V. CARE AND MAINTENANCE

5.1 Replanting, Weeding, Pruning and Thinning

Maintenance of plantation in the field could be divided into maintenance of young plantation and mature plantation. Maintenance for young plantation are including replanting, weeding, fertilizer application, low pruning and high pruning. Meanwhile, maintenance of mature plantation is thinning.

Rarely will planting be so successful that there is no need for replacement of seedlings in the field. Reserve about 20% of the most healthy and vigorous seedlings as replacement stock. Replanting might be necessary two times during the rotation. The first replanting of dead seedlings normally takes place in rainy season at 1 to 2 month after planting and the second replanting at the end of the second years. Decide when further replanting are necessary generally, in large scale plantations, seedlings are replaced if their survival rate less than 70 percent.

Weeds are a major problem in tree plantation because they compete with trees for soil nutrients, light, water, and space. Therefore weeding is essential for ensuring maximum growth and survival of seedlings. Weeds that touch or are higher than the seedling should be removed. This should be removed before they flower and shed their seed. During the first year of planting, weeding should be done every 6 months. It can be conducted along the row of the main species or one meter in diameter around the seedling (ring weeding). To prevent the re-growth of weeds, the grass cut is placed as mulch around the seedling.

Pruning consists of removing dead or nonproductive branches from the lower trunk. It encourages the production of clear wood also reduces the risk of disease and pest infestations. The best time for light pruning is just before the rainy season starts. Sometimes trees grow have two or three stems during the early growth at 6 to 9 months. Singling should be done to get the main stem by removing the co dominant stem. If it is not singled, the stem density might be high per hectare, the stem become tall and slender, with consequences the stems are easily broken by rain or wind.

The principal objective of thinning is usually to improve the growth of remaining trees by felling individual trees. Trees selective to be felled consist of diseased or pest-infested trees, deformed and poor shaped trees and suppressed trees, Thinning is necessary only when the trees are grown to produce sawn timber and veneer. It is not required if the trees are being grown to produce for pulpwood.

The several classical types of thinning selected according to the quality of the stem form desired are:

- High thinning (crown thinning): This method consists of light crown thinning and heavy crown thinning. In light thinning some dominant of undesirable characteristics (diseased or pest trees) should be removed. While in heavy thinning the most promising stems (straight and cylindrical form) should be leaved by removing the competition of inferior neighbors. The best trees should be evenly distributed over the stand.
- Low thinning: Trees of lower crown position (suppressed trees) and poorly shaped should be removed. Dominant trees should be evenly distributed over the stand

Table 5.1 Maintenance activities in young and mature plantation for selected tree species

Species	Young Plantation	Mature Plantation
Acacia mangium	Replacing dead seedlings with new seedlings 1-2 month after planting and in the end of the second year, weeding and hoeing 3-4 times in the first and second year after planting. Singling at 6 to 9 months after planting.	Regular thinning are conducted when the plantation is 3, 5 and 7 years old. No thinning is conducted if the plantation is for pulp and paper industries.
Eucalyptus urophylla	Replacing dead seedlings with new seedlings 1-2 month after planting and in the end of the second year, weeding and hoeing 3-4 times in the first and second year after planting	Regular thinning are conducted when the plantation is 5 and 9 years old. No thinning is conducted if the plantation is for pulp and paper industries.
Gmelina arborea	Replacing dead seedlings with new seedlings in the first and second year, weeding and hoeing 3-4 times in the first and second year after planting. Pruning is recommended when branches are already too thick.	Regular thinning are conducted when the plantation is 3-4 years old then repeated every 2 years. No thinning is conducted if the plantation is for pulp and paper industries.
Khaya anthoteca	Replacing dead seedlings with new seedlings 1 month after planting and in the second year, weeding and hoeing 3-4 times in the first and second year after planting. Fertilizer application, 75 to 100 g per plant in the first year after planting.	Regular thinning after the plantation is 5 years old with 5-year interval, the number of trees reaching 220 to 440 per ha in the final stand (20 years).
Melia azedarach	Replacing dead seedlings with new seedlings 1 month after planting, weeding and hoeing 3-4 times in the first and second year after planting. First thinning when the plantation is 3 years old to reduce the stocking to 400 trees per ha.	Further thinning is conducted when the plantation is 6 years old to reduce the stocking to 200 trees per ha.
Paraserianthes falcataria	Replacing dead seedlings with new seedlings in the first year after planting, weeding and hoeing 2-3 times in the first and second year after planting.	Regular thinning after the plantation is 2 years old and then every year up to 10 years.
Pinus merkusii	Replacing dead seedlings with new seedlings in the first and second year after planting, weeding and hoeing 4 times in the first and second year after planting.	Regular thinning after the plantation is 9-10 years old with 5 year interval.
Shorea spp.	Replacing dead seedlings with new seedlings in 1 month after planting and the end of first year, weeding and hoeing 4 times in the first and second year after planting, and fertilizer application, i.e. 1-2 g NPK per plant.	Regular thinning after the plantation is 5 years old with 5 year interval.
Swietenia macrophylla	Replacing dead seedlings with new seedlings 1 month after planting and in the second year, weeding and hoeing 4 times in the first and second year after planting, and fertilizer application, i.e. 75-100 g NPK per plant.	Started when the plantation is 6 years old and aimed to gradually reduced the stocking to 220-240 per ha (20 years old), and down to 120-150 when 35 years old.
Tectona grandis	Replacing dead seedlings with new one (using seeds, earth ball, or stump) 2 to 5 months after planting, weeding and hoeing, low pruning at 6 months, thinning when the stand is 3-4 years old and repeated every 4 years until the stand is 15 years old.	Regular thinning, 5 years interval until the stand is 25 years old, then every 10 years.

