Beetle assemblages from the Warra log-decay project: insights from the first year of sampling

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Abstract

The Warra log-decay project is a long-term study of biodiversity in decaying logs of two age classes ('oldgrowth' and 'regrowth'), aimed at developing a better understanding of the ecology of coarse woody debris (CWD) and its biodiversity in Tasmanian wet eucalypt forests. Analyses of the first year's data demonstrate the existence of a rich saproxylic beetle fauna, so far amounting to 148 species. As yet, there are few signs of a divergence in assemblage composition between logs in the two age classes, and the differences in species richness are perhaps best explained by differences in the surface area or volume of log sampled. The study has revealed differences in how readily individual species are sampled using the lower or upper collecting heads of the emergence traps. These may reflect differences in dispersal behaviour of the species concerned and may translate into differences in vulnerability to habitat fragmentation such as might be induced by fuelwood harvesting or (in the longer term) by clearfelling and short-rotation silviculture. The project will need to continue for many years to elucidate seasonal patterns, to examine successional processes and to consider how these might influence the nature of species assemblages in logs of different sizes.

Introduction

The log-decay project is one of several that are currently being undertaken in the Warra Long-Term Ecological Research Site in southern Tasmania which together aim at developing a better understanding of the ecology and biodiversity of coarse woody debris (CWD) in Tasmanian wet eucalypt forests. This is particularly important at present because of two developments that may impact on CWD availability. One is the prospect of fuelwood harvesting which may cause a sharp reduction in CWD availability (Grove *et al.* 2002). The other is the prospect of the development of ecologically informed alternatives to clearfelling (Hickey *et al.* 2001), some of which may increase CWD availability in the longer term relative to clearfelling.

Initiated in 1999, the log-decay project aims to compare the biodiversity inhabiting large diameter, oldgrowth logs with that of small diameter, regrowth logs, and to compare these over time as the logs gradually decay. The former are likely to become rare in production forests managed on relatively short silvicultural rotations (especially those subjected to unconstrained fuelwood harvesting), while the latter should continue to be common. For saproxylic species (Speight 1989), it appears that CWD diameter is a key characteristic determining which species make use of the resource (Elton 1966; Bashford 1991; Esaki 1996). Many studies suggest a positive relationship between dead wood diameter and species richness, incidence or abundance (reviewed in Grove 2002). There is currently no information on whether these principles apply in Tasmanian wet eucalypt forest, though concurrent studies are addressing this issue for *Eucalyptus obliqua* logs in an intermediate decay stage (Yee *et al.* 2001).

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Although the main research benefits of the log-decay project will not accrue for many years, in this paper we present some baseline data from analyses of the first year's sampling.

Methods

Sampling and experimental design

Twelve *Eucalyptus obliqua* trees were felled in an area of mature mixed-age wet eucalypt forest at Warra (Figure 1). Six of these trees were classified as 'oldgrowth' (i.e. more than 110 years old—probably nearer 300), while the remaining six were classified as 'regrowth' (i.e. less than 110 years old—probably nearer 90, resulting from regeneration after a non-stand-replacing wildfire). Over the two years following felling, emergence traps were placed over successive sections of the resultant logs to assess what invertebrates are able to make use of them at various stages in their decay. The sampling and experimental design is described more fully in Bashford *et al.* (2001). It takes into account the possibilities of different emergence / dispersal responses among species by locating collecting heads at the top (one) and bottom (two) of each emergence trap. It also takes into account the possibilities of seasonal as well as temporal patterns of colonisation by enclosing and re-exposing successive sections of the logs in an ordered sequence through the seasons and over the years. The aim is to continue to sample at regular intervals as the logs decay, perhaps over decades.

