is likely to remain in demand on international and local markets, but it is available in small quantities only. It is unlikely that this situation will change. The pharmacological properties deserve research attention.

Major references Adjanohoun & Aké Assi, 1979; Bolza & Keating, 1972; Burkill, 1994; Dudek, Förster & Klissenbauer, 1981; Ilic, 1991; Keay, 1958d; Léonard, 1956; Neuwinger, 2000; Savill & Fox, 1967; Voorhoeve, 1979.

Other references Aubréville, 1959a; Betti, 2002; Bouquet & Debray, 1974; Chilima & Namoto, 2008; Chilufya & Tengnäs, 1996; de la Mensbruge, 1966; Dery, Otsyina & Ng'atigwa (Editors), 1999; FAO, 1985; Hubert, undated; Jansen, 1974; Kryn & Fobes, 1959; Lovett et al., 2007; Méniaud & Bretonnet, 1926; Normand, 1955; Normand & Paquis, 1976; Radcliffe-Smith, 1987b; Ruffo, Birnie & Tengnäs, 2002; Tailfer, 1989; Torelli, Piškur & Tišler, 2003; Vivien & Faure, 1985.

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

Authors L.P.A. Oyen

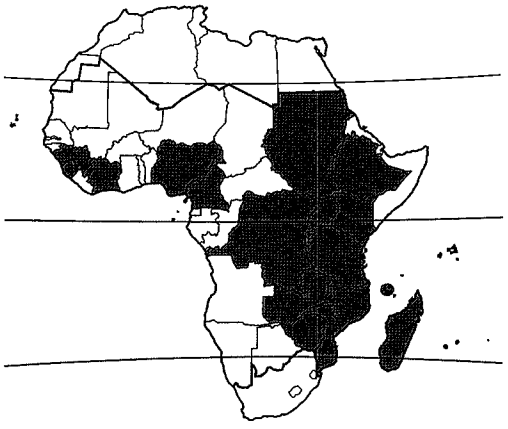
OLEA CAPENSIS L.

Protologue Sp. pl. 1: 8 (1753).

Family Oleaceae

Vernacular names East African olive, ironwood olive, Elgon olive, African ironwood, black ironwood (En). Olivier du Cap (Fr). Mushargi, loliondo (Sw).

Origin and geographic distribution *Olea capensis* is widespread from Guinea and Sierra Leone east to Ethiopia and Kenya, and south to South Africa and Swaziland. It also occurs in Comoros and Madagascar, and on Socotra island (Yemen).



Olea capensis – wild

Uses The heartwood, often traded as 'ironwood', is in high demand for flooring, carpentry and panelling, and is widely used for house and bridge construction, counter and table tops, railway sleepers, tool handles and wagon parts. It produces beautiful furniture, turnery and sliced veneer, and is often used by African artists. It is suitable for interior trim, sporting goods, toys, novelties and agricultural implements. In South Africa it has been used traditionally to make assegais. It is also used as firewood and for charcoal production.

The oily fruits are edible and are used in southern Africa in the preparation of beer and lemonade. In East Africa bark decoctions are used as an emetic and anthelmintic, and to treat malaria, venereal diseases and female sterility; bark ash is applied as a dressing to wounds. In Swaziland bark decoctions are taken to treat peptic ulcers, and in South Africa the bark is used for skin lightening. In southern Africa root powder is applied to fractures and joint swellings, and leaf infusions to treat infections of the respiratory tract and pains. The foliage serves as fodder, especially during the dry season. The flowers produce nectar for honey bees. In South Africa *Olea capensis* has been used as stock for grafting olive cultivars from the Mediterranean region. The tree is considered sacred by the Maasai people and is commonly used in ceremonies.

Production and international trade The international trade in *Olea capensis* wood is very limited. The volumes sold by auction in South Africa in the period 2000–2008 varied from 50 m^3 to 300 m^3/year. In 2008 the price of first-quality boards of 2.5 cm and 5 cm thick was US$ 1225/m^3 and US$ 1335/m^3 respectively, and in 2009 the price of 2.5 cm thick and 10 cm thick boards was US$ 2110/m^3 and US$ 2160/m^3 respectively.

Properties The heartwood is pale brown to dark brown, often with irregular grey-black or yellowish streaks. It is distinctly demarcated from the yellowish white to grey, 2.5–5 cm wide sapwood. The grain is straight to slightly interlocked, texture fine and even. The wood surface shows a nice figure and is slightly oily to the touch.

The wood is heavy, with a density of 860–975(–1170) kg/m^3 at 12% moisture content, and hard. It air dries very slowly with a marked tendency to surface checking, splitting, warping and distortion. Kiln drying is difficult and should

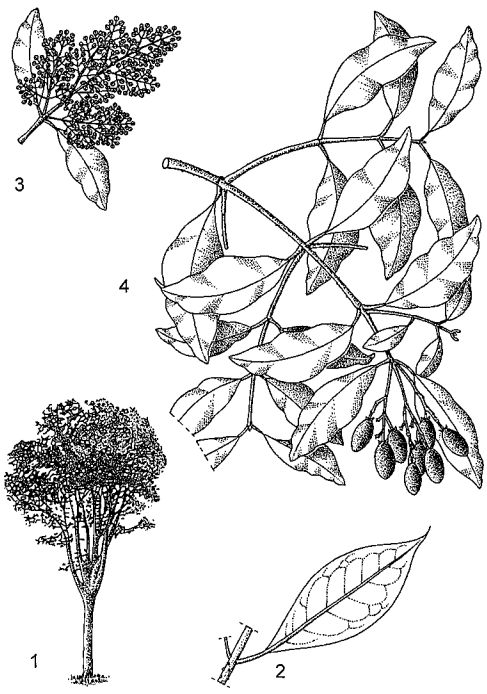
be done at low temperatures. The shrinkage rates are moderate, from green to oven dry 4.0–4.7% radial and 6.7–7.9% tangential. The dried wood is unstable in service unless properly dried. At 12% moisture content, the modulus of rupture is (78–)127–174 N/mm², modulus of elasticity (8600–)16,500–19,500 N/mm², compression parallel to grain (41–)73–84 N/mm², compression perpendicular to grain 19 N/mm², shear (16–)22.5–26 N/mm², cleavage 28–94 N/mm, Janka side hardness 10,050–13,750 N and Janka end hardness 9780–14,200 N.

The wood is easy to saw when green, but difficult to saw and work when dried, and blunts saw teeth and cutting edges rapidly. In working the material should be held firmly. Quarter-sawn surfaces have a tendency to pick up in planing, and a cutting angle of 20° is recommended. The wood finishes with a nice polish without the use of a filler. Pre-boring is necessary in nailing and screwing. The wood does not always glue well with conventional wood glues because of the oily surfaces. It turns fairly well and good-quality veneer has been obtained with slicing. The steam bending properties are satisfactory. The wood is moderately durable to durable. It is sometimes attacked by ambrosia beetles and termites, but is not susceptible to *Lyctus* beetles. The heartwood is somewhat resistant to impregnation with preservatives, the sapwood is permeable.

Coumarin and secoiridoid glucosides have been isolated from the bark. The lignans (–)-olivil and (+)-cyclo-olivil have also been isolated from the bark.

Adulterations and substitutes The wood of wild African olive (*Olea europaea* L. subsp. *cuspidata* (Wall. ex G.Don) Cif.) closely resembles that of *Olea capensis* and is used for similar purposes.

Description Evergreen shrub or small to fairly large tree up to 35(–40) m tall; bole branchless for up to 15 m, straight and cylindrical but sometimes irregular or fluted, up to 90(–150) cm in diameter; bark surface of young trees smooth and pale grey, in old trees becoming longitudinally fissured and dark grey, inner bark thick, hard, cream-coloured to orange-brown or greenish, exuding a blackish gum; crown small and dense with steeply ascending branches, or rounded with spreading branches; twigs rounded, glabrous, with scattered white lenticels. Leaves decussately opposite, simple; stipules absent; petiole 0.5–1(–2) cm long; blade elliptical to oblong-elliptical or ovate-elliptical, 3–11(–16) cm × 1.5–5(–6.5) cm, cuneate at base, obtuse to acute or short-acuminate at apex, entire to slightly wavy at margins, leathery, glabrous, glossy green above, pale green below, pinnately veined with 5–7 pairs of inconspicuous lateral veins. Inflorescence a terminal panicle 3–8 cm long, glabrous, many-flowered. Flowers bisexual, regular, 4-merous, fragrant; pedicel short; calyx cup-shaped, c. 1 mm long, with triangular lobes; corolla 2–3 mm long, white, with short tube and elliptical lobes; stamens 2, inserted on corolla tube, c. 2 mm long; ovary superior, flask-shaped, c. 1.5 mm long, 2-celled, style short. Fruit a globose to ellipsoid drupe 0.5–2 cm × 0.5–1 cm, purple-black when ripe; stone with thick and woody wall, usually 1-seeded. Seed with copious endosperm.



Olea capensis – 1, tree habit; 2, leaf; 3, flowering twig; 4, fruiting twig.
Redrawn and adapted by Achmad Satiri Nurhaman

Other botanical information *Olea* comprises 33 species, most of them occurring in eastern and southern Africa and in tropical Asia.

Three subspecies of *Olea capensis* are distinguished: subsp. *capensis* restricted to South Africa, subsp. *enervis* (Harv.) I.Verd. restricted to South Africa and Swaziland, and subsp.

macrocarpa (C.H.Wright) I.Verd. (synonyms: *Olea guineensis* Hutch. & Dalziel, *Olea hochstetteri* Baker) covering the whole area of distribution of the species. They differ in leaf shape and size, and in size of the fruit, subsp. *macrocarpa* having the largest leaves and fruits. The latter subspecies is often a larger tree than the other two, and consequently more important as a timber tree.

Olea welwitschii (Knobl.) Gilg & Schellenb. has also been considered as a subspecies of *Olea capensis*, but in most recent taxonomic publications it is regarded again as a distinct species, mainly differing in its usually narrower leaves with longer petioles. *Olea welwitschii* is widespread from Cameroon east to Ethiopia and Kenya and south to Zambia, Angola and Mozambique, from lowland rainforest to evergreen mountain forest. It is a small to fairly large tree up to 35 m tall, with bole up to 100 cm in diameter, sometimes with large buttresses. Its wood resembles that of *Olea capensis* and is used for similar purposes, e.g. for construction, flooring, joinery, furniture and sliced veneer. However, its density appears to be slightly lower, 690–820 kg/m^3 at 12% moisture content, and the wood is less strong but more stable in service. In Ethiopia the buttresses are cut to make doors. The wood is also used as firewood and for charcoal production. The bark is applied in traditional medicine for similar purposes as that of *Olea capensis*.

Olea lancea Lam. is also closely related to *Olea capensis*, but differs in its usually narrower leaves with shorter petioles. It is a shrub or small tree up to 6 m tall and occurs in Madagascar, Réunion and Mauritius. The wood ('bois de cerf', 'bois d'olive blanc') is used for construction and joinery. Bark decoctions are used to treat infections of the respiratory tract and skin complaints, and leaf infusions as emmenagogue and aphrodisiac.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; 7: vessels in diagonal and/or radial pattern; 10: vessels in radial multiples of 4 or more common; 13: simple perforation plates; 22: intervessel pits alternate; 24: intervessel pits minute (≤ 4 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: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 70: fibres very thick-walled. Axial parenchyma: 78: axial parenchyma scanty paratracheal; 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); 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. Mineral inclusions: (150: acicular crystals).

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

Growth and development *Olea capensis* is characterized as a shade tolerant species. Initial growth of seedlings may be up to 1.1 m/year, but after about 4 years the tree grows slowly. In Tanzania, 31-year-old trees were 12–15 m tall with a bole diameter of 12.5–14.5 cm. In southern Africa trees flower periodically, at intervals of 2–4(–7) years. Fruits ripen 0.5–1 year later. They are eaten by birds such as hornbills and doves, which may disperse the stones. Stones that have past the digestive system of birds germinate after 4–6 months. Studies of faecal samples of chimpanzees in Rwanda showed that these often contained *Olea capensis* stones. Monkeys, wild pigs, fruit bats and squirrels have also been recorded to feed on the fruits. Investigation of the roots revealed the presence of vesicular mycorrhizae.

Ecology *Olea capensis* is characteristic of humid mountain forest. In West Africa it is restricted to mountains above 600 m altitude, in Central Africa it occurs at 1000–2800 m altitude, and in East Africa it is mainly found at 1500–2700(–3200) m altitude. In South Africa *Olea capensis* is locally a dominant canopy tree, especially in forests along the coast. In East Africa *Olea capensis* can dominate the climax vegetation in lower and mid-altitude montane forest, together with *Olea europaea* L. subsp. *cuspidata* (Wall. ex G.Don) Cif. and *Podocarpus latifolius* (Thunb.) R.Br. ex Mirb. In Ethiopia it is often found together with *Juniperus procera* Hochst. ex Endl. and *Afrocarpus falcatus* (Thunb.) C.N.Page.

In general, *Olea capensis* prefers regions with an annual rainfall of 800–1500 mm and a mean annual temperature of 14–18°C. Young trees prefer well-drained, deep, loamy and fertile soils. Once established, they are quite drought resistant and they also grow in poor soils.

Propagation and planting Natural regeneration in mountain forest in south-eastern

Ethiopia was reported to be poor, but in Tanzania it was reported to be abundant. In South Africa seedlings are often abundant in the forest, but many die off as a result of diseases such as damping-off.

For sowing, the use of fresh stones is recommended. One kg contains 1500–3300 stones. The germination rate is about 35% and germination takes 2–9 months, but sometimes up to 2 years. Whole fruits or stones can be collected from the ground. Stones can be stored for up to 3 months, but they should be cleaned from pulp by rubbing in running water and subsequently dried for about 5 days. At a low temperature of 3°C they can be stored for longer periods. Before sowing the dry stones should be soaked in water for 2 days. Wildlings are sometimes also collected for planting. Planting should be done during the wettest part of the year. Seedlings of about 180 cm tall with lower leaves stripped off are often used for planting into the field.

Management In Tanzania *Olea capensis* is grown in plantations in clusters of up to 10 trees at close spacing (1 m × 1 m) with nurse trees such as *Grevillea robusta* A.Cunn. An interval of 7–8 m is maintained between the clusters. *Olea capensis* does not interfere much with crops and has been recommended for agroforestry systems. The young tree can be managed by lopping, pollarding and coppicing. In South Africa trees showed regeneration by coppices in 40% of cut stems.

Diseases and pests *Olea capensis* is often browsed by goats as well as wild animals such as elephants and antelopes, but it recovers well.

Harvesting In plantations the boles can be harvested for timber about 75 years after planting. In forests in southern South Africa, where *Olea capensis* is a dominant canopy tree, trees are harvested under a 10-year felling cycle and selected according to externally visible criteria of maturity.

Yield In Tanzania well-established stands of *Olea capensis* had a standing volume of about 20 m^3/ha 25–30 years after planting.

Handling after harvest It is recommended to remove logs soon from the forest after felling because the sapwood is prone to fungal and insect attacks. Freshly harvested logs sink in water and cannot be transported by river.

Genetic resources In many regions *Olea capensis* is becoming rare due to overexploitation. This is the case in many mountain regions in Ethiopia, Kenya and Tanzania. Locally in South Africa, already by 1890 overexploitation of forests where *Olea capensis* dominated had made conservation measures essential. However, in forests in southern South Africa, it is still the most common canopy tree. *Olea capensis* is legally protected in South Africa and harvesting is regulated. Some provenance testing has been done in Tanzania with the aim of selecting the best trees regarding growth performance for larger-scale planting.

Prospects The heavy weight and hardness of the wood of *Olea capensis* are serious drawbacks for many applications. However, the nicely figured wood is attractive for furniture and sliced veneer. Plantations could produce wood with good export prospects, but the rotation cycles needed are quite long. *Olea capensis* is an interesting species for planting in degraded forests throughout its natural distribution area. Studies to determine the genetic variation are needed, as well selection of provenances with superior bole characteristics for timber production and investigations on optimal silvicultural systems. In countries with high deforestation rates, immediate action is needed for in-situ conservation of remaining stands.

Major references Bekele-Tesemma, 2007; Bolza & Keating, 1972; Coates Palgrave, 1983; Friis, 1992; Green, 2002; Hines & Eckman, 1993; Maundu & Tengnäs (Editors), 2005; Palmer & Pitman, 1972–1974; Takahashi, 1978; van Wyk & van Wyk, 1997.

Other references Baldoni et al., 2002; Bamuamba et al., 2008; Beentje, 1994; Burkill, 1997; Bussmann, 2001; Chikamai et al., undated; Grace et al., 2002a; Green, 2003; Gurib-Fakim & Brendler, 2004; Hawthorne & Jongkind, 2006; Katende, Birnie & Tengnäs, 1995; Liben, 1973; Maundu et al., 2001; Muthaura et al., 2007; Neuwinger, 2000; Scott, 1981; Shangali et al., 2004; Sommerlatte & Sommerlatte, 1990; Tsukamoto, Hisada & Nishibe, 1985; van Wyk & Gericke, 2000.

Sources of illustration Bekele-Tesemma, 2007; Hawthorne & Jongkind, 2006; von Breitenbach, 1974.

Authors R. Aerts

ONCOBA BREVIPES Stapf

Protologue Journ. Linn. Soc., Bot. 37: 84 (1905).

Family Flacourtiaceae (APG: Achariaceae)

Chromosome number $2n = 24$

Synonyms *Caloncoba brevipes* (Stapf) Gilg (1908).

Origin and geographic distribution *Oncoba brevipes* occurs from Guinea east to western Côte d'Ivoire.

Uses The wood of *Oncoba brevipes* is used for poles in house building, fence posts, tool handles and sticks. The seed arils are edible. The inner bark and the leaves are used medicinally in Liberia against headache, either in a poultice or in decoction by draught. The seed oil or a paste from pulverized seeds is used for treating skin diseases, river blindness and scrofula. The bark yields a fish poison.

Properties The sapwood is greyish, the heartwood pale brown to reddish brown. The wood is medium-weight and moderately hard and strong. The grain is generally straight, texture fine. The wood is easy to work and finishes fairly smoothly. There is no information on its durability.

Botany Deciduous small tree up to 15 m tall; bole up to 25 cm in diameter; bark surface smooth, brown to blackish, inner bark thin, red; twigs covered with scales or resinous glands. Leaves alternate, simple and entire; stipules absent; petiole 1.5–3(–4) cm long; blade obovate-oblong to oblanceolate, 12–20(–26) cm × 4.5–7(–10) cm, base cuneate, apex abruptly short-acuminate, papery to thin-leathery, glabrous, pinnately veined with 7–9 pairs of lateral veins. Flowers solitary or sometimes 2–3 together in axils of leaves on young twigs, bisexual or male, regular; pedicel 3.5–4 cm long, up to 8 cm in fruit; sepals 3, obovate-oblong, c. 3 cm × 2 cm, greenish with white margins, with glandular dots outside; petals 9–12, oblanceolate, c. 6 cm × 3 cm, tapering towards the base, white; stamens numerous, yellow, but anthers becoming brown; ovary superior, oblong-ovoid, 1-celled, style c. 1 cm long, at apex divided into 5–6 stigmatic lobes. Fruit an ellipsoid to ovoid capsule 6–8 cm × 3–5 cm, with faint ridges, many-seeded. Seeds angular, c. 5 mm long, enveloped by an aril. Seedling with epigeal germination; hypocotyl 2–3 cm long, epicotyl c. 1.5 cm long; cotyledons leafy, oblong-elliptical, c. 1.5 cm long; first leaves alternate.

Oncoba brevipes – *wild*

In Côte d'Ivoire, trees flower in September–October, and young fruits have been collected in May.

Oncoba comprises about 35 species, most of them in tropical Africa and 6 in tropical America. Several genera, including *Caloncoba*, have been merged into *Oncoba* in 1997. However, in 2002 a phylogenetic analysis based on DNA sequences resulted in a position of *Caloncoba* in the family *Achariaceae*, whereas *Oncoba spinosa* Forssk., the type of *Oncoba*, was placed in *Salicaceae*. Currently research is done to elucidate the status of the species within *Oncoba* sensu lato.

Oncoba gilgiana Sprague (synonym: *Caloncoba gilgiana* (Sprague) Gilg) is a shrub or small tree up to 15 m tall, occurring from Guinea eastward to Cameroon. Its pale brown and hard wood is used in house construction and for inlay and cabinet work, and also as firewood. The seed arils are edible. It has showy flowers and may have prospects as ornamental.

Ecology *Oncoba brevipes* occurs in the understorey of evergreen rainforest, also in brushwood and forest regrowth, often in swampy and occasionally flooded localities, up to 700 m altitude.

Management There are about 4000 seeds per kg. The germination rate of seeds is high, within 8–12 days after sowing.

Genetic resources and breeding *Oncoba brevipes* does not seem to be selectively harvested for timber or other products and has not been classified as endangered or threatened. However, it has a limited area of distribution and its habitat is shrinking.

Prospects The wood is likely to remain of local importance for posts and poles, and bark, leaves and seeds for medicinal purposes. The ornamental value of *Oncoba brevipes* with its showy flowers deserves attention.

Major references Aubréville, 1959c; Cooper & Record, 1931; Hul & Breteler, 1997; Kryn & Fobes, 1959; Sleumer, 1974.

Other references Bärner & Müller, 1943;

Chase et al., 2002; de la Mensbruge, 1966; Hawthorne & Jongkind, 2006; Keay, 1954b; Kew Science Directory, undated; Neuwinger, 2000; Normand, 1960; Téré, 2004.

Authors L.P.A. Oyen

ONGOKEA GORE (Hua) Pierre

Protologue Bull. Mens. Soc. Linn. Paris 2: 1314 (1897).

Family Olacaceae

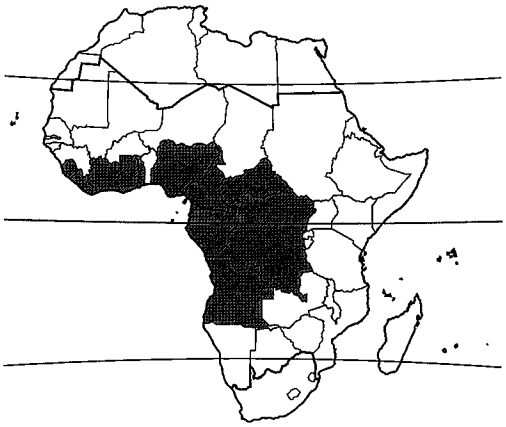
Synonyms *Ongokea klaineana* Pierre (1897), *Ongokea kamerunensis* Engl. (1909).

Vernacular names Angueuk, boleko, isano (En). Angueuk, boléko, ongokéa (Fr). Nsanu (Po). Kileku, ntuli, oleko (Sw).

Origin and geographic distribution *Ongokea gore* occurs from Sierra Leone eastward to eastern DR Congo and southward to Angola.

Uses The wood of *Ongokea gore*, called 'angueuk' in trade, is used mostly locally in heavy construction, for railway sleepers and vehicle frames, in interior and exterior carpentry, for flooring, containers and boxes, turnery and veneer. It is well suited for interior joinery provided it is perfectly dry to avoid deformation.

The seed oil, called 'boleko oil' or 'isano oil', is inedible but can be used as additive to linseed oil in the manufacture of paints, varnishes and linoleum and to oil for moulding cores in metal foundry. It can also be used to protect metal and wooden surfaces. Polymerization at moderately high temperatures yields a film with remarkable properties: strong, flexible and insoluble in acid and alkaline solvents. This makes it suitable for manufacturing brake pads and linings. In association with linseed oil the oil can be made into a standoil (a heat-polymerized oil, very thick and strongly adhesive, but slowly drying; used as a final coat in oil painting) of superior qualities. Boiling boleko oil with copal gives this resin a very high heat resistance. The oil can be used to make de-emulsifying products for the crude oil extraction industry and for the prevention of icing-up of airplane wings. It can also be vulcanized to yield highly resistant synthetic-rubber products. Ozonolytic cleavage can yield saturated double acids, which are used in the synthesis of polyamides. The use of fatty acids from boleko oil in the manufacturing of silicones and of isolating glue for lithium-based batteries has been patented. The oil is used traditionally to anoint the skin.



Ongokea gore – wild

The pulp of the fruit is edible. The bark is laxative; in Congo fresh bark is rubbed on the breasts of lactating mothers to purge their babies; similarly, in Gabon a decoction of the bark is used as a wash for babies or they are given a pinch of pounded bark mixed with a little salt. The sap is used as styptic and the bark to treat splenomegaly in DR Congo. The seeds are used as bait for small rodents and the fruits as spinning tops for children.

Production and international trade The wood of *Ongokea gore* is of little importance in international trade and is mostly included in statistics under 'miscellaneous timbers'. Few accurate data are available: Equatorial Guinea exported 400 m³/year between 1963 and 1968, while Cameroon exported 500 m³/year in 1997 and 1998. In the Central African Republic the total extractible volume has been estimated at 3.7 million m³, of which 2.2 million m³ is quality class 1 and 2.

Boleko oil has been traded in small amounts. At the end of the 1950s less than 100 t/year were exported, although France and Belgium had high hopes to develop the use of the oil in the paint industry. Potential production at that time was estimated at 30,000 t/year for DR Congo alone. No information is available on the current production and trade of boleko oil.

Properties The heartwood of *Ongokea gore* is pale yellow to pale brown and darkens on exposure to light. It is indistinctly demarcated from the 6–10 cm thick sapwood. The grain is straight, sometimes finely interlocked or wavy, texture fine and even. Quarter sawn surfaces are sometimes finely mottled or banded and slightly lustrous. The wood is heavy, with a density of 840–910 kg/m³ at 12% moisture con-

tent. The rates of shrinkage on drying are high, from green to oven dry 4.0% radial and 10.7% tangential. The wood should be dried slowly, and there is a high risk of distortion and a slight risk of checking. Logs should be quarter sawn before drying to avoid warping.

At 12% moisture content the modulus of rupture is 94–143 N/mm², modulus of elasticity 10,000–16,135 N/mm², compression parallel to grain 53–74 N/mm², shear 9–11 N/mm², cleavage 20–33.5 N/mm and Chalais-Meudon side hardness 3.0–7.5.

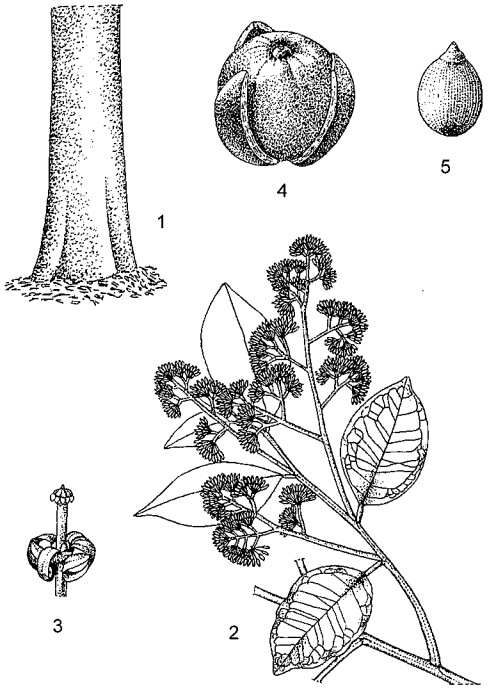
Once dry, the wood is easy to work, saw and plane with little blunting of tools. It is easy to finish, sand and polish. It can be painted, varnished, waxed and glued without difficulty. For nailing pre-boring is often required. It can be sliced into veneer, but requires much force.

The heartwood is durable; in a test in Japan it was little affected by decay fungi or termites and was resistant to marine borers and in a test in Ghana it was little affected in a 3-year wood graveyard test. The sapwood is sensitive to blue-stain and to dry-wood borers. The heartwood is extremely resistant to impregnation, whereas the sapwood is moderately resistant.

The dry seed contains about 63% oil. The seed oil differs from other vegetable oils in its fatty acid composition. Boleko oil has a high iodine number, but it does not dry when exposed in a thin film such as linseed oil or tung oil. When heated to 250°C a strongly exothermic spontaneous polymerization reaction starts, which may lead to a further increase in temperature to more than 400°C and to an explosion. Diacetylenic fatty acids and hydroxy-diacetylenic fatty acids characterize the oil; it consists mainly of isanic acid and bolekic acid (together 30–50%) and of isanolic acid (15–35%). It further contains saturated and unsaturated fatty acids of which linoleic acid is the most important one. Isanic acid is an unbranched C_{18}-fatty acid with a single ethylene bond and 2 conjugated acetylene bonds; its formula is 17-octadecene-9,11-diynoic acid. Bolekic acid is 13-octadecene-9,11-diynoic acid, isanolic acid 17-octadecene-8-hydroxy-9,11-diynoic acid. The unsaponifiable matter of the oil contains a crystalline dialcohol with molecular formula $C_{28}H_{44}O_2$.

The pulp of the fresh fruit contains 67% moisture; its smell is reminiscent of apple, its taste is sweet but slightly astringent. The root and stem bark of *Ongokea gore* contain cyclohexanoid protaflavanones named ongokeins; they are related to sakuranetin and are characterized by a non-aromatic C_6-ring moiety that is otherwise only known from certain ferns.

Description Medium-sized to large, glabrous tree up to 40 m tall; bole straight and cylindrical, branchless for up to 20 m, 100(–150) cm in diameter, without buttresses but sometimes with heavy root swellings; bark surface grey to dark brown or black, finely fissured and peeling off in fine irregular scales, inner bark 1–2 cm thick, softly granular, yellow-brown; crown pyramidal, rather open, with few heavy branches; twigs laterally compressed. Leaves alternate, simple and entire, without stipules; petiole thin, 0.5–1 cm long, grooved above, decurrent into 2 fine ridges along the branch; blade elliptical, 4–12 cm × 2–5 cm, base rounded to cuneate, apex short-acuminate, papery, glabrous, pinnately veined with 6–10 pairs of lateral veins. Inflorescence an axillary panicle up to 15 cm long, consisting of densely flowered, umbel-shaped cymes. Flowers bisexual or functionally unisexual, regular, 4-merous, greenish; pedicel slender, c. 6 mm long; calyx shallowly cup-shaped, c. 1 mm in diameter; petals strap-shaped, 3–4 mm



Ongokea gore – 1, base of bole; 2, flowering twig; 3, flower; 4, fruit; 5, fruit stone.
Redrawn and adapted by Iskak Syamsudin

long, recurved; disk 4-lobed; stamens united into a tube c. 3 mm long; ovary superior, sessile, 1-celled, style hardly exserted from the staminal tube. Fruit a globose drupe 2–4 cm in diameter, enclosed by the enlarged calyx except for apical part, slightly acuminate, 1-seeded. Seed globose, c. 1.5 cm in diameter. Seedling with epigeal germination; hypocotyl very short, epicotyl c. 18 cm long; first pair of leaves opposite.

Other botanical information *Ongokea* comprises a single species. It is closely related to *Aptandra*, a genus with about 4 species in tropical America and one species in tropical Africa, *Aptandra zenkeri* Engl., which differs from *Ongokea gore* in its raceme-like inflorescences and large, collar-shaped, pinkish calyx surrounding the fruit.

Anatomy Wood-anatomical description (IAWA hardwood codes):
Growth rings: 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; (7: vessels in diagonal and/or radial pattern); 9: vessels exclusively solitary (90% or more); 13: simple perforation plates; 22: intervessel pits alternate; (23: shape of alternate pits polygonal); 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; 31: vessel-ray pits with much reduced borders to apparently simple: pits rounded or angular; 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. Tracheids and fibres: 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: 76: axial parenchyma diffuse; 77: axial parenchyma diffuse-in-aggregates; 78: axial parenchyma scanty paratracheal; (86: axial parenchyma in narrow bands or lines up to three cells wide); 92: four (3–4) 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; 116: ≥ 12 rays per mm. Mineral inclusions: 136: prismatic crystals present; 138: prismatic crystals in procumbent ray cells; 139: prismatic crystals in radial alignment in procumbent ray cells; 140: prismatic crystals in chambered upright and/or square ray cells; 142: prismatic crystals in chambered axial parenchyma cells.

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

Growth and development In Côte d'Ivoire *Ongokea gore* flowers from January to June and fruits from May to July; in DR Congo fruiting is abundant in September, in Gabon in December and January. The fruits are eaten by many animals and the seeds are dispersed e.g. by monkeys.

Ecology *Ongokea gore* is found scattered in dense evergreen forest and in moist semi-deciduous forest. It occurs on dry ground and in periodically inundated localities. In Gabon it often occurs in forest dominated by *Sacoglottis gabonensis* (Baill.) Urb. and *Aucoumea klaineana* Pierre.

Propagation and planting Germination is slow and may take several months and even more than one year. Because of its slow and irregular germination, *Ongokea gore* is not grown in nurseries.

Management Large trees of *Ongokea gore* occur scattered in the forest. In Liberia 1 tree with a bole diameter over 60 cm has been reported per 43 ha for evergreen forest, and 1 tree per 7.5 ha for moist semi-deciduous forest.

Harvesting Fruits of *Ongokea gore* are collected from the wild and mostly the pulp is allowed to rot away before the fruit stones are collected from the soil.

Handling after harvest Fresh logs sink in water and cannot be transported by river. Depulping of fruits can be done by passing the fruits between rubber rollers and washing them with cold water. Boleko oil is produced by hydraulic pressing, but this is hampered by the high viscosity of the oil. During pressing the temperature can rise to 80°C which can alter the properties of the oil. The press cake contains considerable amounts of polymerized oil. The cake is unsuitable as cattle feed, but can be used as manure. The oil can also be extracted by solvents after the kernels have been ground and subjected to treatment with cold methanol.

Genetic resources *Ongokea gore* is widespread and does not seem to be in danger of genetic erosion. No germplasm collections are known to exist.

Prospects *Ongokea gore* is likely to remain important in its region of origin. There are no indications that it will become a commodity in international trade, but its volume in miscellaneous timber lots is likely to increase. Demand for the oil is likely to remain low except if local paint industries develop or if new applications for its unique fatty acids are found.

Major references Anonymous, 1957a; Aubréville, 1959b; Chudnoff, 1980; CIRAD Forestry Department, 2003; CTFT, undated; Miller et al., 1977; Normand, 1950a; Pouliquen, 1959; Vieux & Taratibu, 1968; Voorhoeve, 1979.

Other references Burkill, 1997; De Borger, 1960; De Vries, 1956; De Vries, 1957; Heckel, 1902; Jerz, Waibel & Achenbach, 2005; Keay, 1989; Libouga, Womeni & Bitjoka, 2002; Magliocca, 1998; Mangala, 1999; Normand & Paquis, 1976; Pauwels, 1993; Raponda-Walker & Sillans, 1961; Sallenave, 1955; Saunders & Hall, 1968; Tsunoda, 1990; Villiers, 1973b; von Mikusch, 1963; von Mikusch, 1964; Wilks & Issembé, 2000.

Sources of illustration Pauwels, 1993; Voorhoeve, 1979; Wilks & Issembé, 2000.

Authors D. Louppe

OPHIOBOTRYS ZENKERI Gilg

Protologue Bot. Jahrb. Syst. 40(4): 516 (1908).

Family Flacourtiaceae (APG: Salicaceae)

Origin and geographic distribution *Ophiobotrys zenkeri* occurs from Liberia east to the Central African Republic and south to Gabon and western DR Congo.

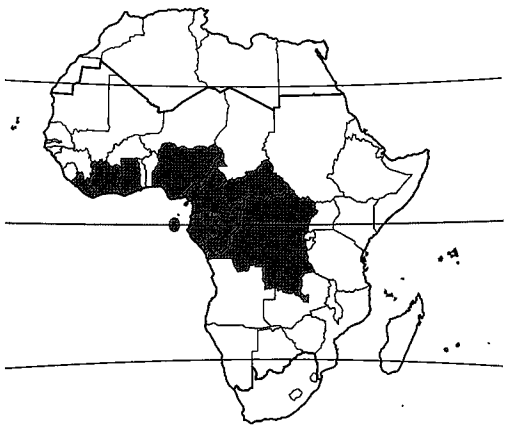
Uses The wood is used locally, but there is little technical information on its uses. In Ghana it has been used for utensils including mortars.

Properties The pale brownish yellow wood is moderately heavy and hard. It has some resemblance to the wood of *Scottellia klaineana* Pierre.

Botany Shrub or small to medium-sized tree up to 30(–40) m tall; bole usually straight and long, up to 90(–120) cm in diameter, with steep and flat buttresses up to 4 m high; bark surface fairly smooth, peeling off in thin flakes, yellowish green to pale brown or pale grey, inner bark thin, brittle, yellow-orange; crown rounded, rather open, with spreading branches; twigs slightly short-hairy or glabrous. Leaves alternate, simple and entire; stipules minute, caducous; petiole c. 1 cm long; blade elliptical, 7–15 cm × 2.5–6 cm, cuneate to obtuse at base, acuminate at apex, papery to thin-leathery, glabrous, with 1–2 pairs of lateral veins from near the base of leaf blade and c. 3 pairs of additional lateral veins. Inflorescence a terminal panicle c. 20 cm long, with long, slender branches, short-hairy, many-flowered. Flowers bisexual or male, regular, small, creamy to greenish white, scented; pedicel c. 1 mm long; sepals 5, free, ovate, c. 2 mm long; petals absent; stamens 5–6, c. 2.5 mm long; disk with hairy lobes alternating with stamens; ovary superior, ovoid, hairy, 1-celled, style thick, with 3 spreading branches. Fruit an ellipsoid capsule up to 1.5 cm × 1 cm, pointed, short-hairy, pinkish to reddish, dehiscent with 3 valves, 3–6-seeded. Seeds with small, lobed aril. Seedling with epigeal germination; hypocotyl 3–3.5 cm long, epicotyl c. 2 cm long, short-hairy; cotyledons leafy, rounded, c. 1.5 cm long; first leaves alternate, slightly toothed.

In Côte d'Ivoire trees have been recorded to flower in June and fruits have been collected in August–October.

Ophiobotrys comprises a single species. It is related to *Casearia* and several genera restricted to tropical America and tropical Asia.



Ophiobotrys zenkeri – *wild*

Ecology *Ophiobotrys zenkeri* occurs mainly in lowland semi-deciduous forest.

Management There are about 25,000 seeds per kg. The seeds germinate within 8–12 days after sowing, but the germination rate is reportedly low, 15–25%. Larger trees are often difficult to fell because they have large buttresses. Freshly harvested logs sink in water and cannot be transported by river.

Genetic resources and breeding Although *Ophiobotrys zenkeri* is quite widespread, it seems to be uncommon or even rare in many regions within its distribution area. From some countries very few herbarium collections are available, e.g. from Côte d'Ivoire and Gabon.

Prospects Very little is known about *Ophiobotrys zenkeri*. It seems to be rarely exploited for timber, probably because it is uncommon and has hard wood and large buttresses.

Major references Aubréville, 1959c; Burkill, 1994; Normand, 1960; Normand & Paquis, 1976; Sleumer & Bamps, 1976.

Other references de la Mensbruge, 1966; Hawthorne, 1995; Hawthorne & Jongkind, 2006; Hul, 1995; InsideWood, undated; Irvine, 1961; Keay, 1954b; Keay, 1989; Miller, 1975; Tailfer, 1989.

Authors R.H.M.J. Lemmens

OUBANGUIA AFRICANA Baill.

Protologue Bull. Mens. Soc. Linn. Paris 2: 869 (1890).

Family Scytopetalaceae (APG: Lecythidaceae)

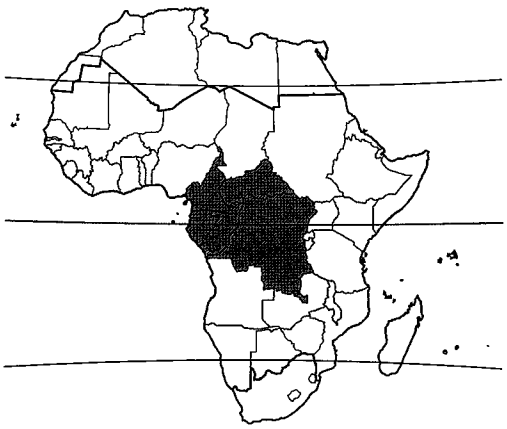
Synonyms *Oubanguia denticulata* Tiegh. (1905), *Oubanguia laurentii* Baill. (1908).

Origin and geographic distribution *Oubanguia africana* is found in Cameroon, Central African Republic, Equatorial Guinea, Gabon, Congo and DR Congo.

Uses The wood of *Oubanguia africana* is used in Gabon to make packing cases. In DR Congo the bark is powdered and taken orally to cure backache and haemorrhoids.

Properties The wood of *Oubanguia africana* is greyish pink, heavy, and similar to that of the commercially more important timber tree *Scytopetalum tieghemii* (A.Chev.) Hutch. & Dalziel.

Botany Small to medium-sized tree up to 20 m tall; bole often short, up to 50(–80) cm in diameter; bark surface longitudinally fissured, pinkish, inner bark fibrous, reddish; crown small; twigs angular. Leaves alternate, crowded towards the ends of twigs, simple; stipules very small, caducous; petiole 1–3 mm long; blade ovate to lanceolate, sometimes elliptical, 8–16 cm × 3.5–6.5 cm, base cuneate and asymmetrical, apex long-acuminate, margin entire to finely toothed, leathery, glabrous, pinnately veined with 6–8 pairs of lateral veins. Inflorescence an axillary or terminal panicle up to 15 cm long. Flowers bisexual, regular; pedicel 5–6(–8) mm long; calyx saucer-shaped to cup-shaped, 3–4 mm in diameter, margin entire or incised; petals 6–8, 6–8 mm long, recurved, white; stamens numerous, c. 5 mm long; ovary superior, globular, 3–4(–5)-celled, style slender, c. 5 mm long, stigma small. Fruit a globose to obovoid capsule, 1.5–2 cm × 1–1.5 cm, violet, usually 1-seeded. Seed oblong, 9–11 mm × 6–7 mm.



Oubanguia africana – *wild*

Oubanguia comprises 3 species. *Oubanguia laurifolia* (Pierre) Tiegh. is a rare species restricted to south-eastern Nigeria, Cameroon and Gabon. It is a small tree up to 15 m tall with a bole diameter up to 60 cm. In Cameroon the wood is used to make oars.

Oubanguia alata Baker f. is also found in south-eastern Nigeria, Cameroon and Gabon, but nowhere further from the coast than 100 km. It is a small to medium-sized tree up to 20 m tall with a low-branching bole up to 50 cm in diameter. The wood is probably used for similar purposes at the other *Oubanguia* spp. Fruits are produced in abundance in some years and the seeds are often eaten by children. The seeds are hard, low in oil content and they taste like coconut but have a bitter aftertaste.

Ecology *Oubanguia africana* is found in swamp forest and periodically inundated forest, and along rivers.

Genetic resources and breeding *Oubanguia africana* is fairly widespread and occurs locally abundantly, although in general considered to be rather uncommon. At present, there is no reason to consider this species as threatened.

Prospects *Oubanguia africana* and other *Oubanguia* spp. will probably remain of interest for local use only.

Major references Ilumbe Bayeli, 2006; Letouzey, 1978a; Raponda-Walker & Sillans, 1961.

Other references Breteler, 2002; Breteler, 2005; Germain, 1963; Lebrun & Stork, 2003; Moyersoen, Alexander & Fitter, 1998; Normand & Paquis, 1976; Thomas et al., 1989; Vivien & Faure, 1985; Vivien & Faure, 1996.

Authors C.H. Bosch

OXYANTHUS ZANGUEBARICUS (Hiern) Bridson

Protologue Kew Bull. 34(1): 119 (1979).

Family Rubiaceae

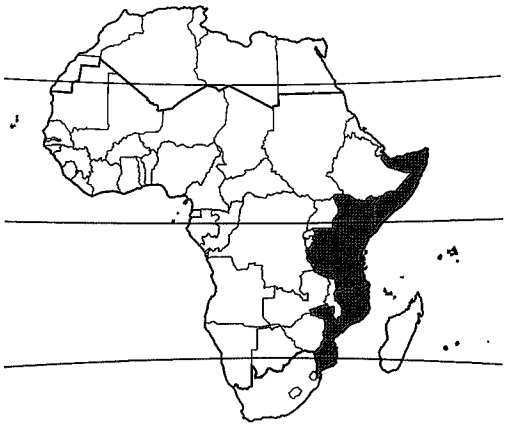
Vernacular names Mfupapu (Sw).

Origin and geographic distribution *Oxyanthus zanguebaricus* is distributed in Somalia, Kenya, Tanzania and Mozambique.

Uses In Kenya the stems are used as poles in building. In Mozambique the wood is made into dishes, spoons and other utensils.

Properties The wood is durable.

Botany Shrub or small tree up to 8.5 m tall, much-branched; twigs somewhat grooved, usually glabrous. Leaves opposite, simple and entire; stipules triangular, 5–11 mm long, acuminate at apex, persistent; petiole 3–10 mm long; blade elliptical to narrowly ovate, 5–15.5(–19) cm × 2–6(–7) cm, base obtuse to rounded, apex acute to short-acuminate, thin-leathery, usually glabrous, pinnately veined with 8–9 main pairs of lateral veins. Inflorescence an axillary, compact, narrowly pyramidal panicle, nearly sessile, (3–)5–12-flowered; bracts lanceolate or linear-lanceolate, (7–)10–12 mm long. Flowers bisexual, regular, 5-merous; pedicel up to 5 mm long; calyx glabrous, tube 4–5 mm long, lobes linear-subulate, (4–)5–8 mm long; corolla white, tube 7–11.5 cm long, lobes oblong-lanceolate, 1–2 cm long, acuminate; stamens inserted on corolla throat, alternating with lobes, anthers nearly sessile; ovary inferior, 1–2-celled, style slender, at apex with an oblong-ellipsoid pollen presenter 2–2.5 mm long. Fruit a pear-shaped berry 3.5–7 cm × 2.5–3 cm, greenish flecked with white. Seeds compressed-ellipsoid, c. 6 mm long, blackish brown, strongly striated.



Oxyanthus zanguebaricus – *wild*

Oxyanthus comprises about 35 species and is confined to mainland Africa. The wood of several species is used in tropical Africa for similar purposes as that of *Oxyanthus zanguebaricus*, but most of these are more important as ornamental shrub or tree.

Ecology *Oxyanthus zanguebaricus* occurs in open forest including coastal and riverine forest, woodland and bushland, from sea-level up to 500 m altitude.

Genetic resources and breeding *Oxyanthus zanguebaricus* has a limited distribution, but is fairly common and seems not threatened with genetic erosion.

Prospects *Oxyanthus zanguebaricus* is a useful local source of wood for construction poles and utensils. Information on its wood properties is lacking, but in view of its small size its importance is unlikely to increase.

Major references Beentje, 1994; Bridson & Verdcourt, 2003; Verdcourt & Bridson, 1991.

Other references Bridson, Thulin & Degreef, 2006; d'Oliveira Feijão, 1960.

Authors M. Brink

PARAMACROLOBIUM COERULEUM (Taub.) J.Léonard

Protologue Bull. Jard. Bot. Etat 24(4): 348 (1954).

Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

Chromosome number $2n = 24$

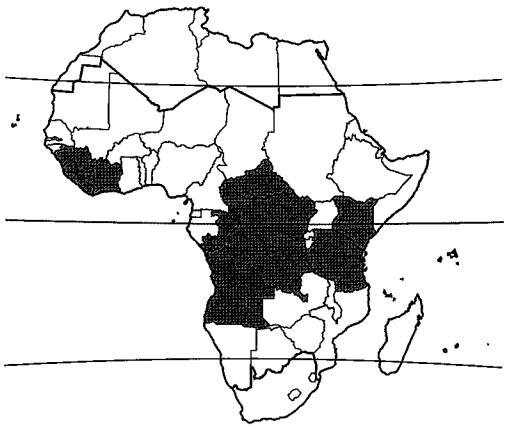
Synonyms *Macrolobium coeruleoides* De Wild. (1907), *Macrolobium coeruleum* (Taub.) Harms (1915), *Macrolobium dawei* Hutch. & Dalziel (1928).

Vernacular names Mkwe (Sw).

Origin and geographic distribution *Paramacrolobium coeruleum* is widespread, from Guinea east to Kenya and south to DR Congo, Tanzania and northern Angola. However, the distribution area is notably discontinuous.

Uses In DR Congo the wood is used for joinery, doors, frames of doors, furniture, railway sleepers and gongs. It is suitable for heavy flooring, interior trim, toys, novelties, turnery, carving, veneer and plywood. *Paramacrolobium coeruleum* has been used as shade tree in cocoa plantations in Sierra Leone. In Kenya the bark is used as rough fibre. The seeds are used in games.

Properties The heartwood is pale brown to yellowish brown or pinkish brown with darker brown streaks on quarter-sawn surfaces, and



Paramacrolobium coeruleum – wild

usually indistinctly demarcated from the sapwood. The grain is straight to interlocked, texture moderately coarse and even. The wood is moderately heavy, with a density of about 700 kg/m³ at 12% moisture content, and is moderately hard. The rates of shrinkage during drying are high and the wood may develop severe surface splits and cupping, whereas it is susceptible to blue stain attack during drying. The wood saws and works well, is easy to plane and takes a good finish. The gluing and bending properties are satisfactory. The wood is moderately durable, being liable to termite, *Lyctus* and marine borer attacks.

Several long-chain fatty acids have been isolated from root bark extracts; these acetylenic acids showed inhibitory activity of 3-hydroxy-3-methylglutaryl coenzyme A reductase, the enzyme responsible for the formation of mevalonate in the rate-determining step of cholesterol biosynthesis.

Botany Evergreen, medium-sized to fairly large tree up to 35(–40) m tall; bole branchless for up to 20 m but often low-branching, straight and cylindrical or irregular, up to 90(–100) cm in diameter, with buttresses; bark surface nearly smooth, but with fine longitudinal grooves and lenticels, becoming flaky, grey-brown, inner bark fibrous, brownish to reddish; crown often long and narrow, often with drooping branches; twigs usually glabrous, with lenticels. Leaves alternate, paripinnately compound with 2–5 pairs of leaflets; stipules fused, up to 1.5 cm long, clasping the twigs, persistent; petiole and rachis together 5–22 cm long, grooved; petiolules 1–4 mm long, twisted; leaflets opposite, elliptical to oblong or lanceolate, 2–15 cm × 1–6 cm, asymmetrical at base, acuminate at apex, thinly leathery, glabrous, pinnately veined with 10–15 pairs of indistinct lateral veins. Inflorescence a terminal, flat-topped panicle 4–8 cm long, usually glabrous. Flowers bisexual, zygomorphic, with 2 bracteoles up to 3.5 cm long at base; pedicel 1.5–3 cm long; sepals 4, 1–1.5 cm long, 1 broader than the other 3 and 2-toothed; petals 5, free, unequal, bluish, upper one largest, up to 4.5 cm × 2.5 cm, lateral 2 up to 3 cm × 2.5 mm, lower 2 minute; stamens 9, fused at base, usually 3 fertile, large, up to 3.5 cm long and 6 rudimentary; ovary superior, linear, 1–1.5 cm long, hairy, with long stipe, 1-celled, style 2–2.5 cm long. Fruit an oblong, flattened pod 8.5–20 cm × 2.5–6 cm, glabrous, dehiscing with 2 spiralling woody valves, 3–8-seeded. Seeds rectangular, flattened, 1.5–2.5 cm × 1–2 cm, glossy dark brown, seed coat hard. Seedling with epigeal germination; hypocotyl 5–12 cm long, epicotyl 4–7 cm long; first 2 leaves opposite, with 2–3 pairs of leaflets.

In the nursery seedlings are about 30 cm tall after 4 months and 60 cm tall after 15 months. In Guinea 6-years-old saplings showed a mean annual height growth of 85–130 cm, but in DR Congo planted trees were only 4.5 m tall after 11 years and had a high mortality. Fruits are eaten by monkeys and large rodents, which may serve as seed dispersers.

Paramacrolobium comprises a single species and seems to be related to *Cryptosepalum*.

Ecology *Paramacrolobium coeruleum* occurs in lowland rainforest up to 450 m altitude, but also in gallery forest in savanna areas and in wooded savanna.

Management Seeds can be stored for at least 18 months, when the viability is still about 40%. Pre-treatment of seeds is not needed, but soaking in cold water for 1–2 days or in boiling water for a few minutes accelerates germination. Seedlings should be planted out in the full sun and in fertile soils to obtain good growth. They are planted at a spacing of 3 m × 3 m in pure stands or together with other moderately fast growing timber species.

Genetic resources and breeding Although *Paramacrolobium coeruleum* occupies a large distribution area, it is absent in large regions within that area and thus shows a disjunct distribution pattern. It is common in many regions, and there is no reason to consider it threatened by genetic erosion.