5.2 Protection

The land area under forest plantations in Indonesia has increased significantly over the last decades, especially in Sumatra and Kalimantan. Most of these plantations have been planted with fast growing, exotic tree species, and often in monocultures. The reduction in species diversity, age diversity and genetic diversity in plantations produce conditions favorable for development and spread of pest and plant pathogens.

5.2.1 Important insect pest in plantation

The uniformity and extensive coverage of forest plantations, especially those that involve a single tree species, provide an ideal condition for insect pest to attack. The possibility of destruction resulting from a massive build-up of pest is one of the most serious threats to success of a plantation. Insect pest almost always attack trees in plantations. Some species may attack chronically though the attack may vary in intensity from year to year, while others may attack occasionally. Table 5.2 list down some of the important insect pest that attacks plantations, as compiled by Nair and Sumardi (2000). Brief description of the pests of each tree species are as follows :

Table 5.2 Important insect pests of forest tree plantations

No	Tree Species	Insect Pest	Common Name	Type of Damage
1	*Acacia mangium*	*Coptotermes curvignathus* (Isoptera, Rhinotermitidae)	Termite	Root feeding, causes death of saplings
		Pteroma plagiophleps (Lepidoptera, Psychidae)	Bagworms	Leaf feeding
		Helopeltis theivora (Hemiptera, Miridae)	Mosquito bug	Sap sucking
		Xystrocera festiva (Coleoptera, Cerambycidae)	Stem borer	Trunk boring
2	*Agathis - loranthifolia*	No major insect pests -problem	-	-
3	*Eucalyptus* spp.	*Helopeltis theivora (*Hemiptera, Miridae)	Tea mosquito bug	Sap-sucking causes die-back of shoot
		Zeuzera coffeae (Lepidotera, Cossidae)	Red borer	Stem boring on saplings
		Several species of termites	Subterramean termites	Root feeding, causes plant mortality
4	*Gmelina arborea*	No major insect pests have been found	-	-
5	*Khaya anthoteca*	*Hypsipyla robusta* (Lepidoptera, Pyralidae)	Mahogany shoot borer	Shoot boring, causes growth retardation and stem forking
6	*Maesopsis eminii*	No insect pests have been recorded	-	-
7	*Melaleuca - leucadendron*	Several species of termites	Subterranean termites	Root feeding -causes mortality too young trees
8	*Melia azedarach*	No insect pests have been recorded	-	-
9	*Paraserianthes - falcataria*	*Xystocera festiva* (Coleoptera, Cerambycidae)	Sengon stem borer	Trunk feeding -can causes tree mortality
		Pteroma plagiophleps (Lepidoptera, Psychidae)	Bagworm	Leaf feeding - Occasionally serious
		Eurema blanda (Lepidoptera, Pieridae)	Yellow butterfly caterpillar	Leaf feeding - Occasionally serious
		Several species of white grub	White grub	Root feeding on seedlings or saplings
10	*Peronema - canescens*	An unidentified shout boring insects	Shoot borer	Shoot mortality, die back
11	*Pinus merkusii*	*Dioryctria rubella* (Lepidoptera, Pyralidae)	Tusam pitch moth	Shoot and stem- boring, causes- shoot die-back and stem distortion
12	*Schima noronhae*	No insect pests have been recorded	-	-
13	*Schleichera oleosa*	No insect pests have been recorded	-	-
14	*Shorea spp.*	*Calliteara cerigoides* (Lepidoptera, Lymantriidae)	Hairy caterpillar	Leaf feeeding
15	*Switenia - macrophylla*	*Hypsipyla robusta* (Lepidoptera, Pyralidae)	Mahogany shoot borer	Shoot boring, causes growth retardation and stem forking
16	*Tectona grandis*	*Hyblaea puera* (Lepidoptera, Hyblaeidae)	Teak defoliator	Leaf feeding causes heavy defoliations
		Neotermes tectonae (Isoptera, Kalotermitidae)	Inger-inger	Stem boring
		Xyleborus destruens (Coleoptera, Scolytidae)	Ambrosia beetle	Stem boring
17	*Toona sureni*	*Hypsipyla robusta*	Mahagony shoot borer	Shoot boring, flower and fruit feeding

1. Acacia mangium (Mangium)

Insect pests

A subterranean termite, *Coptotermes curvignathus* (Isoptera, Rhinotermitidae), is reported to kill 10 – 50% of saplings in plantations in Central Sumatra in their first year (Wylie *et al.,* 1998 in Nair and Sumardi, 2000). The leaf-feeding bagworm, *Pteroma plagiophleps* has been recorded in many plantations. It is a polyphagous caterpillar, which is generally a minor pest on most of its hosts although localized outbreaks have occurred in *Paraserianthes falcataria* and some other hosts. Other unidentified bagworms are commonly seen on *A. mangium* but all are minor leaf-feeders. The grasshopper, *Valanga nigricornis.* also a polyphagous leaf-feeder, is often seen in *A. mangium* plantations in fairly large numbers. It appears sporadically and eats even the shoot tips. In teak plantations in Java, it causes recognizable damage periodically but has not become a serious pest.. *Locusta* sp., with similar feeding habits, occurs less frequently. Other leaf feeding insects are also occasional minor pests. Caterpillars of an unidentified moth, tentatively called, 'Plusia', feeds on the leaves (phyllodes) of young saplings at PT. Riau Andalan Pulp and Paper.

