CONTENTS

Local distribution patterns of terrestrial amphipods in eucalypt forest in northeast Tasmania. A.M. Walsh, R.J. Taylor and P.G. Cale 2

An observation of petal carrying by the superb fairy-wren Malurus cyaneus. M. Pickett 9

Comparison of shell measurements of the Tasmanian endemic land snail Caryodes dufresnii (Leach) from different populations. R. Bashford 10

Unusual nesting record for the pied oystercatcher. H.E. Coles 18

Occurrence of reptiles in logged and unlogged wet and dry eucalypt forest. A.M.R. Duncan 19

Vertebrates of the Domain, an urban bushland remnant in Hobart. R.N. Brereton, R.J. Taylor and M. Rhodes 31

A note on the diet of the scrubtit Acanthornis magnus. M. Pickett. 41

Two new varieties of the Tasmanian Caryodid snail Anoglypta launcestonensis. K.J. Bonham 42

Book Review 51
LOCAL DISTRIBUTION PATTERNS OF TERRESTRIAL AMPHIPods IN EUCALYPT FOREST IN NORTHEAST TASMANIA

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Abstract. Capture rates of amphipods in pitfall traps placed in the ground were compared in dry and wet eucalypt forest communities in an area in northeast Tasmania. Two species were trapped, with Keratroides vulgaris far outnumbering Keratroides angulosus. Captures of K. vulgaris were lowest and no K. angulosus were captured in poorly drained seepages, probably due to stresses associated with waterlogging of the soil and litter. Captures of both species were greatest in forest communities on steep slopes associated with deeply incised gullies, probably due to the moist humid conditions and litter development associated with the high shrub cover.

INTRODUCTION

Up to five species in two or more genera of terrestrial amphipod crustaceans (family Talitridae) can occur in the same soil and litter sample in Tasmania (Friend 1987), with more species likely in wet rather than dry vegetation (Taylor et al. 1995). The distribution and habitat of these species are probably influenced by differences in their humidity and temperature tolerances (Duncan 1969; Richardson and Devitt 1984; Taylor et al. 1995). Keratroides vulgaris and K. angulosus often occur together in forests in eastern Tasmania (Friend and Richardson 1977; Friend 1987; Walsh et al. 1994). Friend and Richardson (1977) investigated the vertical distribution of the two species in the soil/litter habitat and found K. angulosus occurred deeper in the profile. Morton and Richardson (1984) compared the dietary preferences of K. vulgaris and K. angulosus and found no apparent differences between the species. The spatial distribution patterns of these two species have not yet been compared.

In this paper we examine the distribution and habitat use of K. vulgaris and K. angulosus within an area of eucalypt forest in northeast Tasmania.

STUDY AREA

The study area of 400 ha was located in northeast Tasmania on the southeast facing slopes to the north of Old Chum Dam (AMG 5880 54540) and in forest.
southwest of the dam. Altitude varied from 100 to 250 m and the geological substrate present was Ordovician granite. On the basis of a floristic analysis (Duncan and Brown 1995) six vegetation communities were identified from within our study area and are defined as follows:

(1) Blackwood Gully Forest. This forest was associated with gullies and creeklines, often forming a thin corridor along them. Sparse emergents (30m+) of *Eucalyptus obliqua* occurred over a dense secondary tree layer (20-30m) dominated by blackwood (*Acacia melanoxylon*). *Dicksonia antarctica, Olearia argophylla, Pomaderris apetala, Coprosma quadrifida* and *Bursaria spinosa* formed a dense medium to tall shrub layer. The ground layer was dominated by ferns, including *Blechnum nudum, B. wattsii* and *Polystichum proliferum*. The low light levels reaching the forest floor precluded the development of herbaceous species but bryophytes were common.

(2) Eucalypt Gully Woodland. This occurred adjacent to creeks and gullies where the microclimate was slightly less humid and soil moisture higher compared with sites supporting blackwood gully forest. The community is closely related to blackwood gully forest, and is comprised of woodlands, grading into forest, with *E. obliqua* and occasional *E. viminalis* exceeding 30m. A medium to tall shrub layer was present and included eucalypts, *P. apetala, Melaleuca squarrosa* and *Acacia verticillata*. Trunked ferns (*D. antarctica, Todea barbara* and *Cyathea australis*) were prominent. The ground layer was very dense compared with blackwood gully forest and was dominated by ferns with tall graminoids prominent on poorly drained sites. Herbaceous species were sparse and bryophytes less common than in blackwood gully forest.

(3) Tea Tree Gully Woodland. This community was strongly associated with basins and soakages with impeded drainage. *E. obliqua* and/or *E. amygdalina* were dominant. Trees were sparser, lower in height and poorer in form than those in surrounding forest. A dense to very dense medium to tall shrub layer was dominated by *M. squarrosa* with *Leptospermum scoparium* and *A. verticillata* also prominent. The ground layer was often dense, being dominated by sedges, ferns and graminoids.

(4) Wet Sclerophyll Forest. This community occurred on well drained soils on south-facing middle to lower slopes. The upper stratum exceeded 30 m and was dominated by *E. obliqua* with *E. viminalis* a minor species. The small tree and tall shrub layer was very sparse. The medium shrub layer (1-5 m) was dense and mainly comprised *P. apetala, Monotoca glauca, A. verticillata, Zieria arborescens* and *Coprosma quadrifida*. A dense to very dense ground stratum, dominated by ferns (*Culcita dubia* and *Pteridium esculentum*), was present in some areas. Graminoids, grasses and herbs were sporadic in occurrence.

(5) Damp Sclerophyll Forest. This community was widespread, mainly
occupying slopes with south to east aspects. Soils were well drained and had moisture levels intermediate between wet and dry sclerophyll sites. *E. obliqua* and/or *E. amygdalina* were dominant with *E. viminalis* a minor species. The canopy was dense between 20 and 30 m. The medium to tall shrub layer was very sparse and mainly comprised *Acacia terminalis*, *A. verticillata*, *Olearia lirata* and eucalypt regeneration. Vegetation below one metre was moderately dense with the relative abundance of sclerophyllous shrubs (e.g.*Pultenaea juniperina*, *Lomatia tinctoria*, *Leptospermum scoparium*) and bracken probably reflecting a history of frequent fire. Graminoids, herbs and grasses were sparse but more prominent than in the wetter forest communities.

(6) Heathy Dry Sclerophyll Forest. This community was widespread in the study area, occupying well-drained middle and upper slopes subject to moderate drought stress. *E. amygdalina* was dominant with *E. obliqua* co-dominant or subdominant. The medium shrub layer was very sparse and the low shrub/ground layer was moderately dense being dominated by bracken (*P. esculentum*) and *L. scoparium* suggesting a history of frequent burning.

**METHODS**

Sampling of amphipods was undertaken within each of the different vegetation types using pitfall traps. These traps consisted of a plastic drinking cup (85 mm top diameter) placed into a buried section of PVC pipe so that the rim of the cup was flush with the soil surface and sheltered from rain by a plastic tray supported by small wooden sticks. One hundred and eighty traps were located in grids consisting of a set of five pits placed in two lines, one of three and another of two with a spacing of 8-10 m between pits. At the start of a sampling interval each trap was filled with ca. 75 ml of 50% ethanol + 5% glycerol as a preservative. During the summer months pits in open areas were given a little more liquid to allow for evaporation. Traps were left open for seven days each month between June 1989 and May 1990. Recovery of samples was reduced to differing extents in different months due to lifting of some traps by ground water and removal of traps by native animals.

The following environmental variables were assessed in 5 x 5 m quadrats centred on each pitfall trap: vegetation community, dominant plant species, soil type (peaty loam, clay, sandy grey soil, sandy gravel), size and abundance of coarse fragments in the soil (no gravel, low gravel content, moderate gravel, high gravel, rocky), and slope (level, slight, steep). Kruskal-Wallis non-parametric analysis of variance was used to determine whether capture rate of amphipods varied between categories of each variable. Mann-Whitney U tests were used to compare capture rates between pairs of categories within an environmental variable.
RESULTS

Two species of amphipods were captured with *Keratroides vulgaris* (3966 individuals) dominating. The other species, *K. angulosus* (36 individuals), made up only 0.9% of the individuals classified to species. A further 781 individuals were collected but were too immature or damaged to allow identification. These were not included in the analysis.

*K. vulgaris* was found in all vegetation communities with capture rates highest in wet sclerophyll forest and damp sclerophyll forest (Table 1). It was found in all four soil types, with highest captures in peaty loam and grey sandy soils, and in all categories of soils with different particle size, with captures highest in soils of a low to moderate gravel content (Table 2). Densities were higher on steeper slopes than level ground (Table 2).

*K. angulosus* was found in only three of the six vegetation communities, being absent from eucalypt gully woodland, tea tree gully woodland and heathy dry sclerophyll forest (Table 1). Highest captures were found in wet sclerophyll forest and blackwood gully forest, while much lower captures occurred in damp sclerophyll forest (only one individual in this habitat). The occurrence of *K. angulosus* was very patchy, even in the two vegetation communities in which the highest capture rates were recorded (4 pits out of 19 for blackwood gully forest and 12 pits out of 35 for wet sclerophyll forest). *K. angulosus* was only found in pits associated with two types of soil (peaty loam and grey sand), with highest densities in peaty loam, and no captures in pitfalls in soils containing coarse or rocky fragments (Table 2). Capture rates were higher in steeper slopes than level ground

<table>
<thead>
<tr>
<th>Vegetation Community</th>
<th>No. of Pits</th>
<th>K. vulgaris</th>
<th>K. angulosus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackwood Gully Forest</td>
<td>19</td>
<td>130.7±21.2\text{a}</td>
<td>6.7±4.4\text{a}</td>
</tr>
<tr>
<td>Eucalypt Gully Woodland</td>
<td>7</td>
<td>161.0±70.6\text{a}</td>
<td>0\text{c}</td>
</tr>
<tr>
<td>Tea Tree Gully Woodland</td>
<td>40</td>
<td>76.9±10.3</td>
<td>0\text{c}</td>
</tr>
<tr>
<td>Wet Sclerophyll Forest</td>
<td>35</td>
<td>321.9±58.8\text{b}</td>
<td>5.2±1.8\text{a}</td>
</tr>
<tr>
<td>Damp Sclerophyll Forest</td>
<td>38</td>
<td>317.0±30.6\text{b}</td>
<td>0.2±0.2\text{c}</td>
</tr>
<tr>
<td>Heathy Dry Sclerophyll Forest</td>
<td>40</td>
<td>129.1±22.9\text{a}</td>
<td>0\text{c}</td>
</tr>
<tr>
<td>Significance of Difference</td>
<td>51.0 (5) p&lt;0.001</td>
<td>37.6 (5) p&lt;0.001</td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Capture rates (mean no. / 100 pits / 7 days ± S.E.) of amphipods in relation to soil characteristics and slope and the significance of the differences (Kruskal-Wallis analysis of variance with degrees of freedom given in brackets). Capture rates for a species that do not differ significantly between environmental variables have the same alphabetical superscript.

