# INVESTIGATIONS ON THE DURABILITY OF PRESSURE-TREATED TIMBER AGAINST MARINE BORER ATTACK IN MANDOVI ESTUARY, GOA

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## ABSTRACT

Performance of 8 timber species against biodeterioration, when pressure-treated with 3 preservatives (namely Copper-Chrome-Arsenic (CCA), Copper-Chrome-Boric (CCB) and Creosote ; Fuel oil mixture (CFO) and exposed in Mandovi Estuary (Goa) for about 48 months, has been discussed. The untreated control panels were all badly damaged in less than 6 months and those treated with CCA (except panels of *Anogeissus latifolia* and *Pterocarpus marsupium*) and CFO were heavily attacked within 13 months. CCA — treated panels of *A. latifolia*, at absorptions of 16 kg and 32 kg per m<sup>3</sup>, failed within 35 months. Panels of *P. marsupium* with 16 kg per m<sup>3</sup> of CCA were severely destroyed in 18 months, whereas with 32 kg per m<sup>4</sup> dosage they remained in excellent condition even after 48 months. CCB—treated panels of *Mangifera indica* suffered only negligible damage in 25 months, but underwent 12 to 45% destruction in 35 months.

Although six borer species were encountered on the panels, the extremely heavy incidence of *Martesia striata* was singularly responsible for the premature failure of even the treated panels. The rapidity of destruction exposes the high degree of borer hazard in Goa waters, necessitating still higher absorption of the preservatives.

### **INTRODUCTION**

DESTRUCTION of underwater timber structures along the Indian Coast by marine organisms is a very serious economic problem. This has led to detailed investigations, pioneered by Forest Research Institute and Colleges, Dehra Dun, on the various aspects of marine biodeterioration with a view to evolving methods for enhancing the service life of timber. This incresing concern for information on this important problem contributed to the collection of considerable amount of data on the systematics, ecology, biology and physiology of marine wood-borers and also on their response to untreated and chemicallytreated samples of different timber species (Santhakumaran, 1985).

The protection of marine timber structures can be best achieved by impregnating them with preservative chemicals prior to construction. However, this necessitates collection of basic data on the durability of different timber species treated with preservatives in various absorptions so as to recommend the right type of timber and treatment most suited to a particular locality. Such a data base can be made available only through panel tests at as many stations as possible along the coast.

Considerable work on the above aspects has already been carried out along the Indian Coasts at Bombay, Cochin, Madras and Visakhapatnam, employing panels of 32 timber species treated with 8 preservatives and tested for over 15 years (Cheriyan and Cherian, 1980; Santhakumaran *et al.*, 1984). However, no work on this line has so far been carried out along Goa Coast, though the destruction of wood by borers is most extensive and rapid there

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than anywhere else along the Indian Coasts (Santhakumaran and Rao, 1986). In view of this paucity of information, similar investigations were taken up in Goa waters and results have been discussed in this paper.

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#### MATERIALS AND METHODS

Two series of experiments, involving 8 timber species and 3 preservatives, were conducted using test panels of 30.5 cm  $\times$  3.8 cm  $\times$ 3.8 cm size taken from the heart-wood. In Series I, panels of Acrocarpus fraxinifolius, Lagerstroemia microcarpa, Mesua ferrea, Terminalia alata, Anogeissus latifolia and Pterocarpus marsupium, pressure-treated with Copper-Chrome-Arsenic (CCA, at 16 kg and 32 kg per m<sup>8</sup> absorptions) and Creosote : Fuel oil (50:50) mixture (CFO, at 160 kg and 320 kg per m<sup>3</sup>) were tested. Series II comprised panels of Carapu molucensis treated with CCA (at 13 kg and 28.5 kg per m<sup>3</sup>) and and CFO (at 46 kg and 75 kg per m<sup>3</sup>) and samples of Mangifera indica, impregnated with Copper-Chome-Boric (CCB, at 26 kg and 29 kg per m<sup>3</sup>). All the treatments were done in triplicate. The test panels along with the untreated controls were arranged in the form of 'ladders', each consisting of 5 panels, by tying them with nylon thread and were exposed

at about 2 m below low tide level at Betim in the Mandovi Estuary. Series I was started on 30-4-1982 and Series II on 20-5-1983. They were examined periodically and their performance was assessed from the intensity of infestation of wood-borers and the extent of internal damage, which was determined visually. When the panels became brittle due to heavy destruction, they were rejected and withdrawn.