Prospects *Paramacrolobium coeruleum* will remain a locally important timber tree, but it is

unlikely that it will gain importance for commercial exploitation because in areas where it is common the logs are usually too small and too poorly shaped. However, surprisingly little is known about this widespread tree that may have prospects in agroforestry systems or as timber tree in plantations. Research on propagation and growth rates is recommended.

Major references Bolza & Keating, 1972; Brenan, 1967; Chikamai et al., undated; Patil et al., 1989; Savill & Fox, 1967.

Other references Beentje, 1994; Burkill, 1995; Gilbert & Bellefontaine, 1973; Hawthorne & Jongkind, 2006; Hubert, undated; Lewis et al., 2005; Normand & Paquis, 1976; Pauwels, 1993; Wilczek et al., 1952; Wimbush, 1957.

Authors R.H.M.J. Lemmens

PARINARI EXCELSA Sabine

Protologue Trans. Hort. Soc. London 5: 451 (1824).

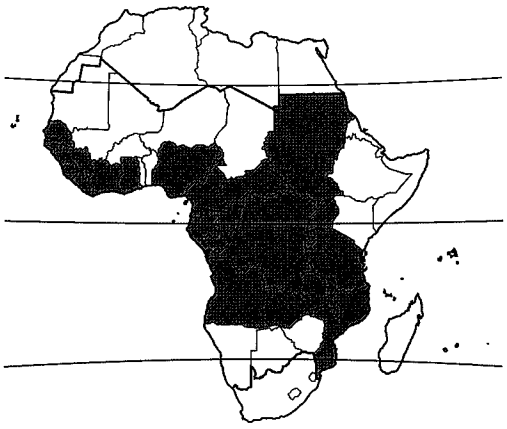
Family Chrysobalanaceae

Chromosome number $2n = 20$

Synonyms *Parinari holstii* Engl. (1895).

Vernacular names Mubura, grey plum, Guinea plum, rough-skinned plum (En). Parinari, manguier sauvage, prunier de Guinée (Fr). Parinari, mampataz (Po). Mbula, mbura (Sw).

Origin and geographic distribution *Parinari excelsa* is extremely widespread, occurring on both sides of the Atlantic Ocean. In Africa it occurs in nearly all forest types of the Guineo-Congolian region, but is absent from the wettest parts; it is also widely distributed on the mountains of East Africa and in the northern part of the Zambezian region. It occurs from Senegal eastward to Sudan and Uganda, and southward to Mozambique and Angola. In South America it is found from Bolivia, Peru and Colombia to eastern Venezuela, the Guianas and Brazil and northward to Costa Rica.



Parinari excelsa – wild

Uses The wood, known in trade as 'sougué', 'kokodi' or 'African greenheart', is traditionally used for house posts. Tenda people from Senegal, Guinea Bissau and Guinea use it to make barrels, drums and mortars. In Zambia it is used similarly and to make dug-out canoes. The wood is suitable for heavy construction, also for hydraulic works in sea water, heavy-duty flooring, poles, piles, joinery, interior trim, mine props, vehicle bodies, furniture, ladders, sporting goods, agricultural implements, tool handles, veneer, plywood and block-board. It has been used for railway sleepers after treatment with preservatives. It is in demand as firewood and for charcoal production.

The pulp of the fruit is eaten, but is not as flavourful as that of *Parinari curatellifolia* Planch. ex Benth. The fruit pulp is also boiled with groundnuts into a sauce, or is fermented into an alcoholic drink. Seeds are oily and eaten after roasting. Roasted bark is added to palm wine to improve its flavour.

Parinari excelsa has numerous uses in traditional medicine in Africa. In the Central African Republic an extract of the bark is taken against gall bladder complaints, and a macerate of the bark is taken in wine as a sexual stimulant. In central DR Congo a decoction of the bark is drunk against chest pain. In Côte d'Ivoire bark decoctions are taken by pregnant women against anaemia and, in combination with a plaster of the leaves, against rheumatic pains. In Tanzania a decoction of the bark enters into medicines against malaria, fever and parasites such as hookworm. In Senegal and Sierra Leone bark decoctions are taken against stomach problems including dysentery. In Senegal and DR Congo a plaster made of the bark is applied to circumcision wounds.

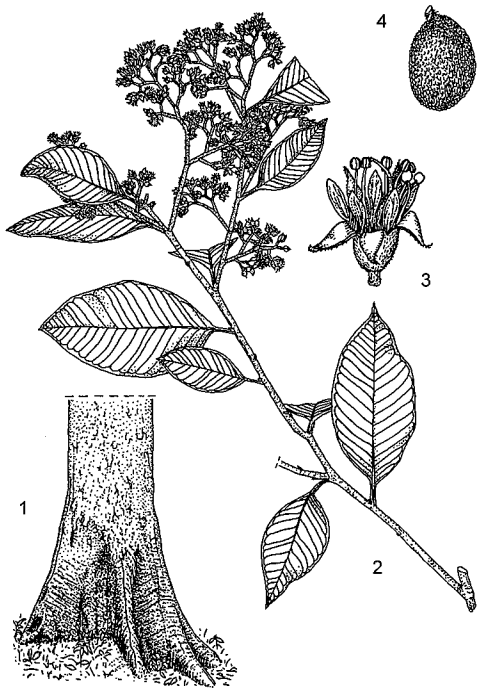
In Senegal and the Central African Republic a decoction of the leaves is applied as a wash or its vapour is inhaled to treat gingivitis and toothache. In Senegal women take root decoctions against headache, stomach pain and infertility. A maceration of the roots is applied to wounds as antiseptic and haemostatic; it is also drunk and applied as a bath against pain of various causes and amnesia. An infusion of the fruit pulp is taken against diarrhoea.

The tree is used for shade in *Cinchona* and coffee plantations. The nectar in the flowers is collected by honey bees. Leafy twigs are used as fodder. A dye obtained from the fruit pulp and fruit stones is traditionally used to colour leather. In Tanzania the bark has been used in tanning leather. The fibre of the fruit stones is used as tinder to start fire.

Production and international trade Formerly, the wood of *Parinari excelsa* was exploited commercially, e.g. in Sierra Leone where it was logged until 1964; later it was considered undesirable because it is too hard, difficult to work and perishable. Like other *Parinari* spp., it has now no commercial value in international timber markets, and even in the countries where it grows its value as timber is limited. It cannot be used economically when resawing and machining of dried wood are required, and may only be used on a larger scale for construction purposes as posts or in large sizes, sawn when still green.
In local markets in Guinea fruits were sold in 2002 at US$ 0.15–0.25 per kg.

Properties The heartwood is yellowish brown, darkening upon exposure to deep red or chocolate brown, and not clearly demarcated from the yellowish white sapwood. The grain is wavy to interlocked, texture moderately coarse to coarse. Fresh sapwood has a smell of honey.
The wood is heavy, with a density of (530–) 730–920 kg/m^3 at 12% moisture content, and hard. It dries slowly with a tendency to distort, check and split. Air drying prior to kiln drying and mild kiln drying schedules are recommended. Boards of 2.5 cm thick were dried in Liberia to 20% moisture content in 3 months. The shrinkage rates are high, from green to oven dry 5.0–7.6% radial and 8.3–11.4(–12.8)% tangential. Once dry, the wood is moderately stable to unstable in service.
At 12% moisture content, the modulus of rupture is 114–204 N/mm^2, modulus of elasticity 10,900–18,050(–23,900) N/mm^2, compression parallel to grain 42–88 N/mm^2, shear 10–16 N/mm^2, cleavage 15–26 N/mm, Janka side hardness 7640–8880 N, Chalais-Meudon side hardness (2.9–)4.5–7.8 and Janka end hardness 8220–10,890 N.
The wood is difficult to saw and work with hand and machine tools, and has a strong blunting effect on saw teeth and tool edges due to its high silica content (usually more than 1%). It is best sawn with stellite-tipped blades and when still green. In planing picking up of grain may occur due to the presence of interlocked grain. The wood finishes well if a filler is used. Pre-boring is required for nailing and screwing, but holding properties are good. Steam bending properties are moderate. The gluing properties are moderate. The wood is technically suitable for plywood or veneer only when processed green. It is not suitable for turning or moulding. The wood is resistant to marine borers, but susceptible to attacks by termites and boring insects. Its susceptibility to fungal decay is moderate; in tests in Tanzania untreated wood lasted for less than 1 year in contact with the ground. The sapwood is permeable to preservatives, the heartwood moderately resistant but easily treatable under pressure. The wood is not suitable for pulping.
The yellowish fruit pulp of *Parinari excelsa* has a taste like avocado, is very nutritive and contains 38–40% carbohydrates. The seed yields about 14% oil. The oil is edible, but dries quickly. It contains α-elaeostearic acid. In spite of the numerous uses of most parts of the tree in traditional medicine, little research has been done into its pharmacological compounds or properties.

Description Evergreen large tree up to 45(–



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

50) tall; bole branchless for up to 20(–25) m, straight or somewhat sinuous, cylindrical, up to 150 cm in diameter, with buttresses up to 3 m high; bark surface slightly rough with numerous warty lenticels or with deep longitudinal fissures, yellowish grey to brownish grey, scaling off in flakes, inner bark hard, granular and brittle, red or pale reddish brown with whitish spots, smelling sour, with a resinous exudate; crown rounded or flattened, cauliflower-shaped, dense, golden brown from below; twigs sparsely hairy. Leaves alternate, simple and entire; stipules up to 2 mm long, caducous; petiole 3–8 mm long, terete, with 2 glands becoming inconspicuous with age; blade ovate to oblong-elliptical, 3–10 cm × 1.5–5 cm, base cuneate to rounded, apex acuminate, leathery, glabrous above, densely brownish or greyish hairy below, pinnately veined with 13–24 pairs of lateral veins. Inflorescence a terminal or axillary panicle, up to 12 cm long, brownish hairy. Flowers bisexual, slightly zygomorphic, 5-merous; pedicel 1–2 mm long; receptacle bell-shaped to top-shaped, 2–3 mm long, hairy; sepals narrowly ovate to triangular, 2–3 mm long, hairy; petals free, obovate to narrowly elliptical, 2–2.5 mm long, pinkish white; stamens 7(–8), c. 2 mm long, on 1 side of flower, with 7–8 rudimentary stamens on opposite side; ovary superior, inserted in upper part of receptacle, hairy, 2-celled, style originating from base of ovary, 2.5–3.5 mm long. Fruit an ellipsoid to nearly globose drupe 2.5–6 cm × 2–4 cm, warty, yellowish to reddish brown when ripe, pulp fleshy, yellowish; stone granular and fibrous, slightly ridged, 1(–2)-seeded. Seedling with hypogeal germination; epicotyl 5–10 cm long, hairy; cotyledons remaining within seed coat; first c. 8 leaves strongly reduced, first normal leaves alternate.

Other botanical information *Parinari* comprises about 40 species and is pantropical with most species in tropical America and tropical Asia and 6 in Africa. In general, the species are remarkably similar despite the very large distribution area of the genus. *Parinari excelsa* is quite variable, particularly in indumentum colour, shape of inflorescence and flower size.

Parinari hypochrysea Mildbr. ex Letouzey & F.White closely resembles *Parinari excelsa*, but differs in its rounded to cordate leaf bases. It is locally abundant in a narrow band of evergreen coastal rainforest in Nigeria, Cameroon, Equatorial Guinea and Gabon, and its wood is possibly used for similar purposes as that of *Parinari excelsa*.

Parinari congensis Didr. is an evergreen medium-sized tree up to 30 m tall with often short, tortuous bole up to 100 cm in diameter, characteristic of swamp forest and periodically flooded forest from Guinea and Mali eastward to the Central African Republic and southward to DR Congo. Its orange-brown and hard wood is used for rafters and for posts and poles in construction, and is probably suitable for other purposes similar to *Parinari excelsa*. In DR Congo the bark is used as purgative and enters into medicines against leprosy, in Congo it is used against dysentery. The fruits are eaten and used as fish bait. The seeds are also edible.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; 9: vessels exclusively solitary (90% or more); 13: simple perforation plates; (19: reticulate, foraminate, and/or other types of multiple perforation plates); 22: intervessel pits alternate; 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); (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); 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: 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: 86: axial parenchyma in narrow bands or lines up to three cells wide; 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; 104: all ray cells procumbent; (106: body ray cells procumbent with one row of upright and/or square marginal cells); 116: ≥ 12 rays per mm. Mineral inclusions: 159: silica bodies present; 160: silica bodies in ray cells.

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

Growth and development Growth follows the tree architectural model of Troll, in which all axes grow horizontally, but the basal part of each axis can assume vertical growth after leaf loss to become the new main axis. In Liberia and Côte d'Ivoire trees flower in January–

April(–June) and fruit in October–January (–March); in Nigeria flowering occurs in January–May and October–November, and fruits mature in November–December and March; in eastern Tanzania flowering occurs in August–March, and fruit maturation peaks in November–December; in Zambia flowering occurs in July–October, and fruiting in May–November. Seed dispersal is mainly by elephants, which eat the fruits, but some studies indicate that dispersal is very limited. Regeneration in mature forest is poor, except in clearings or along roads. In secondary vegetation gregarious stands of all ages may develop from seedlings and root suckers, and this may eventually result in a single-dominant *Parinari excelsa* high forest.

Ecology *Parinari excelsa* is a characteristic canopy tree occurring throughout the African rainforest, but also in drier forest types such as dry evergreen forest and well-drained fringing forest, in areas with average annual temperatures of 10–27°C, up to 2100 m altitude. Sometimes it persists in grassland after the destruction of forest, and then may act as centre for the re-establishment of forest.

Propagation and planting Germination of fruit stones takes 2 months to 3 years, and the germination rate is reported to be low, although natural regeneration may be abundant under optimal circumstances. *Parinari excelsa* can also be propagated by wildlings and root suckers.

Management Densities of up to 0.8 trees per hectare with a bole diameter of more than 60 cm have been recorded in Liberia. The highest density observed in Sierra Leone was 7.5 trees/ha with a bole diameter of 20–60 cm, decreasing to 0.1 trees/ha with a bole diameter of more than 120 cm. *Parinari excelsa* can be managed by lopping, coppicing and pollarding. Seedlings planted into the field should be protected against herbivores.
In logged-over forest where *Parinari excelsa* trees have not been removed during logging operations, its numbers may increase as young trees continue to grow and regeneration can be abundant. Under such circumstances, *Parinari excelsa* may become difficult to control, suppressing more valuable tree species.

Harvesting In the Central African Republic and Gabon, the minimum bole diameter allowed for harvesting is 70 cm.

Handling after harvest Freshly harvested logs sink in water and cannot be transported by river.

Genetic resources *Parinari excelsa* is extremely widespread and locally common, also in disturbed forest. Although there are reports that it is locally becoming threatened, there is no general risk of genetic erosion.

Prospects Although the wood of *Parinari excelsa* is difficult to work, it is available in large sizes and fairly large amounts and may gain importance as better tools have become available. In its area of distribution it will remain important for construction purposes, firewood and charcoal production, and as a source of edible fruits and products for traditional medicine. It may be promising for agroforestry systems, but more research is needed on suitable propagation methods and silvicultural practices.

Major references Aubréville, 1959c; Bolza & Keating, 1972; Burkill, 1985; Burkill, 2000; Graham, 1960; Letouzey & White, 1978a; Phongphaew, 2003; Prance & Sothers, 2003a; Takahashi, 1978; Vivien & Faure, 1985.

Other references Baerts & Lehmann, 2012; Chilufya & Tengnäs, 1996; Coradin, Giannasi & Prance, 1985; de la Mensbruge, 1966; de Saint-Aubin, 1963; Edema, Oderoha & Daro-Idollo, 2009; FAO, 1994; Gross-Camp, Mulindahabi & Kaplin, 2009; Keay, 1958i; Kryn & Fobes, 1959; Lovett et al., 2007; Ogunka-Nnoka & Mepba, 2008; Poorter et al., 2004; Prance & White, 1988; Ruffo, Birnie & Tengnäs, 2002; Vivien & Faure, 1996; Voorhoeve, 1965; White, 1976; White, 1978a; White & Abernethy, 1997.

Sources of illustration Keay, 1958i; Vivien & Faure, 1985; Voorhoeve, 1965.

Authors L.P.A. Oyen

PAUSINYSTALIA JOHIMBE (K.Schum.) Pierre ex Beille

Protologue Act. Soc. Linn. Bordeaux 61: 130 (1906).

Family Rubiaceae

Vernacular names Johimbe, yohimbe (En). Yohimbe, démarreur (Fr). Pau de Cabinda (Po).

Origin and geographic distribution *Pausinystalia johimbe* is distributed from southern Nigeria to Cabinda (Angola). Its occurrence in DR Congo needs to be confirmed.

Uses Young stems are used as poles in construction. The wood is used as fuelwood. The bark is used in house construction, and the inner bark is utilized for making straps for hunting panniers. Young saplings are used as

Pausinystalia johimbe – wild

snare-trap mechanisms.

Bark preparations are widely used as aphrodisiacs and stimulants. In Cameroon, for instance, the bark is popularly known as 'the African viagra'. In Gabon small quantities of the bark are chewed to dispel sleep, while as an aphrodisiac it is used in larger quantities or more frequently. The bark is also used as a local anaesthetic, a hallucinogen, for the treatment of angina, against constipation and intestinal worms, as a performance enhancer for athletes, and to increase the clarity of singers' voices. In Congo a bark decoction is drunk for the treatment of pelvic pain. In Gabon the bark is used as a fish poison.

The bark is the standard source of the alkaloid yohimbine, which is included in various European pharmacopoeias for its sympatholytic, hypotensive and local anaesthetic activity. Yohimbine-based products are widely used as aphrodisiacs in the Western World, either through pharmaceutical channels or herbal medicine markets. The most common use of yohimbine-based drugs in western medicine is in the treatment of diabetes-related male impotence. Yohimbine-based products are also used as food supplements for body weight reduction. In the United States they are recorded to be used as food supplements to substitute anabolic steroids and improve athletic performance. However, in a study investigating the alkaloid content of 26 yohimbe products sold in retail health food outlets throughout the United States, 9 of the products appeared not to contain any yohimbine, 8 only contained trace amounts, and the product with the highest yohimbine content contained only 0.05%. In the United Kingdom yohimbine-based drugs have become fashionable as 'herbal highs'.

Production and international trade The bark is extensively traded in local markets and exported. Most of the bark entering commercial trade comes from Cameroon. In 1985–1991 the annual exports of bark from Cameroon amounted to 286 t, of which 65% to the Netherlands, 18% to Germany, 11% to Belgium/Luxembourg and 6% to France. The bark exports from Cameroon in the season 1997–1998 amounted to 715 t, with a value of about US$ 600,000. However, a large proportion of the exported bark is probably not from *Pausinystalia johimbe* but from *Pausinystalia macroceras* (K.Schum.) Pierre, which has a much lower yohimbine content.

Properties The heartwood is ochre-yellow and not clearly demarcated from the thin, yellow sapwood. The grain is fine. The wood is moderately heavy, with a density of 650–750 kg/m^3 at 12% moisture content, and moderately hard.

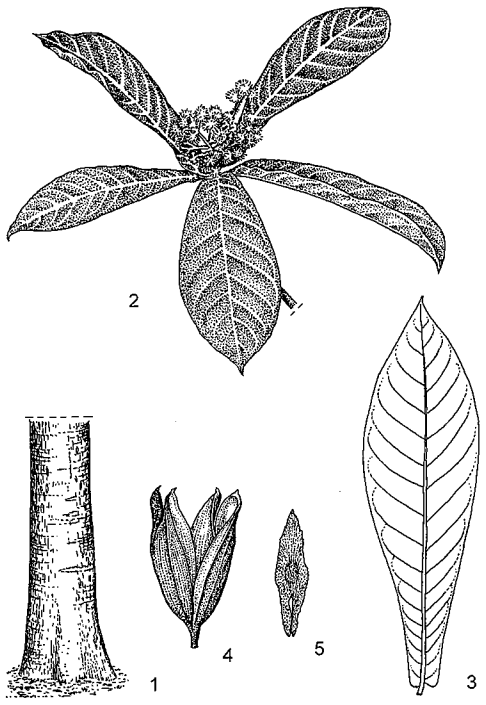
The bast fibre cells are 0.7–1.6 mm long, with a diameter of 22–29 µm. The bark of *Pausinystalia johimbe* contains up to 6% alkaloids. The alkaloid content is highest in the root bark and the bark of the bole, lower in the bark of the branches, and very low in the leaves. Within the bole, the alkaloid content increases from the base upwards. The alkaloids present in *Pausinystalia johimbe* include yohimbine (10–15%), mesoyohimbine, yohimbinine, corynanthine, alloyohimbine and ajamalicine.

Yohimbine (also known as aphrodine, quebrachine or corynine) is a selective inhibitor of α-2-adrenergenic receptors. At low doses it has hypertensive activity, while at higher doses it is hypotensive, through vasodilation of peripheral vessels. Yohimbine raises heart rate and norepinephrine levels. The use of yohimbine as an aphrodisiac is attributed to its dilating effect on the blood vessels of the sexual organs, thus increasing blood supply, while it also provides an enhancement of the reflexes involved in the control of ejaculation. Tests have shown that treatment with yohimbine indeed results in increased libido and easier ejaculation. The effects of yohimbine on smooth muscles favours tonus and movement of the intestine. It also acts on α-2-adrenergenic receptors of adipocytes, resulting in increased lipolysis. However, double-blind trials on the effectiveness of yohimbine for body-weight reduction gave conflicting results, and it is therefore unclear whether yohimbine is effective in reducing body weight. A wide range of adverse effects of

the use of yohimbine have been recorded, including hypertension, mania, bronchospasm, anxiety, agitation, hallucinations, vertigo, stomach problems, headache and weakness. It may also interact with antidepressants. Especially people with hypertension, prostate problems or heart diseases are warned against using yohimbine-based products.
Ajamalicine also has vasodilating activity. Corynanthine closely resembles yohimbine, but is more active as a sympatholytic agent and less toxic. The bark also contains tannins.

Adulterations and substitutes *Pausinystalia johimbe* bark is frequently adulterated with the bark of other *Pausinystalia* and *Corynanthe* spp., which have a lower yohimbine content.

Description Evergreen, medium-sized tree up to 30(–35) m tall; bole straight, up to 50(–60) cm in diameter, without buttresses but grooved at base; bark easy to peel off, bitter-tasting, bark surface longitudinally fissured, with transverse cracks, grey to reddish brown, inner bark fibrous, pinkish, turning reddish brown on exposure; crown compact, with branches in whorls. Leaves in whorls of 3, simple; stipules 1.5–2 cm long, glabrous, caducous; petiole up to 5(–8) mm long; blade obovate or oblanceolate, (11–)13–47 cm × 5–17.5(–19) cm, base cordate, cuneate or rounded, apex short-acuminate, margin often wavy, glabrous, pinnately veined with (8–)10–20 pairs of lateral veins. Inflorescence a terminal or axillary panicle 5–21(–30) cm × 9–15 cm, branched in whorls of 3, with flowers in clusters at the ends of branches, main axes glabrous; peduncle 0.5–5 cm long, with 3 ridges. Flowers bisexual, regular, (4–)5(–6)-merous, fragrant; calyx consisting with short tube and triangular or rounded lobes c. 0.5 mm long, hairy; corolla white, sometimes yellowish, red or purple, with tube consisting of a basal narrow part c. 0.5 mm long and an apical bladder 1.5–2.5 mm long, hairy inside, glabrous outside, lobes erect, shortly toothed, each with a linear appendage 8–20(–25) mm long; stamens attached at the base of the corolla bladder, alternating with the lobes, sessile; ovary inferior, 2(–3)-celled, style 1–2 mm long, stigma 2-lobed. Fruit an oblong, compressed capsule 10–16 mm × 5–7 mm, dehiscing with 4 valves, many-seeded. Seeds oblong, 8–12 mm × 1.5–2.5 mm, compressed, winged.



Pausinystalia johimbe – 1, base of bole; 2, flowering twig; 3, leaf; 4, fruit; 5, seed.
Redrawn and adapted by J.M. de Vries

Other botanical information *Pausinystalia* comprises 5 species, and occurs in West and Central Africa. It is closely related to *Corynanthe*.
Pausinystalia johimbe can be distinguished from *Pausinystalia macroceras* by its larger leaves with shorter or no petioles. Furthermore, the bark of *Pausinystalia johimbe* is tasting extremely bitter and is easy to peel off, whereas that of *Pausinystalia macroceras* is less bitter and difficult to peel off. Differences in slash characteristics, often mentioned as being distinguishing, are not reliable.

Growth and development Light is necessary for germination and good seedling growth, and the survival rate of seedlings under a closed canopy is very low. Growth is usually fast, but the bole diameter never becomes larger than 50–60 cm. Throughout its range, *Pausinystalia johimbe* usually flowers in August–February, and bears fruits in September–March. Pollination is probably by insects. Large amounts of seeds are produced each year. The seeds are dispersed by wind. *Pausinystalia johimbe* coppices well from stumps, producing strong, highly phototropic shoots.

Ecology *Pausinystalia johimbe* occurs in evergreen lowland forest, in primary as well as secondary forest, at relatively low densities.

Propagation and planting Vegetative propagation trials with single-node leafy cuttings have given good results. Propagation with seeds is also done, but seeds are difficult to collect. Furthermore, the survival rate of seedlings was very low in experiments. Wildlings collected from the forest showed poor survival and low growth rates.

Management Although *Pausinystalia johimbe* is often stated to be common, inventories in Cameroon and Equatorial Guinea in the 1990s indicated that there are on average only 15 plants/ha with a diameter over 1 cm and 4 trees/ha with a diameter over 10 cm.

The World Agroforestry Centre (ICRAF) has initiated a research programme to investigate the domestication potential of *Pausinystalia johimbe* and its possible inclusion in agroforestry systems. Initial results have shown that it will readily grow in association with annual food crops.

Diseases and pests Removal of large bark surfaces can lead to stem borers penetrating the unprotected stem and killing the tree.

Harvesting Trees are harvested when they have reached a bole diameter of about 10 cm. As yohimbine levels are highest in the rainy season, harvesting is a seasonal activity. The bark is usually stripped after the tree has been felled for this purpose, making exploitation unsustainable. It would be better to harvest bark strips from standing trees, which will stay alive and renew the bark in 2 years. However, harvesters often claim that the tree will die anyway after removal of part of the bark, because of stem borer attacks. Although a permit is required for harvesting the bark in Cameroon, it is often done by local people who are paid for delivery to contractors. The bark may also be harvested by employees of logging companies after the felling of timber trees in an area.

Handling after harvest The bark is marketed in dried flat or curved pieces up to 1 m long, or ground.

Genetic resources The high demand for medicines based on the bark of *Pausinystalia johimbe* has led to over-exploitation and may lead to local scarcity of the species, if not long-term endangerment.

Prospects The wood is of good quality, but the relatively small bole diameters limit its usability. Nevertheless, it has been suggested as a suitable substitute for *Khaya ivorensis* A.Chev. Probably, however, *Pausinystalia johimbe* will remain more important as a source of yohimbine and local medicine than as a source of timber.

The high demand for medicines based on the bark has led to over-exploitation of natural populations. The tree is easily vegetatively propagated, however, and may have potential for inclusion in agroforestry systems, which could help to relieve the pressure on natural populations. For this purpose, it has been recommended to carry out studies on the breeding system (the presence of self-incompatibility) of *Pausinystalia johimbe*, and on seed dormancy, seed germination and seedling survival.

Care should be taken with the use of yohimbine-based products for medicinal purposes, as adverse side effects have been recorded. As the content of yohimbine and other alkaloids in the bark may vary widely, the use of crude products is even more dangerous than that of products with a known amount of yohimbine. Therefore, yohimbine-based products should be taken cautiously and only under supervision of a specialist, and not as self-medication.

Major references Burkill, 1997; Ernst & Pittler, 1998; Hallé, 1966; Hostettmann et al., 2000; Pousset, 2004; Stoffelen, Robbrecht & Smets, 1996; Sunderland et al., 1999; Sunderland et al., 2004; Tchoundjeu et al., 2004; Vivien & Faure, 1985.

Other references Betz & White, 1995; Cunningham, 1997; de Saint-Aubin, 1963; Goetz, 2006; Hepper & Keay, 1963; Keay, 1989; Keay, Onochie & Stanfield, 1964; Missouri Botanical Garden, undated; Musa, 2005; Neuwinger, 2000; Orwa et al., 2009; Paris & Letouzey, 1960; Pittler & Ernst, 2003; Pittler, Schmidt & Ernst, 2005; Raponda-Walker & Sillans, 1961; Razafimandimbison & Bremer, 2002; Sunderland, Tchoundjeu & Ngo-Mpeck, 2000; Tharakan & Manyam, 2005; Valli & Giardina, 2002; Zanolari et al., 2003.

Sources of illustration Hallé, 1966; White & Abernethy, 1997; Wilks & Issembé, 2000.

Authors R.B. Jiofack Tafokou

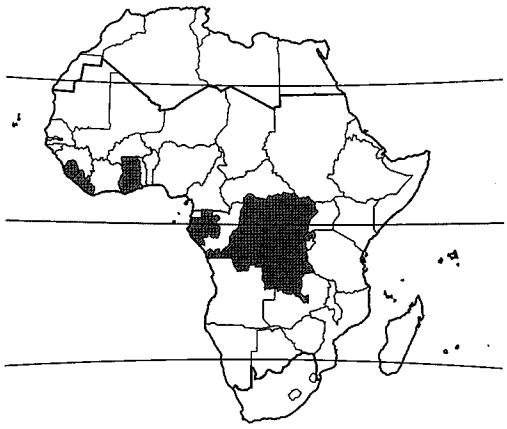
PAUSINYSTALIA LANE-POOLEI (Hutch.) Hutch. ex Lane-Poole

Protologue A list of trees, shrubs, herbs and climbers of Sierra Leone: 74 (1916).

Family Rubiaceae

Origin and geographic distribution *Pausinystalia lane-poolei* occurs from Sierra Leone to Gabon, eastern DR Congo and Rwanda.

Uses The wood is used for house posts and



Pausinystalia lane-poolei – wild

interior joinery. It is suitable for furniture and veneer. The strong and flexible branches are used for making traps. In traditional medicine in Liberia, the pounded bark is used as a poultice for the treatment of yaws, scabies and itch. The root is an ingredient of arrow poison.

Properties The heartwood is pale brown to pinkish, turning pale olive on exposure, and is not clearly demarcated from the sapwood. The grain is straight to irregular, texture fine. The wood is moderately heavy, with a density of about 720 kg/m^3 at 12% moisture content. It is moderately hard. At 12% moisture content, the modulus of rupture is 93 N/mm^2, modulus of elasticity 13,900 N/mm^2, compression parallel to grain 65 N/mm^2, Janka side hardness 6540 N and Janka end hardness 7560 N. The wood works and finishes well. It is recorded to be durable, but it has also been reported to be susceptible to insect attacks.

Botany Evergreen, medium-sized to fairly large tree up to 40 m tall; bole branchless for up to 15 m, straight, cylindrical, up to 120 cm in diameter, with short buttresses or without buttresses; bark surface scaly, the scales leaving rounded pits, grey-brown, inner bark soft, fibrous, pinkish yellow, darkening on exposure, bitter-tasting. Leaves decussately opposite, simple and entire; stipules triangular, caducous; petiole up to 3 cm long; blade elliptical, oblong or obovate, 7–20(–24) cm × 3–9.5 cm, base cuneate to rounded, apex short-acuminate, leathery, glabrous, pinnately veined with 9–14 pairs of lateral veins. Inflorescence a terminal panicle, 10–25 cm × 15–24 cm, with flowers in clusters at the ends of branches. Flowers bisexual, regular, (4–)5-merous, fragrant; calyx with short tube and lobes, hairy inside and outside; corolla white, sometimes pinkish, tube with narrow basal part up to 1 mm long and apical bladder 2–2.5 mm long, hairy inside, glabrous outside, each lobe with a linear appendage 7–15 mm long; stamens attached at base of the corolla bladder, alternating with the lobes, sessile; ovary inferior, 2-celled, style c. 1.5 mm long, stigma 2-lobed. Fruit an oblong, compressed capsule, 8–20 mm long, dehiscent with 4 valves, many-seeded. Seeds 5–9 mm × 1–2.5 mm, winged.
In Liberia *Pausinystalia lane-poolei* flowers in the rainy season.
Pausinystalia comprises 5 species, and occurs in West and Central Africa. It is closely related to *Corynanthe*. *Pausinystalia lane-poolei* has a strikingly disjunct area of distribution. Two subspecies are distinguished. Subsp. *lane-poolei* occurs from Sierra Leone to Ghana. Subsp. *ituriense* (De Wild.) Stoffelen & Robbr. (synonym: *Pausinystalia ituriense* De Wild.) has slightly shorter corolla lobe appendages and slightly smaller fruits and seeds and is found in eastern DR Congo and Rwanda, with one collection from Gabon.

Ecology *Pausinystalia lane-poolei* occurs in evergreen forest, usually at altitudes above 500 m, up to 2000 m altitude.

Genetic resources and breeding It is unclear to what extent *Pausinystalia lane-poolei* is threatened with genetic erosion. In Sierra Leone and Liberia it is recorded to be common, but in Ghana it is rare.

Prospects Few reports exist on the use of the timber of *Pausinystalia lane-poolei*, although research indicated it is of fairly good quality. The timber is unlikely to become more important in the future.

Major references Abbiw, 1990; Burkill, 1997; Kryn & Fobes, 1959; Stoffelen, Robbrecht & Smets, 1996; Takahashi, 1978.

Other references Hallé, 1966; Hawthorne, 1995; Hawthorne & Gyakari, 2006; Hepper & Keay, 1963; Irvine, 1961; Neuwinger, 1998a; Neuwinger, 2000; Razafimandimbison & Bremer, 2002; Savill & Fox, 1967; Voorhoeve, 1979.

Authors M. Brink

PAUSINYSTALIA MACROCERAS (K.Schum.) Pierre ex Beille

Protologue Act. Soc. Linn. Bordeaux 61: 130 (1906).

Family Rubiaceae

Vernacular names False johimbe (En).

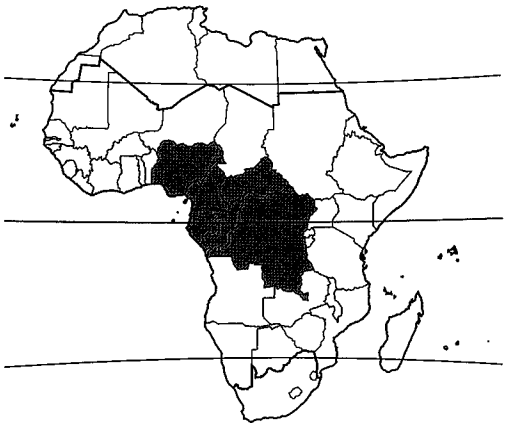
Origin and geographic distribution *Pausinystalia macroceras* is distributed from Nigeria eastward to DR Congo and southward to Cabinda (Angola).

Uses The wood is valued for furniture and cabinet work. In Cabinda (Angola) it is used for house construction and flooring. The wood is suitable for joinery, interior trim, ship building, vehicle bodies, ladders, sporting goods, toys, novelties, agricultural implements, handles, musical instruments, boxes, crates, precision equipment, matches, carvings, turnery, pattern making, veneer and plywood. In Nigeria it is used as fuelwood.

The bark is widely used as an aphrodisiac and stimulant. In Cameroon, for instance, the pulverized bark is eaten against sexual weakness. In Congo the bark is used to stave off sleep, and sap from the bark is applied in an enema as a vermifuge and topically for the treatment of ringworm and other fungal skin infections.

Properties The heartwood is pale yellow to pale pink, with irregular stripes occasionally present; it is not clearly demarcated from the sapwood. The grain is straight, texture fine and even. The wood is lustrous and contains a reddish brown gum.

The wood is medium-weight, with a density of about 700 kg/m^3 at 12% moisture content. It air dries rapidly without serious deformation. The rates of shrinkage are rather high, from green to oven dry 4.7% radial and 10.7% tangential. Once dry, the wood is moderately stable in service. At 12% moisture content, the modulus of rupture is 151 N/mm^2, modulus of elasticity 10,900 N/mm^2, compression parallel to grain 65 N/mm^2, shear 8 N/mm^2, cleavage 12.5 N/mm and Chalais-Meudon side hardness 3.8.



Pausinystalia macroceras – wild

The wood saws well, works easily with all tools, planes to a smooth surface, and finishes well. It takes and holds nails and screws well, and glues satisfactorily. The peeling properties are good, but splitting of veneer may occur during drying. For slicing, radial sections are recommended to reduce defects caused by the rather high shrinkage rates.

The durability of the wood is classified as moderate, although it is not susceptible to attacks by termites and marine borers. The sapwood is not susceptible to *Lyctus* borer attack. The heartwood is resistant to impregnation with preservatives, the sapwood moderately resistant.

The bark contains the indole alkaloid yohimbine, but in smaller quantities than in the bark of *Pausinystalia johimbe* (K.Schum.) Pierre ex Beille, which has led to *Pausinystalia macroceras* sometimes being called 'false yohimbe'. The bark has been recorded to contain only 0.02–0.32% indole alkaloids and more of the inactive alkaloid yohimbinine than of yohimbine. However, bark from Congo was found to contain 4% alkaloids, of which 60–65% yohimbine. Other alkaloids isolated from this bark were corynanthidine (α-yohimbine), β-yohimbine, ajmalicine, corynanthine, and the levorotatory isomer of calycanthine.

The bark also contains saponins and tannins. Methanolic extracts of the stem bark have shown in-vivo anti-ulcerogenic, antidiarrhoeal, analgesic and anti-inflammatory effects in rats.

Botany Evergreen, medium-sized to fairly large tree up to 40 m tall; bole branchless for up to 18 m, straight, cylindrical, up to 90 cm in diameter, without buttresses, but with grooved base; bark surface often fissured, grey to brown, inner bark fibrous, creamy white, turning reddish brown upon exposure. Leaves decussately opposite, simple and entire; stipules caducous; petiole (3–)7–25 mm long; blade obovate to elliptical, 6.5–47 cm × 2.5–17.5 cm, base cuneate to rounded, apex short-acuminate, papery or thinly leathery, glabrous, pinnately veined with 5–16 pairs of lateral veins. Inflorescence an axillary panicle, 9–15 cm × 5–14 cm, with flowers in clusters at the ends of branches. Flowers bisexual, regular, (4–)5–6-merous, fragrant; pedicel up to 0.5 mm long; calyx with short tube up to 0.5 mm long and triangular to rounded lobes 0.5–1 mm long, acute, glabrous or somewhat hairy outside, densely hairy inside; corolla white, sometimes pink, glabrous outside, hairy inside, tube with basal narrow part 0.5–1 mm long and apical

bladder 1–2 mm long, lobes erect, each with a linear appendage 6–12.5 mm long; stamens attached at base of the corolla bladder, alternating with the lobes, sessile; ovary inferior, 2-celled, glabrous, style 1–2 mm long, stigma 2-lobed. Fruit an oblong, compressed capsule, 10–20 mm × 5–7 mm, 4-valved, many-seeded. Seeds 5–14 mm × 1–2 mm, winged.
In Nigeria *Pausinystalia macroceras* flowers in May–September, and fruits in January–March. *Pausinystalia* comprises 5 species, and occurs in West and Central Africa. It is closely related to *Corynanthe*. *Pausinystalia macroceras* can be distinguished from *Pausinystalia johimbe* by its smaller leaves with longer petioles. Furthermore, the bark of *Pausinystalia johimbe* is tasting extremely bitter and is easy to peel off, whereas that of *Pausinystalia macroceras* is less bitter and difficult to peel off. Differences in slash characteristics, often mentioned as being distinguishing, are not reliable.

Ecology *Pausinystalia macroceras* occurs in lowland evergreen forest, primary as well as secondary, and also in gallery forest.

Genetic resources and breeding In view of its fairly wide distribution and local abundance, it is unlikely that *Pausinystalia macroceras* is threatened with genetic erosion.

Prospects Although the wood is recorded to be suitable for a wide range of purposes, evidence of its use is scarce. Its role as a timber is unlikely to become more important in the future. The bark of *Pausinystalia macroceras* is used as an aphrodisiac and stimulant as a substitute or adulterant of that of *Pausinystalia johimbe*, but contains lower amounts of the main active compound (yohimbine).

Major references Bolza & Keating, 1972; Burkill, 1997; Leboeuf et al., 1981; Stoffelen, Robbrecht & Smets, 1996; Sunderland et al., 2004.

Other references Hallé, 1966; Ihenyen, Okoegwale & Mensah, 2009; Keay, 1989; Neuwinger, 2000; Nwafor, Jacks & Ekanem, 2007; Nwafor et al., 2005; Sallenave, 1964; Sunderland et al., 1999; Takahashi, 1978; Vivien & Faure, 1985.

Authors M. Brink

PAUSINYSTALIA TALBOTII Wernham

Protologue Rendle, Cat. pl. Oban: 40 (1913).
Family Rubiaceae
Synonyms *Pausinystalia sankeyi* Hutch. & Dalziel (1931).

Origin and geographic distribution *Pausinystalia talbotii* occurs in Nigeria and Cameroon.

Uses The wood is suitable for construction, flooring, joinery, interior trim, mine props, ship building, vehicle bodies, furniture, cabinet work, ladders, sporting goods, agricultural implements, handles, musical instruments, toys, novelties, precision equipment, boxes, crates, matches, carvings, turnery, draining boards, pattern making, veneer and plywood.
In traditional medicine a bark extract is drunk for the treatment of fever. In Cameroon the pulverized bark is eaten against sexual asthenia. The fruit is eaten to cure dysentery and applied as a topical treatment for tumours.

Properties The heartwood is pale yellow, turning yellow-brown or olive brown upon exposure; it is not clearly demarcated from the sapwood. The grain is usually straight and regular, texture very fine. The wood is lustrous.
The wood is medium-weight, with a density of about 680 kg/m^3 at 12% moisture content. It air dries rapidly with no serious degrade. The rates of shrinkage are moderate, from green to oven dry 2.1–3.0% radial and 3.6–5.0% tangential. At 12% moisture content, the modulus of rupture is 118 N/mm^2, modulus of elasticity 14,100 N/mm^2, compression parallel to grain 57 N/mm^2, cleavage 19.5 N/mm and Chalais-Meudon side hardness 4.7.
The wood is easy to saw and works well with both hand and machine tools. It planes to a lustrous surface. It glues well, takes nails and screws satisfactorily and has good peeling and slicing properties.
The wood is durable, being resistant to attacks

Pausinystalia talbotii – wild

by termites and marine borers. The sapwood is not susceptible to *Lyctus* borer attack. The heartwood is resistant to impregnation with preservatives, the sapwood moderately resistant.

Description Evergreen, small to medium-sized tree up to 30 m tall; bole straight and cylindrical, up to 90 cm in diameter, with buttresses; bark surface smooth, grey, inner bark soft, cream or pink, turning brownish upon exposure. Leaves usually decussately opposite, simple and entire; stipules triangular, caducous; petiole 1–3 cm long; blade elliptical to ovate, 9–25 cm × 4–11.5 cm, base cuneate, apex short-acuminate, leathery, glabrous, pinnately veined with 8–13 pairs of lateral veins. Inflorescence an axillary panicle, (5–)9–15(–20) cm long, with flowers in clusters at the ends of branches, axes more or less hairy. Flowers bisexual, regular, (4–)5-merous, almost sessile; calyx with short tube and triangular lobes, densely hairy outside and inside; corolla white to red, glabrous outside, densely hairy inside, tube with a basal narrow part c. 0.5 mm long and an apical bladder c. 1.5 mm long, lobes each with a linear appendage (4–)5–8 mm long; stamens inserted in throat of the corolla tube, alternating with the lobes; ovary inferior, 2-celled, style c. 1.5 mm long, stigma 2-lobed. Fruit an oblong, compressed capsule, 7–23 mm long, dehiscing with 4 valves, many-seeded. Seeds narrowly ellipsoid, 9–11 mm × 2–2.5 mm, winged.

Other botanical information *Pausinystalia* comprises 5 species, and occurs in West and Central Africa. It is closely related to *Corynanthe*.

Pausinystalia talbotii may have been confused in the literature with other *Pausinystalia* spp., and therefore the information on wood properties may partly refer to other species.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: 2: growth ring boundaries indistinct or absent. Vessels: (4: wood semi-ring-porous); 5: wood diffuse-porous; (9: vessels exclusively solitary (90% or more)); (12: solitary vessel outline angular); 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); 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: 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: 76: axial parenchyma diffuse; 77: axial parenchyma diffuse-in-aggregates; 78: axial parenchyma scanty paratracheal; 93: eight (5–8) 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; 116: ≥ 12 rays per mm.

(S. N'Danikou, P. Baas & H. Beeckman)

Growth and development In Nigeria flowering is in March–April, and fruiting in December–April.

Ecology *Pausinystalia talbotii* occurs in rainforest, but also in secondary vegetation.

Genetic resources *Pausinystalia talbotii* has a limited distribution area, but does not seem to be threatened by genetic erosion.

Prospects Although the wood of *Pausinystalia talbotii* is of good quality and durable, and the range of potential uses is wide, it seems not much used at present. Too little information is available on the prevalence, growth characteristics and management aspects of the species for a good assessment of its prospects.

Major references Bolza & Keating, 1972; Burkill, 1997; Stoffelen, Robbrecht & Smets, 1996; Takahashi, 1978.

Other references GBIF, 2011; Hepper & Keay, 1963; Keay, 1989; Keay, Onochie & Stanfield, 1964; Missouri Botanical Garden, undated; Neuwinger, 2000; Razafimandimbison & Bremer, 2002.

Authors E.E. Ewudzie, J.R. Cobbinah, S. Britwum Acquah & E.A. Obeng

PELLEGRINIODENDRON DIPHYLLUM (Harms) J.Léonard

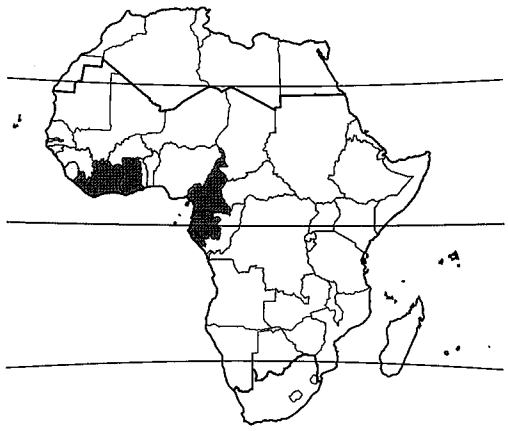
Protologue Bull. Jard. Bot. Etat 25(2): 203 (1955).

Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

Synonyms *Macrolobium diphyllum* Harms (1901).

Vernacular names Faux copalier (Fr).

Origin and geographic distribution *Pellegriniodendron diphyllum* occurs in Liberia, Côte d'Ivoire, Ghana, Cameroon, Equatorial



Pellegriniodendron diphyllum – wild

Guinea and Gabon.

Uses In Ghana the wood is used for door frames and in Gabon for joinery. It is suitable for cabinet work.

Properties The heartwood is brown to reddish brown, often marbled. The texture is moderately fine. The wood is quite heavy and hard.

Botany Small to medium-sized tree up to 25 m tall; bole often low branching, up to at least 30 cm in diameter, often with adventitious shoots at base; bark surface smooth, finely fissured, with lenticels, greyish brown, inner bark fibrous, reddish; crown rounded, with drooping branches. Leaves alternate, paripinnately compound with 1 pair of leaflets; stipules triangular, c. 3 mm long; petiole 3–5 mm long; petiolules 2–3 mm long, with short stipels at base; leaflets elliptical to oblong or obovate, 10–24 cm × 3–10 cm, asymmetrical at base, short-acuminate at apex with acumen often contorted or rolled up, leathery, glabrous, with some glands near margins, pinnately veined with c. 10 pairs of lateral veins. Inflorescence a terminal, drooping panicle up to 10 cm long, with raceme-like, densely flowered side branches 2–3 cm long, with conspicuous scars of fallen flowers and bracts, usually glabrous. Flowers bisexual, zygomorphic, with 2 pinkish bracteoles up to 1 cm long at base; pedicel 6–8 mm long; sepals 5, lanceolate, 3–4.5 mm long, slightly fused at base; petals 5, free, unequal, upper one up to 1.5 cm long, 2-lobed, whitish, other ones resembling the sepals; stamens 3, free, 1–2 cm long, reddish, with a collar of small rudimentary stamens at base; ovary superior, oblong, hairy at margins, 1-celled, style c. 1.5 cm long. Fruit an elliptical to obovoid, flattened pod c. 10 cm × 4 cm, pointed at apex, smooth, glabrous, reddish brown, dehiscing with 2 spiralling thinly woody valves, 1–3-seeded. Seeds rectangular to elliptical, flattened, up to 3 cm × 2 cm, glossy brown, seed coat thin. Seedling with epigeal germination; hypocotyl 1.5–4 cm long, epicotyl 3.5–7 cm long; cotyledons thick and fleshy, rectangular-elliptical, 2–2.5 cm long; first 2 leaves strongly reduced to opposite scales, subsequent leaves alternate, with 1 pair of leaflets.

Young leaves are often bright pink. In West Africa *Pellegriniodendron diphyllum* flowers in September–December and fruits mature about 5 months after flowering. The presence of ectomycorrhizae has been recorded.

Pellegriniodendron comprises a single species and seems to be related to *Gilbertiodendron*.

Ecology *Pellegriniodendron diphyllum* usually occurs in the understorey of lowland rainforest, often on humid localities along streams and in moist gullies.

Management Natural regeneration is often abundant, and the seedlings are shade tolerant. Germination starts 1.5–4 weeks after sowing, with a germination rate of 70–80%. Mature trees are often found in small, dense groups.

Genetic resources and breeding *Pellegriniodendron diphyllum* is not threatened because it is fairly widespread and locally common with abundant regeneration. However, in Ghana it has been rated as a gold star species, meaning that there is some inescapable responsibility for maintaining this species because it has a very restricted distribution in Ghana.

Prospects *Pellegriniodendron diphyllum* will remain of little importance as a timber tree because the logs are usually too small and too poorly shaped.

Major references Aubréville, 1959b; Aubréville, 1970; de Koning, 1983; Irvine, 1961; Raponda-Walker & Sillans, 1961.

Other references Aubréville, 1968; Burkill, 1995; Diabate et al., 2005; Hawthorne, 1995; Hawthorne & Jongkind, 2006; Lewis et al., 2005; Normand & Paquis, 1976; Voorhoeve, 1979; White & Abernethy, 1997.

Authors R.H.M.J. Lemmens

PEMPHIS ACIDULA J.R.Forst. & G.Forst.

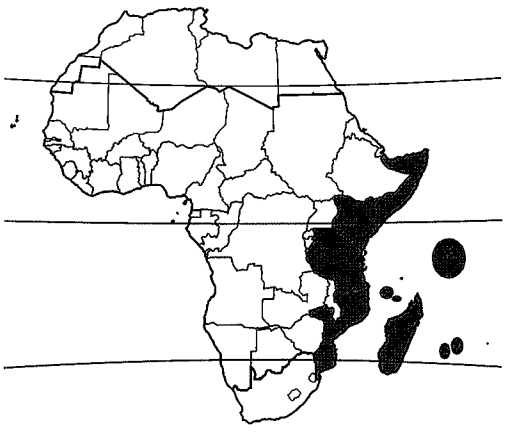
Protologue Char. gen. pl., ed. 1: 34 (1775).
Family Lythraceae
Chromosome number $2n = 32$
Vernacular names Small-leaved mangrove (En). Bois matelot (Fr). Kilalamba kike (Sw).

Origin and geographic distribution *Pemphis acidula* is found along the east coast of Africa from Somalia to Mozambique and on the Indian Ocean islands. It is further found on shores of tropical Asia and Australia, and on islands of the Pacific Ocean.

Uses The hard and durable wood of *Pemphis acidula* is used for house posts, fence posts, tool handles, walking-sticks, domestic implements, turnery, anchors, boat nails and pestles. It is also used for firewood and charcoal production. Along the East African coast the bark has been used for tanning.
In Asia *Pemphis acidula* is occasionally planted as an ornamental, whereas the acid tasting leaves are eaten raw or boiled as a vegetable. In Vanuatu a filtered infusion of the bark is used as an abortifacient, and in Indonesia the bark is used to treat stomatitis.

Production and international trade Because of the small size and the poor form of the bole of *Pemphis acidula*, as well as its limited supply, the use of the wood is on a small and local scale only. There is significant trade in seeds and live plants, especially in Asia for bonsai.

