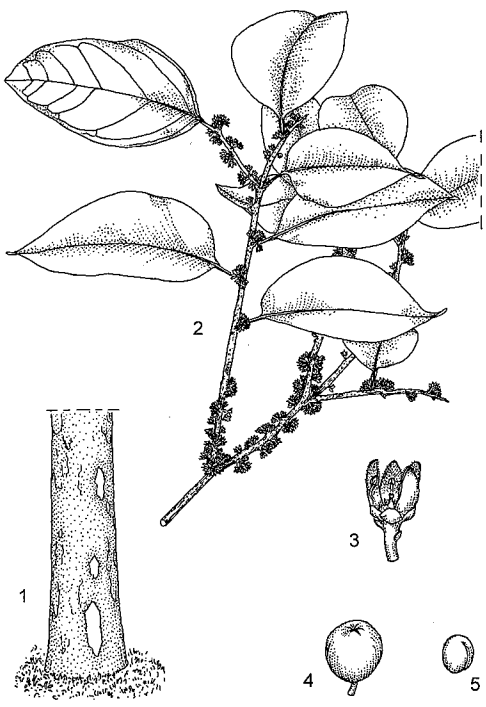
The wood is heavy, with a density of 850–1020 kg/m^3 at 12% moisture content, and hard. Air drying can be problematic, with a high risk of distortion and splitting. Slow drying is recommended. The shrinkage rates are high, from green to oven dry 7.4–8.6% radial and 7.9–11.4% tangential. Once dry, the wood is unstable in service. At 12% moisture content, the modulus of rupture is (115–)170–243 N/mm^2, modulus of elasticity 16,370–20,190 N/mm^2, compression parallel to grain 58–90 N/mm^2, cleavage 18–38 N/mm and Chalais-Meudon side hardness 5.3–7.9(–12.8).

Considering the high density, the wood saws and works comparatively easily with both hand and machine tools. It takes a smooth finish and polishes well. Splitting is common in nailing, and pre-boring is recommended. The wood glues well. It has a high natural durability with an expected service life of up to 50 years. The heartwood is very resistant to fungal and termite attacks, but the sapwood is moderately resistant and susceptible to *Lyctus* borers. The heartwood is very resistant to preservative treatment, the sapwood is permeable.

The wood contains 39–42.5% cellulose, 31–38% lignin, 12–16% pentosan, 0.3–1.9% ash and up to 0.02% silica. The solubility is 0.8–3.3% in alcohol-benzene, 0.4–4.8% in hot water and 9.1–18.6% in a 1% NaOH solution.

Seed samples from Côte d'Ivoire yielded 15–18% of a reddish brown oil with a disagreeable smell, whereas samples from Nigeria yielded 2–3% of a golden-yellow oil.

Description Evergreen medium-sized tree up to 25(–35) m tall; bole cylindrical, usually



Strombosia pustulata – 1, base of bole; 2, flowering twig; 3, flower with one petal removed; 4, fruit; 5, fruit stone.
Redrawn and adapted by J.M. de Vries

straight, up to 60(–100) cm in diameter, slightly fluted at base or with low buttresses; bark surface grey-black, with numerous small corky lenticels, becoming scaly with an irregular pattern of olive-green and whitish patches, inner bark thin, hard, granular, pale yellow to pale orange or brown with narrow white streaks; crown dense, small and rounded; twigs more or less angled, glabrous. Leaves alternate, simple and entire; stipules absent; petiole 0.5–1(–2.5) cm long, grooved above; blade ovate to elliptical or oblong-elliptical, 4–11(–25) cm × 2–7(–18) cm, base cuneate to rounded, often slightly asymmetrical, apex acute to short-acuminate, thick-papery, glabrous, more or less pustulate, pinnately veined with 4–7(–10) pairs of lateral veins. Inflorescence a compact axillary fascicle, usually few-flowered. Flowers bisexual, regular, 5-merous; pedicel 1–3 mm long; calyx lobes almost circular, c. 1 mm long, hairy at margins; petals free, linear-oblong, (2–)3–5 mm long, upper inner half densely short-hairy, outside glabrous, pale green, whitish or yellowish; stamens 3–4 mm long, filaments fused for 1–3 mm with petals; ovary inferior or semi-inferior, c. 1 mm in diameter, 1-celled but at base 5-celled, upper part surrounded by disk, style 1–3 mm long, stigma (3–)5-lobed. Fruit a broadly ellipsoid or globose drupe 1–3 cm in diameter, enclosed by fleshy calyx, blackish purple when ripe, with depression at apex, stone 1-seeded. Seeds ellipsoid, wrinkled, with much waxy endosperm. Seedling with epigeal germination; hypocotyl 8–15 cm long, epicotyl 1–3 cm long; cotyledons nearly orbicular, 3–6 cm in diameter, 3–5-veined from the base; first leaves alternate.

Other botanical information *Strombosia* comprises about 10 species, 7 of which occur in tropical Africa and 3 in tropical Asia. It has been classified in *Olacaceae*, but recent molecular studies showed that it is better placed in a separate family *Strombosiaceae*, together with 5 other genera including *Strombosiopsis*. The wood of some other *Strombosia* spp. is used for similar purposes as that of *Strombosia pustulata*.

Strombosia grandifolia Hook.f. is a shrub or small to medium-sized tree up to 25 m tall with bole up to 60 cm in diameter, occurring from Nigeria east to southern Sudan and south to Cabinda (Angola). Its reddish brown, heavy wood, with a density of (680–)950–1010(–1280) kg/m^3 at 12% moisture content, is used for construction, dug-out canoes, railway sleepers, tool handles and carvings; it is fairly easy to saw and has good durability. The bark yields a dye which is used in DR Congo to blacken pottery. In the Central African Republic pulverized bark wrapped in a large leaf is warmed over a fire and applied to oedema. In Gabon the bark is used to treat chest complaints, post-partum pain and kidney pain. In DR Congo bark decoctions are taken to treat tuberculosis, as an emetic. In Gabon the seed is sometimes eaten after thorough drying, cooking and washing to remove toxicity and bitterness.

Although *Strombosia zenkeri* Engl. is a small tree up to 15 m tall, its wood is probably used for similar purposes as that of *Strombosia pustulata*. It occurs in south-eastern Nigeria, Cameroon, Gabon and Congo. It has been reported that bark and leaf sap are used in traditional medicine in Congo as a substitute of *Strombosiopsis tetrandra* Engl.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; 14: scalariform perforation plates; 16: scalari-

form perforation plates with 10–20 bars; 17: scalariform perforation plates with 20–40 bars; 20: intervessel pits scalariform; 21: intervessel pits opposite; 27: intervessel pits large (≥ 10 µm); 32: vessel-ray pits with much reduced borders to apparently simple: pits horizontal (scalariform, gash-like) to vertical (palisade); 41: mean tangential diameter of vessel lumina 50–100 µm; 48: 20–40 vessels per square millimetre; (49: 40–100 vessels per square millimetre); 56: tyloses common; 57: tyloses sclerotic. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 70: fibres very thick-walled. Axial parenchyma: 76: axial parenchyma diffuse; 77: axial parenchyma diffuse-in-aggregates; (78: axial parenchyma scanty paratracheal); 93: eight (5–8) cells per parenchyma strand; 94: over eight cells per parenchyma strand. Rays: 97: ray width 1–3 cells; 107: body ray cells procumbent with mostly 2–4 rows of upright and/or square marginal cells; 108: body ray cells procumbent with over 4 rows of upright and/or square marginal cells; 115: 4–12 rays per mm; 116: ≥ 12 rays per mm. Mineral inclusions: 136: prismatic crystals present; 137: prismatic crystals in upright and/or square ray cells; 138: prismatic crystals in procumbent ray cells; 140: prismatic crystals in chambered upright and/or square ray cells; 141: prismatic crystals in non-chambered axial parenchyma cells; (142: prismatic crystals in chambered axial parenchyma cells); 157: crystals in tyloses.

(E. Uetimane, P. Baas & H. Beeckman)

Growth and development *Strombosia pustulata* is considered to be slow growing. In silvicultural trials in Ghana, seedlings reached 15 cm tall after 1 year and saplings 1 m tall when 4 years old. *Strombosia pustulata* is considered a shade bearer, but seedlings and saplings grow well in small canopy gaps. In Côte d'Ivoire trees flower from June to September, in Nigeria from October to December, and ripe fruits are found about 3 months after flowering. The fruits are relished by birds such as hornbills and also by elephants, serving thus as important seed dispersers.

Ecology *Strombosia pustulata* occurs in evergreen forest and moist semi-deciduous forest, at low altitudes. It is most common in undisturbed forest. It is in general non-selective of soil conditions but prefers free draining soils.

Propagation and planting There are about 800 fruit stones per kg. Germination is irregular, varying from 2 weeks to 10 weeks after sowing, but the germination rate is generally high, up to 90%. Propagation by wildlings is sometimes practised; these may be very abundant near the mother tree.

Management *Strombosia pustulata* is often common, usually forming part of the dominant species in the middle storey of the forest. In evergreen forest in Ghana, an average density of 60 boles/ha has been reported, but most of the boles had a diameter of less than 30 cm.

Genetic resources *Strombosia pustulata* is widespread and locally common, sometimes even dominant, within its geographical range, and it is not threatened at present. However, its preference for undisturbed forest may make it liable to genetic erosion in forest that is subject to serious damage by logging practices.

Prospects *Strombosia pustulata* is a useful local source of wood and traditional medicine. It does not seem to be promising for more commercial exploitation because of its vulnerability to logging practices in the forest and slow growth. The chemical and pharmaceutical properties of the bark and seed oil deserve further investigation.

Major references Bolza & Keating, 1972; Burkill, 1997; Irvine, 1961; Keay, 1989; Neuwinger, 2000; Oteng-Amoako (Editor), 2006; Raponda-Walker & Sillans, 1961; Savill & Fox, 1967; Takahashi, 1978; Villiers, 1973a.

Other references Abbiw, 1990; Bouquet, 1969; Breteler, 2007; Chudnoff, 1980; de Koning, 1983; de la Mensbruge, 1966; Farmer, 1972; Fouarge & Gérard, 1964; Hall & Swaine, 1981; Hawthorne, 1995; Hawthorne & Jongkind, 2006; Kryn & Fobes, 1959; Kunkel, 1965; Nickrent et al., 2010; Normand & Paquis, 1976; Ofori, 2001; Ofori et al., 2009a; Tailfer, 1989; Vivien & Faure, 1985; Voorhoeve, 1965.

Sources of illustration Voorhoeve, 1965; Wilks & Issembé, 2000.

Authors A.A. Oteng-Amoako

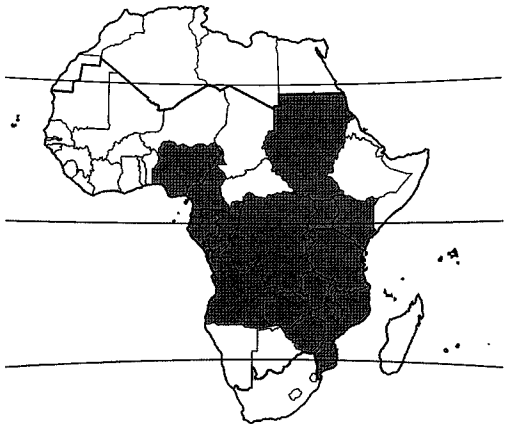
STROMBOSIA SCHEFFLERI Engl.

Protologue Notizbl. Königl. Bot. Gart. Berlin 5: app. 21(1): 4 (1909).

Family Olacaceae

Vernacular names Strombosia (En). Msangana (Sw).

Origin and geographic distribution *Strombosia scheffleri* occurs from south-eastern Nigeria east to southern Sudan and Kenya, and southwards to Angola, Zimbabwe and Mozam-



Strombosia scheffleri – wild

bique.

Uses The wood of *Strombosia scheffleri* is locally used, mainly for heavy construction, poles, carpentry, furniture and mortars. It is suitable for heavy-duty flooring, interior trim, vehicle bodies, railway sleepers, sporting goods, ladders, toys, novelties, utensils, tool handles and turnery. Ground wood chips were found to be suitable for the manufacture of cement particle boards. The wood is also used as firewood and for charcoal production.

The chipped bark is boiled in water in a ceramic pot to strengthen it. The bark powder with water is applied to spear heads to fix them to shafts. In DR Congo pulverized bark in water is taken to treat abdominal problems. In Tanzania a decoction of bark and leaves is drunk to treat diarrhoea. Pulverized twig bark is used as snuff to treat fever. In Angola the seed is eaten in small quantities, but mainly during periods of food shortage, as it can cause vomiting. *Strombosia scheffleri* is often planted as a shade tree in crop plantations including coffee, banana and cocoa. The flowers are much visited by honey bees. In DR Congo fruits are used as bait in traps for small mammals.

Production and international trade The wood of *Strombosia scheffleri* is mainly used locally and rarely traded on the international market. It is often sold in mixed consignments with other *Strombosia* spp.

Properties The heartwood is pale reddish brown, darkening upon exposure, and indistinctly demarcated by a pinkish intermediate zone from the whitish cream, 2.5–5 cm wide sapwood. The grain is fairly straight, sometimes wavy, texture medium to fine and even. The wood is fairly lustrous.

The wood is heavy, with a density of (610–) 800–1010 kg/m^3 at 12% moisture content, and hard. It air dries slowly with moderate to high risk of distortion. End splitting is common and flat-sawn boards have a tendency to cup. Kiln drying should be done slowly to avoid serious distortion and end splitting. The rates of shrinkage are quite high, from green to oven dry about 5.3% radial and 9.3% tangential. Once dry, the wood is unstable in service. At 12% moisture content, the modulus of rupture is 116–123 N/mm^2, modulus of elasticity 14,130–15,190 N/mm^2, compression parallel to grain 65–68 N/mm^2, shear 15 N/mm^2 and Janka side hardness 7520 N.

The outer wood saws easily, but spring is severe and boards are liable to split. The heartwood near the centre of the bole is much harder, causing rapid blunting of saw teeth, whereas gumming up of saw blades may occur. Dry wood works fairly easily with machine tools, but is difficult to work with hand tools; it is recommended to keep the speed in machine operations fairly low. In planing operations, a reduced cutting angle of 10° is recommended for flat-sawn stocks and 20° for quarter-sawn stock. The wood takes a smooth finish and polishes well. Boring and mortising properties are less favourable and ample support should be provided. The wood moulds and turns well, but is difficult to nail without pre-boring; the nail-holding capacity is high. Gluing characteristics are good especially with synthetic resin glues. It can be sliced into veneer. The wood has good durability in general, but is not durable in contact with the ground. It is considered fairly resistant to fungi, but susceptible to termite, *Lyctus* and marine borer attacks. The heartwood is resistant to impregnation by preservatives with ordinary pressure treatment methods, but the sapwood is fairly permeable.

In Angola seed samples showed an oil yield of 15–18%. Dichloromethane extracts of leaves and bark of *Strombosia scheffleri* showed significant antibacterial activity against *Vibrio cholerae*, *Staphylococcus aureus* and *Pseudomonas aeruginosa*. The extracts showed low toxicity in the brine shrimp toxicity test.

Description Medium-sized to fairly large tree up 35 m tall; bole branchless for up to 25 m, slightly sinuous to straight and cylindrical, up to 70(–100) cm in diameter, slightly fluted at base or with buttresses up to 2.5 m high; bark surface smooth, pale brown to grey or yellowish green, often flaking in irregular

Strombosia scheffleri – 1, leaf; 2, flowering twig; 3, flower; 4, fruiting twig.
Redrawn and adapted by J.M. de Vries

patches, inner bark thin, reddish, with a milky exudate; crown small, dense; twigs often drooping, slightly fluted, glabrous. Leaves alternate, simple and entire; stipules absent; petiole 1–3 cm long, deeply grooved above; blade oblong to oblong-elliptical or ovate, (6–)9–16(–38) cm × 4–9(–12) cm, base cuneate to rounded, apex acute to rounded, leathery, glabrous, pinnately veined with (4–)5–7(–10) pairs of lateral veins. Inflorescence an axillary fascicle, few- to many-flowered. Flowers bisexual, regular, 5-merous; pedicel 2.5–5 mm long; calyx lobes broadly ovate, c. 0.5 mm long; petals free, linear-oblong, 2.5–5 mm long, upper inner half densely short-hairy, outside glabrous, white to yellowish green; stamens c. 3.5 mm long, filaments fused for c. 2.5 mm with petals; ovary inferior or semi-inferior, 1-celled but at base imperfectly 3(–5)-celled, upper part surrounded by disk, style 2–4 mm long, stigma 3-lobed. Fruit an ellipsoid, fleshy drupe 2–3 cm long, enclosed by fleshy calyx, black when ripe, with depression at apex, stone 1-seeded. Seeds obovoid, with much waxy endosperm. Seedling with epigeal germination.

Other botanical information *Strombosia* comprises about 10 species, 7 of which occur in tropical Africa and 3 in tropical Asia. It has been classified in *Olacaceae*, but recent molecular studies showed that it is better placed in a separate family *Strombosiaceae*, together with 5 other genera including *Strombosiopsis*.

Anatomy Wood-anatomical description (IAWA hardwood codes):
Growth rings: 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; (10: vessels in radial multiples of 4 or more common); 12: solitary vessel outline angular; 14: scalariform perforation plates; 16: scalariform perforation plates with 10–20 bars; 17: scalariform perforation plates with 20–40 bars; 20: intervessel pits scalariform; 21: intervessel pits opposite; 32: vessel-ray pits with much reduced borders to apparently simple: pits horizontal (scalariform, gash-like) to vertical (palisade); 41: mean tangential diameter of vessel lumina 50–100 μm; 49: 40–100 vessels per square millimetre; 56: tyloses common; (58: gums and other deposits in heartwood vessels). Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 70: fibres very thick-walled. Axial parenchyma: 76: axial parenchyma diffuse; 77: axial parenchyma diffuse-in-aggregates; (78: axial parenchyma scanty paratracheal); 93: eight (5–8) cells per parenchyma strand; 94: over eight cells per parenchyma strand. Rays: 97: ray width 1–3 cells; (98: larger rays commonly 4- to 10-seriate); (106: body ray cells procumbent with one row of upright and/or square marginal cells); 107: body ray cells procumbent with mostly 2–4 rows of upright and/or square marginal cells; 108: body ray cells procumbent with over 4 rows of upright and/or square marginal cells; 115: 4–12 rays per mm; 116: ≥ 12 rays per mm. Mineral inclusions: 136: prismatic crystals present; 141: prismatic crystals in non-chambered axial parenchyma cells; 142: prismatic crystals in chambered axial parenchyma cells.
(E. Uetimane, P. Baas & H. Beeckman)

Growth and development *Strombosia scheffleri* prefers shade and does not grow well when planted in open localities. The leaves vary considerably on the same tree; leaves on the lower half of the tree are usually much larger than leaves on the upper half, whereas the smaller leaves are often folded along the midrib.

Ecology *Strombosia scheffleri* occurs in ev-

ergreen forest, often as understory tree, up to 2500 m altitude. It often occurs on acidic and granitic soils and prefers higher banks along water courses.

Propagation and planting Fruits are collected from the ground. There are about 100 fruits, 140 stones and 220 seeds per kg. Fruit stones can be stored for up to 5 months when they are depulped, cleaned and dried, and kept in a cool and dry place. Germination is enhanced by scarification and soaking in water for 24 hours. In Uganda germination of fresh seeds is said to be rapid with a high germination rate, but germination can take long; periods of several months have been recorded. Propagation by wildlings is also possible; they may be abundant near the mother tree. Tests in Uganda showed that propagation by stem cuttings is promising, but air layering failed, as well as propagation by root cuttings and suckers.

Management *Strombosia scheffleri* trees can be managed by pruning, lopping and pollarding. In East Africa *Strombosia scheffleri* has been planted in pure stands for timber production, and as shade tree for crops.

Harvesting When felling the trees, care is needed because the bole of older trees often shows heart rot.

Handling after harvest During storage of logs, small star shakes may develop, but damage by borers and blue stain is minimal.

Genetic resources *Strombosia scheffleri* is locally common, sometimes even dominant, within its wide geographical range. It is unlikely that it suffers from genetic erosion.

Prospects *Strombosia scheffleri* is a locally useful timber tree, and also has potential as a shade tree in crop plantations. It could have good prospects for inclusion in agroforestry systems. The potential of the antimicrobial properties in leaves and bark are worth further investigation.

Major references Bolza & Keating, 1972; Bryce, 1966; Burkill, 1997; Chikamai et al., undated; Katende, Birnie & Tengnäs, 1995; Keay, 1989; Lucas, 1968b; Maundu & Tengnäs (Editors), 2005; Meunier, Lemmens & Morin, 2010; Takahashi, 1978.

Other references Beentje, 1994; Friis & Vollesen, 1998; Iddi et al., 1992; Moshi et al., 2009a; Muhanguzi et al., 2005; Terashima & Ichikawa, 2003; Villiers, 1973a.

Sources of illustration Lucas, 1968b.

Authors E.A. Obeng

STROMBOSIOPSIS TETRANDRA Engl.

Protologue Engl. & Prantl, Nat. Pflanzenfam., II–IV Nachtr. 1: 148 (1897).

Family Olacaceae

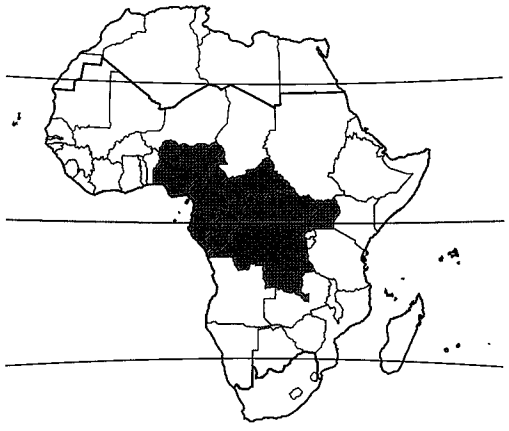
Origin and geographic distribution *Strombosiopsis tetrandra* occurs from south-eastern Nigeria eastward to western Uganda, and southward to DR Congo and Cabinda (Angola).

Uses The wood of *Strombosiopsis tetrandra*, called 'edipmbazoa' in Cameroon, is used for joinery and stakes. It is suitable for construction, flooring, interior trim, mine props, furniture, turnery, toys, novelties, musical instruments, boxes, crates, carvings, draining boards, pattern making, veneer and plywood.

In traditional medicine the bark is used in wound care. Bark decoctions are taken against mange, in Gabon also against dysentery and syphilis; in Congo they are taken or applied as a wash to induce labour or treat menstrual problems, and in DR Congo as enema to treat elephantiasis and orally against bronchitis. Bark sap is rubbed on or made into a vapour bath to treat a variety of ailments. It also enters into preparations for the treatment of rabies and epilepsy. Pounded fruits are used in the preparation of fish poison. The dried sap from the bark is applied to pottery as a brown varnish.

Production and international trade The wood of *Strombosiopsis tetrandra* is only traded locally.

Properties The heartwood is greyish brown with a purplish tinge or yellow-brown turning pinkish brown upon exposure, and fairly distinctly demarcated from the up to 15 cm thick, pale brown sapwood. The grain is usually



Strombosiopsis tetrandra – wild

straight, occasionally wavy, texture fine. The wood often contains gummy substances and dark crystals.
The wood is fairly heavy, with a density of about 790 kg/m^3 at 12% moisture content. Shrinkage during drying is moderate, from green to oven dry about 3.5% radial and 5.8% tangential. However, it is recommended to quarter-saw logs before drying. At 12% moisture content, the modulus of rupture is about 123 N/mm^2, modulus of elasticity 14,900 N/mm^2, compression parallel to grain 59 N/mm^2, cleavage 18.5 N/mm and Chalais-Meudon side hardness 3.4.
The wood saws fairly easily. It planes and polishes well with nice surfaces. It nails without splitting and holds nails well. It glues satisfactorily. The heartwood is durable. It is quite resistant to marine borers. However, the sapwood is liable to *Lyctus* attack. The heartwood is resistant to impregnation with preservatives, sapwood moderately resistant.

Botany Evergreen shrub or small to medium-sized tree up to 30 m tall; bole branchless for up to 15 m, straight and cylindrical or twisted, up to 120 cm in diameter, base irregularly and deeply fluted; bark surface smooth, exfoliating in thin scales, dark grey to brown or dark red, inner bark thick, brownish, slowly but copiously exuding a resinous, red sap; crown large, dense; twigs angular or narrowly winged, glabrous. Leaves alternate, simple and entire; stipules absent; petiole 1–2 cm long, furrowed; blade elliptical to ovate-elliptical or oblong-lanceolate, 5–28 cm × 3–12 cm, rounded at base, short-acuminate at apex, leathery, glabrous, pinnately veined with 6–10 pairs of lateral veins. Inflorescence an axillary fascicle or short raceme, on a short shoot 5–10 mm long, glabrous. Flowers bisexual, regular, 4-merous; pedicel 2–3 mm long; calyx cup-shaped, with deltoid lobes; petals oblong-lanceolate, 4–5 mm long, white to cream; stamens fused to petals; ovary semi-inferior, (3–)4-celled, style short. Fruit an ellipsoid to ovoid drupe 2–3.5 cm long, embedded in swollen receptacle, smooth, greenish, with sepal scars almost at apex of fruit; stone granular, 1-seeded.
Strombosiopsis tetrandra is variable in growth form and leaf size. In Cameroon and Gabon trees flower in November–May.
Strombosiopsis comprises 2 species. It has been classified in *Olacaceae*, but recent molecular studies show that it is better placed in a separate family *Strombosiaceae*, together with 5 other genera including *Strombosia*. *Strombosiopsis nana* Breteler is a shrub up to 3 m tall, only known from Liberia.

Ecology *Strombosiopsis tetrandra* occurs in humid evergreen forest on well-drained soils, but also in forest subject to flooding and in gallery forest, up to 1200 m altitude. In the most humid forest it tends to be a small, densely branched tree.

Management *Strombosiopsis tetrandra* usually occurs scattered in the forest in rather low densities; in southern Cameroon an average density of 0.06 trees with a bole diameter of more than 60 cm has been recorded per ha, with a mean wood volume of 0.3 m^3/ha.

Genetic resources and breeding *Strombosiopsis tetrandra* is widespread and locally fairly common. There are no indications that it is danger of genetic erosion.

Prospects *Strombosiopsis tetrandra* will probably remain a timber tree of limited local use. More research is needed to assess its value in medicine.

Major references Bolza & Keating, 1972; Burkill, 1997; Neuwinger, 2000; Takahashi, 1978; Vivien & Faure, 1985.

Other references Breteler, 2001a; Konda ku Mbuta et al., 2010; Louis & Léonard, 1948; Lucas, 1968b; Raponda-Walker & Sillans, 1961; Tailfer, 1989; Villiers, 1973a; Villiers, 1973b.

Authors L.P.A. Oyen

STRYCHNOS MITIS S.Moore

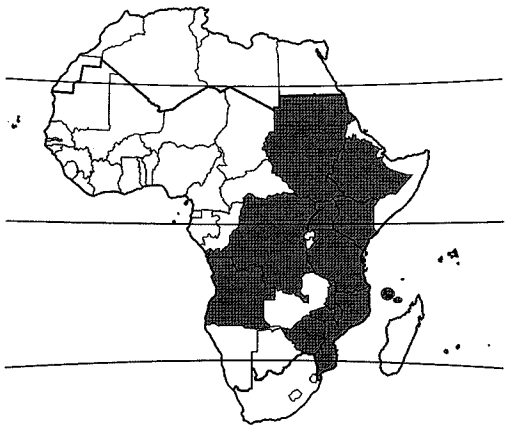
Protologue Journ. Linn. Soc., Bot. 40: 146 (1911).

Family Loganiaceae

Vernacular names Pitted-leaf strychnos (En). Mtonga, mwangajini mdogo, mlyaminga (Sw).

Origin and geographic distribution *Strychnos mitis* occurs from Sudan and Ethiopia southward to Angola, Zimbabwe, Mozambique, eastern South Africa and Swaziland, and in Comoros and Mayotte.

Uses The wood of *Strychnos mitis*, known as 'hard pear', is often used for building poles, railway sleepers and tool handles. It is suitable for flooring, joinery, interior trim, mine props, ship building, vehicle bodies, furniture, sporting goods, toys, novelties, agricultural implements and turnery. It is widely used as firewood and for making charcoal.
In Ethiopia and Uganda *Strychnos mitis* is used as shade tree in coffee plantations, in



Strychnos mitis – wild

Uganda also in cocoa plantations and as an avenue tree. In Ethiopia the fruits are eaten. In DR Congo an ordeal poison is prepared from the wood and roots, and the Mbuti people use the sap of the tree in the preparation of arrow poison.

Production and international trade The wood of *Strychnos mitis* is only used and traded locally.

Properties The heartwood is pale grey to cream, yellow or pale brown with conspicuous white streaks, and indistinctly demarcated from the sapwood. The grain is straight or interlocked, texture coarse.

The wood is heavy, with a density of (785–) 860–990 kg/m^3 at 10% moisture content. It air dries slowly with a considerable risk of distortion and surface checking. The rates of shrinkage are moderate, from green to oven dry about 3.8% radial and 6.9% tangential. At 12% moisture content the modulus of rupture is 120–125 N/mm^2, modulus of elasticity 16,500 N/mm^2, compression parallel to grain 58–65 N/mm^2, cleavage 19 N/mm and Chalais-Meudon side hardness 4.0.

Considerable force is needed for sawing and working, and the wood has a marked blunting effect on saw teeth and tool edges. It has a nice finish when a filler is used. The wood is not durable, being susceptible to insect attacks. The heartwood is resistant to impregnation with preservatives.

Description Evergreen small to fairly large tree up to 35(–40) m tall; bole branchless for up to 20(–25) m, straight and cylindrical or crooked and twisted, up to 60(–100) cm in diameter; bark smooth or slightly fissured and scaly, grey to greyish brown or greenish, inner bark thin, fibrous, pale brown or cream with orange-brown flecks; crown rounded; twigs glabrous, with lenticels. Leaves opposite, simple and entire; stipules reduced to a rim connecting the petiole bases; petiole 2–5 mm long; blade elliptical to ovate, 4–11.5 cm × 1.5–5 cm, base usually cuneate, apex acuminate, thin-leathery, usually glabrous, with 1 pair of lateral veins c. 1 cm above leaf base and a fainter pair of veins from the base along the margins. Inflorescence a compound, axillary or terminal cyme 1–3(–4) cm long, fairly dense, short-hairy. Flowers bisexual, regular, 4–5-merous, sessile; sepals broadly ovate to nearly round, 1.5–2 mm long, glabrous to slightly hairy; corolla cream, yellow or greenish, tube campanulate, 1.5–2 mm long, lobes ovate-triangular, 1.5–2.5 mm long, hairy inside at base; stamens inserted just above the middle of the corolla tube, filaments short, anthers with long hairs at base; ovary superior, ovoid, 1–2 mm long, 2-celled, style 1–1.5 mm long. Fruit a globose berry 1–2 cm in diameter, yellow to orange, 1(–2)-seeded. Seeds ellipsoid, flattened on one side, c. 1 cm long, smooth and

Strychnos mitis – 1, tree habit; 2, part of flowering branch; 3, flower; 4, fruit.
Redrawn and adapted by J.M. de Vries

glabrous but with minute pits.

Other botanical information *Strychnos* comprises about 200 species: about 60 species in Asia, 65 in America and 75 in Africa. Many *Strychnos* spp. are well known as medicinal plants and several for their edible fruits. However, the wood of some species is used for similar purposes as that of *Strychnos mitis*.

Strychnos decussata (Pappe) Gilg (synonym: *Strychnos atherstonei* Harv.) is a shrub or small tree up to 12(–17) m tall with bole up to 30(–45) cm in diameter, occurring from Kenya southward to eastern South Africa, and in Madagascar. Its dark brown and heavy wood, with a density of 850–930 kg/m^3 at 10% moisture content, is used for laths in house construction and musical instruments. Root decoctions and infusions are taken to treat stomachache and snakebites, and root powder is applied externally to snakebites. Fruits have been reported to be edible, but young fruits appear to be toxic.

Strychnos mellodora S.Moore is a medium-sized to fairly large tree up to 35 m tall with bole up to 50 cm in diameter, occurring in montane rainforest in Tanzania, Zimbabwe and Mozambique. Its whitish, heavy and hard wood is used for poles in house building, for tool handles and as firewood. The flowers provide nectar for honey bees. Several alkaloids have been isolated from the bark, some of which showed weak in-vitro antiplasmodial activity.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: 1: growth ring boundaries distinct; 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; 7: vessels in diagonal and/or radial pattern; 8: vessels in dendritic pattern; (10: vessels in radial multiples of 4 or more common); (12: solitary vessel outline angular); 13: simple perforation plates; 22: intervessel pits alternate; 25: intervessel pits small (4–7 μm); 29: vestured pits; 30: vessel-ray pits with distinct borders; similar to intervessel pits in size and shape throughout the ray cell; 41: mean tangential diameter of vessel lumina 50–100 μm; 49: 40–100 vessels per square millimetre. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 70: fibres very thick-walled. Axial parenchyma: 76: axial parenchyma diffuse; (77: axial parenchyma diffuse-in-aggregates); 78: axial parenchyma scanty paratracheal; 83: axial parenchyma confluent; 86: axial parenchyma in narrow bands or lines up to three cells wide; (89: axial parenchyma in marginal or in seemingly marginal bands); 93: eight (5–8) cells per parenchyma strand; 94: over eight cells per parenchyma strand. Rays: (97: ray width 1–3 cells); 98: larger rays commonly 4- to 10-seriate; 107: body ray cells procumbent with mostly 2–4 rows of upright and/or square marginal cells; 110: sheath cells present; 115: 4–12 rays per mm. Secretory elements and cambial variants: 134: included phloem, diffuse. Mineral inclusions: 136: prismatic crystals present; 137: prismatic crystals in upright and/or square ray cells; 138: prismatic crystals in procumbent ray cells; 141: prismatic crystals in non-chambered axial parenchyma cells; 142: prismatic crystals in chambered axial parenchyma cells.

(R. Shanda, P. Baas & H. Beeckman)

Growth and development *Strychnos mitis* regenerates profusely under natural conditions. In southern Africa, trees usually flower in February–April and fruit about 3 months after flowering. In Uganda ripe fruits are produced year-round. They are eaten by turacos, which are probably the main seed dispersers, but also by chimpanzees.

Ecology *Strychnos mitis* occurs in rainforest, riverine forest and montane forest from sea-level up to 2300 m altitude. In southern Africa it is also found in low evergreen coastal forest in moist localities.

Propagation and planting *Strychnos mitis* is propagated by seed. Fruits are collected, seed extracted and thoroughly dried. Seed keeps well in dry and cool conditions. Before sowing, it is recommended to soak seeds in water for one night. Wildlings are sometimes collected for planting.

Management Trees respond well to pollarding and coppicing.

Genetic resources *Strychnos mitis* is widespread and common in many regions within its distribution area, and regenerates well. There are no indications that it is in danger of genetic erosion.

Prospects The wood of *Strychnos mitis* is likely to remain important in local construction, as firewood and as source of charcoal. In Uganda planting of *Strychnos mitis* in firewood plots has been recommended. More attention for its silvicultural management is needed because it may be interesting for more extensive planting in agroforestry systems.

Major references Beentje, 1994; Bolza & Keating, 1972; Coates Palgrave, 2002; Katende, Birnie & Tengnäs, 1995; Leeuwenberg, 1983;

Leeuwenberg, 1984; Maundu & Tengnäs (Editors), 2005; Neuwinger, 2000; Takahashi, 1978; Teketay et al., 2010.

Other references Bruce & Lewis, 1960; Caniato & Puricelli, 2003; Grace et al., 2002a; Leeuwenberg, 2003; Leeuwenberg & Bamps, 1979; Lovett et al., 2007; Pascal et al., 2001; Philippe et al., 2005; Rasoanaivo, Petitjean & Conan, 1993; van Vuuren, Banks & Stohr, 1978; van Wyk & Gericke, 2000; Verdoorn, 1963.

Sources of illustration Leeuwenberg, 1969; Maundu & Tengnäs (Editors), 2005.

Authors L.P.A. Oyen

STUHLMANNIA MOAVI Taub.

Protologue Engl., Pflanzenw. Ost-Afrikas C: 201 (1895).

Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

Synonyms *Caesalpinia dalei* Brenan & J.B.Gillett (1963), *Caesalpinia insolita* (Harms) Brenan & J.B.Gillett (1963).

Origin and geographic distribution *Stuhlmannia moavi* occurs in coastal regions of southern Kenya and Tanzania, and also in northern Madagascar.

Uses In Madagascar the wood is used for carpentry and furniture. The red dye from the glands on young twigs and leaves is occasionally used to colour parts of the body.

Properties The heartwood is dark brown and very hard.

Botany Small to medium-sized tree up to 25 m tall; bole up to 100 cm in diameter, often with buttresses at base; bark surface smooth to fissured, grey to brown, inner bark fibrous; twigs initially hairy but soon glabrous, with small red-brown glands. Leaves alternate, bipinnately compound with (1–)2–8 pairs of pinnae, rarely simple-pinnately compound; stipules and stipels absent; petiole and rachis together (1.5–)5–11(–20) cm long, with reddish glands; pinnae (1–)3–9(–12) cm long, with 3–11 pairs of leaflets; leaflets opposite to alternate, sessile, elliptical, 0.5–8(–12) cm × 0.5–3(–6) cm, glabrous but with reddish glands below. Inflorescence an axillary or terminal raceme 2–11 cm long, densely dark brown short-hairy, c. 15-flowered. Flowers bisexual, slightly zygomorphic, 5-merous; pedicel 3–13 mm long; sepals oblong-ovate, 5–6 mm long, densely hairy and glandular; petals free, obovate, 9–12 mm long, yellow, the upper petal slightly smaller than the others and spotted with red-brown; stamens 10, 6–8 mm long, hairy at base; ovary superior, c. 3 mm long, hairy and glandular, 1-celled, style c. 1.5 mm long. Fruit an obliquely oblong-elliptical, flattened pod 4.5–6 cm long, with beak at apex, slightly hairy, dehiscent with 2 spiralling valves, (1–)2-seeded. Seeds ovate to nearly round, flattened, 10–13 mm long, brown, finely cracked.

The fruits are explosively dehiscent, dispersing the seeds over short distances.

Stuhlmannia comprises a single species. It is closely related to *Caesalpinia* and *Cordeauxia*.

Ecology *Stuhlmannia moavi* occurs in lowland evergreen or deciduous woodland, also in riverine forest. It is found on lime-stone, sandy and basaltic soils.

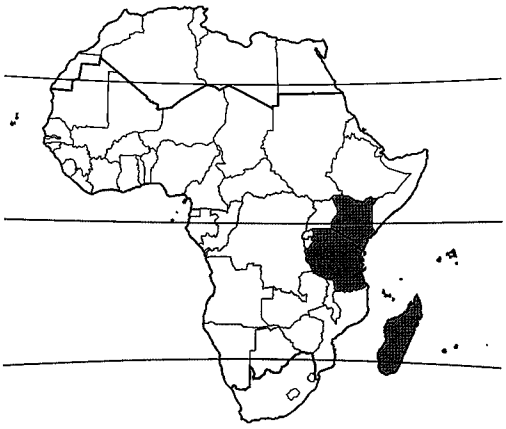
Genetic resources and breeding *Stuhlmannia moavi* is uncommon, although locally frequent in northern Madagascar and very locally in gallery forest in Tanzania. In Kenya and Tanzania it is confined to a few coastal forest fragments. It is classified as vulnerable in the IUCN Red List.

Prospects *Stuhlmannia moavi* is too uncommon to be promoted for use of its timber. The focus of research should be on its conservation rather than its exploitation.

Major references du Puy et al., 2002; Lovett & Clarke, 1998.

Other references Beentje, 1994; Brenan, 1967; Lewis, 1996; Lewis et al., 2005.

Authors R.H.M.J. Lemmens



Stuhlmannia moavi – wild

SUREGADA PROCERA (Prain) Croizat

Protologue Bull. Inst. Bot. Buitenzorg, ser. 3, 17(2): 216 (1942).

Family Euphorbiaceae

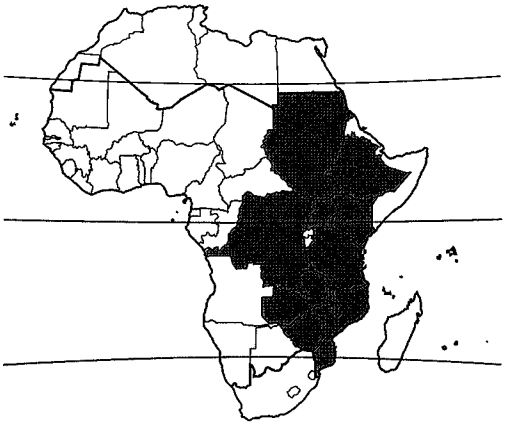
Vernacular names Bush canary berry (En).

Origin and geographic distribution *Suregada procera* occurs from eastern DR Congo, southern Sudan and Ethiopia southward to Zimbabwe, Mozambique and South Africa.

Uses The wood is used for poles in construction, and for tool handles and chopping-blocks. It is suitable for flooring, joinery, interior trim, mine props, vehicle bodies, furniture, sporting goods, musical instruments, toys, novelties, precision equipment, agricultural implements, turnery and draining boards. The wood is also used as firewood. The tree can be used as ornamental shade tree.

Production and international trade The wood of *Suregada procera* is only used locally.

Properties The heartwood is white to pale brown and indistinctly demarcated from the sapwood. The grain is straight to interlocked, texture fine and even. The wood is heavy, with a density of about 880 kg/m^3 at 12% moisture content, and hard. It air dries slowly but fairly well, with slight surface checking. The wood is difficult to saw when dry because of its high density, but sawing is more easy when green. It works fairly well with both hand and machine tools, and planes to a smooth surface. Pre-boring is needed for nailing and screwing. The wood glues satisfactorily and paints and varnishes well. It is resistant to splitting. It is quite durable, but slightly susceptible to termite, pinhole borer and marine borer attacks. The wood is resistant to impregnation with preservatives.



Suregada procera – *wild*

Botany Evergreen, usually dioecious shrub or small to medium-sized tree up to 25(–30) m tall; bole branchless for up to 15(–18) m, often crooked, up to 60 cm in diameter; bark surface smooth to rough or minutely fissured, greenish grey to nearly black; crown spreading, heavily branched; twigs slightly angled, glabrous, greenish. Leaves alternate, simple; stipules triangular, c. 2 mm × 1 mm; petiole c. 0.5 cm long; blade elliptical to elliptical-ovate, 3–14 cm × 1–7 cm, base obliquely cuneate, apex obtuse or short-acuminate, margins entire or slightly toothed, leathery, glabrous, pinnately veined with 7–11(–15) pairs of lateral veins. Inflorescence a leaf-opposed fascicle up to 1.5 cm in diameter, glabrous. Flowers unisexual, regular, greenish white or greenish yellow; pedicel 1–3 mm long; sepals (5–)6(–8), ovate, c. 3 mm long; petals absent; male flowers with (16–)20–30 stamens c. 4 mm long; female flowers with superior, 3-lobed to nearly globose ovary 2–3 mm in diameter, (2–)3-celled, styles (2–)3, 1–2 mm long. Fruit a slightly 3-lobed capsule c. 1 cm × 1.5 cm, smooth, dark green turning brown, 3-seeded. Seeds ovoid, 5–7 mm × 4–5 mm, smooth, with pulpy seed coat.

Suregada comprises about 30 species, all occurring in the Old World tropics; 8 species occur in continental tropical Africa and 14 in Madagascar.

Suregada lithoxyla (Pax & K.Hoffm.) Croizat is very similar to *Suregada procera*, but has larger leaves and an annular disk in male flowers. It is restricted to evergreen forest in eastern Tanzania. Its wood is hard and used for poles, tool handles and spoons, and as firewood. The tree is used as ornamental shade tree. *Suregada lithoxyla* is classified in the IUCN Red List as vulnerable.

Ecology *Suregada procera* occurs in mixed evergreen forest, riverine forest and swamp forest, at 300–2150 m altitude. In central Kenya it is characteristic of dry evergreen forest and montane forest with *Podocarpus gracilior* Pilger and *Pouteria adolfi-friederici* (Engl.) A.Meeuse.

Genetic resources and breeding *Suregada procera* is considered vulnerable in eastern Zimbabwe, but in many other regions within its wide distribution area it is fairly common.

Prospects The wood of *Suregada procera* is likely to remain of local use, but its bole of often too poorly shaped and too small in size to be of more commercial interest.

Major references Bolza & Keating, 1972; Chikamai et al., undated; Lovett, Ruffo & Ge-

reau, 2003; Radcliffe-Smith, 1987a; Radcliffe-Smith, 1996.

Other references Beentje, 1994; Coates Palgrave, 2002; Lovett & Clarke, 1998; Tadesse & Nigatu, 1996; Tadesse & Feyera, 2008.

Authors L.P.A. Oyen

TAMARIX APHYLLA (L.) H.Karst.

Protologue Deut. Fl.: 641 (1882).

Family Tamaricaceae

Chromosome number $2n = 24$

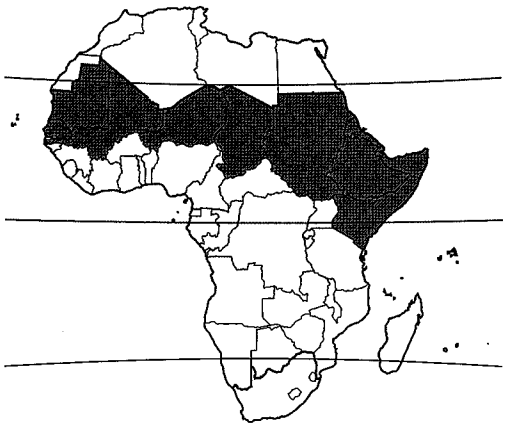
Synonyms *Tamarix articulata* Vahl (1791).

Vernacular names Athel tree, leafless tamarisk, athel tamarisk, tlaie of Morocco (En). Tamaris aphylle, tamaris à galles (Fr).

Origin and geographic distribution In tropical Africa *Tamarix aphylla* occurs in dry regions from Mauritania and Senegal east to Somalia. It is also found in North Africa and the Middle East, and extends east into India. It has been introduced in South Africa, Madagascar, Mexico, the United States, Canada and Australia.

Uses In West Africa the wood is used for carpentry and turnery. In Ethiopia it is used for construction, as firewood and for charcoal production. It is suitable for furniture, agricultural implements, fence posts and boxes.

The shoots are used in Ethiopia as fodder, and to cure scabies in camels. In India the bark is used as an astringent and to treat skin disorders such as eczema. As an auxiliary plant *Tamarix aphylla* is well suited for dune fixation, soil conservation and stabilization, and as shelterbelt and windbreak. Planted in rows or strips it is effective to stop fires as the leaves excrete salt that suppresses undergrowth while the litter does not burn because of the high salt content. Galls are formed when flowers and branches are attacked by a gall midge (*Eriophyes tlaie*). These galls are powdered and mixed with oil for tanning sheep and goat skins. The bark is sometimes also used in leather production and as a mordant in dyeing. *Tamarix aphylla* is widely planted for shade and as an ornamental, often along roads. The twigs are sometimes used for making baskets.

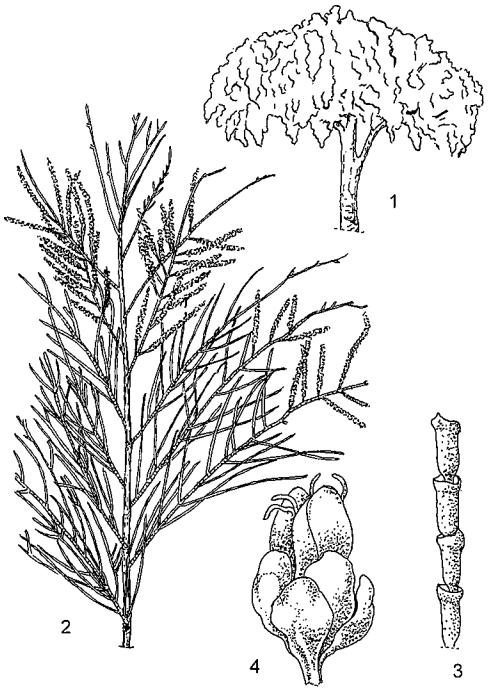


Tamarix aphylla – wild

Properties The heartwood of *Tamarix aphylla* is creamy white and indistinctly demarcated from the sapwood. The grain is often interlocked. The wood shows a silver-grain figure or a mottled to wavy appearance on quarter-sawn surfaces. The wood is medium-weight, with a density of about 680 kg/m^3 at 12% moisture content, and fairly hard. The wood often splits during cutting. Flat-sawn boards tend to cup and warp during drying, and quarter-sawing is recommended. The rates of shrinkage from green to oven dry are about 2.7% radial and 12.4% tangential. The wood is somewhat difficult to machine, but it polishes and turns well with a lustrous surface. It is generally durable for indoor uses, but susceptible to termites. The wood is easy to treat with preservatives for outdoor uses. It is less suitable for pulping as the cellulose content is too low, but it is suitable for the manufacture of particle board.

Galls contain up to 55% tannin, twigs about 16% and bark about 8.5%; wood also contains tannin. The polyphenol tamarixellagic acid is found in the galls, as well as dehydrodigallic acid and dehydrotrigallic acid.

