

Biological and economic value of *Dipterocarpaceae*, the main timber forest product of Indonesia

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ABSTRACT

Dipterocarpaceae is known as a very important tree family both biologically and economically. Its distribution around the world covers the areas of Peninsular Malaysia, the Philippines, Sumatra, Kalimantan, Java, Sulawesi, Maluku to Papua. *Dipterocarpaceae* family has a high economic value, such as producing wood, balsam, resin, charcoal, fat, fruit, bark, essential oil, and camphor. Its products have very important roles for domestic use and export needs. As representatives of *Dipterocarpaceae*, the economic value of *Shorea* Roxb. ex Gaertner f, *Dipterocarpus* Gaertner f, and *Dryobalanops* Gaertner f will be discussed. Considering the very important role of *Dipterocarpaceae*, both biologically and economically, it is necessary to handle it sustainably, through the following actions such as conservation of genetic resources, seed physiology, seed handling, seedling ecology, root symbiosis and nutrition, pest and disease, management of natural forest, and plantation, and also non-timber forest product from *Dipterocarpaceae*.

ABSTRAK

Dipterocarpaceae dikenal sebagai famili pohon yang sangat penting baik secara biologis maupun ekonomis. Penyebarannya di seluruh dunia meliputi wilayah Semenanjung Malaysia, Filipina, Sumatera, Kalimantan, Jawa, Sulawesi, Maluku hingga Papua. Famili *Dipterocarpaceae* memiliki nilai ekonomi yang tinggi, seperti menghasilkan kayu, balsam, damar, arang, lemak, buah, kulit kayu, minyak atsiri, dan kapur barus. Produk-produknya memiliki peran yang sangat penting untuk kebutuhan domestik dan ekspor. Sebagai perwakilan *Dipterocarpaceae*, nilai ekonomi *Shorea* Roxb. ex Gaertner f, *Dipterocarpus* Gaertner f, dan *Dryobalanops* Gaertner f akan dibahas. Mengingat peranan *Dipterocarpaceae* yang sangat penting, baik secara biologis maupun ekonomis, maka perlu dilakukan penanganan secara berkelanjutan, melalui tindakan-tindakan seperti konservasi sumber daya genetik, fisiologi benih, penanganan benih, ekologi semai, simbiosis dan nutrisi akar, hama dan penyakit, pengelolaan hutan alam, dan perkebunan, serta hasil hutan bukan kayu dari *Dipterocarpaceae*.

Keywords: *biological, Dipterocarpaceae, economic, Indonesia, non-timber forest product*

INTRODUCTION

Timber is very important in South East Asian countries in the present stage of their economic development. Malaysia and Indonesia are well in the lead of the exporting countries of tropical timber. Throughout Malaysia, Brunei, and western Indonesia most lowland rain forests are dominated by a vast diversity of tree species of the family *Dipterocarpaceae* (Whitmore, 1986). Dipterocarp genera and species represent a particularly valuable contribution to the world's timber resources and are the most important element in the productive forests of South East Asia (Soerianegara and Lemmens, 1994; Yamada, 1997).

Dipterocarpaceae are probably the most recognized trees in the tropics. The pantropical *Dipterocarpaceae*, have a wide distribution throughout tropical Asia. Each country has from 1 to 200 species, so their use is very different in each country and the history of their management is different in each country, as can be seen from the differences in the strength of the research and development institutions. Information is shared between countries in the region on the management of

Dipterocarpaceae, through technical reports, proceedings and other scientific publications (Ashton, 1982; Stone, 1983; Appanah and Turnbull, 1994).

Dipterocarpaceae with their round, straight and beautiful stems, occur in the lowland tropical rainforest of the Malesia region, which includes Indonesia, Malaysia, the Philippines, and Papua New Guinea. They require rainfall of more than 1000 mm per year and/or a dry season of less than six months. At an altitude of more than 1000 m above sea level and less than 700 m above sea level, this family is less common. *Dipterocarpaceae* disappear at altitudes between 1,000 and 1,500 m; above 1,500 m, montane forest appears, in which the principal flora consists of *Fagaceae* (Yamada, 1997).

In Malesia there are three demarcation nodes, meaning that there are plant genera whose distribution limits stop at certain places. The first is located between the Australian continent and New Guinea (984 genera); second, located between the Philippines and Taiwan (686 genera); and third, between Malaysia and Thailand (575 genera) (Steenis, 1951; Stone, 1983).

More globally, the *Dipterocarpaceae* subfamily *Pakaraimaena* is found in the western part of Guyana in

Southern America the sub-family *Monotoideae* is found in Africa and Madagascar; and the sub-family *Dipterocarpoideae* occurs from Seychelles to East India and Malesia (Ashton, 1982; Stone, 1983).