Properties The heartwood of *Pemphis acidula* is reddish brown to dark reddish brown, turning dark brown upon exposure, and is clearly differentiated from the pale, about 1 cm wide sapwood. The grain is interlocked, texture very fine. The wood is lustrous.
The wood is very heavy, with a density of 1100–1210 kg/m^3 at 15% moisture content. It air dries well with little checking and warping. The rates of shrinkage upon air drying are moderate, from green to oven dry 5.4% radial and 8.5% tangential for wood from the Philippines. The wood is very hard and very strong. It is very difficult to work, but with care it takes a high finish. It is very durable, being resistant to dry-wood termite and *Lyctus* attacks.
The bark contains 19–43% tannin. In-vitro tests of the bark showed an increased activity on the amplitude and frequency of uterine contractions, which confirms the traditional use in Vanuata as an abortifacient. Bark extracts were found to have antibacterial, antioxidant and topoisomerase I inhibitor activities. Four galloyl flavonol glycosides with antioxidant activity have been isolated from leaf extracts.



Pemphis acidula – wild

Botany Shrub to small tree up to 11 m tall; bole usually gnarled and much branched; bark surface dark grey, rough, reticulately flaking; twigs angular, densely hairy, nodes thickened with conspicuous leaf scars. Leaves opposite, simple and entire, sessile; stipules absent; blade obovate-oblanceolate to linear-lanceolate, 1–3.5 cm × 3–13 mm, cuneate at base, acute to obtuse at apex, leathery to fleshy, silky-haired, with only midrib distinct. Flowers solitary in leaf axils, bisexual, regular, 6-merous, heterostylous, sweet-scented; pedicel 5–13 mm long; calyx bell-shaped, greenish, 12-ribbed, hairy, with short lobes; petals inserted on calyx tube, c. 5 mm × 4 mm, white or pink, early caducous; stamens 12, inserted slightly below the middle of the calyx tube, 6 longer ones alternating with 6 shorter or all 12 nearly equal; ovary superior, globose, c. 2 mm long, 3-celled, style short or elongate. Fruit a globose capsule 4–6 mm long, purplish green, the upper part opening by a lid, many-seeded. Seeds c. 3 mm × 2 mm, with thick marginal wing, reddish.
Pemphis comprises a single species since *Pemphis madagascariensis* (Baker) Koehne, endemic to Madagascar, has been transferred to a separate genus *Koehneria*. The development of the tree corresponds to Attims' architectural model, characterized by axes with continuous growth, differentiated into a monopodial trunk and equivalent branches. Flowers show heterodistyly, with stamens and styles in 2 length classes. Flowers are self-incompatible.

Ecology *Pemphis acidula* occurs at the landward side of mangroves. It may also be

found exposed to the ocean, but then often partly sheltered by rocky shore, and it is occasionally even found below the high-water mark.

Genetic resources and breeding Although *Pemphis acidula* is extremely widespread, it is uncommon along the east coast of mainland Africa, and the most important threat is to its habitat, i.e. mangrove vegetation, of which the area is rapidly diminishing.

Prospects Increase of the use of *Pemphis acidula* wood is unlikely in tropical Africa, but the wood will remain of interest for specialty uses.

Major references Graham, Tobe & Baas, 1986; Purnobasuki & Irawan, 1998; Tomlinson, 1986; Verdcourt, 1994.

Other references Bourdy et al., 1996; Coode, 1993; Gilbert & Thulin, 1993; Gill & Kyauka, 1977; Greenway, 1941; Hardjito, 2007; Masuda et al., 2001; MMG, undated.

Authors C.H. Bosch

Based on PROSEA 5(3): Timber trees: Lesser-known timbers.

PETERSIANTHUS MACROCARPUS (P.Beauv.) Liben

Protologue Bull. Jard. Bot. Etat 38: 207 (1968).

Family Lecythidaceae

Chromosome number $2n = 52$

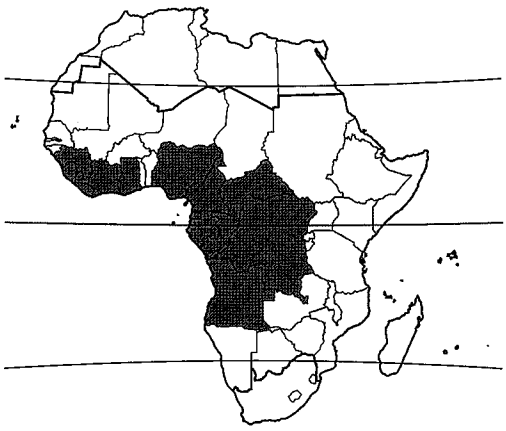
Synonyms *Combretodendron africanum* (Welw. ex Benth.) Exell (1930), *Combretodendron macrocarpum* (P.Beauv.) Keay (1958).

Vernacular names Stinkwood tree, soap tree (En).

Origin and geographic distribution *Petersianthus macrocarpus* is distributed from Guinea eastward to the Central African Republic and southward to DR Congo and northern Angola.

Uses The wood of *Petersianthus macrocarpus* is used for construction, carpentry, furniture, canoes, mortars, tool handles, sliced veneer and plywood. It is suitable for flooring, mine props, vehicle bodies, railway sleepers, sporting goods, toys, novelties, agricultural implements and draining boards. It is valued as firewood and for charcoal production.

In Côte d'Ivoire the bark is used as a purgative and laxative and is considered abortifacient. In Ghana bark decoctions are taken as expectorant, and in DR Congo as cholagogue and as a cure for stomach pain, pneumonia and jaundice. In Equatorial Guinea the bark is administered as anthelminthic and to cure cough. Bark decoctions are widely used to clean wounds and to promote wound healing. Hot bark is applied to the skin against muscle soreness. In Gabon leaf decoctions have been used orally and by enema for the treatment of haemorrhoids, constipation, paralysis and ulcerative wounds. In Cameroon the leaves are used as a medicine for dysentery. Edible caterpillars, which feed on the leaves, are collected and eaten after roasting or boiling.



Petersianthus macrocarpus – wild

Production and international trade Wood of *Petersianthus macrocarpus*, known as 'essia', 'esia', 'abalé', 'abing' and 'owewe', is mainly used locally. Ghana has been exporting considerable volumes, predominantly as sliced veneer, but in 1998 still about 2350 m^3 of logs were exported.

Properties The heartwood is reddish brown, darkening upon exposure and often speckled with darker streaks, and is distinctly demarcated from the 4–10 cm thick, yellowish white sapwood. The grain is straight to interlocked, texture moderately coarse to fine. Quarter-sawn wood shows a nice ray figure. The green wood produces an extremely unpleasant smell when cut, but this disappears upon drying.

The wood is medium-weight to heavy, with a density of 630–920 kg/m^3 at 12% moisture content, and moderately hard. Drying needs to be done slowly to avoid splitting, checking, warping or even collapse. The rates of shrinkage are high, from green to oven dry 4.3–6.8% radial and 9.1–11.6% tangential. It is recommended to quarter-saw logs before drying. Once dry, the wood is moderately stable to unstable in

service.

At 12% moisture content, the modulus of rupture is (76–)112–187 N/mm², modulus of elasticity 7940–19,300 N/mm², compression parallel to grain 43–75 N/mm², shear 8.5–14.5 N/mm², cleavage 13–37 N/mm, Janka side hardness 6360–9690 N, Janka end hardness 7070–10,400 N and Chalais-Meudon side hardness 2.9–6.0.

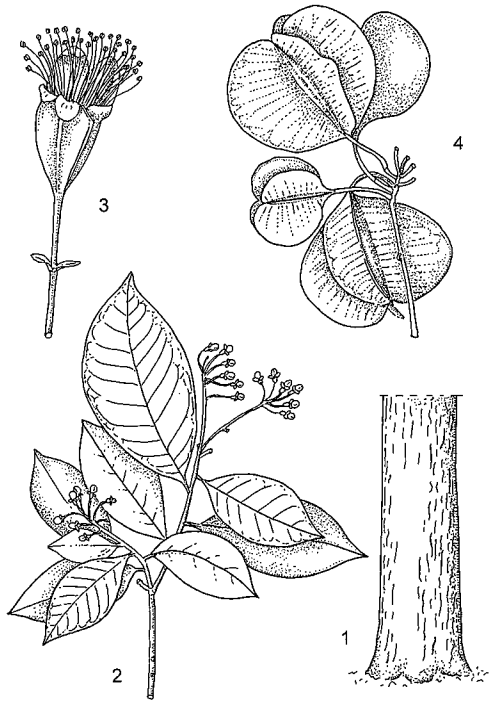
The wood usually saws well, but sometimes with some difficulty because of high density and the presence of interlocked grain resulting in a tendency of over-heating saw blades, thereby charring sawn surfaces. A reduced cutting angle of 20° or less is recommended in planing to avoid picking up of grain at surfaces. The wood has a tendency to char in boring and chiselling operations. It may split upon nailing and screwing, and pre-boring is advised. It stains and polishes well when a filler is used. The bending properties are poor. The heartwood is moderately to fairly durable, with contradictory reports on resistance to termites and borers; it is quite resistant to fungal attacks. The sapwood is fairly resistant to *Lyctus* attack, but susceptible to blue stain. The heartwood is resistant to impregnation by preservatives, but the sapwood is permeable.

The wood contains 39.5–40.5% cellulose, 29–30% lignin, 14.5–15.5% pentosan, 0.4–0.6% ash and little silica. The solubility is 6.2–9.6% in alcohol-benzene, 2.1–3.3% in hot water and 18.3% in a 1% NaOH solution.

The bark contains high levels of sterols, tannins and saponosides, and traces of flavonoids. Bark extracts have shown strong filaricidal effect against *Loa loa*. High concentrations of bark extract act on smooth muscles, circulation, heart-muscles and interferes with the oestrus cycle, conception and pregnancy. An ethanolic leaf extract showed antiproliferative activity on human colon cancer cells (IC_{50} = 17 µg/ml).

Adulterations and substitutes In Ghana *Petersianthus macrocarpus* wood has been suggested as a good substitute for the woods of *Uapaca guineensis* Müll.Arg., *Tieghemella heckelii* (A.Chev.) Roberty and *Diospyros kamerunensis* Gürke which have become scarce as a result of exploitation.

Description Deciduous medium-sized to large tree up to 45 m tall; bole branchless for up to 25 m, usually straight and cylindrical, up to 130 cm in diameter, thickened and slightly fluted at base or with small buttresses; bark surface longitudinally fissured and becoming scaly, medium to dark brown, inner bark fibrous, cream-coloured to yellow-orange or pink-brown, with an unpleasant smell; crown rounded, fairly dense; twigs finely hairy, becoming glabrous. Leaves arranged spirally, crowded towards the ends of twigs, simple; stipules absent; petiole 0.5–2.5 cm long, narrowly winged; blade elliptical or obovate, 6–16 cm × 4–7 cm, base cuneate, apex acute to acuminate, margin entire to slightly wavy or slightly toothed, papery, nearly glabrous, pinnately veined with 6–12 pairs of lateral veins. Inflorescence a terminal panicle or raceme up to 10 cm long, short-hairy. Flowers bisexual, regular, 4-merous; pedicel 1.5–2 mm long, jointed below the middle; sepals broadly ovate, c. 2 mm × 2 mm, attached to winged receptacle; petals broadly elliptical, c. 7 mm × 7 mm, white to pale green, soon caducous; stamens numerous, fused at base, c. 1 cm long, early caducous; ovary inferior, 2-celled, style straight, c. 1 cm long. Fruit a spindle-shaped nut, with 4 papery wings up to 7 cm × 3.5 cm, indehiscent, 1-seeded. Seeds spindle-shaped, 1–1.5 cm long. Seedling with epigeal germination; hypocotyl c.



Petersianthus macrocarpus – 1, base of bole; 2, flowering twig; 3, flower; 4, fruits.
Redrawn and adapted by W. Wessel-Brand

5 cm long, epicotyl very short; cotyledons leafy, elliptical to ovate, 1–1.5 cm long, erect; leaves arranged spirally, nearly sessile, margins finely toothed.

Other botanical information *Petersianthus* comprises only 2 species, one in Africa and the other endemic to the Philippines.

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; 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; 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); 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: (76: axial parenchyma diffuse); 79: axial parenchyma vasicentric; 80: axial parenchyma aliform; 82: axial parenchyma winged-aliform; 83: axial parenchyma confluent; 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); 98: larger rays commonly 4- to 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; 113: disjunctive ray parenchyma cell walls present; 115: 4–12 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.
(L. Awoyemi, A.A. Oteng-Amoako & P. Baas)

Growth and development Growth of seedlings is slow; after 9 months they reach about 11 cm tall. When planted in full sun, seedlings were only 75 cm tall after 5 years, but in moderate shade they reached about 1 m tall 4 years after planting.
Although *Petersianthus macrocarpus* is considered to be an indicator of disturbances in the forest, seedlings have been reported to tolerate some shade and are most common in small forest gaps; saplings can be found in small as well as larger gaps.
Trees are leafless for a short period towards the end of the dry season. Leaves turn red before shedding. In Liberia and Côte d'Ivoire flowering is irregular but peaks around December and May. During flowering the ground under the tree is covered with fallen petals and stamens with a penetrant and unpleasant smell. It has been reported that abundant fruiting occurs twice a year. The fruits are dispersed by wind. In forests where elephants are present, *Petersianthus macrocarpus* trees have strongly swollen bases as a reaction to regular debarking. After debarking the bark grows back not only from the edge of the injury but also from pores in the wood which speeds up recovery and results in reduced rates of infection.

Ecology In Liberia *Petersianthus macrocarpus* is most common in moist semi-deciduous forest and more uncommon in evergreen forest, but in Côte d'Ivoire and Ghana it seems to be more abundant in evergreen forest and transitional zones between evergreen and moist semi-deciduous forest. It apparently does not tolerate waterlogging for longer periods. In Central Africa it is reported to be characteristic for secondary forest. In southern Cameroon it is frequently found in agroforestry plantations of cocoa. *Petersianthus macrocarpus* prefers regions with an annual rainfall of about 2000 mm.

Propagation and planting In Guinea and Côte d'Ivoire seeds are best collected in January–February(–April) and August. There are about 4300 seeds per kg. The germination rate is only 15–25%, and many fruits do not develop a viable seed or are attacked by insects. Germination starts 3.5–7(–10) weeks after sowing. Seedlings are ready for planting after 1 year. In planting tests in Guinea, mortality was quite high, particularly when seedlings had been planted in full sun.

Management In forest in southern Cameroon, the average density of *Petersianthus macrocarpus* trees with a bole diameter of more than 60 cm is 0.3–0.4 trees per ha, with a mean wood volume of 1.5–3 m^3 per ha. In Gabon the mean wood volume has been reported as 0.2 m^3/ha. Trees can be coppiced.

Harvesting In Ghana, Central African Republic and Gabon, the minimum bole diameter allowed for felling is 70 cm. In 2001 it was 50

cm in Cameroon.

Yield A bole felled in south-western DR Congo branchless for 20.5 m and with a diameter of 85 cm yielded 7.7 m^3 of wood.

Handling after harvest It has been recorded that freshly felled logs were subject to pinhole borer attack, but in general logs do not deteriorate rapidly when left in the forest after felling, although deep splits may develop after a longer time. Freshly felled logs are too heavy to be transported by river.

Genetic resources *Petersianthus macrocarpus* is fairly widespread in West and Central Africa and occurs commonly in secondary forest. Export volumes are low, certainly so from Ghana. It is rarely harvested for the international timber market and not commonly cut for local use because of the unpleasant smell and the hardness of the wood. Hence, at present the species is not threatened.

Prospects *Petersianthus macrocarpus* wood has been suggested as a substitute of other more durable woods which have been overexploited. However, little information is available on growth rates, propagation and silvicultural aspects, but the data available suggest that low rates of regeneration may hamper sustainable exploitation from natural forest. More research is justified in the light of its fair wood quality, good bole shape and size and its preference for disturbed forest.

Major references CIRAD Forestry Department, 2008; de Koning, 1983; Fouarge & Gérard, 1964; Irvine, 1961; Liben, 1971; Siepel, Poorter & Hawthorne, 2004; Tailfer, 1989; Takahashi, 1978; Voorhoeve, 1965; White & Abernethy, 1997.

Other references Addae-Mensah & Ayarkwa, 1998; Aubréville, 1959c; de la Mensbruge, 1966; Fouarge, Quoilin & Roosen, 1970; Hawthorne, 1995; Hawthorne & Jongkind, 2006; Keay, 1954c; Kouitcheu-Mabeku, Kuiate & Essame, 2011; Mangenot & Mangenot, 1962; Mengome et al., 2009; Mengome et al., 2010; Nkeoua & Boundzanga, 1999; Normand & Paquis, 1976; Oteng-Amoako (Editor), 2006; Sallenave, 1955; Sallenave, 1964; Sallenave, 1971; Senterre & Lejoly, 2001; Terashima & Ichikawa, 2003; Wilks & Issembé, 2000.

Sources of illustration Liben, 1971; Voorhoeve, 1965; Wilks & Issembé, 2000.

Authors F.W. Owusu

PHYLLARTHRON MADAGASCARIENSE K.Schum.

Protologue Engl. & Prantl, Nat. Pflanzenfam. IV, 3b: 250, t. 93H (1895).

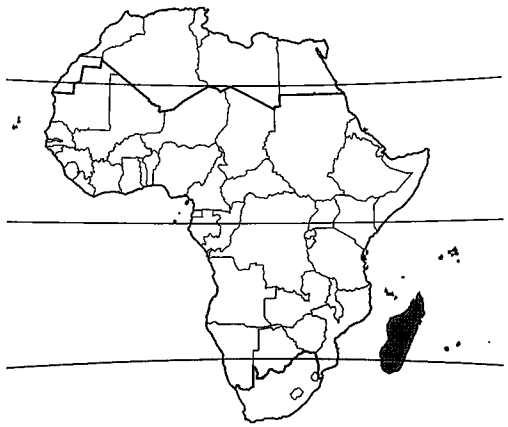
Family Bignoniaceae

Origin and geographic distribution *Phyllarthron madagascariense* is endemic to Madagascar, where it is widespread in the eastern and central parts of the island. It is commonly planted in Madagascar.

Uses The tough wood, known as 'zahana', is traditionally used for the handles of weapons, especially of assegais. It is also in demand for bridges, fence posts, mine props and railway sleepers because of its durability. It is suitable for heavy flooring and framework, joinery, interior trim, vehicle bodies, sporting goods, toys, novelties, agricultural implements and turnery.

The fruits are edible although not very palatable, with a consistency and taste of dried banana. The stem bark is used in traditional medicine to treat diarrhoea, inflammations, wounds and cough. The leaves are applied externally to treat sores, whereas leaf decoctions are administered against blennorrhoea, and as antineuralgic and relaxant. Men drink tea made from the leaves to treat impotence.

Properties The heartwood is yellowish brown and distinctly demarcated from the sapwood. The grain is straight, sometimes slightly interlocked, texture moderately fine. The wood is very heavy, with a density of 1050–1210 kg/m^3 at 12% moisture content. The wood air dries very slowly with little degrade, although there is a slight tendency to surface checking. The rates of shrinkage from green to



Phyllarthron madagascariense – wild

oven dry are quite high, 5.0–6.9% radial and 7.2–13.6% tangential. At 12% moisture content, the modulus of rupture is 214–282 N/mm², modulus of elasticity 14,800–23,540 N/mm², compression parallel to grain 90–122 N/mm², shear 11 N/mm², cleavage 23 N/mm and Chalais-Meudon side hardness 9.1–15.3.
The wood is rather difficult to saw and work. The use of stellite-tipped sawteeth is recommended. It can be finished to a smooth surface. Pre-boring is needed in nailing. The wood glues, stains and polishes satisfactorily. It is very durable. It is resistant to impregnation with preservatives.
The roots, heartwood and stem bark contain lapachol, a known elicitor of contact dermatitis. The roots and heartwood also contain sesamin, which also may cause contact allergy. Several iridoid and phenethyl glycosides were isolated from the leaves, as well as flavonoids.

Botany Evergreen, small to medium-sized tree up to 20(–40) m tall; bole branchless for up to 15 m, usually straight, sometimes fluted at base, up to 80 cm in diameter; bark surface fissured, blackish, inner bark fibrous; twigs glandular hairy. Leaves opposite, occasionally in whorls of 3, consisting of 2 flattened and winged articles formed by petiole and rachis, without leaflets; stipules absent; basal article obovate-oblong, 4.5–15 cm × 1.5–4 cm, terminal article elliptical to oblong-lanceolate, 4–19 cm × 1–5.5 cm, leathery, glabrous, pinnately veined with numerous lateral veins. Inflorescence an axillary or terminal cyme or raceme, up to 20-flowered. Flowers bisexual, zygomorphic, 5-merous, large; pedicel 0.5–1 cm long; calyx campanulate, 0.5–1 cm long, ribbed; corolla funnel-shaped but narrowly cylindrical at base, 3–4(–5) cm long, 2-lipped with 2 upper and 3 lower obtuse lobes, white to pink or purplish red, with yellow markings in throat, hairy; stamens 4 in 2 unequal pairs, inserted on the corolla, included; disk annular; ovary superior, c. 3 mm long, slightly 4-angled, 2-celled, style slender, 12–15 mm long. Fruit a fleshy spindle-shaped berry 6–8 cm × c. 2 cm, smooth, covered with sticky resin, indehiscent, many-seeded. Seeds globose to obovoid, 1–1.5 cm long.
Phyllarthron madagascariense flowers and fruits from November to May. The flowers are pollinated by large insects such as bees and by sunbirds. The fruits are eaten by lemurs, which probably disperse the seeds.
Phyllarthron comprises about 15 species and is restricted to Comoros (1 species) and Madagascar. It can be easily recognized by its leaves consisting of flattened articles (phyllodes) and by its large, sticky, indehiscent fruits.
Phyllarthron articulatum (Desf. ex Poir.) K.Schum. is a small to medium-sized tree up to 25 m tall that is widespread in eastern Madagascar. It differs from *Phyllarthron madagascariense* in its leaves having 3–5 articles. Its wood is similar, also known as 'zahana', and used for the same purposes. Other *Phyllarthron* spp. are either too small trees or occur too local to be of importance for their timber. However, some of them are used in traditional medicine.

Ecology *Phyllarthron madagascariense* usually occurs in more humid types of forest, often in littoral forest on sand, but up to 1600(–2200) m altitude.

Genetic resources and breeding There are no indications that *Phyllarthron madagascariense* or *Phyllarthron articulatum* are immediately threatened. Both species are comparatively widespread and locally common in eastern Madagascar, whereas they are also locally planted.

Prospects Information on propagation, planting and growth rates of *Phyllarthron madagascariense* and other *Phyllarthron* spp. is needed before their prospects as timber plantation trees can be judged.

Major references Bolza & Keating, 1972; Guéneau, Bedel & Thiel, 1970–1975; Perrier de la Bâthie, 1938; Rakotovao et al., en préparation; Takahashi, 1978.

Other references Boiteau, Boiteau & Allorge-Boiteau, 1999; Debray, Jacquemin & Razafindrambao, 1971; Guéneau, 1971a; Harinantenaina et al., 2001; Hudson, Lee & Rasoanaivo, 2000; Parant, Chichignoud & Rakotovao, 1985; Sallenave, 1955; Sallenave, 1964; Schatz, 2001; Tillequin, Henri & Paris, 1977.

Authors R.H.M.J. Lemmens

PHYLLOCOSMUS AFRICANUS (Hook.f.) Klotzsch

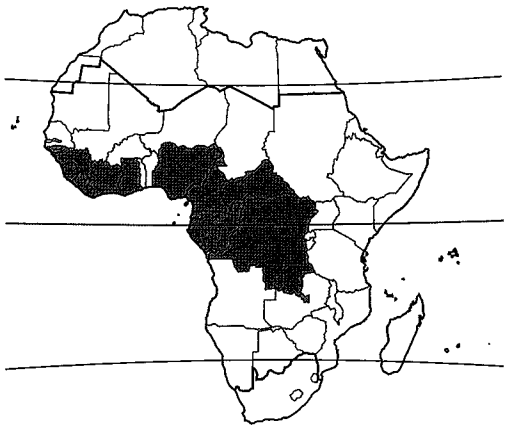
Protologue Abh. Königl. Akad. Wiss. Berlin 1856: 232 (1857).

Family Ixonanthaceae

Synonyms *Ochthocosmus africanus* Hook.f. (1848).

Origin and geographic distribution *Phyllocosmus africanus* occurs from Guinea Bissau to the Central African Republic and DR Congo.

Uses The wood is used for poles and posts in hut and house building, and for carpentry. It is



Phyllocosmus africanus – wild

suitable for hydraulic construction work, flooring, mine props, ship building and railway sleepers, but not recommended for joinery, interior trim, furniture, musical instruments, toys, novelties, carvings and turnery. The pliable twigs are used to make traps for game. The wood is considered a good firewood and is also popular for charcoal production, especially in demand by traditional blacksmiths.

The bark is used in traditional medicine. Bark decoctions are taken to treat diarrhoea, dizziness, stiffness and dysmenorrhoea, and as anodyne.

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

Properties The heartwood is brown to reddish brown and distinctly demarcated from the fairly wide, yellowish brown sapwood. The grain is straight or slightly interlocked, texture fine. Quarter-sawn surfaces show darker streaks or a ribbon figure. The wood contains some gum.

The wood is heavy, with a density of 915–965 kg/m^3 at 12% moisture content, and hard but rather brittle. It should be air dried with care to avoid serious degrade. The rates of shrinkage are very high, from green to oven dry about 9.2% radial and 14.3% tangential. It is recommended to quarter-saw logs before drying. Once dry, the wood is unstable in service.

At 15% moisture content, the modulus of rupture is 180–210 N/mm^2, compression parallel to grain 68–79 N/mm^2, shear 4 N/mm^2, cleavage 22.5 N/mm and Chalais-Meudon side hardness 6.8. The wood saws slowly and does not work easily, but it can be planed and finished to a smooth surface. It holds nails well, although it has a slight tendency to split. It is moderately durable, being moderately resistant to fungi but quite resistant to termite and marine borer attacks. The sapwood is susceptible to *Lyctus*.

Botany Evergreen large shrub or small to medium-sized tree up to 20(–35) m tall; bole branchless for up to 17 m but usually much shorter, usually straight and cylindrical, up to 80(–100) cm in diameter, often with many adventitious shoots at base; bark surface slightly longitudinally fissured, with numerous small lenticels, greyish to nearly black, inner bark fibrous, reddish to dark brown; crown large, with slightly sinuous and drooping branches; twigs glabrous. Leaves alternate, simple; stipules minute, caducous; petiole up to 0.5 cm long; blade ovate to elliptical or obovate, 5–18 cm × 2–6.5 cm, cuneate at base, acuminate at apex, with glandular teeth at margins towards apex of leaf, papery, glabrous, pinnately veined with 5–7 pairs of lateral veins. Inflorescence an axillary raceme up to 10 cm long, short-hairy. Flowers bisexual, regular, 5-merous; pedicel 1–3 mm long; sepals slightly fused at base, ovate-oblong, c. 1.5 mm long; petals free, ovate-oblong, 3–4 mm long, whitish to yellowish; stamens alternating with petals, slightly fused at base, up to 5 mm long; ovary superior, ovoid, c. 0.5 mm long, style 3–4 mm long, stigma 5-lobed. Fruit an ovoid to nearly globose capsule 4–6 mm × 2.5–5 mm, dehiscent with 5 valves, 1–3-seeded, with persistent sepals and petals at base. Seeds ellipsoid, c. 3 mm long, enclosed by a reddish aril. Seedling with epigeal germination; hypocotyl 2–4 cm long, epicotyl very short; cotyledons leafy, elliptical, 6–8 mm long; first leaves alternate.

In Côte d'Ivoire trees usually flower in June–August, but they can also be found flowering in December–March. The flowers are fragrant and visited by flies, which are probably the main pollinators. Fruits take about 3 months to ripen after flowering. The seeds, with their reddish arils, are eaten by birds, which serve as seed dispersers.

Phyllocosmus comprises about 5 species and is restricted to Africa. It has long been included in *Ochthocosmus*, which is now considered to be restricted to tropical America.

Phyllocosmus lemaireanus (De Wild. & T.Durand) T.Durand & H.Durand (synonym: *Ochthocosmus lemaireanus* De Wild. & T.Durand) is a shrub or small tree up to 10(–20) m tall, occurring in southern DR Congo, Tanzania, Malawi,

Zambia, Angola and northern Mozambique. Its wood is used for poles in house building and as firewood. Twigs are used as tooth brush, and the smoke from the wood is inhaled to treat colds, cough and sore eyes. Root decoctions are taken as vermifuge.

Ecology *Phyllocosmus africanus* occurs in various lowland forest types up to about 500 m altitude, from rather dry to moist forest, periodically inundated forest and gallery forest, sometimes even in wooded savanna and on termite mounds in savanna. In the forest, it is often an understorey tree.

Management Fruits are usually picked from the tree before they open, and the small seeds are collected from the dehisced fruits after drying in the shade. The germination rate is 30–40%; seeds start germinating 3–6 weeks after sowing. Seedlings prefer shade. In timber production forest, *Phyllocosmus africanus* is often considered a weedy species, which was formerly sometimes killed by girdling or poisoning, e.g. by sodium arsenite. The tree boles are often small and short, yielding limited amounts of wood, but a bole of 17 m long with a diameter of 70 cm felled in DR Congo yielded 5.5 m^3 of wood.

Genetic resources and breeding *Phyllocosmus africanus* is widespread and locally common in various forest types and is not exploited on a large scale. Consequently, it is not liable to genetic erosion.

Prospects The boles are usually too small to be of interest for commercial timber exploitation. Moreover, the wood is rather difficult to dry, saw and work. *Phyllocosmus africanus* and other *Phyllocosmus* species will remain of some interest for local applications, especially for poles in construction.

Major references Badré, 1972d; Bolza & Keating, 1972; Burkill, 1994; Fouarge, Gérard & Sacré, 1953; Wilczek & Boutique, 1958.

Other references Aubréville, 1959b; Badré, 1973c; Chilufya & Tengnäs, 1996; de Koning, 1983; Hawthorne, 1995; Hawthorne & Jongkind, 2006; Neuwinger, 2000; Normand & Paquis, 1976; Savill & Fox, 1967; Tailfer, 1989.

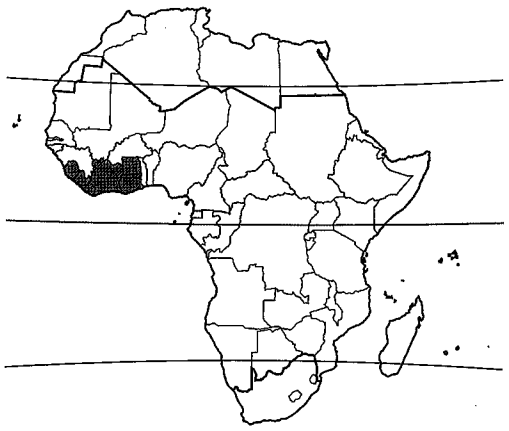
Authors R.H.M.J. Lemmens

PLACODISCUS PSEUDOSTIPULARIS Radlk.

Protologue Sitz.-Ber. Bayer. Akad. 20: 242 (1890).

Family Sapindaceae

Origin and geographic distribution *Placodiscus pseudostipularis* is distributed in Sierra Leone, Liberia, Côte d'Ivoire and Ghana.



Placodiscus pseudostipularis – wild

Uses In Liberia the wood of *Placodiscus pseudostipularis* is used for poles in house building and for tool handles. It has similar characteristics concerning quality and aspect as the wood of European walnut (*Juglans regia* L.), and is suitable for similar purposes such as first-class cabinet work and veneer. It is also used as firewood. The bark, soaked in water, is used as an embrocation to give relief to aching feet and legs.

Properties The heartwood is pale to dark brown. The grain is usually straight, texture fine. The wood is fairly lustrous. It is heavy with a density of about 800–920 kg/m^3 at 12% moisture content, hard and strong. The rates of shrinkage during drying are medium. Once dry, the wood is moderately stable in service. At 12% moisture content, the modulus of rupture is 131–153 N/mm^2, modulus of elasticity 17,540 N/mm^2, compression parallel to grain 49–57 N/mm^2, Janka side hardness 17,760 N and Chalais-Meudon side hardness 5.3–6.1. The wood is somewhat brittle and moderately difficult to saw and work due to its hardness, but can be finished smoothly. It is durable.
The leaves contain saponins and tannins.

Description Dioecious small tree up to 15 m tall; bole slender, often crooked or twisted, up to 30 cm in diameter; bark surface finely plated or covered with bumps and warts, greenish black, inner bark dark reddish brown; twigs glabrous. Leaves alternate, paripinnately compound with 2 pairs of leaflets, sessile; rachis 1–9 cm long; petiolules up to 8 mm long; leaflets ovate to elliptical, obovate or lanceolate, lower

leaflets 2–6 cm × 1–4 cm, usually clasping stem and resembling stipules, upper leaflets 6–24 cm × 1.5–8 cm, cuneate at base, acuminate at apex, margins thickened, leathery, glabrous, pinnately veined with 7–12 pairs of lateral veins and with reticulate fine nervation. Inflorescence an axillary false raceme up to 35 cm long. Flowers unisexual, regular, pale green, nearly sessile; calyx with tube c. 3.5 mm long and wide, with 5 short lobes, hairy; petals absent; stamens 8, free; disk hairy; ovary superior, 3-lobed and 3-celled; male flowers with rudimentary ovary, female flowers with reduced stamens. Fruit a 1–2-lobed berry up to 3 cm long, short-hairy when young but becoming glabrous, yellow to orange when ripe, with fleshy whitish pulp, indehiscent, 1–2-seeded. Seeds ellipsoid, laterally flattened, pale brown. Seedling with hypogeal germination.

Other botanical information *Placodiscus* comprises about 15 species and is restricted to tropical Africa. Even though most species are only small understorey trees, the wood is appreciated for its strength and resilience. This may be the case for at least the following species.

Placodiscus bancoensis Aubrév. & Pellegr. is a small tree up to 15 m tall, occurring locally in evergreen forest in Côte d'Ivoire and Ghana, where it is considered vulnerable. The bark has been used to treat asthma.

Placodiscus boya Aubrév. & Pellegr., a small to medium-sized tree up to 20 m tall, occurs in closed forest in Côte d'Ivoire and Ghana, where it can be quite common. The limited distribution area and the severe loss of its habitat render it vulnerable.

Placodiscus glandulosus Radlk. is a small forest tree of Nigeria, Cameroon and Gabon, having very strong heartwood.

Placodiscus paniculatus Hauman, a small to medium-sized tree up to 25 m tall and with a bole diameter up to 40 cm, is endemic to north-eastern DR Congo and considered vulnerable. The wood is reddish, very hard and used to manufacture arrows. The fruit is eaten.

Placodiscus riparius Keay is confined to riparian, flooded forest of Guinea Bissau, Guinea, Sierra Leone and Liberia, and is a small tree up to 10 m tall.

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); 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; 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); (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: 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); 116: ≥ 12 rays per mm. Mineral inclusions: 136: prismatic crystals present; 138: prismatic crystals in procumbent ray cells; 142: prismatic crystals in chambered axial parenchyma cells.

(S. N'Danikou, P. Baas & H. Beeckman)

Growth and development *Placodiscus pseudostipularis* grows slowly. In Côte d'Ivoire it flowers in July and fruits mature in February–March.

Ecology *Placodiscus pseudostipularis* occurs in the understorey of evergreen forest.

Propagation and planting There are about 100 seeds per kg. The germination rate is quite high and germination starts 10–30 days after sowing.

Management In forest managed for commercial timber production *Placodiscus pseudostipularis* is usually considered and treated as a weed.

Genetic resources *Placodiscus pseudostipularis* is on the IUCN Red List as 'endangered'. The effects of reduction in forest area in West Africa have been severe for this species.

Prospects For commercial timber producers *Placodiscus pseudostipularis* and other *Placodiscus* spp. are not very interesting because of the small size and often poor shape of the bole and their slow growth. They will remain of some local importance because of the excellent wood properties for special purposes such as high-quality cabinet work, or where durability is required for instance for poles in house building.

Major references Bouquet & Debray, 1974;

Chevalier, 1909; Cooper & Record, 1931; Kryn & Fobes, 1959; Sallenave, 1955; Takahashi, 1978.

Other references Burkill, 2000; de Koning, 1983; de la Mensbruge, 1966; Fouilloy & Hallé, 1973a; Hall, 1980; Hauman, 1960; Hawthorne, 1995; Hawthorne, 1998; Hawthorne & Jongkind, 2006; Hegnauer, 1990; Keay, 1958j; Ndjele, 1998; Normand, 1955.

Authors C.H. Bosch

POGA OLEOSA Pierre

Protologue Bull. Mens. Soc. Linn. Paris 2: 1254 (1896).

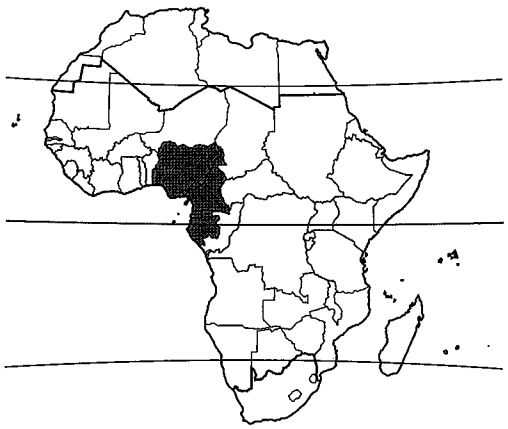
Family Anisophylleaceae

Vernacular names African brazil nut, inoi nut (En). Erable d'Afrique (Fr).

Origin and geographic distribution *Poga oleosa* occurs in southern Nigeria, Cameroon, Equatorial Guinea and Gabon.

Uses The wood, known in Cameroon as 'ovoga' and in Gabon as 'afo', is used for joinery, interior trim, furniture, boxes, crates, veneer, plywood, particle board and fibre board. It is traditionally used for canoes. It is suitable for light construction, vehicle bodies, musical instruments, toys, novelties, vats and turnery.

The sweet fruit pulp is edible. The seeds can be eaten fresh or after roasting. They are often added to sauces. They resemble the brazil nut (*Bertholletia excelsa* Humb. & Bonpl.) from tropical America in flavour and taste. The seed oil has some resemblance to olive oil and groundnut oil, and is used for cooking. The residual meal remaining after expression of the oil is suitable as feed for cattle. Bark decoctions are taken as emetic, whereas powdered bark is applied to wounds and skin diseases. The stone wall of the fruit is burnt and pulverized, and then applied to soothe toothache. Seed oil is taken as purgative in the treatment of gonorrhoea and as a massage oil. The bark, which is rich in tannin, has been used for dyeing cloth blackish.



Poga oleosa – wild

Production and international trade The wood of *Poga oleosa* has been exported in small amounts from Cameroon and Gabon. In 1961 Cameroon exported 1300 m³ of logs. Gabon exported on average 230 m³ of sawn wood in the period 1959–1964 and Equatorial Guinea 3200 m³/year of logs in the period 1959–1968. The export of logs from Gabon was 100 m³ in 2003, 265 m³ in 2004 and 780 m³ in 2005. In Gabon a ban on commercial exploitation has been introduced in 2009 for a period of 25 years. Seeds are fairly commonly available on local markets in Cameroon and Gabon. They are imported in Equatorial Guinea from Cameroon.

Properties The heartwood is pinkish white to pinkish brown, becoming greyish upon exposure, and distinctly demarcated from the white to greyish, 2–5 cm wide sapwood. The grain is straight to slightly wavy, texture coarse. Quarter-sawn surfaces show a silver-grain figure. The wood is lustrous.

The wood is lightweight, with a density of 400–500 kg/m³ at 12% moisture content. It air dries and kiln dries fairly rapidly, with some risk of distortion, checking and warping in backsawn boards. However, the drying rates of boards are quite variable. The rates of shrinkage are moderate, from green to oven dry 2.5–3.2% radial and 6.9–9.6% tangential. Once dry, the wood is moderately stable in service.

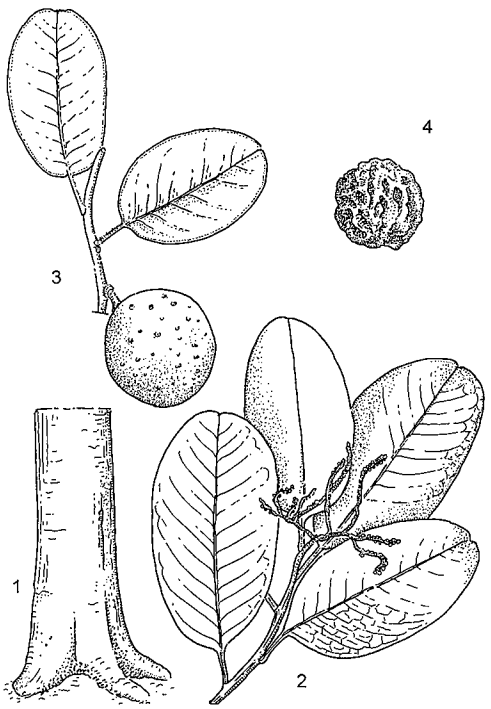
At 12% moisture content, the modulus of rupture is 78–90 N/mm², modulus of elasticity 6370–7160 N/mm², compression parallel to grain 35–38 N/mm², shear 6–6.5 N/mm², cleavage 7.5–13 N/mm and Chalais-Meudon side hardness 0.9–1.8.

The wood is easy to saw and work with ordinary equipment. Planing is somewhat difficult due to the coarse texture. The use of a filler is needed to obtain a good finish and polish, and also for painting and varnishing. The nailing and screwing characteristics are satisfactory, as well as the gluing properties. The wood peels and slices well, producing good-quality veneer. It is moderately durable, being moderately resistant to fungi, fairly resistant to drywood borers and susceptible to termites. The

wood is easy to treat with preservatives.
The weight of 100 dry seeds is about 80 g. The seeds contain per 100 g: total mineral matter 3.8 g, protein 19 g, fat 69 g, cellulose 0.6 g and other extractive matters 6.5 g. Hexane extraction of the seeds resulted in an oil which is fluid at ambient temperature and is mainly composed of triglycerides. Methanolic fruit extracts showed anti-inflammatory activity, inhibiting carrageenan-induced paw oedema in rats, and antibacterial activity against *Staphylococcus aureus* and *Bacillus subtilis*.

Adulterations and substitutes The fruit of *Poga oleosa* strongly resembles that of *Panda oleosa* Pierre, which is used for similar purposes but differs in the more smooth stone.

Description Evergreen, medium-sized to large tree up to 40(–45) m tall; bole branchless for up to 20 m, usually straight and cylindrical, up to 100(–150) cm in diameter, often with broad and rounded buttresses; bark surface smooth to rough or irregularly scaly, grey to greyish brown, inner bark granular, pink with whitish bands; crown rounded, with large, ascending branches; twigs glabrous. Leaves alternate, simple; stipules up to 1.5 cm long, early caducous; petiole 1–2 cm long, stout; blade broadly elliptical, 7–15 cm × 5–7 cm, rounded at base and apex, margins entire but slightly inrolled, leathery, glabrous, with glandular dots below, glossy, pinnately veined with numerous lateral veins. Inflorescence a panicle composed of spikes, short-hairy, many-flowered. Flowers usually functionally unisexual, regular, 4-merous, small, whitish, sessile; sepals fused at base, triangular, c. 1.5 mm long; petals free, c. 3 mm long, 5–7-lobed with gland at apex of the slender lobes; stamens 8, free, nearly sessile; ovary inferior, 4-celled, styles 4, short. Fruit a globose to ellipsoid, fleshy drupe 4–7 cm in diameter, greenish with numerous brownish lenticels; stone nearly globose, 3.5–5 cm in diameter, distinctly rippled, very hard, 2–4-seeded. Seeds ovoid, 2–2.5 cm × 1–1.5 cm, brown, oily.



Poga oleosa – 1, base of bole; 2, flowering twig; 3, part of branch with fruit; 4, fruit stone. Redrawn and adapted by W. Wessel-Brand

Other botanical information *Poga* comprises a single species, and is classified together with *Anisophyllea* (pantropical), *Combretocarpus* (tropical Asia) and *Polygonanthus* (tropical America) in the family *Anisophylleaceae*. Formerly these genera have been included in *Rhizophoraceae*.

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; 43: mean tangential diameter of vessel lumina ≥ 200 μm; 46: ≤ 5 vessels per square millimetre; (58: gums and other deposits in heartwood vessels). Tracheids and fibres: 61: fibres with simple to minutely bordered pits; (62: fibres with distinctly bordered pits); 66: non-septate fibres present; (68: fibres very thin-walled); 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; (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; 99: larger rays commonly > 10-seriate; 102: ray height > 1 mm; 103: rays of two distinct sizes; 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; 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.
(N.P. Mollel, P.E. Gasson & E.A. Wheeler)

Growth and development In a test in Gabon, 57% of seedlings planted in the open survived after one year and 87% of seedlings planted in the undergrowth of opened-up forest; after 6 years the survival rates were 18% and 76%, and after 11 years 8% and 61%, respectively. The young trees in the opened-up forest reached an average height of 22 m and a mean bole diameter of 24 cm 11 years after planting. *Poga oleosa* is classified as a shade bearer.
In Cameroon fruits ripen in June–August and January–March. Trees produce fruits about once every two years. The fruit stones are dispersed by elephants which eat the fruits. However, in a test in Cameroon, stones collected from elephant dung as well as fresh stones failed to germinate within the test period of one year. Gorillas also eat the fruits.

Ecology *Poga oleosa* is a canopy tree of lowland humid evergreen forest, where it is often found in valleys, also in swamp forest. It may be found in secondary forest associated with okoumé (*Aucoumea klaineana* Pierre), where it often shows better growth than the latter species. It is sometimes a relic in farmland.

Propagation and planting The germination of fruit stones is irregular and may take a long period. Wildlings can be used for planting, but they are often rare in the forest.

Management In general, *Poga oleosa* is quite uncommon in the forest; only locally it is more common or even abundant. In forests in south-western Cameroon, the average density of *Poga oleosa* trees with a bole diameter of more than 60 cm is 0.06 per ha, with an average wood volume of 0.62 m^3/ha. In Gabon the average wood volume has been recorded as 0.56 m^3/ha. The trees are sometimes left standing after forest clearance because they are valued by the local population for their oil-rich seeds.
In Gabon *Poga oleosa* has been planted in reforestation projects. It was considered promising, but needed to be planted under light to moderate shade conditions.

Diseases and pests In Gabon longicorn beetles have been recorded as a common pest in standing trees.

Yield A bole branchless for 18 m and with a diameter of 90 cm may yield 10 m^3 of wood. The mean weight of the fruit is 90 g, that of the stone 40 g, and that of the seed 5 g.

Handling after harvest Logs should be removed rapidly from the logging sites after harvesting because they are moderately susceptible to attacks by fungi and insects.

Genetic resources *Poga oleosa* has a restricted area of distribution and is usually not abundant in the forest. It might be easily liable to genetic erosion, although it has been excluded from commercial exploitation in Gabon.

Prospects Although *Poga oleosa* is a multipurpose tree which is not only important for its timber, but also for its edible, oil-rich seeds and as medicinal plant, little is known about many aspects, particularly about silviculture, management and propagation. At present, *Poga oleosa* does not seem to have good prospects for more intensified timber exploitation. However, tests in Gabon showed rapid growth of seedlings planted in the undergrowth of opened-up forest, and this may offer possibilities for enrichment planting in natural forest. The main difficulty is the irregular and slow germination of seeds.
More research is needed on the properties and market opportunities of the seed oil. Some applications in traditional medicine have been confirmed by pharmacological studies, and this may offer possibilities for drug development.

Major references Bolza & Keating, 1972; Burkill, 1997; CIRAD Forestry Department, 2008; CTFT, 1950b; Eyog Matig et al. (Editors), 2006; Ogbole et al., 2007; Raponda-Walker & Sillans, 1961; Vivien & Faure, 1985; Vivien & Faure, 1996; Wilks & Issembé, 2000.

Other references Chudnoff, 1980; de Saint-Aubin, 1963; Gassita et al. (Editors), 1982; Keay, 1989; Koumba Zaou et al., 1998; Louppe et al., 1999; Nchanji & Plumptre, 2003; Neuwinger, 2000; Normand & Paquis, 1976; Pambou Tchivounda et al., 1992; Sallenave, 1955; Sallenave, 1964; Sunderland & Obama, 1999; Tailfer, 1989; Takahashi, 1978; Tobe & Raven, 1988; White & Abernethy, 1997.

Sources of illustration Raponda-Walker & Sillans, 1961; White & Abernethy, 1997; Wilks & Issembé, 2000.

Authors A.T. Tchinda

POLYSCIAS FULVA (Hiern) Harms

Protologue Engl. & Prantl, Nat. Pflanzenfam. III, 8: 45 (1894).

Family Araliaceae

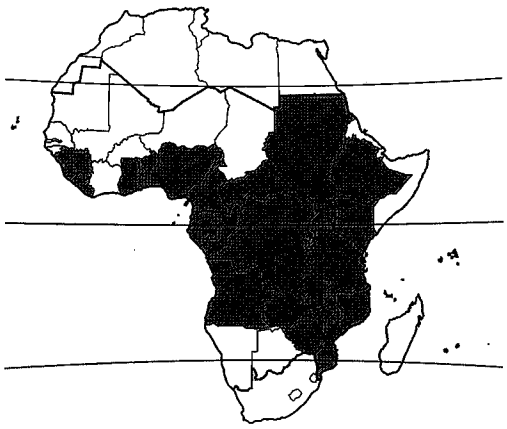
Vernacular names Parasol tree (En).

Origin and geographic distribution *Polyscias fulva* is widespread from Guinea east to Ethiopia and Kenya, and south to Angola, Zimbabwe and Mozambique, but it occurs mainly in mountain regions.

Uses The wood is used for interior joinery, doors, utensils, musical instruments, containers, boxes, crates, beehives, carvings, matches, veneer and plywood. In Cameroon it is valued for carving to make handicrafts and masks, and in Uganda for making drums. It is also used as firewood, although of low quality.

In traditional medicine in DR Congo, bark infusions or decoctions are taken for the treatment of fever and malaria, as an enema to treat colic, and as a purgative. A bark maceration is applied as drops to the nostrils to treat mental illness. Pulverized bark is snuffed as anodyne, and to treat cough, haemoptysis and tuberculosis. In Cameroon the bark is used in mixtures with other plants to treat epilepsy. Leaf decoctions are taken to treat intestinal complaints including those caused by parasites, whereas pounded leaves are applied externally to treat fractures and internally against peptic ulcers. Leaves make good mulch, and the tree is suitable for intercropping with banana, coffee and cocoa. It is planted in life fences. The flowers are a good source of nectar and pollen for honey bees.

Properties The heartwood is whitish to pale yellow-brown, and indistinctly demarcated from the sapwood. The wood is soft and brittle. The grain is usually straight, texture moderately fine to rather coarse. The wood has no distinct smell. The wood is lightweight, with a density of 330–450 kg/m³ at 12% moisture content. It is fairly easy to air dry, but splitting and ring shaking may occur.



Polyscias fulva – *wild*

At 12% moisture content, the modulus of rupture is 61 N/mm², modulus of elasticity 8625 N/mm², compression parallel to grain 29 N/mm², cleavage 12.5 N/mm and Chalais-Meudon side hardness 1.3. The wood is easy to saw and work, but often planes to a rather woolly surface. It is liable to splitting upon nailing and screwing, but glues well. The wood is not durable; it is susceptible to attacks by fungi such as blue stain and brown and white rot, but it is easy to treat with preservatives.

Some triterpene glycosides have been isolated from the stem bark. One of these, α-hederin, showed antifungal activity against *Candida albicans* and *Cryptococcus neoformans*.

Botany Deciduous medium-sized tree up to 30 m tall; bole branchless for up to 15(–25) m, straight and cylindrical, up to 100 cm in diameter; bark surface grey, smooth, with lenticels, inner bark whitish; crown umbrella-shaped, with main branches often whorled, bending upward; branches with prominent leaf scars. Leaves arranged spirally, clustered at ends of branches, usually imparipinnately compound with (3–)5–12(–15) pairs of leaflets; stipules absent; petiole up to 25 cm long, slightly grooved; petiolules up to 8(–14) mm long; leaflets ovate to oblong or lanceolate, 6–20 cm × 2–10 cm, rounded to slightly cordate at base, acute to acuminate at apex, margins entire to slightly wavy, papery to leathery, yellowish brown hairy below, pinnately veined. Inflorescence an axillary panicle up to 70 cm long, yellowish hairy. Flowers bisexual, regular, 5-merous, creamy to greenish yellow, honey-scented; pedicel 1–3 mm long, jointed; calyx with very short teeth; petals free, ovate, 1.5–2 mm long, early caducous; stamens alternating with petals; ovary inferior, 2-celled, styles 2, 0.5–1 mm long, persistent in fruit. Fruit an ovoid drupe-like berry up to 6 mm long, flattened, ribbed, purplish black, glabrous or slightly hairy, 2-seeded. Seeds ovoid, slightly compressed, 3–4.5 mm long, ribbed, glabrous.

