# DECAY RESISTANCE OF 84 INDONESIAN WOOD SPECIES AGAINST FUNGI

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**SUPRAPTI S. 2010. Decay resistance of 84 Indonesian wood species against fungi.** Eighty-four species of wood from Aceh, Jambi, Riau, Sulawesi, Moluccas, Kalimantan and Java, which cover 36 families and 67 genera, were evaluated for their resistance against brown rot (*Dacryopinax spathularia*) and white rot (*Pycnoporus sanguineus* and *Schizophyllum commune*) attacks using Kolle-flask method (DIN 52176-modified standard). Results showed that the attack of white rot fungi were generally more severe than that of brown rot fungi. It was found that 30 wood species were categorised as resistant (class II), 20 species as moderately resistant (class III), 32 species as non-resistant (class IV) and 2 species as perishable (class V).

Keywords: Brown rot, white rot, *Dacryopinax spathularia*, *Pycnoporus sanguineus*, *Schizophyllum commune*

**SUPRAPTI S. 2010. Kerintangan 84 spesies kayu Indonesia menentang kulat.** Sebanyak 84 spesies kayu yang tergolong dalam 36 famili dan 67 genus dan berasal dari Aceh, Jambi, Riau, Sulawesi, Kepulauan Maluku, Kalimantan and Jawa dinilai dari segi ketahanan menentang serangan reput perang (*Dacryopinax spathularia*) dan reput putih (*Pycnoporus sanguineus* serta *Schizophyllum commune*). Kaedah yang digunakan ialah kaedah kelalang Kolle (standard DIN 52176 yang diubah suai). Pada umumnya keputusan menunjukkan bahawa serangan kulat reput putih lebih teruk berbanding dengan kulat reput perang. Sebanyak 30 spesies kayu dikategorikan sebagai tahan (kelas II), 20 sebagai sederhana (kelas III), 32 sebagai tidak tahan (kelas IV) dan dua sebagai mudah rosak (kelas V).

## INTRODUCTION

The endurance of a wood species to attacks by degrading organisms such as termite, powder-post beetle, marine borer and fungi will determine its natural durability (Martawijaya 1996). Factors that influence wood resistance include site, growth rate, age of tree, portion of wood (heartwood and sapwood), extractive contents in wood and the environment the wood is being exposed to. Wood for building material is assessed by its durability and a low durability would mean a short service life. Therefore, natural durability against decaying organism is an important property in wood. Natural durability of Indonesian woods is divided into five classes, i.e. I to V (Seng 1990). Class I is regarded as durable or most resistant wood and in decreasing order, class V, the lowest resistant or the most perishable wood.

Several researches concerning wood decay resistance against fungi have been reported, e.g. Martawijaya (1975), Amemiya and Matsuoka (1979), Wong (1988), Salmiah and Amburgey (1992), and Sukartana and Highley (1997). However, not much emphasis is given to the classification of natural resistance of Indonesian woods against fungal attack. Therefore, in this study, *in vitro* evaluations on the resistance of wood to fungal decay were made based on mass loss value of post-decay wood blocks. Several species of wood were subjected to fungal decay by exposing them to brown rot (*Dacryopinax spathularia*) and white rot (*Pycnoporus sanguineus* and *Schizophyllum commune*) fungi. These three fungi were categorised as the most virulent fungi capable of attacking almost all wood species (Djarwanto *et al.* 2007). This paper is intended to present the decay resistance of 84 Indonesian wood species against *D. spathularia, P. sanguineus*, and *S. commune* in a laboratory experiment. From this study is also expected that laboratory experiment will shorten the time needed to determine the natural durability of wood.

## MATERIALS AND METHODS

*Dacryopinax spathularia* HHBI-145 (brown rot fungus) and *Pycnoporus sanguineus* HHBI-8149 and *Schizophyllum commune* HHBI-204 (white rot fungi) used in this study were obtained from the forest products fungus collection in Bogor, Indonesia. For this experiment, culture media used was made using 3% malt extract and 2% agar in distilled water. Wood samples containing heartwood were obtained from 84 wood species from Aceh (13 species), Jambi (5 species), Riau (1 species), East Kalimantan (11 species), South Kalimantan (1 species), Central Kalimantan (5 species), Moluccas (1 species), South Sulawesi (1 species), Central Sulawesi (2 species), East Java (1 species) and West Java (44 species). There were 85 wood specimens. Each specimen consisted of 18 samples, in the form of small blocks measuring of 2.5 (width) × 1.5 (thick) × 5 cm (length in the direction of wood grain). Samples were treated by three fungal species with six replicates for each specimen.

