The Dispersal of Ground Beetles into Different Aged Eucalypt Plantations in North Eastern Tasmania

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Abstract

The dispersal and establishment of the lucanid Lissotes rudis *Lea and the carabids* Notonomus politulus *(Chaudoir) and* Promecoderus curvipes *Sloane into different aged eucalypt plantations from adjacent undisturbed native forest was examined using pitfall trap captures over several years. Sampling indicated that a breeding population of* L.rudis *(a log decomposer) was established in six year old plantations whereas no breeding population of the carabid species (carnivores) appeared to have been established in plantations of the same age.*

Introduction

The preparation of plantation sites involves intensive management techniques including burning of windrows after logging, the cultivation of the soil prior to planting, and herbicide applications for weed control. This treatment appears to render these sites devoid of reproducing populations of beetle families occupying higher trophic levels, dependent on log or ground cover habitats.

The establishment of breeding populations of litter invertebrates within eucalypt plantations is an important event in the nutrient cycle. Without the presence of decomposers assisting in the breakdown of plant tissues, the nutrient levels within the soil will become depleted over a series of rotations. The insects selected in this study are from two distinct guilds. The lucanid *Lissotes rudis* is a primary decomposer of logs, assisting in the breakdown of material heaped in windrows within plantations. The carabids *Notonomus politulus* and *Promecoderus curvipes* are predators, feeding on other small litter invertebrates. Their presence is an indication of an active invertebrate litter fauna influencing the rate of litter decomposition.

The use of indicator species assumes a relationship between the indicators and the diversity of invertebrates, and the other fauna dependent on them. This alleviates the physical and taxonomic impediments of monitoring 'complete' faunas over long periods (Murdoch 1967). In this study the lucanid and carabid species are used to indicate the invertebrate recolonisation of different aged plantation sites.

Table 1. Lissotes rudis. The ratio of males to females in the years following plantation establishment.

Year	New Plantation (Deviation*)	Established Plantation (Deviation)
1	1.0:1 (+0.57) n = 8	
2	0.7:1 (+0.27) n = 28	
3	0.4:1 (-0.03) n = 28	
4		Not sampled
5		0.5:1 (+0.07) n = 80
6		0.6:1 (+0.17) n = 58

* Deviation from mean of native forest population [Mean ratio over sample period 0.43:1 n = 208]

Table 2. Frequency of capture (months/year) of L.rudis *in plantations of different ages*

Year (Age of Plantation)	1	2	3	4	5	6	Native Forest
Months of Capture	2/12	4/12	5/12	-	10/12	9/12	11/12

Study Sites

The trial was established in State forest at Goulds Country Forest Block Cpt 2 (altitude 120 m; annual rainfall 980 mm).

Two different aged eucalypt plantations were compared with undisturbed native forest. When sampling commenced, one plantation area had been cleared and planted with *Eucalyptus globulus* Labill, *E.nitens* (Deane and Maiden), *E.obliqua* L'Herit and *E.regnans* F. Muell. the previous winter (1986) (New Plantation). The other area was planted with *E.nitens* in 1983 (Established Plantation). The undergrowth in the plantation sites consisted mainly of *Acacia verticillata* (L'Herit), *A.dealbata* Link, *Pteridium esculentum* (G. Forster) Nakai, and the vine *Muehlenbeckia adpressa* (Labill.).

An undisturbed relic of native forest, dominated by *E.obliqua* over dense mixed understorey, bordered both plantations but was separated from each by dirt roads and fire breaks. Both plantations and native forest were approximately 200 m. away from each other at the pitfall sites. (Fig. 1 and Fig. 3).

Methods

Ten pitfall traps were set up at each experimental site at right angles to two windrows with one trap at each end placed in the windrow. The traps were positioned between three and five m. apart. The traps consist of waxed paper cups of 300 ml capacity mounted so the lip fitted flush with the soil surface. Black inverted flower pot bases supported by wooden pegs provided a protective cover against rain, litter, and animal/bird disturbance (Fig. 2). Each cup was charged with 100 ml of preservative solution comprising a 30 per cent ethanol/5 per cent glycerol mixture. The traps were emptied at two week intervals during the months September to March and once a month, April to August. New cups were inserted at each sampling. Each individual pitfall trap site was cleared to a 60 cm radius as recommended by Greenslade (1964).