Polyscias fulva is fast growing. In plantations in Cameroon seedlings reached a height of 2(–3) m after 4 years and 15 m with a bole diameter of 20(–40) cm after 20 years. The flowers are pollinated by insects such as bees and flies.

Polyscias comprises more than 100 species and is distributed in tropical Africa, Asia, Australia and islands in the Pacific Ocean. Mainland tropical Africa has about 10 species and Madagascar about 50.

The wood of *Polyscias kikuyensis* Summerh., a medium-sized tree up to 25 m tall with a straight bole up to 120 cm in diameter and endemic to central Kenya, is similar to that of *Polyscias fulva* and used for similar purposes, especially for food containers, boxes and plywood. In Madagascar the wood of some *Polyscias* spp. is used by the local population, and is known together with the wood of several other genera of *Araliaceae* as 'voantsilana'. One of these is *Polyscias ornifolia* (Baker) Harms, a small to medium-sized tree up to 20 m tall, the wood of which is heavier (density about 630 kg/m^3 at 12% moisture content), stronger and harder than that of *Polyscias fulva*, and locally used for light construction and flooring, as well as for matches.

Ecology *Polyscias fulva* is found in different types of forest up to 2450(–2750) m altitude, often in secondary forest, also in mountain grassland and in vegetations dominated by bamboo. In West Africa it seems to be confined to mountain areas. The mean annual rainfall in its area of distribution is 1500–2000 mm. *Polyscias fulva* is sometimes considered a pioneer species, but in Cameroon natural regeneration seems to be rare. It is sensitive to fire, but may recover by producing sprouts and suckers.

Management Seeds and cuttings are used for planting. One kg contains about 300,000 seeds. The seeds germinate after 5–7 weeks, with a germination rate of up to 75%. Fruits can best be collected from the trees as soon as they have become purplish black, but they are sometimes also collected from the ground. They should be dried in the shade for 1–2 days. Then the fruits should be soaked in water for 4–6 hours and the seeds squeezed out; they float in the water. After drying the seeds in the shade, they can be stored for up to 2 years, preferably at 3°C and 7–10% moisture content. Seedlings are gradually exposed to the sun and can be transplanted from the nursery into the field after 4–6 months. Wildlings are commonly collected for planting.

The logs are susceptible to attack by blue stain fungi directly after felling, and should be treated with anti-stain solution or transported from the logging area and processed immediately.

Genetic resources and breeding *Polyscias fulva* has a very wide distribution area, but it is uncommon in several regions, e.g. in West Africa. In Kenya it has been reported that *Polyscias fulva* is becoming rare in its natural habitat. This is also locally the case in Cameroon and Uganda, where the species has been overexploited for the production of handicrafts. Monitoring of populations in such regions where it is under pressure because of timber harvesting is recommended, but *Polyscias fulva* is not yet subject to serious genetic erosion, as is the case in Kenya with the endemic *Polyscias kikuyensis* that is already included as vulnerable in the IUCN Red List.

Prospects Although the wood of *Polyscias fulva* is of rather poor quality for building purposes, it seems to have good prospects for commercial production of carvings, veneer and plywood. The fair growth rates and the development of a long and straight bole are advantageous. *Polyscias fulva* has good characteristics as a shade tree and auxiliary plant, which make it interesting for agroforestry systems. In Uganda it has already been recommended to start on-farm production of *Polyscias fulva* to guarantee future supply of the wood for purposes for which it is much in demand, such as drum production. However, research is still needed on propagation techniques and on growth and development.

Major references Latham, 2007; Maundu & Tengnäs (Editors), 2005; Takahashi, 1978; Tennant, 1968; World Agroforestry Centre, undated.

Other references Bamps, 1974; Bedir et al., 2001; Beentje, 1994; Bekele-Tesemma, 2007; Chikamai et al., undated; Katende, Birnie & Tengnäs, 1995; Neuwinger, 2000; Noumi & Fozi, 2003; Tshibangu et al., 2002; Vivien & Faure, 1985.

Authors R.H.M.J. Lemmens

POPULUS ILICIFOLIA (Engl.) Rouleau

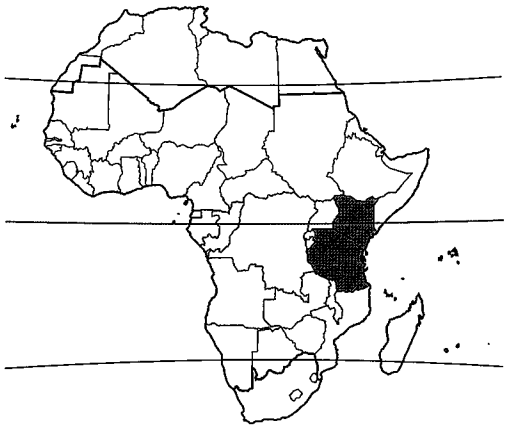
Protologue Rhodora 47: 362 (1945).

Family Salicaceae

Vernacular names Tana River poplar (En).

Origin and geographic distribution *Populus ilicifolia* is endemic to eastern Kenya and north-eastern Tanzania.

Uses The boles of *Populus ilicifolia* trees are used to make dug-out canoes. They are the first choice of Pokomo people for canoes, and these were often sold down the Tana River to fishermen on the coast. These canoes were very



Populus ilicifolia – *wild*

common in the Malindi-Lamu area of Kenya and were often taken aboard sea-going dhows for use as dinghies. The wood is also used for poles, posts, utensils and beehives. *Populus ilicifolia* is suitable for the production of plywood. The wood is used as firewood, but is of low quality for this purpose. The tree is useful for the stabilization of river banks and as ornamental. The foliage is eaten by livestock.

Properties The wood is brown, with a coarse texture. It is lightweight, with a density of about 500 kg/m^3 at 12% moisture content, and rather soft. The wood air dries well with some distortion and end checking. At 12% moisture content, the modulus of rupture is about 70 N/mm^2 and compression parallel to grain 36 N/mm^2. The wood is easy to saw and work. The durability of the wood is low. It has been reported that dug-out canoes last for up to 2 years.

Botany Deciduous, dioecious, medium-sized tree up to 25(–30) m tall; bole cylindrical; bark surface smooth and whitish to pale brown, but becoming longitudinally fissured and red-brown or grey-brown in older trees; crown conical to rounded, open; twigs longitudinally fissured, glabrous, reddish brown, with scattered lenticels. Leaves alternate, simple; stipules strap-shaped or obovate, up to 5 mm long, thin and reddish, deciduous; petiole (0.5–)2.5–4.5 cm long; blade angular ovate or obovate, on juvenile growth linear to narrowly elliptical, 4–7.5 cm × (0.5–)4–5 cm, base cuneate to rounded, apex acute to lobed, margins irregularly lobed or coarsely toothed, papery, glabrous or sparsely hairy, pinnately veined with 4–7(–8) pairs of lateral veins. Inflorescence a unisexual catkin; male inflorescence axillary, 1.5–2 cm long, 6–9-flowered; female inflorescence terminal on short branches, 1–4 cm long, 5–15-flowered. Flowers unisexual, in axils of spatulate bracts 3–6 mm long, lobed or toothed at apex, without perianth, disk thin, reddish, deeply fringed; male flowers with pedicel c. 1 mm long, stamens many, c. 1.5 mm long; female flowers with pedicel 3–5(–8) mm long, ovary ovoid, 3.5–5 mm long, hairy, style c. 1 mm long, stigmas 4, 6–7 mm long, 2–3-lobed. Fruit an ovoid capsule 0.5–1.5 cm × 0.5–1 cm, furrowed, rough with pale lenticels, dehiscent with 2–4 valves, many-seeded. Seeds ovoid, 1–2 mm long, with tuft of long white hairs.

Populus comprises about 40 species, most of them confined to temperate and subtropical areas of the northern hemisphere. *Populus ilicifolia* is the only species of the genus that is a native to tropical Africa. Several *Populus* species and hybrids have been introduced in tropical Africa for timber and pulpwood production, or as ornamental. They are mostly grown in the highlands. *Populus alba* L. and *Populus deltoides* Marshall are most widely planted in tropical Africa. Both are medium-sized trees up to 30 m tall. The hybrid *Populus* ×*canadensis* Moench (*Populus deltoides* × *Populus nigra* L.) has been planted in Mauritius to serve as a windbreak.

Populus ilicifolia is a shade-intolerant pioneer species. It is short-lived, with a lifespan of about 50 years. Leaf fall is usually during the rainy season. It flowers irregularly, depending on moisture levels. Pollination is by wind. Ripe fruits are most common in August–December, and the seeds with their long hairs are widely dispersed by wind.

Ecology *Populus ilicifolia* is found in riverine forest and woodland, and on sand banks and mud flats, from sea-level up to 1000 m altitude. It is most frequently encountered on low-lying sandy point bars that are frequently flooded, but it requires deep soils. The mean annual rainfall within the area of distribution is 200–800 mm and the mean day temperatures vary between 17°C and 35°C.

Management *Populus ilicifolia* produces numerous seedlings on alluvial soils, but many of these are washed away by floods and damaged by grazing animals. It can be propagated by seed, wildlings, layering, and stem and root cuttings. For propagation by seed, fruits should be collected before they open. After opening of the fruits, the seeds are placed in seed trays filled with fine sand flooded with water. They

germinate within a few days. They can also be stored for up to one year at 0°C.
Stem cuttings of 8–10 cm long and 1–2 cm in diameter are recommended; they should be kept moist and at about 25°C, rooting after 3–6 weeks. Root suckers can be planted, as is the case for other *Populus* spp. Trees coppice quite poorly. When they are planted as ornamental, it is recommended to keep some distance from buildings and pavements because of the large superficial roots and because trees are short-living with easily breaking branches. Intercropping with crops such as maize, rice, millet and banana is possible as the quite open tree crown gives little shade.
Seedlings are commonly attacked by blight and stem-rot caused by *Fusarium*, caterpillars of *Phalantha* butterflies and by scale insects. In larger-sized boles, heart rot is common.

Genetic resources and breeding *Populus ilicifolia* is classified in the IUCN Red List as vulnerable because of its restricted distribution area and habitat degradation. However, as long as suitable habitats along rivers are available, it is not threatened because of its pioneer nature, regenerating easily on alluvial soils. Some collection of germplasm has been done in Kenya.

Prospects *Populus ilicifolia* is a promising plantation tree comparable to other *Populus* spp. in temperate regions. Its rapid growth enables high production of wood, which is, however, not suitable for purposes where durability is required. The wood is suitable for similar purposes as that of other *Populus* spp., especially for boxes, crates, utensils, matches, veneer, plywood and pulp for paper production. The establishment of experimental plantations seems worthwhile, but the rather narrow ecological niche of *Populus ilicifolia* should be taken into consideration.

Major references Chikamai et al., undated; Maundu & Tengnäs (Editors), 2005; Oballa, 1996; Oballa et al., 1996; Wilmot-Dear, 1985.

Other references Beentje, 1994; Dale & Greenway, 1961; Johansson, 1991; Maingi & Marsh, 2006; Marais, 1985; Meikle, 1989; Njoroge et al., 2010; van Wyk & Gericke, 2000; Weiss, 1973; Wilmot-Dear, 1991a.

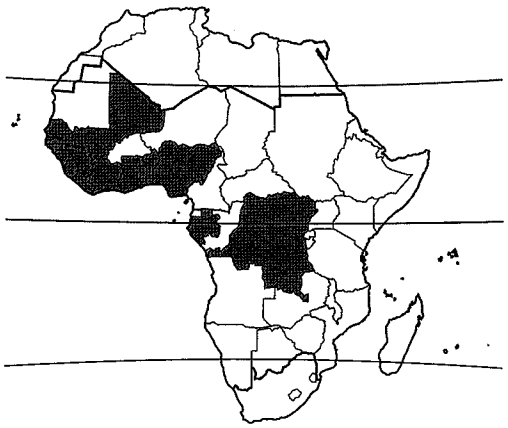
Authors C.H. Bosch, L.P.A. Oyen & R.H.M.J. Lemmens

POUCHETIA AFRICANA A.Rich. ex DC.

Protologue Prodr. 4: 393 (1830).
Family Rubiaceae
Origin and geographic distribution *Pouchetia africana* is distributed from Senegal and Gambia to Gabon and DR Congo.

Uses In Sierra Leone the stems are used as supports for fishing nets. In traditional medicine in Senegal a decoction of leafy twigs is taken in draught and used in frictions for the treatment of kidney pain, stitch, lumbago, stiffness and other pains. A leaf decoction is taken in draught for the treatment of dysentery. In Benin leaf decoctions are externally applied on fractures.

Botany Evergreen shrub or small tree up to 6 m tall; bole cylindrical, slender; branches slender, horizontal. Leaves opposite, simple and entire; stipules triangular, 3–6 mm long; petiole 3–8(–10) mm long, grooved; blade oblong-elliptical, 2–15 cm × 1–6.5 cm, base obtuse or cuneate, apex broadly acuminate, glabrous or with hairs in the axils of the main lateral veins, pinnately veined with 4–8 pairs of lateral veins. Inflorescence an axillary or terminal raceme or panicle up to 11 cm long, lax, pendulous, glabrous; peduncle 3–5 cm long. Flowers bisexual, regular, 4–5-merous, glabrous, fragrant; calyx campanulate, lobes triangular, c. 0.5 mm long; corolla funnel-shaped, whitish or greenish, glabrous, tube 3–4 mm long, gradually widening, lobes elliptical or oblong, 1.5–3.5 mm long, more or less erect; stamens inserted on corolla tube, alternating with lobes, 3–4 mm long, anthers linear, nearly sessile; ovary inferior, 2-celled, style bifid. Fruit an ellipsoid berry 1–1.5 cm long, acute, red to blackish purple,



Pouchetia africana – wild

crowned by persistent calyx, up to 15-seeded. Seeds compressed.

Pouchetia africana is quite variable and 2 varieties have been distinguished. In Benin *Pouchetia africana* flowers and fruits in January–February.

Pouchetia comprises 4 species, distributed in West and Central Africa. *Pouchetia parviflora* Benth. is a shrub or small tree up to 5 m tall, distributed from Guinea and Sierra Leone to São Tomé et Principe and Bioko (Equatorial Guinea). The wood is used for rafters in hut construction.

Ecology *Pouchetia africana* occurs in gallery forest in savanna regions and in coastal vegetation, but also in swamp forest and humid forest.

Genetic resources and breeding In view of its wide distribution, *Pouchetia africana* seems not threatened with genetic erosion.

Prospects *Pouchetia africana* is only locally used as a source of stakes and traditional medicines. In view of its small size its importance as a source of wood is unlikely to increase, but research on pharmacological activity is warranted because the leaves are fairly widely used for medicinal purposes.

Major references Akoègninou, van der Burg & van der Maesen (Editors), 2006; Burkill, 1997; Hallé, 1970; Hawthorne & Jongkind, 2006; Hepper & Keay, 1963.

Other references Aubréville, 1950; Figueiredo, 2005; Irvine, 1961; Kerharo & Adam, 1974.

Authors M. Brink

POUPARTIA SILVATICA H.Perrier

Protologue Mem. Mus. natl. Hist. nat., Paris n.s. 18: 247 (1944).

Family Anacardiaceae

Origin and geographic distribution *Poupartia silvatica* is endemic to western Madagascar, where it is widespread from the extreme north to the south.

Uses The wood is sometimes used for construction, although it is not durable, and for knife handles. It is suitable for the production of veneer, plywood and particle board, and for panelling, light boxes and crates. The fruit pulp is occasionally eaten.

Properties The wood is white to pale grey. The grain is straight, texture medium. The wood is lightweight, with a density of 320–500 kg/m³ at 12% moisture content, and soft. It air dries rapidly and the rates of shrinkage are moderate, from green to oven dry 2.4–3.8% radial and 4.5–7.2% tangential. Once dry, the wood is stable in service. At 12% moisture content, the modulus of rupture is 49–110 N/mm², modulus of elasticity 5000–14,000 N/mm², compression parallel to grain 20–42 N/mm², cleavage 18–24 N/mm and Chalais-Meudon side hardness 0.5–1.7. The wood works easily and finishes well. It is not durable, although in tests it showed fair resistance to fungal attacks. It is quite easy to impregnate with preservatives.

Poupartia silvatica – wild

Botany Deciduous, dioecious, small to medium-sized tree up to 20(–30) m tall; bole usually straight, up to 60(–100) cm in diameter; bark surface greyish, cracking and scaly, inner bark reddish brown, with reddish exudate; young twigs short-hairy. Leaves arranged spirally, clustered near apex of twigs, imparipinnately compound with 5–11 leaflets; stipules absent; petiole and rachis flattened above; petiolules 5–12 mm long, but 2–4 cm long in terminal leaflet; leaflets opposite, ovate to lanceolate, 5–9.5 cm × 2.5–5 cm, asymmetrical at base, acute to acuminate at apex, glabrous, pinnately veined with 8–9 pairs of lateral veins. Inflorescence an axillary panicle or raceme up to 15 cm long, short-hairy. Flowers unisexual, regular, 5-merous, whitish; pedicel up to 4 mm long; sepals free, up to 1 mm long, rounded; petals free, ovate, 2–3 mm long; stamens 10, free; disk thick, annular, slightly 10-lobed; ovary superior, spherical, 5-celled, with 5 sessile stigmas; male flowers with strongly rudimentary ovary, female flowers with rudimentary stamens. Fruit an ovoid drupe c. 2.5 cm × 2 cm, yellowish to orange when ripe, with

fleshy pulp; stone hard and bony, with 3 opercules below the apex and with 5 irregular cavities, 1-seeded. Seed kidney-shaped, c. 1 cm in diameter. Seedling with epigeal germination.
Growth is rather slow. An annual growth rate of seedlings of 25 cm has been recorded. *Poupartia silvatica* usually flowers in September–December, but mainly at the beginning of the rainy season, and fruits mature a few months later, still in the rainy season.
Poupartia comprises about 7 species and is restricted to Madagascar and the Mascarene Islands. It is closely related to *Sclerocarya* from continental Africa, which is sometimes even included in *Poupartia*.
Poupartia chapelieri (Guillaumin) H.Perrier is endemic to eastern Madagascar, where it is widespread from Antsiranana in the north to Taolañaro in the south, in humid, evergreen forest, from sea-level up to 1500(–1700) m altitude. It is an evergreen small to medium-sized tree up to 20(–30) m tall, with usually straight bole, up to 100 cm in diameter. The wood is used for the same purposes as that of *Poupartia silvatica*. The fruit pulp is sometimes eaten. *Protium madagascariense* Engl. (*Burseraceae*) closely resembles *Poupartia chapelieri* and the two species are often confused. Slashed bark of *Protium madagascariense* has a strong turpentine smell, which lacks in *Poupartia chapelieri*.
Poupartia orientalis Capuron ex A.Randrianasolo & J.S.Miller is an evergreen, small to medium-sized tree up to 20 m tall from eastern Madagascar south to Toamasina. It differs from *Poupartia chapelieri* in its flowers with longer pedicels and its fruit stone with 5 opercules (1–2 in *Poupartia chapelieri*). Its wood is probably similar and can be used for the same purposes.

Ecology *Poupartia silvatica* occurs in seasonally dry forest, from sea-level up to 800(–1200) m altitude. It is often found on calcareous soils.

Management Seeds can be collected around February below the trees. The germination rate is about 50%. The seed still showed fair germination rates after 2 years of storage. Fruits should be dried for 4–5 days before storage. Seedlings are ready for planting into the field after 12 months, but the survival rate is often low. They should be protected from wild pigs and be kept free from weeds.

Genetic resources and breeding *Poupartia silvatica* is widespread in eastern Madagascar and locally common. It is not exploited selectively. Therefore, it does not seem to be under threat of genetic erosion at present.

Prospects *Poupartia silvatica* and other *Poupartia* spp. of Madagascar may have good prospects for veneer and plywood production, but although this has been suggested already decades ago, little research has been done until present. Tests on growth performance and propagation methods are warranted.

Major references Blaser et al., 1993; CFPF, 2008; Guéneau, Bedel & Thiel, 1970–1975; Parant, Chichignoud & Rakotovao, 1985; Perrier de la Bâthie, 1946a.

Other references Boiteau, Boiteau & Allorge-Boiteau, 1999; Rakotovao et al., en préparation; Randrianasolo, 1992b; Randrianasolo & Miller, 1999; Schatz, 2001.

Authors R.H.M.J. Lemmens

PRIORIA BALSAMIFERA (Vermoesen) Breteler

Protologue Wageningen Agric. Univ. Pap. 99–3: 21 (1999).

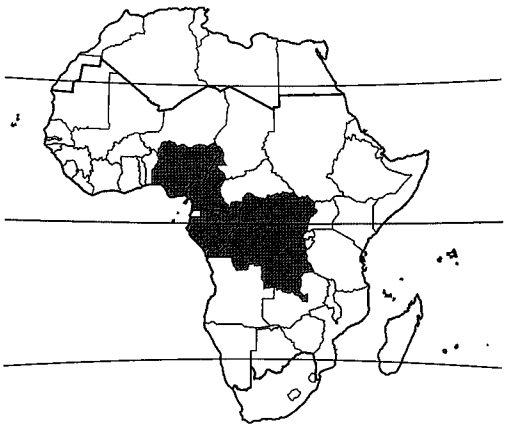
Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

Synonyms *Gossweilerodendron balsamiferum* (Vermoesen) Harms (1925).

Vernacular names Agba (En). Tola (Fr). Tola branca (Po).

Origin and geographic distribution *Prioria balsamifera* is distributed from southern Nigeria eastward to DR Congo and south to Cabinda (Angola).

Uses The wood, known in trade as 'tola' or 'agba', is used for construction, flooring, joinery, interior trim, ship building, furniture, boxes, crates, shingles, veneer and plywood. It is suitable for vehicle bodies, toys, novelties, vats,



Prioria balsamifera – wild

carvings, turnery, hardboard, particle board and pulpwood. The boles are traditionally used to make canoes. The resin exuding from the sapwood has been used as an illuminant, although it reportedly causes a smoky flame, and for caulking canoes.

Production and international trade In 1961–1970 Nigeria exported on average 22,000 m^3 of logs and 11,000 m^3 of sawn wood of *Prioria balsamifera* per year. The export of logs from Gabon increased from 20,500 m^3 in 1991 to 56,000 m^3 in 2001. In 1999 *Prioria balsamifera* ranked 7th on the list of most important Gabonese export timbers. Exports decreased to 13,800 m^3 in 2005. In 2004 Congo exported 13,000 m^3 of logs at an average price of US$ 141/m^3, and 1000 m^3 of veneer at an average price of US$ 309/m^3. Cameroon exported 5600 m^3 of logs in 1999, 12,300 m^3 in 2000, 3000 m^3 in 2001 and only 850 m^3 in 2003. In 2006 small amounts of plywood were exported from Cameroon at an average price of US$ 867/m^3.

Properties The heartwood is pale yellowish brown, darkening to pale reddish brown upon exposure, and not distinctly demarcated from the up to 10 cm wide, slightly paler sapwood. There is an intermediate zone of 2–3 cm wide between sapwood and heartwood. The grain is straight or slightly interlocked, texture moderately fine and even. Wood surfaces are lustrous. Freshly cut wood has a resinous or slightly peppery odour. The intermediate zone between sapwood and heartwood exudes a greenish resin in freshly cut logs, and resin pockets may also be present near the heart of the bole.

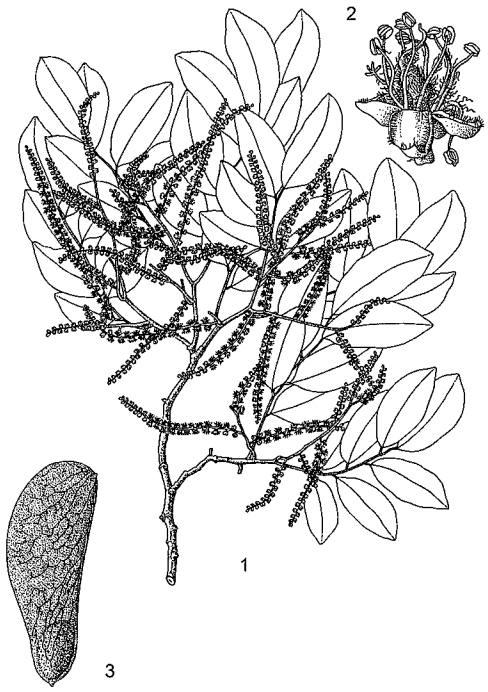
The wood is lightweight to medium-weight, with a density of 445–580 kg/m^3 at 12% moisture content, and moderately hard. It air dries rapidly, with only slight tendency to distortion and checking. Kiln drying should be done with care to avoid collapse; it is recommended to use moderate temperatures to avoid excessive resin exudation. The rates of shrinkage are moderate, from green to oven dry 2.4–3.0% radial and 5.5–6.2% tangential. Once dry, the wood is stable in service. At 12% moisture content, the modulus of rupture is 70–94 N/mm^2, modulus of elasticity 6075–10,900 N/mm^2, compression parallel to grain 33–43 N/mm^2, shear 6.5–11.5 N/mm^2, cleavage 9–14 N/mm, Janka side hardness 2440–3300 N, Janka end hardness 3510–4400 N and Chalais-Meudon side hardness 1.2–2.3.

The wood is easy to saw and work with both hand and machine tools, with little blunting effect on saw teeth and cutting edges. However, tools may be clogged by resin and boards may stick together. After drying of the wood, the difficulties due to the presence of resin have disappeared. The nailing and screwing properties are satisfactory, and the wood glues, paints and varnishes well although the presence of resin may cause difficulties and some staining may occur. It polishes to an excellent finish. The steam bending properties are moderately good. The logs are suitable for rotary peeling, giving a good-quality veneer that can be glued satisfactorily to produce plywood. The wood is moderately durable, being moderately resistant to fungi, but rather susceptible to termite, drywood borer and marine borer attacks. The heartwood is moderately resistant to impregnation with preservatives, the sapwood is permeable. Saw dust can cause irritation of eyes and mucous membranes in wood workers.

Tests on the pulping properties for paper production showed moderate results; the paper was of medium-quality. The wood contains 39–40% cellulose, 27–30% lignin, 16.5–19.5% pentosan, 0.3–0.4% ash and little silica. The solubility is 10.1–11.3% in alcohol-benzene, 1.0–1.7% in hot water, and 17.9–20.2% in a 1% NaOH solution.

Adulterations and substitutes The wood of *Prioria balsamifera* resembles that of African mahogany (*Entandrophragma* and *Khaya* spp.) and has been traded as a substitute.

Description Evergreen, large to very large tree up to 55(–60) m tall; bole branchless for up to 25(–30) m, straight and cylindrical, up to 150(–300) cm in diameter, without buttresses; bark surface scaly with elongate scales, sometimes slightly fissured, greyish brown to reddish brown, inner bark fibrous, reddish; crown usually comparatively small, with sinuous branches; twigs glabrous. Leaves alternate, imparipinnately or paripinnately compound with (4–)6–8(–9) leaflets; stipules small, very early caducous; petiole 1–2(–3) cm long, rachis 4.5–7(–8) cm long, grooved; petiolules twisted, 1–3(–4) mm long; leaflets alternate, obliquely ovate-elliptical to obovate-elliptical, (2.5–)5–7(–9) cm × (1.5–)2–3(–4) cm, rounded to obtuse at base, obtuse to rounded, sometimes slightly acuminate at apex, thin-leathery, glabrous, pinnately veined with 9–13 pairs of lateral veins. Inflorescence an axillary compound raceme up to 12 cm long, with branches up to 7 cm long, short-hairy. Flowers bisexual, regular, whitish; pedicel up to 0.5 mm long; sepals 4(–5), elliptical, 1–2 mm long, spreading, hairy at



Prioria balsamifera – 1, flowering twig; 2, flower; 3, fruit.
Redrawn and adapted by Achmad Satiri Nurhaman

margins; petals absent; stamens usually 10, free, 3–4 mm long, filaments hairy; ovary superior, with a c. 1 mm long stipe, hairy, 1-celled, style slender, curved. Fruit an ovoid, flattened, indehiscent, 1-seeded pod with large wing at base, (7–)12–15 cm × (2–)3–4.5 cm, with numerous resin pockets, wing reticulately veined. Seed rounded to ellipsoid, 2–3 cm long, shallowly grooved. Seedling with hypogeal germination; epicotyl 8–22 cm long, with some small scales; first leaves alternate, with 4–6 leaflets.

Other botanical information *Prioria* comprises 14 species, 7 in Africa (most of them in Central Africa), 6 in tropical Asia and on islands of the Pacific Ocean, and 1 in Central America. Until 1999 the name *Prioria* was reserved for the American species, but then the genera *Kingiodendron* from Asia and the Pacific region, and *Gossweilerodendron* and *Oxystigma* from tropical Africa have been added based on morphological evidence. Wood-anatomical, pollen and molecular studies support the close relationship, but more studies are needed to assess generic delimitation.

Prioria joveri (Normand ex Aubrév.) Breteler (synonym: *Gossweilerodendron joveri* Normand ex Aubrév.) is a large tree up to 40 m tall, with bole up to 150 cm in diameter. It is found in rainforest in Cameroon, Equatorial Guinea and northern Gabon, and differs from *Prioria balsamifera* in more numerous lateral veins in its leaflets and in its fruit tapering to a narrow, curved top. In trade, logs of this species are undoubtedly mixed with those of *Prioria balsamifera* and its wood can probably be used for similar purposes. *Prioria joveri* is classified as vulnerable in the IUCN Red List.

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; 24: intervessel pits minute (≤ 4 μm); 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; 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. Axial parenchyma: (76: axial parenchyma diffuse); 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; 90: fusiform parenchyma cells; 91: two cells per parenchyma strand; (92: four (3–4) 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. Secretory elements and cambial variants: 129: axial canals diffuse. Mineral inclusions: (136: prismatic crystals present); (142: prismatic crystals in chambered axial parenchyma cells). (E, Uetimane, P.E. Gasson & E.A. Wheeler)

Growth and development *Prioria balsamifera* is shade tolerant. Natural regeneration can be abundant. In semi-deciduous forest in south-western DR Congo, up to 7800 seedlings and saplings have been counted per ha. Seed germination can be gregarious under a closed canopy, but it seems that for good growth of seedlings openings in the canopy are needed.

In Nigeria and Cameroon, flowering trees are mainly found from January to March and fruits ripen a few months later. In DR Congo flowering and fruiting trees have been recorded throughout the year. Fruits are dispersed by wind, sometimes quite far from the parent tree.

Ecology *Prioria balsamifera* is most common in lowland semi-deciduous forest up to 600 m altitude, but can also be found in evergreen forest. It prefers deep ferruginous soils and can also be found on sandy soils.

Management *Prioria balsamifera* usually occurs quite scattered in the forest, although often in small groups of a few trees. In Cameroon the average number of trees with a bole diameter of more than 60 cm is 0.05–0.1 per ha, with a mean wood volume of 0.3–1.25 m^3/ha, but locally up to 6 m^3/ha. Locally in eastern Gabon and Congo, 4–6 exploitable trees per ha have been recorded.

Harvesting Some caution is needed during harvesting operations because boles may have brittle heart and ring or wind shakes. The minimum bole diameter allowed for harvesting is 80 cm in Gabon and DR Congo, and 100 cm in Cameroon.

Yield A bole of 13 m long and 120 cm in diameter yielded 8.7 m^3 of wood.

Handling after harvest Freshly harvested logs are sometimes attacked by pinhole borers, but chemical protection of logs is usually not needed when the logs do not stay in the forest for longer periods. They float in water and thus can be transported by river.

Genetic resources *Prioria balsamifera* suffered from habitat loss and heavy exploitation and has therefore been included as endangered in the IUCN Red List of threatened species. FAO recommends that the genetic material of this species should be protected for a future planting programme.

Prospects *Prioria balsamifera* produces an important commercial timber for the international market, but unfortunately there has been no attention for proper management practices to ensure sustainable production. It deserves research attention on genetics and silviculture for future planting programmes.

Major references ATIBT, 1986; Aubréville, 1970; Bolza & Keating, 1972; Breteler, 1999; Burkill, 1995; CTFT, 1979; de Saint-Aubin, 1963; Fouarge & Gérard, 1964; Tailfer, 1989; Wilczek et al., 1952.

Other references African Regional Workshop, 1998; Antoine, Berben & Sauvage, 1959; Christy et al., 2003; Chudnoff, 1980; CIRAD Forestry Department, 2008; Cordiez, 2000; Fouarge, Quoilin & Roosen, 1970; Fouarge, Sacré & Mottet, 1950; Gérard et al., 1998; Keay, 1989; Lewis et al., 2005; Normand & Paquis, 1976; Sallenave, 1964; Takahashi, 1978; UNEP-WCMC, 2006; Vivien & Faure, 1985.

Sources of illustration Breteler, 1999; Wilczek et al., 1952.

Authors J.R. Cobbinah & E.A. Obeng

PRIORIA OXYPHYLLA (Harms) Breteler

Protologue Wageningen Agric. Univ. Pap. 99–3: 37 (1999).

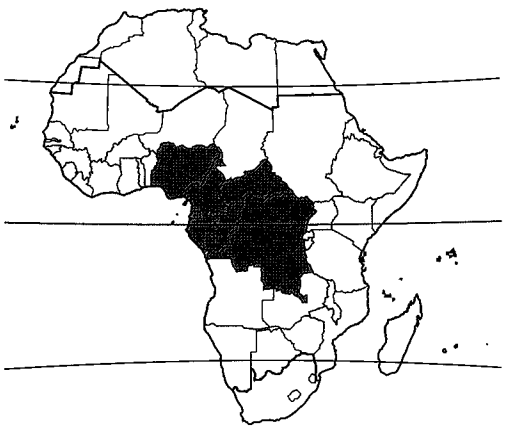
Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

Synonyms *Pterygopodium oxyphyllum* Harms (1913), *Oxystigma oxyphyllum* (Harms) J.Léonard (1950).

Vernacular names Tchitola (Fr). Tola chinfuta, tola mafuta (Po).

Origin and geographic distribution *Prioria oxyphylla* is distributed from southern Nigeria eastward to the Central African Republic, and south to DR Congo and Cabinda (Angola).

Uses The wood, known in trade as 'tchitola', is used for light construction, joinery, furniture, boxes, crates, shingles, veneer and plywood. It is suitable for light flooring, interior trim, vehicle bodies, railway sleepers, handles, ladders, toys, novelties, agricultural implements, turnery and pulpwood. The boles are traditionally used to make canoes. The thick and tough bark is used to make containers. The resin from the bark is heated to combat parasites such as lice and jiggers.



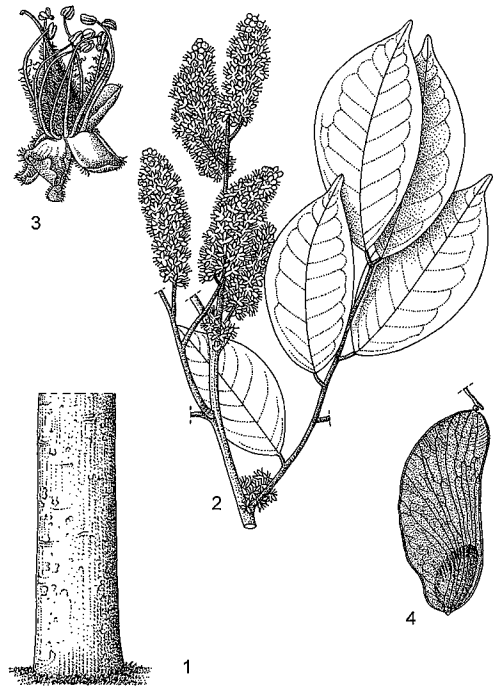
Prioria oxyphylla – wild

Production and international trade The timber of *Prioria oxyphylla* seems to be traded on the international market in small amounts only, although it may be traded in mixed consignments, e.g. together with tola (*Prioria balsamifera* (Vermoesen) Breteler). Gabon exports small amounts of *Prioria oxyphylla* wood, mainly as veneer. In 2006 small amounts of veneer were exported from Congo at an average price of US$ 359/m³.

Properties The heartwood is pinkish brown to coppery brown, darkening to reddish brown upon exposure, with blackish streaks, and distinctly demarcated from the up to 10 cm wide, pale yellow-pink sapwood. An intermediate zone up to 12 cm wide is often present between sapwood and heartwood. The grain is straight or slightly interlocked, texture moderately coarse. The wood contains a greenish resin, becoming brownish to blackish upon exposure.
The wood is medium-weight, with a density of 580–670 kg/m³ at 12% moisture content, and moderately hard. It air dries fairly rapidly, with only slight tendency to distortion and checking. It should not be dried too rapidly because spots caused by resin may develop then. The rates of shrinkage are medium to high, from green to oven dry 3.7–4.6% radial and 8.0–13.1% tangential. Once dry, the wood is moderately stable to stable in service. At 12% moisture content, the modulus of rupture is 85–137 N/mm², modulus of elasticity 9310–14,960 N/mm², compression parallel to grain 37–72 N/mm², shear 14 N/mm², cleavage 14–17 N/mm, Janka side hardness 5560 N and Chalais-Meudon side hardness 3.2.
The wood is easy to saw and work with both hand and machine tools, with little blunting effect on saw teeth and cutting edges. However, tools may be clogged by resin. The resin content can be high and steam and hot water treatments are sometimes needed to reduce the amounts to manageable levels. The nailing and screwing properties are satisfactory, and the wood glues, paints and varnishes well when the surfaces are free of resin. The logs are suitable for rotary peeling, giving a good-quality veneer that can be glued satisfactorily to produce plywood. The wood is moderately durable, being fairly resistant to fungi, termites and dry-wood borers, but susceptible to marine borer attacks. The heartwood is moderately resistant to impregnation with preservatives, the sapwood is permeable. Saw dust can cause irritation of eyes and mucous membranes in wood workers.

Adulterations and substitutes In Europe and the United States the veneer of *Prioria oxyphylla* is considered a substitute for that of walnut (*Juglans regia* L.) and jatoba or guapinol (*Hymenaea courbaril* L.), mainly used for furniture and decorative purposes.

Description Evergreen, large tree up to 50 m tall; bole branchless for up to 20(–40) m, straight and cylindrical, up to 130(–300) cm in diameter, without buttresses; bark surface scaly with elongate scales, sometimes slightly fissured, grey to greenish grey, inner bark fibrous, pinkish to reddish; crown usually comparatively small, with sinuous branches; twigs glabrous. Leaves alternate, imparipinnately or paripinnately compound with (4–)6–8(–10) leaflets; stipules small, c. 3 mm long, very early caducous; petiole (0.5–)1–2(–2.5) cm long, rachis (4–)6–11 cm long; petiolules 3–6(–7) mm long; leaflets alternate, obliquely elliptical to ovate-elliptical, (3–)6–11 cm × (1)2–4.5 cm, cuneate to rounded at base, short-acuminate at apex, leathery, glabrous, pinnately veined with 6–11 pairs of lateral veins. Inflorescence an axillary compound raceme up to 20 cm long,



Prioria oxyphylla – 1, base of bole; 2, flowering twig; 3, flower; 4, fruit.
Redrawn and adapted by Achmad Satiri Nurhaman

with branches up to 15 cm long, short-hairy. Flowers bisexual, regular, yellowish white; pedicel 1–1.5 mm long; sepals 5, obovate-elliptical, 1.5–2 mm long, spreading or erect, usually hairy at margins only; petals absent; stamens 10, free, 2–5 mm long, filaments hairy; ovary superior, c. 1 mm long, densely hairy, 1-celled, style slender, slightly curved. Fruit an ovoid, flattened, indehiscent, 1-seeded pod with large wing at base, 6–11.5 cm × 2–4 cm, sometimes with numerous resin pockets, wing longitudinally and reticulately veined. Seed ellipsoid, flattened, up to 2.5 cm long. Seedling with hypogeal germination; epicotyl 9–17 cm long, with some small scales; first leaves alternate, with 2 leaflets.

Other botanical information *Prioria* comprises 14 species, 7 in Africa (most of them in Central Africa), 6 in tropical Asia and on islands of the Pacific Ocean, and 1 in Central America. Until 1999 the name *Prioria* was reserved for the American species, but then the genera *Kingiodendron* from Asia and the Pacific region, and *Gossweilerodendron* and *Oxystigma* from tropical Africa have been added based on morphological evidence. Wood-anatomical, pollen and molecular studies support the close relationship, but more studies are needed to assess generic delimitation.

Prioria buchholzii (Harms) Breteler (synonym: *Oxystigma buchholzii* Harms, *Oxystigma dewevrei* De Wild.) is a medium-sized tree up to 30 m tall, with bole up to 75(–180) cm in diameter. It is found in periodically inundated forest along rivers from Cameroon east to DR Congo and south to northern Angola. It is characterized by glabrous inflorescences and unwinged fruits circular to obcordate-obovate in outline. Its wood is used for similar purposes as that of *Prioria oxyphylla*, e.g for joinery and traditionally for canoes.

Prioria mannii (Baill.) Breteler (synonym: *Oxystigma mannii* (Baill.) Harms) is a medium-sized tree up to 30 m tall, with bole up to 70 cm in diameter. It occurs in swamp forest along the coast from eastern Nigeria to northern Gabon. It resembles *Prioria buchholzii*, but differs in short-hairy inflorescences and more rough and dull fruits. Its wood is used for construction and utensils, and traditionally for canoes. It has similar properties as that of *Prioria oxyphylla*, but the density is slightly lower, about 510 kg/m^3 at 12% moisture content, and it is slightly less hard and strong, and not durable.

Prioria msoo (Harms) Breteler (synonym: *Oxystigma msoo* Harms) is a large tree up to 40(–50) m tall, with bole up to 150(–300) cm in diameter. It is restricted to evergreen forest in Kenya and Tanzania. It differs from *Prioria mannii* in its sepals which are more hairy inside, and in its shortly winged fruits with longitudinal veins. Its wood is used in house building and for canoes, utensils, tool handles, carvings and plywood, and as firewood. It has similar properties as that of *Prioria mannii*, with a density of about 510 kg/m^3 at 12% moisture content, and it is rather soft and not durable. The tree serves as forage for honey bees. *Prioria msoo* has been 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; 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; 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; 82: axial parenchyma winged-aliform; 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; 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; 116: ≥ 12 rays per mm. Secretory elements and cambial variants: 129: axial canals diffuse. Mineral inclusions: 136: prismatic crystals present; 138: prismatic crystals in procumbent ray cells; 142: prismatic crystals in chambered axial parenchyma cells.

(S. N'Danikou, P.E. Gasson & E.A. Wheeler)

Growth and development In DR Congo flowering and fruiting trees have been recorded throughout the year.

Ecology *Prioria oxyphylla* occurs in lowland rainforest on well-drained soils.

Management *Prioria oxyphylla* occurs scattered in the forest. In Cameroon and Gabon, it is apparently comparatively rare, but it is more common in Congo and DR Congo.

Harvesting The minimum bole diameter allowed for harvesting is 60 cm in Cameroon, 70 cm in Gabon and 80 cm in the Central African Republic and DR Congo.

Yield In DR Congo a bole of 39 m long and 110 cm in diameter yielded 19.8 m^3 of wood.

Handling after harvest Freshly harvested logs are sometimes attacked by pinhole borers, but immediate chemical protection of logs is usually not needed. They usually float in water and thus can be transported by river, but some logs sink because the density of green wood is close to 1000 kg/m^3.

Genetic resources Although *Prioria oxyphylla* has a fairly large area of distribution, it occurs scattered and is in many regions within its area of distribution uncommon. Like *Prioria balsamifera*, it suffered from habitat loss and heavy exploitation, but it is not classified on the IUCN Red List of endangered species like *Prioria balsamifera*. Monitoring of the populations of *Prioria oxyphylla* is recommended because it may become easily liable to genetic erosion.

Prospects *Prioria oxyphylla* produces timber that is of great interest for the international market, but the volume of timber available seems to be limited. Information on growth rates and natural regeneration is needed to draw up directives for proper management practices to ensure sustainable production.

Major references ATIBT, 1986; Aubréville, 1970; Bolza & Keating, 1972; Breteler, 1999; Burkill, 1995; CTFT, 1952b; de Saint-Aubin, 1963; Fouarge & Gérard, 1964; Tailfer, 1989; Wilczek et al., 1952.

Other references Aubréville, 1968; Beentje, 1994; Brenan, 1967; Christy et al., 2003; Chudnoff, 1980; CIRAD Forestry Department, 2008; Fouarge, Gérard & Sacré, 1953; Gérard et al., 1998; Keay, 1989; Lewis et al., 2005; Lovett & Clarke, 1998; Lovett et al., 2007; Normand & Paquis, 1976; Raponda-Walker & Sillans, 1961; Sallenave, 1955; Takahashi, 1978; Vivien & Faure, 1985; Wilks & Issembé, 2000.

Sources of illustration Aubréville, 1970; Breteler, 1999; Wilks & Issembé, 2000.

Authors R.H.M.J. Lemmens

PROTOMEGABARIA STAPFIANA (Beille) Hutch.

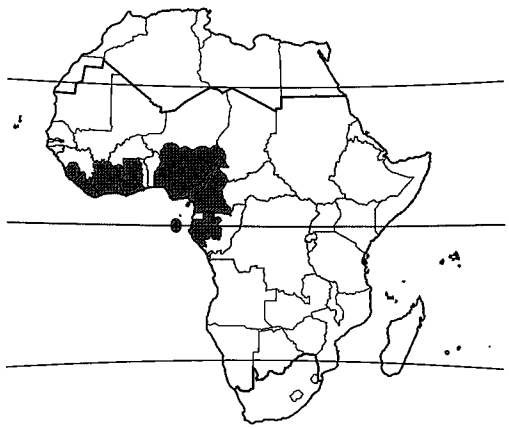
Protologue Prain, Icon. pl. 30: t. 2929 (1913).
Family Euphorbiaceae (APG: Phyllanthaceae)
Chromosome number $2n = 26$

Origin and geographic distribution *Protomegabaria stapfiana* is distributed from Sierra Leone to Gabon.

Uses The wood of *Protomegabaria stapfiana* is widely used for planks, and is also used for construction and furniture. It is considered a valuable firewood.

Properties The heartwood is yellowish to pinkish brown with dark streaks, and not clearly demarcated from the pale brown sapwood. The grain is mostly straight, texture medium. The wood is fairly lustrous. It is medium-weight, with a density of about 700 kg/m^3 at 12% moisture content. At the same moisture content, compression parallel to grain is about 53 N/mm^2, Janka side hardness 6750 N and Janka end hardness 7560 N.
The wood is not difficult to work and it finishes well to a smooth surface. It splits easily and is not resistant to decay.

Botany Evergreen, dioecious, small to medium-sized tree up to 30 m tall; bole short, low-branching, up to 25 cm in diameter, buttresses well developed; bark surface brownish with green patches; twigs soft-hairy, soon becoming glabrous. Leaves alternate, simple and entire; stipules triangular, 2–4 mm long, caducous; petiole 3–11 cm long; blade narrowly oblong-elliptical, 15–37 cm × 7–15 cm, base cuneate to rounded, apex rounded to short-acuminate, sparingly soft hairy below and with few glands, pinnately veined with 10–20 pairs of lateral veins. Inflorescence a glabrous raceme, male



Protomegabaria stapfiana – wild

one c. 10 cm long, female one c. 4 cm long. Flowers unisexual, regular, 5(–6)-merous; pedicel 1–3 mm long; sepals triangular, up to 2 mm long; petals absent; male flowers with stamens 2–3 mm long, disk 5-lobed, ovary rudimentary; female flowers without disk, ovary superior, usually 3-celled, styles (2–)3, 2-branched. Fruit a nearly globose capsule 3–4 cm in diameter, often slightly 3-lobed, glabrous, usually 3-seeded. Seeds obovoid, c. 1 cm long, smooth, shiny. Seedling with epigeal germination; hypocotyl 2–3 cm long, epicotyl 3–5 mm long; cotyledons leafy, roundish, c. 4 cm × 3.5 cm; first leaves alternate.

In Sierra Leone *Protomegabaria stapfiana* flowers from March until the start of the rainy season. Fruits are mature about 6 weeks after flowering.

Protomegabaria is restricted to West and Central Africa and comprises 3 species. Records of *Protomegabaria macrophylla* Hutch. and its uses for West Africa have been based on wrong identifications as this species is restricted to southern Cameroon and Gabon.

Ecology *Protomegabaria stapfiana* is found in the understorey of primary and secondary lowland forest. It sometimes forms pure stands. It is found both in swamps as well as on well-drained localities. In swamps the trees tend to develop adventitious roots.

Management Caution is needed at felling because boles often have a spongy heart.

Genetic resources and breeding *Protomegabaria stapfiana* is widely distributed, often abundant and not much sought after because of its small and often poorly shaped bole. Therefore it is not under threat of genetic erosion.

Prospects The wood of *Protomegabaria stapfiana* will probably remain of some local importance only.

Major references Burkill, 1994; Cooper & Record, 1931; Hawthorne, 1995; Kryn & Fobes, 1959; Takahashi, 1978.

Other references Breteler, 2012b; Chave, 2005; Dalziel, 1937; de la Mensbruge, 1966; Hawthorne & Jongkind, 2006; Keay, 1958d; Keay, 1989; Léonard, 1995; Normand & Paquis, 1976; Savill & Fox, 1967.

Authors C.H. Bosch

PROTORHUS DITIMENA H.Perrier

Protologue Mem. Mus. natl. Hist. nat., Paris n.s. 18: 260 (1944).

Family Anacardiaceae

Origin and geographic distribution *Protorhus ditimena* is endemic to northern and eastern Madagascar.

Uses The wood of *Protorhus ditimena* and other *Protorhus* spp., known as 'ditimena', is used in Madagascar for construction, joinery, flooring, panelling, moulding and railway sleepers. The leaves are used in traditional medicine as sedative.

Properties The heartwood is chestnut brown and streaked; it is distinctly demarcated from the paler, up to 6 cm wide sapwood. The grain is generally straight, texture fine. The wood is moderately heavy, with a density of 750–810 kg/m^3 at 12% moisture content. It air dries easily with little checking and warping. The rates of shrinkage during drying are medium, from green to oven dry 3.4–4.6% radial and 9.1–10.3% tangential. At 12% moisture content, the modulus of rupture is 156–177 N/mm^2, modulus of elasticity 11,800–14,400 N/mm^2, compression parallel to grain 58–70 N/mm^2, shear 7.5–8.5 N/mm^2, cleavage 21–25 N/mm and Chalais-Meudon side hardness 5.8. The wood works easily, glues satisfactorily and the nailing properties are moderate. The wood is moderately durable, with fair resistance to termites, but it is rather susceptible to fungal attacks. Impregnation with preservatives under pressure showed fairly good results. For usage as railway sleepers, it is advised to treat the wood with preservatives under pressure.

Botany Evergreen, small to medium-sized

Protorhus ditimena – wild

tree up to 25 m tall; bole up to 35 cm in diameter; bark surface slightly rough, finely flaky, blackish, inner bark reddish, exuding a whitish resin; young twigs yellowish brown short-hairy. Leaves opposite to alternate, simple and entire; stipules absent; petiole 5–12 mm long; blade obovate to elliptical, 2–7.5 cm × 2–3 cm, cuneate to obtuse at base, rounded to notched at apex, leathery, brownish green above and reddish below, glabrous, pinnately veined with 15–25 lateral veins. Inflorescence an axillary short panicle, densely reddish brown short-hairy, densely flowered. Flowers unisexual, regular, 4–5-merous, whitish or yellowish, sessile; calyx lobes rounded, c. 1 mm long; petals free, ovate, 2–3 mm long, densely short-hairy; stamens c. 2 mm long; disk slightly lobed, hairy; ovary superior, hairy, 3-celled, style short, 3-branched; male flowers with rudimentary ovary, female flowers slightly larger than male ones and with rudimentary stamens. Fruit an ovoid to oblong drupe up to 3 cm long, slightly grooved, reddish brown short-hairy, with resinous pulp, 1-seeded.

Protorhus ditimena grows slowly. Trees flower in September–December and fruits mature 2–3 months later. The fruits are eaten by birds, which probably serve as seed dispersers.

Protorhus comprises nearly 20 species, all endemic to Madagascar except *Protorhus longifolia* (Bernh.) Engl., which is from South Africa. It has been proposed to transfer the species from Madagascar to a separate genus *Abrahamia*. *Micronychia*, an endemic genus from Madagascar, is closely related to *Protorhus*, but differs in sigmoid, mango-like fruits.

The wood of several other *Protorhus* spp. is used for similar purposes as that of *Protorhus ditimena*. One of these is *Protorhus grandidieri* Engl., a small to medium-sized tree up to 25 m tall from western Madagascar. The gum-resin, bark and leaves are used in traditional medicine, but no details are available. The wood of *Protorhus sericea* Engl., *Protorhus louvelii* H.Perrier and *Protorhus thouvenotii* Lecomte, all occurring in eastern Madagascar, is similar in properties and uses to that of *Protorhus ditimena*. A leaf infusion of *Protorhus sericea* is administered to treat indigestion. The leaves are also valued in traditional medicine to treat heart complaints and as disinfectant.