Dipterocarps in Malesia occur in varying habitats and conditions, including (i). seasonal and non-seasonal areas; (ii). West Malesia Region, in nonseasonal areas, including the Philippines; (iii). Areas of red-yellow to dry soil and of moderate to low fertility, mostly on hilly coasts and islands, and some up to hilltops; and (iv). A small proportion of *Dipterocarpaceae* are riparian species, some of which disperse rapidly through water using their drifting fruits (Steenis, 1951; Ashton, 1982; Stone, 1983).

In general, the forests in the Malesia region are much richer than the forests in Africa and tropical America. For example, in the Dipterocarp forest in Wanariset, East Kalimantan, the number of tree species with a diameter of 10 cm and above reaches 239 in a 1.6 ha plot, making this forest the richest in Indonesia and the second richest in the world (Kartawinata et al., 2008). In East Malesia, the rain forest is generally low in stature and open with tall, large and emergent trees making up the main canopy.

The economic value of the *Dipterocarpaceae* forest, among others, is as a producer of both timber and non-timber products: wood, bark, balsam, resin, charcoal, fat, fruit, essential oil, and camphor. The biological value and economic importance of *Dipterocarpaceae* can be seen from their very dominant distribution in Southeast Asia.

BIOLOGICAL VALUE

Ecology of *Dipterocarpaceae*

The history of *Dipterocarpaceae* botany, as understood in modern terms, started more than two centuries ago when Rumphius first mentioned the family in 1750. At that time dipterocarp forests were considered to be inexhaustible sources of wild products. The dipterocarps were thought to dominate extensively throughout southeast Asia. As soon as the high value of their products (camphor, resins, timber) was perceived funds were made available for botanists to conduct expeditions and laboratory research. At present, underestimated and unrestricted exploitation has encouraged excessive harvesting of dipterocarps and together with modern technologies and economics, has finally endangered the future of dipterocarp forests (Maury-Lechon and Curtet, 1998).

The heartwood of Dipterocarps is dark color, sometimes containing resin, when wet it is red or reddish brown and when dry it is brown, gray-brown or red-brown. The wood weight is rather heavy to heavy, hard, coarse-grained, strong but only moderately durable, in a fresh state it is difficult to saw because of the high resin content (Heyne, 1987).

Dipterocarpaceae were distributed in the some types formation forest of Indonesia. Whitmore (1986), Soerianegara and Lemmens (1994) distinguished major forest formations on the basis of climatic and edaphic conditions. The forest formations are briefly described below, and some characteristic trees are mentioned:

- Tropical lowland evergreen rain forest. This is the predominant forest formation in South East Asia; it occurs in places where water stress is absent or only brief and intermittent, from sea level up to 1200 m altitude. It has the largest number of species. In western Malesia dipterocarps are dominant (especially species of the genera *Shorea*, *Dipterocarpus*, *Dryobalanops*, *Parashorea* and *Anisoptera*). The forest trees are very tall.
- Tropical semi evergreen rain forest. This type of forest formation is predominant in the seasonal regions of South East Asia; it occurs in places with regular annual water stress due to rainfall regime or soil conditions. The number of species is high but less than in the evergreen rain forest, and it contains fewer dipterocarps.
- Heath forest (also called "kerangas"). Heath forest develops over coarse siliceous deposits giving rise to podzols. It occurs particularly in Borneo. The storey formed by large saplings and small poles predominates and the canopy is low and uniform. Dipterocarps, mainly heavy wooded species, are often dominant among the larger trees (e.g. *Cotylelobium*, *Hopea* (giam) and *Shorea* (balau) species); Natural regeneration is often very slow because of the extreme poverty of the soil.
- Forest on limestone and ultrabasic rocks. Limestone hills provide a diversity of habitats and soils but the forest has no commercial value. Beach vegetation. On the beach ridge (the low ridge at the inland margin of a sandy beach) a vegetation type is found that is called the *Barringtonia* association. Typical tree species include *Barringtonia asiatica*, *Calophyllum inophyllum*, *Casuarina equisetifolia*, *Cocos nucifera*, *Terminalia catappa* and *Hibiscus tiliaceus*.
- Mangrove and brackish water forest. These forest formations occur in estuaries, deltas and mud flats subjected to regular tides. Peat swamp forest. A very special type of forest is found on peat soils, which are acid and fed only by rain water. It is particularly widespread in eastern Sumatra, near the coasts of Peninsular Malaysia, Borneo and Irian Jaya. The forest often has distinct zones from the outer part of the peat swamp to the inner part. Characteristic species are: *Copaifera palustris*, *Cratoxylum arborescens*, *Dactylocladus stenostachys*, *Dryobalanops rappa*, *Gonystylus bancanus*, *Shorea albida* (northern Borneo) and *Tetramerista glabra*.