Description Evergreen, small tree up to 15(–20) m tall; bole usually straight, up to 80(–90) cm in diameter; bark surface becoming fissured, reddish brown to grey; twigs drooping. Leaves alternate, reduced to sheathing scales 1.5–4 mm long and 1 mm in diameter on twigs, abruptly truncate and with minute point, with salt-excreting glands, larger branchlets with persistent scale-like leaves. Inflorescence a spike up to 6(–8) cm long, inserted towards the end of twigs. Flowers bisexual, regular, 5-merous, nearly sessile; sepals free, almost circular, c. 1.5 mm long, green or pinkish; petals free, oblong, c. 2 mm long, white; stamens c. 2 mm long; disk irregularly lobed between insertion of stamens; ovary superior, obovoid, c. 1.5 mm long, glabrous, style conical, stigmas 3. Fruit an ovoid capsule 4–5 mm long, 3-valved, many-seeded. Seeds c. 0.5



Tamarix aphylla – 1, tree habit; 2, flowering twig; 3, part of young twig; 4, flower.
Redrawn and adapted by Iskak Syamsudin

mm long, with an apical tuft of hairs c. 3 mm long.

Other botanical information *Tamarix* comprises about 50 species of xerophytic and halophytic shrubs and trees. It is restricted to the Old World, but some species have become naturalized in arid regions of the Americas and Australia. About 7 species occur naturally in tropical Africa, and several others have been introduced from Asia and Europe into tropical Africa. The value of the flower disk characteristics, considered important in distinguishing between species, is in doubt. A revision of the genus will probably lead to a reduction of the number of species.

Other *Tamarix* spp. have many uses in common with *Tamarix aphylla*, especially as a source of firewood and in land management. *Tamarix nilotica* (Ehrenb.) Bunge is a small tree found in Sudan, Eritrea, Ethiopia, Djibouti, Somalia, Kenya and Tanzania, as well as in Egypt, Israel and Lebanon. In Kenya the wood is used for house construction and firewood. In Sudan the bark and galls are used to treat fever and colds and methanolic extracts of both were shown to have moderate antiplasmodial activity.

Tamarix senegalensis DC. is recorded from Cape Verde, Mauritania and Senegal. In Mauritania the wood is used for house building. The wood is also used for tent-pegs and tool handles. Camels eat the twigs. An exudate is collected from the tree and used as a sweetener. In Senegal a decoction made of the twigs is applied as an eyewash to cure conjunctivitis and a fruit macerate is used to treat rhinitis.

Tamarix usneoides E.Mey. ex Bunge is distributed in Angola, Namibia and South Africa. In Namibia it is popular as a source of firewood and the leafy branches are eaten by livestock. A decoction of the roots is drunk to cure diarrhoea and indigestion, and to overcome stomach pains.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: 1: growth ring boundaries distinct. Vessels: (4: wood semi-ring-porous); 5: wood diffuse-porous; (11: vessel clusters common); 13: simple perforation plates; 22: intervessel pits alternate; 23: shape of alternate pits polygonal; 24: intervessel pits minute (≤ 4 μm); 25: intervessel pits small (4–7 μm); 30: vessel-ray pits with distinct borders; similar to intervessel pits in size and shape throughout the ray cell; 41: mean tangential diameter of vessel lumina 50–100 μm; 42: mean tangential diameter of vessel lumina 100–200 μm; (45: vessels of two distinct diameter classes, wood not ring-porous); 47: 5–20 vessels per square millimetre; 58: gums and other deposits in heartwood vessels. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 69: fibres thin- to thick-walled. Axial parenchyma: 79: axial parenchyma vasicentric; 83: axial parenchyma confluent; 90: fusiform parenchyma cells; 91: two cells per parenchyma strand; (92: four (3–4) cells per parenchyma strand). Rays: 99: larger rays commonly > 10-seriate; 102: ray height > 1 mm; 106: body ray cells procumbent with one row of upright and/or square marginal cells; 107: body ray cells procumbent with mostly 2–4 rows of upright and/or square marginal cells; (110: sheath cells present); 114: ≤ 4 rays per mm. Storied structure: 120: axial parenchyma and/or vessel elements storied. Mineral inclusions: 136: prismatic crystals present; 137: prismatic crystals in upright and/or square ray cells.

(P. Ng'andwe, H. Beeckman & P.E. Gasson)

Growth and development Under favoura-

ble conditions when groundwater is accessible, growth is rapid. On sand hills in Somalia, the survival rate 7 years after planting was 68%, mean height 4.9 m and mean bole diameter 8.5 cm. In Sudan cuttings planted into irrigated fields showed a survival rate of 55–80% after 2 years, with an average height of 3 m. The root system of *Tamarix aphylla* extends up to 35 m horizontally and 20 m vertically, tapping deep water reserves.

Ecology *Tamarix aphylla* is found in deciduous woodland and thickets on sandy soils, on dunes, canal and river banks, and in salty deserts up to 1700 m altitude. When established, it tolerates drought and high salt concentrations, is tolerant of high temperatures and withstands temperatures as low as –6°C. It grows in areas with a rainfall of (100–)250–500(–1200) mm/year.

Propagation and planting One kg contains 100,000–300,000 seeds. The seeds of *Tamarix aphylla* loose viability quickly. For natural regeneration seed dispersal and flooding have to coincide. Propagation is often done with cuttings of 10 cm long taken from shoots developed during the last growing season, and planted in moist sand. Cuttings of 30–40 cm long and 0.5–1 cm in diameter are also used for planting in the nursery; they are ready for transplanting into the field after about 5 months. Protection of young plants against grazing animals is necessary.

Management Large-scale planting has been done in Israel, Kuwait, the United States and Australia. In Israel drip-irrigation using saline water is practised. In both the United States and Australia the species has become naturalized and in the latter it is considered an invasive weed. In the United States eradication attempts for several of the introduced *Tamarix* spp. tried to spare *Tamarix aphylla* because this species is considered useful.

Spacing plants too closely will lead to water stress, whereas planting too widely may result in damage to young plants caused by the wind. Planting close and thinning after 2 years are suggested as good options. Recommended plant densities are 30–80 plants/ha. A row spacing of 4.5 m has been recommended in Arizona (United States).

For production of firewood coppicing is practised. The first harvest of firewood can be done 4 years after planting. For timber production, pruning to a single bole is essential. Under favourable conditions, poles for fence posts can be harvested after 5–8 years and logs for sawn timber after 20 years. Larger trees produce 20–30 kg of galls per year that need to be collected after the rainy season, and need to be dried carefully to avoid fermentation.

Genetic resources *Tamarix aphylla* is widespread and not intensively used, and therefore no threats of genetic erosion are foreseen.

Breeding Some selection work has been done in Israel on *Tamarix aphylla* and an improved cultivar 'Erecta' has been released. Interspecific hybridization in the genus offers opportunities for breeding.

Prospects *Tamarix aphylla* is a useful species for timber production, control of bush fires, windbreaks and erosion control. When considering the introduction of a *Tamarix* species, *Tamarix aphylla* is often the best choice as it is less invasive than other species. As the plant uses water from deep reservoirs and exudes salt from the leaves, the risk of salinization of the top soil should be considered wherever considering to introduce the plant. More research is needed on wood properties, which may lead to a better use in dry regions, and on the value as a forage, providing salt and other minerals to livestock. The taxonomy of the genus needs to be clarified.

Major references Baum, 1978; Bekele-Tesemma, Birnie & Tengnäs, 1993; Booth & Wickens, 1988; Burkill, 2000; Orwa et al., 2009.

Other references Ali et al., 2002; Arbonnier, 2004; Canadell et al., 1996; Choukr-Allah, Malcolm & Hamdy (Editors), 1995; Hunt, 1966; Jansen, 1981; Mesfin Tadesse, 1993; Milbrath & Deloach, 2006; Nawwar et al., 1994; van den Eynden, Vernemmen & van Damme, 1992.

Sources of illustration Baum, 1978; Bekele-Tesemma, Birnie & Tengnäs, 1993.

Authors C.H. Bosch & D. Louppe

TAMBOURISSA THOUVENOTII Danguy

Protologue Bull. Mus. natl. Hist. nat., ser. 1, 28: 250 (1922).

Family Monimiaceae

Chromosome number $2n = 38$

Synonyms *Tambourissa trichophylla* Baker var. *thouvenotii* Cavaco (1959).

Origin and geographic distribution *Tambourissa thouvenotii* is endemic to Madagascar, where it occurs in the central and eastern parts of the island.

Uses Traditionally the wood is especially appreciated for joinery, coffins and shingles. In house building, it is often used in the round as

Tambourissa thouvenotii – wild

poles. It is also used for cabinet work, panelling and ship building, and is suitable for moulding, veneer and particle board. The larger boles were often used to make dug-out canoes. The fruits are eaten.

Properties The heartwood is yellow, often with a pinkish or greyish tinge, and distinctly demarcated from the up to 5 cm wide, grey-yellow to pale brown sapwood. The grain is usually interlocked, texture medium and even. The wood surface has an attractive figure, nice lustre and pleasant scent.

The wood is medium-weight, with a density of 545–720 kg/m³ at 12% moisture content. Drying of the wood is not easy and checking and twisting may be a problem. The rates of shrinkage are high, from green to oven dry 2.8–4.7% radial and 8.4–11.8% tangential. Once dry, the wood is moderately stable to unstable in service. At 12% moisture content, the modulus of rupture is 86–124 N/mm², modulus of elasticity 8200–11,100 N/mm², compression parallel to grain 41–68 N/mm², cleavage 7.5–8.5 N/mm and Chalais-Meudon side hardness 1.3–3.4.

The wood is easy to work with both hand and machine tools. The nailing and screwing properties are good. The polishing characteristics are excellent, and the wood glues and stains well. The steam-bending properties are moderate. The heartwood is moderately durable, being moderately resistant to fungal, termite and marine borer attacks. It is resistant to impregnation with preservatives.

Botany Evergreen, monoecious, small to medium-sized tree up to 22 m tall; bole often low-branched, up to 90 cm in diameter; twigs densely soft-hairy. Leaves opposite, simple; stipules absent; petiole 1–2 cm long; blade usually broadly elliptical to elliptical, 7–19 cm × 4–9 cm, obtuse to rounded at base, usually short-acuminate at apex, margins usually toothed with few, short teeth, thin-leathery, densely yellowish soft-hairy below, pinnately veined with 4–7 pairs of lateral veins. Inflorescence a dichasium on trunk, branches or in leaf axils up to 5.5 cm long, (1–)3–7-flowered, short-hairy. Flowers unisexual, regular; male flowers c. 5 mm in diameter, with 4 perianth lobes, stamens 50–100, anthers nearly sessile; female flowers c. 6 mm in diameter, with 5–6 incurved perianth lobes, ovaries numerous, inferior and embedded in the receptacle. Fruit consisting of the enlarged, cup-shaped receptacle 4–10 cm in diameter, eventually splitting open, exposing the bright orange-red drupelets.

Tambourissa comprises about 50 species which are restricted to the western Indian Ocean Islands, most of them in Madagascar. The Madagascan vernacular name 'ambora' is applied to all *Tambourissa* spp.; probably the wood of many species is used, but these are generally more important as a source of traditional medicine. *Ephippiandra madagascariensis* (Danguy) Lorence is related and its wood is used for similar purposes, although it is less durable.

Ecology *Tambourissa thouvenotii* occurs in humid forest in the mountains of central and eastern Madagascar at 800–1400 altitude.

Management Large boles are often hollow, and caution is needed during felling.

Genetic resources and breeding *Tambourissa thouvenotii* is fairly widespread and locally common. There is little information on intensity of exploitation, but it is likely that several of the rarer *Tambourissa* spp. are vulnerable.

Prospects The wood of *Tambourissa thouvenotii* and several other *Tambourissa* spp. will continue to be used locally in house building and for carpentry. It has interesting characteristics and *Tambourissa* spp. deserve more research attention on propagation and silviculture.

Major references Boiteau, Boiteau & Allorge-Boiteau, 1999; Guéneau, Bedel & Thiel, 1970–1975; Lorence, 1985; Parant, Chichignoud & Rakotovao, 1985; Styger et al., 1999.

Other references Bolza & Keating, 1972; Cavaco, 1959; Guéneau, 1971a; Jérémie & Lorence, 1991; Lorence, 1982; Renner et al., 2010; Sallenave, 1955; Schatz, 2001; Takahashi,

1978.

Authors C.H. Bosch & D. Louppe

TAPURA FISCHERI Engl.

Protologue Pflanzenw. Ost-Afrikas C: 423 (1895).

Family Dichapetalaceae

Vernacular names Leaf-berry tree (En). Mtama mwitu (Sw.)

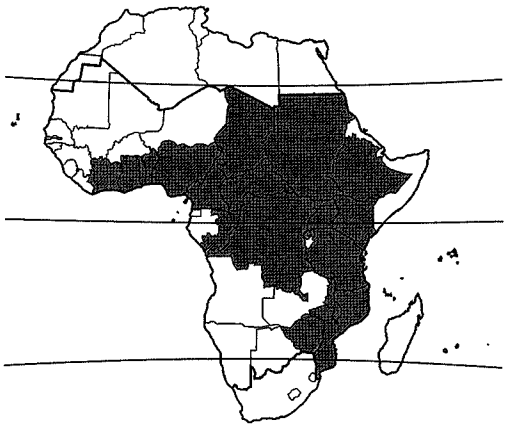
Origin and geographic distribution *Tapura fischeri* is distributed from Côte d'Ivoire eastwards to Sudan and Ethiopia and from there south to South Africa.

Uses The wood is used for building poles, tools and wooden spoons, and as firewood. In Tanzania the leaves are used for fodder and as a medicine for stomach-ache.

Properties The wood of *Tapura fischeri* is tough and hard. Extracts of the leaves were found to contain 4 pheophytins, as well as pheophorbide, a methyl ester.

Botany Shrub or small to medium-sized tree up to 25 m tall; bole straight, up to 45 cm in diameter; bark surface rather smooth, thinly scaly, grey-brown; branches often horizontal, sometimes drooping. Leaves alternate, simple and entire; stipules triangular, 1–5 mm long, caducous; petiole 2–10 mm long; blade elliptical to obovate, (2–)4–10(–16) cm × (1–)2–5(–7) cm, cuneate to rounded and often unequal-sided at base, usually short-acuminate at apex, glabrous above, densely hairy below especially on midrib and veins, pinnately veined with 4–7(–8) pairs of lateral veins. Inflorescence an axillary umbel-like cyme, c. 35-flowered; peduncle usually fused with petiole. Flowers bisexual, zygomorphic, (4–)5-merous, white, fragrant; pedicel up to 3(–6) mm long; sepals unequal, erect, c. 1 mm × 1 mm; petals united with stamens into a tube, unequal, up to 2.5 mm long; fertile stamens 2(–3), sterile stamens 1–3; ovary superior, (2–)3-celled, style slender, up to 3 mm long, (2–)3-lobed at apex. Fruit an ovoid to ellipsoid drupe c. 5 mm long, dehiscent, 1–3-seeded. Seeds ellipsoid, 3–4 mm long.

Tapura is restricted to tropical America and Africa, and comprises nearly 30 species of which 7 are found in Africa.



Tapura fischeri – wild

Ecology *Tapura fischeri* occurs in the understorey of lowland forest, up to 1300 m altitude. In West Africa it is found in drier types of semi-deciduous forest, but it is also common in riverine forest.

Genetic resources and breeding *Tapura fischeri* is widespread in most of mainland tropical Africa and as it is not heavily exploited it is not threatened by genetic erosion. However, the other African *Tapura* spp. have comparatively small areas of distribution in either West or Central Africa.

Prospects The wood of *Tapura fischeri* will remain important for local use, but it does not seem to have prospects for commercial exploitation because the logs are usually too small and the trees occur too scattered in the forest.

Major references Breteler, 1991; Burkill, 1985.

Other references Breteler, 1988; Lovett et al., 2007; Schwikkard, Mulholland & Hutchings, 1998.

Authors C.H. Bosch

TERMINALIA IVORENSIS A.Chev.

Protologue Vég. util. Afr. trop. Franç. 5: 152 (1909).

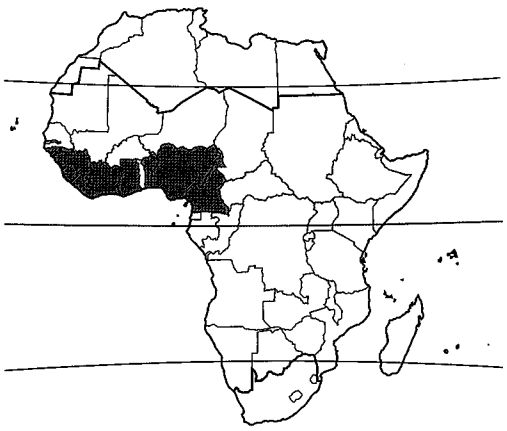
Family Combretaceae

Chromosome number $2n = 24$

Vernacular names Black afara, black barked terminalia, black bark, yellow terminalia, satinwood, shingle wood (En). Framiré, chêne d'Afrique (Fr). Mwalambe (Sw).

Origin and geographic distribution *Terminalia ivorensis* occurs from Guinea-Bissau east to western Cameroon. It has been planted in many tropical countries as a promising timber plantation species, e.g. in Senegal, Uganda, Tanzania, India, Malaysia, the Solomon Islands, Fiji, Costa Rica, Panama and Brazil.

Uses The wood, usually traded as 'framiré' or 'idigbo', is valued for light construction, door



Terminalia ivorensis – wild

and window frames, joinery, furniture, cabinet work, veneer and plywood. It is suitable for flooring, interior trim, vehicle bodies, sporting goods, boxes, crates, matches, turnery, hardboard, particle board and pulpwood. It is used locally for house construction, planks, roof shingles, fencing posts, dug-out canoes, drums and mortars. Mixed with other woods, it is suitable for paper making. The wood is also used as firewood and for charcoal production; offcuts are highly valued in Ghana for making charcoal.

The tree is used in agroforestry systems as a shade tree in cocoa, banana and coffee plantations, and it is also planted as roadside tree. A yellow dye is present in the bark and wood; it is used traditionally to dye clothes and fibres for basketry. Bark decoctions or powdered bark are used in traditional medicine to treat wounds, sores, ulcers and haemorrhoids, against malaria and yellow fever, and as an anodyne in cases of rheumatism and muscular pain. Leaf sap is applied to cuts and against colds, and is also taken, together with bark decoctions, as an enema to treat gonorrhoea and kidney complaints, and as an aphrodisiac.

Production and international trade In 1960 Africa exported about 28,000 m^3 of logs (12,000 m^3 from Côte d'Ivoire, 10,500 m^3 from Ghana, 4000 m^3 from Nigeria and 800 m^3 from Cameroon) and about 13,000 m^3 of sawn wood (mainly from Ghana). In 1974 Côte d'Ivoire exported 132,000 m^3 of logs and in 1983 still 103,000 m^3, but the amount decreased to 2800 m^3 in 1996. In 2005 Côte d'Ivoire exported 35,000 m^3 of framiré sawnwood at an average price of US$ 439/m^3. In Ghana the annual export of *Terminalia ivorensis* logs was estimated at 19,500 m^3 in 1998, but the export volumes declined to 3300 m^3 in 2001 and about 2000 m^3/year for all wood products together after 2001.

Properties The heartwood is yellowish brown to pale pinkish brown and not clearly demarcated from the slightly paler, 2–5 cm wide sapwood. The grain is usually straight, sometimes slightly interlocked, texture moderately coarse. The wood is sometimes irregularly brown striped.

The wood is moderately lightweight to medium-weight, with a density of 410–670 kg/m^3 at 12% moisture content. It air dries well and rapidly, with little degrade, provided there is good air circulation. The rates of shrinkage are moderate, from green to oven dry 2.9–4.8% radial and 4.5–7.4% tangential.

At 12% moisture content the modulus of rupture is 79–124 N/mm^2, modulus of elasticity 7840–12,350 N/mm^2, compression parallel to grain 32–75 N/mm^2, shear 4–12 N/mm^2, cleavage 9.5–20 N/mm, Janka side hardness 3330–3740 N, Janka end hardness 5030–5820 N and Chalais-Meudon side hardness 1.2–3.2.

The wood is easy to saw and work with both hand and machine tools; the blunting effect on cutting edges is slight. Quarter-sawn wood may tear slightly in planing operations. The wood finishes well when a filler is used. It stains, polishes and turns well, and has good nailing and screwing properties. It glues satisfactorily, although gluing must be done with care because the exudates from the wood are acidic. It contains yellowish tannins, which may cause staining under humid conditions and in contact with iron. The wood can be made into good-quality veneer, also by rotary peeling. The steam-bending properties are poor.

The wood is considered fairly durable, but it may be attacked by pin-hole borers, powder-post beetles, longhorn beetles and termites; it is fairly resistant to fungi. The heartwood is resistant, the sapwood moderately resistant to preservatives. The wood dust may cause irritation to the skin and respiratory tracts of wood workers.

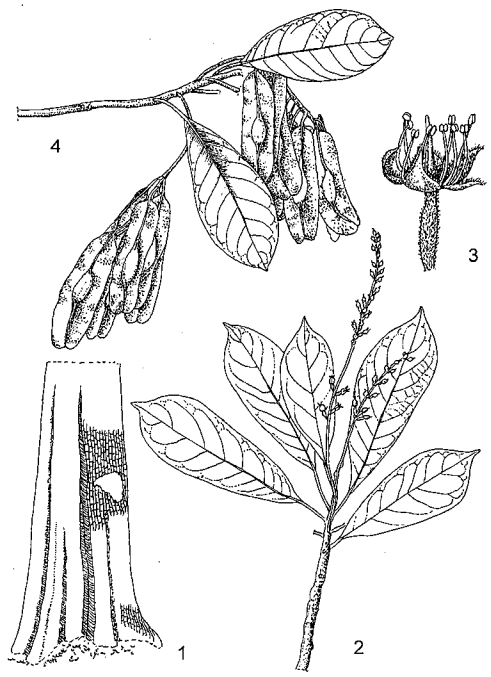
The wood contains 39–41% cellulose, 31–32% lignin, 12–14% pentosan, 0.3–0.6% ash and very small amounts of silica. The solubility is 7.5–10.3% in alcohol-benzene, 2.2–4.5% in hot water and 13.7–14.9% in 1% NaOH solution.

Anti-inflammatory and anti-arthritic properties of *Terminalia ivorensis* bark have been demonstrated in tests with rats. Extracts re-

duced carrageenan-induced paw oedema as well as adjuvant-induced arthritis. Moreover, they effectively checked diarrhoea produced by arachidonic acid and castor oil. Terminolic acid, ellagic acid, sericic acid, quercetin and glycyrrhetinic acid were isolated from the chloroform and methanol extracts. Ethanol extracts of the roots showed distinct trypanocidal activity against both drug-sensitive as well as multi-drug-resistant strains of *Trypanosoma congolense* and *Trypanosoma brucei*.

Adulterations and substitutes In Europa and the United States the wood of *Terminalia ivorensis* is sometimes used as a substitute of oak (*Quercus* spp.).

Description Deciduous medium-sized to large tree up to 45(–50) m tall; root system usually consisting of a taproot and several strong superficial lateral roots; bole branchless for up to 30(–35) m, usually straight and cylindrical, but often slightly fluted or angular near the base, up to 120(–170) cm in diameter, sometimes with small and thick buttresses up to 1 m high; bark surface smooth and grey in young trees, but with deep longitudinal furrows and dark brown to black in older trees, inner bark fibrous, yellow, darkening upon exposure; branches in whorls, spreading; young twigs rusty-brown short-hairy. Leaves arranged spirally, clustered near ends of branchlets, simple and entire; stipules absent; petiole 7–15(–20) mm long, slender; blade obovate or narrowly obovate, 5–15 cm × 2.5–5(–6.5) cm, cuneate at base, short-acuminate at apex, leathery, glabrous, pinnately veined with 6–9 pairs of lateral veins. Inflorescence an axillary spike 7–15 cm long, slender; peduncle 2–4 cm long, whitish short-hairy. Flowers bisexual or male, regular, 5-merous, pale yellow; receptacle spindle-shaped, 1.5–5 mm long; sepals triangular, c. 2 mm long; petals absent; stamens 10, free, 3–5 mm long; disk annular, densely woolly hairy; ovary inferior, 1-celled, style 3–3.5 mm long, glabrous. Fruit a winged nut, oblong in outline, 5–8(–10) cm × 2–4.5(–6.5) cm including the wing, nut c. 1.5 cm × 1 cm, brownish short-hairy, indehiscent, 1-seeded. Seedling with epigeal germination; hypocotyl 4–7.5 cm long, epicotyl c. 1 cm long; cotyledons leafy, spreading; first 2 leaves alternate.



Terminalia ivorensis – 1, base of bole; 2, flowering branch; 3, flower; 4, fruiting branch. Redrawn and adapted by Iskak Syamsudin

Other botanical information *Terminalia* is a pantropical genus of about 200 species. In tropical mainland Africa about 30 species occur naturally, in Madagascar about 35.

Anatomy Wood-anatomical description (IAWA hardwood codes):
Growth rings: (1: growth ring boundaries distinct); (2: growth ring boundaries indistinct or absent). Vessels: 5: wood diffuse-porous; 13: simple perforation plates; 22: intervessel pits alternate; 23: shape of alternate pits polygonal; 26: intervessel pits medium (7–10 μm); 27: intervessel pits large (≥ 10 μm); 29: vestured pits; 30: vessel-ray pits with distinct borders; similar to intervessel pits in size and shape throughout the ray cell; 42: mean tangential diameter of vessel lumina 100–200 μm; (43: mean tangential diameter of vessel lumina ≥ 200 μm); 46: ≤ 5 vessels per square millimetre; 47: 5–20 vessels per square millimetre. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 69: fibres thin- to thick-walled. Axial parenchyma: 78: axial parenchyma scanty paratracheal; 79: axial parenchyma vasicentric; (80: axial parenchyma aliform); (81: axial parenchyma lozenge-aliform); 83: axial parenchyma confluent; 84: axial parenchyma unilateral paratracheal; 92: four (3–4) cells per parenchyma strand; 93: eight (5–8) cells per parenchyma strand. Rays: 97: ray width 1–3 cells; 104: all ray cells procumbent; 106: body ray cells procumbent with one row of upright

and/or square marginal cells; 115: 4–12 rays per mm. Secretory elements and cambial variants: 131: intercellular canals of traumatic origin.
(E. Uetimane, H. Beeckman & P. Gasson)

Growth and development Seedlings grow rather slowly immediately after germination, but after a few months growth accelerates. In medium-sized to large gaps in the forest, young trees may reach 17 m tall and 25 cm in bole diameter 8 years after germination. In Côte d'Ivoire planted trees reached after 20 months a mean height of 2.9–4.9 m, but a maximum height of 9 m, and 3–6 cm in bole diameter. Trees of 22 years old reached 36.5 m in height and 75 cm in bole diameter, but more normal bole diameter increments are 1.5–2.5 cm/year. Studies in plantations in Nigeria showed that mean annual bole diameter increment varied from 19 mm in trees of 6 years old to 5 mm in trees of 23 years old and 2 mm in trees of 52 years old. However, diameter growth is strongly dependent from silvicultural practices. Height growth was most rapid in the first 10 years and decreased steadily afterwards, whereas mean annual wood volume increment reached a peak of 15.5 m^3/ha after 10 years, steadily decreasing to 6.9 m^3/ha 51 years after planting.
The trees are self-pruning, soon developing long and clear boles. They are leafless for 2–3 months in the dry season. Young trees may start flowering and fruiting when 5 years old. New leaves and flowers appear at the beginning of the rainy season, and flowering may continue for 2–3 months from April to July. In each inflorescence the lower flowers are bisexual and the upper functionally male. The flowers are pollinated by insects such as small butterflies and flies. In plantations in Nigeria the flies *Chrysomaya chlorophyga* and *Lucilia euprina* were identified as the major pollinators, with the peak of visiting flies just before noon. Fruits ripen towards the end of the dry season, in Ghana from December to January. They are usually produced annually and in large quantities, but often they are attacked by fungi and insects, whereas natural abscission is also common, probably correlated with adverse temperatures. The fruits can remain for a long time on the tree, but are eventually dispersed by wind.
Terminalia ivorensis is associated with vesicular arbuscular mycorrhizae.

Ecology *Terminalia ivorensis* occurs in evergreen forest and moist semi-deciduous forest, where larger trees are most common in lower-lying localities. It is most abundant in the transition zone between humid semi-deciduous forest and evergreen forest. In Ghana it seems most common along roadsides. It is found in regions with an annual rainfall of 1250–3000 mm and a dry season up to 3 months, and mean annual temperatures of 23–27°C. *Terminalia ivorensis* occurs on a wide range of soil types, from sandy to clayey-loamy and lateritic. It does not tolerate prolonged waterlogging, and is vulnerable to fire.

Propagation and planting *Terminalia ivorensis* is classified as a pioneer species, with seedlings most commonly found along roadsides and on abandoned farmland, in Côte d'Ivoire sometimes abundantly in cocoa plantations. Regeneration is often sparse, but locally secondary forest can be dominated by young trees of *Terminalia ivorensis*. One kg contains 5500–6500 fruits, and about 10,000 de-winged nuts. The seeds show some dormancy, and the germination rate of fresh seed is often low. Soaking in water increases the germination rate. Alternate soaking and drying in the sun for one week improves germination up to a rate of 40%, and when these pre-treated seeds are mixed with mulch and kept in damp sacks in the sun for another 2 weeks, the germination rate can be raised to 80%. Scarification of seeds is another method of attaining high germination rates. Dipping for 3 hours in sulphuric acid, followed by 24 hours in cellulase solution and then 5 days in gibberellic acid gave the best germination results. At room temperature, seeds can be stored for up to 4 months, but in airtight containers stored below 5°C they may remain viable for up to 1 year. Germination starts 2–7 weeks after sowing. Seedlings are susceptible to drought, and under natural conditions are most common near streams and seasonal swamps. In the nursery, they are usually slightly shaded until they are 2 months old. They often remain in the nursery for 4 months.
Stumps or striplings can be used for planting out, usually prepared from 12–15-months-old plants, but these should be well protected against desiccation. Stumps should have a stem diameter of at least 13 mm, and striplings should be 120–180 cm long. Plantations established from container plants showed better results than those established from stumps and striplings, probably because of the damage done to the taproot. Methods for micropropagation have been developed using nodules excised

from 6-year-old plants.
Trees are planted in spacings of 3 m × 3 m to 5 m × 10 m. In Nigeria optimum spacing has been suggested to be 4–5 m × 4–5 m. In Côte d'Ivoire 10,600 ha has been planted with *Terminalia ivorensis* between 1966 and 1994.

Management In general, adult trees of *Terminalia ivorensis* occur scattered in the forest, with low densities. In western Cameroon an average density of 0.2 tree with a minimum bole diameter of 60 cm per ha has been recorded, with an average wood volume of 1.9 m^3/ha.
In the nursery it has been recommended to apply 0.5 g of an inorganic fertilizer to seedlings to promote both height growth and collar diameter growth. In experiments in Nigeria it was found that the application of ammonium sulphate at 100 ppm and NPK 15:15:15 at 50–100 ppm showed best results in height growth of seedlings. In plantations weeding is necessary for 2 years after planting. The first thinning should be done after 4–5 years when trees have reached a height of about 11 m, and the second after 8–9 years. It has been recommended to harvest plantation trees after 32 years with 3 thinnings, or after 40 years with 4 thinnings. In plantations trees often suffered considerable die-back. In the 1960s in Ghana, the die-back in 4–30-year-old plantations of *Terminalia ivorensis*, which was then the most widely planted timber species, was so severe that it was decided to abandon further planting. Trees can be coppiced.

Diseases and pests Plantations in Côte d'Ivoire, Ghana, Nigeria and Cameroon have been defoliated by larvae of the moth *Epicerura* spp., which may cause considerable decrease of the yield and massive die-back. Spraying with the insecticides decamethrin and thiocyclam hydrogen oxalate at concentrations of 900 g and 300 g active ingredient per ha, respectively, showed good results, but a virus disease attacking the pest was also identified. Fruits are often severely attacked by weevils of the genera *Nanophyes* and *Auletobius*.

Harvesting Older trees often develop boles with brittle heart.

Yield The total wood volume of plantations of *Terminalia ivorensis* harvested in Côte d'Ivoire at an age of 32 years was estimated at 335 m^3/ha, and when harvested at an age of 40 years 350 m^3/ha. In natural forest a tree of 60 cm in bole diameter yields about 3.7 m^3 of wood, 6.6 m^3 when 80 cm in diameter and 10.3 m^3 when 100 cm in diameter.

Handling after harvest Freshly harvested logs float in water and can thus be transported by river.

Genetic resources *Terminalia ivorensis* has been classified as vulnerable in the IUCN Red list because of its occurrence in low densities, often poor regeneration and considerable exploitation locally. In Côte d'Ivoire some seed orchards have been planted since 1994.

Breeding Selection and breeding programmes for *Terminalia ivorensis* started in the 1960s, aiming at trees with superior growth rates and bole form.

Prospects The fair wood quality, including durability, high growth rate, straight bole and self-pruning ability make *Terminalia ivorensis* suitable for planting in timber plantations. However, the severe die-back in many plantations stopped the establishment of larger-scale plantations in the 1970s. Studies indicate that in Ghana the problems were caused by severe drought in combination with unfavourable sites, and the negligence of thinning and other appropriate silvicultural practices. Recommendations for successful new plantations include planting on oxysol-ochrosol intergrade soils, planting in mixtures with other timber species, especially line planting, and appropriate spacing and thinning. Trials demonstrated that under suitable growing conditions and proper management *Terminalia ivorensis* plantations are capable to produce trees with 60 cm bole diameter in 30 years.

Major references Boateng, 1992; Bolza & Keating, 1972; Burkill, 1985; CAB International, 2005; CTFT, 1974a; Hawthorne, 1995; Liben, 1983; Takahashi, 1978; Voorhoeve, 1979; World Agroforestry Centre, undated.

Other references Abayomi, 1993; Adewunmi et al., 2001; Akoègninou, van der Burg & van der Maesen (Editors), 2006; ATIBT, 1986; Aubréville, 1959c; CIRAD Forestry Department, 2003; Corbineau & Côme, 1993; Hawthorne, 1998; Hawthorne & Jongkind, 2006; Irvine, 1961; Iwau & Anyanwu, 1982; Katende, Birnie & Tengnäs, 1995; Mbakwe, 1990; Neuwinger, 2000; Normand & Paquis, 1976; Oni, 1990; Phongphaew, 2003; Siepel, Poorter & Hawthorne, 2004; Sosef et al., 1995; Vivien & Faure, 1985.

Sources of illustration Liben, 1983; Vivien & Faure, 1985; Voorhoeve, 1979.

Authors E.G. Foli

TERMINALIA SAMBESIACA Engl. & Diels

Protologue Engl., Monogr. afrik. Pflanzen-Fam. 4: 13, t. 4 (1900).

Family Combretaceae

Synonyms *Terminalia aemula* Diels (1907).

Vernacular names River terminalia, river cluster-leaf (En). Mbombaro, mkulungo, mpululu, mwangati (Sw).

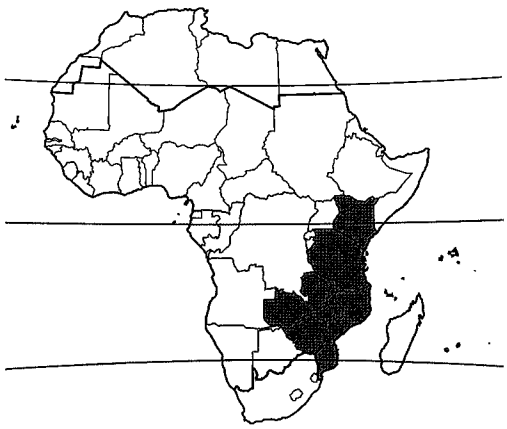
Origin and geographic distribution *Terminalia sambesiaca* occurs from south-eastern Kenya south to Zambia, northern Zimbabwe and Mozambique.

Uses The wood is used for building poles, ship masts, stools, mortars, tool handles and beehives. It is suitable for construction, flooring, joinery, interior trim, bridge decking, ship building, furniture, cabinet work, sporting goods, toys, novelties, railway sleepers, mine props, veneer and plywood. It is also used as firewood and for charcoal production.

In traditional medicine the leaves are used to treat stomach-ache and infertility in women, whereas bark and leaf decoctions are applied to treat fever, colds, cancer, stomach ulcers and appendicitis. Powdered root bark is mixed with porridge and eaten to treat bloody diarrhoea.

Properties The heartwood is yellow with brownish stripes on quarter-sawn surfaces, darkening rapidly to yellowish brown or greenish brown, and distinctly demarcated from the cream-coloured, up to 6 cm wide sapwood. The grain is interlocked, texture fine and even.

The wood is moderately heavy, with a density of 750–820 kg/m^3 at 12% moisture content. It air dries fairly rapidly, with little degrade. The rates of shrinkage are moderate, from green to 12% moisture content 2.2% radial and 3.7% tangential. Boards of 2.5 cm thick air dry in 6 weeks, and 5 cm thick boards in 3 months. Surface checking and some distortion may occur, especially in kiln drying. Once dry, the wood is moderately stable in service. At 12% moisture content, the modulus of rupture is 93 N/mm^2, modulus of elasticity 12,740 N/mm^2, compression parallel to grain 60 N/mm^2, shear 15 N/mm^2 and Janka side hardness 6360 N.



Terminalia sambesiaca – wild

The wood is moderately difficult to saw and work with hand and machine tools. It often finishes well, but the use of a filler has been recommended to produce good surfaces. The wood holds nails well, but pre-boring is recommended. The heartwood is moderately durable, being susceptible to termite attack; the sapwood is susceptible to *Lyctus* attack. The heartwood is resistant to impregnation with preservatives, but the sapwood is permeable.

Methanol extracts of the roots showed marked antibacterial activity against *Enterobacter aerogenes*, *Micrococcus luteus*, *Pseudomonas aeruginosa*, *Sarcina* sp., *Salmonella typhi*, *Shigella boydii*, *Staphylococcus aureus* and *Staphylococcus epidermidis*, as well as distinct antifungal activity against *Candida albicans*, *Candida glabrata* and *Cryptococcus neoformans*. Bark extracts also showed antibacterial activity and leaf extracts antifungal properties against *Candida albicans* and *Cryptococcus neoformans*. Antifungal activity was found especially in polar fractions of the extract and might be due to the presence of tannins. Root extracts showed strong cytotoxic effects against several human cancer cell lines, e.g. against HeLa cervical cancer cells, T24 bladder cancer cells and BBCE endothelial cells.

Botany Small to fairly large tree up to 40 m tall; bole branchless for up to 18 m, straight or crooked, up to 90 cm in diameter, often slightly buttressed, old trees often with bottle-shaped buttresses up to 4 m high; bark surface greyish to dark brown or nearly black, smooth to slightly grooved, inner bark yellowish with brown streaks; crown layered, with horizontal branches; branchlets with fibrous bark, hairy when young. Leaves arranged spirally, clustered near ends of branchlets, simple and usually entire; stipules absent; petiole up to 4 cm long, hairy; blade elliptical to elliptical-obovate, 7–18 cm × 3–13 cm, cuneate to rounded at base, acuminate at apex, papery, hairy especially on the veins below, pinnately veined with 8–11 pairs of lateral veins. Inflorescence an axillary spike 6–15 cm long, short-hairy; peduncle up to 6 cm long. Flowers bisexual or

male, regular, 4–5-merous, whitish sometimes pinkish tinged; receptacle spindle-shaped, c. 3 mm long, hairy; sepals triangular, c. 1.5 mm long; petals absent; stamens usually 10, free, c. 5 mm long; disk annular, hairy; ovary inferior, 1-celled, style 3–5 mm long. Fruit a winged nut, elliptical in outline, 5–7(–9) cm × 2–3(–4.5) cm including the wing, stipe up to 1.5 cm long, reddish brown, finely hairy, indehiscent, 1-seeded.

Terminalia is a pantropical genus of about 200 species. In tropical mainland Africa about 30 species occur naturally, in Madagascar about 35. *Terminalia sambesiaca* has been confused with *Terminalia kilimandscharica* Engl., which differs in being a small tree and usually having smaller, less distinctly acuminate and more permanently hairy leaves.

It has been recorded that *Terminalia sambesiaca* grows rapidly. Annual elongation of the bole results in a layered crown. Flowering usually occurs in December–January. The flowers have a strong and unpleasant smell, and are probably pollinated by flies. Fruits ripen 2–4 months after flowering.

Ecology *Terminalia sambesiaca* occurs in rainforest, dry evergreen forest and riverine forest, less often in savanna woodland and on rocky hills, from sea-level up to 850 m altitude.

Genetic resources and breeding Although *Terminalia sambesiaca* is fairly widespread, it is in most regions rather uncommon and larger specimens occur mainly in lowland evergreen forest and riverine forest.

Prospects Although *Terminalia sambesiaca* has been reported to be an excellent timber tree, very little is known about its growth rates, propagation and possibilities for establishing plantations. The strong antifungal activity of the root against *Cryptococcus neoformans* makes *Terminalia sambesiaca* a valuable medicinal plant in East and southern Africa, where AIDS-related cryptococcal infections are common. Further investigations on the antimicrobial activity against a panel of bacteria causing serious infections and isolation of the active compounds are warranted. Activity-guided isolation of compounds responsible for the anti-cancer activity of the root extract seems also worthwhile.

Major references Bolza & Keating, 1972; Bryce, 1967; Fyhrquist, 2007; Takahashi, 1978.

Other references Beentje, 1994; Coates Palgrave, 1983; Exell, 1978; Fyhrquist et al., 2002; Fyhrquist et al., 2004; Fyhrquist et al., 2006; Lovett et al., 2007; Neuwinger, 2000; Wickens, 1973.

Authors R.H.M.J. Lemmens

TERMINALIA SERICEA Burch. ex DC.

Protologue Prodr. 3: 13 (1828).

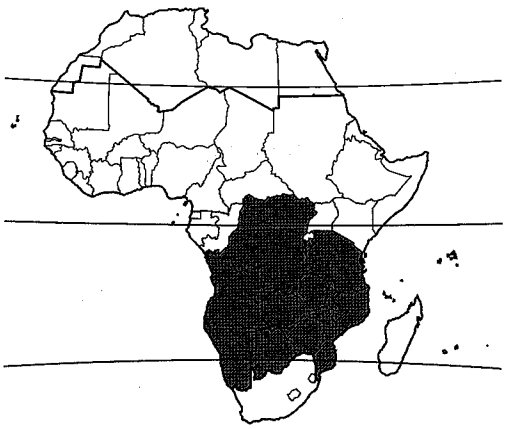
Family Combretaceae

Vernacular names Silver terminalia (En).

Origin and geographic distribution *Terminalia sericea* occurs from southern DR Congo and Tanzania south to Namibia, northern South Africa and Swaziland.

Uses The tree boles of *Terminalia sericea* are highly valued as poles for the construction of houses and huts, e.g. in south-western Zambia and KwaZulu-Natal province in South Africa. They are said to last for at least 5 years, and are also considered valuable for fencing. The wood is used for furniture, tool handles, bows, beehives and ox yokes. It is suitable for flooring, joinery, interior trim, ship building, vehicle bodies, mine props, sporting goods, agricultural implements, railway sleepers and turnery. It is popular as firewood and for charcoal production.

The bark is used as rope, often to tie together poles for huts, and it provides a yellow dye and tannin, whereas the leaves are used as mordant in dye bathes. The flexible roots are used as cross-laths in huts. Root extracts or infusions are used in traditional medicine to treat venereal diseases, diarrhoea, dysentery, colic, pneumonia, cough, skin diseases, schistosomiasis, gonorrhoea and problems with menstruation, and applied as an eye wash to treat trachoma and ophthalmia. Pulverized bark is applied to wounds and taken to treat diabetes.



Terminalia sericea – wild

Leaf extracts serve to treat diarrhoea and stomach complaints, and a leaf infusion to treat cough. Pulverized leaves are applied as a dressing to wounds. The twig juice, leaves and roots are used in Namibia and Botswana in mixtures with other plants and larvae of beetles to prepare arrow poison. The tree produces a gum that is eaten by local people. In the rainy season edible caterpillars commonly feed on the leaves. The flowers provide nectar for honey bees, whereas the leaf hairs have been used for glazing pottery. The leaves are browsed by cattle; *Terminalia sericea* contributes significantly to cattle diet during the hot and dry season in the northern Kalahari desert. The tree has ecological values as soil improver and for erosion control. It is locally regarded as sacred.

Properties The heartwood is dull yellow with brownish stripes, darkening with age, and distinctly demarcated from the narrow sapwood. The grain is usually straight, occasionally interlocked, texture moderately coarse and uneven.

The wood is heavy, with a density of 840–920 kg/m^3 at 12% moisture content. It air dries fairly rapidly, with moderate checking and distortion. The rates of shrinkage are moderate, from green to oven dry 3.8% radial and 6.4% tangential. At 12% moisture content, the modulus of rupture is 91 N/mm^2, modulus of elasticity 11,760 N/mm^2, compression parallel to grain 58 N/mm^2, shear 10.5 N/mm^2, Janka side hardness 9200 N and Janka end hardness 11,065 N.

The wood works well with both hand and machine tools. It planes and finishes easily, although rather dull surfaces are produced. The heartwood is fairly durable, but the sapwood is susceptible to *Lyctus* attack. The wood is resistant to impregnation by preservatives. The sawdust may cause inflammations of the respiratory organs and skin.

The pentacyclic triterpenoid sericic acid has been isolated from the roots, as well as its glycoside sericoside. Root extracts and sericic acid have anti-inflammatory and wound-healing properties, and showed antibacterial and antifungal activities. Root extracts are particularly active against the bacteria *Staphylococcus aureus* and *Streptococcus pyogenes* and against the fungi *Candida albicans*, *Candida glabrata* and *Cryptococcus neoformans*. Sericoside has anti-inflammatory activity, whereas strong lipolytic activity has also been suggested. Anolignan B is another bioactive compound isolated from the roots. It showed activity against both gram-positive and gram-negative bacteria, as well as anti-inflammatory activity. The results from tests support the ethnomedical use of the roots. However, caution is needed because in Tanzania several cases of death after application of root extracts have been recorded. In tests root extracts were toxic to brine shrimps. Root extracts showed strong cytotoxic effects against several human cancer cell lines. Methanol extracts of the leaves showed strong in-vitro activity against HIV-1 reverse transcriptase.

The nutritive value of *Terminalia sericea* leaves is rather low, with a crude protein content of about 11.5%; the tannin content of the leaves is low.

Botany Deciduous shrub or small to medium-sized tree up to 16(–23) m tall; bole branchless for up to 8 m, straight or crooked, up to 50(–100) cm in diameter; bark surface cream-coloured to grey-brown, deeply grooved; crown layered, with horizontal branches; branchlets red-brown to purplish, with peeling bark, silky hairy when young. Leaves arranged spirally, clustered near ends of branchlets, simple and entire; stipules absent; petiole up to 1.5 cm long; blade narrowly elliptical-obovate, 5–13 cm × 1–4.5 cm, cuneate at base, rounded to short-acuminate at apex, silvery silky hairy especially when young, pinnately veined with 5–8(–13) pairs of indistinct lateral veins. Inflorescence an axillary spike 5–12 cm long, densely silky hairy; peduncle 2.5–5 cm long. Flowers bisexual or male, regular, 4–5-merous, greenish white; receptacle spindle-shaped, c. 5 mm long; sepals triangular, c. 2 mm long; petals absent; stamens usually 10, free, c. 4 mm long; disk annular, hairy; ovary inferior, 1-celled, style 3–5 mm long. Fruit a winged nut, broadly elliptical in outline, 3–4 cm × 1.5–2.5 cm including the wing, stipe up to 0.5 cm long, pinkish or purplish brown, finely hairy, indehiscent, 1-seeded.

Terminalia sericea grows slowly. Annual elongation of the bole results in a layered crown. Flowers develop together with young leaves, usually in September–November. The flowers have a strong and unpleasant smell, and are probably pollinated by flies. Fruits ripen 3–5 months after flowering, but they may remain on the tree for up to 1 year.

Terminalia is a pantropical genus of about 200 species. In tropical mainland Africa about 30 species occur naturally, in Madagascar about 35. It has been suggested that *Terminalia seri-*

cea may hybridize with *Terminalia kaiserana* F.Hoffm. and *Terminalia trichopoda* Diels. In some regions intermediate specimens are fairly common.

The wood of *Terminalia prunioides* C.Lawson is used for similar purposes as that of *Terminalia sericea*: for building huts, houses and ships, and for implement handles. It is very heavy, with a density of about 1100 kg/m^3 at 12% moisture content, and very hard and exceptionally durable. It is also used as firewood. In southern Africa the bark is chewed to treat cough, sore throat and stomach-ache, the roots are chewed to treat colds and a root decoction is taken to treat constipation, cough and colds. *Terminalia prunioides* is a shrub or small tree up to 15 m tall occurring in open woodland from Somalia south to Namibia, Mozambique and northern South Africa. The boles of *Terminalia stuhlmannii* Engl., a small tree up to 12 m tall occurring in woodland and wooded grassland from Tanzania south to Botswana, Zimbabwe and Mozambique, are also used for hut building.

