# Shorea javanica Koord. & Valeton



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## ***Shorea javanica*** Koord & Valeton (Bull. Inst. Bot. Buitenzorg 2: 3 (1899)).

DIPTEROCARPACEAE

*x* = unknown

**Synonyms** *Shorea vandekoppelii* Parijs (1933).

**Vernacular names** Indonesia: damar mata kucing (southern Sumatra), damar sibolga (northern Sumatra), damar kaca or 'glass damar' (general).

**Origin and geographic distribution** *Shorea javanica* is indigenous to Indonesia (widespread and common in Sumatra, rare in Central Java).

**Uses** The resin from the wood of *Shorea javanica*, 'damar mata kucing' or 'cat's eye damar', is used in paints and varnishes, in the linoleum industry, in pharmaceuticals, cosmetic products and as a food additive. Traditionally, the resin has been used for torches, caulking boats and baskets and colouring batik.|Its timber is traded as a 'white meranti' and is important in the manufacture of plywood and veneer; it is also used for light construction. The importance of *Shorea javanica* in the white meranti trade group is difficult to assess.

**Production and international trade** Production and international trade Between 1975-1995 the price of 'damar mata kucing' was stable. Currently, this type of damar (resin from *Dipterocarpaceae*) is the most important in the Indonesian domestic market and the international market. The estimated total production from the Krui area in Lampung Province was 8000 t in 1984 and 10 000 t in 1994. Total damar exports ('damar', 'mata kucing' and 'batu') from Indonesia were 14 750 t and 9900 t in 1994 and 1995; mata kucing exports were 3400 t and 2900 t. In 1995 there were about 50 000 ha of damar gardens over 15 years old in this area. In the period 1928-1938 the annual export of damar mata kucing from Indonesia was 4300-7400 t.

**Properties** Damar mata kucing is a transparent, colourless to slightly yellow solid in the form of balls, with a specific gravity of 1.05, 1.4% moisture content, a softening point of 75-85°C and an acid number of 19-31. It is soluble in aromatic hydrocarbon solvents (benzol, toluol) or in a mixture of these with alcohol but is only slightly soluble in turpentine or mineral aromatic hydrocarbons. Damar mata kucing is produced by several *Shorea* and *Hopea* species. The quality of the damar mata kucing from *Shorea javanica* is one of the best as it contains relatively little ß-resene. This is a wax-like compound that causes varnishes made from damar mata kucing to become dull. It needs to be removed if nitrocellulose lacquers are to be manufactured. When treated with alkaline solutions, damar mata kucing yields about 40% resin acids of high quality for varnish manufacture, 45% 'ALFA'-resene and 15% ß-resene.|The resin is found in resin canals in tangential rows and elongated groups embedded in wood parenchyma. The density of the wood is 450-840 kg/m³ at 15% moisture content.

**Description** A large tree up to 40-50 m tall, bole with a diameter of up to 150 cm, buttresses prominent, up to 1.5 m high; bark surface with irregular fissures, outer bark usually thick, chocolate brown, inner bark laminated with bands of orange-yellow and whitish tissue, exuding a clear, whitish to yellowish resin; mature crown hemispherical or dome-shaped, sympodial; twigs, leaf buds, stipule outside, panicles, calyx, parts of petals exposed in bud, ovary and nut persistently evenly tawny brown pubescent; twigs terete, 2-3 mm in diameter apically. Leaves alternate, simple; petiole 16-22 mm long; blade elliptical-oblong to ovate, (6.5-)10-15 cm x (3.5-)4-8 cm, base obtuse to shallowly caudate, margin entire, top with acumen, up to 7 mm long, thinly leathery, with 19-25 pairs of parallel secondary veins, lower surface evenly tomentose on the veins. Inflorescence terminal or axillary, paniculate, up to 14 cm long, branchlets to 4 cm long, bearing up to 3 flowers facing the same direction; flowers bisexual, 5- merous, about 1 cm long in bud, actinomorphic, scented; calyx lobes free, narrowly ovoid, acuminate, somewhat unequal, much enlarged and persistent in fruit; petals white, broadly elliptical or ovate-lanceolate, loosely connate at base; stamens 15, the anthers with 4 pollen sacs, narrowly oblong to linear, with prominent scabrous or glabrous appendages; ovary superior or semi-inferior, (2-)3-locular, stylopodium narrow. Fruit samara-like, consisting of an ovoid, apiculate nut, 14 mm x 10 mm, surrounded by the enlarged calyx with lobes like wings, base obtuse; the 3 outer calyx lobes much longer than the 2 inner ones, thinly spatulate, up to 18 cm x 1.5 cm.

