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A Preliminary Investigation of Teak [*Tectona Grandis* Linn. F] Stain and Possible Control Measures

Saw C. Doo, B.Sc [For.] [Rgn.] M.Sc. [Haii], Divisional Head,
Forest Research Institute
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ကျွန်းပျဉ်အရောင်ပျက်ခြင်းကို စူးစမ်းလေ့လာခြင်း။

ဦးစောရန်အောင်စီဒူး၊ B.Sc. (For.), (Rgn), M.Sc. (Haii) ဌာနမှူး
သစ်တောသုတေသနဌာန

စာတမ်းအကျဉ်းချုပ်

ကျွန်းပျဉ် အရောင်ပျက်ခြင်းကို စူးစမ်းလေ့လာရာ၌၊ အရောင်ပျက်စေသော ပိုးကို မွေးမြူ ဖော်ထုတ်ခြင်းနှင့် (Electron Microscope) ဖြင့် လေ့လာခဲ့ပါသည်။ ကျွန်းအရောင်ပျက်စေသော၊ မှိုပိုး (*Phialophora richardsiae* (Nannf.)) ကိုတွေ့ရှိခဲ့ပြီး၊ ၎င်းပိုးကို ကျွန်းပျဉ်ပေါ်သို့ စမ်းသပ် မွေးမြူရာတွင်၊ ထိုပိုးသည် အရောင်ပျက်စေကြောင်း ထင်ရှားပါသည်။ ၎င်းအရောင်ပျက်ခြင်းကို ကာကွယ်နိုင်ရန် စူးစမ်းလေ့လာ ထားသော စာတမ်းဖြစ်ပါသည်။

A Preliminary Investigation Of Teak [*Tectona Grandis* Linn. F] Stain By Culture Isolation And Scanning Electron Microscopy.

Saw C. Doo, B.Sc [For.] [Rgn.] M.Sc. [Haii], Divisional Head,
Forest Research Institute

Abstracts

A stain problem in teak (*Tectona grandis* Linn. f.) was studied using cultural isolation and scanning electron microscopy. Microscopy demonstrated the presence of fungal hyphae in the vessels of stained wood. Chemicals generally associated with Chemical stains was not present. A black imperfect fungus (*Phialophora richardsiae* (Nannf.) was consistently isolated from stained wood, which reinoculated on teak produced similar stain patterns. The paper also dealt with control measures for stain problem.

Contents

1. Introduction

Teak (*Tectona grandis* Linn.f.) a member of the family Verbanaceae, is a hardwood tree species having a natural dark streak that makes it an esthetically desirable wood for furniture manufacture. Recently, logs have been processed in which this natural appearance has been distorted by wedge and spotted stains which make the wood unacceptable for foreign export. The purpose of this investigation was to determine the cause of the stain and develop recommendations to present it. It consists of two portions, the first, which identified the causal fungus, and the second, which explored end-coating of logs to prevent germination of fungal spores in fresh-cut logs.

Burma is cutting an average of 815,580 M^3 (Forest Department, 1984) of teak annually, of which 77,000 M^3 was exported as saw logs (World Wood, (1982). Burma has as its goal the exportation of seasoned timber rather than saw logs as an economic aim for the country. To achieve this, it will be necessary to determine ways to reduce or eliminate staining problems in teak.

PART I

A literature review indicated that a number of hardwood stains are caused by imperfect fungi. *Diplodia* spp. has been reported as a causal organism for sap stain of hardwood (Cartwright & Findley, 1985; Hong, 1976,1980). In paper mills *Phialophora* spp. also have been reported as major causal agents of stain (Wang, 1965). However, problems of stain in teak have never been reported although other teak diseases have been described (Browne, 1968; Butler & Bisby, 1960; Doo, 1970; Sanbhoy & Agarwal, 1971, 1976; Spaudling, 1961).

2. Materials And Methods

2.1 Preparation of teak stain sample for (SEM) observations:

Both kiln dried and green samples of stained teak wood (Fig. 1) were dried at 60^o C for 48 hrs to reduce moisture content. Samples were mounted on aluminum studs with a carbon suspension and coated with 50-100 A^o gold palladium for observation. All observations were made on an ETEC scanning electron microscope (SEM) using as accelerating voltage of 20 kv. Electron probe analyses were used to determine whether the stains were chemical stains developed during the kiln drying process.

