

**THE RESISTANCE OF MAHOGANY (*Swietenia macrophylla* King.) WOOD
AGAINST MARINE BORERS**

***Ketahanan Kayu Mahoni (*Swietenia macrophylla* King)
Terhadap Penggerek Kayu Di Laut***

By/Oleh:

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ABSTRAK

*Tiga pohon mahoni berumur 12, 21, dan 30 tahun diambil secara acak dari hutan tanaman. Dari ketiga log kayu tersebut dibuat contoh uji berukuran 2,5 cm x 5 cm x 30 cm. Contoh uji diawetkan dengan larutan CCB konsentrasi 3% melalui proses sel penuh dengan tekanan 10 atmospher selama 2 jam. Contoh uji yang diawet dan yang tidak diawetkan diuji terhadap penggerek kayu di laut selama 3 dan 6 bulan. Hasil penelitian menunjukkan bahwa contoh uji yang tidak diawetkan mendapat serangan penggerek di laut. Sebaliknya, yang diawetkan dengan CCB sangat tahan, terutama contoh uji yang diambil dari pohon yang berumur 12 tahun. Penggerek yang menyerang adalah *Martesia striata* Linne. dari famili *Pholadidae*, serta *Teredo bartchi* Clapp., *Dicyathifer manni* Wright., dan *Bankia cieba* Clench./Turner. dari famili *Teredinidae*. Pada contoh uji juga ditemukan crustacean yaitu *Sphaeroma* sp. dari famili *Sphaeromatidae*.*

Kata kunci: Proses sel-penuh, CCB, mahoni, penggerek kayu di laut

ABSTRACT

Three mahogany trees representing three age classes viz. 12-year-old, 21-year-old and 30-year-old were randomly selected from a forest plantation. Sample log from each tree, was cut into specimens measure 2,5 cm by 5 cm by 30 cm. The specimens were treated with CCB using the full cell process for 2 hours at pressure on 10 atmosphere. The treated and untreated wood samples were tested against marine borers for 3 and 6

months. The results showed that all of the untreated specimens were attacked by marine borers. The treated specimens showed greater resistance to marine borer attack, particularly the specimens taken from 12-year-old tree. The specimens were mostly attacked by several borers, *i.e.* *Martesia striata* Linne. of the Pholadidae family, *Teredo bartchi* Clapp., *Dicyathifer manni* Wright., and *Bankia cieba* Clench./Turner. of the Teredinidae family. Crustacean, *Sphaeroma* sp. (Sphaeromatidae) was also encountered on the attacked specimens.

Keyword: Full-cell process, CCB, mahogany, marine borers

I. INTRODUCTION

Utilization of wood for shipbuilding, pier poles, and beach houses is very susceptible to marine borer attack. The most harmful marine borers are Mollusk and Crustacean or better known as “shipworm” and “gribble” respectively. Identity of these two borers can be distinguished from their structure and method in attacking wood. Severity of the damage highly depends on natural durability of the wood.

The wood used for structural purposes usually belongs to durability of class I-II such as ulin (*Eusideroxylon zwageri* T. et B.), laban (*Vitex pubescens* Vahl.), teak (*Tectona grandis* L.f.), merbau (*Instia bijuga* O. Ktze.), and so on. Demand upon these species increases year by year, while the supply tends to decrease in the coming years. This phenomenon insists consumers to look for other alternative species that can be used as substitutes. The phenomena have been anticipated by the government through the establishment and development of plantations forest. However, the time needed to establish and develop such kind of forest is not as short as the time for harvesting. Apart from that, number of species planted within the scheme is very limited.

One of the most species readily available is mahoni (mahogany). This species is considered because of very attractive and suitable for many purposes including for shipbuilding or marine construction. However, it has durability of class III (Oey, 1964) and possesses weaknesses to marine borer attack (Muslich and Sumarni, 2005). Treatment with chemical preservative therefore, becomes necessary in order to increase the life service of the wood.

Effectiveness of chemical treatment using Copper-Chrome-Boron (CCB) as preservative was investigated in this study. The information is useful to improve the utilization of mahogany wood as material for shipbuilding or marine construction.

II. MATERIAL AND METHODS

Three mahogany (*Swietenia macrophylla* King.) trees representing three age classes namely 12, 21 and 30-year-old were randomly selected from a plantation forest in Sukabumi, West Java, Indonesia. Sample log from each tree was cut into specimens measuring of 2,5 cm (thick) by 5 cm (width) by 30 cm (length), and was then drilled at the middle (with hole diameter around 1 cm). The selected specimens were freed from decay, sapwood and all other defects that could in anyway affect the observation. Twenty-five specimens were taken from each log section, thus a total of 75 specimens were prepared for this study.

