

Notes on Some Species of Agarwood in Nusa Tenggara, Celebes and West Papua

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Abstract

There are two kinds of agarwood (*gaharu*); *gaharu* superior and *gaharu* inferior (local name *gaharu buaya*). Each species of *gaharu* has specific area of distribution and ecology. *Gaharu* superior such as *Gyrinops versteegii* distributes in Lombok, Sumbawa, Flores, Sumba, Timor and Alor islands. *Wikstroemia androsaemifolia* Decne. was found in Sumba; *Gyrinops decipiens* Ding Hou in West, Central and South Celebes; *Gyrinops ladermanii* Domke. and *Gyrinops salicifolia* Ridl. in Sentani, Papua; and *Gyrinops caudata* (Gilg.) Domke. and *Gyrinops* spp. in Jaya Wijaya Mountain and in Biak, Papua. *Gaharu* inferior consists of *Exoecaria agallocha* L. found in Samau Island, Nusa Tenggara Timur, *Phaleria capitata* Jack in South, West and Central Celebes, *P. macrocarpa* (Scheff.) Boerl. in Sentani, Jayapura, and *P. nisdai* Kanehira in Biak in Papua.

I. BACKGROUND

Agarwood (or eaglewood) refers to species in 5 genera, such as *Aetoxylon*, *Gonystylus*, *Wikstroemia*, more commonly *Gyrinops* and *Aquilaria* in the family Thymelaeaceae. The valuable part of the tree, aromatic resin, is found in a small percentage of trees mainly harvested from certain species in the Genus *Gyrinops* and *Aquilaria* [Wiriadinata 1998, Mulyaningsih et al. 2004, Ding Hou 1960]. Eaglewood can not generate aromatic resin in healthy wood tissue. It is an induced resinous product of wounding due to herb ivory, wind chill or fire damage and subsequent opportunistic infection by facultative fungal pathogens [Ng et al. 1997]. The first process of olio-resin production is taken in cells of the included phloem, rays, parenchyma para-trachea and trachea. It is the tree's response to injury if its first line of defense, formation of phloem callus tissue, is inhibited forming over the injury [Gunn et al. 2003, Mulyaningsih and Sumarjan 2002, Itoh et al. 2002].

Between the 1980s and early 1990s there was a boom of eaglewood, locally called as '*demam gaharu*' (gaharu fever) in East Kalimantan and Lesser Sunda Islands (especially in Lombok, Sumbawa, Flores and Sumba). It was caused by a significant increase in demand for eaglewood. Expeditions of professional collectors were sometimes carried out using helicopters, funded by ethnic Chinese and Bugis traders. However, as natural eaglewood became distinct in Kalimantan and Lesser Sunda Islands

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after 1995, traders stopped the operation in these areas, and shifted it to West Papua, instead [Gunn et al. 2003].

II. Sumbawa Island

In Sumbawa island only one species (*Gyrinops versteegii* (Gilg.) Domke.) of *gaharu* was found. Local people called it *Seke*. The character of this plant was:

Shrub, 1-4m height, 1-10 cm diameter, the plant still young, it was not in flowering yet. *Young branchlets* pubescent, bark grayish. *Leaves* chartaceous to subcoriaceous, pubescent, on the nerves and veins beneath, glabrescent or glabrous, dull and light green in beneath, shining and dark green above, elliptic-oblong, lanceolate, 8.7-15 by 2.2-5.2 cm; base cuneate, apex up to 0.5-1 cm narrow-acuminate; nerves and veins similar, numerous, slightly oblique and parallel, 24-46 pairs; petiole, short, 3-6 mm, pubescent.

It grows on the hillside (400-800m above sea level) ranging from Tartar village (Doro Tambiung Mountain) in West Sumbawa to Lambu village (Doro Saboke Mountain) in East Sumbawa. These plants grow in secondary and primary forests with high humidity, with *Ficus* sp., *Eugenia* spp., *Garcinia* sp., *Calophyllum* spp., *Maranthes corymbosa* Bl., *Sterculia foetida* L., *Schleichera oleosa* (Lour.) Oken., etc.