## RESULTS

Typical estuarine conditions prevail at the test site with very sharp drop in salinity during the monsoon period of June to August. The salinity at the depth of exposure of panels ranged from  $6.1\%_0$  to  $34.7\%_0$  and the temperature from 25.5°C to 32.2°C.

The wood-borers encountered on the test panels were Martesia striata (Linnacus), Nausitora hedleyi Schepman, Nausitora dunlopei Wright, Lyrodus pedicellatus (Quatrefages), Bankia rochi Moll and Bankia campanellata Moll and Roch. Of these, M. striata and N. hedleyi were the predominant borers and the other species settled only in scarce numbers. M. striata is by far the most important species. both in intensity of incidence and in severity of destruction, particularly of the treated panels, Their activity was such that the untreated control panels were completely riddled and became brittle within 6 months (Pl. I A. CAMO). The treated panels gave varying results as summarised below :

Series I: Details on the extent of destruction caused by marine borers to panels, belonging to Series I, have been presented in Table 1. Incidence of borers in varying intensity was evident with six months on most of the treated panels (except on those of A. fraxinifolius, T. alata, A. latifolia and P. marsupium treated with CC Aat the retention of 32 kg per m<sup>3</sup> and also of A. latifolia and

P. marsupium with 16 kg per m<sup>3</sup> of CCA), though the destruction caused was negligible. By the end of 13 months, the creosoted panels (both absorptions) were heavily destroyed and all of them treated at 160 kg per m<sup>3</sup> dosage were rejected within 18 months. At 320 kg per m<sup>3</sup> absorption, although most of the creosoted panels were severely damaged and rejected after 18 months (Pl. I B, AFC2 AL C2 and MF C2), one each of L. micro. carpa, T. alata and A. Latifolia has still shown some degree of resistance, having undergone only 35%, 5% and 35% damage respectively. However, these three panels reached 45 %, 25% and 50% destruction respectively after 24 months and were rejected after 35 months (Pl. II Å).

Similarly, after 13 months, CCA-treated panels also were heavily attacked, but the extent of destruction was much less than the same on creosoted panels. Panels of A. latifolia and P. marsupium showed excellent resistance to borer attack, particularly in the higher dosage of CCA (Table 1). By the end of 18 months, all the CCA panels at 16 kg per m<sup>3</sup> absorption were rejected (Pl 1 B, AF A1), except the three panels of A latifolia with 50% 25% and 20% destruction and one panel of P. marsupium with 15% damage. During the same period, all the three panels of P. marsuplum with CCA at 32 kg per m<sup>3</sup> were totally free from borer attack, whereas those of A. latifolia underwent 30%, 25% and 20% damage. Although one panel of A. fraxinifolius reached only 35% destruction within 18 months, its two duplicate panels were discarded during this The deterioration progressively period. increased on the above panels (except on those of P. marsupium) and at the end of 38 months, all, but one panel each of A. latifolia and P. marsupium having 16 kg CCA per m<sup>8</sup> and one panel of A. latifolia and all the three panels of P. marsupium at higher dose (32 kg per m<sup>a</sup>), were rejected. The above-mentioned two panels of A. latifolia and one panel of P. marsu

pium, at 16 kg CCA, had also to be withdrawn after 42 months (Pl. II B). The only panels which continued to withstand borer attack and remained in sound condition after 42 months were those of *P. marsupium*, which showed only 2 to 5% damage in 48 months (Table 1).

Series II: The condition of the panels belonging to this series has been presented in Table 2. Here also CCA and CFO treatments failed to protect the panels of C. moluccensis even for a period of 10 months during which time the CFO-treated panels were rejected (Pl. IA) and the CCA-treated ones suffered about 30% average destruction (Table 2) and were eventually withdrawn after 25 months (Pl. II C). However, panels of M. indica treated with CCB at 26 kg and 29 kg per m<sup>3</sup> retention, gave excellent results with only negligible attack even after 25 months. After this period, the panels gradually succumbed to borer infestation and at the end of 35 months, they showed an average destruction of 27% and 21% at 26 kg and 29 kg CCB per m<sup>3</sup> respectively.