The sap-sucking bug *Helopeltis* spp. is the principal pest in plantations in Sumatra. These are well-known pests of several horticultural and tree crops in the tropics, such as, tea. Cacao, cinchona, cashew and neem. *Helopeltis* sp. regularly causes severe damage in 6-18-month-old plantations in North and Central Sumatra (Wylie *et al.,* 1998 in Nair and Sumardi, 2000). The principal species is *H. theivora,* but *H. fasciaticollis* and *H. sumatranus* have also been recorded (Wylie *et al*., 1998 in Nair and Sumardi, 2000). Feeding by *Helopeltis* spp. causes necrotic spots on the leaves and often dieback of tender shoots. Shoot dieback is probably caused by injection of toxic saliva or pathogenic organisms in the feeding process. Some companies have applied urea to boost the growth of attacked saplings and in rare cases, insecticides like deltamethrin have been used. More systematic observations are needed to assess the quantitative impact and some plantation companies are doing this. Usually the intensity of attack is low and is not a threat to plantations. The borer *Xystrocera festiva,* primarily a pest of *Paraserianthes falcataria,* attacks *A. mangium* in agroforestry plantations in East Java and in industrial plantations in South Sumatra where up to 11% of trees have been infested (Matsumoto, 1994), and

also in West Java. It is likely to become a major pest of Acacia in the future, which can decrease the quantity as well as the quality of timber.

2. Agathis loranthifolia (Damar)

Insect pests

No major insect pest problem has occurred on *A. loranthifolia,* in Indonesia.

3. Eucalyptus spp. (Eucalypt)

Insect pests

Generally, they have not posed a major threat, and chemical control methods have been tested. Transplanted saplings are attacked, particularly during the field establishment phase, by species of subterranean termites that often cause substantial mortality, unless prophylactic chemical protection is given (Intari and Natawiria, 1973). Saplings are attacked by *Zeuzera coffeae* (Lepidopiera, Cossidae), which bore into the stem and often cause it to break. In general, there are no major pest problems in older eucalypt plantations.

Figure 5.1 Various form of stem damage *Eucalyptus deglupta* by *Zeuzera coffeae*

4. Gmelina arborea (Gmelina)

Insect pests

No major insect pests have been found on *G*. *arborea* plantations in Indonesia, although there are minor pests. One of the insects consistently associated with it is a carpenter worm, *Prionoxystus* sp. (Lepidoptera, Cossidae). The larva bores into the stem of saplings, feeds from within and weakens the tree. The infestation is conspicuous because the larval frass accumulates on the ground, at the base of the plant. However, the damage is not serious. Multiple infestations may weaken the saplings, but they are not killed, and the insect does not build up in large numbers because it passes through only one generation per year. Shoot cuttings kept in the nursery for rooting were attacked by an unidentified borer, possibly, *Alcidodes ludificator* (syn. *Alcides gmelinae)* (Coleoptera, Curculionidae). This small curculionid beetle bores into the young green shoots of *G. arborea* in India and Myanmar (Beeson, 1941).

5. Khaya anthoteca (Khaya)

Insect pests

Up to now *Khaya anthoteca* is not established in plantations. *Hypsipyla robusta* is the only insect that was recorded to borer into young shoot of the saplings (Ardikoesoema and Dilmy, 1956).

6. Maesopsis eminii (Kayu Afrika)

Insect pests

No insect pests have been recorded

7. Melaleuca leucadendron (Kayu Putih)

Insect pests

Several species of subterranean termites are reported to attack young trees, up to 6 years old, often causing mortality up to 80% (Intari, 1975) Insecticidal treatments have been standardized for control. Among non insect pests, a mite causes leaf gall.

8. Melia azedarach (Mindi)

Insect pests

No insect pests have been recorded

9. Paraserianthes falcataria (Sengon)

Insect pests

The most notable is *Xystrocera festiva* (Coleoptera, Cerambycidae), which is becoming more serious as the area planted to the host increases. *Xystrocera festiva* is present in most areas where *P. falcataria* is grown in Indonesia, although most reports are from Java and Sumatra. The severity of incidence appears to be higher in Java where the host has been cultivated for a long period. It has several other hosts including *Acacia* spp., *Pithecellobium* sp., *Samanea saman.* and *Enterolobium* sp. *Xystrocera festiva* is one of the most studied forest insects in Indonesia and detailed information is available on its biology and impact. Matsumoto (1994) covers some aspects of its ecology and Husaeni and Kasno (1997) present a summary of its present status, with emphasis on control. The beetle lays eggs on fissures in the bark and the larvae initially feed underneath the bark, burrowing deeper into the wood as they grow to maturity in about 4 months. The larvae are somewhat gregarious, with several present at each infestation site. Severe infestation reduces the yield and quality of the wood, and often leads to death of the tree. Infestation usually begins when the trees are 2 – 3 years old and the percentage of infested tree increase with age. In East Java, the estimated yield loss is about 12% if the trees are harvested when 4 years old, and about 74% if harvested after 8 years (Notoatmodjo, 1963).

Xystrocera festiva is currently controlled by cutting and removing infested trees to prevent build up of the beetle population. In Government-owned plantations, this is incorporated into the regular thinning operations carried out at 3, 4, 5 and 6 years of age, by removing infested trees first instead of systematic thinning to reduce competition between trees. This has reduced the infestation rate to between 4 – 10% of trees, although this is not sufficient (Husaeni and Kasno 1997). They recommend an integrated control strategy, involving, (1) a 3-monthly inspection, during which early infestations are detected and the bark

removed from the infested portion of the trunk to expose and kill the early larvae, (2) annual thinning to remove infested trees, and (3) release of the egg parasitoid. *Anagyrus* sp. These may prove helpful, although detecting early infestations on top portions of the trunk is not practicable and release of egg parasitoid is not likely to be cost-effective until rearing methods for the parasitoid are standardized and field effectiveness of parasitoid release demonstrated. Further research is also needed to standardize the promising method of using green light to attract and trap adult beetles (Husaeni *et.al.,* 1998).