Ecology *Terminalia sericea* occurs in open woodland and wooded grassland, often together with *Brachystegia* spp., at 450–1300 m altitude in areas with moderate rainfall. It is often common along wetlands, sometimes forming almost pure stands, and may be dominant in woodland degraded by fire. It seems to prefer sandy and deep, well-drained soils, and can grow on very poor soils that are generally not suitable for agriculture.

Management It is recommended to remove the wing of the fruit before sowing. The bole is often crooked, but lopping may result in straight boles. The preferred length of the poles used for house building in Zambia is 2.5–3 m. In KwaZulu-Natal province in South Africa, the mean diameter of poles used as main posts in houses is 6 cm and the mean length 2.2 m, and when used as roof laths 4 cm and 2.6 m, respectively. In Zambia the bark is removed and the poles are soaked in water for a few weeks, which reputedly increases the durability. The trees can be coppiced, and harvest intervals for fuelwood poles have been recommended as 4–9 years.

In the rainy season the leaves are commonly attacked by large numbers of caterpillars. The twigs often have galls. The fruits may be deformed by parasites, becoming slender, twisted and hairy.

Genetic resources and breeding *Terminalia sericea* is widespread and in many regions common, and not liable to genetic erosion. On the contrary, it is often regarded as a major encroaching species, which has adverse effects on cattle production because it prevents the growth of grass.

Prospects Although *Terminalia sericea* is usually of too small size and grows too slowly to be of value to the international timber market, it is certainly important for wood production for local application, especially for building houses. The presence of anti-inflammatory and wound-healing compounds in the roots deserves more attention. Sericoside has already been tested in topical emulsion based formulations with promising results. In addition to the uses of the wood and in local medicine, *Terminalia sericea* is important for forage supply in the dry season, firewood production and soil protection, making it a true multipurpose species that deserves more research attention.

Major references Bingham, 1996; Neuwinger, 1998a; Palmer & Pitman, 1972–1974; van Wyk & Gericke, 2000; World Agroforestry Centre, undated.

Other references Bolza & Keating, 1972; Chilufya & Tengnäs, 1996; Coates Palgrave, 1983; Exell, 1978; Gaugris et al., 2007; Leger, 1997; Moshi & Mbwambo, 2005; Neuwinger, 2000; Takahashi, 1978; Wickens, 1973.

Authors R.H.M.J. Lemmens

TERMINALIA SUPERBA Engl. & Diels

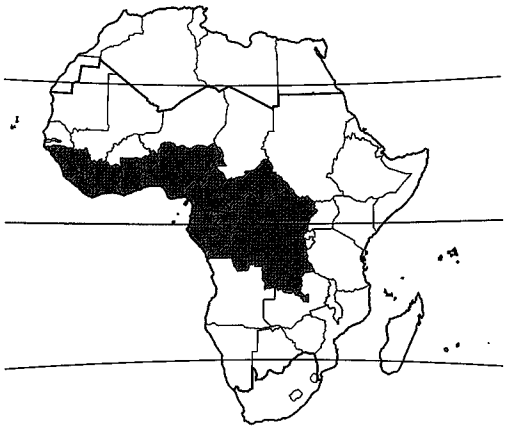
Protologue Engl., Monogr. afrik. Pflanzen-Fam. 4: 26, t. 14B (1900).

Family Combretaceae

Vernacular names Limba, white afara, shingle wood, white mukonja, Congo walnut (En). Limba, fraké, noyer du Mayombe (Fr). Limbo (Po). Mwalambe (Sw).

Origin and geographic distribution *Terminalia superba* is widespread in West and Central Africa, from Guinea Bissau east to DR Congo and south to Cabinda (Angola). It has been planted in many tropical countries outside the natural distribution area as a promising timber plantation species, e.g. in Uganda, Tanzania, Zimbabwe, Madagascar, Indonesia, Malaysia, the Philippines, the Solomon Islands, Fiji, Australia, Brazil and Argentina.

Uses The wood, usually traded as 'limba', 'afara', 'ofram' or 'fraké', is valued for interior joinery, door posts and panels, mouldings, furniture, office-fittings, crates, matches, and particularly for veneer and plywood. It is suitable



Terminalia superba – wild

for light construction, light flooring, ship building, interior trim, vehicle bodies, sporting goods, toys, novelties, musical instruments, food containers, vats, turnery, hardboard, particle board and pulpwood. It is used locally for temporary house construction, planks, roof shingles, canoes, paddles, coffins, boxes and domestic utensils. It is suitable for paper making, although the paper is of moderate quality. The wood is also used as firewood and for charcoal production.

A yellow dye is present in the bark; it is used traditionally to dye fibres for matting and basketry. The bark is also used for dyeing textiles blackish. Bark decoctions and macerations are used in traditional medicine to treat wounds, sores, haemorrhoids, diarrhoea, dysentery, malaria, vomiting, gingivitis, bronchitis, aphthae, swellings and ovarian troubles, and as an expectorant and anodyne. The leaves serve as diuretic and roots as laxative. In Côte d'Ivoire *Terminalia superba* is occasionally used as a shade tree in cocoa and coffee plantations, and in DR Congo it is used as shade tree in coffee, cocoa and banana plantations.

Production and international trade *Terminalia superba* was one of the major timbers of Africa. In the 1960s Congo exported on average 210,000 m³ of logs per year, but the export declined to 60,000 m³ in 1973 and to only 5000 m³ in 1983. Also in other countries the export increased since the beginning of the 1970s, but declined later, e.g. in Côte d'Ivoire from 50,000 m³ in 1973 to 132,000 m³ in 1983 and to 2300 m³ in 1996, and in Cameroon from 3600 m³ in 1960 to 221,000 m³ in 1997 and 71,000 in 2003. *Terminalia superba* still yields an important export timber with in 2005 a total value on the international market of at least US$ 25 million. The major export countries at present are Côte d'Ivoire, Ghana and Cameroon. In 2005 Côte d'Ivoire exported 21,000 m³ of sawn wood at an average price of US$ 439/m³, and Ghana 24,000 m³ of sawn wood at US$ 286/m³ and 3000 m³ of plywood at US$ 328/m³. In 2006 Ghana exported 20,000 m³ of sawn wood at an average price of US$ 311/m³ and 6000 m³ of plywood at an average price of US$ 454/m³. In 2005 Cameroon exported 17,000 m³ of logs at an average price of US$ 128/m³, 15,000 m³ of sawn wood at an average price of US$ 237/m³ and 3000 m³ of plywood at an average price of US$ 256/m³. In 2006 the same country exported 22,000 m³ of logs at an average price of US$ 211/m³, 13,000 m³ of sawn wood at an average price of US$ 311/m³ and 1000 m³ of plywood at an average price of US$ 228/m³.

Congo and DR Congo also export considerable quantities of *Terminalia superba* timber, but supplies have declined. In 1995 the export from Congo was 10,000 m³ of logs and from DR Congo 3000 m³ of logs and 1000 m³ of sawn wood. In 2003 Congo still exported 1000 m³ of sawn wood at an average price of US$ 265/m³. More recent statistics are not available for both countries.

Properties The heartwood is grey to pale yellow or pinkish white, darkening to pale reddish brown, occasionally with a nearly black inner part. It is not clearly demarcated from the 12–15 cm wide sapwood. The grain is straight to slightly interlocked, texture moderately coarse.

The wood is moderately lightweight to medium-weight, with a density of (370–)430–730 kg/m³ at 12% moisture content. It air dries rapidly with little degrade. The rates of shrinkage are moderate, from green to oven dry 2.0–6.4% radial and 4.4–8.7% tangential. Once dry, the wood is stable in service.

At 12% moisture content the modulus of rupture is 50–133(–157) N/mm², modulus of elasticity (3625–)4700–14,300(–16,660) N/mm², compression parallel to grain 26–67 N/mm², compression perpendicular to grain 8–12 N/mm², shear 4.5–10 N/mm², cleavage 7.5–23.5 N/mm, Janka side hardness 3020 N, Janka end hardness 3420 N and Chalais-Meudon side hardness (0.4–)0.8–4.2.

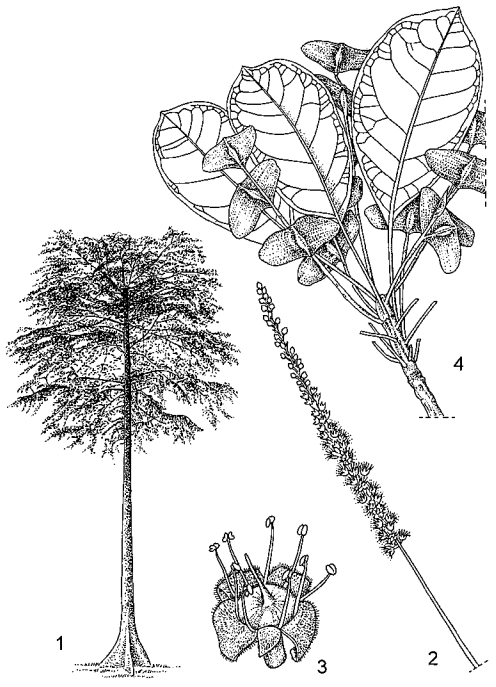
The wood is easy to saw and work with both hand and machine tools; the blunting effect on cutting edges is slight. The wood finishes well, but the use of a filler is necessary. It holds

nails and screws well, but has some tendency to splitting. It glues satisfactorily. The wood can be made into good-quality veneer by slicing as well as rotary peeling. The steam-bending properties are poor.

The wood is not durable, being liable to attacks by pin-hole borers, powder-post beetles, longhorn beetles, termites and marine borers. The heartwood is resistant, the sapwood moderately resistant to preservatives. Wood splinters may cause severe inflammation of the skin, and sawdust allergic reactions to skin and respiratory organs in wood workers. The wood has satisfactory paper-making properties, although the quality of the paper produced is moderate, particularly concerning tearing strength.

The wood contains 40–45% cellulose, 28–35% lignin, 14–17.5% pentosan, 0.9–3.4% ash and very small amounts of silica. The solubility is 1.5–4% in alcohol-benzene, 2.4–8% in hot water and 14.6–21% in 1% NaOH solution.

A methanol extract of the stem bark showed vasorelaxant effects on isolated rat aorta. Stem bark extracts also showed antidiabetic activity in tests with streptozotocin-induced diabetic rats. Ethanol extracts of the roots and stems showed distinct trypanocidal activity against both drug-sensitive as well as multi-drug-resistant strains of *Trypanosoma congolense* and *Trypanosoma brucei*. The bark contains gallic acid and methyl gallate, which showed significant glycosidase inhibition activity.



Terminalia superba – 1, tree habit; 2, inflorescence; 3, flower; 4, fruiting branch.
Redrawn and adapted by Achmad Satiri Nurhaman

Description Deciduous medium-sized to large tree up to 45(–50) m tall; bole branchless for up to 30(–35) m, usually straight and cylindrical, up to 120(–150) cm in diameter, with large, fairly thick, plank-like buttresses up to 5(–8) m high; bark surface smooth and grey in young trees, but shallowly grooved and with elongated, brownish grey scales, inner bark soft-fibrous, pale yellow; crown storied with branches in whorls, spreading; young twigs rusty-brown short-hairy, branchlets with conspicuous rounded scars from fallen leaves. Leaves arranged spirally, clustered near ends of branchlets, simple and entire; stipules absent; petiole (1.5–)3–6(–7) cm long, with 2 glands near apex; blade obovate, (4–)6–17(–20) cm × (2.5–)4–10 cm, cuneate at base, short-acuminate at apex, thinly leathery, glabrous, pinnately veined with 4–7 pairs of lateral veins. Inflorescence an axillary spike 7–20 cm long, slender; peduncle 1–4 cm long, short-hairy. Flowers bisexual or male, regular, usually 5-merous; receptacle spindle-shaped, 1.5–3 mm long; sepals triangular, c. 1.5 mm long; petals absent; stamens usually 10, free, 1.5–3 mm long; disk annular, densely woolly hairy; ovary inferior, 1-celled, style 2–2.5 mm long, sparsely hairy. Fruit a winged nut, transversely oblong-elliptical in outline, 1.5–2.5 cm × 4–7 cm including the wing, nut c. 1.5 cm × 7 mm, golden brown, glabrous, indehiscent, 1-seeded. Seedling with epigeal germination; hypocotyl 3–4 cm long, epicotyl 1.5–2 cm long; cotyledons leafy, spreading; first 2 leaves opposite.

Other botanical information *Terminalia* is a pantropical genus of about 200 species. In tropical mainland Africa about 30 species occur naturally, in Madagascar about 35.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: (1: growth ring boundaries distinct); (2: growth ring boundaries indistinct or absent). Vessels: 5: wood diffuse-porous; 13: simple perforation plates; 22: intervessel pits alternate; 23: shape of alternate pits polygonal; 26: intervessel pits medium (7–10 μm); 27: intervessel pits large (≥ 10 μm); 29: vestured pits; 30: vessel-ray pits with distinct borders;

similar to intervessel pits in size and shape throughout the ray cell; (31: vessel-ray pits with much reduced borders to apparently simple: pits rounded or angular); 43: mean tangential diameter of vessel lumina ≥ 200 µm; 46: ≤ 5 vessels per square millimetre; 47: 5–20 vessels per square millimetre; (58: gums and other deposits in heartwood vessels). Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 69: fibres thin- to thick-walled. Axial parenchyma: 79: axial parenchyma vasicentric; 80: axial parenchyma aliform; 82: axial parenchyma winged-aliform; 83: axial parenchyma confluent; (89: axial parenchyma in marginal or in seemingly marginal bands); 92: four (3–4) cells per parenchyma strand; 93: eight (5–8) cells per parenchyma strand; 94: over eight cells per parenchyma strand. Rays: 96: rays exclusively uniseriate; 104: all ray cells procumbent; (115: 4–12 rays per mm); 116: ≥ 12 rays per mm. Secretory elements and cambial variants: 131: intercellular canals of traumatic origin. Mineral inclusions: (151: styloids and/or elongated crystals).
(E. Uetimane, H. Beeckman & P. Gasson)

Growth and development Growth is rhythmic, resulting in clustered leaves and whorled branches. Annual growth rates of 2.5 m in height have been reported for the first 10 years after planting, but in Ghana trees have reached 14 m in height and 22 cm in bole diameter at an age of 4 years. Under good conditions planted trees may reach a bole diameter of 50 cm in 20 years. In natural forest in the Central African Republic a mean annual bole diameter increment of 9.5 mm has been recorded, in Cameroon 11 mm. The average annual increment in heartwood volume in plantations has been estimated at 14.5 m^3/ha.
The trees are self-pruning, soon developing long and clear boles, up to 16 m long when 12 years old. They are leafless for 2–3 months in the dry season. New leaves and flowers appear at the beginning of the rainy season. Trees may start flowering when the bole is 30 cm in diameter, which can be reached after 6 years. The flowers are visited in the second half of the day by insects such as flies and bees. The age of first fruiting is variable between 15 and 25(–37) years. The fruits ripen 6–9 months after flowering in the dry season and are dispersed by wind. They are usually produced annually and in large quantities. In Central Africa the bark is often removed by elephants.

Ecology *Terminalia superba* is most common in moist semi-deciduous forest, but can also be found in evergreen forest. It occurs up to 1000 m altitude. It is most common in disturbed forest. It is found in regions with an annual rainfall of (1000–)1400–3000(–3500) mm and a dry season up to 4 months, and mean annual temperatures of 23–27°C. *Terminalia superba* prefers well-drained, fertile, alluvial soils with pH of about 6.0, but it tolerates a wide range of soil types, from sandy to clayey-loamy and lateritic. It does not tolerate prolonged waterlogging, but withstands occasional flooding. It is susceptible to fire. *Terminalia superba* is often found in association with *Triplochiton scleroxylon* K.Schum.

Propagation and planting *Terminalia superba* is classified as a pioneer species. It usually regenerates well after forest exploitation. Seedlings are often abundant along roadsides and in medium-sized forest gaps. One kg contains 5000–7000 fruits, and about 8000–10,000 de-winged nuts. The seeds show some dormancy. After collection, fruits should be dried in the sun for a few days. Fresh, sun-dried seeds have a germination rate of up to 90%, decreasing to less than 50% when stored for a year. However, when stored at 2–4°C a germination rate of 40–60% can still be reached after 2 years. Tests in Ghana showed that seeds can best be stored in polyethylene bags at 0–2°C, with a germination rate of 45% after 15 months of storage. Soaking seeds in concentrated sulphuric acid for 15 minutes followed by rinsing them for 15 minutes with water gave the best germination results, but soaking in water for 24 hours also showed good results.
The seeds should be covered by a thin layer of sand. Germination starts 1.5–3(–4) weeks after sowing. Seedlings are susceptible to drought, and should be watered daily. In the nursery, they are usually slightly shaded until they are 2 months old. Inoculation with endomycorrhizae enhances the growth of seedlings by about 25% after 10 weeks. In experiments in Nigeria it was found that the application of ammonium sulphate at 100 ppm and NPK 15:15:15 at 50–100 ppm showed best results in height growth of seedlings.
The seedlings are transplanted after 6–7 weeks when 5–8 cm tall into nursery beds at a spacing of 20 cm × 50 cm. This should be done carefully to avoid damage to the taproot. They often remain in the nursery for at least one year until they have reached a height of about 2 m. Stumps can be used for planting out, usually prepared from 18-months-old plants. They

should be 1 m long and have a stem diameter of at least 10 mm, whereas the taproot should be at least 40 cm long and not be bent at planting. In Guinea and Côte d'Ivoire direct sowing in containers is preferred, plants being ready for planting after 3–4 months; in this way post-planting stress is reduced and early growth is faster. Planting should be done at the beginning of the rainy season. The planting holes should be 40 cm × 40 cm × 40 cm. Establishment rates of over 80% have been recorded. Softwood cuttings taken from the vigorous coppice shoots produced by cutting back young trees rooted in 2 weeks under mist and 50% shadow, with a rooting percentage of 11–100% depending on the degree of rejuvenation. Methods of vegetative multiplication by grafting have been developed. The use of physiologically juvenile scions and young trees seems promising for cloning mature trees.

Trees are planted in spacings of 3 m × 3 m to 12 m × 12 m. In Nigeria optimum spacing has been suggested to be 4–5 m × 4–5 m.

Management In natural forest in Cameroon an average density of 0.4–3.5 *Terminalia superba* tree with a minimum bole diameter of 60 cm per ha has been recorded, with an average wood volume of 3–28 m³/ha. In Côte d'Ivoire 22,000 ha of *Terminalia superba* plantations have been established between 1967 and 1994, and in 1975 in Congo about 6500 ha. The natural forest is usually clear-cut and burned and all remaining vegetation removed, so that seedlings can be planted in full light. Final stocking is usually 12 m × 12 m, and sometimes plantations are established from the beginning at this spacing, and then thinning is not needed. When the initial spacing is closer, the first thinning should be done after 4–6 years when trees have reached a height of about 10 m, the second at a height of about 15 m and the third at 20 m.

Terminalia superba can be planted in pure stand or in mixed stands with other timber species such as *Terminalia ivorensis* A.Chev., *Milicia excelsa* (Welw.) C.C.Berg and *Triplochiton scleroxylon* K.Schum., or on fertile soils with *Khaya* and *Entandrophragma* spp. An experiment conducted in Congo showed that weeds affected tree growth only in the first year, and that the use of a taungya system by intercropping with groundnut, maize, pigeon pea and soya bean reduced weeds and had no adverse effect on tree growth. Mulching in the first year after planting controlled weeds and improved growth of *Terminalia superba*. In Congo *Terminalia superba* planted together with banana showed good results, but association with cocoa showed poor production results for both tree crops.

Diseases and pests Young plantations in Côte d'Ivoire and Nigeria have been defoliated by larvae of the moth *Epicerura* spp. and by the locust *Zonocerus variegatus*, which may cause considerable decrease of the yield. Spraying with the insecticides decamethrin and thiocyclam hydrogen oxalate at concentrations of 900 g and 300 g active ingredient per ha, respectively, showed good results, but a virus disease attacking the pest was also identified. Standing boles are often attacked by ambrosia beetles of the genus *Doliopygus*. This results in small blackish holes in the wood. Newly planted stumps can be attacked by termites; this can be avoided by treating the base with insecticides.

Harvesting In Liberia and Ghana the minimum bole diameter for exploitation has been fixed at 70 cm, in Gabon and Congo at 60 cm. The rotation that is often applied in plantations is 40 years, but under optimum conditions it can be only 20–25 years. Older trees often develop boles with brittle heart.

Yield The total wood volume of plantations of *Terminalia superba* harvested at an age of 20–25 years was estimated at 330 m³/ha. However, yields in plantations range from 6 m³/ha to 25 m³/ha annually. In natural forest a tree of 60 cm in bole diameter yields 3.3–4.0 m³ of wood, one of 90 cm 8.2–10.2 m³ and one of 120 cm 15.5–20.2 m³.

Handling after harvest Freshly harvested logs should be removed from the forest immediately, or de-barked and treated with fungicides and insecticides, to avoid attacks by fungi and borers. They float in water and can thus be transported by river.

Genetic resources As a pioneer species with abundant regeneration and a wide distribution, *Terminalia superba* is not easily liable to genetic erosion. However, it is one of the most heavily exploited African timber species, and locally supplies have dwindled, with reports of declining populations in Côte d'Ivoire, Ghana, Nigeria, Cameroon and Congo. This is compensated for a small part by the establishment of plantations. Its ability to colonize abandoned agricultural land and heavily exploited forest make that *Terminalia superba* is less susceptible to forest clearance than many other tree species.

Provenances have been tested in Côte d'Ivoire,

Cameroon and Congo, especially concerning growth rates and wood characteristics. Several provenances originating from tropical Africa have been planted in other tropical countries, e.g. 13 provenances have been tried in Ecuador; these showed considerable differences in performance. The genetic variability of *Terminalia superba* has been assessed, using samples from Côte d'Ivoire, Cameroon, the Central African Republic and Congo. The samples from Côte d'Ivoire were found to represent a distinct group.

Breeding Clonal breeding is a line of research in the genetic improvement programme for *Terminalia superba*; it was shown valuable in trials in Congo. It is known that there are significant clonal differences in wood formation, e.g. regarding rate of growth and radial dimensions of vessels, fibres and parenchyma.

Prospects *Terminalia superba* is one of the major timber-producing species from tropical Africa. However, it seems that supplies from natural forest are declining in several countries, and they are expected to decline in the near future in other countries. The establishment of plantations is a good option for this species with its high growth rates, but this should be done at a much larger scale than is the case at present to counteract the declining production from natural forest. Studies in DR Congo showed that *Terminalia superba* is suitable for planting in agroforestry sytems as a shade tree in combination with timber production. *Terminalia superba* was identified in Nigeria to have high potential for the development of integrated crop-livestock (sheep and goats) agroforestry technologies based on fodder yield and concentrations of crude protein, neutral detergent fibre, acid detergent fibre and lignin.

Major references Bolza & Keating, 1972; Burkill, 1985; CAB International, 2005; CTFT, 1974b; Groulez & Wood, 1985; Hawthorne, 1995; Liben, 1983; Takahashi, 1978; Voorhoeve, 1979; World Agroforestry Centre, undated.

Other references Adewunmi et al., 2001; Akoègninou, van der Burg & van der Maesen (Editors), 2006; ATIBT, 1986; Aubréville, 1959c; Boutin, 1990; CIRAD Forestry Department, 2003; Dimo et al., 2006; Gyimah, 1999; Hawthorne & Jongkind, 2006; Irvine, 1961; Kamtchouing et al., 2006; Neuwinger, 2000; Normand & Paquis, 1976; N'zala & Ikoungou, 2003; N'zala & Moussounghou, 2006; Phongphaew, 2003; Siepel, Poorter & Hawthorne, 2004; Sosef et al., 1995; Vivien & Faure, 1985; Wierecky, 1997.

Sources of illustration Sosef et al., 1995.

Authors V. Kimpouni

TERMINALIA TETRANDRA (Danguy) Capuron

Protologue Bull. Mus. natl. Hist. nat., sér. 3, bot. 11: 97 (1973).

Family Combretaceae

Synonyms *Terminaliopsis tetrandrus* Danguy (1923).

Origin and geographic distribution *Terminalia tetrandra* is endemic to eastern Madagascar, occurring from Sambava to the south.

Uses The wood, known as 'tafanala' is used for joinery, furniture and tool handles. It is suitable for light construction, flooring, interior trim, ship building, vehicle bodies, musical instruments, boxes, crates, toys, novelties, vats, turnery, veneer, plywood, hardboard and particle board.

The bark is used in traditional medicine; it is taken to treat excessive salivation, and is applied as a wash to boils and ulcers. It is also used in the production of alcoholic drinks with a bitter taste. It is sometimes planted as an ornamental tree.

Properties The heartwood is pinkish pale brown, with uneven yellowish markings. It is clearly demarcated from the yellowish, 5–7 cm wide sapwood. The grain is slightly wavy, sometimes interlocked, texture moderately coarse.

The wood is medium-weight, with a density of 560–690(–750) kg/m³ at 12% moisture content. It air dries well, with little degrade. The rates

Terminalia tetrandra – wild

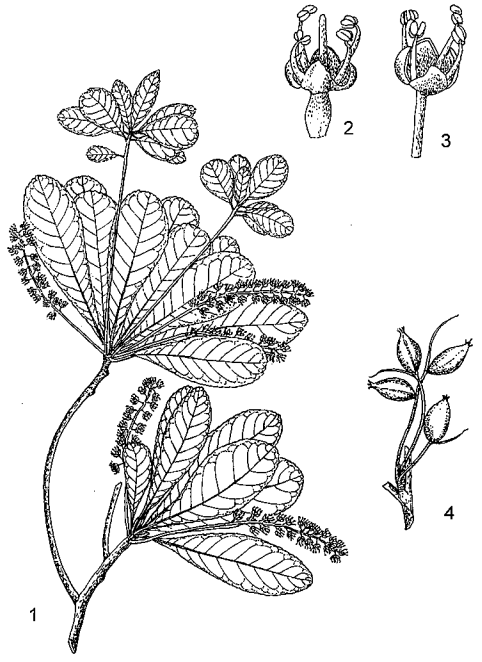
of shrinkage are moderate, from green to oven dry 3.1–4.8% radial and 6.9–9.3% tangential. Board of 2.5 cm thick take 2–3 months to air dry to 30% moisture content.

At 12% moisture content the modulus of rupture is 118–148 N/mm², modulus of elasticity 8820–12,300 N/mm², compression parallel to grain 50–68 N/mm², shear 6–8 N/mm², cleavage 14.5–17.5 N/mm and Chalais-Meudon side hardness 3.1–5.1.

The wood is easy to saw and work with both hand and machine tools, with moderate blunting effect on cutting edges. The wood finishes well, but the use of a filler is necessary to obtain an acceptable polish. It holds nails and screws well, and glues moderately well. The wood is not durable and susceptible to attacks by fungi, termites and *Lyctus* borers. It is difficult to impregnate with preservatives. Wood splinters may cause inflammation of the skin.

Adulterations and substitutes The wood of *Terminalia tetrandra* resembles that of *Terminalia superba* Engl. & Diels from mainland Africa, which is sometimes planted in Madagascar.

Description Deciduous, medium-sized to fairly large tree up to 35 m tall; bole branchless for up to 12 m, usually straight, up to 100(–120) cm in diameter; inner bark yellow; crown storied with branches in whorls, spreading; branchlets slender, very young twigs with minute hairs. Leaves arranged spirally, clustered near ends of branchlets, simple; stipules absent; petiole up to 2.5 cm long, slender; blade obovate to elliptical-obovate, up to 10 cm × 4 cm, long-cuneate at base, rounded to short-acuminate at apex, margins finely toothed, leathery, glabrous, pinnately veined with 7–12 pairs of indistinct lateral veins. Inflorescence an axillary spike 4–10 cm long, slender; peduncle 2–5 cm long. Flowers bisexual or male, regular, 4–5-merous, up to 5 mm long, yellowish; receptacle spindle-shaped; sepals triangular; petals absent; stamens 4–5, free, long-exserted; disk annular, densely hairy; ovary inferior, 1-celled, style thick, narrowly conical. Fruit an ellipsoid drupe c. 2 cm × 1 cm, slightly 4–5-angled, smooth and glabrous, greenish, crowned by the remains of the sepals and disk, indehiscent, 1-seeded.



Terminalia tetrandra – 1, flowering branch; 2, bisexual flower; 3, male flower; 4, fruits. Redrawn and adapted by Iskak Syamsudin

Other botanical information *Terminalia* is a pantropical genus of about 200 species. In tropical mainland Africa about 30 species occur naturally, in Madagascar about 35. *Terminalia tetrandra* differs from other *Terminalia* spp. in having only 4–5 stamens in a single whorl (versus 8–10 in 2 whorls), and it has been placed in a separate genus (*Terminaliopsis*) for this reason. However, as this is not accompanied by other characters, it is considered insufficient for genus status.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: (1: growth ring boundaries distinct); (2: growth ring boundaries indistinct or absent). Vessels: 5: wood diffuse-porous; (12: solitary vessel outline angular); 13: simple perforation plates; 22: intervessel pits alternate; 23: shape of alternate pits polygonal; 26: intervessel pits medium (7–10 μm); 27: intervessel pits large (≥ 10 μm); 29: vestured pits; 30: vessel-ray pits with distinct borders; similar to intervessel pits in size and shape throughout the ray cell; 42: mean tangential diameter of vessel lumina 100–200 μm; 47: 5–20 vessels per square millimetre. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 69: fibres thin- to thick-walled. Axial parenchyma: 80: axial parenchyma aliform; 81: axial parenchyma lozenge-aliform; 83: axial parenchyma confluent; (89: axial parenchyma in marginal or in seemingly marginal bands); 92: four (3–4) cells per parenchyma strand; 93: eight (5–8) cells

per parenchyma strand; 94: over eight cells per parenchyma strand. Rays: 97: ray width 1–3 cells; 104: all ray cells procumbent; 106: body ray cells procumbent with one row of upright and/or square marginal cells; 115: 4–12 rays per mm; 116: ≥ 12 rays per mm.
(E. Uetimane, H. Beeckman, P. Détienne & P. Gasson)

Growth and development The tree shows sympodial growth, with new lateral shoots developing from buds in the leaf axils. These shoots grow rapidly and characteristically exist of a long, slender, leafless basal part and a short apical part with clustered leaves. This growth model results in a crown with tiers of branches, but old trees may lose the storied structure of the crown. *Terminalia tetrandra* mainly flowers from December to January. In the basal part of the inflorescence usually bisexual flowers develop, in the apical part male flowers.

Ecology *Terminalia tetrandra* occurs in more humid evergreen forest, from sea-level up to 1100 m altitude. It seems to be rather uncommon.

Handling after harvest Freshly harvested logs should be removed from the forest rapidly, or de-barked and treated with fungicides and insecticides, to avoid attacks by fungi and borers.

Genetic resources Although *Terminalia tetrandra* is widely distributed in eastern Madagascar, it is rather uncommon and limited to a threatened habitat of moist, dense, evergreen forest. It may easily become threatened by genetic erosion because it is selectively logged for its timber.

Prospects Little is known about *Terminalia tetrandra*, particularly concerning its ecological preferences, growth rates and regeneration. Research is warranted because of the existence of successful timber plantations of other *Terminalia* spp., e.g. *Terminalia superba*. *Terminalia tetrandra* may be a serious candidate for the establishment of timber plantations in Madagascar.

Major references Bolza & Keating, 1972; Capuron, 1966c; Capuron, 1973; Guéneau, 1971a; Guéneau, Bedel & Thiel, 1970–1975; Perrier de la Bâthie, 1954a; Sallenave, 1964; Sallenave, 1971; Takahashi, 1978.

Other references Anonymous, 1962b; Boiteau, Boiteau & Allorge-Boiteau, 1999; InsideWood, undated; Neuwinger, 2000; Novy, 1997; Schatz, 2001.

Sources of illustration Schatz, 2001.

Authors R.H.M.J. Lemmens

TESSMANNIA LESCRAUWAETII (De Wild.) Harms

Protologue Engl. & Drude, Veg. Erde 9, III, 1: 457 (1915).

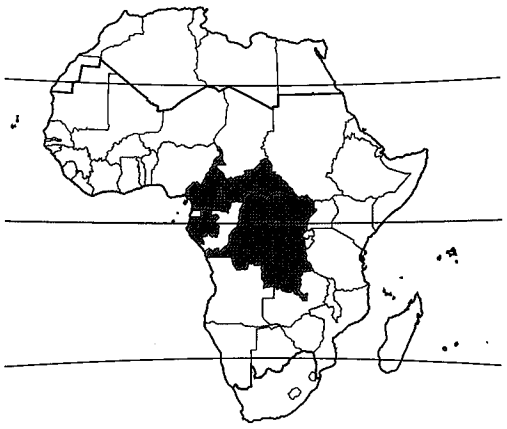
Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

Origin and geographic distribution *Tessmannia lescrauwaetii* occurs in Cameroon, Central African Republic, Gabon and DR Congo.

Uses In DR Congo the wood is used for joinery and boxes. It is suitable for heavy construction, heavy flooring, mine props, railway sleepers, ship building, vehicle bodies, sporting goods and turnery. The tree produces a copal resin, which is possibly used locally.

Production and international trade The wood is only used locally and not traded on the international timber market.

Properties The heartwood is pinkish brown to dark red, sometimes with irregular darker streaks, and distinctly demarcated from the greyish brown, up to 10 cm wide sapwood. The grain is usually straight, texture fine and even. Wood surfaces show a decorative stripe figure. The wood contains a blackish green resinous exudate. It is heavy, with a density of 880–1000 kg/m³ at 12% moisture content, and hard. It is difficult to dry, and logs should be processed soon after felling to avoid serious checking. The rates of shrinkage are moderate to high. Once dry, the wood is moderately stable to unstable in service. At 12% moisture content, the modulus of rupture is about 185

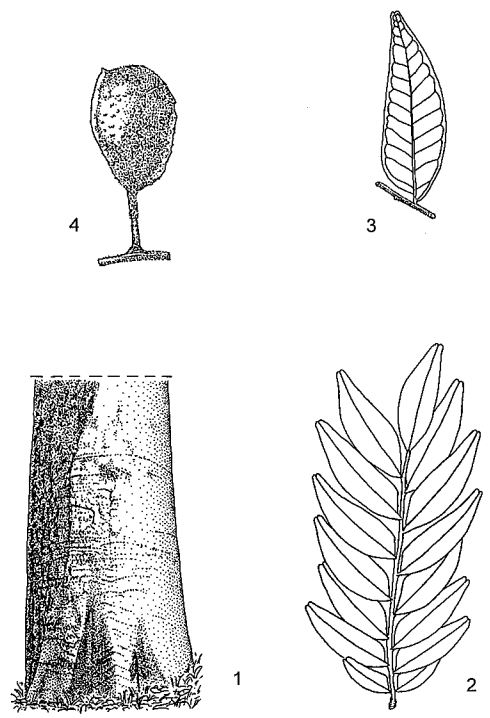


Tessmannia lescrauwaetii – wild

N/mm², modulus of elasticity 20,900 N/mm², compression parallel to grain 78 N/mm², cleavage 24.5 N/mm and Chalais-Meudon side hardness 8.1.

The wood saws fairly well, but considerable power is needed because of its hardness. However, its silica content is low (0.004%). It works well with both hand and machine tools. The resin in the wood may interfere with finishing and gluing. Pre-boring is needed for nailing. The heartwood is very durable, even in contact with the ground or water, and is resistant to fungal and borer attacks, but the sapwood is susceptible to *Lyctus* attack. The heartwood is extremely resistant to impregnation with preservatives. The wood contains 0.5% ash.

Description Medium-sized tree up to 30 m tall; bole branchless for up to 20 m, straight and cylindrical, up to 80(–130) cm in diameter, without buttresses; bark surface fairly smooth or finely fissured, dark grey to blackish, inner bark moderately thick, pinkish brown; twigs short-hairy, becoming glabrous. Leaves alternate, usually imparipinnately compound with 8–18(–20) leaflets; stipules obliquely lanceolate, 1.5–2.5 cm long, caducous or persistent; petiole and rachis together (3.5–)7–15(–25) cm long, channelled above; leaflets usually alternate, oblong to obovate or lanceolate, 1.5–7 cm × 0.5–2.5 cm, asymmetrical at base, indistinctly short-acuminate at apex but tip slightly notched, nearly glabrous, with many translucent dots, pinnately veined with 10–16 pairs of lateral veins. Inflorescence an axillary raceme 2.5–9 cm long, short-hairy and with numerous glands. Flowers bisexual, slightly zygomorphic; pedicel 0.5–2 cm long; sepals 4, slightly fused at base, ovate-lanceolate, unequal, c. 1.5 cm long, one slightly broader than other 3, short-hairy and with numerous glands outside; petals 5, free, linear-oblong to obovate, 2–3 cm × 0.5–1 cm, one smaller than other 4, pinkish white; stamens 10, 9 fused at base and 1 free, unequal in length, 1.5–2.5 cm long; ovary superior, oblong, 0.5–1 cm long, hairy and with glands, on c. 0.5 cm long stipe, style 2–3 cm long, glabrous. Fruit a flattened oblong to ellipsoid or obovoid pod 4.5–6 cm long, reddish brown, short-hairy and with many glandular warts producing a fragrant resin, 2–4-seeded. Seeds oblong, c. 1.5 cm × 1 cm, glossy black, with hard seed coat.



Tessmannia lescrauwaetii – 1, base of bole; 2, leaf; 3, leaflet; 4, fruit.
Redrawn and adapted by J.M. de Vries

Other botanical information *Tessmannia* comprises about 15 species and is restricted to tropical Africa, from Guinea and Sierra Leone eastward to Kenya, and southward to Tanzania, Zambia and Angola. Gabon and DR Congo are richest in species, with about 8 and 10, respectively. It is related to *Sindora* and *Sindoropsis*, which differ in having only 1 petal and 2 fertile stamens, and 1 petal and 10 fertile stamens, respectively. The wood of several other *Tessmannia* spp. is used for similar purposes as that of *Tessmannia lescrauwaetii*.

Tessmannia africana Harms is a medium-sized to large tree up to 50 m tall with bole branchless for up to 30 m and up to 120 cm in diameter, occurring in the same area as *Tessmannia lescrauwaetii*. Its pinkish brown to reddish brown or dark brown and heavy wood, with a density of 840–1070 kg/m³ at 12% moisture content, is used in DR Congo for carpentry and railway sleepers, and it is suitable for similar purposes as that of *Tessmannia lescrauwaetii*, and additionally for toys, novelties, agricultural implements and tool handles. Bark decoctions are applied as an enema in traditional medicine as an aphrodisiac. The resin from crushed fruits is used as perfume.

Tessmannia anomala (Micheli) Harms is a medium-sized to large tree up to 50 m tall with bole branchless for up to 30 m and up to 130

cm in diameter, also occurring in about the same area as *Tessmannia lescrauwaetii*. In DR Congo its dark brown and hard wood is used for carpentry and railway sleepers.
Tessmannia baikiaeoides Hutch. & Dalziel is a small tree up to 10 m tall with bole up to 60 cm in diameter, occurring in upland forest in Sierra Leone, Liberia and western Côte d'Ivoire. Its hard wood is used for posts and tool handles.
Tessmannia dewildemaniana Harms is an apparently rare large tree, occurring in Congo, DR Congo and northern Angola. Its brown wood is locally used for furniture.
Tessmannia yangambiensis Louis ex J.Léonard is a large tree up to 50 m tall with bole branchless up to 30 m and up to 130 cm in diameter with a very limited distribution in DR Congo. Its wood is heavy, with a density of 880–1000 kg/m^3 at 12% moisture content, and is suitable for similar purposes as that of *Tessmannia lescrauwaetii*, and additionally for interior trim, toys, novelties, agricultural implements and tool handles.

Anatomy Wood-anatomical description (IAWA hardwood codes):
Growth rings: 1: growth ring boundaries distinct. Vessels: 5: wood diffuse-porous; 13: simple perforation plates; 22: intervessel pits alternate; 23: shape of alternate pits polygonal; 26: intervessel pits medium (7–10 μm); 29: vestured pits; 30: vessel-ray pits with distinct borders; similar to intervessel pits in size and shape throughout the ray cell; 42: mean tangential diameter of vessel lumina 100–200 μm; 43: mean tangential diameter of vessel lumina ≥ 200 μm; 47: 5–20 vessels per square millimetre; 58: gums and other deposits in heartwood vessels. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 69: fibres thin- to thick-walled; (70: fibres very thick-walled). Axial parenchyma: (78: axial parenchyma scanty paratracheal); 79: axial parenchyma vasicentric; (80: axial parenchyma aliform); 83: axial parenchyma confluent; 85: axial parenchyma bands more than three cells wide; 89: axial parenchyma in marginal or in seemingly marginal bands; 91: two cells per parenchyma strand; 92: four (3–4) cells per parenchyma strand. Rays: 98: larger rays commonly 4- to 10-seriate; 104: all ray cells procumbent; 115: 4–12 rays per mm. Secretory elements and cambial variants: 127: axial canals in long tangential lines. Mineral inclusions: 136: prismatic crystals present; 142: prismatic crystals in chambered axial parenchyma cells.
(E.K. Achi, S. N'Danikou, H. Beeckman & P.E. Gasson)

Growth and development In Gabon flowering *Tessmannia lescrauwaetii* trees have been recorded in December.

Ecology *Tessmannia lescrauwaetii* occurs in lowland rainforest up to 500 m altitude, usually in primary forest.

Management *Tessmannia lescrauwaetii* occurs scattered and in low densities in the forest, and this seems in general also to be the case for other *Tessmannia* spp., although some of them may be locally abundant.

Harvesting The hard and dense wood makes logging of trees quite difficult with ordinary tools, whereas the resin present in the wood may cause additional difficulties by gumming-up saw teeth.

Handling after harvest The logs are too heavy to be transported by river.

Genetic resources *Tessmannia lescrauwaetii* has a fairly large area of distribution, but occurs scattered and mainly in undisturbed forest, which makes it liable to genetic erosion in areas with large-scale logging activities.

Prospects Although the wood of *Tessmannia lescrauwaetii* and other *Tessmannia* spp. is difficult to dry and contains resin, it is decorative and has an excellent natural durability, which makes it useful for local construction including hydraulic works and promising as export timber for purposes where durability is required. However, amounts of timber available seem to be limited as trees usually occur scattered in low densities. Information on growth rates, regeneration and ecological requirements is needed to judge the prospects of *Tessmannia lescrauwaetii* and other *Tessmannia* spp. as timber trees of more commercial importance on a sustainable basis. For the time being, these seem rather poor. A taxonomic revision of the poorly known genus *Tessmannia* is needed.

Major references Aubréville, 1970; Bolza & Keating, 1972; Burkill, 1995; Maisonneuve & Manfredini (Editors), 1988d; Normand & Paquis, 1976; Tailfer, 1989; Takahashi, 1978; Wilczek et al., 1952.

Other references Aké Assi et al., 1985; Aubréville, 1968; de Saint-Aubin, 1963; Fouarge, Gérard & Sacré, 1953; Fouarge, Quoilin & Roosen, 1970; Fouarge, Sacré & Mottet, 1950; Hawthorne & Jongkind, 2006; Neuwinger, 2000; Raponda-Walker & Sillans, 1961; Torelli, Piškur & Tišler, 2003; Vivien & Faure, 1985.

Sources of illustration Léonard, 1950a; Tailfer, 1989.

Authors R.H.M.J. Lemmens

TESTULEA GABONENSIS Pellegr.

Protologue Bull. Soc. Bot. France 71: 76 (1924).

Family Ochnaceae

Origin and geographic distribution *Testulea gabonensis* is restricted to western Central Africa, occurring in south-western Cameroon, Equatorial Guinea, Gabon and Congo.

Uses The wood, traded as 'izombé', is used for construction, flooring, joinery, panelling, windows, doors, stairs, ship building, vehicle bodies, furniture, cabinet work, sporting goods, sculptures, carvings, turnery and sliced veneer. It is suitable for mine props, boxes, crates, toys, novelties and pattern making.

The bark is used in traditional medicine. Ground in water, it is applied to the nostrils to treat headache, and it is also used as aphrodisiac.

Production and international trade *Testulea gabonensis* is available at the international timber market in limited quantities. In 1999 *Testulea gabonensis* ranked 14th on the list of most important export timbers of Gabon, with an export volume of 19,250 m³. In 2003, 5000 m³ of logs were exported from Gabon at an average price of US$ 135/m³, and in 2005 18,000 m³ at US$ 64/m³. In 2004 Congo exported 1000 m³ of sawn wood at an average price of US$ 155/m³.

Properties The heartwood is straw-coloured, becoming orange-yellow to yellowish brown or pink-yellow with greyish tinge upon exposure, and indistinctly demarcated from the 2–5 cm wide sapwood. The grain is usually straight, occasionally slightly interlocked, texture fine and even. The wood shows an indistinct figure and has no distinct smell. Resinous deposits may be present.

Testulea gabonensis – wild

The wood is medium-weight to moderately heavy, with a density of 630–840 kg/m³ at 12% moisture content. It air dries moderately easily with slight risks of distortion and checking; it is recommended to dry carefully and slowly. Kiln drying is moderately easy. Quarter-sawn boards dry faster and with lesser degrade than flat-sawn boards. The rates of shrinkage are moderate, from green to oven dry 3.6–4.5% radial and 6.3–9.5% tangential. Once dry, the wood is moderately stable to stable in service, but somewhat fissile and brittle.

At 12% moisture content, the modulus of rupture is 109–173 N/mm², modulus of elasticity 7850–13,100 N/mm², compression parallel to grain 49–73 N/mm², shear 6–11 N/mm², cleavage 12–22 N/mm and Chalais-Meudon side hardness 3.2–6.1.

The wood is easy to saw and work with both hand and machine tools. The blunting effect on saw teeth and cutting edges is moderate. The wood planes to a good finish, except when interlocked grain is present. It can be sanded to a high polish. It holds nails generally well with occasional tendency of splitting; pre-boring is therefore advised, especially in wood of small dimensions. The wood glues, paints and varnishes well. The steam-bending properties are good. The wood has good slicing properties when it has been steamed for 2–3 days. The heartwood is durable, being resistant to fungal, termite, powder-post beetle and dry-wood borer attacks. It is not resistant to marine borers. It is resistant to impregnation with preservatives.

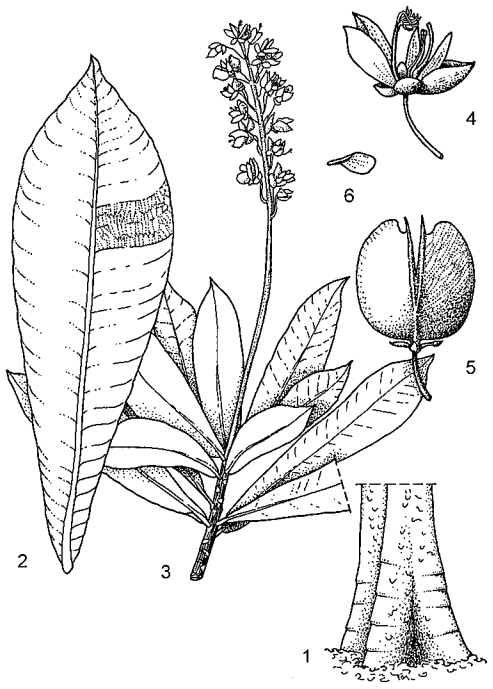
The wood contains about 35% cellulose, 39% lignin, 14% pentosan, 0.4% ash and 0.01% silica. The solubility is 6.7% in alcohol-benzene and 1.9% in water.

Several alkaloids have been isolated from the bark, with Nb-methyltryptamine as main alkaloid. The triterpenes friedeline and friedelinol have also been identified.

Adulterations and substitutes The wood of *Testulea gabonensis* with its good durability and stability and nice colour can be used as a substitute of teak, for instance in ship building and for high-quality furniture. It is similar to but harder than the wood of *Lophira alata*

Banks ex P.Gaertn.

Description Medium-sized to fairly large tree up to 40(–50) m tall; bole branchless for up to 20 m, usually straight and cylindrical, up to 100(–120) cm in diameter, with steep buttresses up to 3 m high, often with horizontal ridges on the buttresses; bark scaly, exfoliating in small irregular patches, yellowish brown to yellowish grey, inner bark granular, brittle, pinkish to reddish with whitish spots, becoming brownish upon exposure; crown irregular; branches glabrous, with distinct leaf scars. Leaves arranged spirally, clustered near tips of branches, simple; stipules fused, triangular, axillary; petiole up to 3 mm long; blade oblanceolate, 20–35 cm × 4–8 cm, rounded at base, short-acuminate at apex, margins entire but slightly wavy, glabrous, pinnately veined with numerous distinct lateral veins. Inflorescence a terminal false raceme up to 35 cm long, with flowers in groups of 3–4. Flowers bisexual, zygomorphic, 4-merous, yellowish white to pinkish; pedicel slender, c. 1.5 cm long; sepals free, unequal, largest one c. 12 mm long; petals free, 2 larger ones c. 1.5 cm long and 2 smaller ones c. 1 cm long; stamen 1, nearly sessile, opening with 2 pores at apex, with 2 appendages at base, staminodes numerous, fused into a long tube but free near apex; ovary superior, cylindrical, 1-celled, style long, curved. Fruit a rounded, inflated, flattened capsule 3–6 cm in diameter, notched at apex, with thin wall, dehiscing with 2 valves, many-seeded. Seeds cylindrical, c. 1 cm long, with papery wing c. 1.5 cm long.



