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TERMITE UTILISATION OF REHABILITATED BAUXITE
MINED AREAS

O.G. Nichols (ALCOA)
S. Bunn (Univ. W.A)

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SUMMARY

Almost all termite species found in the native jarrah forest return to rehabilitated mined areas. This return is crucial in terms of nutrient recycling since along with fungi, termites serve a vital function in the breakdown and recycling of wood and plant material.

The reintroduction of termites into rehabilitated areas at an early stage would also be expected to facilitate vertebrate and particularly reptilian fauna return.

INTRODUCTION

Termites (Isoptera) are known to perform several important roles in the ecology of Australian eucalypt forests (Ratcliffe et al 1952). Apart from their importance in the breakdown of wood they also contribute to the breakdown of other plant material such as leaf litter and grass (Gay and Calaby, 1970). Termites are known to serve as a food source for several species of reptiles (Dell and Chapman, 1979), mammals (Ride, 1970) and birds (Frith, 1976). Indirectly, termite mounds provide shelter for reptile species (recorded by Dell and Chapman, 1979 and pers. obs.), and according to Ratcliffe et al (1952), the subterranean galleries of termite mounds aid tree root penetration. Termites have even been implicated in the possible spread of the jarrah dieback fungus *Phytophthora cinnamomi* (Keast and Walsh, 1979).

Alcoa of Australia Limited undertakes rehabilitation of bauxite mined areas in the Western Australian jarrah forest. Rehabilitation techniques designed to optimise fauna return to the mined areas have been investigated by Majer (1978a), Day (1979), Van der Linden (1979) and Kabay and Nichols (1980). Published works on specific invertebrate faunal groups in rehabilitated areas have included work on ants (Majer 1978b) and Collembola (Greenslade and Majer, 1979).

Because of the important ecological roles of termites as outlined above, it was considered desirable to investigate the degree to which termites utilise rehabilitated areas. If the aim of rehabilitation is to achieve a self-sustaining ecosystem, all ecologically important faunal groups need to be taken into account.

Since termites are able to disperse aerially by the formation of winged alates, movement into rehabilitated areas should present few problems for this group. Hence the presence or absence of colonies of a termite species in an area should be a true reflection of the efficacy of that area for supporting that particular species. A knowledge of which species of termites are catered for by the various rehabilitation methods can then be used to modify current rehabilitation techniques and thus facilitate termite utilisation of rehabilitated areas.

METHODS

Invertebrate plots were established in rehabilitated bauxite mined areas at Alcoa's Jarrahdale and Del Park minesites. These plots were used in the work of Day (1979) and Van der Linden (1979) who investigated ant and general invertebrate recolonisations respectively. They encompassed 27 areas of various ages rehabilitated by a number of different methods. Two control plots were established in unmined jarrah forest areas.

Termite soldiers were collected by hand from under logs, bark, amongst the leaf litter etc. Soldiers are required to identify termite colonies to species level. All 27 rehabilitated plots and two forest control plots were surveyed. Surveys were carried out in November 1979 and each plot took approximately 30 minutes to complete.

Termite collecting was also undertaken in the Willowdale area (30 km south of Del Park) as part of an ongoing pre-mining fauna survey. Termites were collected from 10 plots, 5 each from upland and lowland jarrah forest. One soldier was collected from each gallery and every plot took between 6 and 7 hours to complete. The species present were compared with those present in the rehabilitated Del Park and Jarrahdale areas.

RESULTS

Termite species collected together with their respective food requirements are outlined in Table 1. Presentation of the results on an individual plot basis (Table 2) illustrates several interesting trends. Soldiers of termite species which feed on sound wood, such as *Coptotermes acinaciformis raffrayi*, can be found in rehabilitated areas within 4 years of commencement of rehabilitation; while soldiers of species requiring decayed wood, litter and bark, such as *Termes occiduaalis*, were not recorded in rehabilitated areas until 11 years after rehabilitation commenced.

Although the first soldier termites recorded in rehabilitated areas are those appearing 4 years after rehabilitation, the presence of workers in 1976 plots (rehabilitated for 3 years) indicate that colonies are probably present in more recent plots but soldiers have not yet emerged in significant numbers. It is thus not possible to identify these colonies to species level.

Several plots older than 4 years show unexpectedly low numbers of termite species. Comparison of some of these plots with rehabilitation method (Table 3) suggest possible explanations. For example, the higher numbers of species in plot 8 (1969) compared with plot 7 (1966) may be due to thinning and refertilising operations in plot 8. Wood debris from thinning operations provides greater shelter and food resources for termites.

Reasons for the low number of species in plots 4, 11, 12 and 15 are less obvious. There are large variations between termite faunas of apparently similar forest control areas (S. Bunn, pers. obs.), and this, together with the large physical environmental differences between plots (Day, 1979), may account for the paucity of termite species in some plots.