Sorting

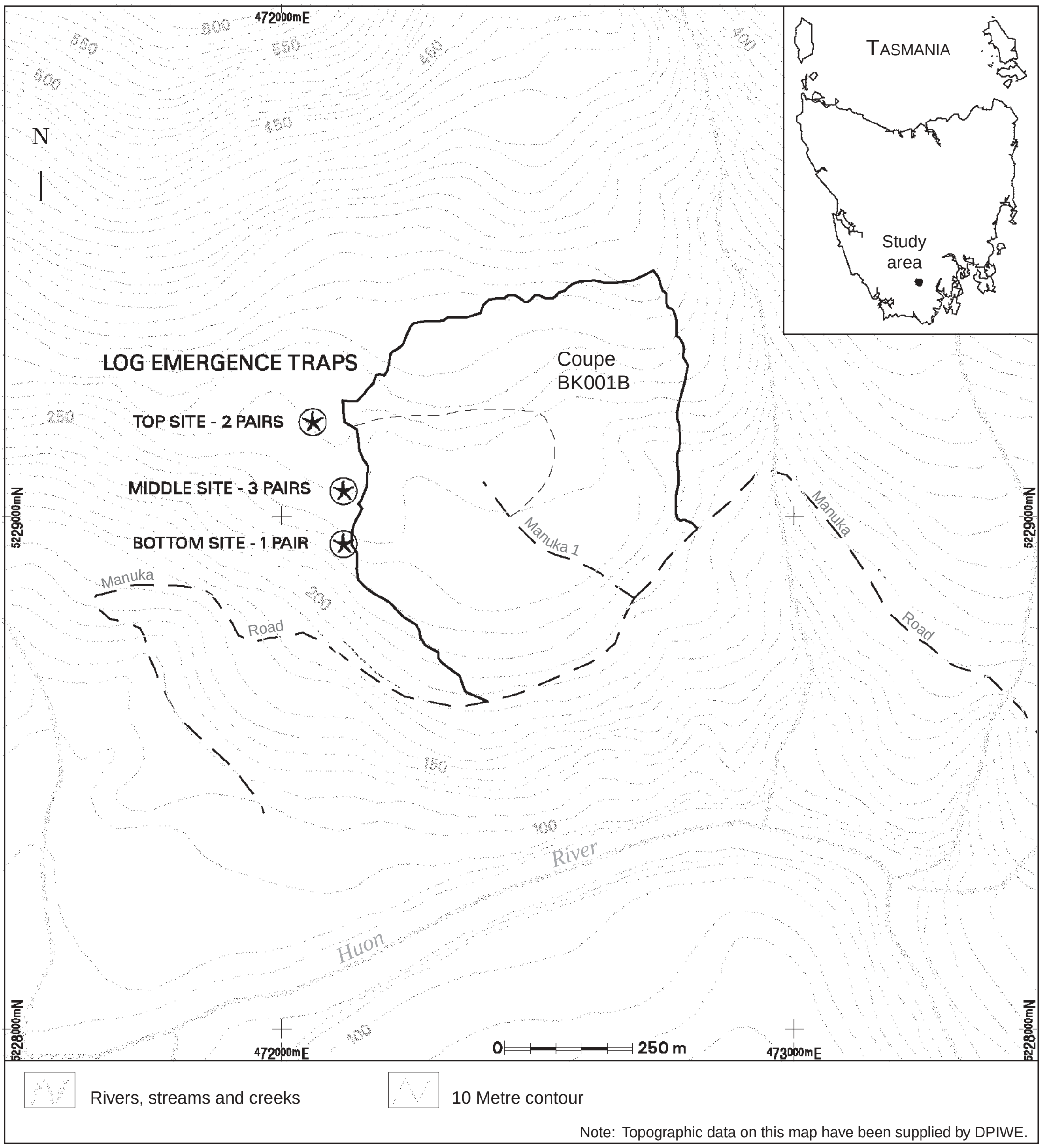
The two lower collecting heads of each trap were merged to form a single sample prior to sorting but kept separate from the sample derived from the upper collecting head of the same trap. All beetles in samples from the first year of sampling were extracted, sorted to morphospecies level, and identified to species level where possible. All specimens were dry-mounted to facilitate examination against material arising from future sampling in this and related projects. Specimens have been incorporated into the Tasmanian Forest Insect Collection, and sample data entered into the Forestry Tasmania biodiversity database.

Analyses

All samples collected within the first year were included in analyses regardless of their physical and sequential position on the log. Overall abundance, species richness and assemblage composition were investigated in relation to log size and collecting-head position.

Analyses were carried out using the computer packages ESTIMATES (Colwell 2000) for generating a randomised species accumulation curve and associated species richness estimators, and PC-ORD (McCune and Mefford 1999) for multivariate analyses examining assemblage composition. Three techniques were used to investigate different aspects of assemblage composition: non-metric multidimensional scaling (MDS, for pattern recognition), multi-response permutation procedures (MRPP, for testing for differences in assemblage composition amongst pre-defined groups), and Indicator Species Analysis (for detecting species indicative of particular groups).

MDS was run in PC-ORD's 'slow and thorough auto-pilot' mode, using the program's recommended Sorensen (Bray-Curtis) distance measure. Essentially, this mode automatically selects the optimal (i.e. low stress, highest dimension) solution based on comparing multiple real runs with multiple randomised runs. To standardise analyses, sample data were $\log_{10}+1$-transformed prior to ordination. MRPP is a non-parametric method for testing for multivariate differences amongst pre-defined groups using a randomisation procedure (e.g. Zimmerman *et al.* 1985). The method was run on non-transformed



Note: Topographic data on this map have been supplied by DPIWE.

Figure 1. Location of logs in the Warra log-decay study.

data using the program's recommended Euclidean distance measure and *n*/sum (*n*) group weighting. PC-ORD employs the method of Dufrêne and Legendre (1997) for calculating species indicator values. The method combines information on the concentration of species abundance in a particular group and the faithfulness of occurrence of a species in a particular group. It produces indicator values for each species in each group, ranging from zero (no indication) to 100 (perfect indication). Perfect indication means that presence of a species points to a particular group without error, at least with the dataset in hand. Indicator values are tested for statistical significance using a Monte Carlo technique, in this case specifying 1000 randomisations. Non-transformed data were used for this analysis.

