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論　文

Attack to *Shorea* spp. (Dipterocarpacae) by Ambrosia Beetles and Wood Borers, and its Preventive Treatment by Insectisides

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穿孔虫類によるラワンへの加害とラワン丸太の殺虫剤による防虫処理

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要　旨：ラワン材に寄生する穿孔虫類を防除する目的で，1970年から1972年にかけ，インドネシア東カリマンタン州を中心に行った5回の現地調査の結果，以下の知見を得た。

1)　いわゆる“中ピン”などと呼ばれているところの，ラワン生立木に寄生する穿孔虫類が，生息数は少ないが確認された。Platypodidae は，比較的大型（直径2～4 mm）のピン・ホールを作り，おもに心材部を加害する。Xyleborini は，小型（直径0.5～1.0 mm）のピン・ホールを作るが，ラワン立木の地表近くの空洞から続く割れ目に沿って心材に侵入し，脆心材を加害することもある。

2)　立木伐倒後の丸太に対しては，剝皮しない場合，内樹皮，辺材を食害するカミキリムシ *Dialeges pauper* などが，伐倒後5日目ごろから産卵し始め，加害する。剝皮した場合，*Xyleborus perforans*, *Arixyleborus granulifer*, *Platypus curtus* などのキクイムシ類が，剝皮丸太の表面が乾燥し始めると（雨季には剝皮後約30分，乾季には約20分），心材，辺材を直接加害する。

3)　ラワン丸太の穿孔虫類による被害を防ぐためには，前述の穿孔虫類の寄生が始まる前の時期に，剝皮しない丸太に対しては，バイジット乳剤を 3cc/m² （バイジット純量），スミチオン乳剤を 1.5cc/m²，剝皮丸太に対しては，バイジット乳剤またはスミチオン乳剤を 3cc/m²，予防散布すればよかった。

Summary: For the purpose of preventing lauan logs from ambrosia beetles and wood borers, field researches were done five times from 1970 to 1972 mainly in East Kalimantan State, Indonesia.

1) A few beetles, which were so-called “involved pin-holes”, attacked standing trees of lauan. Platypodids made comparatively large pin-holes (2～4 mm in diameter), and attacked heart-wood mostly. Xyleborini made small pin-holes (0.5～1.0 mm in diameter), attacked heart-wood with cracks which led to caves in root swelling of lauan, and often attacked brittle heart.

2) To unpeeled logs of lauan, Cerambycids such as *Dialeges pauper* began to oviposit from about the 5th day after felling standing trees. To peeled logs, ambrosia beetles and wood borers such as *Xyleborus perforans*, *Arixyleborus granulifer* and *Platypus curtus* began to attack sapwood and heart-wood directly, when log surface became dry, about 30 minutes in the wet season and 20 minutes in the dry season after peeling.

3) To prevent lauan logs from ambrosia beetles and wood borers, pure quantity of insecticide (emulsion), 3 cc/m² of MPP or 1.5 cc/m² of MEP to unpeeled logs and 3 cc/m² of MPP or MEP to peeled logs, must be sprayed before the attack of ambrosia beetles and wood borers.

I. Introduction

Recently, Japan has been importing a large quantity of logs, at over the 20,000,000 m³ level annually from the Southeast Asia such as the Philippine Islands, Borneo, and so on, where the principal tree species to be exported are *Shorea* spp. (Dipterocarpacae), which is called lauan. As insect control in these regions is sometimes insufficient, some serious problems are caused by ambrosia beetles and wood borers which are mostly so-called pin-hole borers entering Japan with imported logs.[1~6]

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In the first place, ambrosia beetles and wood borers carried alive are threatening to invade Japan successfully as epidemic pests and doing serious harms to Japanese woods such as *Hyphantria cunea* DRURY (Lepidoptera: Actiidae). In fact, pin-hole borers which inhabit the Southeast Asia and Japan commonly are 24 species,[7] and so there is a high possibility of invasion by harmful ambrosia beetles and wood borers.