The decay test was conducted based on the Kolle-flask method by DIN 52176 standard which has been modified by Martawijaya (1975), and Djarwanto and Suprapti (2004). Culture media used was made using 3% malt extract and 2% agar in distilled water and poured into Kolle-flasks (80 ml for each flask). The flasks were then plugged with cotton and then sterilised in an autoclave at a temperature of 121 °C and pressure of 1.5 atm for 30 min and subsequently allowed to cool. After cooling, the sterilised medium in each flask was inoculated by pure culture of tested fungi. The inoculated medium was then incubated until the mycelium growth on the surface of the medium spread and was distributed evenly and became slightly thick.

Before the tests, all blocks were numbered, oven dried at 105 °C for 24 hours and weighed repeatedly until a constant weight was achieved. Test blocks were then put in pairs on each fungi culture aseptically and incubated for 12 weeks. To determine decay, the percentage of weight loss of wood sample was calculated under oven-dry weight condition before and after incubation and thereafter. To classify wood decay resistance, average weight loss of wood samples were measured and determined (Martawijaya 1975, Djarwanto & Suprapti 2004), and the expectancy of service life for each class was ascertained according to Seng (1990) as shown in Table 1.

## RESULTS AND DISCUSSION

Deterioration of wood could be indicated by its weight loss due to fungal attack. The average weight loss of wood samples varied depending on fungal and wood species (Table 2). Wood which suffered either by brown or by white rot has the common feature of loss in weight and strength (Coggins 1980). Depolymerisation of cellulose by brown rot fungi causes the collapse of wood strength (Highley 1991).

Due to shortening and degradation of wood fibres, *Polyporus hispidus* was able to decrease 20% of impact bending strength (toughness) of ash wood after only two weeks of exposure (Cartwright & Findlay 1943). This was caused mainly by depletion and alteration of the cellulose and its associated pentosans. Martawijaya (1996) stated that impact bending strength of sengon wood (*Paraserianthes falcataria*) decreased 80% 24 weeks after being inoculated with *S. commune*. Generally, weight loss of wood caused by fungal attack depends on wood species and also species and strain of fungi (Takahashi & Nishimoto 1967, Pildain *et al.* 2005).

To justify the resistance of a wood species, it should be stated clearly from which part and

**Table 1** Classification of wood resistance based on weight loss caused by fungi

| Average weight loss (%) | Decay resistance | Resistance class | Expectancy of service life (years) |
|---|---|---|---|
| None or negligible | Very resistant | I | ≥ 8 |
| < 5 | Resistant | II | 6–7 |
| 5–10 | Moderately resistant | III | 4–5 |
| 10–30 | Non-resistant | IV | 2–3 |
| > 30 | Perishable | V | < 2 |