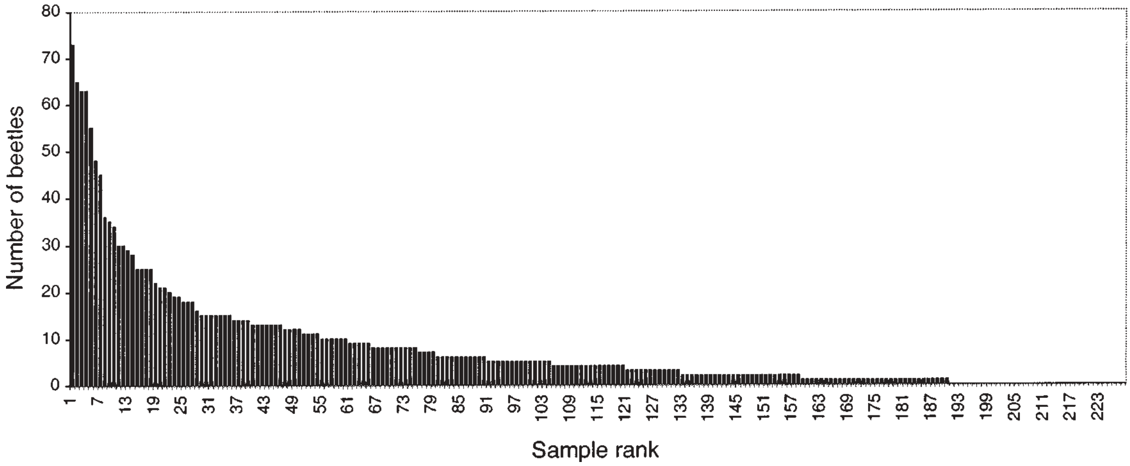


Figure 2. Rank abundance profile by sample for beetles from all 228 of the first year's samples (June 1999 to May 2000) from the Warra log-decay study.

Results

The first year's sampling comprised 228 samples (or 114 emergence trap catches, each comprising a lower trap sample and an upper trap sample). Of these 228 samples, beetles were present in all but 38 (30 upper collecting heads, 8 lower). The maximum number of beetles per sample was 73 (or 86 for a combination of lower and upper trap heads), with most samples having ten or fewer (Figure 2).

Overall species richness

One-hundred and fifty-three species or morphospecies of beetle were identified from the first year's samples, comprising 1803 individuals. About one-third of all sampled species were identifiable to species binomial (Table 1); this proportion should increase on more detailed examination. A randomised species accumulation curve (Figure 3) suggests that further species would continue to be added to the list if it were possible to increase the number of samples (e.g. logs or emergence traps). The various species richness estimators in ESTIMATES predicted that the 'total' beetle species pool for logs in this situation would be in the range of 180 to 249 species.

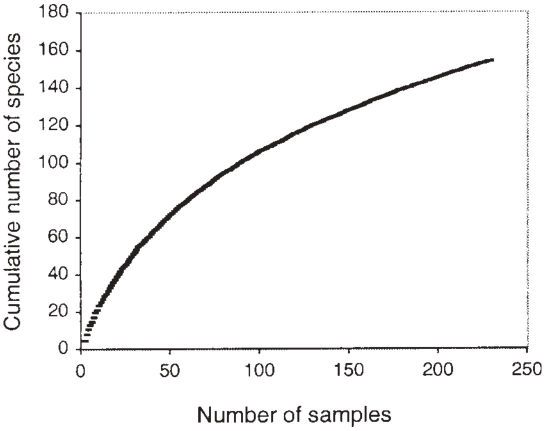


Figure 3. Randomised species accumulation curve (based on 100 randomisations) for beetles from all 228 of the first year's samples (June 1999 to May 2000) from the Warra log-decay study.

Given our lack of understanding of the ecology of most local beetle species, it was not possible to determine with certainty which of these species could be regarded as saproxylic, or which might only be facultatively so. Five species (57 individuals) of chrysomelids were excluded from subsequent analyses because they were assumed to be leaf feeders (Lawrence and Britton 1994). Given that most of these individuals were recorded in the very first samples (i.e. just after the emergence traps

*Table 1. Taxonomic species list and total abundance of beetles from the Warra log-decay project, for the first year's data (June 1999 to May 2000) only. The 'WRLD' in morphospecies names is a temporary assignation that distinguishes 'Warra log-decay' species from other unidentified species in the Forestry Tasmania biodiversity database. * Species also recorded in mid-decay stage logs in a concurrent study in the Warra area (M.Yee, pers. comm.).*

