RING-BARKING AND ROOT DEBARKING OF DIPTEROCARP SAPLINGS BY TERMITES IN AN ENRICHMENT PLANTING SITE IN MALAYSIA

L. G. Kirton* & S. Cheng

Forest Research Institute Malaysia, 52109 Kepong, Selangor Darul Ehsan, Malaysia

Received October 2006

KIRTON, L. G. & CHENG, S. 2007. Ring-barking and root debarking of dipterocarp saplings by termites in an enrichment planting site in Malaysia. This paper reports ring-barking and root debarking of saplings for the first time in South-East Asia from Peninsular Malaysia, specifically on transplanted dipterocarp saplings (*Shorea* spp.) used in enrichment planting in a logged-over lowland dipterocarp forest. Above- and below-ground symptoms of attack are described. Attack could occur on living and otherwise healthy plants, indicating that it was not necessarily secondary to other mortality factors. A number of termite species from the genera *Schedorhinotermes*, *Odontotermes*, *Procapritermes*, *Pericapritermes* and *Nasutitermes* were found on or near the tap-roots of the saplings, the most commonly encountered being species of *Odontotermes*. The nature of damage is very similar to damage caused by termites to young plantation-grown eucalypts in India, Africa and Brazil. The wide range of termite species found, which do not normally attack well-established saplings or trees, and the predominance of *Odontotermes*, also parallel the phenomenon in other regions, particularly India. Possible reasons why this form of termite damage has not been reported previously from South-East Asia and specifically from Malaysia in plantation forestry are discussed. The occurrence of this phenomenon in the understorey of a closed-canopy native forest is significant, as it throws doubt on the hypothesis that the problem arises from a lack of alternative food sources for the termites during the establishment period of young forest plantations.

Keywords: Forestry, pests, Isoptera, damage

KIRTON, L. G. & CHENG, S. 2007. Penggelangan kulit kayu dan pengupasan kulit akar dipterokarpa oleh anai-anai di tapak tanaman mengaya di Malaysia. Kertas kerja ini melaporkan penggelangan kulit kayu dan pengupasan kulit akar buat pertama kali di Semenanjung Malaysia dan Asia Tenggara, khasnya pada anak pokok dipterokarpa (*Shorea* spp.) yang dipindah ke hutan dipterokarpa tanah pamah yang dibalak, di bawah projek tanaman mengaya. Gejala serangan anai-anai pada bahagian atas dan bawah tanah dibincangkan. Serangan boleh berlaku pada pokok yang hidup dan sihat. Ini menunjukkan bahawa serangan anai-anai tidak semestinya merupakan faktor sekunder kepada faktor kematian yang lain. Beberapa spesies anai-anai daripada genus *Schedorhinotermes*, *Odontotermes*, *Procapritermes*, *Pericapritermes* dan *Nasutitermes* ditemui pada atau berhampiran akar tunjang pokok. Anai-anai yang paling kerap ditemui adalah daripada genus *Odontotermes*. Kerosakannya serupa dengan kerosakan yang diakibatkan oleh anai-anai di ladang *Eucalyptus* muda di India, Afrika dan Brazil. Fenomena kepelbagaian spesies anai-anai yang biasanya tidak menyerang anak pokok atau pokok yang sudah kukuh serta pengaruh *Odontotermes* juga dilaporkan di negara lain, khususnya di India. Ketiadaan rekod tentang serangan sebegini di ladang hutan di Asia Tenggara, terutama di Malaysia dibincangkan. Kejadian fenomena ini di kawasan kanopi hutan yang tertutup menimbulkan persoalan tentang hipotesis bahawa masalah anai-anai berpunca daripada kekurangan sumber makanan alternatif kepada anai-anai semasa peringkat awal penubuhan hutan ladang.