Results

(a) *Lissotes rudis*

The number of individuals captured in the undisturbed forest did not fluctuate greatly

Table 3. Numbers of L.rudis *individuals captured per month in native forest and plantation sites. 1987-1989.*

Forest Type	Mean No. and standard errors for beetles captured per month 1987/88	1988/89
Native forest	5.7 ± 1.3	8.0 ± 0.6
1 y.o. plantation	2.3 ± 1.2	-
2 y.o. plantation	-	2.9 ± 0.2
5 y.o. plantation	8.9 ± 1.6	-
6 y.o. plantation	-	6.9 ± 0.5

Table 4. Ratio of N.politulus *to* P.curvipes

Site	Year 1	Year 2	Year 3
Native Forest	1:1.1	1:1.3	1:1.9
Established Plantation	not sampled	1:6.0	1:13.0
New Plantation	0:1	1:4.3	1:2.0

from month to month except for the occasional absence of beetles in some colder months (Fig. 4).

The sex ratio (male:female) in native forest averaged 0.43:1 for the three years of the survey.

A significantly higher proportion ($P<0.005$) of males was captured in the two plantation sites compared with the native forest site. In the first year of plantation establishment the ratio was as high as 1:1. The proportion of males to females appears to decline annually for at least the first three years of plantation establishment (Table 1). Sex ratio levels approaching that of the established native forest site were reached three years after plantation establishment.

As the plantations in this trial aged the frequency of capture of *L.rudis* adults increased (Table 2).

There was a significant correlation between populations of lucanids in native forest and six year old plantation ($P<0.05$) (Table 3).

(b) Carabid Species

The number of individuals for both species sampled (*N.politulus* and *P.curvipes*) was higher in the undisturbed forest than in the plantations ($P<0.01$) (Fig. 5). Neither species appears to be as dispersive in terms of 'straight line distance' as *Lissotes rudis*. More individuals of *P.curvipes* were collected for more months of the year than *N.politulus* in both plantations ($P<0.01$). Table 4 shows the proportion of each species collected and indicates that dispersal into adjacent habitats favours *P.curvipes*.

The activity period of the carabids seems to be more temperature dependent than *Lissotes* with the number of months of capture being lower and higher temperature months resulting in increased individual catches (Fig. 6 and Table 5).

Discussion

The severity of fire damage to heaped logs in the windrows at the new plantation site indicated that large ground dwelling invertebrates would be unlikely to survive. Evidence to support this was provided by a survey of those windrows for the mollusc *Caryodes defreshnii* (Leach) in which it was found that all the mollusc specimens had been killed. Live specimens have not been collected in the subsequent three years (Bashford 1988). Therefore any adult ground beetles captured during the first year at least are assumed to be moving from the native forest site.

L.rudis was the only species of lucanid

Table 5. Frequency of capture (months/year) of carabid species in relation to plantation age

Species	Age of plantation (years) 1	2	3	4	5	6	Native Forest
Notonomus politulus	0/12	3/12	2/12	-	2/12	1/12	6/12
Promecoderus curvipes	1/12	6/12	3/12	-	6/12	5/12	7/12

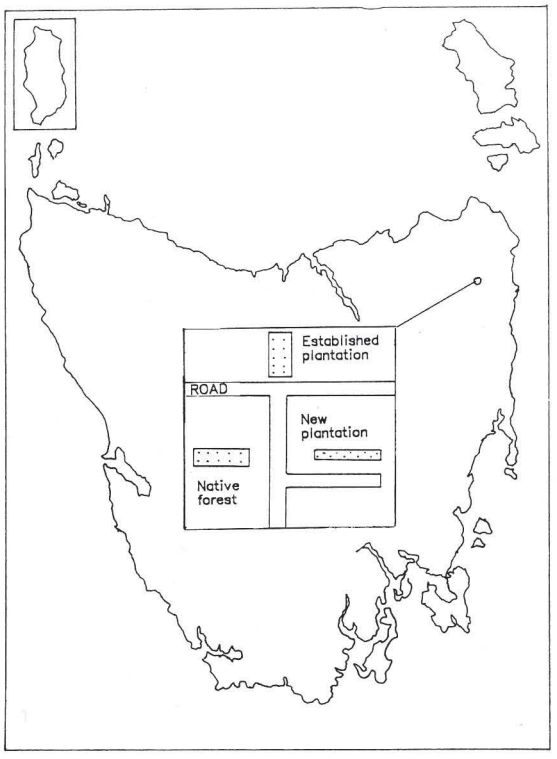

Fig. 1. Locality and site establishment of pitfall traps at Goulds Country in N.E. Tasmania.