Species	Total
CARABIDAE	
**Chylnus ater* (Putzeys) 1868	3
**Notonomus politulus* (Chaudoir) 1865	5
Promecoderus tasmanicus Castelnau 1867	1
**Rhabdotus reflexus* (Chaudoir) 1865	9
**Trechimorphus diemenensis* (Bates) 1878	42
LEIODIDAE	
**Austronemadus* WRLD sp 01	5
*Leiodidae WRLD sp A	33
*Leiodidae WRLD sp B	4
Leiodidae WRLD sp F	1
**Nargomorphus* WRLD sp 02	19
**Pseudonemadus* WRLD sp 01	7
**Zeadolopus* WRLD sp 01	1
SCYDMAENIDAE	
*Scydmaenidae WRLD sp A	2
Scydmaenidae WRLD sp B	1
STAPHYLINIDAE	
*Aleocharinae WRLD sp 01	173
Aleocharinae WRLD sp 02	1
*Aleocharinae WRLD sp 03	7
*Aleocharinae WRLD sp 04	8
Aleocharinae WRLD sp 05	1
Aleocharinae WRLD sp 06	2
Aleocharinae WRLD sp 07	1
**Falagria* WRLD sp 01	1
Falagria? WRLD sp 02	3
**Falagria?* WRLD sp 03	1
Oxytelinae WRLD sp 01	1
Paederinae WRLD sp 01	1
**Philonthus?* WRLD sp 01	7
Pselaphinae WRLD sp A	2
Pselaphinae WRLD sp B	2
Staphylininae WRLD sp 01	301
Staphylininae WRLD sp 02	5
*Tachyporinae WRLD sp 01	5
LUCANIDAE	
**Lissotes cancroides* (Fabricius) 1787	13
**Lissotes subcaeruleus* Bomans 1986	3
Lissotes unidentified females	14
**Syndesus cornutus* (Fabricius) 1801	2
SCARABAEIDAE	
Saprus griffithi Blackburn 1904	5
Saulostomus villosus Waterhouse 1878	2
**Telura vitticollis* Erichson 1842	1
CLAMBIDAE	
**Clambus bornemisszai* Endrody-Younga 1990	28
**Sphaerothorax tasmani* (Blackburn) 1902	26
SCIRTIDAE	
**Macrohelodes* WRLD sp 01	3
*Scirtidae WRLD sp B	4
Scirtidae WRLD sp C	1
Scirtidae WRLD sp D	1
BUPRESTIDAE	
Nascioides quadrinotata (Van de Poll) 1889	1
BYRRHIDAE	
**Microchaetes bryophilus* Lea 1912	1
**Pedilophorus multicolor* Lea 1907	1
**Pedilophorus* nr ANIC sp 04	1
THROSCIDAE	
**Aulonothroscus* nr *elongatus* Bonvouloir	1
ELATERIDAE	
**Augenotus quadriguttatus* (Erichson) 1842	2
*Elateridae nr *Elatochrosis* WRLD sp 01	4
Elateridae WRLD sp A	4
*Elateridae WRLD sp B	5
*Elateridae WRLD sp D	2
*Elateridae WRLD sp E	3
Elateridae WRLD sp F	1
Elateridae WRLD sp G	1
Elateridae WRLD sp K	1
**Elatichrosis trisulcata* (Erichson) 1842	1
**Enischnelater specularis* (Candeze) 1889	1
**Parablax ooliekirra* Calder 1986	6
CANTHARIDAE	
**Heteromastix nigripes* Lea 1909	14
DERODONTIDAE	
Nothoderodontus darlingtoni Lawrence 1985	6
ANOBIIDAE	
**Ptinus exulans* Erichson 1842	2
**Hadrobregmus areolicollis* (Lea)	19
TROGOSSITIDAE	
*Rentoniinae WRLD sp 01	1
CLERIDAE	
Cleridae WRLD sp B	1
**Lemidia* nr *subaenea* Gorham	2
NITIDULIDAE	
Brachypeplus planus Erichson 1842	5
**Epuraea* WRLD sp 01	7
Nitidulidae WRLD sp E	47
**Thalycrodes* WRLD sp 01	11
PHLOEOSTICHIDAE	
**Hymaea succinifera* Pascoe	243

Table 1. Continued.

Species	Total
SILVANIDAE	
Uleiota australis Erichson 1842	66
PHALACRIDAE	
**Litochrus* WRLD sp 01	1
CRYPTOPHAGIDAE	
**Cryptophagus tasmanicus* Blackburn 1907	4
**Cryptophagus* WRLD sp 01	8
Cryptophagus WRLD sp 02	2
LAMINGTONIIDAE	
Lamingtoniidae WRLD sp A	1
COCCINELLIDAE	
Coccinellidae WRLD sp A	1
Coccinellidae WRLD sp B	1
Coccinellidae WRLD sp C	1
CORYLOPHIDAE	
**Alloparmulus* WRLD sp 01	2
Corylophidae WRLD sp B	1
**Corylophodes* WRLD sp 01	3
LATRIDIIDAE	
**Aridius nodifer* (Westwood)	119
**Cortinicara* WRLD sp 01	2
MELANDRYIDAE	
**Orchesia alphabetica* Lea	6
**Orchesia* WRLD sp B	2
**Orchesia* WRLD sp C	2
ZOPHERIDAE	
Caanthus gibbicollis Champion 1894	1
TENEBRIONIDAE	
**Coripera deplanata* (Boisduval) 1835	1
**Euomma tasmanicus* Champion?	3
Platydema WRLD sp A	1
PROSTOMIDAE	
**Prostomis atkinsoni* Waterhouse 1877	1
OEDEMERIDAE	
**Dohrnia simplex* Champion	137
Pseudolycus haemorrhoidalis (Fabricius)	3
MYCTERIDAE	
Mycteridae WRLD sp A	2
PYROCHROIDAE	
Pyrochroidae WRLD sp A	2
Pyrochroidae WRLD sp B	1
CERAMBYCIDAE	
Callidiopis scutellaris (Fabricius) 1801	35
**Dorcadida* TFIC sp 01	3
Stenoderus concolor Macleay 1826	1
Tessaromma sericans (Erichson) 1842	2
CHRYSOMELIDAE	
**Chrysophtharta bimaculata* (Olivier) 1807	46
Eumolpinae TFIC sp 03	1
Eumolpinae TFIC sp 06	2
*Galerucinae TFIC sp 02	7
Galerucinae TFIC sp 07	1
ANTHRIBIDAE	
**Xynotropis* WRLD sp 01	1
CURCULIONIDAE	
**Cossonus simsoni* Lea 1910	2
Cryptorhynchinae WRLD sp 01	3
*Cryptorhynchinae WRLD sp 02	3
*Cryptorhynchinae WRLD sp 03	1
*Cryptorhynchinae WRLD sp 04	4
*Cryptorhynchinae WRLD sp 05	1
Cryptorhynchinae WRLD sp 06	1
Cryptorhynchinae WRLD sp 08	1
Cryptorhynchinae WRLD sp 09	1
Cryptorhynchinae WRLD sp 10	1
Cryptorhynchinae WRLD sp 11	2
*Cryptorhynchinae WRLD sp 12	1
Cryptorhynchinae WRLD sp 13	1
Cryptorhynchinae WRLD sp 14	1
Cryptorhynchinae WRLD sp 15	1
Cryptorhynchinae WRLD sp 16	3
Cryptorhynchinae WRLD sp 17	1
Cryptorhynchinae WRLD sp 18	1
Curculionidae WRLD sp AD	1
*Curculionidae WRLD sp AF	3
Curculionidae WRLD sp AQ	3
Curculionidae WRLD sp AR	1
Curculionidae WRLD sp F	5
Curculionidae WRLD sp J	1
Curculionidae WRLD sp K	1
**Decilaus lateralis* Lea 1913	2
**Decilaus nigronotatus* Lea 1913	7
**Decilaus striatus* Lea 1913	3
Decilaus WRLD sp 01	6
Decilaus WRLD sp 02	1
**Dinichus terreus* Pascoe 1887	1
**Dryophthorus* WRLD sp A	1
**Exithius ?capucinus*	14
**Exithius loculiferus* Lea 1913	2
**Mandalotus* WRLD sp A	2
**Platypus subgranosus* (Schedl)	76
**Poropterus alboscutellaris* Lea 1911	6
Poropterus WRLD sp A	1
Poropterus WRLD sp B	3
**Rhopalomerus piceosetosus* (Lea)	2
**Tyrtaeosus ustulatus* Pascoe	4
UNKNOWN	
Coleoptera unknown WRLD sp D	2
Coleoptera unknown WRLD sp E	1