The healthy plants were wounded by collectors for producing aromatic resin as raw material of *gaharu* oil in Emang Lestari village, Sumbawa Besar. Eaglewood plant has been cultivated in Tartar village in West Sumbawa and Maria village, Dompu since 2003.

III. Alor Island

Agarwood plant was found in east Alor. This plant was introduced by a pastor who brought in seedlings from Lombok island. This plant was planted in field with *Erythrina* sp., and the soil around the seedlings was mulched with rice straw and sprinkled well with water. The species of this agarwood was *Gyrinops versteegii* (Gilg.) Domke. The character of this plant was:

Shrub, 1-1½m height, the plant still young, it was not in flowering yet. *Young branchlets* pubescent, bark grayish. *Leaves* chartaceous to subcoriaceous, pubescent, on the nerves and veins beneath, glabrescent or glabrous, dull and light green in beneath, shining and dark green above, elliptic-oblong, ovate-oblong, or obovate-oblong, 8-15 by 1½-5 cm; base cuneate, apex up to 2 cm narrow-acuminate; nerves and veins similar, numerous, slightly oblique and parallel; petiole short, 3-5 mm, pubescent.

IV. Flores Island

Gyrinops versteegii (Gilg.) Domke.

Tree, 10-17½ m height, 25-30 cm diameter. *Young branchlets* pubescent, bark gray. *Leaves* chartaceous to subcoriaceous, pubescent, on the nerves and veins beneath, glabrescent or glabrous, dull and light green in beneath, shining and dark green above, elliptic-oblong, ovate-oblong, or obovate-oblong, 8-15 by 1½-5 cm; base cuneate, apex up to 2 cm narrow-

acuminate; nerves and veins similar, numerous, slightly oblique and parallel; petiole short, 3-5 mm, pubescent. *Fruits* yellow or orange, slightly obovoid or ellipsoid, 2-2¾ by 1-1½ cm, shortly acuminate to the apex, attenuate to the base. *Seed* ovoid, Plano convex, 9 by 6 mm, with a caruncle-like appendage at the base, ± 2 mm thick.

V. Somau Island

Excoecaria agallocha L. (Euphorbiaceae)

Excoecaria agallocha can produce aloeswood with less fragrance like fired wood and the smoke can irritate eyes, so it is called as *gaharu buaya* (crocodile). It is usually sold with low price and used for mixing material of joystick (*hio*) or incense. This plant grows along beach and composes mangroves.

VI. West Sumba, Sumba Island

Gyrinops versteegii (Gilg.) Domke.

Shrub or Tree, 2 m up to 25 m height, diameter 3 cm up to 40 cm. *Young branchlets* pubescent, bark gray. *Leaves* chartaceous to subcoriaceous, pubescent, on the nerves and veins beneath, glabrescent or glabrous, dull and light green in beneath, shining and dark green above, elliptic-oblong, ovate-oblong, or obovate-oblong, 8-15 by 1½-5 cm; base cuneate, apex up to 2 cm narrow-acuminate; nerves and veins similar, numerous, slightly oblique and parallel; petiole short, 3-5 mm, pubescent.

This plant grows on brown, thin humus soil found in primary forest in Riwuta and on the foot of Meja Mountain, West Sumba.

In Sumba, aloeswood, *G. versteegii*, is known as female *gaharu* or white *gaharu*, and preferred by consumer. In west Sumba, aloeswood is exclusively transacted in a secret way. It is collected by collectors. They take aloeswood from the trace or long wound. If the number of wounds is few, they take only the wound, but if too many wounds are observed, the whole plant is cut. For this reason, wild *Gyrinops versteegii* plant became decreasing.

Wikstroemia androsaemifolia Decne.

Shrub, young branchlets slightly flattened at the nodes, densely appressed pubescent, glabrescent. *Branches* terete, reddish brown, glabrous; axillary buds densely covered with golden-coloured hairs. *Leaves* papery, glabrous, rarely sparsely hairy on the lower surface and especially on the nerves and veins of young leaves, in dry state light-greenish, light brown or greenish-brown to brownish and shining on the upper surface, pale greenish, light-yellowish-green or light-brown and dull on the under surface, elliptic or ovate-oblong, 1¾-5½(8-) by ¾-2½(-4) cm; base acute, apex acute to narrow-acute, very rarely obtuse; nerves 8-11 pairs, elevated below and slightly depressed above, obliquely spreading towards the margin and the curved upward; veins almost as distinct as the nerves, loosely reticulate beneath, obscure above; petiole ± 2mm.