- Freshwater swamp forest. This type of forest occurs where the soil is regularly inundated with mineral rich fresh water. Some typical trees are *Alstonia*, *Campnosperma*, *Dyera*, *Melaleuca* and *Palaquium* species.
- Monsoon forest and tropical moist deciduous forest. These forest formations occur in a seasonal climate where water is periodically limiting to plant growth. The most important commercial timber species is teak (*Tectona grandis*); other characteristic species are *Dalbergia latifolia* (Thailand, Java) and *Eucalyptus* species (Papua New Guinea).
- Montane forest formations. By comparison with lowland rain forest, the montane rain forest has a lower canopy, with fewer, smaller emergent trees. Trees occurring in seasonally dry sites in the lower montane zone are *Pinus* and *Araucaria* species. *Shorea platyclados* is by far the most common lower montane dipterocarp in Peninsular Malaysia, and in New Guinea lower montane forest is often dominated by *Castanopsis* and *Nothofagus* species.

ECONOMIC VALUE

The wood export quantity of *Shorea spp.* (Meranti), *Dipterocarpus spp.* (keruing), *Dryobalanops spp.* (kapur) and *Gonyostilus spp.* (ramin) were very high per year. The total annual export of Indonesian timber (in 1989) it was worth 3,317 US\$, consisted of plywood 2,694 US\$ and sawn timber 623 US\$. Meranti (*Shorea*) and Kapur/Keruing (*Dryobalanops/Dipterocarpus*) are the biggest contributor of the timber trade from Indonesia. Contribution of each species, were Meranti (*Shorea*) 1,408,000 m³ (52%), Kapur/Keruing (*Dryobalanops/Dipterocarpus*) 463,000 m³ (17%), Pulai (*Alstonia*) 90,000 m³ (3%), Teak (*Tectona grandis*) 46,000 m³ (2%), Other timbers 2,692,000 (25%) (PROSEA, 1994).

Comparing in 2000, the timber production of Indonesia consists of logs 13,798,240 m³, sawn wood 2,789,543 m³, and plywood 4,442,735 m³ (BPS, 2011). In 2020, the timber forest production of Indonesia was 4,730.23 m³. The big four was meranti 34.75%, red meranti 13.82%, merbau 12.89% and acacia 10.58%. The other timbers, such as yellow meranti, mixed wood, bangkirai and kapur was around 2.5 to 7.01% (BPS, 2021).

As a representative of *Dipterocarpaceae*, genera of *Shorea* Roxb. Ex Gaertner f, *Dipterocarpus* Gaertner f, and *Dryobalanops* Gaertner f will be described according to trade groups, origin and geographic distribution, economical use, production and international trade in Indonesia, properties, description, wood anatomy as macroscopic character, and microscopic characters, other botanical information, propagation and planting, diseases and pests, harvesting, genetic resources,

breeding, and prospect species of (Soerianegara and Lemmens, 1994), as below:

Shorea Roxb. Ex Gaertner f. (red meranti)

In trade groups, *Shorea* is known as light red meranti and dark red meranti. consists of 194 species, 163 of which occur in Malesia. *Shorea* is used economically as the most important timber genus in the humid Asian tropics. Production and international trade in Indonesia is only export figures for sawn meranti as a whole are available. Wood properties red meranti is a light to medium heavy hardwood. Morphology description, medium sized to very large trees up to 60(-70) m tall; bole straight, cylindrical; diameter of 70-180 (-255) cm. Wood anatomy as macroscopic character is hearthwood light red, and microscopic characters its growth rings usually absent or distinct. Other botanical information, that at infrageneric level the species may be classified by anatomical features of the wood and bark. Propagation and planting, that until recently *Shorea* species were never planted. The only method for propagation was by seed, but without infection by suitable ectomycorrhizal fungi, attempt to grow seedlings failed. Natural regeneration and growth of planted seedlings in logged over or planted forest is generally satisfactory, but canopy manipulation is often needed for optimal growth of seeding and saplings. Diseases and pests is *Fusarium* fungi may kill seedlings. When harvesting of red meranti, logs float in water and can be transported by river. This is commonly practiced in Kalimantan. Yield of species, in forest of Kalimantan the standing volume of trees over 60 cm in diameter is usually 60-90 m³/ha, and 110 is not exceptional. Genetic resources, that a timber grade group including a large number of species blurs information on individual species threatened extinction, and such species may therefore receive insufficient protection. No breeding has been done, so far. Prospect species that producing red meranti are very promising for the establishment of large scale plantation (Ashton, 1982).

