VOLUME 119 (1997)

ISSN 0819–6826

T.F.N.C.

THE TASMANIAN NATURALIST

EDITOR: ROBERT J. TAYLOR

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Published annually by The Tasmanian Field Naturalists Club Inc., G.P.O. Box 68A, Hobart, Tasmania 7001

The Tasmanian Naturalist (1997) **119:** 2-9.

INVERTEBRATES OF THE DOMAIN - A BRIEF SURVEY AND IMPLICATIONS FOR MANAGEMENT

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Abstract. The invertebrate fauna of the Domain, a bushland reserve near central Hobart, is substantial and largely typical of grassy woodlands elsewhere in south eastern Tasmania, although several groups including butterflies are under represented. A number of rare species are present, including the endemic ant *Myrmecia esuriens*, the geometrid moth *Lackrana carbo* and the lucanid beetle *Lissotes basilaris*. The small grass cricket *Balamara albivittata* is recorded from Tasmania for the first time. Numerous animal-plant mutualisms occur, but some may be precarious in the long term due to pressures on one or other partner. Habitat supplementation should be considered to enhance the longer term survival of certain species and invertebrate biodiversity overall. Threatening processes include trampling, pesticide drift, invasion of exotic plants, and the impact of introduced predators such as European wasps, starlings and blackbirds.

INTRODUCTION

The Domain is a council reserve near central Hobart. This reserve contains areas of grassland and grassy woodland communities which have been much depleted and are poorly reserved (Kirkpatrick 1986). This paper reports on a short survey of the invertebrates of the Domain. The conservation status and significance of the invertebrate species and communities are highlighted and suggestions are made for improved management of the natural areas of the reserve. Although there are no comprehensive studies of the insects of grassy woodlands in eastern Tasmania yet published, several are in progress and comparisons are made with these other areas.

METHODS

Four locations, chosen to represent a broad range of vegetation types, were sampled on three occasions in January, February and March 1995. These were a *Eucalyptus viminalis* grassy woodland, a *E. globulus-E. pulchella* forest, an *Allocasuarina* forest and a damp slope rich in graminoids, especially sedges. Ultra-violet light traps to sample nocturnal flying insects were operated on warm nights at all sites. These traps were powered by a 12 volt gel electrolyte battery and controlled by a light sensitive switch which turns the trap on at dusk and off at dawn. Specimens which entered the traps were anaesthetised with the vapours of tetrachlorethane. Pitfall traps were installed at all sites in order to sample terrestrial invertebrates such as ants and beetles. These consisted of 10 cm diameter plastic cups sunk flush with the soil surface and one-third filled with ethylene glycol as a preservative. They were arranged in groups of three and emptied after 30 days on 18 March 1995. The catch was sorted in the laboratory and stored in 70% ethanol. Diurnally active species such as butterflies and grasshoppers were collected with a net on an opportunistic basis. Searching under stones and logs, which were carefully replaced, yielded sedentary species such as trapdoor spiders, beetles, centipedes and millipedes which are not readily caught by other methods. Voucher specimens from this study have been deposited in the collection of the Centre for Environmental Studies at the University of Tasmania.

RESULTS

A large variety of invertebrates was sampled although a full appreciation of their diversity would require sampling across all seasons. In addition, the summer of 1995 was extremely dry and insect numbers were relatively low compared to other years. The invertebrates collected in the survey are listed in Appendix 1. Comments on significant taxa are given below.

Grasshoppers and crickets

Grassy woodlands are a prime habitat for orthopterous insects and a number of interesting species occur on the Domain. Especially noteworthy is the occurrence of the small grass cricket *Balamara albivittata* here recorded from Tasmania for the first time, although otherwise widespread in south eastern Australia. The cave cricket *Parvotettix* sp. is a Tasmanian endemic usually found under logs. The black field cricket *Teleogryllus commodus* is very common in eastern Tasmania, especially on cracking clay soils where it feeds on grass seeds in autumn. The mole cricket *Gryllotalpa australis* makes shallow tunnels in grassland and has a loud and distinctive call.

The grasshopper fauna is typical of grassy woodland, being numerically dominated by the wingless grasshopper *Phaulacridium vittatum*. This species matures in the late summer and overwinters in the subterranean egg stage before hatching in late November. Other grasshopper species are much less abundant although the large yellow-winged locust is conspicuous by its bright yellow wings and noisy flight. The small grasshopper *Austroicetes vulgaris* occurs around eucalypts as does the dead leaf grasshopper *Goniaea australasiae* where it blends into the litter. The endemic flightless *Tasmaniacris tasmaniensis* is widespread.

Beetles

Several significant species of ground dwelling beetles were recorded. However, herbivorous beetles, of which a significant fauna might be expected, are best sampled in the spring and thus would not have been sampled by this survey.

Root feeders. The ground weevil fauna includes three species of flightless Amycterinae and a species of *Mandalotus*. The former feed as larvae on the root crowns of *Poa* tussocks. Amycterinae are a primitive Australian group which are declining in many areas due to pastoralisation. The cockchafer fauna is unremarkable, dominated by the ubiquitous *Scitala sericans* and several species of *Heteronyx*. *Phyllotocus bimaculatus* is also present.

Predators. The predatory carabid fauna is typical of a somewhat degraded grassy woodland or pasture. *Promecoderus* cf *ovicollis* dominates this guild as it does in sheep pastures in the Midlands of Tasmania. An apparent absence is the genus *Rhytisternus* which can be locally common in native grassland in lowland Tasmania. Several native ladybirds were observed, including *Coccinella repanda* and a *Rhizobius*.

Litter Detritivores. The tenebrionid beetles *Celibe costatus* (flightless) and *Lagria grandis* (winged) are widespread.

Log Detritivores. Three lucanid beetles were found in the blue gum forest. *Lissotes obtusatus* is a flightless endemic widespread in southern Tasmania whereas *L. basilaris* is a rare species restricted to the Hobart area west of the Derwent River. *Syndesus cornutus* is a winged species also found on mainland Australia. Both have slow-growing larvae dependent on rotting logs in contact with the soil.

Cambium borers. Evidence in the form of elliptical emergence holes on the trunks of both white gum and blue gum points to a fauna of Cerambycidae or long-horned beetles.

Subcortical feeders. *Chalcopteroides columbinus* lives under the peeling bark of *Eucalyptus viminalis*. This is an uncommon beetle in Tasmania, although the genus has many species on the mainland.

Butterflies

The butterfly fauna of the Domain is smaller than expected for a typical woodland habitat in south eastern Tasmania. Six native species and an exotic were recorded. Two skipper butterflies, the white grass dart *Taractrocera papyria* and the yellow banded dart *Ocybadistes walkeri*, are common in late summer in open grassy areas. The Meadow Argus *Junonia villida* is ubiquitous in areas where *Plantago* is present. Three species of "browns" occur on the Domain: Klug's Xenica *Geitoneura klugii*, the Shouldered Brown *Heteronympha penelope*, and the Common Brown *Heteronympha merope*. All feed on native grasses as larvae, especially kangaroo grass. Despite ample supplies of its foodplant *Poa*, the silver xenica *Oreixenica lathoniella* is absent. The Cabbage White *Pieris rapae* is an introduced species of European origin present in the Hobart area since about 1940.

The absence or rarity of certain key foodplant explains some of the absences, such as *Gahnia*-dependent *Hesperilla* and *Antipodia*, but others are less apparent.

Another notable absence is the *Lomandra*-feeding *Trapezites luteus* which otherwise occurs on Knocklofty, Mt Nelson and the eastern shore of the Derwent River. The small patch of *Gahnia radula* on the Domain appears not to support any butterflies.

Seasonality in activity is strongly marked in the butterfly fauna and further collecting in early summer is recommended to further validate and extend the conclusions drawn here.

Moths

An interesting and varied moth fauna survives on the Domain. It is dominated by grass-feeding and litter-feeding species, but also contains specialist feeders on *Allocasuarina*, *Acacia*, *Eucalyptus*, *Ozothamnus*, and other genera. A list of recorded species appears in Appendix 1. The small geometrid *Scopula rubraria* is very common. Their larvae are associated with *Plantago*. However, the very rare geometrid *Lackrana carbo* is only known from the Domain and from Walkers Lookout on Flinders Island. Nothing is known of its lifecycle or foodplant needs. Noteworthy is the apparent absence of some moths characteristic of *Allocasuarina* forest such as *Catoryctis* and *Rhynchopsota.*

Ants

The Domain ant fauna exhibits a profile of genera characteristic of a grassy woodland. Several are important as dispersers of the seeds of native plants. Three species of *Myrmecia* are present including the uncommon endemic *M. esuriens*. Seed-harvesting ants of the genus *Pheidole* are represented by at least four species. *Anonychomyrma* trails up the trunks of large *E. viminalis* and is strongly dependent on honeydew resources from psyllids in the canopy foliage. It is also an important disperser of eucalypt seeds (Bashford 1993). The nocturnal ant fauna is dominated by *Camponotus consobrinus,* a large orange and brown ant common on tree trunks. The absence of species of *Polyrachis* from the samples may reflect the relative shortage of woody debris in which these ants establish their nests. No inquilines (invertebrates which live in ants nests) apart from springtails (?*Sinella* sp.) were found.

Wasps

The large metallic "blue ant" *Diamma bicolor*, a parasite of mole crickets, was collected in the open grassy woodland. Large orange ichneumonids of the genus *Netelia,* parasites of caterpillars, were collected in all the light traps.

Mutualisms: pollinating insects and plants

The following native plants which have been recorded from the Domain rely completely or partly on native bees for outcrossing: *Diuris sulphurea, Carpobrotus rossii*, some Asteraceae, *Wahlenbergia gracilis, W. quadrifida, Aotus ericoides, Bossiaea prostrata, Dillwynia cinerascens, Pultenaea juniperina, Pultenaea pedunculata, Goodenia lanata, Goodenia ovata*, some *Acacia,* *Eucalyptus* spp., *Myoporum insulare, Bursaria spinosa, Stylidium graminifolium, Viola hederacea.*

Various native bees rely on undisturbed patches of bare soil or clay banks as nesting sites. Others excavate nests in pith stems or occupy abandoned borer holes in dead wood. The identification and maintenance of such breeding sites is therefore essential to guarantee adequate population levels of native pollinators. Unfortunately, most native bee-plant mutualisms in Australia have been disrupted by introduced honeybees, leading to changes in gene flow patterns and possibly rates of seed set. Given that honeybees can forage for nectar and pollen over several kilometres there is little to be gained by actively destroying feral hives on the Domain. However, tree hollows occupied by hives are precluded from use as nesting sites for birds. No feral hives were observed on the Domain during this study but honey bees were abundant.

Key nectar plants on the Domain which are exploited by insects include *Bursaria spinosa, Eucalyptus* species and *Pimelea* species.

IMPLICATIONS FOR MANAGEMENT

The conservation of the insect fauna on the Domain is strongly tied in the first instance to the ongoing conservation of the native plants. Therefore most measures which secure the ongoing survival of the flora will generally be beneficial to the fauna. Invasion by weeds presents a serious threat by displacing native foodplants and smothering habitat. Nevertheless, some native insects are actually advantaged by introduced herbaceous species: *Plantago lanceolata* is utilised by many species formerly dependent only on the native *Plantago varia.* Hence the butterfly *Junonia villida,* the moth *Scopula rubraria* and the dominant grasshopper *Phaulacridium vittatum* flourish.

Predators and competitors include European wasps, honey bees, starlings and blackbirds, although their impacts are not well understood.

The disturbance regime is critical in providing opportunities for certain insects. Important factors here are mowing, trampling, fire and pesticides.

Mowing

Mowing helps maintain a distinctive blend of grasses and herbs which favour certain species. Many of the native grasshopper species prefer to feed on herbaceous dicots and are disadvantaged by tall grass that is allowed to become rank. However, too frequent mowing may favour more prostrate introduced species (such as *Plantago lanceolata*) and also make insects more vulnerable to bird predation through removal of protective cover. Heavy vehicular traffic on wet soils in late summer and autumn is deleterious because it crushes the egg masses of grasshoppers which are buried just below the soil surface.

Fire

There is considerable adaptation to fire in the invertebrate faunas of woodlands in southern Australia. Many grassland insects tolerate fire because their most vulnerable life cycle stages are subterranean. Examples include most ants and moths such as *Hednota, Oncopera* and *Fraus*. A separate strategy involves having sufficient mobility to escape from a fire front and take refuge in adjacent habitat. Detrimental impacts on some insects are likely in the event that untimely fires destroy the nectar resource provided by flowering herbaceus plants in the spring and early summer. Recolonisation of burnt areas from surrounding habitat is an important mechanism in the rehabilitation of woodland faunas. Given the isolation of the Domain from similar habitat, recolonisation would be difficult in the event of an extensive fire.

Re-establishment of habitat

There is a need to establish further habitat for some invertebrates with specialised needs. Logs and similar woody debris in contact with the soil are extremely important for species such as stag beetles, tenebrionid beetles, some spiders and flat worms. This resource has been depleted due to frequent fires and lack of recruitment of new logs from recently dead trees due to their removal by council workers. Scavanging for firewood is also a problem in many near urban areas.

Deep litter is scarce in the Domain but is important as a food resource for moths of the family Oecophoridae which are very diverse at the species level in Tasmania (*ca* 250 species). The litter mat which characteristically accumulates under *Allocasuarina* is a unique invertebrate habitat, rich in scorpions, which is threatened by too frequent burning.

ACKNOWLEDGEMENTS

Karyl Michaels undertook the pitfall trapping. Greg Blake assisted with the ant identifications. The work was undertaken for the Hobart City Council as part of the preparation of a management plan.

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Appendix 1. List of insects recorded on the domain during January-March 1995.
(e) indicates an endemic species

Coleoptera (Beetles)
Carabidae
Promecoderus cf *ovicollis*
Curculionidae
Mandalotus
Lucanidae
Lissotes obtusatus (Westwood)
Lissotes basilaris Deyrolle (e)
Syndesus cornutus Fabricius
Scarabaeidae
Heteronyx sp.
Phyllotocus bimaculatus Erickson
Scitala sericans Erickson
Tenebrionidae
Celibe costatus (Solier)
Lagria grandis Gyllenhal

Hymenoptera (Wasps and Ants)
Formicidae
Anonychomyrma biconvexa (Santschi)
Camponotus claripes Mayr
Camponotus consobrinus (Erichson)
Camponotus gasseri (Forel)
Iridomyrmex bicknelli Emery
Iridomyrmex sp. 1
Myrmecia esuriens Fabricius (e)
Myrmecia forficata (Fabricius)
Myrmecia pilosula F. Smith
Ochtellius punctatissimus Emery
Pheidole spp. (5 species)
Ponerinae undet.
Rhytidoponera tasmaniensis Emery
Rhytidoponera victoriae (Andre)

Lepidoptera (Butterflies and Moths)
Carposinidae
Bondia nigella Newman
Geometridae
Epyaxa subidaria (Guenee)
Lackrana carbo McQuillan (e)
Scopula rubraria (Doubleday)
Hesperiidae
Taractrocera papyria (Boisduval)
Ocybadistes walkeri Heron
Lasiocampidae
Entometa marginata Walker
Noctuidae
Persectania ewingii (Westwood)
Nolidae
Uraba lugens Walker
Nymphalidae
Junonia villida (Fabricius)
Geitoneura klugii (Guerin-Meneville)
Heteronympha penelope Waterhouse
Heteronympha merope (Fabricius)
Oecophoridae
Eulechria episema Meyrick
Garrha ocellifera (Meyrick)
Garrha sp.
Heteroteucha ophthalmica (Meyrick)
Ocystola crystallina Meyrick
Syringoseca mimica (Meyrick)
Tortricopsis euryphanella (Meyrick)
Zacorus cara Butler
Pieridae
Pieris rapae (Linnaeus)
Psychidae
Narycia sp.
Pyralidae
Hednota pedionoma (Meyrick)
Hednota relatalis Walker
Metasia sp.
Thaumetopoeidae
Epicoma contristis Hubner

Mantodea (Mantids)

Mantidae
Paraoxypilus tasmaniensis Saussure
Tenodera australasiae (Leach)

Orthoptera (Crickets and Grasshoppers)
Acrididae
Austroicetes vulgaris (Sjostedt)
Gastrimargus musicus (Fabricius)
Goniaea australasiae (Leach)
Macrotona australis (Walker)
Phaulacridium vittatum (Sjostedt)
Tasmaniacris tasmaniensis (Bolivar) (e)
Gryllidae
Balamara albovittata (Chopard)
Bobilla sp. (e)
Teleogryllus commodus (Walker)
Gryllotalpidae
Gryllotalpa australis Erichson
Rhaphidophoridae
Parvotettix sp. (e)

The Tasmanian Naturalist (1997) **119:**10-22.

NATIVE LAND SNAILS OF KING ISLAND AND THE HUNTER GROUP

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Abstract. This paper documents recent surveys of the native land snails of the major islands of western Bass Strait. Thirteen species were recorded from King Island. Three of these species have not previously been found in Tasmania, a further three species are new records for the island and the Tasmanian population of *Austrochloritis victoriae* (Cox, 1868) was rediscovered. Eleven species were recorded from the previously unsurveyed Hunter Group, including the rare species *Tasmaphena lamproides* (Cox, 1868) on Three Hummock Island. While the King Island fauna has many connections to south-eastern Victoria, the fauna of the Hunter Group is a depleted subset of the north-western Tasmanian fauna. The conservation status of several species is discussed.