Ecology *Protorhus ditimena* occurs in evergreen forest up to 1250(–1600) m altitude. It is commonly found along watercourses.

Genetic resources and breeding *Protorhus ditimena* is quite widespread, but it occurs scattered in the forest and is limited to threatened types of forest. Therefore, caution is needed in harvesting this species to prevent genetic erosion. This is even more the case in some other *Protorhus* spp. with limited areas of distribution.

Prospects *Protorhus ditimena* and other *Protorhus* spp. have been recommended for enrichment planting in natural forest, and as non-pioneer light-demanders that also tolerate some shade they are suited for that purpose. However, they grow slowly and long cutting cycles are needed for timber production, and therefore commercial exploitation on a sustainable basis seems to have little prospects.

Major references Blaser et al., 1993; Guéneau, Bedel & Thiel, 1970–1975; Perrier de la Bâthie, 1946a; Rakotovao et al., en préparation.

Other references Boiteau, Boiteau & Allorge-Boiteau, 1999; Gurib-Fakim & Brendler, 2004; Sallenave, 1955; Sallenave, 1971; Schatz, 2001.

Authors R.H.M.J. Lemmens

PSYDRAX PARVIFLORA (Afzel.) Bridson

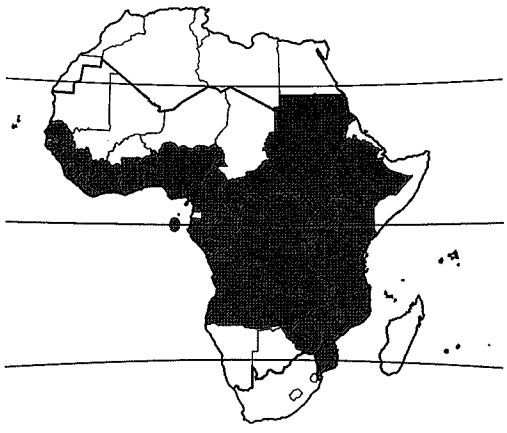
Protologue Kew Bull. 40: 700 (1985).

Family Rubiaceae

Synonyms *Canthium rubrocostatum* Robyns (1929), *Canthium vulgare* (K.Schum.) Bullock (1932).

Origin and geographic distribution *Psydrax parviflora* is widespread from Senegal eastward to Ethiopia and Kenya, and southward to Angola, Zimbabwe and Mozambique.

Uses In Kenya the wood is sometimes used



Psydrax parviflora – wild

for joinery, interior trim, furniture and implements, and in Tanzania in boat construction. It is suitable for construction, flooring, mine props, railway sleepers, ladders, sporting goods, agricultural implements, tool handles, draining boards, pattern making, turnery, veneer and plywood. It is also used as firewood and for charcoal production.

Ripe fruits are eaten fresh. Preparations of leaves and flowers are applied against lice. Root decoctions are taken as anthelmintic and tonic. Fruit extracts are administered against cough and influenza. Unknown parts of the plants have been used to prepare medicine to treat rheumatism, oedema and sores. *Psydrax parviflora* is occasionally planted as ornamental shade tree. The flowers are visited by honey bees.

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

Properties The heartwood is pale brown to dark brown, often with a purplish tinge, and indistinctly demarcated from the paler sapwood. The grain is straight, texture fine and even. The wood is moderately heavy, with a density of 720–800 kg/m^3 at 12% moisture content, and hard. It dries well and rapidly, with only occasional surface and end splitting. The rates of shrinkage are moderate. Once dry, the wood is fairly stable in service.

The wood saws and works moderately well with both hand and machine tools. It is quite brittle. It holds nails and screws satisfactorily and polishes, stains and glues well. It has good turning properties and can be made into good-quality veneer. The wood is moderately durable. The heartwood is very resistant to impregnation with preservatives.

Botany Evergreen or semi-deciduous shrub or small to medium-sized tree up to 25(–30) m tall; bole straight, up to 60 cm in diameter, sometimes fluted; bark surface slightly fissured or cracked, pale grey to brown, inner bark cream-yellow with orange flecks or darker layers, with a smell of almond; twigs usually angular, glabrous. Leaves opposite, simple and entire; stipules triangular, 2–7 mm long; petiole up to 1 cm long; blade elliptical to ovate, 5.5–15.5 cm × 2–8 cm, rounded to cuneate at base, acuminate at apex, leathery, glabrous, pinnately veined with 4–8 pairs of lateral veins. Inflorescence an axillary umbel-like cyme 2–6 cm wide, short-hairy, many-flowered; peduncle up to 2 cm long. Flowers bisexual, regular, 4-merous; pedicel up to 1 cm long; calyx up to 2.5 mm long, with lobes shorter or longer than the tube, glabrous to short-hairy; corolla whitish, tube 2–3 mm long, hairy inside, lobes 1.5–2.5 mm long; stamens inserted at corolla throat, reflexed; ovary inferior, 2-celled, style slender, up to 8 mm long. Fruit a 2-lobed drupe 0.5–1 cm × 1–1.5 cm, black when ripe; stones 2, 0.5–1 cm in diameter, each 1-seeded. Seeds finely reticulate.

Psydrax parviflora is variable and 4 different subspecies have been distinguished. The fruits are eaten by birds, which disperse the seeds. Duiker antelopes have been reported to eat the leaves.

Psydrax comprises about 100 species and occurs in the tropics of Asia and Africa, with approximately 35 species in Africa. It is related to *Canthium* and *Keetia*.

The wood of several other *Psydrax* spp. is used in tropical Africa for similar purposes as that of *Psydrax parviflora*, but most of these are more important for their use in traditional medicine.

The wood of *Psydrax faulknerae* Bridson is used in Kenya for building poles. *Psydrax faulknerae* is a shrub or small tree up to 7 m tall, occurring in woodland and thickets in south-eastern Kenya and eastern Tanzania.

The yellowish brown to reddish brown, heavy and hard wood of *Psydrax obovata* (Klotzsch ex Eckl. & Zeyh.) Bridson (synonym: *Canthium obovatum* Klotzsch ex Eckl. & Zeyh.) is used in South Africa in house building, for main posts but also for wall laths and roof laths. *Psydrax obovata* prevents erosion in coastal dunes. It is a shrub or small tree up to 15 m tall, occurring in coastal forest, mixed evergreen rainforest and woodland in Zimbabwe, Mozambique and South Africa.

Ecology In West Africa *Psydrax parviflora* is found in dry forest and gallery forest in savanna regions, but in East Africa it occurs in humid lowland forest and rainforest in the mountains up to 2000(–2800) m altitude. In southern Africa it is found in evergreen rainforest and woodland up to 2000 m altitude, sometimes on termite mounds. In Ghana trees of all size classes are more abundant in forest that is regularly burned than in undisturbed forest.

Management In Tanzania ripe fruits are collected in January–May. *Psydrax parviflora* is rarely planted, but can be propagated by seed.

Genetic resources and breeding *Psydrax parviflora* is very widespread and locally com-

mon, and not subject to genetic erosion. However, two of the subspecies have restricted areas of distribution in montane forest, and might be more easily liable to habitat degradation.

Prospects *Psydrax parviflora* is valuable as a multipurpose tree, providing wood for local applications but also edible fruits and ingredients for traditional medicine. More research is needed on its wood properties and pharmacological activities, and to explore its possibilities for use in agroforestry systems.

Major references Bolza & Keating, 1972; Bridson, 1985; Bridson, 1998; Chikamai et al., undated; Ruffo, Birnie & Tengnäs, 2002.

Other references Beentje, 1994; Burkill, 1997; Coates Palgrave, 2002; Gaugris et al., 2007; Hawthorne, 1995; Hawthorne & Jongkind, 2006; Lovett et al., 2007; Neuwinger, 2000; Verdcourt & Bridson, 1991; Wimbush, 1957.

Authors R.H.M.J. Lemmens

PYCNANTHUS ANGOLENSIS (Welw.) Warb.

Protologue Notizbl. Königl. Bot. Gart. Berlin 1: 100 (1895).

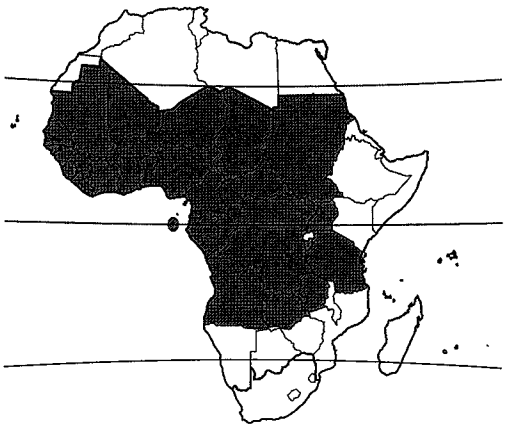
Family Myristicaceae

Chromosome number $2n = 38$

Synonyms *Pycnanthus kombo* (Baill.) Warb. (1897).

Vernacular names African nutmeg, boxboard (En). Ilomba, faux muscadier, arbre à suif (Fr). Menebantamo (Po). Mkungu mwitu (Sw).

Origin and geographic distribution *Pycnanthus angolensis* is found in the forest zone of tropical Africa, from Senegal and Guinea to Angola, and through DR Congo to Uganda, Tanzania and Zambia.



Pycnanthus angolensis – wild

Uses A yellow to reddish brown fat, called 'kombo butter' or 'Angola tallow', is extracted from the seed and is important in West and Central Africa for illumination and in soap making. It is not edible. The seeds somewhat resemble those of nutmeg (*Myristica fragrans* Houtt.) and are burnt as candles. In Central Africa they are used as spice. Traditionally the wood is highly valued as fuel and is used to make split planks, known as 'calabot' or 'caraboard' in the coastal zone of Cameroon. Because it is easy to work, it is used to make shingles both for roofing and covering the sides of native houses, and planks for doors and window frames. The long straight bole makes it suitable for making canoes. Since the Second World War the wood has become an important timber for plywood corestock, veneer, mouldings, interior trim, interior joinery, furniture components and paper pulp. In agroforestry *Pycnanthus angolensis* is planted or retained for shade in coffee and cocoa plantations in the humid lowlands of Cameroon, in Uganda often also in banana plantations. Farmers in Cameroon consider it a good indicator of soil fertility. In Uganda it has been planted as an amenity tree.

Throughout its area of distribution, various preparations of the bark, and to a lesser extent other parts of the tree, are used medicinally to treat skin infections, especially of the mouth. Preparations made from the bark are used as a potent purgative, to cleanse the milk of lactating mothers and to treat coughs and chest complaints. In Ghana a decoction of the bark is taken to treat anaemia, in Côte d'Ivoire as a poison antidote and against ascites and leprosy. In Congo the bark is used to treat a number of gynaecological problems, from infertility to gonorrhoea. In Côte d'Ivoire a root macerate mixed with parts of other plants is taken by draught to treat schistosomiasis. In São Tomé the bark is used to treat malaria.

Production and international trade No information is available on the trade in kombo butter. Trade in the timber 'ilomba' began after the Second World War due to an increased demand for plywood and improvements in wood conservation techniques and also as a substitute for okoumé (*Aucoumea klaineana* Pierre). Trade in ilomba increased spectacularly between 1946 and 1959 from 100 to 5600 boles. Gabon and Cameroon became the first major exporters in 1952/1953, followed by Côte d'Ivoire in 1954 and Congo in 1955. For several

years, ilomba was among the most valued timbers in Central Africa. Between 1950 and 1960, the quantity of wood exported from Gabon was 3000 m^3, from Cameroon 278,000 m^3. Cameroon has enforced a ban on exports of ilomba logs since 1999. Exports of ilomba have fallen drastically. In 2003 the combined exports of veneer, sawnwood and plywood from Cameroon amounted to 72 m^3, from Gabon to 816 m^3. Exports from the Congo basin dropped to 0.06% of total timber exports or about 3000 m^3 in 2003. In 2001 11,000 m^3 of ilomba veneer were exported from Côte d'Ivoire at an average price of US$ 240/m^3, and 5000 m^3 from Ghana at an average price of US$ 351/m^3. The export of plywood from Côte d'Ivoire in 2001 amounted to 3000 m^3 at an average price of US$ 329/m^3, and from Ghana in 2002 to 1000 m^3 at an average price of US$ 456/m^3.

Properties The seeds of *Pycnanthus angolensis* are aromatic, but information on volatile constituents is not available. The seeds yield 45–70% of a yellow to reddish brown solid fat known as 'kombo butter', which tastes bitter and is suitable for making soap and candles, while the residue is used for manure as it is unsuitable as cattle feed. The melting point of the fat is 51°C. The fatty acid composition of kombo butter is lauric acid 5.5%, myristic acid 61.5%, palmitic acid 3.6%, myristoleic acid 23.6%, oleic acid 5.7%. Crude kombo butter contains about 20% kombic acid (a dihydroxymethylphenyl derivative of hexadecatetraenoic acid) and sargaquinoic acid (a quinone derivative) and several of their derivatives. These terpenoid quinonic acids have promising anti-oxidant properties for pharmacology, cosmetics and the stabilization of plastics. They have also shown hypoglycaemic activity in diabetes patients.

The bark contains dihydroguaiaretic acid, which has shown non-selective toxicity towards several human tumour cell lines. Extracts of the bark also showed the presence of flavonoids (2'-hydroxy-formononetin), tannins and saponin glycosides, which might be responsible for its biological activities. Terpenoid quinones that have shown hypoglycaemic activity in both insulin-dependent and insulin-independent diabetes have been extracted from the bole and leaves.

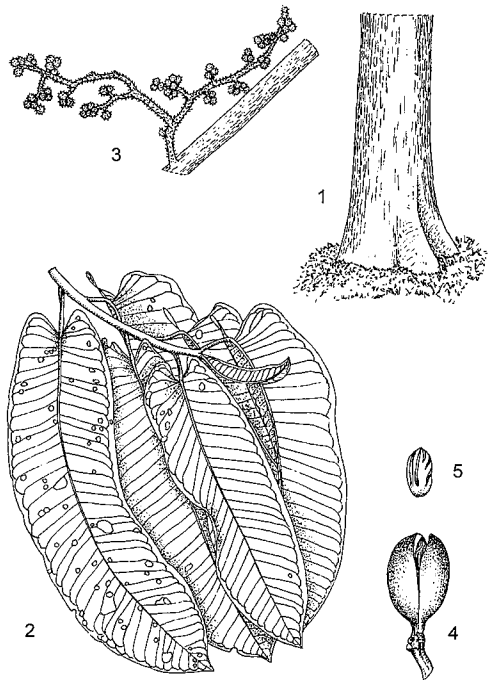
The heartwood is whitish to pinkish brown, sometimes with yellowish markings and indistinctly demarcted from the sapwood. The grain is generally straight, the texture medium to coarse. The wood has no lustre and when freshly sawn it has an unpleasant odour which disappears on drying.

At 12% moisture the density is 440–570 kg/m^3. The wood is rather difficult to dry, it is prone to collapse, end splitting and distortion. Good ventilation is required for air drying. Kiln drying can give good results if done carefully. Shrinkage rates from green to oven dry are 4.6% radial and 8.4% tangential. Drying of beams more than 55 mm thick is very difficult and steaming for 2 days is recommended. At 12% moisture content, the modulus of rupture is 62–72 N/mm^2, modulus of elasticity 8300–12000 N/mm^2, compression parallel to grain 38–39.5 N/mm^2, shear 5.4–8.9 N/mm^2, cleavage 13–24 N/mm, Janka side hardness 2700–3400 N.

The wood is easy to saw and plane with normal tools; blunting effects are moderate. It is difficult to polish. Nailing and screwing are easy and holding properties are good. The wood may stain in contact with tools. It peels and slices well to produce good-quality veneer and plywood, although steaming is recommended because of the occasional presence of numerous small hard spots. It glues well with all types of glue. It paints well but is rather absorbent.

The wood is not durable and liable to attack by termites, powder-post beetles, pinhole borers and marine borers, but it is permeable to preservatives.

Description Evergreen, monoecious or dioecious, medium-sized to large tree up to 25–35(–40) m tall; bole usually straight and cylindrical, branchless for up to 15(–25) m high, up to 120(–150) cm in diameter, usually without buttresses; outer bark greyish brown, with orange-brown exudate; crown small, with branches at right angles to the bole; twigs slender, pendulous, densely rusty hairy. Leaves distichously alternate, simple and entire, without stipules; petiole 1–2 cm long; blade oblong to oblong-lanceolate, 7.5–30(–40) cm × 4.5–11(–16) cm, base cordate, apex acuminate, dark green above, glaucous below, young leaves velvety reddish brown hairy, but glabrescent, pinnately veined with 20–40 pairs of lateral veins. Inflorescence an axillary panicle, often on leafless branches, 10–30 cm long, rusty hairy, with flowers in numerous head-shaped clusters. Flowers unisexual, regular, very small, sessile, with 3-lobed perianth covered with dark brown hairs; male flowers with 2–4 stamens, filaments merged into a column; female flowers with superior, sessile, 1-celled ovary, stigmas 2, sessile. Fruit an ellipsoid to



Pycnanthus angolensis – 1, base of bole; 2, leafy twig; 3, inflorescence; 4, fruit; 5, seed. Redrawn and adapted by Iskak Syamsudin

oblong or globose drupe, 3–4.5 cm × 2–4 cm, in bunches, yellowish orange when ripe, fruit wall rather hard and tough, 2–10 mm thick, splitting longitudinally with 2 valves, 1-seeded. Seed ellipsoid, aromatic, 1.5–3 cm × 1–1.5 cm, dark brown, with pink to red aril, laciniate almost to the base. Seedling with epigeal germination, but cotyledons remaining in the testa.

Other botanical information *Pycnanthus* comprises 3–4 species, all in Africa. *Pycnanthus angolensis* is variable, especially in the hairiness of the leaves, the size and shape of the fruits, and reportedly also in the quality of the timber. Two subspecies have been distinguished: subsp. *angolensis* and subsp. *schweinfurthii* (Warb.) Verdc., the latter occurring DR Congo and East Africa, but possibly also more to the west, and differing from subsp. *angolensis* in having larger, often more globose fruits with thicker fruit wall. The wood of *Cephalosphaera usambarensis* (Warb.) Warb. and several American *Virola* species closely resembles that of *Pycnanthus angolensis*. *Cephalosphaera usambarensis* is restricted to eastern parts of Kenya and Tanzania, where its timber is occasionally used.

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); (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; 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; (68: fibres very thin-walled); 69: fibres thin- to thick-walled. Axial parenchyma: 75: axial parenchyma absent or extremely rare; 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; 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; 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).
(M. Thiam, P. Détienne & E.A. Wheeler)

Growth and development Seeds of *Pycnanthus angolensis* are recalcitrant. The duration of germination is 16–36 days. The cotyledons are pulpy and the first two leaves which appear after two months are simple, opposite or alternate, later leaves alternate. A deep secondary root system develops during the first seven months of growth. In natural stands numerous seedlings appear around the mother tree. In the first year the stem height reaches 20–30 cm and it can reach 50 cm in the second year. In Sierra Leone a mean annual increment in diameter of 1.6–2.4 cm has been observed. Because of the long straight trunk, the volume/trunk ratio is higher than in most other African forest tree species. *Pycnanthus angolensis* is evergreen, and at any latitude in its

range leaf fall and flushing occur simultaneously. The flowering period is long and depends on the location. In Cameroon it flowers in October–May with male and female flowers at separate parts of the same tree, generally also at different times, while it fruits in September–April. Dehiscence takes place on the tree or the whole infructescence falls before dehiscence.

Ecology *Pycnanthus angolensis* occurs in upland and wet evergreen forest and semi-deciduous forest with more than 1600 mm rainfall. It is especially abundant in old fallows and secondary forest as its rate of natural recruitment after disturbance of the forest is high. In southern Africa it occurs in riverine and swamp forest, but in West Africa it does not occur in swamps. In Uganda it also occurs in gallery forest. It is mostly found in small groups or solitary and it regenerates in small to medium-sized gaps in the forest. Its abundance increases with rainfall, the optimum being about 2000 mm/year; above 2600 mm/year numbers decline strongly. It occasionally occurs where rainfall is only 1300 mm or less with 4–5 dry months. Seedlings are very sensitive to drought. *Pycnanthus angolensis* is a light-demanding tree typical of the dominant forest strata, although it can tolerate slight shade when young. It occurs up to 1200(–1400) m altitude. *Pycnanthus angolensis* tolerates light and heavy soils, but is scarce on sandy soils, while other reports indicate that it is often found on poor soils.

Propagation and planting *Pycnanthus angolensis* is propagated by seed. There are about 500 seeds per kg. Young broken or cut trees resprout easily, but in a trial vegetative propagation by stem cuttings failed to succeed. Seeds should not be dried, but sown as soon as possible because of their short viability. Germination is easy and with proper care the germination rate of fresh seed can reach 100%. Soaking in cold water for 24 hours hastens germination. In the case of unsorted seeds, the germination rate is about 50%. Seeds can be planted directly in the field or in an open field nursery preferably in polythene bags. It is important to protect the seeds from rodents. A mixture of sand and arable soil (50/50) is a suitable germination substrate. The seedling rapidly grows a large taproot, whose development should be checked timely in the nursery. Cutting the taproot when it is large greatly reduces the plant's growth rate. It is advisable to transplant seedlings after 1–2 years when 30–50 cm tall, at the beginning of the rainy season. A slight mulching is recommended. In the humid lowlands of Cameroon farmers used to retain or transplant seedlings from the wild when clearing new fields. To improve growth, compost or chemical fertilizer may be applied. In direct sowing in the field, the recommendation is to plant 3–5 seeds per hole and thin to a single plant after germination. Field spacing has been 4 m × 5 m, but recent recommendations are 9 m × 10 m (110 trees/ha).

Management Protection and retention of natural *Pycnanthus angolensis* trees has long been done by farmers in the humid lowland forest of West and Central Africa. In plantations the initial thinning should be done when trees are about 7 years old to reduce the density to 300–350 trees/ha; when trees approach the age of 12 years a second thinning should reduce the density to 150–200 trees/ha.

Diseases and pests Although its leaves are often marred by small holes, no important diseases or pests have been detected in *Pycnanthus angolensis* in either the natural state or plantations and from a phytosanitary point of view, silviculture of the species is very easy. Nevertheless, some sporadic insect (*Monochamus scabiosus*, *Mallodon downesi*, *Bryochaeta interrupta*) and fungi (*Ophiostoma* sp., *Microthyriella* sp.) attacks have been reported in Côte d'Ivoire, Cameroon and Gabon.

Harvesting In good plantations in the evergreen forest zone the exploitable diameter of 50 cm is reached when trees are 30 years old, and a diameter of 60 cm at 45 years.

Yield Little information on seed yield is available; an average tree may produce 60–100 seeds annually. In well growing plantations the annual increment at 15 years of age is 15 m^3/ha/year, at 30 years it can be 10 m^3/ha/year.

Handling after harvest Logs should be treated with preservatives and be converted soon after felling to avoid discoloration by fungi and damage by insects. Logs can be floated and be transported by river.

Genetic resources Because of its wide distribution and occurrence in secondary forest, there is little risk of genetic erosion. No genetic conservation programme is known to exist.

Breeding *Pycnanthus angolensis* is one of the most important agroforestry tree species of the humid lowland forest of West and Central Africa identified by the World Agroforestry Centre (ICRAF) for a domestication programme.

Prospects *Pycnanthus angolensis* is an important medicinal plant in the humid forest region. It is traditionally protected by farmers

during forest clearing. Large amounts of timber have been exported, but recently volumes have dropped markedly. The export of the wood as veneer and plywood has been most important in recent years. New opportunities for exploiting the oil and medicinal properties should be investigated. However, as a fairly fast-growing species that is not very liable to diseases and pests, *Pycnanthus angolensis* seems to have good prospects for timber plantations and for sustainably managed natural production forest.

Major references Borie, 2000; CTFT, 1975; Duguma, Tonye & Depommier, 1990; Katende, Birnie & Tengnäs, 1995; Mapongmetsem et al., 1995; Mapongmetsem et al., 1999a; Mapongmetsem, Nkongmeneck & Duguma, 2002; Normand & Paquis, 1976; Richter & Dallwitz, 2000; Verdcourt, 1997.

Other references Adjanohoun et al., 1991; Adjanohoun et al., 1996; ATIBT, 2004; Berhaut, 1979; CTFT, 1961a; Dalziel, 1937; Dounias, 1995; Forest Product Laboratory, 1999; InsideWood, undated; Irvine, 1961; Laird, 1999; Letouzey, 1955; Luo et al., 1999; Mapongmetsem et al., 1999b; Miquel, 1985; Pérez et al., 2005; Pope, 1997; Raponda-Walker & Sillans, 1961; Simon et al., 2005; Taylor, 1960; Vabi & Mala'a, 1995; World Agroforestry Centre, undated.

Sources of illustration Verdcourt, 1997; Voorhoeve, 1965; Wilks & Issembé, 2000.

Authors P.-M. Mapongmetsem

RAWSONIA LUCIDA Harv.

Protologue Harv. & Sond., Fl. cap. 1: 67 (1860).

Family Flacourtiaceae (APG: Achariaceae)

Synonyms *Rawsonia reticulata* Gilg (1901).

Vernacular names Forest peach (En).

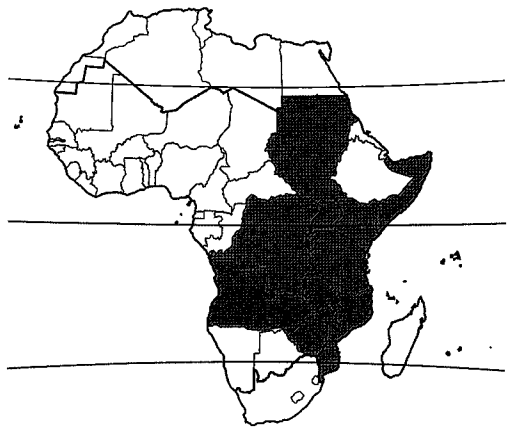
Origin and geographic distribution *Rawsonia lucida* occurs from Sudan east to Somalia and Kenya and south to Angola, Zimbabwe, Mozambique, eastern South Africa and Swaziland.

Uses The wood is locally used for walking sticks, pestles, spoons and tool handles, and also as firewood and for charcoal production. The fruit is recorded as edible.

Properties The pale pink to reddish wood is heavy, hard and tough. The cyanogenic glycosides gynocardin and cyclopentenylglycine have been isolated from the leaves.

Botany Evergreen shrub or small to medium-sized tree up to 20 m tall; bole up to 50 cm in diameter, sometimes fluted at base or with buttresses; bark surface smooth, peeling in rounded scales, grey to reddish brown, inner bark red; crown with spreading branches; twigs short-hairy to glabrous. Leaves alternate, simple; stipules narrowly oblong, c. 5(–10) mm long, caducous; petiole 0.5–1(–1.5) cm long; blade oblanceolate to oblong-obovate, 7–20 cm × 2–8.5 cm, cuneate to obtuse at base, acuminate at apex, margins usually distinctly toothed, thin-leathery, glabrous, glossy, pinnately veined with 6–9 pairs of lateral veins. Inflorescence an axillary raceme up to 2.5(–4) cm long, short-hairy to glabrous, densely flowered. Flowers bisexual or male, regular, scented; pedicel up to 2 mm long; sepals 4–6, free, unequal, rounded to elliptical, (2–)3–4(–5) mm long, short-hairy on margins; petals 4–8, similar to sepals but 5–8 mm long and with basal hairy appendage inside; stamens numerous, up to 1 cm long; ovary superior, glabrous, 1-celled, style up to 2 mm long, with 3–4 short branches. Fruit a globose berry-like capsule 2–2.5(–4) cm in diameter, short-pointed, glabrous, yellow becoming reddish, tardily dehiscent with 4–5 valves, up to 10-seeded. Seeds ovoid to nearly globose, 6–10 mm long, rough.

Rawsonia lucida sometimes flowers when only 3 m tall. In southern Africa trees flower in September to November, and fruits ripen in November to February. They have been reported to fruit in Kenya in June–July. Trees may produce masses of fruits that may carpet the forest floor in the fruiting season. They are eaten by monkeys, which probably disperse the seeds.



Rawsonia lucida – *wild*

Rawsonia comprises 2 species and is related to *Dasylepis*, *Erythrospermum* and *Scottellia*. *Rawsonia burtt-davyi* (Edlin) F.White is a small to medium-sized tree up to 20 m tall, with bole up to 30 cm in diameter, endemic to Mt Mulanje in Malawi.

Ecology *Rawsonia lucida* is most characteristic for mid-altitude and montane semi-evergreen forest up to 2200 m altitude, but it also occurs in the lowlands. It is found in dry to moist evergreen forest and in riverine forest, usually in the understorey.

Management *Rawsonia lucida* can be propagated by seeds and cuttings. It is recommended to soak seeds in water for 24 hours before sowing. They should be covered with 1 cm of soil and kept at about 25°C, constantly moist but not wet. The seeds germinate in 3–6 weeks.

Genetic resources and breeding *Rawsonia lucida* is widespread and locally common, and certainly not endangered by genetic erosion.

Prospects The wood of *Rawsonia lucida* will remain of limited importance for local applications. The small size of the bole makes that it has no prospects for the international timber market. As an evergreen tree with shiny leaves, it may have prospects as ornamental.

Major references Coates Palgrave, 1983; Dowsett-Lemaire & White, 1990; Lovett, Ruffo & Gereau, 2003; Palmer & Pitman, 1972–1974; Sleumer, 1975.

Other references Andersen et al., 2001; Bamps, 1968; Beentje, 1994; Chase et al., 2002; Engel, 2000; Hyde & Wursten, 2011; InsideWood, undated; Wild, 1960; Wimbush, 1957.

Authors R.H.M.J. Lemmens

RHABDOPHYLLUM CALOPHYLLUM (Hook.f.) Tiegh.

Protologue Bull. Mus. natl. Hist. nat., Paris 8 : 216 (1902).

Family Ochnaceae

Chromosome number $n = 12$

Synonyms *Ouratea calophylla* (Hook.f.) Engl. ex Gilg (1893).

Origin and geographic distribution *Rhabdophyllum calophyllum* occurs from Guinea to Ghana, and in Cameroon, Equatorial Guinea, Gabon, Congo and Cabinda (Angola).

Uses The wood of *Rhabdophyllum calophyllum* is used for poles in house building and for tool handles, and also as firewood. In Congo

Rhabdophyllum calophyllum – wild

leaves taken together with fruits of *Aframomum melegueta* K.Schum. are considered aphrodisiac.

Production and international trade The wood of *Rhabdophyllum calophyllum* is only used locally.

Properties The pinkish brown wood is hard, flexible and durable.

Botany Erect shrub or small tree up to 10(–15) m tall; bole up to 15 cm in diameter; bark surface smooth, grey; twigs robust, glabrous. Leaves alternate, simple and entire; stipules fused at base, falling early; petiole 3–6 mm long, slightly corky; blade narrowly elliptical to elliptical-obovate, (6–)9–20(–25) cm × 2.5–8.5 cm, base cuneate, apex acute or acuminate, leathery, pinnately veined with very numerous lateral veins. Inflorescence an axillary false raceme (4–)6–11 cm long, glabrous, densely flowered, with fascicles of (2–)3–5 flowers. Flowers pendant, bisexual, regular, 5-merous; pedicel 7–10 mm long; sepals free, oblong, 7–10(–12) mm × 2.5–6 mm, persistent in fruit; petals free, elliptical-obovate, 6–8 mm long, yellow or cream, falling early; stamens 10, surrounding the style, anthers nearly sessile; carpels 5, free, style 1, long and slender. Fruit pendant, consisting of up to 5 globose, black drupelets, each drupelet 1-seeded, with red sepals at base.

In Ghana flowering occurs in December, and fruits mature in January–February.

Rhabdophyllum comprises 8 species and is restricted to tropical Africa, where it occurs from Guinea to Zambia. It is related to *Campylospermum* and *Idertia*.

Ecology *Rhabdophyllum calophyllum* occurs

in primary and secondary evergreen and semi-deciduous forest on well-drained soils, but sometimes also in swampy localities and occasionally in shrub vegetation near the coast or even in savanna, up to 750 m altitude. In Ghana it is mainly found on mild hill slopes in evergreen forest.

Genetic resources and breeding *Rhabdophyllum calophyllum* is widespread and common, and there are no indications that it is in danger of genetic erosion.

Prospects The wood of *Rhabdophyllum calophyllum* is likely to remain of limited, local use only. The tree deserves attention as an ornamental.

Major references Aubréville, 1959a; Burkill, 1997; Farron, 1965; Keay, 1954e; Sosef, 2008.

Other references Bouquet, 1969; Cooper & Record, 1931; Hawthorne, 1995; Hawthorne & Jongkind, 2006; Irvine, 1961; Neuwinger, 2000; Raponda-Walker & Sillans, 1961.

Authors L.P.A. Oyen

RICINODENDRON HEUDELOTII (Baill.) Pierre ex Heckel

Protologue Ann. Inst. Bot.-Géol. Colon. Marseille 5(2): 40 (1898).

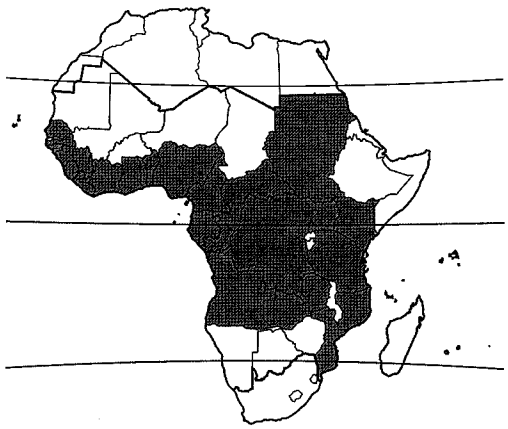
Family Euphorbiaceae

Chromosome number $2n = 22$

Synonyms *Ricinodendron africanum* Müll.Arg. (1864).

Vernacular names Groundnut tree, corkwood tree, African oil-nut tree (En). Essang, essessang (Fr). Menguela, munguella (Po). Muawa (Sw).

Origin and geographic distribution *Ricinodendron heudelotii* occurs from southern Senegal eastwards to Kenya, and southwards to Angola and Mozambique.



Ricinodendron heudelotii – wild

Uses The seeds of *Ricinodendron heudelotii* are widely used in cooking in West and Central Africa. An edible oil is extracted from the seeds and a paste made by crushing dried kernels is sometimes used as a thickening agent for soups and stews. A paste from the dried and pounded kernels is also stored for making porridge in times of food shortage. The protein-rich leaves are eaten as a cooked vegetable with dried fish and are used as forage for goats and sheep.

The wood, called 'erimado' or 'essessang' in trade, is very light, soft and perishable, but is occasionally used in carving and for making household utensils, furniture, boxes and crates. In Uganda the Semliki and Unyoro people use it for making doors for their huts, while in southern Nigeria and DR Congo well-sounding drums are carved from it. It is a potential substitute for balsa wood (*Ochroma pyramidale* (Cav. ex Lam.) Urb.) for making floats and lifebelts. The wood is also suitable for boat building, sporting goods, toys and novelties, hardboard, particle board, plywood, wood-wool and wood-pulp. The ash of the wood is used as vegetable salt in cooking, indigo dyeing and soap making. The seeds are used in rattles and as counters in games. In Bas Congo (DR Congo) the tree is planted to attract edible caterpillars (*Imbrasia epimethea*), and several other edible caterpillars are collected from it. The leaves are used as wrapping material and for mulching. In DR Congo *Ricinodendron heudelotii* is planted as amenity tree, as live fence and for erosion control.

Many parts of the tree are used in medicine. Bark of the root and stem is used in decoctions or lotions to treat constipation, cough, dysentery, rheumatism, rickets in children, oedema, elephantiasis, fungal infection, blennorrhoea, painful menstruation, and to prevent miscarriage, relieve pain in pregnant women, cure infertility in women, give strength to premature babies, and to mature abscesses, furuncles and buboes. The sap is instilled into the eye against filaria and ophthalmia and leaf decoctions are used as febrifuge. Leaves are also used to treat dysentery, female sterility, oedema and stomach pain. Roots are used as aphrodisiac in Côte d'Ivoire. Fruits and latex are used in West Africa to cure gonorrhoea and diarrhoea.

Production and international trade Kernels of *Ricinodendron heudelotii* are traded in-

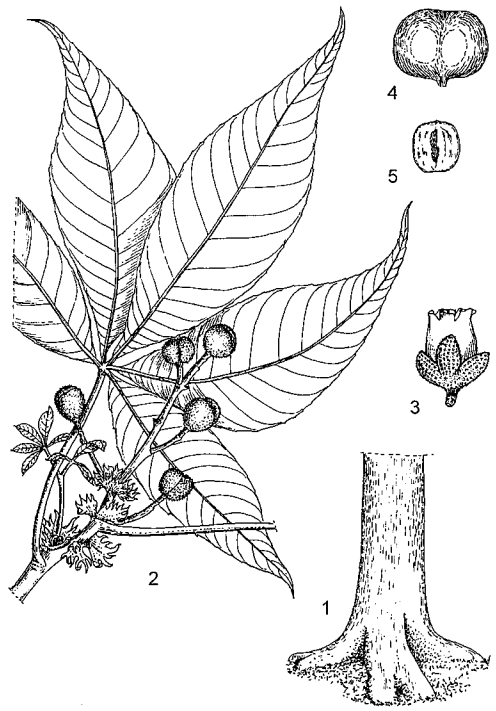
ternationally and are found in many markets in West and Central Africa; they are exported to Europe from Cameroon as 'ndjanssang'. The humid forest zone of Cameroon appears to be the main production area. In 1995, 36,000 kg of seeds were marketed in this zone, for a total value of about US$ 79,000.

Properties The dried seeds of *Ricinodendron heudelotii* contain on average per 100 g: water 6 g, energy 2200 kJ (530 kcal), protein 21 g, fat 43 g, carbohydrate 23 g, Ca 611 mg, P 926 mg, Fe 0.4 mg, thiamin 10 µg, riboflavin and niacin traces (Leung, Busson & Jardin, 1968). Some sources give a fat content of up to 60%. The fat is pale yellow and liquid but somewhat viscous at ambient temperatures. Its fatty acid composition is: palmitic acid 6–10%, stearic acid 6–7%, oleic acid 7–9%, linoleic acid 28–36%, α-eleostearic acid 30–51%. The fat also contains small amounts of β-eleostearic acid, catalpic acid, gadoleic acid and lignoceric acid. When exposed to air in a thin layer it dries to a frosted film; when the oil is heated first to 280°C it dries to a hard clear film.

The heartwood is whitish to pale yellow, and is not differentiated from the sapwood. The wood darkens on exposure to light. The grain is straight, texture coarse and even. The wood is light-weight with a density of 130–300 kg/m^3, soft and brittle. It dries rapidly and with little or no degrade. The shrinkage rates are low: from green to oven dry 1.9–2.4% radial and 4.7–5.4% tangential. At 12% moisture content, the modulus of rupture is 29–46 N/mm^2, modulus of elasticity 3700–4800 N/mm^2, compression parallel to grain 14–21 N/mm^2, shear 2.2–3.2 N/mm^2, cleavage 5.0–7.3 N/mm (tangential) and Chalais-Meudon side hardness 0.2–0.6.

The wood saws and works easily, and nails without splitting, but turning and planing are difficult. The wood is liable to decay and attack by termites, powder-post beetles and marine borers. The wood is permeable to preservatives.

Description Deciduous, dioecious, medium-sized tree up to 30(–45) m tall; bole straight and cylindrical, up to 120(–150) cm in diameter, base with short, thick buttresses often extending into heavy superficial roots; outer bark smooth at first, becoming rough and fissured, grey; inner bark pink to red, densely mottled and granular; crown candelabra-shaped, commonly with many broken branches; twigs with few lenticels, densely brown stellate hairy but soon glabrescent, with thick pith. Leaves alternate, palmately compound with (3–)5–7(–8) leaflets; stipules fan-shaped, 1–5 cm × 1.5–4 cm, with gland-tipped teeth, persistent; petiole up to 5–30(–40) cm long; leaflets obovate to elliptical-lanceolate, median leaflet 10–30 cm × 5–15 cm, lateral ones smaller, base cuneate, apex long-acuminate, margin almost entire to shallowly glandular-toothed, thinly papery, glabrous above, glabrous to densely stellate hairy below. Inflorescence a terminal panicle, densely stellate hairy but glabrescent; bracts awl-shaped to linear, 3–7 mm long; male inflorescence up to 40 cm long; female one up to 20 cm long. Flowers unisexual, regular, (4–)5-merous, pedicellate; sepals fused at base, c. 4 mm long, densely stellate hairy; petals laterally coherent, oblong, c. 6 mm long, greenish white to pale yellow; disk lobes yellowish; male flowers with 6–14 stamens c. 6 mm long; female flowers with superior, globose ovary, 2–3-celled, stellate hairy, styles 2–3, bifid. Fruit a 2–3-lobed drupe 2.5–3.5 cm × 4–5 cm, green when young, black when ripe, each lobe containing one 1-seeded stone. Seeds globose, c. 1.5 cm in diameter, reddish brown to black. Seedling with epigeal germination; hypocotyl



Ricinodendron heudelotii – 1, base of bole; 2, part of branch with young fruits; 3, male flower; 4, fruit; 5, seed.
Redrawn and adapted by Iskak Syamsudin

up to 20 cm long, epicotyl short; cotyledons with petiole 1.5–2.5 cm long, blade leafy, 6–7 cm × 5–6 cm, glandular at margins, palmately veined; first leaf 3-lobed.

Other botanical information *Ricinodendron* comprises a single species. It is closely related to *Schinziophyton*. In *Ricinodendron heudelotii* 2 subspecies are recognized: subsp. *heudelotii* occurring from Senegal to Benin, and subsp. *africanum* (Müll.Arg.) J.Léonard from Nigeria eastwards and southwards. The former has mostly 3-lobed fruits, in the latter 2-lobed fruits are more common.

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; 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); 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; 56: tyloses common. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 68: fibres very thin-walled. Axial parenchyma: 76: axial parenchyma diffuse; 77: axial parenchyma diffuse-in-aggregates; 93: eight (5–8) cells per parenchyma strand; 94: over eight 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; (109: rays with procumbent, square and upright cells mixed throughout the ray); 115: 4–12 rays per mm. Mineral inclusions: 136: prismatic crystals present; 141: prismatic crystals in non-chambered axial parenchyma cells; 154: more than one crystal of about the same size per cell or chamber.
(N.P. Mollel, P. Détienne & E.A. Wheeler)

Growth and development The roots of *Ricinodendron heudelotii* reach deep and cause little competition for nutrients and water in the upper soil layers with adjacent crops. The tree starts bearing fruits at 8–10 years of age. In Sierra Leone flowering takes place in April–May, and fruits are produced in September–October; trees are leafless for a few weeks when the fruits fall. In central Cameroon fruits are collected in July–September. Bats, hornbills and rodents are believed to contribute to the dispersal of the seed. Fruits also break open and scatter their seed when they fall on the ground.

Ecology *Ricinodendron heudelotii* occurs in clearings in rainforest; it is characteristic of humid secondary forest and common in abandoned farmland at 200–500 m altitude. The minimum annual rainfall required is about 1000 mm, but annual rainfall may be as high as 10,000 mm/year as in Dibunscha, Cameroon. It is a fast-growing and light-demanding tree, requiring mean annual temperatures of 18–32°C. *Ricinodendron heudelotii* prefers medium-textured and freely draining acidic soils.

Propagation and planting Seeds start germinating 3–6 weeks after sowing. Scarification before sowing accelerates germination. Vegetative propagation is possible by rooting of leafy stem cuttings, layering and side grafting.

Management There is still little experience with management of planted *Ricinodendron heudelotii*. Trials are in progress at ICRAF, Cameroon. In DR Congo stakes are sometimes planted to create a live fence as they easily strike root. Although the species loses its leaves during the dry season, some farmers in Cameroon use it to shade cash crops such as cocoa. Coppicing is possible, but reports on regrowth are contradictory.

Diseases and pests Some caterpillars have been reported to defoliate *Ricinodendron heudelotii* in DR Congo, such as *Lobobunaea phaedusa*, *Imbrasia* spp. and one identified locally as 'mimpemba'. However, these caterpillars also constitute a considerable protein supply for local people. In Cameroon, a psyllid (*Diclidophlebia xuani*), and aphids have been reported to cause serious damage to young plants.

Harvesting Fallen fruits are collected from the ground.

Handling after harvest After collection, the fruits are left to rot in big piles. Once the fruit pulp is rotten, the stones are extracted by washing and boiling the fruits vigorously. Then the stones are removed from the hot water, put in cold water and left overnight. They are boiled vigorously once more until the shells crack. Shells are then removed using a knife. After extraction, seeds are dried.
Logs felled for timber should be extracted from the forest and converted rapidly because they are prone to staining.

Genetic resources *Ricinodendron heudelotii* is very widespread in tropical Africa and

genetic variation is large. Within a sample of 47 accessions, considerable variation was found in fruit size, seed size and oil content of the seed (49–63%). Because of its wide distribution and prevalence in secondary forest and on farmland there is no risk of genetic erosion. No germplasm collections are known to exist.

Breeding Domestication of *Ricinodendron heudelotii* has started recently under the Tree Domestication Program of the World Agroforestry Centre (ICRAF) in Cameroon. Selection work is still in its infancy. Plant characters preferred by farmers have been identified. They include high yield, long fruiting season, stable yield, thin shell, self-cracking stones and good taste. It appears that fruit size is only weakly correlated with seed size. The self-cracking shell character is not related to shell thickness.

Prospects Continuing intensification of agriculture in humid tropical Africa will increasingly rely on domesticated, fast-growing, multipurpose tree species that fit well in agroforestry systems. If selections can be made that meet farmers' requirements and if appropriate packages of management practices can be developed, *Ricinodendron heudelotii* is likely to become a more important component of such systems and contribute to the regional demand for edible and industrial oil.

Major references Anigbogu, 1996; Ayuk et al., 1999a; Fondoun, Tiki Manga & Kengue, 1999; Franzel, Jaenicke & Janssen, 1996; Latham, 2004; Ndoye, Ruiz-Pérez & Eyebe, 1998; Ngo Mpeck et al., 2003; Shiembo, Newton & Leakey, 1997; Tchoundjeu & Atangana, 2006; Tiki Manga et al., 2000.

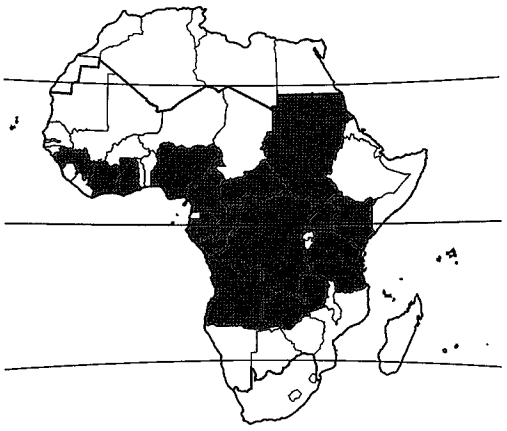
Other references Beentje, 1994; Berhaut, 1975a; Burkill, 1994; Firestone, 1999; InsideWood, undated; Katende, Birnie & Tengnäs, 1995; Léonard, 1962; Leung, Busson & Jardin, 1968; Radcliffe-Smith, 1987a; Richter & Dallwitz, 2000; Tabuna, 1999; Tane, 1997; Tchiegang et al., 1997.

Sources of illustration Govaerts, Frodin & Radcliffe-Smith, 2000; Radcliffe-Smith, 1987a; Wilks & Issembé, 2000.

Authors Z. Tchoundjeu & A.R. Atangana

RINOREA BRACHYPETALA (Turcz.) Kuntze

Protologue Revis. gen. pl. 1: 42 (1891).
Family Violaceae
Synonyms *Rinorea poggei* Engl. (1902).
Origin and geographic distribution *Rinorea brachypetala* is widespread in tropical Africa from Guinea east to Kenya, and south to Zambia and Angola.



Rinorea brachypetala – wild

Uses The wood of *Rinorea brachypetala* is used in Kenya and Uganda for hut construction, walking sticks and knobkerries. In DR Congo it is used in construction and to make household utensils. Boiled leaves are eaten as a vegetable and the dried, powdered leaves are sniffed to relieve headache.

Properties The wood is yellowish white, fine textured and medium-weight.

Botany Shrub or small tree up to 6.5 m tall; bark greyish green; twigs hairy or glabrous. Leaves arranged spirally, simple and entire; stipules awl-shaped, c. 8 mm long, early caducous; petiole 0.5–5.5 cm long; blade obovate to oblong-elliptical or elliptical-oblanceolate, 6–23 cm × 3–10 cm, rounded to cuneate at base, acute or shortly acuminate at apex, nearly glabrous, pinnately veined with 6–10 pairs of lateral veins. Inflorescence a terminal, many-flowered thyrse up to 17 cm long, short-hairy. Flowers bisexual, regular, 5-merous, nodding, cream-coloured to greenish yellow; pedicel 1–2 mm long; sepals free, broadly ovate to oblong, 2–4 mm long, thick, usually short-hairy; petals free, oblong to obovate, 4–6 mm long, thick, tip strongly recurved; stamens c. 3.5 mm long, filaments fused into a ring, anthers with a large central appendage and 2 smaller lateral appendages; ovary superior, obovoid, glabrous, style 3–4 mm long, thickened upwards. Fruit a 3-lobed capsule 1–1.5 cm long, 3–6-seeded. Seeds angular, c. 6 mm × 5 mm.

Rinorea is a large pantropical genus of shrubs and small trees with about 340 species recog-

nized at present, most of them occurring in Africa. Madagascar has about 20 species, nearly all endemic. For continental Africa a proper taxonomic study is long overdue. There are about 50 well-defined species in the Neotropics.
Rinorea arborea (Thouars) Baill. (synonym: *Alsodeia arborea* Thouars), called 'mkandaa-mwitu' in Swahili, is found in coastal Kenya, Tanzania and Mozambique, as well as in Madagascar. The wood is used for hut building and to make tool handles. In Kenya a root decoction is drunk to cure stomach pain.
Rinorea aylmeri Chipp is restricted to Guinea, Sierra Leone, Liberia and Côte d'Ivoire. The wood is used for walking sticks.
Rinorea ilicifolia (Oliv.) Kuntze, called 'mkurute' in Swahili, is widespread in tropical Africa from Guinea east to Kenya, and south to Angola and Mozambique. The hard and heavy wood is used in Uganda to make wooden hammers, tool handles and walking sticks. In West Africa decoctions of the whole plant are drunk to cure epilepsy. In Côte d'Ivoire sap of young leafy twigs is added to palm wine for its aphrodisiac properties. In Kenya the pulped root is steeped in water and the liquid is drunk to treat cough.
Rinorea kibbiensis Chipp, a shrub or small tree up to 7 m tall, is distributed from Côte d'Ivoire to Cameroon. The wood is used to make utensils and the twigs are used as toothbrush.
Rinorea oblongifolia (C.H.Wright) Marquand ex Chipp is one of the taller species of the genus, reaching 12 m tall and 30 cm in bole diameter. In DR Congo the wood is used in construction and for household utensils, and in Sierra Leone for spoons and combs. In the Central African Republic a root extract is drunk as a purgative.
The wood of *Rinorea seleensis* De Wild. and *Rinorea subsessilis* M.Brandt, both found in the Central African rainforest, is used for arrow shafts and house construction, respectively. The bark sap of the latter species is used to dye hair.

Ecology *Rinorea brachypetala* is found in the undergrowth of evergreen forest and gallery forest, but also in savanna. In East Africa it is found up to 1900 m altitude.

Genetic resources and breeding *Rinorea brachypetala* is widespread and not intensively exploited. Therefore, it does not seem to be in danger of genetic erosion.

Prospects In view of the small size of the bole, wood of *Rinorea brachypetala* and other *Rinorea* spp. is not of commercial interest, and use will remain restricted.

Major references Aubréville, 1959; Burkill, 2000; Grey-Wilson, 1986; Neuwinger, 2000; Taton, 1969.

Other references Bakker, van Gemerden & Achoundong, 2006; Beentje, 1994; Bos, 1989; Bouquet & Debray, 1974; Dale & Greenway, 1961; Kokwaro, 1993; Normand & Paquis, 1976; Terashima & Ichikawa, 2003; Wahlert & Ballard Jr, 2009.