were put on the logs), it is assumed that they were using the logs as a temporary shelter (Clarke *et al.* 1998). It is possible that the same may apply to some of the remaining 148 species in the list, but it is felt that the influence of such species on assemblage composition would be minor compared to species utilising the logs as breeding or feeding substrate. Eighty-one of the non-chrysomelid species were also recorded in the concurrent study of beetles in logs in an intermediate decay stage (Yee *et al.* 2001; M. Yee, pers. comm.).

The overall abundance of individuals by species followed a typical distribution pattern (Borda-de-Agua *et al.* 2002), with the majority of individuals belonging to one of a few species (Figure 4). The five most common species, in descending order of abundance, were Staphylininae WRLD sp 01 (Staphylinidae), *Hymaea succinifera* (Phloeostichidae), Aleocharinae WRLD sp 01 (Staphylinidae), *Dohrnia simplex* (Oedemeridae) and *Aridius nodifer* (Latridiidae). At the other end of the scale, 60 species were recorded only as single individuals. These, and an additional four species recorded only in single samples, were excluded from multivariate analyses of assemblage composition. This left 84 species for multivariate analyses.

Oldgrowth versus regrowth logs

Excluding chrysomelids, 125 species (1065 individuals) were collected from the oldgrowth logs, compared with 86 species (631 individuals) collected from the regrowth logs. Figure 5 shows how total numbers were divided between oldgrowth and regrowth logs for the 20 most abundant species. Most of these species seemed to occur preferentially in either the oldgrowth or the regrowth logs. However, an MDS ordination did not suggest any major differences in overall assemblage composition (Figure 6), though MRPP analysis suggested that there were marginally significant differences ($P = 0.046$) in assemblage composition between the two groups. Indicator Species Analysis suggested that only three species discriminated well (high IndVal scores and $P < 0.05$) between oldgrowth and regrowth. Those particularly associated with oldgrowth logs were *Macrohelodes* WRLD sp 01 (Scirtidae) and Curculionidae WRLD sp F. Only *Decilaus*

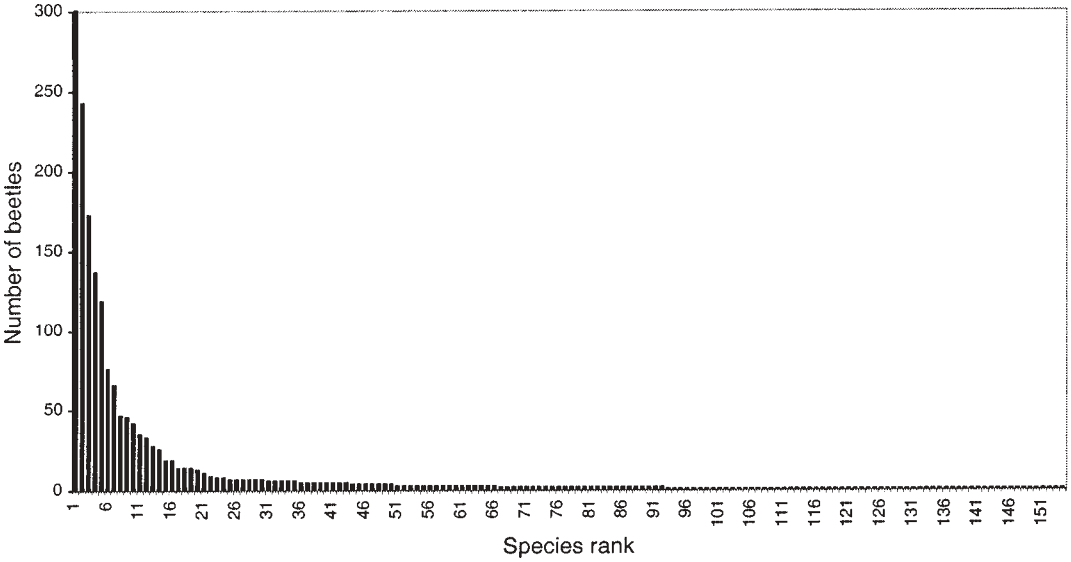


Figure 4. Rank abundance profile by species for all 153 species of beetles from the first year's samples (June 1999 to May 2000) from the Warra log-decay study.