**Table 2** Percentage of weight loss and resistance class of the samples after exposure to fungi

| Class | Origin | Weight loss percentage and resistance | | | Resistance class | |
|---|---|---|---|---|---|---|
| | | *D. spathularia* | *P. sanguineus* | *S. commune* | This study * | Seng ** |
| Class II (Resistant) | | | | | | |
| *Azadirachta indica* | East Java | 0.98 ± 0.49 II | 0.88 ± 0.41 II | 1.59 ± 0.52 II | II | III |
| *Lindera polyantha* | West Java | 1.18 ± 1.05 II | 1.73 ± 0.62 II | 0.81 ± 0.65 II | II | IV/V |
| *Garcinia nervosa* | Aceh | 1.23 ± 0.45 II | 1.29 ± 0.44 II | 1.24 ± 0.39 II | II | IV |
| *Dialium indum* | Aceh | 1.28 ± 0.40 II | 1.27 ± 0.17 II | 1.50 ± 0.27 II | II | I |
| *Tristaniopsis whitheana* | Central Kalimantan | 0.70 ± 0.20 II | 1.05 ± 0.59 II | 2.48 ± 1.01 II | II | I |
| *Shorea laevifolia* | East Kalimantan | 1.34 ± 0.17 II | 1.14 ± 0.11 II | 1.77 ± 0.44 II | II | I–II(III) |
| *S. platyclados* | East Kalimantan | 1.52 ± 0.09 II | 1.01 ± 0.31 II | 1.82 ± 0.47 II | II | III-IV |
| *Acacia mangium* | West Java | 0.59 ± 0.11 II | 0.91 ± 0.61 II | 3.22 ± 0.92 II | II | III |
| *Turpinia sphaerocarpa* | West Java | 1.24 ± 0.94 II | 1.58 ± 0.86 II | 2.37 ± 0.50 II | II | V |
| *Manilkara kanosiensis* | Mollucas/ Maluku | 1.80 ± 0.51 II | 1.63 ± 0.51 II | 1.96 ± 0.35 II | II | I |
| *Vitex cofassus* | Central Sulawesi | 0.93 ± 0.08 II | 1.38 ± 0.15 II | 3.27 ± 1.08 II | II | II–III |
| *Kokoona reflexa* | Aceh | 1.13 ± 0.30 II | 1.80 ± 0.68 II | 3.02 ± 0.89 II | II | - |
| *Dehaasia firma* | Central Kalimantan | 2.39 ± 0.49 II | 2.23 ± 0.62 II | 2.04 ± 0.62 II | II | II |
| *Amoora rubiginosa* | Aceh | 1.96 ± 0.64 II | 1.16 ± 0.25 II | 4.32 ± 1.13 II | II | II–III |
| *Manilkara merrilliana* | South Sulawesi | 2.83 ± 0.27 II | 2.61 ± 0.10 II | 2.80 ± 0.12 II | II | I |
| *Teysmaniodendron symplicioides* | Central Kalimantan | 1.53 ± 0.58 II | 0.50 ± 0.14 II | 7.12 ± 2.06 III | II (II–III) | II–III |
| *Gironniera subaesqualis* | West Java | 2.60 ± 1.08 II | 2.22 ± 1.24 II | 4.37 ± 1.82 II | II | IV/V |
| *Pterospermum elongatum* | Aceh | 6.71 ± 2.11 II | 1.93 ± 0.68 II | 1.47 ± 0.53 II | II (II–III) | - |
| *Vitex pubescen* | West Java | 0.75 ± 0.38 II | 2.96 ± 0.22 II | 6.52 ± 1.94 III | II (II–III) | I |
| *Palaquium gutta* | Jambi | 1.12 ± 0.35 II | 3.67 ± 1.04 II | 6.81 ± 1.41 III | II (II–III) | IV |
| *Trigonopleura malayana* | Central Kalimantan | 3.70 ± 0.13 II | 2.41 ± 0.79 II | 5.73 ± 2.87 III | II (II–III) | IV |
| *Castanopsis tunggurrut* | West Java | 0.51 ± 0.33 II | 1.58 ± 0.49 II | 10.46 ± 1.26 IV | II (II–IV) | II–IV |
| *Litsea odorifera* | West Java | 0.62 ± 0.34 II | 0.57 ± 0.46 II | 11.38 ± 1.67 IV | II (II–IV) | III/IV |
| *Acacia aulacocarpa* | West Java | 1.99 ± 0.81 II | 1.67 ± 0.74 II | 9.30 ± 2.14 III | II (II–III) | - |
| *Planchonia grandis* | East Kalimantan | 1.72 ± 0.71 II | 8.72 ± 2.24 III | 2.76 ± 0.31 II | II (II–III) | II/III |
| *Pinus merkusii* | West Java | 5.52 ± 1.04 III | 4.07 ± 0.99 II | 3.88 ± 0.95 II | II (II–III) | IV |
| *Hymenaea courbaril* | West Java | 1.78 ± 0.85 II | 3.38 ± 1.32 II | 8.99 ± 2.32 III | II (II–III) | III |
| *Lancium* sp. | East Kalimantan | 3.32 ± 1.15 II | 4.51 ± 1.50 II | 6.79 ± 2.18 III | II (II–III) | II |
| *Eucalyptus pellita* | Riau | 0.98 ± 0.52 II | 2.44 ± 0.88 II | 11.26 ± 2.24 IV | II (II–IV) | II |
| *Ganophyllum falcatum* | West Java | 2.24 ± 0.58 II | 11.35 ± .24 IV | 1.17 ± 0.15 II | II (II–IV) | III |