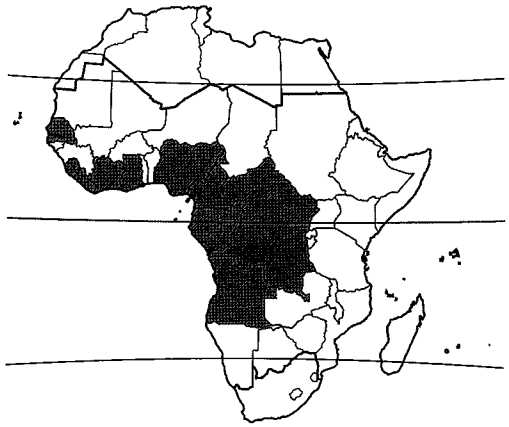
Authors C.H. Bosch

SACOGLOTTIS GABONENSIS (Baill.) Urb.

Protologue Mart., Fl. bras. 12(2): 449 (1877).
Family Humiriaceae
Vernacular names Bitterbark tree, cherry mahogony (En). Bidou (Fr).

Origin and geographic distribution *Sacoglottis gabonensis* occurs from Senegal and Gambia east to the Central African Republic and south to Angola.

Uses The wood of *Sacoglottis gabonensis* is widely, though locally, used for hydraulic construction, house and bridge construction, carpentry, heavy flooring, poles, ship building, vehicle bodies, railway sleepers and mine props. It is suitable for interior trim, furniture, cabinet work, toys, novelties, turnery and pattern making. In Liberia and Nigeria, it is used to make canoes and in Gabon for the ribs of boats. The wood is a good firewood and produces a valuable charcoal.
Infusions of the stem bark of *Sacoglottis gabonensis* are commonly taken to treat fever, diarrhoea, gonorrhoea and abdominal pain, and sometimes they are used to treat hypertension



Sacoglottis gabonensis – wild

and diabetes. In coastal Cameroon the Kola pygmies and Mvae people use a decoction of the crushed bark mixed with leaves of *Dioscorea minutiflora* Engl. as a rectal enema to treat acute abdominal pain. In Congo a decoction of the stem bark is used to cure difficult cases of dermatitis. In Sierra Leone a bark decoction is used to treat stomach-ache and it also used as a spice in food to induce heat in nursing and pregnant mothers. In coastal Côte d'Ivoire the diluted stem sap is used in hipbaths to promote muscle tone in women after childbirth. In Gabon an extract of the stem bark is drunk as an emetic. In Senegal and Congo a stem bark decoction is mixed with other plants and added to bath water to treat ovarian troubles, vaginal infections and children with fever.

Stem bark is used as a palm wine additive, as it is claimed to prolong the shelf life of the wine, add potency, reduce foaming and impart a bitter taste. It is reported to have aphrodisiac properties. The bark is used as a fish poison.

The fruit is edible, sweet and tastes like banana bread. It is mainly eaten by children and can be used to make an alcoholic drink. In coastal Cameroon the seeds are grilled and eaten by pygmies. The sweetness of the resin stored in the cavities of the stone is much sought by bees.

Production and international trade Timber of *Sacoglottis gabonensis* is known in the international trade as 'ozouga', but volumes traded are small. Stem bark is sold for medicinal purposes in local markets. Quantities traded are unknown.

Properties The heartwood is brown to purplish red and rather indistinctly demarcated from the narrow, yellowish sapwood. The grain is straight or wavy, texture fine and even. The wood is heavy, with a density of 870–950 kg/m^3 at 12% moisture content. It should be air dried slowly and with care to avoid serious checking and warping. The rates of shrinkage are quite high, from green to oven dry 5.0–5.8% radial and 9.0–10.0% tangential. Once dry, the wood is moderately stable to unstable in service.

At 12% moisture content, the modulus of rupture is 109–233 N/mm^2, modulus of elasticity 13,330–21,770 N/mm^2, compression parallel to grain 66–104 N/mm^2, shear 10–13 N/mm^2, cleavage 22–23 N/mm, Janka side hardness 9065–11,005 N, Janka end hardness 12,495 N and Chalais-Meudon side hardness 7.3–10.9.

Considering its high density and hardness, the wood is not difficult to saw and work, but it has a severe blunting effect on saw teeth and cutting edges; stellite-tipped saw teeth and tungsten-carbide cutting edges are needed. The wood is difficult to nail and screw, but the holding power is good; pre-boring is recommended. The finishing and gluing properties are satisfactory, but the wood is not suited for veneer and plywood production. It is durable, being resistant to fungal and insect attacks. The heartwood is resistant to impregnation with preservatives.

Bergenin, an isocoumarin, was identified as the main active compound of the stem bark extract of *Sacoglottis gabonensis*. The stem bark extract is reported to have hepatoprotective properties. Both the extract and bergenin reduced the rate of formation of intermediates of the lipid peroxidation pathway (lipid hydroperoxide aldehydes, carbonyls) as well as complementing the primary anti-oxidant enzymes catalase and superoxide dismutase during 2,4-DNPH-induced membrane lipid peroxidation in rat liver and red blood cells. In vivo in rats, bergenin protects against 2,4-DNPH-induced hepatotoxicity and toxicity to red blood cells. However, in another experiment, a stem bark extract given orally to rats showed hepatotoxicity even at low doses. Bergenin also protects stored vegetable oils against peroxidative deterioration over a period of time. A stem bark extract added to drinking water of rats increased prothrombin and thrombin levels of blood plasma.

Further analyses of stem bark extract have shown tannins in appreciable amounts with a trace of saponins. They have also revealed the presence of 2 cis/trans isomers of lignans (calopiptine and galgravine) which may play a role in cancer prevention.

The alcohol content of palm wine from *Raphia hookeri* G.Mann & H.Wendl. with stem bark added became almost twice as high as that of untreated palm wine. It was found that the ethanol tolerance and osmotolerance of the yeast *Saccharomyces cerevisiae* were enhanced by the bark extract, whereas flocculation and invertase activity were reduced.

The endocarp contains 54% oil of unknown composition.

Adulterations and substitutes Bergenin is commercially extracted from *Ardisia* and *Bergenia* spp. (Siberian tea and marlberry bush) and is used as a weight-loss product, e.g. in body building, and in Chinese medicine to increase body heat.

Description Evergreen, medium-sized to

Sacoglottis gabonensis – 1, flowering branch; 2, fruit.
Redrawn and adapted by Achmad Satiri Nurhaman

fairly large tree up to 40 m tall; bole branchless for up to 20 m but often branching low, often crooked, knotty and deeply fluted, up to 180(–450) cm in diameter, with buttresses up to 2.5 m high; bark surface in young trees fairly smooth with horizontal lenticels, in old trees brown to dark brown, very scaly, inner bark fibrous, brittle, pinkish brown to red-brown, exuding a clear, sticky sap; crown very large, wide-spreading, heavily branched, rounded and fairly open. Leaves alternate, simple; stipules c. 1 mm long, early falling; petiole 0.5–1 cm long; blade ovate to elliptical or oblong, 6–15 cm × 2.5–6 cm, base cuneate, apex acuminate, margin obscurely toothed, thin-leathery, glabrous, pinnately veined with 6–12 pairs of lateral veins. Inflorescence a short axillary cyme up to 5 cm long. Flowers bisexual, regular, 5-merous; pedicel 0.5–1.5 mm long, jointed at base; sepals c. 1.5 mm long, hairy outside; petals free, linear, c. 7 mm long, hairy outside, white; stamens 10, fused at base, 5 longer stamens c. 5 mm long, 5 shorter ones c. 3.5 mm long; ovary superior, ovoid, 5-celled, glabrous, style grooved, c. 4 mm long. Fruit an ellipsoid to globose drupe 3–4 cm × 2.5–3.5 cm, smooth, green to yellow; stone with 10 grooves and many resinous cavities, 1–3-seeded. Seeds oblong, c. 15 mm × 3 mm. Seedling with epigeal germination; hypocotyl 5–9 cm long, epicotyl c. 2 cm long; cotyledons leafy, ovate, c. 1.5 cm × 0.5 cm; first 2 leaves opposite.

Other botanical information *Sacoglottis* comprises 9 species, which all occur in South America except *Sacoglottis gabonensis*, which is considered to be closely related to *Sacoglottis amazonica* Mart. from South America and the Caribbean. The fruits of *Sacoglottis amazonica* are eaten in Venezuela to cure diarrhoea. The timber is valued for heavy construction in Venezuela and Brazil.

Sacoglottis gabonensis may have evolved from seeds, which arrived on the West African coast from South America, being one of the most illustrative cases of dispersal by water from South America to Africa. The resin-filled chambers of the stone make it float in water and seeds remain viable for up to 4 years.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: 2: growth ring boundaries indistinct or absent. Vessels: 5: wood diffuse-porous; 9: vessels exclusively solitary (90% or more); 14: scalariform perforation plates; 16: scalariform perforation plates with 10–20 bars; 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; 56: tyloses common. 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; 70: fibres very thick-walled. Axial parenchyma: 77: axial parenchyma diffuse-in-aggregates; 78: axial parenchyma scanty paratracheal; (84: axial parenchyma unilateral paratracheal); (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; (100: rays with multiseriate portion(s) as wide as uniseriate portions); (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 up-

right cells mixed throughout the ray); 115: 4–12 rays per mm. Mineral inclusions: 136: prismatic crystals present; 142: prismatic crystals in chambered axial parenchyma cells.
(L.N. Banak, H. Beeckman & P.E. Gasson)

Growth and development In Liberia flowering of *Sacoglottis gabonensis* occurs from December–March. The fruits are adapted for dispersal by elephants. They develop slowly over the dry season, ripening in September–December in Liberia and remaining dull green. They fall to the ground when ripe and develop a strong yeasty smell. Chimpanzees and mandrills also eat the fruits. Like *Lophira alata* Banks ex P.Gaertn. and *Aucoumea klaineana* Pierre, *Sacoglottis gabonensis* is able to establish in the edges of moist savanna and it is common in younger forest types. It can dominate this habitat, since its branches form huge arches, suppressing vegetation under them, hence cooling annual savanna fires, which might otherwise scorch their trunk. Early colonizers have low, round canopies and branch low down, but later generations grow taller and branch higher to escape from the shadow. Young trees close to the savanna edge often have multiple trunks because they have coppiced after being broken by elephants which feed on their leaves and bark.

Ecology *Sacoglottis gabonensis* occurs in evergreen forest, on river banks, along lagoons, on forest and savanna edges and in secondary forest. It is one of the dominant trees in the coastal rainforests of West and Central Africa and is particularly abundant in Cameroon (associated with *Lophira alata*) and in Gabon (associated with *Aucoumea klaineana*). In Côte d'Ivoire it is characteristic of the most humid evergreen forests. It is usually found in small pockets, but occasionally in quite large and almost pure stands.

Propagation and planting Natural propagation of *Sacoglottis gabonensis* is only by seed. Natural regeneration is not very abundant as many seeds are damaged by insects. The weight of 100 stones is 560–1000 g. Seeds take 2–4 months to germinate. The germination rate is quite low.

Management *Sacoglottis gabonensis* is less desirable for commercial forestry as the large crown suppresses regeneration of more valuable timber species. After cutting the tree, the stump coppices vigorously.

Harvesting The minimum bole diameter for harvesting is 70 cm in Liberia and Gabon. The stem bark and wood of *Sacoglottis gabonensis* is harvested from the wild.

Handling after harvest Logs do not float in water and cannot be transported by river. The bark of *Sacoglottis gabonensis* is generally sold in markets in sheets or rolls for use as an additive to palm wine or as a medicine, less frequently as a powder for emetic use.

Genetic resources *Sacoglottis gabonensis* is widespread and locally common, and therefore not threatened by genetic erosion.

Prospects *Sacoglottis gabonensis* plays an important role in the succession in and regeneration of natural forests. As a widespread and often common species it is important in the local economy as a timber and for firewood and charcoal production. Because of the often poor shape of the bole, commercial exploitation of the timber for international trade is limited. Selection for bole shape and research into proper management practices could lead to better shaped boles with higher commercial value in the timber trade.
The stem bark extracts of *Sacoglottis gabonensis* and its main isolated compound bergenin have interesting hepatoprotective and antioxidant properties, but more research is needed to evaluate its potential as a lead drug. Its use to increase alcohol content in palm wine deserves more research attention, as does information concerning health risks.

Major references Badré, 1972c; Burkill, 1994; Irvine, 1961; Maduka, Okoye & Mahmood, 2004; Siepel, Poorter & Hawthorne, 2004; Takahashi, 1978; Voorhoeve, 1965; White & Abernethy, 1997.

Other references Cuatrecasas, 1961; Ekouya & Itoua, 2005; Ezeronye, Elijah & Ojimelukwe, 2005; Gassita et al. (Editors), 1982; Hawthorne, 1995; Hoshino, 1985; InsideWood, undated; Liben, 1970a; Maduka, 2005; Maduka, Okoye & Eje, 2002; Maduka, Uhwache & Okoye, 2003; Madusolumuo & Okoye, 1993; Ojimelukwe, 2001; Okoye & Ohaeri, 1995; Rapondа-Walker & Sillans, 1961; Renner, 2004; Udosen & Ojong, 1998.

Sources of illustration Voorhoeve, 1965.

Authors E. Dounias

SARCOCEPHALUS POBEGUINII Pobég.

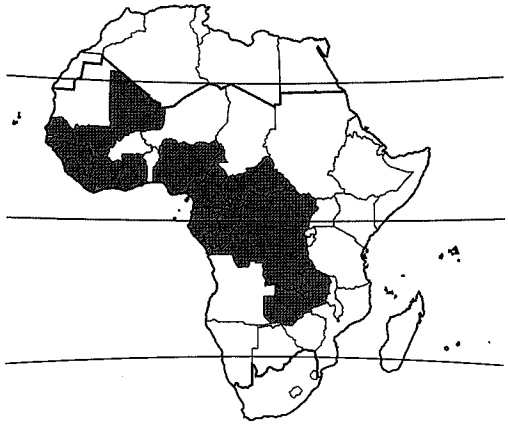
Protologue Essai fl. Guinée franç.: 313 (1906).
Family Rubiaceae
Chromosome number $2n = 44$
Synonyms *Nauclea pobeguinii* (Pobég.) Merr. (1915).

Vernacular names Water kusia (En). Bilinga des marais, bois d'or (Fr).

Origin and geographic distribution *Sarcocephalus pobeguinii* is distributed from Senegal to Zambia. It is occasionally planted.

Uses The wood is used for construction, joinery and cabinet work. Although the wood has been recorded to be suitable for making mortars, like that of the related *Nauclea diderrichii* (De Wild. & T.Durand) Merr., other sources indicate it is not used for making mortars in Ghana because it imparts a bitter taste to food. The pulp of the infructescence is edible, but not much eaten.

Sarcocephalus pobeguinii is widely used in African traditional medicine. A root decoction is taken as an anthelminthic in Guinea. In Nigeria root preparations are used against gonorrhoea. The powdered bark is taken in water against intestinal pain and diarrhoea in Senegal, and a bark decoction as an oxytocic. In Guinea a bark maceration is recorded to be taken as an abortifacient, while in Cameroon the bark is said to be used against threatened abortion. In Côte d'Ivoire bark preparations are used for the treatment of fever and jaundice. In Nigeria a bark decoction is drunk for the treatment of stomach-ache. In Gabon a maceration or decoction of the bark is drunk for the treatment of gonorrhoea. In DR Congo bark decoctions are taken for the treatment of malaria, a decoction of the barks of *Sarcocephalus pobeguinii* and *Symphonia globulifera* L.f. is taken against sexual asthenia, and a bark preparation is applied as a suppository against epilepsy. A leaf decoction is used against jaundice in Nigeria. In Gabon a leaf infusion is taken against fever.



Sarcocephalus pobeguinii – wild

Production and international trade The wood is only used locally and not commercialized.

Properties The heartwood is yellow or pale orange, the sapwood pale yellow to orange. The grain is irregular, texture fine. The wood is medium-weight, with a density of 500–780 kg/m^3, and moderately hard to hard. It works and glues well, and holds nails and screws well.

Aqueous, ethanolic and dichloromethane extracts of the bark have shown in-vitro antimalarial activity against *Plasmodium falciparum* and in-vivo antimalarial activity against *Plasmodium berghei* and *Plasmodium yoellii* in mice. No significant in-vivo toxic effects in mice were observed for aqueous and ethanolic bark extracts, but dichloromethane extracts have shown high in-vitro cytotoxic activity. A hydromethanolic extract of the bark showed significant chromosome-damaging activity, but had no cytotoxic activity. A clinical test with a small group of human adult volunteers diagnosed with uncomplicated *Plasmodium falciparum* malaria has shown that oral administration during meals of capsules of an 80% ethanolic extract of the stem bark was effective against malaria and well-tolerated, giving only mild and self-resolving adverse effects. Alkaloids, especially the major compound strictosamide, are assumed to be responsible for the antimalarial activity. However, neither strictosamide nor other alkaloids did show in-vitro antimalarial activity, suggesting activation of strictosamide, probably by the gastrointestinal tract, is necessary for its activity. The root bark contains alkaloids and quinovic acid glycosides. An aqueous extract of the leaves has shown in-vivo anti-oxidant activity in rats.

Botany Deciduous, small to medium-sized tree up to 30 m tall, sometimes a shrub; bole branchless for up to 15 m, straight and cylindrical, up to 100 cm in diameter, without buttresses; bark surface longitudinally fissured, flaking in papery scales c. 2 cm in diameter, whitish, grey or pale brown, inner bark fibrous, pale yellow-brown, turning darker on exposure; crown with whorled horizontal branches; twigs short-hairy when young. Leaves opposite, simple and entire; stipules triangular, 3–7 mm long; petiole slender, 1.5–5 cm long; blade oblong-elliptical to broadly elliptical, 8–25 cm × 5.5–16 cm, cuneate at base, rounded to acute or acuminate at apex, thin, glabrous, pinnately veined with 7–9 pairs of lateral veins. Inflorescence a solitary, terminal, rounded head 2–5

cm in diameter; peduncle 1–3 cm long. Flowers bisexual, regular, 4–5-merous, fragrant; calyx tubes fused to each other, lobes oblong-spatulate, 2–4 mm long, densely hairy; corolla 8–10 mm long, pinkish white, white or cream-coloured, tube funnel-shaped, c. 7 mm long, hairy inside, lobes oblong to ovate, 1.5–2 mm long; stamens inserted in the throat of the corolla tube, alternating with the lobes, without filaments; ovary inferior, 2-celled, style c. 12 mm long, with spindle-shaped thickening near apex. Fruits fused into a globose, fleshy infructescence 3.5–10 cm in diameter, yellow, densely pitted because of the persistent calyx lobes, with yellow pulp and an apple-like smell, many-seeded. Seeds ellipsoid or ovoid, 1–3 mm long, reddish, reticulate. Seedling with epigeal germination.

Sarcocephalus comprises only 2 species, restricted to tropical Africa, and seems related to *Burttdavya* and *Nauclea*.

In West Africa *Sarcocephalus pobeguinii* flowers in (April–)May–July, and fruits in September–November(–December). The fruits are a favoured food for chimpanzees in Guinea and gorillas in Central Africa. The seeds are recorded to be dispersed by water.

Ecology *Sarcocephalus pobeguinii* occurs from sea-level up to 1400 m altitude on river banks and lake sides, and in swamp forest, where it may grow in nearly pure stands.

Management Seed germination takes 1–3 weeks, and the germination rate is usually high. In an inventory in forest in southern Cameroon, an average wood volume of 0.25 m^3/ha has been recorded for trees with a bole diameter of more than 15 cm.

Genetic resources and breeding As *Sarcocephalus pobeguinii* is widely distributed and not much used, it seems not threatened with genetic erosion.

Prospects The wood of *Sarcocephalus pobeguinii* is only used locally and not traded internationally, and there are no indications that this situation will change. Quantitative data on the wood properties are scarce, and information on the durability of the wood is lacking altogether. Research on the pharmacological properties, especially in relation to the treatment of malaria, showed promising results for possible drug development in the pharmaceutical industry.

Major references Bridson & Verdcourt, 2003; Burkill, 1997; Mesia et al., 2010; Taylor, 1960; Vivien & Faure, 1985.

Other references de la Mensbruge, 1966; Hallé, 1966; Hawthorne & Jongkind, 2006; Kadiri, Adegor & Asagba, 2007; Liu et al., 2011; Mesia et al., 2005; Mesia et al., 2011; Vivien & Faure, 1996; Voorhoeve, 1979; Zeches et al., 1985.

Authors M. Brink

SCHEFFLERA ABYSSINICA (Hochst. ex A.Rich.) Harms

Protologue Engl. & Prantl, Nat. Pflanzenfam. III, 8: 38 (1894).

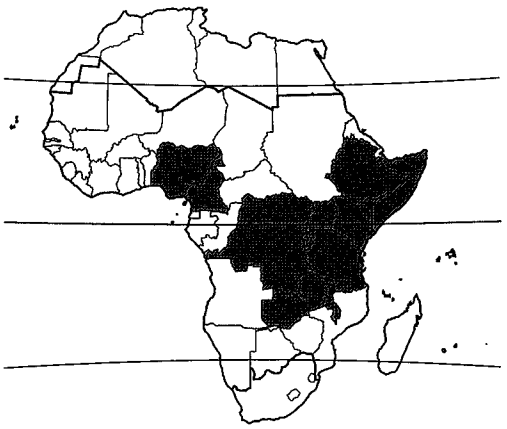
Family Araliaceae

Origin and geographic distribution *Schefflera abyssinica* occurs in mountain regions from Nigeria and Cameroon east to Ethiopia and Kenya, and south to Malawi and Zambia.

Uses The wood is used for furniture, boxes and agricultural implements. It is suitable for inner layers of plywood. Occasionally it is also used as firewood. The flowers are a source of nectar and pollen for honey bees. *Schefflera abyssinica* is planted as life fence.

Properties The heartwood is yellowish brown and indistinctly demarcated from the sapwood. The texture is coarse. The wood is lightweight, with a density of about 460 kg/m^3 at 12% moisture content. It is soft and easy to work. Some triterpene saponins have been isolated from the leaves.

Botany Small to medium-sized tree up to 30 m tall, sometimes an epiphyte; bole often twisted; bark surface smooth to fissured, corky, grey-brown to grey-black, inner bark whitish; crown large, spreading. Leaves arranged spirally, digitately compound with 5–8 leaflets; stipules triangular, 1–1.5 cm long; petiole up to



Schefflera abyssinica – *wild*

42 cm long, slightly grooved; petiolules up to 12.5 cm long; leaflets elliptical to ovate, 6–25(–40) cm × 3–15(–20) cm, rounded to cordate at base, acuminate at apex, margins finely toothed, papery to leathery, glabrous, pinnately veined with 9–14 pairs of lateral veins. Inflorescence a false raceme up to 40 cm long, often many together at ends of branches, consisting of stalked umbels; bracts at base of inflorescences broadly ovate, up to 1.5 cm long. Flowers bisexual, regular, 5–8-merous, creamy to greenish yellow, fragrant; pedicel 2–11 mm long; calyx wavy; petals fused, 1.5–2 mm long, falling as a small cap; stamens the same number as petals, free, 2–3 mm long; ovary inferior, 5–8-celled, styles 5–8, 0.5–1 mm long. Fruit a nearly globose drupe-like berry c. 5 mm in diameter, ribbed, reddish when ripe, glabrous or slightly hairy, several-seeded. Seeds ellipsoid, compressed, smooth.

In Ethiopia trees flower from February to March, and fruits mature 2–3 months later. The flowers are pollinated by insects including bees. The fruits are eaten by birds, which may serve as seed dispersers.

Schefflera probably comprises about 700 species and is widely distributed in the tropics and subtropics. In mainland Africa about 12 species occur, and in Madagascar about 15.

Schefflera umbellifera (Sond.) Baill. is a small to medium-sized tree up to 20 m tall, usually with a straight bole up to 60 cm in diameter, occurring in Malawi, Zimbabwe, Mozambique and South Africa. The whitish, lightweight and soft wood is used for boxes and matches. A bark extract is taken to treat malaria, leaf extracts are drunk against rheumatism, colic and insanity, and root infusions against inflammations. The use of the bark in traditional medicine to treat malaria has been rationalized in experiments with bark extracts, which showed in-vitro activity against chloroquine-resistant strains of *Plasmodium falciparum*. *Schefflera umbellifera* is planted as an ornamental tree in gardens.

Ecology *Schefflera abyssinica* occurs in mountain rainforest at (1200–)1400–2800 m altitude, often in secondary forest. In Ethiopia it is locally one of the dominant forest trees, e.g. with *Hagenia abyssinica* (Bruce) J.F.Gmel. at 2400–2800 m altitude, whereas in mountain forest in southern Sudan it is common.

Management *Schefflera abyssinica* is propagated by seed, cuttings and wildlings. Seeds do not require any pre-treatment; they start germinating about 2 weeks after sowing. Cuttings should be planted at the end of the rainy season.

Genetic resources and breeding *Schefflera abyssinica* is widespread in mountainous regions of Africa, and is not threatened. However, isolated populations, like those in Nigeria and Cameroon, may become threatened with ongoing forest clearing.

Prospects *Schefflera abyssinica* will probably remain of some importance for local applications, but does not seem to have prospects for commercial exploitation, with its often poorly shaped bole and low-quality timber.

Major references Bamps, 1974; Bamps, 1989; Bekele-Tesemma, 2007; Jacques-Félix, 1970; Tennant, 1968.

Other references Beentje, 1994; Cannon, 1978b; Coates Palgrave, 1983; Keay, 1989; Mbambezeli, 2005; Neuwinger, 2000; Pillay, Maharaj & Smith, 2008; Sommerlatte & Sommerlatte, 1990; Tapondjou et al., 2006; Tetyana et al., 2002.

Authors R.H.M.J. Lemmens

SCHOTIA BRACHYPETALA Sond.

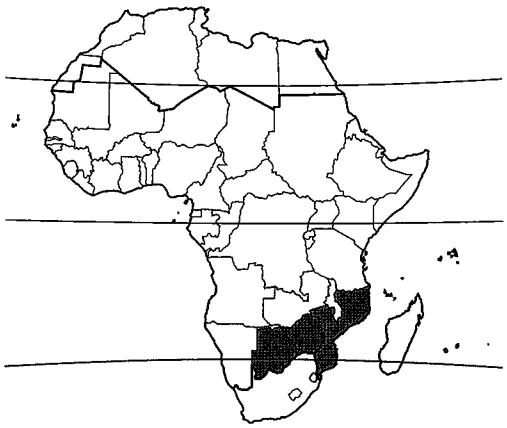
Protologue Linnaea 23: 39 (1850).

Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

Chromosome number $2n = 24$

Vernacular names Weeping schotia, weeping boerbean, fuchsia tree, African walnut (En).

Origin and geographic distribution *Schotia brachypetala* occurs in eastern Botswana, Zimbabwe, southern Mozambique, eastern South Africa and Swaziland.



Schotia brachypetala – wild

Uses The wood is used for furniture, flooring, wagon beams and carving. Roasted seeds are eaten. The flowers, which produce abundantly nectar, are sometimes chewed. Preparations of the bark, and sometimes of roots and leaves, are used in traditional medicine. Bark decoctions and infusions are taken as emetic, and to treat heartburn, hangovers, nervous conditions, mental health problems and fontanel depression in babies, and are applied to swellings. The bark and roots are used to treat diarrhoea, and bark is applied in mixtures as a tonic. Pulverized leaves are used as a dressing to treat ulcers, and the smoke of burnt leaves is inhaled against nose bleeding. The bark has been used for tanning and dyeing reddish brown. *Schotia brachypetala* is planted as ornamental tree in gardens and parks because of its glossy foliage and bright red flowers.

Properties The heartwood is dark brown to nearly blackish, often with a greenish tinge, and is distinctly demarcated from the pinkish sapwood, which changes to yellowish brown upon exposure. The texture is fine. The wood is heavy and hard. It is only moderately durable, but quite resistant to termites. It has been reported that wood dust may cause allergic reactions to the eyes.

The medicinal activity of the bark may be due to the presence of tannins. Fatty acids with antibacterial activity against *Bacillus subtilis* and *Staphylococcus aureus*, and to a lesser extent against *Escherichia coli* and *Klebsiella pneumoniae*, have been isolated from the leaves. Bark extracts exhibited pronounced monoamine oxidase-B inhibition activity, supporting the use in traditional medicine to treat mental health problems. Polyhydroxystilbenes have been isolated from the heartwood; the major compound is 3,3',4,5,5'-pentahydroxystilbene.

Botany Evergreen or briefly deciduous, small tree up to 15 m tall; bole up to 60 cm in diameter; bark surface smooth with hoop marks and reddish brown in young trees, becoming rough and greyish brown to reddish brown in older trees; crown rounded, with spreading branches; twigs short-hairy when young. Leaves alternate, paripinnately compound with (3–)4–6(–7) pairs of leaflets; stipules narrowly triangular, c. 5 mm long, caducous; petiole 1–2 cm long, rachis 3.5–17.5 cm long, grooved; leaflets opposite, elliptical to rhombic-ovate, 2–6.5 cm × 1–3 cm, cuneate to rounded and often asymmetrical at base, rounded to slightly notched at apex, margin entire to slightly wavy, sparsely hairy or glabrous, pinnately veined. Inflorescence a congested panicle up to 13 cm long, usually on older branches. Flowers bisexual, zygomorphic, deep red; pedicel 3–5 mm long, expanding into the 3–5 mm long hypantium; calyx lobes 4, broadly ovate, c. 1 cm long, unequal, gland-dotted; petals often strap-shaped and up to 3 mm long or absent, but sometimes 1–4 narrowly obovate petals up to 2 cm long present; stamens 10, fused at base, up to 2 cm long; ovary superior, narrowly elliptical, flattened, c. 1 cm long, with stipe c. 3 mm long fused to the hypantium, style c. 1 cm long. Fruit an oblong, flattened pod 6–17 cm × 3.5–5 cm, thickened along upper suture, glabrous, tardily dehiscent, several-seeded. Seeds broadly elliptical to rhombic, flattened, 1.5–2 cm × 1–1.5 cm, smooth, pale brown, with cup-shaped, yellow aril at base.

Schotia brachypetala usually grows slowly, but when planted on deep sandy soils it may grow quite rapidly; a planted tree reached 12 m tall 17 years after being planted as a cutting. The tree is usually evergreen, but in colder areas of South Africa it is deciduous for a short period. Young foliage is pink to red, turning gradually to coppery and light green, and is often accompanied by the deep red flowers. Trees usually flower in September–October. Nectar is often so abundant that it drips from the flowers, which are visited by sunbirds, but also by insects such as bees, and by monkeys. Fruits ripen about 6 months after flowering. The seeds are probably mainly dispersed by birds attracted by the yellow arils.

Schotia comprises about 4 species and is confined to southern Africa. Its affinity is still uncertain. *Schotia afra* (L.) Thunb. is a shrub or small tree up to 7 m tall found in southern Namibia and South Africa. The reddish brown wood is used for yokes and felloes, and as firewood; it is hard and durable. Roasted seeds are eaten. The foliage is eaten by livestock. *Schotia afra* is an attractive ornamental. The bark has been used for tanning.

Schotia capitata Bolle is a shrub or small tree up to 7 m tall found in Zimbabwe, southern Mozambique, eastern South Africa and Swaziland. The wood is sometimes used for furniture. *Schotia capitata* is occasionally planted as ornamental.

Schotia latifolia Jacq. is a small tree up to 10(–15) m tall endemic to South Africa, but recently it has also been recorded from southern Mozambique. The tough, whitish wood is used

for fence posts. Roasted seeds are eaten. Bark decoctions are taken to treat stomach-ache. The bark of *Schotia latifolia* is commonly used in South Africa to treat tick-borne diseases of livestock. The bark has been used as a dye producing a greenish colour, and for tanning. *Schotia latifolia* is occasionally planted as an ornamental.

Ecology *Schotia brachypetala* occurs in woodland and thickets up to 1350 m altitude. It is often found on termite mounds and on river banks. The tree is drought resistant and slightly frost tolerant.

Management Propagation can be done by using seeds or truncheon cuttings. Young trees perform best when they have been planted in deep sandy soils with plenty of well-decomposed compost added.

Genetic resources and breeding There are no indications that *Schotia brachypetala* is in risk of genetic erosion. However, the bark is locally popular and much collected, and this may have serious impact on local populations of the species.

Prospects The boles of *Schotia brachypetala* and other *Schotia* spp. are usually too small and too poorly shaped to be of commercial interest for timber. However, *Schotia* spp. are valued as multi-purpose trees, especially as ornamental and for medicinal purposes. Some of the known pharmacological activities deserve more research attention, e.g. the monoamine oxidase-B inhibition activity, which could be of interest for the development of new medicines against Parkinson's and Alzheimer's disease. *Schotia* trees are also important as a source of food for wildlife.

Major references Brummitt et al., 2007a; Coates Palgrave, 1983; Mbambezeli & Notten, 2001; Palmer & Pitman, 1972–1974; van Wyk, van Oudtshoorn & Gericke, 1997.

Other references Drewes & Fletcher, 1974; Grace et al., 2002a; Huxham et al., 1998; Masika, Sultana & Afolayan, 2004; Mathabe et al., 2006; McGaw, Jäger & van Staden, 2002a; McGaw, Jäger & van Staden, 2002b; Neuwinger, 2000; Stafford et al., 2007; van Wyk & Gericke, 2000.

Authors R.H.M.J. Lemmens

SCHREBERA ALATA (Hochst.) Welw.

Protologue Trans. Linn. Soc. London 27: 39 (1869).

Family Oleaceae

Chromosome number $2n = 44, 46$

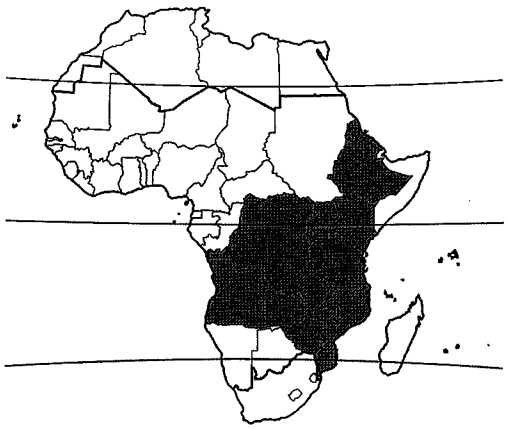
Origin and geographic distribution *Schrebera alata* is widespread, from Eritrea and Ethiopia southwards through eastern DR Congo and East Africa to Angola, northern South Africa and Swaziland.

Uses In Kenya the wood is mainly used for construction in house building, poles, furniture and tool handles. It is suitable for flooring, joinery, interior trim, mine props, vehicle bodies, sporting goods, toys, novelties, agricultural implements, turnery, pattern making, veneer and plywood. The wood is excellent as firewood, and is also used for charcoal production.

Several plant parts are used in traditional medicine. Pounded roots, twigs and leaves are chewed to treat tooth complaints and as antitussive, and in water they are applied as a wash to ulcers. Bark is also chewed to treat toothache, and bark decoctions are applied as anodyne. Leaves are chewed to treat tonsillitis, pharyngitis and headache, and leaf decoctions are administered as a vapour bath for treatment of headache and taken to treat colds, cough, fever, and as emetic, oxytocic and tonic. *Schrebera alata* is occasionally planted as ornamental tree.

Properties The heartwood is whitish to pale brown, often with slightly darker streaks, not distinctly demarcated from the sapwood. The grain is straight to slightly wavy, texture fine and even. The wood is moderately heavy, with a density of 780–835 kg/m³ at 12% moisture content, hard and strong. It should be dried slowly and carefully to avoid serious splitting, checking and distortion. Once dry, it is moderately stable in service.

The wood saws and works fairly easily with



Schrebera alata – wild

both hand and machine tools. It planes to a smooth surface, and polishes well. Pre-boring is needed for nailing. The wood glues, paints and varnishes satisfactorily, and it turns fairly well. The heartwood is moderately durable. The sapwood is susceptible to *Lyctus* attack. The heartwood is resistant to preservatives.
Tests in rats showed that bark extracts have analgesic effects, confirming the use in traditional medicine, but they also demonstrated some toxicity, causing hepatic injuries.

Botany Deciduous, small to medium-sized tree up to 20(–25) m tall; bole usually short and crooked, up to 60 cm in diameter, often fluted; bark surface smooth or longitudinally fissured, sometimes flaking with thin scales, pale grey to yellowish brown, inner bark cream-coloured with orange markings, darkening upon exposure; crown fairly open; twigs initially hairy but becoming glabrous, with lenticels. Leaves opposite, imparipinnately compound with (3–)5(–7) leaflets; stipules absent; petiole 1–5 cm long, slightly winged; rachis 2–5 cm long, winged; leaflets opposite, nearly sessile, elliptical to obovate, 2–14 cm × 1–6 cm, cuneate and often asymmetrical at base, apex rounded to short-acuminate or occasionally notched, glabrous or sparsely short-hairy, pinnately veined with up to 10 pairs of lateral veins. Inflorescence a terminal cyme up to 10 cm long, glabrous to hairy, few-flowered to many-flowered. Flowers bisexual, regular, 5–7-merous, heterostylous, sweet scented; pedicel up to 3(–5) mm long; calyx campanulate, 2–4(–7) mm long, short-hairy; corolla white, sometimes flushed with pink, with reddish brown hairs at the base of lobes, tube funnel-shaped, 1–1.5 cm long, lobes 3–7 mm long, spreading; stamens 2, inserted in the upper part of the corolla tube, with short filaments; ovary superior, c. 1.5 mm in diameter, 2-celled, style slender, short or long. Fruit a pear-shaped or obovoid woody capsule 2–4.5 cm × 1–1.5 cm, pale brown, dehiscing with 2 valves, with up to 8 seeds. Seeds with a large wing, up to 2.5 cm × 1 cm.
Young *Schrebera alata* trees grow fairly rapidly when they are planted in fertile soil. In Uganda young trees showed an annual growth of up to 1 m/year at 1500 altitude and on deep and moist soils, but growth was much less at higher altitudes and on drier sites. In southern Africa trees flower in December to February, and fruits ripen about 4 months after flowering. Fruits usually open while still attached to the tree. The seeds with their wings are dispersed by wind; they spin during falling.
Schrebera comprises about 8 species, of which 5 occur in tropical Africa including Madagascar, 2 in tropical Asia and 1 in South America. It seems most closely related to *Comoranthus* from Comoros and Madagascar, which also has a woody capsule.
Schrebera trichoclada Welw. is a shrub or small tree up to 10 m tall with bole up to 30 cm in diameter, occurring from DR Congo and Tanzania southwards to Angola, Zimbabwe, Mozambique and Madagascar. Its wood is locally used for implements such as spoons. Bark and leaves are chewed as anodyne, leaf macerations are applied to the eyes to treat ophthalmia, and root infusions are used as an eye lotion.

Ecology *Schrebera alata* occurs in evergreen forest, riverine forest, open woodland and sometimes savanna with scattered trees, up to 2500 m altitude. In East Africa it is often associated with *Juniperus*, *Podocarpus* and *Olea* spp., and occurs particularly in forest margins and clearings.

Management *Schrebera alata* can be propagated by seeds and wildlings. Fruits should be harvested from the tree just before they open. They can be dried in the sun until they open and the seed can be collected. It is recommended to sow seeds with wings pointing upwards; they can be sown without pre-treatment. The seeds can be stored in a dry and cool locality for longer periods. Trees can be managed by coppicing and pruning, and intercropped with coffee.

Genetic resources and breeding *Schrebera alata* is quite widespread in various habitats and not selectively harvested on a large scale. Therefore, there is no reason to consider it liable to genetic erosion.

Prospects The wood of *Schrebera alata* will remain of some local importance, but it does not seem to have prospects for trade on the international market because the tree bole is usually too short and crooked or fluted. *Schrebera alata* has been recommended as a firewood crop for highland farmers in East Africa. It deserves more attention as an ornamental tree.

Major references Bolza & Keating, 1972; Chikamai et al., undated; Katende, Birnie & Tengnäs, 1995; Maundu & Tengnäs (Editors), 2005; SEPASAL, 2011.

Other references Beentje, 1994; Coates Palgrave, 2002; Green, 2003; Kokwaro, 1993; Kupicha, 1983b; Liben, 1973; Maundu et al.,

2001; Mbaya, 1976; Neuwinger, 2000; Palmer & Pitman, 1972–1974.

Authors R.H.M.J. Lemmens

SCHREBERA ARBOREA A.Chev.

Protologue Mém. Soc. Bot. France 8: 180 (1912).

Family Oleaceae

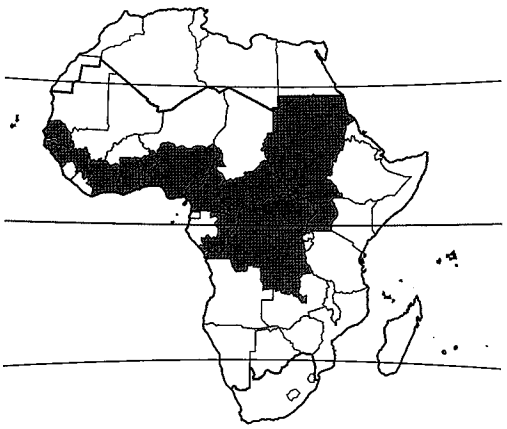
Vernacular names Pau goiaba (Po).

Origin and geographic distribution *Schrebera arborea* is quite widespread, from Senegal and Guinea Bissau eastwards to southern Sudan and Uganda, and south to DR Congo.

Uses The wood is used for general construction, railway sleepers, boat-keels, utensils, tool handles, shafts and beehives. It is suitable for flooring, joinery, interior trim, mine props, vehicle bodies, furniture, sporting goods, toys, novelties, agricultural implements, turnery, pattern making, veneer and plywood. It is also used as firewood and for charcoal production.
In traditional medicine, fresh twigs are an ingredient of a preparation that is taken to treat skin diseases. Macerations of the twigs are administered as purgative to treat abdominal pain. In Nigeria the seeds are applied to the heads of children to treat skin complaints. In Uganda several plant parts are used as purgative.

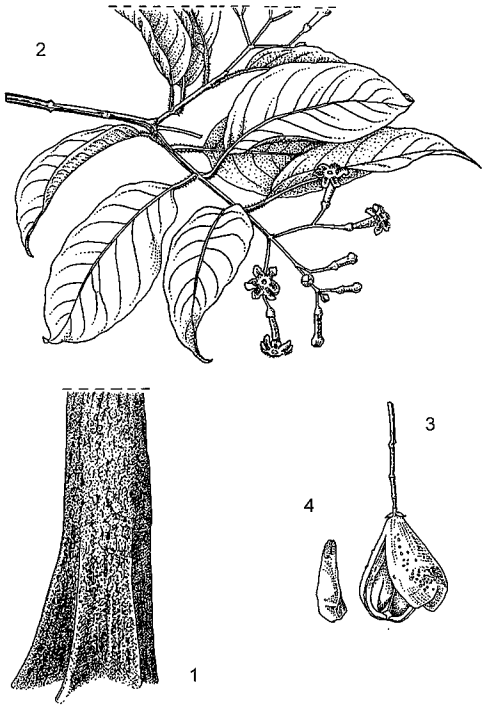
Production and international trade The wood of *Schrebera arborea* is only used locally and not traded on the international timber market.

Properties The heartwood is pinkish to yellowish brown, sometimes with violet streaks, and not distinctly demarcated from the paler sapwood. The grain is straight to wavy, texture usually fine. The wood is moderately heavy, with a density of 750–830(–930) kg/m³ at 12% moisture content, tough and quite hard. It air dries well, but care should be taken to avoid surface checking. The rates of shrinkage are rather high, from green to oven dry 4.7–5.6% radial and 7.8–8.6(–9.5)% tangential. Logs may either be back-sawn or quarter-sawn after felling. Once dry, the wood is unstable in service. At 12% moisture content, the modulus of rupture is (77–)108–132 N/mm², modulus of elasticity 11,800 N/mm², compression parallel to grain 44–63 N/mm², shear 12–14 N/mm², cleavage 14.5–23.5 N/mm and Chalais-Meudon side hardness 2.7–3.6.
The wood is fairly easy to saw and work. In planing, picking-up of grain can be problematic, but it can be polished to a smooth finish. For nailing, pre-boring is recommended to avoid splitting. The gluing properties are satisfactory. The wood is easy to wax, paint and varnish. The heartwood is fairly durable, but occasionally susceptible to wood-boring beetles. The sapwood is liable to *Lyctus* attack. The heartwood is moderately resistant to preservatives.



Schrebera arborea – *wild*

Description Deciduous, medium-sized tree up to 30(–40) m tall; bole branchless for up to 20(–30) m, straight and cylindrical, up to 80 cm in diameter, with small buttresses or fluted at base; bark surface smooth but flaking with thin scales, yellowish white to greyish brown with paler patches, inner bark fibrous, mottled cream and orange, darkening upon exposure; crown rounded; twigs initially hairy but becoming glabrous, with lenticels. Leaves opposite, simple and entire; stipules absent; petiole 1–5 cm long; blade elliptical to ovate, 5–15 cm × 3–10 cm, cuneate to rounded at base, acute to short-acuminate at apex, thinly leathery, glabrous or nearly so, pinnately veined with 6–12 pairs of lateral veins. Inflorescence a terminal or axillary cyme up to 10 cm long, few-flowered. Flowers bisexual, regular, (4–)5–8-merous, heterostylous, sweet-scented; pedicel 3–7 mm long; calyx campanulate, 3–5 mm long, slightly hairy or glabrous; corolla white to greenish white with purplish brown hairs at the base of lobes, tube funnel-shaped, 1–2 cm long, lobes c. 6 mm long, spreading; stamens 2, inserted in the upper part of the corolla tube, with short filaments; ovary superior, c. 1 mm in diameter, 2-celled, style slender, short or long. Fruit a pear-shaped woody capsule up to 6.5 cm × 3.5 cm, purplish brown with paler lenticels, dehiscing with 2 valves, usually with



Schrebera arborea – 1, base of bole; 2, flowering twig; 3, fruit; 4, seed.
Redrawn and adapted by J.M. de Vries

4 fertile seeds. Seeds with a large wing, up to 4(–5) cm × 1 cm. Seedling with epigeal germination; hypocotyl c. 3 cm long, epicotyl c. 1 cm long, glabrous; cotyledons fleshy, flattened, c. 1.5 cm long; first leaves opposite.

Other botanical information *Schrebera* comprises about 8 species, of which 5 occur in tropical Africa including Madagascar, 2 in tropical Asia and 1 in South America. It seems most closely related to *Comoranthus* from Comoros and Madagascar, which also has a woody capsule.
Schrebera arborea has been included in *Schrebera golungensis* Welw., but the latter is probably a synonym of *Schrebera trichoclada* Welw.

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); 13: simple perforation plates; 22: intervessel pits alternate; (23: shape of alternate pits polygonal); 24: intervessel pits minute (≤ 4 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. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; (62: fibres with distinctly bordered pits); 65: septate fibres present; 66: non-septate fibres present; 69: fibres thin- to thick-walled; 70: fibres very thick-walled. Axial parenchyma: 75: axial parenchyma absent or extremely rare; 78: axial parenchyma scanty paratracheal; (92: four (3–4) cells per parenchyma strand); 93: eight (5–8) cells per parenchyma strand. Rays: 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); 115: 4–12 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); 151: styloids and/or elongated crystals.
(F.D. Kamala, P. Baas & H. Beeckman)

Growth and development In Senegal the growth of planted seedlings was quite slow; they reached on average 2.6 m in height 5 years after planting. In Côte d'Ivoire flowering trees have mainly been recorded in October–November and ripe fruits in February–March and November. In Nigeria trees flower in March–May and fruits ripen in April–June and December. Fruits usually open while still attached to the tree. The seeds with their wings are dispersed by wind; they spin during falling.

Ecology *Schrebera arborea* occurs mostly in dry deciduous forest and semi-deciduous forest, up to 1500 m altitude. It is occasionally found in thickets in savanna regions and at forest edges, and in Uganda it occurs in mixed rainforest.

Propagation and planting *Schrebera arborea* is propagated by seed and wildlings. Mature fruits should be collected from the tree before dehiscence. They are usually dried in the sun until they open to collect the seeds. There are about 10,000 seeds per kg. Seeds can be stored for some time in a dry and cool locality. It is recommended to sow seeds with wings up; they can be sown without pre-treatment. They start germinating 2–4 weeks after sowing, with a moderate germination rate.

Management In most regions within the distribution area of *Schrebera arborea*, trees

occur scattered and are not common in the forest. They are sometimes planted in banana and cocoa plantations. Planted trees can be managed by coppicing and pollarding.

Genetic resources *Schrebera arborea* is widespread and harvested on a moderate scale only. Therefore, it is unlikely to be threatened by genetic erosion notwithstanding being uncommon. It has been recorded as endangered in Togo and it is rare in Ghana.

Prospects Although *Schrebera arborea* is considered a valuable timber tree of local importance, very little information is available on its growth rates and proper management practices. It deserves further research as a potential multipurpose species that could be useful in agroforestry systems. In Uganda *Schrebera arborea* has been recommended for planting as ornamental tree and as shade tree in coffee, cocoa and banana plantations.

Major references Aubréville, 1959c; Bolza & Keating, 1972; Burkill, 1997; Irvine, 1961; Katende, Birnie & Tengnäs, 1995; Keay, 1989; Liben, 1973; Takahashi, 1978; Turrill, 1952; Vivien & Faure, 1985.

Other references Adjanohoun et al. (Editors), 1988; Adjanohoun et al., 1989; Akoègninou, van der Burg & van der Maesen (Editors), 2006; Aubréville, 1950; de la Mensbruge, 1966; Eggeling & Dale, 1951; Garzuglia, 2006; Green, 1963; Hawthorne, 1995; Hawthorne & Jongkind, 2006; Idu, Erhabor & Efijuemue, 2010; Kupicha, 1983b; Louppe, 1993; Neuwinger, 2000; Normand & Paquis, 1976; Tailfer, 1989; Taylor, 1960; Wallander & Albert, 2000.

Sources of illustration Keay, 1989; Vivien & Faure, 1985.

Authors S. Pentsil & E.A. Obeng

SCOLOPIA MADAGASCARIENSIS Sleumer

Protologue Repert. Spec. Nov. Regni Veg. 45: 14 (1938).

Family Flacourtiaceae (APG: Salicaceae)

Origin and geographic distribution *Scolopia madagascariensis* is endemic to Madagascar, where is widespread along the eastern coast.

Uses The wood, known as 'menavahatra' in Madagascar, is used for heavy construction, heavy flooring, joinery, panelling, mine props, vehicle bodies and railway sleepers, and also as firewood. The fruit is eaten. A tea made from the leaves is drunk against fever.

Properties A sample of *Scolopia* wood from

Scolopia madagascariensis – *wild*

Madagascar, possibly *Scolopia madagascariensis*, has been tested. The heartwood is greyish to pale brown or slightly reddish, and distinctly demarcated from the yellowish white, 3–5 cm wide sapwood. The grain is straight to interlocked, texture rather coarse. The wood is heavy, with a density of 890–950 kg/m^3 at 12% moisture content, and hard. It should be air dried slowly and with care to avoid serious degrade. The rates of shrinkage are moderate to high, from green to oven dry 5.5% radial and 11.2% tangential. A board of 2.5 cm thick air dried in 3–4 months with little distortion. Once dry, the wood is rather unstable in service. At 12% moisture content, the modulus of rupture is 189 N/mm^2, modulus of elasticity 15,200 N/mm^2, compression parallel to grain 77 N/mm^2, shear 21 N/mm^2 and Chalais-Meudon side hardness 6.8–7.6. The wood is fairly easy to work and takes a good finish. It is moderately durable and rather difficult to treat with preservatives.

Botany Evergreen, small to medium-sized tree up to 25 m tall, glabrous except for the inflorescence; bole up to 60(–100) cm in diameter; bark surface nearly smooth to scaly, greyish, with longitudinal rows of lenticels, inner bark reddish. Leaves arranged spirally, simple and entire; stipules minute, caducous; petiole 0.5–1 cm long; blade elliptical to oblong-elliptical or obovate, 6–11(–14) cm × 2.5–7(–9) cm, base broadly cuneate, apex acuminate, leathery, pinnately veined with many pairs of lateral veins and with 2 distinct basal lateral veins ascending towards the upper part of the leaf. Inflorescence an axillary raceme 1–2.5(–5) cm long, minutely hairy. Flowers bisexual,

regular, 4–5-merous, whitish; pedicel 3–5 mm long; sepals ovate, 1.5–2 mm long; petals similar but slightly narrower than sepals; disk small, lobed; stamens 80–100; ovary superior, glabrous, 1-celled, style 3–4 mm long, slender, stigma obscurely 3–4-lobed. Fruit a globose to ellipsoid berry 1–1.5 cm in diameter, fleshy, 2–5-seeded. Seeds rounded, flattened, c. 2 mm in diameter. Seedling with epigeal germination.

Scolopia madagascariensis trees grow slowly. In an enrichment planting, trees reached on average only 1 m tall 7 years after planting. Young trees tolerate some shade. The flowering period is usually April–June.