<table>
<thead>
<tr>
<th>Environmental variable</th>
<th>No. of Pits</th>
<th>K. vulgaris</th>
<th>K. angulosus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clay</td>
<td>15</td>
<td>61.8±9.4b</td>
<td>0a</td>
</tr>
<tr>
<td>Peaty loam</td>
<td>86</td>
<td>245.5±28.0a</td>
<td>3.7±1.2</td>
</tr>
<tr>
<td>Grey sand</td>
<td>51</td>
<td>202.7±29.6a</td>
<td>0.2±0.2a</td>
</tr>
<tr>
<td>Sandy gravel</td>
<td>28</td>
<td>111.0±20.9b</td>
<td>0a</td>
</tr>
<tr>
<td>Significance of Difference</td>
<td>19.2 (3) p&lt;0.001</td>
<td>16.4 (3) p&lt;0.005</td>
<td></td>
</tr>
<tr>
<td>Size and abundance of coarse fragments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No gravel</td>
<td>54</td>
<td>111.1±19.4bc</td>
<td>2.0±1.5b</td>
</tr>
<tr>
<td>Fine gravel</td>
<td>37</td>
<td>276.0±47.9a</td>
<td>4.0±1.5</td>
</tr>
<tr>
<td>Medium gravel</td>
<td>67</td>
<td>260.7±28.4a</td>
<td>1.0±0.6b</td>
</tr>
<tr>
<td>Coarse gravel</td>
<td>10</td>
<td>112.0±21.9b</td>
<td>0b</td>
</tr>
<tr>
<td>Rocky</td>
<td>12</td>
<td>57.1±16.5c</td>
<td>0b</td>
</tr>
<tr>
<td>Significance of Difference</td>
<td>39.7 (4) p&lt;0.001</td>
<td>17.5 (4) p&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>Slope</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level</td>
<td>77</td>
<td>93.8±11.7</td>
<td>0.1±0.1</td>
</tr>
<tr>
<td>Slight</td>
<td>60</td>
<td>216.7±25.2</td>
<td>1.7±0.9</td>
</tr>
<tr>
<td>Steep</td>
<td>43</td>
<td>354.7±47.3</td>
<td>5.0±2.1</td>
</tr>
<tr>
<td>Significance of Difference</td>
<td>47.7 (2) p&lt;0.001</td>
<td>19.1 (2) p&lt;0.001</td>
<td></td>
</tr>
</tbody>
</table>

DISCUSSION

Capture rates for *K. vulgaris* were much higher than for *K. angulosus* in our study area. In contrast, Friend and Richardson (1977) found densities of *K. angulosus* to be almost twice that of *K. vulgaris* in a wet sclerophyll forest in eastern Tasmania. Friend and Richardson (1977) assessed population levels from bulk litter and soil samples. Our results obtained using pitfall trapping will
most likely have been influenced by the lower susceptibility of *K. angulosus* to capture due to its occurrence deeper in the soil/litter profile (Friend and Richardson 1977). *K. angulosus* would most likely have been found in greater numbers and possibly also in more vegetation communities if sampling of bulk litter and soil had been carried out in the present study area. However, it is also likely that the generally drier conditions and poorer development of the litter layer in our study area would have been less favourable for *K. angulosus* than the wet forest sampled by Friend and Richardson (1977) *K. vulgaris* occurred in all forest communities suggesting this species can tolerate a wide range of environmental conditions. This was also found to be the case for *K. vulgaris* in highland forest in central Tasmania (Taylor *et al.* 1995).

Saturation of the soil/litter habitat can be fatal to amphipods (Duncan 1969; Moore and Richardson 1992). Poor drainage of the tea tree gully woodland may place osmotic stress on both amphipod species. The absence of *K. angulosus* from this habitat may thus be due to water logging associated with the poor drainage of these areas. *K. angulosus* is likely to be more adversely affected by such waterlogging as this species occurs deeper in the soil profile (Friend and Richardson 1977). *K. vulgaris* was present in tea tree gully woodland but capture rates here were lower than in all other vegetation communities. The amphipod *Orchestella neambulans* occurs in low numbers along swampy drainage lines in wet forest in the Central Highlands of Tasmania (Taylor *et al.* 1995). Such a specialist species was not found in poorly drained areas in the present study area, possibly due to the lower rainfall regime leading to occasional drying out of these areas.

Taylor *et al.* (1995) concluded that litter depth and cover influenced the abundance of *K. vulgaris* in highland forests in Tasmania. Litter in the wet sclerophyll and damp sclerophyll forest is better developed than in the heathy dry sclerophyll forest due to a denser shrub cover and lower fire frequency. These differences may explain the differences in capture rates of *K. vulgaris* between these dry and moister communities. Higher capture rates for both species occurred in areas with a steeper slopes. These steep slopes occur in areas above the more deeply incised gullies. Higher densities on these slopes are probably related to the occurrence here of the vegetation communities where litter development is high, where moisture is retained in the litter due to high shading of the ground, but where drainage is good and hence waterlogging does not occur.

**ACKNOWLEDGEMENTS**

Staff from the Fingal and St Helens offices of Forestry Tasmania provided logistical support. Alastair Richardson commented on a draft of the manuscript.
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REFERENCES


AN OBSERVATION OF PETAL CARRYING BY THE
SUPERB FAIRY-WREN MALURUS CYANEUS

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The following observation lasted approximately one minute and was made
on the roadside opposite the camping ground at Sassafras Creek, 4 km west of
Mole Creek in northern Tasmania.

At 1000 h on 7 January 1996 a male Superb Fairy-wren Malurus cyaneus in
nuptial plumage perched on top of a fence post in 'display posture' (Pickett 1995)
with raised and flattened crown, flared ear coverts and lowered tail, whilst
holding an apricot-orange coloured petal in its bill. This male's posturing
appeared to be directed at a 'brown' wren (female/juvenile? M. cyaneus) perched
upon fence wire less than two metres from the male. Both wrens then flew across
the road and out of sight, the brown wren followed by the male still holding the
petal in its bill and flying awkwardly while maintaining the display posture.

Rowley (1991) suggests that "petal carrying [by Malurus spp.] enhances the
attractiveness of the male to females" and cites 11 cases of petal carrying by M.
cyaneus where the colour of the petal was yellow. Pickett (1995) details six
observations of petal carrying by M. cyaneus in which the colour of the petal was
also yellow. This observation indicates deviation from an apparent preference
by M. cyaneus for yellow petals.

REFERENCES
Pickett, M. I. (1995). Some observations of petal carrying and display by the
Superb Fairy-wren Malurus cyaneus. S. A. Ornithol. 32: 64.
Watcher 14: 75-81.
COMPARISON OF SHELL MEASUREMENTS OF THE TASMANIAN ENDEMIC LAND SNAIL CARYODES DUFRESNII (LEACH) FROM DIFFERENT POPULATIONS

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INTRODUCTION

Caryodes dufresnii (Leach, 1815) is Tasmania's largest land snail and is widely distributed across the state with the exception of the Bass Strait Islands and most of the central highlands (Smith and Kershaw 1981). It is commonly found in litter and under rotting logs or rocks mainly in forested areas but also in some alpine or coastal scrub sites. Caryodes dufresnii has a characteristic columellar dextral coiled shell with a lunate aperture. Wide variation in shell form has been reported by Kershaw and Dartnall (1972). These authors concluded that individuals from temperate rainforest sites were heavier and larger than those from dry sclerophyll forests. This suggests there may be some correlation between shell size and rainfall. Iredale (1937) described three sub specific taxa, but Kershaw (1989) cast considerable doubt on the validity of one of these subspecies suggesting that a number of races based on environmental conditions may be a more appropriate interpretation of variation in shell parameters.

In this study adult specimens of C. dufresnii held in the Invertebrate Collection of Forestry Tasmania were measured to assess the extent of variation between populations and to assess whether any such variation was associated with differences in rainfall.

STUDY AREAS

Details of the location of the nine collection sites, the vegetation present, mean annual rainfall and the number of specimens sampled are given in Table 1. Sites were ranked according to annual rainfall figures based on long term means supplied by the Australian Bureau of Meteorology. Grid references refer to TASMAP 1:100,000 sheets. Measurements of specimens from Big Boggy Creek and Saddleback were previously reported by Bashford (1988). The specimens from Dalgarth and Hastings were collected by hand from logging coupes. The specimens from other sites were collected in pitfall traps within riparian reserves. All specimens measured for this paper were collected by the author.

METHODS

Measurements of shell height, shell diameter and aperture length were made following the technique of Smith and Kershaw (1981) using vernier callipers.
Table 1. Details of the locations from which shells of *Caryodes dufresnii* were collected.

<table>
<thead>
<tr>
<th>Locality</th>
<th>No. of specimens</th>
<th>Grid reference</th>
<th>Annual rainfall (mm)</th>
<th>Vegetation type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dalgarth</td>
<td>1</td>
<td>DQ 705 345</td>
<td>800</td>
<td>dry sclerophyll</td>
</tr>
<tr>
<td>Saddleback</td>
<td>3</td>
<td>EQ 673 123</td>
<td>858</td>
<td>dry sclerophyll</td>
</tr>
<tr>
<td>Kermandie</td>
<td>7</td>
<td>DN 896 167</td>
<td>920</td>
<td>wet sclerophyll</td>
</tr>
<tr>
<td>Bracken Ridge</td>
<td>7</td>
<td>DN 897 308</td>
<td>940</td>
<td>wet sclerophyll</td>
</tr>
<tr>
<td>Big Boggy Creek</td>
<td>79</td>
<td>EQ 947 503</td>
<td>977</td>
<td>mixed forest</td>
</tr>
<tr>
<td>Arve Road</td>
<td>15</td>
<td>DN 822 257</td>
<td>1000</td>
<td>mixed forest</td>
</tr>
<tr>
<td>Picton River</td>
<td>4</td>
<td>DN 743 147</td>
<td>1100</td>
<td>mixed forest</td>
</tr>
<tr>
<td>Rueben Falls</td>
<td>8</td>
<td>DN 720 369</td>
<td>1200</td>
<td>mixed forest</td>
</tr>
<tr>
<td>Hastings</td>
<td>30</td>
<td>DM 908 955</td>
<td>1380</td>
<td>wet sclerophyll</td>
</tr>
</tbody>
</table>

Empty shells were cleaned and stored dry while live-collected specimens were preserved in ethanol/glycerol solution in sealed vials.

Specimens with five or more whorls were classed as adults (i.e. sexually mature). Only a small percentage of shells with fewer than five whorls would have reached adulthood. Only 34 of the 164 specimens measured were classified as adult. The ratios of aperture height to shell height and aperture height to shell diameter were calculated so comparisons could be made with the results of Kershaw (1988, 1989). Comparison of shell height and diameter in relation to aperture length are important ratios because a change in aperture size affects the overall shape of the whole shell and can indicate a distribution approaching the species level of determination.

**RESULTS**

Shell measurement are given in Appendix 1. Specimens from Saddleback had a smaller shell height for a given number of whorls and those from Hastings had a greater height than those from other areas (Fig. 1). Specimens from most of the other areas overlapped in their pattern of shell height against number of whorls. A similar pattern was found using shell diameter and aperture height.

The greatest adult shell heights occurred in the area with the greatest rainfall (Hastings) and the smallest shell heights occurred in the area with the second lowest rainfall (Saddleback). Across the other sites there was no consistent correlation with rainfall (Fig. 2). Thus the area with the lowest rainfall (Dalgarth) had the second highest shell height. Comparison of shell diameter and aperture height with rainfall gave similar results.

The ratios of aperture height to shell diameter gave no indication of a different shape for individuals from different areas (Fig 3). Thus there was no separation
The relationship between shell height and number of whorls for populations of *Caryodes dufresnii* from different sites in Tasmania is shown in Fig. 1. Regression lines for the area with the largest (Hastings) and smallest (Saddleback) animals are shown. However, the ratios of aperture height to shell height did show some degree of separation of areas (Fig. 4) but not to the same extent as did shell height.

**DISCUSSION**

Bashford (1988) showed morphological variation between *C. dufresnii* shells from two sites (Saddleback and Big Boggy Creek) in north eastern Tasmania. Analysis of shell measurements of specimens from a larger number of sites in this study showed a range of overlap between different sites but with specimens from Hastings being larger and specimens from Saddleback being smaller than other sites. The individuals from Hastings and Saddleback were sufficiently different to be regarded as distinct populations. However, some caution in applying race status to populations from these sites is required. An example is Hastings where...
Fig. 2. Relationship between adult shell height of *Caryodes dufreshnii* and annual rainfall for populations from different sites in Tasmania.

Fig. 3. Relationship between the ratio of shell aperture to shell diameter and number of whorls for populations of *Caryodes dufreshnii* from different sites in Tasmania.
Fig. 4. Relationship between the ratio of shell aperture to shell height and number of whorls for populations of *Caryodes dufresnii* from different sites in Tasmania.

Kershaw (1989) presents measurements for a single specimen from Hastings Cave which fits within the mean range of measurements for the majority of sites. Comparison of the Saddleback specimens with the dimensions listed by Kershaw (1989) place this population close to, but geographically separate from, the *Caryodes dufresnii dertra* group of Iredale (1937).