This plant grows in primary forest in Meja Mountain. Aloeswood, *Wikstroemia androsaemifolia*, known as male *gaharu* or red *gaharu* is less preferred by consumer because it has spicy smell and the smoke irritates eyes.

VII. Celebes

Gyrinops decipiens Ding Hou

Shrub to tree, 2 m up to 17 m height, diameter 3 cm up to 30cm. *Branchlet* fissure shallow to deep, light to dark gray, glabrous to pubescent. *Leaves* chartaceous to subcoriaceous, above glabrous, below pubescent scattered on the vena, shining on both surfaces, elliptic-oblong, lanceolate 7.5-23.5x 2.6-6.8 cm; base acute-acuminate, base caudate (0.52.0 cm long). Vena parallel, 23-39 pairs, elevation visible on below and obscure on above. Inflorescent axilar or terminal on the short branchlet in the axilar, umbel, consisting of 1-6 flowers, pedicle 2-5 mm, pubescent, brachtea opposite on the base of pedicel, a *crescent*, rounded and thick on the apex of pedicle; pedicel 1-3 mm. *Flower* like club, calyx tube pubescent outside, 4-6x2 mm long, calyx lobe 1.5x1 mm. *Fruit* ovoid-oblong, 1-1.5x0.8-1.3 cm, color orange when fruit mature, two locus, 1-2 seeds each fruit. *Stipes* 7 mm, emerges on the base to mid of calyx lobe. *Seed* planocovex, 6x(5-7)mm, caruncle 5 mm. *Flowering* and *Fruiting* season on July-August.

Aloeswoods were found in primary forest with thin humus on the side and the top of the Ganda Dewatan mountain in Buttu Ada and Salusampe, Salubaka and Tampakura villages, Mamuju, the Tapusaang mountain in Karama village, Mamasa, and the Kapusaan mountain and the Tunggumanu mountain in Karosa in West Celebes. They were found in Kulawi, Tuwulu village, the Ulu Karosa river, Tembok Jerman and Lengke mountains around the Towuti Lake in Central Celebes; and in mountains in North Luwu in South Celebes

This gaharu was divided into two varieties, i.e., *gaharu beringin* and *gaharu cabut*.

Gyrinops decipiens var. *microphylla* Mulyaningsih & Yamada var. nov. (local name: *gaharu beringin*). Character: tree, fissured bark deep. *Leaves* subcoriaceous relative small, lanceolate, 7.5-17.5x2.6-4.5 cm, vena 23-30 pairs, petiole 3-5 mm, pubescent.

Gaharu beringin is generated in specific wood, especially, on the decay. This plant was cultivated since 2003 in some villages such as Dara, Maepi and Lere, North Luwu (South Celebes) and Tampalopo and Tampakura villages, Mamasa (West Celebes).

Gyrinops decipiens var. *macrophylla* Mulyaningsih & Yamada var. nov. (local name: *gaharu cabut*). Character: Shrub, fissured bark shallow. *Leaves* chartaceous, more weigh, elliptic-oblong, 14.5-23.5x6.0-6.8 cm, vena 36-39 pairs, *gaharu* forming in whole wood tissue of plant.

Phaleria capitata Jack

This species is included in *gaharu* inferior (*gaharu buaya*). This wood is hard with color of light and dark brown and the fragrance is not good, so it is used for mixing raw materials of joystick and for craft.

It is found in Kapusaan Puncak and Tiga Puluh Puncak Mountains, Mamasa, West Celebes and in some villages around the Towuti Lake in Central Celebes.

VIII. PAPUA

Ding Hou [1960] refers eight *Gyrinops* species, among which five are found in New Guinea consisting of Indonesian West Papua and Papua New Guinea. *G. ladermannii*, *G.*

caudate, *G. podocarpus*, *G. salicifolia* and *G. versteegii*. It is interesting to note that seven from the eight species of *Gyrinops* are distributed in east of the Wallace Line [Gunn et al. 2003].