INTRODUCTION

Although the Furneaux Group and northern Bass Strait islands have been adequately surveyed for land snails, the islands of western Bass Strait have historically received little attention. Smith and Kershaw (1981) gave mapped records for only eight King Island species, of which one (*Austrochloritis victoriae*) was classified as extinct in Tasmania by the Invertebrate Advisory Committee (1994) on the basis of lack of recent records and evidence of disappearance from the original locality. After these surveys, a prior specimen of a ninth species, *Paralaoma caputspinulae*, was found in the Tasmanian Museum collections. In the case of the Hunter Group islands, Smith and Kershaw gave no records, although *Pernagera officeri* specimens collected by Bob Green from the minor island Albatross Island are held in the Tasmanian Museum's collections. *Magilaoma penolensis* specimens labelled by W.F. Petterd and probably from Hunter Island (as Barren Island) are also held in the Museum's collection.

The surveys documented in this paper were conducted with the aims of rectifying the lack of knowledge of the western Bass Strait snail fauna, clarifying the status of various threatened and rare species, and contributing to biogeographical understanding of the region.

METHODS

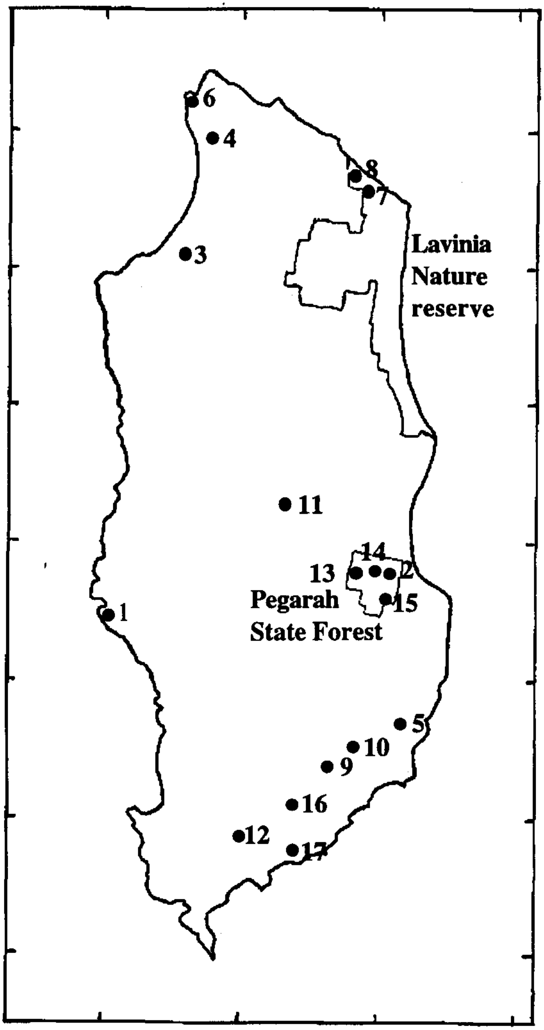

Fig. 1. Location of sample sites on King Island

Owing chiefly to constraints of time and transport, the King Island survey, conducted between 10 and 17 December 1996, was unsystematic. A number of sites were searched by the author on a free-ranging, variable-time basis, with variable numbers of assistants, the aim being to record as many species as possible and achieve a reasonable coverage of the island. Five sites (1,3,4,6,17) were foreshore or dune shrubbery sites, nine (2,5,9,10,11,12,13,14,15) were wet eucalypt forest sites with understoreys including some of *Acacia melanoxylon, Olearia, Pomaderris, Hedicarya, Eleocarpus, Cyathea* and *Dicksonia* and three sites (7,8,16) consisted of medium-height eucalypt/tea-tree scrub. Most sites were searched for at least thirty minutes, with one (site 5) being searched for about two hours. A further nine sites in severely degraded areas were briefly searched with no native snails being found and locations of these are not included in Fig. 1.

The Hunter Group survey was conducted solely by the author on a semi-quantitative basis. Twenty-five sites were sampled over Three Hummock, Robbins and Hunter Islands. Sites of radius fifty metres were searched incompletely for a maximum of one hour, but were abandoned after forty minutes if there was no serious likelihood of finding more species. Foreshore and dune scrub sites (H3,H6,H7,T1,T5,T6,R1,R8) accounted for eight sites. Only four wet eucalypt forest sites were sampled (H2,T4,T6,T9) as this is not a major habitat type in the Hunter Group, but two sites (R6,R7) featured unusual *Leptospermum/Dicksonia* scrub. The remaining eleven sites included a range of drier eucalypt forest (H4,H5,T2,T8,R2,R3,R4), *Leptospermum* scrubs (H1,T3), and *Leptospermum/ Acacia* "swamp forests" (H8,R5) (Fig. 2). It was not possible to achieve a thorough geographic coverage of Hunter or Robbins Islands.

In both surveys all major vegetation types likely to yield native snails were sampled.

RESULTS

The number of each species seen (alive and dead combined) are not a fully reliable indicator of the relative frequency of species for two reasons. Firstly, sampling often specifically targeted distinctive habitats. Secondly, species differed in the extent to which their presence would be detected from a dead shell. Thus *Cystopelta*, being a slug, is nearly always found alive whereas with *Helicarion, Tasmaphena* and *Flammulops* over 85% of specimens were based on dead shells. Thus *Cystopelta* appears less common than it probably is. An important specimen of *Austrochloritis victoriae* (site 2) was a damaged dead shell and appeared to have been predated by a bird, suggesting that the species may not occur in the direct surrounds of the site.

King Island

Numbers of each species at each site are given in Table1. Species recorded were as follows:

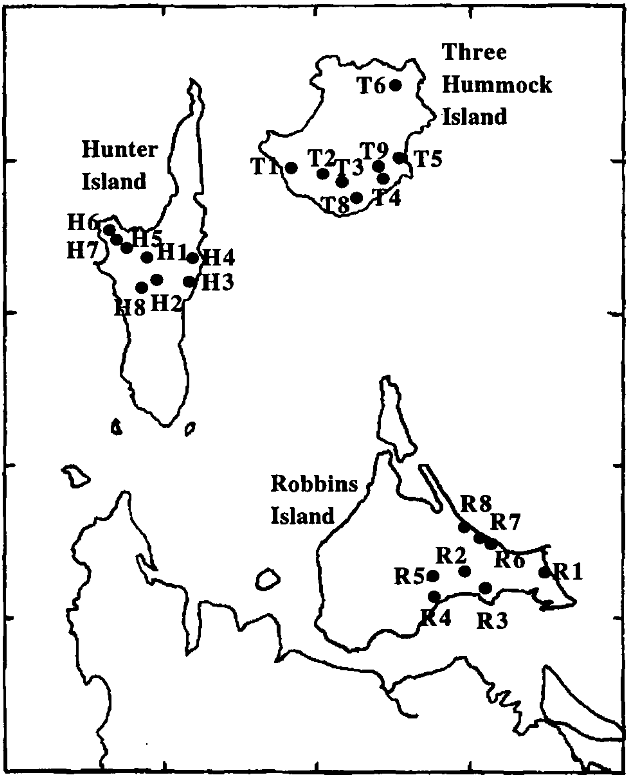

Fig. 2. Location of sample sites in the Hunter group.

Succineidae
    Succinea australis (Ferussac, 1821)
Rhytididae
    Austrorhytida sp. (Undescribed) *#
    Prolesophanta dyeri (Petterd, 1879) Rhytididae
Punctidae
    Paralaoma caputspinulae (Reeve, 1854)
    Laomavix collisi (Brazier, 1877) *
    Magilaoma penolensis (Cox, 1868)

Table 1. Numbers of each species found at sites on King Island.
Species codes are derived from the first letter of the genus and species. See list in text.

Site	GridRef.	Species													No of	Total
		Sa	Ar	Pdy	Pc	Lc	Mp	Al	Po	Pdn	Fe	Cp	Hc	Av	species	
1	23045752	3			5	1	32		25						5	66
2	25115781		2					29	1	21		1	2	1	7	57
3	23826026								2						1	2
4	23806090	3			1	37	8		1						4	49
5	25245673		3				3	10		11		12	8		7	48
6	23726133	1					78		11						3	90
7	24916060		1					2						16	3	19
8	24816068			2		4	4	1	8					3	6	22
9	24565636		3					5		2	6	21			5	37
10	24855655							2				1			2	3
11	24325822							1	2			2			3	5
12	23875592		2				3	4	1			2	1		6	13
13	24795782			1			2	11		1		1			5	16
14	24905785		1	1				2		2		2			5	8
15	25085770							8		6		2			3	16
16	24335596		1	1							21	1			4	24
17	24385573				3	6	12		133						4	154
No. of sites present		3	7	4	3	4	8	11	9	6	2	10	3	3		
Total number		7	13	5	9	48	142	75	184	43	27	45	11	20		628

Charopidae

Allocharopa cf. *legrandi* (Cox, 1868) *

Pernagera officeri (Legrand, 1871)

Pillomena cf. *dandenongensis* (Petterd, 1879) *#

Flammulops cf. *excelsior* (Hedley, 1896) *#

Cystopeltidae

Cystopelta cf. *petterdi* Tate, 1881*

Helicarionidae

Helicarion cf. *cuvieri* Ferussac, 1821

Camaenidae

Austrochloritis victoriae (Cox, 1868)

*indicates species not previously recorded on the island

# indicates species not previously recorded from Tasmanian territory.

Three records given by Smith and Kershaw, namely *Tasmaphena ruga*, *Pedicamista coesa* and *Stenacapha hamiltoni*, were not confirmed. The first is very probably due to the shell of earlier specimens of *Austrorhytida* superficially resembling *T. ruga* but they are more inflated. The animal of *Austrorhytida*, which has a prominent yellow median stripe and a more streamlined, "thin" appearance, is very distinctive even in the field. The *Stenacapha* record is a puzzle as this species should be quite common if present but nothing resembling it was seen. This record may have resulted from an attempt to "shoe-horn" a specimen of any of four or five of the other species, or else a simple locality error. Concerning *Pedicamista*, some past records of this species have proved to be less rugose, unkeeled populations of *Magilaoma* and exactly what forms (if any) are distinct from *Magilaoma* is unclear. Furthermore *Flammulops* may have been misidentified as *Pedicamista* in the past.

A number of the populations found on King Island show slight differences from the species as described. In the case of *Helicarion*, no live animals were seen in this survey. On this basis several of the identifications given are tentative, especially as the other results do not justify complete confidence in the allocation of Tasmanian species names. It is likely that the *Austrorhytida* species found will prove to be a form also present in Victoria, but those Victorian forms not conforming to *A. capillacea* (Ferussac, 1832) remain undescribed. Furthermore there is no usable synonym with a type locality outside New South Wales (see Smith 1992). The King Island specimens are about half the size of typical *A. capillacea* and show slight differences in shell sculpture, morphology and colour pattern, and are therefore treated tentatively as undescribed. It is not even clear how many species exist (Brian Smith *pers.comm.*) In the case of *Pillomena dandenongensis*, there are definite differences between the King Island specimens and those from the Dandenongs, which are much more concave, but this is probably not significant at species level.

Pernagera officeri specimens at site 6 (Cape Wickham) are about 30% larger in most dimensions than those from site 1 (Currie) and site 17 (Colliers Beach), despite having about the same number of whorls. The significance of variation in *Pernagera* is currently being reviewed by the author.

Hunter Group

Native land snails were found at all sites searched (Table 2). Species are as follows:

Rhytididae

Tasmaphena lamproides (Cox, 1868)
Prolesophanta dyeri (Petterd, 1879)

Punctidae

Paralaoma caputspinulae (Reeve, 1854)
Laomavix collisi (Brazier, 1877)
Trocholaoma parvissimia (Legrand, 1871)
Magilaoma penolensis (Cox, 1868)

Charopidae

Allocharopa legrandi (Cox, 1868)
Pernagera officeri (Legrand, 1871)
Thryasona diemenensis (Cox, 1868)
Stenacapha hamiltoni (Cox, 1868)

Helicarionidae

Helicarion cuvieri Ferussac, 1821

Specimens of *Tasmaphena lamproides* were smaller than those from the Togari forestry block on the north-western mainland (adult shells were c.17 mm wide compared with c.21mm) and were generally a darker red colour. *Stenacapha* specimens were extremely small on Hunter and Three Hummock Islands (adult shell width 7-8 mm, although a small number on Three Hummock were closer to 11mm) and moderately small on Robbins Island (11-14 mm) compared to adults on the adjacent mainland, which can reach at least 22 mm (author's records). The genus is awaiting revision and it is possible that forms such as these stunted Hunter Group forms may prove to be distinct.

DISCUSSION

Biogeography

The break between the north-western Tasmanian mainland and the Hunter Group is highly significant for land snails. Only eleven species were found in the group, compared to twenty-three from the "adjacent mainland", defined as the area north of the Bass Highway between Stanley and Marrawah. Although some of these absences are explained by habitat differences, several (including those of *Caryodes dufresnii*, *Victaphanta milligani* and *Cystopelta bicolor*) can only be treated as genuine biogeographical breaks, whether due to "island effects" or otherwise.

Table 2. Numbers of each species found at sites on the Hunter group. Species codes are derived from the first letter of the genus and species. See list in text. For sites H = Hunter Island, T = Three Hummock Island and R = Robbins Island.

Site	Grid Ref.						Species						No.	Total
		Tl	Pd	Pc	Lc	Tp	Mp	Al	Po	Td	Sh	Hc	spp.	
H1	30965117			6	13		1				8	1	5	29
H2	31025107				37		2	3			2	4	5	48
H3	31135110				9		11	2	18				4	40
H4	31205122											5	1	5
H5	30865123				1		1		11			3	4	16
H6	30715158			2	12		4		12			2	5	32
H7	30735148			2	23		2		4				4	31
H8	30935101										5	2	2	7
H(All)				10	95		21	5	45		15	17	7	208
T1	31805192				12		3		23				3	38
T2	31955190			2							17	23	3	42
T3	32005183							2			13	4	3	19
T4	32185174	5								53	12	6	4	76
T5	32585197			27			3		4				3	34
T6	32525242	1			6							3	3	10
T7	31965221						2		47		1	2	4	52
T8	32145170										34	7	2	41
T9	32185178	14						1		8	17	22	5	62
T(All)		20		29	18		8	3	74	61	95	66	9	374
R1	33534925				4								1	4
R2	33114921										27		1	27
R3	33164912			1	2						21		3	24
R4	32784910								2		16		2	18
R5	33034930										23		1	23
R6	33284941		1					2			17		3	20
R7	33194945					3		2			12		3	17
R8	33104952				3		1						2	4
R(All)			1	1	9	3	1	4	2		116		8	137
No. of sites		3	1	6	11	1	10	6	8	2	15	13		
Total number		20	1	40	122	3	30	12	121	61	226	83	719	

Smaller numbers of species are to be expected on smaller islands (McArthur and Wilson 1967).

Of the eleven species present in the Hunter Group, five have trans-Bassian ranges including most of the Tasmanian mainland, King and Flinders Islands and at least southern Victoria. Another trans-Bassian species, *Trocholaoma parvissimia,* is absent from King Island but believed to be present on Flinders. Two (*Helicarion cuvieri* and *Allocharopa legrandi*) are statewide including King and Flinders Islands but are endemic, while two more (*Thryasona diemenensis* and *Stenacapha hamiltoni*) are statewide and endemic excepting King Island. The final species, *Tasmaphena lamproides* (discussed in Bonham and Taylor 1997) has a curious distribution, including wet forests roughly northwest of a line from Smithton to the junction of the Arthur and Frankland Rivers, as well as Wilsons Promontory (Victoria) and now Three Hummock Island, where it occurs in what little wet forest exists on the slopes of South Hummock and North Hummock. Four shell fragments found in dunes at GR 3188 5193, near Granite Hill, indicate that it was once present elsewhere on the island. There appeared to be no suitable habitat for the species on Hunter Island, and although some sites on Robbins Island appeared suitable, the species was not found there and is presumably not present on Robbins Island in significant numbers.

The link between south-eastern Victoria and western Bass Strait is demonstrated more strongly on King Island. As well as the seven species in common with the Hunter Group, and the trans-Bassian marsh snail *Succinea australis,* which was absent from the Hunter Group survey, King Island has an unusual *Cystopelta* population and four species otherwise absent from Tasmania. In the case of *Cystopelta,* the grey colour and flattish profile of the King Island specimens immediately attracts attention. Although *Cystopelta* specimens in Tasmania have not yet been subject to conclusive genetic analysis, populations are divided between essentially "grey" north-eastern and essentially "brown/green" western forms, assigned to *C. petterdi* and *C. bicolor* respectively. The close north coast boundary between them is just west of Burnie (Bob Mesibov *pers comm*) and one might thus expect *C. bicolor* to be present on King Island. If the grey forms present in north-eastern Tasmania, on King and Flinders Islands and in southern Victoria are all *C. petterdi,* then this would suggest *C. bicolor* evolved from *C. petterdi* to adapt to western Tasmanian conditions.

The four Victorian/King Island species are biogeographically interesting because, like *Tasmaphena lamproides,* they have close connections to south-eastern Victoria, although the affinity of the undescribed *Austrorhytida* is yet to be determined. *Austrochloritis victoriae* is widespread in Victoria "south of the Great Divide" (Smith and Kershaw 1979) but the specimens collected from King Island more closely resemble the larger Wilsons Promontory forms than those from the Otway Ranges (Brian Smith *pers. comm.*). *Pillomena dandenongensis* is chiefly a Great Divide species which extends little further west than Melbourne. Most remarkably *Flammulops excelsior* extends well into southern New South Wales and, in Victoria, extends only as far south as the East Gippsland area (Brian Smith *pers. comm.*; Smith and Kershaw 1979). To further complicate matters, the King Island population seems to be confined to the south of the island, and on the Victorian mainland, two possibly related species occur in the "gap". However these species, *mccoyi* and *transluscens*, may well belong to a different genus (Brian Smith *pers. comm.*, based on work in progress).