Comparison of shell shape in terms of parameter ratios showed much less difference between sites than for the size measurements i.e. specimens were of similar form but varied in size. The two distinct populations demonstrated in this study show a small form at Saddleback and a large form at Hastings. Although these two races are near the opposite ends of the rainfall scale for the sites examined, the environmental factor of rainfall by itself is not associated with a gradient in shell size. Thus over the range of annual rainfall examined in this study.
study there was no correlation between rainfall and shell size, as was implied by the findings of Kershaw and Dartnell (1972). There is no reason to assume that the two extreme populations are isolated in any way so it would appear that other environmental factors such as food quality, which may include calcium availability, may be significant.

There is clearly a need for research on the anatomy of animals from sites where shell morphology varies outside the range of populations from the majority of sites. Some work has been done to clarify sub specific status but this has been restricted to an examination of single specimens from a range of sites (Kershaw 1989). The collection of empty shells from a range of localities not previously sampled throughout Tasmania, and examination of museum specimens, would provide data on shell morphology which could be followed up by selective collection of live material for taxonomic examination from those sites showing greatest diversity of form or distinctive morphological features. Examination of specimens from sites adjacent to known faunal breaks, as indicated by Mesibov (1994), would be of particular interest.

The study of endemic invertebrate species which are still relatively widespread provides information enabling strategic planning by land management agencies to ensure the long term protection of the range of genetic variation present in these species. Such work may also prove to be of use in the conservation planning for rarer species.

REFERENCES
Appendix 1. Shell measurements of *Caryodes dufresnii* from nine
different locations in Tasmania.

\[ W = \text{number of whorls; SH = shell height; SD = shell diameter; AH = aperture height} \]

<table>
<thead>
<tr>
<th></th>
<th>SH</th>
<th>SD</th>
<th>AH</th>
<th></th>
<th>SH</th>
<th>SD</th>
<th>AH</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dalgarth</td>
<td>3.5</td>
<td>21.7</td>
<td>16.9</td>
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UNUSUAL NESTING RECORD FOR THE PIED OYSTERCASTER

Helen E. Coles
“Wai-iti”, R.S.D. E205 Swan Point, via Exeter, Tasmania 7275

Our property “Wai-iti” is located at Swan Point on the West Tamar, approximately 30 km from the Tamar Heads. There is a narrow strip of crown land foreshore between our property and the Tamar with rice grass *Spartina anglica* below the high tide mark.

One of our paddocks behind the foreshore was rotary-hoed on 24 October 1995. Not long after this date two pied oyster catchers *Haematopus longirostris* were observed on a daily basis feeding and resting in this paddock. No signs of a nest were discovered. On 6 December I went into the paddock to rotary hoe it again. One of the birds was sitting. On investigation it was found to be incubating two eggs. Needless to say, hoeing of that paddock came to a standstill.

The nest was approximately 300 m from the high water mark. Apparently this is very unusual with most birds nesting nearby high water. Bob Green, the retired Curator of Zoology from the Queen Victoria Museum in Launceston, has never previously heard of nest record so far inland.

On the morning of 13 December a bird was observed sitting on the nest. However, at 6 pm that day both birds were observed wandering around in the vicinity of the nest. On checking the nest it was found to be empty with no sign of any eggshells. The birds were observed for a further hour but no chicks were seen.

The birds were not in the paddock on 20 or 21 December and so the paddock was rotary-hoed on the following day. On 29 December the oystercatchers were again seen attending a nest, but this time in the opposite end of the paddock. When the nest was checked on 6 January one egg was found and on 25 January the egg was still present and the chick could be heard cheeping inside the egg. The birds were present two days later but were not sitting on the nest. No egg or eggshell was present in the nest. No chick was observed that day or the following two days. The birds left the paddock on the 30 January and haven’t returned.

It is possible that the eggs or chicks of the oystercatchers were taken by either a swamp harrier *Circus approximans* or a raven *Corvus tasmanicus* as both these species are present in the area.
OCCURRENCE OF REPTILES IN LOGGED AND UNLOGGED WET AND DRY EUCLYPT FOREST

Anne M. R. Duncan
Forestry Tasmania, 199 Macquarie Street, Hobart, Tasmania 7000
Present address: Endangered Species Unit, Australian Nature Conservation Agency, Canberra, A.C.T. 2601

Abstract. The occurrence of reptiles was compared in logged and unlogged forest at a dry forest and wet forest site. At the dry forest site 17 year old regrowth resulting from clearfelling and partially logged areas were examined. At the wet forest site regrowth of four, twenty, and eighty years of age were sampled. In the dry forest species which prefer more open environments (E. whitii, B. duperreyi, T. diemensis) were advantaged by clearfelling. Seventeen year old regrowth had higher species diversity than mature forest or partially logged forest. Niveoscincus metallicus was found to be disadvantaged by logging, both selective and clearfelling. In partially logged forest species diversity was the same as or slightly higher than mature forest. However, the abundance of species was significantly lower. In the wet forest fewer species and lower densities were found than in dry forest. This is probably related to the lower level of solar penetration and the denser vegetation. Species which prefer open clearings contiguous with dense vegetation (C. casuarinae and T. nigrolutea) were advantaged by logging. N. metallicus was initially disadvantaged by logging but was found to have recovered to population densities similar to that of mature forest in 20 year old regrowth.

INTRODUCTION

Seventeen of Tasmania's twenty reptile species can occur in forested environments (Taylor 1991). However, there have been few studies on the effect of forestry operations on reptiles. In Tasmania the only study relating to reptiles and logging is a pre-logging survey of reptiles in dry sclerophyll forest (Taylor et al. 1993) which speculates about the effects of logging based on a knowledge of habitat preferences of the species. Various species have been observed to survive clearfelling and burning (Gowland 1977, Green 1982). Taylor (1991) suggests that since most lizards depend on the ground layer rather than the forest structure they are not likely to be affected by timber harvesting in the long term.

In this paper the occurrence of reptiles in logged and unlogged forest is...
documented at two areas, wet forest at Hastings in southern Tasmania and dry forest at Tooms in eastern Tasmania.

STUDY AREAS

Two areas were chosen so as to sample both dry and wet eucalypt forest and thus to encompass the broad range of silvicultural treatments used in timber harvesting in Tasmania. The study area with dry forest was located in the Tooms forest block at an altitude of 650 m in the coastal ranges in eastern Tasmania (42°09'S, 147°53'E). The geological substrate of the area is dolerite and the soils are shallow stony loams or clay-loams (Davies 1988). The area is an undulating plateau with rocky crests and occasional swampy areas. Average annual rainfall at Lake Leake (19 km to the north west) is 859 mm, average maximum and minimum temperatures are 13.9°C and 4.2°C respectively (Davies 1988).

Three logging coupes were surveyed at Tooms. In two of these the silvicultural treatment used was partial logging, with advanced growth and seed trees being retained, while the third was clearfelled. The vegetation at Tooms was mostly *Eucalyptus delegatensis* forest (20 - 25 m tall) with *E. amygdalina* and *E. viminalis* as minor species. There were two major understorey types present. One of these had a shrub layer (1 - 3 m) dominated by *Acacia dealbata* with *Lomatia tinctoria* prominent in the ground layer. The other had a shrub layer dominated by *Banksia marginata* (2-5 m) over a ground layer of *Lomandra longifolia*, *Cyathodes glauca* and *Pultenaea juniperina*.

The study area was divided into six treatments on the basis of silvicultural treatment and understorey. These were:

- Mature forest with *Banksia* understorey.
- Partially logged with *Banksia* understorey. The area sampled was part of a coupe of 306 ha which was logged in 1991. Parts of the area were burnt to reduce fuel loads and a small area was burnt again in 1992 as a result of an escape from a smouldering bark heap.
- Clearfelled (17 year old regeneration) with *Banksia* understorey. This coupe was clearfelled in 1975 and artificially sown after a hot regeneration burn. The regrowth varied in height from six to ten metres.
- Mature forest with *Acacia* understorey.
- Partially logged with *Acacia* understorey. This coupe of 40 ha was logged in 1987 but not subject to a postlogging burn.
- Clearfelled (17 year old regeneration) with *Acacia* understorey. This area was on the north easterly aspect of the clearfelled coupe. While the majority of the regeneration was 6 - 10 m in height there was occasional advance growth (which was not burnt in the regeneration burn) which was 14 - 16 m high.

The study site at Hastings was at an altitude of 30 m on the coastal plain near
Lune River in southern Tasmania (43°25'S, 146°51'E). The geological substrate is Parmeener Supergroup (Permian sandstone, mudstone and siltstone) and the soils are generally duplex with fine sandy loams over medium clays (Davies 1988). Average annual rainfall at Southport (10 km east) is 993 mm and average maximum and minimum temperatures at Hastings 16°C and 6.1°C respectively.

Three logging coupes were surveyed at Hastings. In all three the silvicultural treatment used was clearfelling followed by a high intensity regeneration burn and artificial seeding. Two of the coupes had four year old regeneration while the third had twenty year old regeneration. All the mature forest in the vicinity had previously been subjected to light selective logging. An area of forest which regenerated after a fire about 80 years ago was also included as part of the study area. This was adjacent to one of the four year old regeneration coupes and part of it had been burnt when the regeneration burn escaped.

The study area was divided into four treatments, corresponding to the three ages of regeneration (four, twenty and eighty year old) and mature forest.

• Mature forest. The vegetation was tall *E. obliqua* forest (greater than 40 m) over a tall understorey (10-20 m) of *Acacia melanoxylon*, *Encyphilia lucida*, *Atherosperma moschatum* and *Nothofagus cunninghamii*. Underneath this was a tall shrub layer (2 - 5 m) of *Pomaderris apetala*, *Pittosporum bicolor*, *Phebalium squameum*, *Phyllocladus aspleniifolius* and occasional clumps of *Anopterus glandulosus*. Ferns (*Dicksonia antarctica*, *Histiopteris incisa*) were prominent in the ground layer but shrubs such as *Trochocarpa cunninghamii*, *Pimeleadrupacea*, *Acacia verticillata* and *Coprosma nitida* were also present and *Galinia grandis* formed dense patches along old logging tracks. Moss and litter were also a major part of the ground layer.

• 80 year old regrowth. The forest in this treatment consisted of tall *E. obliqua* (30 - 40 m) over a tall understorey (6 - 10 m) of *A. melanoxylon*, *Pomaderris apetala*, *Pittosporum bicolor*, *Phebalium squameum*, *Melaleuca squarrosa* and *Cyathodes glauca* and a shrub layer of *T. cunninghamii*, *C. nitida*, *A. verticillata*, *P. apetala* and the occasional *G. grandis* and *D. antarctica*. The ground layer was dominated by ferns (*Blechnum wattsii*), moss and litter and occasional *P. drupacea*, *C. nitida* and *Drymophila cyanocarpa*. Where the understorey had been burnt there was a dense shrub layer (1 - 5 m) of *P. apetala*, *A. verticillata* and ferns (*B. wattsii* and *H. incisa*) with clumps of *G. grandis* over a ground layer of deep litter. In part of the area the soil was waterlogged. Here there were fewer eucalypts over a dense stand mainly of *M. squarrosa* and *C. glauca* (6 - 10 m) with a ground layer of *B. wattsii*, water-logged moss and clumps of *G. grandis*.

• Twenty year old regeneration. This treatment was a dense stand of *E. obliqua* (10 - 12 m) with *P. apetala*, *A. melanoxylon* and *A. verticillata* forming a tall
understorey (6 - 8 m). The ground layer was quite open, consisting of litter, ferns (*Pteridium esculentum*) and occasional shrubs such as *C. nitida*, *L. scoparium*, *P. bicolor*, *Pimelea drupacea* and vines (*Billardiera longiflora*, *Clematis aristata*). In gaps and along tracks there were dense thickets of *P. esculentum* and regeneration of *L. scoparium* and *P. apetala*.

- Four year old regeneration. This treatment consisted of dense *E. obliqua*, three to four metres tall. Underneath was a tangled shrub and ground layer of species such as *L. scoparium*, *A. verticillata*, *P. apetala*, *M. squarrosa*, *Phebalium squameum*, and *B. longiflora* with occasional patches of *G. grandis* and sedges occurring on tracks.