Testulea gabonensis – 1, base of bole; 2, leaf; 3, flowering branch; 4, flower; 5, fruit; 6, seed. Redrawn and adapted by G.W.E. van den Berg

Other botanical information *Testulea* comprises a single species. The tree has some resemblance to *Lophira alata* Banks ex P.Gaertn. (also *Ochnaceae*), which occurs in the same region.

Anatomy Wood-anatomical description (IAWA hardwood codes):
Growth rings: 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; (12: solitary vessel outline angular); 13: simple perforation plates; 22: intervessel pits alternate; 24: intervessel pits minute (≤ 4 μm); 25: intervessel pits small (4–7 μm); 30: vessel-ray pits with distinct borders; similar to intervessel pits in size and shape throughout the ray cell; 41: mean tangential diameter of vessel lumina 50–100 μm; 49: 40–100 vessels per square millimetre; 58: gums and other deposits in heartwood vessels. Tracheids and fibres: (60: vascular/vasicentric tracheids present); 62: fibres with distinctly bordered pits; 63: fibre pits common in both radial and tangential walls; 66: non-septate fibres present; 69: fibres thin- to thick-walled; 70: fibres very thick-walled. Axial parenchyma: 78: axial parenchyma scanty paratracheal; 84: axial parenchyma unilateral paratracheal; 93: eight (5–8) cells per parenchyma strand; 94: over eight cells per parenchyma strand. Rays: 97: ray width 1–3 cells; 98: larger rays commonly 4- to 10-seriate; 104: all ray cells procumbent; 106: body ray cells procumbent with one row of upright and/or square marginal cells; (107: body ray cells procumbent with mostly 2–4 rows of upright and/or square marginal cells); 115: 4–12 rays per mm. Mineral inclusions: 136: prismatic crystals present; 138: prismatic crystals in procumbent ray cells.
(E. Uetimane, P. Baas & H. Beeckman)

Growth and development Trees usually flower in December–April. The seeds are dispersed by wind, and are a favourite food of grey parrots.

Ecology *Testulea gabonensis* usually occurs in primary humid rainforest on well-drained localities.

Management *Testulea gabonensis* is found

scattered in the forest in low densities. In Gabon the average wood volume of trees with a bole diameter of more than 60 cm is 0.1–1.0 m^3/ha.

Harvesting The high buttresses give some problems in felling and harvested logs may be fluted. The minimum bole diameter allowed for harvesting in Gabon is 70 cm.

Handling after harvest Although the heartwood is quite durable, logs should not be left in the forest too long because the sapwood can be attacked by fungi and insects, which on the longer term can also affect the heartwood. Logs often do not float in water and therefore cannot be transported by river.

Genetic resources *Testulea gabonensis* has been subjected to overexploitation in most regions within its area of distribution. Its occurrence in a small area and low densities make it even more vulnerable. It is classified as endangered in the IUCN Red List of threatened species.

Prospects *Testulea gabonensis* produces a good-quality timber. However, it is clearly threatened by genetic erosion or even extinction and research should focus on proper management measures to ensure sustainable exploitation. This would imply very low production levels for the near future. *Testulea gabonensis* deserves more research on seed harvesting, nursery techniques, silviculture and growth rates.

Major references ATIBT, 1986; Bolza & Keating, 1972; CIRAD Forestry Department, 2008; CTFT, 1952a; CTFT, 1990; de Saint-Aubin, 1963; Takahashi, 1978; UNEP-WCMC, 2006; White & Abernethy, 1997; Wilks & Issembé, 2000.

Other references Adjanohoun et al. (Editors), 1988; African Regional Workshop, 1998; Christy et al., 2003; Chudnoff, 1980; Gassita et al. (Editors), 1982; Gérard et al., 1998; Leboeuf et al., 1977; Neuwinger, 2000; Raponda-Walker & Sillans, 1961; Sallenave, 1955; Sallenave, 1964; Sallenave, 1971; Tailfer, 1989; Vivien & Faure, 1985.

Sources of illustration CTFT, 1952a; Wilks & Issembé, 2000.

Authors K.A. Oduro

TETRABERLINIA BIFOLIOLATA (Harms) Hauman

Protologue Bull. Séanc. Inst. Roy. Col. Belg. 23: 477 (1952).

Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

Synonyms *Berlinia bifoliolata* Harms (1901).

Vernacular names Ekaba (En). Ekaba (Fr).

Origin and geographic distribution *Tetraberlinia bifoliolata* is distributed in Cameroon, Equatorial Guinea, Gabon, Congo, western DR Congo and Cabinda (Angola).

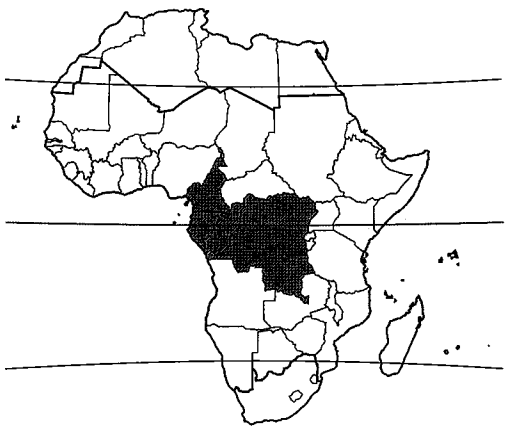
Uses The wood, trade as 'ekaba', is mainly used for veneer and plywood. It is suitable for flooring, joinery, interior trim, furniture, toys, novelties, boxes and turnery.

Production and international trade According to ATIBT statistics, Cameroon exported 6400 m^3 'ekaba' in 2000 and 11,700 m^3 in 2001. In 2004 Cameroon exported about 200 m^3 of 'ekaba' logs to Italy and 275 m^3 to Senegal.

Properties The heartwood is yellowish white, turning pinkish brown to coppery brown with irregular darker streaks upon drying; it is indistinctly demarcated from the up to 12 cm wide, yellowish to greyish white sapwood. Most wood on the market comprises heartwood as well as sapwood. The grain is usually interlocked or wavy and irregular, texture medium to fairly coarse. Quarter-sawn surfaces are glossy and show a ribbon-like figure.

The wood is medium-weight, with a density of 520–680 kg/m^3 at 12% moisture content. It dries fairly rapidly but some care is needed to avoid distortion. Fungal staining may occur during air drying. The shrinkage rates are moderately high, from green to oven dry 3.8–5.4% radial and 6.4–9.5% tangential. Once dry, the wood is moderately stable to unstable in service.

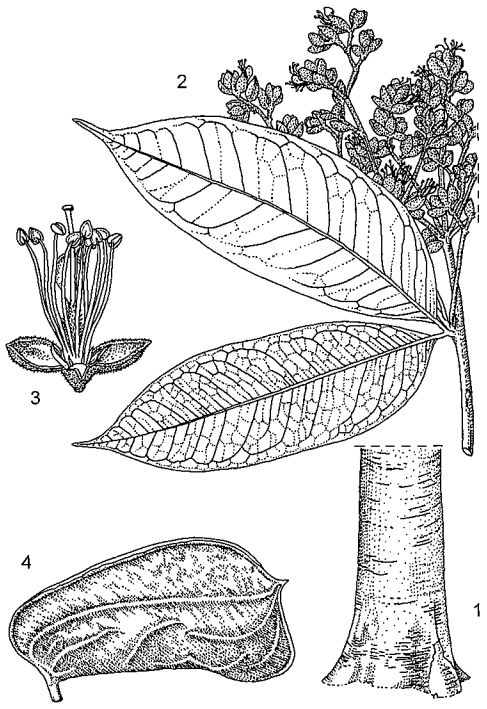
At 12% moisture content, the modulus of rupture is 103–146 N/mm^2, modulus of elasticity 8600–16,200 N/mm^2, compression parallel to



Tetraberlinia bifoliolata – wild

grain 43–58 N/mm², shear 5–7.5 N/mm², cleavage 11–18 N/mm and Chalais-Meudon side hardness 1.5–4.1.
The wood is easy to saw. During planing and moulding some tearing may occur, but a clean finish can be obtained when using an angle of 15–20°. The wood takes nails and screws well, but splitting may occur near edges. It stains, varnishes and paints well. The gluing properties are satisfactory, but casein glue may cause brown blotches. The peeling properties are good, but some tearing may occur due to the presence of interlocked grain. The bending properties are moderate. Staining with iron compounds may occur.
The heartwood is moderately durable. It is susceptible to attacks by fungi and pinhole borers, but moderately resistant to termites. The sapwood is susceptible to *Lyctus* attacks. The heartwood is moderately resistant to impregnation with preservatives, but the sapwood is permeable. The wood is suitable for pulping. The wood contains 41–45.5% cellulose, 26–29% lignin, 16.5–19% pentosan, 0.2–1.1% ash and little silica. The solubility is 1.6–10.2% in alcohol-benzene, 7.0% in hot water and 9.5–19.7% in a 1% NaOH solution.

Description Small to large tree up to 50 m tall; bole branchless for up to 20(–25) m, straight and cylindrical, up to 100(–150) cm in diameter, without buttresses but base sometimes lightly broadened; bark surface smooth, dark grey to bright brown, with pale to reddish brown lenticels in horizontal lines or with horizontal wrinkles, inner bark fibrous, creamy white to orange; crown fairly open and narrow, broader in large trees; twigs soon glabrous. Leaves alternate, paripinnately compound with 1 pair of leaflets; stipules usually free, narrowly triangular, 0.5–3.5 cm long, caducous; petiole 3–8 mm long; petiolules up to 2 mm long; leaflets opposite, obliquely oblong, 4–35 cm × 1–10 cm, base asymmetrical, apex acute to acuminate, margins entire, thick-papery to leathery, glabrous, glossy, pinnately veined. Inflorescence a terminal or axillary panicle 3–10 cm long, hairy; bracts ovate to obovate, 4–9 mm × 3.5–7.5 mm. Flowers bisexual, zygomorphic, 5-merous; pedicel 1.5–4.5 mm long, at apex with 2 oblong to ovate, white to pale pink bracteoles, 7–13 mm × 5–9 mm; sepals unequal, triangular, up to 1 cm × 0.5 cm, 2 partly fused and 3 free, white to pink; petals unequal, one 1–2 cm × c. 0.5 mm, others up to 8 mm long and usually inrolled, yellow, in older flowers white; stamens 10, 9 fused at base and 1 free,



Tetraberlinia bifoliolata – 1, base of bole; 2, flowering twig; 3, flower; 4, fruit.
Redrawn and adapted by J.M. de Vries

1.5–2.5 cm long; ovary superior, 3–6 mm long, brown hairy, 1-celled, with stipe 2.5–4.5 mm long, style 1–2 cm long, stigma heart-shaped. Fruit an oblong to obovate pod, 6–15 cm × 3–7 cm, flattened, with 0.5–2 cm long stipe at base and with short beak at apex, upper suture broadly winged, usually glabrous, brown at maturity, dehiscent with 2 woody valves, 1–2(–5)-seeded. Seeds obovoid, (1.5–)2–3 cm × (1–)1.5–2.5 cm, flattened, dark brown. Seedling with epigeal germination; hypocotyl 2.5–11 cm long, hairy, epicotyl 4–13 cm long, glabrous to sparsely hairy; first 2 leaves opposite, with 1–2 pairs of leaflets.

Other botanical information *Tetraberlinia* comprises 7 species and is restricted to West and Central Africa. It seems related to *Bikinia*. *Tetraberlinia polyphylla* (Harms) J.Léonard ex Voorh. (synonym: *Berlinia polyphylla* Harms) is a small to medium-sized tree, up to 30(–40) m tall, with bole branchless for up to 20 m and up to 70 cm in diameter, endemic to Gabon. Its wood is recorded to be used for carpentry and the bark as anthelmintic, but the identity of the material is dubious. Many literature rec-

ords on *Tetraberlinia polyphylla* actually refer to *Bikinia* species.

Anatomy Wood-anatomical description (IAWA hardwood codes):
Growth rings: 1: growth ring boundaries distinct. Vessels: 5: wood diffuse-porous; 13: simple perforation plates; 22: intervessel pits alternate; 23: shape of alternate pits polygonal; 25: intervessel pits small (4–7 μm); 26: intervessel pits medium (7–10 μm); 29: vestured pits; 30: vessel-ray pits with distinct borders; similar to intervessel pits in size and shape throughout the ray cell; 42: mean tangential diameter of vessel lumina 100–200 μm; 43: mean tangential diameter of vessel lumina ≥ 200 μm; 46: ≤ 5 vessels per square millimetre; 47: 5–20 vessels per square millimetre; 58: gums and other deposits in heartwood vessels. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 69: fibres thin- to thick-walled. Axial parenchyma: 79: axial parenchyma vasicentric; 80: axial parenchyma aliform; 81: axial parenchyma lozenge-aliform; 83: axial parenchyma confluent; 89: axial parenchyma in marginal or in seemingly marginal bands; 91: two cells per parenchyma strand; 92: four (3–4) cells per parenchyma strand. Rays: 96: rays exclusively uniseriate; (97: ray width 1–3 cells); 104: all ray cells procumbent; 106: body ray cells procumbent with one row of upright and/or square marginal cells; 113: disjunctive ray parenchyma cell walls present; 115: 4–12 rays per mm; 116: ≥ 12 rays per mm. Secretory elements and cambial variants: 131: intercellular canals of traumatic origin. Mineral inclusions: 136: prismatic crystals present; 142: prismatic crystals in chambered axial parenchyma cells.
(F.D. Kamala, H. Beeckman & P. Baas)

Growth and development *Tetraberlinia bifoliolata* grows fast. It flowers in the short rainy season, in Cameroon in February–May, in Equatorial Guinea and Gabon in March–June, and in Congo, DR Congo and Cabinda in January–April. Fruits are found year-round. In Cameroon mature pods have been observed on flowering trees, and in Gabon seed fall occurs in November–March. Regeneration is good and trees of all stages are usually present in the forest. The roots form arbuscular mycorrhizae and ectomycorrhizae.

Ecology *Tetraberlinia bifoliolata* occurs from sea-level up to 900 m altitude in evergreen rainforest on well-drained localities, and sometimes in riverine forest where temporary inundations do not last very long. It is only found on nutrient-poor soils. In the centre of its distribution area it is occasionally very common and may even become the most important tree species over large forest areas, but to the margins of its distribution area it becomes rare and scattered in the forest.

Propagation and planting The 1000-seed weight is (350–)800–2700 g.

Management In forest in Gabon, the average wood volume has been reported to be 1.0–1.2 m^3 per ha.

Diseases and pests Galled inflorescences are very characteristic for *Tetraberlinia bifoliolata*, forming broadly ovate, woody, rough heads 1.5–3 cm × 1–2 cm; they are probably caused by gall-wasps. Coccids are frequently observed.

Harvesting The minimum bole diameter allowed for harvesting in Cameroon and Gabon is 60 cm.

Handling after harvest Brittle heart is prevalent in large logs. The bark of freshly cut logs is easily removed. A treatment of logs with a preservative soon after felling is recommended to avoid fungal and insect attacks. Freshly cut logs can be transported floating on water, but it has also been reported that they sometimes sink.

Genetic resources In view of its fairly wide distribution, common occurrence and good regeneration, *Tetraberlinia bifoliolata* does not seem to be threatened with genetic erosion.

Prospects The wood of *Tetraberlinia bifoliolata* is especially suitable for veneer and plywood. It is less suitable for outdoor applications, because its durability is only moderate. Because its exploitation is facilitated by the presence of large and dense stands, fair regeneration and rapid growth, *Tetraberlinia bifoliolata* may gain importance in the timber market.

Major references Anonymous, 1961; Bolza & Keating, 1972; Gérard et al., 1998; Normand, 1952; Phongphaew, 2003; Sallenave, 1955; Sallenave, 1964; Sallenave, 1971; Wieringa, 1999.

Other references Anonymous, 1959; Anonymous, 1964a; ATIBT, 2002; ATIBT, 2005; Aubréville, 1968; Aubréville, 1970; Bâ et al., 2012; de Saint-Aubin, 1963; Laird, 1999; Normand & Paquis, 1976; Takahashi, 1978; Wilczek et al., 1952; Wilks & Issembé, 2000.

Sources of illustration Aubréville, 1968; Wilks & Issembé, 2000.

Authors M. Brink

TETRABERLINIA TUBMANIANA J.Léonard

Protologue Bull. Jard. Bot. Etat 35: 98 (1965).

Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

Origin and geographic distribution *Tetraberlinia tubmaniana* is only known from Liberia, but it may also be present in adjoining parts of Sierra Leone and Côte d'Ivoire.

Uses The wood, traded as 'gola', 'ekop' or 'sikon', is mainly used for furniture, veneer and plywood. It is locally used for construction and canoes. The wood is suitable for light flooring, joinery, interior trim, vehicle bodies, ladders, toys, novelties, boxes, crates, tool handles, turnery, hardboard and particle board.

Production and international trade The wood of *Tetraberlinia tubmaniana* is traded internationally, but statistics are not available.

Properties The heartwood is pale reddish brown, darkening upon exposure; it is distinctly demarcated from the up to 5 cm wide, pale pinkish brown or greyish sapwood. The grain is usually interlocked, texture medium to coarse. Quarter-sawn surfaces show a silver-grain figure.

The wood is medium-weight, with a density of 610–680 kg/m³ at 12% moisture content. It dries fairly slowly with a tendency to produce end and surface checks, and therefore mild kiln-drying schedules must be used. The shrinkage rates are moderately high, from green to oven dry 4.4–5.6% radial and 5.4–10.2% tangential.

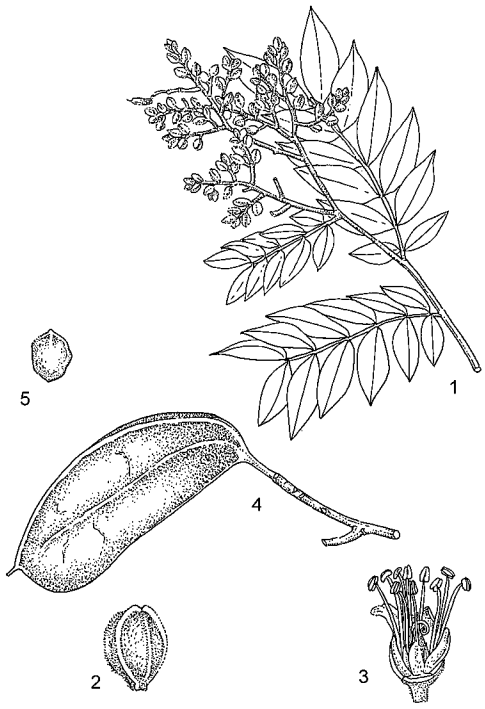
At 12% moisture content, the modulus of rupture is 114–129 N/mm², modulus of elasticity 13,800–17,900 N/mm², compression parallel to grain 62–65 N/mm², Brinell side hardness 20–21 N/mm² and Brinell end hardness 49 N/mm². The wood is easy to saw, and works well with hand and machine tools. During planing of radial surfaces, some picking up may occur due to interlocked grain. The wood takes nails fairly well, but splitting near the edges may occur. It glues well. A filler is necessary to obtain nicely polished surfaces. The wood slices and peels very well. Staining with iron compounds may occur.

The heartwood is only moderately durable. It is liable to attacks by fungi. The sapwood is susceptible to *Lyctus* attacks. The heartwood is moderately resistant to impregnation with preservatives, but the sapwood is permeable.

Experiments have shown that excellent pulp can be obtained from the wood. The pulp bleaches well and can be made into very good paper. The wood fibre cells are (0.7–)1.2–1.7 mm long and 13–22 µm wide.

Tetraberlinia tubmaniana – wild

Description Evergreen, small to medium-sized tree up to 30(–42) m tall; bole branchless for up to 23 m, straight and cylindrical, up to 125 cm in diameter, base without buttresses but often somewhat swollen or with to 50 cm high root swellings; bark surface smooth, with lenticels and some horizontal lines, shallowly fissured in older trees, grey to bright brown, inner bark fibrous, pale to bright brown, yellowish brown or pinkish brown; crown fairly open; twigs short-hairy, becoming glabrous. Leaves alternate, paripinnately compound with (1–)3–6(–7) pairs of leaflets; stipules free, slightly obliquely ovate, 0.5–1.5 cm long, caducous; petiole 2–6 mm long, rachis up to 8(–13) cm long, grooved above, hairy; leaflets opposite, sessile, slightly obliquely rhombic to elliptical, 1–8 cm × 0.5–4 cm, base usually rounded, apex usually short-acuminate, margins entire, leathery, nearly glabrous, pinnately veined. Inflorescence a terminal or axillary panicle 3–9 cm long, brown hairy; bracts ovate, circular or obovate, 2.5–5 mm × 2.5–4 mm, caducous. Flowers bisexual, zygomorphic, 5-merous, sweetly fragrant; pedicel 2–4(–5) mm long, at apex with 2 ovate, greenish white to brownish white bracteoles, 6–9 mm × 4.5–6 mm; sepals unequal, ovate to triangular, up to 0.5 cm long, 2 partly fused and 3 free, white to greenish white; petals unequal, one up to 1 cm long, others narrow and up to 0.5 cm long, medium to pale yellow, in older flowers white; stamens (9–)10, (8–)9 fused at base and 1 free, filaments 1–1.5 cm long; ovary superior, 2–4 mm long, hairy, 1-celled, with stipe 1.5–4 cm long, style



Tetraberlinia tubmaniana – 1, flowering twig; 2, flower bud; 3, flower with one bracteole removed; 4, fruit; 5, seed.
Redrawn and adapted by W. Wessel-Brand

c. 1 cm long, stigma heart-shaped. Fruit an oblong to oblong-obovate pod, 6–13 cm × 3–5 cm, flattened, with 1–2.5 cm long stipe at base and with short beak at apex, upper suture distinctly winged, glabrous or sparsely hairy, glossy brown to grey-brown at maturity, dehiscent with 2 thin-woody, coiling valves, 1–3-seeded. Seeds disk-shaped, 1.5–2.5 cm × 1.5–2 cm, flattened, fairly glossy brown. Seedling with epigeal germination; hypocotyl 5–11 cm long, epicotyl 3–9 cm long, densely hairy; first 2 leaves opposite, with 6–9 pairs of leaflets.

Other botanical information *Tetraberlinia* comprises 7 species and is restricted to West and Central Africa. It seems related to *Bikinia*.

Anatomy Wood-anatomical description (IAWA hardwood codes):
Growth rings: 1: growth ring boundaries distinct. Vessels: 5: wood diffuse-porous; 13: simple perforation plates; 22: intervessel pits alternate; 23: shape of alternate pits polygonal; (25: intervessel pits small (4–7 µm)); 26: intervessel pits medium (7–10 µm); 29: vestured pits; 30: vessel-ray pits with distinct borders; similar to intervessel pits in size and shape throughout the ray cell; 42: mean tangential diameter of vessel lumina 100–200 µm; 43: mean tangential diameter of vessel lumina ≥ 200 µm; 46: ≤ 5 vessels per square millimetre; (47: 5–20 vessels per square millimetre); 58: gums and other deposits in heartwood vessels. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 69: fibres thin- to thick-walled. Axial parenchyma: 79: axial parenchyma vasicentric; 80: axial parenchyma aliform; 81: axial parenchyma lozenge-aliform; (83: axial parenchyma confluent); 89: axial parenchyma in marginal or in seemingly marginal bands; (91: two cells per parenchyma strand); 92: four (3–4) cells per parenchyma strand; 93: eight (5–8) cells per parenchyma strand. Rays: 96: rays exclusively uniseriate; 106: body ray cells procumbent with one row of upright and/or square marginal cells; (107: body ray cells procumbent with mostly 2–4 rows of upright and/or square marginal cells); 115: 4–12 rays per mm. Mineral inclusions: 136: prismatic crystals present; 142: prismatic crystals in chambered axial parenchyma cells; 143: prismatic crystals in fibres.
(E.K. Achi, H. Beeckman & P.E. Gasson)

Growth and development *Tetraberlinia tubmaniana* flowers in April–June, and the fruits are ripe in November–January. Young trees only 9 m tall and 8 cm in bole diameter have been observed to flower already. When the fruits dehisce, the seeds are ejaculated from the coiling valves. Regeneration is good; seedlings are abundant in the forest.

Ecology *Tetraberlinia tubmaniana* occurs from sea-level up to 100 m altitude in evergreen rainforest, in areas with an average annual rainfall of over 2000 mm, becoming abundant in areas with an average annual rainfall over 2500 mm. It grows on flat to slightly undulating terrain with deep soils; the terrain should not be inundated nor have a high water-table. It often occurs gregariously, and in some forests, such as the Krahn-Bassa National Forest in south-eastern Liberia, it is the dominant species over large areas, not only dominating the canopy, but also the middle and lower layers. Trees seem to suffer when suddenly exposed to full light, for instance when too many canopy trees are cut.

Propagation and planting The 1000-seed weight is 600–1900 g.

Management In the 1960s the total standing stock of *Tetraberlinia tubmaniana* in south-eastern Liberia was estimated at over 7 million

m^3, and estimations of the amount of exploitable timber in old forests were as high as 70 m^3 per hectare. In the 1970s it was recorded that stands in the Krahn-Bassa National Forest contained about 30 trees with a diameter over 40 cm per ha.

Yield Because the sapwood is narrow, even small diameter logs contain much heartwood.

Genetic resources In spite of the high numbers of trees counted in the 1960s and 1970s, *Tetraberlinia tubmaniana* is recorded to be overexploited and is classified as vulnerable in the IUCN Red List. It still occurs at high densities in a number of forest reserves. Its small distribution area makes it easily liable to genetic erosion.

Prospects The wood of *Tetraberlinia tubmaniana* has good strength properties and works well, but because of its limited durability it is less suitable for outdoor uses. The wood is especially used for veneer and plywood, but quantitative information on its production, trade and use are not available. As the species is classified as vulnerable, care should be taken that its exploitation is carried out in a sustainable way. To do this properly, more information is needed on growth rates and suitable forest management systems.

Major references Bolza & Keating, 1972; Chudnoff, 1980; Gérard et al., 1998; Gottwald et al., 1968; Kryn & Fobes, 1959; Kukachka, 1969; Sachtler, 1968; Voorhoeve, 1979; Wieringa, 1999.

Other references Bongers et al., 1999; Burkill, 1995; Kunkel, 1965; Normand, 1958; Normand & Paquis, 1976; Poorter et al., 2004; Russell & Sieber, 2005; Takahashi, 1978; World Conservation Monitoring Centre, 1998.

Sources of illustration Voorhoeve, 1979.

Authors M. Brink

TETRAPTEROCARPON GEAYI Humbert

Protologue Compt. Rend. Hebd. Séances Acad. Sci. 208: 374 (1939).

Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

Origin and geographic distribution *Tetrapterocarpon geayi* is endemic to Madagascar, where it occurs in the south-western part of the island from the surroundings of Morondava to the extreme south.

Uses The wood, locally known as 'vaovy', is used for poles in house construction, carpentry and cart construction. It has been recorded to be in demand for the junction of outriggers to pirogues and for wheel axes of carts. The wood is suitable for luxury mosaic parquet flooring, heavy furniture and sliced veneer. It is used for charcoal production.

Tetrapterocarpon geayi – wild

In traditional medicine powdered root bark is applied to wounds and a decoction of the root bark is gargled to treat toothache.

Properties The heartwood is orange-red; sapwood yellowish and narrow, 1.5–2 cm in diameter. The grain is slightly interlocked, texture fine. The wood is heavy and hard, with moderate shrinkage during drying.

Botany Deciduous, dioecious small tree up to 12 m tall; bole up to 45 cm in diameter; bark surface smooth to shallowly fissured, grey, with whitish lenticels; twigs glabrous to short-hairy. Leaves alternate, bipinnately compound with (1–)2–3(–4) pairs of pinnae and with a terminal pinna; stipules small, caducous; petiole 3–5 cm long, rachis (3.5–)5–9(–10) cm long, slender; axes of pinnae 6–12 cm long; leaflets (8–)10–14(–16) per pinna, alternate to opposite, oblong-obovate, 1.5–3 cm × 0.5–1 cm, truncate to slightly notched at apex, glabrous, pinnately veined. Inflorescence an axillary panicle up to 10 cm long, minutely hairy, with densely flowered branches. Flowers unisexual, regular, 4-merous, small, greenish white; pedicel c. 2 mm long; sepals broadly ovate, c. 1 mm long, slightly hairy; petals free, broadly elliptical, c. 2.5 mm long, margins inrolled, glabrous, spreading; stamens free, equal, staminodes hairy, reflexed over the petal bases; ovary superior, spindle-shaped, c. 2 mm long, stiped, 1-celled, style short; male flowers with well-developed stamens and rudimentary ovary, female flow-

ers with rudimentary stamens and well-developed ovary. Fruit a winged pod, broadly elliptical to circular in outline, 2.5–3.5 cm × 2–3.5 cm, with c. 0.5 cm long stipe and spindle-shaped central seed-containing part bearing 2 unequal pairs of papery wings, indehiscent, 1-seeded. Seed club-shaped, c. 1 cm long, smooth, dark brown to blackish.

Trees can be found flowering from November to January.

Tetrapterocarpon comprises 2 species. Relationships with *Acrocarpus*, *Arcoa* and *Ceratonia* have been suggested. *Tetrapterocarpon septentrionalis* Du Puy & R.Rabev. is a small to medium-sized tree up to 20 m tall with larger fruits than *Tetrapterocarpon geayi*; it mainly occurs in northern Madagascar, but with a population in south-central Madagascar.

Ecology *Tetrapterocarpon geayi* occurs in dry woodland and scrubland up to 300 m altitude, locally frequent. It has been recorded on limestone, sand and basalt soils.

Genetic resources and breeding There is no reason to consider *Tetrapterocarpon geayi* as threatened, but in view of the local exploitation of its wood and bark and its probable low growth rates, monitoring of its populations is advisable.

Prospects *Tetrapterocarpon geayi* will probably remain of some local importance for its wood, but it has no prospects as a commercial timber.

Major references du Puy et al., 2002; Guéneau, Bedel & Thiel, 1970–1975.

Other references Bedolla, 1997; Debray, Jacquemin & Razafindrambao, 1971; du Puy & Abraham, 1994; Lewis et al., 2005.

Authors R.H.M.J. Lemmens

TINA STRIATA Radlk.

Protologue Sitz.-Ber. Bayer. Akad. 9: 525, 651 (1879).

Family Sapindaceae

Origin and geographic distribution *Tina striata* is endemic to Madagascar, where it occurs widespread in the central and eastern regions.

Uses The wood of *Tina striata* is especially valued for boat building. It is also used as firewood although it takes a long time to dry. A decoction made of the leaves and twigs is used as an aphrodisiac, in the treatment of epilepsy and to speed up the closing of the fontanel in babies.

Tina striata – wild

Properties The bark of *Tina striata* contains tannins that belong to the group of condensed tannins of the proanthocyanidin type.

Botany Dioecious small to medium-sized tree up to 25 m tall; twigs slightly grooved, short-hairy. Leaves alternate, paripinnately compound with (1–)2–10(–13) pairs of leaflets; stipules absent; leaflets opposite to alternate, elliptical to obovate, (1.5–)2.5–10 cm long, cuneate and usually slightly asymmetrical at base, usually rounded at apex, margins slightly toothed, leathery, glabrous, pinnately veined with many lateral veins. Inflorescence an axillary panicle up to 17 cm long, short-hairy. Flowers unisexual, regular, 5-merous; pedicel c. 1 mm long; sepals free, ovate, 1–1.5 mm long, short-hairy outside, yellowish green; petals free, ovate, 1–1.5 mm long, short-hairy, white, with 2 small lateral scales; stamens 8, free, up to 3 mm long, hairy; ovary superior, 2-celled, style thick and short; male flowers with rudimentary ovary, female flowers with reduced stamens. Fruit an obovoid to nearly globose capsule 1–2 cm long, yellow to orange, glabrous, dehiscent, 2-valved, 1-seeded. Seed obovoid, 0.5–1 cm long, basal part covered by a waxy aril.

Tina striata is morphologically variable and 5 subspecies have been distinguished, mainly differing in number and size of the leaflets and the presence or absence of small pits in the leaflet surface.

Tina comprises 6 species and is endemic to Madagascar. The wood of *Tina chapelieriana* (Cambess.) Kalkman, a small tree of up to 10 m tall with a bole diameter up to 60 cm, is yellowish, heavy, hard and durable. It is used for

construction, carpentry and railway sleepers. The bark is used as fish poison. The wood of *Tina dasycarpa* Radlk., *Tina fulvinervis* Radlk., *Tina isaloensis* Drake and *Tina thouarsiana* (Cambess.) Capuron, all small trees up to 10 m tall, is mainly used for boat building.
The genera *Neotina* and *Molinaea* closely resemble *Tina*; they are difficult to distinguish unless in fruit, and have the same vernacular names and probably also uses.

Ecology *Tina striata* is found in humid and subhumid evergreen forest from sea-level up to 2200 m altitude.

Genetic resources and breeding *Tina striata* is widespread in Madagascar and there seems to be no reason to consider it threatened at present. Its variation is remarkable and deserves more attention.

Prospects Knowledge on *Tina striata* and other *Tina* spp. is very limited and only further study could reveal serious opportunities for more extensive use of the species.

Major references Boiteau, Boiteau & Allorge-Boiteau, 1999; Capuron, 1969.

Other references Bärner & Müller, 1942; Brown et al., 2009; Buerki et al., 2009; Carrière et al., 2005; Debray, Jacquemin & Razafindrambao, 1971; Hegnauer, 1990; Vary et al., 2009.

Authors C.H. Bosch

TINOPSIS APICULATA Radlk.

Protologue T.Durand, Index gen. phan.: 78 (1887).

Family Sapindaceae

Origin and geographic distribution *Tinopsis apiculata* is endemic to Madagascar, where it is widespread in the eastern regions.

Tinopsis apiculata – wild

Uses The wood of *Tinopsis apiculata*, traded as 'ramaindafy' together with the wood of *Neotina isoneura* (Radlk.) Capuron, is especially used to build boats. Smaller-sized poles are used in construction and as fence posts. The wood is suitable for heavy carpentry, mine props and railway sleepers. It is also used as firewood and for charcoal production. The fruits are eaten.

Properties The heartwood is pale pinkish brown and is distinctly demarcated from the greyish creamy sapwood. The wood is fairly heavy, with a density of about 830 kg/m^3 at 12% moisture content, and hard. The rates of shrinkage during drying are fairly high, from green to oven dry about 5.7% radial and 12.4% tangential. Once dry, the wood is not stable in service.
At 12% moisture content, the modulus of rupture is 174 N/mm^2, modulus of elasticity 14,300 N/mm^2, compression parallel to grain 67 N/mm^2, cleavage 23 N/mm and Chalais-Meudon side hardness 6.6. The wood is fairly durable, being moderately resistant to fungi and termites. The heartwood is resistant to impregnation with preservatives, the sapwood is permeable.

Botany Evergreen, dioecious, small to medium-sized tree up to 25 m tall; bole up to 50 cm in diameter; twigs densely yellowish to reddish brown short-hairy. Leaves alternate, paripinnately compound with 1–4 pairs of leaflets; stipules absent; petiole up to 6 cm long, rachis up to 20 cm long; petiolules 2–5 mm long; leaflets opposite, elliptical, 6–20 cm × 2–6.5 cm, cuneate at base, acute to acuminate at apex, margins entire, leathery, glabrous except veins below, pinnately veined with 10–15 pairs of lateral veins. Inflorescence an axillary, slender false raceme-like panicle 3–10(–15) cm long, densely hairy. Flowers unisexual, regular, 5-merous; pedicel up to 2 mm long; sepals free, triangular to ovoid, up to 2.5 mm long, hairy outside; petals free, obovoid, up to 2 mm long and wide, hairy, with 2 lateral scales; stamens free, c. 4 mm long, hairy; ovary superior, ovoid, 2-celled, style up to 2 mm long; male flowers with rudimentary ovary, female flowers with reduced stamens. Fruit an obovoid to globose berry 2–2.5 cm long, yellow when ripe, indehiscent, 1(–2)-seeded. Seed up to 1.5 cm long, completely covered by pulpy-fleshy, translucent aril.
Tinopsis is endemic to Madagascar and com-

prises 11 species. Most of these species yield wood that is used for building boats, and although most of them are suitable for other uses such as house building and furniture, these are often considered a waste of valuable timber. The species with a recorded timber use are *Tinopsis chrysophylla* Capuron, *Tinopsis conjugata* (Thouars ex Radlk.) Capuron, *Tinopsis dissitiflora* (Baker) Capuron, *Tinopsis macrocarpa* Capuron, *Tinopsis phellocarpa* Capuron, *Tinopsis tamatavensis* Capuron and *Tinopsis urschii* Capuron. The aril of *Tinopsis dissitiflora* is edible and parts of the plant are used in traditional medicine as a vermifuge and tonic. The bark of *Tinopsis macrocarpa* is rich in saponins and is used for washing, and this is also the case for the bark of *Tinopsis tampolensis* Capuron.

Ecology *Tinopsis apiculata* is distributed in humid to subhumid evergreen forest from sea-level up to 1000 m altitude. It is most often found on slopes and in depressions.

Genetic resources and breeding Although *Tinopsis apiculata* and other *Tinopsis* spp. are much sought after for their timber, there are no reports that any of these species is under threat. Assessment of the size of the populations and their exploitation is needed and could reveal the need for protection measures.

Prospects Too little is known about *Tinopsis apiculata* and other *Tinopsis* spp. to make projections for the future.

Major references Boiteau, Boiteau & Allorge-Boiteau, 1999; Guéneau, 1971a; Guéneau, Bedel & Thiel, 1970–1975; Sallenave, 1971; Takahashi, 1978.

Other references Buerki et al., 2009; Capuron, 1969; Styger et al., 1999; Vary et al., 2009.

Authors C.H. Bosch

TRICHOCLADUS ELLIPTICUS Eckl. & Zeyh.

Protologue Enum. pl. afric. austral.: 356 (1837).

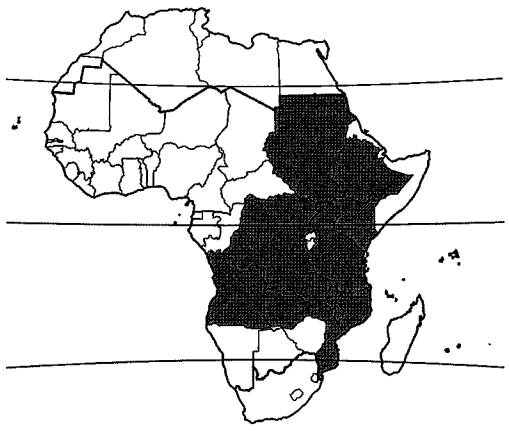
Family Hamamelidaceae

Chromosome number $2n = 24$

Vernacular names Wych hazel, witch-hazel, white witch-hazel, Natal hazel (En).

Origin and geographic distribution *Trichocladus ellipticus* occurs from Sudan and Ethiopia, through eastern DR Congo and East Africa, south to southern Africa.

Uses The wood of *Trichocladus ellipticus* is used for construction, fencing, carpentry and carvings, and as firewood. Larger boles are used as posts in building and smaller stems for cross poles. *Trichocladus ellipticus* is the favourite species of the Maasai people for making frames for their shields. A bark decoction is added to soup or meat to improve digestion and to cure an upset stomach.



Trichocladus ellipticus – wild

Properties The wood is white, tough and hard, but bends easily. It hardens when heated. The Wandorobo people of East Africa consider the wood termite resistant.

Botany Shrub or small tree up to 10(–18) m tall; bark smooth or slightly rough, greyish white or creamy brown; young branches with yellow or rusty-brown stellate hairs. Leaves alternate, simple and entire; stipules linear, early caducous; petiole 0.5–2 cm long; blade elliptical to obovate-elliptical or oblanceolate, (1.5–)5–28 cm × 1–12 cm, cuneate to rounded at base, acute to acuminate at apex, densely soft-hairy below, pinnately veined. Inflorescence axillary, head-like; peduncle 5–15 mm long. Flowers bisexual, regular, sessile; calyx with c. 1 mm long tube and 4–5 lobes c. 1 mm long, soft-hairy; petals free, 1–1.5 mm long, white, greenish yellow or yellow, soft-hairy outside; stamens 5, filaments c. 1 mm long, anthers c. 1 mm long; ovary ellipsoid, hairy, 2-celled, styles 2. Fruit a globose capsule 6–8 mm long, pubescent, 1–2-seeded. Seeds ovoid to ellipsoid, c. 5 mm × 3–4 mm, yellowish or greyish, mottled black.

Trichocladus comprises about 4 species, 2 of them endemic to South Africa. It is the only genus of *Hamamelidaceae* on the African continent and it is not found elsewhere. Two subspecies are distinguished in *Trichocladus ellip-*

ticus: subsp. *malosanus* (Baker) Verdc., widespread in tropical Africa, and subsp. *ellipticus*, restricted to South Africa. The latter is characterized by smaller, narrower and more acuminate leaves.

Ecology *Trichocladus ellipticus* is found in the understorey of montane forest at 1250–2100(–3000) m altitude, often along streams.

Genetic resources and breeding In South Africa *Trichocladus ellipticus* is considered 'near threatened'. Elsewhere, it is widespread, often dominant and even occurring in almost pure stands. As it is apparently not heavily exploited there seems to be no threat of genetic erosion.

Prospects *Trichocladus ellipticus* will remain only locally important.

Major references Dovie, Witkowski & Shackleton, 2008; Kokwaro, 1993; Mendes & Vidigal, 1978.

Other references Coates Palgrave, 1983; Dale & Greenway, 1961; Ichikawa, 1987; Legilisho-Kiyiap, 1998; Medley & Kalibo, 2007; Verdcourt, 1989c; von Breitenbach, 1994.

Authors C.H. Bosch

TRICHOSCYPHA ARBOREA (A.Chev.) A.Chev.

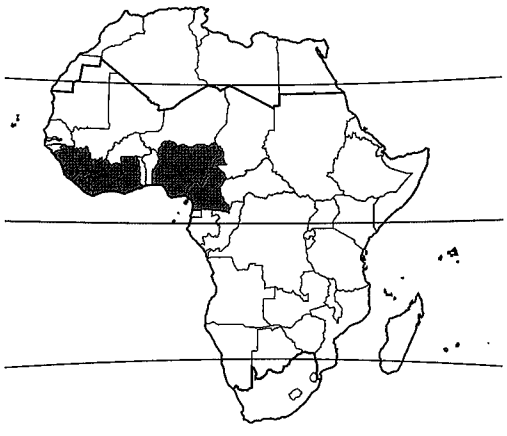
Protologue Explor. bot. Afrique occ. franç.: 161 (1920).

Family Anacardiaceae

Chromosome number $2n = 48$

Origin and geographic distribution *Trichoscypha arborea* occurs from eastern Guinea and Sierra Leone east to western Cameroun.

Uses The wood of *Trichoscypha arborea*, known in Côte d'Ivoire as 'dao', is locally used, mainly for construction. It is also used for canoes and planks. It is suitable for light flooring, joinery, interior trim, furniture, cabinet work, musical instrument, pestles, toys, novelties, veneer, plywood, hardboard and particle board. It is recorded to have some industrial importance in the production of paper pulp, alone or in a mixture with other woods. The bark contains resin which is suitable for vanish production and for medicinal purposes. In Côte d'Ivoire the resin is used by the Guéré people to prevent miscarriage and to treat diarrhoea, dysentery and amenorrhoea. The fruits are edible and largely relished by local people.



Trichoscypha arborea – wild

Production and international trade The wood of *Trichoscypha arborea* is mainly used locally. Production and trade statistics are not available. Bark is commonly sold on local markets in Côte d'Ivoire for medicinal purposes.

Properties The heartwood is variable in colour, from pinkish grey to reddish brown or yellowish brown with a green-pinkish tinge, often with darker streaks, and distinctly demarcated from the greyish sapwood. The grain is often interlocked, texture rather fine and even. The wood is lustrous, odourless and tasteless when dry.

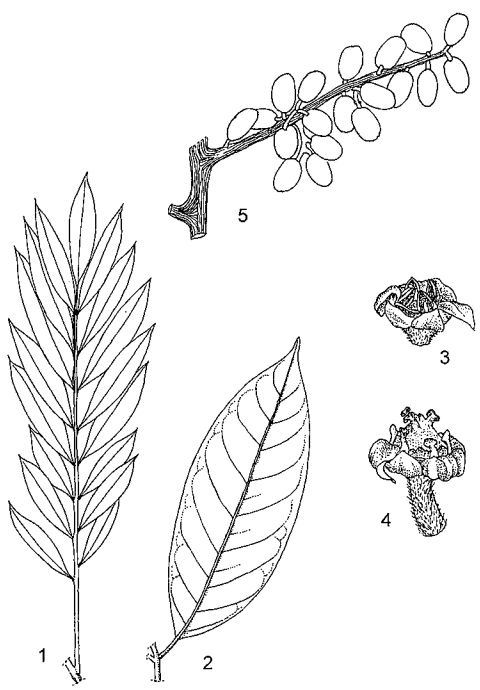
The wood is moderately heavy, with a density of 730–850 kg/m^3 at 12% moisture content, and hard. The drying characteristics are satisfactory, although the rates of shrinkage may be considerable. At 12% moisture content, the modulus of rupture is 151–172 N/mm^2, modulus of elasticity 16,170 N/mm^2, compression parallel to grain 61–69 N/mm^2, cleavage 20–24 N/mm, Chalais-Meudon side hardness 3.5–5.2 and Janka side hardness 8940 N.

The wood is not difficult to saw and work, but has a tendency to develop rough surfaces. It is moderately durable with an expected outdoor service life of 8–15 years; it is liable to attacks by *Lyctus* borers, termites and marine borers.

The 5-deoxyflavonoids sulphuretin, fisetin and rengasin have been isolated from the heartwood of *Trichoscypha arborea*.

The mean weight of a fruit is 45 g, with about 80% of a sweet pulp.

Description Evergreen, dioecious, small to medium-sized tree up to 30 m tall; bole often branchless to a considerable height, usually straight but sometimes twisted, up to 50 cm in diameter, often with small buttresses; bark surface slightly flakey, greyish, inner bark fibrous, reddish brown to purplish brown, exuding small dots of whitish resin; crown small and dense; branches more or less whorled.



Trichoscypha arborea – 1, leaf; 2, leaflet; 3, male flower; 4, female flower; 5, infructescence. Redrawn and adapted by Iskak Syamsudin

Leaves alternate, clustered near ends of twigs, imparipinnately compound with 6–9 pairs of leaflets; stipules absent; petiole and rachis together up to 70 cm long; petiolules 3–15 mm long, wrinkled; leaflets alternate to opposite, narrowly ovate to elliptical, 12–26 cm × 3–9 cm, cuneate at base, acuminate at apex, leathery, glabrous, pinnately veined with 9–14 pairs of lateral veins. Inflorescence a large erect panicle up to 80 cm long, glabrous or slightly short-hairy. Flowers unisexual, regular, 4-merous, red to purplish, nearly sessile; calyx with short lobes, c. 0.5 mm long, hairy; petals free, ovate, c. 1 mm long; disk glabrous; stamens free, alternating with petals; ovary superior, 1-celled, styles 3–4, short; male flowers with strongly reduced ovary, female flowers with reduced stamens Fruit an ellipsoid drupe 2–2.5 cm × 1.5–2 cm, red when ripe, glabrous, with yellow, fibrous but sweetish pulp, 1-seeded. Seedling with hypogeal germination, with cotyledons embedded in fruit pulp; epicotyl 10–12 cm long, longitudinally grooved, reddish brown, finely hairy; first leaves opposite and simple.

Other botanical information *Trichoscypha* comprises about 30 species and is nearly confined to West and Central Africa. Cameroon and Gabon are richest, with 16 and 13 species, respectively.

Trichoscypha lucens Oliv. (synonyms: *Trichoscypha chevalieri* Aubrév. & Pellegr., *Trichoscypha ealaensis* Van der Veken, *Trichoscypha oba* Aubrév. & Pellegr., *Trichoscypha ulugurensis* Mildbr., *Trichoscypha yapoensis* Aubrév. & Pellegr.) is a variable shrub or small tree up to 15(–25) m tall widespread in West and Central Africa and the only *Trichoscypha* species extending to East and southern Africa. Its wood is sometimes used for similar purposes as that of *Trichoscypha arborea*. It is strong, tough, flexible and durable, and additionally used for bows, arrows and fetish masks. The fruit is edible.

Trichoscypha bijuga Engl. (synonym: *Trichoscypha beguei* Aubrév. & Pellegr.) is a shrub to small tree of the forest understorey occurring from Liberia to western DR Congo and northern Angola. The wood is probably used for similar purposes as that of *Trichoscypha arborea*.