2.2 Isolation of stain organisms:

Samples of green stained teak wood were surface sterilized using 1 min in 70 % alcohol and 2 min in 10 % sodium hypochlorite, rinsed three times (5 min per rinse) in sterile distilled water and placed on 2.5 % malt agar medium. Following fungal growth, subcultures were obtained from the hyphal tips of the fungus growing on the plates, transferred to 2.5 % malt agar medium and incubated at room temperature.

2.3 Inoculation of wood:

The fungi isolated from stained teak timbers were used in inoculation studies to determine whether they were the potential stain causing organisms. Wood samples were cut into approximately 10 mm x 10 mm x 80 mm blocks and steam sterilized together with vermiculite supplemented with MS macro- and micro-salts. Each test tube was then inoculated with 10 ml of a fungus spore suspension and inoculated at room temperature. Sterlized distilled water was used to inoculate control test tubes. At least 12 replications were observed for the development of stain on the teak wood samples.

3. Observations

Electron probe analysis of mineral deposits in stained teak wood by EDXA revealed high levels of silica as would be expected for teak. The analysis revealed no significant quantitites of chemicals characteristically associated with chemical stains formed during the process of kiln drying.

Fungal hyphae were observed in both kiln dried and wet wood samples (Fig. 2 & 3). The hyphal masses occurred in the vessel element and were seen in all the wood examined. A number of spherical spores were also observed in and along the vessel cells (Fig 4). The spores were collapsed due to suctional forces generated in the process of sample preparation.

The fungus consistently isolated from the sterilized samples was *Phialophora richardsiae* (Nannf.) Conant * (Fig. 5 & 6).

P. richardsiae was dark in colour on malt agar plates and slow growing, attaining a diameter of 2-3 cm in 1 week. Brown hyphae and phialides produced 2 kinds of spores-hyaline and brownish globose *phialospores* (Fig. 7 & 8).

A preliminary test on the pathogenicity of *p. richardsiae* was made. The inoculated sterilized wood samples were examined after tow weeks. A small area of stain appeared on the wood. The stains were dark in colour (Fig 9) and appeared to be in the early stage of staining. Microscopic examinations revealed hyphae growing in the vessels. Sporulation of the fungus was abundant. Reisolation from the inoculated wood demonstrated that the fungus was *P.richardsiae.*

- The fungus was identified by Dr. C. Wang, College of Environmental Science and Forestry Syracuse, N.Y., and Dr. M. Larsen, Forest Service U.S.D.A., Madison.WI.

Figure 1. Stains on teak panelling caused by the fungus Phialophora richardisiae (Nannf.)

Figure 2. Teak walling stained by the fungus Phialophora richardisiae (Nannf.)

Fig. . Rejected teak stain wood seen after conversion at the Saw-Mill, Ahlone.