The comparison between the King Island fauna and the Furneaux Group fauna is highly significant in that the latter lacks the strong Victorian connection. The Furneaux Group was much more frequently visited by early collectors, and Petterd (1879) records several species. Subsequently Flinders Island has been sampled by Ron Kershaw in the early 1970s, myself in 1987 and Rob Taylor in 1994. At least fourteen species are known from Flinders Island. The lesser Furneaux islands, and the islands of the Kent, Hogan and Curtis groups in northern Bass Strait, have also been well sampled, although Clarke and Cape Barren Islands have not received attention in proportion to their size. In place of the distinctive King Island Victorian fauna of *Flammulops, Pillomena, Austrorhytida,* and *Austrochloritis*, the eastern Bass Strait islands include two local endemics (*Letomola barrenense* (Petterd, 1879) and an undescribed rhytidid *Tasmaphena* sp. which is also known from the Kent Group) as well as one near-endemic (a *Prolesophanta* sp. which has been found twice on the north-eastern Tasmanian mainland) and the large Tasmanian charopids *Stenacapha* and *Thryasona*. The sole Victorian species in the Furneaux Group and believed to be absent from the Tasmanian mainland is *Tornatellinops jacksonensis* (Cox, 1864). This species has also been recorded on Preservation Island (Smith and Kershaw 1981).

The average site diversity of native snails on all four islands surveyed is low: 4.29 for King, 3.75 for Hunter, 3.33 for Three Hummock and 2.00 for Robbins. Only in the case of Hunter Island is this explained adequately by the low snail diversity on the island as a whole. On both King and Three Hummock Islands there is a high degree of habitat specialisation by the species present; on King this even assumes geographical significance with *Austrochloritis* in the north-east and *Flammulops* in the south-east occupying similar habitats. On Robbins Island, habitats apparently capable of sustaining good diversity are instead totally dominated by *Stenacapha*. This may be due to past habitat modification.

Conservation status and further research

Tasmaphena lamproides has been the focus of conservation research funded by Forestry Tasmania (Bonham and Taylor 1997). It is listed by the Invertebrate Advisory Committee (1994) as Rare (non-susceptible) due to small range (c. 25 000 ha), low population density (c. 10 live adults / ha), inadequate reservation and concerns about habitat security. The findingof this species on Three Hummock Island is difficult to interpret as the three sites included twenty specimens (five at T4, one at T6 and fourteen at T9) but only two were live, both adult, one each at T4 and

T6. The find of fourteen dead specimens at T9 probably indicates good preservation conditions rather than large populations (past or present) as the specimens were of varying growth stages and conditions. Presumably the species is confined on Three Hummock to areas of wet sclerophyll forest, of which there is at most a few hundred hectares. The main significance of this population is that it is reserved, as the total formally reserved habitat for this species may be as little as 2000 ha. This find definitely does not justify a change in the status of this species.

The four Victorian species present on King Island are potentially of great conservation significance and some may be listed as rare or vulnerable within Tasmania in future because of their very small area of occupancy within Tasmanian territory. Although this may seem to be a curious result of listing by political rather than biogeographical boundaries, the King Island populations are so disjunct as to be very valuable for biogeographical and ecological studies, quite aside from any possibility that they are genetically distinct.

Austrochloritis victoriae was listed as Extinct on the basis of lack of recent records and failed searches in the type locality of *Helix brunonia* (Johnston, 1887), which is the King Island synonym of *victoriae.* The type locality was given as "The Springs, Cape Wickham, King Island" and Petterd and Hedley (1909) stated "... so far it is only recorded from the locality stated." and noted it was present "...in moist places in tea-tree scrub." It is known that unsuccessful searches have been conducted in the general area (Ron Kershaw *pers. comm.*) although whether the original site was near the Cape Wickham light, on the coast at the Springs property or, more likely, in the tea-tree scrub at the Springs entrance near Lake Flanigan, is not clear. It is not even clear whether there had been confirmed finds since the original collection. In any case, I did not find the species at any of these areas and it appears that habitat degradation of various forms (including by the super-abundant introduced helicid snail *Theba pisana*) has eradicated it. Nevertheless, there was no reason to assume it would not be present elsewhere on the island, and this survey did find it alive at site 7, in dense *Leptospermum lanigerum/Banksia marginata* scrub behind Pennys Lagoon. Both live and dead specimens were loosely clustered around dense twig piles and large logs, especially rotting fallen tree trunks. The species also occurred in quite different scrub at the adjacent Lake Martha Lavinia, and a single bird-dropped shell was found at Raffertys Creek. This suggests that it is probably widespread on the comparatively remote eastern coast of King Island. More research is required to clarify its area of occupancy, reliability and habitat tolerance, but it is likely that it is widespread and fairly secure in Lavinia Nature Reserve, if it has not been permanently affected by recent fires in parts of the area (George Cunningham *pers. comm.*).

Flammulops excelsior is probably the rarest of the four otherwise Victorian species on King Island. It was found only at two sites, a small (c. 20 ha) State Forest block at Gentle Annie and private land on Red Hut Road. It may be present extensively in the area around Grassy but this could not be confirmed due to problems with access. It may also extend through Colliers Swamp. Whatever the case, its range on King Island is probably very small. Moreover, only one specimen out of the 27 found was live. Although the species was abundant in the bark at the bases of eucalypts at site 16 (Red Hut Road), all 21 specimens thus found were dead, and nearly all adult. Whether this indicates a cryptic nature, arboreality, disease or weather-related dieoff is not clear. It is likely that this species has no reserved population on Tasmanian territory, and in view of both its scarcity and the geographic and taxonomic value of the population, further surveys for this species on King Island is a high priority.

Pillomena dandenongensis also did not occur in a reserve, being found consistently in the Pegarah State Forest sites, where it is common, and also in the Gentle Annie State Forest block and on private land at Yarra Creek. It is likely to occur in remnant vegetation along other creeks in the area between Naracoopa and Grassy, and probably has a much wider distribution than the *Flammulops* population. The population is likely to depend on sympathetic management in the Pegarah Block (eg. maintenance of adequate streamside reserves) for its long-term security on the island. The species was probably very common in the now virtually-destroyed rainforest habitats of the south-east.

The species which appears most secure of the four is *Austrorhytida*, which was found at several sites covering much of the island and in a good range of habitats. Although it was not found in high numbers, the species is likely to be widely present through the Lavinia Nature Reserve, as well as in State Forest and on various private blocks.

ACKNOWLEDGEMENTS

King Island: Tasmanian Museum and Art Gallery (transport expenses); Don Hird, John Ashworth and the Forster/Wilkins family (transport, collecting and other assistance); Graeme Batey and Len Sullivan (property access and information); George Cunningham (information).

Hunter Group. Threatened Species Unit, Parks and Wildlife Service (expenses); Hammond family (property access and accommodation); Robert Hutton and Brett Guest (transport and accommodation); Rob Alliston (logistic assistance and information); Peter Brown and Sally Bryant (organisation); Parks, Arthur River (accommodation); Heather Innes (transport).

General thanks: Brian Smith, Queen Victoria Museum (equipment and information); Bob Mesibov and Ron Kershaw (information), Pru Bonham (equipment), Liz Turner and Roger Buttermore, Tasmanian Museum (museum assistance).

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The Tasmanian Naturalist (1997) **119:** 23-30.

NATURALISTS SHOULD CARRY MAPS

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"I saw a blue-winged parrot up the lakes a while back."

Not much of a bird report, is it? It says only that a blue-winged parrot was somewhere on the Central Plateau in the recent past. That might be information enough for some people, but a serious birdo will want to know more. '*A while back*' means when? '*Up the lakes*' means where? Which lake? Which road? What habitat?

Biological records aren't useful unless they're well pinned-down in time and space. Most naturalists have no trouble recording the day, month and year when they made a sighting or a collection. Locality information, alas, seems to be a different story. 'Great Lake', 'Bruny Island' and 'Mt Wellington' might have been acceptable locality descriptions 50 years ago, but not today. They're a lot better as descriptions than 'Van Diemens Land', which appears on specimen labels from the early 1800s, but they could be considerably more precise. For the past 20 years, the standard in Tasmania has been a map grid reference which specifies a locality as a square just 100 m on a side.

Now — hands up all those amateur naturalists (and off-duty professionals) who routinely record their localities as 100 m grid squares.

Not bad. OK, you folks can move on to another *Tasmanian Naturalist* article. The rest of you, PLEASE, keep reading.

Grid references are good for you

The biggest advantage in using grid references to specify a locality is that you can be precise without being wordy. You could say, '*Take the track up Flagstaff Hill from the big quarry up behind Flagstaff Gully, but don't go to the summit, instead keep going east, then a bit south along the top of the Meehan Range to the fork with the Stringy Bark Gully track, but don't go down the gully, keep going maybe half a kilometre along the ridge until you reach the second track going down towards the highway, then follow that track about 200 metres, then go right into the bush about 40 metres.*' Or you could say, '*EN320564*'.

Grid references also make it easier to plot distribution maps, either by hand or by computer. What's more, plotting with grid references allows the map to be more precise, and therefore more useful.

That last point isn't sufficiently appreciated by many naturalists. A birdwatcher, for example, might think, '*The birds I watch are highly mobile. What's the point of recording them from a particular 100 m square near Campbell Town, rather than just*

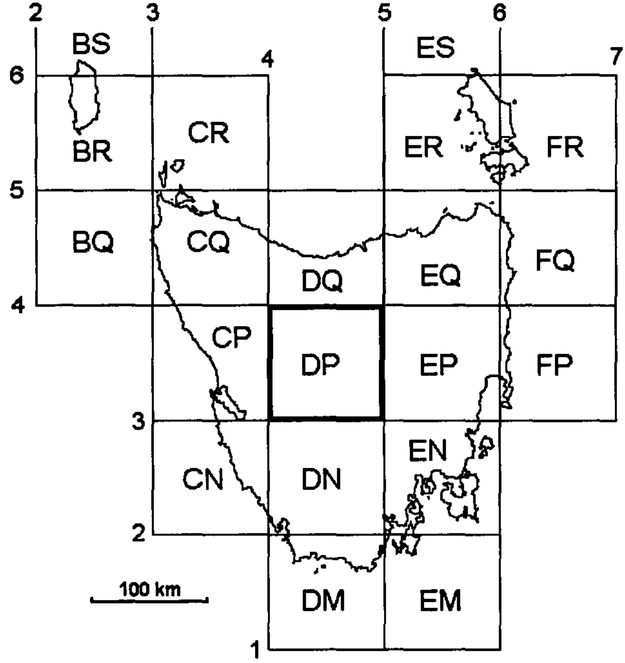

Fig. 1. Tasmania divided up into 100 km grid squares. The central 100 km square 'DP' can also be called '4 3'.

"Campbell Town"? The birds probably feed over several hectares every day.' True, but the 100 m squares visited by some species might contain most of the suitable habitat for those birds in the Campbell Town area. Habitat analysis these days is done by computer, using map-linked databases holding vast amounts of information about climate, topography and vegetation. At coarse spatial scales this information gets blurred. A single 10 km square in Tasmania might contain land at anything from 200 to 1200 m elevation with a wide range of aspects, parent geologies and vegetation types. The simple presence of a species in a particular 10 km square may not say very much about the habitat requirements of that species. A 100 m square record says a lot more.

A similar scale-dependence applies in range mapping. In northeast Tasmania, the endangered blind velvet worm has been recorded from six 10 km squares, a nominal range of 600 km^2. Analysis of 100 m square occurrences has recently shown that

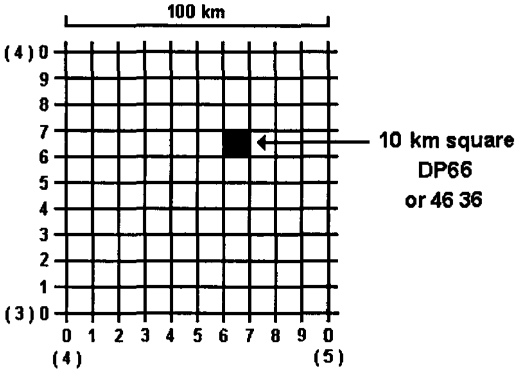

Fig. 2. The 100 km square DP divided into 10 km squares. The blackened 10 km square DP66 can also be called '46 36'. It's the left half of the 1:25 000 'Split Rock' sheet, whose TASMAP number, not surprisingly, is 4636.

the range of this species is actually less than 160 km^2, and that the well-occupied core of the range is less than 50 km^2.

Fine-scale locality records can always be generalised to coarse-scale records, but not vice versa. You can easily build up 10-minute square bird occurrences for the RAOU from 100 m square records, but you can't reconstruct 100 m square records from 10-minute square blobs on a map. To allow for a range of uses, both fine-scale and coarse-scale, natural history observations should always be tied to 100 m grid squares, which is done as follows.....

How to read grid references

Getting the grid reference for a locality is like plotting a point on an x-y graph, in reverse. We know where the point is on the map, and we want to find the point's x-y coordinates. On the map grid, unfortunately, the origin of the coordinates is a long way to Tasmania's southwest. In other words, the local 'y axis' is a long way west of Tasmania, and the local 'x axis' is a long way south.

To make plotting a point possible, the Tasmanian government mapmakers (TASMAP) have drawn on their maps a set of straight lines at 100 km intervals east and north from the origin (Fig. 1).

The vertical (north-south) lines are called '100 km eastings' and are numbered eastwards from the local origin. Tasmania lies between lines 2 and 7; in other words, Tasmania is between 200 and 700 km east of the local 'y axis'. The horizontal (east-west) lines are numbered northwards from the local origin and are called '100 km northings'. Most of Tasmania (for this exercise, let's ignore Macquarie Island and

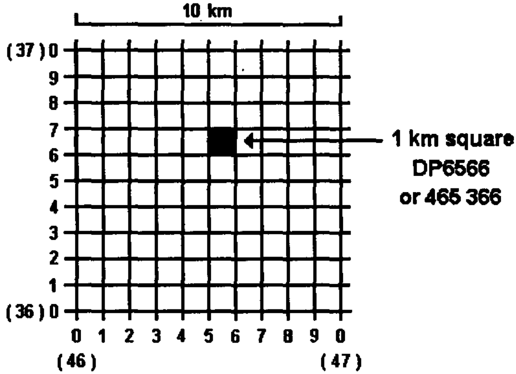

Fig. 3. The 10 km square DP66 divided into 1 km squares. The blackened 1 km square DP6566 can also be called '465 366'.

the near-Victoria islands) lies between lines 1 and 7, which is another way of saying that it's between 100 and 700 km north of the local 'x axis'. This procedure lays a grid of 100 km squares over Tasmania. As shown in Fig. 1, each of these squares has been given a two-letter code by the mapmakers. You can specify the 100 km square in the middle of Tasmania either by calling it 'DP' or by naming first the easting line on its left side and second the northing line on its bottom: '4 3'. The 'easting first, northing second' rule is easy to remember because it's geometrically the same as the 'x first, y second' rule you learned for graphs in primary school mathematics.

Within each 100 km square, the mapmakers have laid out and numbered lines at 10 km intervals. Once again, the origin of these coordinates is at the southwest corner of the square. The 10 km square blackened in Fig. 2 could either be specified as 'DP66' or as '46 36'.

Within each 10 km square, the TASMAP people have drawn and numbered lines at 1 km intervals. The 1 km square in Fig. 3 could be specified as 'DP6566' or '465 366'.

To avoid cluttering up the 1:100 000 and 1:25 000 TASMAPs, the mapmakers haven't drawn lines at 100 m intervals within 1 km squares. You can either estimate their positions by eye or use a ruler for a more accurate reading. The Ibbotts Rivulet bridge in Fig. 4 is within the 100 m square DP653663, or 4653 3663. Either of those is a grid reference for the bridge. 'DP653663' should be understood as '100 km square DP, easting within that square 653, northing within that square 663'.

Note that a grid reference always specifies a grid square within which the locality of interest occurs. It is not the intersection of easting and northing lines closest to

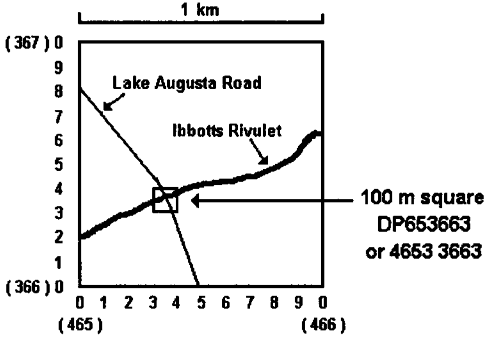

Fig. 4. Within the 1 km square DP6566, the Ibbotts Rivulet bridge is within the 100 m square DP653663, which can also be called '4653 3663'. In 13-digit form this becomes '465300 5366300'.

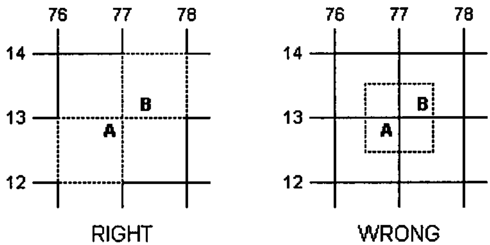

Fig. 5. The grid reference for **A** is 76 12 and for **B**, 77 13. The two localities are <u>not</u> both 'approximately 77 13'.

the locality (Fig. 5).