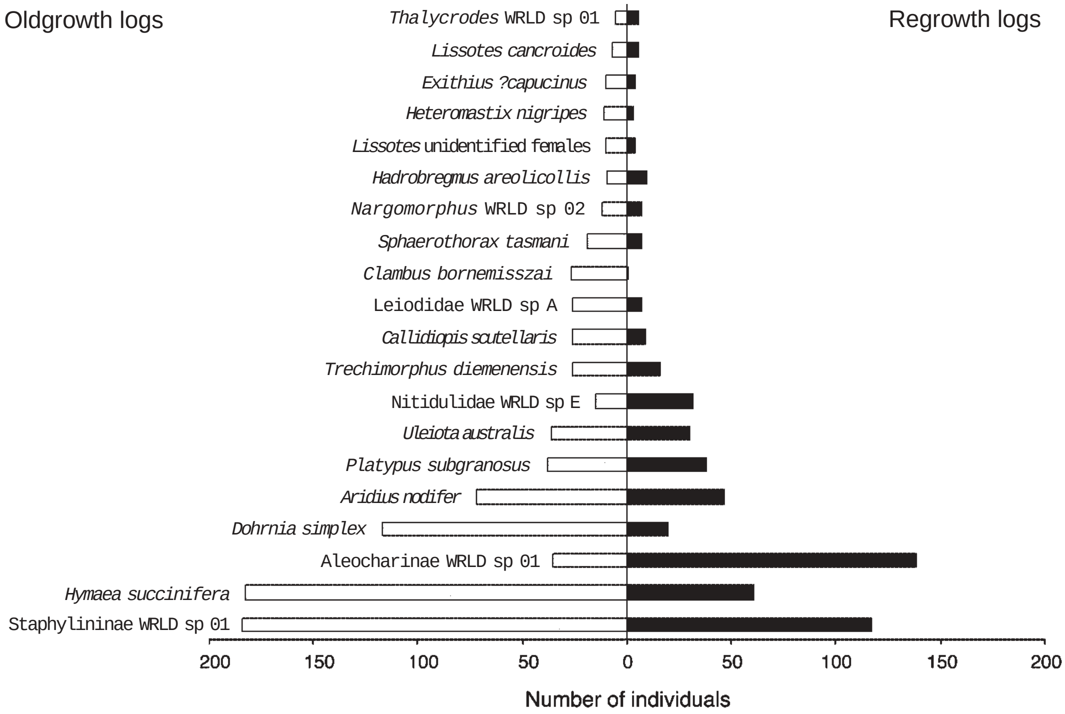


Figure 5. Total abundance in oldgrowth and regrowth logs for the 20 most frequent beetle species in samples from the first year (June 1999 to May 2000) of the Warra log-decay study.

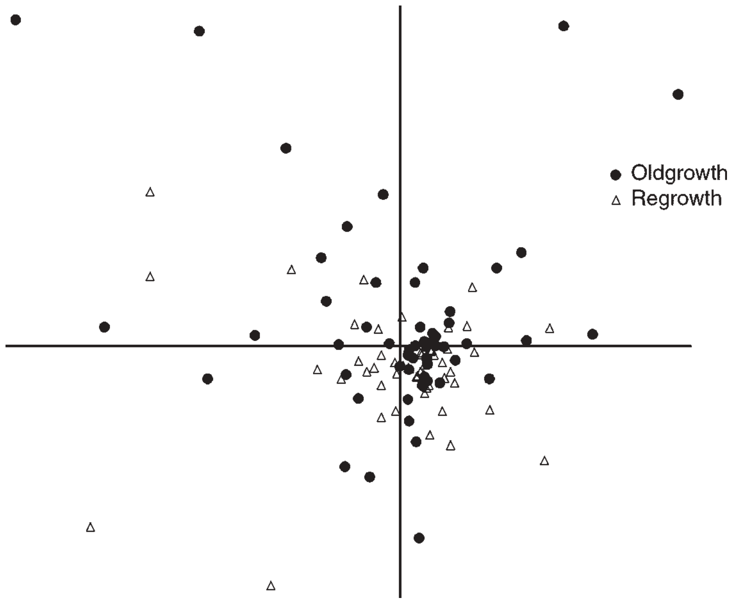


Figure 6. Ordination diagram from non-metric multidimensional scaling of beetle abundance data (log$_{10}$+1-transformed) for the first year's samples from the Warra log-decay study, based on the 84 beetle species present in more than one sample. Each symbol represents a single sample combination (upper and lower collecting heads combined), for either oldgrowth or regrowth logs. The optimal two-dimensional solution is shown. STRESS (Kruskal x 100) = 19.709, P *= 0.0196.*