Trichoscypha cavalliensis Aubrév. & Pellegr. is an understory tree up to 20 m tall with a straight bole up to 20 cm in diameter occurring in Liberia, Côte d'Ivoire and Ghana. Its durable wood is used for poles in house building. *Trichoscypha cavalliensis* is classified as vulnerable in the IUCN Red list.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; (12: solitary vessel outline angular); 14: scalariform perforation plates; 15: scalariform perforation plates with ≤ 10 bars; 16: scalariform perforation plates with 10–20 bars; 21: intervessel pits opposite; (22: intervessel pits alternate); (26: intervessel pits medium (7–10 μm)); 27: intervessel pits large (≥ 10 μm); 32: vessel-ray pits with much reduced borders to apparently simple: pits horizontal (scalariform, gash-like) to vertical (palisade); 41: mean tangential diameter of vessel lumina 50–100 μm; (48: 20–40 vessels per square millimetre); 49: 40–100 vessels per square millimetre. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; (65: septate fibres present); 66: non-septate fibres present; 69: fibres thin- to thick-walled. Axial parenchyma: 75: axial parenchyma absent or extremely rare; 93: eight (5–8) cells per parenchyma strand. Rays: 97: ray width 1–3 cells; (98: larger rays commonly 4- to 10-seriate); (107: body ray cells procumbent with mostly 2–4 rows of upright and/or square

marginal cells); 108: body ray cells procumbent with over 4 rows of upright and/or square marginal cells; 115: 4–12 rays per mm; 116: ≥ 12 rays per mm. Mineral inclusions: 136: prismatic crystals present; 140: prismatic crystals in chambered upright and/or square ray cells. (E. Uetimane, P.E. Gasson & E.A. Wheeler)

Growth and development Seedlings develop a dark red taproot with slender lateral roots. The first 5–10 leaves of seedlings are simple; the first compound leaves develop 6–12 months after germination. The tree is evergreen, but flushes of new dark red leaves appear at the end of the rainy season. Flowering trees have been recorded from May to November, and fruits ripen about 4 months later. They are eaten by monkeys, which may serve as seed dispersers.

Ecology *Trichoscypha arborea* occurs mostly in evergreen forest, sometimes in moist semi-deciduous forest, often along watercourses and in coastal formations. It is found up to 300 m altitude and prefers moist but free draining localities.

Propagation and planting There are 700–800 seeds per kg. Seeds start germinating 3–8 weeks after sowing, but some seeds still germinate after 3 years. The germination rate is usually high, 80–90%.

Genetic resources *Trichoscypha arborea* has a quite large area of distribution and is locally common. There are no indications of any commercial exploitation or threats and it seems therefore not liable to genetic erosion.

Prospects *Trichoscypha arborea* is a multipurpose tree with limited prospects as a commercial timber species because of its relatively small bole size. However, it has a high value for its fruits and the medicinal use of the bark resin. Research on domestication is recommended because it may have prospects as fruit tree in agroforestry systems.

Major references Breteler, 2001b; Breteler, 2004; de Koning, 1983; Hawthorne & Jongkind, 2006; Kryn & Fobes, 1959; Sallenave, 1955; Savill & Fox, 1967; Young, 1976.

Other references Aubréville, 1959a; Bolza & Keating, 1972; Burkill, 1985; Cooper & Record, 1931; de la Mensbruge, 1966; Faure & Louppe, 2006; Hawthorne, 1995; Irvine, 1961; Keay, 1989; Kokwaro, 1986; Normand, 1955; Takahashi, 1978; Vivien & Faure, 1996.

Sources of illustration Aubréville, 1959a; Breteler, 2001b; Hawthorne & Jongkind, 2006.

Authors E.A. Obeng

TRICHOSCYPHA LONGIFOLIA (Hook.f.) Engl.

Protologue Bot. Jahrb. Syst. 1: 425 (1881).

Family Anacardiaceae

Synonyms *Sorindeia longifolia* (Hook.f.) Oliv. (1868).

Origin and geographic distribution *Trichoscypha longifolia* is restricted to Sierra Leone and Liberia.

Uses The wood is used for planks and construction in local house building. A bark decoction is used as an antiseptic wash for sores and wounds. Leaves are applied to heal ulcers. The oily seeds are edible.

Properties The wood is greyish to greenish yellow and somewhat variegated. The grain is fairly straight, texture fine. The wood is lustrous and has no distinct odour or taste. It is heavy, hard, tough and strong, and somewhat splintery. It is not easy to work when dry, but takes a fine polish. The bark exudes a clear, sticky, pungent resin which becomes black upon exposure. This resin can stain hands and clothing and is very difficult to remove.

Botany Evergreen, dioecious, small to medium-sized tree up to 25 m tall; bole often branchless to a considerable height, usually straight, up to 30 cm in diameter, without buttresses; bark surface greenish brown, inner bark exuding a clear resin becoming black upon exposure; twigs densely short-hairy. Leaves alternate, clustered near ends of twigs, up to 60 cm long, imparipinnately compound with 6–9 pairs of leaflets; stipules absent; petiole deeply grooved and slightly winged at base; petiolules c. 1.5 cm long, wrinkled; leaflets alternate to opposite, oblong-lanceolate, up to 30 cm × 10 cm, cuneate at base, acuminate at apex, leath-

Trichoscypha longifolia – wild

ery, nearly glabrous, midrib impressed above, pinnately veined with 13–25 pairs of lateral veins. Inflorescence a lax panicle up to 35 cm long, terminal or on branches below the leaves, red-brown short-hairy. Flowers unisexual, regular, 5(–6)-merous, red-brown, small, nearly sessile; calyx with short lobes, hairy; petals free, ovate, c. 3 mm long, whitish; disk hairy; stamens free, alternating with petals, anthers 1.5–2 mm long; ovary superior, 1-celled, styles 3–4, short; male flowers with strongly reduced ovary, female flowers with reduced stamens. Fruit an ellipsoid drupe c. 2.5 cm × 1.5–2 cm, laterally compressed, glabrous, dehiscent, 1-seeded.

Trees flower between July and September, and fruits ripen about 5 months later.

Trichoscypha comprises about 30 species and is nearly confined to West and Central Africa. Cameroon and Gabon are richest, with 16 and 13 species, respectively.

Ecology *Trichoscypha longifolia* occurs in moist evergreen forest.

Genetic resources and breeding *Trichoscypha longifolia* has a limited distribution area and specific habitat requirements, and is therefore liable to threats of genetic erosion.

Prospects It is very unlikely that *Trichoscypha longifolia* will become a valuable commercial timber species in future because of its small bole size and very limited area of occurrence. However, it is valued by local people as source of timber for construction purposes, edible seeds and bark for medicinal purposes. Protection in the wild and its domestication should therefore be promoted and be given research attention.

Major references Breteler, 2001b; Burkill, 1985; Cooper & Record, 1931.

Other references Hawthorne & Jongkind, 2006.

Authors E.A. Obeng

TRILLESANTHUS MACROURUS (Gilg) Sosef

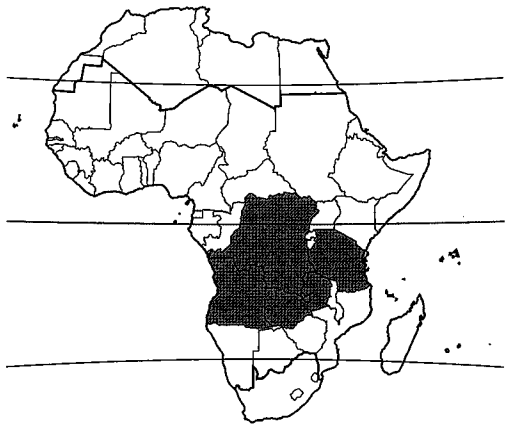
Protologue Blumea 55(1): 90 (2010).

Family Dipterocarpaceae

Synonyms *Marquesia macroura* Gilg (1908).

Origin and geographic distribution *Trillesanthus macrourus* occurs in south-eastern DR Congo, western Tanzania, northern Zambia and north-eastern Angola.

Uses The wood is used for posts, poles and planks in house building, and for fences. It is also used as firewood and produces charcoal of excellent quality. In Zambia the bark is used to make the end-plate of bee-hives. *Trillesanthus macrourus* is a valuable source of nectar and pollen for honey bees.



Trillesanthus macrourus – wild

Properties The wood is brownish, hard and durable. It is heavy, with a density of about 880 kg/m^3 at 15% moisture content. The rates of shrinkage during drying are quite high, from green to oven dry 7.2% radial and 10.4% tangential. At 15% moisture content, the modulus of rupture is 154 N/mm^2, compression parallel to grain 63 N/mm^2, compression perpendicular to grain 3 N/mm^2, shear 10 N/mm^2 and cleavage 17.5 N/mm.

The bark contains up to 10% tannin.

Botany Evergreen, small to medium-sized tree up to 25 m tall; bole branchless for up to 10 m, usually fluted, often twisted, with buttresses; bark surface fissured, grey-brown, often flaking in strips, inner bark thin, slightly fibrous, brown to reddish brown, fading to creamy brown; crown rounded; twigs short-hairy, soon becoming glabrous. Leaves alternate, simple and entire; stipules small, caducous; petiole c. 1 cm long; blade ovate to elliptical-oblong, 4–10 cm × 1.5–5 cm, rounded to slightly cordate at base, usually acuminate at apex, papery, glabrous to short-hairy above, densely whitish short-hairy below, with a gland at base of midrib above, pinnately veined with 8–10 pairs of lateral veins. Inflorescence an axillary or terminal panicle up to 9 cm long, densely short-hairy, many-flowered. Flowers bisexual, regular, 5-merous, sweet-scented; pedicel 2–3 mm long; sepals free, ovate, 1–2 mm long, short-hairy, accrescent to wings in fruit; petals free, obovate to elliptical, 6.5–8

mm long, minutely hairy, white; stamens numerous, free, 6–7.5 mm long; ovary superior, ovoid, hairy, 3-celled below but 1-celled above, style c. 2 mm long. Fruit an ovoid nut 5–8 mm × 5–6 mm, indehiscent, 1-seeded, surrounded by 5 narrowly oblong wings 2–3.5 cm long derived from the sepals.

In Zambia *Trillesanthus macrourus* flowers from June to October. The flowers are pollinated by insects such as bees. Fruits ripen 2–3 months after flowering. The roots have symbiosis with ectomycorrhizae.

Trillesanthus comprises 3 species and occurs from Gabon to Tanzania and Zambia. *Trillesanthus excelsus* Pierre (synonym: *Marquesia excelsa* (Pierre) R.E.Fr.) is a medium-sized to large tree up to 45 m tall with an often fluted bole up to 90 cm in diameter, occurring scattered in the forest in Gabon. Its wood is dark brown, heavy and hard, and seems to be of no economic interest.

Ecology *Trillesanthus macrourus* occurs in dry evergreen forest and woodland, in its eastern part of distribution often together with *Brachystegia*, up to 1500 m altitude. It is found on sandy, loamy as well as rocky soils. It is not very tolerant to fire.

Management *Trillesanthus macrourus* can be propagated by seed, which does not need pre-treatment. Wildlings are sometimes also collected for planting. *Trillesanthus macrourus* is locally very common, sometimes occurring in nearly pure stands. The tree can be managed by pollarding, lopping and coppicing. Froghoppers are commonly found on the tree; they produce a sticky exudation. *Trillesanthus macrourus* can be attacked by the termite *Macrotermes falciger*.

Genetic resources and breeding There are no indications that *Trillesanthus macrourus* is threatened. It is locally common and apparently not much exploited.

Prospects Information on *Trillesanthus macrourus* in the literature is limited. Research on growth rates and propagation is needed to judge its usefulness in agroforestry systems and its prospects as a timber tree of more commercial importance.

Major references Chilufya & Tengnäs, 1996; Sosef, 2010; Takahashi, 1978; Verdcourt, 1989b.

Other references Duvigneaud, 1961; Mickels-Kokwe, 2006.

Authors R.H.M.J. Lemmens

UAPACA GUINEENSIS Müll.Arg.

Protologue Flora 47: 517 (1864).

Family Euphorbiaceae (APG: Phyllanthaceae)

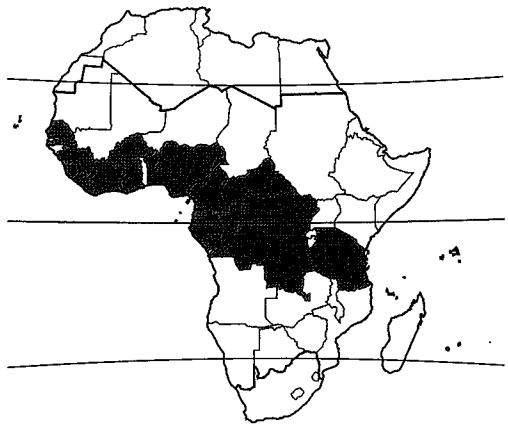
Chromosome number $2n = 26$

Vernacular names Sugar plum, rikio (En). Rikio, palétuvier de rivière, palétuvier d'eau douce (Fr). Sambi, cor de mogno (Po).

Origin and geographic distribution *Uapaca guineensis* occurs from Senegal east to the Central African Republic and south to DR Congo and Tanzania. It possibly also occurs in Uganda.

Uses The wood is used locally for joinery, planks, railway sleepers, beams, furniture, beds and kitchen utensils. It is suitable for construction work where high stability is not required. After quarter-cutting to improve the stability, the wood can be used for flooring, joinery and cabinet work. Throughout West Africa the bole is used to make dugout canoes. The stilt roots and branches are suitable for boat ribs. The wood produces good firewood and an excellent charcoal appreciated for forging.

Especially the roots of *Uapaca guineensis* are widely used medicinally; stem bark, leaves and fruits are used to a lesser extent. Root preparations are commonly taken as an aphrodisiac and to treat male impotence. In Sierra Leone a steam bath with the roots is used to treat headache. In Côte d'Ivoire a root bark preparation is applied to leprous sores and taken as a tonic by women who have just given birth. In Côte d'Ivoire and Congo a root bark decoction is taken orally or as an enema to treat oedema and gastro-intestinal problems. In Gabon a root bark decoction is applied in the form of an



Uapaca guineensis – wild

enema as an emetic; a stem bark extract is drunk for the same purpose. Powdered root bark is sniffed to treat nasal cancer. In Congo and DR Congo a root bark decoction is taken to treat female sterility, toothache, rheumatism and piles. In Congo a root infusion is taken to treat headache caused by fever. Painful parts are embrocated with the crushed roots to ease the pain. A root infusion is taken with sugar cane juice to treat a blocked nose and pulmonary afflictions. In Gabon stem bark scrapings mixed with salt are rubbed in to treat skin complaints. In DR Congo a decoction of leaves, stem bark or root bark is taken to treat dysentery, diarrhoea, stomach-ache and venereal diseases. Pulped leaves with palm oil are applied to furuncles to mature them and to relieve migraine and rheumatism. They are also massaged onto legs of rachitic children to strengthen them. In Tanzania a stem bark decoction is taken to treat malaria. In Liberia unripe fruits are taken as a cough medicine. In northern Nigeria the flowers and bark enter into arrow poison preparations.

The fruits have a sweet edible pulp, which can be eaten raw. Its taste resembles that of dried prunes or avocado. In Nigeria the pulp is made into a refreshing drink. Young twigs exude a red sticky sap, which dries like a gum and is used as a dye, e.g. for fishing lines. In Nigeria the large leaves are used to wrap kola nuts. The tree is used for shade and could be planted in coffee and cocoa plantations. It can also be planted to stabilize river banks.

Production and international trade In Liberia, Cameroon and DR Congo *Uapaca guineensis* is commercially exploited under its trade name 'rikio', but nearly completely for local markets. In Sierra Leone it has been exploited on a commercial basis for some years, but this stopped in the mid-1960s because it was not considered profitable.

Properties The heartwood is red to reddish brown, sometimes with dark streaks, becoming pale greyish brown to pale reddish brown upon exposure, and is indistinctly demarcated from the up to 8 cm wide sapwood. The grain is straight to slightly wavy, texture moderately coarse. Quarter-sawn surfaces show an attractive silver-grain figure.

The wood is medium-weight, with a density of 580–750(–850) kg/m^3 at 12% moisture content. It air dries fairly rapidly. Boards of 2.5 cm thick take about 2 months to dry to 20% moisture content. The wood has some tendency to warping and surface checking during drying. Kiln drying showed good results when mild schedules were used. The rates of shrinkage are quite high, from green to oven dry 3.9–4.9% radial and 10.3–11.7% tangential. Once dry, the wood is moderately stable in service.

At 12% moisture content, the modulus of rupture is 101–118 N/mm^2, modulus of elasticity 12,150–14,100 N/mm^2, compression parallel to grain 48–56 N/mm^2, shear 12.5 N/mm^2, cleavage 18 N/mm, Janka side hardness 5200–7730 N, Janka end hardness 8270 N and Chalais-Meudon side hardness 2.2–3.1.

The wood is rather difficult to saw and work, particularly dried wood, because it contains silica. It is recommended to use stellite-tipped saw teeth and tungsten-carbide tipped cutting edges. The wood tends to split upon nailing and screwing, and pre-boring is necessary. It glues well. The wood is moderately durable, being quite resistant to fungi and dry-wood borers, but less resistant to termites. It is moderately resistant to impregnation with preservatives.

Ethanolic extracts of the wood showed moderate antiplasmodial activity and no significant antibacterial or antifungal activity against human pathogens in vitro. The wood and bark contain much tannin. The seed kernel contains about 28% of a dark green oil.

Description Evergreen, dioecious, small to medium-sized tree up to 30 m tall; bole branchless for up to 15 m, straight or irregular, slightly angular or fluted, up to 100 cm in diameter, on rounded stilt roots up to 4 m high; bark surface cracked or scaly, dark brown to blackish, inner bark granular, brittle, red, with some clear or red exudate; crown dense, much-branched; branches long, slender, nearly glabrous, leaf scars conspicuous; terminal bud sticky. Leaves arranged spirally, crowded towards the end of the branches, simple; stipules absent or triangular to linear, up to 2 mm long, soon falling; petiole 2–6.5 cm long, jointed at top; blade obovate to obovate-elliptical, (9–)13–22 cm × (4–)7–12 cm, base cuneate to rounded, apex usually rounded, margins usually slightly wavy, papery or thin-leathery, glabrous, with numerous minute glandular dots, pinnately veined with (5–)8–9(–11) pairs of lateral veins. Male inflorescence an axillary globose to ovoid head 4–7 mm in diameter, with peduncle 1–2.5 cm long and up to 12 yellow bracts up to 1.5 cm long; female flowers solitary. Flowers unisexual, 4–5-merous; male flowers sessile, with calyx lobes up to 1.5 mm long, petals c. 1 mm long, stamens 4–5, free, c. 2 mm long, rudimentary ovary c. 1 mm long, short-hairy; female flowers

Uapaca guineensis – 1, base of bole; 2, branch with male flowers; 3, fruit; 4, fruit stone. Redrawn and adapted by Achmad Satiri Nurhaman

with 0.5–1 cm long pedicel, calyx shallowly cup-shaped with triangular to rounded lobes c. 1 mm long, short-hairy, ovary superior, ellipsoid, 3–8 mm long, 3-celled, glabrous, styles 3, 4–5 mm long, reflexed, twice bifid towards apex. Fruit an ovoid-globose drupe 2–2.5 cm in diameter, slightly warty, glabrous, greenish, with 3 stones 1.5–2 cm long, each stone 1-seeded. Seedling with epigeal germination; hypocotyl 6–7 cm long, channelled, epicotyl c. 2 cm long; cotyledons rounded, up to 3.5 cm wide; first leaves alternate.

Other botanical information *Uapaca* comprises about 50 species from tropical Africa and Madagascar, and is in need of a complete revision. Several *Uapaca* spp. have been confused with *Uapaca guineensis*, particularly *Uapaca lissopyrena* Radcl.-Sm. in southern Africa, *Uapaca mole* Pax in Central Africa and *Uapaca togoensis* Pax in West Africa, and information found in the literature under *Uapaca guineensis* may refer to either one of these species.

Uapaca lissopyrena Radcl.-Sm. is a medium-sized tree up to 30 m tall with stilt-rooted bole up to 100 cm in diameter, occurring in swamp and riverine forest but also in drier woodland in Malawi, Zambia, Zimbabwe and Mozambique at 400–1650 m altitude. The boles are used to make dug-out canoes.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; 13: simple perforation plates; (14: scalariform perforation plates); (15: scalariform perforation plates with ≤ 10 bars); 22: intervessel pits alternate; 23: shape of alternate pits polygonal; 27: intervessel pits large (≥ 10 μm); 31: vessel-ray pits with much reduced borders to apparently simple: pits rounded or angular; 32: vessel-ray pits with much reduced borders to apparently simple: pits horizontal (scalariform, gash-like) to vertical (palisade); 42: mean tangential diameter of vessel lumina 100–200 μm; 43: mean tangential diameter of vessel lumina ≥ 200 μm; (46: ≤ 5 vessels per square millimetre); 47: 5–20 vessels per square millimetre; (56: tyloses common). Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; (69: fibres thin- to thick-walled); 70: fibres very thick-walled. Axial parenchyma: 76: axial parenchyma diffuse; 77: axial parenchyma diffuse-in-aggregates; 78: axial parenchyma scanty paratracheal; (79: axial parenchyma vasicentric); 92: four (3–4) cells per parenchyma strand; 93: eight (5–8) cells per parenchyma strand; 94: over eight cells per parenchyma strand. Rays: 98: larger rays commonly 4- to 10-seriate; 102: ray height > 1 mm; (103: rays of two distinct sizes); 108: body ray cells procumbent with over 4 rows of upright and/or square marginal cells; (109: rays with procumbent, square and upright cells mixed throughout the ray); 115: 4–12 rays per mm. Mineral inclusions: 159: silica bodies present; 160: silica bodies in ray cells.

(D. Louppe, P. Détienne & E.A. Wheeler)

Growth and development In southern Cameroon seedlings of *Uapaca guineensis* are found to be fast growing, both in shade or in full sun, and even in relatively dry localities. However, slow growth of seedlings has also been reported: about 5 cm tall after 3 months and 10 cm after 5 months. In Guinea the mortality after the first dry season was about 50%, but nearly all plants survived after that. Young trees may become 4–6 m tall in 6 years. Mean annual diameter increments of the bole of 0.5–1.4 cm have been recorded. The fruits are eaten by birds such as turacos, and by fruit bats, monkeys, chimpanzees, gorillas and elephants,

which all may disperse the seeds. The tree grows in symbiosis with several ectomycorrhizae and arbuscular mycorrhizae.

Ecology *Uapaca guineensis* occurs in humid localities in rainforest and is common along river banks, where it sometimes forms pure stands. It also occurs in mixed evergreen forest and forest margins, and in bushland on steep slopes, from sea-level up to 1100 m altitude.

Propagation and planting It has been reported that seedlings and saplings are quite shade tolerant. Multiplication of *Uapaca guineensis* is by seed or wildlings. In Tanzania fruits can be collected throughout the year with a peak in November–December. There are about 1600 seeds per kg. The seeds must be sown when still fresh, as they do not store well. The germination rate is 50–80%, and germination usually starts 3–4 weeks after sowing. In DR Congo seed set and germination are reported to be often poor.

Management In forests in Cameroon, the average density of *Uapaca* trees (several species) with a bole diameter of more than 15 cm has been estimated at 2.3 trees/ha and the average wood volume at 2.2 m^3/ha; in Gabon the average wood volume has been estimated at 0.3 m^3/ha. In Liberia the mean wood volume of *Uapaca* trees with a bole diameter of more than 50 cm has been recorded as 1.9 m^3/ha. In some forests in Sierra Leone the average density of trees with a bole diameter of more than 75 cm is 0.3 tree/ha.

Uapaca guineensis can be coppiced and pollarded. It has been planted as a forest regeneration tree in Guinea, to provide a green corridor for large forest animals. In Burundi it has been planted in an arboretum as an experiment to stabilize river banks.

Diseases and pests No diseases are known on *Uapaca guineensis*, but several insects feed on the leaves and buds, especially beetles (*Anthribidae*, *Chrysomelidae* and *Scolytidae*), whereas other beetles such as *Xylosandrus crassiusculus* feed on the wood.

Harvesting In Gabon the minimum bole diameter allowed for harvesting is 70 cm. Felling *Uapaca guineensis* trees for timber is hampered by the large stilt roots. All plant parts can be harvested for medicinal purposes whenever the need arises. The root bark can be easily harvested from the stilt roots.

Yield In DR Congo a tree with a bole of 6 m long and 60 cm in diameter yielded 1.6 m^3 of wood.

Handling after harvest Fresh logs often sink in water and cannot be transported by river. The common irregular shape of the bole may give difficulties for processing in sawmills.

Genetic resources Although *Uapaca guineensis* is commonly exploited for its timber, it is also widespread and locally common and there are no signs that it is threatened by genetic erosion.

Prospects The wood is mainly used locally, particularly for construction because of its fair durability. This situation will probably not change because the stilt roots, the often poor shape of the bole and difficulties in processing the timber limit the possibilities for export. *Uapaca guineensis* is commonly used as a medicinal plant against a variety of diseases. No phytochemical analyses have been effected, and only few pharmacological tests have been done. Additional research is recommended so that the active compounds can be identified and the potential of these compounds can be evaluated. It is also recommended to plant *Uapaca guineensis* along rivers with a large difference in water flow to stabilize the banks.

Major references Breteler, 2012a; Burkill, 1994; Carter & Radcliffe-Smith, 1988; Dudek, Förster & Klissenbauer, 1981; Lubini & Mandango, 1981; Neuwinger, 2000; Oteng-Amoako (Editor), 2006; Ruffo, Birnie & Tengnäs, 2002; Takahashi, 1978; Voorhoeve, 1979.

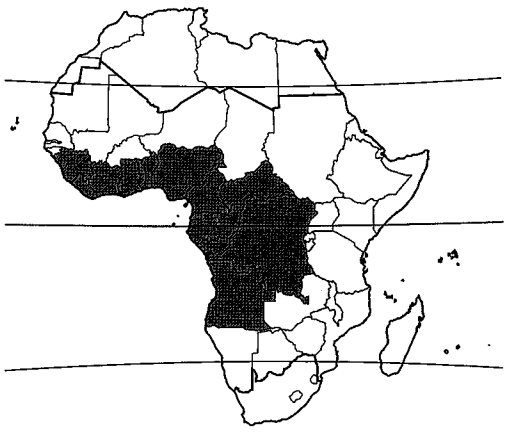
Other references Atindehou et al., 2002; Aubréville, 1959a; Betti, 2004; Bolza & Keating, 1972; de Koning, 1983; de Saint-Aubin, 1963; Eyog Matig et al. (Editors), 2006; Gassita et al. (Editors), 1982; Hawthorne, 1995; Hawthorne & Jongkind, 2006; InsideWood, undated; Katende, Birnie & Tengnäs, 1995; Marshall et al., 2000; Normand & Paquis, 1976; Savill & Fox, 1967; Stäuble, 1986; Vivien & Faure, 1985; Vivien & Faure, 1996; White & Abernethy, 1997; Wilks & Issembé, 2000.

Sources of illustration Voorhoeve, 1979; Wilks & Issembé, 2000.

Authors M.M. Kitambala

UAPACA HEUDELOTII Baill.

Protologue Adansonia 1: 81 (1860).
Family Euphorbiaceae (APG: Phyllanthaceae)
Chromosome number $2n = 26$
Vernacular names Rikio des rivières (Fr).
Origin and geographic distribution *Uapaca heudelotii* occurs from Guinea east to the Central African Republic and DR Congo, and south to northern Angola.



Uapaca heudelotii – wild

Uses The wood is used for construction, joinery and planks. It is suitable for flooring, interior trim, mine props, ship building, vehicle bodies, furniture and railway sleepers. The stilt roots and branches are suitable for boat ribs. The wood produces good firewood and charcoal.
The fruits are edible; they are quite sweet and locally appreciated. The roots and bark are used in traditional medicine for similar purposes as those of *Uapaca guineensis* Müll.Arg. Root preparations are taken as expectorant, and to treat fever and headache. Bark decoctions are administered to treat dysentery, food poisoning, female sterility, ovarian disorders, toothache, rheumatism, oedema and haemorrhoids. They are also applied as enema to treat constipation, and rubbed in against swellings. Pulped leaves with palm oil are applied to furuncles to mature them and to relieve migraine and rheumatism. The bark has been used to dye fishing lines. The tree with its stilt roots prevents erosion on stream banks and promotes accumulation of silt.

Properties The heartwood is pale red to reddish brown, often with darker streaks, and not distinctly demarcated from the sapwood. The grain is usually straight, texture moderately coarse. The wood is medium-weight, with a density of 680–790 kg/m^3 at 12% moisture content. It air dries fairly rapidly, but should be dried with some care because it has some tendency to warp and develop surface checking. The rates of shrinkage are rather high, from green to oven dry 4.6% radial and 9.8% tangential. Once dry, the wood is quite unstable in service.
At 12% moisture content, the modulus of rupture is (100–)132–166 N/mm^2, modulus of elasticity 11,560 N/mm^2, compression parallel to grain 56–63 N/mm^2, cleavage 21–23 N/mm and Chalais-Meudon side hardness 2.9–5.5.
The wood is rather difficult to saw and work, particularly dried wood; it contains silica. It is recommended to use stellite-tipped saw teeth and tungsten-carbide tipped cutting edges. The wood finishes well and glues satisfactorily. It is moderately durable, being quite resistant to fungi and dry-wood borers, and moderately resistant to termites and marine borers. The heartwood is resistant to impregnation with preservatives.
Several alkaloids have been found in the leaves.

Description Evergreen, dioecious, small to medium-sized tree up to 20(–30) m tall; bole branchless for up to 8 m, usually straight and cylindrical, up to 100 cm in diameter, on stilt roots up to 3 m high; bark surface scaly, grey-brown, inner bark pinkish to pale reddish brown, with red exudate; crown rather dense, much-branched; twigs with tufts of reddish hairs in leaf axils, with conspicuous leaf scars. Leaves arranged spirally, crowded towards the

Uapaca heudelotii – 1, flowering twig; 2, male inflorescence; 3, fruits.
Source: Flore analytique du Bénin

end of the branches, simple and entire; stipules absent; petiole 0.5–3.5(–5.5) cm long; blade elliptical to obovate, (6–)10–15(–25) cm × 2.5–5(–8) cm, base cuneate, apex obtuse to rounded or indistinctly short-acuminate, papery, glabrous, pinnately veined with (8–)10–13(–17) pairs of lateral veins. Male inflorescence an axillary globose head 7–8 mm in diameter, on a peduncle up to 2 cm long, with c. 10 yellowish bracts up to 1 cm long; female flowers solitary. Flowers unisexual, 4–5-merous; male flowers sessile, with unequal calyx lobes up to 2 mm long, petals c. 1 mm long or absent, stamens free, 2.5–4 mm long, rudimentary ovary up to 1.5 mm long, glabrous; female flowers pedicelled, calyx shallowly cup-shaped with triangular to rounded lobes up to 1 mm long, glabrous, ovary superior, ellipsoid, 5–6 mm long, 3-celled, glabrous, styles 3. Fruit an ellipsoid to obovoid drupe 2–3 cm long, slightly angular, smooth but often with some small warts, glabrous, with 3 stones, each stone 1-seeded. Seedling with epigeal germination; hypocotyl 3–4 cm long, channeled, epicotyl c. 3 cm long; cotyledons rounded, c. 2.5 cm wide; first leaves alternate.

Other botanical information *Uapaca* comprises about 50 species from tropical Africa and Madagascar, and is in need of a complete revision.

Uapaca acuminata (Hutch.) Pax & K.Hoffm. is a medium-sized to fairly large tree up to 35 m tall with bole up to 80 cm in diameter, supported by stilt roots up to 4 m high. It occurs from southern Nigeria to western DR Congo. It has been considered as a variety of *Uapaca heudelotii* (var. *acuminata* Hutch.) and its wood, bark and fruits are undoubtedly used for similar purposes. In the literature the two species have been confused. *Uapaca acuminata* differs from *Uapaca heudelotii* in its glabrous twigs, usually smaller and more distinctly short-acuminate leaves, and in its ecology, preferring well-drained localities in primary and secondary forest.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; (12: solitary vessel outline angular); 13: simple perforation plates; 22: intervessel pits alternate; (23: shape of alternate pits polygonal); 26: intervessel pits medium (7–10 μm); 27: intervessel pits large (≥ 10 μm); 31: vessel-ray pits with much reduced borders to apparently simple: pits rounded or angular; 32: vessel-ray pits with much reduced borders to apparently simple: pits horizontal (scalariform, gash-like) to vertical (palisade); 42: mean tangential diameter of vessel lumina 100–200 μm; 47: 5–20 vessels per square millimetre. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 69: fibres thin- to thick-walled. Axial parenchyma: 76: axial parenchyma diffuse; 78: axial parenchyma scanty paratracheal; 79: axial parenchyma vasicentric; 93: eight (5–8) cells per parenchyma strand. Rays: (97: ray width 1–3 cells); 98: larger rays commonly 4- to 10-seriate; 102: ray height > 1 mm; 107: body ray cells procumbent with mostly 2–4 rows of upright and/or square marginal cells; 108: body ray cells procumbent with over 4 rows of upright and/or square marginal cells; (109: rays with procumbent, square and upright cells mixed throughout the ray); 113: disjunctive ray parenchyma cell walls present; 115: 4–12 rays per mm. Mineral inclusions: 159: silica bodies present; 160: silica bodies in ray cells; (161: silica bodies in axial parenchyma cells).

(P. Mugabi, P.E. Gasson & E.A. Wheeler)

Growth and development In Côte d'Ivoire trees flower in December–January, in Nigeria in December–February, and in Gabon at the beginning of the rainy season when the water level of the rivers rises. In Côte d'Ivoire fruits have been found in May–June and September–October. They are eaten by birds such as turacos and parrots, and by fruit bats, monkeys, chimpanzees, gorillas, duikers, pigs, civets and elephants, which all may disperse the seeds. Trees grow in symbiosis with ectomycorrhizal fungi.

Ecology *Uapaca heudelotii* is characteristic for riverine forest, in forested as well as savanna regions, up to 500 m altitude. It is always close to the water, or the stilt roots are in the water resembling mangrove vegetation and providing shelter and breeding ground for river fishes. It is locally common in seasonally flooded areas.

Propagation and planting There are about 2500 seeds per kg. Seeds usually start germinating 2–3 weeks after sowing, and the germination rate is high.

Management The preference for river banks makes that felling the trees and removing the logs are often difficult operations, and the stilt roots cause additional difficulties during exploitation.

Genetic resources There are no signs that *Uapaca heudelotii* is threatened by genetic

erosion.

Prospects The wood is mainly used locally and this situation will probably not change because difficulties in processing the timber limit the possibilities for export. The presence of stilt roots and the preference of *Uapaca heudelotii* for water habitats make harvesting difficult. *Uapaca heudelotii* may be well suited for planting to restore riverine forest and to stabilize river banks.

Major references Bolza & Keating, 1972; Breteler, 2012a; Burkill, 1994; Takahashi, 1978; Vivien & Faure, 1996.

Other references Akoègninou, van der Burg & van der Maesen (Editors), 2006; Aubréville, 1959a; Barku, 1996; Cooper & Record, 1931; de la Mensbruge, 1966; Hawthorne, 1995; Hawthorne & Jongkind, 2006; Keay, 1989; Neuwinger, 2000; Normand & Paquis, 1976; Pauwels, 1993; Raponda-Walker & Sillans, 1961; Tailfer, 1989; Voorhoeve, 1979; White & Abernethy, 1997.

Sources of illustration Akoègninou, van der Burg & van der Maesen (Editors), 2006.

Authors R.H.M.J. Lemmens

UAPACA MOLE Pax

Protologue Bot. Jahrb. Syst. 19: 79 (1894).

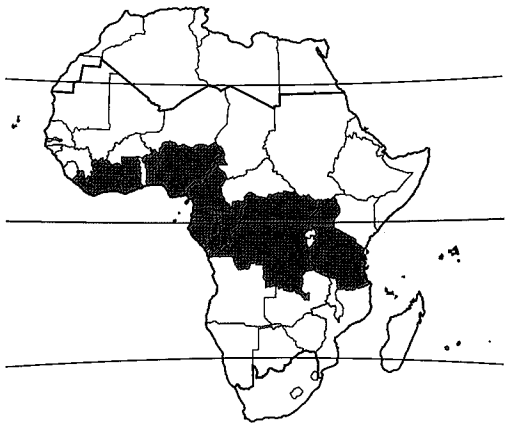
Family Euphorbiaceae (APG: Phyllanthaceae)

Chromosome number $2n = 26$

Synonyms *Uapaca paludosa* Aubrév. & Leandri (1935).

Vernacular names Rikio des marais, rikio à grandes feuilles (Fr).

Origin and geographic distribution *Uapaca mole* occurs from Liberia east to Uganda and Tanzania, and south to Cabinda (Angola).



Uapaca mole – wild

Uses The wood is used for joinery, boxes and kitchen utensils. It is suitable for construction, flooring, mine props, ship building, vehicle bodies, furniture, railway sleepers and vats. In Ghana it is considered a good firewood, and it is also used to produce charcoal.

In Congo a root infusion is taken to treat headache caused by fever. Crushed roots are applied as an embrocation to ease pain. A root infusion is considered expectorant and taken to treat a blocked nose and pulmonary afflictions. Bark decoctions are drunk to treat female sterility, dysentery and food-poisoning. They are used as a mouth wash to treat toothache, as a vapour bath to treat rheumatism and oedema, as an enema to treat piles, and in baths to strengthen rachitic and premature children. Pulped leaves or stem bark with palm oil are applied to furuncles to mature them and also to treat migraine and rheumatism. The fruits are edible and taste like avocado.

Properties The heartwood is pale pink to pale red and not distinctly demarcated from the sapwood. The grain is often wavy to interlocked, texture moderately coarse. Quarter-sawn surfaces show an attractive stripy figure. The wood is medium-weight, with a density of about 760 kg/m^3 at 12% moisture content. It air dries fairly well with little splitting or warping, although the rates of shrinkage are quite high, from green to oven dry 5.9–6.3% radial and 11.3–12.8% tangential.

At 12% moisture content, the modulus of rupture is 133–175 N/mm^2, modulus of elasticity 17,840 N/mm^2, compression parallel to grain 54–57 N/mm^2, shear 10.5 N/mm^2, cleavage 25 N/mm and Chalais-Meudon side hardness 2.6.

The wood is rather difficult to saw and work, particularly dried wood; it contains silica. It is recommended to use stellite-tipped saw teeth and tungsten-carbide tipped cutting edges. The wood planes to a smooth surface. It holds nails and screws well, but pre-boring is necessary. It is moderately durable, being quite resistant to fungi and dry-wood borers, and moderately resistant to termites and marine borers. It is moderately resistant to impregnation with preservatives.

Ethanolic and dichloromethane bark extracts showed moderate antiplasmodial activity in vitro.

Botany Deciduous, dioecious, small to medium-sized tree up to 20(–40) m tall; bole often fluted, up to 75 cm in diameter, usually on stilt roots up to 4 m high; bark surface grey; crown

much-branched; twigs reddish brown short-hairy, becoming glabrous, with conspicuous leaf scars. Leaves arranged spirally, crowded towards the end of the branches, simple and entire; stipules ovate-lanceolate to ovate-spatulate, often slightly asymmetrical, leaf-like, (0.5–)1–3 cm long, persistent; petiole (1.5–)3–6(–9) cm long, robust; blade obovate-elliptical, 9–30(–50) cm × 4–17(–30) cm, base cuneate to rounded or slightly cordate, apex usually rounded, thick-papery to thin-leathery, short-hairy on veins below, pinnately veined with (8–)9–12(–20) pairs of lateral veins. Male inflorescence an axillary globose to ovoid head 8–10 mm in diameter, with peduncle 1–2.5 cm long and up to 12 yellowish bracts up to 1 cm long; female flowers solitary. Flowers unisexual, 4–5-merous, petals usually absent; male flowers sessile, with calyx lobes up to 1.5 mm long, stamens free, c. 2 mm long, rudimentary ovary c. 1 mm long, short-hairy; female flowers with 1–2 cm long pedicel, calyx shallowly cup-shaped with triangular to rounded lobes c. 1 mm long, short-hairy, ovary superior, globose, 3–4 mm in diameter, 3(–4)-celled, slightly hairy, styles 3, 3–4.5 mm long, reflexed, 5–6-fid towards apex. Fruit an ovoid-globose drupe 2–3 cm in diameter, slightly rough, sparingly short-hairy, greenish becoming brown, with 3(–4) stones, each stone 1-seeded. Seedling with epigeal germination; hypocotyl 8–9 cm long, channeled, epicotyl c. 2 cm long, finely hairy; cotyledons rounded, up to 3.5 cm wide; first leaves alternate.

Uapaca comprises about 50 species from tropical Africa and Madagascar, and is in need of a complete revision.

The fruits are eaten by birds such as turacos, and by fruit bats, monkeys, chimpanzees, gorillas and elephants, which all may disperse the seeds.

Uapaca staudtii Pax resembles *Uapaca mole* in having distinct stipules, but these are ear- or cap-shaped; moreover, it has comparatively narrower leaves and slightly hairy fruits. It is a small to medium-sized tree up to 25 m tall, occurring in riverine and swamp forest from Nigeria to Gabon. The reddish brown wood is used for joinery, interior trim, furniture and railway sleepers. It is also used for charcoal production. The fruits are edible.

Uapaca vanhouttei De Wild. (synonyms: *Uapaca brieyi* De Wild., *Uapaca letestuana* A.Chev.) also resembles *Uapaca mole*. It differs in its shorter and narrower stipules, and is a small to medium-sized tree up to 30 m tall with stilt-rooted bole up to 65 cm in diameter, occurring from southern Nigeria to DR Congo. Its purplish brown wood is medium-weight with a density of 655–795 kg/m^3 at 12% moisture content, fairly hard and moderately durable, and is used for similar purposes as that of *Uapaca mole*, and also as firewood and for charcoal production. The bark is probably also used for similar purposes in traditional medicine, and the fruits are edible.

Ecology *Uapaca mole* occurs in swamp, lakeside and riverine forest, but also in rainforest on slopes and crests as well as in well-drained valley bottoms, up to 1400 m altitude.

Management *Uapaca mole* can be propagated by seed and wildlings. It can be pollarded and coppiced.

Genetic resources and breeding There are no signs that *Uapaca mole* is threatened by genetic erosion.

Prospects The wood is mainly used locally and this situation will probably not change because the stilt roots, the often poor shape of the bole and difficulties in processing the timber limit the possibilities for export. In Central Africa *Uapaca mole* has many medicinal uses. The antiplasmodial activity of the root bark is promising, and more research is warranted to elucidate the chemical compounds and evaluate the potential of these compounds for future medicine development.

Major references Bolza & Keating, 1972; Breteler, 2012a; Burkill, 1994; Carter & Radcliffe-Smith, 1988; Takahashi, 1978.

Other references Aubréville, 1959a; de Koning, 1983; de la Mensbruge, 1966; Fouarge & Gérard, 1964; Hawthorne, 1995; Hawthorne & Jongkind, 2006; Mbatchi et al., 2006; Vivien & Faure, 1985; Vivien & Faure, 1996; White & Abernethy, 1997.

Authors G.H. Schmelzer

UAPACA PYNAERTII De Wild.

Protologue Etudes fl. Bas- Moyen-Congo 2(3): 274 (1908).

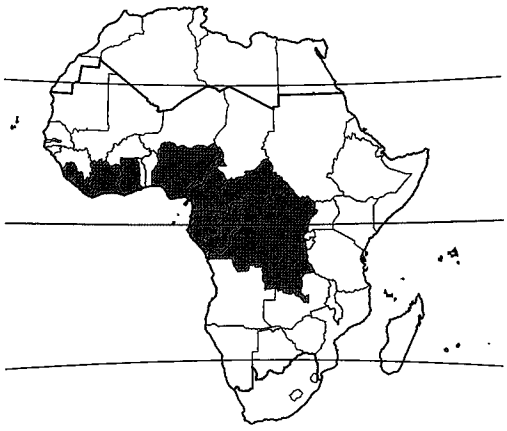
Family Euphorbiaceae (APG: Phyllanthaceae)

Chromosome number $2n = 26$

Synonyms *Uapaca corbisieri* De Wild. (1927), *Uapaca esculenta* A.Chev. ex Aubrév. & Leandri (1935).

Vernacular names Sugar plum (En). Rikio noir, borikio (Fr).

Origin and geographic distribution *Uapaca pynaertii* occurs from Sierra Leone east to the



Uapaca pynaertii – *wild*

Central African Republic and DR Congo, and south to Gabon.

Uses The wood is used for joinery, planks and canoes. It is suitable for construction, flooring, interior trim, mine props, ship building, vehicle bodies, furniture, railway sleepers and turnery. It is also used as firewood and for charcoal production.
The fruits are edible with a nice taste, and locally popular.

Properties The heartwood is pale pink to pale red and not distinctly demarcated from the sapwood. The grain is usually straight, texture moderately coarse. The wood is lustrous. It is medium-weight, with a density of about 730 kg/m^3 at 12% moisture content. It should be air dried with care to prevent distortion and warping. The rates of shrinkage are quite high, from green to oven dry 6.2% radial and 9.3% tangential. Once dry, the wood is unstable in service.
At 12% moisture content, the modulus of rupture is 146 N/mm^2, modulus of elasticity 12,250 N/mm^2, compression parallel to grain 58 N/mm^2, shear 8.5 N/mm^2, cleavage 24 N/mm and Chalais-Meudon side hardness 2.8.
The wood is rather difficult to saw and work, particularly dried wood; it contains silica. It is recommended to use stellite-tipped saw teeth and tungsten-carbide tipped cutting edges. The wood finishes well and glues satisfactorily. It is moderately durable, being quite resistant to fungi and dry-wood borers, and moderately resistant to termites and marine borers. The heartwood is resistant to impregnation with preservatives.

Botany Evergreen, dioecious, small to medium-sized tree up to 30(–40) m tall; bole branchless for up to 20 m, usually straight and cylindrical, usually on stilt roots up to 5 m high; bark surface smooth to slightly cracked, grey to dark green or nearly black, inner bark pinkish brown to reddish brown with white streaks, becoming brown upon exposure; crown layered, rather open; twigs glabrous but slightly scaly, with conspicuous leaf scars. Leaves arranged spirally, crowded towards the end of the branches, simple and entire; stipules absent; petiole (1–)2–5(–13) cm long; blade obovate, 15–25(–40) cm × 5–10(–14) cm, base cuneate, apex obtuse to rounded, leathery, glabrous, pinnately veined with 7–12 pairs of lateral veins. Male inflorescence an axillary globose head 1.5–4 cm in diameter, with c. 10 yellowish bracts up to 2.5 cm long; female flowers unknown. Flowers unisexual, 4–5-merous; male flowers sessile, with unequal calyx lobes up to 1.5 mm long, stamens free, c. 6 mm long, rudimentary ovary up to 2 mm long, short-hairy. Fruit an ovoid-globose drupe up to 5 cm long, smooth, glabrous, with (4–)5 stones, each stone 1-seeded. Seedling with epigeal germination; hypocotyl 5–7 cm long, channeled, epicotyl c. 1 cm long; cotyledons rounded, up to 5.5 cm wide; first leaves alternate.
In Côte d'Ivoire, in 40 years old secondary forest grown on fallow land, trees with a bole diameter of 53 cm have been recorded. In Côte d'Ivoire trees flower in November–December and ripe fruits can be found in January–July. The fruits are eaten by birds such as turacos, and by fruit bats, monkeys, chimpanzees, gorillas and elephants, which all may disperse the seeds.
Uapaca comprises about 50 species from tropical Africa and Madagascar, and is in need of a complete revision.

Ecology *Uapaca pynaertii* occurs in primary as well as secondary, evergreen forest, sometimes in riverine forest, up to 800 m altitude.

Genetic resources and breeding There are no signs that *Uapaca pynaertii* is threatened by genetic erosion.

Prospects The wood is mainly used locally and this situation will probably not change because the stilt roots and difficulties in processing the timber limit the possibilities for export. The fruits are larger than those of other *Uapaca* spp., and they are reportedly delicious; possibilities for further commercialization through domestication could be investigated.

Major references Bolza & Keating, 1972; Breteler, 2012a; Burkill, 1994; de Koning,

1983; Takahashi, 1978.

Other references Aubréville, 1959a; de la Mensbruge, 1966; Hawthorne, 1995; Hawthorne & Jongkind, 2006; Keay, 1989; Normand & Paquis, 1976; Sallenave, 1964; Vivien & Faure, 1996; Voorhoeve, 1979.

Authors R.H.M.J. Lemmens

UAPACA THOUARSII Baill.

Protologue Etude Euphorb.: 596 (1858).

Family Euphorbiaceae (APG: Phyllanthaceae)

Origin and geographic distribution *Uapaca thouarsii* is endemic to Madagascar, where it occurs throughout the eastern parts of the island.

Uses The wood, known as 'voapaka' together with the wood of several other *Uapaca* spp., is used for construction of houses and bridges, railway sleepers and shingles. It is suitable for mine props, ship building (ribs) and vehicle bodies, but less suitable for flooring, joinery and furniture because the wood is not very stable in service. It is also used as firewood and for charcoal production.

The fruits are edible. Bark decoctions are taken to treat colic.

Properties The heartwood is reddish brown to dark brown and not distinctly demarcated from the slightly paler, wide sapwood. The grain is usually straight, texture moderately coarse. The wood is lustrous. Quarter-sawn surfaces show a nice silver grain figure.

The wood is fairly heavy, with a density of 750–900 kg/m^3 at 12% moisture content. It should be air dried with care to prevent distortion and warping. Quarter-cutting before drying is recommended. The rates of shrinkage are quite high, from green to oven dry 3.9–6.2% radial and 10.5–12.8% tangential. It takes 2–3 months to air dry boards of 2.5 cm thick from green to 30% moisture content. Once dry, the wood is moderately stable in service.