The other selected red meranti are *Shorea acuminata* Dyer, *S. albida* Sym, *S. almon* Foxw, *S. amplexicaulis* P. Ashton, *S. Argentifolia* Symp, *S. balangeran* (Korth.) Burck, *S. beccariana* Burck, *S. contorta* S. Vidal, *S. coriacea* Burck, *S. curtisii* Dyer ex King, *S. dasyphylla*, *S. fallax* Meijer, *S. ferruginea* Dyer ex Brandis, *S. flemmichii* Symp, *S. hemsleana* (King) King ex Foxw, *S. inaequilateralis* Sym, *S. johorensis* Foxw, *S. lepidota* (Korth.) Blume, *S. leprosula* Miq, *S. macrantha* Brandis, *S. macrophylla* (de Vriese) P Aston, *S. macroptera* Dyer, *S. mecistopteryx* Ridley, *S. negrosensis* Foxw, *S. ovalis* (Korth.) Blume, *S. ovata* Dyer ex Brandis, *S. pachyphylla* Ridley ex Sym, *S. palembanica* Miq, *S. palosapis* (Blanco) Merr, *S. parvipolia* Dyer, *S. pauciflora* King, *S. pinanga* R. Scheffer, *S. platycarpa* Heim, *S. platyclados* v. Slooten ex Foxw, *S. polysperma*, *S. quadrinervis* v Slooten, *S. rugosa* Heim, *S. scaberima* Burck, *S. scabrifa* Sym, *S. selanica* (DC.) Blume, *S. singkawang* (Miq.) Miq, *S. smitiana* Sym,

S. splendida (de Vriese) P. Ashton, *S. stenoptera* Burck, *S. teysmaniana* Dyer ex Brandis, *S. uliginosa* Foxw, and *S. venulose* Wood ex Meijer (Soerianegara and Lemmens, 1994).

***Shorea* Roxb. Ex Gaertner f. (white meranti)**

In trade groups it is known as white meranti, light weight hardwood. It has vernacular names white meranti, meranti putih, damar meranti. Origin and geographic distribution of *Shorea* consists of about 194 species, 163 of which occur in Malesia. *Shorea* is used economically as the most important timber genus in the humid Asian tropics. Production and international trade for Indonesia, only export figures for sawn meranti as a whole are available. Properties of white meranti is a lightweight hardwood. Description of trees is medium sized to very large trees up to 60 m tall; bole straight, cylindrical; diameter of 70-180 (-255) cm. Wood anatomy, as macroscopic character that its hearth-wood almost white, and as microscopic characters it growth rings usually indistinct or absent. Growth and development, that seedlings need shade until they reach a height of about 1,5 m. Other botanical information that anatomical feature of the wood and bark, as well as anther characters, provide useful evidence for classification of species at intrageneric level. Ecology of *Shorea* that species are confined to tropical climates with a mean annual rainfall exceeding 1600 mm and wit a dry season of less than 6 months. Propagation and planting, that seeds rapidly lose their viability. Stem cutting of *S. bracteolate* treated with growth regulators and planted in coarse river sand show 100% rooting success. The best planting material is 50-100 cm tall seedlings in the nursery, wildlings, or stump cuttings. Silviculture and management that natural regeneration of white meranti species in the forest is often gregarious. Diseases and pests that in plantation of *S. javanica* easily become infested by galls caused by bacterium *Phytopomonas tumefaciens*. Harvesting of trees in mix dipterocarp forest in Indonesia trees of over 50 cm in diameter are harvested, and at least 25 healthy trees/ha of 20-50 cm in diameter are left for future cut. Genetic resources that when large scale logging is practice without distinction at species level, certain species can become endangered. Prospect, that white meranti seem to have good potential for large scale enrichment planting and for the establishment of timber plantations, especially for plywood reproduction.

The other selected white meranti are *S. agamii* A. Ashton, *S. assamica* Dyer, *S. bentongensis* Foxw, *S. bracteolate* Dyer, *S. dealbata* Foxw, *S. gratissima* (Wallich ex Kurz) Dyer, *S. henryana* Pierre, *S. hypochra* Hance, *S. javanica* Koord. & Valetton, *S. lamellate* Foxw, *S. ochracea* Sym, *S. polita* S. Vidal, *S. resinosa*, *S. retinodes* v Slooten, *S. roxburghii* G. Don, *S. virescent* Parisjs (Soerianegara and Lemmens, 1994).