Some fine points

There is no 'correct' or universally accepted way to write grid references. TASMAP recommends the two-letter six-numeral form. At the bottom right-hand corner of every 1:25 000 and 1:100 000 map sheet there are very clear instructions from TASMAP on how to work these out. For data processing by computer, all-number grid references are preferred, but these can be easily generated from the two-letter six-numeral standard. Some government departments run programs which demand six-figure eastings and seven-figure northings for a grid reference. In these 13-figure monsters, the last two digits in the eastings and northings are for 10 m and 1 m gridlines. As you might expect, these are usually '00' in the databases, since very few people other than surveyors and GPS users can estimate position within 100 m squares. Those '00' bits are default entries and usually inaccurate; the locality of interest might really be something like 13 m east and 78 m north from the southwest corner of the 100 m square. For natural history recording, the two-letter six-numeral grid reference is perfectly adequate. It specifies a 100 m square in the Tasmanian landscape, and that's pinpointing as close as most applications will ever need.

It's a good idea to attach a few words, like the name of the nearest creek, to every grid reference you record. You may make a mistake in working out the grid reference, and an inconsistency between words and numbers will alert a data-user (or computer program) to a problem. In a recent analysis of locality records I carried out for the Australian Heritage Commission, I found that data contributors had misread their maps about once every 200 sites on average.

Some people record their map localities as coordinates of latitude and longitude, which is fine. The lat/long and grid reference systems are equally good for specifying position, and can be interconverted with computer programs. On TASMAPs, however, grid references are much easier to read than lat/long, especially since lat/long should be given as one-second squares. A one-minute square like 41°51'S 146°32'E covers something like 250 ha in central Tasmania. By today's standards, that's just not precise enough.

It often happens that a locality can't easily be squeezed into a 100 m square box, either because (a) the item to be recorded, such as a plant, was spread over several hectares; or (b) the item was observed somewhere between point A and point B, where A and B were several hundred metres apart; or (c) you were geographically embarrassed when you made your observation, and you only know roughly where the item was observed. What to do? For (a), write 'centred on [100 m square]' or '[100 m square] and nearby'. For (b), write 'from [100 m square for A] to [100 m square for B]'. For (c), record the 1 km square in which the item was observed. If your locality is truly vague, like 'somewhere on the Overland Track between Pelion and Lake St Clair', then take a deep breath and recite after me: *'Next time I'll carry a map because naturalists should know where they are when they notice things.'*

Finally, for those who own all the 1:100 000 TASMAPs for the State and swear by them, may I point out that it's an awful lot easier on the eyes and brain to get 100 m square grid references from the 1:25 000 map sheets (Fig. 6).

This is not an advertisement

It isn't necessary for the wide-ranging Tasmanian naturalist to buy a complete set of 1:25 000 TASMAPs, although a few selected sheets, covering the areas most frequently visited, would be a worthwhile investment. The maps are available at $9 each from the Land Information Bureau sales office in Hobart and from TASMAP agencies around the State.

You can own the same topographic information for less than a dollar by getting

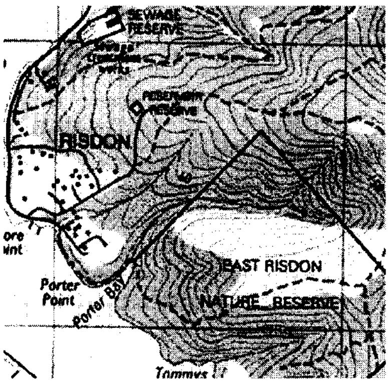

Fig. 6. The 1 km square EN2658 as depicted on the 1:100 000 (top) and 1:25 000 (bottom) TASMAPs. The squares are shown here at the same size; on the maps the bottom square is 16 times bigger than the top square.

black-and-white photocopies of relevant map sections from the public library or co-operating government agencies (try your local Forestry Tasmania office). Grid references can be read for free, of course, off map sheets borrowed for a few minutes (Forestry again...).

The other day my wife and I found a lizard on the East Coast. Not knowing much about lizards, but knowing that herpetology is a vigorously growing and data-hungry movement in Tasmania, we studied the appearance of the animal and took note of the location. On returning to Burnie we used State Library reference books to identify the lizard, then checked the 1:25 000 'Gray' TASMAP to pinpoint the locality. *'The other day my wife and I found a lizard on the East Coast'* has now been upgraded to:

> White's Skink, *Egernia whitei.* Full-grown, torpid. Under log next to logging road in regrowth ironbark forest *ca.* 20 years old. Connors Road, Chain of Lagoons; FP056892, 310m. 2 August 1997. T. Moule & R. Mesibov.

The key elements in this record are the lizard's name and the grid reference. For a whole range of purposes in Tasmanian natural history, both are essential.

The Tasmanian Naturalist (1997) **119**: 31-45.

VEGETATION COMMUNITIES AND VASCULAR PLANTS OF THE CATARACT GORGE RESERVE, LAUNCESTON

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Abstract. Six native vegetation communities occur in Cataract Gorge Reserve: she-oak forest, grassy woodland and forest, native grassland, wet eucalypt forest and woodland, riparian vegetation and wet gully scrub. Many of these communities are poorly reserved and are also of high significance at the regional level. 211 native vascular species have been recorded from the reserve in recent times and 119 exotic species have been found in areas where native vegetation predominates. The highest diversity of species occurs in grassy forest and woodland and the lowest diversity occurs in wet gully scrub. Twenty two native vascular species of Statewide conservation significance have been recorded from the reserve but two of these no longer appear to be present. Most of the significant species occur in grassy woodland or riparian scrub. Management of the vegetation of the reserve requires a monitoring program, attention to the requirements of the rare or threatened species, control of exotic plants, appropriate fire regimes and the suppport of neighbouring landowners.

INTRODUCTION

Less than 20% of the vegetation of the Northern Midlands is native or predominantly native (Fensham and Kirkpatrick 1989). Remaining areas of native vegetation, such as that occurring in Cataract Gorge and the adjacent Trevallyn State Recreation Area, are thus potentially very important for nature conservation. Both Cataract Gorge Reserve and Trevallyn State Recreation Area were selected as Recommended Areas for Protection (see Hickey and Brown 1991) to conserve lowland dry sclerophyll forest on dolerite.

This paper lists the plant communities and vascular species occurring in Cataract Gorge Reserve, identifies species and communities of conservation significance and discusses management issues related to their conservation. It deals mainly with the 85% of the reserve dominated by native vegetation and draws heavily on the previous surveys of Shearing (1993) and Ratkowsky and Ratkowsky (1994).

METHODS

Three days were spent in August/September 1995 surveying the reserve and some adjacent areas. Sampling covered all distinct vegetation types which could be identified from aerial photographs, and covered areas subject to a range of land uses and other environmental variables (e.g. aspect, slope, landform). Notes were made on vegetation composition and structure, environmental attributes and management issues (e.g. health of trees, shrubs and regeneration, presence of exotic species, fire history, effects of recreational and other land use). Much of the data were collected from 48 non-permanent plots, but additional information was recorded, where appropriate, between plot sites.

Throughout this report, vascular species nomenclature follows Buchanan (1995). Generally, scientific names are used in the text for native species, while common names are used for exotic species. Reservation and conservation status of vascular species has been assessed by reference to Kirkpatrick *et al.* (1991), Flora Advisory Committee (1994) and Duncan and Johnson (1995), augmented by other relevant information.

Classification of vegetation communities follows Duncan and Brown (1985) for dry sclerophyll forest and woodland, Kirkpatrick *et al.* (1988a) for grassland and grassy woodland and Kirkpatrick *et al.* (1995) for scrub. The reservation and conservation status of communities has been assessed by reference to Kirkpatrick *et al.* (1994), Duncan and Johnson (1995) and the report of the Joint Commonwealth-Tasmania Technical Group into the Interim Forest Assessment (IFA) process in Tasmania (Tasmanian Public Land Use Commission 1996).

RESULTS

Vegetation communities

Six distinct native plant communities or associations occur in the Cataract Gorge Reserve (Fig. 1). They are:

- She-oak forest (dominated by *Allocasuarina verticillata*).
  This community corresponds to inland *Allocasuarina verticillata* low forest (Duncan and Brown 1985). Sites with emergent *Eucalyptus viminalis* can also be ascribed to *Eucalyptus viminalis/Allocasuarina verticillata-Acacia mearnsii* grassy woodland (Kirkpatrick *et al.* 1988a).
- Grassy woodland and forest (dominated by *Eucalyptus viminalis* or *E. amygdalina*)
  The community corresponds to grassy *Eucalyptus amygdalina* dry sclerophyll forest/woodland or *Eucalyptus viminalis* dry sclerophyll forest/woodland (Duncan and Brown 1985), depending on which eucalypt is dominant. The community can also be ascribed to *Eucalyptus viminalis/Acaena echinata-Dichondra repens* grassy woodland (Kirkpatrick *et al.* 1988a).
- Native grassland
  The grasslands and grassy shrublands are best considered as a disturbance phase of the original forest or woodland community on the site.

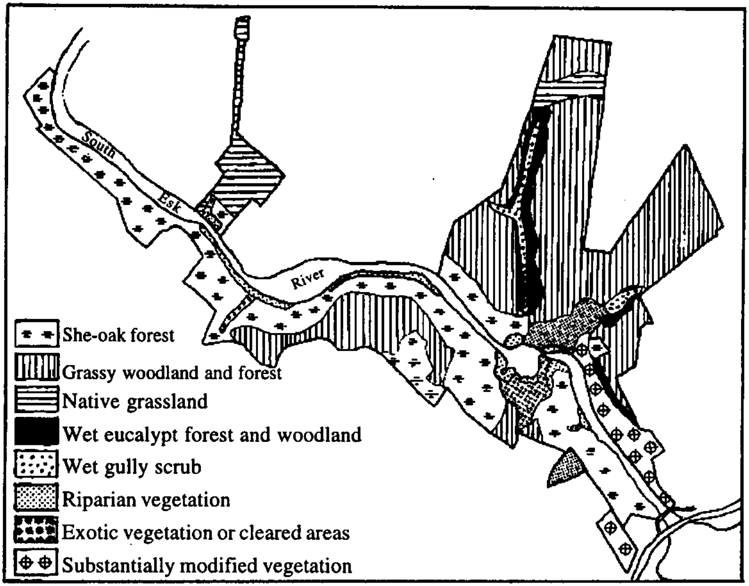

Fig. 1. Distribution of vegetation communities in Cataract Gorge Reserve.

- Wet eucalypt forest and woodland (dominated by *Eucalyptus viminalis*)
  Where the mesophytic shrubs are best developed, the community corresponds to *Eucalyptus viminalis-Acacia dealbata-Pomaderris apetala* wet sclerophyll forest (Kirkpatrick *et al.* 1988b).
- Riparian vegetation
  Riparian vegetation is generally difficult to classify because of its variability over short distances and the presence of many opportunistic species (either native or exotic) which can colonise this relatively unstable environment.
- Wet gully scrub.
  The community has strong affinities with *Pomaderris apetala-Beyeria viscosa-Asterotrichion discolor* closed forest/scrub (Kirkpatrick *et al.* 1995), or riparian blackwood/dogwood forest (Pannell 1992) when blackwood (*Acacia melanoxylon*) is a conspicuous emergent.

She-oak forest is widespread on steeper, north-facing slopes on the southern side of the gorge and also occurs on steep, rocky slopes to the northwest of First Basin. Grassy woodland and forest and native grassland both occur primarily in the areas above the Cliff Grounds, the latter being restricted to cleared and slashed areas under

Table 1. Vascular plant species occurring in predominantly native vegetation in Cataract Gorge Reserve.

Based on Shearing (1993), Ratkowsky and Ratkowsky (1994) and fieldwork in the current study. Numbers of Tasmanian endemic species are given in brackets.

Group	Native species	Exotic species	Total species
Pteridophytes	13 (0)	0	13 (0)
Gymnosperms	1 (1)	1	2 (1)
Angiosperms			
Dicotyledons	139 (8)	87	226 (8)
Monocotyledons	58 (3)	31	89 (3)
Total	211 (12)	119	330 (12)

power lines. Wet eucalypt forest and woodland is also located in the area above Cliff Grounds but on south and east facing slopes as a transition between wet gully scrub and grassy forest. Wet gully scrub is largely restricted to sheltered creeklines and gullies. Substantial areas of the wet forest and wet scrub communities have been replaced or affected by ornamental plantings. Riparian vegetation fringes the South Esk River along its length and grows in depauperate and often weed infested conditions on islands, in dry channels and on rocky outcrops (such as occur near First Basin). The structure, species composition and conservation status of the communities is outlined in Appendix 1.

Vascular species

Ratkowsky and Ratkowsky (1994) recorded 299 vascular species from predominantly native vegetation in Cataract Gorge Reserve. They consist of 188 native species which are indigenous to the area and 111 exotic species (including non-indigenous Australian natives). A further 23 native species and eight exotic species were recorded from predominantly native vegetation during the current study (Appendix 2). Ratkowsky and Ratkowsky (1994) also list 18 native species which had been recorded from Cataract Gorge in the past, but which were not located during their survey. Four of these species were recorded during the current study.

A breakdown of species in the different plant groups is given in Table 1. The majority of native species are dicotyledonous angiosperms, but monocotyledonous angiosperms are also well represented. The pteridophyte flora is depauperate, reflecting the relatively dry and exposed conditions operating over most of the area, and probably fire history.

Highest diversities of native vascular species are in grassy forests and woodlands. These vegetation types typically have high diversities of grasses, graminoids and forbs (Kirkpatrick *et al.* 1988a), with over 50 different species being commonly recorded in 1x10 m quadrats in Tasmanian grassy woodlands. These figures would not be reciprocated in Cataract Gorge Reserve, but up to 30 species in a similar sized quadrat is probable. Research in similar vegetation (e.g. Kirkpatrick 1986; Kirkpatrick *et al.* 1988a; Gilfedder 1994; Duncan, unpublished) has shown that diversity is related to the density and robustness of tussock-forming grasses. Occasional fire and/or browsing will keep the grasses in check, creating gaps which can be exploited by inter-tussock species (both native and exotic). Such species can be lost, through competition for space, light, water or nutrients, if the grasses form a closed tussock canopy in the absence of disturbance.

Lowest diversities of vascular species are in the wet gully scrub, which is associated with creeks, gullies and sheltered slopes of the gorge. This is typical of this vegetation type in relatively dry areas in lowland Tasmania. However, in the case of Cataract Gorge, this trend has probably been exacerbated by the loss of some species, including sassafras *Atherosperma moschatum* and native pepper *Tasmannia lanceolata* which have both been recorded in the past from the Cataract Gorge area. Loss of wet gully scrub species may have resulted from the narrowness of the gully corridors (with past fires or other disturbance contributing to their attrition) and clearing of this community to establish the main garden area around the restaurant. The wet gully scrub had high proportions of fern species (relative to other communities), but it is also likely that some fern species have been eliminated by past land use or fire history.

Riparian vegetation, particularly remnants surviving after establishment of gardens, lawns and infrastructure around the First Basin, contains a diverse and interesting mixture of woody species, most of which are restricted to this environment, and some of which are very localised in the reserve and have a high priority for conservation in Tasmania.

Exotic species occur in most vegetation types, their diversity and abundance in an area largely reflecting its history of ground disturbance and its proximity to sites with high concentrations of invasive exotics. It is not surprising that riparian vegetation, which suffers periodic mechanical disturbance during floods, contains several opportunistic herbaceous and woody species (e.g. willows). High concentrations of exotic species are also found in remnant native vegetation in the heavily "acclimatised" areas, adjacent to many of the suburban boundaries, and along major tracks (including the Zig Zag Track). The abundance and diversity of exotic species are low in dense wet gully scrub and dense riparian scrub, largely because the shade at ground level limits establishment opportunities for many exotics (which often have a high requirement for light). Vegetation which is fairly remote from disturbance also had relatively low numbers of exotics, with most of them being species (e.g. *Hypochoeris radicata, Aira* spp.) which are ubiquitous in native vegetation in many areas of Tasmania.

Ratkowsky and Ratkowsky (1994) found that diversity of native species within areas of bushland in the Northern Midlands is largely related to the diversity of environments present. They note that the presence of similar numbers of native species in Cataract Gorge Reserve and the much larger Trevallyn State Recreation Area underlines the richness of the flora of Cataract Gorge Reserve.

Species of conservation significance

Appendix 3 lists 22 native vascular species of Statewide conservation significance which have been recorded from Cataract Gorge Reserve. Two of the species (*Discaria pubescens, Carex cataractae*) appear to be no longer present in the area. Species of statewide significance are defined here as those listed by the Flora Advisory Committee (1994) as being rare, threatened or unreserved in secure reserves (i.e. World Heritage Area and reserves which require the approval of both Houses of the Tasmanian Parliament to be revoked). Most of the species of conservation significance occur in either grassy woodland or riparian scrub (or associated vegetation). Species with the highest priority for conservation (i.e. those that are categorised as endangered or vulnerable) mainly occur in riparian environments.

Several of the species of conservation significance have been recorded from other areas of remnant bushland in the Northern Midlands (Trevallyn State Recreation Area, Punch Bowl Reserve, Kate Reed State Recreation Area, Tom Gibson Nature Reserve, Hummocky Hills). However, Cataract Gorge Reserve has substantially more rare or threatened species than have been recorded from the other areas and over half of the species listed in Appendix 3 are absent from the adjoiningTrevallyn State Recreation Area.

MANAGEMENT OF THE VEGETATION

The most important management objectives for the vegetation are to:

- maintain the diversity of communities and species;
- maintain (or increase) populations of rare or threatened species;
- protect communities of conservation significance.

Monitoring program

A vegetation monitoring program should be implemented in Cataract Gorge Reserve to provide data on ecological processes (e.g. relationship between fire and vegetation structure and diversity) and changes in abundances and distributions of species, including exotics. Such information is important for long-term management of the vegetation. It would: allow the health and viability of the vegetation to be reviewed; allow the sustainability of land use and management practices to be assessed; and suggest directions for refinement or change.

