Insect Pests and Diseases in Indonesian Forests

An assessment of the major threats, research efforts and literature

K.S.S. Nair (Editor)

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Editor
K.S.S. Nair

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Tel.: +62 (251) 622622; *Fax*: +62 (251) 622100
E-mail: cifor@cgiar.org
Web site: http://www.cifor.cgiar.org

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Abstract

Major pests and diseases of natural and planted Indonesian forests have been reviewed, threats assessed and a bibliography compiled. Indonesia has about 96 million hectares of natural forests, dominated by dipterocarps, and 4 million ha of forest plantations. About half the plantations are in Java, consisting of long-established species including *Tectona grandis, Pinus merkusii, Agathis dammara, Swietenia macrophylla, Dalbergia latifolia* and *Melaleuca cajuputi*, and half in Sumatra and Kalimantan, mainly fast growing pulpwood species. Major plantation species are: *Tectona grandis, Pinus merkusii, Acacia mangium, Agathis dammara, Paraserianthes falcataria, Swietenia macrophylla, Gmelina arborea,* mangrove species*, Eucalyptus* spp.*, Dalbergia* spp.*, Melaleuca cajuputi* and *Azadirachta excelsa.* Only small-scale plantations exist for the other species reviewed, *viz*., *Alstonia* spp.*, Anthocephalus* sp.*,* Dipterocarpaceae*, Dyera* spp.*, Eusideroxylon zwageri, Gonystylus bancanus, Koompassia* spp.*, Maesopsis eminii, Ochroma pyramidale, Octomeles sumatrana, Peronema canescens* and *Schleichera oleosa*. Occasional and unpredictable insect outbreaks have occurred in natural stands of *Pinus merkusii*, *Plaquium* sp., *Casuarina junghuhniana*, mangroves, etc., but plantations of teak, pine, mahogany and *Paraserianthes falcataria* etc., are damaged by pests every year. In natural forests high host density appears to be a predisposing factor for pest build-up. Serious pests occur on *Tectona grandis, Pinus merkusii, Paraserianthes falcataria and Swietenia macrophylla,* with the most damaging being the *Paraserianthes* trunk borer, *Xystrocera festiva*. Disease problems are less significant than pests in the natural forests and no major disease outbreak has occurred in plantations, although many fungal diseases are prevalent in nurseries. No major pest or disease has been recorded on the minor plantation species, but their history is too short and planted areas too small to draw reliable conclusions on their susceptibility. There are indications of impending problems, e.g. root rot in *Eucalyptus* spp. and root and stem rot in *Acacia mangium*. There is also the risk of new pests in *Acacia mangium, Gmelina arborea, Shorea* spp. and *Peronema* sp. Research capacity in Indonesia is inadequate to meet the existing and future challenges and more collaboration between Government, universities and plantation companies is needed for pest and disease surveillance and research in the rapidly expanding forest plantations.

Chapter 1

Introduction

K.S.S. Nair

1.1. Background

Indonesia is a 'forest country'. In 1993, the Indonesian Ministry of Forestry estimated (MoF 1993) that about three-quarters of the 193 million hectares (ha) of the land area, i.e., about 144 million ha, are covered by forest. FAO estimates in 1996 showed the forest area to be 96.2 million ha, i.e., about half of the land area, and there has been further reduction in forested land since then (Fox *et al*. 2000). This trend of deforestation has been continuing for some time. Shifting agriculture by indigenous communities and logging by forest concessionaires have created about 30 million ha of secondary forests in the outer islands, particularly Sumatra and Kalimantan. These are often further degraded into grasslands. Apart from the early planting of nearly 2 million ha of teak, pine, mahogany, agathis and other species in Java for industrial purposes, planting programmes to rehabilitate degraded lands were initiated in the 1970s. In the 1980s, the Government initiated an ambitious programme of Industrial Forest Plantations (Hutan Tanaman Industri, or HTI). Under this programme, intended to meet the raw material demands of forest-based industries, 'Concession' areas were granted to both foreign and national companies, and incentives were offered, e.g. capital in the form of Government equity, interest free loans, etc., in order to promote plantation development. Although the Government target (MoF 1993) of 6.2 million ha of industrial forest plantations by year 2000 was not reached, it is estimated that at least 4 million ha have been planted (including plantations in Java) (see Chapter 2). In the outer islands, fast growing species such as *Acacia mangium, Eucalyptus* spp., *Gmelina arborea* and *Paraserianthes falcataria* are planted.

Replacement of natural mixed forests over vast areas, with plantations, raises several important questions. Apart from the uncertainty in sustainability of production over successive short rotations and the environmental impact (loss of biodiversity, soil compaction, disturbance to water balance, etc.), outbreaks of serious pests and diseases may be a major threat. Devastating outbreaks of the psyllid, *Heteropsylla cubana* in plantations of *Leucaena leucocephala* in South and Southeast Asia, conifer aphids in plantations in East Africa and eucalypt leaf diseases are only recent history. What is the risk of such new pest and disease outbreaks, in the rapidly expanding forest plantations in Indonesia?

This study is an attempt to assess the present pest and disease situation in Indonesian forests, particularly, in forest plantations, and evaluate the future risks.

1.2. Objectives

The specific objectives were:

i. to prepare a bibliography of pests and diseases literature pertaining to Indonesian forests, including informal publications (grey literature), like consultant reports and student theses;
ii. to interpret the literature and summarise the main findings, and

iii. to derive general conclusions on the impact of pests and diseases, and make informed judgment on the future risks.

1.3. Methodology

Information was gathered from published and grey literature, field visits and discussions with Indonesian entomologists and pathologists. The TREECD database published by the Commonwealth Agricultural Bureau International (1939-1998(4)) was screened for abstracts of formal publications. Most relevant publications were in the Indonesian language (Bahasa Indonesia) and many in conference proceedings, student theses and departmental and consultant reports. Full text of most of the relevant publications, both in English and Bahasa Indonesia, was read to extract information.

Field visits were made to plantations of *Tectona grandis*, *Paraserianthes falcataria* and other species in Java, and of *Acacia mangium*, *Gmelina arborea* and *Eucalyptus* spp. in East Kalimantan. Discussions were held with specialist scientists at CIFOR, FERDA (Forestry and Estate Crops Research and Development Agency of Indonesia), IPB (Bogor Agricultural University), Gadjah Mada University and Mulawarman University. In addition, there was correspondence with representatives of several plantation companies to elicit information on pest and disease outbreaks.

1.4. Presentation

The results of the study are presented in five chapters. Chapter 2 presents an overview of the state of the forest and plantation trends in Indonesia and Chapter 3 a general comparison of the pest and disease problems in natural forests and plantations. In Chapter 4, the insect pests and diseases of major plantation species in Indonesia are discussed in detail by tree species. This sets the background for Chapter 5 in which general conclusions are drawn on the impacts of pests and diseases, the current status of research on the subject and constraints to research and management of pests and diseases. Based on the available information and the personal experience of the authors, an assessment is made of the future threats of pest and disease outbreaks in plantations. Suggestions are made to meet the challenges.

In addition to the cited references, there is a separate bibliography of published and grey literature for insect pests and diseases, which includes documents in English, Bahasa Indonesia and Dutch.

Chapter 2

The State of the Forest and Plantation Trends

C. Cossalter and K.S.S. Nair

2.1. A time of change

Indonesian forests are in a state of transition. The traditional low-level exploitation of forests by indigenous communities has been supplemented, over the past 30 years, by increased logging operations for selected timbers which has led to degradation of foests over large areas. Presently, there is large-scale replacement of degraded natural forests with short rotation industrial tree crops, raised and managed by commercial companies. Estate crops such as rubber and oil palm have also replaced part of the natural forests. What drives these changes is not the Indonesian consumer demands, but the rapidly rising international demand for engineered wood products, e.g. medium density fibre board and pulp and paper; and rubber and palm oil.

2.2. Forest types, area and policies

Nature has endowed the country with a rich variety of tropical forests. Dominated by dipterocarps, these include the monsoon forests, hill rainforests, lowland rainforests, peat-swamp forests, swamp forests, littoral forests and mangrove forests (Handadhari 1997). Forest area statistics given by different authors are often conflicting. In addition to degradation due to shifting agriculture and selective logging, since the 1970s, large areas have been converted to agricultural land, estates and human settlements. Estimates based on remote sensed data, show that the forest area of Indonesia is about 124 million ha and the rate of deforestation during 1972–1990 was about 840 000 ha per year (Sumahadi *et al*. 1997). As noted earlier, in 1996 FAO estimated forest area as 96.2 million ha, and there has been further reduction since then (Fox *et al*. 2000). Most Government sources continue to give higher figures with estimates of 92-124 million ha in many publications. Often there is confusion between land area classified as forest in Government records and the land area actually covered by forest. Since most forest policy decisions of Government have been made on the basis of the older figures, it is difficult to use more recent figures in the following discussion.

The 1945 Constitution of the Republic of Indonesia dictates that all forests of the country are to be governed by the State and there are a number of Acts and Rules that set principles and guidelines for their management. In 1984, the Government classified the forests into five categories, based on land-use preference established by a consensus of provincial Government agencies (Handadhari 1997, Gautam *et al*. 2000). Data in Table 2.1 show about 49 million ha reserved for conservation purposes (first and second categories), 34 million ha for production and about 30 million ha for limited production. About 30 million ha are designated as convertible forest area for long-term non-forestry uses. The areas assigned to each category are only estimates, as all lands not otherwise identified with existing agricultural or urban land uses in records available to provincial offices at that time were designated as forests (Gautam *et al*. 2000). The estimates were often contended and adjustments

Table 2.1. Forest categories as per forest land use by consensus

Category	Purpose[1]	Area[2] (million ha)	% Area
Nature Reserve and Recreation forest	Conservation, including wildlife, national parks and tourism	18.8	13
Protection forest	Watershed protection	30.3	21
Production forest	Selective timber harvesting	33.9	24
Limited production forest	Harvest restricted to protect environment	30.5	21
Convertible forest	Conversion for estate crops, smallholdings, future agricultural use, etc.	30.5	21
Total	-	144.0	100

[1]vide Gautam *et al*. (2000); [2]Area in 1984
Source: Handadhari (1997)

were made. Due to this, the area figures given by various authors in the above categories often differ (e.g. see Leech *et al.* 1996; MoFEC 1999).

The 64 million ha of production forest (including the 30 million ha of limited production forest) is a massive resource for wood production. Ensuring the sustainability of production in these forests, and arresting forest conversion within the set limit of about 30 million ha are the main challenges of Indonesian forestry today. The basic principles to guide sound forest management have been identified as national interest, sustainability of yield, multi-sectoral benefits, equality and justice for all provinces and peoples within the country, social participation, and encouragement of agroforestry and smallholder forestry. However, there are constraints putting these principles into practice, which have been identified as conflict of interest among development sectors and the irresponsible attitude of forest concessionaires (see MoF 1993; Handadhari 1997).

2.3. Forest concession right and plantation development

Management of Indonesian forests has traditionally been vested with forest concessionaires. In Java, a Government-owned company, Perum Perhutani, has been given the responsibility for management of about 3 million ha of State-owned forests. The mandate includes planning, management, exploitation and protection of all forests in Java and Madura, except nature reserves and parks. Thus, Perum Perhutani manages about 1 million ha of naturalised teak forests that have been planted and managed since the Dutch colonial times (1870s), in addition to nearly another million hectares of plantations of *Pinus*, *Agathis*, *Dalbergia* spp. and other species were raised later. Teak plantation are managed in Java under the taungya system, in which local farmers are permitted to plant food crops between rows of forest trees during the initial years of tree growth.

In 1967, Forest Concession Right (Hak Pengusahaan Hutan, or HPH) was granted to private and State-owned enterprises, to exploit natural forests in the outer islands. In the "production" and "limited production" forests, besides exploiting the timber, forest concessionaires were required to undertake rehabilitation planting in the logged area. There was a rapid increase in the number of concessionaires, from 64 in 1970, with a concession area of 7.8 million ha to 462 in 1979, with a concession area of about 50 million ha (MoF 1993). Simultaneously, shifting agriculture by indigenous communities and excessive logging by the concessionaires created vast areas of degraded, secondary forests, which were often converted into

unproductive grassland, dominated by *Imperata cylindrica*. Such lands were estimated at about 30 million ha (Supriana and Natawiria 1987a) and intensive efforts were made to reforest them. As many native tree species were suppressed by the grass, the exotic *Acacia mangium* emerged as a promising species for afforestation of such lands. In 1980, in order to meet the increasing raw material demand of forest industries, the Government of Indonesia initiated a programme to develop industrial forest plantations (HTI). This was justified by the anticipated pressure on natural forest resources and the need to rehabilitate denuded areas. The Government assisted the concessionaires by providing capital in the form of Government equity amounting to 14% and interest-free loan up to 32.5% of the plantation cost (MoF 1993). The period of concession was 35 years, plus one rotation length of the tree species planted, with provision for further extension. Concession areas were granted to foreign and Indonesian entrepreneurs. The Government set a target of about 6 million ha of HTI by the year 2000.

The Government also initiated a Forest Village Development Programme, with social benefit schemes adapted to local conditions and requirements, in an attempt to encourage the native shifting cultivators to become settled farmers. The settled manpower was also expected to assist in the development of HTI and the forest concessionaires were assigned the responsibility for implementation of the Forest Village Development Programme. Other forest development programmes included transmigration settlements, in which people from densely populated areas were translocated to the sparsely populated outer islands, with benefits such as housing, land for agriculture, etc. They were also expected to provide the labour force for development of HTI. In addition, several schemes were introduced to encourage agroforestry on forest and non-forest land and for development of smallholder forestry.

Involvement of a large number of plantation companies in the management of state-owned forests, creates its own problems. Although it brings in the much-needed investment and expertise, the short-term financial interests of the investors rather than long term ecological, economic and social prosperity of the country are likely to be given precedence. Liberal government incentives to promote forest-based industries have led to large-scale clearing of productive secondary forest, in some cases to procure land tenure rather than to produce an economic crop, and to deprivation of local people of their traditional rights on the land (Turnbull *et al.* 1998). There is fear of long-term ecological deterioration caused by over-logging and inadequate regeneration efforts in natural forests, and inappropriate management practices in plantation areas. Although the policies and prescriptions are adequate, there are problems in implementation at all levels, and a large number of forest concessionaires who are managing natural forest areas, are not implementing the prescribed forest management systems correctly (Djakaria *et al*. 1997). It is public knowledge that the forest concession system has been plagued by political patronage. Rules and regulations have been grossly violated. Concessions and conversion rights were often granted in areas set aside for conservation. Such patronage has often led to conflicts between local communities, logging concessionaires, plantation companies, transmigrants and other state-sponsored activities (Gautam *et al*. 2000). It has been alleged that some plantation companies, particularly those engaged in oil palm cultivation, clandestinely abet the devastating forest fires that have erupted almost every summer in recent years, for easy clearance of natural growth for raising plantations. Given the vastness of the forest area, monitoring to ensure compliance with the prescriptions is difficult. In many cases, concession rights have been revoked due to poor performance but significant damage has already been done. The magnitude of the problem can be judged from the fact that after 20 years, the concession rights of only 96 out of the 359 HPH companies were renewed (Gautam *et al.* 2000). This means that a large proportion of the allotted area was not managed properly.

2.4. Plantation trends – areas and species

Indonesia has a long plantation history, starting with teak (*Tectona grandis*) cultivation. Believed to have been introduced to Java some 400 - 600 years ago (Phengklai *et al*. 1993), teak has been planted systematically since the 1870s and in 1995 there were about 1 million ha of well-managed plantations, in Java and the adjacent island of Madura (Perum Perhutani 1995). Table 2.2 shows the areas of major tree species planted in Java managed by the Government-owned company, Perum Perhutani.

Table 2.2. Forest plantations in Java in 1995

Species	Area (ha)
Tectona grandis	1 066 532
Pinus merkusii	583 974
Agathis dammara	66 013
Swietenia macrophylla	54 383
Dalbergia latifolia	25 502
Melaleuca cajuputi	11 848
Paraserianthes falcataria	6 064
Schleichera oleosa	3 732
Rhizophora spp.	49 662
Others	89 063
Total	**1 956 775**

Source: Perum Perhutani (1995)

Pine (*Pinus merkusii*) plantations comprise the second largest area, about 0.6 million ha, after teak. Native to the northern part of Sumatra, this species is primarily utilised for resin tapping in Java and yields a general-purpose timber, although it was originally planted for pulpwood production. *Agathis dammara* is also tapped for resin. *Melaleuca cajuputi* is planted for extraction of essential oil from the leaves and *Schleichera oleosa* for cultivation of lac. There is currently an expansion of *Paraserianthes falcataria* plantations by smallholders throughout Java. Among the major plantation species, only *Melaleuca cajuputi* and the mangroves *Rhizophora* spp. are strictly native to Java. Teak (*Tectona grandis*), mahogany (*Swietenia macrophylla*) and rosewood (*Dalbergia latifolia*) are exotic to Indonesia, although teak is naturalised. Other species have been introduced to Java from other parts of Indonesia where they occur naturally.

Plantation forestry in the outer islands began in the 1970s, with attempts to afforest the extensive *Imperata cylindrica* grasslands, particularly in Sumatra and Kalimantan. Opening up of HPH to foreign investors in 1967, with the issuance of Foreign Investment Law (UU PMA) in forestry sector, accelerated the expansion of plantations. By 1989, 565 units of HPH holders operated in about 58 million ha of forest land (MoF 1993: Fact Sheet No. 12). Apart from rehabilitation planting carried out by these companies in the logged areas, over 7 million ha have been allotted (Table 2.3), to about 100 companies for raising HTI. About 67% of the allotted HTI area is for pulpwood production, 23% for sawlog production and 10% for transmigration settlements (Table 2.4). The area allotted to individual companies ranges from about 4000 ha to 300 000 ha.

In the outer islands, over 60% of the geographical area consists of 'forest land'. Forest land is land that has been legally defined as forest land and is not synonymous with 'land under forest cover' for which there are no reliable data. Of the forest land, nearly 7% has been allotted for HTI and by 1998-99 about 22% of the allotted area (about 1.6 million ha) has been utilised by the concessionaires (Table 2.3). It is

Table 2.3. Industrial forest plantations (HTI) in the outer islands of Indonesia

Region	Geographical area (ha)	Forest area (ha)	Area allotted for HTI (ha)	Area planted up to 98-99 (ha)
Sumatra	47 050 873	23 877 500	2 525 486	888 354
Kalimantan	54 824 700	35 745 200	3 129 781	802 505
Sulawesi	19 227 076	11 473 400	187 146	27 931
Irian Jaya	41 066 000	30 611 800	1 389 200	0
Nusa Tenggara	6 744 235	2 732 400	55 074	5 945
Moluccas	8 572 800	4 201 600	74 568	33 264
Total	**178 485 684**	**108 641 900**	**7 361 255**	**1 757 999**

Source: Statistik Pengusahaan Hutan 1998/1999, Dirjen Pengusahaan Hutan Produksi, Dephutbun (1999); Geographical area and forest area from MoFEC (1999); HTI area and planted area from Dit. Bina Pengusahaan Hutan, MoFEC

estimated that the planted area may have reached at least 2 million ha by year 2000. No information is available on the extent of area cleared of forest but apparently it is much more than the area planted.

Table 2.4. Utilisation of HTI area for different purposes to 1998-99

Category	Area allotted	Area planted up to 98/99
	(million ha)	
Pulp	4.94 (67%)	1.04 (64%)
Construction wood	1.65 (23%)	0.32 (20%)
Transmigration	0.76 (10%)	0.26 (16%)
Total	**7.34 (100%)**	**1.63 (100%)**

Source: Dit. Bina Pengusahaan Hutan, MoFEC

The 1998 Government reorganisation of the Ministries of Forestry and Agriculture to bring estate crops under the purview of the new MoFEC is indicative of a change in the Government's strategy. There is strong interest among private investors for diverting forest land for oil palm cultivation, encouraged by the Government's incentives for investment in oil palm. The Government has also granted permission to state-owned forestry companies to convert 30% of their concession areas within production forest boundaries to oil palm. It is estimated that currently 330 000 ha of forest land is being converted annually to oil palm plantations (Gautam *et al.* 2000). These policy changes are still evolving and are likely to impact significantly on the future forest plantation scenario.

The spread of forest plantations across Indonesia and the species planted in each province, including the three provinces in Java, is shown in Fig.2. Unlike in Java (Table 2.2), detailed information on the species planted and the area under each is not available for other regions. However, most area in the outer islands is used for pulpwood species (Table 2.4), mainly, *Acacia mangium*. The main species planted are listed in Table 2.5. Twenty-eight of the 42 companies from whom we requested information provided details; the species and area planted by these companies are summarised in Table 2.6. The overriding dominance of *Acacia mangium* and the relative importance of other pulpwood species are highlighted by this data.

Table 2.5. Main species planted in the HTI in the outer islands

Pulpwood species	Timber or plywood species
Acacia mangium	*Alstonia* sp.
Other *Acacia* spp.	*Anthocephalus* sp.
Eucalyptus spp.	*Azadirachta excelsa*
Gmelina arborea	*Dyera* sp.
Paraserianthes falcataria	*Eusideroxylon zwageri*
	Gonystylus bancanus
	Koompasia sp.
	Maesopsis eminii
	Ochroma pyramidale
	Octomeles sumatrana
	Peronema canescens
	Pinus merkusii
	Shorea spp.
	Tectona grandis

Table 2.6. Species and area planted by some HTI companies

Species	Area (ha)	Percentage
Acacia mangium	443 535	64.2
Other *Acacia* spp.	24 023	3.5
Paraserianthes falcataria	48 401	7.0
Gmelina arborea	47 790	6.7
Eucalyptus spp.	29 821	4.3
Azadirachta excelsa	18 463	2.7
Hevea braziliensis	8 293	1.2
Peronema canescens	4 963	0.7
Octomeles sumatrana	4 456	0.7
Dipterocarps	2 977	0.4
Tectona grandis	1 966	0.3
Maesopsis eminii	282	>0.1
Swietenia macrophylla	244	>0.1
Miscellaneous species	55 213	8.0
Total	**690 528**	**100.0**

Source: Data supplied by 28 responding Companies under Adindo Hutani Lestari, Barito Timber Pacific, Hutrindo, Indah Kiat, Korindo, Musi Hutan Persada, Raja Garuda Mas, Sumalindo and Uniseraya Groups.

2.5. Forest plantations in perspective

The total extent of forest plantations in Indonesia is about 4 million ha including 2 million ha in Java and about 2 million ha in the outer islands. Plantations in the outer islands are poised for huge expansion – from 2.0 million ha to 7.4 million ha in the coming years (see Table 2.3). Based on current trends, much of this will consist of *Acacia mangium,* followed by *Gmelina arborea*, *Paraserianthes falcataria* and *Eucalyptus* spp. Indigenous timber species will constitute a small proportion – about 20%. Although there is concern among environmental groups about such expansion of industrial plantations of a few species, the fact remains that these plantations account for only about 10%of the total extent of Indonesian forests (9.4 million ha out of 96.2 million ha). What is of greater concern is the degradation of the natural forest in the rest of the 64 million ha of production forests entrusted to private and quasi-Government enterprises for logging and management, and the increasing rate of conversion of forest land into oil palm estates.

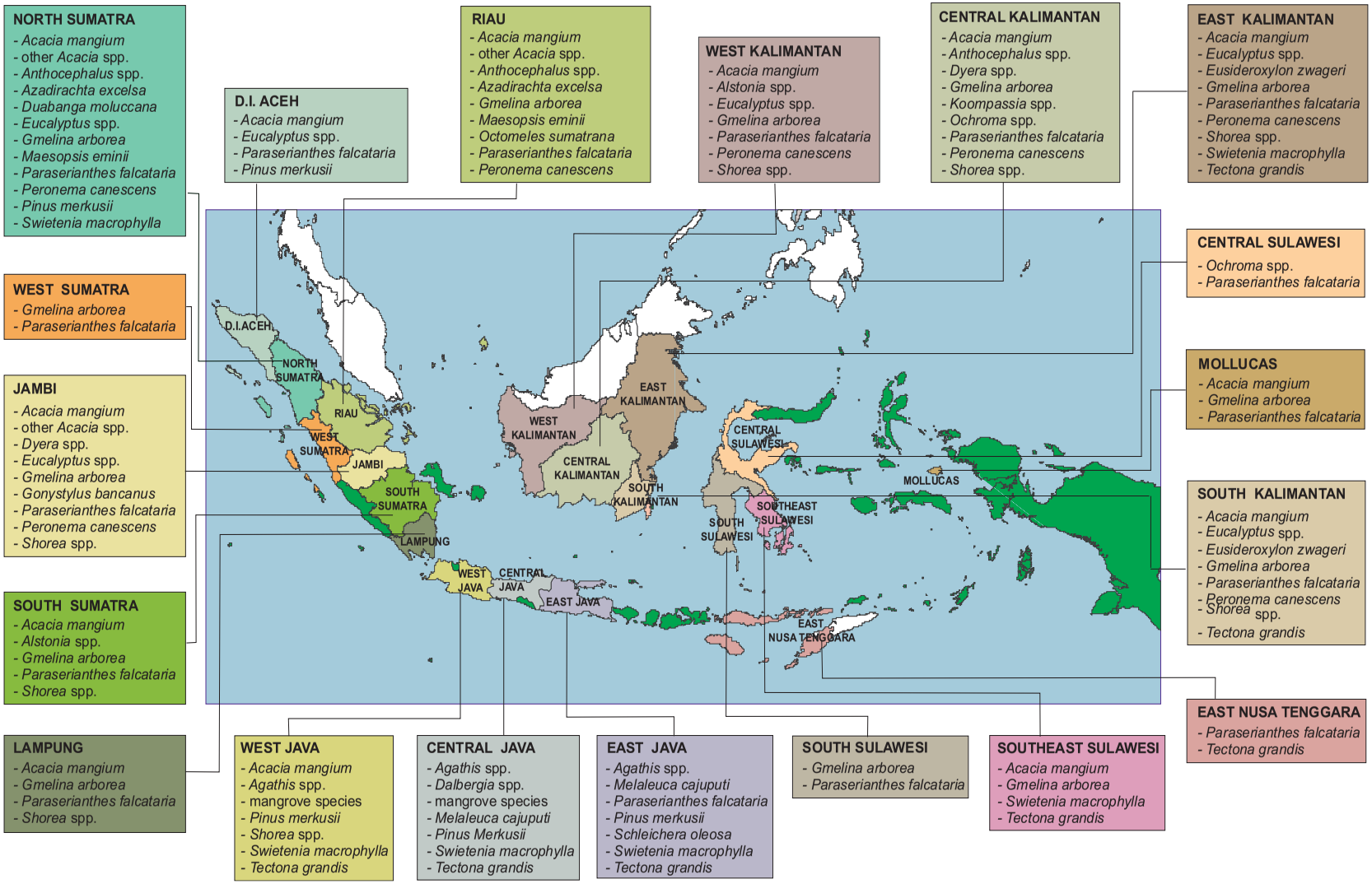
The Government expects plantation-grown wood to satisfy much of the future wood demand by increasing the area of plantations and improving plantation productivity. At present, the mean annual increment of most plantations of fast growing tree species in Indonesia is 15-25 m^3 ha^{-1}, and efforts are under way to increase the productivity through use of genetically improved planting stock, including hybrids, and nutrient management (Natadiwirya 1998; Tiarks *et al*. 1999). Projections by the Ministry of Forestry of future wood production indicates almost a doubling of the present wood production by 2018-19. This will be accomplished by an increase of 52 million m^3 of annual wood production from plantations, while there will be a decrease of 3.23 million m^3 of annual wood production from natural forests (Table 2.7). Plantation forestry in Indonesia has to meet this challenge.

Table 2.7. Projected wood production in 2018-19 from different sources

Year	Natural forest	Plantation forest		Community forest	Total
		For pulpwood	For construction timber		
		million m^3			
1999 - 2000	34.79	15.52	1.70	1.49	53.50
2018 - 2019	31.56	42.58	26.73	2.86	103.73
Difference	-3.23	+27.06	+25.03	+1.37	+50.23

Source: Natadiwirya (1998)

Figure. 2.1. The spread of forest plantations across Indonesia and the species planted in each province



Source: Dit. Bina Pengusahaan Hutan, MoFEC

Chapter 3

General Scenario of Pests and Diseases in Natural Forests and Plantations in Indonesia

K.S.S. Nair and Sumardi

Conventional wisdom suggests that natural stands of tropical forests, characterised by high species diversity, are free of pests and diseases. Tropical forests are often quoted as examples that demonstrate the strong correlation between diversity and stability, in relation to pest and disease outbreaks. However, a critical study of the literature shows that there is more discussion than data on this relationship (Nair *et al.* 1986). Plantations, on the other hand, characterised by even-aged stands of the same tree species are generally believed to be pest and disease prone. There is enough data to support this generalisation, although monocultures of some species may be pest or disease free. An overview of the general situation in natural forests and plantations in Indonesia is given below.

3.1. Natural forests

Published information on pests and diseases in natural forests of Indonesia is scarce. Kalshoven (1953) recorded some of the early instances of insect pest outbreaks, the highlights of which are given below. Natural stands of *Pinus merkusii*, *Casuarina junghuhniana* (syn. *C. montana*), *Palaquium* sp., *Actinophora fragrans* and mangroves have suffered occasional pest outbreaks. Outbreaks of three species of insects are on record in pine stands, which cover an area of about 100 000 ha in North Sumatra, mainly in stands subjected to resin tapping. An undetermined species of the genus, *Pteroma* (a small bagworm belonging to the lepidopteran family Psychidae), has been the most serious. Severe outbreaks occurred in 1924, 1933, and 1934-38, causing defoliation over large areas. The 1934-38 outbreak continued over a four-year period, during which repeated defoliation occurred, month after month. The damage was more serious on poorer sites. Another pine pest was a larger bagworm, *Eumeta* (*Clania*) *variegata,* a well-known polyphagous insect, but its outbreaks were less frequent. The third pest was also a lepidopteran (Geometridae) defoliator, *Milionia basalis*. Repeated outbreaks of this insect have been recorded, smaller outbreaks developing simultaneously in different places all over the pine stands. Our knowledge about these early outbreaks of pine insects was due to regular observations made by the resin and turpentine industry. No systematic observations are available for later periods, although outbreaks of other pests have been recorded in pine plantations.

Occasional severe outbreaks of the caterpillar *Voracia casuariniphaga* (Lepidoptera, Lasiocampidae) occur in natural stands of *Casuarina junghuhniana* growing on mountain ridges and peaks in East Java. In an outbreak in February 1938 on Mt Lawu, 800 ha were totally stripped. Outbreaks of the caterpillar, *Ophiusa serva* (Noctuidae) have been recorded on *Palaquium* sp., which often constitutes 50% or more of the crop in some primary forests in South Sumatra. On the mangrove, *Sonneratia acida*, in an estuary at the Barito River in Southeast Kalimantan, a caterpillar provisionally identified as *Lymantria galinara* (Lymantriidae) caused defoliation of all trees on one occasion. More recently there was a near total defoliation of a mangrove species, *Excoecaria*

agallocha (Whitten and Damanik 1986) This was caused by the caterpillar, *Ophiusa melicerta* (syn. *Achaea janata*) (Lepidoptera, Noctuidae) and covered about 500-1000 ha of forest south of Belawan in North Sumatra, where the tree occurs essentially as single-species stands.

In lowland forests in Java, outbreak of a small woodborer, *Agrilus kalshoveni* (Coleoptera, Buprestidae) caused large-scale mortality of scattered trees of all sizes of *Actinophora fragrans* (Tiliaceae), in 1926-28.

In a recent study in Wanariset and Bukit Soeharto forest area in East Kalimantan, Rahayu *et al*. (1998) recorded damage to *Shorea* spp. by leaf feeding caterpillars. Three diseases were also recorded: prolepsis (excessive proliferation of shoot tissue caused by a bacterium, resulting in stunted growth), leaf spot (leaf blight) and stem canker induced by fungi. However, these pests and diseases were of minor importance. Seed pests are known to make a significant impact in natural dipterocarp forests. Larvae of some small moths and curculionid beetles attack the fruits on the tree and on the ground (Elouard 1998, Natawiria *et al*. 1986) and feed on the cotyledons so preventing seed germination. Curran and Leighton (1991) observed the 1996 seed crop of about 100 000 seeds ha^{-1} was entirely destroyed by insects in the lowland forest of West Kalimantan. The well-known phenomenon of mass fruiting of dipterocarps is thought to be a strategy to escape complete seed destruction by satiating the seed pests (Janzen 1974).