In the second place, the principal methods of controlling beetles in imported logs are fumigation with methyl-bromide and spraying insecticide. But the fumigation is considerably dangerous to human body, and the harbors are considerably polluted with the spraying.

In the third place, it takes so long a time to quarantine harmful ambrosia beetles and wood borers in imported logs that the logs are not distributed smoothly, and some facilities such as log pond or yard which cost much money are needed.

In the fourth place, the logs attacked by ambrosia beetles and wood borers are difficult to use and fall in price seriously.

In order to solve these problems, the most rational ways will be to lay stress on preventive spraying in the habitat of lauan to prevent pin-holes and also to kill ambrosia beetles and wood borers, and consequently to import logs without living insects, on condition that ambrosia beetles and wood borers do not attack standing trees of lauan.

There were some articles on the biology of ambrosia beetles and wood borers in the Southeast Asia,[8~12] but few on the control of them in lauan.[13]

Field researches about their biology and control were done five times from 1970 to 1972 mainly in East Kalimantan State, Indonesia, from which Japan imports the most numerous logs with very serious infestations. Researches have not been completed yet, but some new information has been obtained, which is reported here.

Assistant Professor T. Murakami, one of the authors, died on the 7th day of October in 1971 just after the third research. This is his last achievement.

II. Insect attack to standing trees of lauan

The authors thought it most important to make clear whether ambrosia beetles and wood borers attacked standing trees of lauan, for the purpose of judging the possibility of protecting lauan logs from insect attack, and so tried for the first time to study it.

Main study forests are located near Sotik Village and Subulu Village in East Kalimantan State, Indonesia. There stand mainly red lauan and yellow lauan with the height of from 40 to 50 meters and with the breast height diameter of about 1.2 meters.

1. Methods

Logs soon after felling were peeled off along the radial face, and the presence of tunnels by ambrosia beetles and wood borers was searched. Logs with the tunnels were carefully cut into pieces along the radial face and the cross face, dead beetles found in the tunnels were collected for identification, and types of the tunnels were recorded.

2. Results and discussion

It was reported by BROWNE (1961) that standing trees were attacked by ambrosia beetles such as *Xyleborus perforans* (Coleoptera: Scolytidae), when they were weakened for certain reasons, but continued to grow still involving them after trees recovered their health. These tunnels by the beetles are so-called "involved pin-holes" which are rarely found in the natural stands of lauan.

In our researches, Platypodids making comparatively large pin-holes, Xyleborini making small ones and unknown species making large ones filled with insect frass, attacked standing trees of lauan in natural stands obviously.

(1) Platypodids. (Coleoptera: Platypodidae)

These species made comparatively large pin-holes (2~4 mm in diameter). Most of entrance holes seldom started from heart-wood but from bark or sapwood, which suggested that most species of Platypodids had attacked lauan recently.

As the holes might be made in the young growth of lauan, ten standing trees with the breast height diameter of up to 45 cm were searched, but the holes could not be found.

According to analysis of the pin-holes, Platypodids invaded stems up to 10~30 cm to the center straightly, and then branched tunnels in a circle (Fig. 1). As the entrance holes were closed with resin at the bark or the sapwood after their invasion, Platypodids

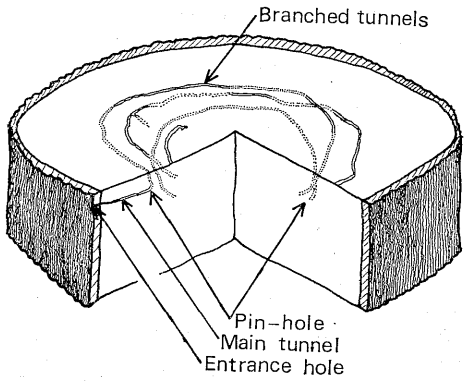

Fig. 1. Pin-holes (2~4 mm in diameter) made by Platypodids

could not get out of the trees, and one dead pair of them was often found in one entrance hole. Larval tunnels were seldom found, which may suggest that Platypodids are unable to grow in healthy trees.