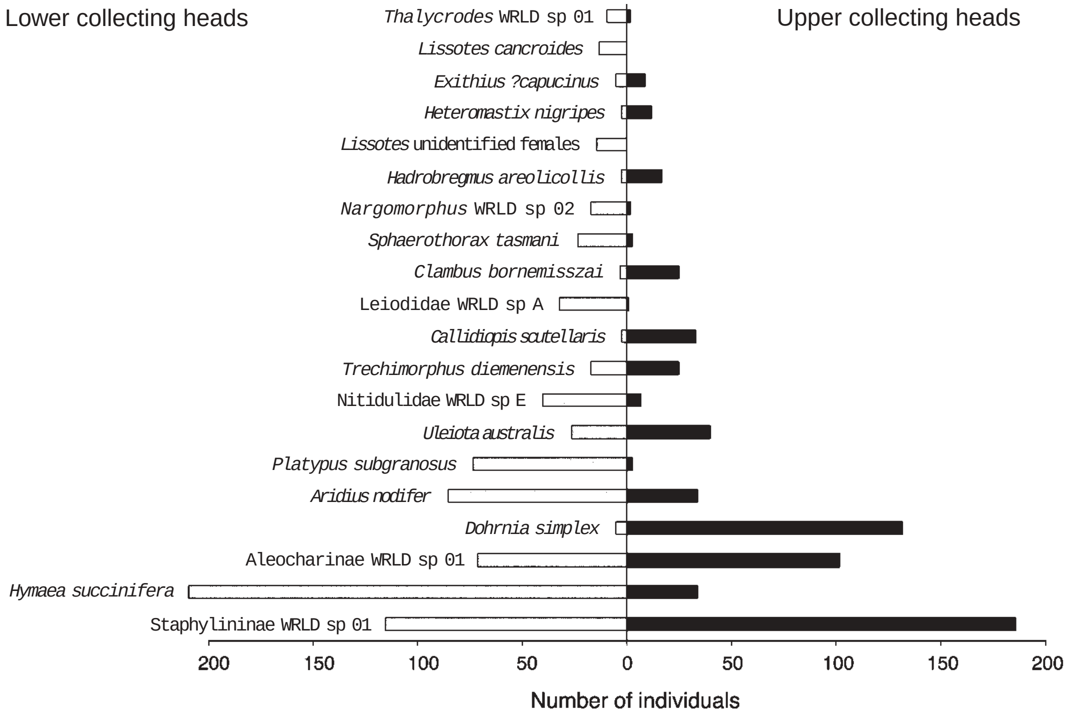


Figure 7. Total abundance in lower and upper collecting heads for the 20 most frequent beetle species in samples from the first year (June 1999 to May 2000) of the Warra log-decay study.

striatus (Curculionidae) showed a significant positive association with regrowth logs.

Upper versus lower collecting heads

Excluding chrysomelids, 95 species (799 individuals) were collected from the upper collecting heads, compared with 93 species (947 individuals) collected from the lower collecting heads. These similarities mask differences for individual species. Figure 7 shows how total numbers were divided between lower and upper collecting heads for the 20 most abundant species. Each of these species seemed to occur preferentially in either the lower or the upper collecting heads. An MDS ordination showed some slight differentiation in overall assemblage composition between samples from lower and upper collecting heads (Figure 8). MRPP analysis suggested that these differences were highly significant ($P < 0.0001$). Indicator Species Analysis suggested that 14 species discriminated well (high IndVal scores and $P < 0.05$) between lower and upper collecting heads. Those particularly associated with lower collecting heads were *Hymaea succinifera* (Phloeostichidae), *Platypus subgranosus* and *Decilaus nigronotatus* (Curculionidae), Nitidulidae WRLD sp E, *Aridius nodifer* (Latridiidae), *Nargomorphus* WRLD sp 01 and sp 02 (Leiodidae) and *Lissotes cancroides* and *Lissotes* unidentified females (Lucanidae). Those particularly associated with upper collecting heads were *Callidiopis scutellaris* (Cerambycidae), *Dohrnia simplex* (Oedemeridae), *Hadrobregmus areolicollis* (Anobiidae), Staphylininae WRLD sp 01 (Staphylinidae) and *Tyrtaeosus ustulatus* (Curculionidae).

Discussion

Northern Hemisphere studies have consistently demonstrated that saproxylic insects are a speciose functional group in

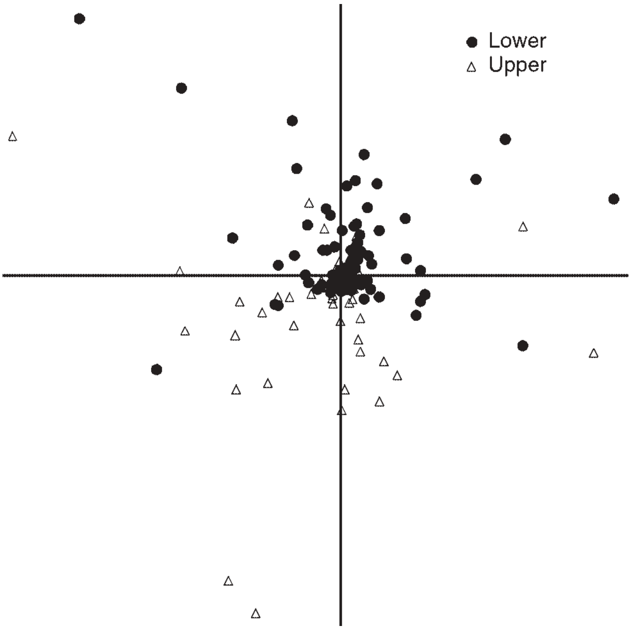


Figure 8. Ordination diagram from non-metric multidimensional scaling of beetle abundance data (log-transformed) for the first year's samples from the Warra log-decay study, based on the 84 beetle species present in more than one sample. Each symbol represents a single sample, either a lower collecting head sample or an upper one. The optimal two-dimensional solution is shown. STRESS (Kruskal x 100) = 27.332, P *= 0.0196.*