**Growth and development** Seedlings need shade until they reach a height of about 1.5 m, after which more sunlight can be provided. Mycorrhizal infection promotes growth considerably, and for *Shorea javanica* 5 common ectomycorrhizal fungi are *Amanita hemibapha*, *Cantharellus cibarius*, *Lactarius* sp., *Russula* sp. and *Scleroderma* sp. *Shorea javanica* flowers and fruits only every 3-5 years. In Lampung Province (Sumatra) it flowers in January. In 50 years a height of 40-50 m can be reached.

**Other botanical information** Over the years many other *Dipterocarpaceae* have been exploited for their resin ('damar'). Only *Hopea dryobalanoides* Miq. has ever been planted, but generally the resin has been harvested from natural forest. Other species yielding damar mata kucing are: *Shorea lamellata* Foxw., *Shorea retinodes* Slooten, *Hopea dryobalanoides*, and *Hopea celebica* Burck.

**Ecology** *Shorea javanica* occurs in primary and secondary forest in dry or periodically inundated locations on flat land or on slopes up to 300(-500) m altitude. Plantations have been established in southern Sumatra where it grows best on deep loamy soils and where the mean annual rainfall is 3300 mm with no dry season. Saplings of 1 m tall can survive and grow in open cropped land and when they reach 3-4 m they behave like true pioneers and need full sunlight. Seedlings at planting time need some shade (usually provided by coffee trees and *Erythrina* in new plantations), but heavy shade adversely affects growth and survival. The mortality of 50 cm tall seedlings 6 years after planting in a mature agroforest under a closed canopy was 45% compared to 8% mortality when planted under a more open canopy. Growth under more open conditions was much faster, with a mean annual height increment of 0.7 m compared to 0.3 m for the seedlings planted in the mature agroforest.

**Propagation and planting** When people started planting *Shorea javanica* in southern Sumatra in the middle to the end of the 19th Century, they obtained planting stock either from wild and cultivated seedlings or from young forest trees by successive air layering. In the latter case, the bark of these 'damar trees' with a diameter of 10-20 cm was notched all around the stem and packed with soil and leaves. When the first roots appeared, the tree was cut down 1 m above and 25 cm below the notch. The rooted stem segment was planted in the field or in the village and the coppice sprouts from these segments were air layered again when about 30 cm long. These rooted layers were used for planting. The next step in cultivation was the use of the seeds from the planted trees. *Shorea javanica*, however, flowers and bears fruit only once every 3-5 years, so seed is available very irregularly. Moreover, seeds are recalcitrant and cannot be stored under dry conditions or at low temperatures. When available, the fruits are even sold in local markets. Instead of storing seeds farmers in southern Sumatra store seedlings. Fruits are collected in old damar plantations, the wings are cut off and the fruit is soaked in water for 2-3 days. The germination percentage is close to 100%. Germinated seeds are put in small bamboo pots or planted very densely in the soil of prepared nursery beds. All small-scale private nurseries, either close to the house or, more usually, in old damar plantations, are shaded. Seedlings grow to 20-30 cm and then growth seems to stop. Seedlings can survive for 3-4 years, and there seems to be only a low rate of mortality. A good nursery must supply seedlings from one fruiting season to the next. The stock is renewed at each fruiting season. Seedlings are planted out in the damar gardens with earth from the nursery, in spots where light intensity is intermediate, so neither under closed canopy nor in large, open areas. Mortality is low. When establishing new damar gardens, seedlings are planted after coffee, that was planted in the second upland rice crop after land clearing. The seedlings benefit from the shade provided by the rice or the coffee. This coffee stage is itself a mixture of various species: *Erythrina* is almost always planted as a shade tree, but also as living poles for pepper which is very often associated with coffee. Fruit trees (e.g. durian, duku, jackfruit, mangosteen, rambutan and mango) are also planted along with the damar trees, so that the latter never develop in an open environment. Damar tree density at planting is very variable, depending on the farmer's short and long term objectives. However, damar tree planting density for a damar agroforest objective is 100-150 trees/ha. The damar trees are 4-5 m tall when the coffee becomes unproductive about 10 years after planting. Initially, these gardens are even-aged, but they will gradually become more complex, involving more species and more differences in age. Direct seeding is not practised, as seed predation is severe.|Vegetative propagation on an experimental scale using cuttings of 2- month-old seedlings is successful, with rooting percentages of 85-95%.