**METHODS**

Pitfall lines with drift fences were established in each treatment at both the wet and dry forest sites. At Tooms a further two lines were established on the interface between logged and unlogged areas. At Hastings two lines were placed in both the mature forest and 20 year old regrowth and one in four year old regrowth and 80 year old regrowth. Because substantial digging was required to establish the pits it was difficult in some treatments to find a suitable spot and in most cases fencelines were established on old tracks. Each line consisted of six pitfalls (20 litre metal ice cream containers, 25 cm in diameter) placed five metres apart, with a flywire fence stretched across the middle of each and to a distance of about two to three metres past the end of the line of pits. The flywire was buried in the ground between the pits. Holes were punched in the bottom of each tin to allow water to drain out. Pitfalls without fences were also used. These consisted of 30 cm long sections of 15 cm diameter PVC pipe. Wire mesh with some litter on top was placed in the bottom of the pit to keep animals off the dirt bottom. The numbers of PVC pits at Tooms was as follows: 10 in each of mature forest with *Banksia* undergrowth, mature forest with *Acacia* and partially logged with *Acacia*; 5 in each of partially logged with *Banksia*, 17 year old regrowth with *Banksia* and unlogged burnt swampy drainage line; and 15 in the interface between mature forest and partially logged with *Banksia*. At Hastings 10 PVC pits were placed in each of the four treatments. The dates of trapping sessions in 1992 and 1993 were as follows: at Tooms 30 September to 7 October, 26 November to 2 December, 19 to 28 January, 23 to 30 March and 18 to 22 May; at Hastings 19 to 27 October, 15 to 22 February, 20 to 27 April and 25 to 29 May. The PVC traps were not set out until the second sampling session at each site.

Habitat measurements were undertaken so that the treatments could be compared in terms of attributes thought to be important for habitat selection by reptiles. Two 4 x 4 m plots were located in association with each pitfall and fence line. From the middle point in each fence one plot was laid out on either side of
the fence, starting at a distance two metres from the fence. In each plot the following were estimated: substrate type (Webb 1985, in Brown and Nelson 1992); % cover of bare ground, litter, rock, grass, shrubs, logs (>10 cm diameter), stumps (>10 cm diameter), and hepatics; litter depth (cm); shrub height (m); and solar penetration - the percent of the ground that was lit by sun. Solar penetration was estimated as the percent of ground not shaded by vegetation. This varies according to the time of day. Estimation took place between 10am and 3pm as it was not possible to undertake the estimation at the same time in each plot. Solar penetration was only estimated when the sun was out.

Some of the pitfall fences were located on tracks and thus the immediate substrate may have been vastly different from the treatment as a whole. Where this was the case, the habitat attributes were estimated for the track in the vicinity of the fence as well as in the adjacent vegetation so that this difference could be taken into account.

Chi-square tests were used to test for differences between treatments and sites in total captures and in numbers of the more common species. Habitat variables for each plot were averaged and in some cases a Kruskal-Wallis non-parametric analysis used to test for differences between wet and dry forest sites.

RESULTS

The pitfall lines with fences were much more effective than the PVC pitfalls without fences (dry forest $\chi^2 = 30$, df = 1, $p<0.001$; wet forest $\chi^2 = 5$, df = 1, $p<0.05$; Table 1) so those without fences were not included in any further analysis. Those without fences did not add any further species to the list.

Dry Forest

Eighty nine lizards of six species were captured in pitfall traps with drift fences (Table 2). The highest diversity of lizard species was found in the 17 year old regrowth: six species associated with the Banksia understorey, and five species with the Acacia understorey. The lowest diversity (three species) was found in the mature forest, both Acacia and Banksia understoreys. Two tiger snakes Notechis ater were observed, one in mature forest and one in 17 year old regrowth.

The total number of reptiles captured differed significantly between treatments ($\chi^2 = 20.4$, df = 5, $p<0.01$). The mature forest and 17 year old regrowth with an Acacia understorey had the highest capture rates, and the partially logged treatments had the lowest capture rates. Only Niveoscincus metallicus had sufficient captures to test for differences between treatments for an individual species. It was captured significantly more often in both the mature forest treatments ($\chi^2 = 25.6$, df = 5, $p<0.01$).
Table 1. Trapping success of pitfalls with and without a drift fence at Tooms and Hastings.

<table>
<thead>
<tr>
<th></th>
<th>Dry forest</th>
<th>Wet forest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With fence</td>
<td>No fence</td>
</tr>
<tr>
<td>Total no animals</td>
<td>89</td>
<td>7</td>
</tr>
<tr>
<td>Trap nights*</td>
<td>1373</td>
<td>922</td>
</tr>
<tr>
<td>Animals/100 trap nights</td>
<td>6.5</td>
<td>0.8</td>
</tr>
</tbody>
</table>

* Each line of pitfalls with a drift fence consisted of six pits with each pit being considered separately in calculating the number of trap nights.

Table 2. Lizards captured in pitfall traps with drift fences and observed (indicated by *) in dry forest at Tooms and wet forest at Hastings.

Nm = Niveoscincus metallicus; Np = N. pretiosus; No = N. ocellatus; Bd = Bassiana duperreyi; Ew = Egernia whitii; Td = Tympanocryptus diemensis; Cc = Cyclodomorphus casuarinae; Tn = Tiliqua nigrolutea.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Trap nights</th>
<th>Nm</th>
<th>Np</th>
<th>No</th>
<th>Bd</th>
<th>Ew</th>
<th>Td</th>
<th>Cc</th>
<th>Tn</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dry Forest</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Banksia understorey</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unlogged</td>
<td>234</td>
<td>10</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15</td>
</tr>
<tr>
<td>Partially logged</td>
<td>234</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>17 yr. old regen.</td>
<td>226</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>7</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>Acacia understorey</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unlogged</td>
<td>228</td>
<td>17</td>
<td>7</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Partially logged</td>
<td>223</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>17 yr. old regen.</td>
<td>228</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
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<td>41</td>
<td>17</td>
<td>15</td>
<td>5</td>
<td>8</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>89</td>
</tr>
<tr>
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<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Unlogged</td>
<td>432</td>
<td>3</td>
<td>7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>80 yr. old regen.</td>
<td>216</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>20 yr. old regen.</td>
<td>432</td>
<td>7</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>4 yr. old regen.</td>
<td>212</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1*</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>1292</td>
<td>10</td>
<td>13</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1*</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>

**Wet forest**

Twenty four lizards of three species were captured in pitfalls with drift fences and another species was observed (Table 2). A tiger snake was observed in 80 year old regrowth and a white-lipped snake *Drysadlia coronoides* was seen in 20
Table 3. Description of substrate around pitfalls lines with drift fences in each treatment at Tooms and Hastings. Treatment codes: M = mature forest, P = partially logged, R = 17 year old regrowth, B = B. unfera understorey, A = A. cupressoides understorey, R4 = four year old regrowth, R20 = 20 year old regrowth, R80 = 80 year old regrowth, tr = estimate for the track on which pitfall line was located. N = no sun (cloudy).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% sun</th>
<th>% fine</th>
<th>% coarse</th>
<th>% grass</th>
<th>% shrubs</th>
<th>Shrub height (m)</th>
<th>% rocks</th>
<th>% logs</th>
<th>% stumps</th>
<th>% hepatics</th>
</tr>
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<tbody>
<tr>
<td>MB</td>
<td>65</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>11</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PB</td>
<td>35</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>RB</td>
<td>70</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>17</td>
<td>11</td>
<td>8</td>
<td>3</td>
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<tr>
<td>MA</td>
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<td>8</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>28</td>
<td>1</td>
<td>3</td>
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<td>0</td>
</tr>
<tr>
<td>PA</td>
<td>50</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>8</td>
<td>11</td>
<td>17</td>
<td>3</td>
</tr>
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<td>RA</td>
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<td>5</td>
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<td>0</td>
<td>0</td>
<td>12</td>
<td>8</td>
<td>11</td>
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<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>PA(tr)</td>
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<td>0</td>
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</tr>
<tr>
<td>RA(tr)</td>
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<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
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<td>Dry forest</td>
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<tr>
<td>Wet forest</td>
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<td>1</td>
<td>0</td>
<td>21</td>
<td>10</td>
<td>3</td>
<td>24</td>
<td>10</td>
</tr>
<tr>
<td>R80</td>
<td>18</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>0</td>
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<tr>
<td>R20</td>
<td>9</td>
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<tr>
<td>R4</td>
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<td>0</td>
<td>0</td>
<td>8</td>
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<td>R20(tr)</td>
<td>38</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>38</td>
<td>10</td>
<td>5</td>
<td>25</td>
<td>10</td>
</tr>
</tbody>
</table>
The twenty year old regrowth had the most diverse reptile fauna (four species), the mature forest had three species, four year old regrowth had two species and no lizards were caught in the 80 year old regrowth.

Capture rates were highest in 20 year old regrowth and mature forest ($\chi^2 = 9.9$, df = 3, p<0.05). *N. metallicus* had its highest capture rates in 20 year old regrowth.

Comparison of dry and wet forest

The dry forest site had significantly higher capture rates than the wet forest site ($\chi^2 = 33$, df = 1, p<0.01) and more species were captured or observed at the dry forest (Table 2). Three species were only captured at the dry forest site (*N. ocellatus, Egernia whitii, Tympanocryptus diemensis*) while there were three species which were only captured or observed at the wet forest site (*Cyclodomorphus casuarinae, Tiliqua nigrolutea* and *Drysdalia coronoides*). The percent of each plot which was sunlit was significantly higher at the dry forest site than at the wet forest site (Kruskal-Wallis = 13.86, p<0.001). In addition the height of the shrub layer was significantly lower at the dry forest site (Kruskal-Wallis = 5.45, p<0.05; Table 3).

DISCUSSION

Dry forest

Three lizard species (*Egernia whitii, Bassiana duperreyi* and *Tympanocryptus diemensis*) were apparently advantaged by logging at the dry forest site as they were found only in the 17 year old regrowth or the partially logged treatments. These species are restricted to the warmer of Tasmania’s two thermal zones (Taylor 1991) and are more commonly associated with open areas and low dense vegetation (e.g. heath/tussocks) (Taylor et al. 1993). Thus their presence can be attributed to the suitable conditions which had been created by the logging. The other three species (*Niveoscincus* spp.) which were common to both mature forest and the 17 year old regrowth treatments are generally widespread and relatively common (Taylor 1991).

In partially logged treatments the species present were similar to those in mature forest, consisting of two or three common species (*Niveoscincus* spp.) but with an additional species *B. duperreyi*. *B. duperreyi* is normally associated with a low ground cover of tussock-grasses or heath-like vegetation (Rawlinson 1974) and the pitlines in partially logged forest were located along tracks but in close proximity to the short dense understorey which develops in gaps after logging.

While there was an additional species in partially logged areas the density of lizards as a whole decreased. The habitat descriptions and substrate composition show no obvious reason for this. It may therefore be related to a reduced food supply (insects) in the same way as has been suggested for birds (Taylor and
Effects of Logging on Reptiles

Haseler 1995), pygmy possums (Duncan 1995) and bats (Rhodes 1996). If this is the case, as the understorey recovers and the canopy becomes denser the population densities of lizards could be expected to increase to pre-logging levels. However, the relative proportions of lizard species could change, with species that prefer more open habitats being disadvantaged by the denser canopy.

One species, *N. metallicus*, was found to be apparently disadvantaged by logging, being significantly more abundant in the mature forest treatments. Taylor *et al.* (1993) found that *N. metallicus* favoured a denser canopy and suggested that while it might suffer a short term decline after logging, it should be able to re-establish high densities in regrowth forest. In another study in dry forest at Eden in NSW, Lunney *et al.* (1992) found that a species which preferred a denser canopy had an initial reduction in density but had increased again in 15-20 year old regrowth. While the results of the present study show lower densities in recently logged forest, they do not show the re-establishment of high densities in 17 year old regrowth. *Tympanocryptus diemensis*, a species found only in open areas, was also recorded in the 17 year old regrowth so it may be that the regrowth was still not dense enough for *N. metallicus* to re-establish high densities. It may be that the time frame for re-establishment of pre-logging densities at this dry forest site is longer due to slower growth rates of trees.

