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Control of bamboo borer *Dinoderis minutes* Fab infesting Sal, *Shorea robusta* in Odisha, India

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Abstract
Considerable loss is observed in valuable timbers during storage due to attack by several insect pests among which the bamboo borer is of primary concern which can attack from a moisture range of 8 to 30%. In the present study a total of 6 treatment schedules viz. soaking in water (T_2), Brushing with turpentine oil (T_3 0, Dipping the log with Turpentine oil (T_4), Brushing with primer (T_5) and dipping in primer for 15 minutes (T_6) including an untreated check were standardised. Countable numbers of insects (20) were released at a month interval up to 3 months. Treatment-2 recorded 30% of mortality after 3months of treatment. T_3 recorded as high as 80% of mortality after 1st release, 70% mortality in 2nd release and 60% mortality in 3rd time release. T_4 provides full protection up to 1 month with a record of 100% mortality and 85.00% and 70.00% mortality during 2nd and 3rd release of the test insect. T_5 recorded a mortality of 75.00% after the 1st release and 70.00% after third release. However, T_6 recorded mortality of 85.00% after 1st release, 75.00% after 2nd release, and 70% after 3rd release. Hence, all the treatments except T_2 was found at par in providing protection against powder post beetle attack after 3 months duration.

Keywords: Timber borers, turpentine oil, wood feeding beetles, wood protectants, wood primers

1. Introduction
Some commercially important useful softwood and hardwood timber species like *Shorea robusta, Samania saman, Tectona grandis* are extracted from the natural forests of Odisha and stored in depots. The felled timber is usually stored in the open for varying periods before transportation to the site of utilization. In factories also, timber were made available in different seasons may be stored for use at a later stage. During such periods of storage, the timbers are susceptible to attacked by various beetles which tunnel into the wood and convert it into waste powder. It can be assumed easily from the fact that, about 130 species of insect borers have been recorded from Sal (*Shorea robusta*) timber alone in India as reported by Beeson, (1941) [1]. The species of insects are found to vary depending on the geographical region, species of timber, season and stage of processing of the timber. However, they are less host-specific, and attack a large number of timber species.

Being an organic material, timber is susceptible to bio-deterioration by a variety of insect and organisms. Among them various insects, beetles and borers are major threats to the service life of wood, Tsunoda, (1990) [2]; Highly, 1999 [3]. Some timber species have comparatively high inherent capacity to resist this kind of attack by borers, showing remarkable resistance when exposed to biodegrading agents, Harris, 1961 [4]. Natural durability is one of the key important factors used to assess the suitability of a timber species for specific construction. Wong *et al.* 2005 [5]. opined that the timber with sapwoods only has very poor resistance, natural durability ratings apply only to the heartwood of a timber species. As wood is used as a constructive and decorative material, due to the destruction of the qualities and properties by insect attack the economy is highly affected. A number of insects attacking dry, seasoned or partly seasoned wood in saw mills. Like stored and seasoned timber, finished timber products and furniture are also attacked by other woodborers as viewed by Wood, 1978 [6]. But none of the stages of wood is free from borer attacks. In United States, Phloem and wood boring insects were predicted to cause huge economic impacts by annually destroying nearly $1.7 billion in local government expenditures and approximately $830 million in local residential property values. They estimate the damage to provide crucial cost-benefit analyses to evaluate policies and management options, in relation to reduce species introductions, Aukema *et al.* 2011 [7]. Some larvae and adults has the ability to reduce sapwood, particularly of hardwoods, into a powdery

form, these are considered as economic importance to forestry and the wood-based industries, primarily in tropical countries as viewed by earlier workers like Beeson 1941 [1]; Liu *et al*. 2006 [8] and Beaver *et al*. 2011 [9].Unfortunately, the huge loss encountered by all the timber infesting insects are not estimated in monetary term in India, but it is estimated that approximately 10% of forest productivity is lost annually due to insect attack alone. In Odisha no such work has been undertaken till date to document the species of insect damaging different timber species in different parts of the year nor has the biology or morphology of the causative insects been studied by any sector. Hence, the present study is undertaken with the objective to study the effectiveness of few wood preservatives on duration of storage of the most used timber Sal from the infestation of few common powder post beetles infesting the structural timbers.

2. Materials and Methods. Pole sized logs of Sal (*Shorea robusta*) of uniform diameter and felling time was collected from Govt. timber depots, Kandhamal and treated with different wood preservatives as detailed in Table -1.