native forests (Grove 2002). In a recent Finnish study, 42% of the beetle species caught in a survey of mature boreal forest were saproxylic (Martikainen *et al.* 2000), while in a German study, 56% of the regional forest beetle species were considered to be saproxylic (Köhler 2000). Since beetles account for some 40% of all insect species (Grove and Stork 2000), this translates into a large number of CWD-dependent species worldwide. Parker (1982) has estimated that the number of species of CWD-dependent beetles may outnumber all terrestrial vertebrates by at least two to one. In this context, the detection of 148 potentially saproxylic beetle species in the first year of the log-decay study (and the prospect of 40 to 100 more had there been more samples to examine), whilst impressive, is unsurprising. The potential for collecting much greater numbers of beetles in the course of the log-decay process is evident by considering that only 55% of species found in the present study were also recorded in a concurrent study (M. Yee, pers. comm.) of *Eucalyptus obliqua* logs in an intermediate decay stage in the Warra area.

Conservation biologists increasingly recognise the value of CWD as a key substrate for forest biodiversity (Speight 1989; Kirby and Drake 1993; Hallenberg *et al.* 1994; Hanski and Hammond 1995; Hammond 1997; Dajoz 2000). Larger diameter CWD is often thought to be particularly important (Grove 2002). For instance, Kleinevoss *et al.* (1996) found higher saproxylic beetle species richness on larger diameter CWD in German forests. Jonsell *et al.* (1998) devised models based on known habitat associations of Swedish red-listed CWD-associated invertebrates. These models predicted that most species would occur in CWD in the largest diameter class, including 178 not found in smaller diameter classes. Only 94 species would occur in the smallest, with only 13 of these not found in larger classes.

In the present study, larger diameter oldgrowth logs were found to support many more species (125) of saproxylic beetle than smaller diameter regrowth logs (86). Superficially, this finding is consistent with other studies. However, differences in assemblage composition between these two log sizes were only marginally significant, and only three species were found to strongly favour one or the other log size class. It thus seems quite likely that the apparent differences in species richness are largely attributable to the different volumes or surface areas of log sampled. A single emergence trap will encase a larger volume and surface area of an oldgrowth log than a similar trap on a regrowth log, and will therefore have the potential to sample more individuals—as indeed was the case in the present study. All things being equal, the total number of species caught will be related to the total number of individuals caught. As the study proceeds, it may prove necessary to adopt statistical resampling techniques (Crowley 1992) to allow for differences in numbers of individuals recorded per sample. At this early stage in the study and in the ecological succession, the apparent lack of difference in beetle assemblage composition between oldgrowth and regrowth logs may simply imply that differences have yet to develop, or at least have yet to be detected by the sampling methods used. It is noteworthy that one of the two species showing a strong association with oldgrowth logs (*Macrohelodes* sp.) probably breeds in water-filled splits and cavities in logs—a habitat that may be more common in larger logs because they are less susceptible to drying out.

The differences in assemblage composition between lower and upper collecting-head samples are interesting, especially as they did not translate into marked differences in species richness. The phenomenon is perhaps most likely to reflect the dispersal behaviour of individual species—though this remains untested as so little is known about the ecology of most Tasmanian beetle species. Those preferentially collected in the upper heads are likely to be attracted to light after they emerge from the log, and to have good powers of flight and long-distance dispersal. *Dohrnia simplex* is one such species in this category that is frequently seen flying around the forests at Warra. Those preferentially collected in the lower heads are more likely to be flightless or have low powers of flight, and to favour more local dispersal by crawling. The flightless *Hymaea succinifera* most clearly fits this profile. Although unproven in the local setting, it is possible that these differences might translate into equivalent differences in vulnerability to habitat fragmentation. They certainly point to the existence of many species with low powers of dispersal. In this context, fragmentation could include reduced abundance of CWD within coupes or within production forestry landscapes brought about by fuelwood harvesting or (in the long term) by clearfelling and short-rotation silviculture (Grove *et al.* 2002). These early findings will help identify target taxa for more detailed autecological and dispersal studies to address these concerns.

Conclusion

In its first year, the Warra log-decay study has demonstrated the existence of a rich saproxylic beetle fauna in *Eucalyptus obliqua* logs at an early stage of decay. As yet, there are few signs of a divergence in assemblage composition between oldgrowth and regrowth logs, and the observed differences in species richness between these two log sizes are perhaps best explained by differences in the surface area or volume of log sampled. The study has revealed differences in how readily individual species are sampled using the lower or upper collecting heads. This may reflect differences in dispersal behaviour of the species concerned and may translate into differences in vulnerability to habitat fragmentation. This will aid the identification of target taxa for more detailed studies to address this issue. Longer term sampling will be required to elucidate seasonal patterns, to examine successional processes and to consider how these might influence the nature of species assemblages in logs of different sizes.

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