The preservative used was CCB (Copper, Chrome, Boron) in paste form with 95% purity. Its active agent is $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ (33%), $\text{K}_2\text{Cr}_2\text{O}_7$ (40%), and H_3BO_3 (24%). The concentration of solution is 3 percent weight for weight (w/w). All specimens were kiln dried to moisture content of below 15 percent. Forty five (45) of the specimens were treated by full-cell process and thirty (30) of the specimens were prepared for control. The full-cell process was conducted in vacuum-pressure vessel. Initial and final vacuum employed is 60 cm Hg for 15 minutes, while the pressure was 10 atmosphere for two hours.

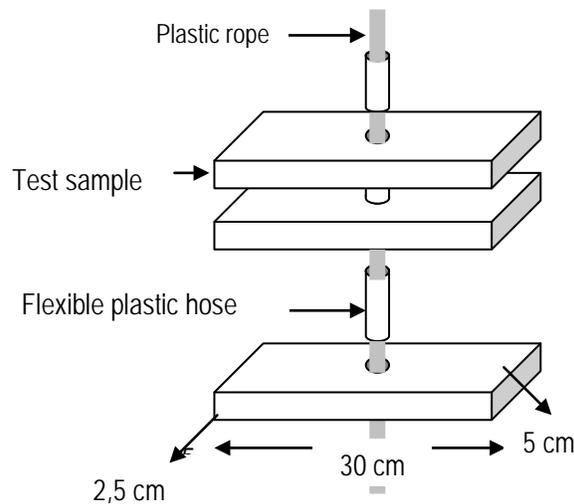
Retention was calculated on weight difference basis before and after treatment. Five (5) treated wood samples of each tree were selected to measure preservative penetration. The samples were cross cut at 5 cm from both ends of the samples. The cutting surface area was subsequently sprayed with reagents.

The treated and untreated samples were arranged into raft using plastic cord, arranged into raft (Figure 1). The raft then was exposed to seashore of Rambut Island for 3 and 6 months. At the end of the experiment, the samples were split into two parts to determine marine borer infestation. The Nordic Wood Preservation Council (NWPC). Standard No. 1.4.2/75 (Anonim, 1973) was used to determine the intensity of infestation. The infested marine borers were identified from the traces of boring holes, cutting form

and pallet on the infested samples. Intensity of borer attack was evaluated using the following criteria:

<u>Wood condition</u>	<u>Intensity</u>
No attack	0 = < 1%
Light attack	1/3 = 1 – 33%
Medium attack	2/3 = > 67%
Heavy attack	1 = > 67%

The traces could be observed by cutting the pallet of the attacked samples. Marine borers identification was accomplished according to marine borers classification described by Turner (1971). Statistical analysis on the collected data was examined using a procedure described by Steel and Torrie (1960).



III. RESULT AND DISCUSSION

A. Retention and Penetration

Table 1 and Table 2 show that the age of tree has significant effect on the CCB retention and penetration. Retention and penetration of wood from 12-year-old tree are higher than those of other classes. These reflect that younger wood is more permeable than the older ones. This could be related to the differences in type and amount of extractive contents, older tree has more extractive substances and more variable. The

extractive substance is one of the inhibiting factors in the preservative permeability (Siau, 1971). Wilkinson (1979) found that the variations in permeability were particularly marked in heartwood on conversion from sapwood. Also, the cells may become blocked, restricting the penetration of preservatives. In some hardwoods, blockage of the vessels occurs as a result of the growths, known as *tyloses*. These are common to species with larger diameter of pit such as eucalypts and merantis. In species with small pits such as mahoganies, blockage of the vessels occurs as a result of the secretion by ray parenchyma of tannin or gum-like substances through the pits (Siau, 1971). These resinous materials, as well as the *tyloses*, are often harder, especially when the wood is dried. Siau (1971) said that *tyloses* are usually found in heartwood, depending upon the species. Gummy substances, such as the reddish deposits in *honeylocust* and black material in ebony, may also occlude the vessels. Chalky deposits are also found in mahogany. Martawijaya *et al.* (1981) also stated that the old mahogany is less resistant to preservative treatment.