INTRODUCTION

Ring-barking and root debarking of seedlings or saplings by termites is a common problem in plantation forestry in South Asia, Africa and South America (Roonwal 1979, Nair & Varma 1985, Cowie *et al.* 1989, Wilcken *et al.* 2002, Mitchell 2002). The termites attack the collar or tap-root of the seedlings while the plants are still in the nursery or shortly after they have been transplanted from the nursery into the field. The rate of attack, which decreases with time, is greatest in the months that follow transplanting and is generally limited to the first

* *E-mail: laurence@frim.gov.my*

few years after transplanting. A wide range of termite species have been reported to damage seedlings in this way, for example, species of *Odontotermes*, *Microtermes* and *Pericapritermes* in India (Nair & Varma 1985), species of *Macrotermes*, *Odontotermes* and *Pseudacanthotermes* in southern Africa (Mitchell 2002) and Ethiopia (Cowie & Wood 1999), and species of *Syntermes* and *Cornitermes* in Brazil (Wilcken *et al.* 2002). The problem is most pronounced in young eucalypt plantations, though other plantation tree species such as *Casuarina* may also be attacked (Cowie & Wood 1999).

Ring-barking and root debarking by termites, however, has never been specifically reported in forestry in Malaysia or in other parts of South-East Asia. In South-East Asia, termite attack is more commonly known to occur on older trees, and the termites responsible are *Coptotermes curvignathus* (Cowie *et al.* 1989, Tho & Kirton 1992, Kirton & Wong 2001) and *Microcerotermes dubius* (Tho 1982, Chey 1996), which have more specialized abilities to kill trees. In this article, we give an account of the first known incidences in South-East Asia of root debarking and ring-barking of saplings in enrichment planting (the planting of valued tree species in logged-over forests) in Malaysia.

MATERIALS AND METHODS

The site investigated was in Compartment 122 of Labis Forest Reserve, in the southern state of Johore in Peninsular Malaysia, and was the site of a joint project on Sustainable Forest Management and Development in Peninsular Malaysia (Phase II), conducted by the Forest Department of Peninsular Malaysia (FDPM) and the International Tropical Timber Organization (ITTO). Termites were said to be causing mortality of many newly out-planted dipterocarp saplings in the logged-over hilly and undulating lowland dipterocarp forest where enrichment planting had been carried out. Data on the extent of the problem were not available. Though not considered severe, the mortality was significant enough to warrant concern on the part of silviculturists undertaking the project. The site was visited in August 2002 during a relatively dry part of the year. We examined saplings planted on the edges of logging tracks and in the adjacent forest slopes. Among the species of dipterocarps planted were *Shorea parvifolia*, *S. acuminata* and *S. macroptera*, which occur naturally in southern Peninsular Malaysia and range from Sumatra to Borneo (Symington 2004).

Ten saplings that were dead or dying were examined for signs of termite attack above and below the ground. All the saplings were species of *Shorea*. Above-ground symptoms were examined *in situ*, and then the saplings were dug up so that the condition of the roots could be examined. Termites found in the close vicinity of the roots or collars of the saplings were sampled and identified based on Tho (1992).

RESULTS

Of the ten dead and dying trees that were examined, six had symptoms of termite damage, while the other four had no perceptible signs of damage to the roots (Table 1). However, three of the four that did not have damage had termites in the soil surrounding the roots or on the tap-root. In the remaining sapling with neither damage nor termites, the roots were covered with fungal mycelia.

Damage by the termites took the form of debarking of the tap-root and, frequently, feeding on the woody tissue of the tap-root, such that it formed a tapered, pencil-like shape or an hour-glass shaped region at the point of attack (Figure 1). All these forms of damage to the tap-root were associated with the severance of all or most of the smaller, non-woody lateral roots from the tap-root.

At least six species of termites were collected from the tap-roots or the soil in proximity to the tap-roots of the dipterocarp saplings (Table 1). They were species of *Schedorhinotermes*, *Odontotermes*, *Procapritermes* and *Nasutitermes*. The *Nasutitermes* was also present on the tap-root itself. The most commonly encountered termites were various species of the genus *Odontotermes*. An earlier collection of termites from the root area of a dead seedling at this site (collected by R. S. Raja Barizan) belonged to yet another genus, *Pericapritermes*.