Brown and Nelson (1992) suggest that the amount of solar penetration to the substrate preferred by reptiles is the key variable in determining reptile abundance and that this is influenced by tree density (via canopy cover) and the presence of a low understorey strata. In this study there seemed little difference in the percent of the ground sunlit between treatments. However, the higher abundance of some lizards in mature forest and 17 year old regrowth with *Acacia* understorey could be explained by the presence of preferred substrate. The mature forest with *Acacia* understorey had a very high percent cover of litter (75%, Table 3), which was also relatively deep, and a relatively high percent cover of logs (16.5%, Table 3). The most numerous species in this treatment was *N. metallicus*. This species is normally associated with logs (particularly those decayed enough to contain cracks and crevices for sheltering in) but is also known to bask and shelter in deep litter at the base of eucalypts (Taylor *et al.* 1993). The 17 year old regrowth with the *Acacia* understorey had a high cover of rocks (36%) on the track immediately surrounding the pitfall line and a high cover of litter (57.5%) and rocks (16%) off the track (Table 3). In this treatment, the most numerous species was *N. ocellatus*, which is restricted to areas of extensive rock cover (Taylor 1991).

**Wet forest**

Two lizard species were caught or observed only in regrowth forest and thus...
could be said to be advantaged by logging: *Cyclodomorphus casuarinae* in 20 year old regrowth and *Tiliqua nigrolutea* in four year old regrowth. Both species occur in many vegetation types but are typically found in clearings bordered by dense vegetation (Taylor 1991). The undergrowth in both four and 20 year old regrowth is dense and pitfall lines were located on tracks which are essentially small clearings. *Tiliqua nigrolutea* was observed on a track.

The other two lizard species caught were *N. metallicus* and *N. pretiosus*, both of which are relatively widespread and common (Taylor 1991). Both *N. metallicus* and *N. pretiosus* were more abundant in mature forest and 20 year old regrowth forest, where the substrate was particularly suitable for them: both treatments had a high cover of litter and logs (Table 3) (Taylor et al. 1993). The low abundance of lizards in the four year old regrowth was slightly surprising but was possibly related to the lack of logs for basking, particularly in the vicinity of the pitfall line which was located on a bare snig track.

The lack of lizard captures in the 80 year old regrowth has no clear explanation: the cover of suitable substrate (litter and logs) in the treatment generally is high (Table 3). However, the pitfall line was actually located on a track, which although it had high litter cover, had no logs associated with it (in a similar way to the four year old regrowth, which also had few lizards). Both *N. metallicus* and *N. pretiosus* have a close association with logs (Taylor et al. 1993), using them for basking sites. Perhaps the raised basking sites that logs provide are particularly important in a wet forest habitat and the lack of captures reflects the localised lack of logs. Alternatively, parts of the 80 year old regrowth treatment were burnt four years ago and the lizard population may have not yet recovered from this.

Two species of snake were observed at Hastings, both in regrowth forest. *Notechis ater*, which was observed in the 80 year old regrowth, is often observed close to water or near swamps (Taylor 1991) and this was the case here: Lune River flows through the middle of the 80 year old regrowth treatment. *Drysdalia coronoides*, observed in 20 year old regrowth, is usually associated with low tussocky heath-like vegetation (Taylor 1991). However, according to Wilson and Knowles (1988) it can also be found in the margins of wet forest.

**Differences between dry forest and wet forest**

Densities of lizards were lower in wet forest at Hastings than in dry forest at Tooms. This would be expected, given that reptiles are poikilothermic (i.e. they cannot maintain body activity through their own metabolic activity) and thus their body temperature is influenced by the temperature of the environment. As a result, dense vegetation in a cool climate, as is the case at Hastings, is not generally considered “hospitable” for reptiles. There was significantly less solar penetration at Hastings and a higher shrub layer.
The dense vegetation, lack of solar penetration and in some cases lack of suitable substrate at Hastings probably also contributed to the lower species diversity found there. *N. ocellatus, Egernia whitii* and *Tympanocryptus diemensis* which were found only at the dry forest site prefer open areas with rocky substrate (Taylor 1991). The low solar penetration and lack of rocky substrate at Hastings (Table 3) meant the preferred habitat for these species was not available. On the other hand the three species found only at the wet forest site (*C. casuarinae, T. nigrolutea* and *D. coronoides*) are all associated with clearings in dense vegetation (Taylor 1991). While there are clearings at Tooms the ground layer may not be dense enough for these species.

Brown and Nelson (1992) investigated habitat utilisation by heliothermic reptiles in different successional stages of wet sclerophyll *E. regnans* forest. They found that habitat attributes such as insolation, proportion of substrate type (e.g. rock, bare ground), litter depth and number and size of logs were significant in influencing the distribution of some of the species they studied. In dry forest at Eden in NSW, Lunney et al. (1992) found that the amount and pattern of sunlight, expressed in terms of the uniformity and density of the regrowth, was important in determining population densities of lizards in regenerating forest. Conditions associated with clearfelling advantaged some species and disadvantaged others, depending on the age of the regrowth. Of three species studied, two were initially unaffected by logging but had reduced densities in 15-20 year old regrowth. The third species, which was associated with shady gullies, had an initial reduction in density but had increased again in 15-20 year old regrowth.

The results of the present study are similar to those obtained in the two studies listed above i.e. the species composition and abundances of lizards in different treatments could generally be explained by the effect of logging on habitat attributes which have been identified as being important for reptiles (insolation, substrate type, litter depth etc). Depending on habitat preferences, species were found to be either advantaged and disadvantaged by logging. Monitoring of species and densities over time would be required to find out how long it would take after logging for the lizard community to return to that characteristic of a mature forest.

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REFERENCES


VERTEBRATES OF THE DOMAIN, AN URBAN BUSHLAND REMNANT IN HOBART

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Abstract. The Domain is a reserve on the edge of the central business district of Hobart which is totally surrounded by urban development. The reserve is a mixture of developed recreational facilities and natural grassland and grassy woodlands. The area has a depleted vertebrate fauna typical of an urban parkland isolated from other natural areas. The only mammals known to be present today are bats and the brushtail possum. The bird fauna is dominated by larger species such as the Australian magpie, eastern rosella and the aggressive noisy miner. Reptiles have not suffered to the same extent as the birds or mammals with six species definitely present and another two species possibly present. Heavy recreational use of the natural areas may be detrimental to the fauna. Past management practices have reduced sheltering sites, such as rocks and logs, for reptiles and destroyed the site most suitable for frogs.

INTRODUCTION
In 1860 the Parliament of Tasmania enacted the Domain as inalienable crown land and in 1917 the area was vested in the Corporation of the City of Hobart as a public reserve

"... solely for the purposes of recreation, health and the other enjoyment of the inhabitants of the said city and others"

(Queens Domain Vesting Act, No. 41, 1917).

Today the Domain contains a mixture of sporting facilities (swimming pool, tennis centre, athletics track, cricket grounds, and playing fields), botanic gardens, residence of the Governor, recreational facilities (Regatta Pavilion, picnic areas, walking tracks), council infrastructure (Clearys Gates depot, quarries, reservoirs), exotic woodland and grassy areas, formal gardens, historic features (Power Magazine, Queens Battery, site of the Beaumaris Zoo and monuments e.g. the
Cenotaph) and native grasslands, open forests and grassy woodland.

Despite the extent of development in the area the remaining native vegetation is of high conservation value as the Domain contains one of only a small number of expansive remnants of grasslands and grassy woodlands in Tasmania (Kirkpatrick 1995). Fertile black soils on dolerite cover the area. The number of exotic plants in the native vegetation has increased over the past several decades but its conservation value has not declined due to the continuing presence of unreserved, rare and threatened plants (Kirkpatrick 1986, 1995).

The areas of natural vegetation in the Domain are now isolated as the reserve is totally surrounded by roads and urban areas. It has been shown in many other remnants that animal species rapidly become extinct after isolation from other areas of natural vegetation (Karr 1982; Lovejoy et al. 1984; Diamond 1987). This paper reviews the information available on the vertebrates of the Domain with particular reference to the impacts of the isolation of the area from other areas of bushland.

METHODS

Spotlighting was undertaken for three hours on one night in April 1996 with echolocation calls of bats being recorded at the same time using an Anabat detector (Titley Electronics, Ballina). This instrument converts the ultrasonic calls of bats to audible sound. Bat calls were also recorded near the boundary fence of the house in the central part of the Domain (accessed from the road running west of Government House) for three nights in April 1996. Calls of bats at this location were monitored all night using a device from Titley Electronics which automatically downloaded bat calls onto a tape recorder whenever they were detected. The recorded bat calls were played through a zero crossing analysis unit into a computer with the Anabat V analysis software. This software displays the frequency of the call as a function of time. Bat species were identified from their calls using the key from Rhodes (1996). Numbers of each species of bird were recorded by Len Wall from three areas each of 3 ha on the hill in the north of the Domain for the Australian Bird Count organised by the RAOU. These areas were each monitored for thirty minutes in most months from September 1989 to August 1992. Records of the reptiles and amphibians of the Domain were compiled from observations by RB during April 1995, the bycatch from invertebrate pitfall traps set by McQuillan (1996) in February and March 1995 and the recollections of John Hickman who regularly visited the Domain in the 1950’s and early 1960’s to study the internal parasites of White’s Skink Egernia whitei. Relevant published material was consulted and approaches for information were made to local experts.
RESULTS

Amphibians

*Litoria ewingii* brown tree frog

This is the only frog to have been recorded from the Domain. It was recorded by John Hickman in the period 1950-60 in a pond on the creek line which runs into the Botanic Gardens. The pond has since been filled in and turned into a car park. The creek line feeding this dam still runs but contains high phosphate levels as a result of run off from the sports ground. This may have an impact on frog populations. *L. ewingii* still occurs in the Botanic Gardens. *L. ewingii* is widespread in Tasmania and occurs in a wide range of habitats from sea level to alpine. This species can be found long distances away from water.

The common froglet *Crinia signifera* is the only other frog species regularly recorded from the Hobart area. This species may occur in the Botanic Gardens. However, it unlikely that it or any other species of frog occurs in other areas outside of the gardens due to the lack of permanent water.

Reptiles

Nine species of reptiles have been recorded from the Domain.

*Austrelaps superbus* lowlands copperhead

This is the only snake recorded on the Domain, one individual being seen in the early 1960’s (J. Hickman pers. comm.). There appears to be no recent records of this species and it probably no longer occurs here.

*Tympanocryptis diemensis* mountain dragon

This species was captured in an invertebrate pitfall trap in the grassland gully in March 1995 (P. McQuillan pers. comm.). It appears it has always been rare on the Domain. In the late 1950’s it was patchily distributed over the grassy woodland (J Hickman pers. comm.). This species usually shelters under fallen timber and lays its eggs in a burrow dug in an open site. John Hickman found a number of burrows in road side batters. The rarity of the mountain dragon may be related to the lack of shelter sites on the Domain due to the removal of timber and frequent burning. The mountain dragon is listed as being of unknown risk status in Tasmania (Vertebrate Advisory Committee 1994).

*Bassiana duperryi* three-lined skink

This species was commonly observed by John Hickman in the native grassland and grassy woodland on the Domain over the period 1951-1966. It was usually found under flat rocks in grassy areas. This species occurs in grassy woodlands and forests and heathlands in eastern and northern Tasmania where it uses grass tussocks and low herbs as basking sites (Rawlinson 1974). The presence of suitable habitat on the Domain suggests that it is likely that this species still occurs here.
Niveoscincus metallicus metallic skink

This species is common and widespread in the native grassland and grassy woodland and also occurs in altered habitats on the Domain. It shelters under rocks and fallen timber.

Niveoscincus ocellatus ocellated skink

There was a small colony in a rocky area near the wireless mast in the late 1950's (J. Hickman pers. comm.). This area has since been cleared and the colony does not appear to have persisted. However, there is still suitable habitat in the northern and north-eastern part of the Domain, particularly around the old quarries, and it is possible that the species may still be present.

Pseudemoia entrecasteauxii southern grass skink

This species occurs in the grassy woodland and is probably uncommon but widespread on the Domain.