2.1 Timber used for study

Sal (*Shorea robusta*) timbers of 18 cm girth were taken from a wood lot at Bhubaneswar, which were originally procured from Kandhamal, District. The pole size timber was crosscut into 12 pieces of 25cm each and air seasoned for one week to approximately 13% moisture content and then treated with the preservatives.

2.2 Data collection procedure

Evaluation of wood stakes was made by visual assessments after every 24 hr. and 48 hr for any sign of insect attack for a period of 3 months. The dead specimens were removed from the bag and cleaned, and then the damage was assessed. The incidence of insect attack was recorded as representing attacked and not attacked by borer. The severity of the damage was recorded and total weight of wood eaten was assessed. (Figure-10)

2.3 Release of insects

Insect were released inside the poly bags containing treated wood in an interval of one month for 3consecutivemonths. In each month 20insects (unsexed) were released to study the effectiveness of different treatments and mortality of insects were recorded after 24 and 48 hr. of release. The whole experiment was planned in completely randomised design and replicated four times. ANOVA, C.V and C.D was calculated by using SPSS soft weir. Version 16.The SE $m^{(\pm)}$ was calculated as $\sqrt{}$EMS/No. of replications where EMS is error mean sum of square of the ANOVA table. Critical Difference=SE (m0$\times\sqrt{}$ $2\times$ tvalue at error degree of freedom. Here total no. of cases or n =24 and No. of treatments are 6. Hence error degree of freedom is 18 and the t value is 1.734 as found from the table. Co-efficient of variation is $\sqrt{}$EMS/Grand mean$\times$ 100

Table 1: Detail of treatments

Treatment	Treatment details	Source of procurement	Dose* (ml/piece of 25cm	Approx. Price (Rs./lit.)
T1	Control	--	--	0.00
T2	Dipped in Water for 24 hr. and shade dried for 48 hrs.	Local	30	0.00
T3	Brushed (50.8mm) with turpentine oil.	Parveen paints	13	56.00
T4	Dipped in turpentine oil for 15 minutes and air dried for 48 hrs.	Parveen paints	26	56.00
T5	Brushed (50.8mm) with primer (Parrot wood primer) composition: Synthetic alkyd binder and micro fine pigments along with extender and different additives.	Berger paints	14	130.00
T6	Dipped in primer for 15 min, (Parrot wood primer) composition: Synthetic alkyd binder and micro fine pigments along with extender and different additive	Berger paints	20	130.00

*Amount of turpentine oil/primer consumed during dipping of the timberpieceof25cm length and pole size, the difference between the initial and final volumes of liquid is taken as dose

3. Results and Discussion

3.1. Description of the test insect.

Adult: Head of the insect is covered by pronotum and not visible from above. Body measures from vertex tip to tip of elytra are nearly3.01mm. Both the elytra are joined firmly and forma semi-circle. Pronotum rounded anteriorly without larger horns or teeth at anterior angles with protibial one apical spine. First tarsomeres of each leg are not equal to second. Scutellum is transverse and rectangular. Dorsal side of body is finely but uniformly punctuated and bears pointed setae within length range of47 to 48 micron each raised from the depression. Cloaca is terminal in position of the ventral side of the measuring about111micron in length and 31,4 micron in width. Compound eyes small and bulging, black in colour. Antennae small, last three antenomeres are roughly triangular. (Figures-1.5, 6, 7, 8 & 9)

Larva: Mature larva of *D. minutes* is grub like, curved and anterior most part of the curve bears small blackish head and six short legs. Compound eyes are black in colour. (Figure-2)

Pupa: Pupa is typical exarate type, whitish with a large prothorax and the mouth parts are laying pressed against the hind thoracic and anterior abdominal segment. For tunnelling inside the wood, head is provided with toothed projections. (Figure-3)

Damage: Mostly causes cylindrical burrows over the dried timbers. Attacks timbers with a moisture content ranged 8 to30%. Sometimes the whole timber and pole sized ones are converted into mere powders. (Figures-4 &11)

3.2. Studying the efficacy of wood preservatives: Data presented in Table2 revealed that untreated control was not causing any mortality of the insect during each release at month's interval up to three months. T_2 recorded 30% of mortality of released insect after 3month of treatment. T_3 recorded as high as 80% of mortality after 1st release, 71.25% mortality in 2nd release and 60% mortality in 3rd time release.