Plant species of conservation significance

A management program for the rare or threatened species needs to be developed. Priority should initially be given to riparian habitats because of the occurrence of many species of conservation significance in this environment.

Exotic species

Exotic species comprise almost 40% of the total number of species in predominantly native vegetation in Cataract Gorge Reserve. The highest abundances and diversities of exotic species are found in: remnant vegetation within areas that have been subject to garden development (e.g. around the restaurant); adjacent to many of the suburban boundaries; associated with some roads and tracks (including the Zig Zag Track); and on sites which have had substantial ground disturbance. Some exotic species (e.g. boneseed) are capable of establishing in relatively undisturbed native vegetation (Kirkpatrick 1986).

Based on precedents in many areas of Tasmania, the abundance and diversity of exotic species will increase when private land adjacent to the reserve boundary (particularly areas along the southwestern boundary) becomes more densely settled. Provision of information to landowners and planning constraints may avoid some of the problems (e.g. dumping of garden waste; planting of invasive species) in currently settled areas. An overall weed management strategy needs to be developed for the reserve.

Fire

The distribution, structure and composition of the vegetation is due, in part, to the frequency and intensity of past fires. She-oak can gain dominance from a long absence of fire, and from low-intensity fires which have a more damaging effect on existing eucalypt seedlings than less flammable she-oak saplings (Kirkpatrick 1986; Kearon 1993). She-oak seedlings also establish more easily than eucalypt seedlings in competition with perennial grasses (Kirkpatrick 1986). Frequent fires in grassy woodlands lead to the demise of some exotic shrubs (notably boneseed) and maintained high diversities of native and exotic inter-tussock herbs (Kirkpatrick *et al.* 1988a; Gilfedder 1994). A range of fire histories in Cataract Gorge Reserve would be partly responsible for different diversities and species combinations in the more widespread vegetation types. Some areas of she-oak forest and grassy woodland should not be subjected to fuel reduction burning. This will provide a basis for comparison with fuel-reduced areas. It will also help in maintaining diversity of non-vascular species, firstly by maintaining favoured habitats (which can be damaged by fire) and secondly because non-vascular species, unlike many vascular species, lack the ability to survive fire by vegetative regeneration. Fires in native vegetation close to exotic-rich areas may facilitate establishment of exotic trees and shrubs (e.g. pines, gorse) and ground layer species. Control of exotic species may be needed on such sites.

It is likely that the intrusion of fires into more humid vegetation types has resulted in retraction of some communities (notably wet gully scrub) and the loss of some species (e.g. *Atherosperma moschatum*, *Tasmannia lanceolata*). Wet gully scrub (e.g. along Reedy Creek) should be actively protected from fire. This community has a high diversity of non-vascular species (which are generally more susceptible to fire than vascular species), and also contains fire-susceptible vascular species (e.g. epiphytic ferns). Although cool burns trickling into the scrub from adjacent vegetation will be extinguished by their moisture differential, further attrition of the wet gully scrub towards more flammable grassy vegetation will have occurred. Wet gully scrub should not be used as a burning boundary.

Liaison with neighbours

Native vegetation adjacent to suburban areas varies in condition, from dominated by exotics to little affected by suburban pressures. Burning or slashing to maintain a fuel-reduced strip behind private property is a better option than ground disturbance, which will encourage colonisation by exotic species, some of which (e.g. gorse) burn readily. Cutting of trees and shrubs for firewood and wattle grubs is occurring in the reserve adjacent to some areas (e.g. Gees Hill). Exotic species have established on some sites following dumping of rubbish and garden waste. This is usually on upper slopes of the reserve, increasing the risk of exotic species extending their distribution in the reserve by downslope movement of propagules. Some landowners have extended their gardens by planting within the reserve. It is likely that some of these species (which include non-indigenous natives such as blue gum and golden wattle) will spread further into the reserve.

Denser settlement in privately owned bushland adjacent to the southwestern boundary is likely to occur in future, leading to some adverse impacts in downslope vegetation in the reserve. Some of these impacts can be reduced, or perhaps avoided, by appropriate education and planning constraints.

ACKNOWLEDGEMENTS

Vegetation of Cataract Gorge Reserve and management issues were discussed with people or organisations with an interest in the area. They include Mary Cameron (Queen Victoria Museum), Don Defenderfer (Landcare groups), and officers of the Launceston City Council and Dept. of Environment and Land Management (DELM). Funding was provided by Launceston City Council as part of the background to the preparation of a management plan for the area. Editorial assistance by Rob Taylor is also appreciated.

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Appendix 1. Structural attributes and common or conspicuous plants in each vegetation community and the conservation status of the community.

She-oak (*Allocasuarina verticillata*) forest

Structure

Dense low forest (8-12 m) often with sparse, emergent eucalypts. Ground layer density is inversely proportional to rock and litter cover.

Native species

Trees: *Allocasuarina verticillata*, (*Eucalyptus viminalis*)
Shrubs: *Allocasuarina verticillata, Acacia dealbata, Acacia mearnsii, Dodonaea viscosa, Bursaria spinosa* (widespread); *Bedfordia salicina, Beyeria viscosa* (humid sites)
Ground: *Poa* spp., *Danthonia* spp., *Stipa* spp., *Themeda triandra, Ehrharta stipoides* (grasses); *Dianella revoluta, Lomandra longifolia, Lepidosperma laterale, Bulbine bulbosa* (graminoids); *Acaena novae-zelandiae, Dichondra repens, Oxalis perennans, Plantago varia, Drosera peltata* (forbs) and the drought-tolerant fern *Cheilanthes austrotenuifolia.*

Conservation status

Inland *Allocasuarina verticillata* low forest is classed as well reserved, but not listed from secure reserves in northern Tasmania. *Eucalyptus viminalis/Allocasuarina verticillata-Acacia mearnsii* grassy woodland is classed as poorly reserved, but has been recorded from Tom Gibson Nature Reserve in the Northern Midlands.

Grassy woodland and forest

Structure

Forest or woodland (15-22 m), with tree cover mainly 10-30% and a sparse to moderately dense shrub layer. The ground layer is dominated by grasses and graminoids and is typically dense (except on rocky sites).

Native species

Trees: *Eucalyptus amygdalina, Eucalyptus viminalis* (usually co-occurring, but dominance varies); (*Acacia dealbata, Acacia mearnsii*)
Shrubs: *Eucalyptus amygdalina, Eucalyptus viminalis, Acacia dealbata, Acacia mearnsii, Bursaria spinosa,* (*Dodonaea viscosa, Exocarpos cupressiformis, Allocasuarina verticillata*); *Bedfordia salicina, Pomaderris apetala* (humid sites)
Ground: *Poa* spp., *Danthonia* spp., *Stipa* spp., *Themeda triandra, Ehrharta stipoides* (grasses); *Lomandra longifolia, Lepidosperma* spp. (graminoids); *Acaena* spp., *Dichondra repens, Oxalis perennans, Plantago varia, Viola hederacea* (forbs) and the fern *Cheilanthes austrotenuifolia.*

Conservation status

These vegetation types are poorly reserved and have a very high priority for conservation.

Native grassland

Structure

Includes grassland and regenerating scrub, resulting from clearing of trees and slashing under powerlines. Small trees are often present at the margins of the community and on steep slopes where power lines are well suspended.

Native species

Small trees and shrubs: *Eucalyptus amygdalina, Eucalyptus viminalis, Acacia dealbata, Acacia melanoxylon, Acacia mearnsii, Allocasuarina verticillata, Bursaria spinosa, Dodonaea viscosa*

Ground: *Poa* spp., *Danthonia* spp., *Stipa* spp., *Themeda triandra, Ehrharta stipoides* (grasses); *Lomandra longifolia, Lepidosperma* spp. (graminoids); *Acaena* spp., *Dichondra repens, Oxalis perennans, Plantago varia, Viola hederacea* (forbs).

Conservation status

Similar to the pre-disturbance community.

Wet eucalypt forest and woodland

Structure

Forest or woodland (18-25 m), with tree cover mainly <20% and a moderately dense shrub layer. The ground layer is sparse, except in transitional areas with grassy woodlands or forests.

Native species

Trees: *Eucalyptus viminalis, Acacia dealbata*, (*Eucalyptus amygdalina, Acacia melanoxylon*)

Shrubs: *Eucalyptus viminalis, Acacia dealbata, Acacia melanoxylon, Bedfordia salicina, Pomaderris apetala, Bursaria spinosa*

Ground: *Poa labillardierei, Ehrharta stipoides* (grasses); *Lomandra longifolia, Lepidosperma elatius* (graminoids); *Acaena novae-zelandiae, Viola hederacea* (forbs); *Pteridium esculentum, Polystichum proliferum* (ferns).

Conservation status

The community is present in some small reserves in eastern Tasmania, but further reservation of *Eucalyptus viminalis*-dominated wet sclerophyll forest is required.

Riparian vegetation

Structure

Varies from dense low forest or scrub (5-10 m), to more open scrub on disturbed sites or adjacent to channels, to open aquatic or semi-aquatic sedgeland or herbland. The ground layer density is inversely proportional to the density of shrubs and rock cover.

Native species

Trees: (*Eucalyptus amygdalina, Eucalyptus viminalis*)
Shrubs: *Acacia mucronata, Hakea microcarpa, Leptospermum lanigerum, Micrantheum hexandrum, Calytrix tetragyna, Pomaderris apetala, Bursaria spinosa,* (*Allocasuarina verticillata, Bedfordia salicina, Banksia marginata, Melaleuca ericifolia*)
Ground: *Poa labillardierei, Danthonia* spp. (grasses); *Lepidosperma elatius, Lomandra longifolia, Juncus* spp. (graminoids); *Oxalis perennans, Gnaphalium* spp. (forbs).

Conservation status

Riparian vegetation in the reserve is variable in composition and structure, making allocation to communities difficult. Conservation status of riparian vegetation is not determined.

Wet gully scrub

Structure

Dense scrub to a height of 10 m, often overtopped by sparse emergent trees (generally associated with adjacent forests and woodlands). The ground layer is sparse. Some epiphytic and lithophytic ferns are present on the most humid sites.

Native species

Trees: *Acacia melanoxylon,* (*Acacia dealbata, Eucalyptus viminalis*)
Shrubs: *Pomaderris apetala, Beyeria viscosa* (dominant); *Coprosma quadrifida, Bursaria spinosa* (common); *Dodonaea viscosa, Bedfordia salicina, Notelaea ligustrina, Prostanthera rotundifolia* (occasional)
Ground: *Carex appressa, Lepidosperma elatius* (graminoids);*Dicksonia antarctica, Blechnum* spp., *Polystichum proliferum, Phymatosorus diversifolius, Asplenium flabellifolium, Hymenophyllum cupressiforme* (ferns)
Some species (e.g.*Atherosperma moschatum, Tasmannia lanceolata*) have probably been lost, because of fire or clearance.

Conservation status

Pomaderris apetala-Beyeria viscosa-Asterotrichion discolor closed forest/scrub is classed as poorly reserved, and riparian blackwood/dogwood forest as unreserved. Both communities have localised distributions in the state.

Appendix 2. Species found in the current survey of Cataract Gorge Reserve that were not included on the list of Ratkowsky and Ratkowsky (1993).

(I) = introduced into Tasmania; (E) = endemic to Tasmania;
Abundance rating: l = local (growing in a few places only, sometimes abundantly); r = rare, only 1–3 plants observed; o = widespread but only occasional; f = widespread and frequent; c = widespread and common.

ANGIOSPERMS: DICOTYLEDONS	Abundance
Asteraceae *Bellis perennis* (daisy) (I)	l
Brachyscome spathulata ssp. *glabra* (daisy)	r
Helichrysum scorpioides (button everlasting)	r
Lagenifera stipitata (blue bottle-daisy)	l
Leptorhynchos squamatus (scaly buttons)	o
Olearia argophylla (musk)	r
Olearia lirata (daisy bush)	r
Solenogyne dominii	l
Taraxacum officinale (dandelion) (I)	r
Caprifoliaceae *Leycesteria formosa* (Elijah's tears) (I)	r
Caryophyllaceae *Stellaria flaccida*	r
Ericaceae *Erica lusitanica* (Spanish heath) (I)	r
Mimosaceae *Acacia pycnantha* (golden wattle) (I)	r
Pittosporaceae *Pittosporum undulatum* (pittosporum) (I)	l
Proteaceae *Grevillea* sp. (grevillea) (I)	r
Ranunculaceae *Clematis microphylla* (small-leaf clematis)	l
Scrophulariaceae *Veronica calycina* (hairy speedwell)	r
Thymelaeaceae *Pimelea humilis* (common rice-flower)	o
ANGIOSPERMS: MONOCOTYLEDONS	
Cyperaceae *Carex breviculmis* (short-flowered sedge)	o
Lepidosperma inops (little sword-sedge) (E)	l
Schoenus absconditis (bog-rush)	r
Hypoxidaceae *Hypoxis glabella* (yellow star)	l
Juncaceae *Juncus pallidus* (pale rush)	r
Juncus pauciflorus (pale rush)	r
Liliaceae *Caesia calliantha* (blue grass-lily)	l
Dianella tasmanica (blueberry flax-lily)	l
Poaceae *Dichelachne rara* (plumegrass)	o
Poa mollis (tussock grass) (E)	l
Poa sieberana (tussock grass)	o

GYMNOSPERMS (CONIFERS)

Cupressaceae	*Callitris oblonga* (South Esk pine) (E)	1
Pinaceae	*Pinus radiata* (radiata pine, Montrey pine) (I)	1

Appendix 3. Vascular species of statewide conservation significance that have been recorded from Cataract Gorge Reserve.

Species	Risk Code*	Community#	Notes
Alternanthera denticulata	e u	GW	Presumed extinct in Tasmania, until located in Cataract Gorge by Ratkowsky and Ratkowsky (1994).
Bolboschoenus caldwellii	r1 u	Riparian	May be more widespread than risk code indicates.
Brunonia australis	v u	GW	Occurs in other reserves.
Caesia calliantha	r2	She-oak & GW	May be restricted to Midlands.
Callitris oblonga	V v	Riparian	Subject of ecological studies (Harris and Kirkpatrick 1991).
Carex cataractae	r2	-	Infrequently recorded endemic. May be extinct in Cataract Gorge.
Carex longebrachiata	r2	She-oak &GW	Difficult to distinguish from the better reserved *Carex iynx*.
Cynoglossum australe	r2	GW	
Discaria pubescens	R e u	-	Extinct in Cataract Gorge.
Epacris exserta	R v u	Riparian	Risk code wrong; species is reserved (but uncommon).
Gyrostemon thesioides	r2	She-oak	
Hydrocotyle callicarpa	r2	She-oak &GW	May be more widespread than risk code indicates
Juncus prismatocarpus	r2	Riparian	
Lythrum salicaria	v	Riparian	
Millotia tenuifolia	r2	She-oak & GW	May be more widespread than risk code indicates.
Persicaria decipiens	v u	Riparian	
Persicaria subsessilis	e u	Riparian	Presumed extinct in Tasmania, until located in Cataract Gorge by Ratkowsky and Ratkowsky (1994).
Poa mollis	r2	She-oak & GW	Cataract Gorge is the type locality of this species.

Prostanthera rotundifolia	v u	Riparian & Wet G	Cataract Gorge supports good populations of this species.
Ranunculus sessiliflorus	r2	She-oak & GW	May be more widespread than risk code indicates.
Velleia paradoxa	v	GW	Species favoured by disturbance.
Viola caleyana	r2	GW	

***Risk codes** are from Flora Advisory Committee (1994). Categories are as follows:

e: endangered in Tasmania); **V:** nationally vulnerable; **v:** vulnerable in Tasmania;

R:Taxa that have limited distributions nationally;

r1: Taxa that are not e or v and have a distribution in Tasmania that does not exceed a range defined by a square measuring 100 km x 100 km;

r2: Taxa that are not e or v and occur in 20 or less 10 km x 10 km Australian Map Grid Squares in Tasmania;

u: Taxa not known from any secure reserve (World Heritage Area and reserves requiring the approval of both Houses of Parliament for revocation).

***Community Codes:**

GW = grassy woodland and forest; She-oak = She-oak forest; Wet G = Wet gully scrub

The Tasmanian Naturalist (1997) **119:** 46-58.

TERRESTRIAL FAUNA OF CATARACT GORGE RESERVE, LAUNCESTON

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Abstract. A survey of the terrestrial fauna of Cataract Gorge Reserve was undertaken in August and September 1995. The invertebrate fauna is dominated by introduced species with only the more resilient native species persisting. This dominance by introduced species occurs despite the native vegetation being in reasonable condition. Such a situation has not previously been reported in Tasmania. Comparison of our results with earlier studies of molluscs indicates that some species have disappeared from the reserve, particularly from the wetter habitats. With the vertebrate fauna the large herbivores and carnivores are still present despite high levels of usage of the reserve by humans. This contrasts with bushland in close proximity to urban areas around Hobart where such species are now rare.

INTRODUCTION

Bushland remnants in urban areas, such as The Domain in Hobart, can sometimes be of high conservation significance due to their preserving ecosystems which have been depleted elsewhere (Kirkpatrick 1986). Because of their accessibility, bushland close to urban areas can also sometimes have a long history of studies of the flora and fauna present. Mt Wellington overlooking Hobart is one such example (Ratkowsky and Ratkowsky 1976; Taylor and McQuillan 1994).

Cataract Gorge is a large bushland reserve of 170 ha which is located less than one kilometre from the centre of Launceston in northern Tasmania. Some elements of the fauna of Cataract Gorge received attention from early naturalists and there have been more recent investigations. In this paper we provide details of a fauna survey we undertook in the area in 1995. We compare our results with those of earlier studies and also contrast the situation in Cataract Gorge with urban bushland in Hobart in southern Tasmania.