***Shorea* Roxb. Ex Gaertner f. (yellow meranti)**

In trade groups it is known as yellow meranti, light weight hardwood. Vernacular names is yellow meranti. Origin and geographic distribution of *Shorea* consists of about 194 species, 163 of which occur in Malesia. *Shorea* is used economically as the most important timber genus in the humid Asian tropics. Production and international trade for Indonesia, that only export figures for sawn meranti as a whole are available. Properties, yellow meranti is a lightweight hardwood. Description, medium sized to very large trees up to 60 (-75) m tall; bole straight, cylindrical; diameter of 150(-300) cm. Wood anatomy as macroscopic character that heartwood pale with age, often to light brown with yellowish tinge, and as microscopic characters that growth ring indistinct or absent. Growth and development, that the growth rates differ considerably between species. Other botanical information that anatomical feature of the wood and bark, useful evidence for classification of species at intrageneric level. Ecology, *Shorea* species are confined to tropical climates with a mean annual rainfall exceeding 1600 mm and wit a dry season of less than 6 months. Propagation and planting that seeds rapidly lose their viability. Silviculture and management that natural regeneration of yellow meranti may be abundant. Diseases and pests that many animal such as wild boars, squirrels and various kinds of insects feed on seeds and young plant. Harvesting in mix dipterocarp forest in Indonesia trees of over 50 cm in diameter are harvested, and at least 25 healthy trees/ha of 20-49 cm in diameter are left for future cut. Genetic resources that may easily lead to endangerment of species if large-scale logging without distinction at species level is practiced. Prospect, by comparison with red meranti and white meranti, not much is known about the propagation, planting and silviculture of yellow meranti.

Selection species of yellow meranti are *Shorea acuminatissima* Sym, *S. balanocarpoideis* Sym, *S. blumutensis* Foxw, *S. faguetiana* Heim, *S. gibbosa* Brandis, *S. hopeifolia* (Heim) Sym, *S. laxa* v. Slooten, *S. longiflora* (Brandis) Sym, *S. longismerpa* Roxb, *S. maxima* (King) Sym, *S. multiflora* (Burck) Sym, *S. polyandra* P. Ashton, *S. xanthophylla* Sym (Soerianegara and Lemmens, 1994).

***Shorea* Roxb. Ex Gaertner f. (balau and red balau)**

In trade groups balau is known as heavy hard hardwood, and Red balau as heavy hard hardwood. It has vernacular names of Balau (Indonesia: damar laut). Origin and geographic distribution of *Shorea* consists of about 194 species, 163 of which occur in Malesia. Uses *Shorea* is economically the most important timber genus in the humid Asian tropics. Production and international trade for Indonesia, that no export figures for balau and red balau are available. Properties of balau is heavy hardwood. Description, medium sized to very large trees

up to 60 (-75) m tall; bole straight, cylindrical; diameter of 180(-300) cm. Wood anatomy as macroscopic character it has heartwood yellowish brown when freshly cut, and as microscopic characters that growth ring indistinct or absent. Growth and development, optimal growth of seedlings was between 30-50% relative light intensity. Other botanical information, that anatomical feature of the wood and bark, useful evidence for classification of species at intrageneric level. Ecology, Shorea species are confined to tropical climates with a mean annual rainfall exceeding 1600 mm and with a dry season of less than 6 months. Propagation and planting that trials on propagation of balau and red balau have been carried out occasionally. Silviculture and management that under selective cutting systems, natural regeneration may be good, at least locally. Diseases and pests, that Seed and seedlings are regularly attacked by insect. Harvesting that the estimated average standing stock of balau in Indonesia is 4 m³/ha for trees with diameter exceeding 50 cm, and 4.5 m³/ha for trees with diameter exceeding 35 cm. Genetic resources, that some species are threatened in specific areas and should be protected. Prospect that in this reserves the forest should be kept free from any human disturbance.

Other selection species of balau and red balau are *Shorea astylosa* Foxw, *S. atrinervosa* Sym, *S. ciliate* King, *S. collina* Ridley, *S. elliptica* Burck, *S. exelliptica* Meijer, *S. falcifera* Dyer ex Brandis, *S. falciferoides* Foxw, *S. foxworthyi* Sym, *S. geniculate* Sym. Ex P. Ashton, *S. glauca* King, *S. guiso* (Blanco) Blume, *S. havilandii* Brandis, *S. kurnstleri* King, *S. laevis* Ridley, *S. lumutensis* Sym, *S. malibato* Foxw, *S. materialis* Ridley, *S. maxwelliana* King, *S. obtuse* Wallich ex Blume, *S. ochrophloia* Strugn. Ex Sym, *S. acrobiculata* Burck, *S. seminist* (de Vriese) v. Slooten, *S. siamensis* Miq, *S. submontane* Sym, *S. sumatrana* (v.Slooten ex Thorenaar) Sym. Ex Desch, *S. superba* Sym (Soerianegara and Lemmens, 1994).