#### DISCUSSION

The destruction of untreated controls within a short span of 6 months is but natural in Goa waters, where even Tectona Grandis and Xylia xylocarpa --- two very durable timbers --- were totally riddled by borers within 12 months (Santhakumaran and Rao, 1986). It may be mentioned here that the premature failure of most of the treated timbers was the result of heavy incidence of M. striata. Since this borer attacks timber only for protection, the dosage of preservatives tested during the present studies, particularly in Series II, was not sufficient to repel their attack for long. Surprisingly, the performance of the treated timber in Goa waters was not encouraging, as the same preservatives in the same dosages enhanced the life of several non-durable timbers



PLATE 1.A. Panels of Campu induccensis of Series II, exposed for 10 months showing complete destruction (CAMO: Control panel after 6 months; 1, 2: CFO at 46 kg per m<sup>3</sup>; 3, 4: CFO at 75 kg per m<sup>3</sup>) and B. Treated panels of Series I, exposed for 18 months; showing heavy damage by borers and growth of huge Crassostrea explosites (AF: Acrocarpus trasinitations: AI:: Anogeneous lotifolia; MF: Mesua ferrea; C2: CFO at 320 kg pet m<sup>3</sup>; A 1: CCA w 16 kg per m<sup>6</sup>).

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BUND II A. Freated papels of Series I, exposed for 35 menths showing heavy borer attack. (LL:). Lagerstraenia microcarpa. AL: Anopensis latifalia. C2: CFO at 320 kg per m<sup>2</sup>), B. Treated panels of Series Ecoposed for 42 months showing heavy destruction by borers (AL: Anogensus latifalia. PTM: Paracarpus marsaguint. A 1: CCA at 16 kg per m<sup>2</sup>: A 2: CCA at 32 kg per m<sup>2</sup>) and C. CCA-streated panels of Catapa moleconsis (Sener II) after about 25 menths showing heavy destruction by borers.

			Percentage destruction of each panel after																			
Timber species and	dosage	6 r	6 months			13 months			18 months		24 months		35 months		38 months			42 months				
· · · · · · · · · · · · · · · · · · ·		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
A. fraxinifolius	Aı Aı	S N	N N	Տ N	60 45	60 55	75 20	R R	R R	<b>R</b> 35	_		50			R		_				
L. microcarpa	A <sub>1</sub> A <sub>2</sub>	S S	S L	L S	65 50	45 	 45	R R	<u>60</u>	55	_	R	R				<u> </u>	· _				
M. ferrea	A1 A3	S L	S S	S S	55	60 50	70 60	R —	R 65	R R	_	R	Ξ	<b>-</b>				_				·
T. alata	A1 A2	S N	S L	S N	55 55	<del>70</del>	50 40	R R	R	<b>R</b> 50	_	_	R	<u> </u>	<u> </u>			_	·	 	_	-
A, latifolia	Aı Az	N N	N S	S N	10 10	20 10	20 5	20 20	50 30	25 25	25 25	Ř R	30 50	40 45	_	55 65	50 60		R R	R R		Ξ
P. marsuplum	A1 A2	N N	N N	N N	15 N	20 N	10 N	R N	R N	15 N	N	<u>_</u>	25 N	N	N	40 N	5	3	55 N	5	5	R N
A. fraxinifolius	Ct Ca	20 S	s s	S S	70 60	70 65	70 75	R 70	R R	R R	R	_	_	_	_							
L. microcarpa	C₁ C₅	S 15	S S	S S	70 60	75 70	70 25	R R	R R	R 35	Ξ		 45			R						
M. ferrea	C₁ C₂	L L	S S	S S		65 65	75 70		R R	R R	Ξ	_	_		_							
T. alata	C₁ C₂	5 S	L S	S S	70 S	65	<b>70</b> 75	R 5	R	R R	25		<u> </u>	R		<u> </u>						:
A. latifolia	Сı Сı	S S	S S	S S	70 45	60 55	75 25	<b>R</b> 65	R. R	<b>R</b> 35	R	Ξ	50		_	R						
P. marsupium	գ գ	L S	S L	S S	45	<u>60</u>	65 40	R	<u>R</u>	R 55			R	_								