METHODS

Cataract Gorge Reserve consists of a narrow and deep gorge on the South Esk River with several associated gentler slopes where drainage lines run into the river. The vegetation of the reserve is described in Duncan (1997).

The fauna of the Gorge was assessed by means of (a) a review of information in the specimen catalogue of the Queen Victoria Museum and in the Tasmanian Wildlife Atlas database maintained by the Tasmanian Parks and Wildlife Service; (b) discussions with naturalists who have knowledge of the area; and (c) field work conducted to compile lists of species and assess the condition of the faunal habitats of the area.

The survey of invertebrates was undertaken by R.M. on 24 August and 5 September 1995. Snails, landhoppers, slaters, centipedes, and millipedes were collected at a range of sites in the Gorge. These five groups of terrestrial invertebrates have been extensively sampled in Tasmania, allowing the fauna of the Gorge to be placed in a realistic ecological context. The presences of a number of miscellaneous invertebrates were also recorded during the field survey.

The survey of frogs, reptiles and birds was undertaken by R.B. over three days in August 1995. Frogs were collected from the margins of the South Esk River and from damp micro-environments in terrestrial environments. Frogs were also identified from their calls, although only a limited number of species call during late winter. Reptiles were surveyed by searching under logs and rocks. Most species were relatively inactive as they were still hibernating. Birds were identified from sightings and from their calls.

Surveys of mammals were carried out by R.T. Mammal trapping was undertaken over two nights in August 1995 using Elliot traps for small mammals and cage traps for medium mammals. In the area north of the river 20 Elliot traps and one cage trap were set in undergrowth in gully scrub (Grid Reference 5090 4115) alongside the creek which runs down past the restaurant to First Basin. The Elliot traps were spaced from 10 to 20 m apart and baited with a mixture of peanut butter, rolled oats and vegetable oil, while the cage traps were baited with meat to attract carnivorous mammals. Four cage traps baited with apple and peanut butter were set in dry sclerophyll forest on the open grassy slopes above the creek line. In the area south of the river four cage traps, one of which was baited with meat, and five Elliot traps were set in a line running downhill from the car park in Denison Grove (Grid Reference 5099 4111). Observations of larger mammals were carried out over the area during the day and spotlighting was undertaken on two nights with R.B. assisting on one night. Mammals were also detected from the presence of their scats. Fifteen scats of carnivorous mammals were collected from the area and the hair contained in them identified using the techniques of Brunner and Coman (1974) and the key of Taylor (1985).

RESULTS

Invertebrates

The large area of native vegetation in the Gorge undoubtedly supports a large number of phytophagous species (insects and mites) and associated predators (insects, mites and spiders), almost all of which are native. Even the black-and-orange soldier bug, the pyrrhocorid *Dindymus versicolor*, which outbreaks in large numbers near the Rotunda, is a genuine 'local'. What is unusual about the terrestrial invertebrate fauna of the Gorge is the abundance of introduced species in litter microhabitats: leaf and twig litter, rotting wood, cavities between and under stones and organic-rich soil horizons. Introduced invertebrates dominate the larger size classes of snails, slaters and millipedes throughout the Gorge, even in areas free of introduced plants. For example, by far the most common snails in the Gorge are introduced *Oxychilus* spp., mainly *O. draparnaldi,* occurring in both dry and wet areas Wetter sites are home to the introduced slugs *Arion hortensis*, *Deroceras reticulatum* and *Limax maximus*. The introduced pill-bug *Armadillidium vulgare* is extremely abundant in the Reserve in all microhabitats. The millipede fauna of the Gorge is dominated by *Ommatoiulus moreleti* (the Portugese millipede) in dry areas and by the introduced *Brachydesmus superus*, *Cylindroiulus latestriatus* and *Ophyiulus pilosus* in wetter spots.

Native snails, slaters and millipedes are relatively hard to find in the Gorge, although like their introduced counterparts they occur in both native and exotic vegetation. Only a small number of snails (*Allocharopa legrandi*, *Pernagera officeri*, *Prolesophanta nelsonensis*, *Tasmaphena ruga*, *Thryasona diemenensis*) were collected after more than seven hours' searching. The only native slater seen was a single immature specimen (not identifiable) of a *Styloniscus* species. The native millipede tally consisted of a siphonotid species (name available but not yet published), a sphaerotheriid (*Procyliosoma* sp.), a iulomorphid (*Amastigogonus* sp.) and three polydesmidans: *Lissodesmus alisonae* and two undescribed species (well-known from collections elsewhere).

Of the above-mentioned natives, *P. officeri*, *T. ruga*, the iulomorphid and all three polydesmidans are known to occur in a wide range of habitats, and to persist in tiny bush remnants surrounded by residential developments. Equally hardy are the native scorpion *Cercophonius squama*, geoplanid flatworms and the nemertine worm *Argonemertes australiensis*, all seen in the Gorge. The native landhoppers *Keratroides vulgaris* and *K. angulosus* and the native geophilomorph centipede *Tasmanophilus* cf. *opinatus* are common not only in the Gorge but in many gardens around Tasmania.

Thus the larger litter invertebrates in the Reserve are mainly introduced species and particularly resilient natives. It is clear that this situation has arisen through the loss of locally resident native species. The snails of Cataract Gorge have been

intensively sampled over a long period of time due to interest from local naturalists, including one of the authors (K.B.), and provide evidence of this loss (Petterd 1879; Ron Kershaw pers. comm.). As noted below, of 16 land snail species recorded from Cataract Gorge, five species are still common, five are now much reduced in numbers and three are close to locally extinct, if not already so. The fate of two is unclear while the last is almost unquestionably gone. On a local scale only six species could be said to have secure populations. These are *Planilaoma luckmanii* (abundant in mossy areas), *Paralaoma caputspinulae* (common), *Thryasona diemenensis* (common), *Allocharopa legrandi* (common in places) and *Prolesophanta nelsonensis* (common in places). The following species are much reduced but surviving:
The punctid *Pasmaditta jungermanniae* was described from the Gorge in 1879 (as *Helix jungermanniae*) and re-collected there by Ron Kershaw in 1983. However, there is some doubt about the identity of this species as it may be a form of *Planiloma luckmanii*. The microhabitat for the 1983 specimens was 'moss on rock face'.
Victaphanta lampra. This species was very common all around Launceston. There is a reasonable surviving population on the north bank of the South Esk River about halfway to Duck Reach but it is now absent from other apparently suitable sites.
Tasmaphena ruga. Ron Kershaw has found this now-rare species on some of the very steep slopes above First Basin.
Cystopelta petterdi. This slug species was originally described from Cataract Hill and was still present when Ron Kershaw collected specimens for redescription in the mid-1980s. However, it hasn't been collected in recent years despite repeated searches.
Pernagera officeri. A few old records are known which are supported by specimens, the last in about the 1950s. A specimen was found during the present study in gully scrub to the north of the restaurant.

The following species may have disappeared:
Roblinella mathinnae (probably synonym of *R. curacoae*). The Gorge is the type locality. It was never very common and hasn't been collected alive since early this century, although old dead shells turn up occasionally (Bonham 1994).
Caryodes dufresnii. The last collection of this species alive was decades ago. Very old dead shells of this species are occasionally found, often deep in rockpiles and usually in what now looks like habitat which would be too dry for snails.
Helicarion cuvieri. In the last 20 years there have only been two records of this species, a shell found by Ron Kershaw near Duck Reach and a live specimen found by K. B. on the north bank near Duck Reach in 1996.

The status of the following species is unclear:
Discocharopa vigens. This species probably occurred only on the southern dry slopes where there are now no native snails left. It was apparently very rare to begin with so it is hard to say whether it has disappeared for sure. However, around Hobart

the species has disappeared from former localities under only moderate environmental pressure.

Elsothera ricei There are no definite records of this from Cataract Gorge but it was originally very common all around Launceston, and the early records don't always distinguish the Gorge from other areas.

Species formerly present and now almost certainly disappeared:

Discocharopa mimosa. Careful searches have failed to yield *D. mimosa* in the Gorge in recent years (Bonham 1995). There have been no known collections this century.

Based on intensive collecting of centipedes and millipedes in the Tamar region since 1990, seven species additional to those located during the present survey could be expected to be common in the Gorge Reserve, i.e. the centipedes *Cormocephalus westwoodi*, *Cryptops* cf. *megalopora*, and *Henicops maculatus*, and the millipedes *Australeuma jeekeli*, *Lissodesmus* n.sp. NE2, *Tasmaniosoma armatum* and *Tasmanodesmus hardyi*. All are either absent from the Reserve or are present in scattered locations in very low numbers.

It is hard to judge whether the loss of natives invertebrates predated the rise of the exotic species or is a consequence of that success. In at least two invertebrate groups, the natives apparently still have the upper hand. The most common landhopper in Launceston home gardens is *Arcitalitrus sylvaticus*, a mainland species which was only found close to the Rotunda during this survey. *Keratroides vulgaris* and *K. angulosus* seem to out-compete *A. sylvaticus* in Burnie as well, in parks containing bush remnants which act as *Keratroides* reservoirs (R. Mesibov unpublished data). The only introduced centipede found in the Gorge during this survey was an (unidentified) geophilomorph species which is likely to be competing (unsuccessfully) with the far more abundant native geophilomorph, *T.* cf. *opinatus*.

Amphibians

Two species of frogs, *Crinia signifera* and *Litoria ewingii*, have been recorded in the Gorge and both are widely distributed in the reserve. They are encountered in most habitats near both temporary and permanent water, but appear to be most abundant along the South Esk River. Two other species have been recorded from the Launceston area. *Geocrinia laevis* occurs in dry open forests and breeds in low-lying areas which are flooded by winter rains (Martin and Littlejohn 1982). *Limnodynastes tasmaniensis* occurs in a range of habitats and breeds in both temporary and permanent water bodies. There is suitable habitat in the Gorge for both these species, particularly in the grassy woodland and native grassland habitats, and hence they are likely to occur here. Neither of these two species call at the time at which the survey was undertaken.

Reptiles

The dry forest and grassy woodland, native grassland and the *Allocasuarina verticillata* forest all provide habitat for reptiles. These open habitats are very rocky and have ample basking and shelter sites. The most abundant reptiles are *Niveoscincus metallicus* and *Niveoscincus ocellatus*. These species were commonly observed basking on rocks on the southern side of the Gorge. *Egernia whitei* is also common in the dry forest. It lives in burrows usually excavated under partially embedded rocks. *Bassiana duperryi* was also observed in dry forest and grassy woodland.

A further six species have been recorded from Launceston and are likely to occur in the reserve. There is suitable habitat for all three species of Tasmania's snakes in the Gorge. *Notechis scutatis* and *Austrelaps superbus* both frequent river banks and wet areas, probably due to the abundance of frogs which form a large part of their diet (Shine 1993). *Lampropholis delicata* is the only lizard species that is likely to be encountered in damp habitats (eg gullies) where it forages within the litter layer. The blotched blue tongue *Tiliqua nigrolutea* and mountain dragon *Tympanocryptis diemensis* are likely to occur in open habitats. Suitable habitat is present in the Gorge for two additional species of reptile, the southern grass skink *Pseudemoia entrecasteauxii* and the she-oak skink *Cyclodomorphorphus casuarinae*, both of which occur in the region.

Birds

Fifty-three species of native birds are considered to regularly occur in Cataract Gorge, including eight of the eleven species endemic to Tasmania (Appendix 1). Most of the species are common and widespread in Tasmania and occur in most habitats in the Gorge. The diversity of the avifauna at Cataract Gorge is comparable to that in Mountain Park on Mt. Wellington where 55 bird species are regularly observed (Taylor and McQuillan 1994). The diversity at the Gorge is of greater significance considering the much larger area covered by the Mountain Park. There is also a greater diversity of habitats on Mt. Wellington, from dry sclerophyll foothill forests through wet forests, sub-alpine woodlands and alpine communities (Taylor and McQuillan 1994).

The dry forest and grassy woodland habitats dominated by *Eucalyptus viminalis* or *E. amygdalina* support the greatest diversity of species. This habitat is dominant in the north-east of the Gorge. The area of *Allocasuarina verticillata* forest on the southern side of the Gorge hosts fewer species than the dry forest grassy woodland, probably because of the lower abundance of eucalypts. Eucalypts provide a range of food sources for birds. A variety of invertebrates can be found on eucalypts; the leaves are fed on by a number of species and others shelter beneath the bark. Insectivorous birds forage for lerps on leaves and probe under bark for invertebrates. Nectivorous species such as the honeyeaters forage in eucalypt flowers for nectar.

The olive whistler and the Tasmanian scrubwren occur in the wet gullies in the Gorge. The brush bronzewing which also prefers closed habitats occurs in the dense riparian vegetation and is likely to be encountered in gully scrub. Riparian vegetation has a very restricted distribution in the Gorge and occurs along the banks of the South Esk River, on the island in the second basin and in a small patch on the south-west bank of the first basin. This habitat is also frequented by honeyeaters (eastern spinebill, New Holland honeyeater, crescent honeyeater) because of the presence of flowering shrubs, particularly *Callistemon pallidus*. The beautiful firetail is also likely to be encountered in this habitat. Areas of dense grass and bracken are also suitable habitat for this species. These four species have only restricted areas of habitat available within the Gorge.

A small number of water birds occur on the river. The rocky bed of the river provides little foraging habitat for waterbirds. The first basin is more suitable for waterbirds but use of this area is probably restricted by the high level of human disturbance.

Eight species of introduced birds occur in the Gorge. The peafowl and Guinea fowl do not venture far from the garden area around the restaurant. There is only one guinea fowl remaining and council staff report that the peafowl population has declined in recent years to its current population, which is estimated to be around 25 birds. The European greenfinch and house sparrow are mostly encountered in areas where exotic plants dominate. The laughing kookaburra (introduced from mainland Australia), blackbird, European goldfinch and the starling are widespread in the Gorge.

The peregrine falcon which is listed as "Requiring Monitoring" by the Vertebrate Advisory Committee (1994) breeds in the area and the Gorge forms a major part of its foraging range (J. Wiersma pers. comm.). Continued persecution of this species threatens its long term survival. There is a specimen of an Australian owlet-nightjar, listed as being held by the Queen Victoria Museum which was collected in 1965 from the Gorge area. This species inhabits dry forest and woodlands and is likely to still occur in the Gorge. The Australian owlet-nightjar is infrequently recorded in Tasmania and the status of this species is unknown (Vertebrate Advisory Committee 1994).

Mammals

Sixteen native species have been recorded from the Gorge or nearby. These are:
Bennett's wallaby *Macropus rufogriseus*. This species is abundant around grassy areas, both in native habitats (grassy woodland and forest) and the planted lawns of First Basin and around the restaurant.
Pademelon *Thylogale billardieri*. As for the Bennett's wallaby, the sites of greatest abundance for pademelons are the areas of lawn. However, the species is widely distributed through most of the Gorge.

Wombat *Vombatus ursinus.* Wombats are reported from dry forest and woodland from the northern side of the river.

Bettong *Bettongia gaimardi.* This species was trapped on the northern side of the Gorge (in grassy forest) and spotlighted on the southern side (in *Allocasuarina* forest). This species prefers areas with an open undergrowth.

Potoroo *Potorous tridactylis.* This species was trapped in grassy forest on the northern side of the Gorge. It prefers areas with a dense ground cover.

Brushtail possum *Trichosurus vulpecula.* This species is widespread in the Gorge but is particularly abundant in areas associated with lawns and ornamental plantings.

Ringtail possum *Pseudocheirus peregrinus.* Like the brushtail possum, the ringtail is widespread and most abundant around areas with ornamental plantings.

Devil *Sarcophilus harrisii.* Scats which were most likely from this species were found on walking tracks on the southern side of the Gorge.

Eastern quoll *Dasyurus viverrinus.* Scats of this species were abundant on the southern side of the Gorge. The water pipe which runs along the mid slope west of First Basin appears to be used as a pathway by quolls with scats littering the length of the pipeline.

Echidna *Tachyglossus aculeatus.* This species has been reported from drier areas both north and south of the river.

Brown bandicoot *Isoodon obesulus.* This species has been reported from around the restaurant and from adjoining areas of Trevallyn State Recreation Area. Diggings which were probably made by this species were common in *Allocasuarina* forest on the southern side of the river.

Barred bandicoot *Perameles gunnii.* This species was recorded in 1984 from nearby suburbs to the north of the Gorge. It is unlikely that it occurs in the area in any numbers.

Bats. Two species, *Nyctophilus geoffroyi* and *Vespadelus vulturnus,* have been recorded from Trevallyn. All eight species of Tasmanian bats are widespread and often co-occur (Taylor *et al.* 1987). Thus it is possible that all species could occur in the area.

Platypus *Ornithorhynchus anatinus* and water rat *Hydromys chrysogaster* are reported to occasionally occur within the upper reaches of the river towards the Duck Reach Power Station (Deeth 1991).

Other species may also be present, particularly the smaller-sized ones. The sugar glider *Petaurus breviceps* and the little pygmy possum *Cercartetus lepidus* are listed by Deeth (1991). However, to our knowledge this is not based on any known specimens or sightings. The sugar glider is unlikely to be very abundant if it does occur due to the lack of suitable habitat (forest with an undergrowth of large *Acacia dealbata* and/or *Banksia marginata*). The little pygmy possum will almost certainly occur. Surprisingly, no swamp rats *Rattus lutreolus* were trapped in the gully scrub.

Among introduced species, feral cats have been noted in nearby Trevallyn State Recreation Area. However, they are not considered to be abundant (P. Davie, pers. comm.) which is surprising given the proximity to urban areas. Rabbit was recorded in several of the scats of the carnivorous mammals, as was black rat *Rattus rattus*. Brown rats *Rattus norvegicus* have also been recorded from Trevallyn State Recreation Area and would probably occur near the restaurant.