Pseudemoia pagenstecheri tussock grass skink

This is a recently described species related to the common and widespread P. entrecasteauxii (Hutchinson and Donellan 1992). P. pagenstecheri appears to be uncommon on the Domain with only two records from the area. It inhabits grasslands and grassy woodlands. P. pagenstecheri is listed as being of unknown risk status in Tasmania (Vertebrate Advisory Committee 1994). Its currently known distribution is restricted and disjunct. It is only known from one conservation reserve, the small Tunbridge Nature Reserve in the Midlands. It is known from five other locations through the Midlands.

Egernia whitei White's skink

This moderately large skink (snout-vent length 95 mm) is common and widespread in the native grassland and grassy woodland. It shelters in burrows and under rocks. This species and the metallic skink are the most commonly encountered species of reptile on the Domain.

Tiliqua nigrolutea blotched blue-tongue

This species is uncommon on the Domain. A blotched blue-tongue was observed crossing the road into Allocasuarina bushland on the eastern side of the soccer ground in March 1995 (P. McQuillan pers. comm.). John Hickman found this species to be rare in the 1950's and early 1960's and was usually encountered on the eastern edge of the Domain near houses. This species is commonly encountered in the Hobart area where suburbs abut bushland.

Cyclodomorphus casuarinae she-oak skink

The she-oak skink was recorded at the Domain in the late 1950's and early 1960's by John Hickman. He occasionally encountered this species on the eastern edge of the Domain close to the Glebe.
Two additional lizard species have been recorded from the Hobart area, the delicate skink *Lampropholis delicata* and the Tasmanian tree skink *Niveoscincus pretiosus*. However, it is unlikely that they would occur on the Domain because of the absence of suitable habitats. The delicate skink inhabits well developed leaf litter layers in forests (Rawlinson 1974). The dry open grassy woodlands do not develop a litter layer suitable for the this species. The Tasmanian tree skink is widespread in Tasmania and occurs in forests and on rock outcrops (Hutchinson *et al.* 1989). It is an agile species and a good climber. It is common on Mount Wellington. The grassy woodland at the Domain would appear to be too dry and open to support populations of the Tasmanian tree skink.

**Birds**

A survey of the birds of the Domain was undertaken in 1969-71 by the Bird Observers Association of Tasmania (1973). They found that the northwestern and western sectors of the Domain had a low bird population, probably due to the exposure of these areas to the prevailing winds. The *Allocasuarina* stands also had few birds due to the bare ground and lack of insectivorous food. The Botanic Gardens were found not to support any bird species which didn’t occur elsewhere in the Domain despite the wide variety of trees and shrubs which are restricted to this site. Thirty nine species were recorded from the surveys with a further two species recorded flying over the area. Five of these species (blackbird *Turdus merula*, starling *Sturnus vulgaris*, house sparrow *Passer domesticus*, goldfinch *Carduelis carduelis* and greenfinch *Carduelis chloris*) are introduced. Only two species of raptor (masked owl *Tyto novaehollandiae* and brown falcon *Falco berigora*) were recorded during the 1969-1971 study. A further eight species of raptors (Australian hobby *Falco longipennis*, peregrine falcon *Falco peregrinus*, brown goshawk *Accipiter fasciatus*, collared sparrowhawk *Accipter cirrhocephalus*, white-bellied sea-eagle *Haliaeetus leucogaster*, marsh harrier *Circus approximans*, grey goshawk *Accipter novaehollandiae* and southern boobook *Ninox novaeseelandiae*) have been recorded by Nick Mooney between 1985 and 1995. The large numbers of raptors is associated with the large starling roost which occurs under the nearby Tasman bridge. An additional four species (noisy miner *Manorina melanocephala*, brown quail *Coturnix ypsilophora*, kookaburra *Dacelo novaeguineae* and yellow-tailed black-cockatoo *Calyptorhynchus funereus*) were recorded by RB in 1995. Prior to World War II yellow-tailed black-cockatoos used to circulate from Mt Wellington to feed on the Domain before returning to the highlands (L. Wall pers. comm.). The one individual of this species seen in 1995 was a juvenile and probably a vagrant as this species is rarely seen in the Domain and was not recorded during the 1969-71 study. Unlike previous studies the survey undertaken by Len Wall between 1989-92 documented the abundance of
individual species of birds. This study found that three species made up 93% of the birds seen (eastern rosella *Platycercus eximius* 49%, noisy miner 37% and Australian magpie *Gymnorhina tibicen* 7%).

Mammals

The Domain is notably depauperate in native mammals, despite the presence of apparently suitable habitat for some. Noteworthy are the absences of species generally associated with more extensive tracts of grassy woodland: there are no recent records of echidnas *Tachyglossus aculeatus*, barred bandicoots *Perameles gunni*, brown bandicoots *Isoodon obesulus*, eastern quolls *Dasyurus viverrinus*, ringtail possums *Pseudocheirus peregrinus*, red-necked wallaby *Macropus rufogriseus* or bettongs *Bettongia gaimardi*.

Introduced rats and the house mouse occur in the Botanical Gardens. The brush tail possum *Trichosurus vulpecula* was seen during spotlighting and its scats are easily found. One chocolate wattled bat *Chalinolobus morio* was detected during the spotlighting and 40 bat passes were recorded at the house in the central Domain. Of the passes which could be identified two were *C. morio* and eight were *Falsistrellus tasmaniensis*.

DISCUSSION

The Domain is now a small disturbed bushland remnant totally surrounded by urban areas and a considerable distance from the closest areas of bushland on the foothills of Mt. Wellington. The composition of the fauna reflects this isolation and disturbance. Many species of mammals can be presumed to have disappeared from the area. Other areas of bushland around Hobart have been affected by isolation and disturbance to differing extents. Waverly Flora Park has only recently been cut off from bushland in the Meehan Range by the construction of a large freeway from Mornington to Rokeby Road. Brown bandicoots and barred bandicoots are still present in this reserve. At Lambert Gully Reserve on Mount Nelson, where a connection is maintained with a large area of bushland to the south, echidnas, brush tail possums, ringtail possums, brown bandicoots, barred bandicoots, potoroos *Potorous tridactylus* and bettongs all occur (Hird 1995). In other areas such as Howrah Hills pademelons *Thylagale billardieri* and red-necked wallaby also persist and Tasmanian devils and eastern quoll have been recorded as road kills (J. Mulcahy pers. comm.). The only non-bat mammal species that is common in the Domain is the brush tail possum. This species occurs in city and suburban areas and hence the population on the Domain is most likely not isolated from other populations. Bats do not appear to have suffered to the same degree as most other mammal species. Bats are less active at the time of year when sampling took place (April) than during the warmer
Vertebrates of the Domain

months and hence sampling in summer and spring would probably detect greater activity levels and further species (Taylor and Savva 1990). Lumsden et al. (1995) have shown that insectivorous bats have not suffered loss of species in rural landscapes in northern Victoria where fragmentation and disturbance of natural vegetation has occurred. They propose that the ability of bats to fly long distances has allowed them to move freely through such fragmented landscapes and utilise resources from multiple locations.

Loyn (1987) has shown that small (<10 ha) forest remnants in Victoria that have been degraded by grazing support only low densities of forest birds. Noisy miners are a prominent part of the bird community in such degraded remnants. This species aggressively excludes small birds that enter their territory and hence densities of insectivorous birds are low in the degraded remnants. The only other birds which were found to be able to nest in the territories of noisy miners territories were larger birds such as kookaburras, Australian magpies and eastern rosellas. The bird fauna of the Domain has these exact characteristics of a degraded remnant being dominated by noisy miners, eastern rosellas and Australian magpies. It is interesting to note that noisy miners were not recorded from the Domain in 1969-71 but made up 37% of the birds recorded in 1989-92. According to LenWall (pers. comm.), whose experience of the area spans the period from the 1930s to the present, there has been a marked decline in the bird diversity present on the Domain this century.

The reptile fauna appears not to have suffered the extent of declines or changes shown in the mammals and the birds. This has also been shown to be the case in other areas of remnant bushland such as the Buloke woodlands in western Victoria (Hadden and Westbrooke 1996) and in the Western Australian wheatbelt (Kitchener et al. 1980). It appears that this is due to the smaller home ranges that these species require thereby reducing the need for a large area to maintain a viable population. The herpetofauna is more affected by changes to the habitat rather than fragmentation and reduction of area (Hadden and Westbrooke 1996).

There is evidence of seven of the ten species of reptiles and amphibians recorded from the Domain being presently extant in the area. However, it is possible that *C. casuariinae* and *N. ocellatus* would be found with further searching. It is likely that *A. superbus* is extinct due to the destruction of suitable habitat. Kirkpatrick (1995) notes that the deepest gully present on the Domain is so badly invaded by exotic plants that it is difficult to determine what vegetation would have been present and also comments that the augmentation of flows into the gully from the playing fields has destroyed the central part of the gully. The paucity of snake records on the Domain is likely to be attributable to the lack of streams and wetlands. The copperhead *A. superbus* is associated with habitats
that are subject to flooding and the tiger snake *Notechis ater* is common on the margins of watercourses and swamps (Rawlinson 1974). Frogs form a significant part of the diet of both species. It is possible that the white-lipped snake *Drysdalia coronoides* may occur on the Domain as this species is not often encountered. However, the pressure from introduced predators, particularly cats, could have eliminated this species from the area if it were once present.

The presence of *T. diemensis* and *P. pagenstecheri* is significant, both species being listed as of unknown risk status in Tasmania (Vertebrate Advisory Committee 1994). *P. pagenstecheri* is the only Tasmanian reptile restricted to tussock grasslands. The other reptile species recorded at the Domain are common and widespread in a range of woodland and forest habitats in Tasmania. Grassy ecosystems are among the most threatened vegetation types in Tasmania (Kirkpatrick *et al.* 1988). They have been extensively cleared and modified and the remnants are poorly reserved.

**Management issues**

It is not known to what extent the recreational use made of the bushland is degrading the area for the fauna. The tracks through the area are heavily used with people often being accompanied by an untethered dog. Cross-country orienteering events are also held regularly. A large increase in human activities in two reserves in Germany over 26 years has been blamed for the loss of species that occurred over this period (Schuster and Peintinger 1994). The internal traffic flow in the Domain can be heavy and much of the circumference of the Domain is isolated by major roads resulting in potentially high mortality for mammals. For these reasons it is considered that it is not justified to try to reintroduce the mammal species which have probably disappeared from the Domain. Even if disturbance factors operating internally within the area could be reduced it is likely that population sizes of those species that have disappeared would be too small to maintain a long term viable population.

The proximity of suburban areas will have increased the populations of introduced birds such as starlings, blackbirds and sparrows. Competition with introduced birds may well be a contributing factor in the decline of many native species. Starlings are known to utilise tree hollows for breeding and could lead to a shortage of these hollows for native species such as rosellas. It seems unlikely that any practical measures could be taken to reduce populations of the introduced birds.

Management of the Domain needs to consider the habitat requirements of the reptiles and provide for their continued presence. Reptiles require shelter sites as protection from predators, as foraging substrates (fallen timber houses invertebrates which are a food source), to rest on, hibernate in and for reproduction
Vertebrates of the Domain

(as egg laying sites or birthing sites). In the 1950's the rocks on the eastern and north eastern slopes above the Derwent River were cleared and piled into windrows apparently to allow mowing and for fire control (J. Hickman pers. comm.). The Domain, including the more natural areas, has until up to five years ago been regularly “tidied up”, i.e. natural grasslands were mowed and fallen timber removed (Jill Hickie pers. comm.). The effects of these activities are still evident and they have resulted in a loss of shelter sites for reptiles, reducing the carrying capacity of the area. The current fire management regime is based on a mosaic burning pattern on a 3-5 year rotation to reduce fuel loads. The frequent use of fire also results in a loss of shelter sites and can cause high mortality in reptiles if suitable sheltering sites, such as rocks and logs, are not available.

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John Hickman willing shared his knowledge of the herpetofauna of the Domain and Jill Hickie provided information on management. Len Wall and Don Hird supplied information about their experience with vertebrates on the Domain. The RAOU supplied the data on birds collected by Len Wall from their Australian Bird Count database.