3.2. Plantations

More data are available on pests and diseases of plantation trees than for native forests. However, as most plantations in the outer islands are still young, plantation experience is limited to species planted in Java. These include teak, pine, mahogany, rosewood, and species of *Melaleuca, Paraserianthes, Schleichera* and *Rhizophora*. Teak plantations have suffered chronic damage from the defoliator, *Hyblaea puera,* throughout the plantations in Java. In some locations, the termite *Neotermes tectonae* that infests the trunk and branches of living teak trees has caused economic damage. However, because the trees are not killed, the pests have not been recognised as serious. Mahogany plantations suffer severely from the shoot borer, *Hypsipyla robusta*, which has been a factor limiting plantation establishment. *Paraserianthes falcataria* is killed by the stem borer, *Xystrocera festiva.* Shoot borers damage pine plantations in Sumatra, but these insects have not been encountered in pine plantations in Java. Other species have suffered no major pest damage.

Diseases have not become a serious threat in any of the plantations in Java, although many fungal diseases have been noted in nurseries.

It is concluded that some tree species are susceptible to pest damage in plantations but others are not. Diseases have made much less impact, except in nurseries. Pests and diseases of each tree species are discussed in detail in Chapter 4.

3.3. Comparison between plantations and natural forests

A comparison of the pest and disease problems in plantations with those in natural forests indicates that pests have a greater impact in plantations. However, pest outbreaks have also occurred in natural forests. Most of these outbreaks have been recorded in tree species that occur gregariously, like in a monoculture plantation. Examples are *Pinus merkusii, Casuarina junghuhniana*, *Palaquium* sp., and *Excoecaria agallocha*. A high host density appears to be a key factor promoting pest outbreaks. Most insects that have acquired pest status are ubiquitous components of the normal insect fauna that are present in low numbers in natural forests. They become pests when a high host density as in plantations or other factors cause a large increase in insect populations.

Many species that are grown in plantations in Indonesia are exotic. Some of them have also suffered damage from pests and diseases, as discussed in the next chapter. By definition, indigenous species are those that occur as part of the natural vegetation within the geographic boundaries of a country. In the case of Indonesia, which has 17 500 islands extending across

5100 km from the Indian Ocean to the Pacific Ocean, between 5^0 N and 11^0 S latitude and 94^0 – 141^0 E longitude (Whitten *et al*. 1996), and the Wallace's line separating a small eastern part, the conventional definition of indigenous species has little relevance. For instance, the natural distribution of *Pinus merkusii* is limited to northern Sumatra and that of *Acacia mangium* and *Paraserianthes falcataria* to some small areas of the eastern islands, and therefore it is not appropriate to consider them as indigenous to Indonesia as a whole. Designating a species as exotic is a matter of definition. If instead of the political boundary of the country, we accept a narrower spatial scale like the major island groups and their surroundings as the spatial unit to define indigenous and exotic species, most plantation species in Indonesia will have to be treated as exotic. A comparison between indigenous and exotic species is best made after a detailed consideration of pests and diseases in plantations.

Chapter 4

Insect Pests and Diseases of Major Plantation Species

K.S.S. Nair and Sumardi

In this Chapter, the pests and diseases of 24 forest trees, including pulpwood and timber species, planted in Indonesia are discussed. The species are based on information supplied by plantation companies and include some species planted only on an experimental scale, so there is little information on their pests and diseases.

A brief introductory paragraph gives general information on the species, including its natural distribution, planting locations within Indonesia (see also Fig. 2.1) and uses. This is followed by a brief description of the damage caused by the main insect pests and diseases. Then information is provided on pests and diseases in neighbouring countries and a critical look at the threat posed by the pests and diseases in Indonesia.

4.1. *Acacia mangium* and other *Acacia* spp.

Indonesian common name: Akasia

Plantation forestry in Indonesia is dominated by *Acacia mangium* due largely to its ability to compete with grasses in the unproductive *Imperata cylindrica* grasslands. Large-scale planting began in 1986 under the Industrial Plantation Scheme and there has been a massive expansion of the area since then (Turnbull *et al.* 1998). Now there are at least 500 000 ha of *A. mangium,* mostly in Sumatra and Kalimantan. It has been planted in the provinces of West Java, Aceh, North Sumatra, Riau, Jambi, South Sumatra, Lampung, West Kalimantan, Central Kalimantan, East Kalimantan, South Kalimantan and Moluccas (see Fig. 2.1). Ten companies had planted 426 000 ha of *A. mangium* by 1996 (Turnbull *et al*. 1998). PT Musi Hutan Persada has reported that 90% of its 200 000 ha of forest plantations in South Sumatra is *A. mangium* (Siregar *et al*. 1999). Second rotation plantations exist in some areas.

Acacia mangium is native to three small islands in the Moluccas and parts of Irian Jaya in eastern Indonesia (Pinyopusarerk *et al*. 1993).

Insect pests

There is little published information on the pests of *A. mangium* in Indonesia. The following data (Table 4.1) have been assembled from a variety of sources, including unpublished reports and information obtained from companies through visits and correspondence.

Nursery seedlings of *A. mangium* are attacked by a number of insects including plant bugs, grasshoppers and bagworms, causing variable damage. A subterranean termite, *Coptotermes curvignathus* (Isoptera, Rhinotermitidae), which eats into the taproot and stem is reported to kill 10-50% of saplings in plantations in Central Sumatra in their first year (Wylie *et al*.1998). In Malaysia, this insect infests even older trees (Chew 1987). Control should be possible by using appropriate prophylactic insecticidal treatment (Varma and Nair 1997).

Table 4.1. Insect pests of *Acacia mangium* in Indonesia

Type of damage	Scientific name	Common name	Notes
Root-feeding	*Coptotermes curvignathus* (Isoptera, Rhinotermitidae)	Termite	Causes death of saplings
Leaf-feeding	*Pteroma plagiophleps* and other bagworms (Lepidoptera, Psychidae)	Bagworms	
	Unidentified caterpillar (Lepidoptera, Noctuidae)	Caterpillar Plusia	On young saplings
	Valanga nigricornis (Orthoptera, Acrididae)	Grasshopper	
Sap-sucking	*Helopeltis theivora* and other *Helopeltis* spp. (Hemiptera, Miridae)	Mosquito bug	On young saplings
Twig-boring	*Xylosandrus* sp. and *Xyleborus fornicatus* (Coleoptera, Scolytidae)	Pinhole borers	Attacked small branches often dry up and break
Trunk-boring	*Xytrocera festiva* (Coleoptera, Cerambycidae)	Stem borer	

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 localised outbreaks have occurred in *Paraserianthes falcataria* and some other hosts (Nair and Mathew 1992). 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 recognisable damage periodically but has not become a serious pest. It is particularly active in the border zone between forests and open ground (Hutacharern 1993). *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 (PT. Riau Andalan Pulp and Paper, personal communication).

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. Localised damage by *Helopeltis* sp. to *A. mangium* has been reported from Malaysia (Hamid 1987) and Philippines (Luego 1990) and it regularly causes severe damage in 6-18-month-old plantations in North and Central Sumatra (Wylie *et al*. 1998). The principal species is *H. theivora,* but *H. fasciaticollis* and *H. sumatranus* have also been recorded (Wylie personal communication). 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. In cashew plantations in Kerala, India, damage by *H. theivora* is most serious during the flushing and flowering season, causing the top layer of the crown to dry out and necessitating regular prophylactic insecticidal sprays to prevent yield loss.

Pinhole borers, *Xyleborus fornicatus* and *Xylosandrus* sp., attack small branches which often dry up and

break off at the point of attack (Hardi and Intari 1990; Riyantoko 1998; Zulfiyah 1998). 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). It is unlikely to become a major pest of *Acacia* as the life cycle is annual and the attacked trees generally survive. A related species, *X. globosa,* occurs on *Albizia* spp. and *A. mangium* in Malaysia. Matsumoto (1994) recorded this species on *A. mangium, A. auriculiformis* and *Paraserianthes falcataria* in East Java and South Sumatra but the larvae of *X. globosa* feed less gregariously than *X. festiva* and had a much lower population level.

Diseases

In general, *Acacia mangium* plantations in Indonesia have suffered little from diseases. Following the threat of widespread occurrence of heart rot disease of *A. mangium* in Malaysia, detailed studies were carried out on diseases of acacias in the region, including Indonesia, and excellent reviews written (Old 1998; Old *et al*. 2000).

Four major categories of diseases have been recognised – foliar diseases, stem canker, heart rot and root rots (Table 4.2). 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. There is considerable variation between provenances in susceptibility which suggests potential for selecting resistant genotypes (Old 1998). Other leaf diseases (Table 4.2) are of minor importance.

Table 4.2. Diseases of *Acacia mangium* in Indonesia

Disease	Causative agent	Notes
Foliar diseases		
Rust	(Near) *Atelocauda digitata*	
Powdery mildew	*Oidium* spp.	
Black mildew	*Meliola* spp.	
Leaf spot	*Cercospora, Pestalotiopsis* and *Collectotrichum* spp.	
Stem cankers		
Pink disease	*Corticium salmonicolor*	< 2% of 5-year old trees were affected in Sumatra
Black canker	*Pytophthora palmivora*	Present in older plantations in Sumatra and Java
	Cytospora sp.	Minor
	Hypoxylon mammatum	Minor
Heart rot	*Phellinus noxius* *Rigidoporus hypobrunneus* *Tinctoporellus epimiltinus*	
Root rots		
Red root rot	*Ganoderma philipii* *(syn.* G. pseudoferreum*)*	
White root rot	*Rigidoporus microporus* (syn. *Leptoporus lignosus*) (syn. *Fomes lignosus*)	

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, is common in Indonesia and is most prevalent in denser stands (Zulfiah and Gales 1997). It causes necrosis of the bark tissue on small stems, and branches, often leading to their breakage. Heart rot, caused by a complex of *Phellinus noxius* and other unidentified basidiomycete fungi entering through wounds, occurs in East Kalimantan (Lee and Sikin 1999). 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. It is not considered to be a major problem when the end use is pulpwood rather than timber (Old *et al*. 2000). The hybrid, *A. mangium* x *A. auriculiformis*, is resistant to heart rot, as is *A. auriculiformis* (Ito and Nanis 1997). 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.

Threat Assessment

In making an assessment of threat, the problems experienced in neighbouring countries must also be taken into consideration. For insect pests, Wylie *et al*. (1998) have reviewed the problems and listed 22 species as main pests in the region covering Australia, Indonesia, Malaysia, Thailand and Vietnam. These pests can be categorised into five groups - leaf feeders (7 spp.), root or stem feeding termites (5 spp.), trunk borers (4 spp.), twig borers (4 spp.), and sapsuckers (2 spp.). Seven important pests in Indonesia were identified in an assessment made in May 1997 (Wylie *et al*. 1998). They were a root feeding termite (1 sp.), a twig borer (1 sp.), leaf feeders (4 spp.) and a sap sucker (1 sp.). In order of importance they are: *Coptotermes curvignathus* (root-feeding termite), *Xylosandrus* sp. (stem-boring scolytid beetle), *Pteroma plagiophleps* (leaf-feeding bagworm), unidentified caterpillar (leaf-feeding), *Valanga nigricornis* (leaf-feeding grasshopper), *Locusta* sp. (leaf feeding), and *Helopeltis theivora* (sap-sucking bug). In a global review, Hutacharern (1993) considered there were only four serious pests of *A. mangium*. These were the termite, *C. curvignathus*; the buprestid root collar borer, *Sternocera* spp.; the bostrychid twig borer, *Sinoxylon* sp.; and the cossid stem borer, *Zeuzera coffeae*. Among the seven serious pests recognised by Wylie *et al*. (1998) for Indonesia, only the termite, *C. curvignathus,* was in Hutacharern's list .

We rate the sap-sucking bug, *Helopeltis* sp., as potentially the most serious pest, based on current knowledge of pest incidence in *A. mangium* plantations in Indonesia and the insect's habits and past history in other crops. Two species of *Helopeltis* are reported to occur in forest plantations in Indonesia - *H. antonii* in *Eucalyptus* spp. (Rahardjo 1992) and *H. theivora* in *Eucalyptus* spp. and *A. mangium* (Hardi 1993; Wylie *et al*. 1998). In addition, *H. fasciaticollis* and *H. sumatranus* have been identified recently from *A. mangium*. Both *H. theivora* and *H. antonii* are serious pests of cashew in India. *Helopeltis* spp. have acquired pest status on various tree crops in Australia, China (Hainan Island), Malaysia, Philippines, Sri Lanka, Thailand and some countries in Africa. Many species of *Helopeltis* occur in Indonesia on a variety of crops and severe outbreaks occurred in the 1960s on tea in North Sumatra before the advent of modern insecticides (Kalshoven 1981). Difficulty in controlling them, other than through repeated chemical sprays, adds to the seriousness of the problem. It is already recognised as serious in young plantations in Sumatra. It was not found in a plantation examined by one of us (K.S.S.N.) in East Kalimantan, but it could build up there as it already occurs in adjacent Sarawak (East Malaysia). Careful monitoring of *Helopeltis* spp. as a potentially serious pest of *A. mangium* is recommended.

Root-feeding termites are the next most serious threat, during the establishment stage of the crop, as experienced in Sumatra, but they can be controlled effectively using insecticidal spot treatment.

The risk of new pests emerging over time cannot be ignored. In 1992 a new pest, *Spirama retorta* (Lepidoptera, Noctuidae), attacked 800 ha of a 1-year-old *A. mangium* plantation in Peninsular Malaysia (Sajap *et al*. 1997b). Little was known about this insect which had been recorded on *Albizia lebbek* in India (Beeson 1941) and on an unknown host in Thailand (Hutacharern and Tubtim 1995). It has been recorded recently on *A. mearnsii* in China (Wang *et al*. 1998).

Another new noctuid pest, *Ericeia* sp., has damaged *A. mangium* in Malaysia (Sajap *et al*. 1997a). The unidentified caterpillar, 'Plusia', found in young plantations in Sumatra is also a noctuid. The lepidopteran family, Noctuidae, contains several well-known pests with outbreak potential. They include *Achaea janata, Helicoverpa armigera (Heliothis armigera), Plecoptera reflexa, Prodenia litura* and *Selepa celtis*. Therefore, there is a high risk of emergence of new noctuid pests on *A. mangium*.

Old (1998) reviewed the risks of diseases in Indonesia and the neighbouring countries. Foliar rust, root rots and heart rot are potentially dangerous. However, there are indications of presence of genotypes resistant to the rust and heart rot. Avoiding wounds to the stem also reduces the risk of heart rot. The heart rot problem may be the result of mismatching of the tree species with the sites (Arentz 1996; Lee and Arentz 1997). In its natural habitat *A. mangium* grows in areas with a seasonal dry period. It has been hypothesised that absence of a dry period may hinder the self-pruning ability of branches, permitting the development of entry points for decay fungi into the main stem through the dying branches. The situation needs monitoring. The *A. auriculiformis* x *A. mangium* hybrid may prove resistant to heart rot. Root rot appears to be potentially more damaging, as the pathogens spread by root contact between diseased and healthy trees. Old *et al*. (2000) have concluded that planting successive rotations of acacias on the same site will provide conditions favourable for the build-up of root rot diseases; particularly if there is no post-harvest burn as the inoculum may build-up in the slash. Careful monitoring of root rot diseases is also necessary as there is no practical means of control.

Other *Acacia* species

After *A. mangium, A. auriculiformis* is the most widely planted acacia in industrial plantations, followed by *A. crassicarpa* and *A. aulacocarpa* (syn. *A. perigrina* from Papua New Guinea). *Acacia auriculiformis* seedlings in nurseries are attacked by the stem boring scolytid beetle, *Xylosandrus compactus*. It has been reported from Java, Sumatra, Kalimantan, and Sulawesi (Intari and Santoso 1990; Natawiria 1990). Related scolytid and bostrychid borers have also been noted on *Acacia* spp. in Malaysia and Thailand. The stem borers *Xystrocera festiva* and *X. globosa* also attack *A. auriculiformis* but the incidence is rare. In general, these *Acacia* species have no major pest problems, although occasional leaf feeding by polyphagous insects is common.

Among diseases, rust occurs on *A. auriculiformis* and pink disease (*Corticium salmonicolor)* in *A. crassicarpa* and *A. aulacocarpa* plantations (Hadi and Nuhamura 1997). Canker caused by unknown agents has been noted in all the three species. Root rot caused by *Ganoderma pseudoferreum* has been reported on *A. auriculiformis* (Widyastuti *et al*. 1998b). *Acacia auriculiformis* is resistant to heart rot and except for this disease the risk rating for these other acacias is the same as for *A. mangium*.

4.2. *Agathis dammara*

Indonesian common name: Damar

Agathis dammara (Lambert) Rich (syn. *A. loranthifolia*) is a conifer native to Indonesia and occurs naturally in Sulawesi and the Moluccas. It also occurs in the Philippines. *Agathis borneensis* Warb. occurs in Sumatra and Borneo, and Peninsular Malaysia; some authors treat it as synonymous with *A. dammara*. About 66 000 ha of *A. dammara* plantations have been established in the provinces of Central and East Java, particularly in mountainous areas, over the past few decades (Perum Perhutani 1995). It provides a general-purpose timber and is tapped for resin (copal).

Insect pests

No major insect pest problem has occurred on *A. dammara*, in Indonesia. Two unidentified beetles have been recorded from seeds (Zethner *et al*. 1996).

Diseases

In nurseries, damping off caused by species of *Fusarium, Rhizoctonia* and *Pythium* has been caused up to 90% mortality of seedlings (Suharti *et al*. 1991) but effective fungicidal control methods are available. In nurseries and young plantations, rust caused by *Aecidium fragiformae* has been noted (Hadi *et al*. 1996). It causes reddish brown raised lesions on the leaves. Although it may cause some growth retardation, it is not considered a serious problem.

Pink disease (*Corticium salmonicolor*) can occur in young plantations (Suharti 1983), particularly when the canopy closes and the humidity increases. Thinning reduces the incidence of disease by lowering humidity.

Threat assessment

Outside Indonesia, decay of mature trees has been recorded in the Philippines and moths (*Agathiphaga* spp.) can destroy the seeds (Bowen and Whitmore 1980) but *A. dammara* has been grown successfully in Java for many years and there is no major threat of pests and diseases.

4.3. *Alstonia* species

Indonesian common name: Pulai

Two species of *Alstonia* (Apocynaceae) are of commercial importance in Indonesia (Whitten *et al*. 1996). *Alstonia scholaris* is common in drier areas and *A. spatulata* in swamps. *Alstonia scholaris* is mainly planted, particularly in West Kalimantan, and yields good pulp and plywood timber.

Insect pests

No information is available on pests in Indonesia, except that the freshly felled logs are attacked by pinhole borers of the families Scolytidae and Platypodidae (Sukartana 1996).

Diseases

No diseases have been reported.

Threat assessment

A few insect pests have been reported on living trees outside Indonesia. In Guangxi, China, the psyllid, *Pseudophacopteron alstonium* (Homoptera) produces galls on the leaf (Yang and Li 1983). In India, caterpillars of a pyralid moth, *Glyphodes bicolor* have been recorded (Beeson 1941) and in Kerala an unidentified *Glyphodes* sp. which feeds in folded leaves causes sporadic damage to isolated trees under semi-natural conditions (K.S.S. Nair unpublished). While there is no indication of threat from diseases, the plantation history of *A. scholaris* is too short to draw a similar conclusion for insect pests.

4.4. *Anthocephalus cadamba*

Indonesian common name: Jabon

Anthocephalus cadamba (Roxb.) Miq. (syn. *A. chinensis* auct.non (Lamk.) Rich. ex Walp.; *Neolamarckia cadamba* ((Roxb.) Bosser) (Rubiaceae) is a fast growing, medium- to large tree. Some authors prefer to use the new generic name, *Neolamarckia.* It has a light coloured wood used for plywood, light construction and pulping. Another species of the genus, *A. macrophyllus*, occurs naturally in Sulawesi and the Moluccas (Smits *et al*. 1993).

Anthocephalus cadamba is planted mainly in HTI plantations in North Sumatra, Riau and Central Kalimantan. It is also planted in Java to replace poor teak plantations after harvest.

Insect Pests

White grubs (larvae of some groups of beetles) feeding on the roots damage 1-2-year-old trees planted under taungya system in Java (Intari and Natawiria 1973). Selander (1990) reported heavy defoliation of experimental plantations of *A. cadamba* in South Kalimantan by an unidentified caterpillar and Ngatiman and Tangketasik (1987) recorded some unidentified insects (presumably, caterpillars) in plantations in East Kalimantan. Suratmo (1987) refers to *Margaronia* sp. (Lepidoptera, Pyralidae) as a defoliator of *A. cadamba*. Suratmo (1996) observed that plantations raised in small areas have been seriously attacked by an undetermined defoliator, which has prevented further planting of this otherwise promising fast growing species.

Diseases

No diseases have been reported on *A. cadamba* in Indonesia.

Threat assessment

In India, a longhorn beetle, *Batocera numitor* (Coleoptera, Cerambycidae) bores into the base of the stem of unhealthy trees; and a caterpillar, *Margaronia hilaralis* (Lepidoptera, Pyralidae) skeletonises leaves (Beeson 1941). Other polyphagous, leaf feeding, caterpillars have also been noted in India, but no serious pest situation has developed. Leaf feeding caterpillars are potential threats but the plantation history is too short to make informed judgment. The main diseases

reported outside Indonesia are on nursery seedlings and include damping-off by *Fusarium* and *Pythium* spp. in Malaysia (Chin 1995) and leaf blight by *Rhizoctonia* in India (Mehrotra 1993). Apart from nursery diseases, which can be controlled by appropriate nursery practices and fungicides, there appears to be no major threat of diseases.

4.5. *Azadirachta excelsa*

Indonesian common name: Nimba, Nimbo

Azadirachta excelsa (Meliaceae) is native to Southeast Asia. Its valuable timber is used for light construction and veneering. Plantations of *A. excelsa* have been established in Sumatra.

Insect pests
No information is available on pests of *A. excelsa* in Indonesia.

Diseases
No information is available.

4.5.3. Threat assessment
Four species of thrips (Thysanoptera, Thripidae) and a moth caterpillar, *Loboschiza vulnerata* (Lepidoptera, Tortricidae) have caused minor damage to *A. excelsa* plantations in Malaysia (Intachat 1997). The tea-mosquito bug, *Helopeltis antonii* (Heteroptera, Myriidae) has attacked tender shoots of the related species, *A. indica* (neem) in India. *Azadirachta excelsa* leaves contain insecticidal and insect repellent chemicals, as in neem, and is resistant to most insects. There is no indication of a threat by pests and diseases.

4.6. *Dalbergia* spp.

Indonesian common names: Sonokeling (*D. latifolia*), Sonosissoo (*D. sisso*)

Dalbergia latifolia and *D. sissoo* (Leguminosae) have been raised in plantations in Indonesia. Both species yield construction and specialty timber and *D. latifolia* (Indian rosewood) is highly prized for furniture and decorative veneers.

There are over 25 000 ha of *Dalbergia* plantations in Java, mostly in Central Java, but the proportion of each species is not available.

Insect Pests
Prawirohatmodjo *et al*. (1993) observed that various insects such as leaf miners, defoliators and stem borers cause minor damage to *Dalbergia* trees in Java, but details are not available. Root feeding by the termites, *Macrotermes gilvus* and *Odontotermes grandiceps* occurs but damage is negligible (Intari *et al*. 1995).

Diseases
There is a high rate of mortality of nursery seedlings caused by damping-off fungi. In 1973, about 300 ha of a 15-year-old *D. latifolia* plantation in East Java was severely damaged by a disease characterised by inrolling of young leaves and discoloration of older leaves, followed by red streaks on the outer layers of sapwood, finally resulting in the death of the trees (Suharti and Hadi 1974). The disease was attributed to *Fusarium solani*. Root rot caused by *Ganoderma* sp. resulted in the death of trees in plantations and along roadsides in Yogyakarta (Widyastuti and Sumardi 1998).

Threat assessment
Several insect pests of *Dalbergia* spp. have been recorded outside Indonesia. In India, Pakistan and Nepal they include root-feeding termites, lepidopteran defoliators, curculionid defoliators, leaf miners and tree hoppers. Of these, the defoliator, *Plecoptera reflexa* (Lepidoptera, Noctuidae) has caused regular defoliation in plantations in northern India and Pakistan. Epidemics of the leaf miner, *Leucoptera sphenograpta*, have occurred occasionally in nurseries in India and Pakistan. As this insect outbreaks took place in northern latitudes with cooler climates, they are unlikely to be a threat in Indonesia.

A large number of diseases, including damping-off, root rot and leaf blight of nursery seedlings; and leaf and twig rust, root rot, stem canker and leaf spot of older plants caused by a variety of fungi have been reported on *D. sissoo* in India. Some of these have also been recorded on *D. latifolia*. A wilt disease, similar to that reported by Suharti and Hadi (1974) on *D. latifolia* in Indonesia (see above), damaged *D. sissoo* in India (ICFRE 1995). Trees aged 15-25 years were susceptible. It was concluded that the soil borne

fungus, *Fusarium solani*, invades the root system, destroys the root hairs, the finer rootlets and the bacterial nodules, and travels a short distance along the stem, clogging vessels and tissues in the sapwood (which develops pinkish brown stain) and stopping the flow of sap to the crown and finally causing the tree to die. Although this appears to be a serious disease, no incidence of this disease has been reported in Indonesia since the first episode in 1973. As *Dalbergia* ssp.have been grown successfully in Indonesia for a long time, more critical study is needed on the differential susceptibility of *D. sissoo* and *D. latifolia* to *F. solani* wilt.

4.7. Dipterocarpaceae (Dipterocarps)

Indonesian common names: Meranti, Balau, Sengkawang, etc.

Natural forests in Indonesia are dominated by dipterocarps but they have not received much attention as plantation species. Apart from experimental plantings in West Java since the 1950s, most planting has been enrichment planting of logged-over forests using wildlings. There is renewed interest in dipterocarps and plantations are being established, mainly in the provinces of West, Central, East and South Kalimantan, South Sumatra and Jambi (see Fig. 2.1). In addition, Perum Perhutani intends to use them to replace poor pine plantations in West Java.

The species planted are mainly *Shorea* and *Dipterocarpus* spp. The genus *Shorea* consists of many species commercially grouped on wood characteristics into red meranti, white meranti, yellow meranti, balau and red balau. Most *Shorea* spp. have been tried in experimental plantations and the relatively fast-growing *S. leprosula, S. selanica, S. javanica, S. smithiana* and *S. parviflora* are receiving more attention. The rates of growth of these species differ between regions but *S. leprosula* grows faster in most places. In cooperation with Japanese plantation companies (Japan is the main importer of Indonesian dipterocarp timber), FERDA (Forestry and Estate Crops Research and Development Agency of Indonesia) and some universities have compared the performance of *Shorea* spp. seedlings and rooted cuttings and established experimental plantations. There will be about 500 ha of plantations in West Java and Sumatra (Riau and Jambi), mostly *S. leprosula* and *S. selanica.*

Insect pests

Major insect pests recorded on dipterocarps are listed in Table 4.3. Various species of weevils (Coleoptera) and small moths (Lepidoptera) attack the seeds when the fruits are on the tree and after they are shed (Curran and Leighton 1991). They damage 40-90% of seeds of several *Shorea* spp., *Dipterocarpus cornutus* and *Hopea odorata* (Natawiria *et al*. 1986). Nursery seedlings of *Shorea leprosula* and *S. parviflora* in East Kalimantan are killed by gall forming mites (Rahayu *et al*. 1998). In Sumatra, a sap-sucking bug, *Mucanum* sp. (Hemiptera, Pentatomidae) kills *Shorea javanica* seedlings in nurseries (Intari 1996) and the sap-sucking cicada, *Lawana candida,* is an occasional pest of 7- to 9-year-old *S. leprosula* in East Kalimantan (Rahayu *et al.* 1998). Unidentified bagworms and other caterpillars have caused serious damage to 5-7-year-old trees of several *Shorea* spp. in East Kalimantan (Rahayu *et al*. 1998). The polyphagous caterpillar *Calliteara cerigoides* is a serious defoliator of dipterocarps in Indonesia (Messer *et al*. 1992, Matsumoto 1994). The species attacked include *Shorea leprosula*, *S. pinanga*, *S. selanica*, *S. stenoptera*, *Hopea mengrawan* and *H. odorata*. Some defoliated saplings of *H. mengrawan* succumbed to the damage. Minor leaf damage by caterpillars and scarabaeid beetles has been noticed in plantations of *S. leprosula* and *S. selanica* in West Java (K.S.S. Nair, unpublished observations). Termites attack living dipterocarps and may cause death of trees (Nuhamara 1977; Elouard 1998).

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. (Table 4.4). Information on fungi on dipterocarps in Indonesia and the diseases they cause is available in Elouard (1991, 1998). Gall formation on shoots of seedlings and saplings of *Shorea* spp. is attributed to the bacterium *Agrobacterium tumefaciens* in Java, Sumatra and Kalimantan and an insectvector is suspected (Elouard 1998). Recently, Rahayu *et al.* (1998) noted a similar disease resulting in abnormal tissue proliferation (prolepsis) and stunting of *Shorea*

Table 4.3. Insect pests of dipterocarps in Indonesia

Type of damage	Scientific name	Common name	Tree species	Notes
Seed damage	*Nanophyes shoreae* (Coleoptera, Curculionidae)	weevil	*Shorea* spp. *Hopea odorata*	
	Alcidodes dipterocarpi (Coleoptera, Curculionidae)	weevil	*Shorea smithiana* and *Dipterocarpus cornutus*	
	Unidentified pyralid (Lepidoptera)	moth larva	*Shorea* spp.	
Sap sucking	*Mucanum sp.* (Hemiptera, Pentatomidae)	plant bug	*Shorea javanica*	On seedlings in nurseries
	Lawana candida (Homoptera, Cicadidae)	cicada	*Shorea leprosula*	Occasional pest on older plants
Leaf feeding	*Calliteara cerigoides* (Lepidoptera, Lymantriidae)	hairy caterpillar	Several species of *Shorea* and *Hopea*	Serious pest
	Unidentified bagworm	bagworm	*Shorea smithiana*	
	Unidentified beetles (Coleoptera, Scarabaeidae)	scarabaeid beetles	*Shorea* spp.	

Table 4.4. Diseases of dipterocarps in Indonesia

Type of damage	Causative agent	Species affected
Flower destruction and seed abortion	*Curvularia harveyi*	*Shorea pinanga*
Necrosis/decay of seeds	*Cylindrocarpon destructens (Nectria radiocola)*	*Shorea pinanga*
	Complex of bacteria and fungi	several
Leaf spots, root and collar rot, bark necrosis and defoliation of seedlings	*Fusarium* spp.	*Shorea* spp.
Leaf spot and defoliation in saplings	*Asterina, Capnodium, Cercospora, Collectotrichum* and *Pestalotia*	Many
Gall formation on shoots of seedlings and saplings	*Agrobacterium tumefaciens*	*Shorea* spp.
Heart rot of trees	-	*S. javanica*

assamica and *S. lamellata* seedlings in East Kalimantan. They also found leaf spots, leaf blight and stem cankers on saplings of *Shorea* spp., but the damage was not serious. There is heart rot in about 10% of *Shorea javanica* tapped for resin in Sumatra (Elouard 1991).

Threat assessment

Insects in Indonesian dipterocarp plantations are polyphagous and none seems to be specially adapted to dipterocarps. The hairy caterpillar, *Calliteara cerigoides* has been consistently associated with experimental dipterocarp plantings but there is no serious pest problem in about 11 000 ha of *Shorea johorensis*, *S. leprosula* and *S. parviflora* plantations of PT. Kiani Hutani Lestari in East Kalimantan (Suhendi and Sembiring 1998). Except for *Helopeltis clavifer* (Hemiptera, Miridae) damage to seedlings, there has been no major pest problem in Malaysia where

dipterocarps have been planted for a longer period. An exception is *Shorea robusta* (sal) in India, where devastating outbreaks of a borer, *Hoplocerambyx spinicornis* (Coleoptera, Cerambycidae) have occurred periodically in northern latitudes (Roonwal 1978). There was a large outbreak of a hairy caterpillar in over 12 000 ha of natural peat swamp forest of *Shorea albida* in Sarawak and Brunei during the 1950s (Anderson 1961). This may be an exceptional situation but details are sketchy. While there is no indication of any serious emerging pest problem in dipterocarps, the situation needs monitoring. In general, the resin present in dipterocarps may afford protection against insects. Diseases do not seem to be a major threat.