DISCUSSION

The invertebrate community that exists in the Gorge today is a mixture of native and introduced species which may well be functioning, in terms of litter breakdown and recycling, in much the same way that an all-native fauna did in the pre-European era. The principal components of this community (the biggest contributors to larger-invertebrate biomass) are distributed throughout the Gorge. It was not the case that common natives were mostly in native vegetation and that common exotics were mostly in garden areas. Elsewhere in the Tamar region there is typically a boundary between native and exotic litter invertebrate assemblages, the boundary corresponding to the contact zone between blocks of native and exotic vegetation. The Gorge litter fauna is a hybrid one, and its species composition may even be stable under the current land management regime. This situation has not previously been noted in Tasmania.

The dominance of introduced invertebrates occurs despite the vegetation (outside of the developed areas) being in reasonable condition. A possible explanation is that native litter invertebrates became locally rare or extinct following massive disturbance in the past, such as a series of very intense fires or the extensive clearance of vegetation on the southeastern slopes of the Gorge in the mid to late 1800s. Following the disturbances, introduced litter invertebrates may have established themselves in the regrowth native vegetation. Native invertebrates which are likely to have found it hard to reinvade are those associated with the wetter habitats. Such wetter habitats are uncommon in the Launceston area and thus suitable populations may well not be available to provide immigrants, particularly as the Gorge is now surrounded by urban areas along much of its boundary. Such losses of species have been documented for remnant patches of native vegetation in extensively modified landscapes (den Boer 1990, Margules *et al.* 1994).

This hypothesis of local extinction in the wetter habitats without subsequent recolonisation may also explain the lack of captures of swamp rats from the drainage line which was trapped. This species has been captured in similar sites in many other locations. Perhaps swamp rats have also to date been unable to disperse into the area due to the isolation from other areas of suitable habitat where the species persists. It is also possible that the limited extent of the wetter habitats has mean these sites are too small to provide enough area to support a viable population.

There is some evidence from early accounts of conditions in the Gorge that support the contention that wetter habitats were once more extensive. The following excerpts from Petterd (1879), describing locations where snail species were collected from the Gorge in the late 19th century, suggest that conditions were wetter in many parts than at present:

"obtained in considerable numbers on the rocks, gregarious under masses of Jungermannia ... thick entangled masses of moss that form such a thick carpet on the rocks a short distance above the water" (p.17-8)

"nestles in masses of moss overgrowing trees and rocks" (p.19)

"in great profusion ... among mosses on the rocks around the First Basin" (p.19)

"among mosses on the branches of trees ... requires careful looking for among the thick mosses" (p.33)

"Near First Basin ... in a gully ... hiding under large stones in a thick jungle" (p.26)

Note that four of these excerpts suggest an abundance of moss. Although there is considerable moss remaining on rocks and trees in parts of the Gorge it is seldom thick, and particularly not on trees. There are two possible sites for the gully described as a "thick jungle", neither of which could be described as such today.

The occurrence of wetter habitats in the past is supported by the fact that the rainforest tree sassafras *Atherosperma moschatum* is known to have formerly occurred in the Gorge (Ratkowsky and Ratkowsky 1994). There is also visible evidence in the form of remnant vegetation that a fairly dense and expansive wet forest existed around the northern side of First Basin. There is no remaining habitat of similar quality. Only the moderately wet areas of *Pomaderris* / *Bedfordia* scrub are now present. However, even these areas are floristically depauperate (see Duncan 1997).

The wetter habitats appear to support very low remnant populations of native invertebrates. It is thus important that these wetter habitats be left alone as much as possible. This includes disturbance by fire. These wetter habitats should also not be eaten away by prescribed burning along their edges but should be allowed to expand outwards where environmental conditions permit.

The most remarkable aspect of the vertebrate fauna of the Gorge, when compared to similar bushland in close proximity to urban areas around Hobart, is the continuing presence of the larger herbivores and the carnivores. In bushland close to settled areas of Hobart Bennett's wallaby, wombat, devils and eastern quoll have all but disappeared despite their occurrence in large numbers in bushland which is continuous with these areas but more remote from intense settlement (Taylor 1994; Hird 1995; Hird and Hammer 1995). Thus the level of usage for recreational activities to date does not appear to have impacted on the fauna (apart from directly via habitat destruction in producing modified areas such as at First Basin). However, it should not be taken for granted that this situation will continue if usage were to increase or the range of activities undertaken in the Gorge change. In Germany, Schuster and Peintinger (1994) attributed a decline in the bird species of a reserve over a 26 year period to an increase in human activities, including festivals and jogging.

ACKNOWLEDGMENTS

Bob Patterson, Ralph Cooper, Peter Brown, Peter Davie, David and Ann Ratkowsky, Bob Green and Jason Wiersma provided information on the fauna of Cataract Gorge. Mammal trapping was undertaken under Permit No FA 95292 from the Parks and Wildlife Service. The Ranger at Trevallyn, Peter Davie, provided a four wheel drive vehicle to allow us to collect the traps. Staff from the Queen Victoria Museum assisted with the extraction of records from their computer database. Funding was provided by the Launceston City Council as part of the background to the preparation of a management plan for the area.

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Appendix 1. Birds sighted regularly at Cataract Gorge.

Common name	Species	Source
Great cormorant	*Phalacrocorax carbo*	AR
Pacific black ducl	*Anas superciliosa*	+
Chestnut teal	*Anas castanea*	+
Brown quail	*Coturnix ypsilophorus*	QVM
Brown goshawk	*Accipiter fasciatus*	JW
Collared sparrohawk	*Accipiter cirrhocephalus*	JW
Peregrine falcon	*Falco peregrinus*	JW
Brown falcon	*Falco berigora*	+
Indian peafowl	*Pavo cristatus*	+
Helmeted guinea fowl	*Numida. meleagris*	+
Masked lapwing	*Vanellus miles*	+
Silver gull	*Larus novaeholandiae*	AR
Feral pigeon	*Columbia livia*	AR
Spotted turtle-dove	*Stretopelia chinensis*	AR
Brush bronzewing	*Phaps elegans*	+
Sulphur-crested cockatoo	*Cacatua galerita*	+
Green rosella	*Platycercus caledonicus*	+
Pallid cuckoo	*Cuculus pallidus*	+
Fan-tailed cuckoo	*Cuculus pyrrophanus*	+
Shining bronze-cuckoo	*Chrysococcyx lucidus*	QVM
Southern boobook	*Ninox novaeseelandiae*	+
Tawny frogmouth	*Podargus strigoides*	+

Australian owlet-nightjar	*Aegotheles cristatus*	QVM
Laughing kookaburra	*Dacelo novaeguine*	+
Welcome swallow	*Hirundo neoxena*	+
Tree martin	*Cecropis nigricans*	AR
Black-faced cuckoo-shrike	*Coracina novaehollandiae*	AR
Blackbird	*Turdus merula*	+
Flame robin	*Petroica phoenica*	+
Scarlet robin	*Petroica multicolor*	+
Dusky robin	*Melanodrynas vittata*	+
Olive whistler	*Pachycephala olivacea*	+
Golden whistler	*Pachycephala pectoralis*	+
Grey shrike-thrush	*Collurincla harmonica*	+
Satin flycatcher	*Myiagra cyanoleuca*	AR
Grey fantail	*Rhipidura fuliginosa*	+
Superb blue wren	*Malurus cyaneus*	+
Tasmanian scrub-wren	*Sericornis frontalis*	+
Brown thornbill	*Acanthiza pusilla*	+
Yellow-rumped thornbill	*Acanthiza chrysorrhoa*	QVM
Yellow wattlebird	*Anthochaera paradoxa*	QVM
Black-headed honeyeater	*Melithreptus affinis*	QVM
Yellow-throated honeyeater	*Lichenostomus flavicollis*	+
Crescent honeyeater	*Phylidonyris pyrrhoptera*	+
New Holland honeyeater	*Phylidonyris novaehollandiae*	+
Eastern spinebill	*Acanthorhynchus tenuirostris*	+
Silvereye	*Zosterops lateralis*	+
European goldfinch	*Carduelis carduelis*	AR
European greenfinch	*Carduelis chloris*	AR
House sparrow	*Passer domesticus*	+
Beautiful firetail	*Emblema bella*	QVM
Spotted pardalote	*Pardalotus punctatus*	+
Striated pardalote	*Pardalotus striatus*	+
Common starling	*Sturnis vulgaris*	+
Dusky woodswallow	*Artamus cyanopterus*	AR
Grey butcherbird	*Cracticus torquatus*	AR
Australian magpie	*Gymnorhina tibicen*	AR
Black currawong	*Strepera fuliginosa*	JW
Grey currawong	*Strepera versicolor*	+
Forest raven	*Corvus tasmanica*	+

Source

AR - Ratkowsky (1993)

QVM - Queen Victoria Museum specimen

JW - Jason Wiersma

+ - This study

The Tasmanian Naturalist (1997) **119**: 59-69.

RELEASE OF CAPTIVE-BRED SUGAR GLIDERS IN SOUTHERN TASMANIA

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INTRODUCTION

The sugar glider (*Petaurus breviceps*) is a small (120g - 160g) arboreal gliding possum which is distributed across many of the forest types of eastern and southern Australia. Colonies live in tree hollows, emerging at dusk to forage for arthropods, honeydew, nectar, pollen, *Acacia* gum and *Eucalyptus* sap. Their longevity in the field can be at least 9 years (Klettenheimer, 1994). It is a highly social species and forms groups of up to 12 individuals where males as well as females establish hierarchies and father and son show cooperative behaviour (Klettenheimer *et. al.* 1997). Males bear two large scent-glands with which the dominant male marks group members and surroundings. The odours appear to be deposited to mark areas used by members of one group so as to exclude other groups. Groups use more than one nest hollow.

The Department of Zoology at the University of Tasmania started research on the sugar glider (*Petaurus breviceps*) in 1987 (Stoddart and Bradley 1991ab; Bradley and Stoddart 1992; Mallick *et.al.* 1994; Stoddart *et al.* 1994). Sugar gliders used in the research were brought in from the wild and held under reverse-daylight conditions. Due to intensive care the captive colony had produced more than 25 offspring during 1993/94 alone, so that the colony consisted of more than 60 individuals by the end of 1994. At this time the sugar glider colony was no longer required for research and had to be disbanded. Some older individuals which were at least 8 years old and individuals with shortened tails due to past injuries were given to wildlife parks. Thirty one sugar gliders, two-thirds bred in captivity, were subject to a release program in an old growth *Eucalyptus* forest with no known population of sugar gliders.

A previous program of release of captive-bred *P. breviceps* had been initiated at the Tower Hill State Game Reserve in south-western Victoria in 1979. Artificial hollows were provided for shelter, because the trees were too young to contain hollows. Surveys in 1981, 1983 and 1986 revealed that a population had probably been established at Tower Hill (Suckling and Macfarlane 1983; Suckling 1984; Suckling and Goldstraw 1989). However, no details were published about the actual release process and what arrangements had been made to prepare gliders for their future in the wild.

In the present study captive-bred and wild-born gliders were released in a habitat that assumingly contained many natural nesting sites. This abundance of nest sites could potentially reduce the re-capture of released individuals or even make a survey infeasible. Therefore feeding stations were used to attract individuals to the release area and enable behavioural observations which are otherwise difficult to obtain. The process of releasing the gliders consisted of four parts ie the pre-release, introduction, release and the monitoring phase. During the pre-release individuals were prepared for their future life eg natural food and natural day and night conditions. During the introduction phase individuals were introduced to their future territory but were still in fully enclosed and therefore protective cages. It is known that environments that are familiar because of visual, tactile, acoustic and/or olfactory cues can serve to increase the confidence of an owner. During the release phase the animals were released to their new environment but food and water were still provided.

The success of the programme was monitored over the first three months after the release and provide information on how to re-establish sugar glider populations in *Eucalyptus* forests. Considerable effort was given to preparing the individuals for their life in a new environment and to finding out if and how captive-bred and wild-born gliders behaved differently in their new environment.

METHODS

Release area

Sugar gliders rely on overmature or dead trees to provide nesting hollows and on *Acacia* understorey to find food in winter (Suckling 1984). If these old trees and/or the necessary understorey disappear through intensive logging or bush fires, the sugar gliders will disappear.

An area close to Mt. Dromedary north of Hobart was chosen as it contained suitable *Acacia* understorey for sugar gliders and enough old growth trees to provide sufficient nesting hollows. Altitude of site was about 580 m. The tall *Eucalyptus* forest was selectively logged for sawlogs in the 1950's and the remaining old growth stems were estimated to be 80 to 100 years old. The commonest tree species was *Eucalyptus obliqua* (Stringy bark) with dominants being in excess of 27 to 41 m tall. It was associated with *Eucalyptus delegatensis*. *Eucalyptus globulus* was less numerous, but reached heights of 45 m. The last fire in the area was in 1967 which promoted new growth of *Acacia* sp., prickly beauty (*Pultenaea juniperina*) and *Eucalyptus* sp. in the understorey. No logging was expected to occur in the area for the next 10 years and the release site was surrounded by other forest patches suitable for sugar gliders, which would enable the released individuals to spread further thus avoiding overpopulation. Further, despite being logged in the past and having frequent guided bush walks from an education center near by, no sugar glider had been reported from this site. An already established population would have brought disadvantages for the released animals in terms of territorial fights and competition for food and nesting hollows.

Animals and preparations prior their release

The release program involved 31 sugar gliders including five young and an additional two pouch young. Four of the 18 males and five of the 13 females were born in the wild. In early October 1994 groups where fighting occurred were separated and groups were formed of either families or 'friends' to ensure that all groups which were to be released together got along well. A friendly group structure should diminish the occurrence of possible fights during the time in the introduction cages or shortly after the release. If possible the released groups contained at least one wild-born individual. If groups remained together for even a short period of time after release captive-bred individuals might profit from the presence of experienced (wild-born) group members.

For some months prior to release food was no longer given in food bowls on the floor but on randomly chosen spots at least 1.5 m above the ground. Six weeks prior to the release date all groups were moved to an outdoor enclosure to acclimatise the animals (ie. natural climate and night/day ratio, smell and noise). Although two third of the to-be-released animals were born in captivity, they were all used to *Eucalyptus* branches and insects which live on the branches or under the bark because *Eucalyptus* branches were given to them regularly. In the pre-release enclosure *Eucalyptus* and *Acacia* branches were given to them predominantly.

Release site

Six introduction cages were established at least 100 m apart from each other at the release site. Each introduction cage was installed about 3-4 m high on a *Eucalyptus* tree (Fig. 1) at least 20 m away from the track. Three feeding stations and 4-5 wooden nesting boxes were established in a radius of 50 m around each introduction cage.

Prior to the installation of the nesting boxes each box was left in the enclosure of the group to be released, so that they could be scent-marked by the gliders. These scent-marks should enable them to detect the nesting boxes easier in an unknown environment. The scent-marked nesting boxes were then established in the future release site of each group. The wooden nesting boxes had descending roofs and were built from weather-resistant plywood and radiata pine. The diameter of the entrance hole was 5 cm. Nesting boxes and feeding stations, on platforms which could be taken off after the release, were fixed directly to the trees between 3.50 m and 5 m height.

Live traps served as feeding stations which could be left in an open, inactivated state (Mawbey 1989). These traps have been successfully used for trapping sugar glider over a period of two years (Klettenheimer, unpublished data). They were designed specifically for sugar gliders (Mawbey 1989) and maintained the trapped

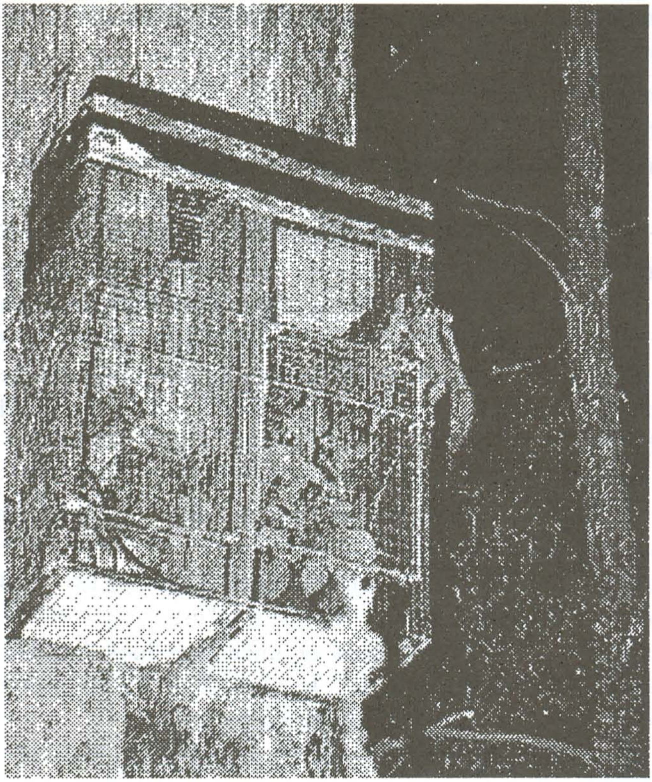

Fig. 1. Introduction cage with released sugar glider.

animals in a comfortable environment in an unstressed condition. The size of the entrance (63 mm) excluded common brushtail (*Trichosurus vulpecula*) and common ringtail possums (*Pseudocheirus peregrinus*). The bait feeder was a plastic trough which could hold 60 ml of honey. The establishment of the feeding station/traps was designed to serve several purposes. Firstly, the traps would be used to indicate the continuing presence of an individual in the area. Secondly, the feeding stations would provide the gliders with food which might be essential at the beginning of the introduction. Thirdly, it was hoped that the feeding stations would attach the animals to one particular area, where they could be observed later on.