***Dipterocarpus* Gaertner f.**

Trade group: keruing. Vernacular name: Keruing. Origin and geographic distribution, that *Dipterocarpus* consists of some 70 species and is distributed from Sri Lanka, India and Burma, through Indochina, Southern China and Thailand towards western Malesia. Uses of Keruing is an important source of general construction timber, for medium and heavy construction. Production and international trade, Keruing is one of the most important export timbers of South East Asia, second only to meranti. In Indonesia keruing is exported together with kapur (*Dryobalanopsis* spp.) in a combine export group.

Properties of Keruing is moderately heavy to heavy hardwood. Keruing description, that Medium-size to large, resinous tree of up to 65 m tall; bole usually branchless for as much as 35 m, straight with little taper with a diameter often exceeding 150 cm with a

maximum of 260 cm and usually with small and concave or sometimes tall and straight stout buttresses.

Wood anatomy. Macroscopic characters. Heartwood varying from greyish-brown, pink brown to red brown. Microscopic characters of growth rings indistinct. Growth and development, that viable fruits start to germinate a few days to a few week after they have fallen on the ground. Other botanical information that genus *Dipterocarpus* is characterized by its dark with warty lenticels. Ecology Keruing, that most species grow scattered, but some, such as *D. elongatus*, *D. gracilis* and *D. obtusifolius*, frequently occur gregariously.

Propagation and planting, that viability of the seeds is short. Silviculture and management that Keruing seedlings can persist in the forest for years under heavy shade. Diseases and pest that insect may damage seeds. Harvesting of Keruing timber is usually obtained from natural forest using selective cutting systems. Genetic resources, that although keruing is common over large areas, and is often outnumbered only by meranti (*Shorea* spp.), the trees usually occurs scattered.

Selected species are *Dipterocarpus acutangulus* Vescue, *D. alatus* Roxb. Ex G. Don, *D. applanatus* v. Slooten, *D. baudii* Korth, *D. borneensis* v. Slooten, *D. caudatus* Foxw, *D. chartaceus* Sym, *D. confertus* v Slooten, *D. conformis* v. Slooten, *D. Cornutus* Dyer, *D. costatus* Gaertner f, *D. costulatus* v. Slooten, *D. crinitus* Dyer, *D. dyery* Pierre, *D. eurynchus* Miq, *D. geniculatus* Vesque, *D. globosus* Vesque, *D. gracilis* Blume, *D. grandifloras* (Blanco), *D. hasseltii* Blume, *D. humeratus* v Slooten, *D. kerrii* King, *D. kunstleri* King, *D. lowii* Hook.f, *D. mundus* v Slooten, *D. oblongifolius* Blume, *D. obtusifolius* Teijsman. Ex Miq, *D. palembanicus* v. Slooten, *D. retusus* Blume, *D. rigidus* Ridley, *D. sublamellatus* Foxw, *D. tempehes* v. Slooten, *D. Validus* Blume, *D. verrucosus* Foxw. Ex v. Slooten (Soerianegara and Lemmens, 1994).

***Dryobalanops* Gaertner f.**

Trade group is keruing. Vernacular name is kapur. Origin and geographic distribution, that *Dryobalanops* consists of some 7 species and is confined to Peninsular Malaysia, Sumatra, Borneo, and intervening islands. Uses of kapur is an important construction timber for local use.

Production and international trade, that kapur is a commercially important timber, particularly in Borneo. Properties of Kapur is moderately heavy timber. Description, that Large or very large, occasionally medium-sized trees, up to 60 (-75) m tall, with a straight, columnar bole, often up to 150 (-200) cm in diameter. Wood anatomy, that Macroscopic characters of Heartwood pink-brown or red-brown. Microscopic characters, that Growth rings indistinct. Growth and development, that Kapur trees are evergreen, and flowering of trees in certain areas is more or less concurrent. Other botanical information, that the genus *Dryobalanops* is homogeneous and well-defined. Ecology.

Kapur often occur gregariously as a canopy tree in lowland dipterocarp forest and mixed peat swamp forest. Propagation and planting. The seed weight is about 6 g to 10 g. Seeds can only be stored for a short period (up to 16 days). Silviculture and management, that Kapur is suitable for management under the selective logging system. Diseases and pest, that brown pinhead spot caused by insect is reported as a leaf diseases. Harvesting, that camphor oil can be obtained by tapping the bole. To collect the solid camphor, the tree must be felled. Yield, that measurements of trees in Peninsular Malaysia have shown that trees with a mean diameter 107 cm have an average timber volume 18.2 m³. Genetic resources, that since *Dryobalanops* species often occur gregariously or semi gregariously, natural regeneration is usually abundant, even in logged-over forest. Prospect, that Kapur seems very suitable for timber production in sustainable managed forest.