4.8. *Dyera* spp.

Indonesian common name: Jelutung

At least three species of *Dyera* (Apocynaceae): *D. costulata, D. polyphylla and D. lowii* occur in Indonesia (Whitten *et al*. 1987; Kessler and Sidiyasa 1994). In Kalimantan, *D. costulata* and *D. polyphylla* occur in lowland swamp forests and they have been tapped for latex and their soft timber used for manufacturing plywood, toys, boards, etc. Plantations of *Dyera* spp. are being established South Kalimantan and Jambi provinces.

Insect pests

No information is available.

Diseases

No information is available except for the occurrence of sapstain fungi on freshly cut logs (Martono 1989).

Threat assessment

Little information is available from other countries. In Malaysia, where there are trial plantations of *D. costulata* (Appanah and Weinland 1993), seeds were damaged by ants (Duncan 1977) but no major pests recorded. The timber is susceptible to damage by powder-post beetles. It appears that there is no major threat of pests and diseases for plantations of *Dyera* spp. Perhaps the latex affords protection as it does in most other Apocyanaceae.

4.9. *Eucalyptus* spp.

Indonesian common names: Empupu, Leda, Ekaliptus

As in many tropical countries, *Eucalyptus* spp. (Myrtaceae) have been planted over large areas in Indonesia for pulpwood production. The main species planted are *E. deglupta* and *E. urophylla*, which are native to Indonesia although their natural distribution is in the eastern islands. Many other species have been tried in small-scale experimental plantations, notably, *E. camaldulensis, E. grandis, E. pellita, E. tereticornis* and *E. torelliana*. Most plantations are in Sumatra (Aceh, North Sumatra, Jambi) and Kalimantan (West, East and South Kalimantan).

Insect pests

In the nursery, eucalypt seedlings may be attacked by several insects, including a pyralid leaf roller (probably *Archips micaceana*), the jassid bug, *Kolla bataviae*, the curculionid shoot borer, *Alcides* sp. and the tea-mosquito bug, *Helopeltis* spp. (Table 4.5) (Hardi 1993; Rachmatsyah and Haneda 1998). Generally, they have not posed a major threat, and chemical control methods have been tested (Hardi 1993). 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 1976; Selander 1990; Santoso and Hardi 1991). Older plants are attacked by *Helopeltis* spp., which cause dieback of young shoots and are a serious pest in North Sumatra where up to 57% of trees may be infested (Hardi and Intari 1990). Saplings are attacked by *Zeuzera coffeae* (Lepidoptera, Cossidae), which bore into the stem and often cause it to break; Suratmo (1996) reported that 12-30% of saplings might be infested in Sumatra and Kalimantan. Recently, an unidentified borer killed 1000 ha of 2-3-year-old *E. deglupta* plantation of PT. Hutan Kusuma (Soepangkat 1998). Most probably, this damage was caused by the varicose borer, *Agrilus sexsignatus* (Coleoptera, Buprestidae) which devastated some plantations in the Philippines in the 1970s. *Eucalyptus deglupta* trees weakened by other causes and the Papua New Guinea provenances are very susceptible to this borer whose density in attacked plants has reached 37 larvae m^{-2} of wood surface in the Philippines (Braza 1988, 1992).

Table 4.5. Insect pests of eucalypts in Indonesia

Category	Scientific name	Common name	Notes
Nursery pests	*Helopeltis* spp. (Hemiptera, Miridae)	Tea mosquito bug	
	Unidentified (Lepidoptera, Pyralidae)	Leaf roller	
	Alcides sp. (Coleoptera, Curculionidae)	Shoot borer	
On young transplants	Several species (Termitidae)	Subterranean termites	Causes plant mortality
Saplings	*Helopeltis* spp. (Hemiptera, Miridae)	Tea-mosquito bug	Causes die-back of shoots
	Zeuzera coffeae (Lepidoptera, Cossidae)	Red borer	
	Unidentified borer (probably *Agrilus* sp., Coleoptera, Buprestidae)		Only on weakened trees, causes heavy mortality

In general, there are no major pest problems in older eucalypt plantations.

Diseases

In the nursery, eucalypt seedlings are susceptible to damping-off by *Pythium* and *Fusarium* spp. (Sitepu and Suharti 1998). 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 (Table 4.6). 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* sp. (Anggraeni and Suharti 1997). In a 7-year-old plantation of *E. urophylla* examined by one of us (K.S.S.N.) at Sebulu, East Kalimantan, several trees in patches were found dead due to root disease. In future plantings in this area *E. urophylla* is being replaced with *E. pellita* which is less susceptible to diseases (S.S. Maurits personal communication). Stem canker was also observed on some trees. Stem canker on *Eucalyptus* has been attributed to *Nectria* sp. (Nazif and Suharti 1990) and in Riau, Sumatra, 52% of 5-year-old trees in a 10 ha *E. urophylla* plantation had stem canker (*Nectria* sp.) and nearly 5% were killed (Suharti and Santoso 1995).

Threat assessment

Pests are not a major constraint to eucalypt plantations. Nursery pests, and termites that attack the out-planted saplings during plantation establishment stage, can be effectively managed.

Table 4.6. Diseases of eucalypts in Indonesia

Disease	Causative agent	Notes
Damping-off	*Pythium* sp., *Fusarium* sp.	In nurseries
Leaf spot	*Pestalotia* sp., *Curvularia* sp., *Mycosphaerella* spp.	On seedlings and saplings
Leaf blight	*Cylindrocladium multiseptatum*	On saplings
	Kirramyces destructens	On saplings
Pink disease	*Corticium salmonicolor*	On saplings
Root rot	*Phytophthora* sp., *Botryodiplodia* sp.	On older trees
Stem canker	*Nectria* sp.	On older trees

Experience with extensive eucalypt plantations outside Indonesia is similar. The buprestid borer, *Agrilus sexsignatus*, which affected some plantations in the Philippines, was restricted to plantations growing on poor sites and a particular provenance. Two serious pests of eucalypts of Australian origin, *Phoracantha* (borer) and *Gonipterus* (defoliator), were accidentally introduced into some eucalypt growing countries in Africa and the Mediterranean where they spread rapidly causing economic damage. Therefore, vigilance is necessary against accidental introduction of these pests.

Nursery diseases can be kept in check by using fungicides and appropriate nursery management techniques. However, root disease affecting older trees is a serious problem which is likely to be aggravated in the future because inoculum build up will occur over successive short rotations and there is no effective control method. Root isolation by trenching around diseased trees is practised but is costly and not fully effective. *Phytophthora* sp. is one of the causative agents identified. *Phytophthora cinnamomi* is a serious and widespread pathogen of *E. marginata* (jarrah) forests in Australia, with a wide host range (Keane *et al*. 2000). There is urgent need for an in-depth study of the fungi associated with root rot of eucalypts in Indonesia and to screen *Eucalyptus* species and provenances for resistance to root rot. Leaf diseases, e.g. *Cylindrocladium* spp., have been a serious problem in humid tropical environments in parts of Asia, but while some have been recorded in Indonesia, e.g. *Macrophoma* sp., they are not yet considered a potential threat.

4.10. *Eusideroxylon zwageri*

Indonesian common name: Ulin

Eusideroxlon zwageri (Lauraceae), also called ironwood, is a highly valued indigenous timber species in Indonesia. It is a monotypic species distributed in Sumatra, Kalimantan and some adjacent islands (Kostermans *et al.* 1993). It is one of the heaviest and highly durable timbers and has a variety of uses. In Sumatra and Kalimantan it is traditionally used for roof shingles. Plantations are being established in South Kalimantan.

Insect pests

There are no records of pests on the living tree, but seeds are damaged by insects (Kostermans *et al*. 1993). The wood is highly resistant to termite attack.

Diseases

No disease of the living tree is on record.

Threat assessment

Although there is very little plantation experience with this species, available information suggests that there is no threat of pests and diseases.

4.11. *Gmelina arborea*

Indonesian common name: Gmelina

Gmelina arborea (Verbenaceae) is exotic to Indonesia, although the related *G. moluccana* occurs naturally in the Moluccas (Yap *et al.* 1993). It is a relatively fast growing species, which produces a lightweight hardwood suitable for construction, carving, etc. It also yields good quality pulp. There are large-scale plantations in Sumatra (Riau, West Sumatra, Jambi, South Sumatra and Lampung), Kalimantan (West, Central, South and East Kalimantan) and the Moluccas (Fig. 2.1). Small plantations have been raised in Java.

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. In East Kalimantan, 5-70% of saplings may be infested (Ngatiman and Tangketasik 1987) and it also occurs in Java and Sumatra. Injecting the larval tunnel with lubricant oil and plugging the hole was effective for control (Pramono *et al*. 1998). One of us (K.S.S.N.) observed at Sebulu, East Kalimantan about 80% of saplings stumped to produce multiple shoots in a clonal multiplication area, were infested by this borer. 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). In a review paper, Suratmo (1996) listed *Alcidodes ludificator* and *Apion argulicolle* (Coleoptera, Curculionidae) as pests of *G. arborea* in Indonesia. He also listed *Xyleborus fornicatus* (Coleoptera, Scolytidae), *Selepa celtis* (Lepidoptera, Noctuidae) and *Calopepla leayana* (Coleoptera, Chrysomelidae) among pests of *G. arborea* and observed that in 2-3-year-old trees 100% defoliation has been recorded. However, Sitepu and Suharti (1998) have listed only *Prionoxystus* sp. as a pest of *G. arborea*. Other insects recorded include the well-known teak beehole borer, *Xyleutes ceramicus* (Rachmatsyah and Haneda 1998).

Diseases

In nurseries, damping off caused by *Pythium, Phytophthora* and *Rhizoctonia* spp. is common (Rahayu 1999). Anthracnose disease characterised by sudden death of seedlings, caused by *Colletotrichum* sp., has been reported (Kobayashi and Zinno 1984). Root rot disease caused by *Botryodiplodia* sp. has affected young plantations in South Kalimantan, Jambi and Sumatra (Anggraeni and Suharti 1997). *Ganoderma* sp. has been isolated from the roots of dead trees of *G. arborea* in the campus of Gajah Mada University in Yogyakarta.

Threat assessment

Gmelina arborea has several serious pests in countries where it is native. The most damaging is the beetle defoliator, *C. leayana*. Suratmo (1996) lists it as a pest of *G. arborea* in Indonesia but no details are available and other reviewers do not mention it. Since this is a potentially dangerous pest which has become a limiting factor for large-scale cultivation of *G. arborea* in its native range, more investigation is needed on the occurrence and severity of this pest in Indonesia. Other serious pests of *G. arborea* outside Indonesia include the sap-sucking bug, *Tingis beesoni* (Hemiptera, Tingidae) which builds up in outbreak proportions in young plantations, causing defoliation and shoot die-back in India (Beeson 1941; Nair and Mathew 1988); the defoliator, *Ozola minor* (Lepidoptera, Geometridae) in the Philippines (Yemane 1990); and the stem borer, *Glena indiana* (Coleoptera, Cerambycidae) in Thailand (Hutacharern 1990). None of these has been reported in Indonesia. At present, there are no major pest problems in *G. arborea* plantations in Indonesia. This is a similar situation to Brazil and some African countries where *G. arborea* has been planted as an exotic. Two common minor pests in Indonesia are the cossid borer, *Prionoxystus* sp., attacking saplings and the unidentified curculionid borer attacking green shoots in the nursery. In clonal multiplication orchards and high value plantations, where attention can be given to individual plants, *Prionoxystus* sp. can be controlled by injecting a suitable insecticide solution to the larval tunnel or by pricking the larva using a wire probe. The curculionid borer in nurseries can also be controlled by using insecticides. Except for nursery diseases, for which effective control measures are available, there is no threat of diseases for *G. arborea*.

4.12. *Gonystylus bancanus*

Indonesian common name: Ramin

Gonystylus bancanus (Thymelaeceae) is the most popular of the several species of *Gonystylus* endemic to the Malesian region. It is a characteristic associate of the dipterocarp forests in the lowland swamps in Sumatra and Kalimantan and is highly prized for its smooth whitish timber suitable for a variety of light construction, including cabinets (Soerianegara *et al.* 1993). In addition to enrichment planting in logged over forests, industrial plantations of *G. bancanus* are being established in Jambi province in Sumatra.

Pests

No information is available on pests of *G. bancanus*, except that freshly felled timber is susceptible to pinhole borers.

Diseases

A disease of unknown etiology, affecting the heartwood of *G. bancanus* and *G. macrophyllus,* is known to produce 'garrowood', a highly valued resinous product used in perfumery (Sumadiwangsa 1997). Although garrowood produced by *Aquilaria* spp. is the most highly prized, *Gonystylus* also shows potential. Except for this 'beneficial disease', no other disease is known.

Threat assessment

Gonystylus bancanus appears to be free of pests and diseases, but the plantation history is too short to become complacent. Continued monitoring is necessary.

4.13. *Koompassia* species

Indonesian common name: Kempas

The leguminous *Koompassia* spp. are characteristic associates of dipterocarp forests in the lowlands and lower hills. The three Indonesian species are *Koompassia excelsa* and *K. malaccensis* in Sumatra and Kalimantan and *K. grandiflora* in Irian Jaya. The dominant *Koompassia* trees in the upper storey are well known for sustaining the combs of the wild honeybee, *Apis dorsata*. The timber is durable and is used for a variety of purposes, including railway sleepers, flooring and furniture. *Koompassia* spp. in natural forests are now protected from cutting and the Ministry of Forestry and Estate Crops is encouraging the forest concessionaires to raise plantations of these species. Plantations have been established in Central Kalimantan.

Insect pests

No information is available on pests of the living tree.

Diseases

No information is available on diseases of the living tree.

Threat assessment

Koompassia spp. appear to be free of pests and diseases but the plantation history is too short to draw valid conclusions.

4.14. *Maesopsis eminii*

Indonesian common name: Kayu afrika, Misopsis

Maesopsis eminii (Rhamnaceae), a native of tropical Africa, was introduced into Java in 1920s and grown in home gardens. It has a light, general-purpose timber. Plantations have been raised in Sumatra.

Insect pests

No insect pests have been recorded.

Diseases

No diseases have been recorded.

Threat assessment

In Uganda, a canker, caused by *Fusarium solani* was described in young trees growing stunted in poor soil (Schabel and Latiff 1993). There is no threat of pests and diseases to this species that has been grown successfully for a long time in agroforestry systems in Java.

4.15. Mangrove species

Indonesian common name: Mangrove

Natural mangrove forests are common along the very long Indonesian coastline. Plantations have been raised mainly to restore the natural vegetation in heavily degraded areas, to prevent coastal erosion, to facilitate coastal fisheries and to protect swamps. The commonly planted species are in the genera *Avicennia, Bruguiera, Rhizophora* and *Sonneratia*. Large plantations have been raised only in Java, while local people have undertaken small-scale planting in Bali and other places. Nearly 50 000 ha of plantations of *Rhizophora* spp. have been established in West and Central Java (Perum Perhutani 1995).

Insect pests

The most common pests of mangroves in Indonesia are scale insects that attach themselves to the shoots and feed on the plant sap, often causing the leaves to wilt. Two species have been recorded: *Chionaspis* sp. (Intari 1997) and *Aulacaspis marina* (Takagi and Williams 1998) (Table 4.7). The stem borer, *Zeuzera conferta* (Lepidoptera, Cossidae) and the twig borer, *Xyleborus* sp. (Coleoptera, Scolytidae) occur and in combination often infest nearly 50% of stems of *Avicennia* spp. (Hardi 1997). Other pests, noted occasionally, include an unidentified leaf-feeding beetle, which damaged up to 80% of 3-month-old seedlings (Intari 1986) and the bagworms, *Acanthopsyche* sp. (Intari 1982) and *Pteroma plagiophleps* (Sitepu and Suharti 1998). A notable, non-insect pest is the crab, *Sesarma* sp. that cuts off the tops of seedlings in the nursery and new outplantings, often causing considerable mortality (Intari 1988).

Table 4.7. Insect pests of mangroves in Indonesia

Type of damage	Scientific name	Common name	Tree species affected	Notes
Sap sucking	*Chionaspis* sp. (Homoptera, Coccoidea, Diaspididae)	Scale insect	*Rhizophora* spp. and *Bruguiera gymnorhiza*	
	Aulacaspis marina (Homoptera, Coccoidea, Diaspididae)	Scale insect	*Rhizophora* spp.	
Leaf feeding	Unidentified beetle (Coleoptera)	Beetle	*Bruguiera* spp.	On seedlings
	Pteroma plagiophleps (Lepidoptera, Psychidae)	Bagworm	*Rhizophora* spp.	
	Acanthopsyche sp. (Lepidoptera, Psychidae)	Bagworm	*Bruguiera* sp.	
Stem boring	*Zeuzera conferta* (Lepidoptera, Cossidae)	Beehole borer	*Avicennia* sp. and *Rhizophora* spp.	Stem borer
	Xyleborus spp. (Coleoptera, Scolytidae)	Scolytid borer	*Avicennia* sp. and *Rhizophora* spp.	Twig borer

Threat assessment

Among the insect pests in Indonesia, the borer, *Z. conferta*, has also been recognised as a pest of mangroves in Bangladesh (Chowdhury 1996). Most pests recorded affect the establishment stage and have seriously threatened the cultivation of mangroves. *Rhizophora* spp. have been grown successfully in Java for a long time. Defoliation during every summer, as occurs in *Avicennia marina* in Hong Kong (Anderson and Lee 1995), is rare. There are occasional defoliator outbreaks in natural stands of mangroves. In 1983, 500-1000 ha of an almost pure stand of *Excoecaria agallocha* (Euphorbiacae) was mass defoliated by caterpillars of *Ophiusa melicerta* (syn. *Achaea janata*) (Lepidoptera, Noctuidae) in North Sumatra (Whitten and Damanik 1986). Other such outbreaks include mass defoliation of the same species by *Achaea serva* (Lepidoptera, Noctuidae) in central Queensland, Australia (McKillup and McKillup 1997); of *Avicennia alba* by larvae of *Cleora injectaria* (Lepidoptera, Geometridae) in Thailand (Piyakarnchana 1981); and of *A. marina* by *Hyblaea puera* (Lepidoptera, Noctuidae) in India (Anonymous 1996). These outbreaks are occasional events and are not a threat to mangrove plantations, particularly as the trees are not killed by defoliation.

The only serious disease reported from the tropics is top death of *Heritiera fomes* over extensive areas of the mangrove forests of Sunderbans in Bangladesh (Rahman 1996), the etiology of which is not fully understood although some fungi and bacteria were implicated. There is no threat of diseases to mangrove plantations in Indonesia.

4.16. *Melaleuca cajuputi*

Indonesian common name: Kayu putih

Melaleuca cajuputi, formerly known as *M. leucodendron* (Myrtaceae) (Blake 1968; Turnbull 1986), is native to Indonesia and planted in Java and Buru island in the Moluccas, particularly in degraded areas. It yields cajuput oil, which is distilled from the leaves. There are about 11 800 ha of plantations in the three provinces of Java (Perum Perhutani 1995).

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 1979; Intari and Wiriadinata 1984). Insecticidal treatments have been standardised for control. Among non-insect pests, a mite causes leaf gall.

Diseases
No disease has been encountered.

Threat assessment
Melaleuca cajuputi (as *M. leucodendron*) has been cultivated successfully in Indonesia for a long time. Apart from the subterranean termites that can be controlled effectively by soil treatment with suitable insecticides, there is no major threat of pests and diseases. The leaves contain chemical components that act as a feeding repellent to some insects (Doskotch *et al*. 1980; Alonso *et al*. 1996).

4.17. *Ochroma pyramidale*

Indonesian common name: Balsa

Ochroma pyramidale (syn. *O. lagopus*; *O. grandiflora*) (Bombacaceae) has been planted in small areas in Indonesia, particularly, Java. A typical pioneering species native to Central and South America (Wiselius 1998), it has been planted mainly in degraded lands in Java and plantations are being established in Central Kalimantan.

Insect pests
The red borer, *Zeuzera coffeae* (Lepidoptera, Cossidae) has been reported in a plantation 1.5 years old in Java (Wiselius 1998). This moth caterpillar is known to attack coffee, tea, cinchona and a few other small trees. The larvae bore into woody stems and branches and make a longitudinal tunnel along the pith, often causing death of the distal part of the branch. In most species it has not been a serious threat. No other pest has been noted on this species in Indonesia.

Diseases
No disease of *O. pyramidale* has been reported from Indonesia.

Threat assessment
Pests of *O. pyramidale*, recorded outside Indonesia, include a shoot borer, *Anadasmus porinodus* (Lepidoptera, Stenomidae) in Costa Rica (Becker 1974) and a leaf roller, *Sylepta derogata* (Lepidoptera, Pyralidae), a common pest of malvaceous plants, in Kerala, India (Mathew 1980). All the known pests, including *Z. coffeae* in Indonesia, are polyphagous insects and there is no major threat to plantations of *O. pyramidale* in Indonesia.

Diseases recorded outside Indonesia include a brown root rot in areas previously planted with cocoa in Papua New Guinea, caused by *Phellinus noxius* (Dennis 1992); a bark canker in Ecuador, with which the hyphomycetes fungus *Stilbella ecuadorensis* was associated (Morgan *et al*. 1991); and a die-back in Kerala, India with which the fungi, *Calonectria rigidiuscula* and *Fusarium moniliformae* were associated (Sharma *et al*. 1985). However, there is no threat of disease in Indonesia where the tree has been grown successfully for a considerable time.

4.18. *Octomeles sumatrana*

Common name in Indonesia: Benuang

Octomeles sumatrana (Datiscaceae) occurs naturally in Indonesia, except in Java and Nusa Tenggara (Fundter *et al*. 1997). It is fast growing and produces a light timber which is used for indoor construction. Plantations are being raised in Sumatra under the HTI scheme.

Insect pests
The leaves are attacked by a moth caterpillar, *Characoma* sp. (Fundter *et al*. 1997). No information is available on the seriousness of damage.

Diseases
No diseases are known.

Threat assessment
No reliable judgment can be made as the plantation history is so short.

4.19. *Paraserianthes falcataria*

Indonesian common name: Sengon laut

Paraserianthes falcataria (Leguminosae) is an exceptionally fast growing tree, native to the eastern islands of the Indonesian archipelago and New Guinea. It is widely planted in Indonesia, in industrial plantations in Java, Sumatra, Kalimantan, Sulawesi, Nusa Tenggara and Moluccas (Fig. 2.1), and in smallholder plantations in Java. The rotation period is usually 8 years. The area of large and small plantations has increased steadily over recent years. Wood from industrial plantations is used for pulp, whereas that from smallholder plantations has a variety of uses, including chopsticks, packing cases and furniture for local use.

Insect pests

The major pests recorded on *P. falcataria* are listed in Table 4.8. The most notable is *Xystrocera festiva* (Coleoptera, Cerambycidae), which is becoming more serious as the area planted to the host increases. First reported in 1897 (Hardi *et al.* 1996), it is present in most areas where *P. falcataria* is grown in Indonesia, although most reports are from Java and Sumatra. In 1990 it was not noted in trial plantations in South Kalimantan (Selander 1990) although Ngatiman and Tangketasik (1987) detected it in East Kalimantan. 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 Kasno and Husaeni (1998) 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 trees 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 (Kasno and Husaeni 1998). 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 standardised and field effectiveness of parasitoid release demonstrated. Further research is also needed to standardise 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. Repeated heavy infestations may result in tree dieback. A 5-year-old plantation in South Sumatra had a severe attack from 1994 to 1997 (Zulfiah 1998).

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. Severe defoliation occurs occasionally in Java, Sumatra, Kalimantan and Sulawesi (Tikupadang *et al*. 1993; Irianto *et al*. 1997; Suhendi and Sembiring 1998). Although heavy defoliation may cause dieback of branches (Irianto *et al*. 1997), the infestation is usually transient and the damage not serious.

Other minor pests reported on *P. falcataria* include a few species of scarabaeid beetles whose larvae feed on the roots of saplings, the bark feeding caterpillar, *Indarbela quadrinotata*, the twig borer, *Xylosandrus morigerus* (Tikupadang *et al*. 1993) (Table 4.8), and other polyphagous, occasional feeders.

Diseases

Damping-off caused by *Pythium, Phytophthora* and *Rhizoctonia* spp. is common in nurseries (Table 4.9). Anthracnose disease, characterised by sudden death of the seedlings and caused by *Colletotrichum* sp., has been reported (Kobayashi and Zinno 1984). Root rot disease caused by *Botryodiplodia* sp. occurs in young plantations in South Kalimantan and Jambi, Sumatra (Anggraeni and Suharti 1997). Older trees are attacked by root rot fungi of the genera, *Ganoderma* (Widyastuti *et al*. 2000) *Ustulina* and *Rosellinia*. 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 any major disease.

Table 4.9. Diseases of *Paraserianthes falcataria* in Indonesia

Disease	Causative agent	Notes
Damping-off	*Pythium* sp. *Phytophthora* sp. *Rhizoctonia* sp.	On seedlings
Anthracnose disease	*Colletotrichum* sp.	On seedlings
Root rot	*Botryodiplodia* sp.	On young trees
	Ganoderma sp. *Ustulina* sp. *Rosellinia* sp.	On older trees

Table 4.8. Insect pests of *Paraserianthes falcataria* in Indonesia

Type of damage	Scientific name	Common name	Notes
Trunk boring	*Xystrocera festiva* (Coleoptera, Cerambycidae)	Sengon borer (albizia borer)	Serious pest
	X. globosa	-	Minor pest
Leaf feeding	*Pteroma plagiophleps* (Lepidoptera, Psychidae)	Small bagworm	Occasionally serious; feeds also on bark surface
	Eurema blanda (Lepidoptera, Pieridae)	Yellow butterfly caterpillar	Sporadic
Root feeding	Several species (Coleoptera, Scarabaeidae)	White grubs	On saplings
Bark feeding	*Indarbela quadrinotata* (Lepidoptera, Indarbelidae)	Bark caterpillar	
Twig boring	*Xylosandrus morigerus* (Coleoptera, Scolytidae)	Scolytid beetle	

Threat Assessment

The borer *X. festiva* is a major threat to *P. falcataria* plantations in Indonesia. Regular surveillance and removal of infested trees reduces the incidence of attack but extension efforts to promote this method and further research to develop improved control techniques are needed. It is a serious pest of *P. falcataria* plantations in Malaysia but not in the rest of tropical Asia. The bagworm, *Pteroma plagiophleps* and the yellow butterfly, *Eurema* spp. are widespread pests with the bagworm potentially capable of causing serious damage in endemic patches of infestation. In Kerala, India, it caused dieback and death of trees in patches where repeated defoliation occurred (Nair and Mathew 1992). Vigilance is necessary against this insect, particularly because it infests many other tree species in Indonesia, facilitating build up to high population levels. Appropriate management methods need to be developed. The yellow butterfly is also capable of causing sporadic, locally widespread defoliation, but since the impact is not serious, it is not a major threat to plantations. Other pests are of minor significance.

Nursery diseases can be managed effectively. Root rot is generally not a serious problem, except in trees older than 10 years, and is not a threat to plantations managed on shorter rotations. Dieback caused by *Botryodiplodia theobromae* has been noted in Kerala, India, but bark injury caused by fire or other agencies is considered to be a predisposing factor (Sharma and Sankaran 1988). In the Philippines, canker caused by *Corticium salmonicolor* is a common problem, but its impact is not serious (Anino 1990). Thus diseases do not appear to be a threat to *P. falcataria* plantations in Indonesia. The problems with *Botryodiplodia* and *Corticium* spp. in other countries may be due to a narrow genetic base of the host where *P. falcataria* is an introduced species.

4.20. *Peronema canescens*

Indonesian common name: Sungkai

Peronema canescens (Verbenaceae) belongs to a monotypic genus indigenous to Indonesia (Kalimantan and Sumatra) and Malaysia. Often called "jati sabrang" (teak across Java) it yields high quality timber, almost comparable to teak, used for furniture and decorative veneers. It is being planted extensively in Sumatra, Kalimantan and West Java and it is also popular as a border tree in private holdings in Java. It is highly valued for construction timber because it grows faster than teak.

Insect Pests

An unidentified shoot-boring insect causes deformation of young trees (Graaf *et al.* 1993). The nymphs of an unidentified bug, *Clovia* sp. (Homoptera, 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). There has been moderate defoliation of *P. canescens* by an unknown insect (Selander 1990).

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).

Threat Assessment

There appears to be no threat of pests or diseases, but the plantation history is too short to arrive at valid conclusions.

4.21. *Pinus merkusii*

Indonesian common name: Tusam

The tropical pine, *Pinus merkusii* (Pinaceae), occurs naturally in the mountains of northern Sumatra. It has been planted widely in Indonesia for afforestation and protection of watersheds since the 1960s. It yields a general-purpose timber but most plantations were for pulpwood production. The estimated area of pine plantations in Indonesia is 700 000 ha (Nambiar *et al*. 1998). It is planted in Aceh, North Sumatra and in West, Central, and East Java. Java has about 584 000 ha of plantations that are tapped for resin (Perum Perhutani 1995).

Insect pests

There are three main pests of *P. merkusii* in Indonesia (Table 4.10). The most damaging is the tusam pitch moth, *Dioryctria rubella* (Lepidoptera, Pyralidae).

Table 4.10. Insect pests of *Pinus merkusii* in Indonesia

Type of damage	Scientific name	Common name	Notes
Shoot and stem boring	*Dioryctria rubella* (Lepidoptera, Pyralidae)	Tusam pitch moth	Causes shoot die-back and stem distortion
Foliage feeding	*Miliona basalis* (Lepidoptera, Geometridae)	Pine looper	
	Nesodiprion biremis (Hymenoptera, Diprionidae)	Pine sawfly	
	Several species (Lepidoptera, Psychidae)	Bagworms	Generally, minor pests, but outbreaks known in natural stands
Root feeding	Several species (Coleoptera, Scarabaeidae)	White grubs	On roots of saplings
	Coptotermes sp. (Isoptera, Rhinotermitidae)	Termites	Feeds on root collar

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 upto 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 1987b). There is no effective control method against this pest.

The pine looper, *Miliona basalis* (Lepidoptera, Geometridae) feeds on the needles and most damage is to 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 1987b). Sporadic outbreaks have continued in the 1970s and 1980s (Mangundikoro and Depari 1958; Husaeni 1993). 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 1987b). 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*.1991) 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 (see Section 3.1).

Diseases

Damping-off, caused by several species of fungi (Table 4.11) is a serious problem in nurseries. Fortnightly spraying of Propanocarb and Captanol effectively control them (Ibnu and Supriana 1987). Soil treatment with Captanol, Captan or Manzzeb also controlled the problem (Suharti 1988). The fruit extract of *Xylocarpus granatum* had antifungal activity against damping-off (Widyastuti 1996; Widyastuti *et al*. 1999). Leaf blight caused by *Cladiospora* sp. causes the death of up to 70% of seedlings in nurseries in Central Java (Sumardi and Widyastuti unpublished); and similar disease symptoms have been noted in the central pine nursery in North Sumatra.

Threat assessment

Pine shoot moths are important pests of tropical pines in Southeast Asia, particularly of young plantations. *Dioryctria rubella* in the Philippines attacks *Pinus caribaea, P. kesiya* and *P. merkusii* (Lapis 1987),

Table 4.11. Diseases of *Pinus merksii* in Indonesia

Disease	Causative agent	Notes
Damping-off	*Pythium* sp. *Fusarium* sp. *Rhizoctonia* sp.	On seedlings
Blight	*Cladiospora* sp.	On seedlings
Root rot	*Botryodiplodia* sp.	Rare incidence in nurseries in Java

D. abietella and *D. sylvestrella* infest *P. merkusii* in Thailand (Hutacharern 1978) and *D. castanea* damages *P. kesiya* in Northern India (Singh *et al*. 1988). Other shoot borers (*Rhyaciona* and *Petrovia* spp.) also occur in the Philippines and Thailand. Since there is no effective method to control this pest, the shoot borer continues to be a threat to pine plantations in Sumatra. It does not occur in Java, possibly because it can survive only in higher latitudes.