Uapaca thouarsii – wild

At 12% moisture content, the modulus of rupture is 135–182 N/mm^2, modulus of elasticity 9800–15,420 N/mm^2, compression parallel to grain 50–73 N/mm^2, shear 11 N/mm^2, cleavage 21 N/mm and Chalais-Meudon side hardness 3.4–6.3.

The wood is rather difficult to saw and work; it contains silica and has a blunting effect on tools. It is recommended to use stellite-tipped saw teeth and tungsten-carbide tipped cutting edges. The wood planes to rather rough surfaces due to the fibrous tissues. It nails and glues moderately well, and varnishes well. It is not suitable for veneer. The heartwood is moderately durable, being quite resistant to fungi and dry-wood borers, and moderately resistant to termites and marine borers. The heartwood is resistant to impregnation with preservatives.

Botany Evergreen, dioecious, small to medium-sized tree up to 20(–25) m tall; bole up to 60 cm in diameter, usually on stilt roots; bark surface slightly rough, greyish white; crown elongate, much-branched; twigs waxy-viscous and greyish short-hairy when young, soon becoming glabrous, with conspicuous leaf scars. Leaves arranged spirally, crowded towards the end of the branches, simple and entire; stipules absent; petiole 2–4 cm long, jointed near apex; blade obovate, 10–14 cm × 4–9 cm, base cuneate, apex obtuse to rounded, thin-leathery, glabrous, pinnately veined with 5–7 pairs of lateral veins. Male inflorescence an axillary globose head c. 8 mm in diameter, on 2–4 cm long peduncle, with up to 7 bracts up to 12 mm long; female flowers solitary. Flowers unisexual, 4–5-merous; male flowers sessile, with unequal calyx lobes, stamens free, rudimentary ovary shorter than stamens, glabrous; female flowers with unequal and hairy calyx lobes, ovary superior, 3-celled, styles 3, branched at apex. Fruit an ovoid-globose drupe up to 3 cm long, warty, yellowish to brownish, with (1–)2–3 stones; stones 3-angled, slightly flattened, 1–1.5 cm long, 1-seeded.

Trees grow fairly fast. Young trees of 7 years old reached an average height of 4 m. They tolerate shade fairly well. Trees flower in November–January and ripe fruits can be found in November–December; fruits take a long time

to mature, about one year.

Uapaca comprises about 50 species from tropical Africa and Madagascar, and is in need of a complete revision. About 12 species can be found in Madagascar, all endemic. Some of these provide useful timber, but for most species the edible fruits are more important.

Uapaca betamponensis Leandri is a small tree up to 15 m tall with a slender bole branchless for up to 12 m, only known from forest north of Toamasina in eastern Madagascar. Its reddish brown wood has been used for planks and for charcoal production, and the fruits are edible.

Uapaca densifolia Baker is a small to medium-sized tree up to 20 m tall, widely distributed in central and eastern Madagascar. Its wood is useful for house and bridge construction and for railway sleepers. The wood is medium-weight with a density of about 750 kg/m^3 at 12% moisture content, and other wood properties are quite similar to those of *Uapaca thouarsii*. It is also used for charcoal production. The fruits are edible.

Uapaca louvelii Denis is a small tree up to 15 m tall, widely distributed in eastern Madagascar. Its wood is useful for house and bridge construction and for railway sleepers, but impregnation with preservatives may be needed for these purposes because it is often only moderately durable. The wood is fairly heavy with a density of about 815 kg/m^3 at 12% moisture content, and other wood properties are quite similar to those of *Uapaca thouarsii*, although the wood is slightly harder. It is also used for charcoal production. The fruits are edible.

Ecology *Uapaca thouarsii* occurs in humid evergreen forest, up to 900 m altitude, in regions with an average annual rainfall of 1500–3000(–3500) mm and up to 2 dry months, and a mean temperature of 20–24°C. It prefers sandy or loamy-sandy soils.

Management The 1000-seed weight is about 600 g. Seeds can be stored in a cool locality for up to 5 months without losing much germination capacity. The germination rate is 60–80%. Pre-treatment of seeds is not needed before sowing. The seeds are usually sown in plastic bags. Propagation by suckers is sometimes possible. Care should be taken in harvesting because the boles of older trees often have heart rot.

Genetic resources and breeding There are no signs that *Uapaca thouarsii* is threatened by genetic erosion at present, although the high pressure on natural forest in eastern Madagascar may become a serious threat even for such a widespread species.

Prospects The wood is mainly used locally and this situation will probably not change because the stilt roots and difficulties in processing the timber limit the possibilities for export. *Uapaca thouarsii* can be useful for enrichment planting in natural forest.

Major references Blaser et al., 1993; Bolza & Keating, 1972; Parant, Chichignoud & Rakotovao, 1985; Sallenave, 1955; Sallenave, 1971.

Other references Boiteau, Boiteau & Allorge-Boiteau, 1999; Guéneau, Bedel & Thiel, 1970–1975; Leandri, 1958; Rabevohitra, 1984; Schatz, 2001; Takahashi, 1978.

Authors R.H.M.J. Lemmens

UVARIODENDRON ANISATUM Verdc.

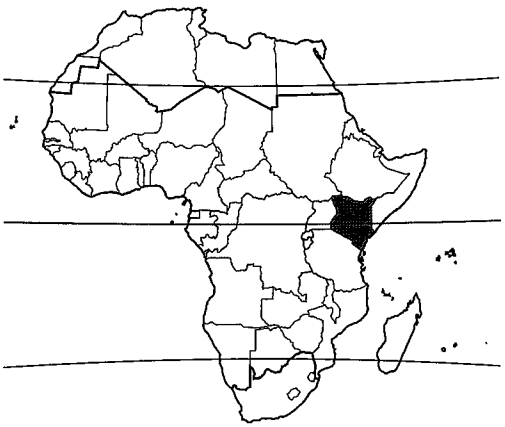
Protologue Kew Bull. 10: 596 (1955).

Family Annonaceae

Origin and geographic distribution The distribution of *Uvariodendron anisatum* is limited to central and southern Kenya.

Uses The wood is used for walking sticks and handles of axes.

Botany Shrub or small tree up to 9(–15) m tall; bole up to 40 cm in diameter; bark surface smooth, grey-brown; twigs with lenticels, glabrous, with an odour of anise when crushed. Leaves alternate, simple and entire; stipules absent; petiole 4–7 mm long, thick; blade oblong to elliptical, 8–30 cm × 3.5–11 cm, cuneate to rounded at base, acute to obtuse at apex, thinly leathery, slightly short-hairy below, pinnately veined with 16–21 pairs of lateral veins. Flowers solitary in the leaf axils or on branches or bole, bisexual, regular, 3-merous,



Uvariodendron anisatum – wild

pendulous, scented; pedicel 2.5–3.5 cm long; sepals free, kidney-shaped, 5–6 mm long, short-hairy outside; petals 6, in 2 whorls, ovate to elliptical-obovate, 2–2.5 cm long, fleshy, velvety brown hairy outside, creamy white to yellow; stamens numerous, c. 2 mm long, anthers sessile; carpels 5–15, free, c. 3.5 mm long, hairy. Fruit consisting of 4–15 indehiscent cylindrical follicles 2.5–6 cm × 1.5–2 cm, becoming glabrous, bluish black, slightly constricted between the seeds, each follicle 5–16-seeded. Seeds ellipsoid, flattened, 1–1.5 cm × c. 1 cm, pale brown, with ruminate endosperm.
Uvariodendron comprises about 15 species and is restricted to tropical Africa.

Ecology *Uvariodendron anisatum* occurs in rather dry evergreen forest at 1150–1800 m altitude. It is locally common.

Genetic resources and breeding Being endemic to Kenya, *Uvariodendron anisatum* has a small distribution area, in which there is much human activity such as development of urban areas and agriculture. In the IUCN Red List it is classified as vulnerable.

Prospects The use of the wood will remain of limited importance. Monitoring of the populations is needed because *Uvariodendron anisatum* may become threatened with extinction in the near future.

Major references Beentje, 1994; Verdcourt, 1971; World Conservation Monitoring Centre, 1998.

Other references Couvreur, 2008.

Authors R.H.M.J. Lemmens

UVARIOPSIS CONGENSIS Robyns & Ghesq.

Protologue Ann. Soc. Sci. Bruxelles, sér. B, 53: 317 (1933).

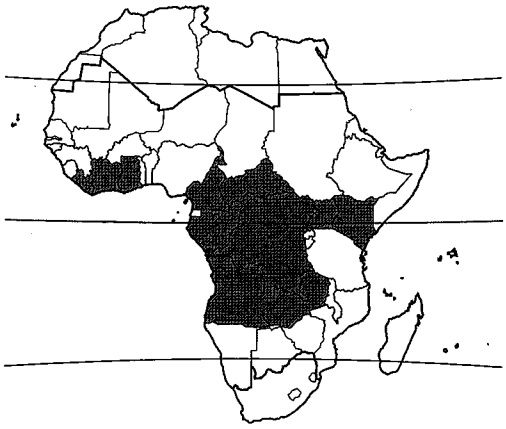
Family Annonaceae

Origin and geographic distribution *Uvariopsis congensis* is widespread, from Liberia east to western Kenya, and south to DR Congo and Zambia.

Uses In Kenya branches are used for bows. In DR Congo the tree is part of many rituals and as such protected by the Mbuti and Efe people.

Properties Leaf extracts showed cytotoxicity against human KB cancer cell lines, as well as antimalarial activity. Acetogenins have been isolated from the leaves.

Botany Shrub or small to medium-sized tree up to 20 m tall; bole up to 30 cm in diameter; bark surface fissured, grey-green with brown-



Uvariopsis congensis – wild

ish patches; twigs glabrous. Leaves alternate, simple and entire, with a strong spicy smell when rubbed; stipules absent; petiole 2–4 mm long; blade oblong to elliptical-oblong, 5.5–15 cm × 1.5–6(–7.5) cm, cuneate to rounded at base, obtuse to acuminate at apex, papery, glabrous, pinnately veined with 8–12 pairs of lateral veins. Flowers solitary in the leaf axils or on branches or bole, unisexual, regular; pedicel up to 1 cm long; sepals 2, fused at base, lobes nearly round, 1–2 mm in diameter, short-hairy outside; petals 4, free, elliptical to ovate-lanceolate, 0.5–1 cm long, fleshy, short-hairy outside, greenish white to yellow; male flowers often higher up the branches amongst the leaves, with numerous stamens c. 0.5 mm long, anthers sessile; female flowers often at main stem, with numerous hairy carpels 3–4 mm long. Fruit consisting of 4–6 indehiscent oblong-ellipsoid to cylindrical follicles 1.5–4.5 cm × 1–2 cm, becoming glabrous, red, slightly constricted between the seeds, each follicle 3–10-seeded. Seeds ellipsoid, slightly flattened, 1–1.5 cm × 0.5–1 cm, yellowish brown, with ruminate endosperm.
Uvariopsis congensis trees fruit fairly synchronously, producing large amounts of fruits. The fruits are an important food for chimpanzees and monkeys, locally even the main food. It has been reported that these primates often spit the seeds, dispersing them in this way, but the seeds are also swallowed and dispersed by the dung. It has been noted that seeds from chimpanzee dung germinated, but that those taken directly from trees did not. The fruits are also eaten by elephants. In some forests in Uganda, *Uvariopsis congensis* is a preferred sleeping

tree for chimpanzees.
Uvariopsis comprises about 15 species and is restricted to tropical Africa. It is closely related to *Monocyclanthus*, which comprises a single species and should possibly be united with *Uvariopsis*, as has recently been done with *Dennettia*.

Ecology *Uvariopsis congensis* occurs in evergreen forest up to 1650 m altitude, commonly on valley slopes, but also in riverine forest and forest margins. It is locally common. It is susceptible to drought.

Management *Uvariopsis congensis* is shade tolerant. It regenerates under the canopy and in small gaps in the forest. Seedlings usually die in large gaps. Seeds probably need pretreatment before they can be used as sowing material.
In western Uganda *Uvariopsis congensis* is a common understorey or mid-storey tree, with a density that locally exceeds 100 trees/ha. It may be common in both unlogged and selectively logged forest, but it attains its maximum abundance in forest areas of minimum disturbance. Adult trees are commonly strongly clumped.

Genetic resources and breeding *Uvariopsis congensis* is widely distributed and locally common, also in secondary forest, and is not under threat of genetic erosion.

Prospects The use of the wood will remain of limited importance. *Uvariopsis congensis* is considered important in traditional ceremonies by some African peoples. It also has an ecological function as an important food plant of primates. Pharmacological research seems worthwhile considering the results of preliminary screening for active compounds.

Major references Beentje, 1994; Kenfack et al., 2003; Verdcourt, 1971.

Other references Boutique, 1951; Couvreur, 2008; Dominy & Duncan, 2005; Hawthorne & Jongkind, 2006; Kiama & Kiyiapi, 2001; Krief, Hladik & Haxaire, 2005; Robson, 1960; Terashima & Ichikawa, 2003.

Authors R.H.M.J. Lemmens

WEINMANNIA MINUTIFLORA Baker

Protologue Journ. Linn. Soc., Bot. 21: 339 (1884).

Family Cunoniaceae

Origin and geographic distribution *Weinmannia minutiflora* is widespread in northern, central and eastern Madagascar, south to Tolanaro.

Weinmannia minutiflora – wild

Uses The wood, known as 'lalona' just like the wood of several other *Weinmannia* spp., is valued for house construction, bridges, scaffolding and railway sleepers, but also for luxury and mosaic parquet flooring. It is suitable for interior and exterior joinery, ship building, furniture, cabinet work, toys, novelties, boxes, crates, carvings, pattern making, turnery, veneer, plywood, hardboard and particle board. It is also used as firewood and for charcoal production.

Properties The heartwood is reddish brown and not distinctly demarcated from the sapwood. The grain is straight or wavy, texture fine and even. The wood is medium-weight, with a density of 650–690 kg/m^3 at 12% moisture content. It air dries slowly with a tendency to check. The rates of shrinkage are high, from green to oven dry 4.1–6.2% radial and 9.2–11.7% tangential. Once dry, the wood is moderately stable in service. At 12% moisture content, the modulus of rupture is 114–137 N/mm^2, modulus of elasticity 9410–12,150 N/mm^2, compression parallel to grain 51–52 N/mm^2, shear 6–8.5 N/mm^2, cleavage 16.5–18.5 N/mm and Chalais-Meudon side hardness 2.8–9.0.
The wood is fairly easy to work with both machine and hand tools. It can be planed to a nice surface. It is fairly easy to nail and has good nail-holding capacity. It glues satisfactorily and the varnishing properties are good. The wood can be sliced into good-quality veneer. The wood is fairly durable, being resistant to attacks by fungi, termites and *Lyctus* borers. It is resistant to impregnation with preserva-

tives, especially the heartwood.

Botany Evergreen medium-sized tree up to 30 m tall; bole branchless for up to 12 m, up to 60 cm in diameter; bark surface grey to reddish brown, with lenticels; twigs slightly quadrangular, short hairy. Leaves decussately opposite, compound with 3(–5) leaflets; stipules fused, ovate, caducous; petiole c. 2 cm long; leaflets sessile, obovate to elliptical, 2 lateral ones 3–4 cm × 1–1.5 cm, central one 5–7 cm × 2–2.5 cm, usually obtuse at apex, margins toothed, papery to thin-leathery, glabrous, pinnately veined with c. 8 pairs of lateral veins. Inflorescence an axillary or apparently terminal spike up to 18 cm long, often several closely together on a branch, short-hairy, with flowers often clustered on the axis in groups of 4. Flowers bisexual, regular, 4(–5)-merous, small, nearly sessile; sepals slightly fused at base, triangular, usually glabrous; petals free, elliptical, up to 1.5 mm long, whitish, early caducous; stamens usually 8, free; disk usually 8-lobed; ovary superior, densely hairy, 2-celled, styles 2, divergent. Fruit an ellipsoid capsule c. 4 mm long, densely short-hairy, crowned with the styles, dehiscing by 2 valves, with yellow endocarp separating from the fruit wall, many-seeded. Seeds broadly ellipsoid, c. 0.5 mm long, reddish brown, with 2 bundles of long hairs at both ends.

The flowers are often visited by bees.

Weinmannia comprises about 150 species and occurs in Central and South America, tropical Asia, the South Pacific, Australia, New Zealand, Comoros, Madagascar, Réunion and Mauritius. Approximately 40 species can be found in Madagascar. The wood of several *Weinmannia* spp. reaching larger tree dimensions is used for similar purposes as that of *Weinmannia minutiflora*, although it is often more heavy, with a density of 750–980 kg/m^3 at 12% moisture content.

The wood of *Weinmannia bojeriana* Tul., a shrub to small or medium-sized tree up to 20 m tall widespread in central and eastern Madagascar, is undoubtedly used. The wood of *Weinmannia rutenbergii* Engl. is heavy, with a density of 930–980 kg/m^3 at 12% moisture content. *Weinmannia rutenbergii* is widespread in Madagascar except in the western part of the island, and varies in habit from a small shrub to a medium-sized tree up to 20 m tall. It is probably one of the most commonly exploited *Weinmannia* spp. for timber, used for instance for parquet flooring. It should be noted that the identity of *Weinmannia* spp. in the literature is often uncertain because of misidentifications and confusion. This is a result of the many species present in Madagascar and difficulties in using identification keys. Pieces of bark and wood of *Weinmannia* spp. have been used to prepare a reddish brown dye, and bark and leaves are used in traditional medicine, especially as astringent and to treat headache.

The wood of *Weinmannia tinctoria* Sm., a small to medium-sized tree up to 20 m tall with a bole up to 100 cm in diameter endemic to Réunion and Mauritius, has been used in Réunion for joinery, furniture, cabinet work and cooperage. However, populations have strongly declined and *Weinmannia tinctoria* is included in the IUCN Red list as critically endangered. Leaf extracts of *Weinmannia tinctoria* showed inhibiting activity of angiotensin converting enzyme, which plays an important role in the regulation of blood pressure and diuresis.

Ecology *Weinmannia minutiflora* occurs in humid evergreen forest from sea-level up to 2000 m altitude.

Management The central part of logs is often speckled whitish or shows signs of heart rot; heart shakes are common at felling.

Genetic resources and breeding *Weinmannia minutiflora* is widespread in Madagascar and does not seem to be threatened.

Prospects *Weinmannia minutiflora* and other *Weinmannia* spp. deserve more attention in research. They may well be interesting timber trees for planting in Madagascar; their wood is highly valued, many species are widespread and some species even invade deforested regions. Research attention should focus on growth rates, optimal ecological conditions and propagation techniques.

Major references Bernardi, 1965; Bolza & Keating, 1972; Guéneau, Bedel & Thiel, 1970–1975; Takahashi, 1978.

Other references Adsersen & Adsersen, 1997; Bedolla, 1997; Boiteau, Boiteau & Allorge-Boiteau, 1999; Bradford, 2001; Sallenave, 1955; Sallenave, 1971; Schatz, 2001; Scott, 1997.

Authors R.H.M.J. Lemmens

WIELANDIA OBLONGIFOLIA (Baill.) Petra Hoffm. & McPherson

Protologue Ann. Missouri Bot. Gard. 94: 547 (2007).

Family Euphorbiaceae (APG: Phyllanthaceae)

Synonyms *Blotia oblongifolia* (Baill.) Leandri

(1957).

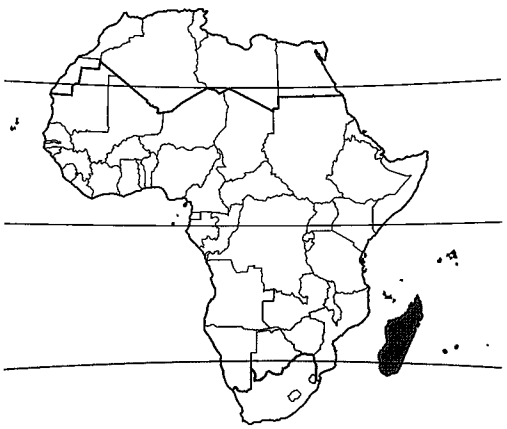
Origin and geographic distribution *Wielandia oblongifolia* is endemic to Madagascar where it is widespread in the eastern part of the island.

Uses The wood of *Wielandia oblongifolia* is used in light construction, e.g. for ridge-poles, and for light carpentry and fences. It is also used as firewood.

Properties The wood is whitish, soft and easy to work.

Botany Evergreen monoecious shrub or small to medium-sized tree up to 20 m tall; bole branchless for up to 10 m, up to 35 cm in diameter; twigs glabrous. Leaves alternate, simple and entire; stipules narrowly triangular to linear, 3–7(–25) mm long, often broken off; petiole 3–10 mm long; blade oblong to elliptical, (4–)6–14(–30) cm × 1.5–4.5(–7) cm, cuneate to obtuse at base, acute to acuminate at apex, leathery, glabrous, pinnately veined with 7–10 pairs of lateral veins. Inflorescence a cluster of flowers in leaf axils or on older branches. Flowers unisexual, regular, 5-merous, reddish; pedicel 0.5–2 cm long; sepals elliptical to oblong or linear, c. 2 mm long, glabrous; petals spatulate to rhombic, clawed, c. 2 mm long, glabrous; disk annular; male flowers with stamens fused up to half their length, 1–1.5 mm long, ovary rudimentary; female flowers with superior, ovoid, 3-celled ovary c. 1 mm long, styles 3, 2-lobed from near the base. Fruit a nearly globose, 3-lobed capsule c. 1.5 cm in diameter, reddish, glabrous, up to 6-seeded. Seeds ovoid to globose or 3-angled, c. 7 mm long, brown, slightly marbled.

Flowering and fruiting specimens of *Wielandia oblongifolia* have been collected throughout the year. It has been reported that fruits are eaten by birds and rodents, which may serve as seed dispersers. However, *Wielandia* fruits open explosively when dry and are also considered to spread the seeds merely by this action.



Wielandia oblongifolia – *wild*

Partly based on molecular phylogenetic work, in 2007 the genera *Blotia* and *Petalodiscus* were incorporated in *Wielandia*, which until then comprised a single species but now comprises 13 species. Most *Wielandia* spp. are endemic to Madagascar, but some extend to Comoros, Mayotte and Seychelles and one to south-eastern Kenya.

Ecology *Wielandia oblongifolia* occurs in humid forest and in the transition zone towards subhumid forest, up to 800 m altitude, usually on gneiss-derived soils.

Genetic resources and breeding Although *Wielandia oblongifolia* is quite widespread and locally common, it has been proposed to assign to it the IUCN Red list 'near threatened' status as its habitat is under pressure because of continuing deforestation and fragmentation of the original forest in eastern Madagascar.

Prospects The wood of *Wielandia oblongifolia* is likely to remain of limited use in Madagascar.

Major references Boiteau, Boiteau & Allorge-Boiteau, 1999; Hoffmann, 1998; Hoffmann & McPherson, 1998; Hoffmann & McPherson, 2007; Leandri, 1958.

Other references Levin, 1986; Ramandimbisoa & Rakouth, 2005.

Authors L.P.A. Oyen

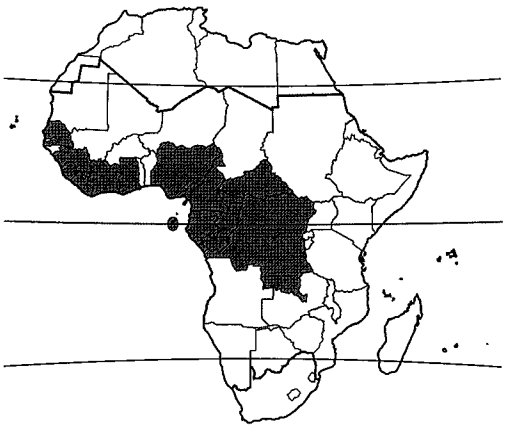
XYLOPIA QUINTASII Engl. & Diels

Protologue Engl., Monogr. afrik. Pflanzen-Fam. 6: 62 (1901).

Family Annonaceae

Origin and geographic distribution *Xylopia quintasii* occurs from Senegal eastward to the Central African Republic, and southward to DR Congo and Cabinda (Angola).

Uses The wood of *Xylopia quintasii*, most commonly known as 'aghako' in Ghana and as 'mvomba' in Cameroon, is commonly used in house building, often for posts, poles and planks, and for pestles, bowls, tool handles, bows, spear shafts, masts, canoe paddles and stakes for yam. It is suitable for heavy construction, heavy flooring, joinery, mine props, ship building, vehicle bodies, railway sleepers, ladders, sporting goods, toys, novelties, pattern making and turnery. The wood is also used as



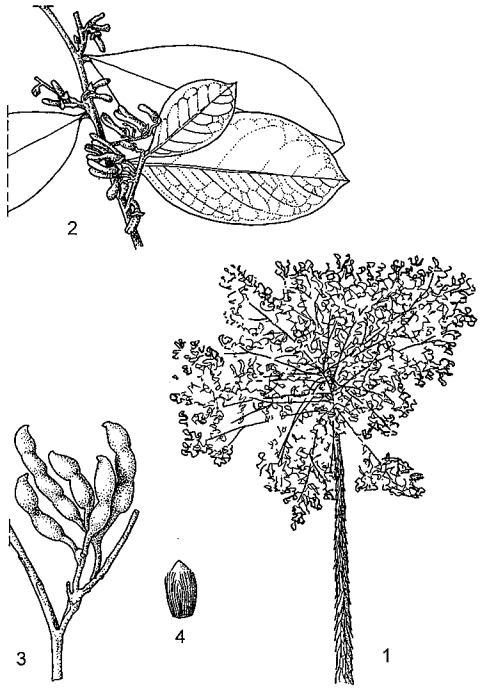
Xylopia quintasii – wild

firewood and for charcoal production.
Several parts of the plant are used in traditional medicine to treat various ailments. The scented bark is used in treating colds, bronchitis and pneumonia, and as anodyne. Macerated inner bark is applied to reduce swellings, and a preparation of scrapings of the inner bark soaked in water is used as mouthwash to treat pyorrhoea. In Nigeria powdered bark is applied to ulcers and in Gabon a lotion prepared from the bark is used to treat headache. Powdered roots are used to cure constipation and to treat sores and inflamed gums; they are also used in cancer treatment. Fruits are eaten to ease childbirth and to cure bronchitis and gonorrhoea. A decoction of leaves, stem bark and roots is used as general tonic and for treating rheumatism and stomach complaints. The fibrous inner bark has been used for cordage.

Production and international trade The wood of *Xylopia quintasii* has no commercial value on the international market; it is only used for local domestic products.

Properties The heartwood is yellowish to brown and indistinctly demarcated from the slightly paler sapwood. The grain is straight, texture fine. The wood has an unpleasant smell when freshly cut. It is heavy, with a density of 840–960 kg/m^3 at 12% moisture content, and hard. It air dries fairly well, but it is recommended to quarter-saw logs before drying. The rates of shrinkage are rather high, from green to oven dry 6.0% radial and 10.4% tangential. Once dry, the wood is moderately stable in service.
At 12% moisture content, the modulus of rupture is 181–198 N/mm^2, modulus of elasticity 14,800–22,830 N/mm^2, compression parallel to grain 73–74 N/mm^2, cleavage 22.5 N/mm, Janka side hardness 13,670 N and Chalais-Meudon side hardness 5.8.
The wood is tough but fairly easy to saw and work with both hand and machine tools. It planes readily and takes a good finish. The wood glues well and has good turning properties. The heartwood is moderately durable, being fairly resistant to termite attacks, but susceptible to marine borers. The sapwood is susceptible to *Lyctus* attack.
The presence of alkaloids, flavonoids, coumarins, tannins and saponosides has been demonstrated in various plant parts. Antispasmodic properties resembling those of papaverine have been reported for the alkaloids from the roots. Administration of aqueous root extracts to rats showed a significant increase of creatinine, alanine aminotransferase, Na^+, K^+ and Cl^- levels and a reduction of bicarbonate. The diterpene 7β-acetoxytrachyloban-18-oic acid has been isolated from the stem bark.

Description Small to medium-sized tree up to 30 m tall; bole usually straight and slender, up to 60(–90) cm in diameter, sometimes fluted



Xylopia quintasii – 1, tree habit; 2, part of flowering branch; 3, fruits; 4, seed.
Redrawn and adapted by G.W.E. van den Berg

at base or with narrow buttresses; bark surface flakey, dark grey to dark brown, inner bark strongly fibrous, peelable in long strips, pale brown to orange-brown, darkening upon exposure, strongly scented; crown often small, conical with horizontal branches; twigs often with small diagonal ridges, with lenticels, glabrous. Leaves alternate, simple and entire; stipules absent; petiole up to 0.5 cm long; blade obovate to elliptical, 7–14 cm × 3–6 cm, cuneate at base, short-acuminate to rounded at apex, thin-leathery, glabrous, pinnately veined with 6–8 pairs of lateral veins. Inflorescence a small fascicle among the leaves, up to 7-flowered, short-hairy. Flowers bisexual, regular, 3-merous, greenish white or yellowish white, fragrant; pedicel 3–7 mm long; sepals slightly fused at base, ovate-triangular, c. 2 mm long; petals free, in 2 whorls, outer ones linear, 1–2 cm long, inner ones shorter, short-hairy; stamens numerous; carpels 3–5, ovaries c. 1.5 mm long, styles up to 0.5 mm long. Fruit consisting of up to 5 cylindrical follicles 3–5 cm long, with stipe up to 1 cm long and constrictions between the seeds, glabrous, red-green, dehiscing with a single slit, 2–4-seeded. Seeds c. 1.5 cm × 0.5 cm, nearly completely enveloped by an orange aril fringed at apex. Seedling with epigeal germination; hypocotyl 5–6 cm long, channelled, epicotyl 3–4 mm long, hairy; cotyledons thin, remaining within the seed coat; first leaves opposite or alternate.

Other botanical information *Xylopia* is a large pantropical genus of about 150 species, with approximately 30 species in mainland tropical Africa and 25 in Madagascar. It is related to *Artabotrys* and badly in need of revision. The wood of several *Xylopia* spp. is used in tropical Africa.

Xylopia acutiflora (Dunal) A.Rich. is a small tree up to 15(–30) m tall, widespread from Guinea east to southern Sudan, and south to Angola and Zambia. Its heavy and hard wood is used in Cameroon and Gabon in house construction and for canoe paddles, bows and spear shafts. Bark decoctions are administered to treat pneumonia and as anodyne. The bark has been used for hut walls. The fruits are added to food as spice.

Xylopia cupularis Mildbr. (synonym: *Xylopia chrysophylla* Louis ex Boutique) is a medium-sized to fairly large tree up to 35 m tall with bole up to 60 cm in diameter, occurring from Cameroon east to DR Congo and south to Cabinda (Angola). Its yellowish brown and heavy wood, with a density of 750–935 kg/m^3 at 12% moisture content, is suitable for similar purposes as that of *Xylopia quintasii*; it is mainly used for construction, railway sleepers, vehicle bodies and implements. Leaf macerations are taken against diarrhoea.

Xylopia hypolampra Mildbr. (synonym: *Xylopia brieyi* De Wild.) is a medium-sized to fairly large tree up to 40 m tall with bole up to 100 cm in diameter, occurring from Cameroon and the Central African Republic to south-western DR Congo and Cabinda (Angola). Its yellowish brown, medium-weight to heavy wood, with a density of 670–920 kg/m^3 at 12% moisture content, is suitable for similar purposes as that of *Xylopia quintasii*; it is mainly used for construction, railway sleepers and implements, and as firewood. Bark macerations and decoctions are used in traditional medicine to treat asthma, cough and stomach-ache, and as diuretic and anthelmintic. The bark has been used for hut walls. The fruits and seeds are added to food as spice.

Xylopia mwasumbii D.M.Johnson is a small tree up to 9 m tall, only known from evergreen forest near the coast of central-east Tanzania. The wood is used for poles in house building and for tool handles.

Xylopia rubescens Oliv. is a small to medium-sized tree up to 20(–30) m tall with stilt-rooted bole up to 40 cm in diameter, widely distributed in swamp forest and riverine forest from Liberia east to Uganda and Tanzania, and south to Zambia and Mozambique. The yellowish white to pale brown wood is suitable for construction, joinery, ship building, vehicle bodies, furniture, toys, novelties, boxes, crates, veneer, plywood and pulpwood; it is used as firewood. The wood density is lower than that of *Xylopia quintasii* and the texture more coarse. The bark has been used for hut walls.

Xylopia staudtii Engl. & Diels is a medium-sized tree up to 30(–45) m tall with often stilt-rooted bole branchless for up to 20 m and up to 100(–150) cm in diameter, widespread from Sierra Leone east to Uganda, and south to DR Congo and Cabinda (Angola). The yellowish white to pale brown wood is suitable for construction, flooring, joinery, interior trim, ship building, vehicle bodies, furniture, sporting goods, toys, novelties, boxes, crates, carvings, vats, matches, veneer, plywood, hardboard, particle board and pulpwood. It is fairly lightweight with a density of about 500 kg/m^3 at 12% moisture content, and rather soft. The bark has been used for hut walls and cordage. Powdered bark or bark macerations are used in

traditional medicine to treat colds and headache, fruit macerations are taken to ease childbirth and pulverized fruits are applied to treat rheumatism. The fruits and seeds are added to food as spice.

Xylopia villosa Chipp is a small to medium-sized tree up to 25 m tall with bole up to 40 cm in diameter, occurring from Liberia to Nigeria. Its tough and fairly durable wood is used for posts in house building and for tool handles. Powdered bark or bark macerations are used in traditional medicine to treat colds and headache, and pounded seeds are applied to ulcers.

Xylopia wilwerthii De Wild. & T.Durand is a small tree up to 10 m tall with bole up to 15(–30) cm in diameter, restricted to DR Congo. Its yellow-brown and very heavy wood, with a density of 955–1085 kg/m^3 at 12% moisture content, is used for construction, implements, utensils, sculptures and turnery.

The best known species of the genus is *Xylopia aethiopica* (Dunal) A.Rich. Its wood is commonly used for similar purposes as that of *Xylopia quintasii*, although the wood density is much lower. However, *Xylopia aethiopica* is more important for its fruits and seeds used as spice, and as medicinal plant. The wood of *Xylopia parviflora* (A.Rich.) Benth. is also used, but this species is also more important as spice and medicinal plant.

Xylopia timber is used in Madagascar, but it is not clear to which species the usage is applicable.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: 1: growth ring boundaries distinct; 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; 13: simple perforation plates; 22: intervessel pits alternate; 23: shape of alternate pits polygonal; 25: intervessel pits small (4–7 μm); 26: intervessel pits medium (7–10 μm); 30: vessel-ray pits with distinct borders; similar to intervessel pits in size and shape throughout the ray cell; 42: mean tangential diameter of vessel lumina 100–200 μm; 47: 5–20 vessels per square millimetre; 58: gums and other deposits in heartwood vessels. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 69: fibres thin- to thick-walled; (70: fibres very thick-walled). Axial parenchyma: 86: axial parenchyma in narrow bands or lines up to three cells wide; 87: axial parenchyma reticulate; 92: four (3–4) cells per parenchyma strand; (93: eight (5–8) cells per parenchyma strand). Rays: 97: ray width 1–3 cells; (98: larger rays commonly 4- to 10-seriate); 104: all ray cells procumbent; (106: body ray cells procumbent with one row of upright and/or square marginal cells); 115: 4–12 rays per mm. Mineral inclusions: (136: prismatic crystals present); (138: prismatic crystals in procumbent ray cells).

(C. Essien, A.A. Oteng-Amoako & P. Baas)

Growth and development The growth of seedlings is slow. The seedlings are shade bearers. In West Africa flowering of *Xylopia quintasii* occurs from December to May, whereas in Gabon flowers can be found in February–April. Fruits mature about 6 months later. In Gabon fruits are produced in the long dry season, and the seeds with their orange aril are an important food for birds and monkeys, which serve as seed dispersers.

Ecology *Xylopia quintasii* usually occurs in humid evergreen lowland forest, often on slopes, but also along streams. It is commonly found in secondary forest.

Propagation and planting There are about 1500 seeds per kg. Seeds start germinating about 1 month after sowing, and all viable seeds have germinated after 2 months. The germination rate is about 70%.

Management In forest in Sierra Leone an average density of 2 *Xylopia quintasii* trees with a bole diameter of more than 15 cm has been recorded per ha.

Xylopia quintasii plays a role in shifting cultivation practices in Senegal. It is an important constituent of forest developing after dry farming of rice in temporarily cleared forest plots, and is one of the species preventing erosion.

Genetic resources *Xylopia quintasii* has a fairly wide distribution range and there are no indications of genetic erosion. However, in some parts of Sierra Leone over-exploitation for firewood and charcoal has been reported, and locally in Cameroon *Xylopia quintasii* has become rare because of over-exploitation for house construction.

Some other *Xylopia* spp. are under severe threat, particularly in coastal forests in East Africa. An example is *Xylopia mwasumbii*, which is classified as endangered in the IUCN Red List.

Prospects *Xylopia quintasii* will probably remain a timber tree of local importance only. Its prospects for the commercial timber trade are poor because of the small size of the bole and its apparently slow growth. Its medicinal value demands further pharmacological research for potential drug development.

Some other *Xylopia* spp., e.g. *Xylopia aethiopica*, *Xylopia hypolampra* and *Xylopia staudtii*, reach larger dimensions and may have better prospects as timber trees of future commercial importance. However, research is needed on growth rates, regeneration and proper management to assess their value for sustainable timber production on a larger scale. At any rate, the mean annual diameter growth of *Xylopia aethiopica* trees is fair, about 1 cm.

Major references Bolza & Keating, 1972; Boutique, 1951; Burkill, 1985; Cooper & Record, 1931; de Koning, 1983; Fouarge & Gérard, 1964; Oteng-Amoako (Editor), 2006; Savill & Fox, 1967; Vivien & Faure, 1985; White & Abernethy, 1997.

Other references Aké Assi et al., 1985; Aubréville, 1959b; Berhaut, 1971; Bobboi et al., 2004; Camara, 2001; de la Mensbruge, 1966; de Saint-Aubin, 1963; Hawthorne, 1995; Hawthorne & Jongkind, 2006; Irvine, 1961; Johnson, 1999; Konda ku Mbuta et al., 2010; le Thomas, 1969; Lovett et al., 2007; Mitani, 1999; Neuwinger, 2000; Quevauviller & Foussard-Blanpin, 1976; Raponda-Walker & Sillans, 1961; Takahashi, 1978; Vanden Berghen, 1994.

Sources of illustration le Thomas, 1969; White & Abernethy, 1997.

Authors A.A. Oteng-Amoako & E.A. Obeng

XYMALOS MONOSPORA (Harv.) Baill. ex Warb.

Protologue Bull. Mens. Soc. Linn. Paris 1: 650 (1886).

Family Monimiaceae

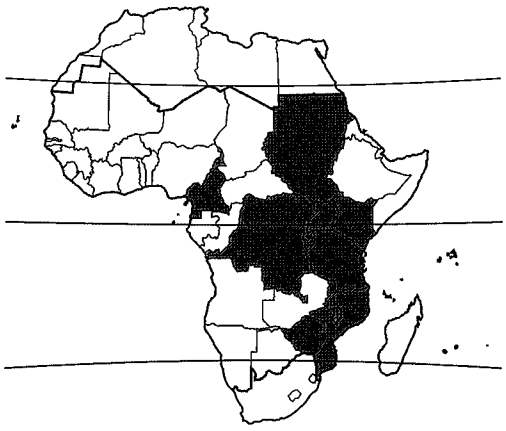
Chromosome number $2n = 38, 40, 42$

Vernacular names Lemonwood, wild lemon (En).

Origin and geographic distribution *Xymalos monospora* is widespread, occurring from Cameroon and Equatorial Guinea eastward to southern Sudan, Uganda and Kenya, and southward to Zimbabwe, Mozambique, South Africa and Swaziland. It has been introduced in India, where it is cultivated sporadically.

Uses The wood is used for light construction, posts, door frames, flooring, joinery, furniture, vehicle bodies, railway sleepers, toys, novelties, boxes, crates, agricultural implements, utensils handles, beehives, brush backs, carvings, turnery, veneer, plywood and pulp and paper products.

Fruits are eaten. The bark, roots and leaves are used in traditional medicine. Root-bark extracts are applied to treat insect stings and bites. In DR Congo a decoction of the pounded bark is drunk to cure colic, and Zulu people in South Africa use the bark for the same purpose. In Kenya dried and pounded roots are applied to wounds and soft leaves are also used as a wound dressing. In Tanzania leaves are pounded together with ginger and the resulting paste is given to children to treat cough. In Burundi leaf decoctions are drunk to treat coughing and to expel the placenta. For whooping cough the ash of burnt leaves is taken. Leaf decoctions or a decoction of root bark and twigs are taken or used as an enema to treat diarrhoea. Leaves are added to drinking water of cattle as a cure for East Coast fever.



Xymalos monospora – wild

Production and international trade The wood of *Xymalos monospora* is mainly used locally and probably only traded in small volumes internationally under the trade names 'lemonwood' and 'bogabog'. Production and trade statistics are not available. Bark, roots and leaves are commonly sold on local markets for medicinal purposes.

Properties The heartwood is lemon-yellow to pale brown or greenish brown and not distinctly demarcated from the slightly paler, 2.5–4 cm wide sapwood. The grain is straight, texture fine and even. Quarter-sawn surfaces show an attractive silver-grain figure. Freshly cut wood has a molasses-like scent.

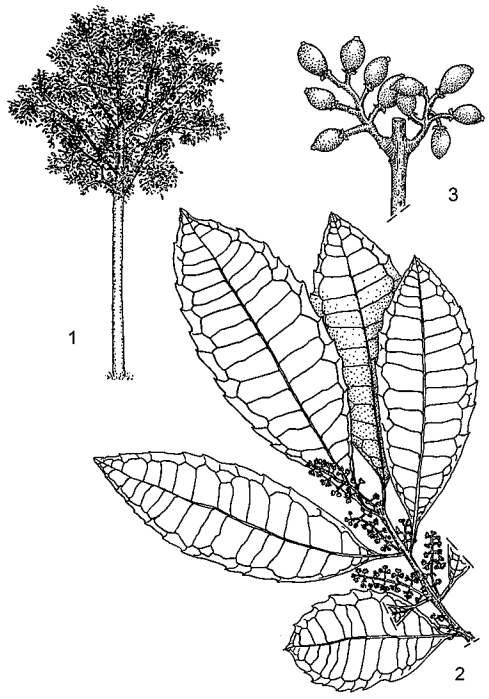
The wood is medium-weight, with a density of 510–610(–670) kg/m^3 at 12% moisture content. It is difficult to air dry; the heartwood dries very slowly and is subject to collapse and honeycombing if dried too rapidly. It takes about 9 months to air dry 2.5 cm thick boards to 12% moisture content. Kiln drying is impracticable.

The rates of shrinkage are moderately high, from green to oven dry 2.7–3.1% radial and 8.8–10.3% tangential. Once dry, the wood is moderately stable in service.

At 12% moisture content, the modulus of rupture is 66–89 N/mm², modulus of elasticity 8750–11,560 N/mm², compression parallel to grain 43–54 N/mm², shear 10.5–12 N/mm², Janka side hardness 3560–3650 N and Janka end hardness 4450 N.

The wood, both green and dry, is easy to saw and work, with little blunting effect on saw teeth and cutting edges. It planes well with a good finish. The wood shows good mortising, drilling and moulding characteristics. It nails well with satisfactory nail-holding power and little tendency to splitting. It is easy to polish and varnish. It turns well, but because it is quite soft some care is needed in finishing. The wood is moderately durable. The sapwood is fairly resistant to *Lyctus* attack. The heartwood is resistant and the sapwood moderately resistant to impregnation with preservatives.

Description Evergreen, dioecious shrub or small to medium sized tree up to 20(–27) m tall; bole usually branchless for only 3–9 m, often crooked, up to 60 cm in diameter; bark surface pale to dark grey or yellowish brown, flaking off in large scales to leave conspicuous concentric ridged markings, inner bark pale brown to pinkish brown, with reddish exudate; crown rounded, dense; branches glabrous. Leaves opposite, simple; stipules absent; petiole 0.5–3 cm long; blade elliptical to obovate, 4–20 cm × 1.5–10 cm, cuneate at base, rounded to acute or short-acuminate at apex, margin entire to irregularly and coarsely glandular toothed, thinly leathery, glabrous, with transparent gland dots, pinnately veined with 6–9 pairs of lateral veins. Inflorescence an axillary raceme or panicle 1–5(–7) cm long, velvety short-hairy. Flowers unisexual, regular, greenish, small, with perianth 1–2 mm long; male flowers with 4–6-lobed perianth and 6–15 stamens; female flowers with 3–5-lobed perianth and superior ovary, stigma sessile, thick. Fruit an ovoid to ellipsoid drupe 0.5–1.5(–2.5) cm long, fleshy, glabrous, orange or red, with persistent stigma, 1-seeded. Seeds ellipsoid, compressed, c. 1 cm long, white. Seedling with epigeal germination.



Xymalos monospora – 1, tree habit; 2, flowering twig; 3, fruits.
Redrawn and adapted by J.M. de Vries

Other botanical information *Xymalos* comprises a single species. The leaves have a lemon scent when crushed and have a slightly 'quilted' appearance because of the lateral veins which are sunken above and prominent below, and this, together with the conspicuous rings, rectangles and whorls which are exposed when patches of bark flake off, make identification of this species in the field easy.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; 12: solitary vessel outline angular; 14: scalariform perforation plates; (15: scalariform perforation plates with ≤ 10 bars); 16: scalariform perforation plates with 10–20 bars; (17: scalariform perforation plates with 20–40 bars); 20: intervessel pits scalariform; 21: intervessel pits opposite; 27: intervessel pits large (≥ 10 µm); (31: vessel-ray pits with much reduced borders to apparently simple: pits rounded or angular); 32: vessel-ray pits with much reduced borders to apparently simple: pits horizontal (scalariform, gash-like) to vertical (palisade); 41: mean tangential diameter of vessel lumina 50–100 µm; 48: 20–40 vessels per square millimetre. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 65: septate fibres present; 69: fibres thin- to thick-walled. Axial parenchyma: 75: axial parenchyma absent or

extremely rare; 78: axial parenchyma scanty paratracheal. Rays: 98: larger rays commonly 4- to 10-seriate; 99: larger rays commonly > 10-seriate; 102: ray height > 1 mm; 103: rays of two distinct sizes; (105: all ray cells upright and/or square); 109: rays with procumbent, square and upright cells mixed throughout the ray; (110: sheath cells present); 114: ≤ 4 rays per mm; 115: 4–12 rays per mm.
(R. Shanda, P. Baas & H. Beeckman)

Growth and development *Xymalos monospora* flowers between June and October. The fruits appear from November to May. They take about a year to ripen from green to orange or red, and are eaten by birds, chimpanzees, gorillas and monkeys, which disperse the seeds. Field observations in south-eastern Kenya revealed that dispersal and natural regeneration depend to a large extent on fruit eating birds and that fragmentation of forests directly affects these birds and indirectly seed dispersal of *Xymalos monospora*.
Old, dying and collapsing trees usually coppice profusely from the base and form dense stands providing deep shade, which suppresses reproduction of other plants.

Ecology *Xymalos monospora* occurs scattered or sometimes co-dominant in the sub-canopy of evergreen forest up to 3000 m altitude. Close to the equator it is most often found in mountain ranges; for example in DR Congo it is restricted to forest at altitudes of over 1600 m, extending to 3000 m into the bamboo zone. The tree is resistant to fire.

Propagation and planting *Xymalos monospora* is propagated by fresh seed. The 1000-seed weight ranges from 68 g to 158 g. The seeds are recalcitrant and should be packed in cotton bags in quantities of less than 5 kg. They cannot tolerate desiccation below 20% moisture content and should be stored at room temperature and sown within 6 weeks after collection. Although germination is slow, the germination rate is quite high. It reaches 50% 6 weeks after sowing and 95% after 10 weeks.

Management An inventory conducted in Uganda reported 850 plants (all size classes) of *Xymalos monosperma* per ha in natural forest, and only 5 per ha in formerly cultivated areas. In forest in Tanzania on average 29 trees with a bole diameter of more than 10 cm were recorded per ha.
Xymalos monospora is uncommon in farmland and plantations, and only few people grow it in their homestead. Because it may form dense stands which shade and suppress other plants, it is unsuitable for planting in arable land. Most people still harvest plant parts from the forest when they need them.

Diseases and pests The leaves of *Xymalos monospora* are consumed by the larvae of the butterfly *Papilio dardanus* (Mocker swallowtail). No important diseases has been reported.

Harvesting Defects of logs include irregular shape and heart rot.

Handling after harvest Deep surface checks develop rapidly in logs after harvesting. Losses during sawing are quite high.

Genetic resources *Xymalos monospora* is not under threat of genetic erosion because it is widespread and common and its wood is not much used. Moreover, the wood does not seem to be suitable as firewood and for charcoal production, and therefore is not heavily exploited. There is no information suggesting that it is protected anywhere. The habitat of the mountain gorilla in the Great Lakes Region is fairly well protected, and *Xymalos monospora* is likely to profit as well from this protection. In some regions natural populations have declined due to forest clearing for cultivation and its poor regeneration in fallow. Systematic germplasm collection has not been done.