Table 1. Average retention and penetration of Copper-Chrome-Boron preservative in mahogany specimens treated by full-cell process.

Tabel 1. Rata-rata retensi dan penetrasi bahan pengawet Tembaga-Chrom-Boron pada contoh uji bengang perlakuan metode vakum tekan sel penuh

Age Class (Kelas Umur)	Retention (<i>Retensi</i>) Kg/m ³	Penetration (<i>Penetrasi</i>) (%)
12 years (tahun)	5.676	35.546
21 years (tahun)	4.650	17.604
30 years (tahun)	4.286	14.016

Table 2. Analisis of variance for CCB retention (kg/m³) and penetration (%) of mahogany

Tabel 2. Sidik ragam retensi (kg/m³) dan penetrasi (%) CCB pada mahoni

Source of Variance (Sumber Variasi)	Df (Db)	Sum of Sqaes (Jumlah pangkat dua)		Mean Square (Derajat tengah)		F Value (F hitung)	
		Retention (<i>Retensi</i>)	Penetration (<i>Penetrasi</i>)	Retention (<i>Retensi</i>)	Penetration (<i>Penetrasi</i>)	Retention (<i>Retensi</i>)	Penetration (<i>Penetrasi</i>)
Age	2	15.59	1330.550	7.795	665.275	8.519 **	35.6911**
Error	42	35.44	223.677	0.915	18.6399		
Total	44	51.03	1554.227				

The penetration of the preservative in 12-year-old mahogany is deeper than those in 30- and 21-year-old specimens. This also could possibly be due to differences in extractive contents. Panshin and de Zeeuw (1980) stated that greater amounts of extractives were formed as the trees growing-order. Siau (1971) mentioned that the extractive substance was one of the inhibiting factors in the preservative permeability.

B. Infestation of Marine Borers

Samples observation after 3 and 6 months treatment showed that intensity of marine borer infestations was different (Table 3). All control specimens (without preservative) were severely attacked by marine borers, particularly the specimens from younger tree. On the other hand, specimens with CCB were only slightly attacked or not attacked at all. Relationship between age class and intensity of infestations for the untreated samples is illustrated in Figure 2.

Table 3. Intensity of marine borers infestation on the tested mahogany wood
Tabel 3. Intensitas serangan penggerek kayu di laut terhadap contoh uji kayu mahoni

Age class <i>Kelas umur</i>)	Tretment <i>(Perlakuan)</i>	Attack intensity (<i>Intensitas serangan</i>) %					Total	Average <i>(Rata-rata)</i>
		1	2	3	4	5		
	3 months							
30 years	Control	36.0	40.5	32.7	36.5	35.7	181.4	36.28
	Treated	0.0	0.0	0.0	0.0	0.0	0.0	0.00
21 years	Control	40.8	40.0	46.8	55.0	50.0	232.6	46.52
	Treated	0.0	0.0	0.0	0.0	0.0	0.0	0.00
12 years	Control	52.5	60.5	70.5	65.5	60.0	309.0	61.8
	Treated	0.0	0.0	0.0	0.0	0.0	0.0	0.00
	6 months							
30 years	Control	55.9	65.5	70.0	73.0	75.0	339.4	67.88
	Treated	0.7	2.5	0.5	2.0	0.1	5.8	1.16
21 years	Control	60.5	65.8	70.5	75.0	75.5	347.3	69.46
	Treated	0.0	0.5	1.5	0.5	0.1	2.6	0.52
12 years	Control	90.5	85.5	85.0	90.5	90.0	441.5	88.30
	Treated	0.0	0.0	0.0	0.0	0.0	0.0	0.00