A small population of the related species, *Xystrocera globosa* has been found on *P. falcataria* (Matsumoto, 1994). This pest is widespread and is known to attack several leguminous tree species, particularly, if they are unhealthy (Beeson, 1941).

Next in importance is the small bagworm, *Pteroma plagiophleps* (Lepidoptera, Psychidae) that defoliates the tree. It is a sporadic pest, but some companies in Sumatra, have reported severe infestations. These usually occur repeatedly in endemic patches. The female moths are wingless and dispersal is limited. The larvae live inside conical bags made out of the host plant material, and feed on the leaves and bark in large numbers. The leaves are skeletonised and eventually shed.

Another sporadic pest is the yellow butterfly. *Eurema* spp. (mainly *E. blanda* and to a lesser extent *E. hecabe* and others), whose caterpillars often build up in large numbers and cause locally widespread defoliation.

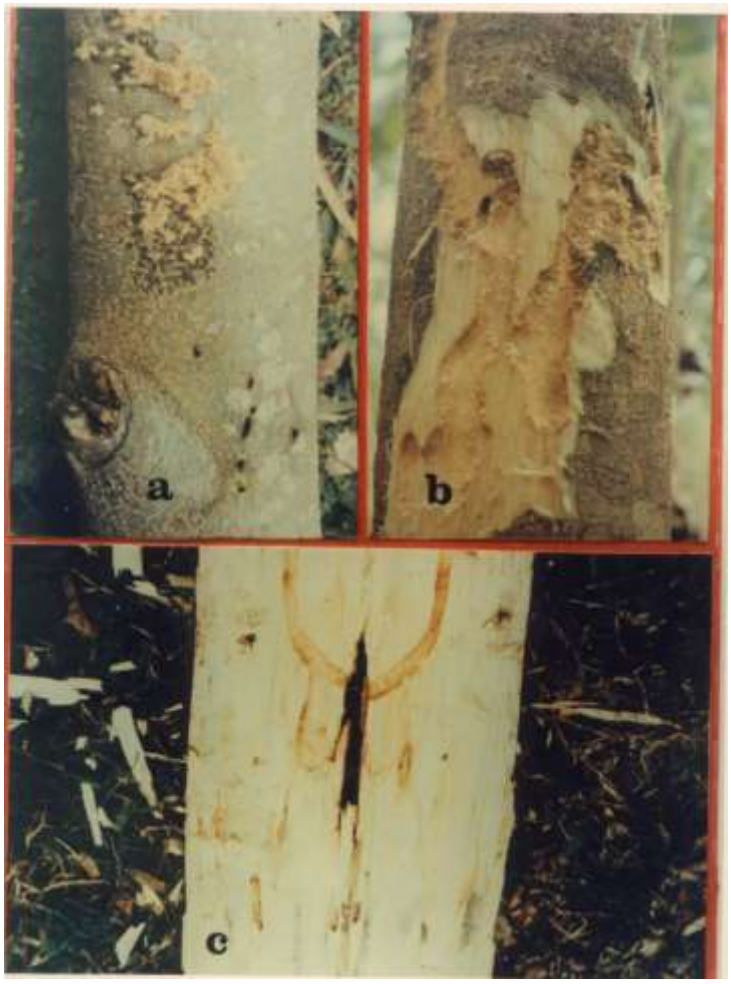


Figure 5.2 Stem of *Paraserianthes falcataria* infested by *Xystrocera festiva* (a) External sign; (b) After the bark is removed; (c) Boring hole to sapwood

***10. Peronema canescens* (Sungkai)**

Insect Pests

An unidentified shoot-boring insect causes deformation of young trees. The nymphs of an unidentified bug, *Clovia* sp. (Homopiera. Aphrophoridae) suck the sap of young leaves, enclosed in a mass of froth on the underside of the leaf, but damage is negligible (Matsumoto, 1994).