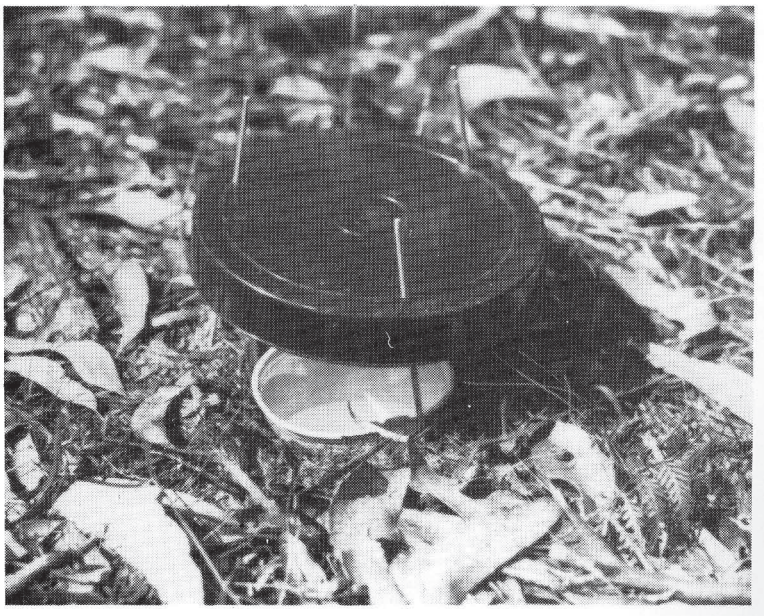

Fig. 2: Pitfall trap showing components

Fig. 3: Native forest area viewed from new plantation site.

captured during the sample period. A few individuals of three other carabid species were collected in the pitfall traps (*Scopodes intermedius* Blackburn, *Mecyclothorax ambiguis* Erichson and *Teraphis tasmanicus* Sloane).

Some individuals of *S.intermedius* were initially collected only in the native forest traps, but after year three this species was also collected in the established plantation traps.

Because there was a significant correlation between lucanid populations in the six year old plantation and the native forest sites it is assumed that a breeding population can become established in plantation windrows of this age.

The presence of high numbers of males in the plantation sites suggest that the proportion of males above the undisturbed forest sex ratio of 0.43:1 (male:female) results from those 'excess' males dispersing from that site. This trend is reflected in the numbers collected in the early years of plantation establishment (1-4 years).

In the case of the carabids there is no significant relationship between the three trap sites to suggest that a base line population i.e. breeding population, has after six years, been re-established. The relatively stable population levels in the native forest site suggest a dispersal of excess individuals into the plantation areas. That some carabids can travel long distances is demonstrated by Baars (1980). He traced radioactive *Pterostichus versidor* individuals which covered up to 160 m in one season. Another small species was traced for 66 m. Baars found that carabids in unfavourable sites travelled continuously in a straight line resulting in dispersal to more favourable sites.

The small carabid *P.curvipes* seems better able to cope with the adversities of desiccation and limited food supply than the larger *N.politulus*. Both species may require a denser ground cover and thicker litter layer than exists after six years in the plantations sampled in order to establish breeding populations.