**Diseases and pests** *Bacterium tumefaciens* is a gall disease observed in West Java on planted *Shorea javanica* seedlings in the second year. Although the disease is not fatal, the affected seedlings continually form new shoots but do not grow any more in height. Damar farmers have reported two unidentified insects (*Homopterae*) as having a deleterious impact on damar production: 'tetuer', a leaf hopper (*Cicadellidae*) and 'tenangao', a brightly coloured red and green bug (*Heteropterae*). Both insects feed on the sap of the plant.

**Harvesting** In the Krui area, tapping of *Shorea javanica* starts when the trees are about 20 years old and have attained a diameter of 25-30 cm. Trees are prepared for tapping by cutting 3-4 rows of small holes, 3 cm in diameter and 2 cm deep. These holes are made with a hatchet fitted with a 2 cm x 4 cm steel blade. Monthly, any exuded resin, or newly formed periderm, is stripped away. Occasionally, the holes are covered by a piece of bark. Though in most cases the holes have filled with resin by the third month, the procedure continues. These small holes presumably render the tree susceptible to fungal attack, which induces resin flow as part of the defensive response. The first triangular holes are made at 1 m height. The triangle points upwards and can function as a foothold for tappers while climbing. These holes may become circular with age, but good tapping is achieved when holes stay triangular and, according to local people, are a sign of careful tapping. The holes are arranged in vertical rows along the stem and 40-50 cm apart. Later, more holes are made, all around and up the stem. The first

triangular holes are several centimetres wide and are enlarged with every tapping. When old, these holes can measure 15-20 cm in width and depth, the holes becoming deeper and deeper due to diameter growth of the tree. With increasing age the number of rows increases to a maximum of 4-5 rows. Each row may comprise 9-11 holes for trees 30-35 m tall and 60-80 cm in diameter, the highest holes are 5(-8) m above the ground. Abandoned holes which have become too deep are filled with soil to promote wound healing, which usually occurs within 1-1.5 years. The use of fire to increase resin production has never been reported for southern Sumatra.|The resin is dry when harvested and in the form of solidified drops or strings of drops, or solidified resin stuck on the wood. The periodicity of tapping and harvesting is usually 1 month, but depends on the distance from the village and ranges from 1 week to 2 months. Tapping stimulates the tree to produce reaction wood, so that the trunk is thickened up to the level of the highest scars. Wood of the tapped portion of the stem is only used as firewood, that of the upper part is converted into timber.

**Yield** Data from the early 20th Century indicate a yield of 0.6 kg/tap with tapping every 2-3 months. This means that the annual yield is 2.4-3.6 kg/tree probably for fairly young trees of 25-30 years. In the Krui area, the average annual yield of mature trees over 60 years old is 15.6 kg/tree. Some big trees of 60- 80 cm in diameter yield 4-5 kg monthly. The resin production of flowering and fruiting trees decreases by about 25% for 2 months, after which it gradually increases to the previous levels.

**Handling after harvest** Grading of damar mata kucing is based on colour, cleanness and the size of the damar particles. Grades A, B and C are the 'export quality' grades, with a good quality, i.e. transparent, whitish or yellowish where grade A comprises large lumps of up to 10-15 cm, grade B lumps of 1-2 cm and grade C lumps smaller than 1 cm. Grades D and E are of medium quality, opaque and dusty lumps, grade D are the particles over 1 cm in size and grade E the small particles of several mm. Grade 'tebu' corresponds to dust and grade 'beku garam' comprises dusty agglomerated lumps, often mixed with small pieces of wood or bark. Medium and low quality damar is used and processed in Indonesia: part of it goes to paint industries near Jakarta, another part to the batik industry in Central Java, and the rest is used as incense, quite often mixed with benzoin. No added-value processing of high grades occurs in Indonesia before exporting.

**Prospects** The damar agroforests in southern Sumatra, mainly of *Shorea javanica*, have been maintained for well over a century now and will continue to be of prime economic importance to the local population as long as damar mata kucing remains an important export commodity. The high quality, the specific characteristics and the homogeneity of damar mata kucing resin are being increasingly recognized, and the traditional demand from the paint and varnish industry is not declining. Moreover, new applications have been developed in the last 10 years by the food industry, where it is increasingly used as food additive in soft drinks. Last but not least, damar mata kucing resin is produced from environmentally sustainable and socially equitable plantations. This production mode ensures a continuous and 'safe' source of supply for downstream industries, as well as the possibility of green labelling for industrial products. This greatly improves its prospects.

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