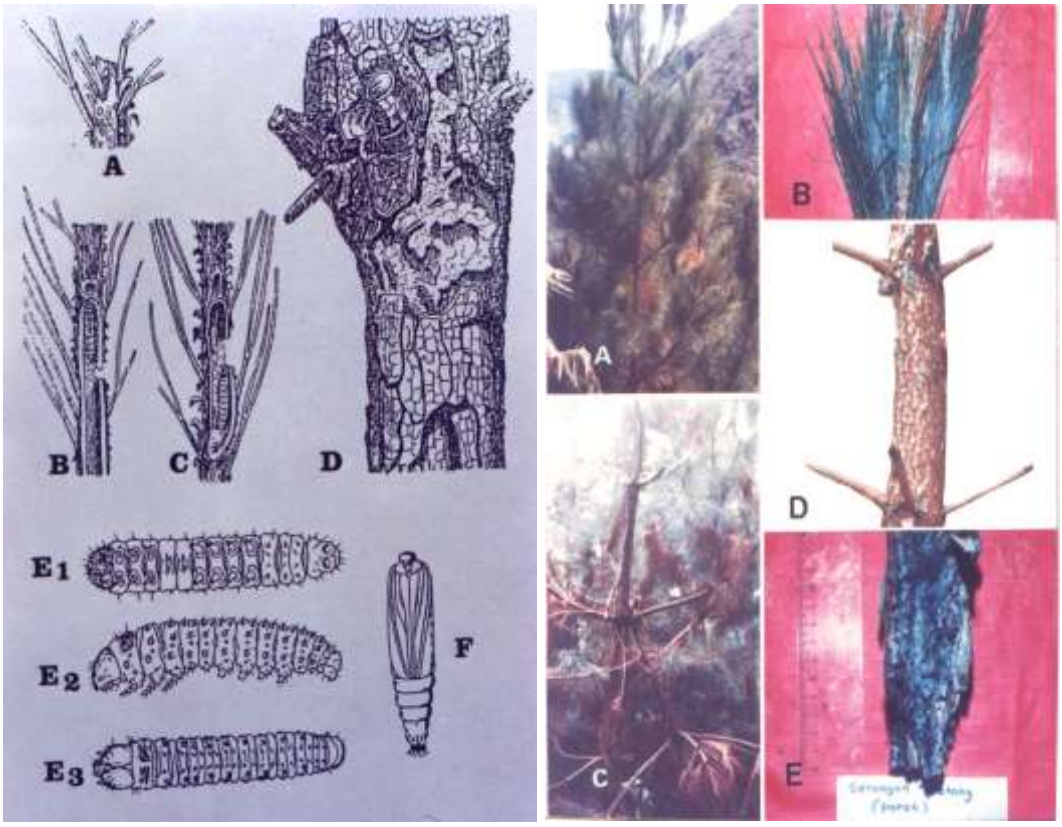
11. Pinus merkusii (Tusam)

Insect pests

The most damaging is the tusam pitch moth, *Dioryctria rubella* (Lepidoptera, Pyralidae). The moth lays eggs on young shoots and the larvae bore into them. It causes dieback of the shoots and stem. It has been considered to be a stem borer rather than a shoot borer because of serious damage caused to the stem by the larval tunnel extending up to 30 cm (Matsumoto 1994). It is a serious pest in North Sumatra. Thousands of hectares of young plantations were affected in an outbreak in 1982 (Supriana and Natawiria, 1987). There is no effective control method against this pest.

The pine looper, *Miliona basalis* (Lepidopiera, Geometndae) feeds on the needles and most damage is found in young plantations. Frequent, but short-lived, outbreaks occurred in the 1950s in plantations in North Sumatra, during which the egg parasitoid *Trichogramma minutus* was released for control (Supriana and Natawiria, 1987). Sporadic outbreaks have continued in the 1970s and 1980s (Mangundikoro and Depart, 1958). It has also been recorded in Aceh. A third pest, *Nesodiprion biremis* (Hymenoptera, Diprionidae) causes sporadic light defoliation in North Sumatra. Groups of 5 – 25 larvae feed on the distal three-fourths of the needles. Generally, the infestation level is not considered serious (Supriana and Natawiria, 1987). These three pests have not been reported from Java although pine plantations have been raised there for many years.

Other pests on *P. merkusii* in Indonesia include white grubs that attack roots of seedlings in nursery (Intari and Natawiria, 1973), termites *(Coptotermes* sp.) that attack the root collar and lower stem of saplings (Suharti *et al.,* 1998) and leaf-feeding bagworms *(Pteroma plagiophleps. Eumeta* sp. and *Cryptothelia variegata).* Outbreaks of bagworms and *Miliona basalis* have occurred in natural pine stands in Sumatra.



(I) (II)

Figure 5.3 (I) : a showing larva, pupa and attack symptom *Dioryctria rubella* (Intari and Misran, 1977); (II) : Various form damage by *Dioryctria rubella*

***12. Schima noronhae* (Puspa)**

Insect pests

No insect pests have been recorded

***13. Schleichera oleosa* (Kesambi)**

Insect pests

No insect pests have been reported from Indonesia although some minor pests occur in India. The main insects of the tree, the lac insect, *Laccifer lacca,* introduced from India, is used for lac production.

14. Shorea spp. (Meranti)

Insect pests

Various species of weevils (Coleoptera) and small moths (Lepidoptera) attack the seeds when the fruits are on the tree and after they are shed. They damage 40-90% of seeds of several *Shorea* spp., *Dipterocarpus comutus* and *Hopea odorata* (Natawiria *et.al.,* 1986). The polyphagous caterpillar *Calliteara cerigoides* is a serious defoliator of dipterocarps in Indonesia (Matsumoto, 1994). The species attacked include *Shorea leprosula, S. pinanga, S. selanica, S. slenoptera, Hopea mengrawan* and *H. odorata.* Some defoliated saplings of *H. mengrawan* succumbed to the damage.

15. Swietenia macrophylla (Mahogany)

Insect pests

In common with many other countries, infestation by the shoot borer *Hypsipyla robusta* (Lepidoptera, Pyrahdae) has limited the expansion of mahogany plantations in Indonesia. Its larvae bore into the growing shoot of saplings destroying the terminal bud causing growth retardation and stem forking. Older trees are not susceptible to attack. With the life cycle lasting between 1 and 2 months there are several overlapping generations and repeated attacks coincident with flushing. At present, there is no effective method to control this pest. It has been suggested that planting of trees repellent to the shoot borer moth along the plantation border or in a mixture will prevent the arrival of moths for egg laying. In preliminary trials, planting of *Acacia mangium* around a mahogany plantation prevented *H. robusta* infestation (Matsumoto *et.al.,* 1996), and interplanting neem. *Azadirachta indica,* with mahagony in uneven admixture reduced shoot borer attack (Suharti *et.al*., 1998). These preliminary results are encouraging, but more critical large-scale trials are necessary to examine the effectiveness and feasibility of this approach.