Scolopia comprises about 40 species and occurs from tropical Africa through tropical Asia to Australia. In mainland Africa about 6 species are found, 14 in Madagascar and 1 in the Mascarene islands. The wood of some other *Scolopia* spp. of the rainforest of eastern Madagascar is used for similar purposes as that of *Scolopia madagascariensis*.

Scolopia erythrocarpa H.Perrier is a large shrub or small tree up to 8(–15) m tall. Its wood is used for similar purposes as that of *Scolopia madagascariensis*. In traditional medicine its leaves are applied as a poultice against rheumatic pain. Its fruits are eaten.

Scolopia hazomby H.Perrier is a small to medium-sized tree up to 20 m tall. Its wood is used for similar purposes as that of *Scolopia madagascariensis*. It has edible fruits.

Scolopia orientalis Sleumer is a small tree up to 15 m tall. Its wood is used for similar purposes as that of *Scolopia madagascariensis*.

Scolopia heterophylla (Lam.) Sleumer is a shrub or small tree up to 7(–15) m tall, endemic to Mauritius, Réunion and Rodrigues. Its wood has been used for similar purposes as that of *Scolopia madagascariensis* in Madagascar. In Mauritius and Réunion leaf decoctions are taken against fever. However, *Scolopia heterophylla* has become rare because of forest degradation.

Ecology *Scolopia madagascariensis* occurs in rainforest up to 1000(–1900) m altitude, in regions with about 2500 mm annual rainfall, usually on lateritic soils.

Management There are 25,000–33,000 seeds per kg. Fresh seeds have a high germination rate, up to 95% in 3.5–15 weeks. They can be stored in a cool locality, but lose their germination capacity after 4–6 months.

Genetic resources and breeding *Scolopia madagascariensis* is widespread and although its habitat is shrinking, it is not yet listed as threatened by genetic erosion.

Prospects The wood of *Scolopia madagascariensis* and some other *Scolopia* spp. from Madagascar is likely to remain of local importance. However, trees seem to grow too slowly to have good prospects for timber plantations.

Major references Blaser et al., 1993; Boiteau, Boiteau & Allorge-Boiteau, 1999; Brown et al., 2009; Sleumer, 1972b; Styger et al., 1999.

Other references Guéneau, 1971a; Gurib-Fakim, 2007; Gurib-Fakim & Brendler, 2004; Gurib-Fakim, Guého & Bissoondoyal, 1996; Lavergne, 2001; Parant, Chichignoud & Rakotovao, 1985; Perrier de la Bâthie, 1946c; Rakotovao et al., en préparation; Sallenave, 1971; Sleumer & Bosser, 1980.

Authors L.P.A. Oyen

SCOLOPIA ZEYHERI (Nees) Harv.

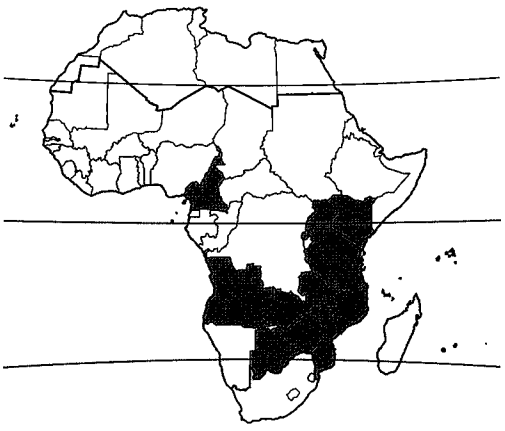
Protologue Fl. cap. 2: 584 (1862).

Family Flacourtiaceae (APG: Salicaceae)

Vernacular names Thorn pear (En). Mgovigovi (Sw).

Origin and geographic distribution *Scolopia zeyheri* occurs from Rwanda, Kenya and Uganda southward to Angola, Botswana, Zimbabwe, Mozambique, eastern South Africa and Swaziland. It has also been reported from Cameroon.

Uses The wood of *Solopia zeyheri* is used in house construction and for poles, tool handles and spoons, and also as firewood and for charcoal production. Because of its strength and hardness, it has been used for teeth of mill wheels and for axles, felloes and spokes in



Scolopia zeyheri – wild

wagon-making.
Ripe fruits are fleshy and sweet, and eaten raw as an occasional snack. In East Africa *Scolopia zeyheri* is an important bee plant. In South Africa the foliage is a preferred browse of goats. Maasai people use the roots against venereal diseases.

Properties The wood is very strong, hard and rather heavy, with a specific gravity (moisture content 0%) of 0.69. It is difficult to saw, but polishes well.

Botany Much-branched shrub or small tree up to 15(–25) m tall, glabrous except for the inflorescence; bole often branching fairly low, up to 60 cm in diameter, sometimes with branched spines; bark surface fissured, dark grey to brownish, inner bark rather thin; branches and twigs often with strong, axillary, simple, straight spines up to 20 cm long. Leaves arranged spirally, simple; stipules minute, caducous; petiole up to 1.5 cm long; blade obovate to oblanceolate or elliptical, 2–10 cm × 1–6 cm, base cuneate, apex acute to obtuse or rounded, margin entire, wavy or bluntly toothed, leathery, pinnately veined with 3–6 pairs of lateral veins. Inflorescence an axillary raceme 1–5(–6) cm long, short-hairy. Flowers bisexual, regular, (3–)4–5(–6)-merous, scented; pedicel (1–)2–5(–10) mm long; sepals elliptical to ovate, 1–1.5 mm × 1 mm; petals smaller than sepals or absent; disk small, lobed; stamens (20–)30–40; ovary superior, glabrous, 1-celled, style 1.5–2.5 mm long, stout, stigma obscurely 2–3-lobed. Fruit a globose berry 7–8 mm in diameter, fleshy, purple-red when ripe, 2–3-seeded. Seeds angular.
Scolopia comprises about 40 species and occurs from tropical Africa through tropical Asia to Australia. In mainland Africa about 6 species are found, 14 in Madagascar and 1 in the Mascarene islands. In East and southern Africa, several other *Scolopia* spp. are used for similar purposes as *Scolopia zeyheri*.
Scolopia mundii (Eckl. & Zeyh.) Warb. is a small tree up to 7(–20) m tall, occurring in dry evergreen forest and wooded grassland in Zimbabwe and South Africa. Its pale brown, heavy, hard and strong wood was formerly considered valuable for furniture and wagon-making, but large specimens are now rare. The bark is used in traditional Zulu medicine in the treatment of heart problems, but has been implicated in cases of lethal poisoning.
Scolopia rhamniphylla Gilg is a shrub or small tree up to 15 m tall, locally common in rainforest or dry evergreen forest from Cameroon east to Kenya and south to Tanzania and Angola. The wood is hard and used for poles, tool handles and yokes, and also as firewood and for charcoal production. The fruits are edible and the flowers are a source of nectar for honey bees. A vapour bath from the leaves is taken as emetic.
Scolopia stolzii Gilg ex Sleumer is a small, much-branched tree up to 10(–15) m tall, occurring in dry evergreen forest or wooded grassland from Cameroon, DR Congo and Kenya south to Zimbabwe, Mozambique and South Africa. The wood is hard and used for poles, tool handles and yokes, and also as firewood and for charcoal production. The fruits are edible. In Tanzania women drink a root decoction to treat boils on the breasts.
Scolopia theifolia Gilg is a much-branched shrub or small tree up to 15 m tall with bole to 25 cm in diameter, occurring in dry evergreen forest and wooded grassland in southern Sudan, Ethiopia, Kenya, Uganda, Tanzania and northern Malawi. The wood is hard and used for poles and tool handles, and also as firewood and for charcoal production. The fruits are edible. The tree is used for shade. Maasai people of Kenya use a root preparation to treat venereal diseases.

Ecology *Scolopia zeyheri* is found in dry evergreen forest, riverine forest and wooded grassland, up to 2400 m altitude, often open rocky and sandy sites.

Genetic resources and breeding *Scolopia zeyheri* is common in East Africa and South Africa, but rare in southern tropical Africa. There are no indications that it is in danger of genetic erosion.

Prospects The wood of *Scolopia zeyheri*, like that of other *Scolopia* spp., is likely to remain of local importance when hardness and toughnes are more important than workability.

Major references Coates Palgrave, 2002; Heine & Heine, 1988; Ruffo, Birnie & Tengnäs, 2002; Sleumer, 1972b; Sleumer, 1975.

Other references Beentje, 1994; Breebaart, Bhikraj & O'Connor, 2002; Burring, 2005; Campbell & Moll, 1977; Kitula, 2007; Lovett et al., 2007; Neuwinger, 2000; Roux, 2003; Wild, 1960.

Authors L.P.A. Oyen

SCORODOPHLOEUS ZENKERI Harms

Protologue Bot. Jahrb. Syst. 30(1): 78 (1901).

Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

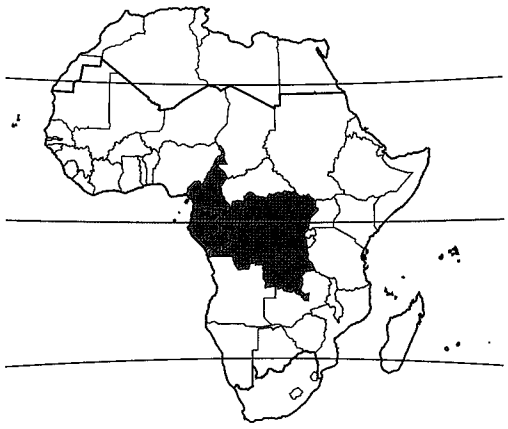
Vernacular names Garlic tree, divida (En). Arbre à ail, divida (Fr).

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

Uses The wood, traded as 'divida', is suitable for poles and piles in construction, flooring, joinery, mine props, ship building, vehicle bodies, furniture, railway sleepers, ladders, agricultural implements and tool handles. In DR Congo it is used for making charcoal.

The wood, bark, young leaves and seeds are locally used as condiments, giving a garlic-like taste to food. The young leaves are eaten as a vegetable after cooking.

In traditional medicine in Gabon, bark infusions are taken for the treatment of constipation. Mixed with chillies and bitter eggplant fruits, they are taken to cure colds and cough. The bark is used in fumigations against rheumatism, and the pounded bark is taken for the treatment of headache. In Congo bark decoctions are drunk, used in vapour baths or sitz baths, or vaginally administered for the treatment of bronchitis and genito-urinary problems and as an aphrodisiac. In DR Congo they are applied in an enema against the complications of measles, whereas decoctions of the bark or leaves are used as an urinary antiseptic and are drunk as anthelmintic. The bark administered as an enema is a purgative, and a maceration of the inner bark is drunk for the same purpose. Bark macerations are also used for wound care, taken for the treatment of an enlarged spleen and used in nasal instillations against headache. Unspecified bark preparations are used for the treatment of hernia.



Scorodophloeus zenkeri – wild

Production and international trade The wood is only used locally and not traded on the international market. The bark and seeds are sold on markets in Cameroon, Equatorial Guinea, Gabon and DR Congo.

Properties The heartwood is yellowish with purplish brown streaks, the sapwood is white. The grain is often irregular or interlocked, texture fine. The wood has an attractive figure. It emits a garlic-like smell.

The wood is heavy, with a density of 765–930 kg/m^3 at 12% moisture content. It has a tendency to distort and check during drying, and mild kiln-drying schedules must be used. The shrinkage rates are high, from green to oven dry 6.0% radial and 10.1–12.0% tangential. Once dry, the wood is unstable in service. At 12% moisture content, the modulus of rupture is 130–199 N/mm^2, modulus of elasticity 13,800–17,100 N/mm^2, compression parallel to grain 59–90 N/mm^2, shear 10.5–15.5 N/mm^2, cleavage 23–26 N/mm and Chalais-Meudon side hardness 6.3–8.0.

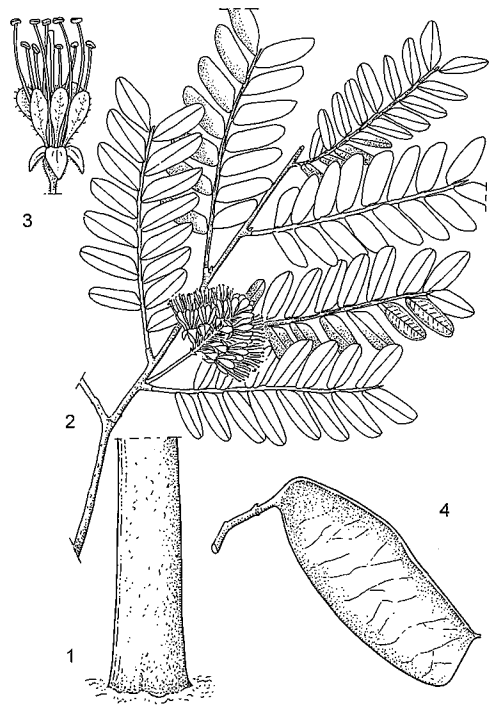
The wood is difficult to work and tends to pick up during planing. It takes a good polish and turns well. It splits easily upon nailing, making pre-boring necessary. It glues satisfactorily. The wood is durable, being resistant to fungal attack but liable to termite attack. The sapwood is susceptible to *Lyctus* attacks.

Wood fibres of a sample from DR Congo were on average (0.70–)1.26(–1.74) mm long and (11–)20(–33) µm wide, with a cell wall thickness of (1–)5(–11.5) µm and a lumen width of (2–)10(–25.5) µm. The wood contains 42–51.5% cellulose, 29–33% lignin, 11–17% pentosan, 0.7–0.8% ash and little silica. The solubility is 1.2–1.6% in alcohol-benzene, 0.9–1.6% in hot water and 12.5–14.7% in a 1% NaOH solution. Pulping experiments gave paper of mediocre quality only.

The garlic-like scent and taste of the bark and other plant parts is due to the presence of sulphur containing compounds. The main constituents of essential oil from the bark are 2,4,5,7-tetrathiaoctane, 2,3,5-trithiahexane, 2,3,4,6-tetrathiaheptane and 2,4,5,6,8-pentathianonane. Essential oil from the bark and several of its constituents have shown activity against various fungi and bacteria. Methanol extracts of the bark and, to a lesser extent, the seeds have

shown anti-oxidant activity. Stem bark extracts have shown in-vitro antiprotozoal activity against *Trypanosoma brucei* and *Leishmania infantum*, without showing cytotoxicity. The powdered stem bark has shown a dose-dependent protective effect against damage to stored beans by the bean beetle *Acanthoscelides obtectus*. Seeds from DR Congo contained 12.1% fat, with as main constituents palmitic acid (49%) and oleic acid (46%).

Description Medium-sized to large tree up to 40 m tall; bole branchless for up to 25 m, straight and cylindrical but sometimes irregular, up to 100 cm in diameter, without buttresses but fluted at base; bark surface initially smooth, later scaly, yellowish grey, inner bark brittle, yellowish; all plant parts, but especially the bark, with a garlic-like scent. Leaves alternate, imparipinnately or paripinnately compound with (3–)5–10 pairs of leaflets; stipules free, linear-lanceolate, caducous; petiole and rachis together up to 10 cm long, grooved, slightly winged; leaflets alternate, sessile, oblong or oblong-lanceolate, 1.5–5.5 cm × 0.5–2.5 cm, base obliquely truncate, apex rounded or obtuse, margins entire, finely hairy below, pinnately veined. Inflorescence an axillary or terminal, dense raceme 5–8 cm long, hairy; bracts linear-lanceolate, 4–5 mm long. Flowers bisexual, nearly regular; pedicel 1–7 mm long, with in the lower half 2 caducous bracteoles 2–3 mm long; sepals 4, free, ovate or oblong, 4–6 mm × 2–3.5 mm, reflexed; petals 5, free, nearly equal, obovate, 7–11 mm × 2–3 mm, hairy at margins, white; stamens 10, free, alternating longer and shorter, 1–2 cm long; ovary superior, ellipsoid, hairy, with distinct stipe, 1-celled, style c. 1 cm long. Fruit an oblong pod 7.5–14 cm × 3–5 cm, flattened, with 0.5–1 cm long stipe, pointed at apex, smooth, brown, dehiscent with 2 curling valves, 1–2-seeded. Seeds ovoid to disk-shaped, c. 2 cm in diameter, flattened, shiny, brown. Seedling with epigeal germination; hypocotyl 1–4 cm long, epicotyl 4–14 cm long, hairy; cotyledons rather thin, green; first 2 leaves alternate with nearly opposite leaflets.



Scorodophloeus zenkeri – 1, base of bole; 2, flowering twig; 3, flower; 4, fruit.
Redrawn and adapted by W. Wessel-Brand

Other botanical information *Scorodophloeus* comprises 3 species, and is restricted to tropical Africa.
Scorodophloeus fischeri (Taub.) J.Léonard (Swahili names: mgodoma, mhande) is a medium-sized tree up to 30 m tall, distributed in coastal forests in Kenya and Tanzania, possibly also in northern Mozambique. Its wood is used for poles in construction, furniture and tool handles. It is also used as firewood. Twigs are used for tying. Root decoctions are taken as anthelmintic. The flowers are visited by honey bees. *Scorodophloeus torrei* Lock is a shrub or small to medium-sized tree up to 20 m tall, endemic to coastal forest and thickets in Mozambique.

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); 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; 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: (76: axial parenchyma diffuse); 78: axial parenchyma scanty paratracheal; 79: axial parenchyma vasicentric; (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; 89: axial parenchyma in marginal or in seemingly marginal bands; 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; 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; 142: prismatic crystals in chambered axial parenchyma cells.
(S. N'Danikou, P.E. Gasson & E.A. Wheeler)

Growth and development Seedling growth is fast. The tree has a deep taproot.

Ecology *Scorodophloeus zenkeri* occurs in mixed evergreen forest on well-drained localities. It does not tolerate waterlogging. It is locally common and sometimes gregarious.

Propagation and planting *Scorodophloeus zenkeri* is easily propagated from seed. Seeds can be sown in nursery beds at a depth of 2–3 cm, in loose and deep soil. Germination is usually rapid, and the germination rate high. Seedlings have been planted out when they were 2–3 years old and 1.5–2 m tall; the use of supports for seedlings has been recommended. Seeds can also be sown directly in the field.

Management In forest near Kisangani in DR Congo, *Scorodophloeus zenkeri* is the most abundant tree species with an average density of 23 trees with a bole diameter of more than 10 cm per ha. In forest in Gabon, a mean wood volume of 0.4 m^3/ha has been reported. In Cameroon trees are protected when forest land is cleared, and the species is sometimes planted in coffee and cacao plantations, for which wildlings or seedlings from nurseries are used. Seedlings can be pruned and lopped to obtain stout boles and straight branches, which will make harvesting of the bark easier.

Harvesting The bark is harvested throughout the year, mainly by women. Staggered removal of bark pieces, for instance every 2–3 years, gives thick bark of good quality. Often, however, too much bark is removed, resulting in the death of the tree.

Handling after harvest Before being used as condiments, the seeds and bark are dried and ground into powder or paste.

Genetic resources Although *Scorodophloeus zenkeri* is locally overexploited, it is currently not considered a threatened species.

Prospects The wood of *Scorodophloeus zenkeri* is heavy, hard and durable, but difficult to work and unstable in service, and very little information is available on its uses. The tree is a popular source of garlic-like condiments, obtained from various plant parts. As the species is locally overexploited, it may be worthwhile to promote its planting. It is considered to have potential for planting in tree plantations as well as in crop fields, because it has a deep root system and its open crown does not give too much shade.

Major references Agbor et al., 2005; Aubréville, 1970; Bolza & Keating, 1972; Dupriez & De Leener, 1989; Eyog Matig et al. (Editors), 2006; Kouokam, Jahns & Becker, 2002; Kouokam, Zapp & Becker, 2001; Sallenave, 1955; Vivien & Faure, 1985; Wilczek et al., 1952.

Other references Allen & Allen, 1981; Beentje, 1994; Brenan, 1967; Burgess & Clarke, 2000; Fouarge, Quoilin & Roosen, 1970; Istas, Raekelboom & Heremans, 1959; Kawukpa & Angoyo, 1994; Konda ku Mbuta et al., 2010; Koona et al., 2007; Lovett et al., 2007; Mukaya et al., 2003; Musuyu Muganza et al., 2012; Neuwinger, 2000; Pakia & Cooke, 2003; Raponda-Walker & Sillans, 1961; Sindani & Ndjele, 1982; Takahashi, 1978; Temu, 1990; Termote, Van Damme & Dhed'a Djailo, 2010; Weiss, 1973.

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

Authors M. Brink

SCOTTELLIA KLAINEANA Pierre

Protologue Bull. Mens. Soc. Linn. Paris, ser. 2, 14: 113 (1899).

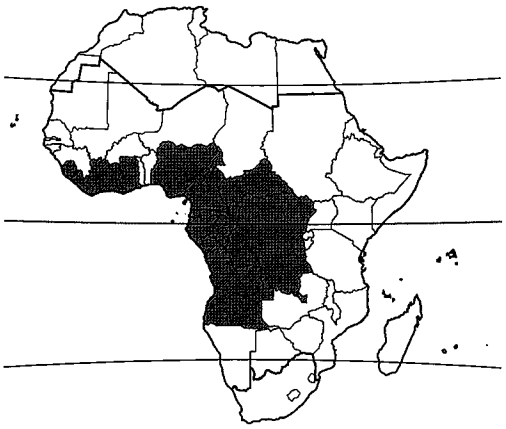
Family Flacourtiaceae (APG: Achariaceae)

Synonyms *Scottellia kamerunensis* Gilg (1908), *Scottellia chevalieri* Chipp (1923), *Scottellia coriacea* A.Chev. ex Hutch. & Dalziel (1927).

Vernacular names Akossika (Fr).

Origin and geographic distribution *Scottellia klaineana* occurs from Sierra Leone east to the Central African Republic and south to DR Congo and northern Angola.

Uses The wood of *Scottellia klaineana*, traded as 'akossika' or 'odoko', is used for posts in house building, light flooring, joinery, interior trim, ladders, sporting goods, toys, novelties, food containers, spoons, ladles, combs, tool handles, draining boards, carving and turnery. It is suitable for furniture, cabinet making, veneer and plywood. It is also used as firewood.



Scottellia klaineana – wild

Roots and bark are used in traditional medicine. Root decoctions are taken as diuretic and purgative, and to treat oedema, and bark decoctions to treat stomach-ache. In Nigeria, the wood ash is used by the Yoruba people in soap making.

Production and international trade The export of 'akossika' wood from Côte d'Ivoire was 58,000 m³ in 2004, 28,000 m³ in 2005 and 16,000 m³ in 2006.

Properties The heartwood is pale yellow to pale yellowish brown, occasionally with darker streaks, and indistinctly demarcated from the up to 10 cm wide sapwood. The grain is usually straight, sometimes interlocked, texture usually fine. Quarter-sawn surfaces show an attractive silver grain figure. The wood is fairly lustrous, odourless and tasteless when dried.

The wood is medium-weight, with a density of 590–750 kg/m³ at 12% moisture content, moderately hard and tough. It air and kiln dries satisfactorily, but is liable to checking, splitting and warping, especially in thick boards. The rates of shrinkage are moderately high, from green to oven dry 4.1–5.4% radial and 9.2–11.6% tangential. During drying, the wood is susceptible to blue stain attack. Once dry, it is moderately stable in service.

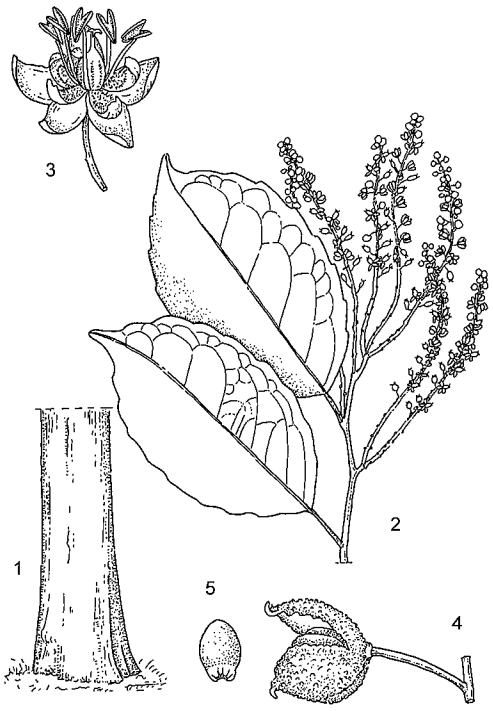
At 12% moisture content, the modulus of rupture is 82–140 N/mm², modulus of elasticity 8000–14,700 N/mm², compression parallel to grain 45–70 N/mm², shear 8–15 N/mm², cleavage 17–25 N/mm, Janka side hardness 4840–7480 N, Janka end hardness 7200–8110 N and Chalais-Meudon side hardness 2.5–4.3.

The wood saws and works well with both machine and hand tools. It takes a good finish and polishes well. It is slightly brittle and quarter-sawn surfaces tend to flake. It has a tendency to split upon nailing; pre-boring is advised. It has good screw-holding properties. The wood paints and varnishes easily. The gluing properties are good. Slicing and peeling should be done with care because the veneer has a tendency to break across. The wood is not durable, being liable to fungal, termite, pinhole borers, *Lyctus* and marine borer attacks. It is permeable to impregnation with preservatives.

Description Evergreen, medium-sized tree up to 30(–35) m tall; bole branchless for up to 20 m, usually straight, up to 100(–130) cm in diameter, slightly fluted at base or with small buttresses; bark surface fairly smooth to slightly scaly, greenish grey to dark brown, inner bark thin, granular, orange brown to reddish brown, rapidly darkening to brown upon exposure, with colourless exudate and almond-like smell; crown often small, narrow and dense; twigs glabrous, with lenticels. Leaves alternate, simple; stipules absent; petiole 0.5–1(–2) cm long, rather slender; blade obovate to obovate-oblong or elliptical, 5–16 cm × 3–9 cm, broadly cuneate at base, usually acuminate at apex, margins entire to wavy or shallowly toothed, leathery, glabrous, pinnately veined with 5–8 pairs of lateral veins. Inflorescence an axillary raceme 4–10 cm long, slightly hairy. Flowers bisexual or male, regular, 5-merous, creamy white, scented; pedicel 3–5(–8) mm long; sepals free, rounded to elliptical, 3–4 mm long; petals oblong-obovate, (4–)5 mm long, hairy at margins, at the base inside with a scale-like hairy appendage; stamens alternating with petals, 3–5 mm long; ovary superior, glabrous, 1-celled, style short, 3-lobed at apex. Fruit a nearly globose capsule (3–)4–8(–9) mm in diameter, finely warty, dehiscing with 3 valves, 1–2(–3)-seeded. Seeds globose-angular, up to 5 mm in diameter, smooth, covered by a thin orange-red aril. Seedling with epigeal germination; hypocotyl 4–5 cm long, epicotyl 0.5–1 cm long, hairy; cotyledons leafy, rounded, 1–2 cm long; first leaves alternate.

Other botanical information *Scottellia* comprises 3 species and is restricted to West and Central Africa. It seems to be related to *Dasylepis*, *Erythrospermum* and *Rawsonia*.

Scottellia leonensis Oliv., a small to medium-sized tree up to 20 m tall with bole up to 30 cm in diameter, occurring in coastal swamp forest and gallery forest from Guinea Bissau east to Liberia, differs from *Scottellia klaineana* in its thicker and often larger leaves with thicker



Scottellia klaineana – 1, base of bole; 2, flowering twig; 3, flower; 4, fruit; 5, seed.
Redrawn and adapted by W. Wessel-Brand

petioles. Its wood is possibly used for similar purposes.

Scottellia orientalis Gilg, a medium-sized to fairly large tree up to 40 m tall with bole diameter up to 100 cm, occurring from Nigeria east to southern Sudan and south to DR Congo, is difficult to distinguish from *Scottellia klaineana*, except by its larger fruits. Its wood is probably used for similar purposes.

Scottellia klaineana is variable, with 2 varieties being distinguished, connected by transitions.

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); 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; 41: mean tangential diameter of vessel lumina 50–100 µm; 42: mean tangential diameter of vessel lumina 100–200 µm; 47: 5–20 vessels per square millimetre; 48: 20–40 vessels per square millimetre. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 62: fibres with distinctly 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. Rays: 98: larger rays commonly 4- to 10-seriate; 102: ray height > 1 mm; 103: rays of two distinct sizes; 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; 110: sheath cells present; 115: 4–12 rays per mm. Mineral inclusions: 136: prismatic crystals present; 137: prismatic crystals in upright and/or square ray cells; (140: prismatic crystals in chambered upright and/or square ray cells); (159: silica bodies present); (160: silica bodies in ray cells). (L.Awoyemi, P.E. Gasson & E.A. Wheeler)

Growth and development The growth is slow. In Côte d'Ivoire an investigation of growth rings showed a mean annual bole diameter growth of 4.5 mm for the first 30 years, 6 mm for trees of 30–80 years old and 5 mm for trees of 80–140 years old. In field trials the mean annual diameter growth was only 2–3 mm.

Although *Scottellia klaineana* is usually evergreen, it is reported to be deciduous for up to 2 months (October–November) in Sierra Leone. In West Africa, flowering has been recorded in February–August and fruits ripen in May–December. In Gabon trees flower in December–January and have ripe fruits in January–April. The seeds with their red arils are probably dispersed by birds, but monkeys also eat the arils.

Ecology *Scottellia klaineana* most commonly occurs in lowland evergreen forest, but can also be found in semi-deciduous forest. It often occurs in small stands along rivers and streams, but may also be common in rocky localities. It is sensitive to forest fires.

Propagation and planting There are about 25,000 seeds per kg. Although seedlings are often common in the understorey close to mother trees, the germination rate of seed has been reported to be low, only 15–25% 8–12 days after sowing. Saplings and young trees are fairly shade tolerant, but older trees are reported to be light demanding. Regeneration is commonly observed in undisturbed forest.

Management *Scottellia klaineana* usually occurs scattered in the forest or in small groups of trees. In forest in western Cameroon, a mean density of 0.15 tree with a bole diameter above 60 cm has been recorded per ha, with an average wood volume of 0.9 m^3/ha. In Côte d'Ivoire 7–27 trees with a bole diameter of more than 10 cm have been recorded per ha. Moderate thinning resulted in better growth of young trees.

Handling after harvest After harvest, logs should be removed rapidly from the forest or treated with preservatives because the wood is susceptible to blue stain attack. Fresh logs float in water and can thus be transported by river.

Genetic resources *Scottellia klaineana* is locally common and in most regions within its distribution area there are no indications of overexploitation. Therefore it is unlikely to be liable to genetic erosion. However, in some regions, e.g. in Côte d'Ivoire, exploitation seems to be considerable and may cause serious pressure on populations of the species.

Prospects Presently, *Scottellia klaineana* has limited importance on the international timber market, but its multipurpose wood may have good prospects for further commercialization. However, information on available stands, growth rates, silviculture and propagation is very limited and much research is still needed to be able to develop sustainable management systems for this poorly known species.

Major references ATIBT, 1986; Bolza & Keating, 1972; Burkill, 1994; CIRAD Forestry Department, 2008; Cooper & Record, 1931; Guiscafre, 1977; Hawthorne, 1995; Oteng-Amoako (Editor), 2006; Savill & Fox, 1967; Sleumer, 1972c.

Other references Aubréville, 1959c; Bamps, 1968; Bertault et al., 1999; Blackett & Gardette, 2008; Chase et al., 2002; de la Mensbruge, 1966; Détienne, 1974; Hawthorne & Gyakari, 2006; Hul, 1995; Irvine, 1961; Keay, 1954b; Keay, 1989; Neuwinger, 2000; Normand & Paquis, 1976; Raponda-Walker & Sillans, 1961; Sallenave, 1955; Takahashi, 1978; Vivien & Faure, 1985; White & Abernethy, 1997; Wilks & Issembé, 2000.

Sources of illustration Aubréville, 1959c; Hul, 1995; Wilks & Issembé, 2000.

Authors A. Addo-Danso

SCYPHOCEPHALIUM MANNII (Benth. & Hook.f.) Warb.

Protologue Notizbl. Königl. Bot. Gart. Berlin 1: 98 (1895).

Family Myristicaceae

Synonyms *Scyphocephalium ochocoa* Warb. (1897).

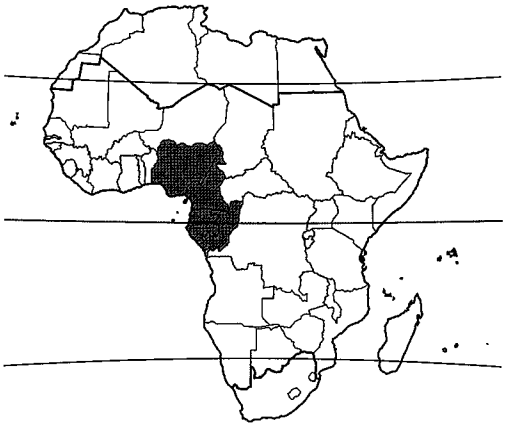
Origin and geographic distribution *Scyphocephalium mannii* occurs from south-eastern Nigeria to Gabon and Congo.

Uses The wood, known as 'sorro' or 'ossoko' in Gabon, is used for interior joinery, furniture, cabinet work, veneer and plywood, and traditionally for canoes. It is suitable for light construction, light flooring, interior trim, toys, novelties and turnery. It is also used as firewood and for charcoal production.

The seeds contain an edible fat, and they are used as condiment or spice in fish dishes and sauces. They are also used as bait in traps for porcupines and squirrels. The bark is used in traditional medicine. Bark decoctions are administered to treat gonorrhoea, sterility in women and cough. The bark is also an ingredient of a preparation to treat convulsions. Dried bark mixed with clay is applied to stop excessive flow of milk.

Production and international trade The wood of *Scyphocephalium mannii* is rarely traded on the international market; it is almost exclusively used locally.

Properties The heartwood is brown to orange-brown towards the centre of the bole, with some greyish streaks, but it has an up to 10 cm wide band of yellowish white or pale greyish brown wood outwards. It is indistinctly demarcated from the narrow sapwood. The



Scyphocephalium mannii – wild

grain is straight, sometimes interlocked, texture moderately coarse. The wood is lustrous, and greasy to the touch. It is lightweight to medium-weight with a density of 460–650(–740) kg/m³ at 12% moisture content. It air dries easily and fast, without serious defects. Boards of 2.5 cm thick take about one month to air dry from 87% to 16% moisture content. The rates of shrinkage are fairly small, from green to oven dry 2.5–4.2% radial and 4.8–7.8% tangential. Once dry, the wood is moderately stable in service.

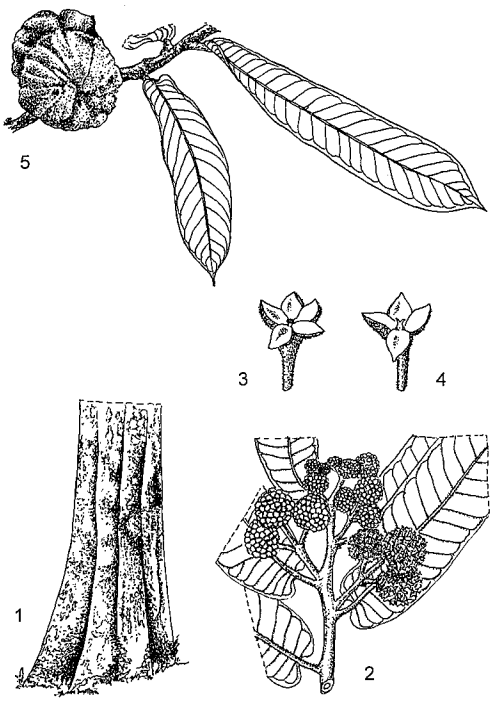
At 12% moisture content, the modulus of rupture is 84–124 N/mm², modulus of elasticity (6660–)9310–14,110 N/mm², compression parallel to grain 29–54 N/mm², shear 4–8 N/mm², cleavage 9–20 N/mm and Chalais-Meudon side hardness (1.4–)2.9–5.8.

The wood is easy to saw and work with both hand and machine tools, with slight blunting effect to saw teeth. It can be planed and sanded to a smooth surface. The nailing and gluing properties are satisfactory. The wood varnishes well, but the heartwood near the centre of the bole may be somewhat difficult to paint. It has good slicing and peeling characteristics, although the logs often have a poor form. The wood is not durable, being susceptible to termite and borer attacks, but the heartwood near the centre of the bole is resistant to dry-wood borers. The heartwood is moderately resistant to impregnation with preservatives, the sapwood is permeable. The wood contains 38–41% cellulose, 33% lignin, 11.5% pentosan, 0.3% ash and 0.1% silica. The solubility is 11.0% in alcohol-benzene, 3.1% in cold water and 21.4% in a 1% NaOH solution.

The aromatic seeds are rich in lipids. Hexane extracts showed the presence of triglycerides in a solid form. Two cyclolignans have been isolated from leaf extracts, one of which (ocholignan A) showed significant in-vitro antibacterial activity against methicillin-resistant *Staphylococcus aureus*.

Adulterations and substitutes The wood resembles that of *Pycnanthus angolensis* (Welw.) Warb. and is used for similar purposes.

Description Evergreen, dioecious, medium-sized to fairly large tree up to 35(–45) m tall; bole branchless for up to 20 m, straight or slightly twisted, up to 140(–300) cm in diameter, often fluted at base or with small buttresses; bark surface scaly with large irregular scales, greyish brown with reddish markings, with lenticels, inner bark slightly fibrous, pinkish, rapidly becoming reddish, with a reddish exudate; crown layered, with horizontal branches; young twigs reddish brown short-hairy. Leaves alternate, simple and entire; stipules absent; petiole c. 1 cm long; blade oblong-lanceolate, 20–25 cm × 4–8 cm, cordate at base, acuminate at apex, thin-leathery, reddish brown short-hairy below but becoming glabrous, pinnately veined with 18–25(–35) pairs of lateral veins. Inflorescence an axillary cyme up to 4(–6) cm long, short-hairy, with flowers in heads, each head with 2 bracts and up to 50(–100)-flowered. Flowers unisexual, regular, up to 5 mm long, reddish, with short pedicel, perianth cup-shaped, 3–5-lobed, reddish brown short-hairy; male flowers with 6–10 fused stamens, filaments merged into a column; female flowers with superior, ovoid, slightly hairy, 1-celled ovary, stigma 2-lobed. Fruit an irregular depressed-globose drupe 2.5–5 cm × 3–6(–7.5) cm, in bunches of up to 4, yellowish to orange when ripe, brown short-hairy, flesh abundant, resinous, dehiscent with 2 valves, 1-seeded. Seed flattened, c. 3 cm in diameter, with entire aril.



Scyphocephalium mannii – 1, base of bole; 2, part of flowering twig; 3, male flower; 4, female flower; 5, part of twig with fruits.
Redrawn and adapted by Iskak Syamsudin

Other botanical information *Scyphocephalium* comprises a single species, possibly 2 because *Scyphocephalium chrysothrix* Warb. has been described based on a single specimen collected over 100 years ago in Cameroon; the latter species seems to have larger fruits.

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; (14: scalariform perforation plates); (15: scalariform perforation plates with ≤ 10 bars); (16: scalariform perforation plates with 10–20 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); (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; 46: ≤ 5 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. Axial parenchyma: 78: axial parenchyma scanty paratracheal; 79: axial parenchyma vasicentric; (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; (100: rays with multiseriate portion(s) as wide as uniseriate portions); 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); 115: 4–12 rays per mm. Mineral inclusions: 159: silica bodies present; 160: silica bodies in ray cells.
(R. Shanda, E. Uetimane, P. Baas & H. Beeckman)

Growth and development In Gabon trees flower mainly in October–December and fruits ripen in January–April. The seeds are occasionally eaten by gorillas.

Ecology *Scyphocephalium mannii* is widespread in lowland rainforest up to 550 m altitude, but is most common in secondary forest. It usually occurs on well-drained soils.

Management In Gabon extensive stands of *Scyphocephalium mannii* have been recorded in evergreen forest, with a estimated standing volume in 1973 of 20–30 million m³. In the 1960s, the average wood volume was estimated at 3.2 m³/ha. In Equatorial Guinea an average density of 1 tree of more than 70 cm in bole diameter per ha has been recorded. In forest in western Cameroon the average density of trees with a bole diameter of more than 60 cm is 0.4 per ha, with an average wood volume of 5.4 m³/ha. The tree can be coppiced.

Harvesting Larger boles may have brittle heart, especially when they are more than 90 cm in diameter, and very large boles are often hollow. In felling, trees with their comparatively lightweight wood may have difficulty to fall when there are lianas in the crown.

Handling after harvest Boles are susceptible to splitting and they should be well supported when they are cross-cut into logs after felling. Logs should be removed from the forest rapidly or treated with preservatives to avoid attacks by fungi and borers. They float in water and thus can be transported by river. Boards and planks should be treated with a fungicide immediately after sawing and before drying.

Genetic resources *Scyphocephalium mannii* is quite widespread in different forest types including secondary forest, and is locally common. There are no indications that it is threatened by genetic erosion.

Prospects Although the wood of *Scyphocephalium mannii* is not considered of premium quality, it has a decorative two-coloured appearance and has good prospects for applications such as panelling and moulding. It may be interesting for further commercialization, providing timber that, although not durable, can be used for various purposes including veneer and plywood production. Its common occurrence in secondary forest formations may imply good prospects for sustainable production in natural forest, but research on growth rates, regeneration and proper management systems are needed. The often more or less fluted bole is a drawback, especially for rotary veneer production.
Further phytochemical and pharmacological investigations of the bark and leaves are recommended to assess the value of their applications in traditional medicine and antibacterial activity. The seed may have commercial importance for the production of edible fat.

Major references Bolza & Keating, 1972; Burkill, 1997; CIRAD Forestry Department, 2008; CTFT, 1971; Fouilloy, 1974; Nziengui, 2001; Sallenave, 1971; Takahashi, 1978; Vivien & Faure, 1985; Yvon, 1973.

Other references Bouquet, 1969; Chudnoff, 1980; de Saint-Aubin, 1963; Fouilloy, 1965; Hu et al., 2005; Keay, 1989; Neuwinger, 2000; Normand & Paquis, 1976; Pambou Tchivounda et al., 1992; Raponda-Walker & Sillans, 1961; Sallenave, 1955; Sallenave, 1964; Senterre & Nguema, 2001; Tailfer, 1989; White & Abernethy, 1997; Wilks & Issembé, 2000.

Sources of illustration Fouilloy, 1965; Tailfer, 1989; White & Abernethy, 1997.

Authors R.H.M.J. Lemmens

SCYTOPETALUM TIEGHEMII (A.Chev.) Hutch. & Dalziel

Protologue Fl. W. trop. Afr. 1: 238 (1927).

Family Scytopetalaceae (APG: Lecythidaceae)

Chromosome number $2n = 22$

Vernacular names Sourwood (En). Moussangoué (Fr).

Origin and geographic distribution *Scytopetalum tieghemii* is restricted to West Africa, where it occurs from Sierra Leone to Ghana.

Uses The wood is used in Sierra Leone and Ghana for poles in house building, and also for telegraph poles. It is suitable for joinery, mine props, ship building, railway sleepers, ladders, sporting goods, agricultural implements, tool handles, veneer and plywood.

The gum from the wood has been used as glue. The fruits are edible. Bark preparations are taken to treat cough, intestinal complaints such as tympanites, and as purgative. Decoctions of the twigs are added to a bath to treat skin diseases including leprosy.

Scytopetalum tieghemii – wild

Production and international trade The wood of *Scytopetalum tieghemii* is only used locally and not traded on the international market.

Properties The heartwood is yellowish to pinkish, turning yellowish brown to greyish brown upon exposure, and indistinctly demarcated from the pinkish sapwood. The grain is straight to interlocked, texture moderately coarse. The wood has little lustre.

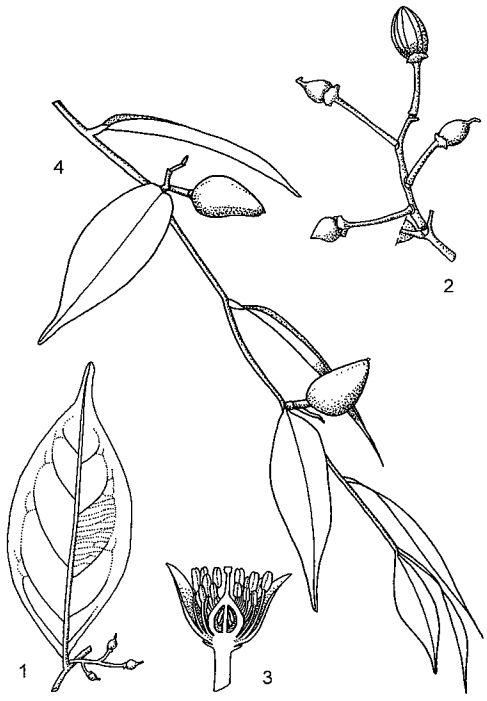
The wood is medium-weight to fairly heavy, with a density of 710–770 kg/m^3 at 12% moisture content, moderately hard but tough and strong. It should be air dried with care to avoid serious checking and end splitting. The rates of shrinkage are high. At 12% moisture content, the modulus of rupture is 123–148 N/mm^2, modulus of elasticity 13,430 N/mm^2, compression parallel to grain 55–59 N/mm^2, cleavage 26.5 N/mm, Janka side hardness 7310 N, Chalais-Meudon side hardness 2.3 and Janka end hardness 7910 N.

The wood is rather difficult to saw and work. It finishes well, but surfaces may be woolly due to the presence of interlocked grain. It holds nails well, but pre-boring is recommended. The wood glues satisfactorily, and is suitable for veneer and plywood production. It is not durable, being liable to fungal and termite attacks. The heartwood is resistant to impregnation with preservatives.

Leafy twigs contain saponosides, tannins and sterols.

Adulterations and substitutes The wood of *Scytopetalum tieghemii* is similar to that of *Oubanguia* spp.

Description Evergreen, small to medium-sized tree up to 25(–40) m tall; bole branchless for up to 15(–20) m, usually straight and cylindrical, up to 60(–100) cm in diameter, sometimes with small buttresses; bark surface scaly, dark grey, inner bark rather thick, spongy-fibrous, pinkish, with unpleasant smell ; crown narrow and dense, with drooping branches; twigs slender, glabrous. Leaves distichously alternate, simple and entire; stipules absent or minute and early caducous; petiole c. 2 mm long; blade elliptical to narrowly elliptical, 4.5–13 cm × 2–4 cm, cuneate at base, distinctly acuminate at apex, papery to thin-leathery, glabrous, pinnately veined with 4–5 pairs of lateral veins, and with numerous very fine, transverse, parallel veinlets. Inflorescence a



Scytopetalum tieghemii – 1, leaf and old inflorescence; 2, inflorescence with old flowers and flower bud; 3, longitudinal section of flower; 4, fruiting twig.
Redrawn and adapted by G.W.E. van den Berg

short axillary raceme, glabrous. Flowers bisexual, regular, whitish, fragrant; pedicel flattened on one side, c. 0.5 cm long, elongating to c. 1.5 cm in fruit; calyx cup-shaped, small, with 2 minute teeth; petals 5–8, slightly unequal, oblong to lanceolate, 5–7.5 mm long; stamens numerous, about as long as petals and fused at base with these; ovary superior, ovoid, usually 6-celled, style short, stigma head-shaped. Fruit an ovoid drupe up to 2 cm × 1 cm, acute with persistent style, red when ripe, 1-seeded. Seeds with ruminate endosperm. Seedling with epigeal germination; hypocotyl 5–6 cm long, epicotyl c. 1 cm long, glabrous; cotyledons leafy, remaining within the fruit stone; first 2 leaves opposite.

Other botanical information The so-called petals of the flower should probably be considered as staminodes, while true petals are lacking.

Scytopetalum comprises 3 species and is restricted to West and Central Africa. The wood of the 2 Central African species is suitable for similar purposes as that of *Scytopetalum tieghemii*.

Scytopetalum klaineanum Pierre is a medium-sized to large tree up to 40 m tall with bole branchless for up to 25 m and up to 100 cm in diameter, occurring from Cameroon south to Cabinda (Angola). Its yellowish white wood is moderately heavy and moderately hard.

Scytopetalum pierreanum (De Wild.) Tiegh. is a small to medium-sized tree up to 30 m tall with bole up to 80 cm in diameter, occurring in Cameroon, Central African Republic, Congo and DR Congo.

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; 25: intervessel pits small (4–7 μm); 26: intervessel pits medium (7–10 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); (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. Tracheids and fibres: 61: fibres with simple to minutely bordered pits; 66: non-septate fibres present; 70: fibres very thick-walled. Axial parenchyma: 77: axial parenchyma diffuse-in-aggregates; 78: axial parenchyma scanty paratracheal; 86: axial parenchyma in narrow bands or lines up to three cells wide; (88: axial parenchyma scalariform); 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); 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.

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

Growth and development *Scytopetalum tieghemii* is classified as a shade bearer. Trees flower in February–April and fruits mature in May–July. The flowers open in the morning and petals and stamens already shrivel and fall in the evening of the same day. The fruits

are eaten by birds such as turacos and hornbills, which are probably the main seed dispersers, but also by monkeys. However, it has also been reported that the fruits fall in quantity to the ground below the mother tree.

Ecology *Scytopetalum tieghemii* occurs in evergreen forest and moist semi-deciduous forest, usually in the middle storey. In Ghana it is reported to prefer acid, base-poor soils.

Propagation and planting There are about 2000 fruit stones per kg, which take 2–5 months for germination. The germination rate is low, 20–25%. Seedlings develop a taproot with short lateral roots.

Management *Scytopetalum tieghemii* occurs locally abundant, e.g. in Liberia and southern Côte d'Ivoire, but is in other regions less common, e.g. in Sierra Leone and Ghana. In forests in western Gabon, the average wood volume of *Scytopetalum klaineanum* is 4 m^3 per ha.

Handling after harvest Freshly felled logs should be removed from the forest rapidly or be treated with preservatives because the wood is susceptible to blue-stain fungal attack.

Genetic resources *Scytopetalum tieghemii* is fairly widespread in West Africa, locally common and currently not heavily exploited. Therefore, there are no reasons to consider it liable to genetic erosion.

Prospects In regions where it occurs abundantly, *Scytopetalum tieghemii* has been considered promising as commercial timber producer for special applications such as construction work where durability is not required. Locally in Gabon *Scytopetalum klaineanum* occurs in fair densities and may be of interest for commercial exploitation. However, data on growth rates and regeneration are needed to assess the possibilities for sustainable commercial production.

Major references Appel, 1996; Aubréville, 1959a; Bolza & Keating, 1972; Burkill, 2000; Cooper & Record, 1931; de la Mensbruge, 1966; Hawthorne & Jongkind, 2006; Kryn & Fobes, 1959; Takahashi, 1978; Taylor, 1960.

Other references Adjanohoun & Aké Assi, 1979; Bouquet & Debray, 1974; Breteler, 2002; Breteler, 2005; de Saint-Aubin, 1963; Germain, 1963; Hawthorne, 1995; Irvine, 1961; Keay, 1958k; Letouzey, 1978a; Letouzey, 1978b; Neuwinger, 2000; Normand, 1955; Normand & Paquis, 1976; Sallenave, 1955; Savill & Fox, 1967; Vivien & Faure, 1985.

Sources of illustration Appel, 1996; Aubréville, 1959a; Hawthorne & Jongkind, 2006.

Authors R.H.M.J. Lemmens

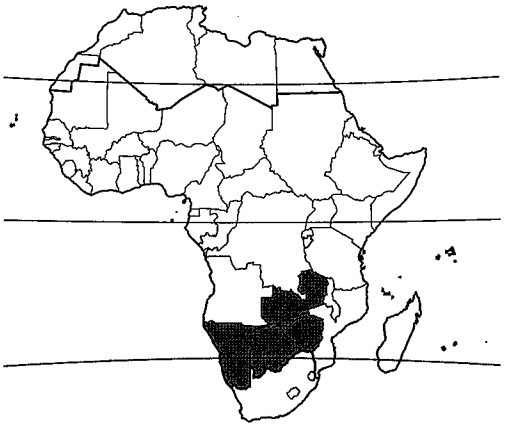
SEARSIA LANCEA (L.f.) F.A.Barkley

Protologue Lundell, Fl. Texas 3: 104 (1943).
Family Anacardiaceae
Chromosome number $2n = 30$
Synonyms *Rhus lancea* L.f. (1781).
Vernacular names Karee, African sumac, willow rhus (En).

Origin and geographic distribution *Searsia lancea* is indigenous in Zambia, Namibia, Botswana, Zimbabwe, South Africa and Lesotho. It is planted in hedges and as ornamental tree, e.g. in South Africa, but also in desert regions of the United States and Mexico, where it is locally naturalized.