Milionia basalis and *Nesodiprion beremis* are also confined to Sumatra. *Nesodiprion beremis*, which is not a serious pest in Indonesia, occurs in Thailand (Hutcharern 1978) but, in general, they are replaced by other species of defoliators (*Dendrolimus*, *Neodiprion*) in more Northern latitudes. The three main pests, *D. rubella, M. basalis* and *N. beremis*, are confined to Northern Sumatra. This suggests there is scope for expanding pine plantations to the higher altitudes of lower latitudes in Indonesia without the risk of major pests. Other pests such as root grubs and termites, which are more prevalent in lower latitudes, can be managed effectively and therefore are of little economic significance. Bark beetles (Scolytidae), which can infest the trees in large numbers and kill them, are major pests of pines in temperate climates. One species, *Ips calligraphus* has been recorded on *P. merkusii* in Jamaica (Garraway 1986). Bark beetles thrive mainly on freshly cut logs and weak trees. As pine plantations extend to poorer sites, vigilance is needed to detect any new pests.

Diseases are not a major threat to pine plantations in Indonesia, as the nursery diseases are manageable.

4.22. *Schleichera oleosa*

Indonesian common name: Kesambi

Schleichera oleosa (Sapindaceae) is an introduced species that is naturalised in many parts of Indonesia. There are about 3700 ha, mainly in East Java, planted for lac production (Perum Perhutani 1995).

Insect pests

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

Diseases

No diseases have been reported from Indonesia although some are known in India.

Threat assessment

There is no threat of pests and diseases to *S. oleosa* in Indonesia.

4.23. *Swietenia macrophylla*

Indonesian common name: Mahoni

Swietenia macrophylla (Meliaceae), commonly called mahogany, is a fairly fast-growing species native to tropical America. It is widely planted across the tropics for its high quality wood that is used for furniture and cabinet making. There are over 54 000 ha of plantations in Indonesia, mainly in West Java (Perum Perhutani 1995). Plantation trials are under way at Pulau Laut, South Kalimantan.

Insect pests

In common with many other countries, infestation by the shoot borer, *Hypsipyla robusta* (Lepidoptera, Pyralidae) has limited 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. Young trees 3-6 years old and 2-8 m tall are the most heavily attacked (Morgan and Suratmo 1976), a finding supported by Suratmo (1977) who observed about

90% of 3-year-old trees (2.5 m tall) were infested but only 5% of trees 14 years old and 13 m tall. 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*. 1997), and interplanting neem, *Azadirachta indica*, with mahogany in uneven admixture reduced shoot borer attack (Suharti *et al*. 1995). 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. *Xyleborus morstatti*) (Coleoptera, Scolytidae) lays eggs in galleries in the stems of seedlings in the nursery leading to their collapse (Suratmo 1982; Natawiria 1990; Suharti and Sitepu 1997; Sitepu and Suharti 1998). It also infests living twigs and branches of older trees (Mayhew and Newton 1998). This species also damages mahogany seedlings in Sri Lanka and Thailand. 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).

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. About 40% of trees have been affected in some patches of *S. macrophylla* stands in Purwodadi forest district, Central Java (Sumardi and Widyastuti unpublished). There are no other major diseases, although occurrence of the root rot pathogens, *Armillaria mellea* and *Phellinus noxius* has been reported (Mayhew and Newton 1998).

Threat assessment

The shoot borer is the major threat to cultivation of mahogany worldwide, with the related species, *Hypsipyla grandella* replacing *H. robusta*, in the Latin American tropics. Although older trees are not attacked, many plantation programmes have been abandoned due to damage during the establishment stage. Development of practical control methods using strategies such as chemical application, insect parasitoids and shade regulation have been unsuccessful. The use of deterrent trees is being tested. Recently, the Australian Centre for International Agricultural Research has supported international cooperation to find a solution to this vexing problem.

The shoot borer does not occur in Fiji, but ambrosia beetle and termites have taken a heavy toll of *S. macrophylla* plantations there. Three species, *Neotermes papua*, *N. samoanus* and an unidentified *Neotermes* sp. infest living trees aged 2 years and older (Kamath *et al*. 1996). They hollow out the trees from within the trunk and older infestations become manifested as gentle to heavy swellings on the trunk. On an average, 7% of trees in plantations are infested. This attack is similar to that of *Neotermes* sp. on teak in Indonesia. Vigilance is necessary to detect signs of termite infestation of mahogany in Indonesia.

Two endemic species of ambrosia beetles (*Crossotarsus externe-dentatus* and *Platypus gerstaeckeri*) also infest trees older than 6-8 years in Fiji. Such attacks appear to be related to poor tree health. Monitoring the possible build up of *Xylosandrus compactus*, which infests twigs of older mahogany trees in Indonesia, in trees of poor health is needed.

The only serious disease is the unidentified pathogen spread through flowing water which results in the death of trees. Research is needed to determine the etiology of this disease. In this context, it is interesting to note that the fungus, *Phytophthora cinnamomi*, causing a serious root disease in *Eucalyptus marginata* and other trees in Australia, can disperse through flowing subsurface water in lateritic soil on hill slopes (Kinal *et al*. 1993).

4.24. *Tectona grandis*

Indonesian common name: Jati

Teak, *Tectona grandis* (Verbenaceae), was probably introduced to Java 400-600 years ago from India. It is now naturalised and occurs over extensive areas in Java and Muna Island in Southeast Sulawesi. It produces one of the finest of tropical timbers that is in high demand for a variety of purposes, from building bee hives to ships. Plantation forestry in Java is dominated by teak, with about 1 million ha making up about 55% of all its forest plantations. The plantations are in East Java (570 000 ha), Central Java (312 000 ha) and West Java (185 000 ha). Some plantations exist also in Southeast Sulawesi. Indonesia has a long tradition in teak plantation management and supplies a significant proportion of teak timber in world trade. Teak is managed on a 60-year rotation and plantations are usually established by direct seeding in a taungya system. Recently, a small area of plantations has been established with rooted cuttings and tissue cultured plantlets from selected clones. Experimental teak plantations have been established in Kalimantan and it appears that although the teak grows faster it does not produce good quality wood.

Insect Pests

There are three well-known pests of teak in Indonesia (Table 4.12). 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. The teak defoliator is a migrant pest, with shifting foci of high-density infestations during the early outbreak period, which coincides with pre-monsoon rains (Nair 1988). This is followed by widespread infestation and sudden disappearance of the pest population. The dynamics of infestation are similar to Indian infestations (Kalshoven 1953), but detailed studies are lacking. In Indian teak plantations *H. puera* causes substantial loss of growth increment (Nair *et al* 1996).

The teak leaf skeletoniser *Eutectona machaeralis* (syn. *Hapalia machaeralis, Pyrausta machaeralis*) (Lepidoptera, Pyralidae) is also present in plantations in Java (Suratmo 1987). This caterpillar feeds on the leaves, leaving the major veins intact, hence the name, 'skeletoniser'. Intachat (1998) identified the species in Indonesia, Malaysia and probably Thailand as *Paliga*

Table 4.12. Insect pests of teak in Indonesia

Type of damage	Scientific name	Common name	Notes
Leaf feeding	*Hyblaea puera* (Lepidoptera, Hyblaeidae)	Teak defoliator	
	Paliga damastesalis (Lepidoptera, Pyralidae)	Teak leaf skeletonizer	Earlier known as *Eutectona, Pyrausta* or *Hapalia machaeralis*
	Valanga nigricornis (Orthoptera, Acrididae)	Grasshopper	
Trunk/stem boring	*Neotermes tectonae* (Isoptera, Kalotermitidae)	Inger-inger	Unique pest of teak in Indonesia
	Xyleutes ceramica (Lepidoptera, Cossidae)	Beehole borer	
	Xyleborus destruens (Coleoptera, Scolytidae)	Ambrosia beetle	Minor pest
	Zeuzera coffeae (Lepidoptera, Cossidae)	Red borer	On saplings

damastesalis, as distinct from *Eutectona machaeralis* present in India, although it has similar habits. She also suggests that the correct nomenclature of *Eutectona machaeralis* is *Paliga machoeralis.* Kalshoven (1953) mentions that although present in Java, it does not attack teak, but other authors list it as a major pest of teak in Java (Natawiria and Tarumingkeng 1971; Mieke 1994; Suratmo 1996; Suharti and Sitepu 1997; Sitepu and Suharti 1998). Little primary data is available on the frequency and intensity of its attack in Java. In India, outbreaks of teak leaf skeletoniser occur during the latter part of the growth season in most years when the leaves are old, and so its impact is negligible (Nair *et al.* 1996).

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. It is a serious problem in Central and East Java (Intari 1990) and various aspects have been studied. 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; Subyanto *et al.* 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 and Amir 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 1953) 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 red borer, *Zeuzera coffeae*, has infested a small proportion of saplings in an 18-month-old teak plantation at Kendal, Boja Forest District, Central Java (K.S.S. Nair and Sumardi unpublished observation). This plantation was intercropped with corn and other agricultural crops under the taungya system. The grasshopper, *Valanga nigricornis* (Orthoptera, Acrididae) causes sporadic defoliation and white grubs damage seedlings in nurseries.

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). 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.

Threat assessment

Teak has been grown successfully in Java for over a century and there is no threat of pests or diseases that will ruin teak plantations. The most acknowledged problem is the trunk-infesting termite, *Neotermes tectonae*, unique to teak in Indonesia. It causes economic loss due to degradation of the timber. It is mostly confined to some endemic patches, particularly in Central Java and is kept under reasonable control by thinning operations. The impact, in terms of growth loss, caused by the teak defoliator, *Hyblaea puera,* is not fully recognised because the loss is not visible. Although its control is still not feasible except in young plantations, it is necessary to gather information on its prevalence and impact in Java. Other pests are of little consequence. Information is also needed on the prevalence and seasonal incidence of the teak skeletoniser, *Paliga damastesalis.*

Teak is becoming popular in the agroforestry systems in Indonesia because of the availability of fast growing, tissue-cultured clones and high returns from planting in homesteads. Problems experienced in taungya system under forest plantations will become important in the homestead agroforestry systems. This will include bacterial root wilt, pink disease, red borer and the teak defoliator.

Chapter 5

General Conclusions

K.S.S. Nair and Sumardi

Indonesian forests are in a state of transition (see Chapter 2). The rate of conversion of natural forests to plantations in recent years has been faster than ever before. There is rapid expansion of plantations of new, fast-growing species in the outer islands while traditional, slow-growing timber species like teak, pine and *Agathis* continue to be grown in Java. One species, *Acacia mangium,* accounts for 64% of the area planted in recent times (Chapter 2, Table 2.6). *Paraserianthes falcataria* occupies 7% of the area followed by *Gmelina arborea* and eucalypts. *Paraserianthes falcataria* is being expanded on private lands in Java with support by various Government agroforestry promotion schemes. Plantation development is taking place in a qualitatively different direction than previously. Although there is a choice for selection from among several species, including some indigenous species recommended under the HTI scheme, growers choose the few species listed above. This is mainly because the emphasis is on fast-growing trees suitable for pulpwood, and more information is available on silviculture, growth performance and suitability for pulping of these species.

Risk of pest and disease damage should be an important criterion for selection of species for large-scale planting, but this is seldom done in practice, because the plantation industry cannot wait for scientists to provide the necessary database to make foolproof choices. Scientific method relies on observational and experimental data that are acquired over a long period. Even then, there are many uncertainties regarding the conditions under which pest and disease problems may develop. However, an attempt has been made here to review existing information and to predict the future risk of pests and diseases in Indonesian forest plantations. There is unavoidable risk in making these judgements but this is typical of many real life situations where decisions must be made without sufficient data. In fact, the plantation companies have already taken the risk. The conclusions drawn here should be taken only as a broad guideline.

5.1. Summary of present problems and future threats

The risk associated with each species has been discussed in Chapter 4. What is attempted here is a summary and analysis of general features. The species fall into two categories: those that have been grown in Indonesia for a long time and those that are new.

Long-standing plantation species

Species grown in Java are in this category. Risk assessments for these species is easier because we have the benefit of experience. The species and a summary of their present pest and disease problems, and future risk is given in Table 5.1.

There is no serious disease problem other than manageable nursery diseases among the ten species grown over a longer period. Serious insect pest problems exist for *Paraserianthes falcataria, Swietenia macrophylla* and *Tectona grandis* and they cause economic loss, although this is not generally recognised in the case of teak. Unfortunately, there is no effective control method yet for any of these pests. There are also localised problems such as the pine shoot borer in Sumatra, ambrosia beetle of teak in

Table 5.1. Summary of pest and disease problems for long-standing plantation species

Tree species	Category	Current major problem	Future threat
Agathis dammara	Pest	None	None
	Disease	None	None
Dalbergia latifolia	Pest	None	None
	Disease	None	None
Mangroves (mainly *Rhizophora*)	Pest	None	None
	Disease	None	None
Maesopsis eminii	Pest	None	None
	Disease	None	None
Melaleuca cajuputi	Pest	None	None
	Disease	None	None
Paraserianthes falcataria	Pest	1. Trunk borer (*Xystrocera festiva*) 2. Defoliator (*Pteroma plagiophleps*)	1. Trunk borer (*Xystrocera festiva*) 2. Defoliator (*Pteroma plagiophleps*)
	Disease	None	None
Pinus merkusii	Pest	None in Java Shoot borer (*Dioryctria rubella*) in Sumatra	None in Java Shoot borer (*Dioryctria rubella*) in Sumatra
	Disease	None	None
Schleichera oleosa	Pest	None	None
	Disease	None	None
Swietenia macrophylla	Pest	Shoot borer (*Hypsipyla robusta*)	Shoot borer (*Hypsipyla robusta*)
	Disease	None	None
Tectona grandis	Pest	Defoliator (*Hyblaea puera*)	Defoliator (*Hyblaea puera*)
	Disease	None	None

areas not subject to seasonal drought, and wilt of *Dalbergia* in some areas. Avoiding planting in risky areas can circumvent these, although in the case of pine, it is not feasible to avoid planting it in its native range in Sumatra.

New plantation species

The risks to the new species are presented in Table 5.2. No major problem has so far been experienced in these 14 species, but there are indications of impending problems, such as root rot in *Eucalyptus* spp. and root

Table 5.2. Summary of pest and disease problems for new plantation species

Tree species	Category	Current major problem	Future threat
Acacia mangium and other *Acacia* spp.	Pest	None	*Helopeltis*, unpredictable caterpillar outbreak
	Disease	None	Root rot, Heart rot of stem
Alstonia spp.	Pest	None	Unpredictable
	Disease	None	None
Anthocephalus sp.	Pest	None	Unpredictable
	Disease	None	None
Azadirachta excelsa	Pest	None	None
	Disease	None	None
Dipterocarps	Pest	None	None
	Disease	None	None
Dyera spp.	Pest	None	None
	Disease	None	None
Eucalyptus spp.	Pest	None	None
	Disease	None	Root rot
Eusideroxylon zwageri	Pest	None	None
	Disease	None	None
Gmelina arborea	Pest	None	Unpredictable
	Disease	None	None
Gonystylus bancanus	Pest	None	Unpredictable
	Disease	None	None
Koompassia spp.	Pest	None	None
	Disease	None	None
Ochroma pyramidale	Pest	None	None
	Disease	None	None
Octomeles sumatrana	Pest	None	None
	Disease	None	None
Peronema canescens	Pest	None	None
	Disease	None	None

and stem rot in *Acacia mangium*. Other potential threats are less obvious. *Eucalyptus* spp.and *Acacia mangium* have been grown in Indonesia over fairly large area for a longer period than other species in this group. Many pest problems develop over a long period, facilitated by favourable conditions provided by extensive monocultures. Therefore, the risk of pests and diseases for most species in this group is unpredictable. Experience with large monocultures of the same species in other countries can provide some pointers to the potential problems, although this is not fully dependable. For example, *Pinus merkusii* is plagued by shoot borer in Philippines, Thailand, Vietnam, India and Northern Sumatra, but not in Java. We have the advantage of such experience in the case of *Eucalyptus* spp., *Gmelina arborea* and to some extent, *Acacia mangium.*

Eucalypts have been generally pest free, except for subterranean termites attacking the tap root during the establishment stage. Diseases create problems in nursery, but are manageable. *Eucalyptus* spp. are susceptible to foliar diseases caused by fungi in humid environments, but selection of resistant species and provenances has circumvented this problem. In Indonesia, some species e.g. *E. urophylla*, have been found to be susceptible to root rot but others e.g. *E. pellita*, are less so. These problems have led to the present trend in Indonesia is to replace *Eucalyptus* spp. with *Acacia*.spp.

Gmelina arborea, except for minor problems with a stem borer, is currently pest free in Indonesia, as in many other countries where it has been planted as an exotic, but the situation needs monitoring, as it suffers from serious pests in its native range. Some companies are now enlarging the area under *Gmelina arborea*, in place of *Acacia mangium*, although it requires more fertile sites than the acacia.

Acacia mangium suffered a heart-rot problem which threatened to proliferate in Malaysia, but it is being kept in check by enlarging the genetic base of planting stock and by planting the heart rot resistant hybrid, *A. mangium* x *A. auriculiformis*. It has been suggested that the heart and root rot problems are the result of mismatching of the species with the sites, with the absence of a seasonal dry spell facilitating the development of the diseases (Arentz 1996; Lee and Arentz 1997). The situation therefore needs monitoring. Although there are no serious insect pest problems at present, the situation also needs attention, in view of the potential threat of the mosquito bug, *Helopeltis* spp. becoming adapted as more of the Indonesian landscape is planted with *A. mangium*. There is also the treat of unpredictable caterpillar outbreaks, as indicated by some instances in Malaysia.

In the case of other new species, most of which are indigenous, there are no serious pest or disease problems, at present. For some of them, limited experience in other countries or the chemical profile of the species (e.g. *Azadirachta* spp.) suggests that there is little risk (Table 5.2) but for others the risk is unpredictable.

Future most important pests and diseases

If one insect pest is to be named as the most dangerous to Indonesian forest plantations in future, the choice will undoubtedly fall on the sengon borer, *Xystrocera festiva*. Its population is likely to increase further as more area is brought under *P. falcataria* all across Indonesia due to its promotion by industrial and agroforestry plantation initiatives. *Xystrocera festiva* has a number of alternative hosts, in the family Leguminosae, including *Albizia* spp. and *Acacia* spp. Although *A. mangium* is not a favoured host of *X. festiva*, its expansion may also help to increase *X. festiva* population. This borer seems to be well-adapted to Indonesia as it is replaced in neighbouring countries by *X. globosa*, a species also present in low numbers in Indonesia.

Another insect likely to build up in future is *Helopeltis*. Many closely related species of *Helopeltis* are important pests of horticultural plantations in the tropics and populations have been increasing in young *A. mangium* plantations, particularly in Sumatra (see Section 4.1). It has a history of outbreaks in cashew, tea and neem in India and in tea and *Eucalyptus* spp. in Sumatra. Care must be exercised to prevent the build up of *Helopeltis* species.

Good quality timber will remain in demand despite of the present emphasis on pulpwood species. Improvements in machinery and utilisation methods will enable smaller dimension timbers to be used

increasingly. Teak, *Shorea* spp. and *Peronema* sp. are likely to fill this need. The teak defoliator and the emerging pests of *Shorea* spp. and *Peronema* sp. may require attention in future.

The most prevalent diseases for most tree species are caused by a host of fungal pathogens in the nursery. Fortunately, they can be kept under control by suitable practices and need-based use of selected fungicides. The most serious threat is the spread of root rot caused by several species of fungi. They will assume greater importance as the disease inoculum builds up on sites where there are consecutive rotations of the same species.

Indigenous versus exotic tree species

The question is often raised whether exotic tree species are at greater risk of pest and disease outbreaks. It is difficult to offer a simple answer and designating a species as exotic is a matter of definition (see Section 3.3). If we accept the narrow definition, based on the boundaries of the larger island groups than the country, most species currently grown extensively in Indonesia are exotic. Since a valid discussion of the comparative susceptibility of exotic versus indigenous species cannot be attempted without a broader coverage of species and countries where they are grown, it is not attempted here. However, based on Indonesian experience it can be said that both exotic and indigenous species may have serious pest problems. Examples are the indigenous *Pinus merkusii* in Sumatra and the exotic *Swietenia macrophylla*. The difference is that an indigenous species is unlikely to be wiped out by a pest because it has evolutionarily outlived such an eventuality and it is therefore safer to grow them. On the other hand, in theory, an exotic species can suffer heavy damage and extinction caused by indigenous pests and pathogens. There is also the risk of pests and pathogens invading from the area of natural occurrence of the exotic host, as in the case of *Leucaena* psyllid, conifer aphids or eucalypt trunk borers. This does not always happen, as exemplified by the thriving exotic rubber tree, *Hevea braziliensis*, in many countries. A comprehensive risk analysis is beyond the scope of this study. We can say that the risk is not associated with whether a species is exotic or indigenous *per se* and that risk must also be balanced with opportunities.

5.2. The research scenario

Existing unsolved pest and disease problems and newly emerging problems call for timely attention to research and development in this field. Research capacity in Indonesia is quite inadequate to meet the challenge. Indonesian forest protection research literature is characterised by a large number of reviews describing or listing the problems (see the bibliography). Most of them have been presented in seminars and conferences that are often organised with external support. Very little new knowledge is generated by the small number of researchers in the forest protection field, although there are exceptions. Some plantation companies have established research units which look at pest and disease problems and collaborate with universities, but there is scope for strengthening the ties for mutual benefit. The main constraints to improving forest protection research are:

Few specialised researchers

Forestry protection research capacity exists at the Forestry and Estate Crops Research and Development Agency (FERDA), two universities in Java (IPB and Gadjah Mada), three in Kalimantan, (East Kalimantan (Mulawarman), Central Kalimantan and West Kalimantan), one in Sulawesi and one in Sumatra. The total number of researchers in forest protection is only about 40, with less than half possessing a Ph.D. degree. This is inadequate to meet the entomological and pathological research needs.

Low budget provision

Staff salaries and research funds are low and often the staff have to depend on external support from plantation companies and other sources to conduct research.

Extensive plantations

Except in Java, most plantations are located far away from the staff headquarters and there are inadequate travelling and field camping facilities to carry out research.

Inadequate research publication effort

Most research results remain in the form of student theses and project reports, and inadequate attention is given to publishing them in peer-reviewed journals. The few published papers appear in in-house journals

and symposia proceedings, mostly in Bahasa Indonesia, the benefits of broader expert review of the research are not captured. While there are numerous publications, the scientific quality of many is inadequate. Although there are some high quality publications that contribute to advancement of knowledge or solving problems, there are also many publications that are premature, and many recommendations that are impracticable, ineffective or prohibitively expensive.

5.3. Future outlook

To meet the needs of expanding plantations, more attention needs to be paid to promoting research on pests and diseases. This calls for a dialogue between Government, universities and plantation companies to formulate appropriate approaches. An immediate need is to set up a plantation health monitoring system for Indonesia covering pests and diseases, and plantation failures due to other causes. This has the support of some plantation companies. Some fundamental research is needed to complement problem-solving research, for example, to create a scientific database and expertise for identification of disease organisms and insects, many of which are poorly identified. Although plantation companies may be interested in immediate problem solving research, the approach should be to simultaneously strengthen indigenous research capability and infrastructure for long-term benefits.

Literature Cited

Alonso, O., Sanchez, S., Berrios, M. del C. and Delgado, A. 1996. Technical note: the oil extract cayeput, a repellent and bio-insecticide against *Andrector ruficornis* (Nota tecnica: el extracto oleoso de cayeput, un bioinsecticida-repelente contra *Andrector rurficornis*). Pastos y Forrajes 19: 289-293.

Anderson, C. and Lee, S.Y. 1995. Defoliation of the mangrove *Avicennia marina* in Hong Kong: cause and consequences. Biotropica 27: 218-226.

Anderson, J.A.R. 1961. The destruction of *Shorea albida* forest by an unidentified insect. Empire Forestry Review 40: 19-29.

Anggraeni, I. and Suharti, M. 1997. Identifikasi beberapa cendawan penyebab penyakit busuk akar pada tanaman hutan (Identification of some pathogens as causal agents of root rot disease on forest trees). Buletin Penelitian Hutan 610: 17-35.

Anino, E.O. 1990. Effects of canker in *Paraserianthes falcataria* (L.) Forsberg grown as a plantation crop. Nitrogen Fixing Tree Research Reports 8: 146.

Anonymous. 1996. Little monsters. India Today, June 15. p. 136.

Appanah, S. and Weinland, G. 1993. Planting quality timber trees in Peninsular Malaysia – A review. Malayan Forest Records No. 38. FRIM, Malaysia. 247p.

Arentz, F. 1996. Root rot in plantations of *Acacia auriculiformis* and *A. mangium*. *In*: Nair, K.S.S., Sharma, J.K. and Varma, R.V. (eds.) Impact of diseases and insect pests in tropical forests, 98-104. Kerala Forest Research Institute and FAO/ FORSPA, Peechi, India.

Becker, V. O. 1974. A stenomatid (Lepidoptera) that bores in the shoots of balsa, *Ochroma lagopus* Sw. (Bombacaceae) in Costa Rica. Turrialba 24: 420-422.

Beeson, C.F.C. 1941. The ecology and control of the forest insects of India and the neighbouring countries. 1961 Reprint. Government of India, New Delhi. 767p.

Blake, S.T. 1968. Revision of *Melaleuca leucadendron* and its allies (Myrtaceae). Contributions of the Queensland Herbarium No. 1: 1-114.

Bowen, M.R. and Whitmore, T.C. 1980. A second look at *Agathis*. Occasional Paper No. 13. Commonwealth Forestry Institute, Oxford University. 19p.

Braza, R.D. 1988. Control of varicose borer in PICOP's bagras plantation. Canopy International 14: 7-9.

Braza, R.D. 1992. Varicose borer infestation and effects on native bagras *Eucalyptus deglupta* Blume growth condition. Sylvatrop 2: 53-59.

Chew, T.K. 1987. Assessment of termite attack and heart rot on thinned *Acacia mangium* trees. Forestry Department, Kuala Lumpur. (Unpublished). 2p.

Chin, F.H. 1995. Damping-off in some forest nurseries in Sarawak. Forest Pathology Information Leaflet No. 2-95. Kuching, Sarawak. 7p.

Chowdhury, S.H. 1996. Borer pests - A threat to coastal forests of Bangladesh. *In*: Nair, K.S.S., Sharma, J.K. and Varma, R.V. (eds.) Impact of diseases and insect pests in tropical forests, 328-335. Kerala Forest Research Institute and FAO/ FORSPA, Peechi, India.

Curran, L.M. and Leighton, M. 1991. Why mast? The role of generalised insect and vertebrate seed predators on the reproductive biology of Dipterocarpaceae in the Gunung Palung Nature Reserve, West Kalimantan. *In*: Soerianegara, I., Tjitrosomo, S.S., Umaly, R.C. and Umboh, I. (eds.) Proceedings of the 4th Round Table Conference on Dipterocarps, 541-542. BIOTROP Special Publication No. 41. SEAMEO-BIOTROP, Bogor, Indonesia.

Dennis, J.J.C. 1992. A new threat from brown root rot of cocoa, caused by *Phellinus noxius*, in Papua New Guinea. Plant Disease 76: 642.

Djakaria, R., Sormin, B. and Kehnert, S.C.S. 1997. Some initiatives to promote concessionare and community participation in Indonesia. *In*: Nasendi,

B.D. (ed.) A state-of-the art report on some recent forestry policies, initiatives and achievements in Indonesia: concepts, strategies and actions for sustainable forest management and forestry development towards 21st century, 179-186. Ministry of Forestry of the Republic of Indonesia, Jakarta.

Doskotch, R.W., Cheng, H.Y., Odell, T.M. and Girard, L. 1980. Nerolidol: an antifeeding sesquiterpene alcohol for gypsy moth larvae from *Melaleuca leucadendron*. Journal of Chemical Ecology 6: 845-851.

Duncan, M.L. 1977. Ants foraging on jelutong seeds. Malaysian Forester 40: 207-209.

Elouard, C. 1991. Contribution a l'etude du parasitisme fongique des Dipterocarpaceae Indonesiennes. Doctorat de l'Universite P. Sabatier, Toulouse.

Elouard, C. 1998. Pests and diseases of Dipterocarpaceae. *In*: Appanah, S. and Turnbull, J.M. (eds.) A review of Dipterocarps: taxonomy, ecology and silviculture, 115-131. CIFOR, Bogor, Indonesia.

Fox, J., Wasson, M. and Applegate, G. 2000. Forest use policies and strategies in Indonesia: a need for change. Paper prepared for the World Bank.

Fundter, J.M., de Graaf, N.R. and Hilderbrand, J.W. 1997. *Octomeles sumatrana* Miq. *In*: Hanum, I.F. and van der Maesen, L.J.G. (eds.) Plant resources of South-East Asia No. 11 - Auxiliary plants, 201-203. PROSEA, Bogor, Indonesia.

Garraway, E. 1986. The biology of *Ips calligraphus* and *Ips grandicollis* (Coleoptera: Scolytidae) in Jamaica. Canadian Entomologist 118: 113-121.

Gautam, M., Lele, U., Hyde, W., Kartodihardjo, H., Khan, A., Ervinsyah and Rana, S. 2000. The challenges of World Bank involvement in forests: an evaluation of Indonesia's forests and World Bank assistance. Preliminary Report. Operations Evaluation Department, World Bank.

Graaf, N.R. de, Hildebrand, J.W., Zwan, van der R.P., and Fundter, J.M. 1993. *Peronema* Jack. *In*: Soerianegara, I. and Lemmens, R.H.M.J. (eds.) Plant resources of South-East Asia. No. 5(1) Timber trees: major commercial timbers, 448-454. Pudoc Scientific Publishers, Wageningen.

Hadi, S. and Nuhamara, S.T. 1997. Diseases of species and provenances of acacias in West and South Kalimantan, Indonesia. *In*: Old, K.M., Lee, S.S. and Sharma, J.K. (eds.) Diseases of tropical acacias: proceedings of an International workshop held at Subajeriji, South Sumatra, 28 April-3 May 1996, 23-47. CIFOR Special Publication CIFOR, Bogor, Indonesia.

Hadi, S., Nuhamara, S.T. and Santoso, E. 1996. Disease problems associated with the large-scale establishment of timber estates in Indonesia. *In*: Nair, K.S.S., Sharma, J.K. and Varma, R.V. (eds.) Impact of diseases and insect pests in tropical forests: proceedings of the IUFRO Symposium, 23-26 November 1993, 105-110. Kerala Forest Research Institute and FAO/FORSPA, Peechi, India.

Hamid, A.A. 1987. Insect pests of *Acacia mangium* Willd. in Sarawak. Forest Research Report No. FE 1. Forest Department, Sarawak, Malaysia. 10p.

Handadhari, T. 1997. Long term strategic planning for forestry development in Indonesia. *In*: Nasendi, B.D. (ed.) A state-of-the art report on some recent forestry policies, initiatives and achievements in Indonesia: concepts, strategies and actions for sustainable forest management and forestry development towards 21st century, 263-268. Ministry of Forestry of the Republic of Indonesia, Jakarta.

Hardi, T.T.W. 1993. Beberapa jenis hama pada persemaian Hutan Tanaman Industri (Some pests at timber estate nurseries). Buletin Penelitian Hutan 554: 19-36.

Hardi, T.T.W. 1997. Serangan hama mangrove dan tingkat kerusakannya di hutan mangrove DKI Jakarta (Pest attack and damage level of mangrove forest in DKI Jakarta). Buletin Penelitian Hutan 608: 37-49.

Hardi, T.T.W. and Intari, S.E. 1990. Pengendalian hama pada tegakan HTI (Pest control in industrial plantation forest). *In*: Buharman, Purba, K. and Hediana, C. (eds.) Proceeding Diskusi Hutan Tanaman Industri, Jakarta 13-14 Maret 1990, 177-186. Badan Litbang Kehutanan Departemen Kehutanan, Jakarta.

Hardi, T.W.H., Husaeni, E.A., Darwiati, W., Nurtjahjawilasa and Hardi, T.T.W. 1996. Studi morfologi dan morfometrik imago *Xystocera festiva* Pascoe (A study of the morphology and morphometrics of adults of *Xystrocera festiva* Pascoe). Buletin Penelitian Hutan 604: 39-48.

Husaeni, E.A. 1993. Hama hutan di Indonesia (Forest pests in Indonesia). Fakultas Kehutanan, Institut Pertanian Bogor, Bogor, Indonesia. (Mimeo).

Husaeni, E.A., Kasno and Haryadi, M. 1998. Pengendalian *Xystrocera festiva* Pascoe (Cerambycidae, Coleoptera) dengan menggunakan lampu perangkap. (Light trapping to control *Xystrocera festiva* Pascoe (Cerambycidae, Coleoptera)). Jurnal Manajemen Hutan Tropica 3: 23-30.