Prospects *Xymalos monospora* produces timber of commercial value with good working characteristics, but with a high conversion loss and needing a long time to dry. In addition, the timber is only available in small quantities because larger trees are often found scattered. However, it will remain an important source of wood for local uses, especially for handicraft and construction purposes. It might be interesting for cultivation as a timber tree of more commercial importance, but research on the silvicultural characteristics would be required as well as on propagation techniques and growth rates. *Xymalos monospora* is not only a source of timber but also of medicine and edible fruits. As an important and widely used medicinal plant, *Xymalos monospora* deserves more research on its active compounds. Protection and domestication of *Xymalos monospora* should be considered with a view to attain sustainable exploitation of this important multipurpose tree.

Major references Bolza & Keating, 1972; Burkill, 1997; Bryce, 1967; Lovett et al., 2007; Palmer & Pitman, 1972–1974; Stannard, 1997; Takahashi, 1978; van Vuuren, Banks & Stohr, 1978; Verdcourt, 1968b; Wimbush, 1957.

Other references Baerts & Lehmann, 2011; Bryce, 1966; Chikamai et al., undated; Coates

Palgrave, 1983; Goldblatt & Briggs, 1979; Goldsmith & Carter, 1992; Hanelt & Institute of Plant Genetics and Crop Plant Research (Editors), 2001; Hyde & Wursten, 2011; Iddi et al., 1992; Lehouck et al., 2009a; Lehouck et al., 2009b; Lejju, 2004; Léonard, 1951; Lyaruu, Eliapenda & Backéus, 2000; Moshi et al., 2009b; Msanga, 1998; Oginuma & Tobe, 2006; Renner et al., 2010.

Sources of illustration Chikamai et al., undated; Léonard, 1951; Verdcourt, 1968b.

Authors W. Mojeremane

ZANHA AFRICANA (Radlk.) Exell

Protologue Fl. Zamb. 2(2): 537 (1966).

Family Sapindaceae

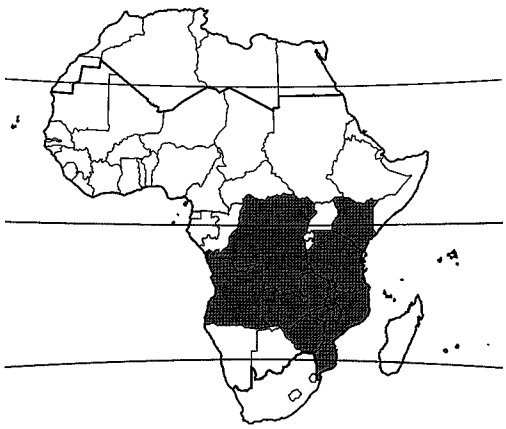
Synonyms *Dialiopsis africana* Radlk. (1907).

Vernacular names Velvet-fruited zanha (En). Mkalya, mkwanga (Sw).

Origin and geographic distribution *Zanha africana* is distributed from eastern DR Congo east to Kenya and south to southern Angola, Zimbabwe and Mozambique.

Uses The wood is locally used for construction, door frames, tool handles, implements and household articles and is of some value as firewood. It is suitable for flooring, mine props, ship building, vehicle bodies, furniture, toys, novelties, agricultural implements, railway sleepers and turnery.

It has been reported that fruits are eaten by humans, having a pleasant taste comparable to the taste of apricots (*Prunus armeniaca* L.), but seeds should not be swallowed as they are reputed to be poisonous and fruits are reported to cause severe diarrhoea if eaten in larger quantities. Various parts of *Zanha africana* contain saponins, especially the root bark, stem bark and fruits, and are used as a substitute for soap. They also act as a purgative, but can be dangerous if given to children. In Tanzania a root decoction is used to facilitate child birth, to treat constipation, prostate problems and fits. In Zimbabwe root infusions are taken as a cure for dysentery, but fatalities have been recorded. Powdered roots are rubbed on legs or are taken as an infusion to stop aching. Root preparations are prescribed to treat tooth-ache, rheumatic pains, pneumonia and vertigo. Half a teaspoon of dry powdered roots is put in cold water and drunk to prevent miscarriage, and to treat typhoid and fever. Root decoctions are drunk or sniffed to treat headache, convulsions and abdominal pain. Powdered root bark is added to tea or porridge to cure constipation, impotency and helminthiasis. Root bark extracts are used to treat fungal infections including ringworm of the head (*Tinea capitis*). The bark is used in the treatment of sexually transmitted diseases, hernia, convulsion, abdominal pain, headache, colds and fever. Pounded leaves added to water are taken or applied to the whole body to cure convulsion. Leaves are browsed by cattle, goats and sheep. In Tanzania *Zanha africana* is planted as a shade tree and is valued as nectar plant for honey bees.



Zanha africana – wild

Properties The heartwood is pinkish to red-brown when freshly cut, turning pale brown to pinkish brown upon drying, and fairly distinctly demarcated from the yellowish white, 1–2 cm wide sapwood. Grain wavy to interlocked, texture fine.

The wood is fairly heavy with a density of 705–900 kg/m^3 at 12% moisture content. It air dries moderately rapidly with slight distortion and no splitting. Boards of 2.5 cm thick dry to 12% moisture content in about 3 months, boards of 5 cm thick in 6 months. The rates of shrinkage are low, from green to 12% moisture content 2.7% radial and 4.5% tangential. At 12% moisture content, the modulus of rupture is 77 N/mm^2, modulus of elasticity 9310 N/mm^2, compression parallel to grain 46 N/mm^2, shear 14 N/mm^2 and Janka side hardness 6660 N.

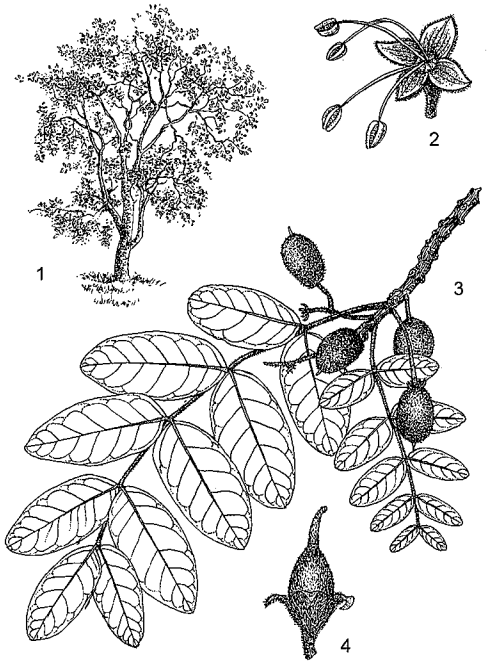
The wood is difficult to saw because it is hard and has a tendency to gum saw teeth. Planing is also difficult because of the presence of interlocked grain causing picking up on quarter-sawn surfaces; a cutting angle of 15° is recommended. The wood shows satisfactory mortising, drilling, moulding and turning characteris-

tics. Pre-boring is needed in nailing; the nail-holding power is good. The wood is durable, being quite resistant to termite, borer and *Lyctus* attacks. It is resistant to treatment with preservatives. The sawdust is irritant to mucous membranes and respiratory tracts.

The fresh fruit contains about 70% water. 100 g of dry matter of the fruit contains: energy 1265 kJ (303 kcal), protein 2 g, fat 1.5 g, fibre 15 g, Ca 90 mg, P 120 mg and Fe 20 mg. The fruits contain 10.5% acid saponin.

The presence of anthocyanins, coumarins, saponins, steroids, tannins and volatile oils has been established in the root bark. Zanhasaponin A, B and C were isolated from the roots, and these compounds showed topical anti-inflammatory activity. Antifungal activity of the root bark has been confirmed, but tests for antibacterial activity gave contradicting results. A dichloromethane extract of the roots showed trypanocidal activity with an IC_{50} value of 12.6 µg/ml.

Description Deciduous, dioecious shrub or small tree up to 12(–17) m tall; bole branchless for up to 6 m, cylindrical, sometimes crooked, up to 100 cm in diameter; bark surface reddish to dark brown, scaling off in large flakes revealing an orange lower layer, inner bark reddish; crown open, with erect branches; twigs hairy when young. Leaves alternate, paripinnately compound with 3–6(–8) pairs of leaflets; stipules absent; petiole 1–5 cm long, rachis 4–34 cm long, reddish brown short-hairy; petiolules 1–3 mm long; leaflets opposite, ovate to elliptical or almost round, 8–15 cm × 4–8 cm, rounded to cordate at base, obtuse at apex, margin entire to slightly toothed towards the apex, reddish brown short-hairy below, pinnately veined with up to 14 pairs of lateral veins. Inflorescence a terminal or axillary panicle with flowers in dense clusters. Flowers unisexual, regular, small, greenish, sweet-scented; pedicel c. 2.5 mm long, hairy; sepals 4–6, c. 4 mm long, fused at base, hairy outside; petals absent; stamens 4–6, up to 10 mm long; disk cup-shaped; ovary superior, hairy, 2-celled, style c. 2 mm long; male flowers without ovary, female flowers with rudimentary stamens. Fruit an ellipsoid fleshy drupe up to 3 cm × 2 cm, velvety hairy, yellow to bright orange, 1-seeded. Seed ellipsoid, c. 1.5 cm × 1 cm.



Zanha africana – 1, tree habit; 2, male flower; 3, fruiting branch; 4, young fruit.
Redrawn and adapted by Iskak Syamsudin

Other botanical information *Zanha* comprises 3 species. The distribution of *Zanha golungensis* Hiern, another timber tree, overlaps with that of *Zanha africana*, but it has a wider distribution, westwards as far as Senegal.

Zanha suaveolens Capuron, endemic to Madagascar, is a small tree up to 15 m tall with a bole diameter of up to 60 cm. Its wood is used in boat building. The bark is used as a soap substitute; it is used especially for delicate textiles such as silk.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; 13: simple perforation plates; 22: intervessel pits alternate; 23: shape of alternate pits polygonal; 25: intervessel pits small (4–7 µm); 26: intervessel pits medium (7–10 µm); 30: vessel-ray pits with distinct borders; similar to intervessel pits in size and shape throughout the ray cell; 41: mean tangential diameter of vessel lumina 50–100 µm; 48: 20–40 vessels per square millimetre; 58: gums and other deposits in heartwood vessels. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 70: fibres very thick-walled. Axial parenchyma: 80: axial parenchyma aliform; 82: axial parenchyma winged-aliform; 83: axial parenchyma confluent; (85: axial parenchyma bands more than

three cells wide); (86: axial parenchyma in narrow bands or lines up to three cells wide); 91: two cells per parenchyma strand; 92: four (3–4) cells per parenchyma strand. Rays: 96: rays exclusively uniseriate; (97: ray width 1–3 cells); 104: all ray cells procumbent; 115: 4–12 rays per mm. Mineral inclusions: 136: prismatic crystals present; 142: prismatic crystals in chambered axial parenchyma cells.
(S. N'Danikou, P.E. Gasson & H. Beeckman)

Growth and development In southern Africa the tree sheds most of its leaves during the dry season. The flowers appear before the new leaves between October and December. Fruits mature between November and February. They are eaten by birds, chimpanzees and monkeys, which probably disperse the seeds.

Ecology *Zanha africana* is found in open woodland, often on granite ridges or kopjes, and occasionally in riverine forest, at 600–1550 m altitude.

Propagation and planting *Zanha africana* is easiest propagated with fresh seeds. Propagation with cuttings is also practised.

Management Although *Zanha africana* is the second most important medicinal tree in the Shinyanga Region in Tanzania, only few people grow the tree at their homesteads. It is more common to grow the species in farmland, but most people still harvest plant parts when needed from the natural forest.

Genetic resources There are no indications that *Zanha africana* is threatened or vulnerable. Its timber is not widely used and it does not produce good firewood. Moreover, the presence of poisonous saponins may discourage people from using it. *Zanha africana* is not a protected species in Africa.

Prospects *Zanha africana* produces timber of little commercial value because it is often only available in small dimensions due to the small size of the bole and because the sawing and working characteristics of the wood are poor. However, it will remain an important source of wood for local uses where durability is important, especially in construction. There is very little or no information on its propagation and management. Therefore, research is needed to explore methods of propagation, planting and managing this multipurpose species.

Major references Bolza & Keating, 1972; Bryce, 1967; Coates Palgrave, 2002; Davies & Verdcourt, 1998; Dery, Otsyina & Ng'atigwa (Editors), 1999; Exell, 1966; Storrs, 1979; van Wyk & van Wyk, 1997.

Other references Abbot & Lowore, 1995; Arbonnier, 2000; Boiteau, Boiteau & Allorge-Boiteau, 1999; Chhabra, Mahunnah & Mshiu, 1991; Cuéllar et al., 1997a; Cuéllar et al., 1997b; Fabry, Okemo & Ansorg, 1996; Gelfand et al., 1985; Kambizi & Afolayan, 2001; Kareru et al., 2007; Malaisse, 1997; Musila, Kisangau & Muema, 2004; Neuwinger, 2000; Nibret et al., 2010; Ruffo, Birnie & Tengnäs, 2002; Schatz, 2001; Takahashi, 1978.

Sources of illustration Coates Palgrave, 2002; Exell, 1966.

Authors W. Mojeremane

ZANHA GOLUNGENSIS Hiern

Protologue Cat. afr. pl. 1(1): 128 (1896).

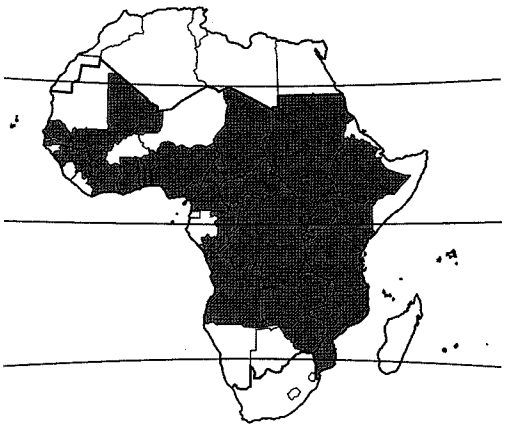
Family Sapindaceae

Vernacular names Smooth-fruited zanha (En). Mkalya, mkwanga (Sw).

Origin and geographic distribution *Zanha golungenis* is widely distributed in Africa, occurring from Senegal east to Ethiopia and Kenya, and south to Zambia, Angola, Zimbabwe and Mozambique.

Uses The wood of *Zanha golungensis* is widely used for construction, furniture and carving. Several sources, especially from West Africa, claim explicitly that the fruits are not eaten by humans, but other reports state that they are consumed.

Various plant parts contain saponins and the bark is used as a substitute for soap. Bark decoctions are taken as a cure for malaria, powdered bark is sniffed against chest complaints and colds and rubbed into the skin of temples and forehead to get relief of headache, and



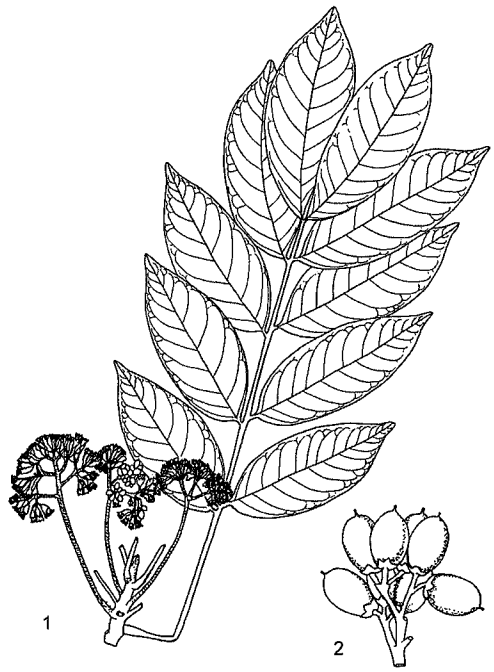
Zanha golungensis – wild

bark preparations are considered galactagogue. In Senegal bark is applied in a poultice to treat broken limbs. In Tanzania a root decoction is drunk as a cure for infected, hard abscesses, and to treat uterus prolapse, hernia and amenorrhoea. A decoction of leafy twigs is used to treat fever. *Zanha golungensis* is occasionally planted as shade tree in coffee plantations.

Properties The heartwood is whitish, sometimes with a pinkish hue, and indistinctly demarcated from the sapwood. The texture is moderately fine.

The fresh fruit contains about 67% water. The fruit contains per 100 g of dry matter: energy 1449 kJ (347 kcal), protein 2.1 g, fat 1.5 g, fibre 3.2 g, Ca 140 mg, P 60 mg and Fe 5 mg. It contains acid saponin. The triterpenoids zanhic acid and zanhic acid-γ-lactone, and the prosapogenins zanhin and medicagin have been isolated from the root bark.

Botany Deciduous, dioecious shrub or small to medium-sized tree up to 30(–40) m tall; bole cylindrical, sometimes crooked, up to 150(–170) cm in diameter; bark surface greyish brown to dark brown, scaling off in large flakes revealing a brown layer; crown dense, heavily branched; twigs glabrous. Leaves alternate, paripinnately compound with 3–7 pairs of leaflets; stipules absent; petiole up to 12 cm long, rachis up to 15 cm long, glabrous or sparsely hairy; petiolules up to 2 mm long; leaflets opposite, ovate to elliptical or oblong-elliptical, 6–11(–17) cm × 2–4(–5.5) cm, cuneate at base, obtuse to short-acuminate at apex, margin entire to slightly toothed towards the apex, glabrous, pinnately veined with up to 16 pairs of lateral veins. Inflorescence a terminal or axillary panicle with flowers in dense clusters. Flowers unisexual, regular, small, greenish, sweet-scented; pedicel up to 3 mm long, hairy; sepals 4–5, c. 4.5 mm long, fused at base, hairy outside; petals absent; stamens 4–5, up to 8 mm long; disk cup-shaped; ovary superior, 2-celled, style simple; male flowers without ovary, female flowers with rudimentary stamens. Fruit an ellipsoid fleshy drupe up to 2 cm × 1.5 cm, glabrous, yellow to orange or pink, 1-seeded. Seed ellipsoid, up to 2 cm long. Seedling with hypogeal germination; epicotyl c. 15 cm long; first 2 leaves opposite, with 2–3 pairs of leaflets.



Zanha golungensis – *1, flowering branch; 2, fruits.*
Source: Flore analytique du Bénin

Zanha golungensis sheds most of its leaves during the dry season. The flowers appear before the new leaves. Fruits are eaten by birds, gorillas, chimpanzees and monkeys, and these probably serve as seed dispersers.

Zanha comprises 3 species. *Zanha africana* (Radlk.) Exell of mainland tropical Africa and *Zanha suaveolens* Capuron, which is endemic to Madagascar, are both trees of which the timber is used locally.

Ecology *Zanha golungensis* occurs in deciduous woodland and forest, sometimes also in evergreen forest and extending into riverine forests in drier areas, at 300–1700 m altitude. It requires proper drainage.

Management Propagation of *Zanha golungensis* with fresh seeds is easy. Seeds germinate within 2 months. In Kenya seedlings survived a dry period of 3 weeks. Propagation by cuttings is probably feasible as well. In Togo *Zanha golungensis* is often retained for its fruits when land is cleared for home gardens. In Ethiopia it is left after forest clearing to serve as a shade tree for coffee.

Genetic resources and breeding There are no indications that *Zanha golungensis* is threatened or vulnerable. Although widespread, it apparently is nowhere common.

The variation in tree height and bole diameter of *Zanha golungensis* is largely due to growing conditions. It may be worthwile to try selections of the largest trees from DR Congo and

Ethiopia in other areas.

Prospects In most of its range *Zanha golungensis* produces timber of little commercial value. However, it will remain an important source of wood for local uses. There is very little or no information on its propagation and management, and research is needed to explore possibilities for domestication of this multipurpose species.

Major references Burkill, 2000; Chhabra, Mahunnah & Mshiu, 1991; Coates Palgrave, 2002; Davies & Verdcourt, 1998; Neuwinger, 2000.

Other references Arbonnier, 2000; Aubréville, 1959a; Friis, 1992; Gelfand et al., 1985; Hauman, 1960; Kambizi & Afolayan, 2001; Kareru et al., 2007; Malaisse, 1997; Robinson, 2004; Vivien & Faure, 1996.

Sources of illustration Akoègninou, van der Burg & van der Maesen (Editors), 2006.

Authors C.H. Bosch

Timbers with other primary use

List of species in other commodity groups (parenthesis), which are used as timbers. Synonyms are given in the indented lines (12 May 2012).
The names listed here have not been repeated in the Index of scientific plant names (p. 787).

Abrus fruticulosus (medicinal plants)
  Abrus pulchellus
  Abrus schimperi
Acacia abyssinica (fuel plants)
Acacia asak (fuel plants)
Acacia auriculiformis (fuel plants)
Acacia brevispica (forages)
Acacia dealbata (essential oils and exudates)
Acacia decurrens (fuel plants)
Acacia elatior (medicinal plants)
Acacia erioloba (stimulants)
Acacia erubescens (essential oils and exudates)
Acacia erythrocalyx (fuel plants)
Acacia etbaica (fuel plants)
Acacia farnesiana (essential oils and exudates)
Acacia gerrardii (fibres)
  Acacia hebecladoides
Acacia gourmaensis (fibres)
Acacia laeta (fuel plants)
Acacia lahai (fuel plants)
Acacia leptocarpa (auxiliary plants)
  Racosperma leptocarpum
Acacia mearnsii (dyes and tannins)
  Racosperma mearnsii
Acacia mellifera (fuel plants)
Acacia natalitia (stimulants)
  Acacia karroo
Acacia negrii (auxiliary plants)
Acacia nilotica (dyes and tannins)
  Acacia adansonii
  Acacia arabica
  Acacia scorpioides
  Acacia subulata
Acacia polyacantha (essential oils and exudates)
  Acacia campylacantha
Acacia reficiens (medicinal plants)
Acacia senegal (essential oils and exudates)
  Acacia rupestris
  Mimosa senegal
  Senegalia senegal
Acacia seyal (essential oils and exudates)
Acacia sieberiana (essential oils and exudates)
Acacia tortilis (forages)
  Acacia raddiana
  Acacia spirocarpa
Acalypha filiformis (fibres)
  Acalypha reticulata
Acalypha fruticosa (medicinal plants)
Acalypha neptunica (medicinal plants)
Acalypha ornata (medicinal plants)
Acalypha volkensii (medicinal plants)
Acokanthera laevigata (medicinal plants)
Acokanthera schimperi (medicinal plants)
  Acokanthera ouabaio
  Carissa schimperi
Acosmium panamense (auxiliary plants)
Adansonia digitata (vegetables)
Adansonia za (vegetable oils)
  Adansonia alba
  Adansonia bozy
Adenanthera microsperma (auxiliary plants)
Adenanthera pavonina (ornamentals)
Adenodolichos paniculatus (medicinal plants)
Aegle marmelos (fruits)
Aeschynomene indica (forages)
Aeschynomene sensitiva (medicinal plants)
Afraegle paniculata (fruits)
Agauria salicifolia (medicinal plants)
  Agarista salicifolia
Agave sisalana (fibres)
  Agave rigida var. *sisalana*
Agelaea pentagyna (medicinal plants)
  Agelaea dewevrei
  Agelaea heterophylla
  Agelaea lamarckii
  Agelaea mildbraedii
  Agelaea nitida
  Agelaea obliqua
  Agelaea pilosa
  Agelaea trifolia
Aidia genipiflora (medicinal plants)
  Randia genipiflora
Aidia micrantha (medicinal plants)
Albizia anthelmintica (medicinal plants)
Albizia chinensis (auxiliary plants)
Albizia dinklagei (medicinal plants)

Cathormion dinklagei
Samanea dinklagei
Albizia lebbeck (auxiliary plants)
Albizia procera (auxiliary plants)
Alchornea cordifolia (medicinal plants)
Alchornea floribunda (medicinal plants)
Alchornea hirtella (medicinal plants)
Alchornea laxiflora (medicinal plants)
Aleurites moluccanus (vegetable oils)
Allanblackia floribunda (vegetable oils)
Allanblackia parviflora (vegetable oils)
Allanblackia stuhlmannii (vegetable oils)
Allanblackia ulugurensis (vegetable oils)
Allophylus africanus (medicinal plants)
Allophylus subcoriaceus
Aloe dichotoma (medicinal plants)
Alsodeiopsis poggei (medicinal plants)
Alsodeiopsis schumannii (fruits)
Anacardium occidentale (fruits)
Andira inermis (medicinal plants)
Angylocalyx braunii (fuel plants)
Angylocalyx pynaertii (medicinal plants)
Angylocalyx zenkeri
Anisophyllea boehmii (fruits)
Anisophyllea pomifera
Anisophyllea laurina (fruits)
Anisophyllea meniaudi (fruits)
Anisotes ukambensis (medicinal plants)
Annona glabra (fruits)
Annona palustris
Annona senegalensis (fruits)
Annona arenaria
Annona chrysophylla
Anonidium mannii (fruits)
Anonidium friesianum
Anthocleista zambesiaca
Anthocleista madagascariensis (medicinal plants)
Anthocleista hildebrandtii
Anthocleista rhizophoroides
Anthocleista nobilis (medicinal plants)
Anthocleista vogelii (medicinal plants)
Anthostema senegalense (medicinal plants)
Antidesma laciniatum (medicinal plants)
Antidesma membranaceum (medicinal plants)
Antidesma venosum (fruits)
Antidesma vogelianum (medicinal plants)
Aoranthe cladantha (medicinal plants)
Porterandia cladantha
Randia cladantha
Randia pierrei
Aoranthe penduliflora (medicinal plants)
Porterandia penduliflora
Aphanamixis polystachya (medicinal plants)
Aglaia polystachya
Aphania senegalensis (fruits)
Lepisanthes senegalensis
Aphloia theiformis (fruits)
Aporrhiza paniculata (medicinal plants)
Aporrhiza nitida
Araucaria columnaris (ornamentals)
Araucaria heterophylla (ornamentals)
Arenga pinnata (carbohydrates)
Artocarpus altilis (fruits)
Artocarpus communis
Artocarpus incisus
Artocarpus heterophyllus (fruits)
Arundo donax (auxiliary plants)
Atroxima afzeliana (medicinal plants)
Averrhoa bilimbi (fruits)
Averrhoa carambola (fruits)
Azadirachta indica (auxiliary plants)
Balanites aegyptiaca (fruits)
Balanites maughamii (vegetable oils)
Balanites dawei
Balanites rotundifolia (fruits)
Balanites gillettii
Balanites orbicularis
Balanites scillin
Balanites wilsoniana (essential oils and exudates)
Balthasaria schliebenii (fuel plants)
Baphia abyssinica (fuel plants)
Baphia nitida (dyes and tannins)
Baphia pauloi (fuel plants)
Baphia pubescens (dyes and tannins)
Baphia bancoensis
Baphia puguensis (fuel plants)
Baphia semseiana (fuel plants)
Barbeya oleoides (fuel plants)
Barringtonia asiatica (medicinal plants)
Barringtonia speciosa
Barringtonia racemosa (dyes and tannins)
Bauhinia purpurea (ornamentals)
Bauhinia rufescens (ornamentals)
Bauhinia tomentosa (ornamentals)
Belonophora hypoglauca (stimulants)
Belonophora coffeoides
Berchemia discolor (fruits)
Phyllogeiton discolor
Berchemia zeyheri (fruits)
Berkheya echinacea (medicinal plants)
Bersama abyssinica (medicinal plants)
Bersama engleriana
Bersama paullinioides
Bombax buonopozense (fibres)
Bombax flammeum
Bombax reflexum
Bombax ceiba (fibres)
Bombax malabaricum
Bombax costatum (fibres)

Bombax andrieui
Bombax houardii
Borassus aethiopum (fruits)
Borassus madagascariensis (vegetables)
Borassus flabellifer var. *madagascariensis*
Boscia albitrunca (medicinal plants)
Boscia coriacea (medicinal plants)
Boscia salicifolia (medicinal plants)
Boscia senegalensis (fruits)
Boscia octandra
Bosqueiopsis gillettii (medicinal plants)
Brachystegia boehmii (ornamentals)
Brachystegia woodiana
Brachystegia bussei (essential oils and exudates)
Brachystegia floribunda (fibres)
Brachystegia longifolia (fibres)
Brachystegia stipulata (fibres)
Brachystegia utilis (fuel plants)
Brazzeia congoensis (medicinal plants)
Brazzeia soyauxii (medicinal plants)
Brazzeia klainei
Brenania brieyi (medicinal plants)
Randia walkeri
Brexia madagascariensis (fruits)
Bridelia atroviridis (medicinal plants)
Bridelia brideliifolia (medicinal plants)
Bridelia ferruginea (fuel plants)
Brucea antidysenterica (medicinal plants)
Brugmansia suaveolens (ornamentals)
Datura suaveolens
Bruguiera gymnorhiza (dyes and tannins)
Buchholzia coriacea (medicinal plants)
Buchholzia macrophylla
Buchholzia tholloniana (medicinal plants)
Buchholzia macrothyrsa
Buddleja polystachya (auxiliary plants)
Burchellia bubalina (ornamentals)
Burttdavya nyasica (medicinal plants)
Butea monosperma (ornamentals)
Butea frondosa
Cadaba farinosa (medicinal plants)
Caesalpinia pulcherrima (ornamentals)
Caesalpinia sappan (dyes and tannins)
Calophyllum tacamahaca (medicinal plants)
Calotropis procera (medicinal plants)
Calpurnia aurea (medicinal plants)
Calycobolus africanus (medicinal plants)
Campylospermum flavum (ornamentals)
Ouratea flava
Campylospermum glaberrimum (ornamentals)
Ouratea glaberrima
Cananga odorata (essential oils and exudates)
Canarium schweinfurthii (essential oils and exudates)
Canarium zeylanicum (essential oils and exudates)
Canthium burtii (fruits)
Canthium inerme (medicinal plants)
Canthium lactescens (fruits)
Afrocanthium lactescens
Canthium mundianum (medicinal plants)
Canthium oligocarpum (fruits)
Canthium parasiebenlistii (fuel plants)
Canthium setiflorum (fruits)
Canthium siebenlistii (fuel plants)
Capparis decidua (spices and condiments)
Capparis fascicularis (medicinal plants)
Capparis elaeagnoides
Capparis rothii
Carapa procera (medicinal plants)
Carapa grandiflora
Caryota mitis (ornamentals)
Caryota urens (carbohydrates)
Casearia coriacea (medicinal plants)
Samyda coriacea
Cassia abbreviata (medicinal plants)
Cassia angolensis (medicinal plants)
Cassia fistula (medicinal plants)
Cassia javanica (ornamentals)
Cassia agnes
Cassia nodosa
Cassia mannii (medicinal plants)
Cassia roxburghii (ornamentals)
Cassia sieberiana (medicinal plants)
Casuarina cunninghamiana (auxiliary plants)
Casuarina equisetifolia (fuel plants)
Casuarina junghuhniana (auxiliary plants)
Catha edulis (stimulants)
Catha inermis
Celastrus edulis
Catunaregam spinosa (medicinal plants)
Xeromphis obovata
Cavacoa aurea (medicinal plants)
Cerbera manghas (medicinal plants)
Cerbera venenifera
Ceriops tagal (dyes and tannins)
Ceriops boiviniana
Ceriops candolleana
Chadsia flammea (medicinal plants)
Chaetocarpus africanus (fuel plants)
Chasmopodium afzelii (forages)
Chasmopodium caudatum (forages)
Chrysobalanus icaco (fruits)
Chrysobalanus ellipticus
Chrysobalanus orbicularis
Chrysophyllum albidum (fruits)
Gambeya albida
Chrysophyllum bangweolense (fruits)

Chrysophyllum cainito (fruits)
Chrysophyllum lanceolatum (auxiliary plants)
Chrysophyllum viridifolium (fruits)
Chytranthus cauliflorus (spices and condiments)
Laccodiscus cauliflorus
Chytranthus obliquinervis (fruits)
Cinchona ledgeriana (medicinal plants)
Cinnamomum camphora (essential oils and exudates)
Cinnamomum porrectum (essential oils and exudates)
Cissus aralioides (medicinal plants)
Citharexylum spinosum (ornamentals)
Citrus aurantifolia (fruits)
Citrus aurantium (fruits)
Citrus limon (fruits)
Citrus reticulata (fruits)
Citrus nobilis
Citrus sinensis (fruits)
Cladostemon kirkii (medicinal plants)
Clappertonia ficifolia (fibres)
Honckenya ficifolia
Clausena anisata (medicinal plants)
Cleistanthus bipindensis (medicinal plants)
Cleistanthus polystachyus (fruits)
Clerodendrum acerbianum (medicinal plants)
Clerodendrum glabrum (ornamentals)
Coccoloba uvifera (fruits)
Cochlospermum vitifolium (ornamentals)
Cocos nucifera (vegetable oils)
Coffea arabica (stimulants)
Coffea costatifructa (fuel plants)
Coffea eugenioides (stimulants)
Coffea intermedia
Coffea mongensis (fuel plants)
Coffea mufindiensis (stimulants)
Coffea stenophylla (stimulants)
Cola acuminata (stimulants)
Cola ballayi (stimulants)
Cola cordifolia (ornamentals)
Cola digitata (fruits)
Cola gigantea (ornamentals)
Cola millenii (fruits)
Cola nitida (stimulants)
Cola rostrata (stimulants)
Cola simiarum (stimulants)
Cola verticillata (stimulants)
Combretum adenogonium (medicinal plants)
Combretum fragrans
Combretum ghasalense
Combretum ternifolium
Combretum albopunctatum (medicinal plants)
Combretum apiculatum (fuel plants)
Combretum caffrum (medicinal plants)
Combretum celastroides (medicinal plants)
Combretum laxiflorum
Combretum patelliforme
Combretum collinum (medicinal plants)
Combretum binderanum
Combretum geitonophyllum
Combretum hypopilinum
Combretum lamprocarpum
Combretum elaeagnoides (medicinal plants)
Combretum erythrophyllum (medicinal plants)
Combretum exalatum (medicinal plants)
Combretum glutinosum (dyes and tannins)
Combretum passargei
Combretum relictum
Combretum hartmannianum (medicinal plants)
Combretum micranthum (medicinal plants)
Combretum raimbaultii
Combretum molle (medicinal plants)
Combretum mossambicense (medicinal plants)
Combretum nigricans (essential oils and exudates)
Combretum padoides (medicinal plants)
Combretum paniculatum (medicinal plants)
Combretum wattii (forages)
Combretum zeyheri (medicinal plants)
Commiphora africana (essential oils and exudates)
Commiphora campestris (medicinal plants)
Commiphora edulis (fruits)
Commiphora boiviniana
Commiphora habessinica (essential oils and exudates)
Commiphora kerstingii (ornamentals)
Commiphora kua (medicinal plants)
Commiphora crenulata
Commiphora ellenbeckii
Commiphora madagascarensis (medicinal plants)
Commiphora mossambicensis (carbohydrates)
Commiphora multijuga (fibres)
Commiphora ogadensis (essential oils and exudates)
Commiphora pteleifolia (auxiliary plants)
Commiphora pyracanthoides (essential oils and exudates)
Comoranthus madagascariensis (medicinal plants)
Conocarpus erectus (fuel plants)
Conocarpus lancifolius (ornamentals)
Cordia alliodora (auxiliary plants)

Cordia crenata (fruits)
Cordia monoica (fruits)
Cordia quarensis
Cordia ovalis
Cordia myxa (medicinal plants)
Cordia sinensis (fruits)
Cordia gharaf
Cordia quercifolia
Cordia nevillii
Cordia rothii
Corynanthe pachyceras (medicinal plants)
Cossinia pinnata (medicinal plants)
Coula edulis (fruits)
Craibia brevicaudata (ornamentals)
Craibia brownii (cereals and pulses)
Craibia elliottii
Craspidospermum verticillatum (medicinal plants)
Craterispermum caudatum (dyes and tannins)
Craterispermum schweinfurthii (dyes and tannins)
Crateva adansonii (fruits)
Crateva religiosa
Cremaspora triflora (dyes and tannins)
Cremaspora coffeoides
Crossandra nilotica (medicinal plants)
Crossopteryx febrifuga (medicinal plants)
Croton dictyophlebodes (fuel plants)
Croton gratissimus (ornamentals)
Croton zambesicus
Croton haumanianus (medicinal plants)
Croton jatrophoides (medicinal plants)
Croton macrostachyus (medicinal plants)
Croton oligandrus (medicinal plants)
Croton penduliflorus (medicinal plants)
Croton pseudopulchellus (auxiliary plants)
Croton somalensis (medicinal plants)
Croton sylvaticus (medicinal plants)
Cryptocarya liebertiana (ornamentals)
Cussonia arborea (medicinal plants)
Cussonia barteri
Cussonia djalonensis
Cussonia kirkii
Cussonia spicata (medicinal plants)
Cyathea manniana (medicinal plants)
Cymbopogon giganteus (medicinal plants)
Cymbopogon caesius
Cymbopogon excavatus
Cymbopogon nardus (essential oils and exudates)
Cymbopogon validus
Cynometra brachyrrachis (fuel plants)
Cynometra engleri (fuel plants)
Cynometra longepedicellata (fuel plants)
Cynometra suaheliensis (fuel plants)
Cynometra ulugurensis (fuel plants)
Dacryodes edulis (fruits)
Pachylobus edulis
Pachylobus saphu
Dactyladenia barteri (auxiliary plants)
Acioa barteri
Griffonia barteri
Dais glaucescens (fibres)
Dais cotinifolia
Dalbergia boehmii (medicinal plants)
Dalbergia saxatilis (medicinal plants)
Dalbergia isangiensis
Dalbergiella welwitschii (medicinal plants)
Delonix boiviniana (essential oils and exudates)
Delonix elata (ornamentals)
Delonix floribunda (essential oils and exudates)
Delonix adansonioides
Poinciana adansonioides
Delonix regia (ornamentals)
Desbordesia insignis (fruits)
Desbordesia glaucescens
Desbordesia oblonga
Desmostachys vogelii (medicinal plants)
Detarium microcarpum (medicinal plants)
Dialium guineense (fruits)
Dialium schlechteri (fruits)
Dichaetanthera africana (ornamentals)
Sakersia africana
Dichaetanthera corymbosa (medicinal plants)
Dichapetalum madagascariense (medicinal plants)
Dichapetalum guineense
Dichapetalum subcordatum
Dichapetalum thomsonii
Dichostemma glaucescens (medicinal plants)
Dichrostachys cinerea (medicinal plants)
Dichrostachys glomerata
Dichrostachys nyassana
Dictyandra arborescens (medicinal plants)
Didymosalpinx norae (ornamentals)
Dillenia indica (fruits)
Diogoa zenkeri (fruits)
Strombosiopsis zenkeri
Diospyros amaniensis (medicinal plants)
Diospyros barteri (medicinal plants)
Diospyros batocana (fruits)
Diospyros bipindensis (medicinal plants)
Diospyros canaliculata (medicinal plants)
Diospyros capricornuta (fuel plants)
Diospyros consolatae (fruits)
Diospyros dendo (fruits)
Diospyros atropurpurea
Diospyros flavescens

Diospyros discolor (fruits)
Diospyros blancoi
Diospyros kirkii (fruits)
Diospyros loureiriana (dyes and tannins)
Diospyros macrocalyx
Diospyros usambarensis
Royena macrocalyx
Diospyros lycioides (fibres)
Royena guerkei
Royena lycioides
Royena nitens
Royena sericea
Diospyros natalensis (fuel plants)
Diospyros occulta (fuel plants)
Diospyros scabra (medicinal plants)
Diospyros tricolor (medicinal plants)
Diospyros wajirensis (fruits)
Diospyros whyteana (stimulants)
Diplorhynchus condylocarpon (medicinal plants)
Diplorhynchus mossambicensis
Discoglypremna caloneura (medicinal plants)
Discopodium penninervium (auxiliary plants)
Dobera glabra (fruits)
Dobera loranthifolia (fruits)
Dodonaea viscosa (medicinal plants)
Dodonaea angustifolia
Dombeya acerifolia (fibres)
Dombeya albisquama (fibres)
Dombeya australis (fibres)
Dombeya burgessiae (fibres)
Dombeya dawei
Dombeya platypoda
Dombeya mastersii
Dombeya laurifolia (fibres)
Dombeya lucida (fibres)
Dombeya macropoda (fibres)
Dombeya mollis (fibres)
Dombeya pilosa (fibres)
Dombeya quinqueseta (fibres)
Dombeya multiflora
Dombeya reclinata (fibres)
Dombeya rotunda (fibres)
Dombeya shupangae (medicinal plants)
Dombeya spectabilis (fibres)
Dombeya umbellata (fibres)
Doratoxylon apetalum (medicinal plants)
Hippobromus apetalus
Melicocca diversifolia
Doratoxylon littorale (medicinal plants)
Dorstenia kameruniana (medicinal plants)
Craterogyne kameruniana
Trymatococcus kamerunianus
Dovyalis abyssinica (medicinal plants)
Dovyalis rhamnoides (fruits)
Drypetes gossweileri (medicinal plants)
Drypetes amoracia
Drypetes ivorensis (medicinal plants)
Drypetes molunduana (medicinal plants)
Drypetes natalensis (medicinal plants)
Drypetes reticulata (fuel plants)
Drypetes usambarica (fuel plants)
Dypsis mananjarensis (vegetables)
Chrysalidocarpus fibrosus
Chrysalidocarpus mananjarensis
Dypsis pembana (ornamentals)
Chrysalidocarpus pembanus
Dypsis pinnatifrons (ornamentals)
Dypsis gracilis
Dypsis utilis (fibres)
Vonitra utilis
Ehretia obtusifolia (medicinal plants)
Ehretia coerulea
Elaeis guineensis (vegetable oils)
Elaeodendron orientale (medicinal plants)
Cassine orientale
Englerodendron usambarense (fuel plants)
Englerophytum magalismontanum (fruits)
Bequaertiodendron magalismontanum
Englerophytum natalense (fruits)
Bequaertiodendron natalense
Entada abyssinica (medicinal plants)
Enterolobium contortisiliquum (ornamentals)
Enterolobium cyclocarpum (ornamentals)
Eremospatha hookeri (fibres)
Erica arborea (fuel plants)
Erica rossii (fuel plants)
Erica excelsa
Eriobotrya japonica (fruits)
Erythrina brucei (forages)
Erythrina fusca (auxiliary plants)
Erythrina glauca
Erythrina senegalensis (ornamentals)
Erythrina sigmoidea (medicinal plants)
Erythrina variegata (auxiliary plants)
Erythrina indica
Erythrococca bongensis (medicinal plants)
Erythrophleum africanum (medicinal plants)
Erythrophleum couminga (medicinal plants)
Erythroxylum emarginatum (ornamentals)
Erythroxylum laurifolium (medicinal plants)
Erythroxylum sideroxyloides
Erythroxylum retusum (medicinal plants)
Eucalyptus alba (fibres)
Eucalyptus leucadendron
Eucalyptus citriodora (essential oils and exudates)

Corymbia citriodora
Eucalyptus cladocalyx (fuel plants)
Eucalyptus deglupta (fibres)
Eucalyptus multiflora
Eucalyptus naudiniana
Eucalyptus schlechteri
Eucalyptus diversicolor (ornamentals)
Eucalyptus maculata (fuel plants)
Eucalyptus microtheca (fuel plants)
Eucalyptus paniculata (auxiliary plants)
Eucalyptus regnans (fibres)
Eucalyptus rudis (fuel plants)
Eucalyptus saligna (fuel plants)
Eucalyptus torelliana (fuel plants)
Euclea divinorum (dyes and tannins)
Euclea keniensis
Euclea natalensis (medicinal plants)
Euclea fructuosa
Euclea racemosa (fruits)
Euclea schimperi
Euclea undulata (medicinal plants)
Eugenia capensis (fruits)
Eugenia albanensis
Eugenia coronata (ornamentals)
Eugenia whytei (medicinal plants)
Euphorbia abyssinica (medicinal plants)
Euphorbia obovalifolia
Euphorbia bussei (medicinal plants)
Euphorbia candelabrum (medicinal plants)
Euphorbia reinhardtii
Euphorbia cooperi (medicinal plants)
Euphorbia cuneata (medicinal plants)
Euphorbia ingens (medicinal plants)
Euphorbia lophogona (ornamentals)
Euphorbia madagascariensis
Euphorbia tirucalli (medicinal plants)
Euphorbia laro
Euphoria longan (fruits)
Dimocarpus longan
Excoecaria madagascariensis (medicinal plants)
Faidherbia albida (auxiliary plants)
Acacia albida
Faurea delevoyi (fuel plants)
Faurea wentzeliana (fuel plants)
Feretia apodanthera (medicinal plants)
Feretia canthioides
Fernandoa magnifica (medicinal plants)
Ficalhoa laurifolia (fuel plants)
Ficus asperifolia (medicinal plants)
Ficus acutifolia
Ficus pendula
Ficus urceolaris
Ficus warburgii
Ficus benghalensis (medicinal plants)
Ficus benjamina (ornamentals)
Ficus bussei (fibres)
Ficus chirindensis (auxiliary plants)
Ficus exasperata (fibres)
Ficus ingens (auxiliary plants)
Ficus katagumica
Ficus kawuri
Ficus mucuso (ornamentals)
Ficus natalensis (fibres)
Ficus leprieurii
Ficus ovata (ornamentals)
Ficus brachypoda
Ficus platyphylla (essential oils and exudates)
Ficus politoria (fibres)
Ficus soroceoides
Ficus sycomorus (fruits)
Ficus cocculifolia
Ficus gnaphalocarpa
Ficus sakalavarum
Ficus vallis-choudae (fruits)
Ficus vasta (fruits)
Ficus dahro
Ficus wakefieldii (essential oils and exudates)
Filicium decipiens (medicinal plants)
Flacourtia indica (fruits)
Flacourtia flavescens
Flueggea leucopyrus (fuel plants)
Flueggea virosa (medicinal plants)
Flueggea microcarpa
Securinega microcarpa
Securinega virosa
Friesodielsia obovata (fruits)
Popowia obovata
Funtumia africana (essential oils and exudates)
Funtumia latifolia
Funtumia elastica (essential oils and exudates)
Gaertnera liberiensis (medicinal plants)
Galiniera saxifraga (fuel plants)
Galiniera coffeoides
Garcinia afzelii (medicinal plants)
Garcinia buchananii (fruits)
Garcinia kingaensis (fruits)
Garcinia mlanjiensis
Garcinia livingstonei (fruits)
Garcinia mangostana (fruits)
Garcinia ovalifolia (medicinal plants)
Garcinia semseii (fruits)
Garcinia smeathmannii (medicinal plants)
Garcinia polyantha
Garcinia volkensii (fruits)
Gardenia aqualla (medicinal plants)
Gardenia erubescens (medicinal plants)
Gardenia fiorii (medicinal plants)

Gardenia imperialis (essential oils and exudates)
Gardenia resiniflua (medicinal plants)
Gardenia volkensii (medicinal plants)
Gigasiphon macrosiphon (fuel plants)
Glenniea africana (fuel plants)
Gliricidia sepium (auxiliary plants)
Glyphaea brevis (auxiliary plants)
Gnidia latifolia (fibres)
  Lasiosiphon latifolius
Gnidia subcordata (fibres)
  Englerodaphne subcordata
Grevillea banksii (fuel plants)
Grevillea robusta (auxiliary plants)
Grewia calvata (fibres)
Grewia conocarpoides (fruits)
Grewia coriacea (fuel plants)
Grewia flavescens (fruits)
  Grewia platyclada
Grewia goetzeana (medicinal plants)
Grewia grevei (fibres)
Grewia microcyclea (fibres)
Grewia monticola (fruits)
Grewia occidentalis (medicinal plants)
Grewia oligoneura (medicinal plants)
Grewia retinervis (fruits)
Grewia sahafariensis (fibres)
Grewia schweinfurthii (medicinal plants)
Grewia sely (fibres)
Grewia similis (fruits)
Grewia tembensis (fruits)
Grewia tenax (fruits)
Grewia trichocarpa (fibres)
  Grewia mollis var. *trichocarpa*
Grewia triflora (fibres)
  Grewia vaughanii
Grewia velutina (fruits)
Grewia villosa (fruits)
Griffonia simplicifolia (medicinal plants)
  Bandeiraea simplicifolia
Guazuma ulmifolia (ornamentals)
Guibourtia copallifera (essential oils and exudates)
  Copaifera copallifera
Guibourtia demeusei (essential oils and exudates)
  Copaifera demeusei
Guibourtia schliebenii (fuel plants)
Guiera senegalensis (medicinal plants)
Gymnosporia acuminata (medicinal plants)
  Maytenus acuminata
Gymnosporia arbutifolia (auxiliary plants)
  Maytenus arbutifolia
Gymnosporia buxifolia (vegetables)
  Maytenus heterophylla
Gymnosporia divaricata (medicinal plants)
  Maytenus leptopus
Gymnosporia senegalensis (medicinal plants)
  Maytenus senegalensis
Gynerium sagittatum (ornamentals)
Haematoxylum campechianum (dyes and tannins)
Hagenia abyssinica (medicinal plants)
  Brayera anthelmintica
  Hagenia anthelmintica
Halleria lucida (ornamentals)
Haplocoelopsis africana (fuel plants)
Harpephyllum caffrum (fruits)
Harpullia pendula (ornamentals)
Harrisonia abyssinica (medicinal plants)
  Harrisonia occidentalis
  Zanthoxylum guineense
Harungana madagascariensis (medicinal plants)
  Haronga madagascariensis
Heckeldora staudtii (medicinal plants)
  Guarea staudtii
Heinsenia diervilleoides (fuel plants)
Heinsia crinita (fruits)
  Heinsia pulchella
Hernandia nymphaeifolia (medicinal plants)
  Hernandia peltata
Heteropteris leona (medicinal plants)
Heteropyxis natalensis (medicinal plants)
Hevea brasiliensis (essential oils and exudates)
Hexalobus monopetalus (fruits)
Hibiscus calyphyllus (vegetables)
  Hibiscus calycinus
Hibiscus macranthus (medicinal plants)
Hibiscus sterculiifolius (fibres)
  Hibiscus quinquelobus
Hibiscus tiliaceus (fibres)
Hildegardia barteri (auxiliary plants)
Hilsenbergia nemoralis (medicinal plants)
  Bourreria nemoralis
  Ehretia nemoralis
Hilsenbergia petiolaris (medicinal plants)
  Bourreria petiolaris
  Ehretia petiolaris
Hirtella megacarpa (fruits)
Hirtella zanzibarica (fruits)
Holarrhena floribunda (medicinal plants)
  Holarrhena africana
  Holarrhena wulfsbergii
Holarrhena pubescens (medicinal plants)
  Holarrhena antidysenterica
  Holarrhena febrifuga
Holmskioldia sanguinea (ornamentals)
Hugonia platysepala (medicinal plants)
Hugonia spicata (medicinal plants)