DISCUSSION

The present investigation has demonstrated that all termite species recorded in the surrounding jarrah forest, with the exception of *Kalotermea aemulus*, utilise rehabilitated bauxite mined areas.

The pattern of termite distribution depends on two interrelated factors: the termite species' food requirements and the characteristics of the particular rehabilitated area. Age appears to be the most important determinant of termite species composition. The most recently rehabilitated areas only possess species capable of utilising sound or near sound wood, such as *Coptotermes acinaciformes raffrayi* and *Heterotermes platycephalus*. Older rehabilitated areas, which contain some rotting logs and more leaf litter can support species which feed on these materials, such as *Paracapritermes kraepelini*, *Microcerotermes newmani* and *Amitermes obeuntis*. Finally, when further leaf litter and decaying plant material accumulates (after some 10-15 years), species such as *Termes occidentalis* and *Tumulitermes apiocephalus* are able to inhabit the rehabilitated areas.

Tree species composition does not appear to have a marked effect on the number of termite species recorded in a particular rehabilitated plot. For any one year of rehabilitation the numbers of termite species found in eastern states eucalypt, indigenous eucalypt or pine plots are not consistently different.

The absence of *Kalotermea aemulus* from rehabilitated areas may be due to its habit of feeding on exposed *Banksia* wood or on fire scars (Gay and Calaby, 1970). Because of their high susceptibility to dieback disease, *Banksia* trees have not been replanted in bauxite mined areas. However, some natural regrowth of *Banksia grandis* has occurred and since *Kalotermea aemulus* also has been recorded feeding on *Eucalyptus* and *Casuarina* species (Gay and Calaby, 1970) there is no reason to expect that it will not eventually return to rehabilitated areas.

The presence of two other species, viz *Tumulitermes westraliensis* and *Microcerotermes distinctus* found at Willowdale and not at either Jarrahdale or Del Park may only be a reflection of their apparently low abundance in the Jarrah forest - both were only present in one out of the ten Willowdale sampling sites. The absence of *T. westraliensis* from rehabilitated areas may also be due to its preference for grass and small organic debris (Perry, pers. comm.). On the basis of its known geographic distribution *T. westraliensis* would be expected to occur from Jarrahdale to Willowdale.

Several species of termites frequently inhabit the nests of other termite species. Examples include *Heterotermes platycephalus*, *Occasitermes occasus* and *Microcerotermes newmani* (Hill, 1942). An extreme example is *Paracapritermes kraepelini* which, according to Hill (1942) may never build it's own nest. For all these species, it is thus important that colonies of early colonisers such as *C.a. raffrayi* and *H. platycephalus* be established as quickly as possible. It is now standard practice to return logs to rehabilitated areas. These will provide more suitable habitat for early colonising species, and it has been noted that *C.a. raffrayi* colonies can actually be introduced to rehabilitated areas by this method. Reintroduction of *C.a. raffrayi* to rehabilitated areas is particularly important since, according to Calaby and Gay (1956), this species is the most abundant termite species in the south-western forests.

Trials are now underway to investigate the feasibility of providing extra ground covering material such as chipped wood waste. Such material would reduce climatic extremes on the ground and increase the availability of rotting wood material thus facilitating the return of termite species such as *Amitermes obeuntis* and *Occasitermes occasus*.

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REFERENCES

- Calaby, J.H. and Gay F.J., (1956). The distribution and biology of the genus *Coptotermes* (Isoptera) in Western Australia. *Australian Journal of Zoology* 4, 19-39.
- C.S.I.R.O., (1973). *The Insects of Australia*. Melbourne University Press, Melbourne.
- Day, J.E., (1979). A study of recolonisation by ants in bauxite mines rehabilitated by a number of different methods. Western Australian Institute of Technology, Biology Project.
- Dell, J. and Chapman, A., (1979). Biological Survey of the Western Australian Wheatbelt, part V. Reptiles and Frogs of Wilroy Nature Reserve. *Records of the Western Australian Museum Supplement No.8*, 47-51.
- Frith, H.J., (1976). (Ed). *Readers Digest Complete Book of Australian Birds*. Readers Digest Services Pty Ltd., Sydney.