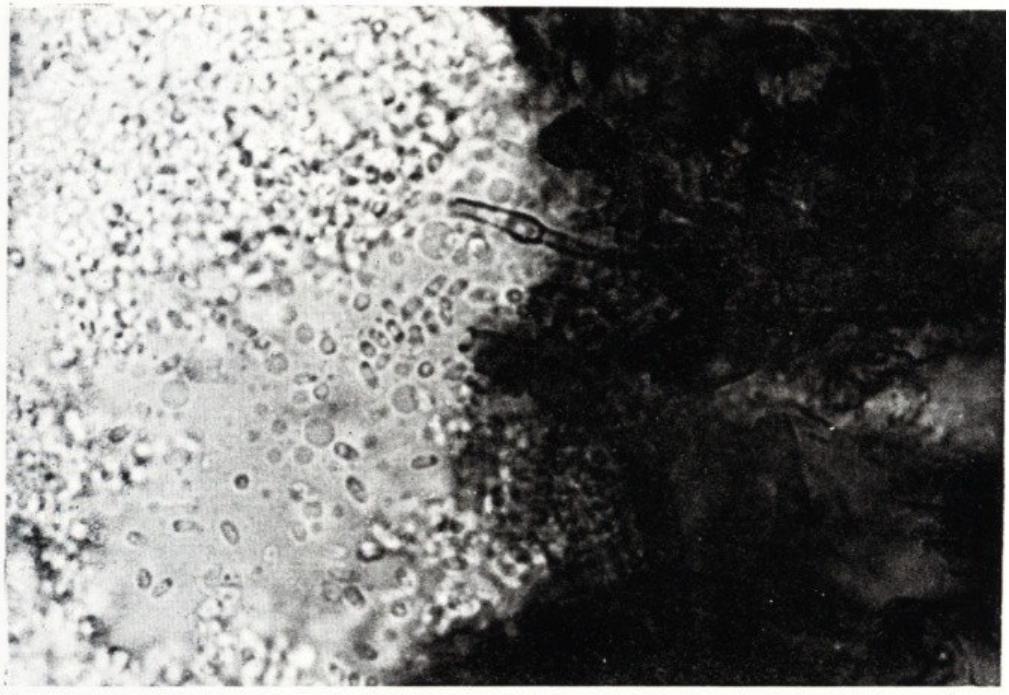


Fig. . Photomicrograph of *P. richardsiae* show the brown color of the hyphal mass (mag. X 2400).

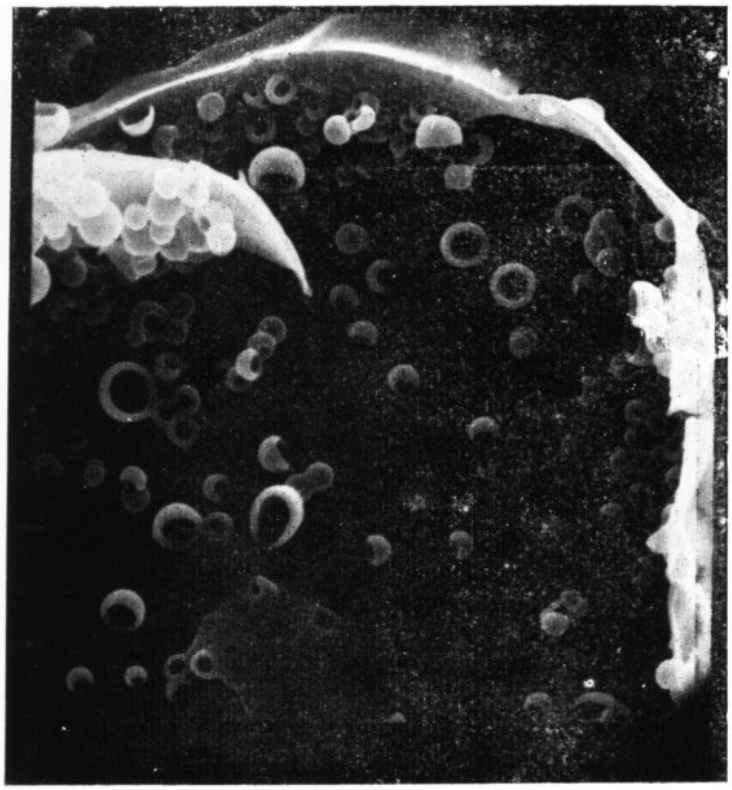
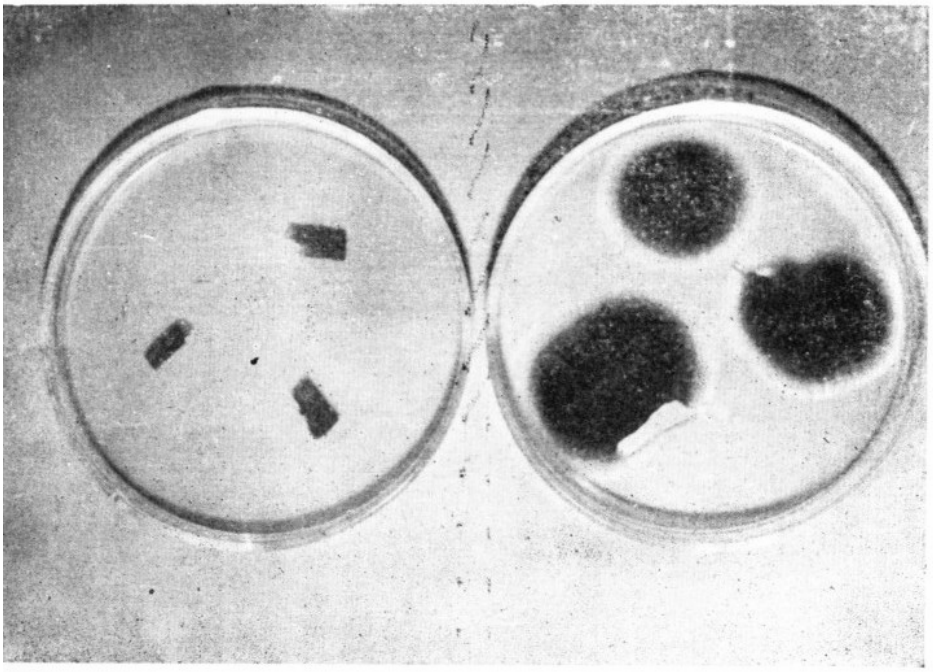