The scolytid beetle, *Xylosandrus compactus* (Syn. *Xylebrous morstaii)* (Coleoptera, Scolytidae) lays eggs in galleries in the stems of seedlings in the nursery leading to their collapse. Minor pests observed in experimental plantings include the leaf-feeding caterpillar, *Attacus atlas* (Lepidoptera, Saturnidae) and the leaf cutter bee, *Megachile* sp. (Hymenoptera, Megachilidae) (matsumoto, 1994).

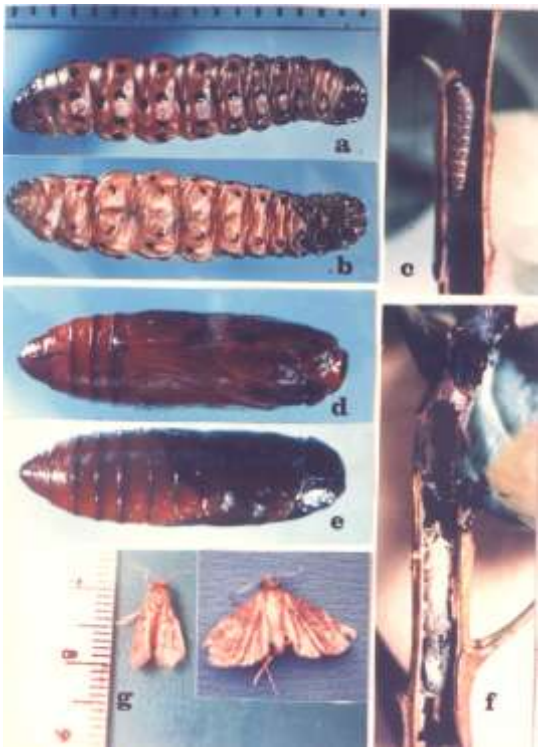


Figure 5.4 Larvae (a, b and c), pupae (d,e and f), and moth (g) *Hypsipyla robusta..*

16. Tectona grandis (Teak)

Insect Pests

Caterpillars of the moth, *Hyblaea puera* (Lepidoptera, Hyblaeidae), commonly known as the teak defoliator, feed on the foliage during the early part of the growth season, soon after flushing. It is believed to cause one or more total defoliation events every year in most teak areas, but systematically gathered data are not available. This is followed by widespread infestation and sudden disappearance of the pest population. The dynamics of infestation are similar to Indian infestations (Kalshoven, 1952).

Kalshoven (1952) mentions that although present in Java, it does not attack teak, but other authors list it as a major pest of teak in Java Little primary data is available on the frequency and intensity of its attack in Java.

The third notable pest of teak in Java is the termite, *Neotermes tectonae* (Isoptera, Kalotermitidae). Popularly known as 'inger-inger', this wood-dwelling termite hollows out portions of stem and branches. Usually, the external symptom, swellings of the trunk and branches, becomes visible only 3-5 years after the initiation of attack. The termites occupy crevices within the swollen stem. Trees over 3 years old are attacked but the symptoms appear only later. In some forest districts in Central Java, 10 – 72% of the trees were attacked and the production loss (degradation of construction timber to fuel wood) estimated at 9 – 21% (Subyanto, 1992). Thinning of infested trees is the only practical method to reduce the incidence of attack, although methods such as introduction of fumigants, e.g. phostoxin, into the affected portion of the trunk have been tried (Intari, 1975).

The following teak pests are of lesser importance. The ambrosia beetle, *Xyleborus destruens,* attacks the trunk of living teak trees making branching tunnels that extend into the heartwood. It is prevalent in areas where there is no definite dry season (Kalshoven, 1952) so such areas are avoided for teak cultivation. The teak beehole borer, *Xyleutes ceramica* (Lepidoptera, Cossidae) which infests the trunk is present but not common in Central Java (Intari 1975). The grasshopper, *Valanga nigricornis* (Orthoptera, Acrididae) causes sporadic defoliation and white grubs damage 1 – 2 year old plant. The red borer, *Zeuzera coffeae* often infests 1 – 3 year old teak plantation in Java.

16 Toona sureni (Suren)

Insect pests

Toona sureni is mostly planted as individual at private land, often mixed with other plant species. Before *Swietenia mahagony* and *Swietenia macrophylla* were introduced to Indonesia, *T. sureni* is the native host of *Hypsipyla robusta*. The insect attack flowers and young fruits of *T. sureni*, and at mahagony the growing shoot is most preferred. Now the insect is the most serious pest of mahagony.

5.2.2 Important diseases in plantation

1. Acacia mangium

Diseases

In general, *Acacia mangium* plantations in Indonesia have suffered little from diseases. Four major categories of diseases have been recognized - foliar diseases, stem canker, heart rot and root rots. Among the foliar diseases, leaf rust caused by a fungus distorts the growing points in nursery plants and young plantations. This has caused concern, particularly in Sumatra and Kalimantan, as there is no effective control method. An epidemic leading to premature leaf shedding occurred in 15-month-old trees in South Kalimantan. The fungus is similar to *Atelocauda digitata* which is common in northern Australia and affects nursery stock and trees of a wide range of age classes. Other leaf diseases are of minor importance.

Among the stem canker diseases, pink disease caused by *Corticium salmonicolor,* a basidiomycete fungus infecting a wide range of hosts in high rainfall areas in the tropics. It causes necrosis of the bark tissue on small stems, and branches often leading to their breakage. However, the proportion of infected trees is small compared to some plantations in Malaysia. In Malaysia more than 50% of trees have been infected in some places, but the wood volume damaged was small. White root rot, caused by *Rigidoporus microporus* (syn. *Fomes lignosus),* has been recorded in plantations in Jambi and South Sumatra. The red root rot, *Ganoderma philipii,* formerly *C. pseudoferreum,* has been isolated from an *A mangium* plantation in Yogyakarta.