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TABLE 1. Condition of the panels belonging to Series I

Date of immersion: 30-4-1982. N = no attack; S = slight attack (larval pits); R = rejected (above 80% destruction); L = panel lost. A<sub>1</sub> = CCA, 16 kg per m<sup>3</sup>; A<sub>2</sub> = CCA, 32 kg per m<sup>3</sup>; C<sub>1</sub> = CFO, at 160 kg per m<sup>3</sup>; C<sub>2</sub> = CFO, 320 kg per m<sup>3</sup>: Control panels were destroyed within 6 months; The three panels of *P. marsupium* (A<sub>2</sub>) suffered only 5%, 5% and 2% destruction after 48 months. for more than 15 years, when tested elsewhere along the Indian Coasts (Santhakumaran *et al.*, 1984).

In the absence of any direct evidence, it is difficult to explain the high rate of attack by *M. striata* along Goa Coast resulting in rapid destruction of timber. Probably, the clean unpolluted water and the nutrient-rich mangrove areas around the coast maintain an abandant supply of planktonic food for this filterfeeding bivelve, thereby enabling the species to breed and thrive along this coast.

panels of *L. microcarpa*, *T. alata* and *A. latifolia* after 13 and 18 months (Table 1); and CCB-treated panels of *M. indica* after 32 and 35 months (Table 2). Such differences in the effect of preservative treatment in various timber species has been reported previously also (Fougerousse and Lucas, 1976; Henningsson and Norman, 1980). In the case of creosoted panels, this behaviour may be the result of subsequent depletion and degrading of the preservative in warm waters (Mc Quire, 1971), where creosote losses due to leaching and weathering are highest and may vary from

				Percentage destruction after								
	Irea	itment	_	10 months	19 months	25 months	35 months					
<u>.</u>	Treated panels of	f Carapa moluccensis										
	Creosote : fuel o	il 46 kg/mª	••	R	_	_	·					
	Do.	48 kg/m <sup>a</sup>	••	R	_							
	Do.	71 kg/m <sup>a</sup>	••	R								
	Do,	75 kg/m³	••	R	_		-					
	CCA 11.5 kg/m <sup>4</sup>		••	35	60	R						
	CCA 13 kg/m <sup>3</sup>		••	35	60	R	_					
	CCA 23 kg/m <sup>3</sup>		••	45	60	R	_					
	CCA 28.5 kg/m <sup>2</sup>	3	••	5	30	R	_					
в.	Treated panels of	f Mangifera indica										
	CCB 26 kg/m <sup>8</sup>	• •	••	S	2	8	45					
	Do.			S	S	3	20					
	Do.		••	Nil	S	2	15					
	CCB 29 kg/m <sup>a</sup>			S	S	2	35					
	Do.		••	S	S	S	15					
	Do.		••	S	S	3	12					

TABLE 2. Condition of the panels belonging to Series II

Date of immersion : 20-5-1983.

Untreated control panels of C. moluccensis and M. indica were completely destroyed within 6 months. S = Slight (few larval pits); R = Rejected (above 80% destruction),

Considerable discrepancies, as manifested by the performance of panels of different timber species and absorptions and also of the same species and same dosages, can be noticed in the results. Examples are CCA-treated panels of A. fraxinifolius and P. marsupium at the end of 18 and 24 months; creosoted

species to species and even from specimen to specimen, as also observed during the present studies. In the case of CCA, it may also be due to the technical limitations in treatability imposed by the wood species itself (Mc Quire, 1971) and also due to a change in the composition of the preservative as a result of using

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the same solution for successive charges, as recently reported by Kuppusamy and Sharma (1986). Even T. alata from which the annual leaching rate of CCA is very slow (Cheriyan et al., 1979), did not last for 13 to 18 months in this line is in progress. in Goa waters.

The results discussed above indicate that still higher absorption of preservatives may be essential for the protection of timber against biodeterioration in Goa waters. Further work

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