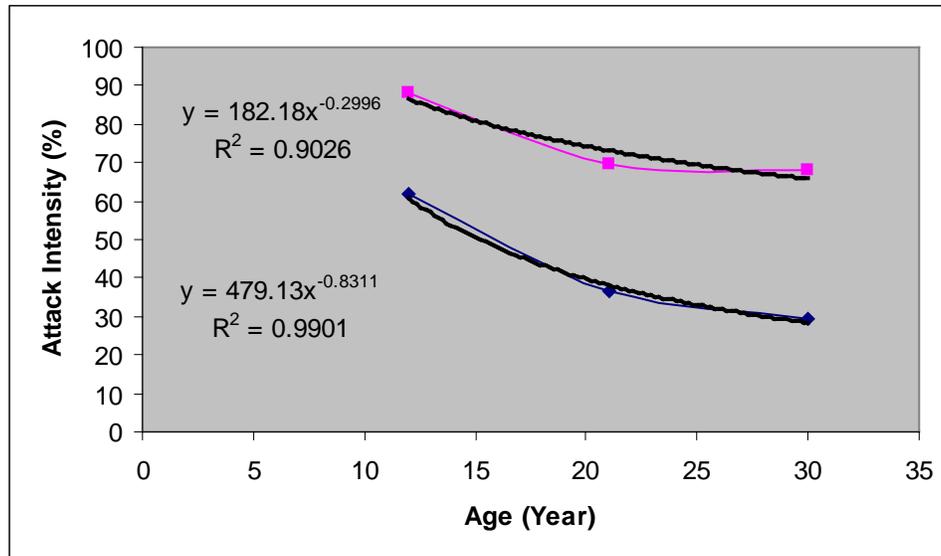


Figure 2. Relationship between age class and attack intensity
Gambar 2. Hubungan antara tingkat kelas umur dengan intensitas serangan

These indicate that the age class has different effect to marine borer attack. The old mahogany tends to be more resistant to marine borer attack than the young mahogany. Panshin and de Zeeuw (1980) stated that the outer heartwood tree is more decay-resistant in older trees than in younger trees. This is due to increase in natural durability of outer heartwood in older trees or to formation of greater amounts of extractives as the trees grow older. This indicates that stronger influences of age class is correlated to the extractive contents. Muslich (1996) stated that the older of mahogany tree containing more extractive substances than the younger one.

Most of the mahogany specimens treated with CCB in 60 atmosphere full-cell process for two hours, were resistant for three months. After six months, only few specimens were damaged. It indicated that CCB preservative is more effective for younger mahogany. The difference in the resistance of treated wood against marine borers is due to the difference in retention and penetration rate of CCB preservatives. Small preservative retention and shallow preservative penetration were easily washed by the seawater so that the woods were easily attacked by marine borers. The young mahogany treated with CCB is more resistant to marine borer attack than the old one. It occurred because the young mahogany was more permeable than the old one so that the CCB retention was bigger and its retention was also deeper. This shows that although

silica content of mahogany is low, damages due to marine borers attack can be reduced through application of preservative treatment with high retention and deep penetration. Marine borers action on other non-silica woods can also be reduced as long as such woods contain poisonous extractive substances. Bianchi and Gongrijp (1932) proved that teruntum wood (*Lumnizera littorea* Voight) and bungur wood (*Langerstroemia spiosa* Pers) were resistant to marine borer although they did not have silica.

The wood resistance to marine borer attack was dependent on the silica content, wood strength or density, and the content of poisonous extractive substances (Bianchi and Gongrijp, 1932; Southwell and Bultman, 1971). Mahogany (*S. macrophylla* King.) wood with silica content of 0.1 percent (Martawijaya *et al.*, 1981) was found to be less resistant to marine borers. Silica content, wood strength or density, and extractive substances were strongly influenced by growing process and growing pattern which were also influenced by the environmental and heredity (Panshin and de Zeew, 1980). These two factors may influence the formation wood elements, so that the silica content, extractive substance, specific weight, and height level also influence the wood resistance against marine borers. Wilkinson (1979) stated that the sapwood of any kind of wood was easily attacked by marine borers, while the heartwood was more resistant. The outer part of heartwood, is more resistant and resistance will be decreased to ward the pith.

Copper-Chrome-Boron (CCB), as a waterborne preservative, consists of mixture of copper, chromium and boron or could be mixtures by oxides of copper, chromium and boron. These preservatives owe their permanence between them after contact with the cell walls, resulting in active ingredients to leaching. This co-precipitation is brought about by addition of Chromates (Findly, 1975). The addition of copper, especially copper sulfate is toxicity class I – highly toxic. Because of its potentially harmful effects on some endangered aquatic species, surface water use may require a permit in some places. Copper sulfate is often found in combination with other pesticides and very toxic to human beings at high levels. Copper sulfate is toxic to aquatic invertebrates, such as crab, shrimp, and oysters. Higher concentrations of the material caused some behavioral changes, such as secretion of mucous, and discharge of eggs and embryos (Wilkinson, 1979).