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A NOTE ON THE DIET OF THE SCRUBTIT *ACANTHORNIS MAGNUS*

*Marcus Pickett*

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The Scrubtit *Acanthornis magnus* is a Tasmanian endemic which occurs in wet forests and highland scrubs with a dense, often ferny, undergrowth. It forages in the undergrowth obtaining most of its food from the trunks of trees and ferns and from branches and fern fronds (Thomas 1974). Possibly the only published observation on the diet of this species is that of Mollison (in Thomas 1974) who found the stomach contents of one bird from the Florentine Valley to be composed entirely of insect remains (spiders and beetles).

The following observation of feeding by this species was made in rainforest adjacent to Timbs Track off Gordon River Road in Southwest Tasmania. From 1715 h to 1720 h on 4 January 1996 an adult scrubtit was observed on the forest floor dismembering and eating the body parts (with the obvious exception of the wings) of an adult Macleay’s Swallowtail (butterfly) *Graphium macleayanum*.

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TWO NEW VARIETIES OF THE TASMANIAN CARYODID SNAIL ANOGLYPTA LAUNCESTONENSIS

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Abstract. The large caryodid snail Anoglypta launcestonensis (Reeve 1853) is confined to rainforest and mixed forest in northeastern Tasmania. Two new distinctive and apparently consistent forms of A. launcestonensis are differentiated and geographical distributions for the different forms are documented.

INTRODUCTION

Anoglypta launcestonensis (Reeve, 1853) is endemic to an area of north-eastern Tasmania roughly between Mount Arthur to the west and Goshen to the east, Roses Tier to the south and Mount Horror to the north. The species occurs almost exclusively in areas containing some rainforest trees. A. launcestonensis was initially thought to be extremely consistent in appearance. For instance, Petterd (1879) remarked “It scarcely ever varies from its normal character.” Available specimens were, however, assigned to four types by Kershaw (1988a) on the basis of “colour variation which correlates broadly with spire height, animal colour and some anatomy features”, although one of the four types was based solely on shell features. However, Kershaw’s four types display essentially the same colour pattern with fairly minor variations in tone. Kershaw’s description of Type Four does suggest a very different shell colour. Having seen the three specimens, I believe this is chiefly due to fading.

In this paper I describe two new forms of A. launcestonensis which display differences in shell colour and colour pattern.

METHODS

In early 1996 I undertook a survey of the distribution and habitat of A. launcestonensis. This involved searching eighty-nine plots of 15 m radius which were distributed throughout the range of A. launcestonensis. A total of 171 specimens were found within 44 plots as well as 39 fragmentary shells dropped by birds. A pile of about 120 shell fragments was found between plots on Mount Michael in the Blue Tier area (Australian Map Grid Reference 5848 4404). Such piles are known to be formed by Bassian thrushes Zooterta lunulata which prey on A. launcestonensis (Sean Blake, pers. comm.), but it is not known whether any other bird species ever forms them. A further 202 specimens from 45 lots in the Queen Victoria Museum were examined. The Queen Victoria Museum sample
is geographically biased by the inclusion of 114 dead shells collected after fire in the Mutual Road (Cascade Dam) area. Some smaller collections were also examined and some people with recent field experience of the species consulted to determine whether the "new" forms had been previously collected. The Tasmanian Museum collection (18 specimens from 12 lots examined) was the only public collection to contain the new forms.

RESULTS

Shells of the different colour forms are illustrated in Fig 1. In the case of the "new" forms, Type Five and Type Six, some comments below must be regarded as tentative due to the small number of specimens known (eight and twenty respectively) and especially due to the small number of complete specimens. Protoconch examination was only possible for three specimens of each form. Furthermore no anatomical work has been undertaken on these forms.

Normal colour pattern forms

Variation in the normal colour pattern forms, which include Kershaw's groups (=types) one to four is discussed here for comparative purposes. Adult shells are from about 25 to 35 mm wide, with shell height ranging from at least 64% to 80% of shell width (based on values given in Kershaw 1988a; the 86% given for one specimen should be 68%). This can now be extended to 59% to 89% (based on measured specimens from Terrys Hill Road (AMG 5925 4337) and Blue Tier (AMG 5846 4402) respectively). The degree of variation in the protoconch sculpture is discussed by Kershaw but the degree of variation in adult sculpture is greater than previously recognised. In particular on Blue Tier, some specimens show very little corrugation in the adult sculpture, which takes the form of fairly smooth spiral ridges. These specimens tend to have very high spires. Moreover, while it is normal for _A. launcetonensis_ to have five to eight more obvious ridges of sculpture, in some Blue Tier specimens (about 7%) there are only one to three obvious ridges. Although this produces specimens which look very distinctive, these may intergrade with more normal specimens. However, specimens of such appearance are very rare away from the Blue Tier area.

The yellow band on the base of the shell is usually 2-3 mm wide, rarely up to 4.5 mm (Fig. 1). Slight variation in tone on all parts of the shell is also common, as documented by Kershaw, but appears to have little geographic basis, except that specimens in the western half of the species' range are more likely to be "black" rather than "dark brown" below, and are more likely to visibly display a very narrow second yellow band on the characteristic peripheral keel.

_Type Five: The "yellow" form_

This form was found at two locations. At Dans Rivulet, Mt Victoria (AMG
Fig 1. *Anoglypta launcestonensis* showing colour pattern of varieties.
Upper: normal colour form (specimen from end of Knights Road, west of Mount Maurice).
Middle: "yellow" Type Five form (Dans Rivulet, south of Mount Victoria).
Lower: "bronze" Type Six form (north of Mount Michael, Blue Tier).
Scale bar represents 10 mm.
Varieties of Anoglypta

5699 4227) one live adult and two dead adults were found, as well as a normally patterned live juvenile. At another site on southern Mount Victoria (AMG 5712 4223) one live adult was the sole A. launcestonensis found. Two shell fragments of this form were found near the Cashs Falls car park, northern Mount Victoria (AMG 5703 4258) in a pile of 16 fragments. Another was found in a pile of 9 fragments near Gold Creek in the Cascade Dam area (AMG 5681 4384). A previous specimen exists in the Tasmanian Museum collection (TM 911/8252) although strangely it is unmentioned in the existing literature. This specimen was collected by W. F. Petterd in 1889 and is marked "H. launcestonensis var.", with the locality given as "Blue Tier", followed by what is probably a contraction of "Goulds Country". While the southern Mount Victoria area appears to be a stronghold of this form, it appears that it is not restricted to this area. It is probably very scarce and/or localised away from Mount Victoria. For instance, the very large QVM sample from Mutual Road contains no specimens of this form.

This form is most clearly distinguished by the colour of the shell. Almost the entire upper surface is unmistakably yellow (as distinct from yellowish brown, yellow-blotched etc) and is almost the same colour as the band underneath. The only brown colour on the upper surface is a very thin (max. 1.5 mm) dark brown band running around the inside of each whorl adjacent to the sutures. (This feature is also sometimes visible in normal colour forms but usually the dark brown is too close to the normal shell colour to be noticed.) Type Five specimens are also distinguished by the very much wider (7-8 mm) yellow band underneath. This restricts the dark brown colour which normally dominates the base to two bands of about 3 mm width, one around the umbilicus and the other peripheral (Fig. 1). The protoconch is greenish grey grading to reddish brown. The sculpture of about five dominant fairly sharp spiral ribs at the periphery of the protoconch and then ten often indistinct flattish spiral ribs closely resembles Kershaw's Type Four. All ribs are cut into fairly regular blocks by radial grooves. The shells are comparatively low (height/width ratio of about 66%) with very slightly depressed spires, but are usually of average width (~ 29 mm, but one shell fragment had a base 33 mm). The whorls are often more convex than normal, both above and (in the case of the body whorl) below, reducing the significance of the keel. Both Type Five specimens were pale orange in colour. No evidence of any intergrading with normal forms was found.

Type Six: The "bronze" form

This form was also only found in two survey plots. At AMG 5849 4402 (Mount Michael, Blue Tier) one live sub-adult and two live juveniles were found. This plot had a total of 24 A. launcestonensis. Of the remaining 21, only one was not normally patterned (see below). At Mount Michael on Blue Tier (AMG 5849...
one live adult was found, as well as two normal coloured specimens. Of the 98 shell fragments collected from the pile nearby, 15 belonged to Type Six, while all the remainder except possibly one (see below) were normally patterned. Eight shell fragments I found at virtually the same place in September 1988 also included one specimen of this form. This form apparently comprises about 15% of the total in the Mount Michael area, but no records are from more than 1 km away. Searching to the immediate north and east of the Mount Michael/Little Mount Michael area has been limited by difficult access and therefore the extent of this form's range is not clear. Normal colour forms (including Type Four) occur at several sites to the east, the closest being 6 km. However there is only one A. launcestonensis record to the north, at Musselroe Creek (AMG 5879 4493) an outlying site 10 km away from the nearest record, with one normally coloured specimen found. The area of rainforest from Mount Michael up to Mc Goughs Lookout is extensive but contains few tracks.

This form is most clearly distinguished by the different markings on the base. In contrast to both normal and Type Five forms which have a dark brown or black base bisected by a yellow band, Type Six forms have the lighter band running around the outside of the dark brown colour (Fig. 1). As with Type Five the band is wider (7-8 mm) than normal. It is of a slightly different colour to that of Type Five being an olive-greenish yellow, semi-translucent in live specimens and having a streaked appearance where crossed by faint irregular growth lines. The shell is a bronzed reddish brown (approaching orange in some) above, noticeably paler than most normal colour forms, and grades to dark chocolate brown in the last 1/8th whorl and indistinctly around the sutures (as for Type Five). Shells are moderately high-spired (c. 75% of shell height) and appear, based chiefly on shell fragments, to be of consistent width (c. 30 mm). The adult sculpture includes a small number (about five) of dominant, darker coloured ribs, which are clearly corrugated but nonetheless continuous. The protoconch, which is similar in colour to the rest of the upper surface, is initially of about ten spiral riblets with about the fifth from the periphery being much wider and higher than the others. The number of riblets increases with growth to at least 17. However segmentation is extremely weak. In all respects except the last this is fairly similar to the Type One protoconch. The body of animals seen was neutral brown to brownish red, with the two larger specimens grading to grey/black around the head and adjacent flanks. Again, no evidence of intergrading was seen and specimens from the fragment pile could be distinguished from normal forms with ease even when quite substantial fading had occurred.

Miscellaneous Specimens
This section documents specimens seen during the survey which appeared not to conform to either the normal colour form or Types Five and Six.
The shell of a live juvenile of about 4 whorls from near Mount Michael was entirely pale yellow-horn except for a very thin (c.1 mm) red-brown band bisecting the base. A shell fragment collected from the large fragment pile on Blue Tier was of a fairly large and high spired adult shell with quite corrugated adult sculpture. The fragment was entirely lemon yellow. It is possible that this was due to fading but no other specimen in the pile exhibited serious fading.

A live adult photographed at Cuckoo Hill Road (AMG 5538 4348) did not have a distinct boundary between the inside of the yellow band on the base and the usual dark brown colour around the umbilicus. Instead the yellow blurred gradually and inconsistently into the darker colour. This may not represent a genuine colour difference, and may be simply due to age. In support of this, the specimen showed visible fading and pockmarks consistent with old age, and furthermore over 85% of live specimens of the related *Caryodes dufresnii* (Leach, 1815) in this plot, were extremely old. A dead juvenile *A. launcestonensis* at this plot was normal.

Whether these specimens represent distinct, regularly occurring forms or simply individual variations is unclear, but the latter is very likely. The same comments apply to a specimen seen at Carneys Creek (AMG 5395 4155). This specimen had extremely reduced adult sculpture and almost totally lacked the characteristic keel of the species. It also had extremely strong radial corrugations resembling those of dry forest *Caryodes dufresnii* specimens. Relatively minor shell colour discrepancies were observed as well.

Differences between some Blue Tier specimens and “normal” colour forms are discussed above. More extensive analysis is required to determine whether these require treatment as separate forms.