Fig. Scanning electron micrograph of collapsed fungal spore along the vessels in wet teak wood.



g. The petri on the left shows sterilized wood piece at the beginning of the isolation procedure. The one on the right shows the fungus mycelium that grows out of the wood after 10 days (mag.X0.6).

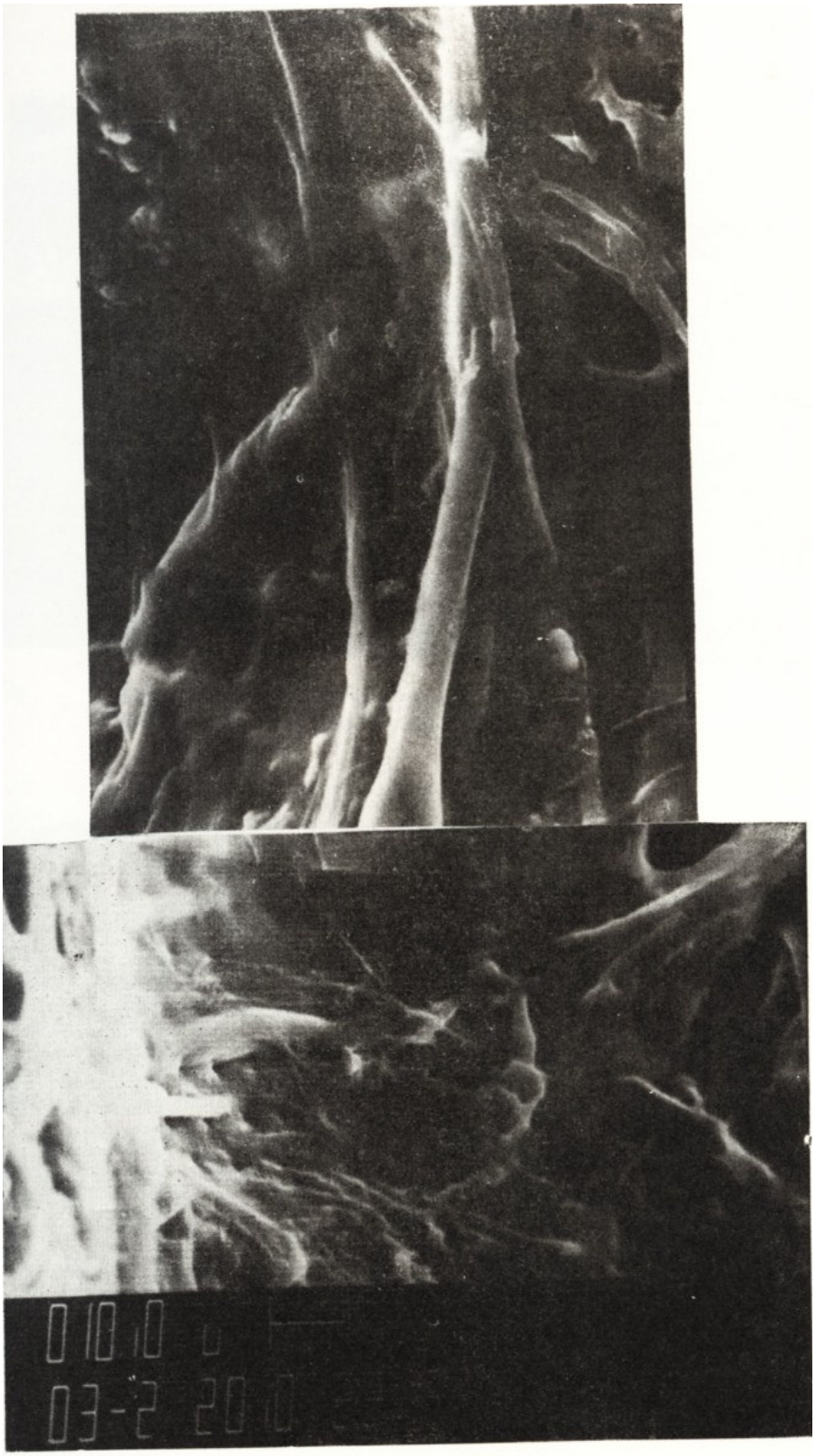


Fig. . Scanning electron micrograph of the fungal mycelium growing on a vessel wall in wet teak wood.

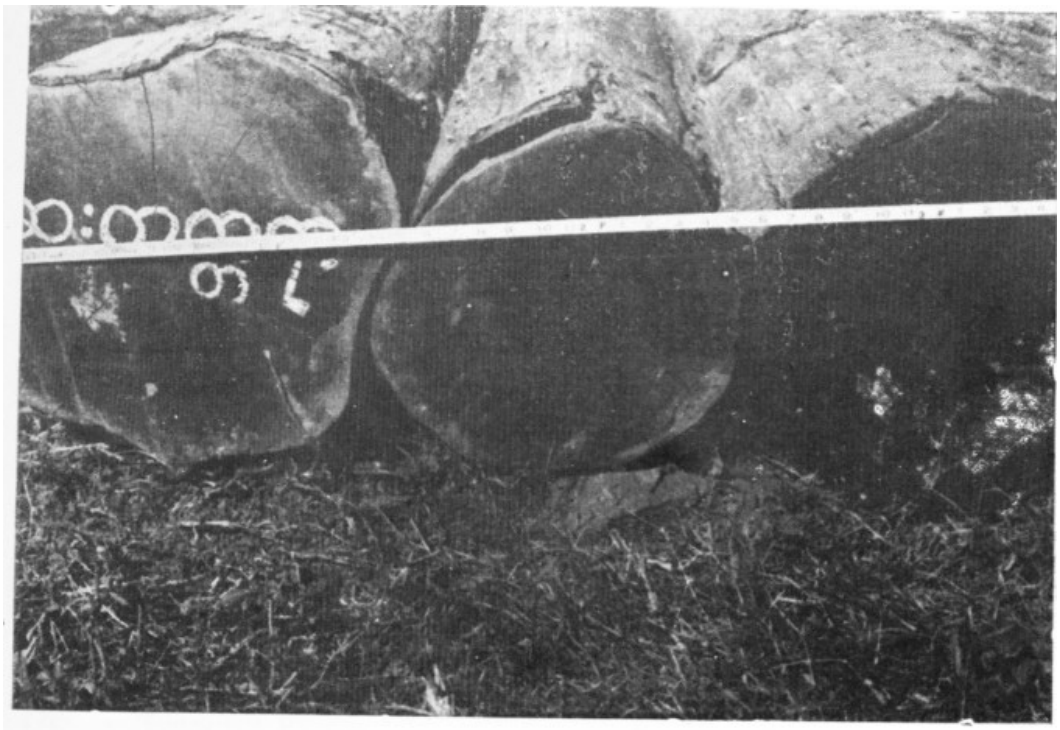


Fig. . Creosote-tar, end-coated green teak logs after 4 months. Cracks on the end can be seen on the log (left).