(continued)

**Table 2** (continued)

| Class | Origin | Weight loss percentage and resistance | | | Resistance class | |
|---|---|---|---|---|---|---|
| | | *D. spathularia* | *P. sanguineus* | *S. commune* | This study * | Seng ** |
| Class III (moderately resistant) | | | | | | |
| *Callophyllum grandiflorum* | West Java | 5.46 ± 1.15 III | 3.64 ± 0.83 II | 6.11 ± 1.72 III | III (II–III) | III |
| *Acacia crassicarpa* | South Kalimantan | 1.20 ± 0.37 II | 1.00 ± 0.55 II | 16.51 ± 3.42 IV | III (II–IV) | - |
| *Agathis borneensis* | West Java | 4.79 ± 1.29 II | 9.58 ± 2.27 III | 5.16 ± 0.52 III | III (II–III) | IV |
| *Castanopsis acuminatissima* | West Java | 1.37 ± 0.39 II | 2.46 ± 0.62 II | 16.28 ± 1.05 IV | III (II–IV) | III |
| *Altingia excelsa* | West Java | 1.65 ± 0.17 II | 1.58 ± 0.35 II | 17.11 ± 3.46 IV | III (II–IV) | II–III |
| *Vitex glabrata* | Central Sulawesi | 1.12 ± 0.45 II | 10.74 ± 1.87 IV | 8.84 ± 1.64 III | III (II–IV) | II–III |
| *Pterospermum diversifolium* | Jambi | 2.51 ± 0.88 II | 7.02 ± 1.48 III | 12.91 ± 0.98 IV | III (II–IV) | IV |
| *Endospermum diadenum* | Aceh | 14.13 ± 3.72 IV | 2.93 ± 1.08 II | 5.44 ± 1.80 III | III (II–IV) | - |
| *Tamarindus indica* | West Java | 5.80 ± 0.92 III | 7.47 ± 1.35 III | 10.08 ± 2.43 IV | III (III–IV) | I |
| *Acacia auriculiformis* | West Java | 2.58 ± 0.75 II | 1.79 ± 0.36 II | 19.12 ± 2.84 IV | III (II–IV) | III |
| *Parkia javanica* | Aceh | 10.63 ± 4.18 IV | 9.63 ± 0.99 III | 3.37 ± 0.97 II | III (II-IV) | - |
| *Neolitsea triplinervia* | West Java | 3.54 ± 1.36 II | 5.58 ± 1.39 III | 14.71 ± 3.54 IV | III (II–IV) | III/IV |
| *Diplodiscus* sp. | West Java | 5.78 ± 0.85 III | 7.01 ± 2.02 III | 11.14 ± 1.14 IV | III (III–IV) | - |
| *Artocarpus horridus* | West Java | 4.96 ± 1.46 II | 6.73 ± 0.48 III | 13.63 ± 2.01 IV | III (II–IV) | - |