Platypodids attacked red lauan more severely than yellow lauan, and thirty-three per cent of lauan trees were attacked in one stand in the most severe case, but the damage was small on the whole in Kalimantan State. There was no relationship between the attack of Platypodids and the diameter of lauan.

Platypodids could not be identified, because there remained no bodies except incomplete dead ones.

(2) Xyleborini (Coleoptera: Scolytidae)

These species made small pin-holes (0.5~1.0 mm in diameter), and attacked heart-wood with cracks which led to caves in the root swelling of lauan. Attacked heart-wood turned into brittle heart in most cases.

It seems to be sure that Xyleborini invaded heart-wood from the cracks, oviposited and bred progenies, because they often attacked heart-wood with cracks near the ground surface and there seldom were pin-holes vertical to the ground. Hence, many irregular pin-holes were made in heart-wood by the adults and their progenies (Fig. 2).

As most of lauan had caves in the root swelling and cracks from them, there were few which had not their attack near the ground surface. These species attacked only heart-wood which was dry and had cracks, but seldom invaded heart-wood which was wet and packed.

Xyleborini could not be identified also, because there remained no bodies except incomplete dead ones.

(3) Unknown species

This species seemed to be of the similar type which is called "Mimizu" in Japan plywood industry or "Cross-bar" in U. S. A.[14]

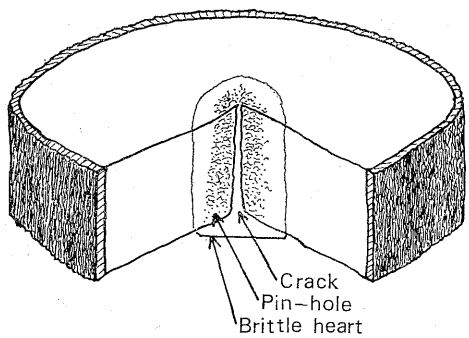

Fig. 2. Pin-holes (0.5~1.0 mm in diameter) made by Xyleborini

This species made vertical or spiral tunnels in heart-wood or sapwood of similar size of thumb which were packed with insect frass like larval tunnels of the family Cerambycidae or Buprestidae (Coleoptera).

This species were very few, could not be collected and identified.

III. Insect attack to Lauan logs

In chapter II, it was mentioned that few standing trees of lauan were attacked by ambrosia beetles, and so, most of ambrosia beetles and wood borers were considered to attack lauan logs after felling.

If logs are to be prevented from ambrosia beetles and wood borers, it is most important to know the time when they begin to attack lauan logs.

1. Methods

After standing trees of lauan are felled in a forest, logs are often left without peeling for considerably a long time. Soon after logs are carried into the log yard, they are peeled. Then, some time after felling trees and peeling logs, and ambrosia beetles and wood borers attacking them were recorded.

Ambrosia beetles and wood borers were stored in glass tubes filled with alcohol, and identified later in Japan.

2. Results and discussion

(1) Attack to logs with bark

Phloeophagous such as *Dialeges pauper* PASCOE and *Plocaederus obesus* GAHAN, belonging to the family Cerambycidae, flew down on the surface of logs immediately after felling, but their successful oviposition was hardly observed on the logs within 4 days from felling at least.

Ambrosia beetles such as *Xyleborus* spp. and *Arixyleborus* spp. (Xyleborini) (Coleoptera: Scolytidae) did not attack lauan logs while cut faces were wet with resin of lauan, but often succeeded to invade logs from cut faces or cracks when resin stopped exuding or logs had brittle heart.

In inner bark of logs over 10 days after felling, a few young larvae of Cerambycids, which were supposed to be mostly larvae of *D. pauper* and *P. obesus*, began to feed on the inner bark.

Over 20 days after felling, numerous larvae of them were found. At the same time, a few ambrosia beetles began to attack, and dominant species both in the dry season (from May to September) and in the wet season (from November to March) were *Xyleborus* spp. in which the most numerous species was *Xyleborus perforans* (WALLASTON), *Arixyleborus* spp. in which the most numerous species was *Arixyleborus granulifer* (EGGERS), and *Platypus curtus* CHAPUIS (Platypodidae).