Introduction and release phase

All sugar gliders were individually marked with numbered eartags. On the first day of the release program the sugar gliders were weighed and individually marked by gluing coloured reflective tape to their eartags. These markings should allow detection and identification of gliders during spotlighting. Individuals were then restrained in cloth bags and transported to the release area. The gliders were put into their respective introduction cage during late afternoon, so that they spent at least some hours in the nesting box and could be observed emerging at dusk later on. Two to three animals were housed in one compartment of an introduction cage, with not more than six animals per cage. The introduction cages provided shelter and food, but also familiarised the animals with their new environment.

The release phase commenced after three nights when the cage doors were opened. During the first four nights after the release the animals were closely observed by spot-lighting and the installed nesting boxes and feeding stations were checked every morning. Food and water were still provided in introduction cages while honey, and later on peanut butter, were provided in the feeding stations/traps.

After the first week nesting boxes in- and outside of the introduction cages and trap/feeding stations were checked every three days until April. One trapping session per month and four trapping sessions in March were also undertaken.

Individuals which spent the night in either the nesting boxes or feeding stations were captured and their physiological condition (ie. weight, scars, injuries and external parasite infestation such as mites or ticks) was noted. They were then put back in their sleeping place.

Spotlighting was conducted on three nights each week. Observation periods usually commenced by watching for the emergence of gliders from one of the six introduction cages or the area close by. Each introduction cage area and adjacent feeding stations were checked for glider movements. Most of the observations were made during the first three hours after the gliders left their nesting boxes or dens, depending on the duration of the batteries which in turn depended on the activity of the individuals. The behaviours of individuals were noted when they emerged from their nesting boxes and while at feeding stations.

Between the 2nd January and 30th March 1995 32 trips to the release site were undertaken. An additional five trips were made to choose the release site, establish introduction cages, artificial nesting boxes, feeding stations/traps and feeding platforms. A total of 120 hours were spent spotlighting and observing the animals at night. Six trapping sessions were undertaken to capture animals.

RESULTS

Trapping success

During 85 trapping nights a total of 16 captures of 13 individuals were obtained. The trapping success of 18.8 % was low. However, on 51 occasions released gliders used either nesting boxes or feeding stations/traps as a day shelter and could be captured by hand. Only on 11 occasions, and only in nesting boxes in the introduction cages, were individuals found to nest in pairs. The number of monitored released gliders decreased after 10 days to half, after 30 days to one-third and after 70 days to one-sixth of the original number of individuals (Fig.2).

During the first night of introduction a single resident glider was spotted close to an introduction cage. No other resident gliders were heard or seen over the next two

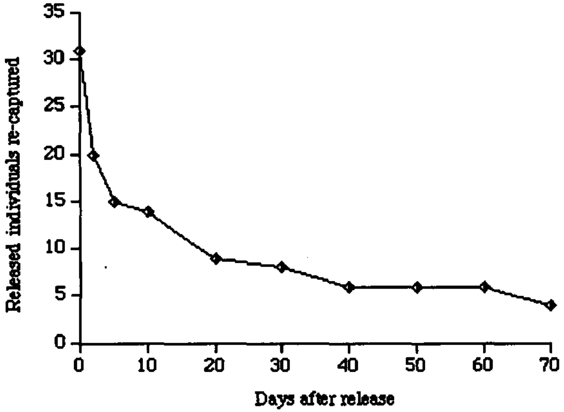

Fig. 2. Numbers of individuals recaptured as a function of time since release.

release periods despite intensive spotlighting. However, fighting screams between released gliders and others which could not be identified clearly (either other released individuals or resident gliders) could be heard high up in the canopy. At the end of February resident gliders were seen to come down to the feeding stations. In March six resident gliders were caught and measured. However, all released gliders which were caught in this period appeared to be in a good condition, no wounds as signs of fights were noticed (Fig. 3).

Physiological condition of released individuals

The weight of all released gliders dropped within the first 10 days after their release. This weight loss ranged from 6g to 35g per individual. Infestation, especially with ticks, occurred during this time and some animals showed scratches which might have resulted from unlucky landings or fights with other gliders. One glider which had just been weaned was found dead in the nesting box. However, no further seriously injured gliders were detected. One male had a severe loss of hair on his forehead and neck and because no wounds could be found infestation with mites was assumed. However, when he was captured 20 days later he was fully furred again and showed no sign of any mite infestation whatsoever.

One male was taken back into captivity two weeks after the release because he had lost more than 1/4 of his body weight, was highly infested with ticks and had a swollen cloaca. After eight days he gained all his weight again and another release attempt was made. After six days he had lost all that weight again and was taken back into captivity for good because his further survival in the field was very unlikely.

Fig. 3. Recaptured 'captive-bred' sugar glider 70 days after release.

In general it took between 14 and 40 days for the gliders to regain their release weight again. Wild-born individuals lost less weight than captive born gliders (eg one wild-born female lost only 6 g over the entire releasing period). By the end of the monitoring all captured gliders had nearly reached their weight at release which was similar to the weight of the resident gliders. All resident gliders found in this area were slightly larger (head size) and heavier (weight) than released gliders.

Behaviour of captive-bred gliders in the field

All groups spent the first days after the release close to their introduction cage. Some fights could be heard and observed between gliders from neighbouring groups. Additionally some animals were observed when chasing others more than 100 m away and it is very likely that these 'subordinate' gliders dispersed. This assumption was supported by the fact that some gliders were captured in good condition after 70 days without being monitored in the meantime at all.

All captive-bred gliders had to learn the 'two gait' pace to quickly climb up tree trunks. Some older captive-bred animals left the introduction cages by climbing down the trees to the ground. However, youngsters (< 2 years) were never observed to come down to the ground.

Gliding itself also seemed to be a learning process. When a glider fell off a tree or if it was forced into a hurried leap, it was in danger of injury from the jagged ends of dead branches jutting up from other trees. Failure to glide out of a fall exposed

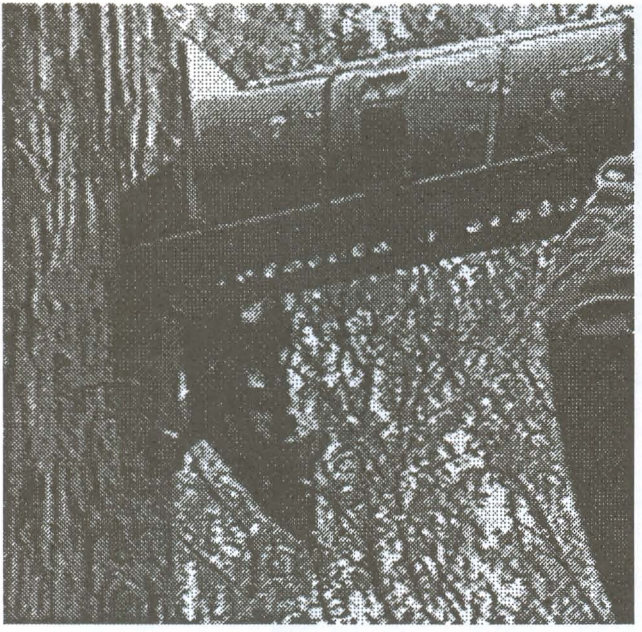

Fig. 4. Eastern Quoll *(Dasyurus viverrinus)* caught in a sugar glider trap.

the animal to the risk of being staked upon ground debris, or suffering injury through striking a hard object. Despite several falls from trees, especially on the night of release, none of the released gliders was seen or found to injure themselves. All gliders which were observed to fall down into the understorey, sometimes from greater than 20 m, were caught again and inspected but showed no injuries.

Despite the inborn reflex of spreading the patagium in case of a fall the gliders obviously had to learn how to control their glide and how to land smoothly. Because of this it is possible that some gliders fell victim to raptors during the first two nights after the release. However, by the third night after their release all gliders observed had learned to climb trees and glide, while their 'landings' became smoother. Thereafter, wild and captive-bred gliders could not be distinguished just from their behaviour. Wild-born individuals first carefully explored their new environment but did not have any difficulties in climbing or gliding although some of them had lived in captivity for more than four years. Once released they were rarely seen near the ground and spent their time high up in the canopy, only coming down to the feeding stations which they mostly approached by highly sophisticated gliding.

Competitors and dispersal

Gliders were only found in the artificial nesting boxes during the first two weeks after the release. The relatively low understorey but high trees led to the assumption that understorey and canopy represented two different habitats for gliders. Further a shortage of natural nesting hollows seemed unlikely in old growth forest and gliders were often seen to disappear under decorticating bark, in dead trees or hollows in branch stubs. Suckling (1989) found that artificial hollows were sometimes used by bees. This occurred with some of the nesting boxes and was especially prevalent for the traps as the honey they contained was highly attractive to bees. Attempts to cover the honey with peanut butter led to a different problem as eastern quolls (*Dasyurus viverinus*) were then caught in the sugar glider traps (Fig. 4). Eastern quolls were observed to climb trees up to six meters high quiet effortlessly. This could be another reason for the failure of the artificial nesting boxes to bind sugar gliders to a specific area. It is therefore suggested that artificial nesting boxes for small marsupials should be placed a minimum of 7 m above the ground in areas where quolls occur.

The occurrence of resident gliders in the release area can be seen differently. On the one hand this confirms the assumption that the habitat was suitable for sugar gliders. On the other, captive-bred gliders were certainly disadvantaged in encountering an already established sugar glider population. Even if they survived fights unharmed they would most likely be forced to leave the area to avoid territorial disputes. Gliders from captive-held groups were probably more exposed to aggression in the past (Klettenheimer 1994) than resident gliders and might therefore have more experience in aggressive encounters. However, whether this outweighed the disadvantages of living in an unknown environment is questionable. It is known that intruders loose more fights than residents as residents will fight more intensely as their territory is at risk.

DISCUSSION

Sugar gliders generally lead a very cryptic life mostly unnoticed by humans. However, it was rather unexpected to find that despite the fact that the area was regularly frequented and logged in the past nobody had ever seen a sugar glider here. Admittedly it was difficult to detect gliders even directly after the release when many were present. They could often be heard, especially during their first landing attempts, territorial fights or when calling, but most of the time they were not able to be observed. Gliders moving from one tree to another more than 30 m above the ground were especially hard to observe and often disappeared from view either due to a glide or when hiding in a hollow.

Even intensive spotlighting can fail to reveal a sugar glider population, but good results were achieved by sitting on the ground and simply listening to the characteristic sound of a landing glider, mostly followed by quick scratching and rustling noises when an individual runs up a tree scratching on the bark. These two methods should both be used before an area is presumed to be free of sugar gliders. Their cryptic life style could lead to the disappearance of the sugar glider population, due to logging or disappearance of the understorey, not being noticed at all.

Feeding platforms provided a good opportunity to observe the behaviour of resident or released gliders and gave a good idea about the residents in a particular area. At the end of the program captive-bred gliders were still present and appeared to be healthy. The ratio of captive-bred and wild-born gliders still resembled the ratio of those originally released. Captive-bred gliders appeared able to cope with their new environment and the intense preparation appeared to have been worthwhile.

The poor physical condition of the glider which was taken back into captivity suggested that if gliders were not adapted to their new environment after three weeks then their chances of surviving were rather low.

The data presented above lead to the assumption that at least some captive-bred sugar gliders will have survived at the Mt. Dromedary release site. Therefore, intense preparation of the individuals with natural food, climate and the opportunity for climbing and gliding prior to release appear to be essential for a successful release. Furthermore, individuals should be accompanied and given additional food sources for some time after the release to support their acclimatisation in the new environment. Studies on the reintroduction of zoo-born golden lion tamarins (*Leonthopithecus rosalia*), which live in a similar complex environment (Brazilian coastal rainforest), have shown that individuals have to be trained for their life in the wild, otherwise their chances of survival are rather low (Beck *et al.* 1991). This also appears to be the case for the sugar glider. The habitat of a sugar glider appears far too complex to be able to release individuals straight from captive conditions into the wild. Captive-born sugar gliders (which were held in captivity for more than two years) had particular difficulties eg they came to the ground instead of climbing up trees. Younger individuals appear to have had fewer problems familiarising themselves with their new environment.

ACKNOWLEDGEMENTS

We would like to thank Forestry Tasmania for their financial support and permission to release the sugar gliders in State forest and particularly Lynn Dean and Tom McCoy for their personal engagement. We are most grateful to Mr. R. Holmes for building introduction cages and nesting boxes and giving us a hand to establish them. Particular thanks go to Mr. R.B. Mawbey for lending us the sugar glider traps. The pictures were taken by Mario Salamon.

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BOOKREVIEW

Freshwater Algae in Australia: A guide to conspicuous genera

by Timothy Entwisle, Jason Sonneman and Simon Lewis

Published by Sainty & Associates, 1997

Softcover $36.95, Hardcover $49.95

Reviewed by Gustaaf Hallegraeff, Department of Plant Science, University of Tasmania.

The freshwater algae of Australian lakes and streams are vital indicators of the environmental health of these important aquatic ecosystems. Nutrient pollution and human interference with river flows can lead to toxic cyanobacterial (blue-green algal) blooms which affect the utility of these waters for human or animal drinking purposes. Similarly, macroscopic filamentous algae ("green slime") can choke rivers and channels resulting in aesthetic and economic damage.

Over 3000 species belonging to 120 genera have been catalogued from Australian freshwaters (Day *et al.* 1995) and hence it is fully understandable that only a small selection of organisms could be covered in "*Freshwater Algae in Australia*". In this attractively produced booklet (242 pp.), the authors who are associated with the Melbourne Botanical Gardens (Entwisle, Lewis) and Monash University (Sonneman) present over 300, mostly high-quality, colour photographs belonging to 96 genera. This is the first portrait gallery of freshwater algae from the Australian region.

It is regrettable that genera are often exemplified by a single species. Important algal divisions such as the diatoms are covered by 6 genera only (*Acanthoceras, Aulacosira, Cyclotella, Fragilaria, Gomphonema, Urosolenia*), among which the omission of common and important genera such as *Navicula* and *Nitzschia* is especially misleading. Similarly, the dinoflagellates are covered by the description of a single genus *Peridinium*, although pictorially *Ceratium* and *Gymnodinium* are also included. By contrast, filamentous members of the red, brown and blue-green algae, often poorly described in other texts on freshwater algae, are dealt with in an admirable fashion. Computer generated icons along the right and bottom margins of each photographic plate represent the gross morphology (single cells, motile, filamentous) and indicate at a glance whether the organism is macroscopic or microscopic, that is, visible by low power hand lenses or high power light microscopes. While this presentation and categorisation has its merits, the icons are too large (covering nearly 30% of the space occupied by the colour plates) thereby seriously detracting from the beauty of the micrographs. Another confusing result of such categorisation is that genera appear neither in alphabetical order nor do they cluster logically within algal groups. For example, the diatom *Cyclotella* (being a solitary plankton cell) appears on p. 39 while the diatom *Aulacosira* appears on p. 73 because it forms filaments.

Despite these shortcomings, as *"A guide to conspicuous genera"* (this subtitle appears on the title page but not the cover of the book), this is a valuable introduction to Australia's freshwater algal flora which will wet the naturalist's appetite to learn more about these fascinating microorganisms. Users of this booklet cannot escape, however, from having to consult more comprehensive taxonomic works for unambiguous identification. For water quality managers who seek to identify potentially toxic cyanobacteria the recent works by Baker (1991, 1992) are indispensable, while for Tasmanian diatoms Hodgson *et al.* (1997) and for Tasmanian dinoflagellates Ling *et al.* (1989) are highly recommended.

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BOOK REVIEW

The Ferns of Tasmania: Their Ecology and Distribution

By Michael Garrett

Published by Tasmanian Forest Research Council. Price $49.95

Reviewed by Fred Duncan

Michael Garret's book developed from a relatively modest goal - to compile an atlas of the distribution of Tasmania's pteridophyte flora. The publishers, and the forest companies that supported Michael's research and subsidised production costs, are to be congratulated for allowing Michael's labour, knowledge (and obsession) to find expression in a text that is attractive, authoritative and functional, covering so many aspects of the ecology and distribution of the 101 fern and fern allies that grace our shores.

The centrepiece of the book is the individual maps and notes on the distribution of each species. These are accompanied by superb colour photographs, which provide an excellent aid to identification. Well-written chapters also describe fern structure, life cycle, propagation and cultivation. There is a general discussion of the taxonomy, ecology, phytogeography and conservation of Tasmania's fern flora.

Appendices provide notes on Tasmanian ferns suitable for cultivation; a summary of typical substrate and habitats of each species; and a table which outlines the distribution of the species within Tasmania and the wider world beyond. The glossary is extensive, and the index well compiled.

A field key to the genera and species is well set out, and in the samples I tested was easy to use. My one criticism of the book is that some of the diagnostic features separating species could have been better illustrated, particularly as the quality of the illustration elsewhere in the book are very high. Consequently, I feel that most people will still find it useful to refer to the photographs, illustration and text in "Ferns and Allied Plants of Victoria, Tasmania and South Australia" (Duncan and Isaacs) to confirm their identifications.

There is an overwhelming feeling of "rightness" about "The Ferns of Tasmania". Perhaps it is because it is a wholly Tasmanian production. The style of writing and layout is comfortable - a credit to both the author and Jean Jarman, the editor. The dimensions of the book make it ideal for a pack or the pocket of a japara. The coated pages of the book have been sewn and perfect bound, so it won't fall apart when exposed to a wilderness experience.

In conclusion, I would recommend this book very highly. Don't be put off by the price - it will provide both good information and good value to naturalists, bushwalkers, field workers, gardeners, land managers and anyone else who has an interest in a group of plants that include some of the most distinctive, and some of the most delicate, components of our flora.