2. *Agathis loranthifolia*

Diseases

It is not considered a serious problem.

***3. Eucalyptus* spp.**

Diseases

The diseases can be managed by appropriate nursery techniques (controlling soil quality, water regime and crowding of seedlings) and, when necessary by

fungicides. Older seedlings and saplings are affected by leaf spot diseases caused by several fungi. Stem canker of saplings caused by *Corticium salmonicolor* (pink disease) has occurred in North Sumatra but little information is available on its severity and extent of incidence. Death of older trees caused by root rot has often been noted and the associated pathogens were *pythium* sp., *Phytophthora* sp. and *Botryodiplodia* Ep. (Anggraeni and Suharti, 1997 in Nair and Sumardi, 2000). Stem canker was also observed on some trees.

4. Gmelina arborea

Diseases

Anthracnose disease characterized by sudden death of seedlings caused by *Colletotrichum* sp., has been reported. Root rot diseases caused by *Botryodiplodia* sp. has affected young plantations in South Kalimantan, Jambi and Sumatra. *Ganoderma* sp. has been isolated from the roots of dead trees of *G. arborea* in the campus of Gajah Mada University in Yogyakarta.

5. Khaya anthoteca

Diseases

No diseases have been recorded

6. Maesopsis eminii

Diseases

No diseases have been recorded

7. Melaleuca leucadendron

Diseases

No diseases has been encountered

8. Melia azedarach

Diseases

No diseases have been recorded

9. Paraserianthes falcataria

Diseases

Root rot disease caused by *Botryodiplodia* sp. occurs in young plantation in South Kalimantan and Jambi, Sumatra (Anggraeni and Suharti, 1997 in Nair and Sumardi, 2000). Dieback due to unknown reasons has been reported by some companies. Generally, root rot is a problem only in trees older than 10 years. Except for nursery diseases that can be controlled, *P. falcataria* does not suffer from anv major disease.

10. Peronema canescens

Diseases

Leaf rust has often been noted on seedlings grown under shade. Infestation by a superficial, black mildew fungus, probably *Meliola* sp., is also common (Selander, 1990 in Nair and Sumardi, 2000).

11. Pinus merkusii

Diseases

No diseases have been recorded

12. Schima noronhae

Diseases

No diseases have been recorded

13. Schleichera oleosa

Diseases

No diseases have been reported from Indonesia.

14. Shorea **spp.**

Diseases

Several fungi, including *Cylindrocarpon* sp. and *Curvularia* sp. attack dipterocarp seeds and reduce germinability. Seedlings and saplings suffer leaf spots, root

and collar rots, defoliation, and darkening of root and twig bark, caused by a variety of fungi, notably, *Fusarium* spp.

15. Swietenia macrophylla

Diseases

The only disease noted in *S. macrophylla* is bark rot, which occurs at the base of the trunk. The lesion appears in the middle of the rainy season, spreads rapidly from bottom upwards and often kills the trees by the end of the season. The lesion always appears on the stem surface facing the water flow along the slope and it is assumed that the pathogen arrives through water and enters through wounds. The causative organism remains unidentified.

16. Tectona grandis

Diseases

Teak is fairly resistant to diseases, although several pathogenic organisms have been recorded. A few diseases affect young trees in taungya systems, notably, an unidentified root wilt and stem canker, *Corticium salmonicolor* (pink disease). In a 31 ha plantation at Kendal, Central Java, 6% of 2-year-old saplings were killed by the root wilt and 2% were affected by canker which resulted in drying up or breakage of stem above the point of canker (about 1.5 m above ground) (Sumardi and Widyastuti, 2000 in Nair and Sumardi, 2000). These problems appear to be associated with high input management, involving close cultivation of taungya crops and tillage. Cultivation of agricultural crops increases the humidity, favouring pink disease. Tillage may cause root injury facilitating invasion by the wilt bacterium, which is a wound pathogen. The diseases can be managed by appropriate silvicultural practices.

17. Toona sureni

Diseases

No diseases have been recorded

5.2.3 Pest Control

Pest control management for some species is summarized in Table 5.3.

Table 5.3 Pest Control Management for some species.

Insect Pest	Host Plant	Pest Management
1. Xystrocera festiva (Coleoptera; Cerambycidae)	Sengon Akasia	• Regular thinning operations carried out at 3, 4, 5 and 6 years old plantation, where the infested trees are cut and removed. • Light trapping to catch adult beetle • A 3 monthly inspection, during which early infestations are detected and the bark removed from the infested portion of the trunk to kill the larvae. • Spraying the bark of the infested portion with Systemic Insecticide
2. *Xyleborus destruens* (Coleoptera; Scolytidae)	Jati	• Never establish teak plantation in the area having annual rainfall of more than 2000 mm and dry month of less than 3 months. • Regular thinning operations, where the infested trees are cut and removed. • Regular slashing of undergrowth of teak stand.
3. Neotermes tectonae (Isoptera, Kalotermitidae)	Jati	• Regular thinning of teak stand. Every thinning operation should be carried out and finished during dry season. the infested trees are cut and removed.
4. *Zeuzera coffeae* (Lepidoptera; Cossidae)	Eucalyptus Jati Mahoni Sungkai	• No control measured
5. Hypsipyla robusta (Lepidoptera; Pyralidae)	Khaya Mahoni Suren	• Cutting of infested shoot and the lateral shoots grow after infestation • Close planting space (Suratmo, 1975). • To establish Mixed stand with none host species
6. Coptotermes curvignathus (Isoptera; Rhinotermitidae)	Akasia	• Removed of wood material during land preparation • Using propylactic insecticide to prevent in plantation on newly planted seedlings
7. *Dioryctria rubella* (Lepidoptera; Lymantriidae)	Pinus	• To mixed *Pinus merkusii* and non host broad leaf trees species
8. Hyblaea puera (Lepidoptera; Hyblaeidae)	Jati	• No artificial control measured has been carried out. Natural agent reduces the insect population. The villagers surrounding the teak forest often collect the pupae for food.
9. Eurema blanda (Lepidoptera; Pieridae)	Sengon	• Application of pupal parasitoid , *Brachymeria femorata* (Chalcididae; Hymenoptera), egg parasitoid *Apanteles javensis* and larval parasitoid *A. tabrobane* (Braconidae; Hymenoptera)