Over 30 days after felling, numerous mature larvae

were found, and some of them began to bore sapwood to make pupal cells. At the same time, numerous ambrosia beetles began to bore actively.

As above mentioned, it is supposed that the period during which lauan logs after felling are not attacked by Cerambycids is about 4 days, and the period during which they are not attacked by ambrosia beetles and wood borers is about 20 days.

In Borneo, lauan logs are commonly gathered at log yard within 10 days after felling and peeled there. As far as the works are done smoothly, little is the damage by ambrosia beetles and wood borers. But, skidding is often badly influenced by unseasonable weather, lack of workers, and so on, and logs without peeling are sometimes left in the forest for over 20 days. Then, the logs are severely attacked by ambrosia beetles and wood borers.

(2) Attack to peeled logs

Lauan logs are always peeled at log yard in Indonesia. To peel is to prevent logs from Cerambycids which feed on the inner bark and then the sapwood with their growth, but at the same time it is not to prevent attacks from ambrosia beetles and wood borers which attack sapwood and heart-wood directly. Ambrosia beetles and wood borers attacked peeled logs of lauan successively as the followings:

Soon after peeling, ambrosia beetles and wood borers began to attack, when log surface became dry with the end of resin exudation. About 20 minutes after peeling in the dry season and 30 minutes in the wet season, Xyleborini and Platypodids, whose dominant species were *Xyleborus perforans*, *Arixyleborus granulifer* and *Platypus curtus*, began to succeed in invading lauan logs up to the depth over the body length.

Over the next day after peeling, above mentioned ambrosia beetles to which *Heterobostrychus aequalis* (WATERHOUSE) and *Xylothrips flavipes* (ILLIGER) (Coleoptera: Bostrychidae) were added in the wet season, attacked lauan logs actively. *P. curtus* invaded logs more numerously in the wet season than in the dry season.

IV. Chemical control of ambrosia beetles and wood borers

In Chapters II and III, it is made clear that the attack to lauan by ambrosia beetles and wood borers is mostly done after felling standing trees or peeling logs. In case some adequate control is done before the attack, it is possible to prevent lauan logs from the attack.

The authors considered the prevention easy by using insecticide, and tried by using BHC-γ emulsion in Kalimantan State in the wet season (January) and in the dry season (July) of 1971. As the result, it was made clear that complete prevention for two months was obtained by spraying 5 cc of BHC-γ over 1 m^2 of log surface.

But, to use BHC to forest insects was prohibited from October of 1971 by the Japanese Goverment, and so, it was tested in Kalimantan State from December of 1971 to July of 1972 whether chemical control of ambrosia beetles and wood borers was possible or not by spraying MPP (fention)·EDB (ethylene dibromide) emulsion or MEP (fenitrothion)·EDB emulsion which were sprayed as the insecticide against ambrosia beetles and wood borers in Japan.

1. Methods

10, 20, 40 and 80-fold solution of MPP·EDB emulsion (commercial name, Finechem EC:MPP-10%, EDB-10%, others-80%) and 25, 50, 100 and 200-fold solution of MEP·EDB emulsion (commercial name, Sumibark E: MEP-50%, EDB-15%, others-35%) were sprayed at the rate of 300 cc over 1 m^2 of peeled surface or 600 cc over 1 m^2 of unpeeled surface of lauan logs soon after felling or barking, which had not been attacked by ambrosia beetles and wood borers. With the dose of 300 cc or 600 cc, sprayed solution dripped a little from logs in each case.

On the 15th, 30th and 60th day after the treatment, it was carefully scrutinized whether ambrosia beetles and wood borers could attack lauan logs successfully or not, as they did not often attack logs practically despite their trial to attack. This research was repeated twice in the wet season and in the dry season.

2. Results and discussion

Preventive effect of MPP·EDB emulsion and MEP·EDB emulsion against ambrosia beetles and wood borers are shown in Tables 1 and 2.