1. Sentani

Gyrinops salicifolia Ridl.

This plant was found in Dosay village, Sentani, Papua. It was cultivated by a person as decoration plant, because it has good canopy and leaves. The source of aloeswood from Sentani and Jayapura was taken from this hill.

Slender shrub, up to 2 m. Branchlet light brown, pubescent. *Leaves* sparsely pubescent on the midrib and sometimes on the nerves and veins beneath, lanceolate to linear-lanceolate, 1½-10 by ½-1 cm; base cuneate apex acuminate and pointed; nerves and veins similar and equally strong, slightly visible beneath, obscure above; petiole ⅓-½ mm.

Gyrinops ladermannii Domke.

This plant resembles *G. salicifolia*, but it has habit as shrub of small trees with 7-10 m high and 13-15 cm in diameter. The leaf is broader, the angle of leaf and branchlet is larger. Branchlet has darker color, and the wood is harder.

Leaf subcoriaceous, obovate-oblong to lanceolate, 6½-12 kali (1½) 2½-5 cm; pubescent scattered on vein and midrib beneath and glabrous above. Base acute-cuneate, apex acuminate to caudate, nerves spread, visible, dense, curve, ascending face to tip. *Inflorescentia* pseudo lateral or terminal, sessile, consisted of 2-3 flowers, pedicellus thin, 3-5 mm. Calyx tube cylinders, 13 mm long, diameter 1½ mm. Calyx lobe ovate, 1½-2 kali ½ mm, outside acute, pubescent, inside obtuse, tomentose. *Petaloid* square, ⅓ x ½ mm, obtuse, villous. Stamen sessile, oblong, 1-1¼ x ⅓ mm. *Fruit* pyriform 1¾ x ⅓ cm (included stipe 3 mm and apex up to 4 mm acuminate or caudate), pannose, irregular, wrinkled to transversal. *Seed* 2 or 1, one abortion, 9 mm long (included caruncle 3 mm), villous.

This plant grows in secondary forest with *Callophylum* sp. on lime soil with thin humus. It was found on a hill in Maribau village, 50-200 m above sea level, Sentani, Jayapura, Papua.

Phaleria microcarpa (Scheff.) Boerl.

This plant has local name as 'gaharu puk-puk'. It has no commercial value as it does not give off a desirable fragrance when burnt. It has very thick bark whereas eaglewood has thin bark. In the upper Sepik, *bilums* (traditional woven carrying bags) are made from the bark. *Phaleria* has smoky, bitter and unpleasant smell.

2. Jaya Wijaya Mountain

Gyrinops sp.

The character of this plant is similar to *G. ladermanni*. However, this is different from *G. ladermanni* in the size of leaves and flowers: more little, apex of leaves and flowers longer.

Shrub or tree up to 15 m by 25 cm., branchlets grayish, whitish, wooly (lanate). *Leaves* subcoriaceous, glabrous and shining above, pubescent at the lower parts, oblong or ovate-lanceolate sometimes obovate-lanceolate, 6½-14 by 2-5 cm, base obtuse, apex acuminate or caudate; nerves curved and ascending towards the apex, close to each other, c.16-36 stronger pairs; petiole 3-5 mm, pubescent. *Inflorescences*, axilar or at the short lateral

branchlet, umbel, bractea on the apex of peduncle, peduncle woolly, 3-5 cm, consisted of 6-12 flowered; pedicels thin, 6-10 mm, pubescent. *Flower* tube cylindrical pubescent, neck formed in the top, 10-15 mm long, 1-1⁴/₅ mm in diameter; calyx lobes ovate, 1⁴/₅-2¹/₂ mm by 1¹/₅-1¹/₂ mm, pubescent on the outer and tomentose in the inner surfaces; petaloid appendages 5 lobes, quadratic c. ½-1 by ½-1 mm, connected at the base, villose; ovule lanseolatus-rhomboid, 4-6 by 1 mm, villous; stamens sessile 5, oblong 1½ by 1/5 mm, bassifix. *Fruit* ellipsoid or rhomboid, 1¹/₅-1½ by 4-6 mm including stipes 2 mm and apex caudate, short pillose, compressed. *Seeds* plano-convex, 2 or 1 by abortion c. 9-12 by 3-5 mm including an appendage c. 1 mm, woolly.