Hutacharern, C. 1978. The situation of insects and diseases of pines in Thailand. Paper to the Meeting of IUFRO Working Parties S 2.06.12 and S 2.07.07, Pests and diseases of pines in the tropics. 'Piedras Blancas', Medellin, Colombia, September 3-14, 1978. Instituto Nacional de los Recursos Naturales Renovables y del Ambiente, Bogota, Colombia. 2p.

Hutacharern, C. 1990. Forest insect pests in Thailand. *In:* Hutacharern, C., MacDicken, K.G., Ivory, M.H. and Nair, K.S.S. (eds.) Pests and diseases of forest plantations in the Asia-Pacific Region, 75-80. Regional Office for Asia and the Pacific (RAPA), FAO, Bangkok.

Hutacharern, C. 1993. Insect pests. *In*: Awang, K. and Taylor, D. (eds.). *Acacia mangium* - Growing and utilization, 163-202. Winrock International and FAO, Bangkok, Thailand.

Hutacharern, C. and Tubtim, N. 1995. Check list of forest insects of Thailand. OEPP Biodiversity Series Vol. 1. Ministry of Science, Technology and Environment, Thailand. 391p.

Ibnu, Z. and Supriana, N. 1987. Pengujian empat jenis fungisida terhadap serangan penyakit damping-off di persemaian *Pinus merkusii* (An efficacy test of four fungicides against damping off in *Pinus merkusii* nurseries). Buletin Penelitian Kehutanan 3: 53-61.

Indian Council of Forestry Research and Education (ICFRE). 1995. Sisham (*Dalbergia sissoo*). Indian Council of Forestry Research and Education, Dehra Dun, India. 15p.

Intachat, J. 1997. Insect pests in teak and sentang: are they a serious problem? Paper to the 4th Conference on Forestry and Forest Products Research, 2-4 October, 1997, Kuala Lumpur, Malaysia.

Intachat, J. 1998. The identity of a Malaysian teak skeletoniser, *Paliga damastesalis* Walker (Lepidoptera: Pyralidae). Journal of Tropical Forest Science 10: 561-563.

Intari, S.E. 1975. Hasil pengamatan hama oleng-oleng (*Duomitus ceramicus* Wlk.) pada tegakan jati di KPH Kendal dan Ciamis (Observations on beehole borer (*Duomitus ceramicus*) in teak plantations in Kendal and Ciamis forest districts, Java). Lembaga Penelitian Hutan 204: 14.

Intari, S.E. 1979. Termite community in cayeput plantation at Urug, Tasikmalaya. Laporan Lembaga Penelitian Hutan No. 311. Bogor, Indonesia.

Intari, S.E. 1982. A trial using Dimecron to control case worm *Acanthopsyche* sp. attacking *Bruguiera* spp. in Tritin Cilacap, Central Java. Laporan Balai Penelitian Hutan No. 386. Bogor, Indonesia

Intari, S.E. 1986. Percobaan efikasi insektisida terhadap kumbang *Chaetocnema* sp. pada tanaman *Bruguiera* spp. di Tritih, Cilacap, Jawa Tengah (Efficacy of some insecticides on *Chaetocnema* sp. beetles attacking leaves of *Bruguiera* spp. in Tritih, Cilacap, Central Java). Buletin Penelitian Hutan, 477: 1-6.

Intari, S.E. 1988. Percobaan efikasi insektisida terhadap ketam *Sesarma* sp. pada bibit mangrove di Pamanukan, Jawa Barat (An experiment on the efficacy of insecticides on the crab *Sesarma* sp., a pest of mangrove seedlings at Pamanukan, West Java). Buletin Penelitian Hutan 500: 27-33.

Intari, S.E. 1990. Pengaruh serangan inger-inger (*Neotermes tectona* Damm) terhadap kualitas kayu jati di KPH Kebonharjo, Jawa Tengah (Effects of *Neotermes tectonae* Damm attack on the quality and quantity of teak timber in the Kebonharjo forest district, Central Java). Buletin Penelitian Hutan 530: 25-35.

Intari, S.E. 1996. Percobaan pengendalian hama kepik *Mucanum* sp. yang merusak bibit *Shorea javanica* di Krui, Lampung Barat (The control of *Mucanum* sp. causing damage to seedlings of *Shorea javanica* in Krui, West Lampung). Buletin Penelitian Hutan 604: 31-37.

Intari, S.E. 1997. Pengendalian hama kutu sisik (*Chionaspis* sp.) yang menyerang tanaman mangrove di Bali (The control of the scale insect pest (*Chionaspis* sp.) of mangrove forest in Bali). Buletin Penelitian Hutan 605: 19-26.

Intari, S.E. and Amir, M. 1975. Pengamatan terhadap serangan inger-inger, *Neotermes tectonae* Damm, di KPH Mantingan dan percobaan pemberantasannya dengan phostoxine (An observation on the attack of *Neotermes tectonae* Damm on teak plants, and a trial on the use of phostoxine to control them in the Mantingan forest

district). Laporan Lembaga Penelitian Hutan No. 198. Bogor, Indonesia. 18p.

Intari, S.E. and Natawiria, D. 1973. White grubs in forest tree nurseries and young plantations. Laporan Lembaga Penelitian Hutan No. 167, Bogor, Indonesia. 2p.

Intari, S.E. and Natawiria, D. 1976. Percobaan pencegahan serangan rayap pada tanaman *Eucalyptus alba* Reinw. dengan insektisida hidrokarbon-khlor (A trial of chlorinated hydrocarbon insecticides to prevent termite attack on young plants of *Eucalyptus alba*). Laporan Lembaga Penelitian Hutan No. 229. Bogor. 11p.

Intari, S.E. and Santoso, E. 1990. Pola tanam HTI sebagai usaha penanggulangan hama dan penyakit (Planting pattern of industrial plantation forest as an effort to control pests and diseases). *In*: Buharman, Purba, K. and Hediana, C. (eds.) Proceedings Diskusi Hutan Tanaman Industri, Jakarta 13-14 Maret 1990, 85-94. Badan Litbang Kehutanan Departemen Kehutanan, Jakarta.

Intari, S.E. and Wiriadinata, Y.A.P. 1984. Percobaan pencegahan serangan rayap pada tanaman kayu putih dengan insektisida dan cara santisi di Gundih, Jawa Tengah (Trials on the prevention of termite attack on cayuput (*Melaleuca leucadendron*) using insecticides and a sanitation method at Gundih, Central Java). Laporan Pusat Penelitian dan Pengembangan Hutan No. 433. Bogor, Indonesia. 11p.

Intari, S.E., Santoso, E. and Sophie, M.M. 1995. Percoban pengendalian hama rayap dan penyakit busuk akar yang menyerang tanaman sonokeling di kecamatan Wanayasa, Purwakarta (An experiment to control termites and rot root diseases attacking the *Dalbergia latifolia* plantation in Wanayasa district, Purwakarta). Duta Rimba 20: 179-180.

Irianto, R.S.B., Matsumoto, K. and Mulyadi, K. 1997. The yellow butterfly species of the genus *Eurema* Hubner causing severe defoliation in the forestry plantations of *Albizzia* and *Paraserianthes falcataria* (L.) Nielsen, in the western part of Indonesia. JIRCAS Journal 4: 41-49.

Ito, S. and Nanis, L.H. 1997. Survey of heart rot on *Acacia mangium* in Sabah, Malaysia. Japanese Agricultural Research Quarterly 31: 65-71.

Janzen, D.H. 1974. Tropical backwater rivers, animals and mast fruiting by the Dipterocarpaceae. Biotropica 6: 69-103.

Kalshoven, L.G.E. 1953. Important outbreaks of insect pests in the forests of Indonesia. *In*: Transactions of the 9th International Congress of Entomology, Amsterdam, 1951, 229-234. Volume 2.

Kalshoven, L.G.E. 1981. Pests of crops in Indonesia. van der Laan, P.A. (trans. and ed.) PT Ichtiar Baru - Van Hoeve, Jakarta. Translation of: De plagen van de cultuurgewassen in Indonesie.

Kamath, M.K., Senivasa, E. and Bola, I. 1996. Impact of termites on mahogany (*Swietenia macrophylla*) plantation in Fiji. *In:* Nair, K.S.S., Sharma, J.K. and Varma, R.V. (eds.) Impact of diseases and insect pests in tropical forests, 298-303. Kerala Forest Research Institute and FAO/FORSPA, Peechi, India.

Kasno and Husaeni, E.A. 1998. An integrated control of sengon stem borer in Java. Paper to IUFRO S7.03.09 Workshop on Pest Management in Tropical Forest Plantations, Chanthaburi Province, Thailand, 25-29 May 1998. 8p.

Keane, P.J., Kile, G.A., Podger, F.D. and Brown, B.N. (eds). 2000. Diseases and pathogens of eucalypts. CSIRO, Collingwood, Australia.

Kessler, P.J.A. and Sidiyasa, K. 1994. Trees of the Balikpapan-Samarinda area, East Kalimantan, Indonesia: a manual to 280 selected species. The Tropenbos Foundation, Wageningen. 446p.

Kinal, J., Shearer, B.L. and Fairman, R.G. 1993. Dispersal of *Phytophthora cinnamomi* through lateritic soil by laterally flowing subsurface water. Plant Disease 77: 1085-1090.

Kobayashi, T. and Zinno, Y. 1984. Anthracnose of legume tree seedlings in the Philippines and Indonesia. Journal of the Japanese Forestry Society 66: 113-116.

Kostermans, A.J.G.H., Sunarno, B., Martawijaya, A. and Sudo, S. 1993. *Eusideroxylon* Teisjm. & Binnend. *In*: Soerianegara, I. and Lemmens, R.H.M.J. (eds.) Plant resources of South-East Asia No. 5(1) Timber trees: major commercial timbers, 211-215. Pudoc Scientific Publishers, Wageningen.

Lapis, E.B. 1987. The pine shoot moths, *Dioryctria rubella* Hamps. (Lepidoptera, Pyralidae) and *Petrova cristata* Wals.(Lepidoptera, Tortricidae), in the Philippines. *In:* de Guzman, E.D. and Nuhamara S.T. (eds.) Forest pests and diseases in Southeast Asia, 97-103. BIOTROP Special Publication No. 26. SEAMEO-BIOTROP, Bogor, Indonesia.

Lee, S.S. and Arentz, F. 1997. A possible link between rainfall and heart rot incidence in *Acacia mangium*? Journal of Tropical Forest Science 9: 441-448.

Lee, S.S. and Sikin, N.Y. 1999. Fungi associated with heart rot of *Acacia mangium* in Peninsular Malaysia and East Kalimantan. Journal of Tropical Forest Science 11: 240-254.

Leech, J.W., Rombouts, J. and Rahayu, Y. 1996. Report of the Indonesian National Forest Inventory. Directorate General of Forest Inventory and Land Use Planning, Ministry of Forestry, Government of Indonesia and Food and Agriculture Organization of the United Nations, Jakarta. 135p.

Luego, J.N. 1990. Mirid bug (*Helopeltis* sp.): A threat to *Acacia mangium*. Nitrogen Fixing Tree Research Reports 8: 105-106.

Mangundikoro, A. and Depari, K.S. 1958. Gangguan hama di hutan *Pinus merkusii* di Sumatra Utara (Insect and fungus attack in the pine forest of Northern Sumatra). Rimba Indonesia 7: 417-451.

Martono, D. 1989. Kerentanan empat jenis kayu rimba terhadap serangan jamur pewarna (The susceptibility of four woods to sapstain). Jurnal Penelitian Hasil Hutan 6: 314-317.

Mathew, G. 1980. Occurrence of *Sylepta derogata Fb*. (Lepidoptera, Pyraustidae) as a pest of balsa (*Ochroma pyramidale*) in Kerala. Entomon 5: 71-72.

Matsumoto, K. 1994. Studies on the ecological characteristics and methods of control of insect pests of trees in reforested areas in Indonesia. Final Report submitted to Agency for Forestry Research and Development, Ministry of Forestry, Indonesia. 63p.

Matsumoto, K., Mulyadi, K. and Irianto, R.S.B. 1997. A promising method to protect mahogany plantations from attack by the shoot borer, *Hypsipyla robusta* Moore (Lepidoptera: Pyralidae). JIRCAS Journal 5: 23-29.

Mayhew, J.E. and Newton, A.C. 1998. The silviculture of mahogany. CAB International, Wallingford, U.K. 226p.

McKillup, S.C. and McKillup, R.V. 1997. An outbreak of the moth *Achaea serva* (Fabr.) on the mangrove *Excoecaria agallocha* (L.). Pan Pacific Entomologist 73: 184-185.

Mehrotra, M.D. 1993. *Rhizoctonia* leaf blight, a new disease of *Anthocephalus chinensis*. Indian Forester 119: 590-591.

Messer, A.D., Wanta, N.N. and Sunjaya. 1992. Biological and ecological studies of *Calliteara cerigoides* (Lepidoptera, Lymantriidae), a polyphagous defoliator of Southeast Asian Dipterocarpaceae. Japanese Journal of Entomology 60: 191-202.

Mieke, S. 1994. Some pests and diseases of forest timber estate in Indonesia. *In:* Kashio, M. and Ze, M.E. (eds.) Rehabilitation of degraded forest lands in the tropics - technical approach, 158-162. JIRCAS International Symposium Series 1. JIRCAS, Tsukuba, Japan.

Ministry of Forestry of the Republic of Indonesia (MoF). 1993. Indonesian forests in brief. (A collection of 20 Fact Sheets). Ministry of Forestry, Jakarta, Indonesia.

Ministry of Forestry and Estate Crops (MoFEC). 1999. Forestry and estate crops statistics of Indonesia. Special Edition. Secretariat General of Ministry of Forestry and Estate Crops, Bureau of Planning, MoFEC, Jakarta.

Morgan, F.D. and Suratmo, F.G. 1976. Host preferences of *Hypsipyla robusta* (Moore) (Lepidoptera: Pyralidae) in West Java. Australian Forestry 39: 103-112.

Morgan, J.G., McKemy, J.M.and Kelley, W.D. 1991. Notes on hyphomycetes. LXI. *Stilbella ecuadorensis*, a new synnematous species belonging to section Didymostilbella, from balsa. Mycotaxon 40: 151-156.

Nair, K.S.S. 1988. The teak defoliator in Kerala, India. *In:* Berryman, A.A. (ed.) Dynamics of forest insect populations, 267-289. Plenum Press, New York.

Nair, K.S.S. and Mathew, G. 1988. Biology and control of insect pests of fast-growing hardwood species. KFRI Research Report No. 51, Kerala Forest Research Institute, Peechi, India. 45p.

Nair, K.S.S. and Mathew, G. 1992. Biology, infestation characteristics and impact of the bagworm, *Pteroma plagiophleps* Hamps. in forest plantations of *Paraserianthes falcataria*. Entomon 17: 1-13.

Nair, K.S.S., Mathew, G., Mohanadas, K. and Menon, A.R.R. 1986. A study of insect pest incidence in natural forests. KFRI Research Report No.44. Kerala Forest Research Institute, Peechi, India. 28p.

Nair, K.S.S., Sudheendrakumar, V.V., Varma, R.V., Chacko, K.C. and Jayaraman, K. 1996. Effect of defoliation by *Hyblaea puera* and *Eutectona machaeralis* (Lepidoptera) on volume increment of

teak. *In:* Nair, K.S.S., Sharma, J.K. and Varma, R.V. (eds.) Impact of diseases and insect pests in tropical forests: proceedings of the IUFRO Symposium, 23-26 November 1993, 257-273. Kerala Forest Research Institute, Peechi, India.

Nambiar, E.K.S., Gintings, A.N., Ruhiyat, D., Natadiwirya, M., Harwood, C.E. and Booth, T.H. 1998. Executive summary - Sustained productivity of short and medium rotation plantation forests for commercial and community benefit in Indonesia - an analysis of research priorities, 1-2. CSIRO Forestry and Forest Products, Canberra.

Natadiwirya, M.1998. Plantation forest in Indonesia: Basic resources issues and national goals. *In*: Nambiar, E.K.S., Gintings, A.N., Ruhiyat, D., Natadiwirya, M., Harwood, C.E. and Booth, T.H. (eds.) Sustained productivity of short and medium rotation plantation forests for commercial and community benefit in Indonesia - an analysis of research priorities, 13-16. CSIRO Forestry and Forest Products, Canberra.

Natawiria, D. 1990. Insect pests in plantation forests in Indonesia. *In:* Hutacharern, C., MacDicken, K.G., Ivory, M.H. and Nair, K.S.S. (eds.) Pests and diseases of forest plantations in the Asia-Pacific Region, 56- 61. Regional Office for Asia and the Pacific, FAO, Bangkok.

Natawiria, D. and Tarumingkeng, R.C. 1971. Some important pests of forest trees in Indonesia. Rimba Indonesia 16: 3-4.

Natawiria, D., Kosasih, A.S. and Mulyana, A.D. 1986. Beberapa jenis serangga hama buah Dipterocarpaceae (Some insect pests of dipterocarp seeds). Buletin Penelitian Hutan 472: 1-8.

Nazif, M. and Suharti, M. 1990. Weed and disease control in industrial forest plantations (Pengendalian gulma dan penyakit pada tegakan HTI). *In*: Buharman, Purba, K. and Hediana, C. (eds.) Proceeding Diskusi Hutan Tanaman Industri, Jakarta 13-14 Maret 1990, 163-176. Badan Litbang Kehutanan Departemen Kehutanan, Jakarta.

Ngatiman and Tangketasik, J. 1987. Some insect pests on trial plantation of PT ITCI, Balikpapan, East Kalimantan, Indonesia. Tropical Forest Research Journal Samarinda 2: 41-53.

Notoatmodjo, S.S. 1963. Cara-cara mencegah serangan masal dan boktor *Xystrocera festiva* Pascoe pada tegakan *Albizia falcataria* (Prevention of massive attacks of *X. festiva* on *A. falcataria*). Laporan Lembaga Penelitian Hutan No. 92. Bogor, Indonesia. 12p.

Nuhamara, T. 1977. Some termites in Bogor Botanic Garden. *In:* Hadi, S., Tarumingkeng, R.C., Suratmo, F.G., Eusebio, M.A., Kirtibutr, N. and Dhanarajan, G. (eds.) Proceedings of the Symposium on Forest Pests and Diseases in Southeast Asia, 105-111. BIOTROP Special Publication No. 2. SEAMEO-BIOTROP, Bogor, Indonesia.

Old, K.M. 1998. Diseases of tropical acacias. *In:* Turnbull, J.W., Crompton, H.R. and Pinyopusarerk, K. (eds.) Recent developments in *Acacia* planting. Proceedings of an International Workshop held in Hanoi, Vietnam, 27-30 October 1997, 224-233. ACIAR Proceedings No. 82. ACIAR, Canberra.

Old, K.M., Lee, S.S., Sharma, J.K. and Zi, Q.Y. 2000. A manual of diseases of tropical acacias in Australia, South-East Asia and India. CIFOR, Bogor, Indonesia.

Perum Perhutani. 1995. A glance at Perum Perhutani (Forest State Corporation), Indonesia. Perum Perhutani, Jakarta, 40p.

Phengklai, C., Smitinand, T., Kartasubrata, J., Laming, P.B., Lim, S.C. and Sosef, M.S.M. 1993. Tectona L.f. *In:* Soerianegara, I. and Lemmens, R.H.M.J. (eds.) Plant resources of South-East Asia No. 5(1) - Timber trees: major commercial timbers, 448-454. Pudoc Scientific Publishers, Wageningen.

Pinyopusarerk, K., Sim, B.L. and Gunn, B.V. 1993. Taxonomy, distribution, biology, and use as an exotic. *In:* Awang, K. and Taylor, D. (eds.). *Acacia mangium* - growing and utilization, 1-19. Winrock International and FAO, Bangkok.

Piyakarnchana, T. 1981. Severe defoliation of *Avicennia alba* BL. by larvae of *Cleora injectaria* Walker. Journal of the Science Society of Thailand 7: 33-36.

Pramono, S., Sudarsono, H. and Sudiono. 1998. Pengedalian penggerek batang jati putih dengan minyak pelumas bekas (Control of stem borer of *Gmelina* with used lubricant). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 95-97. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor, Indonesia.

Prawirohatmodjo, S., Suranto, J., Martawijaya, A., den Outer R.W. and Sosef, M.S.M. 1993. *Dalbergia latifolia* Roxb. *In:* Soerianegara, I. and Lemmens, R.H.M.J. (eds.) Plant resources of South-East Asia No. 5(1) – Timber trees: major commercial timbers, 160-161. Pudoc Scientific Publishers, Wageningen.

Rachmatsyah, O. and Haneda, N.F. 1998. Jenis-jenis serangga hama potensial pada hutan tanaman di Indonesia (Kinds of potential pests in Indonesian plantation forest). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 167-170. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor, Indonesia.

Rahardjo, A.W.B. 1992. Early warning system: suatu metoda pengendalian *Helopeltis* sp. pada tanaman *Eucalyptus* sp. (Early warning system: a method to control the pest *Helopeltis* sp. in *Eucalyptus* sp. plantations). Duta Rimba 18: 149-150.

Rahayu, S. 1999. Penyakit tanaman hutan di Indonesia: gejala, penyebab, dan teknik pengendaliannya. (Forest diseases in Indonesia: the symptoms, causal and technical control). Kanisius, Yogyakarta. 112p.

Rahayu, S., Subyanto and Kuswanto. 1998. The occurrence of pest and disease of *Shorea* spp. - A preliminary study in Wanariset and Bukit Soeharto Forest Area in East Kalimantan, Indonesia. *In*: Sabarnudin, H.M.S., Suhardi and Okimori, Y. (eds.) Proceedings of the Seminar on Ecological Approach for Productivity and Sustainability of Dipterocarp Forests, 53-57. Faculty of Forestry, Gadjah Mada University, Yogyakarta, Indonesia and Kansai Environmental Engineering Center, Kyoto, Japan.

Rahman, M.A. 1996. Top dying of sundri (*Heritiera fomes*) and its impact on the regeneration and management in the mangrove forests of Sunderbans in Bangladesh. *In:* Nair, K.S.S., Sharma, J.K. and Varma, R.V. (eds.) Impact of diseases and insect pests in tropical forests, 117-133. Kerala Forest Research Institute and FAO/ FORSPA, Peechi, India.

Riyantoko, A. 1998. Sistem silvikultur intensif sebagai upaya meningkatkan produktivitas tegakan serta perlindungan dari serangan hama dan penyakit (Intensive silviculture system as an effort to improve stand productivity and protection from the attack of pests and diseases). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 157-165. Fakultas Kehutanan IPB dan Departemen Kehutanan. Bogor, Indonesia.

Roonwal, M.L. 1978. The biology, ecology and control of the sal heartwood borer, *Hoplocerambyx spinicornis*: a review of recent work. Indian Journal of Forestry 1:107-120.

Sajap, A.S., Wahab, Y.A. and Murshidi, A. 1997a. Biology of *Spirama retorta* (Lepidoptera: Noctuidae), a new pest of *Acacia mangium* in Peninsular Malaysia. Journal of Tropical Forest Science 10: 167-175.

Sajap, A.S., Wahab, Y.A. and Murshidi, A. 1997b. An outbreak of *Ericeia subcinerea* Snellen (Lepidoptera: Noctuidae), new pest of *Acacia mangium*. MAPPS Newsletter 20: 1.

Santoso, E. and Hardi, T. 1991. Pengendalian hama dan penyakit di hutan tanaman industri Kalimantan Timur (Pest and disease control of timber estates in East Kalimantan). Jurnal Penelitian dan Pengembangan Kehutanan 7: 14-17.

Schabel, H.G. and Latiff, A. 1993. *Maesopsis eminii* Engler. *In:* Hanum, I.F and van der Maesen, L.J.G. (eds.) Plant resources of South-East Asia No. 11- Auxiliary plants, 184-187. PROSEA, Bogor, Indonesia.

Selander, J. 1990. Forest pests and diseases of plantation trees in South Kalimantan, Indonesia. Technical Report No. 8. Reforestation and Tropical Forest Management Project, Phase V, FINNIDA and Ministry of Forestry of Indonesia. Enso Forest Development Oy Ltd. 22p.

Sharma, J.K. and Sankaran, K.V. 1988. Incidence and severity of *Botryodiplodia* die-back in plantations of *Albizia falcataria* in Kerala, India. Forest Ecology and Management 24: 43-58.

Sharma, J.K., Mohanan, C. and Florence, E.J.M. 1985. Disease survey in nurseries and plantations of forest tree species grown in Kerala. KFRI Research Report No. 36. Kerala Forest Research Institute. 268p.

Singh, P., Joshi, K.C. and Gurung, D. 1988. Efficacy of some insecticides against the larvae of khasi pine shoot borer, *Dioryctria castanea* Bradley (Lepidoptera, Pyralidae). Indian Forester 114: 29-34.

Siregar, S.T.H., Hardiyanto, E.B. and Gales, K. 1999. *Acacia mangium* plantations in PT Musi Hutan Persada, South Sumatera, Indonesia. *In:* Nambiar, E.K.S., Cossalter, C. and Tiarks, A. (eds.) Site management and productivity in tropical plantation forests. Proceedings of Workshop in Pietermaritzberg, South Africa on 16-20 February 1998, 39-44. CIFOR, Bogor, Indonesia.

Sitepu, I.R. and Suharti, M. 1998. Pest and disease management in industrial forest plantations in Indonesia. *In*: Nambiar, E.K.S., Gintings, A.N., Ruhiyat, D., Natadiwirya, M., Harwood, C.E. and Booth, T.H. (eds.) Sustained productivity of short and medium rotation plantation forests for commercial and community benefit in Indonesia - an analysis of research priorities. Proceedings of a Workshop held at Bogor, Indonesia, 6-7 May 1998, 39-47. CSIRO Forestry and Forest Products, Australia.

Smits, W.T.M., Hildebrand, J.W., Keating, W.G., Fundter, J.M. and Sosef, M.S.M. 1993. *Anthocephalus* A. Rich. *In:* Soerianegara, I. and Lemmens, R.H.M.J. (eds.) Plant resources of South-East Asia No. 5(1) - Timber trees: major commercial timbers, 102-108. Pudoc Scientific Publishers, Wageningen.

Soepangkat, S. 1998. Program penanggulangan hama pada HTI-trans PT Hutan Kusuma (Protection programme for pests in IPF-trans PT Hutan Kusuma). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 49-54. Fakultas Kehutanan, Institut Pertanian Bogor dan Departemen Kehutanan, Bogor, Indonesia.

Soerianegara, I., Sambas, E.N., Martawijaya, A., Sudo, S. and Groen, L.E. 1993. *Gonystylus* Teisjm. & Binnend. *In:* Soerianegara, I. and Lemmens, R.H.M.J. (eds.) Plant resources of South-East Asia No. 5(1) - Timber trees: major commercial timbers, 221-230. Pudoc Scientific Publishers, Wageningen.

Subyanto. 1992. Masalah hama inger-inger (*Neotermes tectonae* Damm.) serta pengaruhnya terhadap pertumbuhan dan produksi kayu perkakas pohon yang diserang (Problem on the attack of *Neothermes tectonae* and the impact to growth and wood production). Pen. No. UGM/7810/M/05/01. Fakultas Kehutanan Gadjah Mada University, Yogyakarta.

Subyanto, Sultoni, A. and Musyafa. 1992. Inger-inger (*Neotermes tectonae* Damm.): one of the problems on teak management in Central Java. *In:* Simon, H. (ed.) One century of sustainable forest management with special reference to teak in Java. Proceedings of an International Symposium on Sustainable Forest Management, September 21-24, 1992, Yogyakarta, Indonesia, 209-212. Perum Perhutani and Gadjah Mada University, Yogyakarta, Indonesia.

Suharti, M. 1983. Busuk batang pada *Agathis loranthifolia Roxb.* (Stem rot on *Agathis loranthifolia*). Duta Rimba 9: 61-62.

Suharti, M. 1988. Efektivitas beberapa jenis fungisida untuk pengendalian penyakit lodoh pada bibit *Pinus merkusii* di Sempolan, Jember, Jawa Timur (Effectiveness of some fungicides in the control of damping off in *Pinus merkusii* seedlings at Sempolan, Jember, East Java). Buletin Penelitian Hutan 496: 31-41.

Suharti, M. and Hadi, S. 1974. Penyakit layu pada *Dalbergia latifolia* Roxb di KPH Malang, Jawa Timur (Wilt diseases of *Dalbergia latifolia* Roxb. in Malang forest district, East Java). Laporan Lembaga Penelitian Hutan No. 194, Bogor, Indonesia. 10p.

Suharti, M. and Santoso, E. 1995. Penyakit kanker batang pada *Eucalyptus urophylla* di areal hutan PT Arara Abadi Perawang, Riau (Stem canker diseases on *Eucalyptus urophylla* in forest area at PT Arara Abadi Perawang, Riau). Buletin Penelitian Hutan 567: 37-45.

Suharti, M. and Sitepu, I.R. 1997. Some important pests and diseases of forest plantation in Indonesia. *In:* Nasendi, B.D. (ed.) A state-of-the art report on some recent forestry policies, initiatives and achievements in Indonesia: concepts, strategies and actions for sustainable forest management and forestry development towards 21st century, 39-45. Ministry of Forestry of the Republic of Indonesia, Jakarta.

Suharti, M., Asmaliyah and Hawiati, W.P. 1995. Tanaman mimba (*Azadirachta indica*) sebagai sumber insektisida nabati dalam pengendalian hama tanaman hutan (Neem (*Azadirachta indica*) trees as a natural insecticide resource to control forest pests). Buletin Penelitian Hutan 589: 1-26.

Suharti, M., Hardi, T. and Irianto, R.B.S. 1991. Mengenal beberapa hama dan penyakit penting pada tanaman HTI (Identification of some important pests and diseases in industrial forest plantations). *In:* Hadi, S., Rachmatsyah, O. and Nuhamara, S.T. (eds.) Proceedings Seminar National Peningkatan Produktivitas Hutan Tanaman Industri melalui Upaya Pengendalian Hama dan Penyakit Secara Terpadu, 97-106. Fakultas Kehutanan, Institut Pertanian Bogor, Bogor, Indonesia.

Suhendi, D. and Sembiring, S. 1998. Permasalahan dan strategi pengelolaan hama *Eurema* sp. (kupu kuning) di HTI PT Kiani Hutani Lestari (Problem and strategy for managing *Eurema* sp. in HTI PT Kiani Hutani Lestari). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 37-48. Fakultas Kehutanan, Institut Pertanian Bogor dan Departemen Kehutanan, Bogor, Indonesia.

Sukartana, P. 1996. Laju serangan kumbang penggerek lubang jarum pada enam jenis kayu Hutan Tanaman Industri (Infestation rate of pinhole borers on some timber species of the Industrial Forest Estate). Duta Rimba 20: 193-194.

Sumadiwangsa, S. 1997. Kayu gaharu komoditi elit di Kalimantan Timur (Agarwood as a high-value commodity in East Kalimantan). Duta Rimba 20: 205-206.

Sumahadi, Sarbini, B. and Prihatno, K. 1997. Forest resource monitoring and assessment at national level: an Indonesian experience. *In:* Nasendi, B.D. (ed.) A state-of-the art report on some recent forestry policies, initiatives and achievements in Indonesia: concepts, strategies and actions for sustainable forest management and forestry development towards 21st century, 1-6. Ministry of Forestry of the Republic of Indonesia, Jakarta.

Sumardi and Widyastuti, S.M. 2000. Hama dan penyakit tanaman jati kultur jaringan di daerah Kendal, Jawa Tengah (The incidence of pest and disease in teak plantation from tissue culture in Kendal, Central Java). Buletin Kehutanan UGM No. 42, Yogyakarta.

Supriana, N. and Natawiria, D. 1987a. Forest pests and diseases in Indonesia. *In*: de Guzman, E.D. and Nuhamara, S.T. (eds.) Forest pests and diseases in Southeast Asia, 21-41. BIOTROP Special Publication No. 26. SEAMEO-BIOTROP, Bogor, Indonesia.

Supriana, N. and Natawiria, D. 1987b. Current potential pine forest pests in Indonesia: a particular case in North Sumatra. *In*: de Guzman, E.D. and Nuhamara, S.T. (eds.) Forest pests and diseases in Southeast Asia, 139-145. BIOTROP Special Publication No. 26. SEAMEO-BIOTROP, Bogor, Indonesia.