Other selected species are *Dryobalanops beccarii* Dyer, *D. fusca* v. Slooten, *D. keithii* Sym, *D. lanceolata* Burck, *D. obongifolia* Dyer, *D. rappa* Becc, *D. sumatrensis* (J.F.) Gmelin Kosterm (Soerianegara and Lemmens, 1994).

Plants are essential for human well-being. Considering the potential value of plants as well as the value of its other benefits, so we need to appreciate the value of ecosystems through conserving biodiversity and ecosystems, while remind that (1) biodiversity is best conserved in its natural habitat, (2) the integrity of an ecosystem is maintained through the interaction of species constituents and the interaction of species with environmental factors, (3) traits species in an ecosystem is the result of these interactions, (4) and knowledge about these species is still minimal, which means that preserving these species individually outside of their original ecosystem is not possible (Kartawinata, 2010).

Widyatmoko (2019), reported that based on threatened in Indonesia, *Dipterocarpaceae* was dominant family that their species threatened (up to 33%), followed by family of *Myristicaceae* (12%), *Nepenthaceae* (7%), dan *Orchidaceae* (5%). This is consequence of plant family that has high commercial value, so their population in the natural forests were degraded.

Woody trees are an element of natural resource production, that plays an important economic role in the Southeast Asian region. Without proper management, excessive use of trees such of logging, shifting cultivation, and various human activities, will result total destruction of tropical forests. Conservation is very necessary for proper management. Considering the very important role of *Dipterocarpaceae*, both botanically and economically, it is necessary to handle it sustainably, through the following actions such as conservation of genetic resources, seed physiology, seed handling, seedling ecology, root symbiosis and nutrition, pest and disease, management of natural forest, and plantation, and also non-timber forest product from *Dipterocarpaceae*.

We need to conserve both in situ and ex situ conservation for this high value of commercial trees species.

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Appendix 1. Economic value and distribution of *Dipterocarpaceae* in Malesia (Heyne, 1987)

No.	Name	Economic Value	Spread
1	<i>Dipterocarpus baudii</i> Korth (Keruwing)	timber	North Sumatran, Peninsular Malaysia
2	<i>D. crinita</i> Dyer (Keruwing bulu)	timber, balsam	East Sumatra, Peninsular Malaysia, Kalimantan
3	<i>D. gracilis</i> Bl. (Damar kacawai)	timber, balsam	All of Western Indonesia
4	<i>D. grandiflora</i> Blanco (Keruwing gombang)	timber, balsam	Philippine, Western Indonesia, except Java
5	<i>D. hasseltii</i> Bl. (Lagan)	timber, balsam	Western Indonesia, in Java is rare
6	<i>D. kunsleri</i> King. (Lagan)	timber, balsam	Sumatra
7	<i>D. marginata</i> Korth. (Keruwing)	timber, charcoal	Kalimantan
8	<i>D. retusa</i> Bl. (Palahlar)	timber	West Java, Central java
9	<i>D. Skinneri</i> King. (Keruwing bulu)	timber, balsam	Peninsular Malaysia
10	<i>D. tampurau</i> Korth. (Tampurau)	timber, plank	Kalimantan, Sumatra, West Java
11	<i>D. trinervil</i> Bl. (Palahlar)	timber, balsam	Java
12	<i>D. warburgii</i> Brandis (Day)	timber	Central Kalimantan
13	<i>Anisoptera costata</i> Korth (Entenam, Tenam)	timber, resin	Western Indonesia
14	<i>A. marginata</i> Korth (Tenam, Resak gunung)	timber, resin	Western part of Indonesia (East Sumatra, Southeast Kalimantan)
15	<i>Dryobalanops champora</i> Colebr (Kayu kapur, kapur baru)	wood, resin, camphor, essential oil, fruit	North Sumatra (Tapanuli), West Sumatra
16	<i>D. oblongifolia</i> Dyer (Keladan, Petanang)	timber, fruit	Palembang, Kalimantan (to the west)
17	<i>D. oiocarpa</i> V.Sl. (Kayu kapur, Sintek)	timber	East Kalimantan
18	<i>Hopea selebica</i> Burck (Damar dere hitam)	timber	East Sulawesi
19	<i>H. mengarawan</i> Miq. (Merawan, Emang besi)	timber, bark, resin	West Nusantara (West Kalimantan, Southeast)
20	<i>H. sangal</i> Korth (Damar putih, Cengal)	timber, leather, resin	Lebong, Southeast Kalimantan, Bangka, Java
21	<i>Shorea acuminata</i> Dyer (Meranti hijau); dark red meranti	timber, resin	Peninsular Malaysia
22	<i>S. balangeran</i> Burck (Kaweh, Kahoi, Melangir)	timber, resin	Bangka, Belitung, Kalimantan
23	<i>S. bracteola</i> Dyer (Kedontang, Kayu putih)	timber	Bengkulu, Palembang
24	<i>S. collina</i> Ridley (Balau bukit)	timber, resin (low quality)	Malaka
25	<i>S. curtisii</i> King	timber	
26	<i>S. exemia</i> Scheff (Kalup, Lungkong)	timber, resin	Bangka, Belitung, South Sumatra, Lampung