Flowering and fruiting season in August-September.

Distributed: in Jaya Wijaya Mt. in Welarek village, Wamena.

Ecology: On the slope of the mountains, primary forest, mossy. It is associated with mid-high canopy tree species in rainforest, such as *Aghthis* sp., *Podocarpus* sp., *Intsia bijuga*, *Pandanus*.

Soil types include sticky yellow to red clays. Typically acid (pH 4.8-5.6), with a thick humus layer, often with a dense humus root mat. In the seasonal swamp soils the most common soil type is sandy (Gunn, 2003).

3. West Papua (Merauke, Agat, Mappi and Boven Digul)

Gyrinops caudate (Gilg.) Domke.

Shrub or tree up to 17 m by 36 cm. *Branchlets* grayish, whitish pubescent and glabrescent. *Leaves* chartaceous, glabrous, dull beneath and shining above, elliptic-oblong, ovate-oblong, rarely lanceolate, 6-13 by 1½-4 cm; base cuneate; apex up to 1½ cm, acuminate; nerves and veins scarcely distinguishable, numerous, parallel, visible beneath, obscure above; petiole ± 3 mm. *Inflorescences* axillary or on the terminal of short branches, 12-18 flowers, peduncle 2-8 mm. *Flowers* c. 5 mm pedicelled 5-7 mm, floral tube copular, 3-4 mm long, calyx lobes oblong, 1 mm long, petaloid appendages transverse oblong, c. ½ mm long; stamen subsessile, slightly longer than the appendages. Ovary ovoid, densely pillose; style very short; stigma capitate. *Fruit* protruding from the flower, rhombicus-oblong, constricted from the base to apex, pubescent, 2¹/₅ cm included 5 mm stipes, apex acuminate, two locus with 2 seeds. *Seeds* ovoid, apex acuminate c. 5 mm included caruncle 1 mm.

Flowering and *fruiting* season on August-September.

Distributed: Agat, Mappi and Boven Digul and Merauke, West Papua.

Ecology: primary forest in the swamp, 5-20 m above the sea, among in the sago plant, the most common soil type is sandy clay over clay. This plant was cultivated in Aboge and Ecy village, District Assue, Mappi.

4. Biak

Phaleria nisdai Kanehira

Shrub c. 2 m, branchlets reddish-brown. *Leaves* lanceolate, ovate-oblong, 8½-14 by 2½-4 cm, base cuneate, apex acuminate and narrow c. 1½ cm, glabrescent on the both surfaces, dull beneath, nerves 5-9 pairs, elevation, decendent, veins reticulate, beneath distinct, obscure above. *Inflorescences* terminal and or at a long axils of branchlets, umbelliform, 10-12 flowers, one peduncle each nodes, peduncles 6-8 mm, small bracts at the base, involucre bracts 2, 2½ by ½ mm opposite, oblong, persistent or caudocous when anthesis. *Floral tube* c. 1½ cm, Floral tube gradually enlarged towards the top, glabrous outside. In side, calyx lobes oblong or ovale 4 by 2 mm glabrescent on the both surfaces, papillate, appendages petaloid, stamens, styles exerted up to 6 mm, ovary. *Fruit* obovate slightly compressed and constricted from the base to apex, usually 2 fruits opposite each peduncle, yellow when ripe,

3-4½ by 5-6½ cm, two locus usually with 2 seeds. *Seeds* subglobose c. 2 by 1½ cm slightly compressed.

Distributed: PNG. This plant was cultivated in Yomdory village Biak Papua.

***Gyrinops* sp.**

Tree, branchlet brown, pubescent, bark grey. *Leaves* subcoriaceous, lanceolate, 8.5-13.5x2-3.9 cm, base cuneate, apex up to 1.5 cm caudate, pubescent on the nerves and vein scattered beneath; vena partalel, 26-36 pairs; petiole pubescent, 4-7 mm.

These plants were found in secondary forest in Yomdory village, west Biak, Papua. In this village this *gaharu* has been cultivated since 2003.

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