| *Paraserianthes falcataria* | West Java | 11.07 ± 2.22 IV | 9.35 ± 1.12 III | 5.42 ± 1.11 III | III (III–IV) | IV–V |
| *Mezzettia parviflora* | Aceh | 9.45 ± 2.60 III | 8.99 ± 1.58 III | 8.96 ± 1.80 III | III | V |
| *Cananga odorata* | Aceh | 20.63 ± 3.68 IV | 4.51 ± 1.21 II | 2.61 ± 0.90 II | III (II–IV) | V |
| *Glochidion philippicum* | East Kalimantan | 2.03 ± 0.63 II | 10.63 ± 1.31 IV | 15.23 ± 2.45 IV | III (II–IV) | III |
| *Pouteria duclitan* | West Java | 6.07 ± 1.76 III | 12.83 ± 3.41 IV | 9.22 ± 2.06 III | III (III–IV) | - |
| Class IV (non-resistant) | | | | | | |
| *Xanthophyllum excelsum* | Aceh | 11.54 ± 2.59 IV | 9.58 ± 1.67 III | 8.96 ± 1.80 III | IV (III–IV) | V |
| *Litsea angulata* | West Java | 8.57 ± 1.48 III | 5.91 ± 0.93 III | 17.31 ± 1.41 IV | IV (III–IV) | IV |
| *Drypetes* sp. | East Kalimantan | 2.88 ± 0.98 II | 7.79 ± 2.22 III | 21.26 ± 7.57 IV | IV (II–IV) | III |
| *Cinnamomum iners* | West Java | 2.17 ± 0.15 II | 8.09 ± 1.79 III | 22.93 ± 4.13 IV | IV (II–IV) | IV/V |
| *Ehretia accuminata* | West Java | 1.33 ± 0.78 II | 21.47 ± 5.77 IV | 12.04 ± 1.28 IV | IV (II–IV) | III |
| *Gonystylus macrophyllus* | Aceh | 9.45 ± 2.21 III | 14.92 ± 1.11 IV | 10.73 ± 1.01 IV | IV (III--V) | V |
| *Blumeodendron kurzii* | East Kalimantan | 5.00 ± 1.84 III | 11.47 ± 2.55 IV | 19.68 ± 4.77 IV | IV (III–IV) | IV-V |
| *Mastixia trichotoma* | East Kalimantan | 2.17 ± 0.51 II | 14.79 ± 1.39 IV | 19.95 ± 4.80 IV | IV(II-IV) | V |
| *Ficus nervosa* | West Java | 8.31 ± 1.32 III | 9.64 ± 1.91 III | 20.12 ± 1.99 IV | IV (III–IV) | V |
| *Triomma malacenccensis* | Central Kalimantan | 7.57 ± 1.57 III | 15.78 ± 5.38 IV | 15.56 ± 2.65 IV | IV (III–IV) | IV |
| *Horsfieldia glabra* | West Java | 3.26 ± 0.80 II | 11.03 ± 1.42 IV | 25.23 ± 1.38 IV | IV (II–IV) | V |
| *Hibiscus macrophyllus* | West Java | 1.38 ± 0.46 II | 24.17 ± 1.38 IV | 16.51 ± 2.09 IV | IV (II–IV) | III–IV |