Table 1 Damage symptoms and species of termites found around the roots of dead or dying *Shorea* saplings

Sample	Above-ground symptoms	Below-ground damage to tap-root	Termite species present	Location of termites
1	Dead, dry	None (roots covered with fungal mycelia)	None	–
2	Dead, dry	None	Two species (only workers collected): one *Odontotermes* sp. and the other unidentified	Soil surrounding roots
3	Dead, dry	None	*Odontotermes* c.f. *formosanus*	On tap-root
4	Dead, dry	Virtually none	*Schedorhinotermes medioobscurus*	Soil surrounding roots
5	Dead, dry	Debarked around middle of tap-root	*Odontotermes* c.f. *oblongatus*	Soil surrounding roots
6	Dead, dry	Hour-glass-like damage	*Odontotermes* c.f. *malaccensis*	Soil surrounding roots
7	Living stem, some dry leaves and non-dry green leaves	Short pencil-like damage with some lateral roots attached	*Odontotermes* sp. (only workers collected)	Soil surrounding roots
8	Living stem, a few dry green leaves	Short pencil-like damage	None	–
9	Dead, dry	Long pencil-like damage	*Procapritermes setiger*	Soil surrounding roots
10	Dead, dry	Very long pencil-like damage	*Nasutitermes* sp.	On tap-root

Figure 1 Damage to roots of *Shorea* saplings by termites. (a) Tap-root partially debarked around the middle. (b) Hour-glass-like damage caused by debarking and feeding on the woody tissue in the middle portion of the tap-root. (c)–(d) Short pencil-like damage resulting from complete severance of the tap-root and/or consumption of the lower portion of the tap-root. (e)–(f) Long pencil-like damage, caused by complete debarking of the tap-root and different degrees of feeding on the apex of the root.

DISCUSSION

The ability of the termites to damage roots of the saplings could be seen from the severance of the lateral roots and debarking of the tap root. In some of the saplings with root damage, leaves had dried green on the stems, suggesting that they had dried up very quickly. This may have been a result of rapid severance of the tap-root by termites. One sapling still had green leaves that were not dry, indicating that the termites were able to attack the roots of the plant while it was living. Debarking or ring-barking of the tap-root disrupts the flow of nutrients from the leaves to the tap-root through the cambium layer in the bark, thereby killing the tap-root. Severance of the lateral roots and tap-root prevents the uptake of water from the roots to the leaves of the plant, resulting in rapid wilting and death of the plant.

It is also evident that there were other possible causes of death of the saplings, such as dehydration or fungal attack. This can be deduced from the absence of symptoms of termite damage in some saplings and the presence of fungal mycelia around the intact roots of one sapling. Damage by termites could sometimes also have been secondary, taking place after other causes of death, or the termites could have accelerated the death of weak or stressed plants. However, wilting and root damage was observed just a day or two after out-planting of the saplings (S. A. Sheikh Ibrahim, pers. comm.), which strongly suggests that the termites were a primary cause of death of many of the saplings. Similar conclusions that termites are the primary cause of death of seedlings have been observed in India and parts of Africa (Harris 1969, Sands 1973, Nair & Varma 1985).

The nature of damage to the roots of the saplings bears many similarities to the damage termites cause to *Eucalyptus* in India (Nair & Varma 1985), Africa (Mitchell 2002) and Brazil (Wilcken *et al.* 2002). The termites sometimes remove a ring of bark from the roots below the collar or may sever the tap root or consume it, leaving a blunt point. They may also completely debark the tap-root. The spectrum of termite genera that caused the damage also parallels the genera that cause damage in South Asia, with species of *Odontotermes* being predominant (Roonwal 1979, Nair & Varma 1985). As in other countries, the termite species are not specialists that would normally attack living plants or trees. Their feeding habits differ greatly from the feeding habits of tree-killing termite species such as *C. curvignathus* or *M. dubius*. Some of the species, such as *Odontotermes*, occasionally feed on the outer bark of living trees in Malaysia, but they do not damage the living tissue and, therefore, usually cause no harm to trees (L. G. Kirton, personal observations).