Hunteria simii (medicinal plants)
Tetradoa simii
Hunteria umbellata (medicinal plants)
Hunteria eburnea
Hunteria elliotii
Hunteria mayumbensis
Picralima elliotii
Hunteria zeylanica (medicinal plants)
Hunteria corymbosa
Hura crepitans (ornamentals)
Hymenaea courbaril (essential oils and exudates)
Hymenaea verrucosa (essential oils and exudates)
Trachylobium verrucosum
Hymenocardia acida (medicinal plants)
Hymenodictyon floribundum (ornamentals)
Hymenostegia afzelii (ornamentals)
Hyperacanthus amoenus (fruits)
Gardenia amoena
Hypericum revolutum (medicinal plants)
Hyphaene compressa (carbohydrates)
Hyphaene thebaica (fibres)
Hyphaene dankaliensis
Hyphaene nodularia
Indigofera swaziensis (medicinal plants)
Inhambanella henriquesii (fruits)
Irvingia grandifolia (vegetable oils)
Klainedoxa grandifolia
Irvingia smithii (vegetable oils)
Irvingia wombolu (vegetable oils)
Ixora albersii (fuel plants)
Ixora burundiensis (ornamentals)
Ixora coccinea (ornamentals)
Ixora narcissodora (ornamentals)
Ixora pavetta (ornamentals)
Ixora scheffleri (ornamentals)
Jacaranda mimosifolia (ornamentals)
Julbernardia globiflora (fibres)
Brachystegia globiflora
Isoberlinia globiflora
Pseudoberlinia globiflora
Julbernardia magnistipulata (fibres)
Berlinia magnistipulata
Isoberlinia agnistipulata
Julbernardia paniculata (fuel plants)
Julbernardia unijugata (fibres)
Justicia schimperiana (ornamentals)
Adhatoda schimperiana
Kigelia africana (medicinal plants)
Kigelia aethiopica
Kigelia pinnata
Kleinhovia hospita (ornamentals)
Kotschya aeschynomenoides (fuel plants)
Kotschya africana (medicinal plants)
Smithia chamaecrista
Labourdonnaisia calophylloides (medicinal plants)
Labourdonnaisia glauca (medicinal plants)
Lagerstroemia speciosa (ornamentals)
Laguncularia racemosa (dyes and tannins)
Lagynias pallidiflora (fuel plants)
Lagynias rufescens (fuel plants)
Landolphia foretiana (essential oils and exudates)
Lannea acida (medicinal plants)
Lannea antiscorbutica (medicinal plants)
Lannea barteri (dyes and tannins)
Lannea kerstingii
Lannea discolor (fruits)
Lannea fruticosa (carbohydrates)
Lannea fulva (fruits)
Lannea humilis (medicinal plants)
Lannea microcarpa (dyes and tannins)
Lannea schimperi (fibres)
Odina schimperi
Lannea schweinfurthii (fruits)
Lannea stuhlmannii
Lannea triphylla (fruits)
Lannea velutina (dyes and tannins)
Lantana camara (medicinal plants)
Lasianthera africana (medicinal plants)
Lasianthus kilimandscharicus (fuel plants)
Lasianthus wallacei (fuel plants)
Latania verschaffeltii (ornamentals)
Laurus nobilis (spices and condiments)
Lawsonia inermis (dyes and tannins)
Lawsonia alba
Lecaniodiscus cupanioides (fruits)
Lecaniodiscus fraxinifolius (fruits)
Leonardoxa africana (ornamentals)
Schotia africana
Leonotis nepetifolia (medicinal plants)
Leonotis africana
Leptactina platyphylla (fuel plants)
Leptactina senegambica (essential oils and exudates)
Leptaulus daphnoides (medicinal plants)
Leptonychia usambarensis (auxiliary plants)
Leucaena guatamalensis (auxiliary plants)
Leucaena leucocephala (auxiliary plants)
Leucaena glauca
Lijndenia brenanii (fuel plants)
Lijndenia greenwayii (fuel plants)
Memecylon greenwayii
Lijndenia jasminoides (fuel plants)
Warneckea jasminoides
Litchi chinensis (fruits)
Nephelium litchi
Litsea glutinosa (medicinal plants)
Livistona carinensis (fibres)
Hyphaene carinensis

Wissmannia carinensis
Livistona rotundifolia (ornamentals)
Lodoicea maldivica (fibres)
Cocos maldivica
Lodoicea callipyge
Lodoicea sechellarum
Loesenera kalantha (medicinal plants)
Loesenera walkeri (medicinal plants)
Loeseneriella africana (fibres)
Hippocratea africana
Hippocratea richardiana
Lonchocarpus bussei (fuel plants)
Lonchocarpus capassa (forages)
Lonchocarpus eriocalyx (medicinal plants)
Lonchocarpus nelsii (forages)
Lonchocarpus sericeus (ornamentals)
Lophira lanceolata (vegetable oils)
Lumnitzera racemosa (fuel plants)
Macaranga barteri (fuel plants)
Macaranga cuspidata (medicinal plants)
Macaranga echinocarpa (medicinal plants)
Macaranga hurifolia (fuel plants)
Macaranga myriolepidea (medicinal plants)
Macaranga schweinfurthii (fuel plants)
Macaranga spinosa (medicinal plants)
Machaerium lunatum (medicinal plants)
Drepanocarpus lunatus
Maerua angolensis (medicinal plants)
Maerua crassifolia (medicinal plants)
Maerua duchesnei (medicinal plants)
Ritchiea duchesnei
Maesa lanceolata (medicinal plants)
Maesa nuda (medicinal plants)
Maesobotrya barteri (fruits)
Maesobotrya floribunda (medicinal plants)
Maesopsis eminii (auxiliary plants)
Magnistipula cupheiflora (fruits)
Hirtella cupheiflora
Mallotus baillonianus (medicinal plants)
Deuteromallotus acuminatus
Mallotus oppositifolius (medicinal plants)
Mammea americana (fruits)
Mammea usambarensis (fruits)
Mangifera indica (fruits)
Fegimanra africana
Manilkara butugii (fruits)
Manilkara dawei (fruits)
Manilkara discolor (fruits)
Manilkara mochisia (fruits)
Manilkara obovata (fruits)
Chrysophyllum obovatum
Manilkara angolensis
Manilkara lacera
Manilkara multinervis
Manilkara sansibarensis (fruits)
Manilkara sulcata (fruits)
Maprounea membranacea (medicinal plants)
Maranthes polyandra (fuel plants)
Parinari polyandra
Mareya micrantha (medicinal plants)
Mareya spicata
Margaritaria anomala (medicinal plants)
Phyllanthus erythroxyloides
Marsdenia schimperi (medicinal plants)
Dregea schimperi
Massularia acuminata (medicinal plants)
Randia acuminata
Maytenus undata (medicinal plants)
Gymnosporia undata
Megistostegium nodulosum (fibres)
Hibiscus nodulosus
Melaleuca leucadendron (essential oils and exudates)
Melia azedarach (auxiliary plants)
Melia volkensii (auxiliary plants)
Melicope floribunda (medicinal plants)
Euodia floribunda
Memecylon myrianthum (fuel plants)
Memecylon polyanthemos (medicinal plants)
Mesogyne insignis (fuel plants)
Mesua ferrea (ornamentals)
Michelia champaca (essential oils and exudates)
Microdesmis haumaniana (medicinal plants)
Microdesmis keayana (medicinal plants)
Microdesmis puberula (medicinal plants)
Microdesmis zenkeri
Millettia dura (auxiliary plants)
Millettia eetveldeana (auxiliary plants)
Millettia ferruginea (auxiliary plants)
Millettia thonningii (medicinal plants)
Millettia zechiana (auxiliary plants)
Millingtonia hortensis (ornamentals)
Mimosa delicatula (fuel plants)
Mimosa grandidieri (essential oils and exudates)
Mimosa hildebrandtii (fuel plants)
Mimosa rubicaulis (auxiliary plants)
Mimosa scabrella (auxiliary plants)
Mimosa bracaatinga
Mimusops aedificatoria (fuel plants)
Mimusops bagshawei (fruits)
Mimusops penduliflora (fruits)
Mimusops riparia (fruits)
Mitragyna inermis (medicinal plants)
Monodora crispata (spices and condiments)
Monodora grandidieri (ornamentals)
Monodora myristica (spices and condiments)
Monodora tenuifolia (spices and condiments)

Morelia senegalensis (medicinal plants)
Morinda asteroscepa (fuel plants)
Morinda citrifolia (medicinal plants)
Morinda geminata (medicinal plants)
Morinda lucida (dyes and tannins)
Morinda titanophylla (medicinal plants)
Morus alba (forages)
Multidentia fanshawei (fuel plants)
Multidentia sclerocarpa (fuel plants)
Mundulea sericea (medicinal plants)
Murraya koenigii (medicinal plants)
  Murraya foetidissima
Murraya paniculata (medicinal plants)
  Murraya exotica
  Murraya paniculata var. *exotica*
Mussaenda microdonta (medicinal plants)
Myrianthus arboreus (vegetables)
Myrianthus holstii (fruits)
Myrianthus libericus (fruits)
Myrianthus serratus (fruits)
Myrica humilis (medicinal plants)
  Myrica arborea
  Myrica kandtiana
  Myrica kilimandscharica
  Myrica meyeri-johannis
  Myrica salicifolia
Myroxylon balsamum (essential oils and exudates)
Myrsine africana (medicinal plants)
Mystroxylon aethiopicum (fruits)
  Cassine aethiopica
  Elaeodendron oliganthum
Napoleonaea imperialis (ornamentals)
  Napoleonaea mannii
Napoleonaea vogelii (ornamentals)
  Napoleonaea leonensis
  Napoleonaea parviflora
Neobeguea mahafaliensis (medicinal plants)
Neocarya macrophylla (fruits)
  Parinari macrophylla
Newbouldia laevis (auxiliary plants)
Nicotiana glauca (stimulants)
Ochna membranacea (ornamentals)
Ochna multiflora (ornamentals)
Ochna pulchra (medicinal plants)
Ochrosia borbonica (medicinal plants)
Ochrosia oppositifolia (medicinal plants)
  Ochrosia parviflora
Octoknema orientalis (fuel plants)
Okoubaka aubrevillei (medicinal plants)
Olax dissitiflora (medicinal plants)
Olax latifolia (medicinal plants)
Olax obtusifolia (medicinal plants)
Olea europaea (vegetable oils)
Olinia rochetiana (fuel plants)
  Olinia macrophylla
Omphalocarpum procerum (medicinal plants)
  Omphalocarpum pierreanum
Oncoba echinata (medicinal plants)
  Caloncoba echinata
Oncoba glauca (medicinal plants)
  Caloncoba glauca
Oncoba spinosa (medicinal plants)
Oncoba welwitschii (medicinal plants)
  Caloncoba welwitschii
Ormocarpum kirkii (medicinal plants)
Osyris lanceolata (essential oils and exudates)
  Osyris abyssinica
  Osyris quadripartita
  Osyris lanceolata
  Osyris tenuifolia
Oxyanthus formosus (ornamentals)
Oxyanthus speciosus (ornamentals)
Ozoroa insignis (fuel plants)
  Heeria insignis
  Heeria reticulata
  Ozoroa reticulata
Ozoroa schinzii (medicinal plants)
  Heeria arenophila
  Heeria schinzii
Pachyelasma tessmannii (medicinal plants)
  Stachyothyrsus tessmannii
Pancovia golungensis (fuel plants)
Pancovia harmsiana (fruits)
Pancovia pedicellaris (fruits)
  Pancovia turbinata
Panda oleosa (vegetable oils)
Pandanus heterocarpus (fibres)
Pappea capensis (fruits)
  Pappea ugandensis
Paraserianthes falcataria (auxiliary plants)
  Albizia falcataria
  Albizia moluccana
  Falcataria moluccana
Parinari curatellifolia (fruits)
  Parinari mobola
Parkia biglobosa (spices and condiments)
  Mimosa biglobosa
  Parkia africana
  Parkia clappertoniana
  Parkia oliveri
Parkinsonia anacantha (forages)
Pauridiantha callicarpoides (medicinal plants)
  Urophyllum callicarpoides
Pauridiantha hirtella (medicinal plants)
  Urophyllum hirtellum
Pauridiantha paucinervis (medicinal plants)
Pauridiantha viridiflora (medicinal plants)
  Urophyllum gilletii

Pavetta gardeniifolia (auxiliary plants)
Pavetta saxicola
Pavetta hymenophylla (fuel plants)
Pavetta subcana (medicinal plants)
Pavonia urens (fibres)
Pavonia bojeri
Pavonia ruwenzoriensis
Payena leerii (essential oils and exudates)
Peddiea africana (fibres)
Peddiea fischeri
Peltophorum africanum (medicinal plants)
Peltophorum dasyrhachis (auxiliary plants)
Peltophorum pterocarpum (ornamentals)
Penianthus longifolius (medicinal plants)
Pentaclethra eetveldeana (vegetable oils)
Pentaclethra macrophylla (vegetable oils)
Pentadesma butyracea (vegetable oils)
Pericopsis laxiflora (medicinal plants)
Afrormosia laxiflora
Perriera madagascariensis (medicinal plants)
Persea americana (fruits)
Persea gratissima
Philenoptera laxiflora (dyes and tannins)
Lonchocarpus laxiflorus
Phoenix dactylifera (fruits)
Phoenix reclinata (fibres)
Phoenix abyssinica
Phoenix comorensis
Phyllanthus emblica (dyes and tannins)
Emblica officinalis
Phyllanthus engleri (medicinal plants)
Phyllanthus inflatus (fuel plants)
Phyllanthus muellerianus (medicinal plants)
Phyllanthus floribundus
Phyllanthus reticulatus (medicinal plants)
Phyllanthus sepialis (medicinal plants)
Phyllostachys aurea (ornamentals)
Physalis peruviana (fruits)
Picralima nitida (medicinal plants)
Piliostigma malabaricum (forages)
Piliostigma reticulatum (fibres)
Bauhinia reticulata
Piliostigma thonningii (fibres)
Bauhinia thonningii
Pinus merkusii (essential oils and exudates)
Pistacia aethiopica (essential oils and exudates)
Pistacia lentiscus var. *emarginata*
Pithecellobium dulce (auxiliary plants)
Pittosporum abyssinicum (medicinal plants)
Pittosporum lanatum
Pittosporum goetzei (fuel plants)
Pittosporum undulatum (essential oils and exudates)
Pittosporum viridiflorum (medicinal plants)
Pittosporum mannii
Pittosporum spathicalyx
Plagioscyphus danguyanus (medicinal plants)
Plagioscyphus jumellei (medicinal plants)
Plagioscyphus louvelii (fruits)
Plagioscyphus unijugatus (fruits)
Plagiostyles africana (medicinal plants)
Platypterocarpus tanganyikensis (fuel plants)
Pleiocarpa mutica (medicinal plants)
Pluchea ovalis (forages)
Polyceratocarpus scheffleri (spices and condiments)
Polygala ruwenzoriensis (medicinal plants)
Polyscias albersiana (ornamentals)
Polyscias stuhlmannii (ornamentals)
Polysphaeria macrantha (fuel plants)
Polysphaeria parvifolia (fruits)
Pongamia pinnata (medicinal plants)
Premna chrysoclada (medicinal plants)
Premna quadrifolia (medicinal plants)
Premna serratifolia (medicinal plants)
Premna corymbosa
Premna integrifolia
Premna obtusifolia
Prosopis africana (fuel plants)
Prosopis glandulosa (auxiliary plants)
Prosopis juliflora (auxiliary plants)
Protea madiensis (medicinal plants)
Protea argyrophaea
Protea elliottii
Protium obtusifolium (essential oils and exudates)
Prunus africana (medicinal plants)
Pygeum africanum
Prunus persica (fruits)
Amygdalus persica
Persica vulgaris
Pseudolachnostylis maprouneifolia (medicinal plants)
Pseudospondias microcarpa (fruits)
Psidium cattleianum (fruits)
Psidium littorale
Psidium guajava (fruits)
Psidium pomiferum
Psorospermum alternifolium (medicinal plants)
Psorospermum androsaemifolium (medicinal plants)
Psychotria bagshawei (fuel plants)
Psychotria elachistantha (fuel plants)
Psychotria gabonica (medicinal plants)
Psychotria rowlandii
Psychotria lauracea (medicinal plants)

Psychotria mahonii (medicinal plants)
Psychotria megalopus (fuel plants)
Psychotria megistantha (ornamentals)
Psychotria orophila (ornamentals)
Psychotria peduncularis (medicinal plants)
  Cephaelis peduncularis
Psychotria succulenta (medicinal plants)
Psydrax horizontalis (medicinal plants)
  Canthium anomocarpum
  Canthium horizontale
Psydrax livida (medicinal plants)
  Canthium huillense
  Canthium lividum
Psydrax schimperiana (medicinal plants)
  Canthium schimperianum
Pteleopsis hylodendron (medicinal plants)
Pteleopsis myrtifolia (medicinal plants)
Pteleopsis suberosa (medicinal plants)
Pteleopsis tetraptera (medicinal plants)
Pterocarpus mildbraedii (vegetables)
Punica granatum (fruits)
Pycnocoma littoralis (medicinal plants)
Pyrostria bibracteata (fruits)
  Canthium bibracteatum
Pyrostria phyllanthoidea (fruits)
Raphia africana (fibres)
Raphia australis (fibres)
Raphia farinifera (fibres)
  Raphia kirkii
  Raphia pedunculata
  Raphia ruffia
Raphia gentiliana (fibres)
  Raphia gilletii
Raphia hookeri (fibres)
  Raphia gigantea
  Raphia sassandrensis
Raphia mambillensis (fibres)
Raphia palma-pinus (fibres)
  Raphia gracilis
Raphia sudanica (fibres)
  Raphia humilis
Raphia vinifera (fibres)
  Raphia diasticha
Rauvolfia caffra (medicinal plants)
  Rauvolfia macrophylla
Rauvolfia vomitoria (medicinal plants)
Ravenala madagascariensis (ornamentals)
Ravenea robustior (vegetables)
Rhamnus prinoides (spices and condiments)
Rhamnus staddo (spices and condiments)
Rhipidantha chlorantha (auxiliary plants)
Rhizophora harrisonii (fuel plants)
Rhizophora mangle (fuel plants)
Rhizophora mucronata (fuel plants)
Rhizophora racemosa (fuel plants)
Rhus taratana (medicinal plants)
  Baronia taratana
Rinorea angustifolia (ornamentals)
Rinorea elliptica (medicinal plants)
Rinorea welwitschii (medicinal plants)
  Rinorea arenicola
  Rinorea elliotii
  Rinorea longicuspis
Ritchiea albersii (carbohydrates)
Rothmannia engleriana (fruits)
Rothmannia fischeri (fruits)
Rothmannia globosa (medicinal plants)
Rothmannia longiflora (dyes and tannins)
  Randia maculata
  Rothmannia maculata
Rothmannia ravae (fuel plants)
Rothmannia whitfieldii (dyes and tannins)
  Randia malleifera
Roystonea regia (ornamentals)
  Oreodoxa regia
Rytigynia acuminatissima (fuel plants)
Rytigynia canthioides (medicinal plants)
Rytigynia induta (fuel plants)
Rytigynia lichenoxenos (fuel plants)
Rytigynia neglecta (fruits)
  Canthium neglectum
Rytigynia pseudolongicaudata (fuel plants)
Rytigynia uhligii (medicinal plants)
  Rytigynia schumannii
Saba comorensis (fruits)
  Landolphia florida
  Saba florida
Saccharum spontaneum (auxiliary plants)
Salacia lehmbachii (medicinal plants)
Salacia senegalensis (medicinal plants)
Salix mucronata (medicinal plants)
Salix subserrata (fuel plants)
Samanea leptophylla (medicinal plants)
Samanea saman (auxiliary plants)
  Albizia saman
Sambucus nigra (medicinal plants)
  Sambucus mexicana
Santalum album (essential oils and exudates)
Santiria trimera (fruits)
  Pachylobus balsamifera
  Pachylobus trimera
Sapindus saponaria (ornamentals)
Sapindus trifoliatus (ornamentals)
Saraca indica (ornamentals)
Sarcocephalus latifolius (fruits)
  Nauclea latifolia
  Sarcocephalus esculentus
Scaphopetalum amoenum (medicinal plants)
Schefflerodendron usambarense (fuel plants)
Schinziophyton rautanenii (vegetable oils)
  Ricinodendron rautanenii

Schleichera trijuga (fuel plants)
Schleichera oleosa
Schumanniophyton magnificum (medicinal plants)
Sclerocarya birrea (fruits)
Sclerocarya caffra
Poupartia birrea
Poupartia caffra
Sclerocroton integerrimus (medicinal plants)
Sapium integerrimum
Searsia chirindensis (medicinal plants)
Rhus chirindensis
Searsia crenulata (fruits)
Rhus crenulata
Searsia glaucescens (fruits)
Rhus glaucescens
Searsia pyroides (fruits)
Rhus pyroides
Rhus vulgaris
Searsia tenuinervis (fruits)
Rhus tenuinervis
Securidaca longipedunculata (medicinal plants)
Securinega capuronii (medicinal plants)
Securinega seyrigii (medicinal plants)
Senna alexandrina (medicinal plants)
Cassia acutifolia
Cassia alexandrina
Cassia angustifolia
Cassia senna
Senna auriculata (dyes and tannins)
Cassia auriculata
Senna didymobotrya (medicinal plants)
Cassia didymobotrya
Cassia nairobensis
Senna siamea (fuel plants)
Cassia siamea
Senna singueana (medicinal plants)
Cassia goratensis
Cassia singueana
Senna spectabilis (ornamentals)
Cassia spectabilis
Sesbania grandiflora (ornamentals)
Sesbania keniensis (medicinal plants)
Sesbania sesban (auxiliary plants)
Sesbania aegyptiaca
Setaria megaphylla (forages)
Setaria chevalieri
Shirakiopsis elliptica (medicinal plants)
Sapium ellipticum
Shirakia lliptica
Sibangea pleioneura (medicinal plants)
Sideroxylon borbonicum (medicinal plants)
Smeathmannia laevigata (ornamentals, medicinal plants)
Sorindeia africana (medicinal plants)
Sorindeia gilletii
Thyrsodium africanum
Sorindeia juglandifolia (fruits)
Sorindeia claessensii
Sorindeia submontana
Sorindeia madagascariensis (fruits)
Sorindeia obtusifoliolata
Spathodea campanulata (ornamentals)
Bignonia tulipifera
Spathodea nilotica
Spathodea tulipifera
Spondianthus preussii (medicinal plants)
Spondias cytherea (fruits)
Spondias dulcis
Spondias mombin (fruits)
Spondias purpurea (fruits)
Stachyothyrsus stapfiana (fibres)
Kaoue stapfiana
Oxystigma stapfiana
Steganotaenia araliacea (auxiliary plants)
Peucedanum fraxinifolium
Sterculia africana (fibres)
Sterculia guerichii
Sterculia triphaca
Triphaca africana
Sterculia mhosya (fibres)
Stereospermum acuminatissimum (ornamentals)
Stereospermum euphorioides (essential oils and exudates)
Stereospermum kunthianum (medicinal plants)
Strephonema mannii (medicinal plants)
Strephonema pseudocola (medicinal plants)
Strephonema sericeum (medicinal plants)
Strophanthus courmontii (medicinal plants)
Strophanthus hispidus (medicinal plants)
Strophanthus preussii (medicinal plants)
Strophanthus sarmentosus (medicinal plants)
Strychnos angolensis (medicinal plants)
Strychnos barteri (medicinal plants)
Strychnos cocculoides (fruits)
Strychnos henningsii (medicinal plants)
Strychnos innocua (fruits)
Strychnos triclisioides
Strychnos longicaudata (medicinal plants)
Strychnos malchairii (medicinal plants)
Strychnos nux-vomica (medicinal plants)
Strychnos potatorum (medicinal plants)
Strychnos spinosa (fruits)
Strychnos usambarensis (medicinal plants)
Strychnos cerasifera
Suregada zanzibariensis (medicinal plants)
Suriana maritima (medicinal plants)
Symphonia clusioides (vegetable oils)

Symphonia fasciculata (vegetable oils)
Symphonia louvelii (vegetable oils)
Symphonia macrocarpa (vegetable oils)
Symphonia tanalensis (vegetable oils)
Symphonia urophylla (vegetable oils)
  Symphonia laevis
Symphonia verrucosa (vegetable oils)
Synsepalum cerasiferum (fruits)
  Afrosersalisia cerasifera
  Sersalisia djalonensis
Synsepalum msolo (fruits)
  Pachystela msolo
Synsepalum passargei (fruits)
  Vincentella passargei
Syzygium aromaticum (spices and condiments)
  Caryophyllus aromaticus
  Eugenia aromatica
  Eugenia caryophyllus
Syzygium cumini (fruits)
  Eugenia jambolana
Syzygium jambos (fruits)
  Eugenia jambos
Syzygium malaccense (fruits)
  Eugenia malaccense
Syzygium masukuense (fruits)
Syzygium owariense (fruits)
Syzygium rowlandii (dyes and tannins)
  Syzygium abidjanense
Tabebuia donell-smithii (ornamentals)
  Cybistax donell-smithii
Tabernaemontana crassa (medicinal plants)
  Conopharyngia crassa
  Conopharyngia durissima
Tabernaemontana elegans (medicinal plants)
  Conopharyngia elegans
Tabernaemontana pachysiphon (medicinal plants)
  Tabernaemontana angolensis
  Tabernaemontana holstii
Tabernaemontana ventricosa (medicinal plants)
  Tabernaemontana usambarensis
Tamarindus indica (fruits)
Tannodia swynnertonii (fuel plants)
Tapiphyllum parvifolium (fruits)
  Vangueria parvifolia
Tarchonanthus camphoratus (medicinal plants)
Tarchonanthus trilobus (medicinal plants)
Tarenna graveolens (fruits)
Tarenna luhomeroensis (fuel plants)
Tarenna pavettoides (medicinal plants)
Tecoma stans (ornamentals)
Tephrosia vogelii (medicinal plants)
Terminalia albida (medicinal plants)
Terminalia arjuna (medicinal plants)
Terminalia avicennioides (medicinal plants)
Terminalia bellirica (medicinal plants)
Terminalia bentzoe (medicinal plants)
Terminalia brachystemma (medicinal plants)
Terminalia brevipes (medicinal plants)
Terminalia brownii (medicinal plants)
Terminalia catappa (ornamentals)
Terminalia chebula (dyes and tannins)
Terminalia kilimandscharica (medicinal plants)
Terminalia macroptera (medicinal plants)
Terminalia mantaly (ornamentals)
Terminalia mollis (fuel plants)
Terminalia orbicularis (medicinal plants)
Terminalia schimperiana (medicinal plants)
  Terminalia baumannii
  Terminalia glaucescens
Terminalia scutifera (dyes and tannins)
Terminalia spinosa (medicinal plants)
Ternstroemia polypetala (fuel plants)
Tetrapleura tetraptera (medicinal plants)
Tetrorchidium didymostemon (medicinal plants)
  Tetrorchidium minus
Thespesia garckeana (fruits)
  Azanza garckeana
Thespesia lampas (ornamentals)
  Azanza lampas
Thevetia peruviana (medicinal plants)
  Cascabela thevetia
  Thevetia neriifolia
Thomandersia hensii (medicinal plants)
Thomandersia laurifolia (medicinal plants)
Tipuana tipu (ornamentals)
Trachyphrynium braunianum (fibres)
  Hybophrynium braunianum
Treculia africana (fruits)
  Treculia madagascarica
  Treculia mollis
  Treculia perrieri
Trema orientalis (auxiliary plants)
  Trema guineensis
Triadica sebifera (vegetable oils)
  Sapium sebiferum
  Stilingia sebifera
Tricalysia anomala (fuel plants)
Tricalysia pallens (essential oils and exudates)
  Tricalysia myrtifolia
Tricalysia verdcourtiana (fuel plants)
Trichilia dregeana (vegetable oils)
  Trichilia splendida
Trichilia emetica (vegetable oils)

Trichilia roka
Trichilia lovettii (fuel plants)
Trichoscypha oddonii (fruits)
Trichoscypha reygaertii (fruits)
Trilepisium madagascariense (fruits)
Bosqueia angolensis
Bosqueia boiviniana
Bosqueia phoberos
Triphasia trifolia (fruits)
Triplochiton zambesiacus (vegetables)
Triumfetta cordifolia (fibres)
Turraea abyssinica (medicinal plants)
Turraea holstii (medicinal plants)
Turraea mombassana (medicinal plants)
Uapaca bojeri (fruits)
Uapaca kirkiana (fruits)
Uapaca benguelensis
Uapaca nitida (fruits)
Uapaca rivularis (fruits)
Uapaca sansibarica (fruits)
Uvariastrum pierreanum (fruits)
Uvariodendron usambarense (fuel plants)
Vangueria apiculata (fruits)
Vangueria infausta (fruits)
Vangueria rotundata
Vangueria tomentosa
Vangueria madagascariensis (fruits)
Vangueria acutiloba
Vangueria edulis
Vangueria venosa
Vangueriopsis lanciflora (fruits)
Vangueriopsis longiflora (fruits)
Vateria seychellarum (medicinal plants)
Vatovaea pseudolablab (cereals and pulses)
Vepris ampody (medicinal plants)
Vepris arenicola (medicinal plants)
Vepris elliotii (medicinal plants)
Vepris eugeniifolia (medicinal plants)
Vepris louisii (medicinal plants)
Vepris macrophylla (medicinal plants)
Vepris nitida (medicinal plants)
Vepris samburuensis (fruits, medicinal plants)
Vepris verdoorniana (medicinal plants)
Teclea verdoorniana
Vernicia montana (vegetable oils)
Aleurites montana
Vernonia amygdalina (vegetables)
Gymnanthemum amygdalinum
Vernonia lasiopus (medicinal plants)
Vernonia iodocalyx
Vismia guineensis (medicinal plants)
Vismia orientalis (medicinal plants)
Vitellaria paradoxa (vegetable oils)
Butyrospermum niloticum
Butyrospermum paradoxum
Butyrospermum parkii
Vitellariopsis cuneata (fuel plants)
Vitellariopsis marginata (fruits)
Vitex chrysocarpa (medicinal plants)
Vitex ferruginea (fruits)
Vitex amaniensis
Vitex fosteri
Vitex mombassae (fruits)
Vitex pachyphylla (medicinal plants)
Vitex payos (fruits)
Vitex strickeri (fruits)
Voacanga africana (medicinal plants)
Voacanga angolensis
Voacanga thouarsii (medicinal plants)
Orchipeda thouarsii
Warburgia elongata (medicinal plants)
Warburgia salutaris (medicinal plants)
Warburgia stuhlmannii (medicinal plants)
Warburgia ugandensis (fuel plants)
Warneckea sansibarica (fuel plants)
Whitfieldia elongata (medicinal plants)
Whitfieldia longifolia
Woodfordia uniflora (fuel plants)
Xanthocercis zambesiaca (fruits)
Ximenia americana (fruits)
Ximenia caffra (fruits)
Xylocarpus granatum (dyes and tannins)
Carapa granatum
Carapa obovata
Xylocarpus obovatus
Xylopia aethiopica (spices and condiments)
Xylopia eminii
Xylopia ambanjensis (spices and condiments)
Xylopia parviflora (spices and condiments)
Xylopia longipetala
Xylopia vallotii
Zanthoxylum capense (medicinal plants)
Fagara capensis
Zanthoxylum chalybeum (medicinal plants)
Fagara chalybea
Zanthoxylum decaryi (medicinal plants)
Zanthoxylum deremense (fuel plants)
Zanthoxylum heterophyllum (medicinal plants)
Zanthoxylum lemairei (medicinal plants)
Fagara lemairei
Zanthoxylum leprieurii (medicinal plants)
Fagara angolensis
Fagara leprieurii
Zanthoxylum rubescens (medicinal plants)
Fagara rubescens
Zanthoxylum usambarense (medicinal plants)
Fagara becquetii
Fagara usambarensis

Zanthoxylum becquetii
Zanthoxylum viride (medicinal plants)
Zanthoxylum zanthoxyloides (medicinal plants)
Fagara zanthoxyloides
Zanthoxylum senegalense
Zenkerella capparidacea (fuel plants)
Zenkerella egregia (fuel plants)
Zenkerella perplexa (fuel plants)
Ziziphus abyssinica (fruits)
Ziziphus mauritiana (fruits)
Ziziphus jujuba
Ziziphus mucronata (fruits)
Ziziphus pubescens (fruits)
Ziziphus spina-christi (fruits)

Literature

Abayomi, J.O., 1993. Growth trends for plantation grown Terminalia ivorensis in South-Western Nigeria. Forskningsserien, Forskningcentret for Skov og Landskab (Denmark) 1993 No 3: 181–187.

Abbiw, D.K., 1990. Useful plants of Ghana: West African uses of wild and cultivated plants. Intermediate Technology Publications, London and Royal Botanic Gardens, Kew, Richmond, United Kingdom. 337 pp.

Abbiw, D.K., 1996. Misuses and abuses in self-medication with medicinal plants: the case of Erythrophleum in Ghana. In: van der Maesen, L.J.G., van der Burgt, X.M. & van Medenbach de Rooy, J.M. (Editors). The biodiversity of African plants. Proceedings of the 14th AETFAT Congress, 22–27 August 1994, Wageningen, Netherlands. Kluwer Academic Publishers, Dordrecht, Netherlands. pp. 714–718.

Abbot, P.G. & Lowore, J.D., 1995. Livestock grazing in Chimaliro Forest Reserve: preliminary results and implications for the management of browse. Forestry Research Institute, Zomba, Malawi. 25 pp.

Abubakar, M.S., Musa, A.M., Ahmed, A. & Hussaini, I.M., 2007. The perception and practice of traditional medicine in the treatment of cancers and inflammations by the Hausa and Fulani tribes of northern Nigeria. Journal of Ethnopharmacology 111: 625–629.

Achenbach, H., Renner, C. & Waibel, R., 1995. Constituents of tropical medicinal plants. LXIX. The hexalobines, diprenylated indoles from Hexalobus crispiflorus and Hexalobus monopetalus. Liebigs Annalen der Chemie 1995(7): 1327–1337.

Adam, J.G., Echard, N. & Lescot, M., 1972. Plantes médicinales Hausa de l'Ader. Journal d'Agriculture Tropicale et de Botanique Appliquée 19(8–9): 259–399.

Adama, K., Gaston, B.A.M., Hamidou H.T., Amadou, T. & Laya, S., 2009. In vitro anthelmintic effect of two medicinal plants (Anogeissus leiocarpus and Daniellia oliveri) on Haemonchus contortus, an abosomal nematode of sheep in Burkina Faso. African Journal of Biotechnology 8(18): 4690–4695.

Adamson, I., Okafor, C. & Abu-Bakare, A., 1986. Erythrocyte membrane ATPases in diabetes: effect of dikanut (Irvingia gabonensis). Enzyme 36(3): 212–215.

Addae Mensah, I., Waibelo, R., Achenbach, H., Muriuki, G., Pearce, C. & Sanders, J.K.M., 1989. A clerodane diterpene and other constituents of Croton megalocarpus. Phytochemistry 28(10): 2759–2761.

Addae-Mensah, A.D. & Ayarkwa, J., 1998. Some machining qualities of selected lesser-used timber species in Ghana. Ghana Journal of Forestry 6: 8–14.

Adedapo, A.A., Jimoh, F.O., Koduru, S., Afolayan, A.J. & Masika, P.J., 2009. Antioxidant properties of the methanol extracts of the leaves and stems of Celtis africana. Records of Natural Products 3(1): 23–31.

Adedapo, A.A., Sofidiya, M.O. & Afolayan, A.J., 2009. Anti-inflammatory and analgesic activities of the aqueous extracts of Margaritaria discoidea (Euphorbiaceae) stem bark in experimental animal models. Revista de Biologia Tropical 57(4): 1193–1200.

Adeeba Anjum, Haque, M.E., Rahman, M.M. & Sarker, S.D., 2002. Antibacterial compounds from the flowers of Alangium salviifolium. Fitoterapia 73(6): 526–528.

Adekunle, A.A., 2000. Antifungal property of the crude extracts of Brachystegia eurycoma and Richardia brasiliensis. Nigerian Journal of Natural Products and Medicine 4: 70–72.

Adeneye, A.A., Ajagbonna, O.P., Adeleke, T.I. & Bello, S.O., 2006. Preliminary toxicity and phytochemical studies of the stem bark aqueous extract of Musanga cecropioides in rats. Journal of Ethnopharmacology 105(3): 374–379.

Adeneye, A.A., Ajagbonna, O.P. & Ayodele, O.W., 2007. Hypoglycemic and antidiabetic activities of the stem bark aqueous and ethanol extracts of Musanga cecropioides in normal and alloxan induced diabetic rats. Fitoterapia 78: 502–505.

Adeniyi, B.A., Robert, M.F., Chai, H. & Fong, H.H., 2003. In vitro cytotoxicity activity of diosquinone, a naphthoquinone epoxide. Phytotherapy Research 17(3): 282–284.

Adesokan, A.A., Akanji, M.A. & Yakubu, M.T., 2007. Antibacterial potentials of aqueous extract of Enantia chlorantha stem bark. African Journal of Biotechnology 6(22): 2502–2505.

Adesokan, A.A., Yakubu, M.T., Owoyele, B.V., Akanji, M.A., Soladoye, A.O. & Lawal, O.K., 2008. Effect of administration of aqueous and ethanolic extracts of Enantia chlorantha stem bark on brewer's yeast-induced pyresis in rats. African Journal of Biochemistry Research 2(7): 165–169.

Adetuyi, A.O., Popoola, A.V., Lajide, L. & Oladimeji, M.O., 2005. The dyeability potential of cellulosic fibres using African yellow wood (Enantia chlorantha). Pakistan Journal of Scientific and Industrial Research 48(1): 59–62.

Adewunmi, C.O., Agbedahunsi, J.M., Adebajo, A.C., Aladesanmi, A.J., Murphy, N. & Wando, J., 2001. Ethno-veterinary medicine: screening of Nigerian medicinal plants for trypanocidal properties. Journal of Ethnopharmacology 77: 19–24.

Adjanohoun, E.J. & Aké Assi, L., 1979. Contribution au recensement des plantes médicinales de Côte d'Ivoire. Centre National de Floristique, Abidjan, Côte d'Ivoire. 358 pp.

Adjanohoun, E.J., Aké Assi, L., Floret, J.J., Guinko, S., Koumaré, M., Ahyi, M.R.A. & Raynal, J., 1979. Médecine traditionelle et pharmacopée - Contribution aux études ethnobotaniques et floristiques au Mali. Agence de Coopération Culturelle et Technique, Paris, France. 291 pp.

Adjanohoun, E.J., Ahyi, M.R.A., Aké Assi, L., Akpagana, K., Chibon, P., El-Adji, A., Eymé, J., Garba, M., Gassita, J.N., Gbeassor, M., Goudote, E., Guinko, S., Hodouto, K.K., Houngnon P., Keita, A., Keoula, Y., Hodouto, W.P., Issa Lo, Siamevi, K.M. & Taffame, K.K., 1986. Contributions aux études ethnobotaniques et floristiques au Togo. Médecine Traditionelle et Pharmacopée. Agence de Coopération Culturelle et Technique, Paris, France. 671 pp.

Adjanohoun, E.J., Adjakidjè, V., Ahyi, M.R.A., Aké Assi, L., Akoègninou, A., d'Almeida, J., Apovo, F., Boukef, K., Chadare, M., Cusset, G., Dramane, K., Eyme, J., Gassita, J.N., Gbaguidi, N., Goudote, E., Guinko, S., Houngnon, P., Lo, I., Keita, A., Kiniffo, H.V., Kone-Bamba, D., Musampa Nseyya, A., Saadou, M., Sodogandji, T., De Souza, S., Tchabi, A., Zinsou Dossa, C. & Zohoun, T., 1989. Contribution aux études ethnobotaniques et floristiques en République Populaire du Bénin. Agence de Coopération Culturelle et Technique, Paris, France. 895 pp.

Adjanohoun, E.J., Ahiyi, M.R.A., Aké Assi, L., Dramane, K., Elewude, J.A., Fadoju, S.U., Gbile, Z.O., Goudote, E., Johnson, C.L.A., Keita, A., Morakinyo, O., Ojewole, J.A.O., Olatunji, A.O. & Sofowora, E.A., 1991. Traditional medicine and pharmacopoeia: contribution to ethnobotanical and floristic studies in western Nigeria. OUA/ST & RC, Lagos, Nigeria. 420 pp.

Adjanohoun, E.J., Aboubakar, N., Dramane, K., Ebot, M.E., Ekpere, J.A., Enow-Orock, E.G., Focho, D., Gbilé, Z.O., Kamanyi, A., Kamsu, K.J., Keita, A., Mbenkum, T., Mbi, C.N., Mbiele, A.L., Mbome, I.L., Mubiru, N.K., Nancy, W.L., Nkongmeneck, B., Satabié, B., Sofowora, A., Tamze, V. & Wirmum, C.K., 1996. Contribution to ethnobotanical and floristic studies in Cameroon. CSTR/OUA, Cameroon. 641 pp.

Adjanohoun, E.J., Aké Assi, L., Ali Ahmed, Eymé, J., Guinko, S., Kayonga, A., Keita, A. & Lebras, M. (Editors), 1982. Médecine traditionelle et pharmacopée - Contribution aux études ethnobotaniques et floristiques aux Comores. Agence de Coopération Culturelle et Technique, Paris, France. 217 pp.

Adjanohoun, E.J., Ahyi, A.M.R., Aké Assi, L., Baniakina, J., Chibon, P., Cusset, G., Doulou, V., Enzanza, A., Eymé, J., Goudoté, E., Keita, A., Mbemba, C., Mollet, J., Moutsamboté, J.-M., Mpati, J. & Sita, P. (Editors), 1988. Médecine traditionnelle et pharmacopée - Contribution aux études ethnobotaniques et floristiques en République Populaire du Congo. Agence de Coopération Culturelle et Technique, Paris, France. 606 pp.

Adjétey, T.A.K., Djè, M.K., Vangah-Manda, M., Adoubryn, A.D., Koné, L.P., Koné, M. & Guédé Guina, F., 2007. Antimalarial activity of Mitragyna ciliata (Aubrev. and Pellegr.) (Rubiaceae): Preliminary study. South African Journal of Botany 73(2): 226–229.

Adomako, E.E., 1999. Leaf litter production and soil fertility improvement in a home garden in the Akuapem district of Ghana. MSc degree thesis, Department of Botany, Faculty of Science, University of Ghana, Accra, Ghana. 170 pp.

Adsersen, A. & Adsersen, H., 1997. Plants from Réunion Island with alleged antihypertensive and diuretic effects - an experimental and ethnobotanical evaluation. Journal of Ethnopharmacology 58: 189–206.

Adu-Anning, C. & Anglaaere, L.C.N., 1997. Biomass and nutrient accumulation and distribution in a 15-year old unthinned stands of Nauclea diderrichii and Funtumia elastica in the moist semi-deciduous forest of Ghana. Ghana Journal of Forestry 5: 57–66.

Adubiaro, H.O., Olaofe, O. & Akintayo, E.T., 2011. Chemical composition, calcium, zinc and phytate interrelationships in Albizia lebbeck and Daniellia oliveri seeds. Electronic Journal of Environmental, Agricultural and Food Chemistry 10(7): 2523–2530.

Adzu, B., Amos, S., Dzarma, S., Muazzam, I. & Gamaniel, K.S., 2002a. Pharmacological evidence favouring the folkloric use of Diospyros mespiliformis in the relief of pain and fever. Journal of Ethnopharmacology 82: 191–195.

Adzu, B., Amos, S., Muazzam, I., Inyang, U.S. & Gamaniel, K.S., 2002b. Neuropharmalogical screening of Diospyros mespiliformis in mice. Journal of Ethnopharmacology 83: 139–143.

Affoué, Y., 1995. La forêt classée de Badénou: Etat - accroissements de quelques espèces, grandes décisions de l'aménagement, association des paysans à sa gestion. In: Ouattara, N. & Louppe, D. (Editors). Cinquième réunion tripartite, Burkina Faso, Cote d'Ivoire, Mali. Rapport final. Korhogo, 21–23 March 1995. IDEFOR-DFO, Korhogo, Côte d'Ivoire. pp. 18–30.

Afolayan, A.J. & Yakubu, M.T., 2009. Erectile dysfunction management options in Nigeria. Journal of Sexual Medicine 6(4): 1090–1102.

African Regional Workshop (Conservation & Sustainable Management of Trees, Zimbabwe), 1998. In: IUCN. 2007 - 2011 IUCN Red list of threatened species. Version 2009.1 - 2011.2. [Internet] <http://www.iucnredlist.org>. Accessed September 2009 - February 2012.

Agbaje, E.O. & Okubadejo, O.O., 2004. Relaxant effect of Enantia chlorantha on the gastrointestinal smooth muscle of rodents. Sahel Medical Journal 7(3): 80–83.

Agbor, G.A., Oben, J.E., Ngogang, J.Y., Xinxing, C. & Vinson, J.A., 2005. Antioxidant capacity of some herbs/spices from Cameroon: a comparative study of two methods. Journal of Agricultural and Food Chemistry 53(17): 6819–6824.

Aggarwal, S., 1998. Celtis L. In: Sosef, M.S.M., Hong, L.T. & Prawirohatmodjo, S. (Editors). Plant Resources of South-East Asia No 5(3). Timber trees: Lesser-known timbers. Backhuys Publishers, Leiden, Netherlands. pp. 150–153.

Aggarwal, S., 2001. Elaeocarpus L. In: van Valkenburg, J.L.C.H. & Bunyapraphatsara, N. (Editors). Plant Resources of South-East Asia No 12(2): Medicinal and poisonous plants 2. Backhuys Publishers, Leiden, Netherlands. pp. 241–246.

Agnaniet, H., Makani, T., Menut, C. & Bessière, J.M., 2004. Aromatic plants of tropical Central Africa. Part 51. Chemical and biological investigation of essential oils from seeds and bark of Staudtia gabonensis Warb. Journal of Essential Oil-bearing Plants 7(2): 107–112.

Agnaniet, H., Menut, C. & Bessière, J.M., 2004. Aromatic plants of tropical Central Africa. Part LII. Comparative study of the volatile constituents from barks of four Annonaceae species growing in Gabon. Journal of Essential Oil-bearing Plants 7(3): 201–209.

Agom, D. & Ogar, D., 1994. Report of study on timber extraction in the Ikobi concession area in Afi river forest reserve. Working Paper Cross River State Forestry Project No 3. 15 pp.

Agyeman, V.K., Ayarkwa, J., Owusu, F.W., Boachie-Dapaah, A.S.K., Addae-Mensah, A., Appiah, S.K., Oteng Amoako, A., Adam, A.R. & Pattie, D., 2003. Technological and investment profiles of some lesser used timber species in Ghana. Publication of International Tropical Timber Organization and Forestry Research Institute of Ghana, Accra, Ghana. 85 pp.

Ahawaadong, E.B., 2006. Effect of inorganic (NPK) fertilizer on the early growth performance of Diospyros mespiliformis seedlings. B.Sc. Natural Resources Management thesis, Department of Silviculture and Forest Management, Faculty of Renewable Natural Resources, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana. 33 pp.

Ahmadu, A., Kaita, H.A., Garba, M. & Yaro, A.H., 2003. Antispasmodic actions of the leaves of Daniellia oliveri. Nigerian Journal of Natural Product and Medicine 7: 13–15.

Ahmadu, A, Haruna, A.K., Garba, M., Ehinmidu, J.O. & Sarker, S.D., 2004. Phytochemical and antimicrobial activities of the Daniellia oliveri leaves. Fitoterapia 75(7–8): 729–732.

Ahoba, A., Edi, K. & Coulibaly, K., 1994a. Epaisseur et proportion d'aubier et de bois parfait de quelques essences de savane. IDEFOR/DFO, Abidjan, Côte d'Ivoire. 13 pp.

Ahoba, A., Edi, K. & Coulibaly, K., 1994b. Etude des caractéristiques de l'Isoberlinia doka. Note interne, division technologie n° 227, IDEFOR/DFO, Abidjan, Côte d'Ivoire. 7 pp.