As the period from felling trees till the departure by ship to Japan is less than 60 days, the sprayed insecticide is required to prevent logs from ambrosia beetles and wood borers for 60 days. From Tables 1 and 2, it is clear that each insecticide can not prevent logs from them for 60 days despite the large quantity of sprayed insecticide.

But, from Chapters II and III, it is seen that the damage by ambrosia beetles and wood borers is done in most cases within the period less than 30 days when logs are peeled and left at the log yard. Little damage is done in a log pond or on board a ship. Then, the sprayed insecticide is considered sufficient if it keeps preventive effect for 30 days.

Minimum pure quantity of sprayed insecticide enough to prevent logs from ambrosia beetles and wood borers for 30 days is 3 cc/m^2 of MPP or 1.5 cc/m^2 of MEP in case of logs with bark, and 3 cc/m^2 of MPP or MEP in case of peeled logs. In addition,

Table 1. Preventive effect of MPP (Fenthion) emulsion as lumber-protectant against ambrosia beetles and wood borers of lauan

Concentration of MPP (%)		1		0.5		0.25		0.125		0 (Control)	
Log		with bark	without bark	with bark	without bark	with bark	without bark	with bark	without bark	with bark	without bark
Dose (cc/m²)		600	300	600	300	600	300	600	300	0	0
Pure quantity of MPP (cc/m²)		6	3	3	1.5	1.5	0.75	0.75	0.375	0	0
Number of ambrosia beetles and wood borers after treatment	15th day	0	0	0	few	few	few	few	few	few	many
	30th day	0	0	0	many	many	many	many	many	many	many
	60th day	many	many	many	many	many	many	many	many	many	many

Table 2. Preventive effect of MEP (Fenitrothion) emulsion as lumber-protectant against ambrosia beetles and wood borers of lauan

Concentration of MEP (%)		2		1		0.5		0.25		0 (Control)	
Log		with bark	without bark	with bark	without bark	with bark	without bark	with bark	without bark	with bark	without bark
Dose (cc/m²)		600	300	600	300	600	300	600	300	0	0
Pure quantity of MEP (cc/m²)		12	6	6	3	3	1.5	1.5	0.75	0	0
Number of ambrosia beetles and wood borers after treatment	15th day	0	0	0	0	0	few	0	many	few	many
	30th day	0	0	0	0	0	few	0	many	many	many
	60th day	many	many	many	many	many	many	many	many	many	many

EDB turns into gas and has no preventive effect.

When the works such as skidding, peeling and logging are done smoothly, the sprayed insecticide is considered sufficient when it keeps preventive effect for 15 days. Then, it was researched whether preventive effect for a short term was possible or not by lessened pure quantity of insecticide. Pure quantity of the sprayed insecticide enough to protect logs for 15 days was found to be the same quantity needed to protect them for 30 days, and to attain preventive effect only for a short term by a lesser amount of the insecticide was found to be impossible.

Spraying on logs with bark should only be done in case the felled logs are left in the forest for a long period, or peeling of logs soon after felling is impossible for reasons of labor shortage and others. But in the usual cases where yarding and peeling are done within 10 days after felling, spraying on unpeeled logs is not necessary. If it is desired to prevent unpeeled logs from the attack of Cerambycids, although the damage from these insects would not debase the quality of logs very much, spraying should be done within 4 days after felling.

It is the case of peeled logs that gives rise to real problems in Kalimantan State. Within 20 or 30 minutes after peeling, few logs remain intact from the attack of wood borers. So, insectcides must be sprayed immediately after peeling.

The authers tried to make Indonesian workers spray insecticide with a shoulder sprayer immediately after peeling. This work was not difficult, and they could easily spray and prevent lauan logs from ambrosia beetles and wood borers.

Field application-test was done in July of 1972.[15] In case pure quantity of MEP (emulsion) was sprayed at the rate of 3 cc over 1 m² of peeled surface of lauan by Indonesian workers, ambrosia beetles and wood borers did not attack 83.9 or 86.7% (34.1%—without spraying) of lauan logs. It was proved actually that chemical control of ambrosia beetles and wood borers was enough effective.

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