What is unusual in this example of ring-barking and root debarking is that the attack occurred on dipterocarp species that were planted in their native habitat. Most attack of this form in other regions has been reported occurring in young eucalypt plantations, and has been thought to be related to the lack of alternative food sources for the termites during the early establishment period of the plantation (Nair & Varma 1985). In Africa, attack has also been said to cease after canopy closure and development of a leaf litter layer (Logan *et al.* 1990, Mitchell 2002). However, in this case, attack occurred in a relatively closed-canopy native forest with ample alternative food resources, thus throwing doubt on the hypothesis that environmental factors contribute to the problem in young plantations. Although attack occurred in a relatively dry period of the year, which may have contributed in part to sapling mortality, dehydration is unlikely to have been a key predisposing factor for termite attack, as attack has been observed to occur during wet periods of the year and under wet soil conditions in India (Nair & Varma 1985).

The type of damage caused by termites at Labis Forest Reserve is not a localized problem specific to this site. Similar damage has been observed in a forest rehabilitation project at Serting in Negeri Sembilan, where saplings of *Shorea leprosula* and *S. ovalis* were attacked by termites up to two years after planting (R. S. Raja Barizan, pers. comm.). However, it is surprising that a pest problem of this severe a consequence to out-planted saplings has not been documented earlier in Malaysia. Although enrichment planting has been practised in the country since the early 1900s (Appanah & Weinland 1993), none of the studies on enrichment planting mention termites attacking young saplings, even where pests are specifically examined (e.g. Daljeet-Singh 1975). The problem has also never been highlighted

in reviews of pest problems on indigenous forest tree species (e.g. Tho & Norhara 1983, Elouard 1998), or reviews of termite problems in Malaysia (e.g. Dhanarajan 1969, Tho & Kirton 1992, Kirton & Wong 2001). It is possible that this phenomenon has been overlooked in the past or that there may have been changes over the years in the methods of raising and transplanting saplings that have given rise to the problem.

It is also surprising that this form of termite damage has not been encountered in plantation forestry in Malaysia. It may be that termites do not cause this type of damage in forest plantations in Malaysia, or that all the species that have been widely planted have been resistant to this form of attack. Eucalypts, which are very susceptible to termite damage, have never been widely planted in South-East Asia, and this may be one reason why termite damage to newly transplanted seedlings has not been noted much in the region. However, it has been said that termites caused an estimated 15% mortality to young eucalypts planted in Malaya in 1955 (Harris 1969). Little information is available on termite attack on seedlings in other parts of South-East Asia, but damage to young eucalypts by termites has been known to occur in neighbouring China and in Indonesia (Harris 1969). It is also possible that attack rates on eucalypts are much lower in this region, as much higher seedling loss rates of up to 80% have been reported in India (Nair & Varma 1985, Varma 1990), while in southern Africa, seedling mortality due to termites is commonly 30–50% and may be as high as 100% (Mitchell 2002).

The problem of termite attack on saplings in enrichment plantings in Malaysia is a relatively recently encountered and insufficiently studied phenomenon. More research is needed to determine the rates of attack, the factors that may contribute towards the problem, the range of termite species that cause the damage and the type of damage associated with different termite species. A method of control that is not harmful to the environment is also needed, since enrichment planting is carried out in natural logged-over forests where the application of chemical insecticides may have unwanted harmful effects on wildlife and the forest ecosystem.

ACKNOWLEDGEMENTS

The authors are grateful to S. A. Sheikh Ibrahim, the manager of the FDPM/ITTO Project on Sustainable Forest Management and Development in Peninsular Malaysia (Phase II), for facilitating our study and for providing additional information on the onset and progress of attack in the site. We are also grateful to R. S. Raja Barizan for drawing our attention to the problem of termite attack in enrichment planting and for providing some personal observations. In addition, we thank M. Azmi for assistance with processing the samples and examining literature on pests in enrichment planting.

REFERENCES

Appanah, S. & Weinland, G. 1993. *Planting Quality Timber Trees in Peninsular Malaysia—a Review*. Malayan Forest Records No. 38. Forest Research Institute Malaysia, Kepong.