**DISCUSSION**

*Nature of the variation*

Two unusual aspects of variation are notable in *A. launcestonensis*. Firstly, there is some suggestion, noted by Kershaw (1988a) and reinforced by examination of the two “new” forms, for forms to consistently differ in more than one regard from each other. Secondly, different varieties can occur in sympatry. Although it was impractical to determine to which (if any) of Kershaw’s Types all specimens surveyed belonged to, definite sympatry was observed involving Types 3 and 6, 1 and 6, 1 and 4, 1 and 5, 1 and 3 and possibly 3 and 5, and 1 and 2. In the case of Types 3 and 6, specimens were found living together under the same piece of bark on a fallen tree.

The occurrence in sympatry of forms of the one species with multiple distinguishing features is otherwise unknown in the Tasmanian snail fauna. Significant sympatric variation in shell morphology and sculpture is common in
the punctid *Paralaoma caputspinulae* (Reeve, 1854) and the charopids *Allocharopa legrandi* (Cox, 1868) *Thryasona diemenensis* (Cox, 1868) and forms assigned to *Stenacapha hamiltoni* (Cox, 1868) (pending current study by Brian Smith of the Queen Victoria Museum). However, such variation usually appears to be continuous at any given site. Sympatric variation in shell colour, usually discontinuous, is known in the rhytidid *Tasmaphena sinclairi* (Pfeiffer, 1845) and in some small charopids, especially *Pernagera* and *Geminoropa* species. However, this variation does not appear to correspond with variation in other characteristics. More significant discontinuous variations are present in some species. The most notable example is *Caryodes dufresnii* (Leach, 1815) where variation has been extensively analysed (e.g. Kershaw 1988b, 1989). Variation in *C. dufresnii* is in many respects similar to that in *A. launcestoneus*, its closest Tasmanian relative. The variation, especially in shell size and morphology, and also in anatomy, is much greater in *C. dufresnii*, as is to be expected in a much commoner snail with a much wider habitat range and much greater distribution. However both species have a characteristic colour pattern with some recognisable exceptions. In the case of *C. dufresnii*, the three-banded forms and predominantly yellow forms present or formerly present in the dry forests around the Tamar Valley are relevant comparisons. However, unlike in *A. launcestoneus*, all significant variation in *C. dufresnii*, excepting individual variations, appears to be strictly non-sympatric and more or less environmentally determined. Presumably the competitive advantages of various forms are sufficiently minor for no single form to have become predominant at those sites where *A. launcestoneus* displays sympatric variation.

**Geographic patterning of variation**

Although not all specimens surveyed were identified to form level, the distributions given by Kershaw (1988a) were largely confirmed. The known range of the apparently quite distinctive Type Four was extended from the Murdoch's Road/Lottah/Goulds Country area to include St Columba Falls, and some high-spired specimens were seen around Mount Michael which did not correspond to any of the six Types given, as noted above. The disjunct records for Type Two from Bells Hill and Type Three from South Barrow were not confirmed, but the presence of supposedly disjunct Type One in the far east was. Type One appears to be the most general form of the species, although it is difficult to differentiate Types One and Two on sight, and it is possible that they intergrade. If Type Two is distinct, its distribution appears to include the westernmost and some of the central northern localities. However, all the remaining four forms, plus the largest group of "difficult" specimens, come from the east (clustered around the Blue Tier - Mount Victoria area, and in particular the Mount Michael area) which may contain nearly as great a diversity of *A.*
Varieties of Anoglypta

launcestonis as the species' entire range. While this may simply be to coincidence or to subtle habitat factors, it also could suggest that a former refuge for Anoglypta occurred in the far east of the current range, and that the stock which subsequently populated the western portion of the species range was genetically impoverished by comparison. The species presumably had a very restricted distribution in the Pleistocene due to its rather specific habitat requirements (Kershaw, 1988a).

There are two possible explanations for the concentration of forms which can be rejected. The first is that it is simply an edge effect, and the second is that it is an artificial phenomenon because of the large amount of material studied from the Blue Tier area, a known centre of dense A. launcestonis populations. Good evidence against both ideas is provided by the plot at Ikes Creek, Roses Tier (AMG 5558 4094). At this site 28 specimens were found and no significant variation, apart from the usual variation in shell width and height, was noted. Roses Tier is the southernmost site where specimens have been found. Even stronger evidence against the second contention is that Kershaw was able to place all of the several dozen Mutual Road shells in one Type, and there is indeed little variation between these specimens, once one discounts apparent colour variations caused by the burning of some shells.

Status of variations

Both the "new" colour forms are clearly quite rare. They each accounted for four of the 171 specimens found in my 1996 survey which covered the entire range of the species. The existence of forms which are sympatric with normal forms, but which do not occur over the species' entire range, and which appear not to intergrade with sympatric normal forms, raises interesting questions about the genetic status of these forms, questions which deserve further investigation. There are at least three relevant explanations. The first is that this variation has no genetic basis and is expressed simply because of environmental factors (such as camouflage advantage) and/or normal statistical fluctuation. For instance, Tasmaphena sinclairi has a purely yellow-shelled form which is widely distributed and can account for up to 15% of some quite large samples, while being far less prevalent in others. In the case of A. launcestonis the evidence against this explanation is still inconclusive for Type Five but very strong for Type Six. The species does not have a wide habitat tolerance and the habitat differences between Blue Tier and other areas do not appear to be significant enough to cause a difference in the frequency of Type Six as absolute as that observed. The second explanation is that there are slight genetic differences between A. launcestonis populations which cause some variations to arise normally in some populations but not in others. The third explanation is that the sympatric forms are largely or entirely reproductively isolated from each other. This does not necessarily imply full speciation, but is nonetheless
much stranger than the second explanation. The apparent multiple and unconnected nature of the difference between forms does lend some support to this explanation but this needs confirmation. In the case of Type Five it has not been possible to confirm the occurrence in sympatry of adult specimens of normal form. Fragmentary specimens may not have been precisely sympatric with those from the same piles, as the range over which birds forage for snails is not known. In the case of Type Six the evidence for differences in sculpture and morphology to that of normal shells is tenuous compared to the evidence for distinct colour forms. This is because most fragmentary specimens do not have an intact protoconch and the normal colour forms present on Blue Tier include a range of protoconch variation, as well as variation in most other sculptural and morphological characters.

The evidence in favour of at least some Blue Tier specimens being genetically distinct is quite strong. Any hypothetical loss of the habitat around Mount Michael could therefore adversely affect the gene pool of *A. launcestonensis*, although the species as a whole appears quite secure. The Mount Michael area is currently within the Blue Tier (unresolved) Recommended Area for Protection, but whatever the fate of the area as a whole, it is likely that the Mount Michael area will remain secure due to its status as a moderately popular eco/historical tourism location. The Type Five population is also likely to be secure as most specimens found so far have been within the Mount Victoria Forest Reserve.

**ACKNOWLEDGEMENTS**

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**REFERENCES**


BOOK REVIEW

by Ken Simpson and Nicholas Day
Published by Penguin Books. Price $35.
Reviewed by Robert Taylor

This latest edition of Simpson and Day's field guide to Australian birds has some major changes compared with previous versions. The biggest change flows from the use of the most recent taxonomic classification of Australian birds (Christidis and Boles 1994). Genetic studies have lead to a greater understanding of the evolutionary relationships amongst birds. As a result some species which have been grouped on the basis of morphology have been found to have divergent evolutionary origins e.g. the plains wanderer is a wader not a button-quail. Simpson and Day have relisted and largely rearranged the grouping of species to account for this. However, there are exceptions. For example, the varied sitella has been retained with the treecreepers to allow ease of comparison rather than being placed with the whistlers. The changes have led to the inclusion of 19 new colour plates and the modification of two others. More images of immature stages have been included. There are also many more black and white drawings; 154 of these are additions or replacements of those in the previous edition.

The abundance and movement pattern of each species has been represented by a symbol in this edition. Information on movement patterns is certainly worthwhile but abundance varies greatly over the range of a species and so may only be of limited use.

The presentation has been significantly improved through the use of colour for text headings and shading for maps to indicate breeding versus non-breeding or vagrant distributions. Changes have been made to 180 of the distribution maps. More detail has been shown in the portrayal of exact locations or regions of occurrence rather than shading larger areas with scattered populations.

The book comes in two parts with a handbook comprising the second half. The handbook contains information on the biology of each of the families as well as sections on habitats, prehistoric birds, faunal regions and hints for bird watchers. Additions to this section in the new edition include profile diagrams of the major vegetation types, details of recent molecular techniques for the study of evolutionary relationships and a checklist for the birds of Australian island territories (e.g. Macquarie Island, Christmas Island, Norfolk Island).

So how does this book rate against the other three major field guides on the market? Graham Pizzey's A Field Guide to the Birds of Australia used to be the most
popular. However its illustrations now don’t stand up in comparison with the others and the text, distribution maps and drawings for each species are in different sections, a most annoying feature. The recently released *Reader’s Digest Photographic Field Guide* is the first based solely on photographs. However, the photographs used often do not depict distinguishing features and different plumages phases, such as breeding and non-breeding or sexual and age differences, are often not shown. Thus this book is not recommended.

To my mind the only real competition for Simpson and Day is *The Slater Field Guide to Australian Birds*. The retail price of both books is the same. The major advantage of the Slater guide is its size, being approximately 110 mm wide compared to 155 mm for Simpson and Day. The Slater guide is thus more pocket-sized and easier to carry around in the field. The handbook section of Simpson and Day, whilst containing very useful information, is really not required for a field guide and is probably a relict from its previous incarnation as a coffee table book. The larger number of pages in Simpson and Day (400) than in Slater (344) is due to the inclusion of the handbook with the guide finishing on page 279.

Despite its greater bulk, I would still recommend Simpson and Day over the Slater guide. I particularly like the inclusion in Simpson and Day of the visual index to the families. I often use this in preference to the traditional index to find the relevant pages for a particular group of species. I find the illustrations in Simpson and Day better than in Slater. Slater has most birds set against a motley background and the illustrations often seem stiff and lifeless. Simpson and Day often provide a more natural backdrop. The drawing on page 255 is a wonderful example of this. The presentation of other features in Simpson and Day, such as races, sex and age differences, distribution maps and copious black and white drawings, often showing useful behavioural features, is also first class. There are also drawings on the inside of the covers of life size profiles of the bills of many marine birds which allows the identification of birds washed up on beaches.

If you are thinking about replacing your tattered old bird guide or buying one for the first time I can thoroughly recommend Simpson and Day’s new edition. It is truly a world class guide.

REFERENCES
ADVICE TO CONTRIBUTORS

The Tasmanian Naturalist publishes articles on all aspects of natural history and the conservation, management and sustainable use of natural resources. These can be either in a formal or informal style. Articles need not be written in a traditional scientific format unless appropriate. A wide range of types of articles is accepted. Examples include observations of interesting or unusual animal behaviour, flora or fauna surveys, aspects of the biology and/or ecology of plants and animals, critical reviews of management plans and overviews on contemporary issues relating to natural history.

Reviews of publications on Australian natural history are included. Unsolicited reviews are welcome as are suggestions for books to be considered for review.

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Manuscripts should be sent to Dr Robert Taylor, C/- Forestry Tasmania, GPO Box 207B, Hobart, Tasmania 7001.

Formal articles should follow the style of similar articles in recent issues. Informal articles need not fit any particular format. An abstract need only be included with longer articles. References cited in the text should be listed at the end of the paper in the following format:


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The Tasmanian Field Naturalists Club aims to encourage the study of all aspects of natural history and to advocate the conservation of our natural heritage. The club is comprised of both amateur and professionals who share a common interest in the natural world.

ACTIVITIES
Members meet on the first Thursday of each month in the Biological Sciences Building at the University of Tasmania at Sandy Bay. These meetings include a guest speaker who provides an illustrated talk. This is followed by an excursion on the next weekend to a suitable site to allow field observations of the subject of that week’s talk. A mammal survey group also undertakes trapping and recording of native mammals in local areas. The Club’s committee coordinates input from members of the club into natural area management plans and other issues of interest to members.

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Membership of the Tasmanian Field Naturalists Club is open to any person interested in natural history. The Tasmanian Naturalist is distributed free to all members, the club’s library is available for use and a quarterly bulletin is issued with information covering forthcoming activities. Enquiries regarding membership should be sent to The Secretary at the above address or by phoning Don Hird on (03) 62284434.

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