T_4 provides full protection up to 1 month with a record of 98.75% mortality and after 2nd release the mortality count was 86.25. %.whereas after 3rd release the mortality count was 70.00% only. Treatment-5 recorded a mortality of 76.25% after the 1st release and 70.00% after third release. However, dipping in primer for 15 minutes recorded mortality of 86.25% after 1st release, 75.00% after 2nd release, and 70% after 3rd release. Hence, all the treatments except T_2were found at par in providing protection against powder post beetle attack. Workers like Tewari and Singh, 1979 [10] has used different chemical preservative treatments for increasing durability of bamboos. They have used $CuSo_4$and ZnCl2 and found $CuSO_4$as the best one. However, Laxman, 1970 [11] has reported boric acid treatment up to 48 hrs. fail to prevent beetle infestation. As reported by Tamblynv and Rosel, 1979 [12] in Australia, treatment of wood has been made mandatory by legislation requiring complete penetration of all susceptible wood with approved preservative, or alternately the limitation of susceptible wood to a defined maximum in building timber use.

In addition to this use of glue-line additives were found as the best method for protecting plywood from powder post beetle by several workers like Tambyn and Gordon, 1950 [13]; Tyler, 1968 [14]; Van Acker *et al*.1990 [15]. The preservatives used included creosote, Froggatt, 1925 [16], arsenical, Cummins and Wilson, 1936 [17]; Rosel 1969 [18], and Borates, McGregor 1958 [19]; Forestry; Williams and Mauldin 1985 [20].Several remedial treatments were proposed by many workers, like heating, French and Johnstone 1968 [21], and fumigation, Burden and McMullen 1952 [22]. But it was found that such remedial treatments don't provide protection against reinfestation.