The technique of pitfall trapping continuously over several years may reduce

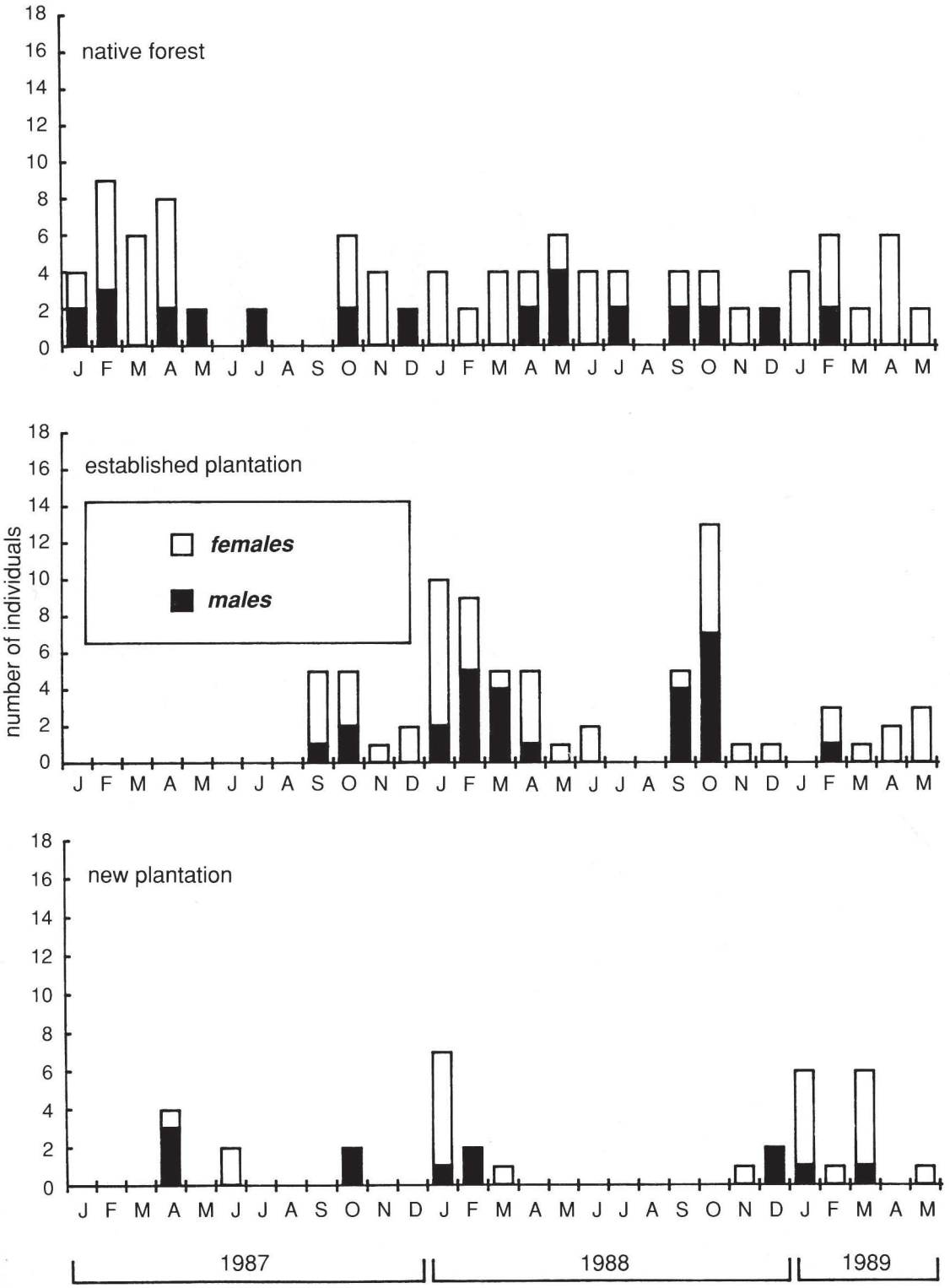

Fig. 4. Number of Lissotes rudis *adults captured in native forest and plantation sites using pitfall traps.*