(continued)

**Table 2** (continued)

| Class | Origin | Weight loss percentage and resistance | | | Resistance class | |
|---|---|---|---|---|---|---|
| | | *D. spathularia* | *P. sanguineus* | *S. commune* | This study * | Seng ** |
| *Diospyros macrophylla* | East Kalimantan | 10.76 ± 1.23 IV | 20.44 ± 0.88 IV | 11.03 ± 0.90 IV | IV | V |
| *Macaranga pruinosa* | Jambi | 1.78 ± 0.76 II | 26.74 ± 1.68 IV | 14.10 ± 0.87 IV | IV (II–IV) | V |
| *Koilodepas* sp. | East Kalimantan | 4.50 ± 1.88 II | 15.77 ± 4.35 IV | 22.36 ± 7.27 IV | IV (II–IV) | - |
| *Colona javanica* | West Java | 7.10 ± 1.04 III | 15.17 ± 5.82 IV | 21.46 ± 4.43 IV | IV (III–IV) | V |
| *Sloanea sigun* | West Java | 24.21 ± 4.83 IV | 8.07 ± 2.10 III | 14.97 ± 3.44 IV | IV (III–IV) | V |
| *Sterculia oblongata* | West Java | 29.11 ± 5.99 IV | 5.56 ± 2.61 III | 15.16 ± 2.93 IV | IV (III–IV) | - |
| *Ceiba petandra* | West Java | 16.42 ± 3.01 IV | 18.40 ± 6.59 IV | 15.69 ± 1.42 IV | IV | V |
| *Aleurites moluccana* | West Java | 18.75 ± 7.10 IV | 12.49 ± 1.64 IV | 20.13 ± 4.19 IV | IV | V |
| *Macaranga gigantea* | Jambi | 5.38 ± 0.96 III | 33.22 ± 5.10 V | 13.24 ± 0.41 IV | IV (III–V) | V |
| *Sonneratia caseolaris* | Aceh | 18.75 ± 2.91 IV | 21.27 ± 3.03 IV | 14.66 ± 1.43 IV | IV | V |
| *Acer niveum* | West Java | 20.05 ± 3.86 IV | 20.34 ± 4.17 IV | 14.88 ± 2.72 IV | IV | IV/V |
| *Ficus vasculosa* | West Java | 7.21 ± 1.42 III | 34.76 ± 8.99 V | 13.67 ± 2.13 IV | IV (III–V) | V |
| *Evodia aromatica* | West Java | 14.94 ± 3.69 IV | 24.31 ± 0.38 IV | 17.07 ± 2.27 IV | IV | V |
| *Khaya anthotheca* | West Java | 17.11 ± 3.42 IV | 16.32 ± 3.54 IV | 22.96 ± 5.12 IV | IV | III-IV |
| *Hopea odorata* | West Java | 18.93 ± 3.23 IV | 16.13 ± 6.62 IV | 22.35 ± 7.73 IV | IV | - |
| *Ficus variegata* | West Java | 10.00 ± 1.89 IV | 34.55 ± 9.34 V | 12.94 ± 2.56 IV | IV (IV–V) | V |
| *Hevea brasiliensis* | West Java | 16.28 ± 2.92 IV | 10.70 ± 1.31 IV | 33.58 ± 6.40 V | IV (IV–V) | V |
| *Litsea* sp. | Jambi | 4.36 ± 1.15 II | 29.15 ± 8.29 IV | 28.89 ± 4.04 IV | IV (II–IV) | III-IV |
| *Dracontomelon mangiferum* | West Java | 25.46 ± 6.99 IV | 15.46 ± 4.67 IV | 28.61 ± 7.09 IV | IV | IV |
| *Ficus variegata* | East Kalimantan | 23.06 ± 7.51 IV | 26.41 ± 8.93 IV | 22.84 ± 5.30 IV | IV | V |
| *Melia excelsa* | West Java | 30.13 ± 5.67 V | 18.67 ± 5.51 IV | 27.42 ± 8.89 IV | IV (IV–V) | III–IV |
| *Cinnamomum parthenoxylon* | West Java | 33.70 ± 4.42 V | 22.99 ± 4.72 IV | 30.04 ± 4.25 V | IV (IV–V) | IV |
| Class V (perishable) | | | | | | |
| *Artocarpus gomezianus* | Aceh | 48.97 ± 4.19 V | 36.08 ± 2.56 IV | 17.19 ± 5.07 IV | V (IV–V) | - |
| *Shorea selanica* | West Java | 38.77 ± 4.54 V | 31.27 ± 8.06 V | 39.98 ± 3.83 V | V | IV |

The weight loss data (%) represent average of six replications; roman numbers explain the resistance classes of wood; *= resistance tested based on the average weight loss by three fungi species; **= resistance class according to Seng 1990; ± = standard deviation data; - = data not available.

position in the log, and growth site the tree is taken, and what species of tested fungus is used. The ability of fungi to cause weight loss in wood depends on their ability to degrade lignin (Harsh & Tiwari 1990). Weight loss of heartwood due to fungal attack was generally lower than that of sapwood (Suprapti *et al.* 2007). Therefore, it could be assumed that the resistance of heartwood to fungi is higher than that of sapwood, as stated by Coggins (1980) and Khan (1954). The weight losses of wood samples due to the attack of *D. spathularia* were generally low. Higher weight losses were found on samples exposed to *S. commune* and *P. sanguineus* cultures. This concurs with findings by Luna *et al.* (2004) who reported that weight loss of poplar wood placed on *P. sanguineus* culture for two to five months was 50–60%. However, weight loss of rubber wood (*Hevea brasiliensis*) against *P. sanguineus* was 40.6% (Wong 1988).