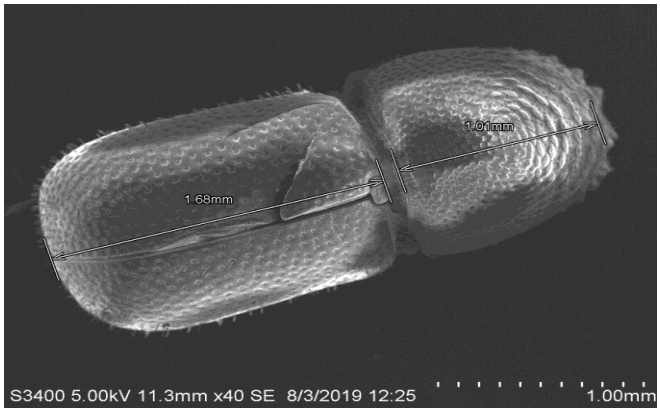

Fig 1: Adult from Dorsal side, head invisible Dentations are clear

Fig 2: Larvae small whitish, c shaped with blackish head

Fig 3: Pupa, small exarate type, Appendages firmly glued to the body

Fig 4: Damage to cart boards

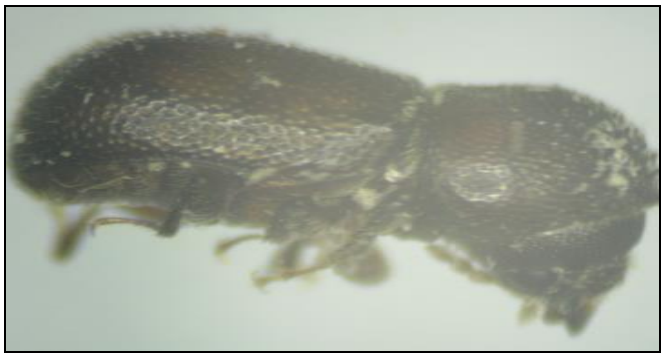

Fig 5: Adult lateral view with mouthparts and legs visible

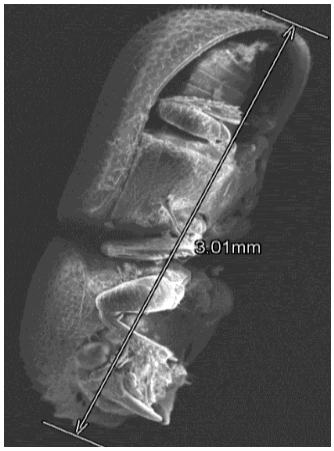

Fig 6: SEM of ventolateral side, length 3.0 1mm Abdominal segments visible

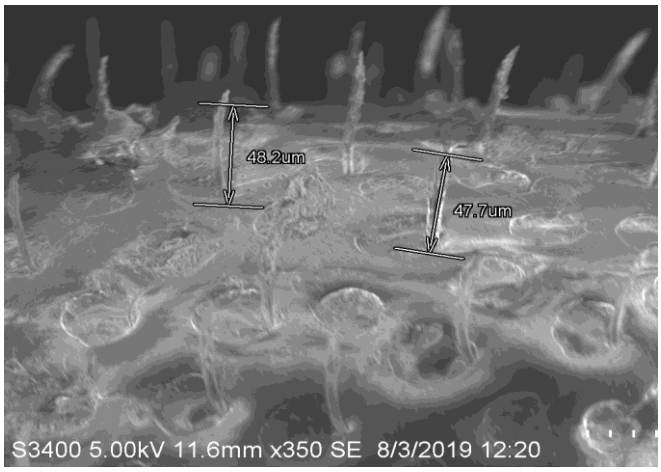

Fig 7. Enlarged view elytral joints, base of body hairs (In SEM photographs resolution times are mentioned at the base)

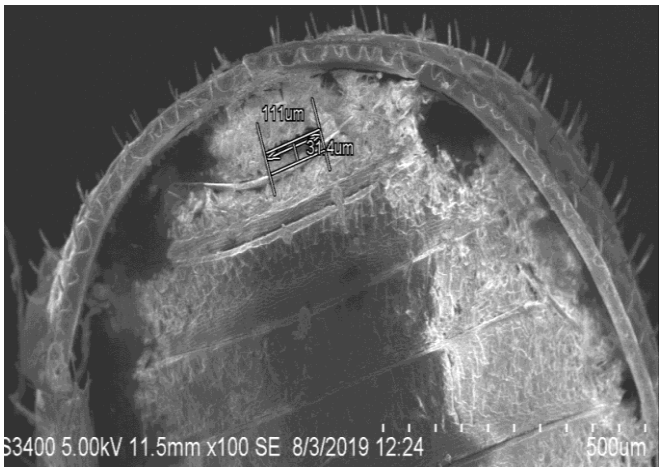

Fig 9: Structure of cloaca at the last abdominal segment (length and width 11.1 and 31.4 micrometers respectively

Fig 8: Adult in the damaged timber

Fig 10: Wood presurevative treatments

Fig 11: Sal log fully infested with larvae and pupae

Table 2: Efficacy of different wood protectants in protecting Sal timbers (*Shorea robusta),* from infestation due to *D. minutes* in laboratory condition at Bhubaneswar (2018-2019)

Treatment	*No of insect s released in each month/ replication (Feb-April)	Mortality after 1st release.		Total mortality after 1st release	% of mortality after 1st release.	Mortality after 2nd release.		Total mortality after 2nd release	% of mortality after 2nd release	Mortality after 3rd release		Total mortality after 3rd release	% of mortality after 3rd release
		In 24hr.	In 48hr.			In 24hr	In 48hr			In 24hr.	In 48hr		
T1	20	0.0	0.0	0	0.0 (0.7071)	0	0.0	0	0.00 (0.7071)	0	0	0.0	0.00
T2	20	0.0	5.0	5.0	25.0 (5.7071)	0.00	3.25	3.25	16.25 (3.9370)	0.00	6.0	6.0	30.00 (5.5226)
T3	20	12.0	4.0	16.0	80.0	10.0	4.25	14.25	71.25	10.0	2.0	12.0	60.00

					(8.9721)				(8.7050)				(7.7781)
T4	20	15.0	4.75	19.75	98.75 (9.9624)	13.0	4.25	17.25	86.25 (9.3135)	11.0	3.0	14.0	70.00 (8.3964)
T5	20	9.0	6.25	15.25	76.25 (8.7607)	10.0	6.25	16.25	81.25 (9.0415)	10.0	4.0	14.0	70.00 (8.3964)
T6	20	13.0	4.25	17.25	86.25 (9.3139)	11	4	15	76.25 (8.7607)	11.0	3.0	14.0	68.75 (8.3964)
SEm(±)					0.047				0.078				0.066
C.D (P =0.05)					0.1410				0.233				0.196
C.V					1.31				2.34				2.01
*Replicated four times, Figures in parenthesis are transformed valuesi.e√.x+.5													

4. Conclusion

It can be concluded from the present study that dipping Sal imbers or wooden structures in water before use or seasoning and recorded mortality of 30% after 3months of storage. However, brushing with turpentine oils and dipping with turpentine oils recorded 605 and 98.755 mortalities respectively in third time release made after3months.Brushing with common wood primers with composition of Synthetic alkyd binder and micro fine pigments along with extender and different additives or dipping with the same recorded mortalities70%each during third time release made after 3months of storage.

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