Uses The tree boles are considered valuable as fence poles, and the wood is used for implement handles and wagon parts. Branches have been used for bows and for spars in hut building. Young twigs are occasionally used for basketry. The fruits are edible; they are pounded with water and produce a beer after fermentation, and they are also used to produce curdled milk. *Searsia lancea* is commonly planted in hedges, as an ornamental tree in gardens and parks, as a roadside tree and in live fences and wind breaks. Roots, leaves and stem bark are used to treat skin diseases. A root infusion is taken to treat abdominal and chest complaints and diarrhoea, and the roots are chewed against stomach-ache. Leaf decoctions or infusions are taken to treat measles and pustules, whereas leaf vapours are inhaled to cure cough. The bark and wood have been used for tanning, and the bark gives a brown dye. The leaves are browsed by livestock, especially in the dry season.

Properties The wood is reddish brown, with



Searsia lancea – wild

a fine texture, and it is hard, tough and durable. It is heavy, with a density of 890–970 kg/m^3 at 10% moisture content. The rates of shrinkage are moderate, from green to oven dry about 3.1% radial and 7.2% tangential. The wood works well and takes a nice polish. It has a sweetish and spicy smell.

Bark extracts showed in-vitro antibacterial activity against a wide range of gram-positive and gram-negative bacteria. Leaves yield 0.2% of essential oil, with α-pinene, benzene and δ-3-carene as main constituents. The oil showed remarkable anti-oxidant activity and dose-dependent antibacterial and antifungal activities. These activities may be associated with the high concentration of α-pinene in the oil (87%). The flavour of cattle milk is affected when large quantities of *Searsia lancea* leaves are browsed.

Botany Evergreen, dioecious shrub or small tree up to 9(–12) m tall, glabrous; bole often twisted and crooked; bark surface dark grey to dark brown, rough, often irregularly fissured; twigs reddish brown, angular or slightly grooved, pendulous. Leaves arranged spirally, 3-foliolate; stipules absent; petiole 2–7 cm long, slender but slightly winged near apex, grooved above; leaflets sessile, narrowly lanceolate, often slightly sickle-shaped, 7–24.5 cm × 0.5–3 cm, cuneate at base, acute at apex, margins entire, thinly leathery, pinnately veined with numerous lateral veins. Inflorescence an axillary or terminal, much-branched panicle up to 9 cm long, lax. Flowers unisexual, regular, usually 5-merous, greenish yellow; pedicel 2–3 mm long; calyx segments c. 0.5 mm long, obtuse; petals free, oblong, c. 1.5 mm long; stamens usually 5, free; disk cup-shaped; ovary superior, globose, 1-celled, styles 3, thick, recurved; male flowers without ovary or with strongly rudimentary ovary, female flowers with rudimentary stamens. Fruit a depressed-globose drupe 4–6.5 mm in diameter, often slightly asymmetric, dull yellow to greyish or brown, with fleshy pulp.

Searsia lancea grows fairly fast, up to 80 cm/year in height for young trees. It flowers from April to September(–January) and ripe fruits can be found from September to February. The flowers have a sweet smell and are visited by insects such as bees, which serve as pollinators. The fruits are eaten by birds such as guinea-fowl, francolins and bulbuls, which are probably the main seed dispersers.

Searsia comprises approximately 110 species and occurs in southern Europe, Asia and Africa. Southern Africa is by far richest in species. Until recently, most authors did not separate *Searsia* from *Rhus*, although the separation has already been proposed at the beginning of the 1940s. Recent phylogenetic research using DNA and gene spacer data confirmed that *Searsia* is distinct from *Rhus* sensu stricto, which is limited to the Northern Hemisphere.

Several other *Searsia* spp. produce wood that is used for similar purposes as that of *Searsia lancea*. The wood of *Searsia glutinosa* (Hochst. ex A.Rich.) Moffett (synonyms: *Rhus abyssinica* Oliv., *Rhus glutinosa* Hochst. ex A.Rich.), a shrub or small tree up to 10 m tall from Sudan, Eritrea and Ethiopia, is used for agricultural implements and tool handles, and as firewood. The leaves are used in traditional medicine to treat influenza, the roots in veterinary medicine to treat udder complaints. They have been used for tanning.

The reddish, hard and tough wood of *Searsia gueinzii* (Sond.) F.A.Barkley (synonym: *Rhus gueinzii* Sond.), a shrub or small tree up to 8 m tall occurring in Zimbabwe, southern Mozambique and eastern South Africa, is used for wall laths in house building. Branches are used to treat eye complaints; they are made into a lotion, or smoke from burning twigs is applied to the eyes. A root infusion is taken to treat schistosomiasis and a leaf decoction against gall sickness.

The stems of *Searsia lucida* (L.) F.A.Barkley (synonym: *Rhus lucida* L.), a shrub or small tree up to 7 m tall from Zimbabwe and South Africa, are valued for fence posts. The bark has been used for tanning. Ground bark is applied to ring worm infections.

The stems of *Searsia pendulina* (Jacq.) Moffett (synonyms: *Rhus pendulina* Jacq., *Rhus viminalis* auct. non Aiton nec Vahl), a small tree up to 10 m tall occurring in Namibia and South Africa, are used as fence posts and in hut building, whereas the twigs are used for fish traps. The bark yields a reddish brown dye. The fruits are edible and have been used in beer making. *Searsia pendulina* is planted as ornamental tree.

The wood of *Searsia retinorrhoea* (Steud. ex Oliv.) Moffett (synonym: *Rhus retinorrhoea* Steud. ex Oliv.), a shrub or small tree up to 6 m tall from Sudan, Eritrea, Ethiopia, Somalia and Arabia, is used for agricultural implements and walking sticks, and as firewood. The leaves serve for local mattresses. Several flavonoids have been isolated from the leaves, some of which showed weak antibacterial and

antimalarial activities in vitro.

Ecology *Searsia lancea* occurs in grassland and open woodland, often on river banks and termite mounds. It is considered as an indicator of underground water. It seems to prefer soils rich in lime. Once established, the tree is drought and frost tolerant.

Management *Searsia lancea* is easy to propagate by seed, cuttings, truncheons and air layering. Ripe seeds should be sown in seedling trays and can be transplanted in containers when the seedlings have 2 leaves. Cuttings taken from young shoots often root successfully.

The tree boles are often crooked, and straight pieces of wood of fair length are usually difficult to obtain. Moreover, the bole of older trees is reportedly often hollow. A disease, causing leaves at the extremities of young branches to become deformed, has been recorded from the central highlands of Namibia. In South Africa the fungus *Muribasidiospora indica* was identified as the causal organism associated with leaf spots, a serious disease in several *Anacardiaceae*.

The fruits are usually rubbed between the hand palms to remove the tough skin before they are being eaten, or are soaked in milk.

Genetic resources and breeding *Searsia lancea* is widespread and locally common, and is not threatened by genetic erosion.

Prospects The boles of *Searsia lancea* and other *Searsia* spp. are too small and poorly shaped to yield timber of sufficient dimensions and quality for the international market, but locally the wood will continue to be valued for e.g. fences and implements. The tree has considerable ornamental value, and has a non-aggressive root system and provides shade throughout the year with its evergreen, wide-spreading crown. The pharmacological properties of the leaf oil deserve more attention.

Major references Gundidza et al., 2008; Moffett, 1993; Palmer & Pitman, 1972–1974; Stern, 2002; van Wyk & Gericke, 2000.

Other references Bekele-Tesemma, 2007; Coates Palgrave, 1983; Crous, Groenewald & Carroll, 2003; Fernandes & Fernandes, 1966; Moffett, 2007; Neuwinger, 2000; Obi et al., 2003; van Vuuren, Banks & Stohr, 1978.

Authors R.H.M.J. Lemmens

SENNA LACTEA (Vatke) Du Puy

Protologue Kew Bull. 50(3): 581 (1995).

Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

Synonyms *Cassia lactea* Vatke (1880).

Origin and geographic distribution *Senna lactea* is endemic to northern Madagascar, south to Mananara.

Uses The wood is used for furniture, and also as firewood and for charcoal production. *Senna lactea* is planted as a shade tree in coffee plantations.

Properties The wood is reportedly yellowish and strong.

Botany Deciduous small to medium-sized tree up to 30 m tall; bole up to 150 cm in diameter; bark surface grey, often mottled; twigs short-hairy. Leaves alternate, paripinnately compound with (11–)15–22(–25) pairs of leaflets; stipules awl-shaped, 5–7 mm long, early caducous; petiole 2.5–4 cm long, rachis up to 30 cm long, grooved; petiolules 2–3 mm long; leaflets opposite to alternate, oblong, 2–5.5 cm × 0.5–1.5 cm, rounded to notched at apex, glabrous or sparsely hairy, pinnately veined. Inflorescence a terminal or axillary raceme 5–12 cm long, often combined into a lax panicle at ends of shoots, short-hairy. Flowers bisexual, slightly zygomorphic, 5-merous; pedicel 12–18 mm long; sepals free, unequal, 3–8 mm long, reflexed, tinged red; petals free, nearly equal, oblong-elliptical, 10–11 mm long, white, sometimes tinged pink; stamens 10 of which 7 fertile and up to 9 mm long, 3 rudimentary and up 5 mm long; ovary superior, 6–7 mm long, style 5–6 mm long, curved. Fruit a strap-shaped, flat pod 16–20 cm × 3–4 cm, with transverse lines

Senna lactea – wild

between the seeds, glabrous, reddish brown to blackish, dehiscing with 2 thin valves remaining fused at one margin, up to 22-seeded. Seeds oblong, flat, c. 1 cm × 0.5 cm, smooth, brown. *Senna lactea* can be found flowering from April to August.

Until the early 1980s, *Cassia* was considered a very large genus of about 550 species, but was then split into 3 genera: *Cassia* s.s. with about 30 species, *Chamaecrista* with about 250 species and *Senna* with about 270 species. *Senna* is very similar to *Cassia*, but is distinguished from it by the possession of 3 adaxial stamens which are short and straight, and the pedicels which have no bracteoles.

Madagascar has 9 endemic *Senna* species. Additional to *Senna lactea*, some of these have documented uses of their wood. *Senna meridionalis* (R.Vig.) Du Puy is a shrub or small tree up to 5 m tall restricted to south-western Madagascar. The branches are used as poles in building local houses. *Senna viguierella* (Ghesq.) Du Puy is a shrub or small tree up to 8 m tall occurring in southern Madagascar. Its wood is also used in house construction.

Senna siamea (Lam.) H.S.Irwin & Barneby, a small to medium-sized tree up to 20 m tall originating from tropical Asia, is planted in western Madagascar and also in mainland tropical Africa. Although it is most commonly used for firewood and as ornamental, it is sometimes also planted for poles because of its durable wood.

Ecology *Senna lactea* occurs in humid evergreen forest from sea-level up to 1600 m altitude, often along rivers, but it can also be found in degraded vegetation.

Genetic resources and breeding Alhough *Senna lactea* has a comparatively small area of distribution, it has not been reported to be endangered. It has been recorded as locally common as an adventive in degraded vegetation and thus may survive in areas subject to forest degradation caused by human intervention.

Prospects Too little is known about *Senna lactea* to judge its prospects as a timber tree of more commercial importance. It may have possibilities as an auxiliary plant and may be interesting for planting in agroforestry systems. However, much research is still needed, e.g. on wood properties, growth rates and propagation.

Major references du Puy et al., 2002.

Other references Capuron, 1968.

Authors R.H.M.J. Lemmens

SINDORA KLAINEANA Pierre ex Pellegr.

Protologue Bull. Mus. natn. Hist. nat., Paris 25: 653 (1919).

Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

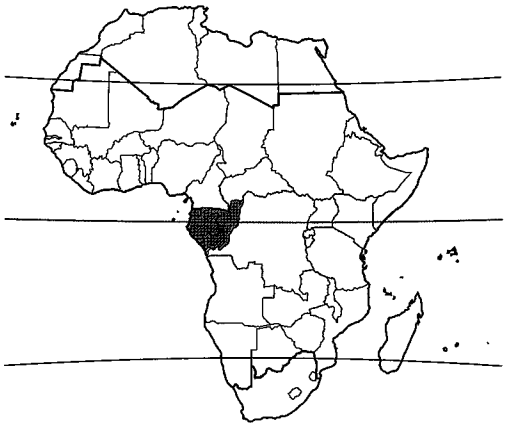
Origin and geographic distribution *Sindora klaineana* has a small distribution area, restricted to western Equatorial Guinea, western Gabon and south-western Congo.

Vernacular names Banda rouge (Fr).

Uses In Gabon the wood, known as 'n'gomé' or 'ngom', is used for joinery and that of the buttresses for implements. It is suitable for light construction, interior trim, furniture, boxes, crates, draining boards, veneer, plywood, hardboard and particle board.

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

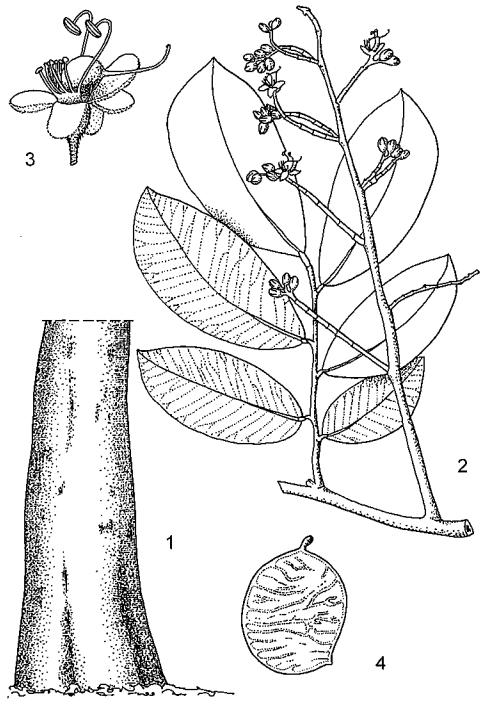
Properties The heartwood is pinkish brown to pinkish grey, darkening upon exposure with a coppery tinge, and indistinctly demarcated from a pale reddish intermediate zone, which is more distinctly demarcated from the whitish yellow sapwood. The grain is variable, texture medium. Wood surfaces show a decorative figure of dark and pale stripes. The wood contains a resinous exudate becoming dark upon drying. It is medium-weight, with a density of 610–690 kg/m^3 at 12% moisture content, and moderately hard. It air dries slowly but well, with little tendency to splitting and distortion. The rates of shrinkage are moderate. Once dry, the wood is moderately stable in service. At 12% moisture content, the modulus of rupture is 103–128 N/mm^2, compression parallel to grain 46–49 N/mm^2, cleavage 12 N/mm and Chalais-



Sindora klaineana – wild

Meudon side hardness 3.0–3.3.
The wood saws and works well with both hand and machine tools, with little blunting effect on saw teeth and cutting edges. It usually produces a nice finish except when interlocked grain is present. The resin in the wood may interfere with gluing, polishing and painting. The nailing and screwing properties are good, with satisfactory holding power. The wood peels well, producing good-quality veneer. The heartwood is fairly durable, but slightly susceptible to termite attack, whereas the sapwood is liable to *Lyctus* attack. The heartwood is resistant to impregnation with preservatives, the sapwood moderately resistant.

Description Medium-sized to large tree up to 40(–45) m tall; bole branchless for up to 30 m, straight and cylindrical, up to 130(–200) cm in diameter, without buttresses but slightly thickened at base; bark surface fairly smooth but finely fissured, greenish grey, inner bark moderately thick, fibrous, pinkish brown, with some transparent sticky exudate; twigs short-hairy, becoming glabrous. Leaves alternate, imparipinnately compound with 6–10 leaflets; stipules absent or early caducous; petiole and rachis together 6–14 cm long; petiolules c. 0.5 cm long; leaflets alternate, oblong to elliptical, 5–9 cm × 3–4 cm, usually rounded at base, obtuse to acute at apex, leathery, glabrous, with many translucent dots, pinnately veined with many lateral veins, midrib below with gland at distal end. Inflorescence an axillary or terminal panicle up to 20 cm long with branches up to 10 cm long, densely yellowish brown short-hairy. Flowers bisexual, zygomorphic, yellowish white; pedicel c. 2.5 mm long; sepals 4, fused at base, oblong-lanceolate, unequal, c. 8 mm long, one larger than other 3, brown short-hairy outside; petal 1, elliptical, c. 6 mm × 4 mm, brown hairy outside, often 4 additional minute petals present; stamens 2, with 8 rudimentary stamens, all fused but 1 rudimentary stamen free; ovary superior, obliquely ovoid, slightly hairy, with short stipe, style slender, glabrous. Fruit a flattened nearly round pod 5–7 cm in diameter, glabrous, transversely veined, dehiscing with 2 woody valves, with short stipe, 1(–2)-seeded. Seeds flattened ovoid, c. 4 cm × 3 cm, glossy black. Seedling with epigeal germination; hypocotyl 11–13 cm long, epicotyl 11–15.5 cm long, finely hairy; cotyledons fleshy and thick; first leaves alternate, with 2–4 leaflets.



Sindora klaineana – 1, base of bole; 2, part of flowering twig ; 3, flower; 4, fruit.
Redrawn and adapted by G.W.E. van den Berg

Other botanical information *Sindora* comprises about 20 species, which are all found in tropical Asia except *Sindora klaineana*. *Sindora* timber from tropical Asia, traded as 'sepetir', is important on the international market. *Sindora* is related to *Sindoropsis* and *Tessmannia*, which differ in having 1 petal and 10 fertile stamens, and 5 petals and 10 fertile stamens, respectively.

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; 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; (68: fibres very thin-walled); 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: 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. Secretory elements and cambial variants: 129: axial canals diffuse; 131: intercellular canals of traumatic origin. Mineral inclusions: 136: prismatic crystals present; 142: prismatic crystals in chambered axial parenchyma cells.
(E.K. Achi, S. N'Danikou, P.E. Gasson & P. Baas)

Ecology *Sindora klaineana* occurs in lowland rainforest near the coast and along mangroves, sometimes at the edge of small natural savanna areas, up to 100 m altitude.

Harvesting The minimum bole diameter allowed for harvesting in Gabon is 70 cm. The resin present in the wood may cause difficulties in sawing by gumming-up saw teeth.

Genetic resources *Sindora klaineana* has a small area of distribution and is there not common, which makes it easily liable to genetic erosion.

Prospects *Sindora klaineana* provides a general-purpose timber of fair quality, with as only drawback the presence of resin. However, the amounts available are too limited to have prospects for commercial exploitation, and research could better focus on protection of this species, which is so strangely isolated from other species of the genus.

Major references Anonymous, 1957b; Aubréville, 1968; Bolza & Keating, 1972; de Saint-Aubin, 1963; Léonard, 1994; Normand & Paquis, 1976; Raponda-Walker & Sillans, 1961; Sallenave, 1955; Takahashi, 1978; Tucker, 2003.

Other references Aubréville, 1970; Sambas et al., 1993; Tailfer, 1989.

Sources of illustration Aubréville, 1968; de Saint-Aubin, 1963.

Authors R.H.M.J. Lemmens

SINDOROPSIS LE-TESTUI (Pellegr.) J.Léonard

Protologue Mém. Acad. Roy. Belg., Cl. Sci. sér. 2, 30(2): 82 (1957).

Family Caesalpiniaceae (Leguminosae - Caesalpinioideae)

Synonyms *Copaifera le-testui* (Pellegr.) Pellegr. (1947).

Origin and geographic distribution *Sindoropsis le-testui* has a small distribution area, restricted to Equatorial Guinea and Gabon.

Uses The wood, known as 'ghéombi', is suitable for construction, flooring, joinery, interior trim, mine props, ship building, vehicle bodies, furniture, toys, novelties, boxes, crates, veneer and plywood.
Bark decoctions are used in traditional medicine; they are applied as enema to treat intestinal complaints and externally to treat headache and as stimulant, whereas they are administered orally as anthelmintic. Pulverized bark is rubbed in to treat scabies. Bark extracts have been used to dye *Raphia* fibres blackish. The seed oil is applied as skin care product and perfume.

Production and international trade The wood is traded on the international timber market in small amounts. In 1997 Gabon exported nearly 4000 m³ of logs, but in 1999 the amount had declined to about 500 m³ and to 100 m³ in 2001. However, it increased again to 2750 m³ in 2005.

Properties The heartwood is pinkish brown to reddish brown, darkening upon exposure with a coppery shine and slightly darker streaks, and distinctly demarcated from the whitish, 8–10 cm wide sapwood turning greyish to brown upon drying. The grain is straight

Sindoropsis le-testui – wild

to slightly interlocked, texture medium to coarse and even. The wood contains a resinous exudate. It is medium-weight to fairly heavy, with a density of 630–810 kg/m³ at 12% moisture content, and fairly hard. It air dries quite well but slowly, with some tendency of distortion and checking. Air drying to 15–20% moisture content is recommended before kiln drying, especially for thin boards. The rates of shrinkage are moderate, from green to oven dry 3.0–4.8% radial and 5.5–9.0% tangential. Once dry, the wood is moderately stable to unstable in service. At 12% moisture content, the modulus of rupture is 115–201 N/mm², modulus of elasticity 10,700–20,200 N/mm², compression parallel to grain 55–70 N/mm², shear 7.5–12.5 N/mm², cleavage 13–24 N/mm and Chalais-Meudon side hardness 4.5–8.8.

The wood saws and works well with both hand and machine tools, but with some blunting effect on saw teeth and cutting edges; stellite-tipped saw teeth and tungsten-carbide cutting edges are recommended. Clogging of saw blades and tools may occur due to the presence of resin. The wood planes to a smooth finish except when interlocked grain is present. The nailing and screwing properties are good, with satisfactory holding power. The resin in the wood may interfere with polishing and painting. The wood glues well. The peeling and slicing characteristics are satisfactory after steaming. The heartwood is moderately durable, being moderately resistant to fungal, termite, borer and marine borer attacks. The sapwood is liable to *Lyctus* attack. The heartwood is moderately resistant to impregnation with preservatives, the sapwood is permeable.

The resin has been reported to be very inflammable.

Botany Medium-sized to very large tree up to 60 m tall; bole branchless for up to 30 m, straight and cylindrical, up to 130(–200) cm in diameter, thickened at base or with rounded buttresses; bark surface fairly smooth but finely fissured, dark grey, inner bark moderately thick, fibrous, reddish brown, with some dark resinous exudate; twigs short-hairy, becoming glabrous. Leaves alternate, imparipinnately compound with 6–11 leaflets; stipules absent or early caducous; petiole and rachis together 8–10 cm long; petiolules c. 0.5 cm long; leaflets alternate, oblong to ovate or elliptical, 4–6 cm × 2–3 cm, usually rounded at base, short-acuminate at apex, leathery, glabrous, with many translucent dots, pinnately veined with many lateral veins, with a gland near attachment of petiolule and another gland at distal end of midrib below. Inflorescence an axillary raceme up to 10 cm long, densely yellowish brown short-hairy. Flowers bisexual, zygomorphic, white; pedicel 5–7 mm long, jointed at base; sepals 4, oblong-lanceolate, unequal, 5–7 mm long, one slightly shorter than other 3, short-hairy; petal 1, elliptical, up to 5 mm long, glabrous; stamens 10, all fused but 1 free, up to 1 cm long but alternately long and short; ovary superior, obliquely ovoid, hairy at margins, with short stipe, style slender, glabrous. Fruit a flattened oblong to lanceolate pod 7–10 cm long, distinctly pointed at apex, glabrous, smooth, dehiscing with 2 thin-leathery valves, with short stipe, 1–2-seeded. Seeds flattened oblong, glossy black. Seedling with epigeal germination; hypocotyl 8–10 cm long, epicotyl 4–5 cm long, finely hairy; first 2 leaves opposite, with 4 leaflets.

Trees flower at the end of the dry season and fruits ripen around January, when they split open suddenly dispersing the seeds over short distances.

Sindoropsis comprises a single species. It is related to *Sindora* and *Tessmannia*, which differ in having 1 petal and 2 fertile stamens, and 5 petals and 10 fertile stamens, respectively.

Ecology *Sindoropsis le-testui* occurs in lowland rainforest up to 700 m altitude, often scattered but sometimes locally abundant in primary forest.

Management The minimum bole diameter allowed for harvesting in Gabon is 70 cm. Freshly felled logs should not be left in the forest too long or treated with preservatives because they are susceptible to fungal and insect attacks. They do not float in water and thus cannot be transported by river. The greenish resin present in the wood may cause difficulties in sawing by gumming-up saw teeth.

Genetic resources and breeding *Sindoropsis le-testui* has a small area of distribution mainly in undisturbed forest, which makes it easily liable to genetic erosion. Monitoring of stands is recommended.

Prospects *Sindoropsis le-testui* provides a general-purpose timber of fair quality, with as drawback the presence of resin. However, the amounts available in its small distribution area are probably too limited to have prospects for more extensive commercial exploitation. Knowledge on growth rates and regeneration are lacking.

Major references Aubréville, 1968; Bolza &

Keating, 1972; CIRAD Forestry Department, 2008; de Saint-Aubin, 1963; Sallenave, 1955.

Other references Aubréville, 1970; Christy et al., 2003; Maisonneuve & Manfredini (Editors), 1988c; Neuwinger, 2000; Normand & Paquis, 1976; Raponda-Walker & Sillans, 1961; Sallenave, 1971; Tailfer, 1989; Takahashi, 1978; White & Abernethy, 1997.

Authors R.H.M.J. Lemmens

SLOANEA RHODANTHA (Baker) Capuron

Protologue Adansonia, ser. 2, 12(3): 386 (1972).

Family Elaeocarpaceae

Synonyms *Elaeocarpus rhodanthus* Baker (1883), *Elaeocarpus quadrilobus* Jum. & H.Perrier (1916).

Origin and geographic distribution *Sloanea rhodantha* is endemic to Madagascar, where it is widespread in the central and eastern parts of the island.

Uses The wood, known as 'voanana', is traditionally used for construction and planks in house construction, for joinery and furniture. Kitchen utensils such as plates, boles and spoons are produced from the buttresses, whereas the bole is used to make dug-out canoes. The wood is suitable for panelling, ceiling, lathing, poles, piles, interior trim, agricultural implements, containers, matches, turnery, veneer, plywood and particle board. Wood pulp is used for paper making and the wood for charcoal production. The fruits are used in ritual ceremonies.

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

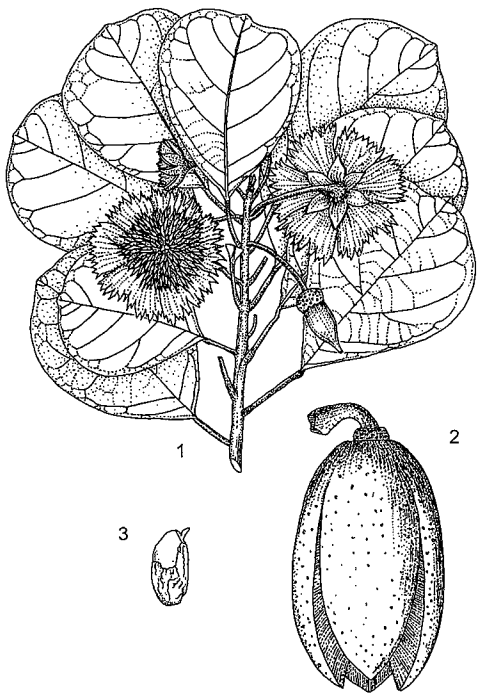
Sloanea rhodantha – *wild*

Properties The heartwood is purplish red to purplish brown and distinctly demarcated from the 5–10 cm wide, yellowish white sapwood. The grain is variable but often wavy to interlocked, texture medium to coarse. The wood is medium-weight, with a density of 520–690 kg/m^3 at 12% moisture content. The rates of shrinkage are rather high, from green to oven dry 2.8–4.0% radial and 7.0–10.2% tangential. Partial air drying before kiln drying is recommended. At 12% moisture content, the modulus of rupture is 108–137 N/mm^2, modulus of elasticity 8600–10,980 N/mm^2, compression parallel to grain (37–)46–54 N/mm^2, shear 4–6 N/mm^2, cleavage 13–17 N/mm and Chalais-Meudon side hardness 1.9–3.4.

The wood saws and works easily with both hand and machine tools, but in planing the presence of interlocked grain may be problematic. The bending properties are good. The wood is not durable, being susceptible to fungal and insect attacks. The sapwood is liable to blue stain attack and to *Lyctus* borers.

Root bark extracts showed weak inhibitory activity against strains of *Plasmodium falciparum*. Several phenolic compounds have been isolated as active compounds.

Description Medium-sized to large tree up to 40 m tall; bole branchless for up to 20 m, up to 120(–200) cm in diameter, with rather thin and spreading buttresses up to 2 m high; twigs glabrous to short-hairy. Leaves arranged spirally, more or less clustered near apex of twigs, simple; stipules minute, peg-like to linear, caducous; petiole 0.5–3.5(–6) cm long, usually jointed at apex; blade obovate, 3.5–15(–18) cm × 1.5–9.5(–11) cm, cuneate to rounded at base, obtuse to rounded or short-acuminate at apex, margins entire to slightly toothed, papery to leathery, glabrous to slightly hairy, pinnately veined with 3–7 pairs of lateral veins. Flowers solitary in leaf axils of twigs, pendant, bisexual, regular, 4–6(–8)-merous, large and showy; pedicel 2–4.5 cm long; sepals free, triangular, 0.5–1 cm long, hairy; petals free or variably fused, 1.5–3 cm long, irregularly lobed or toothed at apex, dark pink to red; stamens numerous, 0.5–1 cm long, yellow; disk c. 1 cm in diameter, flat, hairy; ovary superior, conical, c. 0.5 cm long, hairy, (3–)4–5-celled, with a narrowly conical style up to 1 cm long. Fruit an ovoid-oblong capsule 6–11 cm × 3–7 cm, smooth but with numerous small whitish lenticels, brown, with cushion-shaped persistent disk at base, dehiscent with (3–)4–5 woody valves,



Sloanea rhodantha – 1, flowering twig; 2, dehisced fruit; 3, seed.
Redrawn and adapted by J.M. de Vries

each cell with 1–10 seeds. Seeds oblong, c. 1 cm long, black, with fleshy, irregularly lobed, orange-red aril.

Other botanical information *Sloanea* comprises about 100 species and occurs in all tropical and subtropical regions except mainland Africa. Only *Sloanea rhodantha* is found in Madagascar.

Sloanea rhodantha is variable, particularly in leaf size and shape, in hairiness of the leaves, in shape of petals and in number of stamens. Two varieties have been distinguished; var. *rhodantha* has glabrous leaves below, var. *dalechampioides* (Baker) Capuron short-hairy.

Anatomy Wood-anatomical description (IAWA hardwood codes):

Growth rings: 1: growth ring boundaries distinct. Vessels: 5: wood diffuse-porous; 13: simple perforation plates; 21: intervessel pits opposite; 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; 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: 75: axial parenchyma absent or extremely rare; 89: axial parenchyma in marginal or in seemingly marginal bands; 92: four (3–4) cells per parenchyma strand. Rays: 98: larger rays commonly 4- to 10-seriate; 102: ray height > 1 mm; 103: rays of two distinct sizes; 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); 115: 4–12 rays per mm. Secretory elements and cambial variants: 131: intercellular canals of traumatic origin. Mineral inclusions: 136: prismatic crystals present; 137: prismatic crystals in upright and/or square ray cells; 154: more than one crystal of about the same size per cell or chamber.
(E.A. Obeng, P.E. Gasson & E.A. Wheeler)

Growth and development Trees flower from October to March.

Ecology *Sloanea rhodantha* occurs in dense, humid primary forest at (300–)400–2000 m altitude. It is most common in mid-elevation forest at 800–1200 m altitude.

Management *Sloanea rhodantha* is locally common; up to 650 trees with a bole diameter of more than 10 cm have been recorded per ha. However, in general natural regeneration is rated as quite poor.

Genetic resources *Sloanea rhodantha* is quite widespread in Madagascar and locally common. However, the on-going fragmentation of forest may make it liable to genetic erosion in the future because it is characteristic for undisturbed forest.

Prospects Research on propagation and silviculture is recommended to ensure sustainable management in the future for this locally important but relatively poorly known species.

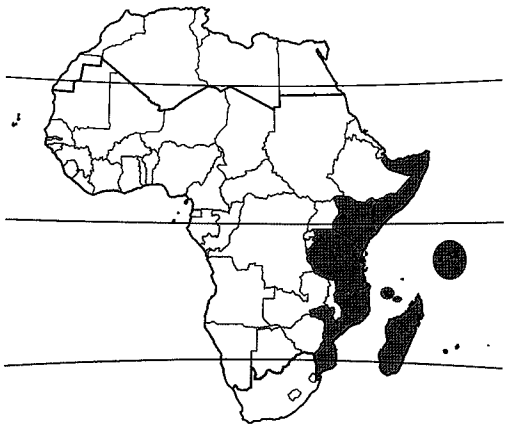
Major references Bolza & Keating, 1972; Cao et al., 2006; Guéneau, Bedel & Thiel, 1970–1975; Guéneau & Guéneau, 1969; Sallenave, 1971; Schatz, 2001; Takahashi, 1978; Tirel, 1985; Wiselius & Sosef, 1998.

Other references Boiteau, Boiteau & Allorge-Boiteau, 1999; Brown et al., 2009; Capuron, 1966e; Coode, 1983; Decary, 1946; Guéneau, 1971a; Guéneau, 1971b; Guéneau, 1972; Miandrimanana, 2008.

Sources of illustration Tirel, 1985.
Authors S. Rakotonandrasana

SONNERATIA ALBA Sm.

Protologue Rees, Cycl. 33(I): Sonneratia no. 2 (1816).
Family Sonneratiaceae (APG: Lythraceae)
Chromosome number $n = 11, 12$
Vernacular names Red-brown mangrove (En). Mlilana, mpia (Sw).
Origin and geographic distribution *Sonneratia alba* is extremely widespread. It occurs along the east coast of tropical Africa from Somalia south to Mozambique and in Comoros, Mayotte, the Seychelles and Madagascar. It is also found throughout tropical Asia, and in northern Australia, Vanuatu and New Caledonia.
Uses The wood of *Sonneratia alba* is used in Kenya and Tanzania for carpentry, canoes, boat ribs, paddles, masts, floats, and window and door frames. It is further used as firewood and for charcoal production. In Madagascar the wood is preferred for making paddles. In tropical Asia the wood is used for house building, ship building, piles of bridges, sleepers, paving blocks, flooring, furniture and sporting goods. Sulphate pulp of the wood is suitable for making paper.
The sour fruits are eaten raw or cooked and used to make vinegar. Leaves are used for camel fodder in Kenya. The bark is locally used as a brownish dye and for tanning leather and fishing nets.
Production and international trade In tropical Africa there is no significant trade in *Sonneratia* timber. For Asia trade statistics are not readily available and refer to timber of all *Sonneratia* species together. In 1992 about 5100 m^3 of logs and 1700 m^3 of sawn timber were exported from Sabah at prices of about US$ 73/m^3 and US$ 150/m^3, respectively. Very small amounts of *Sonneratia* timber are exported from Papua New Guinea.



Sonneratia alba – *wild*

Properties The heartwood is brown to reddish brown and distinctly demarcated from the paler sapwood. The wood is moderately heavy, hard and durable. It contains small amounts of salt, making it resistant to wood borers. It corrodes metal and therefore special nails and screws are needed.
The wood is of moderate quality for firewood. Although it produces a lot of heat, it produces much ash and salt. The bark of *Sonneratia alba* contains 9–12% tannin based on dry weight.
Botany Evergreen shrub or small tree up to 15(–20) m tall; bole often crooked and fluted at base, without buttresses, surrounded by aerial roots arising vertically from long horizontal roots; bark surface initially smooth, greyish, becoming irregularly fissured and dark grey-brown; twigs distinctly jointed above the nodes and 4-angled. Leaves opposite, simple and entire; stipules absent; petiole 3–15 mm long; blade elliptical to ovate, 3–13 cm × 2–9 cm, cuneate at base, rounded or notched at apex, leathery, pinnately veined with 11–14 pairs of lateral veins. Flowers solitary or 3 together at the apex of twigs, bisexual, regular, 6–8-merous; calyx tube c. 1.5 cm long, thick, leathery, persistent, lobes 1–2 cm long; petals strap-shaped, 1–2 cm long, caducous; stamens numerous, showy, white; ovary superior, 12–20-celled, style 4–6 cm long, slender. Fruit a depressed-globose berry, 2–3 cm × 2.5–4.5 cm, indehiscent, crowned by the style base, many-seeded. Seeds irregularly angular, c. 12 mm long. Seedling with epigeal germination; hypocotyl elongated; cotyledons emergent.
Sonneratia alba trees develop according to Rauh's architectural model, characterized by a monopodial trunk which grows rhythmically and so develops tiers of branches. It flowers at night and petals and stamens drop within hours from anthesis.
Sonneratia comprises about 5 species.
Ecology *Sonneratia alba* is found at the seaward edge of mangrove because it does not tolerate wide fluctuations in salt concentration. A tidal range of at least 1 m is necessary and it grows along seashores and at the mouth of

tidal creeks on sandy, rocky or muddy soils, and also on coral terraces. It may act as a pioneer, colonizing newly formed sandy mud flats in sheltered situations. It is often gregarious, but usually does not form dense stands.

Management *Sonneratia alba* can be propagated by seed as well as by air-layering. It is less suited for replanting on sites where sedimentation is high as the sediment will cover the pneumatophores and hence kill the plants.

Genetic resources and breeding *Sonneratia alba* is widespread and common in many regions and does not seem vulnerable, although the rate of destruction of mangrove habitats is alarming with an estimated annual loss of 1–2% worldwide.

Prospects In mangrove forest *Bruguiera* and *Rhizophora* are usually economically more important timber species than *Sonneratia*. Replanting in damaged and logged mangrove vegetations is usually done with *Avicennia* and *Rhizophora* species and thus the importance of *Sonneratia* for its wood is likely to decrease. However, it has very good potential as a valuable source of raw material for kraft pulp which warrants serious consideration.

Major references Boer & Lemmens, 1998b; Bosire et al., 2008; Duke & Jackes, 1987; Fernandes, 1978; Kairo et al., 2001.

Other references Alongi, 2008; Dahdouh-Guebas et al., 2000; Ellison, 1998; FAO, 2007; Nshubemuki, 1993; Schatz, 2001; Shi et al., 2000; Williams Sangai, 1968.

Authors C.H. Bosch

SOYAUXIA GRANDIFOLIA Gilg & Stapf

Protologue Journ. Linn. Soc., Bot. 37: 102 (1905).

Family Medusandraceae

Origin and geographic distribution *Soyauxia grandifolia* is found in Liberia, Côte d'Ivoire and Ghana.

Uses The wood of *Soyauxia grandifolia*, known as 'abotesima' in Ghana, is mainly used as posts for construction of huts and houses. Twigs are used as chewing-sticks for cleaning teeth.

Properties The wood is dull purple-brown, hard, strong and flexible. It has a fine texture, is easy to work and finishes smoothly.

Botany Small to medium-sized tree up to 25 m tall; bole usually crooked, up to 25 cm in diameter, buttresses absent; bark surface grey-brown, thin, flaking; crown spreading; twigs flat and with lenticels. Leaves arranged spirally, simple and entire; stipules paired, oblong, c. 10 mm × 2 mm; petiole short; blade oblong to lanceolate, 12–32 cm × 4–11 cm, obtuse at base, acuminate to acute at apex, leathery, almost glabrous, pinnately veined with more than 15 pairs of distinct lateral veins. Inflorescence a dense raceme 6–12 cm long. Flowers bisexual, regular, 5-merous; pedicel very short; sepals c. 5 mm long, persistent in fruit, rusty hairy; petals free, whitish; corona short, tubular; stamens many, filaments long, anthers 4-celled; ovary superior, 1-celled, styles 3, long and exserted. Fruit a sessile, 3-valved capsule up to 3 cm × 2.5 cm, red-brown to purple, 1-seeded. Seed trigonous, c. 2 cm in diameter.

Soyauxia grandifolia – wild

Soyauxia comprises about 6 species. It has been placed in *Flacourtiaceae* and *Passifloraceae* and resembles some *Euphorbiaceae*. More recently it has been included in *Medusandraceae*, but the most modern approach is to place it in *Peridiscaceae*, together with 2 genera from tropical America.

Ecology *Soyauxia grandifolia* is found in humid, evergreen forest, sometimes in secondary forest, on river banks and in coastal savanna. It prefers regions with high annual rainfall (above 2500 mm), but can also be found in regions with a lower mean annual rainfall, from 1500 mm onwards. In Ghana it is only common on very acid soils, but elsewhere it has been recorded on sandy, loamy as well as lateritic soils.

Management *Soyauxia grandifolia* regenerates in the shade of the forest canopy.

Genetic resources and breeding Although *Soyauxia grandifolia* is not widely distributed,

no serious threats are envisaged.

Prospects The wood of *Soyauxia grandifolia* is not of interest for commercial exploitation but will continue to play a role for local uses.

Major references Aubréville, 1959c; Burkill, 1997; Holmgren et al., 2004; Keay, 1958f.

Other references Bancroft, 1935; Bayer, 2007; Brenan, 1953; Hawthorne, 1995; Hawthorne & Jongkind, 2006; Normand & Paquis, 1976.

Authors C.H. Bosch

SPIROSTACHYS AFRICANA Sond.

Protologue Linnaea 23: 106 (1850).

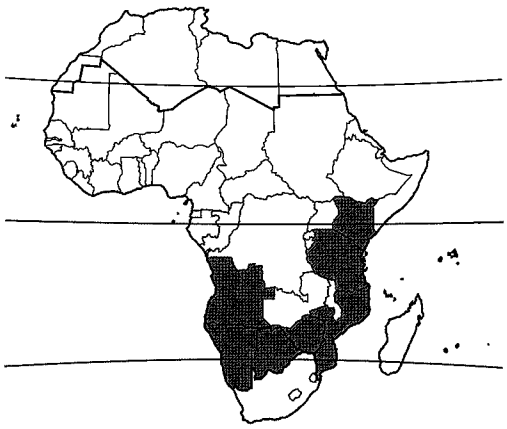
Family Euphorbiaceae

Vernacular names African sandalwood, Cape sandalwood, headache tree, tamboti (En). Sandalo africano (Po). Msarakana (Sw).

Origin and geographic distribution *Spirostachys africana* occurs from south-eastern Kenya south to Namibia, Botswana, Zimbabwe, Mozambique, South Africa and Swaziland.

Uses The wood is in high demand for decorative joinery, furniture and cabinet work, and for carvings and turnery. It is also appreciated for use in house construction for posts, beams and roof laths, and to make scented beads for necklaces. It is suitable for heavy flooring, mine props, ship building, toys, novelties, agricultural implements and musical instruments. It is also used as fuelwood, but should not be used for cooking because of the toxic smoke; the branches have been used for making scented torches. The wood is not appreciated for charcoal production.

The roots, bark and latex are widely used in traditional medicine. Root decoctions are taken to treat malaria, constipation but also diarrhoea, cough, gonorrhoea and headache, and they are dropped into the eyes to treat ophthalmia. Bark decoctions and infusions in small dosage are used as purgative to treat constipation but also diarrhoea, and to treat stomach ulcers, kidney complaints, cough and eye complaints, and to purify the blood. Dried bark is applied to rashes in children. Powdered bark is taken as anthelmintic. Latex diluted in water is taken as emetic and purgative, and the latex is administered against toothache and as anodyne. It is also applied to sores in cattle to kill maggots, whereas the wood serves as insect repellent. Extreme caution is needed when bark or latex is administered for medicinal purposes. Several complications caused by an overdose and resulting in the death of patients have been recorded. Extracts are used in the treatment of opportunistic oral infections such as candidiasis in HIV-infected patients, and although they have potent antifungal activity, they should be used with care because they may have interactions with antiretroviral agents. The bark has been used as fish poison, and the latex as hunting poison for arrow heads. Leaf decoctions are applied to the eyes to treat ophthalmia. In Namibia the powdered oily wood, mixed with fat, has been rubbed into the hair, and it has also been used as perfume.



Spirostachys africana – wild

Production and international trade A study in 2003 in Maputo (Mozambique) showed that the wood of *Spirostachys africana* is commonly used by wood artists. The annual volume was estimated at 360 m^3. In general, it has been reported that about 40 m^3 of *Spirostachys africana* wood per month is available from sustainably managed sources.

Properties The heartwood is brown to dark brown with darker markings and streaks, and distinctly demarcated from the whitish to pale yellow, 2.5–5 cm wide sapwood. The grain is straight to slightly wavy, texture moderately fine to fine, and even. The wood has a beautiful banded figure and a satin-like lustre, with an oily surface. It has a fragrant, spicy smell, resembling that of East Indian sandalwood (*Santalum album* L.), which can persist for many years.

The wood is very heavy, with a density of 910–1090 kg/m^3 at 12% moisture content, and hard. It air dries slowly. Boards of 2.5 cm thick take about 7 months to air dry and boards of 10 cm thick about one year. End checking is common, but the wood is usually not very liable to dis-

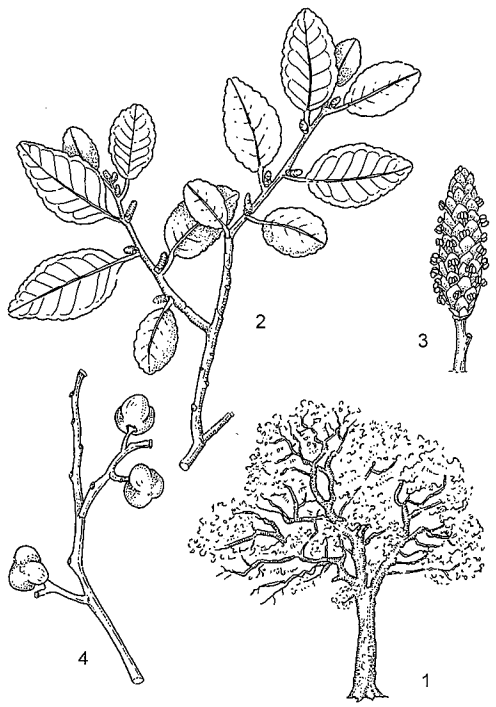
tortion. The rates of shrinkage are low, from green to oven dry 2.1–3.5% radial and 4.0–6.7% tangential. Once dry, the wood is moderately stable in service.

At 12% moisture content, the modulus of rupture is 102–108 N/mm², modulus of elasticity 8600–9210 N/mm², compression parallel to grain 57–60 N/mm², shear 16 N/mm² and Janka side hardness 8940 N.

The wood is difficult to saw, particularly green wood, but it is more easy to work. It rapidly blunts saw teeth. The saw dust is gummy and sticks to the teeth. The wood near the centre of the log may be extremely hard to saw. It planes smoothly and moulds well. Drilling and mortising require considerable effort, and nailing is only possible after pre-boring. Turning gives excellent results. Sanding is difficult because of the oily wood surface. The wood is durable and resistant to fungi, termites and wood borers. It is very resistant to preservatives. The sawdust is highly irritant to eyes and respiratory tracts. The wood is not well suited as firewood because the smoke is irritant, causing headache and complaints of the respiratory organs.

The latex is irritant and may cause inflammation and blistering of the skin. It is particularly harmful when in contact with the eyes. It may cause severe purging and vomiting. It contains a complex mixture of diterpenes. Bark extracts showed antibacterial activity and genotoxicity in tests. Experiments showed that powdered bark suppressed populations of the cowpea weevil (*Callosobruchus maculatus*) in stored cowpea seeds. The bark contains diterpenoids, triterpenoids, tannins, anthocyanins and saponins. Several diterpenoids have been isolated from the heartwood.

Description Deciduous, dioecious or monoecious shrub or small tree up to 15(–20) m tall, with white latex; bole branchless for up to 7 m, straight or bent, up to 50(–90) cm in diameter, more or less fluted near base; bark surface rough and flaking in rectangular scales, dark grey to dark brown or black, inner bark fibrous, dark red, exuding white latex; crown rounded, heavily branched; twigs glabrous, with lenticels. Leaves arranged spirally, simple; stipules triangular-ovate, c. 1 mm long, caducous; petiole 0.5–1(–1.5) cm long, channelled above, with 2 small glands at apex; blade ovate to elliptical, (1.5–)2–7 cm × (0.5–)1–3.5 cm, usually rounded at base, obtuse to rounded or slightly short-acuminate at apex, margins obtusely toothed, papery to thinly leathery, glabrous, pinnately veined with 6–14 pairs of lateral veins. Inflo-



Spirostachys africana – 1, tree habit; 2, flowering twig; 3, inflorescence; 4, twig with fruits. Redrawn and adapted by W. Wessel-Brand

rescence an axillary spike 1–2.5 cm long, densely flowered, with only male flowers or with many male flowers and 1–3 female flowers at base; bracts arranged spirally, broadly ovate, c. 1.5 mm broad. Flowers unisexual, regular, sessile or nearly so; petals and disk absent; male flowers with (2–)3 obovate to rounded sepals c. 1 mm long, stamens 3, fused at base into a tube; female flowers with 5 triangular-ovate sepals c. 1 mm long, ovary superior, c. 1 mm in diameter, 3-lobed and 3-celled, styles 3, c. 1.5 mm long, fused at base, with red stigmas. Fruit a 3-lobed capsule c. 1 cm in diameter, smooth, becoming yellowish brown, falling apart into 3 parts, each part 2-valved and 1-seeded. Seeds ovoid to globose, c. 4 mm long, smooth, pale brown to yellowish brown with darker streaks.

Other botanical information *Spirostachys* comprises 2 species and is closely related to *Excoecaria*. *Spirostachys africana* closely resembles *Excoecaria simii* (Kuntze) Pax, which is restricted to South Africa and differs in more sharply toothed leaves without glands at petiole apex.

Spirostachys venenifera (Pax) Pax is a shrub or small tree up to 15 m tall, occurring in southern Somalia, Kenya and eastern Tanzania. Its wood is used for construction, door frames, ceiling beams, implements, tool handles and carvings, and also for charcoal production. The wood is yellowish brown to pale brown, with brown markings, medium-weight with a density of about 750 kg/m^3 at 12% moisture content, and quite durable. The bark and latex are used as fish poison. Tests in mice showed immunosuppressive activity of bark extracts. *Spirostachys venenifera* is highly poisonous.

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); 13: simple perforation plates; 22: intervessel pits alternate; (23: shape of alternate pits polygonal); 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; 49: 40–100 vessels per square millimetre; 58: gums and other deposits in heartwood vessels. Tracheids and fibres: (60: vascular/vasicentric tracheids present); 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; (77: axial parenchyma diffuse-in-aggregates); (86: axial parenchyma in narrow bands or lines up to three cells wide); 92: four (3–4) cells per parenchyma strand; 93: eight (5–8) cells per parenchyma strand. Rays: 96: rays exclusively uniseriate; 104: all ray cells procumbent; (106: body ray cells procumbent with one row 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; 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.
(P. Mugabi, P.E. Gasson & E.A. Wheeler)

Growth and development Young trees may have spiny branches. The trees grow very slowly. They are usually deciduous, but sometimes can be nearly evergreen, shedding the old leaves when young leaves develop. In southern Africa, trees usually start to flower in September before new leaves develop, and flowers may be present until January. Fruits ripen 1–2 months after flowering.
Although the tree is poisonous, several animals feed on it; birds such as guinea-fowl, francolin and doves eat the fruits, and large herbivores such as antelopes, elephants and rhinoceros young foliage. Squirrels, often nesting in the hollow bole, feed on the young leaves, bark and seeds.

Ecology *Spirostachys africana* occurs in deciduous woodland and wooded grassland, often on termite mounts and stony slopes, sometimes in thickets, up to 1350 m altitude. The largest trees are found near streams and seasonal watercourses. *Spirostachys africana* prefers well-drained sandy or sandy loam soils. In southern Africa, it is often associated with *Colophospermum mopane* (Benth.) J.Léonard and *Acacia*, *Brachystegia* and *Combretum* spp.

Propagation and planting In Botswana fresh seeds showed a germination rate of 55–80% 1–3 weeks after sowing, without pretreatment. They can be sown in containers filled with river sand, with the seeds pushed into the sand until level. They should be kept moist. Seeds should be selected carefully because they are often infested with moth larvae.

Management Trees can be coppiced, but the average number of shoots per stump is small (0.4–1).

Diseases and pests The seeds may be infested with the larvae of a moth (*Emporia melanobasis*), and these may cause the seed to jump into the air for several centimetres.

Handling after harvest The boles are often hollow, and larger dimensions of wood are therefore difficult to obtain. Star shakes often develop during log drying. In an inventory in KwaZulu-Natal (South Africa), the mean length of posts used in house building was 2–2.5 m and the mean diameter 7.5–9.5 cm.

Genetic resources There are no indications that *Spirostachys africana* is currently threatened; it is both widespread and locally common. However, in many regions its wood is greatly appreciated and sought for, and regulation of the yield is there needed to avoid too much pressure on the populations. A study in 2007 in southern Tanzania showed that the trees were harvested on a large scale below the legally prescribed minimum bole diameter. In South Africa the bark is locally in high demand for medicinal purposes, but it seems to be still readily available.

Prospects *Spirostachys africana* produces one of the most beautiful African woods. In