From the 85 wood samples tested against *D. spathularia*, 47 species were categorised as resistant (class II), 15 species moderately resistant (class III), 18 species (containing 19 samples) non-resistant (class IV) and 4 species perishable. The capability of *D. spathularia* in degrading wood was generally low. This was possibly influenced by the intrinsic characteristic of some wood samples which were less susceptible to fungal attack, e.g. *Castanopsis tunggurrut, Acacia mangium* and *Litsea odorata*. The resistance of woods against the white rot fungi *P. sanguineus* and *S. commune* was classified into classes II–V. Against the former, 35 wood species were categorised as class II, 17 species class III, 27 species (containing 28 samples) class IV and 5 species, class V. Against *S. commune*, 21 species were categorised as class II, 16 species class III, 44 species (containing 45 samples) class IV and 3 species, class V. It was found that the attacks by these two white rot fungi were more severe than that by *D. spathularia*. Possibly, white rot fungi grew better on wood samples dominated by broad-leaved wood species (hardwood) over conifer (softwood). It has been reported that hardwood is frequently attacked by white rot and softwood by brown rot (Takahashi & Kishima 1973, Schmidt 2006), although in another report, it was observed that both hardwood and softwood are attacked by white rot (Coggins 1980). In this study decay intensity on hardwood by white rot was more severe than that by brown rot fungi. In nature, brown rot fungi occur on softwood but under laboratory conditions it is found that brown and white rot fungi will decay both hardwoods and softwoods (Highley 1987).

Naturally, *P. sanguineus* and *S. commune* are able to grow on almost any kind of wood in Indonesia. Moreover, the three tested fungi are often found growing on the same log. Therefore, for classification purposes it should be based on the average weight loss due to attacks by these fungi as presented in Table 2. No species was categorised as class I but 30 species (35.5%) generally belonged to class II (II to III), while the rest (64.7%) were class III (23.5%), class IV (38.8%) and class V (2.4%). Of the 20 Indonesian wood species tested against *Postia placenta, Trametes versicolor* and *Ganoderma applanatum*, 12–13 species are categorised as resistant and highly resistant; the rest as moderately resistant and non-resistant (Sukartana & Highley 1997). However, from a laboratory and grave yard tests on 40 tropical wood species against *Tyromyces palustris, Coriolus versicolor* and *Pycnoporus coccineus*, it was observed that 62.5% of the wood species had low durability (class III–V) (Amemiya & Matsuoka 1979).

When compared with other works, results of this study showed that the resistance of *A. mangium* which originated from Bogor, West Java is higher than *A. mangium* from Jasinga (class III) and Banten (class IV), also in West Java (Djarwanto & Suprapti 1998, Suprapti 2002). The resistance of *A. borneensis* (from Bogor) in this study is categorised as class III and this is higher compared with that reported by Djarwanto and Suprapti (1998) for the species from Jasinga (class IV). *Hevea brasiliensis* from Bogor in this study and from Jasinga (Djarwanto & Suprapti 1998) are both in class IV. Growth sites of trees (sources of wood sample) seem to influence wood resistance, and this agrees with findings by Salmiah and Amburgey (1992).

Rasamala wood (*Altingia exelsa*) from Sukabumi, West Java is grouped in class III (III–IV). This is higher than the class IV rasamala wood from Gunung Bunder (Martawijaya 1975) but lower than those originated from Ciwidey which are grouped in class I (Martawijaya 1989).

*Pinus merkusii* from West Java in this study is in resistance class II–III, more resistant compared with that from Sumatera, which belongs to class IV (Martawijaya 1965). However, *Glochidion philippicum* (class II–IV) and *Blumeodendron kurzii* (class III–IV) woods were more resistant than the same species (class V) tested in the field by Sumarni and Muslich (2004).

It was also found that the resistance of *Ficus variegata* originated from East Kalimantan (class IV) is similar to that of the same wood species from West Java (IV–V) but was a little bit higher than the class V reported by Seng (1990). Of the 84 wood species tested, 27 species have similar resistance to samples studied by Seng (1990), 35 are higher and 9 are lower. However, the other 13 species were not observed by Seng (1990). The wood durability classification by Seng (1990) was based on the duration of the wood service life in the field, which varies according to locations and conditions, including the presence of water, fungi, termite and powder-post beetle. The resistance of *Shorea laevifolia* and *S. platyclados* in this study was class II, similar to that reported by Martawijaya (1983) for *S. laevifolia* but higher than *S. platyclados* (class III).

There are about 4000 wood species found in Indonesia, but only a few of them have been classified according to their decay resistance. Therefore, studies concerning the natural decay resistance of wood should be continued.

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