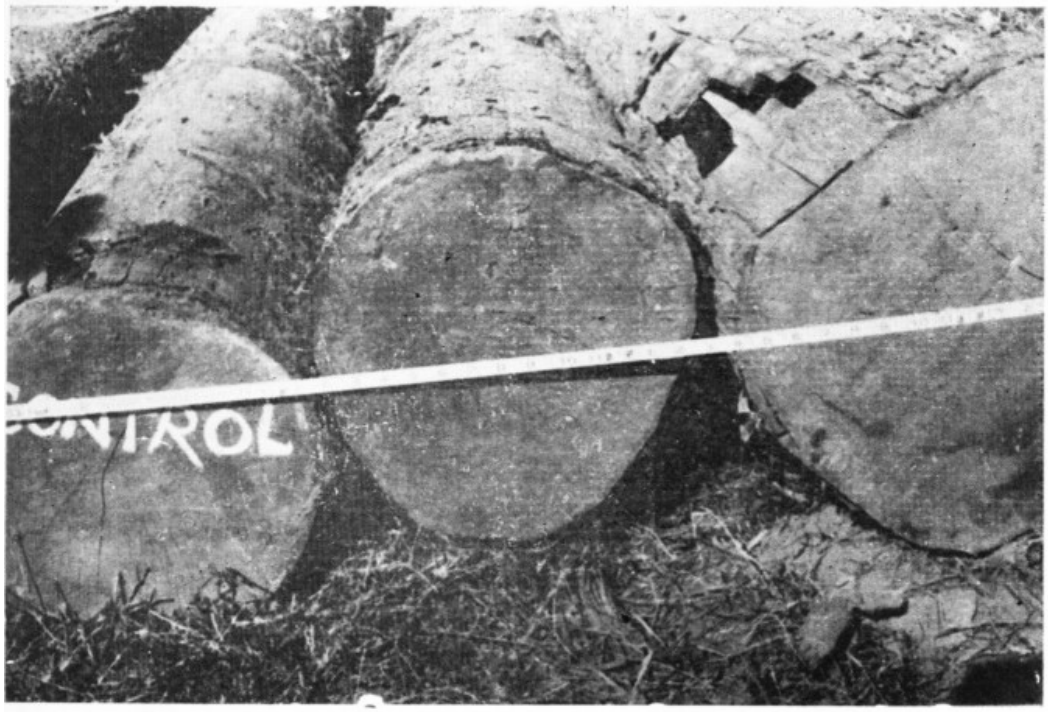


Fig. . Non-treated green teak logs after 4 months. Cracks occurred on most of the logs.

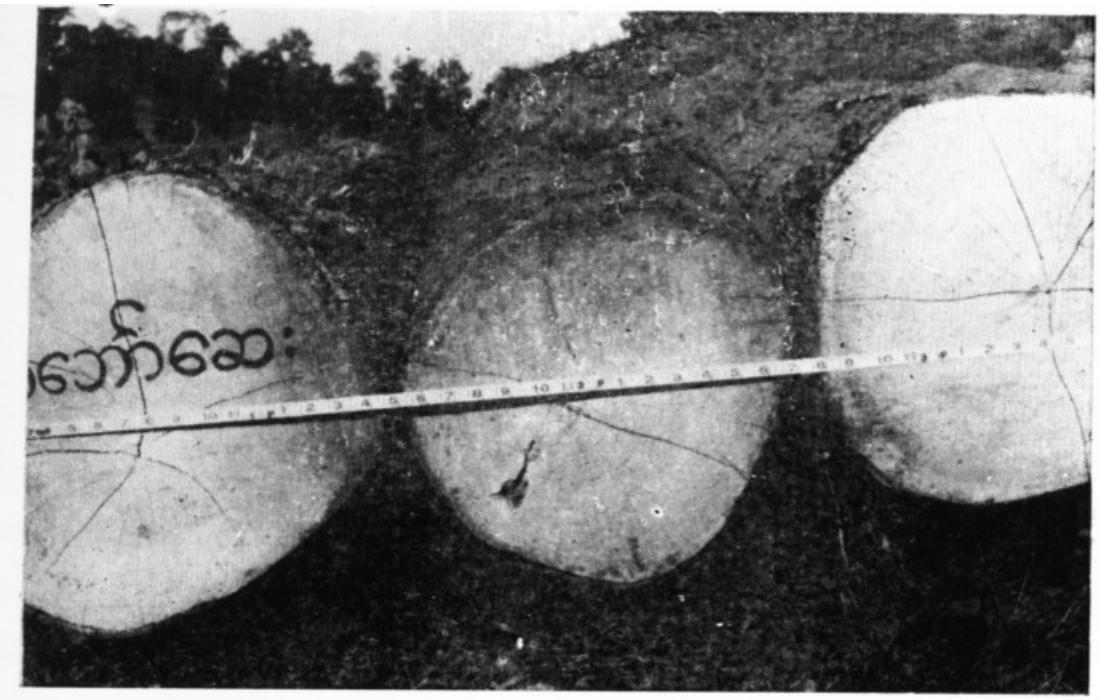


Fig. . Emerald point, end-coated teak green logs after 4 months. Creaks occurred on most of the logs.