Chey, V. K. 1996. *Forest Pest Insects in Sabah*. Sabah Forest Records No. 15. Sabah Forest Department, Sandakan.

Cowie, R. H., Logan, J. W. M. & Wood, T. G. 1989. Termite (Isoptera) damage and control in tropical forestry with special reference to Africa and Indo-Malaysia: a review. *Bulletin of Entomological Research* 79: 173–184.

Cowie, R. H. & Wood, T. G. 1999. Damage to crops, forestry and rangeland by fungus-growing termites (Termitidae: Macrotermitinae) in Ethiopia. *Sociobiology* 15: 139–153.

Daljeet-Singh, K. 1975. A preliminary survey of insect attack on seedlings and saplings in Bukit Belata Forest Reserve. *Malaysian Forester* 38: 14–16.

Dhanarajan, G. 1969. The termite fauna of Malaya and its economic significance. *Malayan Forester* 32: 274–278.

Elouard, C. 1998. Pests and diseases of Dipterocarpaceae. Pp. 115–131 in Appanah, S. & Turnbull, J. M. (Eds.) *A Review of Dipterocarps: Taxonomy, Ecology and Silviculture*. Center for International Forestry Research, Bogor.

Harris, W. V. 1969. *Termites as Pests of Crops and Trees*. Commonwealth Agriculture Bureau, London.

Kirton, L. G. & Wong, A. H. H. 2001. The economic importance and control of termite infestations in relation to plantation forestry and wood preservation in Peninsular Malaysia—an overview. *Sociobiology* 37: 325–349.

Logan, J. W. M., Cowie, R. H. & Wood, T. G. 1990. Termite (Isoptera) control in agriculture and forestry by non-chemical methods: a review. *Bulletin of Entomological Research* 80: 309–330.

Mitchell, J. D. 2002. Termites as pests of crops, forestry, rangeland and structures in southern Africa and their control. *Sociobiology* 40: 47–69.

Nair, K. S. S. & Varma, R. V. 1985. Some ecological aspects of the termite problem in young eucalypt plantations in Kerala, India. *Forest Ecology and Management* 12: 287–303.

Roonwal, M. L. 1979. *Termite Life and Termite Control in Tropical South Asia*. Scientific Publishers, Jodhpur.

Sands, W. A. 1973. Termites as tree and crop pests. *Mededelingen van de Faculteit Landbouwwetenschappen, Rijksuniversiteit* 38: 817–830.

Symington, C. F. 2004. *Foresters' Manual of Dipterocarps*. Second edition. Revised by Ashton, P. S. & Appanah, S. Malayan Forest Records No. 16. Forest Research Institute Malaysia, Kepong.

Tho, Y. P. 1982. Gap formation by the termite *Microcerotermes dubius* in lowland forests of Peninsular Malaysia. *Malaysian Forester* 45: 184–192.

Tho, Y. P. 1992. *Termites of Peninsular Malaysia*. Malayan Forest Records No. 36. Forest Research Institute Malaysia, Kuala Lumpur.

Tho, Y. P. & Kirton, L. G. 1992. The economic significance of *Coptotermes* termites in Malaysian forestry. Pp. 193–199 in *Proceedings of the 3rd International Conference on Plant Protection in the Tropics*. Volume IV. 20–23 March 1990, Genting Highlands.

Tho, Y. P. & Norhara, H. 1983. On insects associated with kapur (*Dryobalanops aromatica*) and their status. Pp. 181–192 in de Guzman, E. D. & Nuhamara, S. T. (Eds.) *Biotrop Special Publication No. 20. Proceedings of Biotrop Symposium on Forest Pests and Diseases in Southeast Asia*. 14–16 October 1981, Bogor.

Varma, R. V. 1990. The termite problem in forest plantations and its control in India. *Sociobiology* 17: 155–166.

Wilcken, C. F., Raetano, C. G. & Carlos, L. 2002. Termite pests in *Eucalyptus* forests in Brazil. *Sociobiology* 40: 179–190.