Suratmo, F.G. 1977. Infestation of the leading shoots of mahogany (*Swietenia macrophylla* King) by *Hypsipyla robusta* (Moore) in West Java, Indonesia. *In*: Hadi, S., Tarumingkeng, R.C., Suratmo, F.G., Eusebio, M.A., Kirtibutr, N. and Dhanarajan, G. (eds.) Proceedings Symposium on Forest Pests and Diseases in Southeast Asia, on 20-23 April 1976, 121-132. BIOTROP Special Publication No. 2. BIOTROP, Bogor, Indonesia.

Suratmo, F.G. 1982. Pest management in forestry. Protection Ecology 4: 291-296.

Suratmo, F.G. 1987. Current potentially dangerous forest pests in Indonesia. *In:* de Guzman, E.D. and Nuhamara, S.T. (eds.) Forest pests and diseases in Southeast Asia, 91-95. BIOTROP Special Publication No. 26. SEAMEO-BIOTROP, Bogor, Indonesia.

Suratmo, F.G. 1996. Emerging insect pest problems in tropical plantation forest in Indonesia. *In:* Nair, K.S.S., Sharma, J.K. and Varma, R.V. (eds.) Impact of diseases and insect pests in tropical forests, 502-506. Kerala Forest Research Institute and FAO/ FORSPA, Peechi, India.

Takagi, S. and Williams, D.J. 1998. A new mangrove-infesting species of *Aulacaspis* occurring in South-East Asia, with a revision of *A. vitis* (Homoptera: Coccoidea: Diaspididae). Insecta Matsumurana 54: 51-76.

Tiarks, A., Nambiar, E.K.S., Cossalter, C. and Ranger, J. 1999. A progress report. *In:* Nambiar, E.K.S., Cossalter, C. and Tiarks, A. (eds.) Site management and productivity in tropical plantation forests. Workshop Proceedings, 16-20 February 1998 in Pietermaritzburg, South Africa, 73-76. CIFOR, Bogor, Indonesia.

Tikupadang, H., Sumardjito, Z. and Sila, M. 1993. Inventarisasi dan identifikasi serangga potensial menjadi hama dan mikroba potensial menjadi penyakit pada hutan tanaman industri PT Inhutani I Kabupaten Gowa, Propinsi Sulawesi Selatan.

(Inventory and identification of potentially serious pests and diseases in industrial forest plantation at PT Inhutani I, Gowa Regency, South Sulawesi). Jurnal Penelitian Kehutanan 7: 10-21.

Turnbull, J.W. 1986. Multipurpose Australian trees and shrubs - lesser-known species for fuelwood and agroforestry. ACIAR Monograph No. 1, ACIAR, Canberra. 316p.

Turnbull, J.W., Midgley, S.J. and Cossalter, C. 1998. Tropical acacias planted in Asia: an overview. *In:* Turnbull, J.W., Crompton, H.R. and Pinyopusarerk, K. (eds.) Recent developments in *Acacia* planting. Proceedings of an International Workshop held in Hanoi, Vietnam, 27-30 October 1997, 14-28. ACIAR Proceedings No. 82. ACIAR, Canberra.

Varma, R.V. and Nair, K.S.S. 1997. Evaluation of newer termiticides including plant products for forest plantation establishment. KFRI Research Report No. 127. Kerala Forest Research Institute, Peechi, India. 24p.

Wang, H., Floyd, R., Farrow, R., Hong, C., Gao, C., Lin, C., Ren, H., Farrell, G. and Xu, T. 1998. Insect damage on *Acacia mearnsii* in China. *In*: Turnbull, J.W., Crompton, H.R. and Pinyopusarerk, K. (eds.) Recent developments in *Acacia* planting. Proceedings of an International Workshop held in Hanoi, Vietnam, 27-30 October 1997, 240-245. ACIAR Proceedings Series No. 82. ACIAR, Canberra.

Whitten, A.J. and Damanik, S.J. 1986. Mass defoliation of mangroves in Sumatra, Indonesia. Biotropica 18: 176.

Whitten, A.J., Damanik, S.J., Anwar, J. and Hisyam, N. 1987. The ecology of Sumatra. Gadjah Mada University Press, Yogyakarta, Indonesia. 227p.

Whitten, T., Soeriaatmadja, R.E. and Afiff, S.A. 1996. The ecology of Java and Bali. The Ecology of Indonesia Series II. Periplus Editions, Hongkong. 969p.

Widyastuti, S.M. 1996. Penghambatan penyakit damping-off (rebah semai) pada semai pinus oleh ekstrak biji nyiri (*Xylocarpus granatum*). (Inhibition of damping-off of pine seedling by extract from seeds of *Xylocarpus granatum*). Jurnal Perlindungan Tanaman Indonesia 2: 32-35.

Widyastuti, S.M. and Sumardi. 1998. Antagonistic potential of *Trichoderma* spp. against root rot pathogen of forest tree species. Asian Journal of Sustainable Agriculture 2: 1-8.

Widyastuti, S.M., Sumardi and Harjono. 1999. Potensi antagonistik tiga *Trichoderma* spp. terhadap delapan penyakit busuk akar tanaman kehutanan. (Antagonistic potential of three species of *Trichoderma* spp. against eight root rot diseases of forest trees). Buletin Kehutanan Gajah Mada University 41:2-10.

Widyastuti, S.M., Sumardi and Hidayati, N. 1998a. Kemampuan *Trichoderma* spp. untuk pengendalian hayati jamur akar putih pada *Acacia mangium* secara in vitro. (Potential of *Trichoderma* spp. for biological control white root rot of *Acacia mangium*). Buletin Kehutanan Gajah Mada University 36: 24-38.

Widyastuti, S.M., Sumardi and Puspitasari, D. 1999. Uji kemampuan penghambatan ekstrak biji nyiri (*Xylocarpus granatum*) terhadap jamur benih tanaman kehutanan. (Test toward inhibition potential of the extract of *Xylocarpus granatum* against fungi on seed of forest tree species). Buletin Kehutanan Gajah Mada University 37: 2-9.

Widyastuti, S.M., Sumardi, Sulthoni, A. and Harjono. 1998b. Pengendalian hayati penyakit akar merah pada akasia dengan *Trichoderma*. (Biological control of red root rot on *Acacia* using *Trichoderma*). Jurnal Perlindungan Tanaman 4: 65-72.

Wiselius, S.I. 1998. *Ochroma* Sw. *In:* Sosef, M.S.M., Hong, L.T. and Prawirohatmodjo, S. (eds.) Plant resources of South-East Asia No. 5(3) – Timber trees: lesser-known timbers, 414-416. Backhuys Publishers, Leiden.

Wylie, R. *et al*. 1998. Insect pests of tropical acacias: a new project in Southeast Asia and Northern Australia. *In:* Turnbull, J.W., Crompton, H.R. and Pinyopusarerk, K. (eds.) Recent developments in *Acacia* planting. Proceedings of an International Workshop held in Hanoi, Vietnam, 27-30 October 1997, 234-239. ACIAR Proceedings No. 82. ACIAR, Canberra.

Yang, C.K. and Li, F.S. 1983. A preliminary study on Chinese *Pseudophacopteron* with descriptions of three new species (Homoptera, Psyllidae). Wuyi Science Journal 3: 120-128.

Yap, S.K., Sosef, M.S.M. and Sudo, S. 1993. *Gmelina* L. *In:* Soerianegara, I. and Lemmens, R.H.M.J. (eds.) Plant resources of South-East Asia No. 5(1) - Timber trees: major commercial timbers, 215-221. Pudoc Scientific Publishers, Wageningen.

Yemane, A. 1990. Further considerations on pest management of grassland reforestation in the

Philippines. *In:* Hutacharern, C., MacDicken, K.G., Ivory, M.H. and Nair, K.S.S. (eds.) Pests and diseases of forest plantations in the Asia-Pacific Region, 214-218. Regional Office for Asia and the Pacific (RAPA), FAO, Bangkok.

Zethner, O., Jorgensen, J. and Husaeni, E.A. 1996. The current status of diseases and pests of forest tree seeds in South-East Asia, especially diseases in Indonesia. *In:* Prochazkova, Z. and Sutherland, J.R. (eds.) Proceedings of the Tree Seed Pathology Meeting, Opocno, Czech Republic, 9-11 October 1996, 86-94. International Seed Testing Association (ISTA), Switzerland.

Zulfiyah, A. 1998. Gangguan dan ancaman hama terhadap hutan tanaman industri di PT Musi Hutan Persada, Sumatera Selatan (Pest problems and threat on industrial plantation forests in PT Musi Hutan Persada, South Sumatra). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 153-156. Fakultas Kehutanan, Bogor Agricultural University (IPB) dan Departemen Kehutanan, Bogor, Indonesia.

Zulfiah, A. and Gales, K. 1997. Diseases of tropical acacias in South Sumatra. *In*: Old, K.M., Lee, S.S. and Sharma, J.K. (eds.) Diseases of tropical acacias: proceedings of an International Workshop held at Subanjerji (South Sumatra), 28 April-3 May 1996, 48-52. CIFOR Special Publication. CIFOR, Bogor, Indonesia.

Chapter 6

Bibliography of Insect Pests and Diseases

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6.1. Insect pests

1. Adisoemarto, S., Amir, M., Rahayu, A., Anggraitoningsih, W. and Rahayningsih,Y. 1977. The good, the bad and the ugly of forest insects. *In*: Hadi, S., Tarumingkeng, R.C., Suratmo, F.G., Eusebio, M.A., Kirtibutr, N. and Dhanarajan, G. (eds.) Proceedings Symposium on Forest Pests and Diseases in Southeast Asia, 27-32. BIOTROP Special Publication No. 2, BIOTROP, Bogor, Indonesia.
2. Anderson, J.A.R. 1961. Destruction of *Shorea albida* forest by an unidentified insect. Empire Foresrty Review 40: 19-29.
3. Anggraeni, I., Asmaliyah and Suharti, M. 1995. Identification of some pests and diseases of *Acacia mangium*. Technical Information. Pusat Penelitian dan Pengembangan Hutan dan Konservasi Alam, Bogor. 36p.
4. Anwar, C. 1996. Kajian tentang derajat penularan "scale insect" pada tanaman *Rhizophora mucronata* di hutan mangrove Suwung, Bali (Preliminary study on the infestation rate of the scale insect (*Chionaspis* spp.) in *Rhizophora mucronata* plantation in the Suwung mangrove forest, Bali). Buletin Penelitian Hutan 603: 9-18.
5. Apandi, M. and Depari, K.S. 1958. Gangguan hama di hutan *Pinus merkusii* di Sumatra Utara (Pests problem on *Pinus merkusii* forest in North Sumatra). Rimba Indonesia 7(3-4): 417-451.
6. Ardikoesoema, R.I. 1954. Plantation of *Shorea javanica* in Java. Rimba Indonesia 3: 141-151.
7. Asmaliyah and Ismail, B. 1998. Uji pengendalian hama pemakan daun (*Clouges glauculalis*) pada tanaman pulai (*Alstonia scholaris*) dengan insektisida biologi secara in-vitro (In-vitro application of biological insecticides for controlling foliage damage in *A. scholaris* by *C. glauculalis*). Buletin Teknologi Reboisasi 08: 1-10.
8. Asmaliyah and Suharti, M. 1994. Teknik pengenalan beberapa hama di persemaian, tanaman muda dan tua pada hutan tanaman industri (Pest identification technique in nursery, young trees and old trees in industrial plantation forest). Volume 1. Pusat Penelitian dan Pengembangan Hutan dan Konservasi Alam. Bogor. 20p.
9. Asmaliyah, Anggraeni, I. and Suharti, M. 1997. Identification of some pests and diseases of *Pinus merkusii*. Technical Information. Pusat Penelitian dan Pengembangan Hutan dan Konservasi Alam, Bogor. 33p.
10. Austria, E.A. 1978. Patterns of attack and damage by *Neotermes tectonae* Damm. on *Tectona grandis* L.f. plantations. SEAMEO Regional Centre for Tropical Biology, Bogor. 24p.
11. Balfas, J. and Sumarni, G. 1995. Keawetan kayu tusam (*Pinus merkusii* Jungh. et de Vr.) dan mangium (*Acacia mangium* Willd.) setelah furfurilasi (Durability of tusam (*Pinus merkusii*

Jungh. et de Vr.) and mangium (*Acacia mangium* Willd.) after furfurylation). Jurnal Penelitian Hasil Hutan 13(7): 259-265.

12. Beaver, R.S. 1977. Bark and ambrosia beetles in tropical forest. *In*: Hadi, S., Tarumingkeng, R.C., Suratmo, F.G., Eusebio, M.A., Kirtibutr, N. and Dhanarajan, G. (eds.) Proceedings Symposium on Forest Pests and Diseases in Southeast Asia, 133-150. BIOTROP Special Publication No. 2, BIOTROP, Bogor, Indonesia.

13. Chan, H.T., Razani, U. and Putz, F.E. 1984. Study on planting of *Rhizophora* species in an *Avicennia* forest at the Matang Mangroves. *In*: Soemodihardjo, S., Soerianegara, I., Sutisna, M., Kartawinata, K., Supardi, Naamin, N. and Al-Rasyid, H. (eds.) Prosiding Seminar II Ekosistem Mangrove, 340-345. Lembaga Ilmu Pengetahuan Indonesia, Jakarta, Indonesia.

14. Chey, V.K., Holloway, J.D., Hambler, C. and Speight, M.R. 1998. Canopy knockdown of arthropods in exotic plantations and natural forest in Sabah, North-East Borneo, using insecticidal mist-blowing. Bulletin of Entomological Research 88(1): 15-24.

15. Curran, L.M. and Leighton, M. 1991. Why mast? The role of generalised insect and vertebrate seed predators on the reproductive biology of Dipterocarpaceae in the Gunung Palung Nature Reserve, West Kalimantan. *In*: Soerianegara, I., Tjitrosomo, S.S., Umaly, R.C. and Umboh, I. (eds.) Proceedings of the 4th Round Table Conference on Dipterocarps, 541-542. BIOTROP Special Publication No. 41, SEAMEO-BIOTROP, Bogor, Indonesia.

16. Darma, I.G.K.T., Oemijati, R. and Surya, J. 1986. Berbagai jenis hama dan penyakit pada tanaman *Acacia mangium* Willd. di Subanjeriji, Sumatra Selatan (Some pests and diseases in *Acacia mangium* in Subanjeriji, South Sumatra). *In*: Prosiding Seminar Nasional Ancaman terhadap HTI, 20 December 1986, Jakarta, 108-113. FMIPA dan Departemen Kehutanan. Inhutani I, Jakarta.

17. Dennis, J.J.C., Prior, R.N.B., Saul, J.K. and Konam, J.K. 1995. Comparative observations on control of some pests and diseases of cocoa common to Indonesia, Malaysia and Papua New Guinea. Cocoa Growers' Bulletin 49: 41-51.

18. Elouard, C. 1998. Pests and diseases of Dipterocarpaceae. *In*: Appanah, S. and Turnbull, J.M. (eds.) A review of Dipterocarps: Taxonomy, ecology and silviculture, 115-131. CIFOR and FRIM, Bogor.

19. Fatah, A.D.S. 1983. Eradication of *Mikania micrantha* in East Java by the State Forest Corporation (Perhutani). *In*: de Guzman, E.D. and Nuhamara, S.T. (eds.) Forest pests and diseases in Southeast Asia, 44-54. BIOTROP Special Publication No. 20, BIOTROP, Bogor, Indonesia.

20. Field, S.P., Momuat, E.O., Smith, R.A. and Bamualim, A. 1992. Developing land rehabilitation technologies compatible with farmer needs and resources. Journal of the Asian Farming Systems Association 1(3): 385-394.

21. Hadi, S. 1986. Pendekatan biologi pengendalian gangguan hutan tanaman industri (Biological approach to control industrial plantation forest disturbance). *In*: Prosiding Seminar Nasional Ancaman terhadap HTI, 20 December 1986, Jakarta, 29-37. FMIPA dan Departemen Kehutanan. Inhutani I, Jakarta.

22. Hadi, S., Tarumingkeng, R.C., Suratmo, F.G., Eusebio, M.A., Kirtibutr, N. and Dhanarajan, G. (eds.) 1977. Proceedings Symposium on Forest Pests and Diseases in Southeast Asia, April 20-23, 1976, Bogor, Indonesia. BIOTROP Special Publication No. 2, BIOTROP, Bogor, Indonesia. 225p.

23. Hallsworth, E.G. 1986. Resources for the future: Measuring and managing of the ultimate limit to growth. ILRI 40: 51-63.

24. Hanafi, S. 1991. Masalah hama dan penyakit pada Hutan Tanaman Industri di wilayah Perum Perhutani (Pest and diseases problem in Perum Perhutani area). *In*: Hadi, S., Rachmatsyah, O. and Nuhamara, S.T. (eds.) Proceedings Seminar Nasional Peningkatan Produktivitas Hutan Tanaman Industri melalui Upaya Pengendalian Hama dan Penyakit secara Terpadu, 113-119. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

25. Hardi, T.T.W. 1986. Informasi beberapa hama hutan tanaman industri. (Information on pests in industrial plantation forest). *In*: Prosiding Seminar Nasional Ancaman terhadap HTI, Jakarta 20 December 1986, 76-86. FMIPA dan Departemen Kehutanan. Inhutani I, Jakarta.

26. Hardi, T.T.W. 1993. Beberapa jenis hama pada persemaian Hutan Tanaman Industri (Some pests at timber estate nurseries). Buletin Penelitian Hutan 554: 19-36.

27. Hardi, T.T.W. 1995. Percobaan pencegahan serangan rayap tanah pada *Acacia mangium* (A preventative measure against subterranean termite attack on *Acacia mangium*). Buletin Penelitian Hutan 584: 29-37.

28. Hardi, T.T.W. 1997. Serangan hama mangrove dan tingkat kerusakannya di hutan mangrove DKI Jakarta (Pest attack and damage level of mangrove forest in DKI Jakarta). Buletin Penelitian Hutan 608: 37-49.

29. Hardi, T.T.W. and Asmaliyah. 1993. Inventarisasi hama pada tanaman *Acacia mangium* dan *Paraserianthes falcataria* di Subanjeriji (A pest inventory of *Acacia mangium* and *Paraserianthes falcataria* plantations at Subanjeriji). Buletin Penelitian Hutan 555: 33-43.

30. Hardi, T.T.W. and Asmaliyah. 1995. Hama penggerek batang *Gmelina arborea* (Bark beetle pest of *Gmelina arborea*). Jurnal Penelitian dan Pengembangan Kehutanan 10(1): 12-16.

31. Hardi, T.T.W. and Darwiati, W. 1996. Pengendalian hama kupu kuning secara biologi (Biological approach to control *Eurema* sp.). Info Hutan No. 66. Pusat Penelitian dan Pengembangan Hutan dan Konservasi Alam, Bogor.

32. Hardi, T.T.W. and Intari, S.E. 1990. Pengendalian hama pada tegakan HTI (Pest control in industrial plantation forest). *In*: Buharman, Purba, K. and Hediana, C. (eds.) Proceedings Diskusi Hutan Tanaman Industri, Jakarta 13-14 Maret 1990, 177-186. Badan Litbang Kehutanan Departemen Kehutanan, Jakarta.

33. Hardi, T.T.W., Husaeni, E.A., Darwiati, W. and Nurtjahjawilasa. 1996. Studi morfologi dan morfometrik imago *Xystocera festiva* Pascoe (A study of the morphology and morphometrics of adults of *Xystrocera festiva* Pascoe). Buletin Penelitian Hutan 604: 39-48.

34. Husaeni, E.A. 1993. Hama hutan di Indonesia (Forest pests in Indonesia). Fakultas Kehutanan, Institut Pertanian Bogor, Bogor, Indonesia. 119p.

35. Husaeni, E.A., Kasno and Haryadi, M. 1998. Pengendalian *Xystrocera festiva* Pascoe (Cerambycidae, Coleoptera) dengan menggunakan lampu perangkap (Light trapping as a means to control of *Xystrocera festiva* Pascoe (Cerambycidae, Coleoptera)). Jurnal Manajemen Hutan Tropica 3: 23-30.

36. Husaeni, E.A., Kasno and Suratmo, F.G. 1988. Penelitian hama ekaliptus (*Eucalyptus* spp.) di Hutan Tanaman Industri PT Inti Indo Rayon Utama Sumatra Utara (Experiment on *Eucalyptus* spp. pest in Industrial Plantation Forest of PT Indo Rayon Utama, North Sumatra). Fakultas Kehutanan, Institut Pertanian Bogor, Bogor, Indonesia.

37. Intachat, J. 1998. The identity of a Malaysian teak skeletonizer, *Paliga damastesalis* Walker (Lepidoptera: Pyralidae). Journal of Tropical Forest Science 10(4): 561-563.

38. Intari, S.E. 1975. Hasil pengamatan hama oleng-oleng (*Duomitus ceramicus* Wlk.) pada tegakan jati di KPH Kendal dan Ciamis (Observations on beehole borer (*Duomitus ceramicus*) in teak plantations in Kendal and Ciamis forest districts, Java). Laporan Lembaga Penelitian Hutan No. 204, Bogor. 14p.

39. Intari, S.E. 1976. Pengaruh inger-inger (*Neotermes tectonae* Damm) terhadap kualita dan kuantita kayu jati (Effect of *Neotermes tectonae* Damm on quality and quantity of teak timber). Laporan Pusat Penelitian dan Pengembangan Hutan No. 444, Bogor.

40. Intari, S.E. 1979. Termite community in cayeput plantation at Urug, Tasikmalaya. Laporan Lembaga Penelitian Hutan No. 311, Bogor.

41. Intari, S.E. 1982. A trial using Dimecron to control case worm *Acanthopsyche* sp. attacking *Bruguiera* spp. in Tritin Cilacap, Central Java. Laporan Balai Penelitian Hutan No. 386, Bogor.

42. Intari, S.E. 1984. Pengaruh serangan inger-inger (*Neotermes tectonae* Damm) terhadap kualitas dan kuantitas kayu jati (Effect of *Neotermes tectonae* attack on the quality and quantity of teak timber). Pusat Penelitian dan Pengembangan Hutan 444-447: 1-13.

43. Intari, S.E. 1986a. Pengaruh serangan *Milionia basalis* terhadap produksi getah *Pinus merkusii* di Harangan Ganjang, Sumatera Utara (Effects of *Milionia basalis* attack on resin production of *Pinus merkusii* at Harangan Ganjang, North Sumatra). Buletin Penelitian Hutan 474: 53-58.

44. Intari, S.E. 1986b. Percobaan efikasi insektisida terhadap kumbang *Chaetocnema* sp. pada tanaman *Bruguiera* spp. di Tritih, Cilacap, Jawa Tengah (Efficacy of some insecticides on *Chaetocnema* sp. beetles attacking leaves of *Bruguiera* spp. in Tritih, Cilacap, Central Java). Buletin Penelitian Hutan 477: 1-6.

45. Intari, S.E. 1990. Pengaruh serangan inger-inger (*Neotermes tectona* Damm) terhadap kualitas kayu jati di KPH Kebonharjo, Jawa Tengah (Effects of *Neotermes tectonae* Damm on the quality of teak timber in Kebonharjo forest district, Central Java). Buletin Penelitian Hutan 530: 25-35.

46. Intari, S.E. 1991a. Efikasi beberapa insektisida sistemik terhadap hama penggerek pucuk rotan (*Macrochirus praetor* Gyll) (Efficacy of some systemic insecticides for the rattan top borer (*Macrochirus praetor* Gyll)). Buletin Penelitian Hutan 539: 25-34.

47. Intari, S.E. 1991b. Pengaruh naungan terhadap serangan hama penggerek pucuk rotan (The effect of shade on rattan top borer). Buletin Penelitian Hutan 537: 37-41.

48. Intari, S.E. 1993. Pengendalian hama biji meranti dengan insektisida sistemik (Control of seed meranti pests using systemic insecticide). Buletin Penelitian Hutan 556: 41-49.

49. Intari, S.E. 1995a. Hama hutan tanaman industri dan cara pengendaliannya (Pests of industrial plantation forest and its control). Rimba Indonesia 30(4): 31-39.

50. Intari, S.E. 1995b. Percobaan pengendalian hama kumbang yang menyerang tanaman albisia (*Paraserianthes falcataria*) di Kecamatan Citeureup, Bogor (An experiment to control beetle pests attacking *Paraserianthes falcataria* in Citeureup district, Bogor). Duta Rimba 20: 175-176.

51. Intari, S.E. 1996. Percobaan pengendalian hama kepik *Mucanum* sp. yang merusak bibit *Shorea javanica* di Krui, Lampung Barat (Control trial of *Mucanum sp*. causing damage to seedlings of *Shorea javanica* in Krui, West Lampung). Buletin Penelitian Hutan 604: 31-37.

52. Intari, S.E. 1997. Pengendalian hama kutu sisik (*Chionaspis* sp.) yang menyerang tanaman mangrove di Bali (The control of *Chionaspis* sp. attack on mangrove forest in Bali). Buletin Penelitian Hutan 605: 19-26.

53. Intari, S.E. and Amir, M. 1975. Pengamatan terhadap serangan inger-inger, *Neotermes tectonae* Damm, di KPH Mantingan dan percobaan pemberantasannya dengan phostoxine (Observation on the attack of *Neotermes tectonae* Damm on teak plants and a trial on the use of phostoxine to control them in Mantingan forest district). Laporan Lembaga Penelitian Hutan No. 198, Bogor. 18p.

54. Intari, S.E. and Misran. 1977. Siklus hidup dan daerah sebaran *Dioryctria* sp. di Sumatra (Life cycle and geographical distribution of *Dioryctria* sp. in Sumatra). Laporan Lembaga Penelitian Hasil Hutan No. 248, Bogor. 23p.

55. Intari, S.E. and Natawiria, D. 1973. White grubs in forest tree nurseries and young plantations. Laporan Lembaga Penelitian Hutan No. 167, Bogor. 22p.

56. Intari, S.E. and Natawiria, D. 1976. Percobaan pencegahan serangan rayap pada tanaman *Eucalyptus alba* Reinw. dengan insektisida hidrokarbon-khlor (A trial of chlorinated hydrocarbon insecticides to prevent termite

attack on young plants of *Eucalyptus alba*). Laporan Lembaga Penelitian Hutan No. 229, Bogor. 11p.

57. Intari, S.E. and Ruswandy, H. 1986. Preferensi *Dioryctria* sp. terhadap tiga jenis pinus (Preferences of *Dioryctria* sp. about three species of pines). Buletin Penelitian Hutan 479: 44-48.

58. Intari, S.E. and Santoso, E. 1990. Pola tanam HTI sebagai usaha penanggulangan hama dan penyakit (Planting pattern of industrial plantation forest as an effort to control pests and diseases). *In*: Buharman, Purba, K. and Hediana, C. (eds.) Proceedings Diskusi Hutan Tanaman Industri, 13-14 Maret 1990, Jakarta, 85-94. Badan Litbang Kehutanan Departemen Kehutanan, Jakarta.

59. Intari, S.E. and Wiriadinata, Y.A.P. 1984. Percobaan pencegahan serangan rayap pada tanaman kayu putih dengan insektisida dan cara sanitasi di Gundih, Jawa Tengah (Preventive trial on termite attack to cajuput (*Melaleuca leucadendron*) by using insecticides and sanitation method in Gundih, Central Java). Laporan Pusat Penelitian dan Pengembangan Hutan No. 433, Bogor. 11p.

60. Intari, S.E., Santoso, E. and Sophie, M.M. 1995. Percobaan pengendalian hama rayap dan penyakit busuk akar yang menyerang tanaman sonokeling di kecamatan Wanayasa, Purwakarta (An experiment to control termites and root rot diseases attacking the *Dalbergia latifolia* plantation in Wanayasa district, Purwakarta, West Java). Duta Rimba 20: 179-180.

61. Irianto, R.S.B., Matsumoto, K. and Mulyadi, K. 1997. The yellow butterfly species of the genus *Eurema* Hubner causing severe defoliation in the forestry plantations of albizia, *Paraserianthes falcataria* (L.) Nielsen, in the western part of Indonesia. JIRCAS Journal 4: 41-49.

62. Ismanto, A. 1990. Several rattan destroying powder post beetles and their prevention methods. Duta Rimba 16: 115-116.

63. Janzen, D.H. 1974. Tropical backwater rivers, animals and mast fruiting by the Dipterocarpaceae. Biotropica 6: 69-103.

64. Kalshoven, L.G.E. 1953a. Important outbreaks of insect pests in the forests of Indonesia. *In*: Transactions of the 9th International Congress of Entomology, Amsterdam, 17-24 August, 1951, 229-234. Volume 2. W. Junk, The Hague.

65. Kalshoven L.G.E. 1953b. Survival of *Neotermes* colonies in infested teak trunks after girdling or felling of the trees (Second Communication). Tectona 43: 59-74.

66. Kalshoven, L.G.E. 1959. Studies on biology of Indonesian Scolytidie 4. Data on the habits of Scolytidae. Second part. Tijdschrift voor Entomologie 102 (2): 135-173.

67. Kalshoven, L.G.E. 1981. Pests of crops in Indonesia. van der Laan, P.A. (rev. and trans.) PT Ichtiar Baru-Van Hoeve, Jakarta. Translation of: De Plagen van de Cultuurgewassen in Indonesië.

68. Kasno and Husaeni, E.A. 1998. An integrated control of sengon stem borer in Java. Paper to IUFRO S7.03.09 Workshop on Pest Management in Tropical Forest Plantations, Chanthaburi Province, Thailand, 25-29 May 1998. 8p.

69. Kertadikara, A.W.S. 1998. Penggunaan teknik biologi molekuler untuk pemuliaan sifat ketahanan terhadap hama dan penyakit (Use of moleculer biology technique for resistance characteristic improvement to pests and diseases). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 77-86. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

70. Kiman, Z.B. 1983. Termites associated with *Agathis dammara* (Lamb.) L.C. Rich. plantation in Java. *In*: de Guzman, E.D. and Nuhamara, S.T. (eds.) Forest Pests and Diseases in Southeast Asia, 55-74. BIOTROP Special Publication No. 20, BIOTROP, Bogor, Indonesia.

71. Kokubo, A. 1987. Mortality factors in seed of the Dipterocarpaceae (preliminary study). Tropical Forestry 8: 21-25.

72. Komariah, E. 1985. Serangan serangga pada batang tegakan *Gmelina arborea* di PT ITCI Balikpapan (Attack of insect on *Gmelina arborea* in PT ITCI Balikpapan). Thesis, Fakultas Kehutanan, Universitas Mulawarman, Samarinda, Indonesia.

73. Liem, J.S. 1983. The presence of a periodicity in the occurance of vertebrate pests in East Kalimantan: A preliminary report. *In*: de Guzman, E.D. and Nuhamara, S.T. (eds.) Forest Pests and Diseases in Southeast Asia, 138-153. BIOTROP Special Publication No. 20, BIOTROP, Bogor, Indonesia.

74. Mangundikoro, A. and Depari, K.S. 1958. Gangguan hama di hutan *Pinus merkusii* di Sumatra Utara (Insect and fungus disturbance to *Pinus merkusii* forest in North Sumatra). Rimba Indonesia 7: 417-451.

75. Matsumoto, K. 1994. Studies on the ecological characteristics and methods of control of insect pests of trees in reforested areas in Indonesia. Final Report submitted to Agency for Forestry Research and Development. Ministry of Forestry, Indonesia. 63p.

76. Matsumoto, K. and Irianto, R.S.B. 1998. Adult biology of the albizia borer, *Xystrocera festiva* Thomson (Coleoptera: Cerambycidae), based on laboratory breeding, with particular reference to its oviposition schedule. Journal of Tropical Forest Science 10(3): 367-378.

77. Matsumoto, K., Mulyadi, K. and Irianto, R.S.B. 1997. A promising method to protect mahogany plantations from attack by the shoot borer, *Hypsipyla robusta* Moore (Lepidoptera: Pyralidae). JIRCAS Journal 5: 23-29.

78. Messer, A.D., Wanta, N.N. and Sunjaya. 1992. Biological and ecological studies of *Calliteara cerigoides* (Lepidoptera, Lymantriidae), a polyphagous defoliator of Southeast Asian Dipterocarpaceae. Japanese Journal of Entomology 60(1): 191-202.