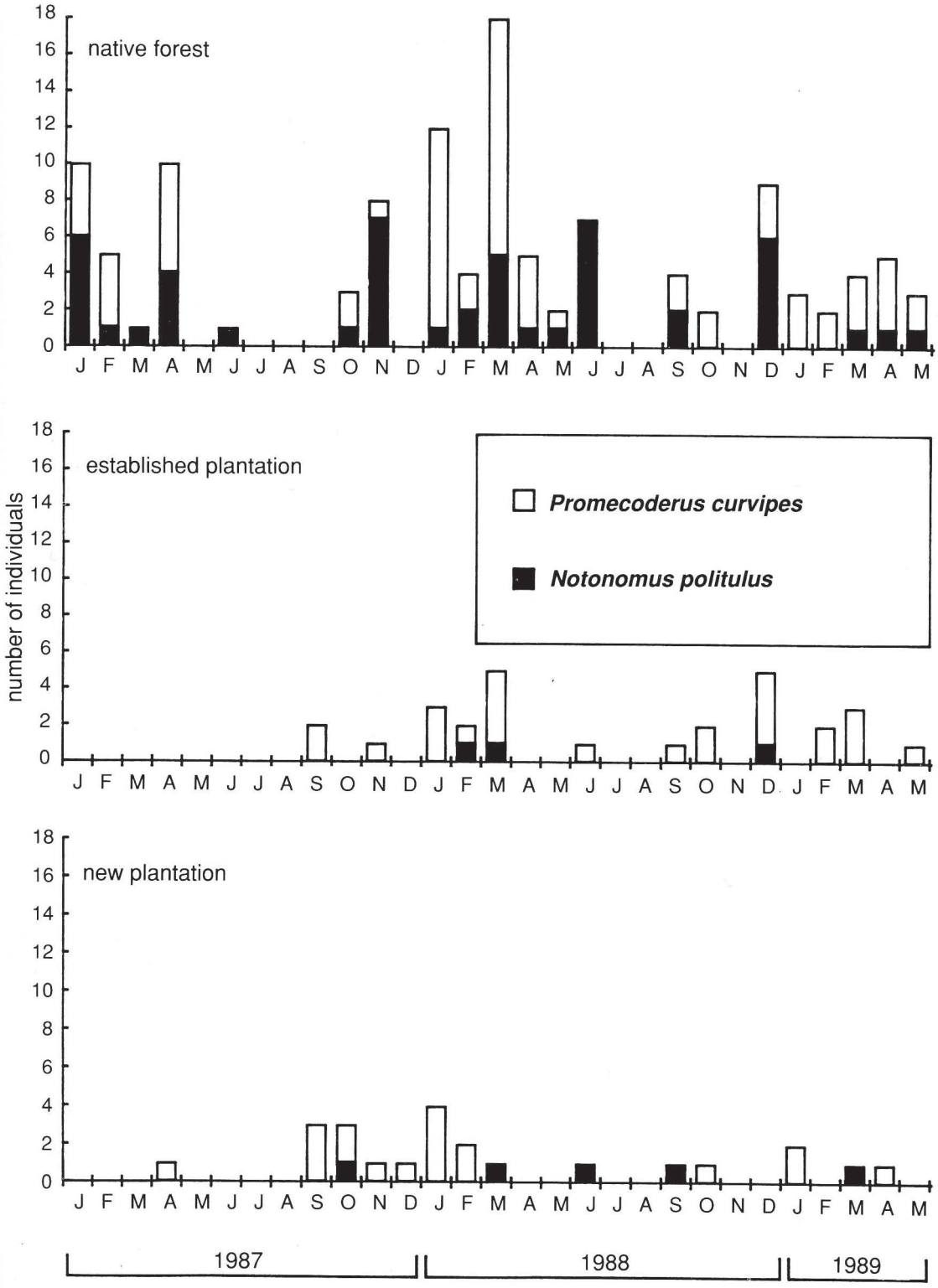

Fig. 5. Number of carabid adults captured in native forest and plantation sites using pitfall traps.