27	<i>S. glauca</i> King (Simanto, Rasak)	timber, resin	Aceh, Simelue Island
28	<i>S. gibbertiana</i> Burck (Tengkawang layar, T. telur)	timber, fruit	West and Southeast Kalimantan (Sampit)
29	<i>S. kordersii</i> Brandis (Tenang, Asi-asin)	timber, resin	North Sulawesi, North Maluku
30	<i>S. leavis</i> Ridl. (Kumus)	timber, resin	Malay Peninsula
31	<i>S. lepidota</i> Bl. (Meranti beras, Tengkawang majau)	timber, resin, fruit	Palembang, West Sumatra, West-South-East Kalimantan
32	<i>S. leprosula</i> Miq. (Damar kerakah, Meranti sarang punai)	timber, resin	Aceh, Palembang, East Sumatra, West Sumatra, West-South-East Kalimantan
33	<i>S. macroptera</i> Dyer (Kayu kuning)	timber, resin	Malay Peninsula, Singkep Island
34	<i>S. martiniana</i> Scheff (Tengkawang pinang)	timber, resin	Sambas
35	<i>S. materialis</i> Ridl. (Balau betul)	timber, resin	Malay Peninsula
36	<i>S. parvifolia</i> Dyer (Meranti daun kecil, M.semak)	timber	Malay Peninsula
37	<i>S. rigida</i> Brandis (Kepung labu)	timber	Malay Peninsula
38	<i>S. scaberrima</i> Burck (Tengkawang babi)	timber	West Kalimantan (Sambas)
39	<i>S. selanica</i> Bl. (Kayu bapa, Bahut)	timber, resin	Maluku (P. Buru)
40	<i>S. singkawang</i> Miq. (Sengkawang, Tengkawang lisum)	timber, fat	Sumatra (Rawas, Minang), Malay Peninsula, Kalimantan
41	<i>S. stenoptera</i> Burck (Tengkawang tungkul)	fruit, resin	West Kalimantan (cultivated)
42	<i>S. teysmanniana</i> Dyer (Sasak)	timber, leather	Bangka
43	<i>S. utilis</i> King (Damar laut no. 1)	timber	Malay Peninsula, North Sumatra
44	<i>Parashorea lucida</i> Kurz. (Meranti hitam, Timbalon)	timber	West and Central Sumatra
45	<i>P. stellata</i> Kurz. (Damar laut, Seraya, Meranti)	timber (soft)	Malay Peninsula, Sumatra
46	<i>Isoptera borneensis</i> Scheff (Tengkawang tertindak)	timber, resin, fat	West and Southeast Kalimantan (Sampit)
47	<i>I. sumatrana</i> V. Sl. (Tengkawang)	timber, resin, fat	Palembang, West Sumatra
48	<i>Balanocarpus spec.</i> di\ v (Cengal)	timber, resin	Malay Peninsula
49	<i>Vatica bancana</i> Scheff (Resak gelingga, Kayu daging)	timber	Bangka, Belitung, Palembang, Lampung
50	<i>V. cupularis</i> V. Sl. (Damar tingkis, Rasak)	timber	Southeast Kalimantan
51	<i>V. faginea</i> Dyer (Damar batu)	timber, resin	Southeast Kalimantan
52	<i>V. leucocarpa</i> Foxw (Resak bukit)	timber	Riau Island, West Kalimantan
53	<i>V. papuana</i> Dyer (Damar alung, Salo hiru)	timber, resin	East Kalimantan, North Maluku, Irian Jaya
54	<i>V. rassak</i> Bl. (Rasak danau)	timber, resin	West Kalimantan, Southeast Kalimantan
55	<i>V. simalurensis</i> V. Sl. (Siloki, Silongkis)	timber	Simelue Island

56	<i>V. songa</i> V. Sl. (Songa)	timber	Norsala Island (West Sumatra)
57	<i>V. sumatrana</i> V. Sl. (Recop)	timber, resin, fat	Palembang, Lampung
58	<i>V. teysmanniana</i> Burck (Resak ayer, Resak paya)	timber, resin	East Sumatra, Bangka
59	<i>V. wallichii</i> Dyer (Resak ayer, Resak padang)	timber, resin	Malaka, East Sumatra, Kubu