79. Mieke, S. 1994. Some pests and diseases of forest timber estate in Indonesia. *In*: Rehabilitation of degraded forest lands in the tropics, 158-162. JIRCAS International Symposium Series 1, JIRCAS, Japan.

80. Morgan, F.D. and Suratmo, F.G. 1976. Host preferences of *Hypsipyla robusta* (Moore) (Lepidoptera: Pyralidae) in West Java. Australian Forestry 39(2): 103-112.

81. Natawiria, D. 1969. Timbulnya hama dan penyakit di hutan Indonesia (The apprearance of pest and diseases in Indonesian forest). Laporan Lembaga Penelitian Hutan No. 100, Bogor. 14p.

82. Natawiria, D. 1975. Hama dan penyakit *Albizzia falcataria* Fosb. (Pests and diseases of *Albizzia falcataria* Fosb.). Rimba Indonesia 17(1-2): 58-69.

83. Natawiria, D. 1986. Ancaman hama dan penyakit terhadap hutan tanaman (Threat on pests and diseases to plantation forests). *In*: Prosiding Seminar Nasional Ancaman terhadap HTI, 20 December 1986, Jakarta, 69-74. FMIPA dan Departemen Kehutanan. Inhutani I, Jakarta.

84. Natawiria, D. and Miseran. 1981. Siklus hidup, pertelaan dan daerah sebaran kerawai tusam di Sumatera Utara (Life cycle, description and distribution of tusam sawfly in North Sumatra). Laporan Balai Penelitian Hutan No. 368, Bogor. 27p.

85. Natawiria, D. and Tarumingkeng, R.C. 1971. Some important pests of forest trees in Indonesia. Rimba Indonesia 16(3-4): 151-165.

86. Natawiria, D., Kosasih, A.S. and Mulyana, A.D. 1986. Beberapa jenis serangga hama buah Dipterocarpaceae (Some insect pests of dipterocarp seeds). Buletin Penelitian Hutan 472: 1-8.

87. Natawiria, D., Soeyamto, C.H. and Mardji, D. 1986. Penelitian hama dan penyakit di persemaian (Research on pests and diseases in nursery). Badan Litbang Kehutanan, Universitas Mulawarman, Samarinda.

88. Ngatiman. 1990. Pengendalian hama dan penyakit tanaman HTI (Pest and disease control in industrial forest plantations). *In*: Buharman, Purba, K. and Hediana, C. (eds.) Proceeding Diskusi Hutan Tanaman Industri, 13-14 Maret 1990, Jakarta, 231-240. Badan Litbang Kehutanan Departemen Kehutanan, Jakarta.

89. Ngatiman and Tangketasik, J. 1987. Some insect pests on trial plantation of PT ITCI, Balikpapan, East Kalimantan, Indonesia. Wanatrop 2(1): 41-53.

90. Notoatmodjo, S.S. 1963. Cara-cara mencegah serangan masal dan boktor *Xystrocera festiva* Pascoe pada tegakan *Albizia falcataria* (Preventive way of massive attack of *X. festiva* to *A. falcataria*). Laporan Lembaga Penelitian Hutan No. 92, Bogor. 12p.

91. Nobuchi, A. and Hariyono. 1987. Insect pests of plantation trees at the trial plantation project (ATA-186) in Benakat, South Sumatra. Japan International Cooperation Agency.

92. Ohno, S. 1990a. The Scolytidae and Platypodidae (Coleoptera) from Borneo found in logs at Nagoya port I. Research Bulletin of the Plant Protection Service, Japan 26: 83-94.

93. Ohno, S. 1990b. The Scolytidae and Platypodidae (Coleoptera) from Borneo found in logs at Nagoya port II. Research Bulletin of the Plant Protection Service, Japan 26: 95-103.

94. Palokangas, E. 1996. *Acacia mangium* in pulp and paper production. *In*: Otsamo, A., Kuusipalo, J. and Jaskari, H. (eds.) Reforestation: Meeting the future industrial wood demand, 24-26. Proceedings of a Workshop held in Jakarta, 30April-1 May 1996. Enso Forest Development Oy Ltd, Jakarta.

95. Partua, Jr.P.C. 1966. Beetle problems in logging area, sawmills and plywood plans in Mindanao. Forest. Prod. Entomol. 1(4): 38-39.

96. Pearce, M.J. 1987. *Antennopsis gayi* Buchli. parasitises a termite pest species in Dumoga-Bone National Park, Sulawesi. Antenna 11(3): 89.

97. Pramono, S., Sudarsono, H. and Sudiono. 1998. Pengendalian penggerek batang jati putih dengan minyak pelumas bekas (Control of stem borer of *Gmelina* using used lubricant). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 95-97. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

98. Prat, A.W. and Haneda, N.F. 1999. Studi mekanisme toleransi leda (*Eucalyptus deglupta* Blume) terhadap penggerek batang (*Zeuzera coffeae*) untuk menunjang pemuliaan jenis (Mechanism study for tolerance of *Eucalyptus deglupta* Blume to bark beetle (*Zeuzera coffeae*) to support tree improvement. Jurnal Manajemen Hutan Tropika I(1-2):47-54.

99. Rachmatsyah, O. 1983. Harmful insects in Pasir awi Experimental Garden. *In*: de Guzman, E.D. and Nuhamara, S.T. (eds.) Forest Pests and Diseases in Southeast Asia, 110-116. BIOTROP Special Publication No. 20, BIOTROP, Bogor, Indonesia.

100. Rachmatsyah, O.1990. Studi dinamika populasi serangga pada hutan tanaman industri dan hutan alam tropika dalam rangka pengendalian hama terpadu (Study of insect population dynamic in industrial plantation forest and natural forest in conjunction with integrated pest control). Laporan Penelitian. Fakultas Kehutanan IPB, Bogor. 30p.

101. Rachmatsyah, O. and Haneda, N.F. 1998. Jenis-jenis serangga hama potensial pada hutan tanaman di Indonesia (Some potential pests in Indonesian plantation forest). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 167-170. Fakultas Kehutanan IPB dan Departemen Kehutanan. Bogor.

102. Rahardjo, A.W.B. 1992a. Early warning system: Suatu metoda pengendalian *Helopeltis* sp. pada tanaman *Eucalyptus* sp. (Early warning system: A method to control pest *Helopeltis* sp. in

Eucalyptus sp. plantations). Duta Rimba 18: 149-150.

103. Rahardjo, A.W.B. 1992b. *Helopeltis antonii* (Hemiptera: Miridae) hama pucuk pada tanaman *Eucalyptus* (*Helopeltis antonii* (Hemiptera: Miridae), a pest of *Eucalyptus* buds). Duta Rimba 18: 145-146.

104. Raharjo, A.W.B. 1993. *Xystrocera festiva*: Hama penggerek batang tanaman sengon (*Xystrocera festiva*: Bark beetle on *P. falcataria* plantation). Duta Rimba 19: 151-152.

105. Rahayu, S., Subyanto and Kuswanto. 1998. The occurrence of pest and disease of *Shorea* spp. - A preliminary study in Wanariset and Bukit Soeharto Forest Area in East Kalimantan, Indonesia. *In*: Sabarnudin, H.M.S., Suhardi and Okimori, Y. (eds.) Proceedings of the Seminar on Ecological Approach for Productivity and Sustainability of Dipterocarp Forests, 53-57. Faculty of Forestry, Gadjah Mada University, Yogyakarta, Indonesia and Kansai Environmental Engineering Center, Kyoto, Japan.

106. Rhainds, M., Gries, G. and Saleh, A. 1998. Density and pupation site of apterous female bagworms, *Metisa plana* (Lepidoptera: Psychidae), influence the distribution of emergent larvae. Canadian Entomologist 130(5): 603-613.

107. Riyantoko, A. 1998. Sistem silvikultur intensif sebagai upaya meningkatkan produktivitas tegakan serta perlindungan dari serangan hama dan penyakit (Intensive silviculture system as an effort to improve stand productivity and protection from the attack of pests and diseases). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 157-165. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

108. Roonwal, M.L. and Maiti, P.K. 1966. Termites from Indonesia including West Irian. Treubia 27: 63-140.

109. Rostaman. 1997. Hama dan penyakit tanaman cendana di Kabupaten Kupang (Pests and diseases of sandalwood in Kupang regency). Duta Rimba 23: 209-210.

110. Ruga, A. CH. 1991. Beberapa hama dan penyakit pada tanaman *Eucalyptus deglupta* dan *Acacia mangium* di Proyek HTI PT ITCI Kenangan, Balikpapan (Some pest and disease on *Eucalyptus deglupla* and *Acacia mangium* in Kenangan HTI Project of PT ITCI, Balikpapan). *In*: Hadi, S., Rachmatsyah, O. and Nahamara, S.T. (eds.) Peningkatan Produktivitas Hutan Tanaman Industri melalui Upaya Pengendalian Hama dan Penyakit Secara Terpadu, 107-112. Prosiding Seminar National di Bogor 30 Juli 1991. Fakultas Kehutanan IPB dan Departemen Kehutanan, Indonesia.

111. Saharjo, B.H. 1995. *Acacia mangium*: Amankah dari gangguan? (*Acacia mangium*: Safe from problem?) Rimba Indonesia XXX(3): 40-50.

112. Santoso, E. and Hardi, T. 1991. Pengendalian hama dan penyakit di hutan tanaman industri Kalimantan Timur (Pest and disease control of timber estates in East Kalimantan). Jurnal Penelitian dan Pengembangan Kehutanan 7(1): 14-17.

113. Sastrodihardjo, S. 1986. Masalah serangga hama dalam kaitannya dengan stabilitas ekosistem (Insect pests problems in their relation with ecosystem stability). *In*: Prosiding Seminar Nasional Ancaman terhadap HTI, 20 December 1986, Jakarta, 26-28. FMIPA dan Departemen Kehutanan. Inhutani I, Jakarta.

114. Sidabutar, H. and Natawiria, D. 1974. Aspek serangan hama *Dioryctria* sp. pada *Pinus merkusii* di Sumatra Utara dan Aceh (Aspect of *Dioryctria* sp. attack on *Pinus merkusii* in North Sumatra and Aceh). Laporan Lembaga Penelitian Hutan No. 183, Bogor.

115. Sitepu, I.R. and Suharti, M. 1998. Pest and disease management in industrial forest plantations in Indonesia. *In*: Nambiar, E.K.S., Gintings, A.N., Ruhiyat, D., Natadiwirya, M., Harwood, C.E. and Booth, T.H. (eds.) Sustained productivity of short and medium rotation plantation forests for commercial and community benefit in Indonesia - An analysis of research priorities, 39-47. Proceedings of a Workshop held at Bogor, Indonesia, 6-7 May 1998. CSIRO Forestry and Forest Products, Australia.

116. Sitepu, I.R. and Wibowo, A. 1998. Hama hutan tanaman industri: Alternatif teknik pengendalian selain insektisida sintetik (Pest in industrial plantation forests: Alternative for controlling technique beside synthetic insecticides). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 63-76. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

117. Soehardjan, S. and Soehardjan, M. 1989. Population development study of *Curinus coeruleus* at Cimanggu experimental garden, Bogor. Industrial Crops Research Journal 2(1): 36-41.

118. Soepangkat, S. 1998. Program penanggulangan hama pada HTI-trans PT Hutan Kusuma (Protection programme for pests in IPF-trans PT Hutan Kusuma). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 49-54. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

119. Soepardi, R. 1958. Penyakit dan hama *Pinus merkusii* hama serangan di tanah Gayo (*Pinus merkusii* pests and diseases of in Gayo land). Rimba Indonesia 7(3-4): 264-277.

120. Soepardi, R. 1976. Hutan dan penyakit *Pinus merkusii* di tanah Gayo (Pest and diseases of *Pinus merkusii* in Gayo land). Gema Rimba 3(15): 20-27.

121. Soeyamto, C.H. and Mardji, D. 1986. Hama dan penyakit pada persemaian dan tegakan hutan tanaman industri (Pests and diseases in nursery and stands of industrial plantation forest). *In*: Prosiding Seminar Nasional Ancaman terhadap HTI, 20 December 1986, Jakarta, 100-107. FMIPA dan Departemen Kehutanan. Inhutani I, Jakarta.

122. Subyanto. 1989. Pengendalian hama inger-inger (*Neotermes tectonae* Damm.) (Isoptera: Kalotermitidae) pada tegakan jati (*Tectona grnadis* L. f.) dengan insektisida Fastac 15 EC (Control of *Neotermes tectonae* Damm. (Isoptera: Kalotermitidae) on teak used insectiside Fastac 15 EC). Fakultas Kehutanan UGM. Pen. No. UGM/58/M/09/01. Yogyakarta, Indonesia.

123. Subyanto. 1992. Masalah hama inger-inger (*Neotermes tectonae* Damm.) serta pengaruhnya terhadap pertumbuhan dan produksi kayu perkakas pohon yang diserang (Problem of *Neotermes tectonae* Damm. and the impact on growth and timber production of attacked tree). Fakultas Kehutanan UGM. Pen. No. UGM/7810/M/05/01. Yogyakarta, Indonesia.

124. Subyanto, Sultoni, A. and Musyafa. 1992. Inger-inger (*Neotermes tectonae* Damm.): One of the problems on teak management in Central Java. *In*: Simon, H. (ed.) One century of sustainable forest management with special reference to teak in Java, 209-212. Proceedings of an International Symposium on Sustainable Forest Management. Perum Perhutani and Gadjah Mada University, Yogyakarta, Indonesia.

125. Suharti, M. 1976. The intensity of *Loranthus* spp. attack on stands in Central Java in relation to the age and site classes. Laporan Lembaga Penelitian Hutan No. 238, Bogor.

126. Suharti, M. and Intari S.E. 1974. Pedoman pengenalan hama dan penyakit pada jati (*Tectona grandis* L.f.) (Guide to identify pest and disease on teak (*Tectona grandis* L.f.)). Laporan Lembaga Penelitian Hutan No. 182, Bogor.

127. Suharti, M. and Santoso, S. 1990. Perilaku dan persentase serangan penggerek pucuk mahoni di Jawa (Behaviour and percentage of attack by the mahogany shoot borer in Java). Buletin Penelitian Hutan 529: 37-45.

128. Suharti, M. and Sitepu, I.R. 1997. Some important pests and diseases of forest plantation in Indonesia. *In*: Nasendi, B.D. (ed.) A state-of-the art report on some recent forestry policies, initiatives and achievements in Indonesia: Concepts, strategies and actions for sustainable forest management and forestry development towards 21st century, 39-45. Ministry of Forestry of the Republic of Indonesia, Jakarta.

129. Suharti, M., Asmaliyah and Hawiati, W.P. 1995. Tanaman mimba (*Azadirachta indica*) sebagai sumber insektisida nabati dalam pengendalian hama tanaman hutan (Neem (*Azadirachta indica*) trees as a natural insecticide resource to control forest pests). Buletin Penelitian Hutan 589: 1-26.

130. Suharti, M., Asmaliyah and Sitepu, I.R. 1998. Control of *Xystrocera festiva* stem borer of *Paraserianthes falcataria* using *Beauveria bassiana*. Buletin Penelitian Kehutanan 613: 18-29.

131. Suharti, M., Hardi, T. and Irianto, B. 1991. Mengenal beberapa hama dan penyakit penting pada tanaman HTI (Identification of important pests and diseases in industrial plantation forest). *In*: Hadi, S., Rachmatsyah, O. and Nahamara, S.T. (eds.) Peningkatan Produktivitas Hutan Tanaman Industri melalui Upaya Pengendalian Hama dan Penyakit Secara Terpadu, 97-106. Prosiding Seminar National di Bogor 30 Juli 1991. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

132. Suharti, M., Irianto, B. and Santosa, S. 1994. Perilaku hama penggerek batang sengon *Xystrocera festiva* Pascoe dan teknik pengendalian secara terpadu (Behaviour of the stem borer *Xystrocera festiva* Pascoe of *Paraserianthes falcataria* and the technique for integrated control). Buletin Penelitian Hutan 558: 39-53.

133. Suharti, M., Asmaliyah, Anggraeni, I. and Sitepu, I.R. 1998. Prospek cendawan *Beuveria bassiana* (Balsamo) Vuillemin sebagai agen pengendali biologi hama penggerek batang sengon (Prospect of *Beauveria bassiana* as biocontrol agent of *Paraserianthes falcataria* stem borer). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 55-62. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

134. Suhendi, D. and Sembiring, S. 1998. Permasalahan dan strategi pengelolaan hama *Eurema* sp. (kupu kuning) di HTI PT Kiani Hutani Lestari (Problem and strategy for managing *Eurema* sp. in HTI PT Kiani Hutani Lestari). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 37-48. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

135. Sukartana, P. 1995. Serangan serangga perusak pada contoh kayu di gudang Pusat Penelitian dan Pengembangan Hasil Hutan dan Sosial Ekonomi Kehutanan Bogor (Attack by deteriorating insects on wood samples in storeroom of Forest Products and Forestry Socio-economics Research and Development Centre, Bogor). Jurnal Penelitian Hasil Hutan 13(3): 118-126.

136. Sukartana, P. 1996a. Laju serangan kumbang penggerek lubang jarum pada enam jenis kayu Hutan Tanaman Industri (Infestation rate of pinhole borers on some timber species of the Industrial Plantation Forest). Duta Rimba 20: 193-194.

137. Sukartana, P. 1996b. Suatu monograf hasil penelitain 1978-1994: kerentanan dolok ramin (*Gonystylus bancanus* Kurz.) terhadap kumbang ambrosia (Forest products monograph 1978-1994: damage to ramin (*Gonystylus bancanus* Kurz.) by ambrosia beetles). Info Hasil Hutan 3(2): 1-11.

138. Sulthoni, A. 1986. Permasalahan perlindungan tanaman pada hutan tanaman industri dan kaitannya dengan teknologi maju (Issues on plant protection in industrial plantation forest and its relation with advance technology). *In*: Prosiding Seminar Nasional Ancaman terhadap HTI, 20 December 1986, Jakarta, 20-25. FMIPA dan Departemen Kehutanan. Inhutani I, Jakarta.

139. Sulthoni, A. 1998. Masalah dan strategi pengelolaan hama di hutan tanaman (Issues and strategies for pest management in plantation forest). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T.

and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 3-10. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

140. Sumadiwangsa, S. 1997. Kayu gaharu komoditi elit di Kalimantan Timur (Agarwood as a high-value commodity in East Kalimantan). Duta Rimba 20: 205-206.

141. Suparta, O. 1986. Intensitas serangan hama *Dioryctria* sp. pada kompleks hutan tanaman *Pinus merkusii* Jungh et de Vr di Aek na Uli, KPH Simalungun, Propinsi Sumatera Utara (Pest disturbance intensity of *Dioryctria* sp. at *Pinus merkusii* plantation forest complex in Aek Na Uli, Sumalungun forest district, North Sumatra). Buletin Penelitian Hutan 2(1): 1-10.

142. Suparta, O. 1990. Serangan hama penggerek pucuk *Hysiphyla robusta* Moore pada tanaman muda mahoni (*Swietenia macrophylla* King) di PT SSPI, Kabupaten Labuan Batu, Sumatra Utara (Attack of *H. robusta* M. shoot borer pest on mahogany plantation (*Swietenia macrophylla* King) at the PT SSPI, Labuan Batu, North Sumatra). Buletin Penelitian Kehutanan 6(3): 149-160.

143. Supriana, N. and Natawiria, D. 1987a. Forest pests and diseases in Indonesia. *In*: de Guzman, E.D. and Nuhamara, S.T. (eds.) Forest Pests and Diseases in Southeast Asia, 21-41. BIOTROP Special Publication No. 26, SEAMEO-BIOTROP, Bogor, Indonesia.

144. Supriana, N. and Natawiria, D. 1987b. Current potential pine forest pests in Indonesia: A particular case in North Sumatra. *In*: de Guzman, E.D. and Nuhamara, S.T. (eds.) Forest Pests and Diseases in Southeast Asia, 139-145. BIOTROP Special Publication No. 26, SEAMEO-BIOTROP, Bogor, Indonesia.

145. Supriana, N., Tarumingkeng, R., Wardoyo, S. and Turngadi, A. 1978. Intensity and range of ambrosia beetle infestation on ramin (*Gonystylus bancanus* Kurz.). Forum Sekolah Pasca Sarjana 2(1): 1-18.

146. Suratmo, F.G. 1974. Hama hutan di Indonesia (Forest entomology). Proyek Peningkatan Mutu Perguruan Tinggi, IPB, Bogor.

147. Suratmo, F.G. 1975. The Biology and behaviour of the mahogany shoot borer, *Hypsipyla robusta* Moore in West Java, Indonesia. PhD Thesis, Bogor Agricultural University, Bogor, Indonesia. 108p.

148. Suratmo, F. G. 1976. Laporan penelitian penggerek pucuk mahoni *Hypsipyla robusta* Moore (Research report on *H. robusta* M. shoot borer pest on mahoni plantation). Lembaga Kerjasama Fahutan IPB, Bogor.

149. Suratmo, F.G. 1977. Infestation of the leading shoots of mahogany (*Swietenia macrophylla* King) by *Hypsipyla robusta* (Moore) in West Java, Indonesia. *In*: Hadi, S., Tarumingkeng, R.C., Suratmo, F.G., Eusebio, M.A., Kirtibutr, N. and Dhanarajan, G. (eds.) Proceedings Symposium on Forest Pests and Diseases in Southeast Asia, 20-23 April 1976, 121-132. BIOTROP Special Publication No. 2, BIOTROP, Bogor, Indonesia.

150. Suratmo, F.G. 1978a. Diklat Ilmu Perlindungan Hutan (Forest protection). Pusat Pendidikan Kehutanan Cepu. Direksi Perum Perhutani. 171p.

151. Suratmo, F.G. 1978b. Ilmu perlindungan hutan (Forest protection science). Department of Forest Protection, Faculty of Forestry, Bogor Agricultural University, Indonesia. 203p. (Mimeographed).

152. Suratmo, F.G. 1982. Pest management in forestry. Protection Ecology 4(3): 291-296.

153. Suratmo, F.G. 1987. Current potentially dangerous forest pests in Indonesia. *In*: de Guzman, E.D. and Nuhamara, S.T. (eds.) Forest Pests and Diseases in Southeast Asia, 91-95. BIOTROP Special Publication No. 26, SAEMEO-BIOTROP, Bogor, Indonesia.

154. Suratmo, F.G. 1996. Emerging insect pest problems in tropical plantation forest in Indonesia. *In*: Nair, K.S.S., Sharma, J.K. and Varma, R.V. (eds.) Impact of diseases and insect

pests in tropical forests, 502-506. Kerala Forest Research Institute and FAO/FORSPA, Peechi, India.

155. Suratmo, F.G. 1998. Pusat komunikasi dan koordinasi penelitian perlindungan hutan di Indonesia (Center for communication and research coordination on forest protection in Indonesia). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 19-25. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

156. Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) 1998. Permasalahan dan strategi pengelolaan hama di areal hutan tanaman (Problems and strategy in pest management for plantation forest areas). Proceedings Workshop on 17-19 June 1997, Bandungan Ambarawa, Central Java. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor. 183 p.

157. Takagi, S. and Williams, D.J. 1998. A new mangrove-infesting species of *Aulacaspis* occurring in South-East Asia, with a revision of *A. vitis* (Homoptera: Coccoidea: Diaspididae). Insecta Matsumurana 54: 51-76.

158. Tarumingkeng, R.C. 1975. Serangan inger-inger (*Neotermes tectonae*) dan penjarangan sebagai tindakan pemberantasannya pada jati (Attach of *N. tectonae* and thinning process as a control for teak). Laporan Lembaga Penelitian Hutan No. 158, Bogor.

159. Tarumingkeng, R.C. 1984. Manajemen hama pada hutan tanaman industri (Pest management in industrial plantation forests). Paper to Prosiding Lokakarya Pembangunan Timber Estates 29-31 Maret 1984. Fakultas Kehutanan IPB, Bogor.

160. Tarumingkeng, R.C. and Tantra, I.G.M. 1971. Preventing ambrosia beetle attack on fresh-cut logs. Rimba Indonesia 16: 1-2.

161. Tikupadang, H., Sumardjito, Z. and Sila, M. 1993. Inventarisasi dan identifikasi serangga potensial menjadi hama dan mikroba potensial menjadi penyakit pada hutan tanaman industri PT Inhutani I Kabupaten Gowa, Propinsi Sulawesi Selatan (Inventory and identification of potentially serious pests and diseases in industrial forest plantation at PT Inhutani I Gowa regency, South Sulawesi). Jurnal Penelitian Kehutanan 7: 10-21.

162. Tikupadang, H., Sumardjito, Z. and Sila, M. 1995. Biologi hama sengon (*Paraserianthes falcataria*) dan identifikasi musuh-musuh alamnya di lokasi HTI PT Inhutani Borisallo Kabupaten Gowa. (Biology of deteriorative insect on *Paraseriathes falcataria* and identification of their natural enemies at HTI PT Inhutani Borisallo in Gowa regency). Jurnal Penelitian Kehutanan 9(1): 29-35.

163. Torguebiau, E. 1984. Man made Dipterocarp forest in Sumatra. Agroforestry Systems 2: 103-127.

164. Weinland, G. 1998. Plantations. *In*: Appanah, S. and Turnbull, J.M. (eds.) A review of Dipterocarps: Taxonomy, ecology and silviculture, 151-185. CIFOR and FRIM, Bogor.

165. Whitten, A.J. and Damanik, S.J. 1986. Mass defoliation of mangroves in Sumatra, Indonesia. Biotropica 18(2): 176.

166. Wylie, R., Floyd, R., Elliot, H., Khen, C.V., Intachat, J., Hutacharern, C., Tubtim, N., Kha, L.D., Do, N.V., Rachmatsyah, O., Gales, K., Zulfiyah, A. and Vuokko, R. 1998. Insect pests of tropical Acacias: A new project in Southeast Asia and Northern Australia. *In*: Turnbull, J.W., Crompton, H.R. and Pinyopusarerk, K. (eds.) Recent developments in Acacia planting, 234-239. Proceedings of an International Workshop held in Hanoi, Vietnam, 27-30 October 1997. ACIAR Proceeding No. 82, ACIAR, Canberra.

167. Zakir, Simon, T. and Suharti, M. 1993. Jenis jamur yang berasosiasi dengan biji *Paraserianthes falcataria* and *Pinus merkusii* dalam berbagai periode serta cara simpan (Fungi associated with *Paraserianthes falcataria* and *Pinus merkusii* in various method and period of storage). Buletin Penelitian Hutan 554: 37-55.

168. Zethner, O., Jogensen, J. and Husaeni, E.A. 1996. Technical Report on phytosanitary control and forest entomology: Seed borne pests and diseases affecting forestry and tree planting in Indonesia and phytosanitary considerations. Ministry of Forestry - Indonesia Tree Seed Source, Jakarta.

169. Zethner, O., Jorgensen, J. and Husaeni, E.A. 1997. The current status of diseases and pests of forest tree seeds in South East Asia, especially diseases in Indonesia. *In*: Prochazkova, Z. and Sutherland, J.R. (eds.) Proceedings of the ISTA Tree Seed Pathology Meeting, 9-11 October 1996, 86-94. Internatioal Seed Testing Association (ISTA), Zwitzerland.

170. Zulfiyah, A. 1998. Gangguan dan ancaman hama terhadap hutan tanaman industri di PT Musi Hutan Persada, Sumatera Selatan (Pest problems and threat on industrial plantation forests in PT Musi Hutan Persada, South Sumatra). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 153-156. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

171. Zulfiah, A. and Gales, K. 1997. Diseases of tropical Acacias in South Sumatra. *In*: Old, K.M., Lee, S.S. and Sharma, J.K. (eds.) Diseases of tropical Acacias, 48-52. Proceedings of an International Workshop held at Subanjerji (South Sumatra), 28 April-3 May 1996. CIFOR Special Publication, CIFOR, Bogor, Indonesia.

6.2. Diseases

172. Achmad. 1997. Mekanisme serangan patogen dan ketahanan inang serta pengendalian hayati penyakit lodoh pada *Pinus merkusii* (Attack mechanism of pathogen, and host resistance, and biological control of damping-off on *Pinus merkusii*). PhD Thesis, Program Pasca Sarjana IPB, Bogor, Indonesia.

173. Achmad. 1999. Prospek pengendalian terpadu penyakit lodoh pada persemaian tanaman kehutanan (Prospect of integrated management of damping-off on forest tree seedlings). Jurnal Manajemen Hutan Tropika I(1-2): 1-9.

174. Achmad, Hadi, S., Herliyana, E.N. and Setiawan, A. 1999. Patogenitas *Rhizoctonia solani* pada semai *Pinus merkusii* dan *Acacia mangium* (Pathogenicity of *Rhizoctonia solani* on *Pinus merkusii* and *Acacia mangium* seedlings). Jurnal Manajemen Hutan Tropika I(1-2): 10-17.

175. Achmad, Hadi, S., Sa'id, E.G., Setiawihardja, B., Kardin, M.K. and Harran, S. 1999. The potential use of two species or *Trichoderma* for the biological control of damping-off on *Pinus merkusii*. *In*: Cruz, R.E.D. *et al*. (eds.) Challenges for biotechnology in the next millennium, 103-107. Proceedings of the 7th International Workshop of BIO-REFOR, Manila Philippine, 3-5 November 1998. BIO-REFOR, IUFRO/SPDC.

176. Anggraeni, I. and Suharti, M. 1994. Sifat antagonis *Trichoderma* sp. terhadap pertumbuhan beberapa jamur penyebab penyakit busuk akar dan busuk batang pada tanaman kehutanan secara in-vitro (In vitro antagonism *Trichoderma* sp. to some fungi causing root and stem rot in forest trees). Buletin Penelitian Hutan 561: 25-40.

177. Anggraeni, I. and Suharti, M. 1995. Pengaruh ekstrak umbi bawang putih dan *Trichoderma* sp. terhadap pertumbuhan patogen *Botryodiplodia* sp. secara in-vitro (The effect of garlic extract and *Trichoderma* sp. in inhibiting the growth of the pathogen *Botryodiplodia* sp. in vitro). Buletin Penelitian Hutan 583: 27-39.

178. Anggraeni, I. and Suharti, M. 1996. Penyakit bercak daun pada *Shorea* spp. di kebun percobaan Carita dan Haurbentes (Leaf spot diseases on *Shorea* spp. in Carita and Haurbentes experimental gardens). Buletin Penelitian Hutan 600: 39-46.

179. Anggraeni, I. and Suharti, M. 1997. Identifikasi beberapa cendawan penyebab penyakit busuk akar pada tanaman hutan (Identification of some pathogens as causal agents of root rot disease on forest trees). Buletin Penelitian Hutan 610: 17-35.

180. Anggraeni, I., Asmaliyah and Suharti, M. 1995. Identification of some pests and diseases of *Acacia mangium*. Technical Information. Pusat Penelitian dan Pengembangan Hutan dan Konservasi Alam, Bogor. 36p.

181 Anggraeni, I., Lisnawati, Y. and Rostiwati, T. 1996. Identifikasi patogen penyebab busuk bonggol pada anakan sagu (*Metroxylon sagu* Rottb) (Identification of rhizome rot disease of sago (*Metroxylon sagu* Rottb) seedlings). Buletin Penelitian Hutan 604: 23-29.

182. Ardikoesoema, R.I. 1954. Plantations of *Shorea javanica* in Java. Rimba Indonesia 3: 141-151.

183. Asmaliyah, Anggraeni, I. and Suharti, M. 1997. Identification of some pests and diseases of *Pinus merkusii*. Technical Information. Pusat Penelitian dan Pengembangan Hutan dan Konservasi Alam, Bogor. 33p.

184. Balfas, J. and Sumarni, G. 1995. Keawetan kayu tusam (*Pinus merkusii* Jungh. et de Vr.) dan mangium (*Acacia mangium* Willd.) setelah furfurilasi (Durability of tusam (*Pinus merkusii* Jungh. et de Vr.) and mangium (*Acacia mangium* Willd.) after furfurylation). Jurnal Penelitian Hasil Hutan 13(7): 259-265.

185. Boa, E. and Lenne, J. 1994. Disease of nitrogen fixing trees in developing countries: An

annotated list. Natural Resource Institute, Chatham, UK. 82p.

186. Booth, T.H., Jovanovic, K.M., Old, K.M. and Dudzinski, M.J. 2000. Climatic mapping to identify high-risk areas for *Cylindrocladium quinqueseptatum* leaf blight on eucalypts in mainland Southeast Asia and around the world. Environment Pollution 108: 365-372.