- Gay, F.J., (1971). The termitinae (Isoptera) of temperate Australia. Australian Journal of Zoology, Supplementary Series No.3, 1-36.
- Gay, F.J. and Calaby, J.H., (1970). Termites of the Australian Region. Biology of Termites (Eds. K. Krishna and F.N. Weesner) 2, 393-448.
- Greenslade, P. and Majer, J.D., (1979). Collembola of rehabilitated minesites in Western Australia. In: Proceedings of the 7th International Colloquium of Soil Zoology (in press).
- Hill, G.F., (1942). Termites (Isoptera) from the Australian Region. Council for Scientific and Industrial Research, Melbourne.
- Kabay, E.D. and Nichols, O.G., (1980). Use of rehabilitated bauxite mined areas in the jarrah forest by vertebrate fauna. Alcoa of Australia Limited, Environmental Research Bulletin No.8.
- Keast, D. and Walsh, K.G., (1979). Passage and survival of chlamydospores of *Phytophthora cinnamomi* Rands, the causal agent of forest dieback disease, through the gastrointestinal tracts of termites and wild birds. Applied and Environmental Microbiology 37 (3), 661-664.
- Majer, J.D., (1978a). Studies on invertebrates in relation to bauxite mining activities in the Darling Range: A review of the first eighteen months research. Alcoa of Australia Limited Environmental Research Bulletin No.3.
- Majer, J.D., (1978b). The ecology of ants in relation to bauxite mine rehabilitation. Bulletin of the Ecological Society of Australia 8, 9.
- Ratcliffe, F.N., Gay, F.J. and Greaves, T., (1952). Australian Termites. Commonwealth Scientific and Industrial Research Organisation, Melbourne.
- Ride, W.D.L., (1970). A guide to the Native Mammals of Australia. Oxford University Press, Melbourne.
- Van der Linden, F., (1979). A study of recolonisation by invertebrates in bauxite mines rehabilitated by a number of different methods. Western Australian Institute of Technology, Biology Project.

TABLE 1. Food Requirements of termite species recorded in the present survey.

<u>Species</u>	<u>Food Requirement</u>	<u>References</u>
<i>Coptotermes acinaciformis raffrayi</i>	Sound wood, living trees	Gay and Calaby (1970)
<i>Heterotermes platycephalus</i>	Logs, stumps and dry wood of living trees	Hill (1942)
<i>H. occiduus</i>	Can destroy apparently sound softwood	Hill (1942)
<i>Amitermes conformis</i>	Sapwood of fallen trees	Gay and Calaby (1970)
<i>A. obeuntis</i>	Fence posts, poles, rotting timber	Gay and Calaby (1970)
<i>Microcerotermes newmani</i>	Decayed and weathered surfaces of wood	Hill (1942) and Gay and Calaby (1970)
<i>M. distinctus</i>	Decayed plant material	Gay and Calaby (1970)
<i>Paracapritermes kraepeleni</i>	Sapwood and decay affected wood of logs and stumps	Gay (1971)
<i>Occasitermes occasus</i>	Rotting logs, weathered wood	Hill (1942) and Gay and Calaby (1970)
<i>Trumilitermes apiocephalus</i>	Decayed plant material	Perry (pers. comm.)
<i>Termes occidentalis</i>	Weathered or decay affected wood, litter or bark	Gay (1971) & CSIRO (1973)
<i>Kalotermes aemulus</i>	Sound and exposed dead wood on <i>Banksia</i> , <i>Casuarina</i> and <i>Eucalyptus</i> spp.	Gay & Calaby (1970)
<i>Trumilitermes westraliensis</i>	Grass and other small organic debris	Perry (pers. comm.)

TABLE 3. Characteristics of rehabilitated plots considered likely to affect termite utilisation of these areas.

Plot	Tree Species	Thinned	Topsoil Stripped	Refertilised	Understorey Seeded
1.	<i>Pinus</i> sp.			x	
2.	<i>Pinus</i> sp.	x			
3.	<i>Eucalyptus maculata</i>	x		x	
4.	<i>E. maculata</i>				
5.	<i>E. maculata</i>			x	
6.	<i>E. maculata</i>				
7.	<i>E. saligna</i>				
8.	<i>E. saligna</i>	x		x	
9.	<i>E. wandoo</i>	x		x	
10.	<i>E. resinifera</i>				
11.	<i>E. resinifera</i>				
12.	<i>E. resinifera</i>				
13.	<i>E. resinifera</i>				
14.	<i>E. globulus</i>				
15.	<i>E. calophylla</i>	x		x	
16.	<i>E. calophylla</i>				
17.	Arboretum				
19.	<i>Pinus</i> and natural growth				
20.	<i>E. calophylla</i> & <i>E. resinifera</i>				
21.	Seed cover		x		
22.	<i>E. calophylla</i> & <i>E. wandoo</i>		x		x
23.	<i>E. calophylla</i>				
24.	Arboretum		x		
25.	<i>E. muelleriana</i>			x	
26.	Unplanted	x		x	
27.	<i>E. globulus</i>		x		
28.	<i>E. resinifera</i>				x

(Topsoil stripped = Topsoil used in rehabilitation of mined area was recently removed from an adjoining mined area, not stockpiled).