C. Identification of Marine Borers

All of the untreated samples were severely attacked by the marine borers after 3-month exposure to the sea of Rambut Island, particularly young mahogany of 12-year-old tree. Marine borers which attacked the mahogany specimens were *Martesia striata* Linne. of Pholadidae family, *Teredo bartchi* Clapp., *Dicyathifer manni* Wright., and *Bankia cieba* Clench./Turner. of Teredinidae family.

IV. CONCLUSSION AND SUGGESTION

All of the wood specimens without any preservative treatment were severely attacked by marine borers, particularly the specimens taken from younger of mahogany tree. Specimens treated with CCB preservative were only slightly attacked or not attacked at all.

Young mahogany preserved with CCB is more resistant to marine borer than that of the treated old one. The difference in resistibility of the treated wood against marine borers is due to the difference in retention and penetration of CCB preservatives.

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LITERATURE CITED

- Anonim. 1973. NWPC Standar No. 1.4.2.2/73. Nordic Wood Preservation Council. Standard for Testing of Wood Preservatives, 1973. New Zeeland.
- Bianchi, A.T.J. and J.W. Gonggrijp. 1932. The resistance of some Netherlands East Indian Timbers against the attack of shipworms (Teredo). Fith Pacific Congress, September 23- 24, 1933. Ottawa. Canada.
- Findlay. W.P.K. 1975. Preservative of Timber in The Tropic. Martinus Nijhoff/Dr W.Junk Publisher. Dordrect.
- Muslich, M. 1996. Pengaruh zat ekstraktif pada kayu mahoni (*Swietenia macrophylla* King.) terhadap retensi dan penetrasi bahan pengawet Cooper-Chrome-Arsenate (CCA). Buletin Penelitian Kehutanan I: 1-23. Balai Penelitian Kehutanan Ujung Pandang. Makassar.

- Muslich, M dan G. Sumarni. 2005. Keawetan 200 jenis kayu Indonesia terhadap penggerek di laut. *Jurnal Penelitian Hasil Hutan* 23(3):163-176. Pusat Litbang Hasil Hutan. Bogor.
- Martawijaya, A., I. Kartasujana, K. Kosasi dan S.A. Prawira. 1981. Atlas Kayu Indonesia. Jilid I. Balai Penelitian Hasil Hutan. Bogor.
- Oey Djoen Seng. 1964. Berat jenis dari jenis-jenis kayu Indonesia dan Pengertian beratnya kayu untuk keperluan praktek. Pengumuman No. 1. Lembaga Penelitian Hasil Hutan. Bogor.
- Panshin, A.J. and C. de Zeeuw. 1980. Textbook of wood technology. 14th ed. Mc Graw-Hill Book Co. pp. 351-402. Toronto.
- Siau, J.F. 1971. Flow in wood. First edition, Syracuse University Press, New York. pp. 11-40.
- Southwell, C.R. and J.D. Bultman. 1971. Marine borers resistance of untreated woods over long periods of immersion in tropical waters. *Biotropica* 3(1): 81-107. Naval Research Laboratory. Washington D.C.
- Steel, R.G.D. and J.H. Torrie. 1960. Principles and Procedures of Statistic. McGraw Hill Book Co. Inc. New York, Toronto, London.
- Turner, R.D. 1971. Identification of marine wood-boring mollusks. Marine borers, fungi and fouling organisms of wood. Organisation for Economics Co-operation and Development. Paris.
- Wilkinson, J.G. 1979. Industrial timber preservation. Associated Business Press. pp. 73-247. London.

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Three mahogany trees representing three age classes viz. 12-year-old, 21-year-old and 30-year-old were randomly selected from a forest plantation. Sample log from each tree, was cut into specimens measuring 2,5 cm by 5 cm by 30 cm. The specimens were treated with CCB using the full cell process for 2 hours at pressure on 10 atmosphere. The treated and untreated wood samples were tested against marine borers for 3 and 6 months. The results showed that all of the untreated specimens were attacked by marine borers. The treated specimens showed greater resistance to marine borer attack, particularly the specimens taken from 12-year-old tree. The specimens were mostly attacked by several borers, *i.e.* *Martesia striata* Linne. of the Pholadidae family, *Teredo bartchi* Clapp., *Dicyathifer manni* Wright., and *Bankia cieba* Clench./Turner. of the Teredinidae family. Crustacean, *Sphaeroma* sp. (Sphaeromatidae) was also encountered on the attacked specimens.

Keyword: Full-cell process, CCB, mahogany, marine borers

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Kata kunci: Proses sel-penuh, CCB, mahoni, penggerek kayu di laut