5.2.4 Forest fire control

Forest in Indonesia and the changing land use cause ecological damage by reducing biodiversity. Loss of soil cover negatively affects hydrological regimes and soil properties, leading to serve erosion and loss of soil productivity. Smoke from catastrophic forest fires also may cause problems to human health, not only Indonesia but also in the neighboring countries. The dual role of fire must be recognized both being a natural agent of ecosystem maintenance, and potentially disastrous cause of ecosystem destruction. Both need fire control.

There are several approaches in forest fire control that can be applied in any one province or area. These approaches are based on the specific situations and conditions found in their respective provinces or areas. One management approach is an Integrated Forest Fire Control where all aspects of prevention, suppression and fire use are integrated together. This is a correct approach for Indonesia, considering the complexity of the fire problem, which is related to the diversity of communities in terms of ethnic groups, economy, customs and biophysical environmental factors within the given provincial area.

Forest fire control incorporates all activities required for the protection of forest and human values from fire, and the use of the fire to meet land management goals and objectives. The strategy of forest fire control has three components; 1) to prevent fire ignition, 2) to modify the environment in which a fire burns, and 3) to suppress small fires before they can make the transition to large fire status.

5.2.4.1 Fire prevention

Fire prevention is the key to successful forest fire protection. In Indonesia, forest fire is generally caused by human activities. Thus, the prevention should be emphasized on enhancing people's awareness toward the negative effects of fire, without neglecting other engineering and enforcement efforts. The success of the forest fire prevention is determined by:

1. Appropriate selection of activities that meet the goal
2. Appropriate selection of method and scheduling
3. Adequate facilities, infrastructure and funding
4. Number and quality of human resources as executors
5. Other related resources

To obtain successful prevention the following activities should be implemented:

1. Develop an operational guideline for forest fire prevention
2. Implement the guidance, campaign, extension by using the following method :
    a. Personal contact
    b. Interview and discussion with target group: farmers groups, environmental lovers, forest and estate concessionaires, etc.
    c. Printed and electronic media
    d. Schools – especially primary and secondary schools
    e. Exhibition, festivals and parades
    f. National campaign, using “Si Pongi” mascot
    g. Sign and warning notice board especially at the fire risk areas
3. Prevention by engineering and regulation approaches:
    a. Patrol fire risk areas
    b. Fuel treatments (logging waste and other organic) either by fuel modification, fuel isolation and fuel reduction (including prescribed burning, waste utilization, and silvicultural treatments (weeding, pruning, etc)
    c. Development and maintenance fire break, fuel break and green belt.
    d. Disseminate fire weather forecasting
    e. Socialization and law enforcement including custom and tradition laws.
4. To conduct formal, informal and non formal education and training (on the job training, in house training) on fire prevention
5. To involve communities in all prevention activities, including construction of fire breaks, fuel breaks, green belts and prescribed burning carried out either by the communities of forest concession holders.

5.2.4.2 Forest fire suppression

To be effective and efficient, every forest fire must be suppressed at an early stage (initial attack), carried out progressively, organized properly and completed by mopping-up. This need rapid detection, adequate infrastructure and manpower to support fire suppression.

Important activities to suppress fire are :

1. Fire detection
    a. Fire detection is an important work and is the key to initial attack. In order to achieve this, all fire detection potentials should be employed, especially detection from fire lookouts, ground and air patrol, satellite imagery and reports from communities.
    b. To increase the awareness of fire reporter on the rapid reporting of fire event to the responsible protection organization

2. Implementation of fire suppression
    1) Increase knowledge and skill of all parties involved in fire suppression, particularly the fire crews, on steps of fire suppression, they are:
        a. Size up and decide method of initial attack
        b. Briefing and supervision to every fire man based on point a above, and clearly define task and responsibility of every member
        c. Carry out initial attack as the crew arrive at fire site
        d. Choose correct control method (direct attack, indirect attack) based on topography, forest fuel and weather conditions.
    2) If fire escapes initial action and is expected to increase appreciably in size or develop into a large fire (national emergency), there is need to report promptly to the higher organization level following the chain of command in order to mobilize additional suppression resources.
    3) Logistic preparation

        The logistic includes back up team, equipment, water, food and medical aid. It also needed to prepare facilities and infrastructure to mobilize these logistics on time and at specified location.
    4) Safety measures

        Determine a plan for action and escape routes planned in case the situation become dangerous and every member involved in suppression operation needs to clearly understand this plan and route.
    5) Mop up
        a. To provide understanding to all crew members involved in the suppression not to leave the fire location until the fire is completely extinguished.
        b. To examine (patrol) the burned area