187. Chan, H.T., Razani, U. and Putz, F.E. 1984. Study on planting of *Rhizophora* species in an *Avicennia* forest at the Matang Mangroves. *In*: Soemodihardjo, S., Soerianegara, I., Sutisna, M., Kartawinata, K., Supardi, Naamin, N. and Al-Rasyid, H. (eds.) Prosiding Seminar II Ekosistem Mangrove, 340-345. Lembaga Ilmu Pengetahuan Indonesia, Jakarta, Indonesia.

188. Crous, P.W. and Alfenas, A.C. 1995. *Mycosphaerella gracilis* and other species of *Mycosphaerella* associated with leaf spots of *Eucalyptus* in Indonesia. Mycologia 87(1): 121-126.

189. Crous, P.W. and Wingfield, M.J. 1997. New species of *Mycosphaerella* occurring on *Eucalyptus* leaves in Indonesia and Africa. Canadian Journal of Botany 75(5): 781-790.

190. Crous, P.W., Kendrick, W.B. and Alfenas, A.C. 1997. New species of *Hyphomycetes* associated with *Eucalyptus*. South African Journal of Botany 63(5): 286-290.

191. Crous, P.W., Wingfield, M.J., Mohammed, C. and Yuan, Z.Q. 1998. New foliar pathogens of *Eucalyptus* from Australia and Indonesia. Mycological Research 102(5): 527-532.

192. Darma, I.G.K.T., Oemijati, R., and Surya, J. 1986. Berbagai jenis hama dan penyakit pada tanaman *Acacia mangium* Willd. di Subanjeriji, Sumatra Selatan (Some pests and diseases in *Acacia mangium* in Subanjeriji, South Sumatra). *In*: Prosiding Seminar Nasional Ancaman terhadap HTI, 20 December 1986, Jakarta, 108-113. FMIPA dan Departemen Kehutanan. Inhutani I, Jakarta.

193. Dennis, J.J.C., Prior, R.N.B., Saul, J.K. and Konam, J.K. 1995. Comparative observations on control of some pests and diseases of cocoa common to Indonesia, Malaysia and Papua New Guinea. Cocoa Growers' Bulletin 49: 41-51.

194. Djaryono, H. and Hadi, S. 1981. Etiology and prevention of a disease of *Pinus merkusii* seedlings accuring at Cinta Alam nursery Aceh, Sumatra. Laporan Balai Penelitian Hutan No. 372, Bogor.

195. Elouard, C. 1989. Notes on some *Fusarium* and *Cylindrocarpon* on Dipterocarpaceae of Indonesia. Biotropia 3: 25-40.

196. Elouard, C. 1991. Regeneration of Dipterocarpaceae: Some pathological aspects. *In*: Soerianegara, I., Tjitrosomo, S.S., Umaly, R.C. and Umboh, I. (eds.) Proceedings of the 4th Round Table Conference on Dipterocarps, 165-170. BIOTROP Special Publication No. 41, SEAMEO-BIOTROP, Bogor, Indonesia.

197. Elouard, C. 1998. Pests and diseases of Dipterocarpaceae. *In*: Appanah, S. and Turnbull, J.M. (eds.) A review of Dipterocarps: Taxonomy, ecology and silviculture, 115-131. CIFOR and FRIM, Bogor.

198. Elouard, C., Zakaria, M. and Maziah, Z. 1997. Fungi associated with Dipterocarpaceae. FRIM Technical Information Handbook No. 9. Forest Research Institute Malaysia, Kuala Lumpur. 44p.

199. Field, S.P., Momuat, E.O., Smith, R.A. and Bamualim, A. 1992. Developing land rehabilitation technologies compatible with farmer needs and resources. Journal of the Asian Farming Systems Association 1(3): 385-394.

200. Frohlich, J. and Hyde, K.D. 1995. *Guignardia candeloflamma* sp. nov. causing leaf spots of *Pinanga* spp. Mycological Research 99(1): 110-112.

201. Hadi, S. 1977. Forest disease problems in Indonesia. *In*: Hadi, S., Tarumingkeng, R.C., Suratmo, F.G., Eusebio, M.A., Kirtibutr, N. and Dhanarajan, G. (eds.) Proceedings Symposium

on Forest Pests and Diseases in Southeast Asia, 201-206. BIOTROP Special Publication No. 2, BIOTROP, Bogor, Indonesia.

202. Hadi, S. 1979. The importance of insect pests and diseases in the conversion of natural forests into forest plantations. Paper to Symposium on Forest Regeneration and Utilization of Tropical Rain Forests, 8 November 1979, Darmaga, Bogor.

203. Hadi, S. 1980. Problems on pests, diseases, and weeds on forest trees. Paper to the Workshop on Plant Protection, 11-13 December 1980, Cisarua, Bogor, Indonesia.

204. Hadi, S. 1981. Development and control of forest tree diseases. Paper to the 6th National Congress of Indonesian Pathological Society, 11-13 May 1981, Bukit Tinggi, Indonesia.

205. Hadi, S. 1984. Disease problems in the establishment of timber estates. Paper to the Workshop on the Establishment of Timber Estates, 29-31 March 1984, Darmaga, Bogor, Indonesia.

206. Hadi, S. 1986a. Management of timber estates with the emphasis on problems related to the control of diseases. Paper to the National Seminar on Hazards associated with the Establishment of Timber Estates, 20 December 1986, Jakarta, Indonesia.

207. Hadi, S. 1986b. Pendekatan biologi pengendalian gangguan hutan tanaman industri (Biological approach to control industrial plantation forest disturbance). *In*: Prosiding Seminar Nasional Ancaman terhadap HTI, 20 December 1986, Jakarta, 29-37. FMIPA dan Departemen Kehutanan. Inhutani I, Jakarta.

208. Hadi, S. 1994. Establishment of forest plantations and protection of biodiversity in Indonesia. *In*: Suzuki, K., Sakurai, S. and Ishii, K. (eds.) Biotechnology assisted reforestation project (BIO-REFOR): Proceedings of Yogyakarta Workshop, September 20-23, 1993, Yogyakarta, Indonesia. BIO-REFOR Japan, Department of Forest Science, Faculty of Agriculture, University of Tokyo, Japan.

209. Hadi, S. 1997. The association of fungi with Dipterocarps. *In*: Kostermans, A.J.G.H. (ed.) Proceedings of the 3rd Round Table Conference on Dipterocarps, held at Mulawarman University, Samarinda, East Kalimantan, Indonesia, 16-20 April 1985, 73-79. United Nations Educational, Scientific and Cultural Organisation, Jakarta.

210. Hadi, S. 1998. Gangguan penyakit pada hutan dan masalah perlindungannya (Disturbance of forest disease and its protection). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 99-110. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

211. Hadi, S. and Nuhamara, S.T. 1997. Diseases of species and provenances of Acacias in West and South Kalimantan, Indonesia. *In*: Old, K.M., Lee, S.S. and Sharma, J.K. (eds.) Diseases of tropical Acacias, 23-47. Proceedings of an International Workshop held at Subanjerji (South Sumatra), 28 April-3 May 1996. CIFOR Special Publication, CIFOR, Bogor, Indonesia.

212. Hadi, S., Nuhamara, S.T. and Santoso, E. 1996. Disease problems associated with the large scale establishment of timber estates in Indonesia. *In*: Nair, K.S.S., Sharma, J.K. and Varma, R.V. (eds.) Impact of diseases and insect pests in tropical forests, 105-110. Kerala Forest Research Institute and FAO/FORSPA , Peechi, India.

213. Hadi, S., Samosir, R. and Kamil, H. 1978. Histopathology of *Agathis dammara* leaves infected by *Aecidium fragiforme*. Paper to the Third International Congress of Plant Pathology, 16-23 August 1978, München, Germany.

214. Hadi, S., Tarumingkeng, R.C., Suratmo, F.G., Eusebio, M.A., Kirtibutr, N. and Dhanarajan, G. (eds.) 1977. Proceedings Symposium on Forest Pests and Diseases in Southeast Asia, 20-23 April 1976, Bogor, Indonesia. BIOTROP Special Publication No. 2, BIOTROP, Bogor, Indonesia. 225p.

215. Hagul, A.T., Simon, T. and Suharti, M. 1993. Efektivitas beberapa jenis fungisida untuk mengendalikan penyakit bercak daun pada anakan *Eucalyptus* spp. (Effectiveness of some fungicides for controlling leaf spot disease on *Eucalyptus* spp.). Buletin Penelitian Hutan 555: 1-20.

216. Hallsworth, E.G. 1986. Resources for the future: Measuring and managing of the ultimate limit to growth. ILRI 40: 51-63.

217. Hamzah, Z. and Natawiria, D. 1974. Fox tailing in *Pinus merkusii*. Laporan Lembaga Penelitian Hutan No. 181, Bogor. 15p.

218. Hanafi, S. 1991. Masalah hama dan penyakit pada Hutan Tanaman Industri di wilayah Perum Perhutani (Pest and diseases problem in Perum Perhutani area). *In*: Hadi, S., Rachmatsyah, O. and Nuhamara, S.T. (eds.) Proceedings Seminar Nasional Peningkatan Produktivitas Hutan Tanaman Industri melalui Upaya Pengendalian Hama dan Penyakit Secara Terpadu, 113-119. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

219. Ibnu, Z. 1985. Intensitas serangan penyakit *Pinus merkusii* pada beberapa persemaian di Sumatra Utara (Attack intensity on *Pinus merkusii* disease at some nurseries in North Sumatra). Balai Penelitian Kehutanan Pematang Siantar. (Unpublished Report).

220. Ibnu, Z. and Supriana, N. 1987a. Inventarisasi penyakit di tiga persemaian *Pinus merkusii* Jungh. Et de Vr. di Sumatra Utara (Inventory of diseases at three *Pinus merkusii* nurseries in North Sumatra). Buletin Penelitian Kehutanan 3(1): 37-44.

221. Ibnu, Z. and Supriana, N. 1987b. Penggunaan fungisida (copperoxychlorida 85%) dalam pengendalian penyakit embun tepung pada tanaman *Acacia auriculiformis* A. Cunn (The use of the fungicide copper oxychloride 85% to control powdery mildew diseases on *Acacia auriculiformis*). Buletin Penelitian Kehutanan 3(1): 63-72.

222. Ibnu, Z. and Supriana, N. 1987c. Pengujian empat jenis fungisida terhadap serangan penyakit damping-off di persemaian *Pinus merkusii* (An efficacy test of four fungicides against damping-off in *Pinus merkusii* nurseries). Balai Penelitian Kehutanan 3(1): 53-61.

223. Intari, S.E. and Santoso, E. 1990. Pola tanam HTI sebagai usaha penanggulangan hama dan penyakit (Planting pattern of industrial plantation forest as an effort to control pests and diseases). *In*: Buharman, Purba, K. and Hediana, C. (eds.) Proceedings Diskusi Hutan Tanaman Industri, 13-14 Maret 1990, Jakarta, 85-94. Badan Litbang Kehutanan Departemen Kehutanan, Jakarta.

224. Intari, S.E., Santoso, E. and Sophie, M.M. 1995. Percobaan pengendalian hama rayap dan penyakit busuk akar yang menyerang tanaman sonokeling di kecamatan Wanayasa, Purwakarta (An experiment to control termites and root rot diseases attacking the *Dalbergia latifolia* plantation in Wanayasa district, Purwakarta, West Java). Duta Rimba 20: 179-180.

225. Irman. 1995. Detection of seed diseases of *Eucalyptus alba* Reinw (in Indonesian). Thesis, Faculty of Forestry, Bogor Agricultural University, Bogor, Indonesia.

226. Kertadikara, A.W.S. 1998. Penggunaan teknik biologi molekuler untuk pemuliaan sifat ketahanan terhadap hama dan penyakit (Use of moleculer biology technique for resistance characteristic improvement to pests and diseases). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 77-86. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

227. Kobayashi, T. and Zinno, Y. 1984. Anthracnose of legume tree seedlings in the Philippines and Indonesia. Journal of the Japanese Forestry Society 66(3): 113-116.

228. Lee, S.S. and Sikin, N.Y. 1999. Fungi associated with heart rot of *Acacia mangium* trees in Peninsular Malaysia and East Kalimantan. Journal of Tropical Forest Science 11: 240-254.

229. Martono, D. 1989. Kerentanan empat jenis kayu rimba terhadap serangan jamur pewarna (The susceptibility of four woods to sapstain). Jurnal Penelitian Hasil Hutan 6(5): 314-317.

230. Mieke, S. 1994. Some pests and diseases of forest timber estate in Indonesia. *In*: Kashio, M. and Ze, M.E. (eds.) Rehabilitation of degraded forest lands in the tropics, 158-162. JIRCAS International Symposium Series 1, JIRCAS, Japan.

231. Natawiria, D. 1969. Timbulnya hama dan penyakit di hutan Indonesia (The apprearance of pest and diseases in Indonesia Forest). Laporan Lembaga Penelitian Hutan No. 100, Bogor. 14p.

232. Natawiria, D. 1975. Hama dan penyakit *Albizzia falcataria* Fosb. (Pests and diseases of *Albizzia falcataria* Fosb.). Rimba Indonesia 17(1-2): 58-69.

233. Natawiria, D. 1986. Ancaman hama dan penyakit terhadap hutan tanaman (Threat on pests and diseases to plantation forests). *In*: Prosiding Seminar Nasional Ancaman terhadap HTI, 20 December 1986, Jakarta, 69-74. FMIPA dan Departemen Kehutanan. Inhutani I, Jakarta.

234. Natawiria, D., Soeyamto, C.H. and Mardji, D. 1986. Penelitian hama dan penyakit di persemaian (Research on pests and diseases in nursery). Badan Litbang Kehutanan. Universitas Mulawarman, Samarinda.

235. Natawiria, D., Suharti, M. and Santoso, E. 1995. Identification technique for diseases in industrial plantation forests. Pusat Penelitian dan Pengembangan Hutan dan Konservasi Alam, Bogor. 34p.

236. Nazif, M. and Suharti, M. 1990. Pengendalian gulma dan penyakit pada tegakan HTI (Weed and disease control in industrial forest plantations). *In*: Buharman, Purba, K. and Hediana, C. (eds.) Proceeding Diskusi Hutan Tanaman Industri, 13-14 Maret 1990, Jakarta, 163-176. Badan Litbang Kehutanan Departemen Kehutanan, Jakarta.

237. Ngatiman. 1984. Seed diseases of *Shorea smithiana* Sym. and *S. acuminatissima* Sym. and the causative agents (in Indonesian). Thesis, Faculty of Forestry, Mulawarman University, Samarinda, Indonesia.

238. Ngatiman. 1990. Pengendalian hama dan penyakit tanaman HTI (Pest and disease control in industrial plantations forest). *In*: Buharman, Purba, K. and Hediana, C. (eds.) Proceeding Diskusi Hutan Tanaman Industri, 13-14 Maret 1990, Jakarta, 231-240. Badan Litbang Kehutanan Departemen Kehutanan, Jakarta.

239. Notoatmodjo, S.S. 1964. Penyelidikan sementara tentang penyakit jamur karat, *Aedicium fragiforme* Ges. pada tanaman *Agathis dammara* Rich. (A preliminary investigation on the rust disease *Aedicium fragiforme* Ges. of *A. dammara* Rich.). Bagian Penyakit dan Hama Hutan, Lembaga Penelitian Hutan, Bogor, Indonesia. 40p.

240. Nuhamara, S.T. 1986. Forest tree diseases: problems associated with the establishment of industrial forest plantation (in Indonesian). *In:* Wirakusuma, S. *et al*. (eds.). Threats of industrial forest plantations, 87-93. PT INHUTANI I, Jakarta.

241. Nuhamara, S.T. 1991. Berbagai penyakit pada Hutan Tanaman Industri di Indonesia (Some diseases on industrial plantation forests in Indonesia). *In*: Hadi, S., Rachmatsyah, O. and Nuhamara, S.T. (eds.) Proceedings Seminar Nasional Peningkatan Produktivitas Hutan Tanaman Industri melalui Upaya Pengendalian Hama dan Penyakit Secara Terpadu, 29-41. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

242. Nuhamara, S.T. 1996. Timbul dan berkembangnya penyakit hutan tanaman: Studi kasus pada penanaman *Acacia mangium* Willd di BKPH Parung panjang, KPH Bogor (Etiology of man-made forest disease: A case study on *Acacia mangium* Willd plantation in Parung panjang circle, district of Bogor). Jurnal Manajemen Hutan Tropika 2(1): 55-63.

243. Nuhamara, S.T., Pragnyono, R.S. and Setiadi, Y. 1990. Association of *Ramaria canieticolor* Corner with the roots of *Acacia mangium* (in Indonesian). *In:* Proceedings of National Seminar on Research and Development of Multipurpose Tree Species, 18-27. Agency for Research and Development, Ministry of Forestry and F. Fred Project Winrock International, Bogor.

244. Old, K.M., Lee, S.S., Sharma, J.K. and Zi, Q.Y. 2000. A manual of diseases of tropical Acacias in Australia, South-East Asia and India. CIFOR - CSIRO - ACIAR, Bogor, Indonesia.

245. Palokangas, E. 1996. *Acacia mangium* in pulp and paper production. *In*: Otsamo, A., Kuusipalo, J. and Jaskari, H. (eds.) Reforestation: Meeting the future industrial wood demand, 24-26. Proceedings of a Workshop held in Jakarta, 30 April-1 May 1996. Enso Forest Development Oy Ltd, Jakarta.

246. Prastowo, H. 1998. Kendala yang dihadapi didalam pengelolaan penyakit di areal hutan tanaman (Constraints to disease management in plantation forests). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 13-17. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

247. Rahayu, S. 1999. Penyakit tanaman hutan di Indonesia: Gejala, penyebab, dan teknik pengendaliannya. (Forest diseases in Indonesia: The symptom, causal and technical control). Kanisius, Yogyakarta. 112p.

248. Rahayu, S., Subyanto and Kuswanto. 1998. The occurrence of pest and disease of *Shorea* spp. - A preliminary study in Wanariset and Bukit Soeharto Forest Area in East Kalimantan, Indonesia. *In*: Proceedings Seminar on Ecological Approach for Productivity and Sustainability of Dipterocarp Forests, 53-57. Faculty of Forestry, Gadjah Mada University, Indonesia and Kansai Environmental Engineering Center, Japan.

249. Riyantoko, A. 1998. Sistem silvikultur intensif sebagai upaya meningkatkan produktivitas tegakan serta perlindungan dari serangan hama dan penyakit (Intensive silviculture system as an effort to improve stand productivity and protection from the attack of pests and diseases). *In*: Suratmo, F.G., Hadi, S., Husaeni, E.A., Rachmatsjah, O., Kasno, Nuhamara, S.T. and Haneda, N.F. (eds.) Proceedings Workshop Permasalahan dan Strategi Pengelolaan Hama di Areal Hutan Tanaman, 157-165. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor.

250. Rostaman. 1997. Hama dan penyakit tanaman cendana di Kabupaten Kupang (Pests and diseases of sandalwood in Kupang regency). Duta Rimba 23: 209-210.

251. Ruga, A. CH. 1991. Beberapa hama dan penyakit pada tanaman *Eucalyptus deglupta* dan *Acacia mangium* di Proyek HTI PT ITCI Kenangan, Balikpapan (Some pest and disease on *Eucalyptus deglupla* and *Acacia mangium* in Kenangan HTI Project PT ITCI, Balikpapan). *In*: Hadi, S., Rachmatsyah, O. and Nahamara, S.T. (eds.) Peningkatan Produktivitas Hutan Tanaman Industri melalui Upaya Pengendalian Hama dan Penyakit Secara Terpadu, 107-112. Prosiding Seminar National di Bogor 30 Juli 1991. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor, Indonesia.

252. Santoso, E. and Hardi, T. 1991. Pengendalian hama dan penyakit di hutan tanaman industri Kalimantan Timur (Pest and disease control of timber estates in East Kalimantan). Jurnal Penelitian dan Pengembangan Kehutanan 7(1): 14-17.

253. Santoso, E. and Suharti, M. 1984. Studi morfologis dan anatomis cendawan karat yang menyerang tanaman *Acacia auriculiformis* A. Cunn (Morphological and anatomical studies on rust diseases of *Acacia auriculiformis* A. Cunn.). Pusat Penelitian dan Pengembangan Hutan. Report No. 441, Bogor. 15p.

254. Santoso, E., Anggraeni, I. and Irianto, R.S.B. 1995. Researches of diseases of IFP (Industrial Plantation Forestry). Paper presented at

Seminar of IFP Research: Efforts to improve IFP quality in Welcoming Eco-label Era. Cisarua, Indonesia. 11p.

255. Shiomi, T., Mulya, K. and Oniki, M. 1991. Bacterial wilt of cashew (*Anacardium occidentale* L.) caused by *Pseudomonas solanacearum* in Indonesia. Industrial Crops Research Journal 2(1): 29-35.

256. Siswanto, T.H. 1984. The effect of plant residues on the occurrence of damping-off on *Pinus merkusii* Jung. Et de Vriese (in Indonesian). Thesis, Faculty of Forestry, Bogor Agricultural University, Bogor, Indonesia.

257. Sitepu, I.R. and Suharti, M. 1998. Pest and disease management in industrial forest plantations in Indonesia. *In*: Nambiar, E.K.S., Gintings, A.N., Ruhiyat, D., Natadiwirya, M., Harwood, C.E. and Booth, T.H. (eds.) Sustained productivity of short and medium rotation plantation forests for commercial and community benefit in Indonesia - An analysis of research priorities, 39-47. Proceedings of a Workshop held at Bogor, Indonesia, 6-7 May 1998. CSIRO Forestry and Forest Products, Australia.

258. Smits, W.T.M., Yasman, I., Leppe, D. and Noor, M. 1991. Some observations on diseases of Dipterocarpaceae. *In*: Soerianegara, I., Tjitrosomo, S.S., Umaly, R.C. and Umboh, I. (eds.) Proceedings of the 4th Round Table Conference on Dipterocarps, 147-163. BIOTROP Special Publication No. 41, SEAMEO-BIOTROP, Bogor, Indonesia.

259. Soepardi, R. 1958. Penyakit dan hama *Pinus merkusii* hama serangan di tanah Gayo. (Pests and diseases of *Pinus merkusii* in Gayo land). Rimba Indonesia 7(3-4): 264-277.

260. Soepardi, R. 1976. Hutan dan penyakit *Pinus merkusii* di tanah Gayo (Pests and diseases of *Pinus merkusii* in Gayo land). Gema Rimba 3(15): 20-27.

261. Soeyamto, C.H. and Mardji, D. 1986. Hama dan penyakit pada persemaian dan tegakan hutan tanaman industri (Pests and diseases in nursery and stands of industrial plantation forest). *In*: Prosiding Seminar Nasional Ancaman terhadap HTI, 20 December 1986, Jakarta, 100-107. FMIPA dan Departemen Kehutanan. Inhutani I, Jakarta.

262. Suharti, M. 1973. Causal agents and the environmental influence to the damping-off disease of *Pinus merkusii* seedlings. Laporan Lembaga Penelitian Hutan No. 162, Bogor.

263. Suharti, M. 1976. Root cancer disease on the *Paulownia kawakamii* Ito in Riau, Sumatra. Laporan Lembaga Penelitian Hutan No. 221, Bogor.

264. Suharti, M. 1980. Gall disease on cayeput (*Melaleuca leucadendron*) leaves at Ponorogo, Madiun. Laporan Lembaga Penelitian Hutan No. 340, Bogor.

265. Suharti, M. 1981. The influence of leaf gall disease attack on cayeput oil quality. Laporan Lembaga Penelitian Hutan No. 364, Bogor.

266. Suharti, M. 1983. Busuk batang pada *Agathis loranthifolia* Roxb. di BKPH Gunung Slamet Barat, Banyumas Timur (Bark rot on *Agathis loranthifolia* Roxb. in BKPH Gunung Slamet Barat, Banyumas Timur). Duta Rimba 61-62: 17-19.

267. Suharti, M. 1988. Efektivitas beberapa jenis fungisida untuk pengendalian penyakit lodoh pada bibit *Pinus merkusii* di Sempolan, Jember, Jawa Timur (Effectiveness of some fungicides for the control of damping-off in *Pinus merkusii* seedlings at Sempolan, Jember, East Java). Buletin Penelitian Hutan 496: 31-41.

268. Suharti, M. and Hadi, S. 1974. Wilt disease of *Dalbergia latifolia* in Malang forest district, East Java. Laporan Lembaga Penelitian Hutan No. 194, Bogor. 9p.

269. Suharti, M. and Intari S.E. 1974. Pedoman pengenalan hama dan penyakit pada jati (*Tectona grandis* L.f.) (Guide to identify pest and disease on teak (*Tectona grandis* L.f.)). Laporan Lembaga Penelitian Hutan No. 182, Bogor.

270. Suharti, M. and Santoso, E. 1988. Hubungan antara faktor ketinggian tempat, curah hujan, umur tanaman dan intensitas fox-tail pada

tegakan *Pinus merkusii* di Jawa (Relation between factors of altitude, rainfall and plantation age and the intensity of fox-tail in *Pinus merkusii* stands in Java). Buletin Penelitian Hutan 494: 21-29.

271. Suharti, M. and Santoso, E. 1989. Penyakit kanker batang pada *Ecalyptus urophylla* di areal hutan PT Arara Abadi, Riau (Stem cancer of *Ecalyptus urophylla* in forest area of PT Arara Abadi, Riau). Buletin Penelitian Hutan 509: 37-45.

272. Suharti, M. and Santoso, E. 1995. Penyakit kanker batang pada *E. urophylla* di areal hutan PT Arara Abadi Perawang, Riau (Stem cancer diseases on *Eucalyptus urophylla* in forest area at PT Arara Abadi Perawang, Riau). Buletin Penelitian Hutan 567: 37-45.

273. Suharti, M. and Sitepu, I.R. 1997. Some important pests and diseases of forest plantation in Indonesia. *In*: Nasendi, B.D. (ed.) A state-of-the art report on some recent forestry policies, initiatives and achievements in Indonesia: Concepts, strategies and actions for sustainable forest management and forestry development towards 21st century, 39-45. Ministry of Forestry of the Republic of Indonesia, Jakarta.

274. Suharti, M., Anwar, C. and Santoso, E. 1981. Wilt disease of pine at Aek Na Uli, North Sumatra. Laporan Balai Penelitian Hutan No. 376, Bogor.

275. Suharti, M., Hardi, T. and Irianto. B. 1991. Mengenal beberapa hama dan penyakit penting pada tanaman HTI (Identification of important pests and diseases in industrial plantation forest). *In*: Hadi, S., Rachmatsyah, O. and Nahamara, S.T. (eds.) Peningkatan Produktivitas Hutan Tanaman Industri melalui Upaya Pengendalian Hama dan Penyakit Secara Terpadu, 97-106. Prosiding Seminar Nasional di Bogor 30 Juli 1991. Fakultas Kehutanan IPB dan Departemen Kehutanan, Bogor, Indonesia.

276. Suharti, M., Santoso, E. and Intari, S.E. 1986. Mengenal beberapa jenis hama dan penyakit tanaman hutan industri (Identification of some pests and diseases in industrial plantation forests). Badan Litbang Kehutanan, Universitas Mulawarman, Samarinda.

277. Sulthoni, A. 1986. Permasalahan perlindungan tanaman pada hutan tanaman industri dan kaitannya dengan teknologi maju (Issues on plant protection in industrial plantation forest and its relation with advanced technology). *In*: Prosiding Seminar Nasional Ancaman terhadap HTI, 20 December 1986, Jakarta, 20-25. FMIPA dan Departemen Kehutanan. Inhutani I, Jakarta.

278. Sumadiwangsa, S. 1997. Kayu gaharu komoditi elit di Kalimantan Timur (Agarwood as a high-value commodity in East Kalimantan). Duta Rimba 20: 205-206.

279. Supriana, N. and Natawiria, D. 1987. Forest pests and diseases in Indonesia. *In*: de Guzman, E.D. and Nuhamara, S.T. (eds.) Forest pests and diseases in South-East Asia, 21-41. BIOTROP Special Publication No. 26, SEAMEO-BIOTROP, Bogor, Indonesia.

280. Tikupadang, H., Sumardjito, Z. and Sila, M. 1993. Inventarisasi dan identifikasi serangga potensial menjadi hama dan mikroba potensial menjadi penyakit pada hutan tanaman industri PT Inhutani I, Kabupaten Gowa, Propinsi Sulawesi Selatan. (Inventory and identification of potentially serious pests and diseases in industrial forest plantation at PT Inhutani I, Gowa regency, South Sulawesi). Jurnal Penelitian Kehutanan 7: 10-21.

281. Torquebiau, E. 1984. Man-made Dipterocarp forest in Sumatra. Agroforestry Systems 2: 103-127.

282. Widyastuti, S.M. 1996. Penghambatan penyakit damping-off (rebah semai) pada semai pinus oleh ekstrak biji nyiri (*Xylocarpus granatum*). (Inhibition of damping-off of pine seedling by extract of *Xylocarpus granatum*'s seed). Jurnal Perlindungan Tanaman Indonesia 2(1): 32-35.

283. Widyastuti, S.M. and Sumardi. 1998. Antagonistic potential of *Trichoderma* spp. against root rot pathogen of forest tree species. Asian Journal of Sustainable Agriculture 2:1-8.

284. Widyastuti, S.M., Sumardi and Harjono. 1999. Potensi antagonistik tiga *Trichoderma* spp. terhadap delapan penyakit akar tanaman kehutanan. (Antagonistic potential of three species of *Trichoderma* spp. against eight root rot diseases of forest trees). Buletin Kehutanan Gadjah Mada University 41:2-10.

285. Widyastuti, S.M., Sumardi and Hidayati, N. 1998a. Kemampuan *Trichoderma* spp. untuk pengendalian hayati jamur akar putih pada *Acacia mangium* secara in vitro. (Potential of *Trichoderma* spp. for biological control white root rot of *Acacia mangium*). Buletin Kehutanan Gadjah Mada University 36: 24-38.

286. Widyastuti, S.M., Sumardi and Puspitasari, D. 1999. Uji kemampuan penghambatan ekstrak biji nyiri (*Xylocarpus granatum*) terhadap jamur benih tanaman kehutanan. (Test toward inhibition potential of the extract of *Xylocarpus granatum* against fungi on seed of forest tree species). Buletin Kehutanan Gadjah Mada University 37: 2-9.

287. Widyastuti, S.M., Sumardi, Sulthoni, A. and Harjono. 1998b. Pengendalian hayati penyakit akar merah pada akasia dengan *Trichoderma*. (Biological control of red root rot on *Acacia* using *Trichoderma*). Jurnal Perlindungan Tanaman 4: 65-72.

288. Zaidi, M.D.H. 1997. Mekanisme masuknya intensitas serangan jamur pelapuk kayu teras pada tegakan *Acacia mangium* Willd di HTI PT Wirakarya Sakti, Propinsi Jambi (Entry mechanism of heart rot disease on *Acacia mangium* Willd in HTI PT Wirakarya Sakti, Jambi province). Thesis, Fakultas Kehutanan, Institut Pertanian Bogor, Bogor, Indonesia.

289. Zakir, Simon, T. and Suharti, M. 1993. Jenis jamur yang berasosiasi dengan biji *Paraserianthes falcataria* and *Pinus merkusii* dalam berbagai periode serta cara simpan (Fungi associated with *Paraserianthes falcataria* and *Pinus merkusii* in various method and period of storage). Buletin Penelitian Hutan 554: 37-55.

290. Zulfiah, A. and Gales, K. 1997. Diseases of tropical Acacias in South Sumatra. *In*: Old, K.M., Lee, S.S. and Sharma, J.K. (eds.) Diseases of tropical Acacias, 48-52. Proceedings of an International Workshop held at Subanjerji (South Sumatra), 28 April-3 May 1996. CIFOR Special Publication, Bogor, Indonesia.

6.3. Bibliography Indexes

Scientific Indexes

Tree Species	Bibliography Number						
Acacia	003	011	016	027	029	094	110
	111	166	171	174	180	184	192
	211	221	228	242	243	244	245
	251	253	284	287	288	290	
Acacia auriculiformis	221	253					
Acacia mangium	003	011	016	027	029	094	110
	111	174	180	184	192	228	242
	243	245	251	284	287	288	
Agathis dammara	070	213	239				
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Alstonia scholaris	007						
Anacardium occidentale	255						
Avicennia	013	187					
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Bruguiera	041	044					
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	258	281					
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	188	189	190	191	215	225	251
	271	272					
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