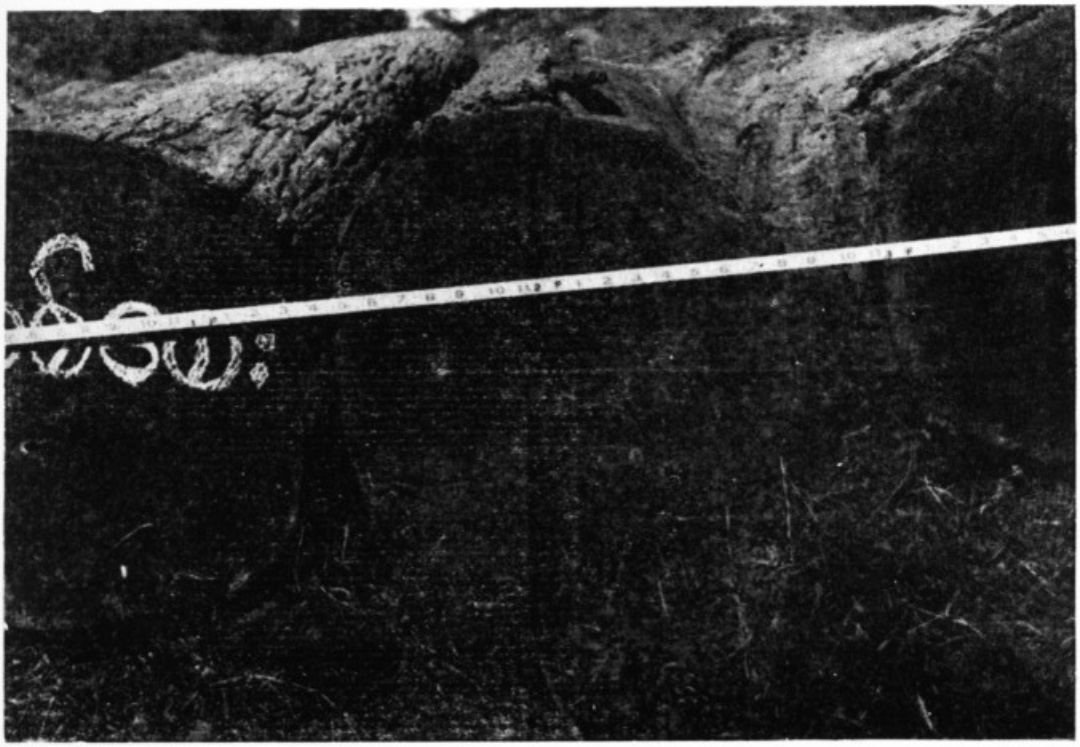


Fig. . Sit-si end-coated green teak logs after 4 months. No crack was observed.

Part II

4. Introduction

With the knowledge that the discoloration was a fungal stain, methods to prevent its occurrence in wood were explored. This type of discoloring stain is commonly called "Blue stain". The color of the stain may very from grayish through dark blue to blackish. It may appear in dying trees but usually develops in dead trees, logs and in green lumber, as well as in manufacture products. As long as the wood contains a sufficient amount of moisture, the fungus will develop. The best way to prevent staining is to reduce exposed wood surface moisture content to less than the wood fiber saturation point (about 25 %) before the spores can germinates. In fresh-cut logs, the cut ends should be coated if storage on land for long periods is to be expected (Panshin & de Zeeuw 1980).

Wood in a log starts to lose moisture from the exposed wood surface as soon as it is severed from the stump. Thus a gradient of moisture content occurs from the surface to the center, As wood shrinks at different rates tangentially, longitudinally, and radially, stresses are built up in the wood which can result in cracks or checks. It the newly exposed wood has a surface moisture content above fiber saturation point, fungal spore germination can take place (Panshin & de Zeeuw 1980).