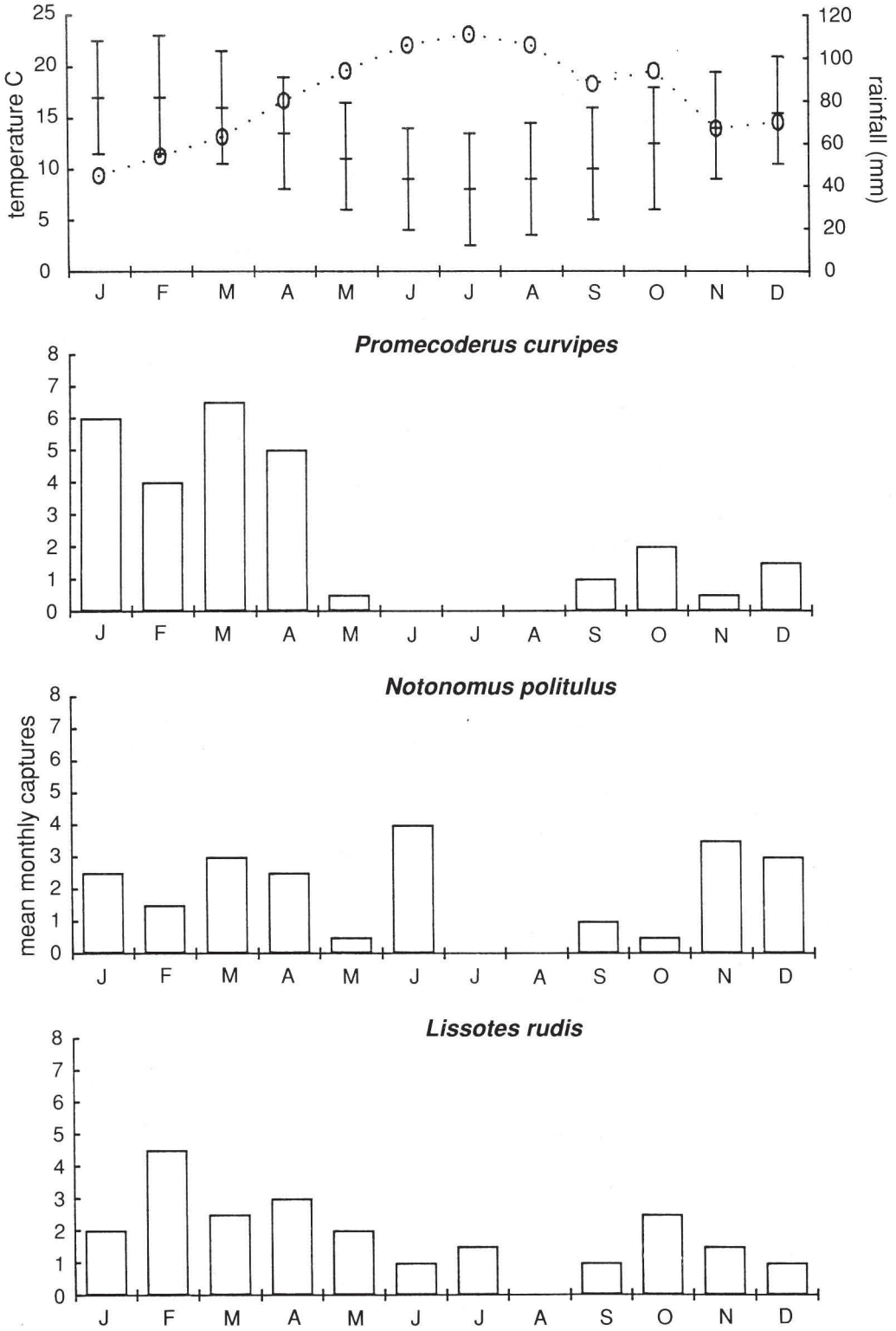

Fig. 6. Monthly mean of temperature and rainfall related to pitfall captures of carabid and lucanid species.

the overall population but does not trap males or females in a biased manner. Moeed and Meads (1985) showed that trapping did not reduce base level populations but in years of high population levels caught more individuals.

Baars (1979) reviewed the literature relating to the usefulness of pitfall traps in measuring populations of carabids and found that for most species the measure of relative abundance when comparing populations, in sites and years, was reliable and comparable statistically. There was also a clear relationship between the ratio of numbers caught in pitfall traps over two years, and the number captured in m^2 plots for the same period. The ratio of species within each sampled population was the same for both techniques. The contention that pitfall trap catches reflect the relative abundance of carabid species to each other is supported by Greenslade (1964). The same technique of pitfall trapping as used by Greenslade has been adopted in this study.

The use of cheap, easily maintained pitfall traps provides a simple method of monitoring the 'health' of a eucalypt plantation in relation to the establishment of invertebrate populations. These invertebrate populations are essential for decomposition of litter and the establishment of food chains dominated by higher animals.

This study indicates that log dwelling lucanids can re-establish populations in six years but that carabid predators, which are reliant on other litter invertebrates for prey, may not re-establish in that time span. This suggests that for the first six years of eucalypt plantation establishment at similar sites, litter decomposition rates may not be high.

Acknowledgement

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