Staining fungi, like other fungi, develop much more rapidly under warm than cool condition. In Burma, with a prevailing monsoon for about 4 months, and a hot climate (25^{o}-35^{o}) C, very favorable conditions are provided for the growth of stain fungus. Green teak logs with moisture content over fiber saturation point upon arrival at the sawmill, also favor the infection processes. Relative humidity varies from 85-90 % in wet season again which also accelerates the spread of stain fungus.

5. Materials and Methods

Forty teak logs were randomly selected from a log storage pile at Ahlone. Samples were taken from the interior of each log and the moisture content determined in the Wood Anatomy Laboratory of FRI.

Next 12 teak logs were randomly selected from freshly felled teak tress. End coatings of Sit-si, Emerald paint, and Creosote-tar was applied to both ends of 3 logs for each treatment coating with 3 loge were left uncoated for control. The logs were left exposed to natural conditions. The site was the Ngalaik Reserve Forest, Moswe and the logs were examined after four months.

The three coatings selected are:

Sit- Si - Lacquer oil used in making Lacquerware.

Emerald Paint- a water soluable plastic paint made in Burma.

Creosote-tar - commercial creosote.

6. Observations

The moisture contents of the forty logs randomly selected are shown in Table 1. It is to be noted that all but five have moisture content above 25% which indicated that there was a certain amount of free water in the cells and a good medium for spore germination in cracks. The logs with moisture content below fiber saturation point probably have in storage longer than the rest.

Preservation of stain by end-coating was observed after 4 months. End splitting occurred on logs treated with Emerald paint (Figure 10), creosote-tar (Figure 11) and the untreated control loges (Figure 12). The logs treated with Sit-si (Figure 13) had no evidence of end -splitting.

Table (1). Determination of Moisture Content of logs in the Vicinity of Sawmill, Ahlone.

Log No.	Moisture Content %	Log No.	Moisture Content %
1	74.32	21	20.11
2	16.35	22	46.23
3	47.87	23	32.43
4	55.35	24	23.23
5	66.67	25	39.11
6	45.30	26	37.18
7	49.43	27	66.00
8	36.57	28	39.96
9	58.60	29	48.50
10	71.10	30	59.82
11	49.31	31	48.38
12	55.95	32	53.21
13	44.64	33	14.79
14	28.94	34	74.15
15	38.30	35	61.18
16	26.88	36	26.77
17	49.10	37	20.04
18	58.00	38	16.89
19	63.76	39	32.17
20	22.19	40	26.78

7. Discussions and Conclusions

SEM observations indicate that a fungus is characteristically present in the vessels of stained teak wood and that the stain is not a chemical stain. Inoculation tests on the wood revealed the fact that the fungus, *P.richardsiae,* existed in all stained wood. It penetrates the cell wall and attacks teak when favorable moisture and temperature condition exist.

This species has been recorded previously from groundwood pulp in Sweden and from pulp slime in Newfoundland and New Brunswick pulp mills. Davidson (1936) reported this fungus as *Cadophora brunnescens* which caused stains in log and lumber in the United States.

Stain fungi apparently cause little damage to the structure of wood they inhabit. Hyphae may be present in most elements, but are often found in vessel cells. Although the structure of wood remains intact, the stain problem seriously limits use

of the wood in the production of finished products. As the stain fungus has specific temperature and wood moisture requirements for inflection and growth, the best method of controlling it is to create environmental conditions such that the fungal growth is prevented.

The logs in storage could develop stain quite readily as wood surfaces above fiber saturation point are exposed to the air. If left in exposed storage subject to rapid drying due to high temperature, and-splitting and entrance of stain pores is very likely to occur.

The end-coating with Sit-si appears to be a method to reduce end splitting as it slowed the rate of drying and the build-up of internal stresses.

This would suggest that felling of girdled tree is the best method for harvesting. The processes of drying is slowed and at the same time there is no splitting injury as the tree is left standing for there years until dried. However, modern extraction processes and machinery as well as the long delay in developing foreign exchange. Indicates extraction of fresh logs will continue.

Storing fresh logs in water (river or mill pond) might keep the moisture content above the level which the fungus can grow. As an alternative, end - coating the fresh-cut logs as soon as felled with Sit-si appears to be one way to reduce end-splitting.

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